The Locomotive

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Fig. 1.— Milwaukee Boiler Explosion: General View of the Wreckage

The Milwaukee Boiler Explosion.

A fearful boiler explosion occurred at 4:20 a. m., on October 25, 1909, at the plant of the Pabst Brewing Co., Milwaukee, Wis. Owing to the early hour at which the accident occurred, the only persons in the boiler room at the time were two firemen, Frederick Stirn and Gottlieb Jehnert. Mr. Stirn was killed, and Mr. Jehnert was seriously injured. The plant was badly damaged also, as will be evident from the illustrations presented herewith.

The boiler house, which was totally wrecked, had a frontage of approximately 50 feet on Tenth street (the street seen in Fig. 2), and was 161 feet deep. A big malt elevator adjoining the boiler plant on the south, one corner of which can be seen at the extreme left of Fig. 2, was moved bodily from

FIG. 2.— GENERAL VIEW OF TENTH STREET.

its foundation by more than three feet, and the south wall of the three-story machine shop (shown in Fig. 2) was torn out. Two of the six steam drums that burst were hurled across Tenth street, landing on top of a refrigerator house some seventy feet high; and Tenth street itself was buried under tons of brick and iron débris.

The plant was insured with the Hartford Steam Boiler Inspection and Insurance Company, under a policy for $150,000, with a limit of $50,000 for any one explosion. The property loss was estimated, by the assured, to be more than $114,000; and as soon as it became apparent that the damage exceeded $50,000, the Hartford company tendered the owners of the plant a check for that sum in full. At the time of writing this article, however, the matter has not been closed.

A few weeks prior to the explosion the boilers that were destroyed were thoroughly inspected by one of the most competent and painstaking boiler experts in our organization — a man with over twenty years of continuous experience as a boiler inspector, and with previous experience as a marine engineer, under a U. S. Government license. A careful investigation made by experts after the explosion showed that the accident was not due to any cause that inspection could have detected.

Fig. 3.— Ruptured Steam Drum on the Refrigerator House Roof.

Boiler Explosions.

SEPTEMBER, 1909.

(351.) — A boiler exploded, September 1, at Flemington, near Trenton, N. J. John Schenck was seriously injured.

(352.) — On September 1 a boiler exploded at the Filer mining plant, Grove City, Pa.

(353.) — A boiler ruptured, September 2, at the plant of the Chicago Insulated Wire & Mfg. Co., Sycamore, Ill.

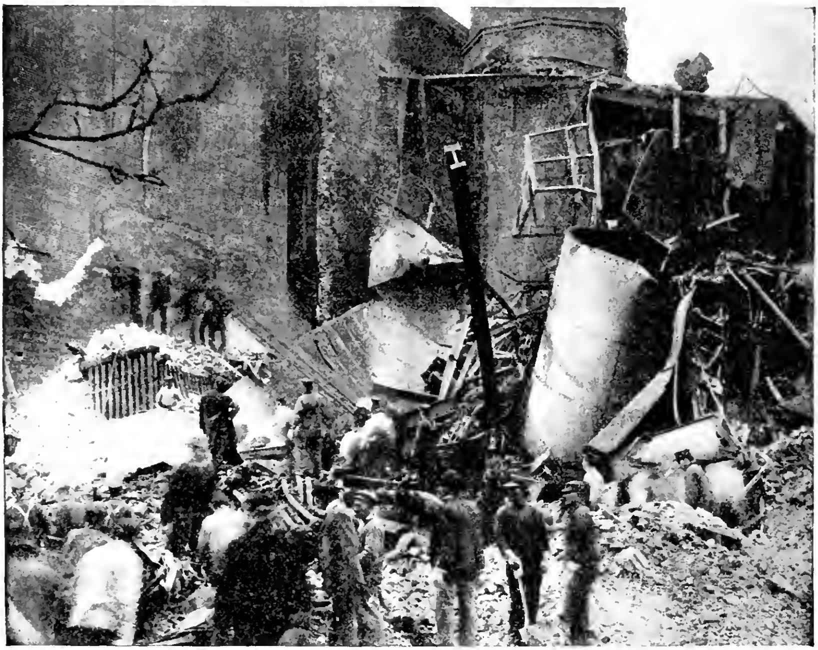

FIG. 4.— ANOTHER VIEW OF THE WRECKAGE.

(354.) — On September 2 a tank used for the storage of compressed air exploded in the boiler room of the Fort Logan military post, near Denver, Colo. Fireman Frank Becovar was seriously injured, and the property loss amounted to several thousand dollars.

(355.) — The boiler of a threshing outfit exploded, September 2, at Deloraine, Man. John R. Rogers was killed.

(356.) — A small boiler exploded, September 2, at the fair grounds, Des Moines, Iowa.

(357.) — On September 3 a boiler exploded on the tug *R. B. Little,* of the Rugge Towing Co., near the upper end of Blackwell's Island, East River, opposite New York City. John O'Donald was killed, and James Lavin and one other man were seriously injured. The explosion occurred as the result of a collision between the tug and a float.

(358.) — Four tubes burst, September 4, in a boiler at the plant of the Flint Electric Light & Power Co., Flint, Mich. James K. Grandy and Frederick McLail were injured, and it was thought that Grandy might not recover.

(359.) — A cast-iron header fractured, September 5, in a water-tube boiler at A. H. Belo & Co.'s printing plant, Dallas, Tex.

(360.) — A boiler exploded, September 6, on the steam yacht *Eulie*, at Halifax, N. S. One person was severely injured.

(361.) — On September 7 a blowoff pipe failed at the plant of the Uptegrove Cigar Box Lumber Co., Brooklyn, N. Y.

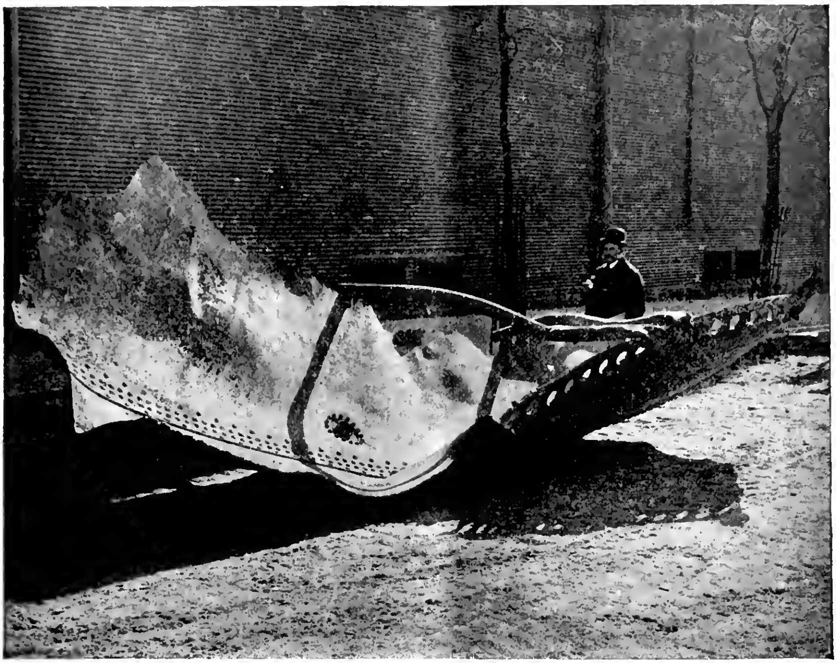

Fig. 5.— One of the Ruptured Drums.

(362.) — A tube ruptured, September 8, in a water-tube boiler at the plant of the John C. Roth Packing Co., Cincinnati, Ohio.

(363.) — The boiler of a freight locomotive exploded, September 8, at Ellensburg, Wash. One man was fatally injured, and two others were injured severely but not fatally.

(364.) — A cast-iron mud drum, attached to a water-tube boiler, exploded, September 8, in a building owned by the Corporation of Trinity Church, and located at 440-444 Canal St., New York City.

(365.) — Two tubes failed, September 9, in a water-tube boiler at the Evansville & Southern Indiana Traction Co.'s power plant, Evansville, Ind.

(366.) — A boiler exploded, September 10, in Rozelle's cotton gin, at Fullbright, fourteen miles west of Clarksville, Tex. Engineer McMillan was killed, and the owner of the plant was scalded.

(367.) — A tube ruptured, September 10, in a water-tube boiler in the plant of the Texas Refining Co., Greenville, Tex. Fireman John V. Russell was scalded.

(368.) — A tube failed, September 10, in a water-tube boiler in the Pabst Grand Circle Hotel, New York City. William Ander was slightly scalded.

(369.) — A heating boiler exploded, September 12, on Mrs. J. D. Layng's estate, at Mount Kisco, N. Y. Hugh Burch was seriously injured, and the boiler house was wrecked.

(370.) — On September 12 a tube ruptured in a water-tube boiler in the plant of the Sioux City Gas & Electric Light Co., Sioux City, Iowa. Alfred Johnson and John Tilton were injured.

(371.) — The boiler of a steam shovel belonging to David Benjamin & Co. exploded, September 13, at Buck Mountain, near Hazleton, Pa. Two men were injured very seriously, and six others were injured somewhat less severely. The shovel was demolished.

(372.) — A boiler exploded, September 13, at the Lurline baths, on Geary street, San Francisco, Calif. Richard Damme and William C. Hansen were severely injured, and one corner of the building was blown out.

(373.) — The boiler of a traction engine exploded, September 15, on William Haas's farm, near East Randolph, N. Y. H. Lee Bushnell was badly injured, and C. B. Stoughton and a man named Darling received minor injuries. The machine was demolished.

(374.) — The boiler of a threshing outfit exploded, September 15, on the Patrick O'Mera farm, ten miles southwest of Junction City, Kans. Charles Kruger was instantly killed, J. L. Waters and Joseph Smith were severely injured, and several other persons were badly bruised.

(375.) — A boiler exploded, September 16, in a sawmill at Middle Fork, on Dog Creek, Jackson county, W. Va. David and Bascom Roggess were instantly killed, and Appleton Garner was injured so badly that he died three hours later.

(376.) — A boiler exploded, September 16, near River Falls, Wis. Charles R. Ecker was killed.

(377.) — On September 17 a stop-valve ruptured on a boiler at the Pennsylvania Industrial Reformatory, Huntingdon, Pa.

(378.) — A cast-iron header ruptured, September 18, in a water-tube boiler in the plant of the American Steel & Wire Co., Waukegan, Ill.

(379.) — A tube ruptured, September 18, in a water-tube boiler in the Metropolitan West Side Electric Railway Co.'s power plant, Van Buren and Throop streets, Chicago, Ill.

(380.) — A boiler exploded, September 18, in G. M. Lanning's sawmill, several miles east of Lawrenceburg, Tenn. One man was slightly hurt.

(381.) — A slight boiler accident occurred, September 20, in the Bockstege furniture factory, Evansville, Ind.

(382.) — A tube ruptured, September 21, in a water-tube boiler at the Ingersoll-Rand Co.'s plant, Phillipsburg, N. J.

(383.) — On September 21 a boiler accident occurred at the wood working plant of the Hotchkiss Bros. Co., Torrington, Conn. The accident consisted in the rupture of a triple-riveted butt joint, through the plate at the outer row of rivets.

(384.) — On September 22 a boiler exploded in Basil Roberts's sawmill, three miles west of Crofton, Ky. Three sons of the owner, Houston, Edgar, and Charles, were badly injured.

(385.) — The boiler of a Canadian Pacific locomotive exploded, September 22, at St. Augustin, near Montreal, P. Q. Fireman Edward Edwards was instantly killed.

(386.) — A tube failed, September 23, in a boiler at the Smith ice plant, Tiffin, Ohio, killing fireman William Hooveral.

(387.) — A small boiler exploded, September 25, on the steamer *Admiral Sampson*, at San Francisco, Calif. Mack Moore was terribly scalded.

(388.) — A boiler exploded, September 26, in the milk sterilizing plant of R. F. & T. E. Osborne, Providence, R. I. Leon A. Osborne, a brother of the owners of the plant, was fatally injured, and Edward Ziegler was scalded seriously but not fatally.

(389.) — On September 28 a boiler exploded in E. E. Boone's sawmill, near Spring Lick, Grayson county, Ky. Edward Boone (a son of the owner) and Frank Westerfield were killed, and John Boone, Charles Boone, and George Boone were seriously injured.

(390.) — A boiler used for operating a steam plow exploded, September 30, at Mansfield, near Malette, S. Dak. Clarence Wilson was seriously injured.

October, 1909.

(391.) — A tube ruptured, October 1, in a water-tube boiler at the plant of the Greenville Electric Light, Heat & Power Co., Greenville, Pa.

(392.) — A tube ruptured, October 1, in a water-tube boiler at the H. C. Frick Coke Co.'s Bridgeport mine, Brownsville, Pa.

(393.) — A slight accident occurred, October 1, to a boiler in the Dahm & Kiefer Tanning Co.'s plant, Grand Rapids, Mich.

(394.) — A tube ruptured, October 1, in a water-tube boiler at the Olympia Cotton Mills, Columbia, S. C. Fireman Isaac Dixon was injured.

(395.) — On October 2 a boiler exploded at a mine on the Cox land, a mile and a half north of Joplin, Mo. E. H. Hover and Ramey Oldfield were injured badly, but not fatally.

(396.) — A tube ruptured, October 3, in a water-tube boiler at the Standard works of the H. C. Frick Coke Co., Mt. Pleasant, Pa.

(397.) — A boiler exploded, October 4, in the Poindexter sawmill, at Addison, near Gallipolis, Ohio. George Poindexter was fatally injured.

(398.) — On October 4 a boiler exploded in the Brighton flouring mill, Sacramento, Cal. The explosion wrecked one side of the building, and the destruction of the plant was then completed by fire. The total property loss was estimated at from $50,000 to $60,000.

(399.) — A tube ruptured, October 4, in a water-tube boiler at the National Ring Traveler Co.'s plant, Providence, R. I.

(400.) — An accident occurred, October 4, to the boiler of A. J. Henry & Co., Camden, N. Y.

(401.) — A boiler ruptured, October 4, in the American Granite Co.'s plant, Lohrville, Wis.

(402.) — A boiler exploded, October 5, in Arnold's feed mill, at Byron, near Owosso, Mich.

(403.) — The boiler of an Illinois Central freight locomotive exploded, October 5, at Waterloo, Iowa. Two men were fatally injured.

(404.) — On October 5 the drum of a superheater attached to a boiler ruptured at the Jeffersonville Water Supply Co.'s plant, Jeffersonville, Ind.

(405.) — A boiler belonging to the Pacific Borax Co. exploded, October 5, at San Bernardino, Cal. Two persons were fatally injured.

(406.) — A boiler exploded, October 6, in R. F. Campbell's sawmill and ginnery, three miles southeast of West, Miss. Dudley King and Otis McAfee were fatally injured.

(407.) — A boiler ruptured, October 7, at the Mammoth shaft of the H. C. Frick Coke Co., Scottdale, Pa.

(408.) — A boiler exploded, October 9, on the Rogers dredge boat, at Bishop, Ill. The owner of the boat and one fireman were seriously injured, and the property loss was estimated as over a thousand dollars.

(409.) — On October 9 a cast-iron header ruptured in a water-tube boiler in the Polar Wave Ice & Fuel Co.'s plant, St. Louis, Mo.

(410.) — A boiler exploded, October 9, in the Cincinnati, Hamilton & Dayton shops, at Fort Wayne, Ind. One man was killed.

(411.) — A tube ruptured, October 9, in a water-tube boiler at the Carnegie Steel Co.'s plant, Duquesne, Pa.

(412.) — On October 11 a boiler belonging to the Chicago, Burlington & Quincy Railroad exploded at Forest City, Ill. One man was fatally injured.

(413.) — A boiler exploded, October 12, in J. B. Hastings' cotton gin, in Fork township, near Goldsboro, N. C. Mr. Hastings was instantly killed, and Tobias V. Crocker and several other men were more or less seriously injured.

(414.) — A boiler exploded, October 12, in the pumping station at El Paso, Ill. The fireman was killed.

(415.) — A boiler exploded, October 12, at the office of the Havana Metal Wheel works, Havana, Ill.

(416.) — A boiler exploded, October 12, in the West Side power house of the Amoskeag Mills, Manchester, N. H. Joseph Lyons and Edgar B. Harrington were injured so badly that they died in the hospital a few hours later. Five other men were also injured to a lesser degree. According to the local press, the property damage amounted to some thousands of dollars.

(417.) — A boiler exploded, October 12, in the Aylmer Electric Light Co.'s plant, Aylmer, Ont. One person was killed.

(418.) — A boiler exploded, October 13, in the Turkish Bath Hotel, at Montreal, Canada. Arthur Quelette was instantly killed, and Charles Binks was seriously injured.

(419.) — The boiler of a donkey engine exploded, October 13, at the Lake Whatcom Logging Co.'s Camp 4, near Bellingham, Wash. Fireman John Larson and engineer George Beckwith were badly injured, and were conveyed to the hospital at Bellingham, where Larson died.

(420.) — On October 15 a boiler exploded at Harmon's cotton gin, at Graham, near Ardmore, Okla. Fireman William Ross was instantly killed, and three other persons were injured. The plant was destroyed by fire.

(421.) — A small boiler used for heating water exploded, October 15, in the basement of Holyoke Hall, at Massachusetts avenue and Holyoke street, Cambridge, Mass.

(422.) — A boiler ruptured, October 15, at the Glenn Lowry Manufacturing Co.'s cotton mill, Whitmire, S. C. (See also the next item.)

(423.) — A tube ruptured, October 16, in a water-tube boiler at the Glenn Lowry Manufacturing Co.'s plant, Whitmire, S. C. (See also the preceding item.)

(424.) — On October 16 an east-bound passenger train on the St. Louis & San Francisco railroad was wrecked near Tahlequah, Okla. As a result of the wreck, the boiler of the locomotive exploded, killing engineer A. P. Vance.

(425.) — On October 16 the main stop valve ruptured on a steam main in Burch & Champagne's sugar house, Glendale Plantation, Lucy P. O., La.

(426.) — A boiler belonging to the Ohio Western Lime Co. exploded, October 16, at Sugar Ridge, Ohio. One man was seriously injured.

(427.) — A boiler belonging to the Griffin Lumber Co. exploded, October 18, at Griffin, fifteen miles south of Camden, Ark. Seven persons were killed, and three others severely injured. The planing mill was demolished and several neighboring buildings were badly wrecked.

(428.) — A heating boiler exploded, October 19, in the United States Indian School at Rapid City, S. D. Adolph Russel, a pupil from the Pine Ridge reservation, was killed, and Ronald Whitefeather, another pupil from the same reservation, received injuries that were believed to be fatal.

(429.) — On October 19 a tube ruptured in a water-tube boiler at the plant of the Lehigh Portland Cement Co., Ormrod, Pa. One man was injured.

(430.) — A cast-iron header fractured, October 21, in a water-tube boiler at the plant of the St. Lawrence International Electric Railroad & Land Co., Alexandria Bay, N. Y.

(431.) — On October 22 several tubes failed in a water-tube boiler at the plant of the Shenango Furnace Co., Sharpsville, Pa.

(432.) — A boiler exploded, October 22, at the Ratz sawmill, at St. Clements, twelve miles from Berlin, Ontario, killing a well driller and seriously injuring another man. The mill was completely demolished, and the property loss was estimated at upwards of $10,000.

(433.) — On October 22 a heater exploded in the Chateau Frontenac, Quebec, Canada. Four men were more or less seriously injured.

(434.) — A boiler ruptured, October 23, in the sawmill of the E. Libby & Sons Co., Gorham, N. H.

(435.) — On October 23 a boiler ruptured in the Iroquois Creamery Co.'s plant, Iroquois, S. D.

(436.) — A heating boiler exploded, October 24, in Plamondon & Paro's dry-goods store, Quebec, P. Q. Fire followed the explosion, and the entire property loss was about $1,200.

(437.) — The boiler of a freight locomotive exploded, October 24, about a mile from Gano station, on the Big Four railroad, twenty miles north of Cincinnati, Ohio. Oscar Pease and Charles Wycoff were killed outright, and Granville Fuller was fatally injured. Two other men were also injured more or less seriously, but not fatally.

(438.) — On October 25 a terrible boiler explosion occurred in the Pabst Brewing Co.'s plant, Milwaukee, Wis. Frederick Stern was killed, and one other man was injured. The property loss was estimated at over $114,000. (See the illustrated article on this explosion, elsewhere in the present issue of The Locomotive.)

(439.) — On October 25 several cast-iron headers ruptured in a water-tube boiler in the plant of the Elyria Iron & Steel Co., Elyria, Ohio.

(440.) — A boiler exploded, October 26, at the No. 2 mine of the Chicago, Wilmington & Vermilion Coal Co., Joliet, Ill. Fireman Jerome Shenk was badly scalded.

(441.) — A boiler ruptured, October 26, in the Norwood Manufacturing Co.'s plant, Tupper Lake, N. Y.

(442.) — On October 27 a heating boiler exploded in a public school building, near Lafayette, Pa. The janitor was badly scalded.

(443.) — The boiler of a Trinity & Brazos Valley railroad freight locomotive exploded, October 27, at Pearland, Tex. Engineer M. E. Tarver, fireman W. M. Murchison, and brakeman F. Leach were seriously injured.

(444.) — A slight boiler explosion occurred, October 28, in the electric lighting plant at Red Bank, N. J. W. B. Sheppard and Joseph Valleau were injured.

(445.) — The boiler of a Grand Trunk locomotive exploded, October 29, at Montreal, Canada. One man was fatally injured, and three others received lesser injuries.

(446.) — A boiler exploded, October 29, in a sawmill on David Dawson's farm, at Rockford, near Clarksburg, W. Va. Arthur Kringle and Curtis Nutt were instantly killed, and Worthy Dawson was severely injured.

(447.) — A small boiler exploded, October 30, at Iuka, Miss. Some boys built a fire under it without authorization, and the explosion was the result. Samuel Kimberly was fatally injured, and Sidney Patterson, James Wood, and Joseph Ross were seriously scalded.

(448.) — A boiler ruptured, October 30, on C. S. Mathews' sugar plantation, Mathews, La.

(449.) — The boiler of a freight locomotive exploded, October 30, on the Coal & Coke railroad, near Yankee Dam, forty-six miles from Charleston, W. Va. Engineer John Rogers, firemen W. E. Carruthers and T. J. Finley, conductor James Riddle, and brakeman R. B. Thomas were instantly killed, and brakeman Charles Patten was seriously injured.

(450.) — The boiler of Lake Shore locomotive No. 5948 exploded, October 31, just east of Geneva, Ohio. Fireman A. E. Crawford was instantly killed, and engineer Harry Braymer was badly injured.

NOVEMBER, 1909.

(451.) — A boiler ruptured, November 1, in the pumping station of the city water works, Frederick, Okla.

(452.) — A boiler ruptured, November 1, in the plant of the Evans Marble Co., Baltimore, Md.

(453.) — A tube ruptured, November 2, in a water-tube boiler at the power station of the Columbus Railway & Light Co., Columbus, Ohio. Fireman James Gaszway was injured.

(454.) — On November 3 a boiler exploded in E. P. Catron's sawmill, at Purcell, Lee county, Va. A. J. Deaton was instantly killed, and William Carroll was seriously injured.

(455.) — On November 4 an accident occurred to a boiler in William Booth's shoddy mill, Gladwyne, Pa.

(456.) — On November 4 the mud drum of a boiler exploded in Westphal & Sons' flouring mills, Oakland, Cal. James Peterson was badly scalded, but at last accounts his condition was improving.

(457.) — A boiler explosion occurred, November 4, on the steamboat *Gloria*, at Sterling, Ill.

(458.) — A tube ruptured, November 5, in a water-tube boiler at the power plant of the Philadelphia Rapid Transit Co., Thirty-third and Market streets, Philadelphia.

(459.) — A boiler tube burst, November 5, on the United States battleship *North Dakota*, while she was on an endurance run off Cape Ann, Mass. William H. Grange, John Souden, A. Peterson, and Peter McConnell were injured.

(460.) — Several sections of a cast-iron heating boiler fractured, November 5, in an apartment building owned by Mary H. Husted, Denver, Colo.

(461.) — On November 5 a boiler exploded at Orangeburg, S. C., killing one person.

(462.) — The boiler of a freight locomotive exploded, November 6, on the New York Central railroad, at Belmont, near Hornell, N. Y. Engineer Chauncey C. Green and fireman Christopher Rider were instantly killed, and three other men were injured. The freight train was wrecked as the result of the explosion.

(463.) — A boiler exploded, November 6, in Keith & Thomas' sawmill, Algood, Tenn. Three men were injured, and the property loss was about $2,500.

(464.) — A tube ruptured, November 7, in a water-tube boiler in the plant of the Sharon Tin Plate Co., South Sharon, Pa.

(465.) — A boiler used in drilling an oil well exploded, November 7, on the S. I. Davis farm, on Big Wheeling creek, near Wheeling, W. Va.

(466.) — On November 9 a boiler exploded in Charles Creech's cotton gin, near Selma, N. C. L. S. Parrish was instantly killed, three other men were injured, and the plant was wrecked.

(467.) — A boiler exploded, November 9, at the plant of the Palatka Gas, Light & Fuel Co., Palatka, Fla. Walter Croomer and Marshall Smith were killed, and the property loss was about $3,000.

(468.) — On November 9 a boiler exploded in the brick and terra cotta plant at Carnegie, some thirty miles south of Stockton, Calif. Two persons are said to have been injured, and the plant was considerably damaged.

(469.) — On November 10 a slight boiler explosion occurred in the Samuel Mundheim Co.'s hat factory, Brooklyn, N. Y. John Wheeler and John Kurz were scalded to death.

(470.) — A small boiler exploded, November 12, in Brace, McGuire & Co.'s cleaning works, Chenango street, Buffalo, N. Y.

(471.) — A heating boiler exploded, November 12, in the basement of the building occupied by the post office, at Allegan, Mich. The damage was serious, but we have seen no estimate of its actual amount.

(472.) — A boiler belonging to the Stewart Logging Co. exploded, November 12, at Aberdeen, Wash. One man was killed.

(473.) — A tube ruptured, November 13, in a water-tube boiler in the Pillsbury-Washburn Flour Mills Co.'s Palisade Mill, Minneapolis, Minn. Fireman Edward Lafore was injured.

(474.) — A tube ruptured, November 13, in a water-tube boiler at the

Dall Lead & Zinc Co.'s plant, Meekers Grove, near Platteville, Wis. Fireman Joseph Raisbeck was injured.

(475.) — The boiler of freight locomotive No. 777 of the Seaboard Air railroad exploded, November 14, between Richmond, Va., and Petersburg. Engineer Thomas C. Ennis was seriously injured, and died within a few hours.

(476.) — Three cast-iron headers fractured, November 15, in a water-tube boiler at the Kingston Coal Co.'s plant, Kingston, Pa.

(477.) — A boiler exploded, November 15, at Storm & Corsa's paper mill, Catskill, N. Y. Five persons were more or less injured, the boiler house was demolished, and several other buildings were damaged.

(478.) — On November 16 a blowoff pipe failed in Maley & Wertz's planing mill, Evanville, Ind. Henry Strunk was scalded.

(479.) — Several tubes ruptured, November 17, in a water-tube boiler at the Havlin Hotel, operated by The Havlin Realty Co., Cincinnati, Ohio.

(480.) — A boiler exploded, November 17, at the Beaver Dam Paper Mills, near Timicula, Chester county, Pa. One end of the mill was torn out.

(481.) — The boiler of a locomotive belonging to the New York Central railroad exploded, November 17, at Buffalo, N. Y. One person was injured fatally, and two others severely, but not fatally.

(482.) — On November 18 a blowoff valve broke on a boiler at the plant of the North Shore Gas Co., Waukegan, Ill.

(483.) — The boiler of freight locomotive No. 2046, of the Chicago, Burlington & Quincy railroad exploded, November 18, at Lincoln, Neb. Fireman George Meecham was instantly killed, and engineer George Pierce and brakeman Upton were seriously injured.

(484.) — A tube ruptured, November 18, in a water-tube boiler at the plant of the Crescent Portland Cement Co., Wampum, Pa.

(485.) — The boiler of a locomotive used in connection with a construction train exploded, November 19, five miles west of New Castle, Ind. Engineer Edward Walters was instantly killed, and fireman Glessie Davison was seriously injured.

(486.) — The boiler of a locomotive exploded, November 20, on the St. Louis & San Francisco railroad, near South Greenfield, Mo. William O'Brien was injured so badly that he died on the following day.

(487.) — A tube ruptured, November 22, in a water-tube boiler at the Beach street power house of the Philadelphia Rapid Transit Co., Philadelphia, Pa.

(488.) — On November 22 a boiler exploded in E. B. Arnold's steam laundry, Aurora, Neb.

(489.) — A boiler ruptured, November 23, on the dredge *Niagara*, at Tonawanda, N. Y. Two persons were seriously injured.

(490.) — A boiler exploded, November 24, on the Hunter farm, Franklin, Pa. One person was killed, and two others severely injured.

(491.) — A boiler exploded, November 24, in a laundry at Joplin, Mo., wrecking the building. Mr. Loren Galloway, who was passing the place at the time, was seriously injured, but will recover.

(492.) — The boiler of a sawmill belonging to R. S. Nickle and Riley Thompson exploded, November 25, at Richmond Falls, near Beckley, W. Va.

(493.) — A heating boiler exploded, November 25, in the Westminster Apartments, Seattle, Wash. The property loss was estimated at $3,000.

(494.) — On November 25 a boiler exploded on McDowell's farm, near Tarboro, N. C. One person was killed, and one severely injured.

(495.) — A boiler exploded, November 27, in R. L. Owens' shingle mill, four miles west of Magnolia, Ark., killing a child, and severely burning the engineer.

(496.) — A cast-iron header fractured, November 27, in a water-tube boiler in the Fairfield Dairy Co.'s plant, Fairfield, N. J.

(497.) — A copper boiler exploded, November 27, in J. A. Wright & Co.'s silver-polish plant, Keene, N. H. The property loss was estimated at $2,000.

(498.) — A rotary boiler exploded, November 28, in R. S. Morehouse's paper mill, Bridesburg, Philadelphia, Pa. The entire first floor of the plant was wrecked.

(499.) — A header fractured, November 28, in a water-tube boiler at the Baldwin Locomotive Works, Philadelphia, Pa.

(500.) — A boiler exploded, November 29, in the Foreman-Blades Lumber Co.'s sawmill, Elizabeth City, N. C. Henry Smith and Robert Perry were injured, and the property loss was about $3,800.

(501.) — Several cast-iron headers fractured, November 29, at the Rose Hill Sugar Refining Co.'s plant, Abbeville, La.

(502.) — A boiler exploded, November 29, in the J. A. Greene stone quarry, Stone City, Iowa. One person was killed, and the property loss was estimated at $10,000.

(503.) — A heating boiler exploded, November 30, in the Central High School building, Pueblo, Colo.

(504.) — On November 30 the inner shell of a steam-jacketed drier collapsed at the rendering works of the Erie Reduction Co., Erie, Pa.

December, 1909.

(505.) — A boiler exploded, December 1, in Radcliffe Brothers' woolen mills, Shelton, Conn. One man was instantly killed, and another was injured. The property loss was estimated at from $200,000 to $250,000.

(506.) — A tube ruptured, December 1, in a water-tube boiler in the Brooklyn Rapid Transit Co.'s power house, Kent and Division avenues, Brooklyn, N. Y. George Williams and Robert Hansen were scalded seriously and probably fatally.

(507.) — A boiler exploded, December 1, in the Temple-Belton Traction Co.'s power house at Midway, near Temple, Tex. Engineer Asa Bunn was injured.

(508.) — A blowoff pipe ruptured, December 1, at the Boston Woven Hose & Rubber Co.'s plant, Cambridge, Mass. Fireman Abraham Jones was slightly injured.

(509.) — On December 1 several tubes ruptured in a water-tube boiler in the Havlin Hotel, operated by the John H. Havlin Realty Co., Cincinnati, Ohio.

(510.) — A small boiler, intended for use on a steam launch, exploded, December 3, at Hudson, Mich. Linford McQueen was badly injured.

(511.) — A tube ruptured, December 3, in a water-tube boiler at the plant of the Universal Portland Cement Co., South Chicago, Ill.

(512.) — A boiler exploded, December 4, in St. Patrick's Orphanage, Ottawa, Canada. The property loss was estimated at $3,000.

(513.) — A tube ruptured, December 4, in a water-tube boiler at the Beach street power station of the Philadelphia Rapid Transit Co., Philadelphia, Pa.

(514.) — A boiler exploded, December 6, at the Peccio coal slope just north of Brazil, Ind. Charles Durgan and Felix Nelson received injuries that were believed to be fatal. Another man was also injured seriously but not fatally.

(515.) — A boiler ruptured, December 6, at the Oconee Mills, Westminster, S. C.

(516.) — A boiler exploded, December 6, in a six story building owned by the Homestead Realty Co., and situated at 910 Broadway, Kansas City, Mo. James Foley and James Cox were killed, and four other men were injured, — one of them, it is believed, fatally. The damage to the building was estimated at $7,500. It is also said that there was a stock of drugs on the third floor, which was damaged to the extent of $40,000. It is reported that the explosion was due to simple overpressure, and that between the boiler and the safety-valve there was a stop-valve, which was found to be tightly closed, after the explosion.

(517.) — On December 6 the crown-sheet of locomotive No. 208, of the Denver & Rio Grande railroad, collapsed at a point 25 miles north of Santa Fé, N. M. Fireman Kincaid was injured.

(518.) — The boiler of a Denver & Rio Grande locomotive exploded, December 8, at Blanca, 18 miles east of Alamosa, Cal. Fireman W. B. Chase and brakeman Joseph Wetsenberger were injured, and the former died of his injuried a few hours later.

(519.) — On December 8 a number of sections fractured in a cast-iron heating boiler in the opera house owned by W. A. Maurer and W. S. Keeline, Council Bluffs, Iowa.

(520.) — The boiler of a hot-water heating plant exploded, December 8, in the residence of D. W. R. Macdonald, Washington street, St. Louis, Mo. The property loss was estimated at about $1,000.

(521.) — A boiler belonging to the Logan Gas Co. exploded, December 8, at Avon, near Lorain, Ohio. Joseph Wolf and William Cummings were seriously injured, and it was believed that the former would die.

(522.) — On December 9 a boiler exploded at the plant of the Union Phosphate Co., at Tioga, nine miles west of Gainesville, Fla. The plant was completely demolished.

(523.) — On December 9 a number of tubes failed in a water-tube boiler at the Havlin Hotel, Cincinnati, Ohio.

(524.) — A boiler used for heating water exploded, December 9, in the basement of a three-story house at 416 West Forty-second street, New York City. Mrs. Daniel O'Keefe was slightly injured. The property loss is estimated at $5,000.

(525.) — The boiler of a hot-water heating plant exploded, December 9, in the basement of John A. Bubb's residence, Williamsport, Pa.

(526.) — On December 9 an accident occurred to the boiler in the office building of Morley Bros., Saginaw, Mich.

(527.) — A hot-water boiler exploded, December 10, in the basement of McVicker's Theatre, Chicago, Ill.

(528.) — On December 10 twelve sections of a cast-iron heating boiler fractured in the Phœnix Insurance Co.'s office building, on Pearl St., Hartford, Conn.

(529.) — A cast-iron header fractured, December 10, in a water-tube boiler at the plant of the South Western Milling Co. (owned by the Standard Milling Co.), Kansas City, Kans.

(530.) — On December 10 a blowoff pipe ruptured in the plant of the Commercial Sash & Door Co., Chicago, Ill.

(531.) — A heating boiler exploded, December 12, in the Maple Hall building, Park City, Utah. Fire followed the explosion, and the total property loss (mainly from the fire) was $26,500.

(532.) — A tube ruptured, December 14, in a water-tube boiler at the plant of the West Virginia Pulp & Paper Co., Covington, Va. Lawrence Jones was killed, and Lee Loving was injured slightly.

(533.) — A boiler exploded, December 15, at the Earlington Iron Works, Earlington, Ky. William Patterson, Frank Breman, and John Cox were injured, and Patterson will die. The entire building was wrecked.

(534.) — On December 16 the boiler of locomotive No. 476, of the Chicago, Milwaukee & Puget Sound railroad, exploded at Miles City, Mont. Engineer James M. Marker, fireman Frank H. Walters, and brakeman James E. Bowman were badly injured. Walters died two days later, and at last accounts it was thought that both of the other injured men might also die.

(535.) — A hot-water heating boiler exploded, December 17, in the Great Western automobile factory, Peru, Ind.

(536.) — A boiler exploded, December 17, at the Oakville Pin factory, Oakville, Conn.

(537.) — On December 17 a boiler exploded at the Rayol plant of the Robinson Clay Product Co., three miles from New Philadelphia, Ohio. David Hines and Daniel Abraham were instantly killed.

(538.) — A vertical heating boiler exploded, December 18, in the Railroad Department of the Young Men's Christian Association, Knoxville, Tenn.

(539.) — The boiler of a Baltimore & Ohio locomotive exploded, December 18, at the foot of Clark avenue, Cleveland, Ohio. Fireman Thomas Klindel was badly injured.

(540.) — The boiler of locomotive No. 140, of the Rio Grande Western railroad, exploded, December 19, at Salt Lake City, Utah. Fireman L. M. Strick and brakeman H. B. Williamson were seriously injured.

(541.) — On December 21 five cast-iron headers fractured in a water-tube boiler at the Leamy Home for Aged Ladies, at Mt. Airy Philadelphia, Pa.

(542.) — A tube ruptured, December 21, in a water-tube boiler at the Interstate Iron & Steel Co.'s rolling mill, Cambridge, Ohio.

(543.) — On December 22 an accident occurred to a boiler in the Freiberg & Workum Co.'s distillery, Lynchburg, Ohio.

(544.) — A boiler exploded, December 23, in Hoffman Bros.' lumber yard, Reserve street, Youngstown, Ohio. The property loss was about $1,000.

(545.) — On December 23 a section fractured in a heating boiler in the Methodist church at Sullivan, Ind.

(546.) — A tube ruptured, December 24, in a water-tube boiler at the Astoria Veneer Mills, Astoria, N. Y. Fireman Frederick Campo was scalded.

(547.) — A locomotive boiler exploded, December 24, in the repair shop of the Chicago, Rock Island & Pacific railroad, at Shawnee, Okla. Robert Kerr, John Johns, and a boy whose name was not known, were killed, and thirteen others were more or less severely injured. The shop was almost totally wrecked, and the property loss was estimated at $100,000.

(548.) — A slight explosion occurred, December 25, in the boiler room of Saengerbund Hall, Schermerhorn and Smith streets, Brooklyn, N. Y.

(549.) — A tube ruptured, December 28, in a water-tube boiler at the Athens State Hospital for Insane, Athens, Ohio.

(550.) — A boiler exploded, December 29, at the new power plant (now in course of erection) of the Metropolitan Electric Co., West Reading, Pa. Elmer Dengler, Frank Cole, Matthew Lynch, Clifford Martin, and James Cooney were instantly killed.

(551.) — A heating boiler exploded, December 30, on the premises occupied by George A. Heiden, Green Bay avenue, Milwaukee, Wis. Fire followed the explosion, and the total property loss was estimated at about $18,000.

Summary of Boiler Explosions, from 1886 to 1909 Inclusive.

Year.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured
1886	185	254	314	568
1887	198	264	388	652
1888	246	331	505	836
1889	180	304	433	737
1890	226	244	351	595
1891	257	263	371	634
1892	269	298	442	740
1893	316	327	385	712
1894	362	331	472	803
1895	355	374	519	893
1896	346	382	529	911
1897	369	398	528	926
1898	383	324	577	901
1899	383	298	456	754
1900	373	268	520	788
1901	423	312	646	958
1902	391	304	529	833
1903	383	293	522	815
1904	391	220	394	614
1905	450	383	585	968
1906	431	235	467	702
1907	471	300	420	720
1908	470	281	531	812
1909	550	227	422	649

The Locomotive.

A. D. RISTEEN, PH.D., EDITOR.

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THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
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Obituary.

CHARLES B. DUDLEY.

WE note with deep regret that Mr. Charles B. Dudley, President of the International Association for Testing Materials, died, on December 21, at Philadelphia, Pennsylvania. Mr. Dudley's whole life had been devoted to the testing of materials, and to cognate studies, and it was a high compliment to him, and to the engineering profession in the United States, when the International Association elected him to its highest office. He lived barely three months to enjoy the honor conferred upon him. In a special note, issued by the Association and signed by its first vice-president and its general secretary, we find the following well-merited tribute: "For the Association itself it is indeed a most serious loss, that the work of the newly elected president should come suddenly to so abrupt a conclusion. From the moment when Mr. Dudley accepted the difficult office of president, he set to work with positively youthful ardor, to smooth all paths, so as to facilitate the future development of the Association, to make the attainment of its great aims possible, and to ensure the success of its coming Congress. As a prominent researcher, as a clear-sighted and untiring worker, and at the same time as a man both of touching goodness and of that fine simplicity which recalls the great men of American tradition — as such, the late President will continue to live in the memories of all who had the happiness of knowing him."

IN our regular list of boiler explosions for the month of April, 1909, as printed on page 231 of our last issue, we gave an account (No. 161) of the foundering of the tug *George A. Floss,* on Lake Erie, with a statement that her disappearance was accompanied by a loud noise that was believed to be due to the explosion of her boiler. We learn that the tug has since been raised, and that her boiler was found to be intact, so that it is now in use again. It is of course impossible to make the statements of today agree, in every case, with the information that comes on the morrow; and in the present instance we can only say that our original item was based upon the best information available at the time it was written.

Why is it that writers and periodicals every now and then appear to be obsessed by some devil that makes them want to print things that they steal from somebody else? This ancient query, which often occurs to the honest purveyor of printers' ink, is prompted, on the present occasion, by an article in the issue for July, 1909, of the *Practical Engineer*, of Chicago, and by a similar one in Ryerson's *Monthly Journal and Stock List* for December, 1909. The article in the *Practical Engineer* is entitled "Diagonal Riveted Joints," and it appears under the name of Mr. Norman S. Campbell. It is, in effect, an abstract of two articles that have appeared in The Locomotive, one in the issue for July, 1897, and the other in the issue for July, 1908. Credit is indeed given to the Hartford Steam Boiler Inspection and Insurance Company, for a short table occupying something like an inch of space, but otherwise we are not honored by the least mention, and the implication is, that the rest of the article is Mr. Campbell's own child. The article in Ryerson's *Journal* is condensed from the one put forth by Mr. Campbell, and gives us precisely the same notice, and no more.

The only objection that we know of, to giving credit, in this case, where credit is due, is that that might involve granting the "Hartford" a little free advertising. In a case of this kind, however, that argument appears to have little force. We did not ask either paper to print the article, and if they desired to do so on their own initiative, it would be only ordinary civility to mention the fact that they took it from us. Let us hope that with the new year they have turned over a new leaf, and that hereafter a higher standard of literary ethics will prevail in their offices.

The Diseases of Boilers.*

Boilers are heirs to nearly as many diseases as the human family. Some are crippled from birth, owing to errors in construction. The most marked and important of these congenital troubles is the one that makes itself known by the failure of the lap seam along a line which passes close to the rivet holes, but usually does not enter them, except when radiating branch cracks are present.

There were few failures from the lap joint crack when iron plate was exclusively used in the construction of boilers, and this was doubtless due to two main facts, — first, the fact that the plates then used were small, and second, the fact that steel (which is now used almost universally for boiler shells) is much more likely than iron to develop this particular defect.

Certainly the workmanship was no better in the days of iron than it is now, and in fact it was, as a rule, probably distinctly inferior; and while the pressures that were carried were less than they are today, the boilers were no better adapted, by reason of design and construction, to bear those lower pressures, than modern boilers are, to bear the higher ones that we find today.

*From an address before the New England Association of Electric Lighting Engineers, by F. S. Allen, Chief Inspector of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

A more important circumstance was, that in the use of iron it was impossible to obtain large plates. Thus boilers four feet or more in diameter were made with two plates to a course, and a boiler sixteen feet long was usually built in five courses, and never in less than four. The girth seams doubtless stiffened the plates, for in the examination of a great number of boilers that had exploded by rupture of the seams it was found that the fractures commenced midway between the girth joints. In hundreds of cases, too, the main line of fracture has developed lateral branch cracks, which have been detected by the inspector because they showed just beyond the edge of the inner lap; and then, by cutting out rivets and opening the joint longitudinal fractures have been discovered without actual explosion of the boiler. Cracks discovered in this manner are always in the center of the course. Furthermore, in destructive tests of boilers we have found the distress to begin, and failure to occur, at the middle of the course. All of these facts show the importance of the stiffening action of the girth joints upon the shell.

Passing now to the consideration of the effect of the material itself, we note, first, that iron withstood the severe treatment of whipping down the ends of the plates with sledges, — this practice having once been nearly universal in boiler shops. The only remedy for this is to provide a massive former, which, by heavy pressure, finishes the ends of the plates and brings the laps to as nearly a circular form as possible, though even with this precaution there is always some flattening at the lap.

Steel appears to resent the sledge-hammer treatment, and it is also sensitive to the slight local movements that occur near the joint, owing to variations of pressure in the boiler, and to the fact that the contour of the boiler shell is not truly circular near the joint.

These causes, singly or in combination, are very likely to cause fractures at the longitudinal joints, these being undiscoverable except by cutting the plates apart, unless branch cracks happen to radiate from the main line of fracture, and run out from the edge of the lap. Often, too, the plates are not bent in the rolls, so that they conform to each other in shape at the ends; and in this case the closing up of the joint, as the rivets are driven, causes a severe and permanent stress in the material, the effect of which is doubtless to hasten the formation of a lap joint crack.

Another defect that can be produced in riveted joints is due to neglect in adapting the pressure that is employed for closing the rivets, in hydraulic riveting (which is the best method of riveting), to the nature of the joint that is being made. The pressure that is maintained upon the accumulator should be varied according to the diameter of the rivet that is to be driven, and the thickness of the plate of which the shell is to be made.

Ruptures of plates from these causes occur with little reference to factors of safety, or to the age of the boiler. They sometimes develop within a year or two, while in other cases they do not appear until after several years of service.

Alteration of the structure of the material of the boiler, under the influence of stress and temperature, is undoubtedly the cause of failure in many cases, and evidence of the fatigue of metal, which admittedly occurs in all classes of machinery, is found in boiler plates. Fractures in the plates, away from the seams, have been found occasionally, and surface cracks, either internal or external, may develop in the shell, the plates being then brittle enough to be readily broken up with a hammer when they have been removed from the boiler. Such cracks are not so frequent, in the central or free parts of the plate, as they are near a flange or some other rigid connection, where the effect of the movement of the plate may be localized. The localization of strains in this way has been the cause of frequent failure or fracture in some types of boilers, with the result that expensive repairs have been required, and in many cases explosions have resulted.

We also find evidence of profound alteration of the structure of the material in boiler tubes, these often losing their ductility after a few years of service, even though they may have been reasonably ductile when new. Undoubtedly the skelp from which these tubes were made was of an inferior quality; and the alteration in their structure, with the resulting liability of fracture, is probably due to the temperature to which they are exposed, rather than to the pressure.

There is much difficulty in detecting alteration in the structure of a boiler tube, although there is not infrequently some unusual color to the tube, or some unusual sound given out under the hammer test, that will attract the attention of the examiner. A case which came under my own observation related to a large battery of boilers in which the tubes showed no evidence of thinning, over-heating, distortion, or sediment. They were found to have the full standard thickness required for boiler tubes of their diameter. When they were rubbed clean of soot and ash, down to the original skin of the metal, however, they showed a peculiar and unusual color, although under the file bright metal showed at once. The appearance of the tubes was so peculiar that two of them were removed for testing, with the result that they were found to have lost their ductility almost entirely. The tubes in all the boilers were subsequently removed, and all (or nearly all) were found to be brittle, often breaking when one or two blows were struck upon the chisel in cutting them off. For the sake of comparison, a tube that had been in service in another boiler in the same plant for 23 years was removed, and the physical tests that were made upon it showed that its condition was excellent. In this case, however, the tube had not been subjected to a temperature in excess of that due to 125 lbs. of steam pressure, while the boiler having the defective tubes had been operated at 160 lbs. pressure. The old tube, moreover, which was in good condition after many years of service, was made of charcoal iron, while the others, which had become brittle, were of steel.

Of late there are many defective bolts found, among those that are used for holding the tube-caps on the manifolds in some types of water-tube boilers. This is a dangerous defect, as most of these boilers are operated under high pressure, and the caps are upon the outside, so that the failure of the bolt releases the whole contents of the boiler into the fire room. This matter is so serious that it has been taken up by one of the large electric road operators, and chemical tests have been made of the various bolts in actual use, and of the bolts purchased. The number of defective bolts found during the past year was very great, while ten years ago it was the exception to find any such bolt defective. I cannot say what the result of the investigations now going on in my department, and among steam users, will develop, but from personal investigation I believe that the bolts that have been used for the past few years are of steel, and evidently they are commercially-made bolts. The ductility of many of the defective bolts is so far reduced that, though they are an inch in diameter, a blow from the light hammer used by the inspector would snap them off with a single blow. Many were also found to be cracked partially through.

With regard to these bolts I would say that the remedy, in my opinion, would be to use bolts that are forged from the very best quality of Swedish iron. These bolts are not subject to alternating or intermittent variations of stress, and hence it appears probable that the change in molecular structure that they undergo is to be ascribed to the natures of the material from which they are made, the alteration taking place as a result of the temperature to which they are exposed.

One other cause of rapid deterioration and loss of efficiency in boilers is the formation of incrustation and scale. Water-tube boilers are peculiarly sensitive to this, as their tubes are liable to become overheated, and the thin material of which they are made then becomes subject to distortion, where the relatively heavy plates of a boiler shell would remain comparatively unaffected. A great many cases of this kind occur yearly, and the rupture of the tubes is not infrequent.

Some twelve years ago several tubes ruptured in one of our best equipped and largest electric plants, and overheating of the lower tubes was noted in all the boilers. Many were quite badly affected, and others not so seriously. Some of the least affected tubes were selected, and many specimens taken from them were sent to Watertown, Mass., for test. The results were of considerable value. Test pieces were taken from different parts of the same tube, and on two tubes, specimens taken from the top of the tube, over the furnace, gave an elongation, in a length of 8 inches, of 18 and 19 per cent., respectively, the ultimate strength of the material being 57,800 and 58,000 lbs. per square inch, and the elastic limit 38,900 and 39,000. Specimens taken from the same tubes, in the rear of the bridge wall, and on the upper side where they were exposed to the descending currents of heat, but not quite at the exact topmost point, gave elongations of 16 and 17 per cent., respectively, in a length of 8 in., the corresponding tensile strengths being 55,700 lbs. and 58,000 lbs., and the elastic limits 36,300 lbs. and 38,000 lbs. These were the best tests, some of the others running somewhat lower for strips taken in similar localities. Test pieces taken from the bottom of a tube, over the furnace, but in locations selected so as to avoid distorted spots, and to secure specimens that were apparently uninjured, gave ultimate strengths running from 41,500 lbs. to 46,500 lbs. per square inch, the elastic limit in these cases ranging from 24,000 to 31,000 lbs. per square inch, and the elongation, in a length of 8 inches, from 2 to 9 per cent. Another set of tests gave results better than those just quoted, but in these cases the specimens were taken from the side of the tube, just above the center; the tensile strength running, in these instances, as high as 47,000 lbs. per square inch, and the elongation as high as 12 per cent. in a length of 8 in.

The tests made upon specimens taken from the top of the tubes in the upper part of the boiler, where there was no direct exposure to the fire, showed a total strength and a percentage of elongation that were practically the same as the corresponding results for new tubes, although the boilers had seen some two years of service. The rapid deterioration of the tubes was considered to be largely due to the feed water and to the nature of the incrustation. A change was made in the water supply, and I do not recall any trouble with tubes that has been experienced at this plant since.

The failure of tubes in water-tube boilers is not infrequent. It is sometimes due to defects in construction or in welding; but I have noted one peculiar fact, which has impressed me considerably, and that is, that except in cases in which the weld was defective, I have not noted a single case in which the failure occurred directly at the bottom of a tube. This fact may be of little interest, but it has impressed upon my mind the view that structural change in the material, leading to the failure or splitting of the tube, takes place a little towards one side of the bottom, or (say) at "about eight o'clock" in the circle of the tube.

The increase of temperature attendant upon the use of higher pressures has brought about some new developments, detrimental to boilers, in connection with the formation of scale, and this is especially true in the fire-box type of upright boilers. There is little space, in these boilers, for the deposit of scale upon the tube sheets directly over the fire, and in view of the large amount of heating surface and the normal evaporation, the formation of scale must be very rapid upon the tube sheet, especially when the feed water is at all brackish. Two marked instances are worthy of notice, the observed results seeming hardly credible. In both cases the boilers were nearly new, and were of good construction, and working under proper factors of safety. Leakage around the tubes developed quite early. In one of the cases the trouble occurred in a battery of very large boilers of this upright type, operating at a pressure of 170 lbs. per square inch; the owners in this case (as well as in the second one, presently to be noted) having a large number of boilers of the same type operating at 125 lbs. There had never been trouble from scale, although in the older boilers, operated at 125 lbs., there was a considerable deposit of mud which was readily removed by periodical washings. No trouble from leakage had been experienced from this sediment at any time, in any of the boilers of this plant, until the new high-pressure boilers were installed for electric power; and the plant was thoroughly modern and up-to-date, and everything of the best construction. An examination of the high-pressure boilers, after the leakage around the tube-ends had developed, showed a thin, hard coating of sulphate of lime over the whole tube sheet, and making a slight fillet around each tube. The coating resembled an enamel lining more than a scale, owing to its extreme thinness, and its adherence to the plate. The fact that the same water had been used in boilers in operation in this plant for over twenty years, and that no trouble had occurred from scale or deposit, made it difficult to persuade the engineer that the leakage was due to the feed water, and to scale formation; but by the judicious use of solvents the enamel-like coating was finally dissolved, and no leakage has occurred since, solvents being now used to prevent further deposition of scale. The second case was similar to the first, but the plant was many miles away, and used an entirely different water. Nevertheless, the same kind of action took place in the boilers that were operated at 160 lbs., although boilers in the same room had been operated on the same water, with entire success, for twelve years, at 125 lbs. This second case also yielded to treatment, and the affected boilers have since been running at their maximum capacity without leakage or trouble of any kind.

By way of explanation we may assume that the difference between the temperature due to 125 lbs. pressure, and that due to 160 lbs., was sufficient to cause the precipitation, in each case, of a small quantity of sulphate of lime, which, at the lower temperature, had remained either in solution, or in suspension with the mud that had been washed out so readily.

The importance of eliminating all lubricating oils from boilers is almost too well known to be worthy of mention, yet oil continues to be a great source of injury and destruction, where the water of condensation is recovered from the exhaust steam, and used over again in the boilers. Separators are put in, having a nominal capacity based upon the area of the exhaust pipes, without reference to the volume of steam that these exhaust pipes are to carry. This is a grave error, in many cases. Separators have capacity, as well as other machinery; and in installing an oil separator, care should be taken to ensure for it a capacity sufficient to handle the full volume of steam passing through it.

There also seems to be much difficulty experienced in removing oil from boilers, when it has once effected an entrance. This can be done readily, in some types of boilers, by swabbing the sheets and tubes with a mop dipped in kerosene oil, after taking the highly important precaution of *extinguishing all open lights* about the boiler, as a measure of safety. In other cases, where the boilers are inaccessible for mopping, they can be boiled out with a strong solution of soda ash (or caustic soda if the soda ash does not prove effective), with a generous addition of kerosene oil, the pressure being maintained at half or two-thirds of the regular working pressure for from twelve to twenty hours. After this treatment the oil can usually be washed out in the form of a curd. (With respect to the treatment of boilers for scale troubles, see The Locomotive for October, 1908.)

Corrosion, another boiler disease, is not so common today as formerly, but it still is an active enemy of steam boilers. I say it is less common than it was formerly, because a great change has been made, in the last few years, in the types of boiler in general use, and those that are at present most common are less liable to corrosive action than were the drop flue, hammer head, and similar types having a poor circulation at the bottom. We still have with us some types in which there is a tendency to corrosion, and no universal remedy can be relied upon. Instead, each case must be carefully investigated, and a remedy applied that is appropriate to the cause of the difficulty. Where the water is pure and the boilers are operated intermittently, corrosion is frequently found in the form of pitting. This action takes place very often in pumping stations, and in power plants and electric stations where the fires are kept banked for long periods, with the water in the boilers quiescent, and far less often in boilers that are always in active service. Boilers that are used exclusively for heating purposes suffer more than any others from pitting.

Once started, corrosion is likely to go on until the material of the boiler is destroyed, unless measures are taken to check it. When corrosion is observed in connection with the use of a pure water, one of the best methods of treatment is to keep the water alkaline with soda ash, for this tends to check the corrosive action, and the soda does not injure the boiler.

Care should be exercised, in selecting feed water for a new plant, or for a new location of a plant, to see that the quality of the water is good. Nitrates in the water should be especially avoided, as they are especially troublesome and dangerous. The presence of nitrates commonly results in the formation of a light scale coating, under which an active destruction of the material of the boiler goes on, the plates and tubes becoming wasted away, and the braces and rivet heads cut off.

In certain types of boilers the breakage of staybolts is a frequent and annoying, as well as expensive, occurrence. Such bolts are often drilled with a 3/16 in. hole, which either passes through the entire length of the bolt, or at least goes in deeper than the thickness of the outside sheet; and such holes are supposed to give absolute safety, so far as the detection of broken bolts is concerned, the theory being that steam will escape from the end of the bolt as soon as fracture has occurred, and thereby call attention to the trouble. The drilled hole is not to be relied upon, however, because, in the process by which the staybolt fails, the fracture will creep into the bolt slowly, and when it first encounters the hole, moisture from the boiler will leak out through it in very slight quantities, and evaporate without attracting any attention. In evaporating, however, the moisture leaves behind it a certain amount of solid matter, and this accumulates until it forms a hard, baked residue, completely choking the opening in the center of the bolt, so that the apparent absence of leakage leads to a sense of security which is far from corresponding to the actual facts. Many bolts that have been drilled, for the purpose of providing security against undiscovered fracture, have been found to be completely broken off, and many others have been found to be partially broken, without any noticeable leakage occurring in either case. It will be plain, therefore, that if any reliance is to be placed upon the drilled staybolt, it is important to ream out the holes frequently, and keep the openings free. The breakage of staybolts is sometimes due to circumstances connected with the environment of the boilers, to their exposure to injury from external causes, to strains from varying temperature and differential expansion, and to faulty construction or poor material in the bolt.

Many of the minor diseases of boilers, such as rapid loss of ductility, and development of incipient fractures at different parts (as at the girth joints in the plain tubular boiler), may be due to the conditions under which the boilers are operated, such as to the varying level of the water, and to the introduction of cold feed water, or to blowing down the boilers under high pressure and leaving the drafts on, so that cold air may be drawn through and so give rise to serious unequal contraction, or to pushing the fires too hard in raising steam from cold water. Severe strains, resulting in leakage at the seams and around the staybolts and tube ends of fire-box boilers, are frequently caused by the burning out of the fire under one boiler of a battery, while this boiler is left connected with the rest of the battery, and with the draft full on. All these defects are developed by poor practice or management.

Just a word, in conclusion, about the action of superheated steam. When superheating is done in connection with steam generators, the elasticity and strength of the material are affected if a high temperature is produced, and I look forward with considerable anxiety to the results that may follow when boilers are operated in this way for a term of years. It has been brought to your knowledge, I believe, or to the knowledge of similar bodies, and it has come under my own observation, that cast-iron is an unsuitable material to use, for exposure to superheated steam of high temperature. I have in mind some extra heavy valves of the best make, with cast-iron bodies, which, when exposed to superheated steam at high temperature, became badly checked and marked, so that the whole body of the casting had an appearance suggestive of the crazy cracking observed on imperfect crockery. These valves were replaced by others in which soft steel castings of the best quality were used in the place of the cast-iron, and the new ones have thus far, I believe, shown no defects. Fittings or manifolds of cast-iron, connecting superheaters with the generator, should not be endorsed or approved for superheating to 100 degrees or over. In fact, I think that cast-iron for such purposes has already been abandoned in the best practice, forged or wrought iron being substituted for it.

Boiler Explosions During 1909.

We present, herewith, our usual annual summary of boiler explosions, giving a tabulated statement of the number of explosions that have occurred within the territory of the United States (and in adjacent parts of Canada and Mexico) during the year 1909, together with the number of persons killed and injured by them. As we have repeatedly explained, it is difficult to make out accurate lists of boiler explosions, because the accounts that we receive are not always satisfactory; but we have taken great pains to make the present summary as nearly correct as possible. It is based upon the brief accounts that we have published in our regular lists, in The Locomotive, during the past year. In making out those lists it is our custom to obtain several different accounts of each explosion, whenever this is practicable, and then to compare these accounts diligently, in order that the general facts may be stated with a considerable degree of accuracy. We have striven to include all the explosions that have occurred during 1909, but it is quite unlikely that we have been entirely successful in this respect, for many accidents have doubtless occurred that have not been noticed in the public press, and many have doubtless escaped the attention of our numerous representatives who furnish the accounts. We are confident, however, that most of the boiler explosions that have attracted any considerable amount of notice are here represented.

The total number of boiler explosions in 1909, according to the best information we have been able to obtain, was 550, which is the greatest number we have ever had occasion to report in any one year. There were 470 in 1908, 471 in 1907, 431 in 1906, and 450 in 1905. But while the number of explosions was greater this past year than ever before, we note, with pleasure, that the number of deaths was less than it has been for any year since 1904.

The number of persons killed by boiler explosions in 1909 was 227, against 281 in 1908, 300 in 1907, 235 in 1906, 383 in 1905, and 220 in 1904; and the number of persons injured (but not killed) in 1909 was 422, against 531 in

1908, 420 in 1907, 467 in 1906, 585 in 1905, and 394 in 1904.

The average number of persons killed, per explosion, during 1909, was 0.413, and the average number of persons injured (but not killed), per explosion, was 0.767. The average number of persons that were *either* killed or injured, per explosion, was therefore 1.180.

The statistics herein given for the year 1909, taken in connection with those given in THE LOCOMOTIVE for January, 1909, show that for the period included between October 1, 1867, and January 1, 1910, we recorded 10,601 boiler explosions, these being attended by the deaths of 11,111 persons, and by the more or less serious injury of 16,056 others.

It will be noted that the table gives the number of explosions in April, 1909, as 35, whereas the number actually reported for that month, in our list as printed in the issue for October last, was 36. The change is made because, as noted elsewhere in the present number, we have learned that item No. 161, in the October issue, should have been excluded from the list.

During the year 1909 there were many very serious explosions, but we are glad to be able to record that there was none in which the loss of life approached the appalling total that characterized the great explosion at Brockton, Mass., in 1905, or the one on the U. S. gunboat *Bennington,* in the same year. The worst boiler explosion of 1909, so far as loss of life and injury to person is concerned, was the one that occurred in Denver, Colo., on June 15. By this explosion six persons were killed, and six others were more or less seriously injured.

SUMMARY OF BOILER EXPLOSIONS FOR 1909.

MONTH.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January,	61	14	39	53
February,	59	11	37	48
March,	37	16	24	40
April,	35	13	17	30
May,	40	21	32	53
June,	38	18	32	50
July,	40	11	19	30
August,	39	25	58	83
September,	40	14	42	56
October,	60	42	48	90
November,	54	19	40	59
December,	47	23	34	57
Totals,	550	227	422	649

The total loss of property from boiler explosions, during the year, was very large, although we have no complete figures relating to it. In the Denver explosion, just cited, the immediate damage to property was estimated at $60,000, and the total loss, including damage to wire service and equipment, and through failure to supply power in accordance with contracts, was said to be $200,000. In the explosion at the plant of the Pabst Brewing Co., Milwaukee, Wis., on October 25, the property damage was estimated by the owners to be in excess of $114,000; and we are credibly informed that the explosion at the plant of Radcliffe Bros., of Shelton, Conn., on December 1, damaged property to the amount of $250,000. The total value of the property destroyed by these three explosions alone was thus estimated to be $564,000. Other very disastrous explosions of the year might be included, if our purpose were merely to make as impressive an exhibit as possible. Thus on December 24 a locomotive boiler exploded at Shawnee, Okla., causing a property loss reputed to equal or exceed $100,000; but we have not included this large sum with the three that are mentioned above, because we are not equally well informed as to the accuracy of the estimate.

A Terrible Explosion in Iowa.

The following clipping from the St. Louis *Post-Dispatch* of January 4 is forwarded to us by Mr. Victor Hugo, Manager of our St. Louis department, with a request that we submit, for his guidance, some ruling as to the size of safety-valve that a duck should have, in order that it may be acceptable to us as a risk, provided inspection shows it to be in good condition in other respects, and free from all discoverable defects.

Duck Eats Yeast, Explodes, and Puts Man's Eye Out.

RHADAMANTHUS WAS PRIZE-WINNER'S NAME, BEFORE HE BLEW TO PIECES.

DES MOINES, IOWA, January 4. — The strangest accident recorded in local history occurred when Rhadamanthus, a duck, which had taken prizes at the recent Iowa poultry show, exploded into several hundred pieces, one of which struck Silas Perkins in the eye, destroying the sight.

The cause of Rhadamanthus' untimely explosion was a pan of yeast. This, standing upon Perkins' back porch, tempted the duck, which gobbled it all up.

Upon returning from church, Perkins discovered his prize duck in a logy condition. Taletale marks around the pan of yeast gave him a clew to the trouble.

He was about to pick up the bird when it exploded with a loud report and Perkins ran into the house, holding both hands over one eye. A surgeon was called, and it was found that the eyeball had been penetrated by a fragment of flying duck. He gave no hope that the sight could be saved.

[We don't believe the yeast had a thing to do with the explosion. The accident was plainly due to the presence, somewhere in the duck, of a concealed quack. — *Editor* THE LOCOMOTIVE.]

Summary of Inspectors' Reports for the Year 1909.

During the year 1909 the inspectors of the Hartford Steam Boiler Inspection and Insurance Company made 174,872 visits of inspection, examined 342,136 boilers, inspected 136,682 boilers both internally and externally, subjected 12,563 to hydrostatic pressure, and found 642 unsafe for further use. The whole number of defects reported was 169,356, of which 16,385 were considered dangerous. The usual classification by defects is given below, and a summary by months is given on page 29.

SUMMARY, BY DEFECTS, FOR THE YEAR 1909.

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	20,644	1,235
Cases of incrustation and scale,	41,451	1,251
Cases of internal grooving,	3,188	256
Cases of internal corrosion,	14,086	576
Cases of external corrosion,	9,782	706
Defective braces and stays,	2,947	534
Settings defective,	5,371	639
Furnaces out of shape,	7,264	298
Fractured plates,	3,278	520
Burned plates,	4,887	368
Laminated plates,	663	38
Cases of defective riveting,	3,584	770
Defective heads,	1,469	204
Cases of leakage around tubes,	13,423	2,039
Cases of defective tubes,	9,523	2,205
Tubes too light,	3,045	495
Leakage at joints,	5,184	340
Water-gages defective,	2,942	670
Blow-offs defective,	4,137	1,234
Cases of deficiency of water,	307	76
Safety-valves overloaded,	1,350	442
Safety-valves defective,	1,546	559
Pressure gages defective,	8,781	454
Boilers without pressure gages,	466	466
Unclassified defects,	38	10
Total,	169,356	16,385

COMPARISON OF INSPECTORS' WORK DURING THE YEARS 1908 AND 1909.

	1908.	1909.
Visits of inspection made,	167,951	174,872
Whole number of inspections made,	317,537	342,136
Number of complete internal inspections,	124,990	136,682
Boilers tested by hydrostatic pressure,	10,449	12,563
Total number of boilers condemned,	572	642
Total number of defects discovered,	151,359	169,356
Total number of dangerous defects discovered,	15,878	16,385

Summary by Months for 1909.

Month.	Visits of inspection.	Number of boilers examined.	No. inspected internally and externally.	No. tested hydro-statically.	No. con-demned.	No. of defects found.	No. of dangerous defects found.
January, .	14,851	28,570	10,987	658	62	12,850	1,257
February, .	14,070	27,278	9,315	676	22	11,999	1,105
March, . .	16,069	31,073	10,897	872	40	14,723	1,180
April, . .	14,840	28,763	11,878	1,088	47	15,207	1,637
May, . . .	13,812	27,742	12,476	1,056	43	14,980	1,412
June, . . .	14,560	28,775	13,541	1,504	55	15,948	1,525
July, . . .	14,684	26,504	13,934	1,448	78	16,593	1,503
August, . .	12,975	25,566	11,429	1,135	79	14,155	1,465
September, .	13,990	27,693	11,267	1,177	50	13,810	1,286
October, .	15,010	30,013	11,366	1,043	71	13,942	1,415
November, .	14,743	29,070	9,831	1,001	53	12,181	1,246
December, .	15,268	31,089	9,761	905	42	12,968	1,354
Totals, .	174,872	342,136	136,682	12,563	642	169,356	16,385

The following table is also of interest. It shows that our inspectors have made nearly three million visits of inspection, and that they have made nearly five million and three-quarters of inspections, of which nearly two and a quarter million were complete internal inspections. The hydrostatic test has been applied in more than a quarter of a million cases. Of defects, more than three and a half million have been discovered and pointed out to the owners of the boilers; and more than a third of a million of these were, in our opinion, dangerous. More than twenty thousand boilers have been condemned by us as unfit for further service, good and sufficient reasons for the condemnation being given to the assured in every instance.

Grand Total of the Inspectors' Work Since the Company Began Business, to January 1, 1910.

Visits of inspection made, ...	2,954,134
Whole number of inspections made, ...	5,713,658
Complete internal inspections, ...	2,239,126
Boilers tested by hydrostatic pressure, ...	274,349
Total number of boilers condemned, ...	20,342
Total number of defects discovered, ...	3,654,065
Total number of dangerous defects discovered, ...	375,483

We append, also, a summary of the work of the inspectors of this company from 1870 to 1909, inclusive. The year 1878 is omitted, because the data that we have at hand for that year are not complete. Previous to 1875 it was the custom of the company to publish its reports for the year ending with September 1st, but in that year the custom was changed and the summaries were thereafter made out so as to correspond with the calendar year. The figures given opposite 1875, therefore, are for sixteen months, beginning September 1, 1874, and ending December 31, 1875.

SUMMARY OF INSPECTORS' WORK SINCE 1870.

Year.	Visits of inspection made.	Whole number of boilers inspected.	Complete internal inspections.	Boilers tested by hydrostatic pressure.	Total number of defects discovered.	Total number of dangerous defects discovered.	Boilers condemned.
1870	5,439	10,569	2,585	882	4,686	485	45
1871	6,826	13,476	3,889	1,484	6,253	954	60
1872	10,447	21,066	6,533	2,102	11,176	2,260	155
1873	12,824	24,998	8,511	2,175	11,998	2,892	178
1874	14,368	29,200	9,451	2,078	14,256	3,486	163
1875	22,612	44,763	14,181	3,149	24,040	6,149	216
1876	16,409	34,275	10,669	2,150	16,273	4,275	89
1877	16,204	32,975	11,629	2,367	15,964	3,690	133
1879	17,179	36,169	13,045	2,540	16,238	3,816	246
1880	20,939	41,166	16,010	3,490	21,033	5,444	377
1881	22,412	47,245	17,590	4,286	21,110	5,801	363
1882	25,742	55,679	21,428	4,564	33,690	6,867	478
1883	29,324	60,142	24,403	4,275	40,953	7,472	545
1884	34,048	66,695	24,855	4,180	44,900	7,449	493
1885	37,018	71,334	26,637	4,809	47,230	7,325	449
1886	39,777	77,275	30,868	5,252	71,983	9,960	509
1887	46,761	89,994	36,166	5,741	99,642	11,522	622
1888	51,483	102,314	40,240	6,536	91,567	8,967	426
1889	56,752	110,394	44,563	7,187	105,187	8,420	478
1890	61,750	118,098	49,983	7,207	115,821	9,387	402
1891	71,227	137,741	57,312	7,859	127,609	10,858	526
1892	74,830	148,603	59,883	7,585	120,659	11,705	681
1893	81,904	163,328	66,698	7,861	122,893	12,390	597
1894	94,982	191,932	79 000	7,686	135,021	13,753	595
1895	98,349	199,096	76,744	8,373	144,857	14,556	799
1896	102,911	205,957	78,118	8,187	143,217	12,988	663
1897	105,062	206,657	76,770	7,870	131,192	11,775	588
1898	106,128	208,990	78,349	8,713	130,743	11,727	603
1899	112,464	221,706	85,804	9,371	157,804	12,800	779
1900	122,811	234,805	92,526	10,191	177,113	12,862	782
1901	134,027	254,927	99,885	11,507	187,847	12,614	950
1902	142,006	264,708	105,675	11,726	145,489	13,032	1,004
1903	153,951	293,122	116,643	12,232	147,707	12,304	933
1904	159,553	299,436	117,366	12,971	154,282	13,390	883
1905	159,561	291,041	116,762	13,266	155,024	14,209	753
1906	159,133	292,977	120,416	13,250	157,462	15,116	690
1907	163,648	308,571	124,610	13,799	159,283	17,345	700
1908	167,951	317,537	124,990	10,449	151,359	15,878	572
1909	174,872	342,136	136,682	12,563	169,356	16,385	642

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1910.

Capital Stock, . . . $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission,	$154,845.83
Premiums in course of collection,	228,048.46
Real estate,	93,600.00
Loaned on bond and mortgage,	1,107,060.00
Stocks and bonds, market value,	3,063,476.00
Interest accrued,	67,580.50
Total Assets,	$4,714,610.79

LIABILITIES.

Re-insurance Reserve,		$1,943,732.29
Losses unadjusted,		90,939.53
Commissions and brokerage,		45,609.69
Other liabilities (taxes accrued, etc.),		41,835.50
Capital Stock,	$1,000,000.00	
Surplus,	1,592,493.78	
Surplus as regards Policy-holders,	**$2,592,493.78**	2,592,493.78
Total Liabilities,		$4,714,610.79

On January 1, 1910, THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY had 104,589 steam boilers under insurance.

L. B. BRAINERD, President and Treasurer.
FRANCIS B. ALLEN, Vice-President. CHAS. S. BLAKE, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
W. R. C. CORSON, Assistant Secretary.

A. S. WICKHAM, Superintendent of Agencies.
E. J. MURPHY, M. E., Consulting Engineer.
F. M. FITCH, Auditor.

BOARD OF DIRECTORS.

CHARLES M. BEACH, of Beach & Co., Hartford, Conn.

GEORGE BURNHAM, Baldwin Locomotive Works, Philadelphia.

PHILIP CORBIN, Prest. American Hardware Corporation, New Britain, Conn.

ATWOOD COLLINS, Prest. Security Co., Hartford, Conn.

LUCIUS F. ROBINSON, Attorney, Hartford, Conn.

JOHN O. ENDERS, U. S. Bank, Hartford, Conn.

LYMAN B. BRAINERD, Director, Swift & Company.

MORGAN B. BRAINARD, Treasurer Ætna Life Insurance Co.

F. B. ALLEN, Vice-Prest., Hartford Steam Boiler Inspection and Insurance Co.

CHARLES P. COOLEY, Vice-Prest., Fidelity Trust Company, Hartford, Conn.

ARTHUR L. SHIPMAN, Attorney, Hartford, Conn.

GEORGE C. KIMBALL, President Smyth Manufacturing Co., Hartford, Conn.

CHARLES M. JARVIS, 1st Vice-Prest., American Hardware Corporation, New Britain, Conn.

FRANCIS T. MAXWELL, President, Hockanum Mills Co., Rockville, Conn.

HORACE B. CHENEY, of Cheney Brothers Silk Manufacturing Co., South Manchester, Conn.

The Locomotive

Vol. XXVIII. HARTFORD, CONN., APRIL 25, 1910. No. 2.

Explosion of a Fly Wheel.

The accident described in the present article consisted in the explosion of a fly wheel, with disruption of the wheel, and the projection of its parts to considerable distances. It is well worth reporting and illustrating, for its own sake; and it also derives an added interest (at least for the Hartford Steam Boiler Inspection and Insurance Company and its policy-holders) from

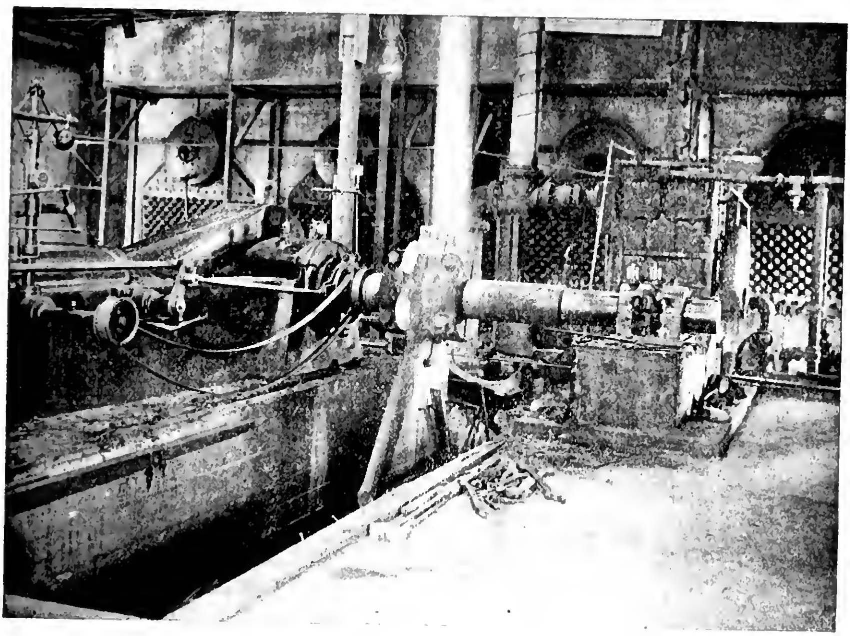


Fig. 1.— View of the Wrecked Wheel. (Looking South.)

the fact that it is the first loss of the kind that we have experienced since we have been engaged in the insurance of fly wheels. Our activity in this field, it is probably unnecessary to say, is as yet only a few months old.

General Description of the Plant.

The wheel that burst was on an engine generating some 560 horse-power, and its normal speed was 100 revolutions a minute. It was a rope-drive pulley,

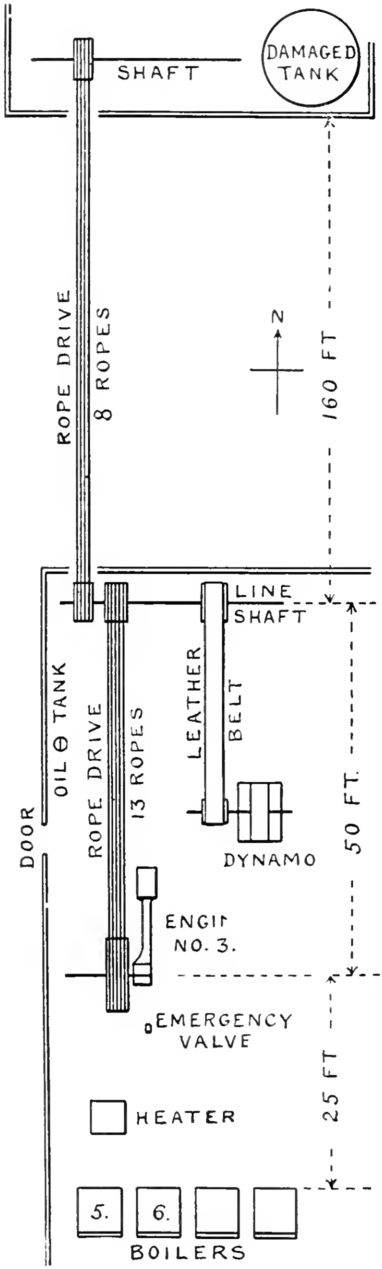


Fig. 2.— Plan of Engine Room.
(Not drawn to scale.)

14 feet in diameter with 13 grooves, and it drove a similar pulley, 7 feet in diameter, on a line shaft 50 feet distant, by means of a 1½ inch continuous manila rope.

The general arrangement of that part of the power plant with which we shall have to deal in the present article will be understood from Fig. 2. On one side of the driven pulley there was belted a 400-kilowatt direct-current dynamo, which was taking about 200 horse-power at the time of the accident. On the other side of the driven pulley was another 7-foot, 8-groove rope pulley, which delivered about 350 horse-power to another part of the plant, located in a separate building, some 160 feet to the north of the engine room. Between the fly wheel that burst, and the line shaft pulley that it drove, there was a framework bearing auxiliary pulleys and a carriage, for keeping the rope properly taut. These details are not shown in Fig. 2, as they were situated exactly in line between the fly wheel and the driven pulley, and hence would lie directly below the 13 ropes that are there indicated. The ruined framework may be seen in Fig. 4, however, as it appeared after the accident.

General Description of the Explosion.

The attendant in the engine room states that he was about twenty-five feet from the engine, drawing some oil, when he heard a report, apparently between the engine and the shaft pulley. He turned at once toward the engine, but before he could reach the throttle, or the rope to the quick-closing valve (presently to be described) in the steam line, débris was falling so thickly that he concluded to try to reach the stop valves on top of the boilers. He went out of the door of the engine room for this purpose, but before he could get to the stop valves in question the fly wheel had ruptured. The time, in all, he says, was not over fifteen seconds. Men working in the yard outside say that one fragment passed through the roof of the building and went 600 feet up into the air. Only one person was injured, he being struck a glancing blow and bruised about the legs and arms, with the result that he was incapacitated for some days.

The first evidence of trouble, outside of the engine room itself, was the extinguishing of the electric lights. The electrician, who was in his work house (a separate building), ran at once to the power plant to see what was the trouble, and as he reached the engine room the wheel ruptured. One of our own representatives afterward timed this man with a stop watch, while he

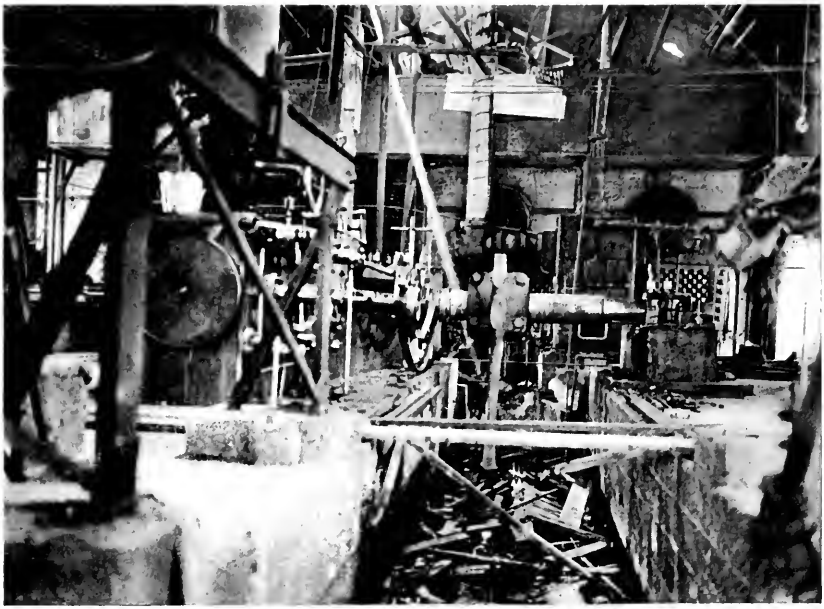


FIG. 3.— VIEW OF THE WRECKED WHEEL. (LOOKING SOUTH.)

ran over the same course. The time so taken was just fifteen seconds, so that it appears that the estimates, given independently by the engineer and the electrician, that it was fifteen seconds from the first indication of trouble up to the explosion of the wheel, were unusually close to the actual facts.

THE DAMAGE WROUGHT BY THE EXPLOSION.

The fly wheel was made in two sections, and had eight arms in all. Its general appearance after the accident will be evident from Figs. 1 and 3, which show it from two slightly different positions. Seven of the spokes broke at the hub of the wheel, but the eighth remained attached to the hub. The hub itself was not injured in any way, and was found to be still tight upon the shaft. No parts of the spokes were left attached to the rim, but all were broken off close to the rim, and all parts of the spokes were found in the rope pit. The outward foundation was broken, and the anchor bolts were pulled loose in both foundations.

Fragments of the ruptured rim were thrown about with great violence. One of the flanged joints was found to be intact, the section of rim in which it occurred being, after the rupture, 5½ feet long as measured along the curved surface. This was the largest piece of the rim, and in the unbroken wheel it had extended from one spoke exactly to the next one, the flanged joint being in the middle of its length. The other flanged joint was broken, the line of fracture passing through the bolt hole in one of the flanges. A careful examination of this joint leads us to believe, however, that it did not fracture at the outset, but that it was broken after the failure of the wheel, by being thrown violently against one of the other wheels, or against a shaft. It was

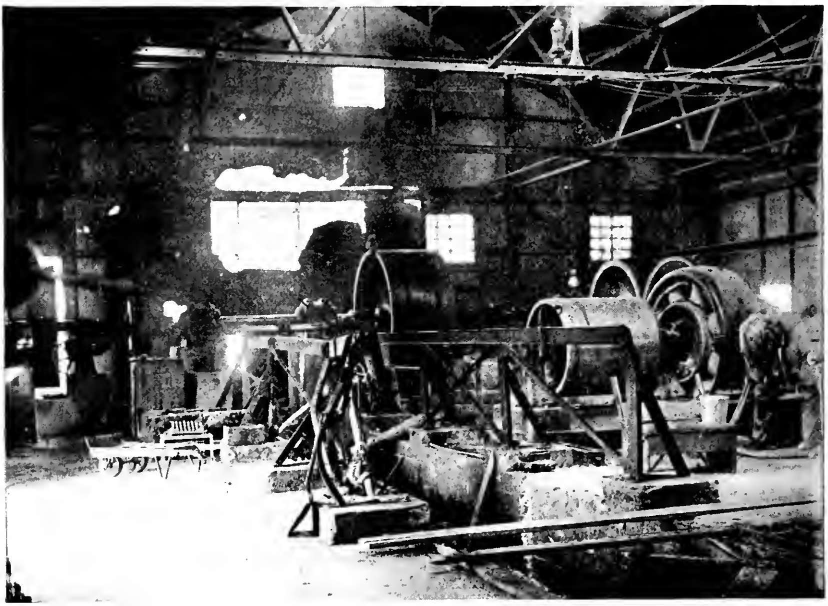


Fig. 4.— View of the Engine Room. (Looking North.)

found in the rope pit. Apart from these two sections, containing the respective flanged joints, the fragments of the rim were of no especial interest, and all were broken into small pieces.

Several of the roof girders were damaged by fragments of the wheel, and a number of pieces went up through the roof. Boiler No. 6 (the one seen in Figs. 1 and 3 with the manhole open) was struck in the rear head and indented, and it was likewise indented in the water-leg so badly that the depression there had to be heated and pressed out with jacks. The feed-water heater, seen also in these two engravings, was somewhat damaged. The greater part of the fragments of the ruined wheel-rim went northward, however, or in the direction in which the camera was looking when the photograph shown in Fig. 4 was taken. This view shows the wreck of the framework on which the carriage for the rope-tightening device traveled. It also shows the bent shaft on which the one-groove winder pulley ran. The three pulleys along this path were broken to pieces.

Fig. 6 shows the damage that was done to one of the large storage tanks. This tank was 16 feet in diameter and 25 feet high, and was built of 3/16 in. tank steel. It was situated more than 200 feet from the fly wheel, as will be understood from Fig. 2. Fragments of the fly wheel rim struck this tank and tore it badly, so that it was necessary to replace 380 square feet of it with new sheets.

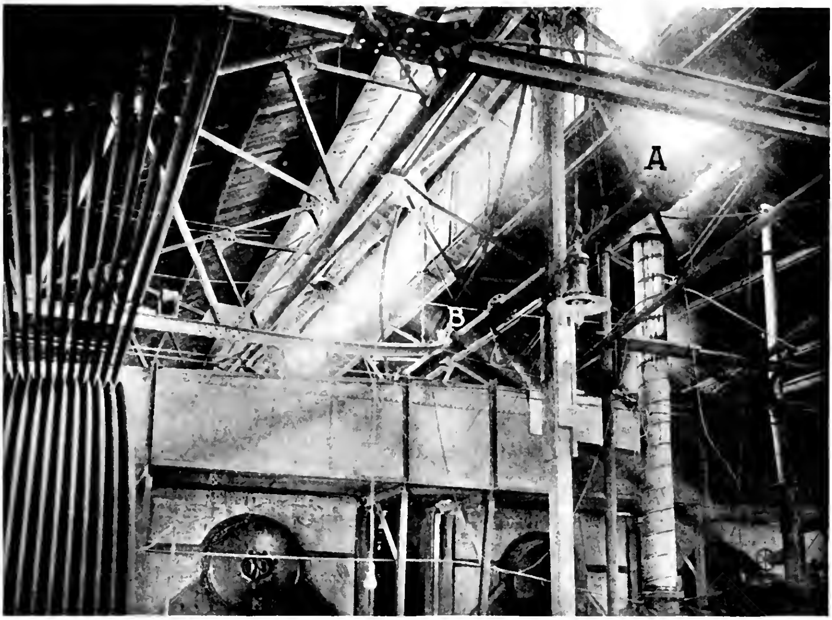


Fig. 5.— Showing the Emergency Valve, *A*.

Eight days after the accident enough steam was given to the engine to turn it over, and, apart from a cracked main bearing cap and a slight spring in the crank shaft, the engine appeared to have suffered no great injury. After the crank shaft had been taken out, however, and properly centered on two pins fastened in two vertical 12 in. by 12 in. timbers, it was found to be sprung about 3/16 in. The strain extended to the main bearing, as was to be expected, since the outboard bearing was shoved south, cracking the cement pedestal on which it rested, as may be seen in Fig. 1, on the right and directly under the end of the shaft. The crank disk was likewise found to be out by 3/32 in., when the shaft was turned on the pins. The piston rod was then put in a lathe and was found to be sprung about 3/32 in., and the connecting rod, when examined in the lathe in the same way, was found to be sprung about 1/16 in. The total property loss was about $4,200.

The Closing of the Emergency Valve.

One singular and very fortunate thing about the accident here described is that the explosion of the wheel shut off the steam from the engine, though in a most unexpected and unforeseen way. In the main steam line leading to the engine, and about 24 feet from the cylinder, was a quick-closing, emergency steam valve, seen, though unfortunately not very distinctly, at *A* in Fig 5. This valve was supposed to be operated from the floor by means of a rope, a jerk on the rope shutting off the steam from the engine at once. The fragment of the rim bearing the uninjured flanged joint, which weighed about 500 pounds and which was, as we have already said, the largest section of the rim, struck the girder *B* (seen in Fig. 5), over which the rope from the quick-acting valve hung. This girder was broken and displaced in a southward direction, and in moving it pulled the rope, closed the valve, and thereby shut off the steam from the engine, causing it to come to a stop almost immediately after the rim fractured. Had it not been for this interesting and fortuitous incident, the engine would doubtless have torn itself to pieces. We may add that the flying fragment of rim that displaced the girder and thus shut off the steam, having given up its momentum in this way, fell to the floor after passing over the boilers, and crashed down upon the fireman's chair. The chair was unoccupied at the time, to the fireman's subsequent great joy.

The Governor Stop.

The engine was not provided with an automatic speed controlling device, in the proper sense of that term, although the contrary would naturally be inferred from the earlier reports of the accident that were made public. The device that was reported as an automatic speed stop did not have for its purpose the controlling of the speed of the engine, but its object, instead, was to so regulate the action of the governor balls as to prevent any difficulty in starting up the engine, after it had been purposely stopped.

In a centrifugal ball governor, such as is usually found upon engines of the Corliss type, the balls drop when their speed of rotation lessens, and by so doing they cause more steam to be admitted to the engine, and so tend to bring back the speed to its correct value. Or, which amounts to the same thing, they increase the period of admission of the steam, by lengthening the cut-off. Now this mode of operation is correct, so long as the engine is operating properly. It is easy to see, however, that if the governor belt (or whatever other means of transmission is used to drive the governor) should break, so that the governor slows up and its balls fall without a corresponding slowing of the engine, the result will be to admit more steam to the engine, and hence to accelerate its motion. The governor belt being broken, the balls will not respond to this increase in the speed of the engine, but will continue to fall lower and lower as they lose their own speed, thereby admitting more and more steam to the engine, and causing it to race, with serious results.

To guard against an accident of this character, it is now usual to construct fly-ball governors so that although they increase the amount of steam delivered to the engine so long as they do not fall below a certain point, yet, when they do fall *below* that point, they cause the supply of steam to be *diminished*, and cut it off altogether when they come into their lowest possible position. Such a governor provides a proper regulation of the speed of the engine under normal conditions, but brings the engine to a standstill in the event of the breakage of the belt by which the governor is operated.

The governor, modified as here indicated, is a great improvement over the earlier style, yet there is one difficulty in its use that the older form did not have. Namely, when the engine has been purposely stopped, it cannot be started again by merely opening the throttle valve, unless further special provision for this contingency is made; because the governor, with the balls in their lowest position, will not permit steam to enter the engine. In starting up with such a governor it is therefore necessary for the engineer to block up the balls in some way, so that the engine will take steam when he opens the throttle. Several methods are in use for accomplishing this end conveniently

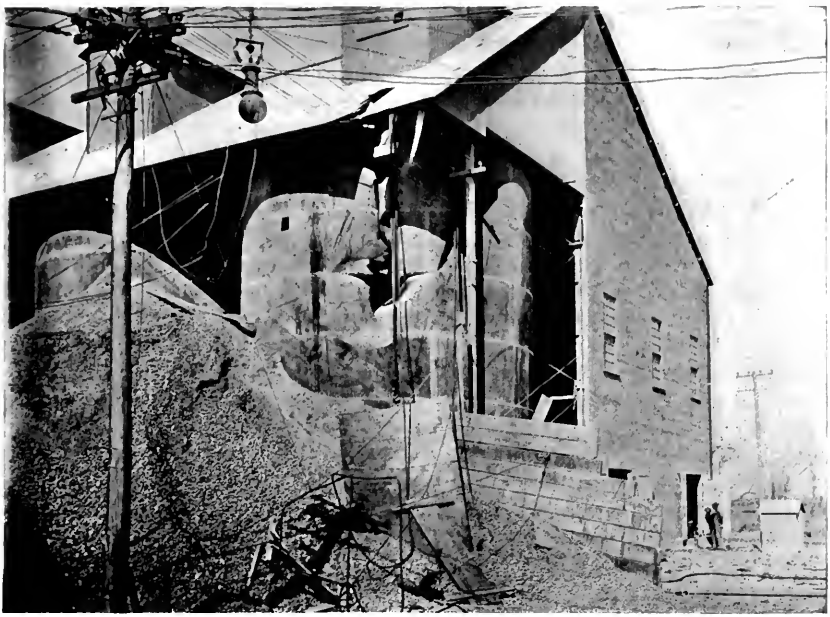


Fig. 6.— Showing the Damaged Storage Tank.

and safely. It is plain that any device that is employed for the purpose should be *automatically* thrown out of action when the engine has once attained a certain speed, because the engineer might forget to attend to it himself, and then, if the governor belt should break, the engine would run away just as it would if the governor were of the old-fashioned type. Any device whose purpose is to prevent the balls from falling to their lowest possible position when the engine is intentionally stopped, or to hold them up, when the engine is started, until it attains a certain speed, is called a "governor stop."

The engine whose wreck we are describing was fitted with a form of governor stop in which a pin is automatically thrust under the balls, when the engine is stopped *by closing the throttle,* thus holding them up so that when it is desired to start the engine again it is only necessary to open the throttle once more. If the governor slows down from any other cause than the closing of the throttle, however, the pin is supposed to remain out of the way, so that the balls can descend to their lowest possible position without hindrance, and thus shut off the steam entirely. The device was operated by steam, conveyed to the governor through a small pipe from a point in the main steam pipe, below the throttle valve. The pin was therefore supposed to be held out of the way so long as the throttle was open, but to be promptly thrust under the balls when the throttle was closed.

We have explained this feature of the engine at considerable length, because an understanding of it is essential to a clear comprehension of the way in which the accident herein described came about.

Cause of the Accident.

A superficial glance at Figs. 1 or 3, where the arms of the wheel are seen to be broken off at the hub, might lead one to think that the accident was due to the throwing of a sudden overload upon the engine, this producing a bending moment upon the spokes which caused them to fracture. The condition of the fragments, however, and the distances to which they were hurled, when taken in connection with all the other available evidence, shows that there is no foundation for this idea, and shows, moreover, that the explanation outlined below is the true one.

There is no doubt but that the first thing that happened was the breakage of one of the ropes from the engine-pulley. This may have been a simple break, or the ropes may have piled up and then jumped off and broken, or they may have jumped off without piling up, and then broken. However these particulars may have been, it appears clear that the breaking of the rope was the initial cause of the accident, and it was very likely this, that the engineer heard, and described as a "report". The rope was certainly found to be broken, after the accident.

If the spokes had fractured first, from overload, there would not have been the fifteen seconds of warning that the engineer and electrician both describe, before the wheel went altogether to pieces. The fact that the lights went out some time before the wheel burst into fragments also bears out the view that the breaking of the drive-rope was the first thing that happened.

When the rope broke, it tore up some 160 square feet of two-inch planking, which was over the rope pit. One of the fragments of the planking struck the governor belt and knocked it off. It did not break the belt, however, although it tore it, and also knocked a piece out of the flange of one of the pulleys, as may be seen in Fig. 1. There were but 9 inches of space between the governor belt and the fly wheel, and in this space was the vertical wooden housing of the wheel, from which fact it is easy to account for the throwing off of the governor belt.

The engine, being freed from its load by the breaking of the rope, would at once begin to race. The governor being thrown out of service by the loss of its driving belt, its revolving balls would begin to slow up and fall at once, and while this would mean the increased admission of steam for a few moments, the steam supply would presently be cut off altogether by the balls falling to their lowest possible position, provided the automatic governor stop had acted as it was supposed to act under these circumstances.

But it so happened that one of the planks cast up by the flying rope broke the small steam pipe leading to the governor stop, and this caused the pin of the stop to be thrust into position so as to prevent the balls from falling to their lowest position, just as it would be if the steam had been cut off from the engine by the closing of the throttle. The result was that the governor balls fell until they rested against the pin that was intended to come into play only when the throttle was closed. They could descend no lower, and hence could not shut off the steam. The engine therefore continued to race at an ever increasing speed, until the fly wheel burst; and nothing stood in the way of its utter annihilation except the fortuitous closing of the emergency valve, at *A* in Fig. 5, when the flying fragment of the rim of the wheel struck the girder over which the valve rope passed.

Fortunate Features of the Accident.

There were many fortunate things about this accident,— many ways in which it would have been far worse, if the pieces of wreckage had taken slightly different directions. It was certainly a happy circumstance that nobody was killed, and that only one man was injured, and that his injuries were not of a very serious nature. The remarkable way in which steam was shut off from the engine by the emergency valve is also worthy of special consideration. We wish to call attention, furthermore, to the fact that with the boilers and steam piping situated as they were, it was little short of providential that none of the sections of the wrecked wheel penetrated the boilers nor broke the steam main. Either of these contingencies would have added a serious element to a situation already quite bad enough.

In designing a steam plant, the boilers and piping, as well as any rooms in which considerable numbers of workmen are congregated, should be kept well away from the plane of the fly wheel, whenever this is possible; for the fragments of an exploding wheel are far more likely to remain near that plane than they are to depart from it by any great amount. The company insuring the wheels rarely has an opportunity to make suggestions of this nature at a time when they might be of value, because the plant is usually built and in operation before the insurance is sought.

Generally speaking, the reports that we send to our assured, after making our inspections, are full enough to give a good idea of the condition of the boiler in all respects. Once in a while, however, the routine is broken by circumstances over which the inspector has no control. Recently, for example, one of our assured received this communication, when he was looking for a report of an external inspection: "On account of the smallpox in this section, the train conductor had orders not to stop at this station. No inspection made".

In another recent case one of our assured was surprised at receiving the following note: "Will you kindly advise me if the rat-tail file which Inspector Day found driven into the fusible plug in your locomotive No. 999 has been removed, and the plug re-filled?"

By the way, the use of nails, rat-tail files, and other infusible things, in the repairing of "fusible" plugs, is no modern invention. We find this brilliant conception carried out every little while, and we illustrated a case of it in The Locomotive, more than twenty years ago,— namely, in the issue for August, 1889.

Boiler Explosions.

January, 1910.

(1.) — On January 1 a tube failed in a boiler in the cotton gin of I. Dornbush, Vicksburg, Miss.

(2.) — A cast-iron sectional heating boiler ruptured, January 1, in the Catholic School and Asylum, Hamlin and Schubert streets, Chicago, Ill.

(3.) — A tube ruptured, January 1, in a water-tube boiler in the John H. Havlin Realty Co.'s hotel, Cincinnati, Ohio.

(4.) — A boiler belonging to R. J. Pender exploded, January 1, at Tarboro, N. C. One person was seriously injured.

(5.) — A tube ruptured, January 3, in a water-tube boiler in the Germania building, Milwaukee, Wis.

(6.) — On January 3 a locomotive boiler exploded on the Colorado & Southern railroad, at Trinidad, Colo. Two persons were seriously injured.

(7.) — A flue collapsed, January 4, in a boiler on a pumping boat at Safe Harbor, opposite Industry, Pa. George Young was killed, and two other men were slightly injured.

(8.) — On January 4 a tube ruptured in a water-tube boiler at the plant of the American Steel & Wire Co., Waukegan, Ill.

(9.) — A tube ruptured, January 5, in a water-tube boiler in the John H. Havlin Realty Co.'s hotel, Cincinnati, Ohio.

(10.) — On January 5 a blowoff pipe failed in William H. Coleman & Co.'s sawmill and finishing works, Jackson, Tenn.

(11.) — Two sections of a cast-iron heating boiler ruptured, January 5, in "Forbes House", Milton Academy, Milton, Mass.

(12.) — A boiler shell ruptured, January 5, in the Keokuk Hotel Co.'s hotel, Keokuk, Iowa.

(13.) — A boiler exploded, January 6, at the American Dewey mine, at Porto Rico, near Carthage, Mo. John Jones, a miner, was seriously injured.

(14.) — A boiler belonging to Walker Bros. exploded, January 7, at Herrs Island, Pa. One person was fatally injured.

(15.) — A tube failed, January 7, in a water-tube boiler at the Perry Iron Co.'s plant, Erie, Pa.

(16.) — On January 7 the boiler of a locomotive exploded at Grand Junction, Colo. Two persons were killed.

(17.) — A heating boiler exploded, January 8, in the I. O. O. F. building, Boise, Ida. The property loss was estimated at $2,500.

(18.) — A heating boiler ruptured, January 9, at the Terre Haute Rose & Carnation Co.'s greenhouse, Terre Haute, Ind.

(19.) — A heating boiler exploded, January 9, in Charles Utermoehler's bakery, 1614 South Tenth street, Philadelphia, Pa. Four persons were injured and the building was badly damaged.

(20.) — On January 9, a cast-iron header ruptured in a water-tube boiler in the store of the Emery, Bird-Thayer Dry Goods Co., Kansas City, Mo.

(21.) — A boiler ruptured, January 9, at the Centerville Water Works, Centerville, Iowa.

(22.) — A heating boiler belonging to the Boston & Maine railroad exploded, January 10, at Portland, Me.

(23.) — A tube burst, January 11, in a water-tube boiler at the Commonwealth Edison Co.'s Quarry street station, Chicago, Ill. Fireman James Glennon was injured.

(24.) — A boiler exploded, January 11, at High Point, N. C.

(25.) — A blowoff pipe ruptured, January 12, at the Campbell Mills, Toronto, Can.

(26.) — A blowoff pipe failed, January 13, in the Dean Hotel Co.'s hotel, Kansas City, Mo.

(27.) — A water-tube boiler ruptured, January 13, in the Grasselli Chemical Co.'s plant, Grasselli, Ind.

(28.) — A live steam heater, used for heating feed water and located on top of one of the boilers, exploded, January 13, at the Central Kansas mill, Lyons, Kans. One man was injured.

(29.) — Two sections of a cast-iron sectional heating boiler ruptured, January 13, at Clemson Agricultural College, Clemson College, S. C.

(30.) — On January 13 three tubes failed in a water-tube boiler at the Athens State Hospital, Athens, Ohio.

(31.) — A heating boiler belonging to A. L. Johnson exploded, January 14, at Palmer, Mass.

(32.) — On January 14 a connection to a superheater on a water-tube boiler failed at the Edison Electric Illuminating Co.'s plant, South Boston, Mass.

(33.) — Three cast-iron headers fractured, January 15, in a water-tube boiler at the North American Lace Co.'s plant, Philadelphia, Pa.

(34.) — A heating boiler exploded, January 15, in the Seabright Methodist church, at Red Bank, N. J.

(35.) — A tube collapsed, January 15, in a vertical boiler at the American Steel & Wire Co.'s plant, Worcester, Mass.

(36.) — A heating boiler exploded, January 15, at Southbridge, Mass. It was used for heating the Tremont theater and a building adjoining it.

(37.) — A boiler belonging to the Vanderbeck Ice Co. exploded, January 15, at Dundee Lake, near Paterson, N. J. Richard Vanderweel was seriously injured.

(38.) — On January 16 a tube ruptured, and ten cast-iron headers fractured, in a water-tube boiler at the American Steel & Wire Co.'s plant, Waukegan, Ill.

(39.) — A small boiler exploded, January 16, at the Monongahela furnace plant, McKeesport, Pa. Three men were injured.

(40.) — A heating boiler exploded, January 16, at Frederick C. Witthuhn's greenhouse, Cleveland, Ohio. The boiler room was blown to atoms, and the greenhouse was wrecked.

(41.) — The boiler of a locomotive exploded, January 17, on the Dawson railroad, at Tucumcari, N. M. Two persons were fatally injured.

(42.) — A flue collapsed, January 17, in a fertilizer drier, in Swift & Co.'s packing house, South Omaha, Neb.

(43.) — A blowoff pipe failed, January 17, in W. L. Petty & Co.'s tobacco curing plant, Lexington, Ky. Two men were injured.

(44.) — On January 17 a cast-iron header fractured in a water-tube boiler at the Hammermill Paper Co.'s plant, Erie, Pa.

(45.) — A slight accident occurred, January 17, to a boiler in the Angola Lumber Co.'s plant, Wilmington, N. C.

(46.) — A tube ruptured, January 17, in a water-tube boiler at the Metropolitan Street Railway Co.'s power plant, Second and Grand streets, Kansas City, Mo. One man was slightly injured.

(47.) — A tube ruptured, January 19, in a water-tube boiler at the H. C. Frick Co.'s plant, near Ronco, Pa. Two men were injured.

(48.) — The boiler of locomotive No. 1208, of the Southern railway, ruptured, January 20, near Afton, Tenn. The engineer was injured.

(49.) — A blowoff pipe failed, January 20, at the Warsaw Furniture Manufacturing Co.'s plant, Warsaw, Ky.

(50.) — On January 20 a boiler exploded at Boyle's sawmill, five miles from Mayesville, S. C. Five persons were fatally injured, and three others were injured less severely.

(51.) — An economizer exploded, January 21, in the Edison Electric Light Plant, Paterson, N. J. Emil Van Wounden was fatally scalded, and eight others were severely injured. The property loss was estimated at $25,000.

(52.) — The boiler of a Pere Marquette switching locomotive exploded, January 22, at Saginaw, Mich. The locomotive was wrecked.

(53.) — On January 23 a blowoff pipe drew out of the elbow at the plant of the Gem Hammock & Fly Net Co., Milwaukee, Wis.

(54.) — A small boiler exploded, January 23, in the Hotel Macatee, Houston, Tex. A bell boy was injured.

(55.) — The boiler of a Norfolk & Western locomotive exploded, January 24, at Roanoke, Va. Two persons were seriously injured.

(56.) — The crown sheet of a freight locomotive failed, January 24, on the Wisconsin division of the Chicago & Northwestern railroad, two miles south of Barrington, Ill. Engineer F. Wooding and fireman A. Caeder were injured.

(57.) — Three cast-iron headers ruptured, January 24, in a water-tube boiler at the plant of the American Steel & Wire Co., Waukegan, Ill. One man was injured.

(58.) — The boiler of a locomotive exploded, January 25, on the Denver & Rio Grande railroad, near La Veta, Colo. Two men were killed and two were injured.

(59.) — A slight boiler explosion occurred, January 27, at the Nelsonville Electric Light & Water works, Nelsonville, Ohio.

(60.) — On January 27 the boiler of a donkey engine exploded at Elmhurst, L. I. John Dawson was badly scalded.

(61.) — A tube ruptured, January 28, in a water-tube boiler at the plant of the Illinois Steel Co., Milwaukee, Wis. One man was injured.

(62.) — On January 28 a tube ruptured in a water-tube boiler at the Philadelphia Rapid Transit Co.'s power station, Thirty-third and Market streets, Philadelphia, Pa.

(63.) — A blowoff pipe failed, January 28, at the Greer-Beatty Clay Co.'s plant, Magnolia, Ohio. One man was injured.

(64.) — A tube ruptured, January 29, in a water-tube boiler at the Allegheny Steel Co.'s plant, Breckenridge, Pa.

(65.) — A boiler exploded January 30, in the plant of the Pennsylvania Rubber Co., Jeannette, Pa. The property loss was estimated at $4,000.

(66.) — A boiler exploded, January 30, in the William Strange Co.'s silk mill, at Paterson, N. J. One man was fatally injured.

(67.) — A blowoff pipe ruptured, January 31, at the Morss Hill Coal Co.'s plant, Fell Township, Pa.

(68.) — A blowoff pipe ruptured, January 31, at the plant of the American Brass Co., Ansonia, Conn.

(69.) — On January 31 two flues ruptured in a boiler at the Flint Electric Light Co.'s plant, Flint, Mich. Eli T. Crump and Hiram Marsh were killed. (See, also, explosion No. 76, below.)

February, 1910.

(70.) — A heating boiler exploded, February 2, in a school building at Cullom, near Bloomington, Ill.

(71.) — A tube ruptured, February 2, in a water-tube boiler at the Upson Nut Co.'s plant, Cleveland, Ohio.

(72.) — On February 2 a boiler exploded at Rice Bros.' mine, Tuscaloosa, Okla.

(73.) — On February 3 the crown sheet of a St. Paul locomotive collapsed at Portage, Wis. Three men were injured.

(74.) — On February 3 a tube burst in a water-tube boiler at the plant of the Mutual Electric Light Co., San Francisco, Cal.

(75.) — On February 4 the crown sheet of a locomotive type boiler collapsed at the plant of the Allentown Non-Freezing Powder Co., Allentown, Pa.

(76.) — On February 5 a tube burst in a water-tube boiler at the Flint Electric Light Co.'s plant, Flint, Mich. George Palmer was killed, and four other men were injured. (The boiler that exploded in this instance was next to the one that exploded in the same plant on January 31, as described above, under No. 69.)

(77.) — The boiler of an agricultural engine exploded, February 5, on the Frank Clay farm, near Quincy, Ohio. Four men were badly injured, and a barn was destroyed by fire.

(78.) — A tube failed, February 7, in a water-tube boiler at the South Works of the Illinois Steel Co., South Chicago, Ill.

(79.) — On February 7 a boiler exploded in the lumber and spoke mill of J. Ezra Thomas, at Thomastown, near Scottsburg, Ind. One man was fatally injured, one was injured badly but probably not fatally, and some four others received lesser injuries.

(80.) — A tube burst, February 7, in a heating boiler at the Lee avenue police station, Brooklyn, N. Y.

(81.) — On February 9 a steam drying cylinder exploded in the Frost Finishing Co.'s factory, West Barrington, R. I. Two men were seriously injured.

(82.) — A heating boiler exploded, February 9, in the Y. M. C. A. building, Knoxville, Tenn. One person was severely injured.

(83.) — A tube ruptured, February 10, in a water-tube boiler in the Congress Hotel, Chicago, Ill. Two men were killed.

(84.) — On February 10 a heater exploded in the Fairchild & Shelton Co.'s soap factory, Bridgeport, Conn. One man was killed.

(85.) — A boiler exploded, February 10, in L. I. Princing & Son's sawmill, near Crump, 22 miles northwest of Bay City, Mich. Seven men were killed, and six other persons were injured, of whom it was thought one would die. The mill was completely wrecked, as was also the neighboring residence of Mr. Princing.

(86.) — A boiler exploded, February 10, in a sawmill on Shelton Laurel creek, in Madison county, near Marshall, N. C. One man was killed and several others were badly injured.

(87.) — On February 11 the furnace of a locomotive partially collapsed on the St. Joseph Valley railway, at La Grange, Ind.

(88.) — A boiler exploded, February 11, at the Snow Hill mine, at Roscoe, near Monongahela, Pa. One man was injured.

(89.) — A heating boiler exploded, February 11, in the Dearborn-Morgan school, Orange, N. J. No pupils were present at the time.

(90.) — A tube ruptured, February 12, in a water-tube boiler at the Ohio Electric Railway Co.'s power plant, Medway, Ohio.

(91.) — On February 12 a boiler exploded in James Hasey's grist mill, at Hardiman, four miles from Campton, Ky. Two men were killed, and four others (one of whom will die) were injured.

(92.) — A boiler exploded, February 13, in the oil fields at Robinson, Ill. One person was killed.

(93.) — The boiler of a steam heating plant exploded, February 13, in Mrs. Mary C. Struve's residence, Huntsville, Ala. Two men were severely injured, and the house was badly wrecked.

(94.) — A tube ruptured, February 14, in a water-tube boiler at the Lackawanna Steel Co.'s plant, Lackawanna, N. Y.

(95.) — A hot-water heating boiler exploded, February 14, in H. Bernhart's residence, Reading, Pa.

(96.) — A boiler tube ruptured, February 14, on the United States torpedo-boat destroyer *Hopkins*, in the harbor of San Diego, Cal. Fireman R. E. Taylor was scalded to death, and six other men were badly injured. It was thought that one of the injured could not recover. (This accident occurred close to the place where the terrible explosion on the gunboat *Bennington* took place, on July 21, 1905. Compare explosion No. 144, page 48.)

(97.) — On February 15 a boiler exploded in the Harrison & Shraner grist mill, Tell City, Ind. Four men were seriously injured.

(98.) — A heating boiler burst, February 16, in a public school building at Middlesboro, Ky.

(99.) — A main stop valve failed, February 17, in the Washington Ice Co.'s plant, New Orleans, La.

(100.) — A boiler used for heating a Pullman tourist car exploded, February 17, in the Big Four railroad yards, Cincinnati, Ohio. The property loss was estimated at $1,000.

(101.) — A boiler belonging to Ward & Grisham exploded, February 17, at Ironton, Mo. Two men were killed and one severely injured.

(102.) — The Voelkner & Harry Manufacturing Co.'s plant, Detroit, Mich., was partially destroyed, February 18, by a fire that was said to have been started by a boiler explosion in the basement.

(103.) — The boiler of switching locomotive No. 339, on the Frisco road, exploded, February 18, near Joplin, Mo. Two men were killed and one fatally injured.

(104.) — The boiler of a Reading railroad locomotive exploded, February 19, at New Hope, Pa.

(105.) — The boiler of a Pennsylvania railroad locomotive exploded, February 19, at Lambertsville, N. J

(106.) — On February 20 a drum fractured on a water-tube boiler at the Summit Branch Coal Mining Co.'s plant, Williamstown, Pa.

(107.) — A boiler exploded, February 21, at the East Side coal mines, at Equality, near Shawneetown, Ill. Two men were killed.

(108.) — A boiler flue burst, February 21, at the Scranton Gas & Water Co.'s plant, Scranton, Pa. One person was killed.

(109.) — A blowoff pipe failed, February 21, in the Major & Loomis Co.'s saw and planing mill, Hertford, N. C. One man was injured.

(110.) — A blowoff pipe failed, February 22, at the American Lead Pencil Co.'s plant, Murfreesboro, Tenn. Four men were scalded.

(111.) — On February 23 a boiler exploded at the Stanley Motor Carriage Works, Newton, Mass.

(112.) — A blowoff pipe failed, February 23, at the tannery of Thomas A. O'Keefe, and M. J. O'Keefe, Peabody, Mass. One man was injured.

(113.) — On February 23 a tube ruptured in a water-tube boiler at the Camden Coke Works of the Public Service Corporation of New Jersey, Camden, N. J. One man was injured.

(114.) — On February 24 the boiler of a locomotive exploded two miles north of Tremonton, near Ogden, Utah. Two men were injured.

(115.) — On February 25 the crown sheet of a locomotive collapsed at the logging camp of the Interstate Lumber Co., Columbus, Miss.

(116.) — On February 27 a hot-water heater ruptured at Bridgeport, Conn. It was connected with engine No. 7 of the city fire department.

(117.) — A cast-iron header ruptured, February 27, in a water-tube boiler in the hotel building belonging to the estate of John Plankinton, at Milwaukee, Wis.

March, 1910.

(118.) — On March 1, a tube ruptured in a water-tube boiler at the Portage Coal Mining Co.'s plant, Portage, Pa. One man was injured.

(119.) — The boiler of a freight locomotive exploded, March 1, at Lincoln, Neb.

(120.) — A flue ruptured, March 1, in a boiler at the City Hall, Milwaukee, Wis. One man was severely scalded.

(121.) — A boiler exploded, March 3, in the oil fields near Tiffin, Ohio.

(122.) — A boiler exploded, March 4, at the Poll Hill mica mine, near Newdale, N. C. Two men were killed and another was seriously injured.

(123.) — A tube ruptured, March 5, in a water-tube boiler at the Toledo Furnace Co. plant of the Pickands-Mather Co., Toledo, Ohio.

(124.) — A tube ruptured, March 6, in a water-tube boiler in the Baltic Mining Co.'s stamp mill, Redridge, Mich.

(125.) — On March 7 a tube ruptured in a water-tube boiler in the Illinois Maintenance Co.'s office building, Chicago, Ill. Three men were scalded.

(126.) — The boiler of an Oregon Railway & Navigation Co. locomotive exploded, March 8, at Whitman station, near Walla Walla, Wash. Nine persons were severely injured.

(127.) — The boiler of a freight locomotive exploded, March 8, on the St. Louis & San Francisco railroad, near Hoxie, Ark. Three men were killed.

(128.) — A heating boiler exploded, March 10, in the parish house of the Church of the Annunciation, Chicago, Ill. Property loss about $1,500.

(129.) — A tank used for the storage of compressed air exploded, March 11, at the Herald mine, Cave Springs, Mo. Loss about $400.

(130.) — Six cast-iron headers fractured, March 12, in a water-tube boiler at the Cass avenue plant of the Pressed Steel Car Co., Pittsburg, Pa.

(131.) — A cast-iron mud drum ruptured, March 13, in a water-tube boiler at the power house of the Terre Haute, Indianapolis & Eastern Traction Co., Terre Haute, Ind.

(132.) — A boiler exploded, March 14, on the towboat *R. L. Aubrey,* off Arctic Springs, near Louisville, Ky. One man was killed, one is missing and was probably killed also, and two were fatally injured. Three other men were injured less severely. The *Aubrey* sank almost immediately.

(133.) — A tube ruptured, March 14, in a water-tube boiler at the Metropolitan West Side Elevated Railway Co's power house, Throop and Congress streets, Chicago, Ill.

(134.) — On March 15 a tube ruptured in a water-tube boiler in the Philadelphia Rapid Transit Co.'s power plant, at Beach and Laurel streets, Philadelphia, Pa.

(135.) — Seven cast-iron headers fractured, March 15, in a water-tube boiler at the Valley Electric Co.'s plant, New Brighton, Pa.

(136.) — The boiler of a donkey engine exploded, March 17, at Bordeaux, Mason county, Wash. Arthur Sapp's residence was demolished.

(137.) — The boiler of a sand dredge belonging to the Meierhoffer Sand Works exploded, March 18, at Boonville, Mo. Loss about $15,000.

(138.) — Two tubes ruptured, March 20, in a water-tube boiler in the County Court and Jail building, Greensburg, Pa.

(139.) — The boiler of a Santa Fé freight locomotive exploded March 22, near Bakersville, Cal. One man was killed, and one fatally injured.

(140.) — On March 22 a tube and six headers ruptured in Swift & Co.'s packing plant, Kansas City, Kans.

(141.) — A tube ruptured, March 23, in a water-tube boiler at the Home Riverside Coal Co.'s No. 3 mine, Leavenworth, Kans.

(142.) — The boiler of a basket factory, near Galesburg, Mich., exploded on March 23.

(143.) — A boiler exploded, March 23, in the Michigan Creamery Co.'s plant, Clare, Mich. Three men were injured, and the property loss was $6,500.

(144.) — On March 25 several tubes, located in two different boilers, ruptured on the United States torpedo-boat destroyer *Hopkins,* just outside the Golden Gate, near San Francisco, Cal. (Compare explosion No. 96, page 46. The *Hopkins* was on her return trip from San Diego and San Pedro to the Mare Island Navy Yard when the present explosion occurred, temporary repairs having been made on her boilers after the San Diego accident.)

(145.) — A tube ruptured, March 28, in a water-tube boiler at the Oak Park Construction Co.'s power plant, Oak Park, Ill.

(146.) — On March 28 a blowoff failed in the Fred L. Sayles Co.'s woolen mill, Pascoag, R. I.

(147.) — A boiler exploded, March 28, in F. L. Kister's sawmill, Bowling Green, Ky. One man was killed, one was fatally injured, and three were injured less seriously. The property loss was estimated at $1,000.

(148.) — The boiler of freight locomotive No. 432, of the Houston & Texas Central railroad, exploded, March 29, near Sherman, Tex.

Changes in our Personnel.

Mr. F. H. Williams, Jr., who has been a special agent in our Hartford department for some years, has been appointed general agent in that territory, in the place of Mr. E. H. Warner, whose resignation we announced recently.

Mr. F. H. Kenyon has been appointed special agent in the Hartford department.

Mr. J. P. Hagarty, who has been assistant to the chief inspector in the Hartford department for several years, has been appointed a special agent, in addition to his other duties. His time will continue to be mainly devoted to the engineering work in which he has heretofore been engaged.

Mr. John L. Mee has been appointed a special agent for the company, and is temporarily located at the Hartford office.

Mr. W. W. Manning has been appointed acting chief inspector in the New York department, in the place of Mr. R. K. McMurray, whose assistant he has been for a number of years, and whose death is announced in the present issue.

Mr. S. B. Adams has been appointed assistant chief inspector in the Philadelphia department, with which he has long been connected, both as an inspector and as a special agent.

Mr. C. H. Dennig, formerly a special agent for this company at New York, and later at Denver, will hereafter represent us, in the same capacity, at Detroit, Mich.

A Mechanical Minstrel Joke.— In looking over an old number of *Power,* the other day, we came across a joke having for its victim Professor Jacobus, who is an acknowledged authority upon the flow of liquids through pipes, and upon the loss of hydraulic head due to elbows, valves, orifices, and the like. The joke is mellow with age, but it seems good enough to resuscitate. So here it is, with our apologies to the professor.

Imagine yourself, if you please, at a minstrel show.

"Dat Professor Jacobus is a nice man", says Tambo, the end-man.

"Yes", says the interlocutor, "I think Professor Jacobus is a very nice man".

"Now, me and him was talking dis afternoon", continues Tambo, "down in the bar-room; and —"

"What's that?" cries the horrified interlocutor. "You were talking to Professor Jacobus down in the bar-room?"

"Yassir, an' he says —"

"But you are surely mistaken. Professor Jacobus is a very serious minded and sober man. He could not possibly have been down in the bar-room."

"No, I ain't mistaken. He was thar all right, but he had a good right to be thar".

"He had a right to be there, did he.. Well, what was Professor Jacobus doing in the bar-room?"

"He was collecting data on the loss of head due to the flow of a liquid through an orifice".

The Locomotive.

A. D. RISTEEN, PH.D., EDITOR.

HARTFORD, APRIL 25, 1910.

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Bound volumes one dollar each.

ROBERT KERMIT MCMURRAY.

Obituary.

Robert Kermit McMurray.

We record, with profound sorrow, the death of Robert Kermit McMurray, who was prominently connected with the Hartford Steam Boiler Inspection and Insurance Company for many years, and widely esteemed for his estimable personal qualities, and for the breadth and soundness of his professional attainments. He was born in Brooklyn, New York, on February 23, 1837, and died in that city, of pneumonia, on March 8, 1910. He was ill only a few days, and was at his desk on March 2.

Mr. McMurray was a veteran of the Civil War. He enlisted in the Thirteenth Regiment, New York Engineers, on April 21, 1861, and was assigned almost immediately, by General Benjamin F. Butler, to the construction of the first military railroad of the United States. This extended from the wharves of the military academy at Annapolis, Maryland, to a point two miles distant, where it made a junction with the Elk Ridge railroad. In the execution of the work he was put in command of three thousand troops, and in four days he surveyed and leveled the road-bed, superintended the construction of the road itself, and ran the first train over it. For this service he was commended by the War Department, and also honored by the Secretary of War, who wrote him a personal letter of thanks.

On May 26, 1862, Mr. McMurray was promoted to the rank of lieutenant of Company F, of the Thirteenth Regiment of New York Volunteers, and in the same year he was in several skirmishes near Suffolk and Black Water, Virginia. He was discharged from the service on July 21, 1863, his term of enlistment having expired.

On December 24, 1867, he entered the service of the Hartford Steam Boiler Inspection and Insurance Company, and served continuously from that date until the day of his death, as Chief Inspector of its New York department. His work as a designer of boilers and settings is well known, especially to the steam-using public of New York and New Jersey. He was one of the pioneers in the preparation of definite specifications for the construction of boilers, and was an early advocate of the use of steel for boiler shells. He was famous, too, as a designer of chimneys. The celebrated brick stack of the Clark Thread Company's factory, near Newark, New Jersey, was built from his designs, twenty years ago or more.

He was also one of the original few who taught that steam boiler insurance should be primarily of a preventive character,— a principle that has guided this company in its development, since its earliest days. Our late president, Mr. J. M. Allen, continually sought his counsel in laying the foundations of our business, and great weight was assigned to his judgment upon all mechanical matters.

At the time of his death Mr. McMurray was a member of the New York Yacht Club, of the Thirteenth Regiment Veteran's Association, of Grant Post of the Grand Army of the Republic, and of the Masonic Club. In the Masonic order he was a member of Damascus Commandery, a thirty-second degree Scottish Rite Mason, and a member of Kismet Temple of the Mystic Shrine.

It is impossible to estimate the value of the services that Mr. McMurray has rendered to the Hartford Steam Boiler Inspection and Insurance Company, with which he had been identified practically from its very start, and to whose interests he had given his unremitting attention for over forty years. Of his personal qualities it is equally impossible to speak with justice. As a token of the respect and affection that he had inspired throughout his long term of service, a complimentary dinner was given to him in New York, on February 22, 1906, by his associates, in celebration of his sixty-ninth birthday. He there received the honorary title of "Dean of Steam Boiler Inspection", which fittingly expresses the light in which his co-workers had long regarded him. In his death this company has met with a great loss. His personal and professional influence will be felt and remembered for many years.

THE article in our issue for January, 1909, respecting the terrible boiler explosion on the *Sultana,* in 1865, aroused much interest. Mr. S. M. Gaston, one of the few living survivors, has since given us some further particulars concerning it, calling our attention, at the same time, to a letter written on the subject by him, and published in *Power* for May, 1897, page 17. It appears that the *Sultana,* arriving at Memphis on the afternoon preceding the explosion, stopped there and discharged her cargo of sugar. She then crossed the river and took on a supply of coal, after which she proceeded on her way up the river toward Cairo, Ill. Except for these few additional details, the story of the explosion is as we told it.

There is a legend to the effect that the late Samuel L. Clemens ("Mark Twain") was pilot, or assistant pilot, on the *Luminary,* which preceded the *Sultana* up the river; but this was not the case, because Mr. Clemens, although he had been a pilot, left the river when the breaking out of the Civil War interrupted traffic there, and, as related in his *Life on the Mississippi,* he did not return to it again for twenty years. A letter addressed by us to Mr. Clemens, asking for a definite assurance on this point, brought back the reply that on the date of the explosion of the *Sultana* he was at San Francisco, California.

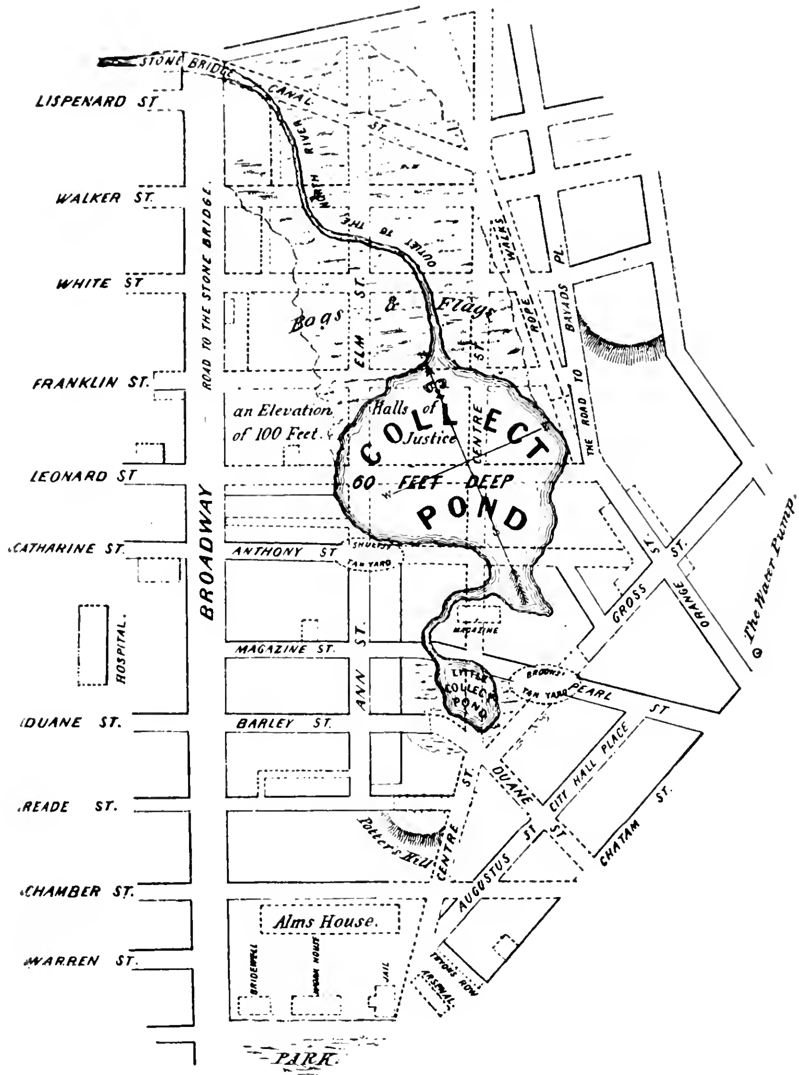
Robert Fulton or John Fitch?

Since the article with this heading was printed in the issue of THE LOCOMOTIVE for October, 1909, our attention has been called to the second volume of "The Documentary History of the State of New York", which was printed at Albany, N. Y., in 1850, and edited by E. B. O'Callaghan, "under direction of the Hon. Christopher Morgan, Secretary of State".

A portion of this volume is devoted to the question of priority in the invention of the steamboat, so far as it relates to the rival claims of Rumsey and Fitch. It reprints in full, for example, "A Short Treatise on the Application of Steam, etc.; by James Rumsey, of Berkely County, Virginia". This was originally printed in Philadelphia in 1788, and is an attempt, on the part of Rumsey, to establish his claim to the invention of the steamboat. The work before us also gives, in full, Fitch's "The Original Steam-Boat Supported; Or, A Reply to Mr. James Rumsey's Pamphlet". This was also printed originally in Philadelphia, in 1788.

As there are now few historians who put forth any claim to priority on

Rumsey's behalf, we have not thought it necessary to give any extracts from either of the pamphlets noted above. The "Documentary History" contains, however, a lithographed sheet about 20 inches long and 16 wide, prepared by John Hutchings and dated 1846, which has a direct and (as it appears to us) a very important bearing upon the question of priority between John Fitch and Robert Fulton. For this reason we have thought that it would be of interest to reproduce the contents of the sheet, and this we do, below, following the original faithfully, even to the spelling, which is here and there somewhat erratic, particularly where a certificate of Hutchings' "voracity" is given.

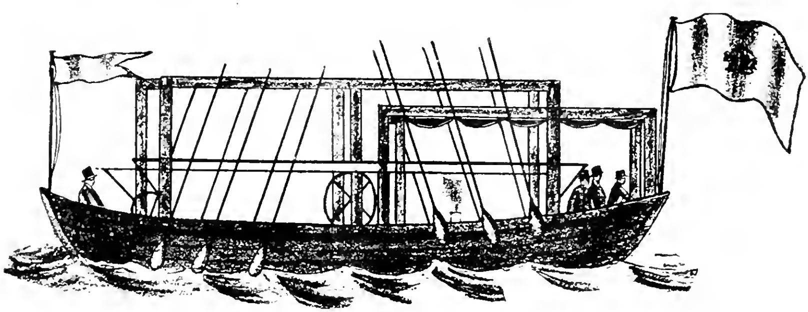


At the top of the sheet are the following title and introduction:

"'Honor to Whom Honor is Due'.
"Origin of Steam Navigation.
"A View of Collect Pond and its Vicinity
in the City of New York in 1793.
"On which Pond the first boat, propelled by steam with paddle wheels or screw propellers was constructed by John Fitch, six years before Robert Fulton made trial of his boat upon the River Seine, in France, and ten years prior to his putting into opperation his boat *Clermont* in New York; with a representation of the boat and its machinery, on the Collect pond.
"By John Hutchings,
"*No. 3 Wesley Place, Williamsburg, L. Island.*
"1846."

Then follow the data given below. The arrangement of the sheet is not very logical, and the story is not as consecutive as it might have been made;

John Fitch's First Boat Perseverance



as seen on the Delaware Phila. 1787. Speed 7 miles an hour.

but we should be grateful to Mr. Hutchings for the facts that he has given us, rather than critical respecting his imperfect literary style.

"John Fitch was born in Conn. 21th of June 1743. First we find him a farmers boy, next an apprentice to a Watch-maker, then in a store at Trenton N.J. with a stock valued at 3000 dolls. all of which was destroyed, when the British took Trenton next a Lieutenant in the A. Army, taken prisoner by the Indians, and sold from one tribe to another through the N.W. Territory, until he was purchased by an Englishman and thus obtained his freedom. During this time he became acquainted with that part of the country of which he made a map, and although printed on a common Cider press it had an extenive sale. He was then a Surveyor in Kentucky, then a Civil Engineer in Pa. and on the Delaware made his first experiment of & Steam-Boat with paddles, he then left America, and traveled through France and England, but not meeting with the encouragement anticipated, became poor and returned home, working his passage as a common sailor to Boston, from there to his native town in Connecticut, thence to New York, where he remained some time, then back to Kentucky where he died in 1798.

"Mr. John Hutchings
Sir
I have a perfect recollection of having seen a Boat on the Collect Pond in this City with a screw Propeller in the Stern driven by Steam accross the Pond. I do not recollect the year but I am certain that it was as early as 1796, it was about the size of a Ships yawl.

I am Sir Respectfully
yours &c.

"New York, July 3d, 1846. ANTHONY LAMB.
Residence, Albion Place,
City N. York.

"This is to Certify, that we have Personally known Mr. John Hutchings of the Village of Williamsburg for the last Forty years past, and have the utmost confidence in him for truth and voracity. New York, Octr. 10th 1846.

RICHARD LAYCRAFT.
Residence 178 Franklin st. City N. Y. was a member of the first Methodist Class in the City of N. Y. and has been a Respectable member of the M. E Church from its commencement in the U. S.

MATT O. HALSTED
Senior Partner of the Firm of Halsted, Hains & Co. No. 31 Nassau At. N. Y. Family Residence Orange N. Jersey.

New York, July 3th, 1846.

"To Mr. John Hutchings
Dear Sir,
It affords me much pleasure, to state: that I was an eye witness to the circumstance of a Boat, being propelled be Steam on the Collect Pond in this City about the Year 1796 as exhibited on your Map and that I have a perfect recollection of all these localities as there shewn, and you are perfectly welcome to use my name in connection with it.

Yours,
WM. H. MIETLOCK*
City Surveyor.

"State of New York
City and County of New York Ss.
John Hutchings of Williamsburgh L. I. being duly Sworn deposeth and saith that the facts set forth in the foregoing remarks and description by him, subscribed are correct to the best of this deponents remembrance and belief
JOHN HUTCHINGS

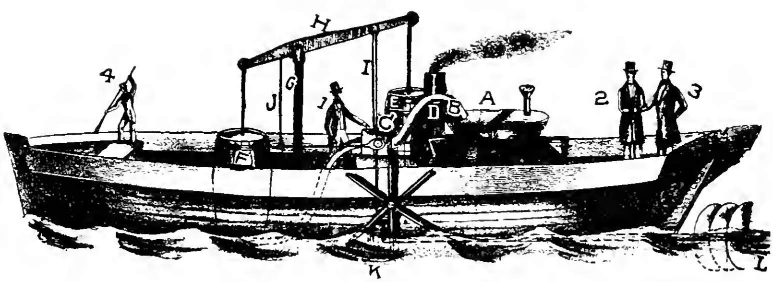
"Sworn before me, this First day of December 1846.
THOMAS S. HENNY
Com. of Deeds &c.

"S. S. 1797. 8 When his health would allow of moderate exercise, he wrought upon a model Boat about three feet in length, at the shop of Mr. Howell Its machinery was constructed of brass. This model Boat had wheels, and has been seen floating in a small stream near the Village by persons now living. It was burnt in Mr. Cown's tavern in 1805 Nelson Co. Kentucky.

(Spark's American Biography)
New Series Vol. VI.

* [The signatures on the sheet are *fac similes* of the originals, and there is some doubt if this name is Mietlock, as it is hard to decipher.—*Editor* THE LOCOMOTIVE.]

"REMARKS. In the Summer of 1796 or 7 Mr. Hutchings, then a lad, assisted Mr. Fitch in steering the boat, and otherwise attending to the working of the Machinery. At that time Robert R. Livingston Esq. and Robert Fulton with Mr. Fitch and the lad Hutchings, worked or passed several times around the pond on different occassions, white Mr. Fitch explained to Livingston & Fulton the Modus-Operandi of the Machinery Mr. Fitch having a patent for his invention from the State of N. Y. I believe Mr. Fitch to have been the original inventor of the application of steam to boats as a propelling power and likewise, the two persons represented in the drawing (dressed in black) to have been Robert R. Livingston Esq. and Robert Fulton. I being a lad had conversation only with Mr. Fitch. From hearsay, I believe Colonel Stevens of Hoboken, N. Jersey, and another person by the name of Rosevelt had some knowledge of the enterprise and felt an interest in its success. In conversation Mr. Fitch remarked to Mr. Fulton that in a former experiment paddle wheels splashed too much and could not be used in Canal Navigation. No one in that time, thought of having them covered with boxes. They had no doubt, but the boat might be propelled 6 Miles per hour, (though then making something less.) The steam was sufficiently high to propel the boat once, twice or thrice around



the pond, when more water being introduced into the boiler (or pot) and Steam generated She was again ready to start on another expedition —

"DESCRIPTION. The boat was a common long boat, or Yawl about 18 ft. in length and 6 ft. beam, with square stern, and round bows, with seats. She was steered at the bow with a small oar when the propeller was used.

"The boiler was a 10 or 12 gallon iron pot, with a lid of thick plank, firmly fastened to it by an iron bar, placed transversely. The Cylinders were of wood, barrel shaped on the outside and straight on the inside, strongly hooped. The main steam pipe led directly from the boiler top into a copper box, (about 6 inches square) receiver, or valve box. The leading pipes led seperately into the bottom or base (The one short cylinder F and longer one E) seperate cylinders and each piston rod was attached to the extremities of the working beam. This beam was supported by an iron upright, the connecting rod was so arranged as to turn the crank of the propelling shaft which passed horrizontally through the stern of the boat and was made fast to the propeller or screw as at L. The valves were worked by a simple contrivance attached likewise to the working beam as will be easily seen and understood by refference to the attached perspective drawings —

"*A*, Boiler. *B*, Maine pipe. *C*, Valve box. *D*, Smoke pipe. *E*, Cylinder *F*, do. *G*, Supporter of beam. *I*, Connecting rod. *J*, Valve rod. *K*, Crank. *L*, Screw propeller. No. 1, Mr. Fitch, 2, Mr. Fulton, 3, R. R. Livingston Esq. 4, Lad Hutchings.

"The boat, together with a portion of its machinery was abandoned, by Mr. Fitch, and left to decay on the muddy shore of the Collect Pond and was carried away piece by piece by the children of the neighbourhood for fuel. In the Autumn Mr. Fitch left New-York for Kentucky, being forced to go by his pecuniary and domestic troubles. Having made his last successful effort, to succeed in this glorious enterprise of Steam Navigation.

"John Fitch died in Kentucky in the year 1798, and if he or R. Fulton had written their own history, I have no doubt, either one or both of them would have left some account of the transaction as related here by me, but finding no account of it in the history of either, I have given as exact an account of it as I possibly can. Having often spoken of it, I do betieve my memory to be perfectly correct. If his country had furnished. J. Fitch the means, we should have been blessed with Steam Navigation, ten or fifteen years sooner that we were

"John Hutchings.

"The progress of Steam Navigation from that date to the present period is such that nearly all Navigable waters on the face of the Globe have Steam boats on them, thus fulfilling Fitch's prediction in a letter to Franklin dated Oct. 12th, 1785.

"Charles Browne built the *Clermont* for Livingston & Fulton in 1806 and the machinery came from England. James P. Allaire who is now, and has been manufacturing machinery for Steam boats, did the brass and ornamental Work for the Boat, as I was repeatedly on board the boat and Fulton was present and I then believed him to be the same man that was with us on the Collect in 1796 or 97. The *Clermont* left the wharf at Corlears Hook & made in speed from 4 to 5 miles an hour 1807.

"The World is indebted for the original idea and to the mechanical genius of JOHN FITCH, of East Windsor, Conn.

"And to the perseverance and indefatigable attention to the use of Steam of Robert Fulton Esq. Pa. The wealth & exalted character of Robert R. Livingston Esq. Chancellor of the State of New York.

"Entered according to act of Congress in the year 1846 by JOHN HUTCHINGS in the Clerk's Office of the District Court of the Southern District of N. Y.

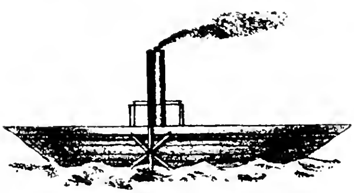
"Census of the City New York

Periods.

1697	4305	1820	123000
1699	6000	1825	166088
1756	13040	1830	203005
1771	21865	1835	259873
1790	33231	1840	312710
1800	60000	1845	371702"
1810	96373		

The illustration showing Fulton and Fitch on the boat has no cut line under it in the original, and is placed in the upper left hand corner of the sheet. The one with the flag and pennant flying has the cut line here given and stands in the upper right hand corner of the sheet. The map occupies the center of the sheet, and has no cut line. The census figures and the little cut of the Bardstown boat are placed below the map, the cut just to the right of the center line of the sheet, and the figures just to the left, so that the two balance each other. The cut line under the small illustration is as here given.

The Collect pond was filled up in 1817, and about 1840 the Tombs prison was erected on the square bounded by Elm, Leonard, Center, and Franklin streets, occupying the entire block. In the map before us this square is marked "Halls of Justice", from which we infer that in 1846 the criminal courts were held in the Tombs building. A few years ago the New Criminal Courts building was erected on the square immediately north of the Tombs, and communication between the two squares is afforded by a covered bridge spanning Leonard street, which is locally known as the "Bridge of Sighs". The middle of the pond was on the north side of Leonard street, just west of Center. Quite recently the New Criminal Courts building settled and developed numerous cracks, so that it was considered to be in a dangerous condition. A glance at the accompanying map will show that the ground upon which it stands was formerly a bog, bordering on the north edge of the Collect pond; and it will also be seen that the pond itself was sixty feet deep.



The Model Boat at Bardstown, 1797-8.

The most striking part of Mr. Hutchings' contribution is his testimony, given under oath and with no hope of personal reward, to the effect that Fulton and Livingston were actual passengers on Fitch's boat, on the Collect. This, taken in connection with the fact that Fulton lived in Philadelphia when Fitch was operating his boat there, and that Fulton afterwards had possession of all of Fitch's plans and specifications for several months*, would seem to throw the entire burden of proof upon whoever claims priority for Fulton. On the face of things, he appears to have no reasonable ground whatever for such a claim.

In our issue for January, 1910, we took occasion to remark upon a certain article that was printed in the *Practical Engineer*, of Chicago, and which, in substance, was an abstract of two that had appeared in The Locomotive. Our objection to the article lay in the fact that no credit was given to us for the matter that was thus taken from our pages. Since our remarks were printed, we have received from the managing editor of the *Practical Engineer*, assurances which abundantly satisfy us that the discourtesy was offered entirely without his knowledge or approval; and we therefore desire to offer to him and to his paper the apology that is due, and to express our regret with respect to the entire incident.

[* See The Locomotive for October, 1909, page 250.]

Selling Second-hand Boilers.

Engineers are concerned more or less with the elastic properties of materials. From gage glasses possessing little elasticity to rubber packing rings possessing a great deal, the range is very considerable. The elastic qualities of many of the materials and things that lie within these limits are interesting, but none is more inexplicable or harder to understand than the elasticity of the conscience of the average steam user when he wishes to sell a second-hand boiler. He may be a pillar in the community, and a most conscientious man in all other business transactions, but when it comes to disposing of a second-hand boiler, he seems to take, as it were, a moral holiday, and lets what is unscrupulous in him, and hidden from sight under ordinary conditions, run riot until the boiler is sold.

We should expect such a man to say: "Here is a boiler that has been condemned, and because it is not good enough for me, it is not good enough for you, and it is valuable only as scrap, and I will accept no greater amount than that which its weight justifies; and I have further caused the word 'Condemned' to be stenciled on the front head, so that no unsuspecting person may be led to use this boiler as a steam generator, and thus endanger his life and property and the lives of others." But does he do this? No. He gives the boiler a nice coat of thick tar paint and chuckles at his shrewdness as he palms it off on an unsuspecting public.

Just as all horses offered for sale are three years old, so all second-hand boilers are offered for sale because the plant has out-grown them, and they are now too small for the work. Possibly this may be the case, and it is also possible that the thick coat of tar paint which is invariably given the boiler when it is offered for sale may be in the nature of an affectionate testimonial on the part of the owner in behalf of the good service the boiler has rendered in the past; it may be merely a natural pride in having the object which he offers for sale appear at its best, but we doubt it.

If a factory closes down permanently, and the whole plant is sold piecemeal, then one would be justified in assuming that the boilers offered for sale were in as good condition as the length of time they had been in service would warrant, and in such a case one can expect to pay a reasonable price, and not to get a great bargain; but it is seldom that a large plant is abandoned and the machinery sold in this manner, and generally when a second-hand boiler is offered for sale by a concern still in operation, it is because that boiler is no good. — *Power.*

[There is much in the foregoing article that prospective purchasers should bear in mind. Yet there are some honest sellers of second-hand boilers, just as there are some honest plumbers. A boiler may be sold, for example, because it is not considered to be safe at the pressure that the seller finds it necessary to carry; but this need not of necessity signify that it would be dangerous at a lower pressure, such as might suffice for the man who is to buy it. Yet buying a second-hand boiler is a good deal like buying a pig in a poke, unless the said boiler has a certificate of good character from some competent inspector who has known it in its better days.— *Editor* THE LOCOMOTIVE.]

Water-Back and Kitchen Boiler Explosions.

In our regular lists of boiler explosions we do not include explosions of water-backs connected with kitchen ranges, nor do we include kitchen boilers of any kind, unless it appears that they were of a size or design that would fairly entitle them to be classed as something more than ordinary domestic tanks. Kitchen boilers and water-backs frequently explode, however, and often with serious consequences. A number of cases of this sort have come to our attention since the first of the year, although we make no effort to collect data regarding them. A few examples are given below.

January 5, 1910. A hot-water boiler attached to a kitchen range exploded in a dwelling house at 327 Sip avenue, Jersey City Heights, N. J. The explosion was doubtless due to the freezing of the water-pipe between the tank and the city main. Live coals were scattered about by the explosion, and fire ensued, with a resulting property damage estimated at $200.

January 5. A hot-water boiler exploded at 240 Main street, Everett, Mass., injuring Mrs. Esther Williams. The accident was due to the freezing of the water-pipe.

January 5. An accident of almost identically the same nature occurred at 83 Birch street, Roslindale, Mass., injuring Mrs. Catherine Hastings.

January 13. During the course of a fire, a kitchen boiler exploded in the residence of Albert Wood, 3224 Pierce street, San Francisco, Calif. In this case the explosion appears to have been the result of the fire, and not its cause.

February 7. A hot-water boiler exploded in the kitchen of the Memorial Hospital, Morristown, N. J. Jennie Hendershot and two other employees were seriously burned. Windows, doors, and walls were shattered. The kitchen and its contents were wrecked, and adjoining rooms were much damaged. The force of the explosion may be inferred from the fact that an opening was blown through a twelve-inch brick wall. The property loss was estimated at from $3,000 to $4,000, and the probable cause of the explosion is not stated.

February 7. A water-back exploded in the cooking range of the Tiffin Dining Club, 114 State street, Boston, Mass., setting fire to the place, with a resulting loss estimated at $35,000. The explosion is said to have been caused by the freezing of the water-pipe.

February 7. A hot-water boiler, or tank, exploded in Max Herzka's restaurant, West Twenty-eighth street, New York City. Mr. and Mrs. Herzka and Mary Phillips were badly burned, and it was thought that Mrs. Herzka could not recover. The restaurant was badly damaged, and the wreckage took fire, the total property loss being estimated at $5,000. The accident was said to be due to the freezing of the water-pipe.

February 10. A water-back exploded in A. E. Miller's residence, Hinton, W. Va. The stove was completely demolished and a number of windows were broken. The accident was attributed to the freezing of the water-pipe.

February 24. A boiler attached to a gas range exploded in the residence of Luther D. Wishard, 175 South Mountain avenue, Montclair, N. J. Miss Janet Wishard, Laura Green, and Kate Dawson were seriously injured, and it was considered doubtful if any of them could recover. The kitchen was wrecked. We have seen no estimate of the property loss, nor any statement as to the probable cause of the accident.

It will be noted that the reason assigned for the explosion in most of these cases is the freezing of the supply pipe, or feed pipe, extending from the boiler or the water-back to the city or town main. A word of explanation in regard to this may not be amiss. Kitchen boilers in this country rarely are provided with safety valves, though such valves are in common use, we are informed, in England. When the heating arrangements are operating as they are intended to operate, the pipe by which the boiler or water-back is supplied with water is freely open, and hence the pressure in the boiler cannot exceed that in the city main. If the water in the boiler is expanded by being warmed, or if the fires are run so vigorously as to generate steam, a portion of the water in the boiler merely backs out into the water main, and there is no increase of pressure.

If, on the other hand, the feed pipe through which water is introduced into the boiler becomes sealed by freezing, then the boiler or water-back has no means of relieving itself, and the expansion of the water by heat is attended by the development of a considerable pressure; and the formation of steam, if it occurs, may easily cause the boiler or the water-back to explode violently.

It will be seen, therefore, that it is highly important, before building a fire in a cold house where the range has a water-back, to assure one's self that the feed pipe is not frozen. This may easily be done by opening the faucet at the kitchen sink, through which hot water is drawn when the range is operating normally. If there is a free flow from it, we may be assured that the supply pipe is not frozen. There may, of course, be a temporary flow, with but little force, due to the head or pressure already in the pipes in the house; but any flow due to this cause will quickly cease, and the cessation must be interpreted as a danger signal.

Stoppage of the supply pipe from any cause other than freezing will of course have a result similar in all respects to that due to the actual freezing. For example, every house has a "shut-off" valve on its water system, this being usually located where the pipe enters the building, in the basement. If this valve is closed for any reason, the free communication between the boiler and the mains is thereby interrupted, and an explosion upon building a fire in the range is the probable result. In addition to the general "shut off" in the basement, a valve is sometimes placed upon the hot-water pipe near the kitchen range, on the street side of the range and its boiler, so that the entire hot water system may be isolated without shutting off the cold water supply from the rest of the house. Valves of this sort constantly invite trouble. They are intended for use only in case of leakage developing about the boiler or the piping, and they should never be closed except in real emergencies; and when they are closed, a faucet somewhere on the hot-water system should be opened at the same time, so that the boiler may be relieved of pressure in case the fire in the range generates steam in the water-back. It is safest to fasten these emergency valves in the open position by wiring their wheels, so that they cannot be accidentally closed; and if this cannot be done conveniently, the valves should be provided with tags warning the would-be operator not to close them.

In houses in which the tenants use a basement laundry in common, valves are almost invariably provided upon the hot water systems in the several kitchens; but these should always be put between the boiler and the laundry tubs, and never between the boiler and the city main. In fact, they always are so placed, except by gross error on the part of the pipe-fitter; for if they are placed on the wrong side of the boiler they will not only shut off communication with the laundry, but will also (when closed) make it impossible to draw hot water even at the kitchen sink.

In some cases check valves are placed between the street main and the boiler, to prevent hot water from backing out through the water meter in event of the generation of steam. This, of course, is a dangerous practice, since, as we have already sufficiently explained, the safety of the whole place depends upon permitting the water to back out freely in this manner; and it is far more important to protect the building and its inmates than it is to protect the water meter. Moreover, the water meter may be adequately protected in a much better way,— namely, by placing a cold-water tank of generous capacity between the boiler and the main, and locating the meter on the street side of this tank. Hot water from the boiler will then back out into the intermediate tank, thereby displacing cold water from the tank out through the meter.

That the placing of a check valve upon the water-pipe between the boiler and the main is a real source of danger, was abundantly shown in the issue of The Locomotive for December, 1903, where an explosion due to this cause is illustrated and described.

Returning to the matter of frozen pipes, it should be borne in mind that the test proposed above, of trying the hot-water faucet before building a fire, will not detect stoppage of the pipes between the water-back and the boiler. If both the pipes connecting these two are frozen solidly, the water-back will be thereby shut off from communication with the boiler, while the boiler itself may yet be in free communication with the city main. Building a fire in the range will then be very likely to cause a disastrous explosion of the water-back, although no harm would come to the boiler. To prevent an accident of this kind, judgment must be exercised. If it is known, for example, that the kitchen has been less cold than the pipes have been elsewhere, it may be reasonably inferred that the water-back is not frozen, provided the rest of the pipes are free. If there is any doubt, no fire should be built in the range until the kitchen has been heated by other means (say by gas or by lamps or by warm air from other rooms) to a temperature well above the freezing point (32° Fahr.), for a considerable time.

A frozen water-back may also be thawed out without danger by keeping a *very light* fire of paper or shavings in the range, provided care is taken to prevent the range from becoming more than moderately warm in the region of the water-back. We have some hesitation in making this suggestion, however, because if the operation is not carried out intelligently, it may lead to the very result that it is designed to prevent. The running of such a light fire, for thawing the water-back, should certainly not be entrusted to an ordinary domestic servant.

There is a slight but unimportant error on page 253 of the issue of The Locomotive for October, 1909, in the article entitled "Robert Fulton or John Fitch." The third signature should read "Luke E. Wood, Committee",—*not* "Luke E. Wood, *Senate* Committee". The error arose from a misunderstanding of the official record.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1910.

Capital Stock, . . . $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission,		$154,845.83
Premiums in course of collection,		228,048.46
Real estate,		93,600.00
Loaned on bond and mortgage,		1,107,060.00
Stocks and bonds, market value,		3,063,476.00
Interest accrued,		67,580.50
Total Assets,		$4,714,610.79

LIABILITIES.

Re-insurance Reserve,		$1,943,732.29
Losses unadjusted,		90,939.53
Commissions and brokerage,		45,609.69
Other liabilities (taxes accrued, etc.),		41,835.50
Capital Stock,	$1,000,000.00	
Surplus,	1,592,493.78	
Surplus as regards Policy-holders,	**$2,592,493.78**	2,592,493.78
Total Liabilities,		$4,714,610.79

On January 1, 1910, THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY had 104,589 steam boilers under insurance.

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FRANCIS B. ALLEN, Vice-President. CHAS. S. BLAKE, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
W. R. C. CORSON, Assistant Secretary.

A. S. WICKHAM, Superintendent of Agencies.
E. J. MURPHY, M. E., Consulting Engineer.
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The Locomotive

VOL. XXVIII. HARTFORD, CONN., JULY 25, 1910. No. 3.

Water-Hammer Action in Steam Boilers.

"Water-hammer action" is the action that occurs, in a steam boiler or in steam piping, when a mass of water is driven with a considerable velocity against a solid body, or against another mass of water, in such a way as to have its motion suddenly checked or destroyed. Under these circumstances a severe momentary pressure is generated in the region where the collision occurs,

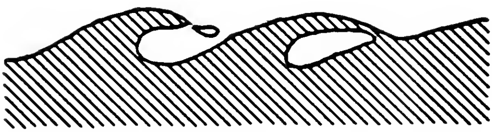


FIG. 1.— FORMATION OF A BUBBLE.

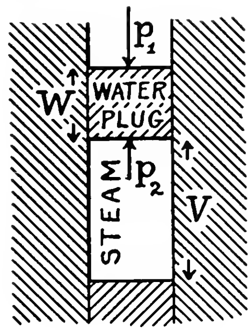


FIG. 2.— THE CYLINDRICAL PLUG OF WATER.

just as there is when we bring a heavy sledge hammer down forcibly upon an anvil. If the moving water strikes directly against the boiler shell, the pressure is also exerted directly against the shell; while if the moving mass is stopped by colliding with another mass of water, the pressure arises in the midst of the fluid, where the collision occurs. In the latter case, however, a pressure-wave is generated in the water, and this travels forward until it presently comes to bear against the shell of the boiler. In either case, therefore, the shell will be subjected to a shock, as the result of the sudden stoppage of the moving water; and under suitable conditions this shock may be very heavy indeed — quite sufficient, in fact, to rend the boiler in pieces.

CONDITIONS FOR THE DEVELOPMENT OF WATER-HAMMER ACTION.

It is plain, from what has been said, that the immediate conditions for the development of water-hammer action are two in number. (1) Some portion of the water must be caused to move with a considerable speed, and (2) this moving mass must strike against the boiler, or against another mass of water, in such a way that its own speed is *suddenly* checked or destroyed. The pressure that is generated is only momentary, but it may be of great intensity during the instant that it lasts.

The violent commotion which precedes and leads to the water-hammer effect cannot arise unless there are sensible differences of pressure *or of temperature*, within the boiler. There can be no water-hammer action, for example, in a boiler whose contents are everywhere at the same temperature and pressure.

In practice we find that the action develops in undrained steam pipes when steam is turned into them, and in boilers that are being cut in (*) with a steam main that is already in communication with other boilers; but in order to realize it, the conditions referred to above must be fulfilled. That is, the water and steam must be at different pressures, or at different temperatures.

When a boiler is cut into a steam main, it will be the difference in *pressure* that determines the action, provided the pressure in the boiler *exceeds* that in the main; for when we open the stop-valve under these circumstances, the water in the boiler will tend to "lift," and considerable masses of it may be thrown against the shell, with a resultant shock that may be sufficient to produce rupture.

Conversely, if the pressure in the boiler is *less* than that in the main, the action will be primarily due to the difference in *temperature* between the steam in the pipe and the water in the boiler. (This will appear later.)

The case in which the pressure in the boiler is *greater* than that in the pipe, and the action consists in the lifting of the water, is undoubtedly the better understood of the two, and we shall therefore dwell, in this article, upon the second case, in which the pressure in the boiler is *less* than that in the main. This second case appears to be widely misunderstood by engineers in general, and yet it is the one that is most likely to arise in practice; for in firing up a boiler that has been out of service for a time, the attendant is far more likely to cut it in as soon as the pressure *approaches* that in the main, than he is to wait until it is *higher* than that in the main. In fact, it is a more or less common (though highly dangerous) practice, to cut in the boiler as soon as the pressure comes up to within (say) ten or fifteen pounds of that prevailing in the pipe line at the time.

Our attention has been called quite recently to a plant in the South, where the practice was, for a time, to fill up a boiler with comparatively cold water, and then to open its stop-valve at once, so that the steam in the main would assist in bringing the water up to the operating temperature. It seems incredible that this can be true, and the boiler still remain upon earth; but from the representations that have been made to us we are forced to believe it. At all events the practice has been discontinued in that particular plant, on account of certain emphatic counsel given by our inspector. The superintendent of the plant admitted, by the way, that the boiler occasionally "jumped some" while it was being warmed up. Why it didn't jump a couple of miles is a mystery that we cannot solve.

THE TWO POINTS OF VIEW.

We may look at the water-hammer problem from two different points of view. Thus we may ask ourselves (1) what pressure may be produced within a boiler by water-hammer action, or we may ask (2) what is the maximum mechanical work that can be performed, under given circumstances.

The first of these questions cannot be answered with any approach to precision, partly because we never know, in any given case, just how the water in the boiler is thrown about, and partly because the entire theory of impact is still in an imperfect state, as we have already explained at some length, in

* For the benefit of the non-technical reader, it may be well to explain that "cutting in" a boiler is the act of putting a boiler that has been previously isolated, into full and free communication with a steam main that is already carrying the pressure from other boilers.

the issue of THE LOCOMOTIVE for July, 1909. The second question can be definitely answered, however, since, in solving it, we do not need to know the exact way in which the disturbance of the water takes place.

We shall take up these two questions in order.

NATURE OF THE DISTURBANCE IN THE BOILER.

In dealing with the momentary pressure that water-hammer can produce in a boiler, we have, first, to go over a line of reasoning very similar to that given in THE LOCOMOTIVE for July, 1909; so that we can here treat the matter more briefly than might otherwise be permissible, referring the reader, for a further elucidation of the principles involved, to the articles in the issue cited.

The steam that is discharged into the boiler from the main disturbs the surface of the water there, and generates waves; and the moment one of these waves breaks, so as to form a sort of bubble enclosing some of the steam, the water-hammer action begins. (See Fig. 1.) For, by hypothesis, the water is somewhat cooler than the steam (on account of the original pressure in the boiler being lower than that in the main), and it follows that the steam enclosed within the bubble will condense, leaving a partially vacuous space there. The pressure acting upon the surface of the water will then close the bubble up almost instantly, the water that forms its upper wall being brought down against that which forms the bottom of it, with great speed and corresponding violence. The hammering action thus initiated will increase the disturbance in the water, and larger and larger bubbles will be formed in the same way, with the production of increasingly violent shocks when they collapse.

A more concrete idea may be had of the action by considering the familiar operation of blowing steam into cold water from a small pipe. A bubble of steam forms momentarily, and is immediately condensed by the cooler water, the sides of the bubble coming together with a resounding crack. In the boiler the case is similar, save that the experiment is there performed on a terrible scale, with steam furnished by a battery of boilers, through a six-inch pipe (perhaps) instead of a quarter-inch one, and with the bubbles, quite likely as big as water-pails, collapsing under a pressure of 100 pounds or so, per square inch, instead of under simple atmospheric pressure.

IDEAL CASE OF A CYLINDRICAL PLUG OF WATER.

In order to estimate the magnitude of the momentary pressure that is produced in the water by these sudden shocks, we proceed as follows:

Consider first (as in our previous article of July, 1909, already cited), the case of a cylindrical plug of water, moving along the interior of a smooth, cylindrical tube which it just fills. (See Fig. 2.) Underneath the plug there is a space which is filled, at the outset, with steam fresh from the main steam pipe, and having, therefore, a temperature higher than that of the water in the boiler. Now let us suppose that the imaginary tube in which the plug travels is surrounded by water at the temperature that prevails in the boiler, and that the walls of the tube are not real walls, of metal, but that they are imaginary, permitting the free passage of heat, while not allowing the water composing the plug to flow out sidewise.

Under these circumstances the steam under the plug, being surrounded by water cooler than itself, will partially condense. Its pressure will promptly fall, in fact, to the pressure corresponding to the temperature of the water.

If we represent the pressure in the steam main by p_1, and the reduced pressure below the plug by p_2, and if we also assume that the sectional area of the plug is one square inch, we see that (as indicated in Fig. 2) the plug is subject to a downwardly-directed force equal to p_1, and an upwardly-directed force equal to p_2. Since p_1 is greater than p_2, the resultant force acting on the plug is downward, and equal to $p_1 - p_2$. In forcing the plug downward through a distance of V inches, so as to cause the space under it to disappear, the work done by the steam is therefore $(p_1 - p_2) V$ inch-pounds.

As soon as the plug strikes the water below it, a pressure is produced at the surface where the two come together, accompanied by a local compression of the water along that surface, in the vertical direction. This pressure at the surface of contact acts downward on the free substratum of water, and upward on the water-plug. The motion of the plug is arrested at this point, but the rear (or upper) part of the plug will continue to press forward, for a moment, after the front part has become stationary. So far as the pressure within the water is concerned, the effect will be as though there were a wave of compression transmitted through the water, traveling with the same velocity as sound (since sound is only a succession of compression waves). As soon as the wave of compression has passed back through the plug and reached its rear (or upper) surface, this rear surface will also become stationary, and for an instant the entire plug will be motionless and in a state of uniform compression. The compressive stress to which it is subjected at this instant, by reason of its own sudden loss of momentum, is, in fact, the "water-hammer pressure" that we are seeking to determine.

The water below the plug will be compressed, in just the same way as is the water of the plug itself; and since the compression wave will have the same velocity, downward through the free water, as it has backward through the plug itself, it follows that at the moment when the pressure-wave reaches the back end of the plug (the length of which we will call W inches), it will also have penetrated the water below the plug to the same distance. Hence, at the instant the plug comes to rest, there will be a *total* volume of water under compression, equal to $2W$ cubic inches (the sectional area of the plug being one square inch); half of this being the volume of the plug itself, and the other half being the volume of that part of the free water which is also at the same time under an equal compression.

If we think of this volume, $2W$, as being under a momentary uniform compression equal to P lbs. per square inch, we may deduce the pressure, P, by the following process: Let C be what is termed the "modulus of compressibility" of water. That is, C is the pressure, per square inch, that would suffice to compress the water to nothing, if its diminution of volume, at indefinitely high pressures, should follow the same law that holds for pressures that are moderate. (Of course there is no pressure that actually would compress the water to a zero volume; but the "modulus of compressibility," as defined above, is an exceedingly convenient thing to use, in practical computations.) Also, let x be the amount by which the volume $2W$ of the compressed water is reduced by the actual (though as yet unknown) pressure P. We then have the proportion

$$P : C :: x : 2W.$$

And solving this for x we find

$$x = \frac{2PW}{C}$$

The work done in compressing a liquid is very nearly independent of the way in which the compression is performed. (We mention this, because the fact is quite otherwise with a gas or vapor.) Hence the potential energy stored up in the compressed water will be the same (or sensibly the same) as it would be if we effected the compression slowly and uniformly, beginning with the pressure at zero, and gradually increasing it up to P. Now in this case the *average* pressure applied would be $\frac{1}{2}P$; and multiplying this by x (the height by which the volume $2W$ has been reduced), we find that the total work done would be $\frac{1}{2}Px$. And if we replace x by its value as just found, above, we see, finally, that the potential energy stored in the $2W$ cubic inches of water under compression is $\frac{P^2 W}{C}$

Now since energy cannot be created nor destroyed, this must be equal to the work done by the steam in pushing the plug to the end of its cylindrical passage; and hence we have the equation

$$(p_1 - p_2)\ V = \frac{P^2 W}{C}$$

which, upon being solved for P, gives

$$P = \sqrt{\frac{(p_1 - p_2)\ C\ V}{W}}$$

This, it is to be remembered, is the expression for the pressure that may be produced in the *ideal* case, in which a plug of water is driven along a cylindrical channel so as to come suddenly and violently against another mass of water of equal cross section, and extending indefinitely in the direction of the length of the channel.

Application to the Actual Case.

In order to see how the foregoing formula for P applies in the actual case that arises in practice, let us consider a bubble of rectangular shape, such as is indicated in Fig. 3. This consists, as will be seen, of a sort of slab of water, of thickness W, raised to a distance V. Let us imagine the upper slab, the space below it, and the water that lies below the space, to be divided into imaginary cylindrical tubes, as suggested by the dotted lines. If, now, the top wall, or slab, comes down uniformly in all its parts when the bubble collapses, the water in each of these imaginary cylindrical tubes will act just as we have supposed the plug to act, in the ideal tube described above. There will be no sidewise flow of the water, or none of any account, provided the rectangular bubble is big enough in its horizontal dimensions. Hence the formula will be as applicable to this case, as it is to the case of the single plug in its cylindrical tube.

Finally, if the bubble, instead of being rectangular, is more or less oval or ellipsoidal, as in Fig. 4, the pressure actually developed will agree with the calculated pressure to an order of approximation corresponding to the (unknown) degree in which the conditions in the actual case conform with those that were assumed to exist, in deriving the formula.

After the pressure that is due to the impact has been generated, it is transmitted through the water to the boiler shell. In this transmission it will be somewhat lessened in intensity, and it will be propagated mainly in the direction in which the top slab of the bubble collapses.

We have supposed, for the sake of simplicity, that the bubble collapses vertically; but since the water in the boiler is thrown about in an utterly indescribable manner, the actual collapse may take place horizontally or obliquely, and hence the maximum pressure may be exerted upon the boiler shell sidewise, or in any other direction.

The formula may be expressed in words as follows: First find the difference $(p_1 - p_2)$ between the pressure in the steam main and that in the boiler before opening the valve, and multiply this by the modulus of compressibility of water (C), which may be taken as equal to 300,000 lbs. per square inch. Then multiply

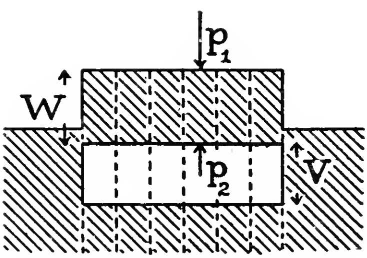


FIG. 3. — RECTANGULAR BUBBLE.

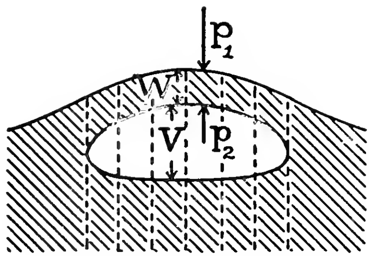


FIG. 4. — OVAL BUBBLE.

again by the depth (V), in inches, of the steam inside of the bubble, measuring this depth in the direction in which collapse takes place. Finally, divide the product so obtained by the thickness of the upper layer (W) of the bubble, in inches, and take the square root of the quotient. The result will be the momentary pressure produced in the water by the collapse of the bubble.

This rule, be it understood, cannot be used to determine anything but the general *order of magnitude* of the pressures produced by water-hammer. No rule could do more than this, however, when applied to a problem as indefinite as the one with which we are dealing. Yet with all its limitations the rule has a considerable value, since it shows that water-hammer effects may be exceedingly serious, and that we need to guard against their production, with the greatest care.

NUMERICAL EXAMPLE.

Let us now apply the formula to the calculation of the maximum possible pressure that water-hammer might produce, in a particular case. We shall suppose, for this purpose, that a boiler is being cut in with others, and that the pressure it carries is less than that prevailing in the steam main at the time. We shall assume that the pressure in the main is 95 lbs. per square inch, and that that in the boiler is 88 lbs. per square inch.

In this example, as in all others of like nature, we shall have to arbitrarily assume the thickness of the bubble and of the top layer thereof. We cannot tell what these thicknesses were, but we must endeavor to choose values for them that might reasonably be expected to occur. Let us suppose that the thickness of the steam-filled portion of the bubble was 6 in., and that that of the slab, or top portion, was 3 in. Then our rule works out as follows: The difference between the pressure in the steam main and that prevailing in the boiler just before opening the stop-valve was 95 — 88 = 7 lbs. per sq. in. This, multiplied by 300,000, gives 300,000 × 7 = 2,100,000. Multiplying again by the thickness of the steam space of the bubble, we have 2,100,000 × 6 = 12,600,000. Then, dividing this by the thickness of the top layer of the bubble, we have 12,600,000 ÷ 3 = 4,200,000. And, finally, taking the square root of this last number, we have $\sqrt{4,200,000} = 2,049$ lbs. per sq. in., which is the maximum pressure that could be developed by water-hammer action in the given boiler, under the assumed conditions. It is evident, here, that we may make very large allowances indeed for the fact that the conditions may not have been just like those pre-supposed, and yet we shall have a pressure quite sufficient to cause the rivets, or any other part of the boiler, to snap at once — especially when we remember that the instantaneous pressure developed by the water-hammer action was in *addition* to the normal load of 95 lbs. per sq. in., which the steam exerted upon the shell directly, as soon as the stop-valve was opened.

Once again we may state that when a boiler is burst by water-hammer action, the pressure that is generated acts only for an instant, and its effect upon the boiler is similar to that of a sudden hydrostatic pressure. That is, it disrupts the boiler, but it does not throw the pieces about. The momentary water-hammer pressure having separated the parts of the boiler, it is the normal steam pressure within the boiler that does the rest of the work.

The Maximum Amount of Mechanical Work that can be Performed.

We come, now, to the second aspect of the water-hammer question. Namely, we have to look at the case from the following point of view, which is more general than the one from which we have approached it above. A boiler containing a mass of water at a given temperature is placed in free communication with a steam main capable of supplying a practically unlimited amount of steam at a pressure higher than that due to the temperature prevailing within the boiler. As we have here two bodies, or substances, at two different temperatures (namely, the steam in the main and the water in the boiler), the theory of heat teaches us that a certain amount of mechanical energy can be developed, as an accompaniment to the process of temperature-equalization which at once begins. The quantity of mechanical energy that can be so developed, however, is strictly limited by the laws of thermodynamics; and it is not at all difficult to find an expression from which its maximum amount can be calculated.

Let t_1 be the temperature of the steam that is admitted from the steam main — this being constant throughout the entire operation, since the steam is furnished by outside boilers, at a constant pressure and temperature. Also, let t_2 be the temperature that the water in the boiler has at the outset, just as the stop-valve is opened. As soon as the steam, at the higher temperature t_1, enters the boiler, it comes in contact with the cooler water there, and begins to condense; and although the heat that it gives out in condensing may be partially converted into mechanical energy, available for throwing the water in the boiler about, the major portion of it must go to the direct heating of the water, without the production of any such mechanical work. In fact, the principles of thermodynamics, upon which we have dwelt in many of the previous issues of The Locomotive, show that when, in the equalizing process, the incoming steam gives up a small quantity of heat — a quantity so small, namely, that it does not materially alter the temperature of the water in the boiler as a whole — we may find the maximum quantity of mechanical energy that can be developed, by multiplying this small quantity of heat (expressed in foot-pounds) by the fraction

$$\frac{t_1 - t_2}{t_1 + 459.7°},$$

the constant number 459.7° being the Fahrenheit temperature of the Fahrenheit zero, on the absolute scale of temperature.

If, as in the example worked out above under the other rule, we take the pressure in the main at 95 lbs. per square inch, and that in the boiler before the stop-valve was opened at 88 lbs., we find, by consulting a table of the properties of steam, that the temperature (t_1) of the steam in the main was 334.4°, and that the temperature (t_2) of the water in the boiler was 329.5° Fahr. Hence $t_1 - t_2 = 334.4° - 329.5° = 4.9°$, and $t_1 + 459.7° = 334.4° + 459.7° = 794.1°$. With these values of the temperatures, the foregoing fraction becomes equal to $4.9 \div 794.1 = 0.00617$; so that when the entering steam begins to condense, the first foot-pound of heat that it gives up can generate 0.00617 of a foot-pound of mechanical energy, which can manifest itself by throwing the water about; but the remaining 0.99383 of the foot-pound must pass directly and quietly into the water, without appearing in the mechanical form at all.

As the water in the boiler rises in temperature, owing to the heat that it is receiving from the steam, the same sort of a calculation can be made at every stage of the process. The only difference will be, that the value of t_2 will increase as the water warms up, while the value of t_1 remains constant. The fraction that expresses the proportion of the heat that can be converted into mechanical energy will grow less, therefore, as the temperatures become equalized. The *average* value of the expression given above for the efficiency of the conversion is

$$\frac{1}{2} \cdot \frac{t_1 - t_2}{t_1 + 459.7°};$$

and if we multiply this last expression by the total amount of heat given up by the steam, we shall have the *total* amount of mechanical energy that can be developed, within the boiler, as a result of cutting it into the steam line, at a temperature (or pressure) below that of the steam in the main.

Now the total amount of heat that is given up by the steam is equal to that absorbed directly by the water, *plus* that which is converted into mechanical energy. But since considerably more than 99 per cent. of that which the steam gives up is directly absorbed by the water, we shall not commit any error of the slightest practical importance if we assume, in this particular calculation, that the two are equal. If the average specific heat of the water between t_1 and t_2 is S, then each pound of water, in becoming warmed from t_2 to t_1, will absorb $S(t_1 - t_2)$ units of heat. To express this quantity of heat in foot-pounds, which is a more convenient way for our present purposes, we have merely to multiply it by Joule's equivalent, which we will take at 780 foot-pounds per Fahrenheit heat unit. Moreover, we may take the specific heat, S, of the water as equal to unity. Hence the total quantity of heat absorbed by the water is $780 (t_1 - t_2)$ foot-pounds. Assuming that this is equal to the amount given up by the steam (as explained above), we have merely to multiply it by the fraction given in the preceding paragraph, and again by the number of pounds (say w) of water in the boiler, and we have the total number of foot-pounds of mechanical energy that can be developed when the boiler is cut in with its fellows. Thus the expression in question becomes

$$\frac{390w(t_1 - t_2)^2}{t_1 + 459.7^\circ}.$$

In words, this may be expressed as follows: Find the square of the difference in temperature between the steam in the main and the water in the boiler, multiply this by the number of pounds of water in the boiler, and multiply again by the constant number 390. Then divide the product so obtained by the temperature of the steam *plus* 459.7°. (Fahrenheit temperatures are to be used.) The result is the greatest possible number of foot-pounds of mechanical work that the water can do, in being thrown about as a consequence of the boiler being cut in before the pressure within it has become equal to that prevailing at the time in the steam main.

Application to a Numerical Example.

By way of illustration, we shall apply this formula to the same example as before. We have already found the difference of temperature between the water and the steam to be 4.9°. The square of this is $4.9 \times 4.9 = 24.01$. We shall throw away the small decimal, and call it 24. We next need to know the total weight of water in the boiler, and for the purposes of illustration we shall take this to be 12,000 lbs. Then proceeding with the application of the rule, we have $12{,}000 \times 24 = 288{,}000$; and $288{,}000 \times 390 = 112{,}320{,}000$. We have already found that $t_1 + 459.7^\circ = 794.1$. Hence we have $112{,}320{,}000 \div 794.1 = 141{,}440$ foot-pounds, which is the maximum quantity of mechanical energy that could be developed inside of the boiler, as a consequence of cutting it in with the others before the pressure had become equalized to within less than seven pounds per square inch.

As before, this result is merely a *maximum* one, but in obtaining it we do not have to make any supposition respecting the proportions of the steam bubbles that are formed. The result is exact, save that we have made certain assumptions of a merely arithmetical nature, in the interest of simplicity — assumptions which certainly do not affect our conclusion by more than a few per cent.

A mere fraction of this maximum available amount of work would suffice, without doubt, to start the rivets shearing; and, as we have several times remarked, it is the steam pressure normally within the boiler that throws the parts asunder, when once the work of disruption has been well begun. The energy developed directly by the water-hammer does not have to account for any portion of the mechanical work of the explosion, save that which is required to stress some of the parts up to their breaking points.

We would direct attention particularly to the fact that the quantity of mechanical energy that can be developed within the boiler, and be manifested by throwing the water about with more or less violence, varies as the *square* of the difference in temperature between the water and the steam. Hence if this difference were *twice* as great as we have assumed, the quantity of mechanical energy that could be developed, under otherwise similar conditions, would be *four times* that calculated above.

Can the Water-Hammer Action be Delayed?

Water-hammer action, if the conditions for its occurrence exist, usually begins the moment the stop-valve is opened. If, however, the pressure in the main exceeds that in the boiler, and the stop-valve is opened cautiously, there appears to be no reason why the steam might not enter quietly. Part of it must condense, of course, on account of the chilling action of the water upon it; but this might conceivably occur without mechanical disturbance, the superficial layers of the water in the boiler becoming heated, so that a sort of equilibrium would be established. If nothing should occur to agitate the water, this state might persist until the entire bulk of the water became heated up to the temperature of the steam in the main; and after that no water-hammer would be possible.

The pseudo-equilibrium thus established would be highly *unstable,* however, and the least disturbance of the water, by bringing its deeper and cooler layers to the surface, would precipitate water-hammer action at once. It would be only under the most *exceptional* circumstances that delayed development such as we have suggested could occur, and yet such delay is manifestly *possible.*

Precautions for the Avoidance of Water-Hammer Action.

In conclusion, let us emphasize the fact that it is of *exceeding* importance, in cutting in a boiler, to be sure that the pressure upon it is as exactly identical as possible with the pressure that is prevailing, at the time, in the steam main. Mathematically exact equality can hardly ever be attained, however, partly because commercial steam gages will seldom agree to within a pound or so. Hence when the equality of pressure is judged to be exact, the stop-valve should be opened very carefully indeed — opened just a bare crack at first, and then, as the slight outstanding difference of pressure equalizes itself, opened wider, very slowly, until it is open full. The complete operation should occupy a couple of minutes or more, and the attendant should hold himself in readiness, at every instant, to close the valve at once, if there is the slightest evidence of any unusual jar or disturbance of any kind, about the boiler.

Boiler Explosions.

April, 1910.

(149.) — A heating boiler exploded, April 1, in the Portland Mfg. Co.'s factory, Portland, Mich. One man was injured, and the plant was badly damaged.

(150.) — The boiler of a Milwaukee locomotive exploded, April 2, at River Junction, near La Crosse, Wis. Two men were badly injured.

(151.) — Four tubes burst, April 2, in one of the boilers of the U. S. cruiser *Maryland,* near Santa Barbara, Calif. One man was killed, two were fatally injured, and two other received lesser injuries.

(152.) — A boiler flue failed, April 4, at the Delaware River Steel Co.'s blast furnace, Chester, Pa.

(153.) — A boiler exploded, April 5, in Horace M. Moser's stone crushing plant, Mount Carmel, Pa. The boiler was thrown three blocks, over the tops of a dozen houses, but nobody was hurt.

(154.) — A portable boiler, owned by McCarry & Co., of Knoxville, Tenn., exploded, April 5, near Newport, Tenn. Two men were badly hurt.

(155.) — The boiler of a Santa Fé railroad locomotive exploded, April 6, at Gallup, N. M. One man was killed.

(156.) — On April 6 a blowoff pipe failed at the plant of the Beaven-Jackson Lumber & Veneer Co., Evergreen, Ala.

(157.) — A slight explosion occurred, April 6, at the Illinois Steel Co.'s plant, Joliet, Ill. One man was seriously injured.

(158.) — The boiler of a Michigan Central locomotive exploded, April 6, near Grayling, Mich. One man was killed outright, and two others were fatally injured.

(159.) — A tube ruptured, April 8, in a water-tube boiler at the plant of the Cincinnati Horse Shoe & Iron Co., Cleves, Ohio. Two men were injured.

(160.) — A boiler tube failed, April 8, in the power house of the Oil Well Supply Co.'s Twenty-first street plant, Pittsburg, Pa. Three men were scalded.

(161.) — A tube ruptured, April 10, in a water-tube boiler at the blast furnace of Pickands, Mather & Co., Toledo, Ohio.

(162.) — On April 10 a tube ruptured in a water-tube boiler in the Brooklyn Rapid Transit Co.'s power house, Kent Avenue and Division street, Williamsburg, N. Y. Four men were injured, two of them fatally.

(163.) — A slight boiler explosion occurred, April 13, at the American Sheet & Tin Plate Co.'s plant, Dresden, Ohio.

(164.) — A tube ruptured, April 13, in a water-tube boiler in the Lavonia Cotton Mills, Lavonia, Ga.

(165.) — A boiler exploded, April 14, at the plant of the Robinson Water, Light & Heat Co., Robinson, Ill. Two men were injured, and the property damage amounted to about $5,700.

(166.) — A tube ruptured, April 16, in a water-tube boiler at the Crescent Portland Cement Co.'s plant, Wampum, Pa.

(167.) — A boiler exploded, April 16, in a new sawmill plant at Madison, Boone county, W. Va. One man was killed and three others were fatally injured.

(168.) — A tube ruptured, April 16, in a water-tube boiler at the Omaha Electric Light & Power Co.'s plant, Omaha, Neb. One man was slightly injured.

(169.) — The boiler of a locomotive exploded, April 16, at Monterey, Mex., in the yards of the National Railways of Mexico. Eleven men were instantly killed, and two others were terribly injured.

(170.) — A boiler exploded, April 17, in the municipal light and power plant, at Santa Maria, Calif. One man was injured, and the boiler house was wrecked.

(171.) — A boiler exploded, April 18, in the Miller sawmill, at Casper, Wyo. One man was killed.

(172.) — A tube ruptured, April 19, in a water-tube boiler at the plant of the National Malleable Casting Co., 52d Avenue and 11th street, Chicago, Ill.

(173.) — A blowoff pipe failed, April 20, at the Birmingham Coal & Iron Co.'s plant, Short Creek, Ala.

(174.) — A heating boiler exploded, April 21, in the Rich block, Malden, Mass. The property loss was estimated at $3,500.

(175.) — A tube failed, April 21, in a superheater attached to a water-tube boiler at the water works and light station, Bloomington, Ill.

(176.) — A boiler exploded, April 21, in a small lumber mill operated by George Noyes, at Orneville, near Milo, Me. Property loss, $1,000.

(177.) — A boiler exploded, April 21, at the Wyoming Brick Works, Wyoming, Pa. Fireman Burke was terribly injured and is likely to die.

(178.) — A slight explosion occurred, April 21, at the Eleanor Moore Hospital, Boone, Iowa. One person was severely injured.

(179.) — A heating boiler exploded, April 24, in Julius Thomesert's residence, 4730 Sheridan road, Chicago, Ill.

(180.) — On April 24 a slight accident befell a boiler in the Equitable Electric Light Co.'s plant, Lake Geneva, Wis.

(181.) — A boiler belonging to A. Cameron exploded, April 25, at Chatham, Canada.

(182.) — A slight explosion occurred, April 25, in the heating apparatus in the residence of Prof. H. G. Chase, West Somerville, Mass. Fire followed, and the total property loss was about $1,000.

(183.) — The boiler of a locomotive on the C. & O. R. R. exploded, April 26, at Russell, Ky. Three men were severely injured.

(184.) — On April 27 an accident befell a boiler in the No. 1 ice plant of Victor Erath, New Iberia, La.

(185.) — A small boiler exploded, April 28, in the Wilson greenhouses, Des Moines, Iowa.

(186.) — A tube ruptured, April 28, in a water-tube boiler in the Union Special Machine Co.'s plant, Chicago, Ill.

(187.) — On April 28 a boiler exploded in Tidwell Bros.' sawmill, ten miles east of Selmer, Tenn. One man was killed, and nine were injured. Property loss, about $1,200.

(188.) — A boiler belonging to W. A. Willig exploded, April 29, at St. Cloud, Minn.

(189.) — A blowoff pipe ruptured, April 29, at the City Water Works, McAlester, Okla. One man was slightly injured.

MAY, 1910.

(190.) — A boiler exploded, May 2, on a steam dredge, off the foot of Hamburg place road, Newark, N. J. One man was killed and eight were severely injured. The dredge, which belonged to the Newark Meadow Improvement Co., was wrecked and sunk.

(191.) — On May 2 a manifold ruptured in a cast-iron sectional boiler in Henry Joseph Richter's school, at Grand Rapids, Mich.

(192.) — A tube ruptured, May 3, in a water-tube boiler at the Helenbacher Forge & Rolling Mills plant of the American Car & Foundry Co., St. Louis, Mo. One man was injured.

(193.) — The boiler of locomotive No. 195, attached to the Pitcairn express, on the Pennsylvania railroad, exploded, May 6, at Pittsburg, Pa., near the old Ben Venue station. One man was killed and five were injured.

(194.) — The crown-sheet of a boiler of the locomotive type collapsed, May 7, in the Sioux Falls Gas Light Co. plant of the United Gas Improvement Co., at Sioux Falls, S. Dak.

(195.) — A heating boiler exploded, May 7, in the Y. M. C. A. building, Lansing, Mich. The property loss was estimated at $500.

(196.) — A boiler shell ruptured, May 7, in the Pennsylvania Milk Product Co.'s dairy, at Shippensburg, Pa.

(197.) — The boiler of a locomotive exploded, May 7, at Waycross, Ga. One man was killed.

(198.) — A tube ruptured, May 7, in a water-tube boiler at Armour & Co.'s glycerine works, 31st and Benson streets, Chicago, Ill. Two men were injured.

(199.) — A blowoff ruptured, May 8, in the water works and electric lighting plant at St. Johns, Mich.

(200.) — A tube ruptured, May 10, in a water-tube boiler at the U. S. Portland Cement Co.'s plant, Yocemento, Kans.

(201.) — A boiler exploded, May 11, in a sawmill near San Bernardino, Calif. One man was killed.

(202.) — A big hot-water boiler exploded, May 11, in the basement of the quarters occupied by Troop L, Sixth cavalry regiment, at Fort Des Moines, Des Moines, Iowa. The building was partly wrecked.

(203.) — Several cast-iron headers fractured, May 13, in the American Graphite Co. plant of the Joseph Dixon Crucible Co., Graphite, N. Y.

(204.) — The boiler of a New York, New Haven & Hartford railroad locomotive exploded, May 13, at Green Haven, near Poughkeepsie, N. Y. Two men were severely injured.

(205.) — On May 13 a slight boiler explosion occurred in the Gisholt plant, Madison, Wis.

(206.) — A boiler explosion occurred, on May 13, at the McIlroy Belting & Hose Co.'s plant, 131 North Canal street, Chicago, Ill. The plant was destroyed by the fire that followed, the entire loss being about $25,000.

(207.) — A blowoff pipe failed, May 14, at the Easley Cotton Mills, Easley, S. C. One man was fatally scalded.

(208.) — An internally fired water-tube boiler exploded, May 15, in the plant of the Fremont Gas & Electric Light Co., Fremont, Neb.

(209.) — A boiler exploded, May 15, at the plant of the Diamond Coal & Coke Co., at Chewtown, near Brownsville, Pa. Three persons were killed, and six seriously injured. The property loss was estimated at $25,000.

(210.) — A handhole plate failed, May 16, in a water-tube boiler at the Barney & Smith Car Co.'s plant, Dayton, Ohio. One man was scalded to death.

(211.) — A hot-water boiler exploded, on or about May 16, in the basement of the three-story dwelling at 4457 Matilda avenue, Borough of the Bronx, New York. A large section of the front of the house was blown out, and the damaged building took fire. The total loss was about $2,000.

(212.) — A boiler exploded, May 16, in O'Neil's mill, at Arthur, Ont. Total property loss estimated at $20,000.

(213.) — A boiler exploded, May 17, in the McCurdy Lumber Co.'s plant, at Fruithurst, Ala., twelve miles west of Tallapoosa, Ga. One man was killed, one was fatally injured, and five others received injuries more or less serious, but not fatal.

(214.) — A boiler exploded, May 17, at the plant of the American Sheet & Tin Plate Co., Canton, Ohio. Thirteen persons were killed and fifty were injured, and the property loss was many thousands of dollars.

(215.) — A boiler belonging to the Zeir Oil Co. exploded, May 18, near Los Angeles, Calif. Two persons were severely injured.

(216.) — A cast-iron header fractured, May 18, in a water-tube boiler at shaft No. 2 of the Kingston Coal Co., Kingston, Pa.

(217.) — A boiler exploded, May 19, at J. R. Brown's sawmill, in Jones county, Ga. Two men were killed and the mill was wrecked.

(218.) — A tube ruptured, May 19, in a water-tube boiler at the East Palisade Irrigation District plant, Palisade, Colo.

(219.) — A slight explosion occurred, May 19, in the Monarch Laundry, Shamokin, Pa.

(220.) — On May 19 a boiler exploded in A. F. Sides' sawmill, near Winston-Salem, N. C. Mr. Sides was slightly scalded. The explosion was heard for miles.

(221.) — On May 19 a tube ruptured in a water-tube boiler at Waterside Station No. 1 of the New York Edison Co., New York City. Three men were injured.

(222.) — A boiler explosion occurred, May 20, in the Jefferies sawmill, at Huntington, W. Va. One man was killed and one fatally injured.

(223.) — A tube ruptured, May 21, in a water-tube boiler at the Northwestern Iron Co.'s plant, Mayville, Wis.

(224.) — A tube ruptured, May 23, in a water-tube boiler in the Commerce street power station of the Milwaukee Electric Railway & Light Co., Milwaukee, Wis. Two men were badly scalded.

(225.) — A boiler exploded, May 23, at the plant of the Charles A. Brickley Novelty Works, Cranston, R. I. The property loss was estimated at $3,000.

(226.) — On May 23 a tube ruptured in a water-tube boiler at the hosiery mill of the Joseph Black & Sons Co., York, Pa.

(227.) — The boiler of a freight locomotive exploded, May 24, at Bluefield, W. Va. One person was killed and one injured.

(228.) — On May 24 a tube ruptured in a water-tube boiler at the plant of the Choctaw Railway & Lighting Co., McAlester, Okla.

(229.) — A boiler exploded, May 24, in the Simon Korb sawmill, at Venus, Pa.

(230.) — On May 24 the head blew out of a steam drum on a boiler in the W. R. Pickering Lumber Co.'s plant, Pickering, La.

(231.) — On May 25 a tube ruptured in a water-tube boiler in the North Adams Gas & Electric Co.'s plant, North Adams, Mass. Two men were injured.

(232.) — A boiler exploded, May 25, in the oil fields near Coalinga, Calif.

(233.) — A boiler exploded, May 26, at the Dilworth Paper Co.'s plant, Newcastle, Pa. One man was killed, and one was slightly injured. The property loss was estimated at $10,000.

(234.) — A tube ruptured, May 26, in a water-tube boiler at the Philadelphia Rapid Transit Co.'s power house, Beach and Laurel streets, Philadelphia, Pa.

(235.) — On May 26 a boiler exploded at Tietjen & Lang's drydock, Hoboken, N. J. Three men were badly injured, and two others received minor injuries.

(236.) — Seven cast-iron headers fractured, May 26, in a water-tube boiler at the Milwaukee Coke & Gas Co.'s main plant, Milwaukee, Wis.

(237.) — A blowoff pipe failed, May 27, in the Bay City Gas Co.'s plant, Bay City, Mich.

(238.) — A boiler exploded, May 28, in the Sherman Cotton Oil & Provision

Co.'s plant, Sherman, Tex. One man was seriously injured. Property loss, $2,000.

(239.) — A boiler ruptured, May 28, in Charles J. Spies' flouring mill, Wykoff, Minn.

(240.) — A tube ruptured, May 30, in a water-tube boiler at the plant of the Savannah Electric Co., Savannah, Ga. Two men were injured.

(241.) — On May 30 a tube collapsed in a vertical boiler in Isaac Frink's amusement park, Chalfont, Pa. One man was injured.

(242.) — A blowoff pipe ruptured, May 31, in Hillman's department store, Chicago, Ill. One man was severely scalded.

(243.) — A traction engine boiler exploded, May 31, on the Hanlon farm, three miles west of Maxwell, Iowa. One man was severely injured.

June, 1910.

(244.) — A locomotive boiler exploded, June 1, on the Troy & Eastern railway, at Donk Bros.' coal mine, eight miles from Edwardsville, near Alton, Mo. Three men were killed.

(245.) — On June 1 a blowoff pipe failed at the lumber mill of McWilliams & Henry, Everett, Wash. One man was injured.

(246.) — An accident occurred, June 1, to a water-tube boiler in the Siegel & Cooper Co.'s department store, Chicago, Ill.

(247.) — A blowoff pipe failed, June 2, at George Frank & Co.'s fruit packing plant, San José, Calif. Two men were injured.

(248.) — The crown sheet of a boiler of the locomotive type collapsed, June 2, at the Roberts-Kingston Contracting Co.'s Union mine, at Eveleth, St. Louis county, Minn. One man was fatally injured.

(249.) — On June 3 a boiler exploded in the plant of the Midvale Steel Co., Nicetown, Philadelphia, Pa. Four men were killed and two others were seriously injured.

(250.) — A tube ruptured, June 3, in a water-tube boiler in the American Iron & Steel Manufacturing Co.'s plant, Lebanon, Pa.

(251.) — On June 4 a tube ruptured in a water-tube boiler at the National Works of the American Sheet & Tin Plate Co., Monessen, Pa.

(252.) — A boiler exploded, June 6, in Joseph Clevenger's sawmill, seven miles south of Nacogdoches, Tex. One man was killed and two were injured.

(253.) — An accident occurred, June 6, to a water-tube boiler at the Hensel-Colloday Co.'s plant, Philadelphia, Pa.

(254.) — A boiler exploded, June 9, at the Yellow Pine Lumber Co.'s plant, Franklinton, La. Three men were injured. Property loss, about $3,000.

(255.) — On June 12 a boiler exploded at the Oklahoma Portland Cement Co.'s plant, Ada, Okla. The property loss was estimated at $15,000.

(256.) — On June 13 a tube-sheet fractured in a water-tube boiler at the power plant of the Columbus Railway, Light & Power Co., Columbus, Miss.

(257.) — A boiler exploded, June 16, on Joseph H. Wagner's farm, at Woytych Station, near Annapolis, Md. Two men were badly injured.

(258.) — On June 16 the boiler of a hoisting engine belonging to the Pittsburg Sand & Supply Co. exploded near Baden, Pa. Two men were severely injured, and one of them will die.

(259.) — A boiler exploded, June 16, in the Myer & Lutz sawmill, near Clarion, Pa. One man was killed, and the entire upper end of the mill was wrecked.

(260.) — A tube ruptured, June 17, in a water-tube boiler at the Highland Iron & Steel Co.'s plant, Terre Haute, Ind. Three men were injured.

(261.) — A feed water heater exploded, June 18, at the Keeler Brass Co.'s plant, Pottsville, Pa. One man was seriously injured.

(262.) — Several cast-iron headers fractured, June 19, in a water-tube boiler at Jeddo No. 4 mine of the G. B. Markle Co., Jeddo, Pa.

(263.) — A boiler exploded, June 19, at the Central colliery of the Erie Coal Co., at Avoca, Pa.

(264.) — On June 20 several cast-iron headers fractured in a water-tube boiler at the plant of the Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa.

(265.) — A boiler exploded, June 21, at the sawmill operated by William Hansel at Borden Shaft, near Cumberland, Md. One man was seriously injured, and a man and three children received minor injuries.

(266.) — A boiler exploded, June 22, in the Vinegar Bend Lumber Co.'s plant, Vinegar Bend, Ala. Two men were killed, and the property loss was heavy.

(267.) — On June 22 a boiler ruptured at the rendering and ice plant of the St. Joseph Ice & Manufacturing Co., St. Joseph, Mo.

(268.) — A boiler exploded, June 23, in F. J. Lutz' bakery, Kensington avenue and Lippincott street, Philadelphia, Pa. The property loss was estimated at about $1,000.

(269.) — A small boiler exploded, June 23, at the Prosch-Harris boiler shop, Terre Haute, Ind.

(270.) — A boiler exploded, June 24, at High Shoals, near Bogart, Ga. One man was killed and three others were severely injured.

(271.) — On June 24 a cast-iron header ruptured in a water-tube boiler at the power station of the Philadelphia Rapid Transit Co., Thirty-third and Market streets, Philadelphia, Pa.

(272.) — A boiler exploded, June 26, in the garbage reduction plant at Cherry Hill, Va. One man was severely injured.

(273.) — On June 28 a small boiler used for vulcanizing automobile tires exploded in T. E. Downs' shop, Kalamazoo, Mich. Mr. Downs was killed, and another man was injured.

(274.) — A boiler exploded, June 28, in the W. L. Judd malt drying plant, Aurora, Ill.

(275.) — On June 29 the boiler of a switching locomotive exploded in the freight yards of the Eastern District Terminal Co., Brooklyn, N. Y. Two men were scalded seriously and perhaps fatally.

In our issue for April, 1908, we reprinted an article by Mr. William H. Bryan, entitled "A Color Scheme for Pipe Lines," which he originally published in *Steam*. In *Power*, for April 26, 1910, there is a similar article by Mr. J. P. Sparrow, to which we would direct attention, not only because of the excellence of the text, but also because the article is illustrated in colors.

The Locomotive.

A. D. RISTEEN, PH.D., EDITOR.

HARTFORD, JULY 25, 1910.

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Bound volumes one dollar each.

A Reasonably True Story, as Told by a Two-flue Boiler.*

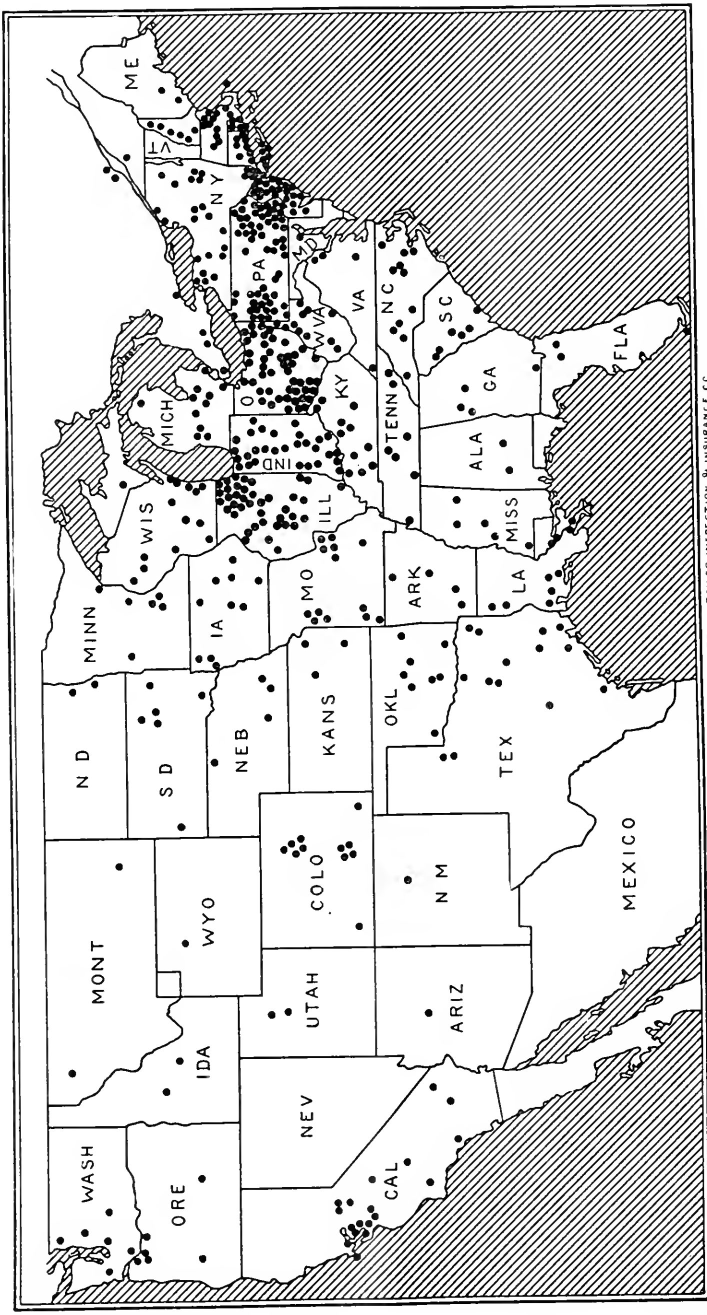
BY CHARLES S. BLAKE.

Some years ago I had the misfortune of being born but since I came into the steam world I have conscientiously endeavored to conduct myself in a manner becoming my station in life. I cannot tell where my parts came from, but they were doubtless from some good place, because the materials were faultless. My makeup was of the ordinary kind, but I claim a lineage dating far beyond some of the new kind of so-called boilers. I am now about ten years old. I suppose this would be called middle-aged, though I am prematurely worn out. I was purchased by a mine-owner, who gave me a permanent home in the coal regions of the Hocking Valley, where I was surrounded by other helpmates. We were placed side by side so that we could work in harmony, and we enjoyed the same pleasures and suffered the same sorrows.

We were given water to drink, and at most times we had all we wanted. This, too, was a good feature of our care, for our thirst seemed unquenchable when we were warm, and the greater the temperature, the greater the thirst became. It is upon this subject of drinking-water that I shall say the most, for the quality served to us was, in the end, the cause of my downfall. It was mine-water that they gave us. It was collected in a reservoir, and during what you would call a dry season it became quite roily and tasted bad. At times it was quite fishy. However, we managed to get along all right by having our insides washed out once in a while. We naturally grew a little crusty, and we had some sore spots. None of these seemed to threaten our lives, however, until for some inscrutable reason we were given a water to drink that not only nauseated us, but also fairly burned our vital organs. We manifested our discomfort, to our master, by emitting blood from our joints. A day or so later we had another change, but while the new water tasted somewhat different, it acted in the same way upon our constitutions.

After one month I realized that I was going into a rapid decline. I tried to bear up under the thought, but one day a lung was punctured and I had to go out of commission until my master inserted a bolt in the opening. This served to stop the flow of blood, and I was again "fired up." I was very weak, but rallied and tried to do my duty. A few days later one of my companions

*Originally written for the *Boiler Maker*.



Locations of Steam Boiler Explosions in the United States during 1909.

(Each of the 550 dots represents one explosion.)

collapsed and died. I was so grieved and indignant that on the spur of the moment I, too, rebelled, collapsed, and — horror of horrors — killed my master. I have been very repentant ever since, but that will not bring him back again. I knew he liked me, though he had a knowledge of my feeble condition when he plugged my lung.

I might say, right here, that I am able to translate this story by the aid of an expert who makes a specialty of investigating the causes of troubles such as my own, and holding autopsies. He was sympathetic and understood boiler talk, so I confided in him, and he in turn helped me translate my experiences. He explained that the water that had brought me to an untimely end was strongly impregnated with sulphur, which must have come from the mines. That is what had eaten my vitals away so rapidly. What is to become of me now I do not know. My boiler friend thinks I ought to be cut up and worked over into some other product, where the dangers are not so great. I should not object to this; but if they sell me to a second-hand dealer, and he tries to repair my organs, puts a coat of paint on me, and then sells me for a boiler "as good as new," I shall most likely make a further record as a man-killer.

Steam Boiler Explosions in the United States during 1909.

In our issue for July, 1907, we published a map of the United States, upon which the location of each of the boiler explosions of 1906 was marked by a dot. In the present issue we give a similar map, prepared by Inspector Royal H. Holbrook of our Cincinnati department, and showing the locations of the boiler explosions of the year 1909. Like its predecessor, this map is based upon the explosion lists that we print in The Locomotive regularly, and a short account of each of the explosions here indicated will be found in one or another of our last six issues.

The number of explosions represented upon the present map is 550, and our records show that these were accompanied by 227 deaths, and by injuries to 422 persons. Roughly speaking, therefore, every alternate dot represents a death, and four out of every five of the dots represent more or less serious personal injuries.

As might be expected, the explosions of 1909, like those of 1906, were grouped in a marked manner about the regions in which steam power is most extensively employed. The comparative absence of dots in the western portion of the map is due in large measure to the fact that there are fewer boilers in that part of the country; but there can be no doubt that the reports that we receive from regions west of the Mississippi are less complete than those that come to us from the northeastern section, so that the relative scarcity of the dots in the west is attributable, in some measure at least, to the incompleteness of our data.

A comparison of the two maps is interesting. It will be noted, for example, that there is an unmistakable increase in the number of explosions in states which showed but few in 1906. Thus Washington had 1 in 1906, but 6 in 1909; Colorado had 1 in 1906 and 11 in 1909. Oklahoma (including the region known as Indian Territory in 1906) increased, similarly, from 1 to 8, and North Carolina increased from 3 to 11. Maine, on the other hand, fell off from 5 to 2, and Vermont has the distinction of being the only state that had no boiler explosion in either year.

A New Mode of Inspecting Boilers.

In the first volume of THE LOCOMOTIVE (old series), under the date June, 1868, there is an article with the caption given above, which was written by our late president, Mr. J. M. Allen. If we remember aright, it was based upon an actual experience of his, and as it has doubtless been forgotten by all of our friends, we reprint it below:

It is a trite saying that "we live in an age of progress"; and because the truth of the thing is so universally conceded, we presume our readers will not be greatly surprised to learn of a new application of an old "system." It came to our notice in this wise: A few days ago, our editorial meditations on the subject of boiler explosions were interrupted by the entrance of a stranger, who inquired (in a manner indicating the performance by him of an unpleasant duty) respecting the whereabouts of our inspector. Quoth he, "I've got a small boiler in use out here in —— (naming a village not many miles away), which I 'pose I've got to have inspected, as the law makes me liable to a fine if it ain't done. So I called in to see about it." We gave him the information he desired, and then he volunteered this opinion: "I don't consider this inspection *wuth* anything to me, for I've had my boiler inspected by a higher power." "Ah! have you? How is that?" we asked, with a desire to learn of any improvement that might have been made in our line of business. He replied with the air of a man communicating an important fact, and standing forth in the calm consciousness of a superior intelligence, "I had a *clairvoyant* examination of my boiler a few days ago, and the medium told me it was all right — clean and nice inside, and safe to run." So saying, he withdrew, and left us in deep thought.

This discovery may signify but little to those unskilled in the mysteries of boiler inspection, but we are sure it will excite a peculiar interest in the minds of our inspectors, who have been accustomed to regard the process now in vogue as a rather laborious way of accomplishing what the Frenchman called "making his bread of ze perspiration of his eyebrows."

In imagination, our men will foresee a mighty change. Instead of a sturdy-looking man, grimy with soot and ashes, clad in a suit of well-worn "dirt-proof," and busying himself with hammer and pump, or striving, with many contortions, to pass himself through a manhole many sizes too small for his shoulders, or coming "to the surface" for air after trying to find out how much heat a human being can endure without being converted into a roast — instead of all this, they will see a benevolent-looking old gentleman, bidding defiance to the summer sun in a suit of spotless linen and a huge Panama. He enters the boiler room, and after gazing abstractedly about him for a moment, sinks into an easy chair and composes himself for a siesta, while an attendant prepares to record the words of somnolent wisdom, as they shall drop from his lips.

"General appearance of interior good," he murmurs, when the trance is well upon him; "slight incrustation, 1/64th of an inch thick, on the crown sheet. Some corrosion — of second plates — around fourth and fifth rivets — from rear end. Boiler safe — at a running pressure of — eighty — pounds."

Then his mild blue eye gently opens, he draws his bandanna across his massive brow, affixes his signature to the certificate of inspection, and departs, after mechanically depositing the fee in his well-lined wallet.

You see, gentlemen of the inspection department, what an immense amount of uncomfortable experience would be avoided, should the new system go into general use; and it may be that a few lessons would suffice to make you all adepts at it.

The Agent on the Spot.

It often happens that an insurance agent approaches a prospective patron at the wrong time. Occasionally, however, he arrives at the exact psychological moment, and finds his task unexpectedly easy. Mr. John R. Bentley, a special agent in our Philadelphia department, tells of an experience of the latter kind that recently befell him.

"Calling at the plant of one of our assured," he writes, "the manager mentioned two canning establishments at the other end of the town, with which he thought I might be able to do business. I visited one of them at about six o'clock in the afternoon, and found that its owner and manager is a woman. I spoke with her respecting the advisability of insuring the three boilers in the plant, and she admitted that it would be well to consider the subject, but said that in their experience of twelve or fifteen years they had never had an accident. Before there was time for me to reply there was a terrific explosion, and I made a hasty retreat to an open field. In the course of the said retreat I passed through a perfect deluge of débris from the roof of the plant, accompanied by a hail of cans of peas, exploding in the air and all around me on the ground. I was literally smeared from head to foot, with overcooked peas.

"Reaching a point on the edge of the shower, I looked back and saw the employees, mostly girls and boys, escaping through the doors and windows. The storm having subsided, I hastened back and found that one of the two cast-iron steam cooking kettles had blown up, the cover being broken in half. Inside the kettle there were three iron racks, holding, I presume, a hundred or more cans each. These were thrown through the roof, tearing everything to pieces in their passage, and scattering the exploding cans in every direction.

"The young man in charge of this kettle was sitting in front of it at the time, and was quite badly cut about the face and arms. If he had been standing, it is likely that he would have been killed, or, at all events, far more seriously injured.

"In the morning a so-called tailor endeavored to clean my clothes, while I, being fortunate enough to have a second suit, visited the proprietress and secured the application on the three boilers. The scare from the kettle-explosion made further persuasion unnecessary."

Some of our readers, in going over this interesting communication, may wonder why the *cans of peas* exploded. A word of enlightenment on this point may therefore be acceptable. The cans are first filled with uncooked peas, and then, after being sealed, are placed in the closed kettle and exposed to steam at a pressure somewhat higher than that of the atmosphere until their contents are properly cooked. After a time the peas become heated up to the temperature of the steam by which they are surrounded, and this rise in temperature causes steam to be generated *inside* the cans, by the evaporation of some of the moisture there. In fact, the pressure inside the cans will become equal to that outside, as soon as the temperature becomes the same in both places. When the kettle exploded, the pressure that had been acting *externally* upon the cans was suddenly removed, while the *internal* pressure upon them remained unaltered. As soon as the kettle gave way, therefore, the cans were in the condition of little boilers carrying an internal pressure too great for them to withstand, and they popped open by the dozen, bespattering our respected representative with a hot vegetable diet.

(The peas were not literally "overcooked," but they exploded individually as soon as the cans failed, and became converted into a sort of mush. Grain kernels are treated in this way commercially, and the process is patented.)

Buggy and Shovel Inspections.

The following is a true story, save that we have changed the name of the man mentioned, doing this because we don't want to throw any mud at state inspectors. The real name is uncommon enough to make the identification of the place possible.

In soliciting fly wheel insurance of Mr. Jones (writes one of our agents), he asked me what kind of inspections we give on fly wheels.

"Do you give buggy inspections, or shovel inspections?" he inquired.

I told him he could have both if he wanted them, and added that there isn't any kind of an inspection that the Hartford wouldn't give the assured, if he desired it. But I added that I was unfamiliar with the special kinds he had mentioned, and asked him to explain.

He said that a few years ago they received visits from an inspector who, when his horse was particularly fractious or his rheumatism was bothering him, gave them a buggy inspection, by driving to the engine room and whistling to attract the attention of the boiler man. Without alighting from his buggy he would then ask a few questions, after which he would drive back to the office and whistle again; and when some one from the office went out to him, he gave them his inspection report. At other times, when he had a quiet steed that would stand without hitchin', and when his rheumatism was not particularly aggressive, he sometimes went into the boiler room, opened the furnace door, and poked at the bottom of the boiler with a long-handled shovel. If this particular part of the boiler seemed reasonably solid, and his shovel did not perforate it, he said everything was all right.

I asked Mr. Jones whom he was insuring with at that time, and he said with the Hartford company. I need not tell you that I was shocked to hear one of our patrons give such an acount of our service as that. I hardly knew what to say, so I merely told him that I had never heard of one of the Hartford's inspectors making any such examination as that.

"Neither have I", he responded. "It is true that I was insuring with the Hartford at the time, but these particular inspections were made by the State inspector".

At that a great load was lifted from my soul, and I thought that if the State inspector had known that the Hartford was insuring the boilers, his own examinations might have been more carefully made. Or did he feel that a "shovel inspection" was good enough for him to make, after the Hartford's man had been there?

The Speed of Masses Thrown by Boiler Explosions.

It is occasionally possible to calculate, with some approach to accuracy, the initial speed with which masses of matter are projected into the air by exploding steam boilers. The best example of this that we know of was afforded by the explosion at the plant of the Denver Gas & Electric Co., at Denver, Colo., on June 15, 1909. This was described in the issue of The Locomotive for July, 1909, where we showed how to determine, not only the initial velocity of the boiler shell and the maximum height to which it was thrown, but also the actual path that the shell followed, through the air.

It is rare indeed that data enough are available to compute the actual initial velocity of a fragment of a boiler, or of any mass that is thrown to a distance by a boiler explosion; but we wish to draw attention to the fact that it is always easy to find a *minimum limit* to that velocity, — that is, it is always easy to determine a velocity which is the *least* that the projected mass could possibly have had, at the moment when its flight began.

Thus it is not hard to show, from the theory of falling bodies, that when the mass is thrown in such a way that it first returns to its original level after traveling a horizontal distance of D feet, its original speed must have been equal, at the very least, to $\sqrt{32D}$ feet per second. In other words, if the ground about the boiler is level, we may conclude that the original speed of projection was certainly as great as that calculated by the following rule:

Multiply the horizontal distance, in feet, between the place where the part first stood and the place where it first struck the ground, by 32, and then take the square root of the product. The result will be the smallest velocity, in feet per second, that the part could have had, when it started off.

This rule gives the *actual* initial velocity, when the starting point and the point of first contact with the ground are on the same level, and when the angle of elevation at which the mass started off was 45°. In general, the flying mass will first hit the ground at a point a little lower than the level that it originally occupied, and neglecting this circumstance will tend to make the rule give too large a result. On the other hand, the fact that the actual angle of elevation of projection will never be exactly 45°, but will always be greater or less than this by some indeterminate amount, will tend to make the rule give too small a result. The two sources of error will therefore tend to neutralize each other, so that the rule may be employed, with some considerable confidence, in the form given above. Moreover, the slope of the ground about the boiler may be neglected, unless it is very marked indeed.

In explosion No. 214 of our regular list for May, printed in this issue, one of the firemen was thrown 527 feet, passing through a wooden dwelling on the way. Let us apply the foregoing rule to calculate the least possible value of the velocity with which the poor fellow started on his fearful course.

The body must have been retarded to some considerable extent by the two walls of the house through which it crashed, and perhaps we may reasonably assume that it would have traveled 600 feet, horizontally, in all, if it had not been impeded in that way. Applying the rule on this assumption, we have $600 \times 32 = 19{,}200$; and taking the square root of 19,200, we have 138 feet per second, which is the least velocity it could have had, as it left the boiler room. This is equivalent to about 94 miles per hour.

The Properties of Steam.

Ninth Paper. — The Experiments of Holborn and Baumann at High Pressures.

Since the appearance of our last previous paper on the properties of steam (The Locomotive, July, 1909, page 217), an important and exceedingly valuable contribution to the subject has been made by Messrs. L. Holborn and A. Baumann, who have investigated the pressure of saturated steam from 200° centigrade up to the critical point of water, — that is, from a pressure of 225 lbs. per square inch up to a pressure of about 3,200 lbs. per square inch. Their original paper is in German, is entitled "Ueber den Sättigungsdruck des Wasserdampfes oberhalb 200°" ("On the Pressure of Saturation of the Vapor of Water above 200° C."), and was published April 5, 1910, in the *Annalen der Physik*, fourth series, volume 31, page 945. The paper is wholly experimental, and the work was carried out at the Physikalisch-Technische Reichsanstalt, Charlottenburg, Germany, — a fact which in itself is sufficient to give great weight to the results.

The investigation was conducted by the static method (The Locomotive, July, 1906, page 87), and the apparatus that was used is shown diagrammatically, in the accompanying illustration. The steam was generated in the steel cylinder *S*, shown on the right, this being submerged in a liquid bath of known temperature. By means of steel tubing, *N M L*, having a very fine bore, the cylinder *S* was placed in communication with an apparatus *AZ*, shown on the extreme left, which served for the determination of the pressures. The intermediate parts *E, C, B, D*, that appear in the illustration, were auxiliary devices, whose purposes will be explained below.

Steam Generation and Temperature Measures.

The cylinder *S* was about ¾ in. in diameter internally, and 6 in. high, enclosing a space of about 2 cubic inches. It was not heated directly by a flame, but was submerged in a hot fluid bath, whose temperature could be raised and controlled by means of a heating coil of nickel resistance-wire, through which an electric current was passed. The bath was arranged to slide up and down along vertical ways, so that it could be drawn away from the cylinder *S* at will. For temperatures below 230° C. (that is, for steam pressures below 400 lbs. per sq. in.) the bath was filled with oil, while at higher temperatures, where the oil could be no longer used, it was filled with melted saltpeter. In each case the bath was kept well stirred, so that its temperature was sensibly the same in all parts.

The temperature of the steam in the cylinder *S* was ascertained by measuring the temperature of the bath in which it was submerged, a platinum resistance thermometer being used for this purpose. This part of the work does not call for extended explanation in the present place, as it was carried out in the same general way as in Holborn and Henning's experiments, which were described in The Locomotive for April, 1909,* save that in the present investigation the observers do not state that there was any secondary comparison with the boiling points of naphthalin and benzophenon.

The platinum-resistance thermometer that was used is designated as "No.

* See pages 181 and 19? of that article.

11." Its constants were determined by observations at the melting point of ice, and at the boiling points of water and of sulphur. In order to test its accuracy, it was further compared with the Reichsanstalt's standard thermometer No. 7, at 200° C. and at 373° C. At 200° the two agreed to within 0.01° C., and at 373° to within 0.03° C.,

Pressure Measurements.

The pressure-measuring device, which was designed by Thiesen and constructed under his direction, consisted of a heavy brass cylinder *Z*, fitted with a plunger, *K*, upon which a known load could be placed, by means of the weights shown at *A*. It will be seen that the apparatus determined the total upward fluid pressure against the plunger *K* by balancing it directly against the weights. This method was proposed by Altschul, and instruments based upon the same principle are in use for the testing of standard pressure gages, and for other commercial purposes where accuracy is desired. The chief difficulties to be overcome in using this apparatus are two in number. Thus (1) there will be more or less friction between the plunger *K* and the cylinder *Z*, unless means are employed for its elimination; and (2) a small error in measuring the diameter of *K* may give rise to an error in the result that would be quite inadmissible in work of a high degree of precision. In the experiments that we are describing these two sources of error were considered with much care.

In the ordinary commercial form of this apparatus, the friction of the plunger *K* is eliminated by causing it to spin around about its own axis while the measurement is being performed. In Holborn and Baumann's experiments it was not practicable to accomplish the desired end in quite this way, but the same purpose was achieved by causing the plunger *K* to rotate back and forth about its own axis through an angle of about 18°, the rotation being executed in a period of approximately one second. The motion was produced by means of an electric motor, not shown in the sketch, which operated on *K* in such a way as to produce the desired backward and forward oscillations about the vertical axis, while not interfering in the least with the entire freedom of the plunger in a vertical direction.

The effective diameter of the plunger *K* was found by a separate series of experiments, in which pressures running up to 227 lbs. per square inch were measured by the dead-weight apparatus shown in the illustration, and also, simultaneously, by a mercury column. By comparing the readings of the mercury column with the indications of the dead-weight apparatus, it was found that the effective sectional area of *K* was 0.99964 square centimeters (or approximately 0.155 sq. inch.).

The sensitiveness of the pressure-measuring apparatus was carefully investigated, and was found to be satisfactory. When the pressure of the steam was 225 lbs. per square inch, the plunger *K* was sensitive to 5 grams, or one-sixth of an ounce, — the addition or subtraction of this amount to or from the pile of weights *A* causing an unmistakable motion of the plunger. At higher pressures the apparatus became less sensitive, but when the pressure was 3,000 lbs. per square inch, it was still sensitive to a change in the weight-pile of 1¾ ounces.

The standard weights that were used were disk-like in form, each having a radial slot so that it could be placed centrally under the plunger, and each weighing ten kilograms (about 22 lbs.). For obtaining values intermediate between those afforded by two successive standard weights, smaller weights were used, of the type employed for ordinary balances.

THE REMAINING PARTS OF THE APPARATUS.

The space below the plunger *K*, in the pressure-measuring device, was filled with oil; and since the plunger could not fit the cavity in *Z* too tightly without the production of an excessive amount of friction, oil slowly exuded around it during the course of the experiments, the amount so escaping being about a quarter of a cubic inch per hour at the highest pressures that were

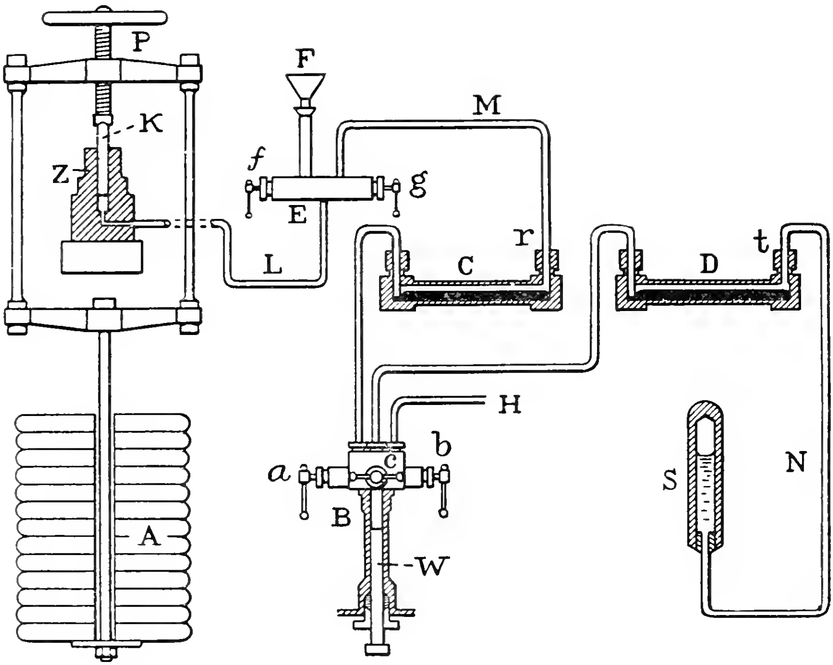


DIAGRAM OF HOLBORN AND BAUMANN'S APPARATUS.

encountered. On account of this leakage it was necessary to introduce more oil from time to time, and this was accomplished by means of the device shown at *E*. In operating *E* the conical valve *g* was first closed, and then the screw *P* was turned until the frame in which it worked, and which supported the weights, was lowered so as to rest against a stop not shown in the illustration. By this means the plunger *K* was relieved of its load, the pressure being at the same time relieved in the cavity in *Z*. Then, by opening the valve *f*, oil could be introduced into the interior of *Z* by means of *F*. Upon closing *f* and opening *g*, the apparatus was again ready for use, with an additional supply of oil in the cavity of *Z*.

To prevent the water in *S* from becoming contaminated by contact with the oil in the pressure-measuring device, the horizontal tubes *C* and *D* were provided. The lower half of each of these was filled with mercury, the upper half of *D* being filled with water and the upper half of *C* with oil.

Between the tubes *C* and *D* there was an apparatus shown at *B*, whose main purpose was to vary the volume occupied by the steam in *S*. This apparatus, *B*, consisted essentially of a plunger *W*, which could be forced into the cylinder to a variable distance, by means of a hand wheel and screw that are not shown. At the upper end of this apparatus there were three conical valves, *a, b, c*, by means of which the space in *B* could be placed in communication with the steam space *S*, or with the pressure-measuring apparatus, or (by means of the tube *H*) with an air-pump or any other external device.

In order to free the entire apparatus of air as completely as possible, the tubes *C* and *D* and the device *B* were placed in communication with one another and pumped out by means of the openings *r* and *t*. Then the necessary quantity of mercury (for partly filling *C* and *D*) was allowed to flow in through the tube *H*, after which the space remaining in the tube *D* was filled with water through the opening *t*, and that in the tube *C* with oil through the opening *r*. Finally, by taking every precaution against the admission of air, the tube N was secured to *D* at *t*, and the tube *M* was similarly secured to *C* at *r*. When the plunger *K* was loaded, after putting the whole apparatus together, it was easy to tell, from its motion, whether all the air had been expelled from the apparatus or not, and if any were present it could be located by successively closing the intermediate conical valves *c* and *a*.

Manipulation.

Before bringing the hot-bath up around the cylinder *S*, the plunger *W* was drawn back so as to make room for the expansion of the water in *S*. This was particularly important at the higher temperatures, where the expansion of the water was very marked.

Shortly before each series of observations was begun, the plunger *W* was run into the receiver *B* until the pressure produced by any further motion showed that the apparatus was entirely filled with fluid. Under these circumstances there would be no steam-space in the cylinder *S*, but any desired amount of space could be produced there by withdrawing the plunger *W* by a measured amount. This feature of the apparatus was extremely important, since it enabled the experimenters to vary the volume in the cylinder *S* at will. If there were no air nor other fixed gas present, the pressure should depend entirely upon the temperature, and be entirely independent of the volume of the steam space in *S*; whereas if air or other similar gas were present, the observed pressure would vary to some extent with the volume of the space occupied by the steam. Ordinarily, each series of observations for obtaining the pressure corresponding to a given fixed temperature was divided into two parts, one being executed with one fixed value of the steam space, and the other with a materially different value. A practically identical agreement of the various parts of the series so taken was assumed to prove the absence of air or other fixed gas.

Previous observers have maintained that water does not attack the steel containing vessel to any noticeable extent, even at the highest pressures; but Holborn and Baumann do not agree with this conclusion. They state that after the cylinder *S* had been repeatedly heated to above 300°, a small quantity of iron went into solution, so that upon standing in contact with air the water became somewhat colored, and finally threw down a precipitate of oxide of iron. This action appeared to be attended by the production of a small quantity of gas (undoubtedly hydrogen) in the cylinder *S*. Direct evidence of the presence of such gas was afforded, indeed, by the observed fact that when the same mass of water had been used for a long time above 300°, the saturation pressures which were subsequently obtained with it at lower temperatures were no longer independent of the steam volume. Observations, which we have not thought it necessary to reproduce, are given by Holborn and Baumann to illustrate this point. The data that we give in present article are believed to be free from error due to this cause, since, to guard against its occurrence, the water in the cylinder *S* was renewed at frequent intervals.

THE FINAL DATA.

The experimental data obtained by Holborn and Baumann will be found in the accompanying table. In the original paper the observations are all given separately, but inasmuch as they were made in groups, with the temperatures in each group almost identically constant throughout, we have thought it sufficient to reprint only the mean value as obtained from each individual group, indicating in every case, however, the number of separate observations that were combined to yield the result as given. The entire range of temperature comprised in any one group did not ordinarily exceed a tenth of a degree or so. The result that we give for the temperature 336.15°, for example, is the mean of six separate observations, taken at the respective temperatures 336.10°, 336.12°, 336.16°, 336.16°, 336.20°, and 336.17°.

EXPERIMENTS BY HOLBORN AND BAUMANN, ABOVE 200° C.

Temperature. (Centigrade.)	Pressure. (Kg. per sq. cm.)	No. of observations.	Temperature. (Centigrade.)	Pressure. (Kg. per sq. cm.)	No. of observations.
200.98°	16.168	12	336.15°	141.61	6
202.14	16.553	11	341.33	151.03	10
214.07	21.061	12	347.25	162.50	9
219.86	23.574	12	348.34	164.85	7
230.90	28.952	12	353.88	176.18	11
241.05	34.713	13	356.72	182.44	6
250.41	40.750	13	358.29	185.76	14
261.97	49.315	12	362.25	194.92	16
271.78	57.560	11	364.73	200.61*	9
281.34	66.629	12	365.31	202.13	3
292.07	78.061	11	368.38	209.71	3
301.82	89.75	6	370.25†	214.30‡	10
311.14	102.14	12	370.96	216.43	3
321.61	117.40	11	373.39	222.67	4
330.44	131.57	14	374.08§	224.47	7
335.11	139.60	2	......	......	..

* 200.79 in the original. † 370.26 in the original ‡ 214.28 in the original. § 374.07 in the original.
(The changes here noted were made because the averaging in the original appears to be erroneous.)

Holborn and Baumann are not quite so explicit as we could wish, with reference to the nature of their thermometric scale, but if we understand them correctly, their temperatures are supposed to be given on the scale of the normal, constant-volume hydrogen thermometer. We may also, without material error, regard them as given on the absolute thermodynamic scale, since this scale, according to Berthelot, is almost identically the same as that of the hydrogen thermometer.

The pressures are expressed in kilograms per square centimeter, and they have been corrected for all recognized experimental errors, such as for the fact that the bottom of the plunger K was not at precisely the same level as the surface of the water in the cylinder S, the connections between S and Z being filled with water, oil, and mercury. The barometric pressure acting upon the top of the plunger K was of course taken into account also, and all pressures have been reduced to the values they would have had if observed at sea-level in latitude 45°.

We find nothing in Holborn and Baumann's paper respecting the purity of the water that was employed, save in respect to the absence of air and other free "fixed" gases, nor do we find any statement as to the density of the mercury in the gage that was used in determining the effective diameter of the plunger K, as described above. The following words that we used in our seventh paper, in speaking of a similar omission in the paper of Holborn and Henning, apply here with equal force: "It would have been exceedingly reassuring if explicit statements respecting these points had been given, and the omission is most unfortunate. As it is, we have to depend upon the known reputation of the observers for accuracy and care, and upon the fact that all that emanates from the Reichsanstalt, where these measures were made, is distinguished by a faithful attention to details of this sort. According to experiments made at the Reichsanstalt, a cubic centimeter of pure mercury, at 0° C., weighs 13.59593 grammes at sea-level in latitude 45°; and in the absence of further information, we shall have to assume that this was the density of the mercury used in the experiments herein described." If this assumption be made, then the pressures of Holborn and Baumann, which are expressed in kilograms per square centimeter, may be reduced to their equivalent values in millimeters of mercury by multiplying them by the number 735.5141 (whose common logarithm is 2.8665910).

The Critical Temperature of Water.

As we have previously explained in The Locomotive (see, for example, the issue for November, 1891, page 173), there is a temperature, known as the "critical temperature," at which water and its vapor cease to be distinguishable, and above which the expression "saturated steam" has no meaning. In The Locomotive for July, 1907, we described the methods used by Battelli and by Cailletet and Colardeau for the determination of this temperature. Holborn and Baumann carried their experimental work up to the same point, and determined the value of the critical temperature with much care. Battelli found it to be 364.3 C., and Cailletet and Colardeau found it to be 365°. Holborn and Baumann found it to be a fraction of a degree above 374°, and although their result differs by nearly ten degrees from those just cited, it will probably be accepted in preference to the earlier values, since the experimental evidence upon which it is based appears to be of a higher order of precision. Moreover, the value found by Holborn and Baumann agrees almost perfectly with that obtained by Traube and Teichmann (namely, 374°) in 1904, by a totally different method. (See the *Annalen der Physik,* volume 13, page 620.)

Briefly described, the method used by Holborn and Baumann for finding the critical temperature was as follows: So long as there were both steam and water in the cylinder *S,* and no air or other fixed gas, the observed pressure depended upon nothing but the temperature, — a slight change in the volume of the steam-space making no difference whatever in the pressure, so long as the temperature remained constant. As the temperature at which the trials were made became progressively higher, it was found that at 374.08° C. there was still a distinctly recognizable difference between the steam and water in *S,* so that a slight change could be made in the steam-volume without any consequent change resulting in the pressure. At 374.62° C., however, this was found to be no longer possible, for at this temperature and at higher ones, the contents of the cylinder *S* behaved like a homogeneous gas, the pressure upon which could be varied at will, while the temperature was kept constant. Somewhere between 374.08° C. and 374.62° C., therefore, the distinction between water and steam ceases to exist. Holborn and Baumann do not give a close estimate of the exact point at which this occurs. They merely say: "Die kritische Temperatur liegt . . . bei 374°" ("The critical temperature is close to 374°"). From an examination of the diagram given on page 966 of their original paper, we are of the impression that a close analysis of their results would indicate that the critical temperature of water is about 374.5° C.

Eel Oil as Boiler Fuel.

The following astonishing item was printed in a recent issue of the Syracuse, N. Y., *Herald,* and it purports to be a "special" from Dugway. We don't know Dugway. Dugginsville, Mo., we know, and Dugdemona, La., and Dugdown, Ga., and Dugout, W. Va.; but Dugway is outside the pale of our geography. Anyhow, here is what the item says:

"For the last month the sawmill here has been running on a fuel which puzzled the fireman of the boiler, and not until Friday did he solve the enigma.

"Several weeks ago the fireman was feeding the firebox a cord of four-foot wood a day; while today he uses only a few sticks in the morning to start the fire. The boiler is fed from a creek back of the mill, a three-inch pipe running from the boiler to the stream. This creek is noted for its small eels. The eels ran up the pipe to the injector on the boiler and were forced into the flues [!]. The hot water soon cooked the eels, and investigation showed that the boiler contains several barrels of eel oil. The flues of the boiler leak,— not badly, but just enough to let the oil into the firebox, where it keeps us a seething flame."

[Shades of Louis de Rougemont! In comparison with the author of that item, we shall have to count Ananias among the minor prophets.]

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1910.

Capital Stock, ... $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission, ...	$154,845.83
Premiums in course of collection, ...	228,048.46
Real estate, ...	93,600.00
Loaned on bond and mortgage, ...	1,107,060.00
Stocks and bonds, market value, ...	3,063,476.00
Interest accrued, ...	67,580.50
Total Assets, ...	$4,714,610.79

LIABILITIES.

Re-insurance Reserve, ...		$1,943,732.29
Losses unadjusted, ...		90,939.53
Commissions and brokerage, ...		45,609.69
Other liabilities (taxes accrued, etc.), . . .		41,835.50
Capital Stock, ...	$1,000,000.00	
Surplus, ...	1,592,493.78	
Surplus as regards Policy-holders, . .	**$2,592,493.78**	2,592,493.78
Total Liabilities, ...		$4,714,610.79

On January 1, 1910, THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY had 104,589 steam boilers under insurance.

L. B. BRAINERD, President and Treasurer.
FRANCIS B. ALLEN, Vice-President. CHAS. S. BLAKE, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
W. R. C. CORSON, Assistant Secretary.

A. S. WICKHAM, Superintendent of Agencies.
E. J. MURPHY, M. E., Consulting Engineer.
F. M. FITCH, Auditor.

BOARD OF DIRECTORS.

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The Locomotive

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The Stiffening Effect of Girth Joints.

From time to time we have pointed out, in THE LOCOMOTIVE, that the girth joints in a steam boiler have a stiffening effect upon the shell which is of considerable importance on the score of safety. In the issue for October, 1909, for example, we discussed the number of courses that have been recommended and used in the manufacture of boiler shells, and we there said that "the stiffening action of the girth joint is quite an important element in a boiler shell, and its absence was doubtless one of the causes of failure of the single bottom-sheet type."

The correctness of our contention is beautifully shown by the accompanying photograph, which represents an ammonia tank that exploded recently in an

ILLUSTRATING THE STIFFNESS OF A GIRTH JOINT.

ice-manufacturing plant at Coffeyville, Kans. The building was destroyed by fire, and the ammonia tank became overheated in consequence, so that it was unable to sustain the pressure to which it was subjected. The tank was originally cylindrical, with the same diameter throughout, and, as will be seen, the two end courses toward the right of the photograph were swelled out by the pressure, so that one of them assumed an almost perfectly spherical form, drawing down in thickness at the same time until a rent opened in the shell, lengthwise.

The main thing to which we would draw attention is the fact that notwithstanding the severe overheating to which the shell was exposed, the girth joint between the first and second courses retained its diameter, almost without any change whatever, while the shell bulged to a very marked extent on each side of it.

If the shell had not been provided with girth joints, it is highly probable that it would have swelled out through a considerable part of its length, and that, instead of merely opening locally, it would have exploded violently, with much more serious results.

Steam Boiler Insurance.*

ORIGIN OF "UNDERWRITING."

It is recorded that no serious attempt was made to engage in the business of insurance, in any form, until after the great fire of 1666, in London, England; and I cannot find definitely whether fire or marine hazards were the first to be covered, although the evidence appears to favor the latter. One historian, however, states that an office was opened in 1681 "at the back side of the Royal Exchange," to insure against loss by fire. About the same time, or at any rate not later than 1687 or 1688, the Lloyd's method was conceived, grew into favor, and met with success.

Many things have been charged against coffee, our common beverage. I have heard persons say they had coffee hearts or coffee heads, and some, affected in the limbs, have laid this trouble to coffee also. Now I find that at least one form of insurance had its inception in a coffee house, where it was probably inspired by that delicious stimulant, and I am not sure but that some of the troubles of present day companies can be traced to *too much* coffee.

Edward Lloyd was one of a number to open a place, in the latter part of the seventeenth century, for the purpose of serving what then was a new beverage, called "kauphy." It was first located in Tower Street, London, England, but in 1692, some two hundred years after the discovery of America, it was removed to Lombard Street. Certain merchants and ship-owners were wont to gather there to talk over their cargoes and profits, and other matters, and to discuss the merits of different vessels, including their speed and safety.

The English are reputed to have been great betters, and in the early reign of George the Third, about one generation after Edward Lloyd's time, an extraordinary mania for betting had developed. Human nature still tends somewhat in that direction, even (I might add) in insurance circles. In fact, insurance *is* a legalized form of chance-taking.

It is my theory that the frequenters of Lloyd's first began to bet on the vessels in which they were interested, and it seems but a step from betting to the acceptance, as then practiced, of individual responsibility for others' loss. The patrons of Lloyd's were wealthy, and they agreed to assume limited individual liability upon vessels and their cargoes. After setting down in a document (or, as one historian has said, "on a blackboard") the sum they were willing to guarantee, they would write their names under the amount; hence the term "*underwriting*" sprang into being. I can fi[illegible] rlier use of this word. In Dickens' "All the Year Round" (May, 18[illegible] [illegible] article entitled "Who's Lloyd's?" where it is said that the insure[illegible] [illegible]rwrote"

* An address before the Insurance Institute of Hartford, by Charles [illegible] Secretary of the Hartford Steam Boiler Inspection and Insurance Co.

their names to contracts of insurance, and were hence known as "underwriters." Edwards, in "Words, Facts and Phrases" (London, 1901) also states that the word originated at Lloyd's.

We are not told what part Lloyd himself originally took in underwriting at his kauphy house, but either through his interest in it, or through the associations of the place, the method or practice took his name, and became known as Lloyd's. Later on he did take an active, personal part in gathering maritime news, and in marine underwriting.

The same association of merchants and owners continued the underwriting with varying degrees of success, but with the lapse of time certain loose and unsatisfactory practices crept in, and finally, after 130 years, the institution was reorganized to correct the said troubles. In 1871 Lloyd's was granted all the rights and privileges of a corporation by the English Parliament. The same 230-year-old Lloyd's is still in business, making money, and continuing practically the same old form of contract. The early form of guaranteeing has been broadened, and developments have taken place in systems, but the original term "underwriting" has been retained, and is now applied to all forms of insurance. Indeed, it is commonly used in connection with many forms of contract, to designate the guarantors thereof.

Boiler Underwriting.

Boiler underwriting is the practice of insuring against losses arising from boiler explosions. An owner or operator, having a steam boiler or boilers, is approached, and when the terms of the contract have been agreed upon, a document in the form of a policy is executed and signed by the authorized officials. It then becomes the instrument to decide all questions which may arise under the contract. The act performed by the insurer is termed "underwriting," and the company issuing the policy is the underwriter.

Boiler underwriting, like marine and fire underwriting, was first practiced in England. An inspection company was organized at Huddersfield in the fifties of the last century (I have not been able to obtain the exact date), and was called "The Huddersfield Association for the Prevention of Steam Boiler Explosions."

In 1859 The Steam Boiler Assurance Company was organized, at Manchester, England, to inspect and insure boilers; and in 1860 it absorbed the Huddersfield Association. This company was probably the first to issue a guarantee, or policy of insurance, covering steam boilers, and the present Vulcan Boiler & General Insurance Company, by reason of its being the ultimate successor of the Steam Boiler Assurance Company, claims to be the oldest company writing this form of insurance.

The Steam Boiler Assurance Company, as I infer from its records, started as a mutual company, but in November, 1864, it became a stock company, and a change of name made it The Boiler Insurance & Steam Power Company, Ltd., under which title it had a varied experience of ups and downs until a little over thirteen years ago, in December, 1896, when it was again reorganized as The Vulcan Boiler & General Insurance Company, Ltd.

Late in 1854 numerous meetings were held in the "Town Hall Buildings," at Manchester, England, for the purpose of organizing an association to lessen the dangers in the use of steam, and to study its economy. At this meeting a resolution was adopted, to the effect: "That an Association be formed under the title of 'The Association for the Prevention of Steam Boiler Explosions, and for Effecting Economy in the Raising and Use of Steam.'" The association does not appear to have been actually formed, however, until the public meeting in January, 1855.

At first, this organization did not contemplate the *insuring* of boilers, but between 1861 and 1864 its business of inspecting boilers and indicating engines fell off to such an extent that it was decided, in December of the latter year, to guarantee the safety of boilers. The loss of business to which I refer was attributed to the inroads made by The Steam Boiler Assurance Company, which insured as well as inspected boilers. It was first proposed that the members voluntarily subscribe a sum of money as a guarantee, and that they be reimbursed at the rate of 6s. 8d. per boiler per annum; but most of the members had such confidence in the inspection service that they refused to accept any bonus or profit. Thirteen members came forward, at first, and put up £1,000 each, and afterwards five others came in on a like basis, making the total guarantee fund £18,000 (or about $90,000). The name of the company was changed to "The Manchester Steam Users' Association for the Prevention of Boiler Explosions and for the Attainment of Economy in the Application of Steam." Strange as it may seem, the company's own history does not show when this change was made. So far as the length of title goes, the last one slightly outdistances its predecessor.

There was an antagonistic feeling abroad in the early sixties concerning the combination of inspecting and insurance by one company, but, as a compromise, the last-named company issued a guarantee in which it undertook to make good the owners' loss, if a boiler under its inspection care should explode. While in this sense a guarantee and a policy of insurance are synonymous, the Manchester Association evidently preferred to keep to the form of a wager, and to bet on its work, instead of issuing a contract of indemnity, as its competitor did.

There are several other companies abroad, with from 20 to 30 years' experience, Canada having one,— The Boiler Inspection & Insurance Company of Canada — which was organized on English lines 35 years ago, and is to-day the leading company of the Dominion.

The pioneer company of this continent was organized in 1866, in this city of Hartford. It was then, as now, known as The Hartford Steam Boiler Inspection and Insurance Company.

In the spring of 1876, the Knickerbocker Plate Glass and Accidental Insurance Company was organized in New York. Its name was soon changed to the Knickerbocker Casualty Insurance Company, and shortly afterward it was again changed to the Fidelity & Casualty Company, which it still retains. As the name indicates, this company transacts a general casualty business.

In 1883, the now defunct American Steam Boiler Insurance Company, devoted solely to boiler insurance, was formed in New York, and in more recent times many companies have entered the field, to underwrite boiler insurance.

Since the days of the American Steam Boiler Insurance Company, there has been strenuous competition in the business. There are today no less than 14 companies writing boiler insurance in the United States, but only two are confining themselves exclusively to the underwriting of the hazards pertaining to steam — one of these, The Hartford Steam Boiler Inspection and Insurance Company, operates in all the states of the Union, while the other, The Mutual

Boiler Insurance Company of Boston, confines its operations to the State of Massachusetts. All the remaining companies are doing various lines of underwriting, such as liability, plate glass, automobile, burglary, and so on, one of them priding itself on the multiplicity of its lines, of which it has, not fifty-seven varieties, but sixteen.

A number of multiple-line companies have retired from the boiler-insurance field, finding, after an honest endeavor to maintain an adequate inspection service on a necessarily small premium income, that it is impossible to do so to the satisfaction of the assured, without severe loss to the stockholders.

While there are still 14 companies trying to build up boiler departments, it is necessarily slow work, not because their efforts are not well directed, but because the field is not developing so as to keep pace with *industrial* advances. At first thought you will charge me with being a pessimist, but when I tell you the facts about the narrowing field, you will readily understand what I mean, and I think you must also admit the truth of my contention.

Up to a few years ago the boiler-making industries were keeping pace with other advances, but in more recent times there has been a tendency toward the use of larger units of power, and this means a reduction in the number of boilers used for the development of a given power. The smaller steam powers are also giving way to internal-combustion engines that do not require the generation of steam. Indeed, there are some large and notable power plants abroad, as well as in our own country, where no boilers are employed, at all, except possibly in a small way as auxiliaries, for furnishing steam for minor purposes.

It is the intention of one of the largest and latest equipped boiler shops of this country to go out of the boiler business entirely, and engage in the manufacture of internal combustion engines. This shop has had a capacity for producing from 2,500 to 3,000 boilers per annum, and has actually turned out that number when business was fairly good. Every day some owner gives up boiler insurance because he has substituted either gas, gasoline, or kerosene engines, for steam power. We have also to reckon with the concentration of power, as it is observed in public utility corporations, supplying electric power to the smaller consumers, and displacing a corresponding number of the minor steam power plants.

Successful methods of transmitting electric power over long distances have permitted the utilization of great and heretofore undeveloped water powers, and made it possible to bring the electric current generated therefrom within the zone of power users, and this has still further checked the multiplication of steam-power plants. The number of boilers so being discontinued is startling, yet every year some new company is formed to insure boilers (with other lines of casualty insurance), or some casualty company adds boiler insurance to the lines it is already carrying.

Boiler owners have been fairly well educated to perceive the need of inspection service, and of protection in case of loss, although there are occasional exceptions where they are still unfamiliar with the subject, or indifferent to it. The education has been brought about by liberal advertising upon the part of the companies engaged in the business, and by severe penalties exacted from uninsured boiler owners in the courts, in suits for recovery for personal injuries. Competition is so keen that little or no business comes in, as one would say commercially, "over the counter." It is mostly secured by personal solicitation.

Boiler insurance differs from some other forms of insurance in the fact that the contracts or policies offered by the various companies are widely different, there being no two absolutely alike. Occasionally a company will undertake to furnish a duplicate form, but will balk at some one or two clauses, so that there is never any real identity in the contracts.

I intended to point out the differences in the policy forms that are in actual use, but as I found that it would take an entire evening to do so, I shall have to confine myself to a brief review of the most important points.

Taking a composite view of those that exist, we have a policy covering, in blanket form, the property of the assured, as well as the property of others, and also any personal injuries for which the assured may be liable,—provided such injuries and losses are caused directly by the explosion of the insured boiler.

All contracts agree, within certain limits, to absolutely indemnify the assured for his own property, wherever it may be located, and whether it consists of boilers, buildings, machinery, or stock; and while some contracts permit the owner to exercise an option as to whether his own property loss shall be paid first, or before the policy contributes to other claims, others do not do so. In my own experience, extending over 25 years, I have never known an owner to ask the suspension of payment for his own property loss, in order to first determine his legal liability for his neighbors' property, or to ascertain the outcome of the adjudication of personal injury claims, both of which settlements might conceivably be drawn out for years. An insuring company may sometimes be asked, however, to first settle personal injury claims of a minor character, when it is evident that there would be a remaining sum large enough to cover the property loss. Self-preservation is the first law of nature, so naturally the owner would always prefer to have his own direct property loss paid first.

It is my opinion that under the optional clause, a coinsuring liability company could force the boiler policy to participate in the personal injury claims before the property claims could be paid out of it; hence, under certain conditions, the owner might suffer a loss that, under a contract covering property first, he might be saved. I base my opinion upon this reasoning: Assuming, of course, that liability insurance is also carried, if the owner should hold an optional boiler contract at the time of an explosion, and if he had not indicated prior thereto which character of loss should first be paid, the personal injury indemnity would be in full force at the moment of the explosion, and it would therefore be subject to pro rate with other insurance of like nature, and it would be beyond the power of the holder to discriminate against another insuring company.

As all liability companies make conditions in their policy contracts providing that they shall participate in personal injury claims only in the proportion that their limits bear to the whole amount applicable *at the time of the accident,* the liability company can force either the boiler policy or the assured to contribute, inasmuch as at the moment of the explosion there *was* contributing insurance.

The optional contract seems analogous to the following: If the assured carries a like or similar insurance in another company, and one company fails after the accident, the solvent company cannot be held for more than its proportion of insurance carried by the assured at the time of the accident, for at that moment the insurance of the defunct company was in force. A policy which makes the payment of death and injury claims secondary, and effective only after the payment of property damage, cannot be made to contribute until the property claim is settled, as it is not contributing at the moment of the explosion.

Boiler policies do not cover fire, whether it is caused by an explosion or not.

The maximum pressure allowed on the insured boilers is sometimes fixed in the policy. This is a better plan than the one followed by some companies of having it fixed by the reports or certificates of the inspectors, because under the latter system changes with intent or by error can easily be made by the insuring company, and overlooked by the policy-holder; — and then, in case a claim arises under the policy, there is a loophole provided, which may enable the insuring company to escape payment, if it should be disposed to make the attempt.

An increase of pressure beyond that allowed by the policy or certificate, comes within the general clause of "Changes material to the risk," and thus makes the contract void. The same clause is necessary in all contracts, to avoid liability for damages caused by a weakening of the structure, and within the control of the assured; for otherwise the hazard might be increased without the knowledge of the insuring company.

The definition of an explosion, under the composite view, is "a violent separation of the metal, or of the component parts of the boiler," and the contract is usually extended to cover all pipes — water or steam — up to, and including, the first shut-off valve in each pipe. A necessary provision is, that the explosion shall be caused by the pressure of steam. You may ask, What else would burst, explode, or rupture a boiler? To which I answer, Dynamite, gas, ice, or a number of other agencies that it would be easy to enumerate. I have personally observed results from the three causes mentioned, and I have known of a case in which a boiler was destroyed by a landslide.

No company agrees, in its policy contract, to make inspections, although it provides that its inspectors shall have all reasonable opportunity to inspect the insured boilers and the appliances on which their safety depends. Very properly, all companies reserve the right to suspend the insurance at once, in the event of urgent need; — for example, in case a dangerous defect were found in a boiler, and the local persons in charge of the boiler should insist upon its continued use. There is but little difference among policies in the matter of the terms of cancellation. The inspection service being quite expensive, it is necessary to provide that in the event of cancellation by the assured, the cost of the inspections rendered shall be included in the charge to the assured.

It is imperative that immediate notice of accident shall be rendered to the insuring company, so it may have an opportunity to investigate the cause, as well as to determine the extent of the damage.

Sufficient consideration is not always given to fixing the amount of insurance needed to properly protect the assured. It has been common practice to determine the amount of the policy by allowing $5,000 per boiler, but such a custom is illogical, and inconsistent with the best interests of either of the parties concerned. There are many one-boiler or two-boiler plants, carrying, on that basis, $5,000 or $10,000 of insurance, respectively, while, by reason of their locations, in proximity to expensive buildings or to a large number of persons, they should be carrying $50,000 to $75,000. A boiler is equally capable of exploding and causing death and destruction, whether it be isolated or set in company with a number of others.

In these days of aggregations and combinations, many companies owning boilers have consolidated, so that a demand has arisen for a form of policy covering a number of individual plants under one contract, and commonly known as a "schedule form." Such a contract is sometimes demanded, also, by owners having a number of boilers in one plant, and desiring a coverage beyond the usual limit for one explosion. In these cases a policy is issued having a limit fixed for any one accident, and a larger or principal sum, which would cover two or more accidents of the same limit. Such a policy has the advantage of affording continued protection to the remaining boilers in a battery, if their use were continued immediately after the destruction of one of them.

Occasionally an owner desires to cover property loss only, with no provision for personal injuries and death claims. This appears to me to be the best way, for I believe boiler policies should cover property only, leaving claims for personal injuries and deaths to the liability policies. But as such protection against personal injury claims was demanded and provided, before any employers' liability or public liability insurance was written in this country, it has become a fixed feature in connection with boiler insurance.

That part of the hazard which relates to compensation for the destruction of property belonging to persons other than the owner of the boiler, stands upon exactly the same basis as death claims and claims for personal injury; that is, the insurance is really and legally applicable only to the liability of the policy-holder. In general practice this part of the loss is usually settled by the insuring company, and upon the same basis as that adopted in settling for the property of the assured,— namely, the actual cash value of the property at the time of the explosion.

Death and personal injury indemnity, under a boiler policy, is really a protective feature that can be classed as liability insurance, pure and simple.

Inspection Service.

A full evening would be required, to treat this part of the subject properly, and hence I shall try to interest you in a few things only.

The success of a boiler insurance company depends very largely upon the nature of its inspection service. The organization and maintenance of an inspection department seems a simple thing, even to shrewd business men and engineers; but high efficiency in this work implies familiarity, on the part of the employees, with an enormous mass of facts respecting boiler design, construction, operation, defects, and so on, and it takes many years to fully train an inspector; and his superior must have had much more experience, in order to lay out the work and guide the men, and then to pass upon doubtful points. Boiler inspectors are selected from a class of men who have had experience in as many of the following branches as possible: Boiler designing, construction and operation, and the manufacture of the different elements that go to make up a boiler and engine plant.

The company with which I have had the pleasure to be connected, endeavors to inspect all boilers offered for insurance before their acceptance, and thereafter it makes periodical inspections, characterized as internal and external, and often applies a hydrostatic test.

Internal inspections are made when the boilers are prepared by having their fires drawn, and being slowly cooled. All parts must be open, and must be clean and accessible to the inspector, who examines every visible part, sounds with a hammer any part liable to be affected, and takes the dimensions of all parts of the boiler subject to strain. He tests the steam gages, examines the gages for determining water-levels, inspects the safety-valves, and closely scrutinizes all the other apparatus of the boiler plant upon which safety depends.

The external inspection is made when the plant is working under the regular running conditions, and, contrary to the opinion of many persons, it is really a highly important detail. Some of the appliances can best be tested when the boilers are in operation, this being true, in particular, of the water and steam-gages and the safety-valves. The inspector is also able, at this time, to observe the general attention given to the operation, to detect leaks in the boiler connections, to observe the efficiency of the feeding methods, and to form some opinion of the duty required of the boilers and of their attendants.

The hydrostatic pressure is applied only under certain conditions or in conformity with special requirements. In the City of Philadelphia a water-pressure must be applied annually, and before the certificates are issued.

Each day brings some new lesson with regard to defective boilers, and it is here that long experience better qualifies a man or a company to decide the future of a boiler. In our own practice the inspectors figure up the pressure allowable upon the boilers under examination, according to the requirements of the company, and of any state or municipal laws that may apply to them,— making due allowance for defects and deterioration. The result is passed on to the chief inspector of the department, who, in turn, checks up the data and the figures, and forwards them to the home office, where a corps of experts review the work of both the inspector and the chief inspector.

New conditions, new types of boilers, and rare defects are reported daily, and taken up with the experts at the home office, who keep in close touch with all the chief and field inspectors, and give the benefits of a wide range of experience to the assured.

The average man does not always understand how much trouble and expense an inspector may cause, by an immature judgment. If he fails to grasp the significance of certain defects, and permits the use of the boiler without repairs, an explosion or rupture may follow, and frequently *does* follow, causing damage to property, and very likely loss of life and personal injury. On the other hand, if his judgment is equally imperfect in the opposite direction, he may cause great expense by ordering unnecessary repairs, or he may even require the installation of a new boiler, when the old one is really quite safe and fit for several more years of service.

Some time ago, in this state, and not far from Hartford, an inspector of a liability company reduced the pressure on a boiler so greatly that it could not perform its accustomed work, and, if the inspector had been the court of last resort, the boiler would have had to be removed. In the particular case I have in mind, the owner did not accept the judgment of the inspector, but cancelled his insurance and placed the boiler with another company that had insured it previously, and whose men were familiar with the risk. The pressure was thereupon restored, and the installation of a new boiler, with its attendant expense, was postponed,— for how long I cannot yet tell, but more than four years have elapsed since the incident, and the boiler is still doing effective duty.

It would be impossible for me this evening to tell you how to discover defects, or where to look for them in a boiler. Corrosion, structural weakness, bad workmanship, the formation of scale, and many other things, go to make boilers unsafe, and different types are differently affected.

I will take this opportunity to say that firemen and engineers are too often blamed for causing explosions, especially if either has lost his life and cannot be present to defend his acts. It is so easy for those who are inexperienced, or who do not know the actual conditions, to attribute an explosion to low water, or, the attendants being killed, to say that they alone could tell the cause. Whenever the facts justify an exoneration of the engineer or fireman, I take great pleasure in freeing him from the criticism and stigma, for those attendants, as a class, have been unjustly condemned, on many occasions.

Adjusting.

Even though a boiler insurance company has enjoyed the fullest confidence of its assured for many years, and has been trusted in all its dealings, these facts are often forgotten after an explosion, and the company is put to a severe test in facing the problem of adjusting a loss. Save for the facilities it has for rendering valuable mechanical service, one company is as good as another until that test of tests comes,— the adjusting and settling of the losses.

An explosion occurs, a telegram is received, and immediately two persons who have never known each other personally are brought together to settle a purely business transaction, involving many thousands of dollars. Confidence on the part of both is most needed at this time, and it is a hard position for either the claimant or the adjuster. I think there is no other line of business, outside of insurance, in which two strangers are suddenly brought face to face, to transact a business deal involving so large an expenditure.

It is highly important for the adjuster to show a friendly disposition from the very outset. He should so conduct himself as to inspire confidence, not only in the company he represents, but also in himself; for unless he commands confidence personally, he cannot obtain it for his company.

Time and again have I appeared on the scene of an accident for the purpose of investigating the cause of a boiler explosion and settling the claims arising therefrom, and found the owners anxiously waiting to see with what kind of a man they were to reckon. The adjuster is always looked upon with suspicion, and the belief is held that he is the sharpest man that could be selected to drive a bargain with a claimant. At such a time he should be most discreet, even in his manner of expressing sympathy,— a single injudicious remark, or a single misunderstood action being sufficient to broaden the gulf that appears to stand between the assured and the insuring company. Even commonplace conversation with employees, or with people of the town, is sometimes looked upon with suspicion, as though one were working up a case *against* the assured, instead of being friendly and acting in his interests. Every movement of the adjuster is watched, and note is made of where he goes, what he does, whom he talks with, and what he says.

In my experience I have found most men honest, and I have had but little difficulty in arranging satisfactory terms of agreement; but occasionally I have found a person who has deliberately set out to defraud the company. When dishonesty or fraud is thus resorted to by the assured, it forces the adjuster to assume the defensive, much to his dislike. It then becomes legitimate, in fact, for him to stifle his natural tendency towards liberality, and to adhere to the strict letter of the contract, and compel the assured to do the same.

I believe most insurance companies have a desire to be fair with their patrons, and that, if treated right, they will leave the claimant in the same mood in which I found a jeweler in a Southern city a few years ago. Upon discovering that I had been adjusting a loss, he told me that some months before he had suffered from fire and water — mostly the latter. He said he thought insurance companies were honest and liberal, as he spoke from experience. After his loss had been scheduled and paid, and the repairs to buildings, show-cases, etc., were all completed, he found that he was two thousand dollars ahead. "Don't you think that was pretty good?" he asked. I agreed with him, especially after running my eye over his place of business.

It has been my practice in adjusting losses to find out what had existed before the explosion, and to get the assured to agree upon two or more reputable contractors for each character of construction involved, and have these men estimate the loss. With their figures as a basis, and a reasonable allowance for depreciation, it is usually not a hard matter to arrive at the true cash value of the property destroyed. Losses on boilers and machinery may be determined largely by the same process. Owing to fluctuations in the price of materials and labor, the cost of restoring property may be either greater or less, at the time of an explosion, than the original first cost.

The value of stock in the raw state, or in process of manufacture, can usually be determined from the assured's records, which are commonly preserved. The market price is always available, and in case of need, advice as to the cost of carrying the materials through the various stages of production can be had from neighboring factories, although one is sometimes compelled to send outside the zone of influence of the local company for such assistance.

Consequent losses, or losses incurred subsequently to an explosion, are not covered, except under special contracts. Hence they are absolutely ruled out of consideration when a boiler policy alone covers.

A knowledge of buildings, and of mechanics as applied to boiler construction and operation, is positively essential to the satisfactory adjustment of losses arising from boiler explosions. It is also important to have some knowledge of machinery, general and special, because many questions arise concerning all those things — sometimes when you are many miles away from anyone with whom you might consult. In Florida I once encountered a most singular situation in relation to the immediate use of a boiler thrown out of its setting by the force of the explosion of another one. It was at an ice manufacturing plant, far from a boiler shop, and to get the boiler back into immediate service we had to devise a method of making repairs that had never before been used, so far as I am aware. We met the emergency, however, and effected the repairs, and for all that I know to the contrary, the boiler is still in use.

After the adjuster has gained the confidence of the assured, he can, if so trained, render valuable advice concerning temporary expedients, as well as the permanent restoration of the power plant. Each case, since it necessarily involves persons and questions peculiar to itself, must be carefully studied by the adjuster, who should be a student of human nature. To be successful, he must be open and frank, and, above all, honest; taking no advantage of the assured even in little things. But his duties nevertheless require him to be firm, and this attitude he can maintain with dignity and courtesy, so as to command the hearty respect of the assured.

The Locomotive.

A. D. Risteen, Ph.D., Editor.

HARTFORD, OCTOBER 25, 1910.

The Locomotive *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.

Obituary.

Charles Mason Beach.

It is with profound regret that we record the death of Mr. Charles Mason Beach, who passed away on June 27, 1910, at his home at Vine Hill, West Hartford, Connecticut. He was born at Hartford on February 18, 1826, the son of George and Harriet Bradley Beach, and was one of seventeen children, of whom but one, Isaac T. Beach of Atlantic City, New Jersey, is now living. He began his business career as a clerk in the store of Howe, Mather & Company, on Asylum Street, Hartford, and in 1848, in company with two of his elder brothers, he organized the firm of Beach & Company, to deal in dye-stuffs and chemicals. This is still in active existence, and Mr. Beach retained his connection with it up to the time of his death, although for the last two years or so he had taken no active part in its management.

Mr. Beach was widely known, also, on account of his agricultural interests, and at Vine Hill he maintained a farm which was managed in accordance with strictly scientific methods, and was regarded as a model, particularly in respect to the raising and handling of sheep and dairy cattle. He was one of the founders of the American Jersey Cattle Club, and of the American Guernsey Cattle Club, and he was a director of the Phoenix Insurance Company, the Hartford Steam Boiler Inspection and Insurance Company, the Phoenix National Bank, the Connecticut Mutual Life Insurance Company, the Hartford Carpet Corporation, and the Holyoke Water Power Company. For many years, too, he was a director of the Illinois Central Railroad Company, resigning only a short time ago, on account of his age.

At a meeting held on September 26, the Directors of the Hartford Steam Boiler Inspection and Insurance Company adopted the following minute:

"In the death of Mr. Charles Mason Beach, this Board loses a valuable counsellor, and its members lose a friend who was universally respected and esteemed. He was elected to the directorate on October 6, 1866, when the company was first organized, and he had served upon it, continuously and faithfully, to the end. In his departure we have lost the sole remaining member of the first, historic board, that laid the foundations of our success.

"Mr. Beach was the first vice-president of the company, holding that position from the outset up to 1873, when the pressure of his own affairs forced him to relinquish it. In January, 1904, he was again elected to the same office, accepting the second tenure temporarily, pending the appointment of a permanent incumbent.

"Mr. Beach was markedly optimistic, with a philosophy that was cheerful and full of hope, and his confident and reassuring counsel was largely instrumental in preventing the dissolution of this company, shortly after its first organization. His years were spent in Hartford and its suburbs, and he had been closely identified with many phases of the city's business life. With increasing age he had retired from many of the activities of earlier days, but he retained a prominent connection with numerous institutions of a varied character, in an advisory capacity, his counsel being widely sought and highly prized.

"He was a kind-hearted, generous and considerate man, showing a courteous regard for others in all relations, whether business or social. He was a man of the finest instincts, with a keen sense of personal honor and integrity. He passed away full of years, venerated by all, and commanding the deepest respect and the tenderest regard of hosts of friends and associates."

In the last issue of THE LOCOMOTIVE we printed a short article under the heading "Buggy and Shovel Inspections." Some of our readers have taken it for granted that the story relates to Connecticut, but this assumption is entirely incorrect. The incidents really occurred, precisely as we related them, but not in Connecticut, nor anywhere near Connecticut.

WE beg to announce that Mr. A. S. Wickham, our former superintendent of agencies, has associated himself with Messrs. Corbin & Goodrich in the management of our Philadelphia department, under the firm name of Messrs. Corbin, Goodrich & Wickham, General Agents.

Messrs. Corbin & Goodrich opened an office in Philadelphia in August, 1867, and through their efforts the Philadelphia department has been built up and established, as since that date they have been the company's sole representatives. Under their long and able management, the department has grown until it now ranks as one of the largest and most important of the company, doing annually a volume of business approximating the total volume done by the entire company in any one of its first fifteen years, and today, with but two exceptions, the premium receipts of their department exceed the *total* premiums paid for steam boiler insurance to any one of the fifteen other companies now writing this line of insurance.

Mr. Wickham first entered the employ of the Hartford Steam Boiler Inspection and Insurance Company in September, 1899, as senior special agent in the New York department, which position he held until March, 1908, when he was invited to come to the home office and assume the responsibilities of superintendent of agencies. He has filled these various positions with credit to himself, and acceptably to the company, and from his varied and extended experience and natural adaptability we consider that he is peculiarly qualified to render Messrs. Corbin & Goodrich the assistance they now need in the executive management of a department so large and important.

Wooden Boilers.

The following extract, from a recent issue of the New Haven *Evening Register,* may be of interest to those who were unaware that wood was sometimes used as structural material for the manufacture of boilers, in the early days of steam engineering.

"The newspapers of New London, Conn., have long occupied a prominent place in the opinion of those who seek accurate information respecting marine affairs. This was so, even back in 1817, when the New London *Gazette* was being pulled out of the press; for that paper 'explained' the real reason for the accident that 'befell the Norwich steamboat on July 2, 1817,' and the points brought out were so important that the Connecticut *Herald* of Tuesday, July 15, 1817, reprinted the *Gazette's* story of the accident, assigning, as its cause, the fact that a wooden boiler was used. Think of a wooden boiler, and figure out where the ocean-skimmers would wind up, if such boilers were used nowadays!

"The *Gazette* disliked the idea of misleading the public, as do all good newspapers, and herewith is reproduced the true story of the accident to the Norwich boat, which, as shown, was due entirely to the desire of someone to save money:

"'The account given of the accident which befell the Norwich steamboat on the 2nd instant, and running through the public papers, is calculated to mislead those who are unacquainted with steamboats. The facts are as follows.

"'The boat in question is a small vessel, lately built, and owned by a few individuals in Norwich, to ply between Norwich and New London. The proprietors, wishing to save the expense of Fulton and Livingston's patent right and an expensive engine, have put into her a simple engine upon a new construction, and entirely experimental, with high-pressure cylinders and (extraordinary as it may seem) *wooden* boilers, without condensers, safety-valves, or balance wheels. As was predicted, her wooden boilers burst, and three persons were hurt, though not dangerously.

"'It is a fact worthy of notice that the steamboats upon the North river and Long Island sound, constructed upon the Fulton and Livingston plan, have been running ten years without a single person ever being injured; and it is impossible that any serious injury should happen to them, since their safety-valves are calculated to relieve an excess of steam spontaneously.*

"'Editors who think the public ought to be correctly informed upon this subject are requested to publish the above.'

"Great boiler this, — made of wood without balance wheels, condensers, or safety-valve.

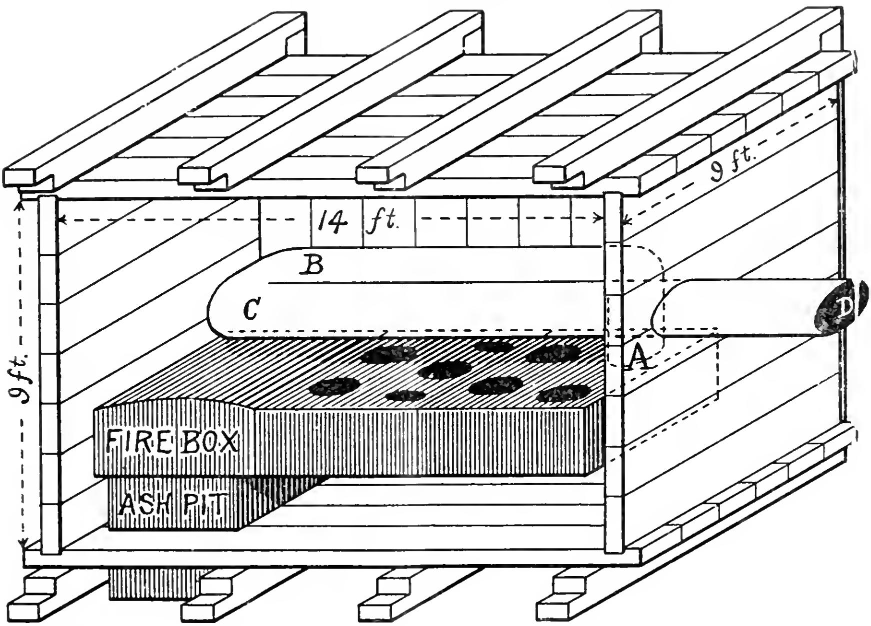
"The Connecticut *Herald,* from which the foregoing presumably truthful account of this accident is taken, is a well-preserved copy, owned by John Lucy, former station master at the Union station, New Haven, Conn. The *Herald* was published by Steele & Gray, printers, on State street, New Haven."

We are not quite sure whether the next-to-last paragraph of the foregoing was evolved by the present management of the *Register,* or by his respected fellow-townsman, the former editor of the *Herald,* long since gone to his reward. If we *did* know with certainty, we should try, by United States post or through some efficient spiritualistic medium, to let the responsible individual know that

* The serene confidence in the safety-valve, here shown, has hardly been justified by subsequent experience! — *Editor* THE LOCOMOTIVE.

balance wheels and condensers are not regarded as in any way essential to the safety of steam boilers, whether the said boilers be made of steel, or wood, or putty.

Wooden boilers were used to a limited extent when the steam engine was in its infancy, and when the pressures that were employed were to be measured, as we might say, in *ounces* per square inch, instead of pounds. (The term "high pressure," as employed in the foregoing extract, is not to be interpreted in the modern sense, of course, but merely as meaning a pressure higher than was commonly employed in other boilers at the same period.) The *Scientific American Supplement* of November 4, 1876, gives some highly interesting data respecting a wooden boiler that was in regular use for nearly four years, in



Wooden Boiler in the Center Square Water Works, Philadelphia.

the pumping station of the Center Square Water Works, at Philadelphia, Pa This boiler began its service on January 21, 1801, and its use was continued up to December 1, 1804.

The Center Square boiler had the form of a rectangular chest, and was made of white pine planks, five inches thick. It was nine feet square inside, at the ends, and fourteen feet long in the clear. It was braced upon the sides, top, and bottom with oak scantling, ten inches square, the whole being securely bolted together by inch-and-a-quarter iron rods, passing through the planks. Inside of this chest was placed a fire-box 12 feet 6 inches long, 6 feet wide, and 1 foot 10 inches deep, with vertical flues, six of 15 inches diameter and two of 12 inches diameter. Through these flues the water circulated, the fire acting around them and passing up into an oval flue situated just above the fire-box.

The illustration shows the boiler with one side removed. It was fired at the left-hand end, the fire-doors not being shown. The black, elliptical patches represent the flues through which the water circulated. The gases of combustion passed horizontally to the right, through the shaded fire-box and combustion chamber, and then up into the smoke-flue at *A*, passing toward the front end of the boiler along *A B*, and then back, and finally out to the chimney, along *C D*.

The fire-box and the water-flues appear to have been made, at first, entirely of cast-iron. A wrought-iron fire-box was next tried, the water-flues still being of cast-iron. This arrangement was found to be unsatisfactory on account of leakage, which was attributed to the unequal expansion and contraction of the two metals, and eventually the water-flues were also made of wrought-iron.

So far as we can judge from the data at hand, the smoke-flue, *A B C D*, was made of wrought-iron from the first. Thus under date of July 4, 1800, Thomas Cope says of a similar plant, having a similar wooden boiler and located on the Schuylkill river at the foot of Chestnut street, "The wrought-iron for the flue of the boiler over the fire will be imported from England, and is in sheets 38 inches by 32 inches. That yet made in this country is clumsy stuff of different sizes, the largest being 36 inches by 18 inches, with rough edges, which have to be cut smooth by the purchaser."

The low heat-conducting power of wood was supposed to be of great advantage on the score of economy, and the water-flues running vertically through the fire-box were also supposed to be highly important for like reasons.

As might be expected, great difficulty was experienced in keeping these wooden boilers tight, and the one at the Center Square works was replaced, on December 1, 1804, by a boiler having a cast-iron shell.

Boiler Explosions.

July, 1910.

(276.) — A sectional boiler exploded, July 2, in the Hahnemann Hospital, Philadelphia, Pa., where it was being installed. One man was killed.

(277.) — On July 2 a boiler exploded at Endicotte, near Littleton, W. Va. One man was killed and one fatally injured. The boiler house was destroyed.

(278.) — On July 3 a tube ruptured in a water-tube boiler at the Hammond plant of the National Packing Co., Union Stock Yards, Chicago, Ill.

(279.) — The boiler of freight locomotive No. 949, of the Santa Fé railroad, exploded, July 3, at Yucca, near Needles, Calif. One man was killed, and one was fatally injured.

(280.) — A tube ruptured, July 5, in a water-tube boiler in the American Steel & Wire Co.'s plant, De Kalb, Ill. One man was injured.

(281.) — The boiler of Jenkins Bros.' laundry exploded, July 5, at Laconia, N. H. One man was killed and seven were injured, and the building was badly wrecked.

(282.) — A boiler ruptured, July 5, at the No. 1 plant of the Washington Coal & Coke Co., Star Junction, Pa.

(283.) — On July 7 a boiler ruptured at the plant of the Appleton Brewing & Malting Co., Appleton, Wis.

(284.) — A boiler exploded, July 8, in John L. McQueen & Co.'s mill, eight miles from Butler, Johnson county, Tenn. One man was instantly killed.

(285.) — A tube ruptured, July 8, in a water-tube boiler in the Johnstown Passenger Railway Co.'s power plant, Johnstown, Pa. One man was injured.

(286.) — On July 9 a tube ruptured in a water-tube boiler at the plant of Spang, Chalfant & Co., Etna, Pa. One man was injured.

(287.) — A boiler used by the Good Roads Commission for operating a rock crusher exploded, July 10, four miles southeast of Los Angeles, Calif. One man was instantly killed.

(288.) — A boiler ruptured, July 12, in F. L. Jones' laundry, Fort Wayne, Ind.

(289.) — On July 12 a flue ruptured in a boiler in the pumping station at California, Ohio, near Cincinnati. One man was fatally scalded.

(290.) — A boiler exploded, July 13, at Neave's coal mine, Sheffield, Ill.

(291.) — On July 13 a tube ruptured in a water-tube boiler in the Detroit Salt Co.'s plant, Detroit, Mich. (See, also, No. 299, below.)

(292.) — On July 15 a boiler exploded in the plant of the Peoria Auto Tire Co., Peoria, Ill. One person was severely injured.

(293.) — A boiler exploded, July 15, in James Webb's sawmill, eight miles west of Cove, Ark. Three men were killed and seven injured, and the mill was demolished.

(294.) — On July 18 a boiler exploded in Gay's sawmill, near Smithfield, Va. One man was killed and two were seriously injured. The mill was demolished.

(295.) — A boiler ruptured, July 19, at the No. 7 mine of the Boone Coal & Mining Co., Fraser, Iowa.

(296.) — The boiler of a threshing outfit exploded, July 20, on the Huntington ranch, two miles south of Redondo Beach, near Los Angeles, Calif. Two men were injured.

(297.) — A boiler exploded, July 21, in the United Portland Cement Co.'s plant, at Lehunt, five miles from Independence, Kans. The engineer was fatally scalded.

(298.) — On July 23 a boiler exploded in Hill Bros.' sawmill, near Atlee, Ark. One man was fatally injured.

(299.) — A tube ruptured, July 24, in a water-tube boiler at the Detroit Salt Co.'s plant, Detroit, Mich. (Compare No. 291, above.)

(300.) — A boiler exploded, July 24, in the B. & O. S. W. plant, Cincinnati, Ohio. One person was killed, and one seriously injured.

(301.) — On July 25 a boiler exploded on a dredge boat in the Nixon special drainage district, near Weldon, Ill.

(302.) — A tube ruptured, July 25, in a water-tube boiler in the Indiana Provision Co.'s ice and cold storage plant, Indiana, Pa. (Compare No. 309, below.)

(303.) — A boiler exploded, July 26, in the Coquille Mill & Mercantile Co.'s sawmill, Coquille City, Ore. One man was killed, and his wife was seriously injured. The property loss was estimated at $10,000.

(304.) — A boiler belonging to the New York Coal Co. exploded, July 27, at Hamley Run, Ohio. One person was severely injured.

(305.) — The boiler of a threshing outfit exploded, July 27, on A. L.

Scott's farm, four miles north of Lincoln, Neb. One man was killed, and three were injured.

(306.) — A slight explosion occurred, July 27, on the tugboat *Peerless,* at Spedden's wharf, Baltimore, Md. One man was killed, and two others were seriously injured.

(307.) — The boiler of a threshing outfit exploded, July 28, on a farm occupied by Daniel Dearwachter, at McGillstown, Lebanon county, Pa. Two persons were injured.

(308.) — On July 29 the boiler of Santa Fé freight locomotive No. 975 exploded at McConnico, near Kingman, Ariz. One man was killed, and one fatally injured.

(309.) — A tube ruptured, July 30, in a water-tube boiler at the plant of the Indiana Provision Co., Indiana, Pa. (Compare No. 302, above.)

(310.) — A boiler ruptured, July 30, at the department store of Hillman's, Inc., on State street, Chicago, Ill.

(311.) — On July 30 a tube ruptured in a water-tube boiler at the Dayton Arcade Co.'s office and market building, Dayton, Ohio.

August, 1910.

(312.) — A boiler exploded, August 1, in J. O. McMillan's sawmill, at New Prospect, near Spartanburg, S. C. Some four persons were injured.

(313.) — The boiler of a traction engine, used at the time for sawing wood, exploded, August 2, on Union avenue, just outside of Saginaw, Mich. One man was seriously injured.

(314.) — The boiler of a threshing outfit exploded, August 3, on J. A. Doner's farm, seven miles east of Celina, Ohio. Two men were killed.

(315.) — On August 3 a boiler exploded in C. W. Shimp's sawmill, two miles west of Germantown, Ohio. Two men were seriously injured, and the mill was wrecked.

(316.) — A boiler exploded, August 4, in the oil fields at Nowata, Okla. One man was seriously injured.

(317.) — On August 4 a boiler tube burst on the fishing-excursion steamer *Satellite,* off Spectacle Island, near Boston, Mass. Two men were killed and one was fatally injured.

(318.) — The boiler of a Boston & Maine locomotive exploded, August 5, at Oak Island, near Boston, Mass. The rupture occurred in the firebox. The engineer and fireman were injured.

(319.) — On August 6 a fertilizer drier ruptured in the packing house of Schwartzschild & Sulzberger, Kansas City, Kans.

(320.) — A cast-iron header ruptured, August 7, in a water-tube boiler in the plant of the North American Cold Storage Co., Chicago, Ill.

(321.) — A boiler exploded, August 8, in C. A. Durbin's shingle mill, Keenan, Tex. Five men were killed and one was fatally injured.

(322.) — On August 8 a boiler ruptured at the brick works of the Harbison-Walker Refractories Co., Layton, Pa.

(323.) — A hot-water boiler exploded, August 8, in the rear of Simon Newman's bakery, at the corner of Clinton and Broome streets, New York City. Two men were badly scalded, and the basement of the building was considerably damaged.

(324.) — On August 10 an upright boiler used for hoisting exploded on the dock of the Farist Steel Co.'s plant, Bridgeport, Conn.

(325.) — A boiler exploded, on or about August 11, in the oil fields near Childers, Okla. One man was fatally injured.

(326.) — A boiler of the locomotive type exploded, August 11, in the Chess-Wymond Co.'s stave factory, at Duttonville, near Jackson, Miss. One man was killed and one was severely scalded. Three others also received minor injuries.

(327.) — A locomotive boiler exploded, August 12, on the Chicago & Northwestern railroad, Chicago, Ill. One man was killed, and one was seriously injured.

(328.) — The boiler of William Jackson's threshing outfit exploded, August 12, at Winterset, Iowa. One man was seriously injured.

(329.) — On August 13 a boiler exploded in J. G. Peery's sawmill, at Rich Valley, near Big Stone Gap, Va. Three men were killed and one was fatally injured.

(330.) — A boiler exploded, August 13, on the steam schooner *Phoenix*, about ten miles north of Point Arena, Calif., and 100 miles north of San Francisco. Two men were killed outright, two died within a few hours, and three others were more or less injured. The schooner was lost.

(331.) — A boiler exploded, August 13, in the Robinson Land & Lumber Co.'s mill, at Chicora, three miles west of Buckatunna, Miss. Two men were instantly killed, and two were badly injured.

(332.) — The boiler of John Donart's threshing outfit exploded, August 14, at New Corydon, Ind. One person was killed, and two were seriously injured.

(333.) — On August 14 a boiler exploded on a jet-boat used in dredging out the channel at the Government dam, at Fernbank, near Cincinnati, Ohio. One man was badly burned, and the machinery and cabin of the boat were completely wrecked.

(334.) — On August 17 a tube ruptured in a water-tube boiler at the Columbia Chemical Co.'s plant, Barberton, Ohio.

(335.) — The boiler of Larson Bros.' threshing outfit exploded, August 18, at Geddes, S. D.

(336.) — A tube ruptured, August 18, in a water-tube boiler in the Baltic Mining Co.'s stamp mill, Redridge, Mich.

(337.) — On August 18 a slight boiler accident occurred in Glen D. Finney's ice plant, Eureka, Kans.

(338.) — Four cast-iron headers ruptured, August 19, in a water-tube boiler at the Howell-Hinchman Co.'s tannery, Middletown, N. Y.

(339.) — A tube ruptured, August 22, in a water-tube boiler in the Thomas Steel Co.'s rolling mill, Niles, Ohio. One man was injured.

(340.) — On August 22 a boiler exploded in Mullen & St. Onge's meat market, Willimantic, Conn.

(341.) — A boiler exploded, August 22, in the Maverick hotel, San Antonio, Tex.

(342.) — On August 23 a tube ruptured in a water-tube boiler in the power house of the Northern Cambria Street Railway Co., St. Benedict, Pa.

(343.) — A boiler exploded, August 23, in the Nicholas sawmill, at Mossy Head, near Pensacola, Fla. Two men were killed and two were badly injured, and the mill was wrecked.

(344.) — The boiler of a Cincinnati, Hamilton & Dayton locomotive exploded, August 23, at Barr's station, near Dayton, Ohio. Three men were injured.

(345.) — A tube ruptured, August 23, in a water-tube boiler in the power plant of the Choctaw Railway & Lighting Co., McAlester, Okla.

(346.) — A boiler exploded, August 24, on the Compton oil lease, at Heward, near Sapulpa, Okla. One man was killed.

(347.) — On August 24 a cast-iron header failed in an economizer at the Arlington Mills, Lawrence, Mass.

(348.) — A tube failed, August 25, in a water-tube boiler in the Selma Oil, Ice & Fertilizer Co.'s plant, Selma, Ala.

(349.) — On August 26 a boiler exploded in the oil fields at Earlsboro, Okla. One man was killed.

(350.) — On August 27 a boiler exploded in the plant of the McAllister Dry Dock & Shipbuilding Co., at West New Brighton, Staten Island, N. Y. The building in which the boiler stood was badly damaged.

(351.) — A tube exploded, August 29, in a water-tube boiler at the plant of the West Virginia Pulp & Paper Co., Luke, Md. One man was killed and one severely injured.

(352.) — On August 29 a boiler exploded at the Val Dukey coal bank, near Catlin, Ill. One man was seriously injured, and the boiler room was wrecked.

(353.) — A slight boiler accident occurred, August 29, in the A. Merriam Co.'s plant, South Acton, Mass.

(354.) — The boiler of Michael Alcorn's threshing outfit exploded, August 31, near Sedalia, Mo. One man was badly injured.

(355.) — A portable boiler, used for hoisting, exploded, August 31, at Speed, Ind., ten miles north of Jeffersonville. Two men were killed and one was fatally injured, and three others also received less serious injuries. The explosion resulted from the overturning of the boiler, consequent, apparently, upon the breaking of a guy rope.

SEPTEMBER, 1910.

(356.) — On September 1 a blowoff pipe failed in the J. R. Williams Lumber Co.'s sawmill, Bay St. Louis, Miss.

(357.) — On September 3 a tube ruptured in a water-tube boiler at the Denver Tramway Power Co.'s plant, Denver, Colo. One man was scalded.

(358.) — A boiler exploded, September 4, at the Crane Iron Works, Oxford, N. J. One man was killed.

(359.) — A slight boiler explosion occurred, September 5, at the Arcade, Cleveland, Ohio. Two men were injured.

(360.) — The boiler of a threshing outfit exploded, September 6, on Hayes Jarret's farm, near Middleburg, Pa. One man was fatally injured, and two others were injured seriously.

(361.) — The boiler of a threshing outfit exploded, September 7, at Danville, near Martinez, Calif. One man was killed, and one was fatally injured.

(362.) — The boiler of a Santa Fé locomotive exploded, September 7, at White's Ranch, near Galveston, Tex., while drawing a freight train on the Gulf & Interstate railway. One man was killed, and one was injured.

(363.) — A tube failed, September 8, in a horizontal tubular boiler in the Ensley-Pratt Ice Co.'s plant, Ensley, Ala. One man was injured.

(364.) — A boiler exploded, September 9, in Simmons' sawmill, near Florence, Ala. Two men were killed and one was injured.

(365.) — A boiler exploded, September 10, at an oil well at Eaton Rapids, Mich.

(366.) — On September 11 a blowoff pipe failed at the plant of the American Candy Mfg. Co., Selma, Ala.

(367.) — On September 11 a boiler exploded in the pumping station of the T. & O. C. railroad, at New Lexington, near Zanesville, Ohio. One man was killed and two were fatally injured.

(368.) — On September 12 a boiler accident occurred in the plant of the Macomb Electric Light & Gas Co., Macomb, Ill.

(369.) — A boiler exploded, September 12, on the tug *Joseph Peene,* at Yonkers, N. Y. One man was severely injured.

(370.) — A number of cast-iron headers fractured, September 12, in a boiler at the Chittenden Hotel, Columbus, Ohio.

(371.) — On September 13 a boiler ruptured in the Madison Brewing Co.'s plant, Madison, Ind.

(372.) — The boiler of a locomotive drawing a Missouri, Kansas & Texas passenger train exploded, September 15, near Coffeyville, Kans. One man was killed and one was fatally injured, and the locomotive was wrecked.

(373.) — On September 15 a boiler ruptured at the Standard No. 2 plant of the H. C. Frick Coke Co., Mt. Pleasant, Pa.

(374.) — On September 16 a blowoff pipe failed at the Home Laundry, Paducah, Ky.

(375.) — A tube ruptured, September 17, in a water-tube boiler at the Inland Steel Co.'s plant, Indiana Harbor, Ind.

(376.) — A boiler ruptured, September 20, at the plant of the City Ice Delivery Co., Cleveland, Ohio.

(377.) — On or about September 20, the boiler of a locomotive exploded in the shops of the Chicago & Northwestern railroad, Chicago, Ill. One man was killed, and one was seriously injured. (It is said that the explosion was due to an attempt to calk the flues of the boiler while it was under pressure.)

(378.) — The boiler of the locomotive drawing the south-bound "Meteor express" on the St. Louis & San Francisco railroad exploded, September 20, near Olathe, Kans. Two men were instantly killed, and one person was injured.

(379.) — A cast-iron header fractured, September 21, in a water-tube boiler in A. H. Belo & Co.'s publishing plant, Dallas, Tex.

(380.) — The boiler of a threshing outfit exploded, September 21, on Wright Bros.' farm, near Modale, Iowa. One man was scalded.

(381.) — On September 22 the boiler of John M. Lee's threshing outfit exploded near Selma, Iowa. Mr. Lee was fatally scalded.

(382.) — On September 23 a blowoff pipe failed in the Brushy Gin Co.'s cotton gin, at Brushy, near Montague, Tex.

(383.) — Three cast-iron headers fractured, September 23, in a water-tube boiler at the Edge Moor Iron Co.'s plant, Edge Moor, Del.

(384.) — A tube ruptured, September 23, in a water-tube boiler at the Hot

Springs Water Co.'s electric lighting and water works, Hot Springs, Ark. One man was injured.

(385.) — On September 25 three tubes ruptured in a water-tube boiler at the Jacob Dold Packing Co.'s plant, Wichita, Kans.

(386.) — A tube ruptured, September 26, in a water-tube boiler at the Sharon works of the American Steel & Wire Co., Sharon, Pa. Two men were injured.

(387.) — On September 27 a tube failed in a boiler in the convent of the Sisters of Charity of Our Lady Mother of Mercy, Baltic, Conn.

(388.) — On or about September 28 a boiler exploded at St. Francis' Hospital, Topeka, Kans.

The Properties of Steam.

TENTH PAPER. — THE EXPERIMENTS OF SCHEEL AND HEUSE, AT TEMPERATURES BETWEEN 0° C. AND 50° C.

Messrs. Karl Scheel and Wilhelm Heuse have recently published a valuable series of experimental results respecting the pressure of saturated steam at temperatures between 0° C. and 50° C. (32° Fahr. and 122° Fahr.). The data previously obtained by Thiesen and Scheel within this interval, and published in THE LOCOMOTIVE for October, 1907, were classed by us as "exact determinations," because they were apparently of a higher order of precision than any that had been published, up to that time, for the same range of temperature. Those that they made *at the freezing point itself* are still to be regarded in the same light. Their measures *above* the freezing point were professedly provisional, however, and we presume that the data now furnished by Scheel and Heuse constitute the additional investigations that were then foreshadowed, although the apparatus used in the present research is different from that employed by Thiesen and Scheel.

The paper that we are about to review is printed in the German language, under the title "Bestimmung des Sättigungsdruckes von Wasserdampf zwischen 0° und + 50°" ("Determination of the Pressure of Saturated Water Vapor between 0° and + 50° C."), and was published on March 15, 1910, in the *Annalen der Physik*, fourth series, volume 31, page 715. It is wholly experimental in character, and the work was carried out at the Physikalisch-Technische Reichsanstalt, Charlottenburg, Germany.

The static method was used (see THE LOCOMOTIVE, July, 1906, page 87), and all the work was done with the care characteristic of the observers, and of the institution at which the research was carried out. The apparatus of Scheel and Heuse, as well as their experimental methods, varied somewhat according as the temperature of the water was higher or lower than that of the room in which the apparatus stood. Roughly speaking, three fifths of the experiments were made at temperatures below that of the room, and two fifths at temperatures higher than that of the room.

FORM OF THE APPARATUS AT TEMPERATURES BELOW THAT OF THE ROOM.

The apparatus that was used at temperatures below that of the room is shown diagrammatically (with the exception of the manometer) in Fig. 1. The part of the apparatus containing the water and the water-vapor was constructed entirely of glass, and the water itself was contained in two tubular receptacles, u_1 and u_2. *Two* such receptacles were provided, instead of one, in order to avoid error from the supercooling that is produced when, by reason of a sudden connection of the water-vapor space with some part of the tubing that is highly exhausted, a considerable quantity of vapor is generated very quickly. The rapid evaporation under these circumstances chills the water that gives off the vapor, so that its temperature is no longer exactly equal to that of the bath in which it is submerged. One of the water-tubes was therefore used exclusively for the production of the major portion of the vapor required under these circumstances, while the other was reserved for effecting the final adjustment of the pressure, and for maintaining its constancy while the measurements were made.

The manometer could be put into communication with either of the water-tubes, u_1 and u_2, or with the condenser K (which was surrounded by a mixture of alcohol and solid carbon dioxide), by means of the mercury-valves, U_1, U_2, U_3. The mode of operation of these valves will be sufficiently obvious from the illustration. By causing mercury to flow up or down through the lower stems of these valves, the corresponding connections could be sealed or opened. In the illustration the manometer is in communication with the tube u_2, while it is shut off from u_1 and K. The condenser K was used in order to ascertain the position of the "zero-point" of the manometer. For when, by closing U_1 and U_2 and opening U_3, the manometer was shut off from u_1 and u_2 and placed in communication with K, it measured the pressure in K, and this could be taken to be zero, since it is known that the pressure of water-vapor at the temperature of solid carbon dioxide is less than 0.001 mm., or, in other words, practically indistinguishable from zero.

Before beginning the work, the entire apparatus was exhausted as perfectly as possible, by means of a Gaede air pump. While the observations were being made, the pump was sealed off from the rest of the apparatus by means of a mercury valve, shown on the right.

The water-tubes were submerged in a water-bath, which was kept well stirred by means of a screw stirrer, and the temperature of the bath was measured by means of a platinum-resistance thermometer. The cooling of the bath, and the maintenance of the lower temperatures, were effected by passing into the water-bath a continuous stream of chilled water, whose flow could be closely regulated by a stopcock, and which had been drawn through crushed ice, and so brought to 0° C. An overflow was provided, so that the water in the bath was kept at a constant level.

Form of the Apparatus for Temperatures Higher than that of the Room.

In the part of the research where the temperature of the water was *higher* than that of the room, it was necessary to modify the apparatus somewhat, because the conditions that had to be fulfilled, in order to ensure accuracy, were then different from those that prevailed before the temperature relations between the apparatus and its environment were reversed.

If we have a piece of apparatus sealed up hermetically, and entirely free from air, but containing water in two different places, then if one of these masses of water is warmer than the other, the warmer mass will become continuously diminished by evaporation, and the cooler mass will be simultaneously increased by condensation. The pressure of the vapor within the apparatus will always tend towards that particular value which corresponds to the temperature of the *cooler* of these masses of water. It may happen (if the evaporation is active enough) that the actual pressure at any given moment stands a little above the value due to the temperature of the cooler mass, but it will never be as high as the value due to the temperature of the *warmer* mass.

The bearing of these facts upon the experiments under consideration is plain. They show, namely, that if the pressure that we measure in our apparatus is to be the pressure corresponding to the temperature of the water in the tubes u_1 u_2 (in Fig. 1), then the water in these tubes must be cooler than any other part of the apparatus that the vapor can reach at the time the measurement is made. For if there is any other part that is cooler than u_1 u_2, vapor will condense upon this cooler part, and thereafter the pressure will not be that due to the temperature in u_1 u_2, but will be less than this, and nearly equal, in fact, to the pressure due to the temperature of the cooler spot where the condensation has occurred.

No error from this cause could arise when the water in u_1 u_2 was below the temperature of the room; but in order to avoid such error when the water

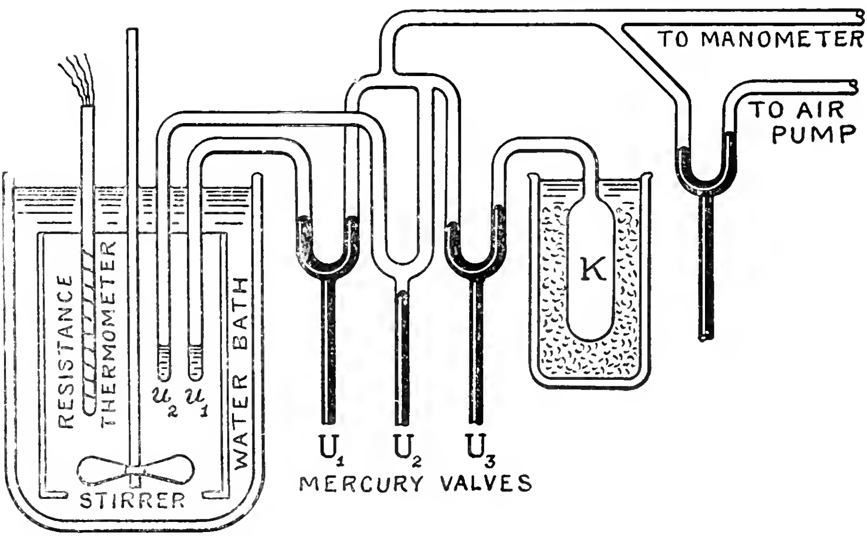


FIG. 1. — DIAGRAM OF THE LOW-PRESSURE APPARATUS.

was *warmer* than the room, it was necessary to heat the entire apparatus — manometer, connecting tubes, and all,— to a temperature higher than that of the water in u_1, u_2.

Under these changed circumstances, it was not convenient to make use of mercury valves, and the omission of these valves made it necessary to dispense with one of the water-tubes, the remaining tube being fused directly to the manometer, by a glass connection. In the first part of the work, at the lower temperatures, the zero-point of the manometer was noted before and after each separate observation. At the higher temperatures, however, where the omission of the mercury valves made it necessary to dispense also with the condenser K, the zero-point of the manometer was taken only at the beginning and end of each *series* of observations, the water-tube being surrounded, for this purpose, with solid carbon dioxide, in order to reduce the pressure within the apparatus sensibly to zero. As in the earlier experiments, the entire apparatus was freed from air by the Gaede pump, before beginning the work; but in the later experiments the connection to the air pump was *fused* off after the exhaustion was completed, instead of being sealed by a mercury valve.

At the higher temperatures the bath in which the water-tube was submerged was filled with mineral oil instead of with water, and it was surrounded by a vacuum jacket, to reduce the loss of heat from radiation. The temperature was maintained by means of an electric heating coil surrounding the stirrer and kept in an upright position.

Some experiments were executed with the oil-bath, at temperatures slightly lower than that of the room. To maintain these temperatures, use was made, with good results, of a "cooling wire," which could be submerged to a greater or lesser depth in the bath. This cooling wire was soldered to the bottom of a metal vessel, which, according to the desired degree of chilling to be produced, was filled with cold water, ice, or solid carbon dioxide. (The effectiveness of the wire depended, it will be understood, upon its removing more or less of the heat in the bath, by conduction, to the cold vessel above.)

Throughout the experiments of Scheel and Heuse, it was found that the temperature of the bath could be kept constant for a long period of time, to within a few thousandths of a degree.

Pressure Measurements.— Manometer No. 3.

Two different forms of manometer were used in the experiments, one for temperatures below that of the room, and the other for the higher temperatures. The manometer used at the lower temperatures is shown in Fig. 2. (A full account of this instrument is given in the *Zeitschrift für Instrumentenkunde,* 1909, volume 29, page 347.) The tube C_2 here communicated with the vapor whose pressure was to be measured, while C_1 communicated with a space that had been exhausted of air as perfectly as possible, by a pump.

The tubes C_1 and C_2 were fitted with a pair of spherical bulbs, B_1 B_2, which were partially filled with mercury, and united by the long, thin, flexible glass tube H. The difference in pressure between C_1 and C_2 was then measured by noting the difference in height of the mercury in the bulbs B_1 and B_2, to each of which there was fused, internally, a downwardly-projecting glass point, or spur; the mercury surfaces being so adjusted, in making the observation, that each of these spurs either touched its own image in the brilliant, reflecting surface below, or came within a certain very small, measured distance of it.

The bulb B_2 was adjustable in a vertical direction, it being attached, for this purpose, to a sliding piece, L, which was operated by a screw S. By turning this screw the bulb B_2 could be lowered by any desired amount, within the range of the apparatus; and by means of the barometric tube extending downward from B_1, mercury could be introduced into the bulbs or withdrawn from them, so that the level could be brought to the ends of both of the glass index points simultaneously.

When the adjustment we have just described had been effected, it only remained to measure the difference in level between the two glass points. For doing this, the bulbs were provided with glass tubes, G_1 G_2, projecting upward, and made flat and horizontal on their tops. Across the upper ends of the two there lay a sort of little table, T, which was provided with three tiny, conical feet, two of these resting upon P_1 and the third upon P_2. Secured to this table was a small mirror N, whose inclination from the vertical position could be observed by means of a telescope and scale. Then, knowing this inclination and the length (between supports) of the little table T, a simple calculation gave the difference in level of the two ends P_1 P_2, from which the corresponding difference in level between the glass points in the bulbs below followed at once.

The lengths of the tubes G_1 G_2 were so selected that when the bulb B_2 was at the highest point to which it could be raised, the flat ends P_1 P_2 were approximately upon the same level with each other. With this disposition of the apparatus, pressures up to about 5 millimeters of mercury could be

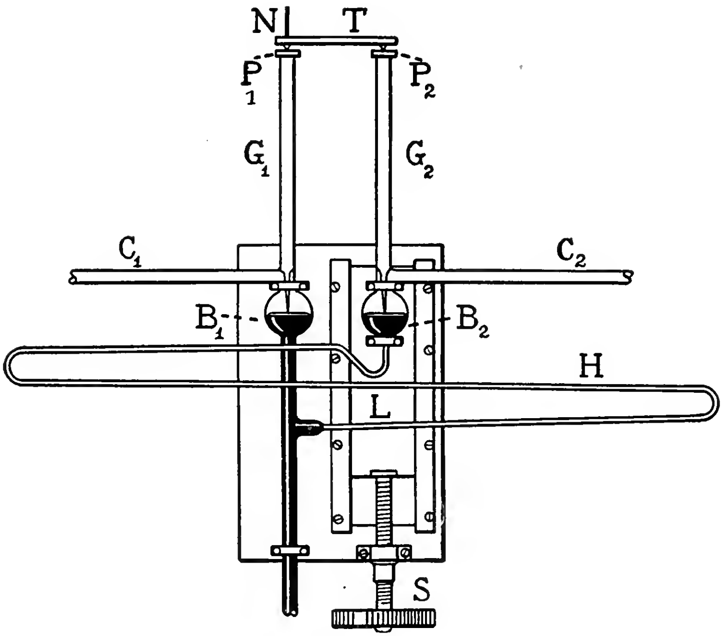


FIG. 2. — MANOMETER NO. 3. (FOR THE LOWEST PRESSURES.)

measured with ease. When the pressure in B_2 became greater than 5 millimeters, however, the inclination of the little table T became inconveniently large; hence for higher pressures the table was not allowed to rest directly upon P_2, but upon a glass plate of known thickness, that was first laid upon P_2. Observation and calculation then proceeded as before, save that allowance had to be made for the known thickness of the interposed plate. Further increases of pressure were provided for in the same way, either by inserting several plates of equal thickness, or by inserting a single plate of a greater thickness.

This manometer had a useful pressure-range extending from zero up to about 30 millimeters of mercury. In other words, it could be used, conveniently and accurately, from the lowest temperatures encountered in the research, up to about 30° C. (or 86° Fahr.).

Pressure Measurements.— Manometer No. 4.

As already explained, it was necessary to heat every part of the apparatus, in carrying out the experiments that were made at temperatures higher than that of the room. The manometer that was used for these higher temperatures was therefore constructed with especial reference to the possibility of heating it conveniently. It was designated as "No. 4," and is shown diagramatically in Fig. 3. (It is also described, at length, in the *Zeitschrift für Instrumentenkunde,* 1910, volume 30, page 45.) It consisted essentially of a U-shaped glass tube of about 25 mm. (1 in.) diameter, whose closed branch (shown on the left) was free from air, and whose branch upon the right communicated with the water, the pressure of whose vapor was to be measured.

The heights of the mercury columns in the branches of the manometer tube were determined by the aid of sighting-collars, B_1 B_2, which encircled the manometer tube closely, but without actually touching it. These collars were operated by means of the screws S_1 S_2, and were supported by forks of nickel-steel, having a small but known coefficient of expansion. The positions of the sighting-collars could be determined by means of the nickel-steel millimeter scale, N, the errors of whose graduations were known to within $\pm$ 0.005 mm. Each of the fork-shaped pieces was provided with an index-mark (I_1 I_2), which traveled along the scale, and a micrometer eye-piece, not shown in Fig. 3, was used for accurately determining the positions of these index-marks relatively to the scale divisions next above and below them.

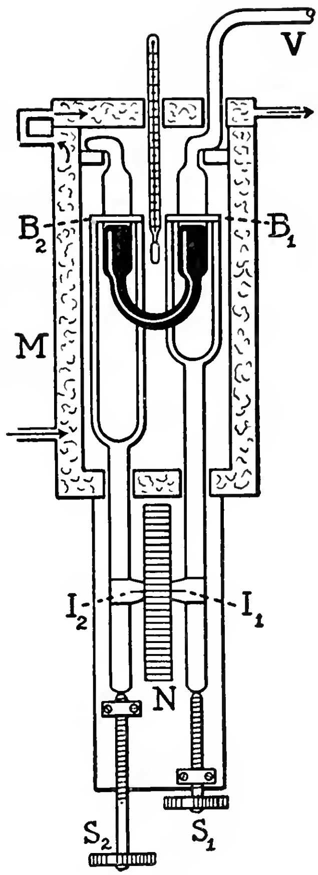


Fig. 3.— Manometer No. 4.

The manometer was enclosed in a double-walled metallic case, M, and was jacketed with the vapor of boiling acetone (56° to 57° C.), which passed through the hollow cover as well as through the lower portion of the case, as indicated by the arrows. A thermometer was provided, for ascertaining the exact temperature of the interior of the case of the manometer, so that the necessary correction might be subsequently applied, for reducing the height of the mercury column as read, to the value that would have been observed if the mercury in the gage had been ice-cold.

The tube V, which connected the manometer to the tube containing the water whose vapor pressure was to be determined, was wound with an electrically-heated spiral of wire, from the point where it left the manometer case up to the point where it entered the bath containing the water-tube. In this way its temperature was kept at 10° to 20° C. above the temperature of the bath.

Windows were provided in the casing of the manometer, through which the sighting-collars on the mercury-tubes could be seen. It was found that this arrangement gave a higher degree of accuracy than could be had by taking direct observations of the mercury columns by means of a cathetometer, through windows damp with acetone.

All the manometer readings were reduced to the values they would have had, if the mercury had been ice-cold (*i. e.*, at 0° C.), and, further, they were reduced to the values they would have had if the experiments had been made at sea level, in latitude 45°. (This last correction is important in all accurate work of this kind, in order that measurements made in various parts of the world may be strictly and immediately comparable with one another.)

Temperature Measurements.

The temperatures of the baths surrounding the water whose vapor pressure was under investigation were obtained by means of a platinum-resistance thermometer, which had been in use for several years in the Reichsanstalt. This part of the work was carried out similarly to that executed by Messrs. Holborn and Henning, and described on pages 181 and 190 of the issue of The Locomotive for April, 1909. The constants of the thermometer were obtained by observations made at 0° C., 100° C., and the boiling point of sulphur,— the boiling point of sulphur being taken to be 445.0°, on the scale of the hydrogen thermometer. The temperatures given by Scheel and Heuse may therefore be regarded as given on the international hydrogen scale; and if we accept the present view of physicists, to the effect that the hydrogen scale is practically identical with the absolute thermodynamic scale (save for the addition of a constant), we may also assume that the temperatures, as given, are sensibly the same as they would be if stated upon the absolute scale.

The temperatures were mainly determined by means of one particular platinum-resistance thermometer, designated as "R 6." In addition, however, certain measurements were made, for purposes of verification, with a second thermometer of like nature, designated as "N." The constants of thermometer "N" were determined by observations at the freezing and boiling points of water, and at the boiling point of naphthalene (about 218° C.). In general, the observations made by these two thermometers were very close, so that the mean of the readings of the two instruments might have been taken, when both were used. Messrs. Scheel and Heuse were of the opinion, however, that thermometer No. R 6 was the more trustworthy, and hence they used its readings alone for the definitive determinations of the temperatures, employing the other one solely as a check.

Results of the Observations.

The accompanying table gives the results that were obtained by the experiments we have described (save for a few at 0° C., presently to be mentioned). The arrangement of the table will be understood at a glance. The first, third, and fifth columns give the observed temperatures of the bath in which the water under investigation was immersed, while the second, fourth, and sixth give the corresponding observed pressures of the saturated vapor. The pressures are given in millimeters of mercury, and (as already noted) they have all been corrected to the values they would have had, if the mercury in the manometer gages had been at 0° C., and if the experiments had been performed at sea-level in latitude 45°. Nothing is said respecting the density of the mercury employed, but, as we stated in our last paper in this series, experiments made at the Reichsanstalt indicate that mercury, purified by the method there used, has a density such that a cubic centimeter of it, at the temperature 0° C., weighs 13.59593 grammes, at sea-level in latitude 45°. As Scheel and Heuse's experiments were made at the Reichsanstalt, it is fair to assume, in the absence of further information, that the mercury in their manometer tubes had this density.

Table of the Experimental Results of Scheel and Heuse.

(Pressure of Saturated Water Vapor between 0° C. and 50° C.)

Temperature. (C.)	Pressure. (mm.)	Temperature. (C.)	Pressure. (mm.)	Temperature. (C.)	Pressure. (mm.)
1.520°	5.116	14.424°	12.318	23.155°	21.256
3.100	5.725	14.927	12.735	23.611	21.856
3.766	6.004	15.479	13.192	24.133	22.570
4.574	6.352	16.659	14.225	27.806	28.036
4.837	6.467	16.744	14.306	27.819	28.074
5.612	6.833	16.757	14.321	29.995	31.824
6.988	7.511	17.306	14.821	31.725	35.133
7.158	7.602	17.889	15.384	34.478	40.985
7.760	7.911	18.903	16.377	34.619	41.311
8.295	8.209	19.049	16.536	34.652	41.392
8.998	8.602	19.154	16.642	34.887	41.918
9.278	8.772	19.923	17.457	37.473	48.315
9.454	8.904	19.959	17.499	39.379	53.490
9.578	8.950	20.279	17.846	41.619	60.305
10.972	9.824	20.304	17.868	41.710	60.565
11.168	9.950	21.000	18.648	46.010	75.667
11.539	10.202	21.067	18.734	49.200	88.940
11.935	10.473	21.830	19.640	49.293	89.356
12.749	11.047	22.222	20.101	50.026	92.707
12.774	11.071	22.293	20.171	......	......
13.448	11.564	22.476	20.420	......	......

The Pressure of Water Vapor at 0° C.

By way of testing the manometers that were used, separate experiments were made for determining the pressure of saturated water-vapor at the freezing point of water. With manometer No. 3, the result was 4.576 mm., and with manometer No. 4 the result was 4.580 mm. These values agree very satisfactorily indeed with the careful determination made by Thiesen and Scheel some years ago, and also with the later determination by Scheel and Heuse in 1909. The result of Thiesen and Scheel's researches (see The Locomotive, October, 1907, page 250) was 4.579 mm., and that obtained by Scheel and Heuse (*Annalen der Physik,* 1909, volume 29, page 729) was 4.5788 mm. We may also note that the value obtained by Marvin, according to the re-calculation made in our eighth paper on this subject (The Locomotive, July, 1909, page 222), was 4.578 mm. The experiments of Scheel and Heuse, in the paper to which the present article is devoted, were not intended to correct the previously accepted value (4.579 mm.) of the pressure of saturated water vapor at 0° C., but were executed merely to test the apparatus and methods that they were using in this research.

Concluding Remarks.

Especial care appears to have been taken by Scheel and Heuse, to ensure accuracy in all respects, and the various known sources of error have been eliminated by the design of the apparatus and the mode of conducting the experiments, or else nullified by the subsequent application of corrections calculated from known data. The influence of mercury vapor upon the observed pressures was studied by varying the temperature of manometer No. 4, and corrections were applied to eliminate error from this source. Corrections were also applied for the slight static pressure arising from the fact that the surfaces of the water in the water-tube and of the mercury in the manometer were not at the same level, though, since the density of water vapor is very small at the temperatures at which these experiments were conducted, the corrections thus called for were trivial, though not absolutely negligible.

There is no statement in Scheel and Heuse's paper respecting the purity of the water that was used. This omission has characterized several of the most important papers upon the vapor pressure of water that have appeared in recent years, and it is to be deplored. In the present case we may rest fairly well assured that the water was as pure as it could be made, since, as we said in our ninth paper, "all that emanates from the Reichsanstalt, where these measures were made, is distinguished by a faithful attention to details of this sort."

Scheel and Heuse give a table in which the pressure of saturated water-vapor, as inferred from their own experiments, is given for every degree, from 0° C. to 50° C. They consider that the results therein summarized are likely to be correct to within about 0.005 mm. at 20° C., and to within about 0.05 mm. at 50° C.

The two final sections of Scheel and Heuse's paper are devoted to a consideration of the relation of their own measurements to those made by other experimenters just above 50° C., and just below 0° C. They conclude that their own results do not suffer by the comparison, and in connection with the work of their predecessors they make a few remarks to which attention should be given by anyone engaged in the preparation of a final table of the pressure of saturated steam. The consideration of these remarks must be deferred, however, until a later paper of the present series, in which we propose to give a critical discussion of points of this nature.

An esteemed correspondent writes: "Yours of the 29th, referring to fly wheels bursting, came duly to hand. I think a firm ought to be put in state prison for allowing such murderous work. It is all nonsense, to have a wheel fly to pieces." We're sorry our good friend considers the fly wheel problem so simple. He's got a lot to learn. He'll learn it quick, too, if one of his own wheels goes up.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1910.

Capital Stock, . . . $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission,		$154,845.83
Premiums in course of collection,		228,048.46
Real estate,		93,600.00
Loaned on bond and mortgage,		1,107,060.00
Stocks and bonds, market value,		3,063,476.00
Interest accrued,		67,580.50
Total Assets,		$4,714,610.79

LIABILITIES.

Re-insurance Reserve,		$1,943,732.29
Losses unadjusted,		90,939.53
Commissions and brokerage,		45,609.69
Other liabilities (taxes accrued, etc.),		41,835.50
Capital Stock,	$1,000,000.00	
Surplus,	1,592,493.78	
Surplus as regards Policy-holders,	**$2,592,493.78**	2,592,493.78
Total Liabilities,		$4,714,610.79

On January 1, 1910, The Hartford Steam Boiler Inspection and Insurance Company had 104,589 steam boilers under insurance.

L. B. BRAINERD, President and Treasurer.
FRANCIS B. ALLEN, Vice-President. CHAS. S. BLAKE, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
W. R. C. CORSON, Assistant Secretary.

E. J. Murphy, M. E., Consulting Engineer.
F. M. Fitch, Auditor.

Incorporated 1866. Charter Perpetual.

The Hartford Steam Boiler Inspection and Insurance Company

ISSUES POLICIES OF INSURANCE COVERING

ALL LOSS OF PROPERTY

AS WELL AS DAMAGE RESULTING FROM

LOSS OF LIFE AND PERSONAL INJURIES DUE TO EXPLOSIONS OF STEAM BOILERS OR FLY WHEELS.

Full information concerning the Company's Operations can be obtained at any of its Agencies.

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BOSTON, . . .	C. E. Roberts, Manager, F. S. Allen, Chief Inspector,	Boston, Mass., 101 Milk St. Providence, R. I., 17 Custom House St.
PHILADELPHIA, .	Corbin, Goodrich & Wickham, G. Agts., Wm. J. Farran, Chief Inspector, S. B. Adams, Asst. Chief Inspector,	Philadelphia, Pa., 432 Walnut St.
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ATLANTA, . .	W. M. Francis, Manager, W. M. Francis, Chief Inspector,	Atlanta, Ga., 611-613 Empire Bldg.
BIRMINGHAM, .	George C. Oliver, General Agent, H. E. Stringfellow, Chief Inspector,	Birmingham, Ala., Brown-Marx Bldg.
NEW ORLEANS, .	Peter F. Pescud, General Agent, R. T. Burwell, Chief Inspector,	New Orleans, La., 833-835 Gravier St.
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The Locomotive

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Boiler Explosion near Midvale, Ohio.

Our leading illustrations in this issue show the damage wrought by a boiler explosion that occurred some months ago, at Factory No. 6 of the Robinson Clay Products Co., located at Uhrichsville, Ohio. Two men were killed, the body of one of them being thrown to a distance of 900 feet. The destruction of property was also large, as will be understood from the illustrations, and we are credibly informed that it amounted to approximately $25,000.

The factory in which the explosion occurred was a four-story brick building. All the floors gave way, allowing the entire machinery to fall to the

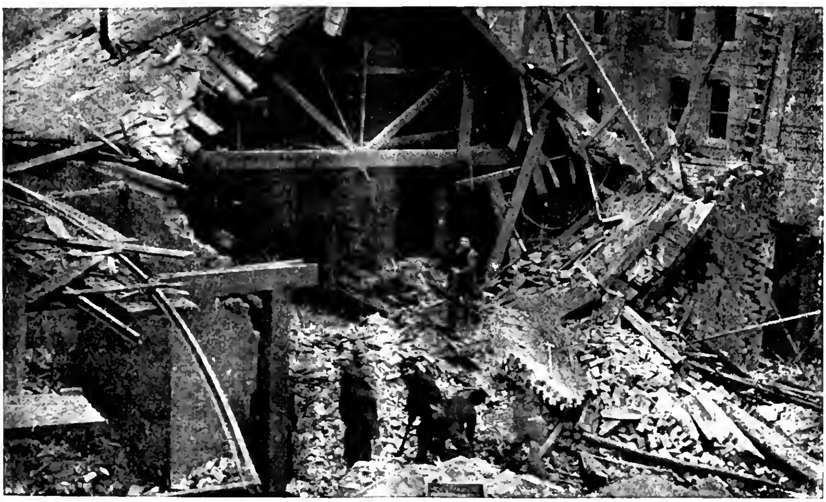

FIG. 1.— GENERAL VIEW OF RUINS.

ground, and damaging it badly. There were six boilers, set in a single battery. Only one of them exploded, but all were destroyed, and the large engine was also practically ruined.

The exploded boiler was of the horizontal tubular type, and was built in two courses, the top half of the shell being composed of one sheet and the bottom half of another, so that there were no girth joints save at the ends, where the heads were attached. (The construction will be understood from Fig. 4.)

The shell plates were of steel, 11/32 in. thick. No brand was to be readily found, but *Power* states that the material composing the shell was tested, after the explosion, and found to have a tensile strength of about 67,000 pounds per square inch. This, of course, is a rather high tenacity for boiler plates, in which it is particularly important to secure not only strength, but also ductility; and, as is well known, these two properties are to a certain extent incompatible with each other, high tenacity being usually accompanied by a reduced ductility, and a smaller reduction of area upon fracture. The boiler had a flush front, and was built by the Stearns Manufacturing Co.

The longitudinal joints were of the lap-riveted type, the rivet holes being 13/16 in. in diameter, and pitched 3 in. from center to center. The heads were of steel, 7/16 in. in thickness, and there were 40 lap-welded tubes, each 4 in. in diameter and 16 feet long. All the tubes were beaded. There were thirteen one-inch square braces to each head above the tubes, and two similar braces to each head below the tubes.

The boiler was provided with two manhole openings, one in the top of the

Fig. 2.— General View of Ruins.

shell, and the other in the front head, below the tubes. The manhole frame at the upper opening was of cast-iron, with the dimensions and sectional form indicated in Fig. 5. The blowoff pipe was 2 in. in diameter, and was connected at the bottom of the shell, near the rear head. The feed water was taken from a neighboring creek, and was of fairly good quality. It was introduced at the top of the shell, and an open heater was used. The boiler was provided with a three-inch pop safety-valve, and it had no fusible plug. We are informed that the stipulated pressure allowed by the company carrying the insurance was 110 lbs. per square inch, and that the boiler was in operation at this pressure when the explosion occurred.

There were no evidences of external corrosion or leakage, nor were any of the plates or tubes burned. There was a slight internal deposit, and we should pronounce the general condition of the boiler to be fair, so far as it could be determined by an inspection made under unfavorable circumstances.

Fig. 3.— Shell of Exploded Boiler.

The positions and general nature of the lines of rupture in the shell are shown in Figs. 6, 7, and 8. The initial rupture occurred, so far as could be judged by an examination of the ruins, along the center line of the boiler, on top, where indicated in Fig. 6. (According to *Power*, the company insuring the boiler maintained that the initial rupture was on the top of the boiler, *towards the back head;* but we cannot agree with this, from our own examination of the plate.)

It will be noted that the manhole opening in the shell was so placed that its length extended in the direction of the length of the boiler. This design was formerly more or less common, and is still met with occasionally, though it is not to be commended. When a boiler is under pressure, the stress in the plate is twice as great in the girthwise direction as it is in the direction of the length of the boiler. Therefore the manhole opening should be cut so that its *least* diameter comes in the longitudinal direction. In the exploded boiler there was a ligament of plate only fourteen inches long between the edge of the manhole opening and the edge of the steam pipe opening, and it was apparently along this ligament that the initial rupture occurred.

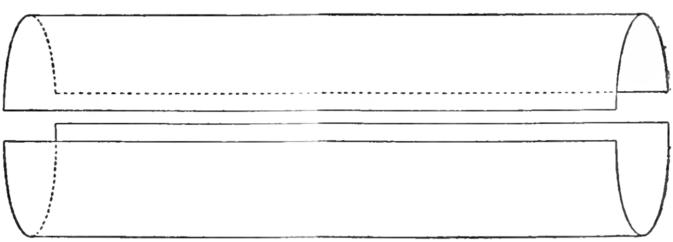

Fig. 4.— Illustrating the Construction of the Shell.

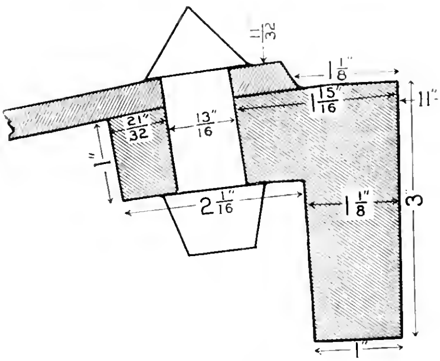

FIG. 5.— SECTION OF MANHOLE FRAME.

The front head of the boiler was blown clear of the shell, and the back head was bent into the shape suggested by the dotted line on the right of Fig. 7.

At the time of the explosion, one of the men that were killed appears to have been on the top of the boiler. We have been advised that leakage appeared along the upper part of the shell somewhere, a short time before the explosion, and that the fireman went up to ascertain the nature of the trouble.

The theory of the cause of the explosion that was put forth by the company insuring the boiler was, that there was a water-hammer effect produced by the sudden lifting of the pop safety-valve, and that it was this that caused the shell to suddenly give way. It appears to us doubtful if this explanation is tenable, in the case under consideration.

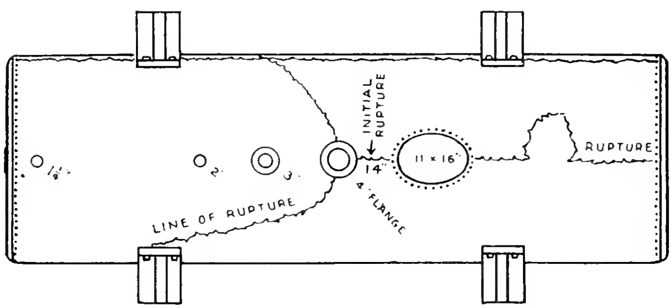

FIG. 6.— TOP VIEW OF BOILER, SHOWING INITIAL RUPTURE.

We were also advised that the boiler was cleaned, the day before the explosion, and that it was supposed to have been connected with the main steam line during the night, or early in the morning, before the accident. We have been unable to determine whether the stop valve to the exploded boiler was

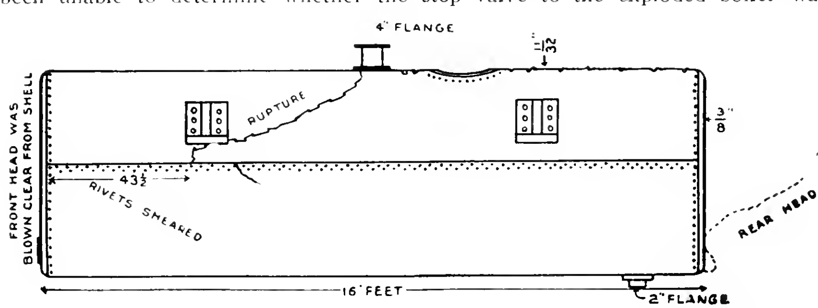

FIG. 7.— RIGHT-HAND SIDE OF BOILER, SHOWING LINES OF RUPTURE.

open when it was found, or not. If it were closed, and if no proof were forthcoming to show that the safety valve was in a proper operating condition, we might have to add this explosion to the list, already far too long, of those due to not cutting a boiler in properly, when it had been out of service for a time.

Taking all the ascertained facts together, we are of the opinion that the explosion was due either to a weakness developed at or near the manhole, or

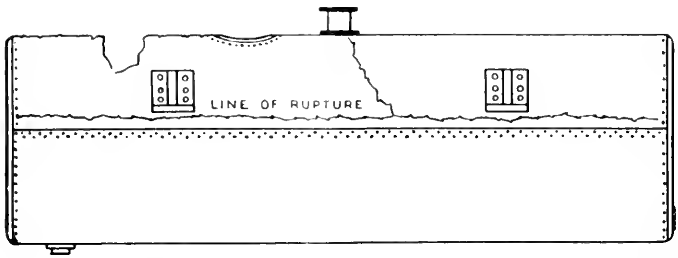

Fig. 8.— Left-Hand Side of Boiler, Showing Lines of Rupture.

to simple over-pressure from the boiler not being properly cut in with the rest of the battery, when it was supposed to be.

In conclusion, let us add that the dimensions and other data given above, in connection with this explosion, were obtained under difficulties. We believe them to be correct in all essential particulars, but they may contain slight inaccuracies, of no serious import. The parties most nearly interested in the explosion were unwilling to give our representatives access to the ruins for purposes of examination, and the photographer who took the views refused to furnish us with copies of them, so that we had to obtain them in another way.

Boiler Explosions.

October, 1910.

(389.) — The boiler of Hradec Bros.' threshing outfit exploded, September 16, on the John Calelly farm, near Clarkson, Neb. One man was killed, and another received minor injuries. (This account was received too late to be given in its proper place, in the regular list for September.)

(390.) — A boiler exploded, October 1, in a planing mill at West Augusta, near Staunton, Va. One person was killed.

(391.) — On October 1, the boiler of a Northern Pacific locomotive exploded at Missoula, Mont. One man was killed and two were severely injured.

(392.) — The boiler of a Denver & Rio Grande locomotive exploded, October 1, at Tennessee Pass, near Leadville, Colo. Two men were killed.

(393.) — On October 2 the boiler of a C. & O. locomotive exploded at Fowlerton, Ind. Two men were severely injured.

(394.) — A boiler exploded, October 3, in W. R. Fossett's gin and grist mill, Toomsboro, Ga. Five persons were injured, and it was thought that two of these might not recover.

(395.) — Two tubes failed, October 3, in a water-tube boiler at the Inland Steel Co.'s rolling mills, Indiana Harbor, Ind.

(396.) — Eight cast-iron headers ruptured, October 3, in a water-tube boiler at Swift & Co.'s packing house, East St. Louis, Ill.

(397.) — On October 4 a slight accident occurred to a boiler in an apartment building owned by the Weissinger-Gaulbert Real Estate Co., Louisville, Ky.

(398.) — Nine cast-iron headers fractured, October 5, in a water-tube boiler at the Shoenberger Works of the American Steel & Wire Co., Pittsburg, Pa.

(399.) — On October 5 an accident occurred to a boiler in the plant of the Rowesville Cotton Oil Co., Rowesville, S. C.

(400.) — The boiler of a narrow gage locomotive exploded October 5, at the plant of the Lackawanna Steel Co., Buffalo, N. Y. One man was severely injured.

(401.) — A tube ruptured, October 6, in a water-tube boiler at Swift & Co.'s plant, South Omaha, Neb. One man was injured.

(402.) — A boiler exploded, October 6, in the Breise sawmill, at Frederick House, Ont. One man was killed, and two were seriously injured.

(403.) — The boiler of a Chesapeake & Ohio freight locomotive exploded, October 7, at Losantville, near Newcastle, Ind. One man was fatally injured.

(404.) — The boiler of a Cleveland & Pittsburg locomotive exploded, October 7, at Newburg, Ohio. Three men were killed, and two were severely injured.

(405.) — On October 8, a flue burst in a heating boiler at New Jersey avenue and E street, Washington, D. C. One man was seriously scalded.

(406.) — An accident nearly identical with No. 405 occurred October 8, in the District Pumping Station, Washington, D. C. One man was seriously injured, his skull being fractured. He may not recover.

(407.) — The boiler of a Pennsylvania freight locomotive exploded, October 8, near Bedford, Ohio. Three men were fatally injured.

(408.) — On October 10, the crown sheet of a boiler of the locomotive type collapsed in the plant of the M. Rumely Co., La Porte, Ind. One man was injured.

(409.) — A boiler belonging to Witham & Bowen exploded, October 11, at Union City, Ind. One man was severely injured.

(410.) — On October 12, an accident occurred to a boiler in the Richmond Baking Powder Co.'s plant, Richmond, Ind.

(411.) — On October 12, a boiler exploded on the Marion Oil Co.'s lease, three miles north of Lafayette, Ohio. One man was instantly killed, and another was seriously injured.

(412.) — A boiler belonging to J. W. Boyd exploded, October 14, at Lewiston, Ill. One person was seriously injured.

(413.) — A boiler exploded, October 14, in W. T. Carroll's sawmill, at Dunmor, near Russellville, Ky. Two men were killed, and two were seriously injured.

(414.) — A tube ruptured, October 14, in a water-tube boiler at the blast furnace of the R. Heckscher & Sons Co., Swedeland, Pa.

(415.) — A boiler exploded, October 16, at the shops of the National Railways of Mexico, Mexico City, Mex. Two men were injured, and a fire followed, which caused a heavy property loss.

(416.) — The boiler of a Kansas City Southern locomotive exploded, October 17, at Dequeen, Ark. Two men were killed and two were severely injured.

(417.) — The mud drum of a water-tube boiler exploded, October 17, in the department store of the Emery-Bird-Thayer Dry Goods Co., Kansas City, Mo. One man was injured.

(418.) — The boiler of a threshing machine outfit exploded October 18, near Lawrence, Kan. One man was fatally injured.

(419.) — A boiler exploded, October 18, in the Bertig Supply Co.'s cotton gin, at Jonesboro, Ark.

(420.) — A cast-iron header ruptured, October 18, in a water-tube boiler at the plant of the Great Western Sugar Co., Longmont, Colo.

(421.) — Three sections of a cast-iron heating boiler fractured, October 19, in William Buthorn's hotel, Grand Junction, Colo.

(422.) — On October 20, a blow-off pipe failed at the power plant of the Marquette City & Presque Isle Railway Co., Marquette, Mich.

(423.) — A tube ruptured, October 20, in a water-tube boiler at the power plant of the American Railways Co., Scranton, Pa. One man was scalded.

(424.) — An accident occurred, October 20, to a boiler in the Richmond Cotton Oil Co.'s plant, Holcomb, Mo. One man was scalded.

(425.) — A boiler exploded, October 20, in the bagging and rope plant of the American Manufacturing Co., at Green Point, Brooklyn, N. Y. Six men were killed and two were seriously injured, and one of the injured men subsequently died. The property loss was $20,000.

(426.) — The boiler of a freight locomotive exploded, October 20, at Hartwick, near Belle Plains, Iowa. One man was instantly killed, one was fatally injured, and a third was injured so badly that his recovery was considered doubtful.

(427.) — On October 22, an accident occurred to a boiler in Brandon & Beal's brewery, Leavenworth, Kans.

(428.) — A tube ruptured, October 24, in the Bettendorf Axle Co.'s plant, Bettendorf, Iowa.

(429.) — On October 24, a section ruptured in a heating boiler in the Pennsylvania railroad station at Nescopeck, near Bloomsburg, Pa.

(430.) — A boiler exploded, October 25, in Enos Fuller's sawmill, near Emory, Tex. Two men were scalded so badly that they may not recover. The plant was badly wrecked.

(431.) — A tube ruptured, October 25, in a water-tube boiler at the Chicago Coated Board Co.'s plant, North Water Street, Chicago, Ill.

(432.) — On October 25, a tube ruptured in a water-tube boiler at the plant of the Semet-Solvay Co., Ensley, Ala.

(433.) — On October 25, a boiler exploded on the steamer *City of Berlin*, Sturgeon Bay, Wis. One person was killed.

(434.) — A tube collapsed, October 26, in a boiler in C. C. Barton's sugar house, Albemarle, La.

(435.) — The boiler of a traction engine exploded, October 28, at Scuffletown, some four miles northeast of Eaton, Ohio. Two young men, owners of the outfit, were badly injured.

(436.) — The boiler of a Frisco locomotive exploded, October 28, at Pocahontas, Ala. The fireman was badly scalded.

(437.) — On October 28, a tube ruptured and ten cast-iron headers fractured in a water-tube boiler in the Savannah Lighting Co.'s power station, Savannah, Ga.

(438.) — A tube collapsed and ruptured, October 28, in a sugar house boiler on R. Chauffe Bros.' Ruth Planation, Breaux Bridge, La.

(439.) — On October 28, a blow-off pipe failed on a cotton gin boiler operated by Henry E. Wynn, near Bremen, Ga. Mr. Wynn was fearfully scalded.

(440.) — On October 30, a blow-off pipe failed at the plant of Henry A. Silsbee, Brookline street, Lynn, Mass.

(441.) — On October 30, an accident occurred to three boilers at the Lockhart Iron & Steel Co.'s plant, McKees Rocks, Pa.

(442.) — On October 31, a boiler exploded in Blackwell's cotton gin, Maysville, Ga. Two persons were seriously injured.

(443.) — A boiler belonging to E. R. Earley exploded, October 31, at Louisville, Ky. One person was injured.

(444.) — A tube ruptured, October 31, in a water-tube boiler at the Kimberly-Clark Co.'s paper mill, Appleton, Wis. One man was scalded.

NOVEMBER, 1910.

(445.) — On November 1 the boiler of a threshing outfit exploded at Rich's Corners, near Lapeer, Mich. Three men were killed.

(446.) — A boiler used in drilling an oil well exploded, November 2, at Martinsville, Ill. One man was killed.

(447.) — The boiler of a Northern Pacific freight locomotive exploded, November 2, at Newton Station, near Billings, Mont. One man was killed, one was fatally injured, and two others were injured seriously but not fatally.

(448.) — On November 2, several tubes ruptured in a water-tube boiler at the Old 76 Distilling Co.'s plant, Finchtown, Ky.

(449.) — A water-tube boiler ruptured, November 3, in the Sharon Tin Plate Co.'s works, South Sharon, Pa.

(450.) — The boiler of a Big Four locomotive exploded, November 3, at Newcastle, Ind. One man was seriously injured.

(451.) — On November 3, a boiler exploded on the Ohio River Sand Co.'s dredge boat *Ohio*, at Ambridge, Pa. One man was killed, and six persons were injured.

(452.) — The boiler of a traction engine, used for shredding corn, exploded, November 4, on C. G. Lee's farm, at Putnamville, near Greencastle, Ind. Two men were killed and one was seriously injured.

(453.) — A tube failed, November 4, in a water-tube boiler at the Warren Manufacturing Co.'s plant, Milford, N. J. One man was severely scalded.

(454.) — The boiler of a N. & W. locomotive exploded, November 5, in the yards at Columbus, Ohio. The locomotive was wrecked.

(455.) — A hot-water heating boiler exploded, November 7, in A. H. Lanm's residence, on Grand Boulevard, Chicago, Ill. The property loss was estimated at $500.

(456.) — A tube ruptured, November 7, in a water-tube boiler in the Kimberly-Clark Co.'s paper mill, Appleton, Wis. One man was scalded.

(457.) — On November 7, a tube ruptured in a water-tube boiler at the power house of the Edison Electric Co., Brooklyn, N. Y. Six men were injured.

(458.) — A boiler exploded, November 8, in the Deemer Manufacturing Co.'s plant, Deemer, Miss.

(459.) — On November 9, a tube failed in a water-tube boiler at the power house of the Johnstown Passenger Railway Co., Johnstown, Pa.

(460.) — A boiler used for agricultural purposes exploded, November 10, at Lewiston, Ill. One person was severely injured.

(461.) — A tube collapsed, November 11, in a boiler at the Doe Run Lead Co.'s plant, Flat River, Mo. One man was killed and two were injured.

(462.) — A sawmill boiler exploded, November 11, at Byhalia, near Kenton, Ohio. Four men were killed.

(463.) — A slight boiler explosion occurred, November 13, in the press room of the *Index-Appeal*, Petersburg, Va. One man was injured.

(464.) — The boiler of a Grand Rapids & Indiana locomotive exploded, November 13, at Vicksburg, Mich. Three men were injured.

(465.) — Two sections of a cast-iron heating boiler fractured, November 14, in Canode's hotel, Amarillo, Tex.

(466.) — Two tubes ruptured, November 15, in a water-tube boiler at the Spring street power plant of the Columbus Railway & Light Co., Columbus, Ohio.

(467.) — A boiler used for agricultural purposes exploded, November 15, at Dime, near Vandergrift, Pa. One man was injured seriously and perhaps fatally.

(468.) — A tube ruptured, November 15, in a water-tube boiler at the power plant of the Philadelphia Rapid Transit Co., on Thirty-third and Market streets, Philadelphia, Pa.

(469.) — On November 16, several sections of a cast-iron heating boiler fractured in a business and apartment building at 77-79 Second avenue, New York City.

(470.) — On November 16, a boiler accident occurred in the plant of the Beaver Dam Light, Heat & Power Co., Beaver Dam, Wis.

(471.) — On November 16, a boiler exploded in J. P. Mosher's sawmill, at Tunmouth Creek, near St. Martin's, N. B.

(472.) — The boiler of a traction engine exploded, November 17, on Lindsey Reese's farm, near Pana, Ill. Four men were injured.

(473.) — A tube ruptured, November 17, in the Highland Park Manufacturing Co.'s cotton mill, Charlotte, N. C. One man was injured.

(474.) — On November 17, an accident occurred to a boiler owned by the Hinsdale Sanitarium & Benevolent Association, Hinsdale, Ill.

(475.) — The boiler of a Texas & Pacific locomotive exploded, November 18, at Sulphur river, near Texarkana, Tex. Two men were killed and a third was fatally injured.

(476.) — A heating boiler exploded, November 19, in the Methodist Church at Califon, N. J. The boiler was new, and had been installed during the past summer.

(477.) — The boiler of a freight locomotive exploded, November 19, in the Pennsylvania yards at Altoona, Pa., causing a wreck which resulted in the death of three men and injuries to three others.

(478.) — A boiler exploded, November 20, in the electric lighting plant at Long Prairie, near Sauk Center, Minn. The property loss was estimated at $1,500.

(479.) — A cast-iron header ruptured, November 20, in a water-tube boiler at the Philadelphia Rapid Transit Co.'s power station, on Thirty-third and Market streets, Philadelphia, Pa.

(480.) — On November 21, a heating boiler exploded in a school building at Ainsworth, near Omaha, Neb.

(481.) — A boiler exploded, November 22, on the Braun farm, near Grand Rapids, Wis. Two men were badly injured.

(482.) — A blow-off pipe failed, November 22, in the oil refinery of the A. D. Miller Sons Co., Pittsburg, Pa. One man was injured.

(483.) — On November 23, a tube failed in a water-tube boiler at the Hyde Park Manufacturing Co.'s cotton mill, Charlotte, N. C.

(484.) — The boiler of a freight locomotive exploded, November 24, on the Pittsburg division of the Pennsylvania railroad, at Manor, near Greensburg, Pa. One man was killed and two were injured.

(485.) — A heating boiler ruptured, on or about November 26, in the South Chester Methodist church, South Chester, Pa.

(486.) — A boiler exploded, November 26, in the basement of Joseph Berkowitz's glazier store, 775 Westchester avenue, the Bronx, New York City. Four persons were slightly injured, and the property loss was estimated at $1,000.

(487.) — On November 26, an accident occurred to a boiler at the Hoyle Lumbering Co.'s plant, South Carver, Mass.

(488.) — Two tubes ruptured, November 27, in the Omaha Electric Light & Power Co.'s plant, Omaha, Neb.

(489.) — On November 28, a mud drum, attached to a boiler, exploded at the No. 10 shaft of the St. Joseph Lead Co., Gumbo, Mo.

(490.) — A boiler belonging to Wheeler & Howes, coal merchants, ruptured, November 28, at Bridgeport, Conn.

(491.) — The boiler of a Big Four locomotive exploded, November 28, at Tilden, Ind. Three men were injured.

(492.) — A boiler belonging to the Bell Union Coal Co. exploded, November 28, at Bell's mines, on Tradewater river, near Sturgis, Ky. Two men were instantly killed.

(493.) — A tube ruptured, November 30, in a water-tube boiler at the Omaha Gas Co. plant of the United Gas Improvement Co., Omaha, Neb.

DECEMBER, 1910.

(494.) — A boiler ruptured, December 1, in the Akron Laundry Co.'s plant, Akron, Ohio.

(495.) — On December 2 a blowoff pipe ruptured at a power plant under the charge of Doliver A. Spaulding, Trustee, Plainville, Mass. One man was injured.

(496.) — The boiler of a freight locomotive exploded, December 3, on the Denver & Rio Grande railroad, at Soldier Summit, near Salt Lake City, Utah. Three men were killed.

(497.) — A blowoff pipe ruptured, December 3, in the plant of the Worcester Lumber Co., Chassell, Mich.

(498.) — A heating boiler ruptured, December 5, in the North School building, Ada, Okla.

(499.) — A slight boiler accident occurred, December 5, in G. A. Robertson & Co.'s paper mill, Hinsdale, N. H.

(500.) — On December 5 a boiler exploded at Boyce, near Alexandria, La., in Dr. Robinson James's shingle mill. Dr. James was killed, and another man was injured badly.

(501.) — A tube exploded, December 6, in a water-tube boiler at the plant of the Pueblo & Suburban Traction & Lighting Co., Pueblo, Colo. One man was killed, and one was injured.

(502.) — On December 6 one or more tubes failed in a boiler at the power house of the Aurora, Elgin & Chicago lines, at Batavia, Ill. One man was severely injured.

(503.) — A blowoff pipe failed, December 6, in the plant of the Traders' Paper Board Co., Bogota, N. J. One man was slightly scalded.

(504.) — A tube ruptured, December 6, in a water-tube boiler at the Inland Steel Co.'s plant, Indiana Harbor, Ind.

(505.) — On December 7 a boiler accident occurred in the plant of the Mountain Ice & Coal Co., Pueblo, Colo.

(506.) — A boiler belonging to A. W. Allen & Co. exploded, December 9, at New Bedford, Mass. Seven men were injured, three of them seriously. The building was said to be a total loss.

(507.) — A boiler exploded, December 10, in the butcher shop of Mrs. Lizzie Landis, Palmyra, Pa.

(508.) — A small boiler exploded, December 10, in the laundry of the Mount Mercy hospital, Buffalo, N. Y. One man was badly scalded.

(509.) — A cast-iron header ruptured, December 11, in a water-tube boiler at the Rose Hill Sugar Refining Co.'s plant, Abbeville, La.

(510.) — A tube ruptured, December 12, in a water-tube boiler in the office building of the Union Savings Bank & Trust Co., Cincinnati, Ohio. One man was injured.

(511.) — The boiler of locomotive No. 261, of the Missouri, Kansas & Texas railroad, exploded, December 12, some seven miles north of Dallas, Tex. Two men were killed and another was injured.

(512.) — On December 12 a boiler exploded at Weatherly, Pa., in the plant of Read & Lovatt, silk throwsters. Two men were killed, and the property loss was estimated at $22,000.

(513.) — A freight locomotive, drawing an International & Great Northern freight train, exploded its boiler, December 13, at Aldine, between Houston and Palestine, Tex. Three men were injured, and it was believed that one of these could not recover.

(514.) — A tube ruptured, December 13, in a water-tube boiler at the Brooks works of the American Locomotive Co., Dunkirk, N. Y.

(515.) — On December 15 a tube ruptured in a water-tube boiler at the Southern Iron & Steel Co.'s plant, Alabama City, Ala.

(516.) — Two boilers exploded almost simultaneously, on December 15, in the plant of the Bendure Steam Heating Co., Fredonia, N. Y. One man was killed, and another received injuries which may result fatally. The building was completely demolished, and all buildings within a radius of 300 feet were damaged. The property loss was estimated as high as $250,000, but it is likely that it did not materially exceed $150,000.

(517.) — A heating boiler exploded, December 16, in the county buildings at Riverhead, L. I. One man was severely scalded.

(518.) — The boiler of a camel-back locomotive exploded, December 17, on the Erie railroad, at Cresthill, N. J. The fireman was fatally scalded.

(519.) — On December 20 a boiler belonging to T. J. Treadwell exploded at Burke, Tex.

(520.) — On December 21 a section ruptured in a cast-iron sectional heating boiler in the Allied Investors' Realty Co.'s apartment house, 18-20 West 107th street, New York City.

(521.) — As the result of a collision, the boiler of the locomotive drawing the "Manhattan Flyer" on the Pennsylvania railroad exploded, December 21, at West Fifty-seventh street, Chicago, Ill. One man was fatally bruised and scalded. Ten other persons were also injured in a lesser degree, by the shock due to the collision.

(522.) — A small boiler, used in a tunneling operation, exploded, December 21, at Belleville, N. J. Three men were injured.

(523.) — A tube ruptured, December 22, in a water-tube boiler at the plant of the Electric Storage Battery Co., Philadelphia, Pa.

(524.) — On December 22 a slight explosion occurred on freight locomotive No. 92 of the Grand Trunk railroad, at Battle Creek, Mich. Two men were badly injured, and one of them cannot recover.

(525.) — A slight boiler explosion occurred, December 22, in the plant of the Standard Manufacturing Co., Council Bluffs, Iowa.

(526.) — A boiler explosion occurred, December 22, in the electric lighting plant at Alexandria, La.

(527.) — A boiler belonging to the J. Wood Manufacturing Co. exploded, December 24, at Conshohocken, Pa. One person was injured.

(528.) — On December 24 a boiler exploded at the Pueblo smelter, Pueblo, Colo. One man was injured seriously and perhaps fatally.

(529.) — A boiler used for heating the Grand Trunk railway station at St. Catharine's, Ont., exploded on December 25.

(530.) — A flue ruptured, December 25, in a boiler at the Rail-Light power house, Detroit avenue and Virginia street, Toledo, Ohio. One man was killed.

(531.) — Several cast-iron headers fractured, December 26, in a water-tube boiler at the paper manufacturing plant of M. & W. H. Nixon, Manayunk, Pa.

(532.) — On December 26 a tube ruptured in a water-tube boiler at the Louis Bergdoll Brewing Co.'s plant, Philadelphia, Pa.

(533.) — Three cast-iron headers fractured, December 28, in a water-tube boiler at the Anson-Gilkey & Hurd Co.'s sash, door, and blind factory, Merrill, Wis.

(534.) — A boiler exploded, December 29, at the plant of the Morewood Lake Ice Co., Morewood Lake, near Pittsfield, Mass. Thirteen men were killed, and some twenty others were injured.

(535.) — Several cast-iron headers fractured, December 30, in a water-tube boiler in the Marion Hotel Co.'s hotel, Little Rock, Ark.

(536.) — A blowoff pipe failed, December 30, at the sawmill of E. B. Norman & Co., Louisville, Ky. Five men were injured.

Boiler Explosions During 1910.

We present, herewith, our usual annual summary of boiler explosions, giving a tabulated statement of the number of such explosions that have occurred within the territory of the United States (and in adjacent parts of Canada and Mexico) during the year 1910, together with the number of persons killed and injured by them. As we have repeatedly explained, it is difficult to make out accurate lists of boiler explosions, because the accounts that we receive are not always satisfactory; but, as usual, we have taken great pains to make the present summary as nearly correct as possible. It is based upon the chronologically arranged lists of explosions that are regularly published in The Locomotive; and in making out these lists it is our custom to obtain several different accounts of each explosion, whenever this is practicable, and then to compare these accounts diligently, in order that the general facts may be stated with accuracy. We have striven to include all the explosions that have occurred during 1910, but it is quite unlikely that we have been entirely successful in this respect, for many accidents have doubtless occurred that have not been noticed in the public press, and many have doubtless escaped the attention of our numerous representatives who furnish the accounts. We are confident, however, that most of the boiler explosions that have attracted any considerable amount of notice are here represented. Moreover, we can assure our readers, with the utmost positiveness, that no statistics of boiler explosions, at all comparable in accuracy with those given in The Locomotive, can be had from any other source whatever.

In three cases, during the year 1910, our attention has been called to the fact that the source from which we drew our information was incorrect, and that our accounts were correspondingly in error. The cases in question were as follows:

No. 111, February 23, Stanley Motor Carriage Works, Newton, Mass.
No. 174, April 21, Rich block, Malden, Mass.
No. 182, April 25, residence of Prof. H. G. Chase, West Somerville, Mass.

Summary of Boiler Explosions for 1910.

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January, ...	69	17	44	61
February, ...	47	27	53	80
March, ...	31	13	24	37
April, ...	39	26	36	62
May, ...	54	30	102	132
June, ...	32	15	29	44
July, ...	36	21	32	53
August, ...	44	33	38	71
September, ...	34	17	15	32
October, ...	55	30	39	69
November, ...	49	23	44	67
December, ...	43	28	50	78
Totals, ...	533	280	506	786

In these three instances the accidents that occurred could not properly be described as boiler explosions, and we have therefore omitted them in preparing the present summary.

The total number of boiler explosions in 1910, according to the best information we have been able to obtain, was 533, which is somewhat smaller than the number we recorded in 1909. There were 550 in 1909, 470 in 1908, 471 in 1907, 431 in 1906, and 450 in 1905.

The number of persons killed by boiler explosions in 1910 was 280, which is almost identically the same as the number in 1908. There were 227 persons killed in 1909, 281 in 1908, 300 in 1907, 235 in 1906, and 383 in 1905.

The number of persons injured (but not killed) was 506 in 1910, against 422 in 1909, 531 in 1908, 420 in 1907, 467 in 1906, and 585 in 1905.

The average number of persons killed, per explosion, in 1910, was 0.525; the average number of persons injured (but not killed), per explosion, was 0.949; and the average number of persons that were *either* killed or injured was 1.474 per explosion.

A summary of the boiler explosions that we have recorded as occurring in the United States, Canada, and Mexico, between October 1, 1867, and January 1, 1909, is given in THE LOCOMOTIVE for January, 1909. Correcting the figures there given so as to bring them down to date, we find that between October 1, 1867, and January 1, 1911, we recorded no less than 11,134 boiler explosions, and that these resulted in the deaths of 11,391 persons, and in more or less serious injuries to 16,562 others — the total number of persons that were *either* killed or injured by boiler explosions during this period being no less than 27,953.

AT the quarterly meeting of the directors of the Hartford Steam Boiler Inspection and Insurance Company, held at Hartford on January 2, 1911, Mr. D. Newton Barney and Dr. George C. F. Williams were elected members of the board. Mr. Barney is treasurer of the Hartford Electric Light Company and a director of the New York, New Haven and Hartford Railroad, and Dr. Williams is vice-president and general manager of the Capewell Horse Nail Company, and a director of the Standard Fire Insurance Company, of Hartford, and of the Hartford National Bank.

MR. Sherwood F. Jeter, recently appointed supervising inspector of the Hartford Steam Boiler Inspection and Insurance Company, is a native of the south. He was born at Columbus, Georgia, on December 5, 1872, attended the public schools of New York and Atlanta, and was graduated in the class of 1893 from the Georgia School of Technology. He entered the mechanical department of this company at New Orleans in 1898, and (save for a short period) continued with us, at New Orleans, Pittsburg, and Hartford, until 1906, when he became associated as mechanical engineer with The Bigelow Company, a well known boiler manufacturing concern of New Haven, Connecticut. Mr. Jeter is a member of the American Society of Mechanical Engineers, is a fluent writer on boilers and related subjects, and is peculiarly fitted, by education, experience, and temperament, to perform the duties of the office to which he has been called.

The Locomotive.

A. D. Risteen, Ph.D., Editor.

HARTFORD, JANUARY 25, 1911.

The Locomotive *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
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Obituary.

Philip Corbin.

Philip Corbin, one of the foremost citizens of Connecticut, died, November 3, at his home in New Britain, Connecticut, at the age of eighty-six. Born a poor boy, he made his way, by his own efforts, to the high position that he occupied in the industrial life of the state, and his life history should be thoughtfully considered by all young men who aspire to a like advancement.

Mr. Corbin was born at Willington, Connecticut, October 26, 1824, and was one of a family of ten children. He had few educational advantages, his experience in this direction, outside of the ordinary public schools, being limited to a term and a half at the West Hartford Academy. Up to the time that he was nearly twenty he worked at farm labor, but on March 18, 1844, he went to New Britain and entered the employ of Matteson, Russell & Company, a concern later known as the Russell & Erwin Manufacturing Company, where he earned fourteen dollars a month, eking out his revenue by sweeping the factory for an additional fifty cents a week. In the fall of 1844 he entered the shops of North & Stanley, where he worked for a lock contractor at nineteen dollars a month, spending his evenings with another contractor, who taught him the trade of lock-making. He soon began to take contracts for the manufacture of locks, and at the age of twenty-one he had nineteen men working for him, and four years later his force numbered thirty. In June, 1849, he married Francina T. Whiting, of New Britain, and the union proved a happy and altogether fortunate one, up to the time of Mrs. Corbin's death, in February, 1909.

In 1848 Mr. Corbin, together with his brother Frank and a brass founder named Edward Doen, formed a partnership under the name of Doen, Corbin & Company, to manufacture hardware, each of the partners contributing three hundred dollars to the capital. Six hundred dollars were expended for land and a building, and a horse and tread-mill were installed to supply power for the machinery, which consisted of two lathes, a grindstone, and an emery-wheel. Work was begun in May, 1849, and the first shipment of goods was made on July 4, 1849. Mr. Corbin usually began work at daylight, and did, each day, labor probably equivalent to what three or four paid employees would have performed.

On September 1, 1849, Mrs. Corbin's father bought out Doen's interest in the concern, and this interest he re-sold, in the fall of 1851, to the two Corbin brothers. The firm then became known as P. & F. Corbin, under which name it is still doing business, after the lapse of nearly sixty years. In 1858 Andrew Corbin, another brother, joined the firm, and from that date down to Andrew's death, on January 4, 1907, he and Philip were inseparably associated. Dr. Styles, who had been intimate with these two brothers for nearly thirty years, said they were two of the finest men he had ever known, and there are multitudes of others who will give this sentiment their heartiest approval.

The growth of the business interests of the Corbin brothers was rapid and continuous, and as they expanded, new companies were organized for dealing with the special branches of manufacture, though all were under the same central management. The Corbin Cabinet Lock Company was formed in 1882, the American Hardware Corporation on March 13, 1902, the Corbin Screw Corporation on May 2, 1903, and the Corbin Motor Vehicle Corporation on June 11, 1903. During Mr. Corbin's career, the invested capital under his management increased from nine hundred dollars to ten million dollars, and the number of persons employed increased from the original three to approximately ten thousand.

He was a Christian of the most genuine kind, and a man generous in his gifts of money and of counsel. Save under exceptional circumstances, he was careful not to have his name known in connection with his benevolences, and hence no man can tell how great these may have been. It is known, however, that they were far in excess of any estimate of them that has yet been made, and in some years his gifts exceeded his income. He did not leave a great fortune, as fortunes are now reckoned, because he preferred to expend his wealth in the doing of good, during his own life.

Mr. Corbin had no desire for public office, but he served New Britain as representative in the general assembly in 1884, and as senator in 1888. He was also one of the presidential electors in 1892. As corporator, director, vice-president, and ultimately president, of the New Britain Savings Bank, he gave his services to the public without any recompense whatever, and, as Mr. C. E. Mitchell has well said, "His integrity was of that rock-ribbed order which is based upon a man's recognition of his responsibility to God."

It is a rare man indeed, whose departure is felt as deeply as that of Philip Corbin.

The following minute was adopted by the directors of the Hartford Steam Boiler Inspection and Insurance Company, at a meeting held on January 2, 1911:

"With profound sorrow we, the directors of the Hartford Steam Boiler Inspection and Insurance Company, record the death of our venerated associate, Mr. Philip Corbin, who passed away at his home in New Britain, Connecticut, on November third, beloved by thousands of his fellow citizens, and respected and esteemed by all. Born in 1824, he had been actively engaged in business for sixty-six years, and the remarkable development of the city in which he lived was due in no small measure to his influence. He became a member of this Board on February sixteenth, 1892, and served upon it continuously from that time until his death. The great industries that grew up and prospered under his guidance tell eloquently of his ability as an organizer and an executive, and his name was the symbol of integrity and honor. His loss will be keenly felt, and he will long be gratefully and kindly remembered by his associates, and by legions of others who knew him for the fame that his noble character had won."

Flywheel Explosions during the Year 1910.

We present, below, a list of the flywheel explosions that occurred in the United States during the year 1910, so far as they have come to our attention. It is doubtless incomplete, although we have tried to make it as comprehensive as possible. Any of our friends who may be interested in statistics of this nature can help us materially in the collection of the data, by giving us notice of any flywheel accidents that may happen in their own neighborhood, and assistance of this nature will be most gratefully received. Newspaper accounts should always be marked with the *name* and *date* of the paper from which they are taken, and the name and location of the plant at which the accident occurs should also be accurately stated.

In the 67 accidents here recorded there were 16 men killed and 28 more or less seriously injured. In many cases there were very narrow escapes from loss of life on an appalling scale, and hence we ought not to assume the figures for 1910 to be fairly representative of extended experience in the matter of deaths and injuries. Some of the averted possibilities of 1910 may become gruesome actualities in 1911.

The total property loss from flywheel explosions in 1910 cannot be stated with any approach to accuracy. The loss is given whenever we knew what it was, and the sum total for the year, counting only the estimates that are cited, was $153,600. Yet a perusal of the facts as given in the list shows that this is far short of representing the true loss. Thus in No. 21 "the engine was destroyed," though the loss is not stated; in No. 36 "the building and machinery were damaged so that it was said that the department could not be operated for several weeks," and yet no estimate of the damage is given; in No. 40 it is said that "the mill was shut down for three weeks as a result of the accident"; in No. 48 "the engine room was totally wrecked"; and so on. It is not at all unlikely that the actual total loss of property from the accidents that we have listed exceeded half a million dollars.

Flywheel Explosions During 1910.

(1.) — A flywheel burst, January 10, at the plant of the Vaughn Manufacturing Co., Columbia, Tenn. The accident appears to have been due to the working loose of a set screw in one of the governor gears, permitting the engine to race. Property loss estimated at $500.

(2.) — A flywheel burst, January 10, at a gas well in Chesterfield, Ind. Property loss estimated at $100.

(3.) — On February 18 a flywheel and wood chipper burst in the plant of the Brevard Tannin Co., at Pisgah Forest, near Asheville, N. C. Apparently the wood chipper went to pieces first, and then the governor of the engine failed to operate properly, so that the engine raced on account of the removal of its load. The flywheel was nine feet in diameter, and the property loss was said to be between $5,000 and $6,000.

(4.) — A flywheel exploded, February 24, in the Boehme & Ranch mill, Monroe, Mich.

(5.) — The flywheel of a gasoline engine, used for driving a pump, ruptured, on or about February 25, in the city water works, Stockton, Kans. The wheel was 55 in. in diameter, and we are informed that the rim was not broken.

The hub was defective, and a new key was fitted — the said key being driven so hard as to split the hub. There was no racing, so far as we are aware.

(6.) — A flywheel, 80 in. in diameter and normally making 200 revolutions a minute, exploded, February 26, in the Provident Coal Co.'s plant, St. Clairsville, Ohio. The accident was caused by the fracture of a bolt securing a leaf spring in the shaft governor. The engineer was within a few feet of the engine, yet the wheel exploded before he could shut off the steam. Property loss estimated at $2,000.

(7.) — On February 27 a flywheel burst at M. C. Harper's brick pit, McKeesport, Pa. Property loss estimated at $2,000.

(8.) — On March 2 a flywheel exploded in the plant of the Ashgrove Lime & Portland Cement Co., at Ashgrove, near Chanute, Kans. The wheel that burst was a rope-drive wheel, 14 feet in diameter, on an engine generating some 560 horse-power. Apparently the driving rope ruptured or ran off the wheel, breaking the governor belt in so doing. The engine, being thus relieved of its load, and freed from the regulating action of the governor, ran away. As soon as the wheel burst, a fragment of the rim accidentally struck and closed the emergency valve on the main steam pipe to the engine, thus shutting off any further supply of steam. The property loss was estimated at $4,200. (An illustrated account of this accident is given in the issue of THE LOCOMOTIVE for April, 1910.)

(9.) — A flywheel burst, March 17, at the plant of the Central City Veneering Co., Huntington, W. Va. Property loss estimated at $1,500.

(10.) — On March 19 a flywheel exploded in the power house of a mine at Ducktown, Tenn.

(11.) — A flywheel weighing some 15 tons exploded, March 26, on a Corliss engine in the paper mill of the C. G. Weeks Co., near Mottville, N. Y. After the accident it was found that the main belt was broken, but it does not appear whether this was the cause of the explosion, or one of its results. The broken wheel is said to have shown no flaws, and the owners of the plant stated that there was no unusual duty on the engine at the time.

(12.) — A flywheel exploded, March 26, in the Mershon shops, at Saginaw, Mich. One man was fatally injured.

(13.) — On March 27 a pulley burst in the plant of the Central Massachusetts Electric Light Co., Palmer, Mass.

(14.) — A flywheel exploded, April 1, at the Universal Stone Co.'s plant, Ives, Wis.

(15.) — On April 5 a flywheel burst at the Never Sweat mine, Anaconda, Mont. One man was killed.

(16.) — A flywheel burst, April 5, in Butler county, Pa. One man was killed.

(17.) — On April 14 an eight-foot flywheel exploded at the Pittsburg-Buffalo mines, Marianna, near Monongahela, Pa. Fragments of the wheel broke two ten-inch steam mains, so that for a time it was impossible to enter the building. The chief engineer's skull was fractured by the flying wreckage, and he was scalded to death by the escaping steam.

(18.) — A pulley exploded, April 28, in the Meade paper mill, Chillicothe, Ohio. The accident was apparently due to the speeding up of the engine from some cause. It is thought that the man in charge of the engine tried to stop it, but just as he reached it a heavy pulley on another shaft exploded, killing him instantly. It was found that the engine was uninjured, save for the breaking of a steam pipe that was struck by a fragment of the wrecked pulley.

(19.) — A six-foot flywheel exploded, April 30, at the Steger piano factory, Steger, Ill. The chief engineer was instantly killed.

(20.) — On May 5 a serious accident occurred in the power-house of the Owosso & Corunna Electric Co., Owosso, Mich. The exact nature of the accident is not clear, but so far as we can judge from the data at hand, it was a flywheel explosion. Apparently the governor failed to operate properly, and the engine ran away. The engine itself was practically destroyed, and a dynamo is said to have been seriously damaged. The property loss was estimated at $10,000.

(21.) — A ten-foot flywheel exploded, May 6, at the plant of the Westport Paving Brick Co., Westport, Md. It is said that "one of the ball springs of the throttling governor worked out of place, preventing the governor from regulating the admission of steam, with the result that the engine ran away." The engine was destroyed, and one fragment of the flywheel was found a thousand feet from the engine room.

(22.) — On May 7 a flywheel exploded in the Miller-Link sawmill, at Newton, near Orange, Tex.

(23.) — A flywheel exploded, May 9, at Freeport, Long Island, N. Y., in Ira H. L'Hommedieu's bakery. The governor broke and permitted the engine to run away. Mr. L'Hommedieu was badly injured.

(24.) — A four-foot flywheel exploded, May 2[illegible] in the electric light plant at Kennett Square, Philadelphia, Pa. The building was badly wrecked.

(25.) — A four-foot driven pulley burst, May 24, at the plant of Russe & Burgess, Inc., Memphis, Tenn. The normal speed of the pulley was 210 revolutions per minute. (See also Nos. 59 and 65, below.)

(26.) — On May 25 a twelve-foot flywheel exploded in the Weyerhaeuser planing mill, Everett, Wash. The roof of the building and one of the walls were damaged.

(27.) — On May 31 a large flywheel exploded in the plant of the Escanaba Manufacturing Co., Escanaba, Mich. Three employees were slightly injured, and many had narrow escapes from death.

(28.) — A flywheel exploded, June 8, in the Stafford Mill, Fall River, Mass.

(29.) — A flywheel exploded, June 11, at the Empire Plow Works, Cleveland, Ohio. One man was injured.

(30.) — On June 12 a pulley, 70 in. in diameter, exploded in Frost & Son's paper mill, Napanoch, N. Y. One man was killed, and two others were injured. (See also No. 39, below.)

(31.) — The flywheel of a 400 horse-power Bates-Corliss engine exploded, June 12, at the plant of the Oklahoma Portland Cement Co., Ada, Okla. One man was slightly injured, and fragments of the wheel were thrown to a distance of 600 feet. The wheel was 16 feet in diameter, weighed about twenty tons, and carried a 16-inch belt. It is said that the governor belt broke, and that the safety cams, which are supposed to throw out the valve mechanism under these circumstances, were improperly adjusted and inoperative. The engine raced, and the flywheel burst before steam could be shut off.

(32.) — On or about June 17 a flywheel exploded at Cambridge, Iowa, injuring H. M. Bennington so badly that he died a week later.

(33.) — The flywheel of an Overland automobile exploded, June 19, while the machine was being tested in a garage at Somerset, Pa. One man was injured. The wheel broke into five pieces, one of which passed through two plank floors and an inch of concrete, and the others went through the ceiling and walls.

(34.) — On June 23 a large flywheel burst at the Russell oil well, near New Carlisle, Ind. One man was injured.

(35.) — A flywheel, 80 in. in diameter and 13 in. across the face, exploded, June 23, in the Morgantown & Kingwood railroad shops, Morgantown, W. Va. One man was killed.

(36.) — On June 28 a flywheel exploded in No. 1 rod mill of the Illinois Steel Co., Joliet, Ill. One man was slightly injured. The building and machinery were damaged so that it was said that the department could not be operated for several weeks.

(37.) — A flywheel exploded, July 2, in the file room of the Disston Saw Works, at Tacony, Philadelphia, Pa. One man was injured. The wrecked wheel was hurled through a sixteen-inch brick wall.

(38.) — On July 2 a flywheel exploded in the plant of the Neosho Electric Light Co., Neosho, Mo. It is said that a generator pulley broke first, thereby removing the load from the engine, and that the governor failed to shut off the steam, so that the engine raced. The estimated property loss was $2,800.

(39.) — A particularly interesting pulley explosion occurred, July 5, at the Frost & Son's paper mill, Napanoch, N. Y. After the explosion at this plant on June 12 (see No. 30, above), a new pulley was constructed to take the place of the one that was destroyed, and especial care was taken to have the new one strong and safe. It was 70 in. in diameter, with a rim 7/8 in. thick, and it weighed about 1,800 lbs., and ran at 350 revolutions per minute. The new pulley exploded on July 5, after running 15 hours.

(40.) — At 12.15 a. m., on the morning of July 9, a twelve-foot flywheel exploded in the factory of the Akers & Taylor Manufacturing Co., at Charlton City, Mass. It was running at 93 revolutions per minute, and formed part of a George H. Corliss engine, which was not provided with a separate safety stop. The factory was running all night at the time, and the engineer in charge had not been in the engine room for about half an hour. Suddenly the lights began to grow dim, and the engineer ran to the boiler room at once, and proceeded to the top of the boiler to shut off the steam. While he was there the wheel exploded. One spoke, weighing about 500 lbs., passed up through three stories of the mill, and fell again, through another part of the building, into the cellar. Another part of the wheel tore through the outside wall of the building, and landed some distance away, in a field. It is said that the mill was shut down for three weeks, as a result of the accident. No cause has been definitely assigned, but the fact that the lights grew dim just before the explosion would naturally lead one to infer that the load was taken from the engine (by the breaking of the main belt or otherwise), and that the engine then ran away.

(41.) — The flywheel of an automobile exploded, July 13, at the Pittsburg Automobile Academy, Pittsburg, Pa., while the machine was undergoing a test. Two men were injured.

(42.) — The flywheel of an automobile belonging to Dr. Laidlaw exploded, July 17, at Bluffton, Ind. One person was severely injured.

(43.) — On July 21 a flywheel exploded at the plant of the Burlington Flouring Co., Winooski, Vt. The property loss was estimated at $4,000.

(44.) — A flywheel exploded, July 28, in the plant of the Lebanon Valley Iron & Steel Co., Lebanon, Pa., killing one man. The engine, which was used to operate a train of rolls, ran away, and the wheel burst before steam could be shut off.

(45.) — An eight-foot flywheel exploded, July 29, in the Friend Paper Co.'s plant, West Carrollton, Ohio. The engine was a Buckeye, running at 138 revolutions per minute, and the rim of the wheel was 3 in. thick and 24 in. wide. It is said that the accident was caused by the rocker arm key working out, and rendering the cut-off inoperative. One fragment of the wheel passed through the roof, 80 feet above the engine, and came down on the tracks of the Ohio Electric Co., 600 feet away. Another passed through a 17-inch brick wall and down through a floor, where it broke off a four-inch pipe.

(46.) — On August 9 a flywheel burst in the pickling department of the Cambridge plant of the American Sheet & Tin Plate Co., Cambridge, Ohio. One man was killed almost instantly. The wheel was eight feet in diameter.

(47.) — On August 18 a flywheel belonging to Edson J. Neighbor exploded at Vernoy, N. J.

(48.) — The engine room of the Bicking Paper Mills, at Bridgeport, near Norristown, Pa., was totally wrecked, August 26, by the explosion of a flywheel. One man was slightly injured. The engine house was unroofed, and one side was torn out. It is said that the main belt ran off the wheel, and that the engine then raced.

(49.) — A thirty-ton flywheel exploded, August 29, in the Arkansas Lumber Co.'s plant at Warren, Ark. Seven men were injured, and it was thought that two of these could not recover. The plant was also wrecked, and the property loss was estimated at $90,000. Some of the flying fragments of wreckage cut off twelve-inch timbers. The main drive belt broke, and one end of it struck the governor and rendered it inoperative. The engine then ran away.

(50.) — A flywheel exploded, September 6, in the Standard Sanitary Manufacturing Co.'s plant, Louisville, Ky., killing the engineer. The engine was of the Corliss typ,e making 72 revolutions per minute, and the wheel was 14 feet in diameter, and built in two sections. The accident was caused by the racing of the engine. Apparently the governor belt broke. The engine was not equipped with a broken-belt stop, nor with an automatic stop of any kind. Every spoke of the wheel was broken off close to the hub, and the engine was completely wrecked.

(51.) — The flywheel of an automobile belonging to E. L. Sprague, of Brandon, Vt., exploded, September 11, at Syracuse, N. Y. The chauffeur was seriously injured. He had just cranked up the engine, and the wheel had come up to speed, but the automobile itself was not in motion. The wheel flew into hundreds of pieces, and the entire machine was badly damaged.

(52.) — On September 16 a flywheel burst in the Hanover mill, at Whippany, N. J. The engine had been shut down, and for some reason (probably for repair purposes) the governor had been removed, or disconnected. It is said that an unauthorized workman, unaware of the true state of things, started up the engine for the purpose of doing a small job. The engine at once developed great speed, and the workman, becoming alarmed, ran out of the building, instead of shutting off the steam. One piece of the wheel passed through a brick wall, and landed 500 feet away. Another fragment, weighing nearly 500 pounds, went out through the side of the building.

(53.) — A flywheel exploded, September 16, in the Pittsburg Coal Co.'s power station, at Scott Haven, Pa. The chief engineer was instantly killed. The wheel was 12 feet in diameter, and 31 in. across the face. Its normal speed was 148 revolutions per minute. The main shaft was thrown fifteen feet, and the engine was damaged beyond repair. Property loss estimated at $6,000.

(54.) — A driven pulley, 48 in. in diameter, exploded, September 30, in the Roswell Manufacturing Co.'s plant, Roswell, Ga. The engine was connected with a water-wheel. The belt ran off of the pulley driven by the water-wheel, and the engine then ran away, the governor being inoperative.

(55.) — A flywheel exploded, September 30, in the canning factory at Onarga, near Loda, Ill. One man was badly injured.

(56.) — The flywheel of Joseph C. Hutchinson's automobile exploded, October 6, on South Thirtieth street, Philadelphia, Pa. Three men were slightly injured, and the automobile was ruined. Fragments of the wheel also damaged a near-by house.

(57.) — On October 12 a flywheel exploded in the Demmler Plate Co.'s plant, McKeesport, Pa. Property loss estimated at about $25,000.

(58.) — A flywheel belonging to F. Wayne exploded, October 15, at Jamestown, N. D. One person was seriously injured.

(59.) — On October 15 a driven pulley, 48 in. in diameter, and running at 210 revolutions per minute, exploded at the plant of Russe & Burgess, Inc., Memphis, Tenn. This pulley was installed on May 26, to take the place of the one whose explosion is noted under item No. 25, above. (See also No. 65, below.)

(60.) — On October 29 a flywheel exploded in the plant of the Fostoria Glass Co., Moundsville, W. Va.

(61.) — On November 3 a flywheel exploded in the Scranton Electric Co.'s power plant, Scranton, Pa. One person was injured.

(62.) — A flywheel exploded, on or about November 14, in the Grafton Roller Mills, Grafton, N. D.

(63.) — The flywheel of a threshing outfit exploded, November 18, at Staunton, Va. One man was instantly killed. The accident was due to the failure of the governor, the belt of which either broke or ran off its pulleys.

(64.) — A flywheel exploded, December 2, in W. D. Byron & Sons' tannery, Mercersburg, Pa. One man was killed and another was severely injured. It is said that the engine raced, and that the men ran to shut off the steam, but that the explosion occurred before they could do so. A piece of the wheel struck the main steam pipe and broke it.

(65.) — On December 8 a 48-inch driven pulley, running at 210 revolutions per minute, exploded at the plant of Russe & Burgess, Inc., Memphis, Tenn. This pulley was installed on October 16, to take the place of the one whose failure is recorded above, in item No. 59. (See also No. 25.)

(66.) — On December 18 an unusual flywheel accident occurred in the Lonaconing Electric Light Co.'s plant, Lonaconing, Md. A spring broke on the shaft governor, within the flywheel, and some part of the governor flew outward against the rim of the wheel. The rim was a foot or so in width, and two inches thick, but the shock cracked it completely through. The engineer succeeded in stopping the engine before further trouble ensued.

(67.) — On December 20 a flywheel exploded in the plant of William Ayres & Son, Philadelphia, Pa.

Some Boiler Mathematics.

Here is a problem upon which any of our readers who may be so inclined can try their mathematical teeth. It came up in actual practice, although we have changed the figures somewhat, so as to make the calculations a little simpler.

A certain boiler had two available sources of feed water, either one of which was quite sufficient to supply all that was needed, under ordinary circumstances. One of the sources was a brook, and the other was a well. Experience showed that when the boiler was running on the brook water alone, it had to be opened and cleaned every eight weeks, while when it was running on the well water alone, it had to be cleaned every three weeks.

The past summer being an unusually dry one in the locality in question, it was found that neither source would furnish enough water, by itself, to meet the needs of the plant. The two waters were therefore used together, being run into a storage tank in the proportion of 1,600 gallons of the brook water to 900 gallons of the well water. The problem is, to determine, from the data here given, how often it would be necessary to clean the boiler when running with the *mixed* feed.

Please note that this is a *purely mathematical* problem. In other words, it is to be assumed that the character of the solid matter deposited by the two waters is identically the same, and it is also to be assumed (although this would not be the case in practice) that in the dry season each of the waters carries just the same amount of solid matter, per gallon, that it does when the rainfall is more plentiful.

We shall take pleasure in printing the solution of this problem, some time in the near future; but we must utterly and absolutely and unconditionally decline to enter into correspondence about it. We make this explanation so that our friends will spare us a repetition of the experience we had once before, when we printed some problems without making this stipulation about writing letters. The editor then had stacks of them to answer, so that before he had finished the task, he accumulated a great and unprofitable weariness of the spirit.

Inspectors' Reports.

On pages 152 to 155, inclusive, we present general summaries of the work done by the inspectors of the Hartford Steam Boiler Inspection and Insurance Company, showing the number of defects of various kinds that were discovered during each of the twelve months of the year 1910. The number of visits of inspection, the total number of inspections (both internal and external), and the number of complete internal inspections, as well as the number of hydrostatic tests performed, and the number of boilers condemned, during these respective months, are given in the "Summary by Months," which will be found on page 157.

Inspectors' Reports for January, February, and March, 1910.

Nature of Defects.	January.		February.		March.	
	Total defects.	Dangerous.	Total defects.	Dangerous.	Total defects.	Dangerous.
Cases of deposit of sediment,	1,736	107	1,419	121	1,781	120
Cases of incrustation and scale,	3,583	118	3,077	123	3,665	129
Cases of internal grooving,	257	14	177	8	246	26
Cases of internal corrosion,	971	40	948	65	1,061	53
Cases of external corrosion,	905	65	673	63	733	52
Defective braces and stays,	199	43	218	29	297	46
Settings defective,	475	53	421	40	430	55
Furnaces out of shape,	633	36	604	30	643	35
Fractured plates,	340	60	278	23	312	38
Burned plates,	486	41	388	49	390	29
Laminated plates,	66	7	31	1	67	2
Cases of defective riveting,	293	53	233	35	284	40
Defective heads,	116	8	74	8	129	13
Cases of leakage around tubes,	1,593	170	1,289	188	1,271	134
Cases of defective tubes,	1,204	249	580	166	1,018	211
Tubes too light,	362	73	102	26	184	37
Leakage at joints,	554	36	486	31	507	23
Water-gages defective,	331	71	229	44	306	43
Blow-offs defective,	402	121	316	84	437	124
Cases of deficiency of water,	46	15	44	5	24	5
Safety-valves overloaded,	107	32	81	21	82	22
Safety-valves defective,	111	30	98	24	129	30
Pressure gages defective,	802	32	679	31	755	47
Boilers without pressure gages,	29	29	31	31	36	36
Unclassified defects,	0	0	0	0	0	0
Totals,	15,601	1,503	12,476	1,246	14,787	1,350

Inspectors' Reports for April, May, and June, 1910.

Nature of Defects.	April.		May.		June.	
	Total defects	Dangerous.	Total defects.	Dangerous.	Total defects.	Dangerous.
Cases of deposit of sediment,	1,802	92	1,840	167	1,643	122
Cases of incrustation and scale,	3,968	140	4,245	124	3,740	100
Cases of internal grooving,	261	18	268	24	298	28
Cases of internal corrosion,	1,165	62	1,251	44	1,603	58
Cases of external corrosion,	882	75	835	64	979	68
Defective braces and stays,	231	43	224	49	329	30
Settings defective,	459	56	495	54	523	77
Furnaces out of shape,	713	37	727	32	646	39
Fractured plates,	344	71	357	33	201	41
Burned plates,	473	54	546	38	449	43
Laminated plates,	42	4	50	6	58	5
Cases of defective riveting,	305	86	295	50	254	32
Defective heads,	98	17	106	15	153	26
Cases of leakage around tubes,	1,338	190	1,176	201	856	95
Cases of defective tubes,	1,012	211	834	191	841	192
Tubes too light,	166	45	187	52	176	35
Leakage at joints,	494	28	541	33	472	22
Water-gages defective,	273	43	259	50	291	49
Blow-offs defective,	411	110	438	124	379	117
Cases of deficiency of water,	40	10	26	10	26	11
Safety-valves overloaded,	115	26	95	31	70	25
Safety-valves defective,	104	33	147	41	109	26
Pressure gages defective,	725	51	737	54	698	39
Boilers without pressure gages,	45	45	44	44	24	24
Unclassified defects,	4	0	0	0	0	0
Totals,	15,470	1,547	15,723	1,531	14,908	1,304

Inspectors' Reports for July, August, and September, 1910.

Nature of Defects.	July.		August.		September.	
	Total defects.	Dangerous.	Total defects.	Dangerous.	Total defects.	Dangerous.
Cases of deposit of sediment,	1,899	108	1,464	87	1,509	115
Cases of incrustation and scale,	4,178	153	3,441	100	3,759	127
Cases of internal grooving,	245	26	223	14	267	16
Cases of internal corrosion,	1,589	44	1,187	40	1,231	63
Cases of external corrosion	937	78	889	61	815	86
Defective braces and stays,	182	43	172	39	163	30
Settings defective,	569	79	447	48	433	67
Furnaces out of shape,	718	32	620	34	621	29
Fractured plates,	264	38	260	31	284	43
Burned plates,	427	31	363	36	409	33
Laminated plates,	66	9	35	4	44	1
Cases of defective riveting,	208	53	233	45	301	72
Defective heads,	108	19	109	15	83	16
Cases of leakage around tubes,	937	175	819	106	870	122
Cases of defective tubes,	768	183	696	179	746	252
Tubes too light,	129	29	158	44	189	92
Leakage at joints,	485	35	434	19	489	34
Water-gages defective,	254	77	269	56	282	50
Blow-offs defective,	365	105	396	118	322	94
Cases of deficiency of water,	32	6	38	6	32	8
Safety-valves overloaded,	116	42	107	46	106	42
Safety-valves defective,	78	20	106	31	108	32
Pressure gages defective,	631	30	650	49	624	35
Boilers without pressure gages,	53	53	25	25	33	33
Unclassified defects,	0	0	0	0	1	0
Totals,	15,298	1,468	13,141	1,233	13,721	1,492

Inspectors' Reports for October, November, and December, 1910.

Nature of Defects.	October.		November.		December.	
	Total defects.	Dangerous.	Total defects.	Dangerous.	Total defects.	Dangerous.
Cases of deposit of sediment,	1,548	109	1,465	110	1,365	109
Cases of incrustation and scale,	3,819	117	3,364	128	2,824	109
Cases of internal grooving,	186	17	236	17	166	21
Cases of internal corrosion,	932	36	955	60	888	46
Cases of external corrosion,	726	72	653	60	[illegible]	57
Defective braces and stays,	213	57	220	57	163	58
Settings defective,	446	60	411	42	568	56
Furnaces out of shape,	646	33	578	34	525	3[illegible]
Fractured plates,	336	48	291	51	297	44
Burned plates,	456	44	414	43	373	37
Laminated plates,	38	3	39	3	29	5
Cases of defective riveting,	288	52	285	61	186	31
Defective heads,	86	12	73	10	69	7
Cases of leakage around tubes,	992	147	1,039	142	835	119
Cases of defective tubes,	702	208	681	269	609	197
Tubes too light,	124	48	1[illegible]4	25	118	46
Leakage at joints,	577	29	514	30	403	33
Water-gages defective,	323	65	316	68	269	52
Blow-offs defective,	346	98	344	93	250	100
Cases of deficiency of water,	37	13	46	10	39	23
Safety-valves overloaded,	122	22	110	21	98	24
Safety-valves defective,	123	38	110	22	111	29
Pressure-gages defective,	621	29	661	38	502	34
Boilers without pressure-gages,	8	8	23	23	18	18
Unclassified defects,	0	0	1	1	3	3
Totals,	13,695	1,365	12,943	1,418	11,439	1,289

Summary of Inspectors' Reports for the Year 1910.

During the year 1910 the inspectors of the Hartford Steam Boiler Inspection and Insurance Company made 177,946 visits of inspection, examined 347,255 boilers, inspected 138,900 boilers both internally and externally, subjected 12,779 to hydrostatic pressure, and found 625 unsafe for continued insurance. The whole number of defects reported was 169,202, of which 16,746 were considered dangerous. The usual classification by defects is given below, and a summary by months is given on page 157.

SUMMARY, BY DEFECTS, FOR THE YEAR 1910.

NATURE OF DEFECTS.	Whole Number.	Dangerous.
Cases of deposit of sediment,	19,471	1,367
Cases of incrustation and scale,	43,663	1,468
Cases of internal grooving,	2,830	229
Cases of internal corrosion,	13,781	611
Cases of external corrosion,	9,668	801
Defective braces and stays,	2,611	524
Settings defective,	5,677	687
Furnaces out of shape,	7,674	402
Fractured plates,	3,654	521
Burned plates,	5,174	478
Laminated plates,	565	50
Cases of defective riveting,	3,225	610
Defective heads,	1,204	166
Cases of leakage around tubes,	13,015	1,789
Cases of defective tubes,	9,691	2,508
Tubes too light,	2,009	552
Leakage at joints,	5,956	353
Water-gages defective,	3,402	668
Blow-offs defective,	4,436	1,288
Cases of deficiency of water,	430	122
Safety-valves overloaded,	1,209	354
Safety-valves defective,	1,334	356
Pressure gages defective,	8,145	469
Boilers without pressure gages,	369	369
Unclassified defects,	9	4
Total,	169,202	16,746

COMPARISON OF INSPECTORS' WORK DURING THE YEARS 1909 AND 1910.

	1909.	1910.
Visits of inspection made,	174,872	177,946
Whole number of inspections (both internal and external),	342,136	347,255
Number of complete internal inspections,	136,682	138,900
Boilers tested by hydrostatic pressure,	12,563	12,779
Total number of boilers condemned,	642	625
Total number of defects discovered,	169,356	169,202
Total number of dangerous defects discovered,	16,385	16,746

Summary by Months for 1910.

Month.	Visits of inspection.	Number of boilers examined	No. inspected internally and externally.	No. tested hydrostatically.	No. condemned.	No. of defects found.	No. of dangerous defects found.
January, .	15,431	30,978	10,647	784	41	15,601	1,503
February, .	13,944	27,275	8,520	898	45	12,476	1,246
March, . .	15,732	30,831	11,157	1,079	52	14,787	1,350
April, . .	15,503	29,913	12,359	1,251	69	15,470	1,547
May, . . .	14,671	29,716	12,821	1,097	44	15,723	1,531
June, . . .	14,329	26,934	13,232	1,119	64	14,908	1,304
July, . . .	14,104	26,529	14,304	1,334	77	15,298	1,468
August, . .	13,772	26 276	11,863	1,134	39	13,141	1,233
September, .	14,211	27,937	11,902	1,292	50	13,721	1,492
October, .	16,143	31,754	12,079	1,194	60	13,695	1,365
November, .	15,701	30,082	10,979	913	38	12,943	1,418
December, .	14,405	29,030	9,037	684	46	11,439	1,289
Totals, .	177,946	347,255	138,900	12,779	625	169,202	16,746

The following table is also of interest. It shows that our inspectors have made over three million visits of inspection, and that they have made over six million inspections, of which more than two and a third million were complete internal inspections. The hydrostatic test has been applied in more than a quarter of a million cases. Of defects, more than three million and three-quarters have been discovered and pointed out to the owners of the boilers; and nearly four hundred thousand of these were, in our opinion, dangerous. Nearly twenty-one thousand boilers have been condemned by us as no longer insurable, good and sufficient reasons for the condemnation being given to the assured in every instance.

Grand Total of the Inspectors' Work from the Time the Company Began Business, to January 1, 1911.

Visits of inspection made, ...	3,132,080
Whole number of inspections (both internal and external), . .	6,060,913
Complete internal inspections, ...	2,378,026
Boilers tested by hydrostatic pressure, ...	287,128
Total number of boilers condemned, ...	20,967
Total number of defects discovered, ...	3,823,267
Total number of dangerous defects discovered, ...	392,229

We append, also, a summary of the work of the inspectors of this company from 1870 to 1910 inclusive. The year 1878 is omitted, because the data that we have at hand for that year are not complete. Previous to 1875 it was the custom of the company to publish its reports for the year ending with September 1, but in that year the custom was changed and the summaries were thereafter made out so as to correspond with the calendar year. The figures given opposite 1875, therefore, are for sixteen months, beginning September 1, 1874, and ending December 31, 1875.

SUMMARY OF INSPECTORS' WORK SINCE 1870.

Year.	Visits of inspection made.	Whole number of boilers inspected.	Complete internal inspections.	Boilers tested by hydrostatic pressure.	Total number of defects discovered.	Total number of dangerous defects discovered.	Boilers condemned.
1870	5,439	10,569	2,585	882	4,686	485	45
1871	6,826	13,476	3,889	1,484	6,253	954	60
1872	10,447	21,066	6,533	2,102	11,176	2,260	155
1873	12,824	24,998	6,511	2,175	11,998	2,892	178
1874	14,368	29,200	9,451	2,078	14,256	3,486	163
1875	22,612	44,763	14,181	3,149	24,040	6,149	216
1876	16,409	34,275	10,669	2,150	16,273	4,275	89
1877	16,204	32,975	11,629	2,367	15,964	3,690	133
1879	17,179	36,169	13,045	2,540	16,238	3,816	246
1880	20,939	41,166	16,010	3,490	21,033	5,444	377
1881	22,412	47,245	17,590	4,286	21,110	5,801	363
1882	25,742	55,679	21,428	4,564	33,690	6,867	478
1883	29,324	60,142	24,403	4,275	40,953	7,472	545
1884	34,048	66,695	24,855	4,180	44,900	7,449	493
1885	37,018	71,334	26,637	4,809	47,230	7,325	449
1886	39,777	77,275	30,868	5,252	71,983	9,960	509
1887	46,761	89,994	36,166	5,741	99,642	11,522	622
1888	51,483	102,314	40,240	6,536	91,567	8,967	426
1889	56,752	110,394	44,563	7,187	105,187	8,420	478
1890	61,750	118,098	49,983	7,207	115,821	9,387	402
1891	71,227	137,741	57,312	7,859	127,609	10,858	526
1892	74,830	148,603	59,883	7,585	120,659	11,705	681
1893	81,904	163,328	66,698	7,861	122,893	12,390	597
1894	94,982	191,932	79,000	7,686	135,021	13,753	595
1895	98,349	199,096	76,744	8,373	144,857	14,556	799
1896	102,911	205,957	78,118	8,187	143,217	12,988	663
1897	105,062	206,657	76,770	7,870	131,192	11,775	588
1898	106,128	208,990	78,349	8,713	130,743	11,727	603
1899	112,464	221,706	85,804	9,371	157,804	12,800	779
1900	122,811	234,805	92,526	10,191	177,113	12,862	782
1901	134,027	254,927	99,885	11,507	187,847	12,614	950
1902	142,006	264,708	105,675	11,726	145,489	13,032	1,004
1903	153,951	293,122	116,643	12,232	147,707	12,304	933
1904	159,553	299,436	117,366	12,971	154,282	13,390	883
1905	159,561	291,041	116,762	13,266	155,024	14,209	753
1906	159,133	292,977	120,416	13,250	157,462	15,116	690
1907	163,648	308,571	124,610	13,799	159,283	17,345	700
1908	167,951	317,537	124,990	10,449	151,359	15,878	572
1909	174,872	342,136	136,682	12,563	169,356	16,385	642
1910	177,946	347,255	138,900	12,779	169,202	16,746	625

To avoid possible misunderstanding with respect to the figures in the last column of this table, we would direct attention to the fact that no insurance company has the power to cause the use of a boiler to be discontinued. In other words, when we say we "condemn" a boiler, we merely mean that we pronounce it unfit for the continuance of the insurance.

The Locomotive

VOL. XXVIII. HARTFORD, CONN., APRIL 25, 1911. No. 6.

A Fly-Wheel Explosion at Towanda, Pa.

The bursting of a wheel on an "automatic" engine in the plant of the Towanda Electric Illuminating Co., at Towanda, Pa., in the early morning of April 20, 1911, gives striking evidence of the incorrectness of the popular opinion that engines of this class are immune from such explosions. A brief description of the attendant conditions, and a discussion of the probable cause of failure, should therefore be of interest.

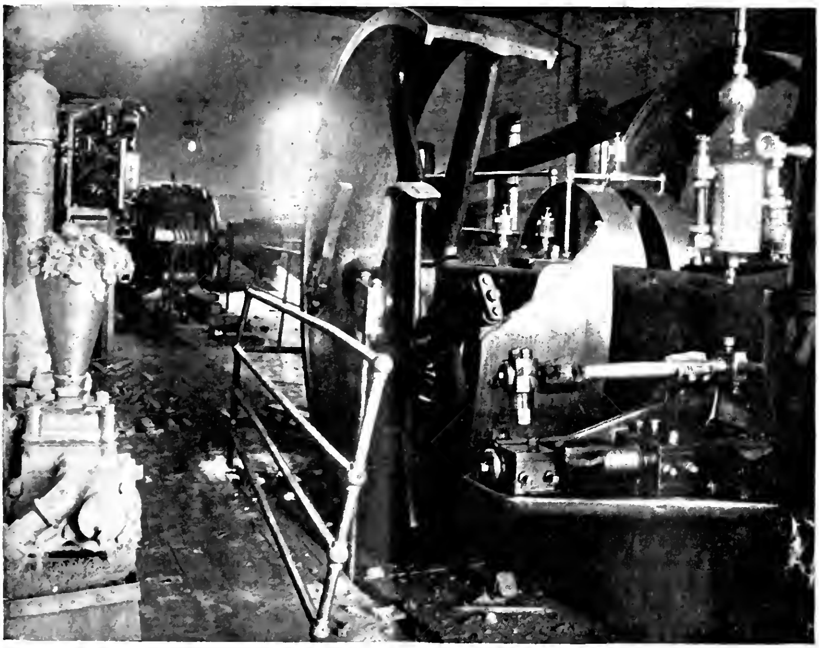

FIG. 1.—SHOWING THE BROKEN WHEEL AND GOVERNOR.

The wheel in question was mounted upon one of a pair of center-crank, automatic, slide-valve, simple engines, each of which was belted to an electric generator. Each engine was equipped with a shaft governor of the Rites inertia type, the governor on the south engine (on which the failure occurred) involving the use of a very heavy weight-bar.

During the evening of April 19 this south engine had been in operation alone, and it was easily carrying the station load. At about 12.30 a. m. of April 20 the night engineer, standing in the front doorway of the room, heard a noise from the engine as though something was thrown from it. He states that the lights immediately grew dim, and he thinks they went out completely. In the darkness he hurried back to the rear of the room, intending to shut off steam at the throttle. He had reached the throttle and had started to turn its hand wheel, when suddenly the engine speeded up, the lights grew intensely bright, and, as he expressed it, "things began to fly." Under the circumstances he prudently and hurriedly sought refuge in the adjacent boiler room. In a brief time the commotion in the engine room ceased, and upon returning he found the engine at rest with its valve gear broken. He then completed the closing of the throttle valve, and, with assistance, soon had the north engine in operation.

When opportunity afforded, an examination was made of the wrecked engine, and it was found that the eighty-inch governor wheel had lost a section of its rim, that one end of the governor weight-arm was missing, and that the remainder of this arm had swung around on its pin so as to wedge against the rim. The springs were still attached to the weight-arm, but the rod or bolt by which they had been secured to the rim was broken at the lock-nut, close to the spring-yoke, the portion which passed through the wheel rim not being found. A structure of cast-iron, fastened to the inner face of the rim and forming stops to limit the motion of the governor arm, had been torn apart and destroyed. The eccentric rod and rocker arms were irreparably damaged, and the foundation was so cracked and broken that rebuilding will be necessary. The general appearance of the engine, after the accident, is shown in Figs. 1 and 5.

The damage, except to the engine itself, was fortunately small. The slightest imaginable deviation of the fragments from the courses they actually took would probably have resulted in heavy losses, however. One fragment of the rim passed through the ceiling and roof of the building, narrowly missing the main steam pipe. A larger piece had apparently been thrown on a descending tangent against the light floor, which it crushed, and from which it rebounded against the face of the main switch board. It merely sheared off a pair of pilot lamps from this board, and then carromed aside and finally came to rest just short of the dynamo. The heavy weight-arm end also bounded from the floor against the resistance box of a voltage regulator, destroying this resistance and cracking the marble panel to which it was attached, but not damaging the delicate mechanism of the regulator itself, nor even breaking its glass case.

Happily no one was injured by the flying wreckage, though it is almost certain that one death would have resulted, if the accident had occurred a few minutes later. One of the attendants was purposing to change the load from the south engine to the other one, and this operation would have taken him to the front of the switchboard, directly in the path of the fragments.

In fly-wheel accidents, especially when they occur on shaft-governed engines, it is often most difficult to determine the primary cause of the failure. In this case, however, the behavior of the engine immediately before "things began to fly" tells a pretty fairly intelligible story, which we proceed to relate, so far as we have been able to read it.

Fig. 2 is an outline drawing of the wheel and the governing apparatus. *AB* is a heavy arm, called the "governor arm", which is secured to one of the spokes by means of a pivot, *P*. At the respective ends of the governor arm are cast-iron boxes, *A* and *B*, within which are weights, firmly bolted in position so that they cannot shift about during the operation of the engine. The little cross indicates the center of the shaft, and the point *M* shows the position of the center of mass of the arm and its weights. If the weights in *A* and *B* were exactly equal, and were also similarly placed, the point *M* would coincide with the geometrical center of the governor arm. In the actual case, however, more weights are placed in *B* than in *A*, so as to make the center of mass of the governor arm lie a little towards *B*, as indicated. At *E* is a pin, known as the "eccentric pin", which operates the slide valve of the engine, and at *S* is a device for limiting the motion of the governor arm in both directions.

In Fig. 2 the governor is shown with the arm close to the position giving the maximum cut-off. When the wheel is revolving at a uniform speed the governor arm is subject to a centrifugal force which tends to throw its center of mass, *M*, further away from the center of rotation (which is

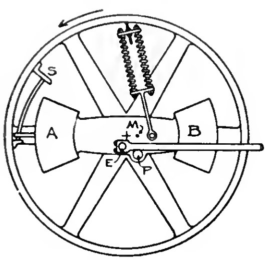

Fig. 2.

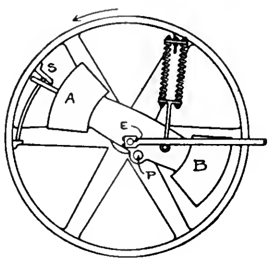

Fig. 3.

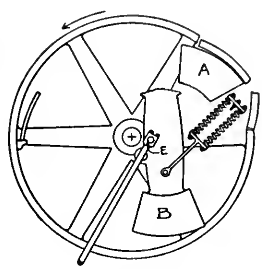

Fig. 4.

Diagrams Illustrating the Action of the Governor.

marked by the cross). This tends to make the governor arm turn about the pin *P* in the direction in which the hands of a clock move. To oppose this tendency a pair of springs are provided, as shown, and when the apparatus is properly adjusted, the centrifugal force of the arm is balanced against the tension of the springs in such a way that the cut-off of the engine has the proper value, at the speed at which the engine is designed to run.

If, now, the engine were to *gradually* speed up, the centrifugal force developed in the governor arm would also gradually increase at the same time, and this would cause the point *M*, in Fig. 2, to recede further from the little cross, the governor arm turning about the pin *P*, and simultaneously stretching the springs. In this way the eccentric pin, *E*, would be brought nearer to the center of the shaft, and the cut-off shortened.

Furthermore, if the engine were to speed up *suddenly* (instead of gradually), as might happen, for example, from the breakage of the main driving belt, the wheel itself (which is revolving in the direction of the arrow) would jump forward quickly, but the heavy governor arm, *AB*, would not do so, on account of its inertia. As a result, the wheel would almost instantly gain on the arm, and the cut-off of the engine would be reduced with corresponding promptness.

It will be seen, from the account here given, that in a governor of this type it is the *inertia* of the arm that regulates the cut-off when the change of speed is sudden, while it is the *centrifugal force* acting upon the arm that effects the regulation when the change of speed is gradual. The mechanism is ingenious, and under ordinary circumstances it is also quite efficient. It has the disadvantage, however, that any sudden variation in the speed, even though it be but slight in amount, causes the governor arm to be brought smartly against one or the other of the limiting stops at *S*; and we are of the opinion that the shocks so produced are

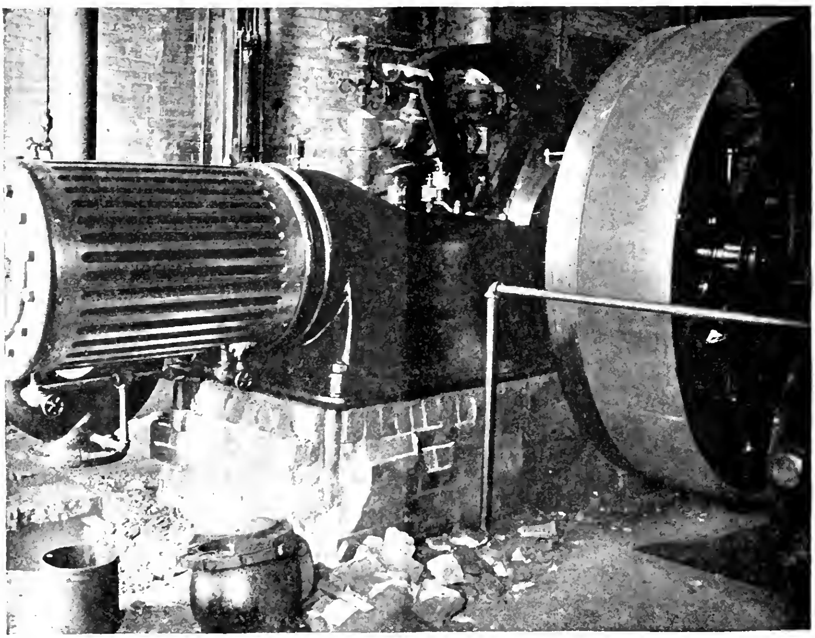

Fig. 5.— Showing the Damaged Foundation.

likely, sooner or later, to weaken the cast-iron parts upon which these shocks are thrown. Care should therefore be taken to detect such incipient cracks as may form in any part of the stop device, *S*, or in the projection from *A* that engages with these stops, or along the lines where the boxes *A* and *B* join the central portion of the governor arm.

Returning, now, to a consideration of the accident which serves as a text for these remarks, we may assume that prior to the accident the arm was approximately in the position shown in Fig. 2, although, as the load was light, it probably was swung on its pin so as to produce a somewhat shorter cut-off than that here indicated. Now the engineer first heard a noise as of something thrown from the wheel, and immediately thereafter the electric lamps grew dim and perhaps went out entirely. Of course the dimming of the lamps indicates a slowing of the engine speed, and with undiminished steam admission pressure, the reduced speed suggests a shortening cut-off. The bolt holding the springs to the rim of the wheel was found to be broken, after the accident, and it appears almost certain that it was this bolt that gave out first, its breakage releasing the spring tension and permitting the governor arm, under the influence of centrifugal force, to fly around to its position of minimum cut-off, as shown in Fig. 3. The broken end of the spring bolt was probably thrown from the wheel at the outset, and it was very likely this that made the noise that first attracted the engineer's attention. Our theory that it was the spring bolt that first failed would seem to explain each circumstance of the early events that were noted. We proceed, next, to trace the later consequences.

Had the governor arm, under the action of centrifugal force, remained in the position shown in Fig. 3, the engine should gradually have come to rest without further damage. This would doubtless have been the actual course of events, except for the inertia of the governor arm itself, which in this type of apparatus (as we have explained above) is utilized to secure close regulation. As the wheel slowed down, it presently reached a speed where the centrifugal force of the governor weight was insufficient to hold the arm in its extreme position, against the tendency of its mass to maintain its own velocity of rotation. When this state of affairs had been attained, the slightest additional retardation of the engine would cause the governor arm to advance relatively to the wheel, until it was again in the position shown in Fig. 2, with the eccentric pin in the position of maximum cut-off. This movement, when it took place, was undoubtedly very sudden, and the engine, then acting under the stimulus of a long cut-off, at once leaped to high speed, generating the brilliant lights noted by the attendant.

Reasoning along the lines here indicated, it will be seen that we might logically anticipate an alternate retarding and speeding of the wheel, which might continue without any great damage until the throttle was closed. Experiences of this sort are not uncommon, with broken springs upon shaft governors. In the case now before us, however, the rapid acceleration of the wheel was attended by a powerful effort of the arm — due to inertia, acting this time in conjunction with centrifugal force and unopposed by the spring — to seek the position shown in Fig. 3. Apparently the effort was so great that the rim stop at *S* was broken away, and the arm ceased its individual motion only when the weight box, *B*, had wedged against the rim as shown in Fig. 4. The shock of this sudden stop was severe enough to snap off the weight box *A*, which may have been already weakened in fracturing the stop *S*. The box *A*, flying against the rim, then broke it out at the point shown in the illustrations. The flange of the broken portion of the rim shows evidence of contact with the weight box, and thus corroborates the foregoing theory of the accident.

We can still furnish copies of the little book entitled *The Metric System.* It gives many tables for converting metric measures into our own, and the reverse. We believe it to be the handiest and best thing of its kind to be had. Price $1.25. (Bond paper edition $1.50.)

Boiler Explosions

January, 1911.

(1.) — On January 1 a slight boiler explosion occurred in Secor's greenhouses at Forest City, Iowa.

(2.) — Several headers fractured, January 1, in a water-tube boiler at the power house of the Lima-Honeoye Electric Light & Railroad Co., Lima, N. Y.

(3.) — A tube ruptured, January 1, in a water-tube boiler at the power plant of the Pueblo & Suburban Traction & Lighting Co., Pueblo, Colo. Two men were injured.

(4.) — On January 2 a blowoff pipe failed at the water works and electric light plant, Appleton, Minn. The engineer was scalded.

(5.) — A blowoff fractured, January 3, in the Colburn Mills, McPherson, Kans. Three persons were severely injured.

(6.) — A cast-iron section ruptured, January 3, in a heater at the Staples School, Bridgeport, Conn.

(7.) — A boiler flue burst, January 4, on the Big Four railroad, at Brooks Station, Ohio. Four persons were severely injured.

(8.) — On January 4, a blowoff pipe failed at the New Mohn Laundry, Cincinnati, Ohio. One man was scalded.

(9.) — A boiler belonging to C. A. Lindan exploded, January 4, at Duluth, Minn.

(10.) — A blowoff pipe ruptured, January 4, in the Warrant Warehouse Co.'s Cotton Compress, Birmingham, Ala. The fireman was injured.

(11.) — On January 4 a blowoff pipe failed in E. B. Norman & Co.'s sawmill, Louisville, Ky.

(12.) — A tube ruptured, January 4, in a water-tube boiler in the light, power and water works plant of the City of Monroe, La.

(13.) — A boiler exploded, January 5, in a seminary at Manchester, Vt.

(14.) — A hot water boiler exploded, January 5, in the high school building at St. Paul, Neb.

(15.) — A tube ruptured, January 5, in a water-tube boiler at the Joliet plant of the Illinois Steel Co., Joliet, Ill. One man was injured.

(16.) — On January 5 a return bend failed in a pipe boiler in the plant of O. J. Maigne & Co., New York City.

(17.) — On January 5 a hot water boiler exploded in the Collegiate Institute, St. Catharines, Ont.

(18.) — A tube failed, January 5, in a water-tube boiler in Charles Pope's beet sugar factory, Riverdale, Ill. One man was injured. (Compare No. 38 below.)

(19.) — On January 5 a heating boiler exploded in the Hotel Royal, Altoona, Pa.

(20.) — On January 5 a boiler ruptured in the Duff Grain Co.'s elevator, Nebraska City, Neb.

(21.) — The boiler of a locomotive exploded, January 6, on the Burlington Railroad, at Bachester, Wyo. Two persons were killed and one was fatally injured.

(22.) — A tube ruptured, January 6, in a water-tube boiler at the Union Buffalo Mills, Union, S. C. One man was injured.

(23.) — Four cast-iron headers ruptured, January 7, in a water-tube boiler at the plant of the Ingersoll-Rand Co., Easton, Pa.

(24.) — A boiler belonging to O. C. Heggen exploded, January 8, at Des Moines, Iowa. Four persons were severely injured.

(25.) — On or about January 8 a boiler exploded in the central heating plant of the George Junior Republic, at Freeville, N. Y.

(26.) — The boiler of a Chesapeake & Ohio locomotive exploded, January 8, fifteen miles east of Frankfort, Ky. One man was fatally injured, and two were injured less seriously. The explosion consisted in the failure of the crown sheet.

(27.) — A slight boiler explosion occurred, January 8, at the sanitarium of the Kneipp Water Cure Co., New Orleans, La.

(28.) — A heating boiler exploded, January 9, in the residence of Julian H. Hill, Richmond, Va. The property loss exceeded $3,000.

(29.) — On January 9, at the plant of the Light, Heat and Power Co., Fairbury, Ill., a spring broke in a pop safety valve while under steam pressure, causing the rupture of the bonnet of the valve.

(30.) — On January 9, a tube ruptured in a water-tube boiler in A. J. Stahl's electric light and hot water heating plant, Belvedere, Ill. One man was injured.

(31.) — A boiler exploded, January 10, in Charles Hearst's saw and grist mill, near Little Rock, Ark. Two men were severely injured.

(32.) — On January 10, a tube ruptured in a water-tube boiler at the plant of the Michigan Alkali Co., Wyandotte, Mich.

(33.) — On January 10, a slight boiler explosion occurred in a bakery at Elyria, Ohio.

(34.) — On January 11, a tube failed in a horizontal tubular boiler at the Central Grammar School, Grand Rapids, Mich.

(35.) — A boiler exploded, January 12, in the city hall at Crookston, Minn. One person was injured.

(36.) — The crown sheet of a locomotive belonging to the Longdale Iron Co. exploded, January 12, at Longdale, Va.

(37.) — The boiler of a Southern Pacific locomotive exploded, January 12, near Flatonia, Texas. Two men were killed.

(38.) — A tube failed, January 12, in a water-tube boiler at Charles Pope's beet sugar factory, Riverdale, Ill. One man was injured. (Compare No. 18 above.)

(39.) — A locomotive boiler exploded, January 13, on the Illinois Central Railroad, at Kankakee, Ill. Three persons were severely injured.

(40.) — A tube ruptured, January 13, in a water-tube boiler at the plant of the Southern Iron & Steel Co., Alabama City, Ala. One man was scalded. (Compare Nos. 43, 71, 93, and 109 below.)

(41.) — On January 13 a tube ruptured in a water-tube boiler at the plant of the Lackawanna Steel Co., Lackawanna, N. Y. (Compare No. 45, below.)

(42.) — A boiler exploded, January 14, in the electric light and power house at Rushville, Mo. Two men were killed and the plant was demolished.

(43.) — A tube ruptured, January 14, in a water-tube boiler at the plant of the Southern Iron & Steel Co., Alabama City, Ala. (Compare Nos. 40, 71, 93, and 109.)

(44.) — On January 14 a tube ruptured in a water-tube boiler in the Electric Storage Battery Co.'s plant, Philadelphia, Pa.

(45.) — A tube ruptured, January 15, in a water-tube boiler at the plant of the Lackawanna Steel Co., Lackawanna, N. Y. (Compare No. 41, above. The accidents were on different boilers.)

(46.) — A tube ruptured, on January 16, in the J. L. Hudson Co.'s department store, Detroit, Mich.

(47.) — A slight explosion occurred, January 16, in a heating boiler in a public school building at White, S. D.

(48.) — A boiler exploded, January 16, on the towboat *T. N. Davis*, on the Ohio River, six miles above Cairo, Ill. One man was killed and the boat was badly damaged.

(49.) — On January 16, a boiler exploded at Cleary's Stone Works, Marietta, Ohio. Two men were killed and one was seriously injured.

(50.) — A boiler exploded, January 17, in the Archer sawmill, at Eagle Point, twelve miles north of New Boston, Ill. One man was killed.

(51.) — On January 17, three headers failed in a boiler on the U. S. battleship *Delaware*, as she was nearing Hampton Roads, Va. Eight men were killed and one received injuries that were believed to be fatal.

(52.) — A heating boiler burst, January 18, in the high school building at Wethersfield, Conn.

(53.) — A tube ruptured, January 18, in a water-tube boiler at the plant of the Old '76 Distilling Co., Finchtown, Ky.

(54.) — The boiler of a New York Central freight locomotive exploded, January 18, at Wende, twenty miles east of Buffalo, N. Y. Three men were killed.

(55.) — A cast-iron header fractured, January 19, in a water-tube boiler at the power station of the Philadelphia Rapid Transit Co., Thirty-third and Market streets, Philadelphia, Pa. (Compare No. 134, below.)

(56.) — A boiler exploded, January 19, in the primary school building, at Hopkinton, Iowa.

(57.) — A cast-iron header fractured, January 19, in a water-tube boiler at the power station of the Terre Haute, Indianapolis & Eastern Traction Co., Terre Haute, Ind.

(58.) — On or about January 19 a boiler exploded in Benjamin Hendrickson's greenhouse, Delphi, Ind. Two men were injured, and the property loss was estimated at $400.

(59.) — A tube failed, January 19, in a boiler at the power house of the Lehigh Coal & Navigation Co., Lansford, Pa. One man was fatally injured.

(60.) — A heating boiler exploded, January 19, during the course of a revival in the Wesley Methodist Episcopal Church, Georgetown, Del.

(61.) — A tube ruptured, January 20, in a water-tube boiler in the power house of the East Liverpool Traction & Light Co., East Liverpool, Ohio. Two men were injured.

(62.) — A boiler exploded, January 20, in the Sunday Creek Coal Co.'s plant, Cedar Grove, W. Va. Two persons were severely injured.

(63.) — A cast-iron header fractured, January 20, in a water-tube boiler in the Savannah Lighting Co.'s plant, Savannah, Ga.

(64.) — A blowoff pipe failed, January 20, in E. H. Plank's elevator mills, Lodi, Ohio. One man was slightly injured.

(65.) — On January 20, a blowoff pipe ruptured in the Locke Cotton Mills, Concord, N. C. Two men were injured.

(66.) — A small boiler exploded, January 21, in the basement of the Sweetwater College Preparatory School building, Sweetwater, Tenn. The property loss was estimated at from $500 to $600.

(67.) — Two tubes ruptured, January 21, in a water-tube boiler in the Chittenden Hotel, Columbus, Ohio. (Compare No. 88, below).

(68.) — On January 24, a boiler exploded in a public school building at Greensboro, N. C.

(69.) — A cast-iron header ruptured, January 24, in a water-tube boiler operated by the Philadelphia Rapid Transit Co., Philadelphia, Pa.

(70.) — A boiler exploded, January 24, in the St. Germain Garage, St. Cloud, Minn.

(71.) — A tube ruptured, January 25, in a water-tube boiler in the Southern Iron & Steel Co.'s plant, Alabama City, Ala. (Compare Nos. 40, 43, 93, and 100.)

(72.) — On January 26, a tube ruptured in a water-tube boiler in the Alkali Rubber Co.'s plant, Dubuque, Iowa.

(73.) — A boiler belonging to Barkley Bros. exploded, January 27, in the Cannon oil field, near Sour Lake, Tex.

(74.) — On January 27, a cast-iron header fractured in a water-tube boiler at the Philadelphia Rapid Transit Co.'s power house, Ninth and Dauphin streets, Philadelphia, Pa.

(75.) — On January 29, five sections of a cast-iron sectional heating boiler fractured in the building of Tintic Lodge No. 711, B. P. O. E., Eureka, Utah.

(76.) — A tube ruptured, January 31, in a water-tube boiler in the Newberry Cotton Mills, Newberry, S. C.

February, 1911.

(77.) — A boiler exploded, February 1, in a grist mill at Bruin, Elliott county, Ky. Two persons were killed and two others were fatally injured.

(78.) — A tube failed, February 1, in a water-tube boiler in the Colonial Theater, Boston, Mass.

(79.) — On February 2 a tube ruptured in a water-tube boiler in the City Light & Water Works, Fairbury, Neb.

(80.) — On February 2 a blowoff pipe connected to a digester fractured in the Champion Fibre Co.'s plant, Canton, N. C. Five men were scalded.

(81.) — Three sections of a cast-iron sectional heating boiler fractured, February 3, in the Skelton Publishing Co.'s plant, Salt Lake City, Utah. (Compare No. 119, below.)

(82.) — A blowoff pipe failed, February 3, in the L. B. Southwick Co.'s tannery, Peabody, Mass. Two men were injured.

(83.) — A tube ruptured, February 5, in a water-tube boiler in the Northern Cambria Street Railway Co.'s plant, St. Benedict, Pa.

(84.) — On February 5 a tube ruptured in a water-tube boiler in the Ohio Electric Railway Co.'s plant, Medway, Ohio.

(85.) — On February 6, a hot water boiler exploded in a tenement house on East Seventy-seventh Street, New York City. Fire followed the explosion, and the building, which was known as the "House of All Nations" (on account of the varied nationalities of its tenants), was badly damaged.

(86.) — On February 6 a blowoff pipe failed in the boiler plant of the Michigan Agricultural College, Lansing, Mich. One man was injured.

(87.) — A blowoff failed, February 6, in the American Carving Mfg. Co.'s plant, Grand Rapids, Mich.

(88.) — A cast-iron header ruptured, February 7, in a water-tube boiler at the Chittenden Hotel, Columbus, Ohio. (Compare No. 67, above.)

(89.) — The boiler of a Missouri, Kansas & Texas locomotive exploded, February 8, in the roundhouse at Smithville, Tex. Ten men were instantly killed and nine were injured. The property loss was estimated at $20,000.

(90.) — Several tubes ruptured, February 8, in a water-tube boiler at the plant of the Waterloo, Cedar Falls & Northern Railway Co., Waterloo, Iowa.

(91.) — A boiler exploded, February 10, in Franks' steam laundry, West Third street, Little Rock, Ark. Three persons were slightly injured.

(92.) — On February 10, a boiler exploded in Thomas King's sawmill at Parksville, six miles south of Benton, Tenn. Four men were killed and three were seriously injured.

(93.) — On February 14 two tubes failed in a water-tube boiler in the Southern Iron & Steel Co.'s plant, Alabama City, Ala. (Compare Nos. 40, 43, 71, and 109.)

(94.) — The boiler of a Great Western freight locomotive exploded, February 14, near Ingalton, Ill. One man was instantly killed and five others were injured. It was believed that one of the injured could not recover.

(95.) — On February 14 a boiler exploded in the basement of the candy factory of H. Nuss & Co., Philadelphia, Pa. One man was killed.

(96.) — On February 15, a blowoff pipe failed in the Taylor-Burt Co.'s paper mill, Holyoke, Mass. One man was injured.

(97.) — A section fractured, February 17, in a cast-iron heating boiler in the public library, Salt Lake City, Utah.

(98.) — A boiler exploded, February 17, at Fiborn Quarry, Mackinac county, Mich. One man was killed and seven were injured. The property loss was estimated at $10,000.

(99.) — On February 18 a boiler ruptured in St. Joseph's Retreat, an insane asylum at Dearborn, Mich.

(100.) — A boiler exploded, February 18, at the pumping station of the Hooks Oil Co., at Vinton, La. One man was killed.

(101.) — A boiler exploded, on or about February 18, in a saw-mill near Montreal, P. Q. Three men were killed.

(102.) — On February 19 an accident occurred to a boiler at the hospital of the Congregation of St. Agnes, Fond du Lac, Wis.

(103.) — A flue collapsed, February 20, in a boiler in the Randolph Milling Co.'s flouring mill, Baldwin, Ill.

(104.) — The boiler of a Baltimore & Ohio locomotive exploded, February 20, near Rockville, Md., some twelve miles northwest of Washington. Three men were injured, one of them fatally so.

(105.) — On February 20 several sections fractured in a cast-iron heating boiler in the city hall, Taunton, Mass.

(106.) — On February 20 a tube failed in a boiler at the Southern Lumber & Mfg. Co.'s plant, Nashville, Tenn.

(107.) — The boiler of a Grand Trunk locomotive exploded, February 20, at Ionia, Mich. One person was injured fatally and two others seriously.

(108.) — A tube ruptured, February 20, in a water-tube boiler in the Sparks Milling Co.'s flouring mill at Alton, Ill. One man was injured.

(109.) — A tube ruptured, February 21, in a water-tube boiler at the Southern Iron & Steel Co.'s plant, Alabama City, Ala. (Compare Nos. 40, 43, 71, and 93, above.)

(110.) — On February 21 a tube burst in a water-tube boiler in the Philadelphia Rapid Transit Co.'s power station, Beach and Laurel streets, Philadelphia, Pa.

(111.) — On February 21, a slight accident befell a boiler in the McDermott Oil Co.'s plant, Fairmont, W. Va. One person was killed.

(112.) — A tube ruptured, February 22, in a water-tube boiler in the Grand Rapids Railway Co.'s power station, Grand Rapids, Mich. One man was injured.

(113.) — A boiler exploded, February 22, in the Timpson Lumber Mill, two miles west of Silas, Tex. Two men were fatally injured, two were injured seriously but not fatally, and three others received minor injuries.

(114.) — A small hot water boiler exploded, February 22, in the basement of the Angle Hotel, Decatur, Ill. The owner of the hotel was killed, and his wife was slightly injured.

(115.) — On February 22 five sections of a cast-iron heating boiler fractured in E. J. Hines & Co.'s hotel, Independence, Kans.

(116.) — On February 24 a slight accident befell a boiler in the Cyril Johnson Woolen Co.'s plant, Stafford Springs, Conn.

(117.) — A tube ruptured, February 26, in a water-tube boiler in the Pratt street station of the United Railways & Electric Co., Baltimore, Md. One man was injured.

(118.) — On February 28 the boiler of a locomotive exploded in the vicinity of the Wellington street subway, at Point St. Charles, near Montreal, P. Q. One man was badly hurt.

(119.) — Several sections of a cast-iron heating boiler ruptured, February 28, in the Skelton Publishing Co.'s plant, Salt Lake City, Utah. (Compare No. 81, above.)

(120.) — A boiler exploded, February 28, in the Ideal Steam Laundry at Verona, a suburb of Pittsburg, Pa. Two men were injured, and the property loss was estimated at $10,000. The boiler went high into the air, and in coming down it crashed through two floors of the Zimmerman building, half a block away.

March, 1911.

(121.) — A boiler exploded, March 1, in Capt. Ogden Gandy's lumber mill, at Dennisville, near Ocean City, N. J. Two men were seriously injured.

(122.) — A tube burst, March 1, in a water-tube boiler at the Portland Iron & Steel Co.'s plant, South Portland, Me. Two men were injured.

(123.) — On March 1 an accident occurred to a boiler in one of the power stations of the Philadelphia Rapid Transit Co., Philadelphia, Pa. One man was injured.

(124.) — A boiler exploded, March 3, at a mine at Sligo, Ala. A boy was fatally injured, and two men were injured seriously.

(125.) — A boiler used for operating a wood-cutting outfit exploded, March 3, on the Melvin White farm, near Wyalusing, Bradford county, Pa. Five men were injured, and it was thought that one of them would die.

(126.) — A boiler ruptured, March 4, in the Taylor Chair Co.'s plant, Bedford, Ohio.

(127.) — On March 4 a boiler exploded in the plant of the Atlantic Coast Lumber Co., Georgetown, S. C. Five men were instantly killed and another was fatally injured. The property loss was estimated at $25,000 to $30,000.

(128.) — The boiler of a logging locomotive exploded, March 4, at Estacada, Oregon. Five men were killed and four were injured.

(129.) — A boiler exploded, March 4, in the Blackburn-Gambill distillery, on Howards Creek, Breathitt county, Ky. Three children and a man were killed, and six other persons were injured.

(130.) — A cast-iron hot water heating boiler exploded, March 4, in the basement of Andrew Marelli's restaurant, South Twelfth street, Philadelphia, Pa. The basement was totally wrecked.

(131.) — A tube ruptured, March 5, in a water-tube boiler in the Kimberly-Clark Co.'s paper mill, Appleton, Wis. One man was slightly scalded.

(132.) — On March 6 a tube ruptured in a water-tube boiler in the plant of the Leavenworth Light, Heat & Power Co., Leavenworth, Kans.

(133.) — A blowoff pipe failed, March 6, in the Hamilton Woolen Co.'s plant, Amesbury, Mass. One man was injured.

(134.) — A cast-iron header fractured, March 6, in a water-tube boiler in the power station of the Philadelphia Rapid Transit Co., Thirty-third and Market streets, Philadelphia, Pa. (Compare No. 55, above.)

(135.) — A tube ruptured, March 6, in a water-tube boiler at the plant of the American Locomotive Co., Schenectady, N. Y. One person was injured.

(136.) — A hot water heating boiler exploded, March 9, on a Lehigh Valley transit car, Allentown, Pa.

(137.) — The Russ building, San Francisco, Cal., was destroyed, March 10, by a fire accompanied by a boiler explosion. It is not clear whether the explosion was a consequence of the fire, or its cause. The total property loss was estimated at $125,000.

(138.) — A boiler used for heating water exploded, March 14, in the Y. M. C. A. building at Bloomington, Ill.

(139.) — A boiler ruptured, March 14, in the electric light and water works plant at Downers Grove, Ill.

(140.) — A boiler exploded, March 14, in the Pennsylvania Railroad company's power house at East Altoona, Pa. One man was injured seriously and perhaps fatally. The property loss was probably about $2,000.

(141.) — On March 15 a boiler exploded at John Huffman's coal slope, three miles north of Brazil, Ind. One man was instantly killed.

(142.) — A tube ruptured, March 16, in the Athens State Hospital for the Insane, Athens, Ohio.

(143.) — On March 17 a boiler explosion, followed by a fire, occurred in the D. B. Martin Co.'s fertilizer factory, at the Union Abattoir, Baltimore, Md. One man was killed, and the property loss was estimated at $20,000.

(144.) — On March 20 two corrugated furnaces collapsed in an internally fired boiler at the Lane Cotton Mills, New Orleans, La.

(145.) — On March 20 the shell of a boiler fractured in Pomeroy & Co.'s flouring mill, Barrington, Ill.

(146.) — A small boiler used for heating water exploded, March 21, in the Abercrombie apartment building, on West 165th street, New York City. The basement doors and windows were blown out.

(147.) — A tube ruptured, March 21, in a water-tube boiler in the Crane Co.'s plant, Chicago, Ill.

(148.) — A boiler exploded, March 21, in Lowder's sawmill, five miles south of Albemarle, N. C. The owner of the plant was fatally injured, and several others received minor injuries.

(149.) — On March 22 a section fractured in a cast-iron power boiler in the Lycoming Opera House, Williamsport, Pa.

(150.) — The boiler of a Union Pacific locomotive exploded, March 22, at Cheyenne, Wyo. The fireman was killed.

(151.) — On March 22 a cast-iron section fractured in a heating boiler in a building owned by the Estate of John C. Haynes, Boston, Mass.

(152.) — A tube ruptured, March 23, in a water-tube boiler in the Scranton suburban plant of the American Gas & Electric Co., Scranton, Pa. One man was fatally scalded.

(153.) — A boiler ruptured, March 23, at the coal plant of the Henry C. Clark Estate, Providence, R. I.

(154.) — A boiler exploded, March 24, in the Cobourg Apartments, on Stanley street, Montreal, P. Q. One man was killed.

(155.) — A boiler used for operating a pile driver exploded, March 24, at the new Southern Railway steel bridge, Augusta, Ga. Two men were killed, and two others were seriously injured.

(156.) — On March 25 a tube ruptured in a water-tube boiler in the plant of the Thomas Phillips Paper Co., Akron, Ohio. Two men were injured.

(157.) — A boiler exploded, March 29, in Phillips & Bros.' sawmill, near Campbellsville, Ky. Three men were instantly killed, and another received minor injuries. The mill was destroyed, and part of the wreckage was thrown half a mile.

(158.) — On March 30 a boiler explosion occurred in the Harrison Boiler Works, Philadelphia, Pa. A fireman was injured so badly that he will probably die.

(159.) — A boiler exploded, March 31, in the Rocheport flouring mill, at Rocheport, Mo. Three persons were injured. Fire followed the explosion, and the total loss was estimated at $10,000.

We receive many letters from persons seeking employment in the inspection corps of this company. It sometimes happens that these applications do not receive direct acknowledgment, but they are always filed for future reference. In making such applications our friends would do well to address the nearest department of the company, as their communications would be referred to that department in any event, before any favorable action were taken. A list of our principal offices will be found on the last page of this issue.

Fly-Wheel Explosions.

(1.) — On January 3 a 16-foot fly-wheel exploded in the engine room of the Champion Coated Paper Co.'s plant, at Hamilton, Ohio. One man had his leg crushed. A piece of the wheel weighing over a ton flew through a concrete floor to the roof, passed fifty feet into the air, and finally fell upon a big paper making machine. The floor, roof, and machine were badly damaged.

(2.) — The fly-wheel of an outfit run by horse-power, and used for sawing wood, exploded, January 3, at Nappanee, Ind. One man was badly injured.

(3.) — A 16-foot cast-iron fly-wheel exploded, January 5, in the Lafean paper mill, at York, Pa. The engine was wrecked.

(4.) — On January 9 the fly-wheel of a corn grinding machine exploded in Stark & Plunkett's elevator, at Perry, Mich. One man was injured.

(5.) — A 20-foot fly-wheel exploded, January 9, in the B. B. & R. Knight Co.'s cotton mill, at Manchaug, near Sutton, Mass. The main driving belt broke and the wheel ran away, wrecking the engine room when it burst. Half the roof of the engine house was torn off. One fragment of the wheel, weighing some 1,200 pounds, passed high into the air and came down through the roof of another building, and a second piece, weighing half a ton, came down through the ell of a neighboring gas house. Estimates of the property loss range from $1,000 to $20,000. It very likely was $6,000 or so.

(6.) — On January 11 a fly-wheel burst in the Thompson Roller Mills, Thompsontown, Pa.

(7.) — Two large wheels, one connected with an engine and the other with a water wheel, exploded, January 11, at the plant of the American Ax & Tool Co., East Douglas, Mass. The belt connecting the two wheels broke, and both wheels (as we understand the reports) then ran away. The property loss was probably about $500.

(8.) — On January 16 a fly-wheel exploded in the mill and elevator plant at McKinney, Tex. One section of the wheel, weighing about 1,000 pounds, was thrown through the roof, and landed about 100 feet from its original position. The engine is said to have run away. The property loss was estimated at $3,000.

(9.) — A fly-wheel burst, January 17, in the electric lighting plant at Richmond, Mich. One person was injured, and the plant was wrecked.

(10.) — On January 19 a fly-wheel exploded in the National Casket Co.'s plant, at Louisville, Ky. One person was fatally injured.

(11.) — A fly-wheel exploded, January 20, in the city electric lighting plant at Nelsonville, Ohio. The night engineer of the plant was killed, and the property damage was very heavy. The engine ran away.

(12.) — On January 21 a fly-wheel exploded in the Jackson Veneering Co.'s plant, Jackson, Tenn., as the result of the racing of the engine. One man was injured severely and perhaps fatally, and the north wall of the engine room was torn away. Two or three pieces of the wheel imbedded themselves in the machinery of the sawmill department, after crashing through the walls. Our account says that "the buildings in the immediate vicinity of the engine room looked as though they had been bombarded by a battery of heavy artillery." The property loss was severe.

(13.) — The fly-wheel of an engine belonging to Louis Sapolsky exploded, January 25, at Connellsville, Pa. One person was fatally injured.

(14.) — On January 26 a fly-wheel exploded in the Boott Mills, at Lowell, Mass. The engine to which the wheel belonged was of the cross compound condensing Corliss type, running at 61 to 65 revolutions per minute, and generating about 1,200 horse-power. The fly-wheel carried three 24-inch belts. It is presumed that the governor belt was broken, or forced off by one of the 24-inch belts. At all events the engine raced with disastrous results, and the wheel, in exploding, practically destroyed the engine, the economizer, the smoke flue, and the 14-inch steam main and its branches, besides damaging shafting and looms on five floors. One section of the wheel passed up through the entire five floors and the roof of the building. Other sections were thrown sidewise through the brick walls, penetrating them as though they were paper. The property loss was estimated at $50,000. No one was hurt save a young Greek girl, who received minor injuries.

(15.) — A fly-wheel burst, February 1, in Schrade's cutlery shop, at Walden, N. Y.

(16.) — On February 11 a fly-wheel burst in the Wise Manufacturing Co.'s plant at Watertown, N. Y. The property loss was estimated at $400.

(17.) — A fly-wheel burst, February 20, in B. D. Blake & Co.'s redrying plant, at Springfield, Ky. The wheel was totally destroyed, the rim and spokes all being broken. The property loss was estimated at $1,000.

(18.) — On March 1 a fly-wheel exploded in the trial assembling department of the Buick plant, Flint, Mich.

(19.) — A fly-wheel exploded, March 2, in the plant of the Bromwell Brush & Wire Co., Greensburg, Ind. It appears that the governor belt broke and the engine then raced until the wheel burst. Fragments of the wheel were thrown through the walls of the building, and one large piece was found 500 feet from the engine. Estimates of the property loss ranged from $1,500 to $3,000.

(20.) — On March 3 a fly-wheel belonging to Hodgkinson & Kennelly exploded at Charlotte, Mich.

(21.) — A fly-wheel burst, March 14, in the Belmont bleachery, at Fairview, N. J. One person was severely injured.

(22.) — On March 17 a fly-wheel burst in the rod mill of the steel plant at Pueblo, Colo. Three men were instantly killed, and nine others were injured. The wheel that burst operated a rope drive. It appears that the cable broke, and that the engine then ran away, its governor being presumably damaged by the flying end of the cable. Pieces of the wheel were thrown through the brick walls of the mill. The total property loss was measured by thousands of dollars, although we have seen no exact estimate of it.

(23.) — The fly-wheel of a corn-shredding machine exploded, April 6, at John Ruble's place, near Springbrook, Iowa. Mr. Ruble was seriously injured, one of the spokes of the wheel penetrating his lung.

(24.) — On April 6 a fly-wheel exploded in the Griswold Worsted mill, at Darby, a suburb of Philadelphia, Pa. One young woman was killed, and five other persons were injured. The young woman who was killed was struck by a fragment of the wheel that crashed up through the second floor of the mill. Another fragment took a horizontal course, and tore a hole ten feet in diameter through one of the walls of the engine room. It appears probable that the governor belt broke or became loose.

(25.) — A fly-wheel exploded, April 12, in the power plant of the Richmond Electric Co., at Richmond, Ky. Apparently the engine raced, on account of the failure of the governor to operate properly. The wheel was torn into many pieces, and these were thrown about with great violence. The engine (which was new, and of the Corliss type) was badly damaged, a new generator was seriously injured, and one side of the building was torn out. The property loss was undoubtedly as great as $5,000.

(26.) — On April 17 a shaft governor broke on an automatic slide-valve engine in the plant of the Ludowici Celdon Co., Chicago Heights, Ill. The governor was somewhat similar to the one whose explosion is illustrated elsewhere in the present issue, and the arm broke into three pieces, one of which struck and killed the engineer. The wheel, proper, was not injured.

(27.) — On April 20 a fly-wheel accident occurred in the plant of the Towanda Electric Illuminating Co., Towanda, Pa. (An illustrated account of this accident is given on another page.)

(28.) — A fly-wheel accident occurred, April 26, in the machine shop of Harrison Bros.' paint works, Thirty-fifth street and Gray's Ferry road, Philadelphia, Pa. One man received injuries that were believed to be fatal. We have been unable to obtain further particulars.

Explosion Freaks.

The drag-net that we have out for data for our regular list of boiler explosions occasionally brings us a queer fish. Here is an item from Ida Grove, Iowa: "The oldest daughter of Mrs. Gibelstein was terribly burned about the face and neck by the explosion of a can of water. A molasses can filled with water exploded, and the scalding water and steam burned the little girl severely." We don't know what a molasses can is, but presumably is is something that can be closed up tight with a screw top, and probably it was placed upon a stove to heat the water, and left there too long.

Here is another item from Kenton, Ohio: "John William Exline, 72 years old, is awake after a sleep of thirty years,— just ten years longer than Rip Van Winkle's,— and is face to face with the wonders that science and invention have accomplished since his memory was blasted by a boiler explosion in 1880. Before he received this injury he had thought of the possibility of men flying like birds, and had even discussed the subject with his fellow-workmen, a few moments before the explosion took place. 'We flew *that* day,' says Exline, rather grimly, 'and now they tell me that men can fly without waiting for somebody to blow them up. Oh, I can see I have a great deal to learn.'"

In our explosion lists for 1880 we do not find anybody of the name of Exline mentioned among the injured. Nevertheless, the foregoing item may be truthful, because our list of the names of the injured is not complete. In some cases we merely knew how many were hurt, without knowing who they were.

The Locomotive.

A. D. RISTEEN, PH.D., EDITOR.

HARTFORD, APRIL 25, 1911.

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.

Sulphite Digester Accidents.

The failure of a wood-pulp digester, in a paper mill, is one of the worst forms of accident that we meet with in connection with apparatus carrying pressure. The digester itself is a huge upright cylindrical tank, built of heavy steel plates, and lined with cement and acid-proof brick. It is often big enough to hold fifty cords of wood chips at one filling. In operating it the chips are first introduced, and after the cover-plate has been put on, a solution of bisulphite of lime is run in. Steam is then blown into the mass, and as the pulping process requires an elevated temperature, the pressure that is carried may be moderately heavy. The bisulphite of lime dissolves the gummy matter by which the woody particles are cemented together in the natural tree, and after a time the chips are reduced to a homogeneous mass of loose, disconnected fibres, suitable for the manufacture of paper. Large quantities of sulphur dioxide (the suffocating gas produced by burning sulphur) are also given off by the bisulphite solution at the same time. When this stage of the process has been reached, the contents of the digester are blown off into a cement-lined room, and allowed to drain and cool.

Some years ago a digester of this sort exploded near Bangor, Me., and blew the major portion of the big plant from the face of the earth. These tanks are so large that their contents have a tremendous storage capacity for heat, and the damage wrought when an explosion occurs is correspondingly great.

A blowoff valve ruptured, recently, on a digester in the International Paper Co.'s plant at Fort Edward, near Glens Falls, N. Y., overwhelming the night superintendent of the mills with tons of hot chips, boiling water and chemicals. There was no possible way of rendering him aid. Two other men were also badly injured at the same time.

We recall a similar case at another plant, where a workman apparently fell asleep in the blowoff room. His companions, receiving no response when they called out to know if all was clear, concluded that the room was empty, and discharged the entire contents of a digester upon him. When he was found, later, nothing having any definite form was left of him, save his bones.

The consequences of digester accidents are so terrible that it behooves paper mill operators to exercise every care for their prevention. Among other things, the protective value of good insurance should be considered; for although a cash indemnity will not restore the life of a man who is killed, the inspections that go with the insurance will materially reduce the chance of accident. It should not be forgotten, however, that digester inspection is a highly specialized form of work, and that there are few boiler insurance companies that employ men skilled at it. The Hartford has such men, and it makes inspections of the very highest order.

Calking and Making Repairs under Pressure.

Never do any calking nor make any repairs whatsoever, upon a boiler, or a pipe, or a fitting, that is under pressure!

We have given this counsel over and over again, and we shall keep on giving it until our mortal career is ended; because experience shows that this particular lesson, simple as it is, is hard to learn.

Consider, for example, the accident that occurred some months ago at the Merrimack Woolen Mills, Dracut, Mass. According to the information that we have at hand, "Pierre Pelletier was engaged in calking a joint when the accident occurred. It was in the boiler room in the rear of the big mill, and he was 16 or 18 feet from the floor. He used a hammer in the course of his work, and while hammering a pipe that carried somewhere in the neighborhood of 100 lbs. of steam to the square inch, it blew out at the joint that he was

Before. After.

calking and hurled him with terrific force against a stone wall. His head struck the wall and death was instantaneous. Even though he had not been killed by the fall, he would have died from his scalds." The unfortunate man is survived by a wife and seven children. We reproduce, herewith, two pictures from the Lowell *Sun*, which, though they are but crude newspaper sketches, illustrate graphically the nature of the accident, and may serve to fix the danger of the thing in the mind of the next man who is tempted to try it. The very fact of leakage shows that something is loose or corroded or wrong in some way, and it is the height of folly, while the steam pressure is on, to pound upon the weakened place with a hammer.

Another somewhat similar accident came to our attention in October. In this case two men were engaged in connecting a six-inch steam pipe to an engine.

We have been unable to ascertain the details in full, but it appears that the men were working about the pipe while it was under pressure, and that it suddenly gave way, releasing the steam from three boilers upon them. One of the men was fatally injured, and the other was injured so badly that it was thought to be doubtful if he could live.

In November another case of this kind came to our notice, in which three men were fatally scalded. Our informant says that "it was another case of attempting to make repairs to the pipe while it was under pressure, and was a shining example of things as they ought not to be." "It seems too bad," he continues, "that such accidents can occur in these enlightened times, but in spite of all warning engineers seem to make it a common practice to attempt to tighten joints under pressure, the all too frequent result being that a hurry call is sent out for the undertaker."

In another more recent example a man was killed by a steam pipe failure, and his employers were held to be responsible for his death. Naturally they were reticent, under the circumstances, about giving out particulars; but as nearly as we could learn, the accident was due to the use of some kind of a patent clamp, in an effort to stop a leak at a joint. The joint itself was said to be a bad one, only a few threads on the pipe having engaged in the fitting. It had been leaking considerably, and we understand that the engineer was endeavoring to tighten the bolts on the clamp when the explosion occurred.

In January of the present year an accident apparently due to manipulating a fitting while under pressure occurred in Brooklyn, N. Y. In this case "something went wrong with one of the pipes connected with a boiler, and the foreman with three helpers went down into the basement to repair the damage. He found that there was a leak in the pipe which ran along the floor overhead, and, getting a ladder, he climbed up to make a closer examination. An explosion followed shortly afterward. The sound was heard in the engine room above, and in a few moments clouds of scalding steam were rolling up the stairway. One of the helpers, though badly burned, succeeded in reaching the engine room alone, and the other two were rescued by fellow employees. Steam was shut off from the pipe at the boiler, and the foreman was then found to be dead, on the basement floor. Beside him lay the fragments of a valve that had burst from the pipe."

We should like to say something that would convince every boiler attendant in the land of the grave danger of doing any kind of work upon a pipe or fitting that is under pressure, but if a perusal of such accounts as we have given above will not accomplish this object, we do not know how it can be done. Whenever there is a leakage or a sign of weakness of any kind, the thing to do, of course, is to shut off the steam from the affected pipe or fitting, and investigate the trouble *when the pressure is off.* All too frequently the difficulty is that some pipe thread has not been made to standard, or has not been screwed into place properly. Poor pipe fitting is unfortunately quite common, and leakage at a joint, when it is due to this cause, indicates that there is liability of failure in the ordinary course of events. The stress upon the pipe threads, if the joint is not properly made up, may have caused them to yield a little, so as to allow steam to escape around them. Then a little injudicious hammering, or the application of a pipe wrench or a calking tool, may be like the last straw that broke the camel's back. We dealt with the subject of poor pipe fitting at some length in the issue of The Locomotive for January, 1905, to which the reader is referred for further information along that line.

Never do any calking, nor make any repairs whatsoever, upon a boiler, or a pipe, or a fitting, that is under pressure!

An Engineer for Two Hours.*

Jones, Smith & Co. were extensive manufacturers, who owned and operated a mill in one of the interior towns of this state. Jones and Smith were capitalists, and resided in New York; while Robinson, who was the "Company," lived near by, and superintended the concern's operations.

The mill, a very modest affair when first constructed, had been furnished with two boilers and an engine, of sufficient power for the work that the firm contemplated doing. The needs of their business required additional buildings and machinery from time to time, and at the period of which we write the aggregate horse power required was more than double that used when the mill first started.

The boilers, the engineer said, had been used twelve years when he took charge of them fifteen years before; and now he began to have fears of their safety under the high steam pressure required to do the work, and he often spoke to Mr. Robinson, recommending him to buy new ones or at least to have the old ones thoroughly examined, and repaired if they were worth it. The general reply was, "We must run along awhile yet; can't stop now. We'll think of it. They are good enough for the short time we shall use them." Next year, when business slackened up, Greaser, the engineer, spoke again about new boilers and a new engine, and said it would be a capital time to make the change, while the mill could be idle without loss. But Jones & Smith thought the outlook for business was very bad, and perhaps they might never need the factory again. Anyway, they were opposed to spending so much money just then, when so little was coming in.

Business began to boom in the following fall, and at the mill they were very soon head over ears in work, demanding more and more power, and running overtime. Robinson said it was a pity they did not overhaul when they had a chance, but that they could not help that now. It was no use crying over spilt milk. "Keep her going, Greaser, till we get another chance." And so the years came and went, and the old boilers steamed away, while the wheezy engine squirmed as though it might jump off its bed some day, and walk out in disgust.

The faithful engineer, tired out trying to keep things together, and alarmed for his own safety and for that of his fellow employees, had been talking about a new engine and new boilers so much that he had been voted a nuisance by the firm. They thought he made more fuss than was necessary about what they regarded as a small matter.

About this time certain changes in the market called for a new class of goods, and another line of shafting for some additional machinery was added.

* This sketch originally appeared in the issue of the *American Machinist* for April 22, 1882, where it was credited to "A Traveling Engineer". The real author was Mr. Francis B. Allen, now vice president of the Hartford Steam Boiler Inspection and Insurance Co. The article is reproduced here, because the lesson it contains is still good, and still needed.

Greaser said it was no use trying any longer,—he "might as well give it up first as last." He was pacified for a time. Having a large family, and no other job offering, he concluded to try it a while longer; but his conversation showed he was very much dissatisfied. When this was reported at the office, Smith thought they ought to look out for another man "not so full of old woman's notions." Jones said: "If we employ another regular engineer he will be just as cranky as this one." He was not in favor of paying eighteen dollars a week to such a man for finding fault with their management. "They're all alike," said he. "We'd better get one of our own men and train him for the business as we want it done. I'll ask Robinson if he can't find such a man." Of course it never for a moment occurred to Jones that a man might be *trained* (that is, taught all the firm knew about the duties of an engineer), and still be very lightly equipped.

Robinson agreed with his partners, and thought he had just the man they wanted in the person of Jimmy, who at the time was driving an ox cart, hauling in coal and carrying away ashes. He had been about the fire room a great deal, and had often been ordered to "lend a hand" in helping the engineer. Almost any one could be an engineer, declared Robinson, if he would only keep the fires up, and oil the engine.

Jimmy was approached and offered an increase of pay to twelve dollars a week, if he thought he could run the engine. He thought he could, if he watched around for a week or so. So he was told to post himself in that way, and at the end of the week they would discharge the old engineer and give him the job. For the next few days Jimmy kept his eyes and ears open and did his level best to acquire the needed education, and in due time the engineer was called up, paid off, and told that his services were not wanted there any longer, as they had employed another man in his place. He complained that it was pretty short notice, but obtained no satisfaction; so he picked up his tools and other effects and started off for home, feeling relieved at getting away from the old boilers, but yet sad at the prospect of being out of work.

On Monday morning the new shaft was coupled on, and Jimmy busied himself about the fires and the engine, feeling the importance of his new position. The superintendent — or the "super," as he was more familiarly known — was in and out of the engine room several times, to ask how things were going. He got satisfactory replies, and things certainly were *humming*.

About nine o'clock Robinson came to the mill, and, meeting the "super," asked how Jimmy was getting along.

"Everything is running finely," was the reply. "I never saw shafting run faster. You can see for yourself. And all our work is on."

"Glad I made the change," said Robinson. "We didn't get rid of that other fellow any too soon. Those engineers are always wanting some foolish thing done. If we had satisfied him then, the next thing we knew he would have wanted the boiler fronts nickel plated."

"Sure as you live he would," said the "super."

"Let's go 'round to the engine house," proposed Robinson.

They found that Jimmy had just finished firing one of the furnaces.

"Good morning, Jimmy," said Robinson with a sly wink at the "super;" "this is better than engineering the ox cart, eh?"

"You're right, boss," was Jimmy's reply.

"Any trouble to keep steam?"

"Oh, no; it's as easy as rolling off a log."

"Well, Jimmy, you attend to your business, and we'll do well by you," said the "super," by way of encouragement.

Meanwhile Robinson was looking intently at the water glass, and he now began to try the gage cocks. Finding no signs of water with either, he called out, "Hey, Jimmy, where's your water?"

"I guess it's there," said Jimmy; "I didn't change it any."

"What! haven't you put on your pump this morning?"

"What's that? Pump? I don't know," was the bewildered reply of the whilom ox cart manager.

"Haul your fires; the water's all out of your boilers!" shouted Robinson as he fled from the fire room, the "super" close at his heels. Jimmy, thoroughly demoralized, did not stop to haul any fires, but took to his heels also; and later in the day the boiler makers pronounced the old boilers unfit to repair. Robinson then sent a messenger after Greaser, the former engineer, informing him that his discharge was a mistake, which arose from a misunderstanding on the part of the "super." He was to come back at once, and go right on repairing his engine and other machinery, so that all would be ready when the new boilers were in.

Several of Greaser's friends, engineers at other mills about the town, came around to his house that evening, and all seemed greatly amused at what he told them: — how Jimmy had fired up that morning on less than one gage of water, had followed too literally the injunction of the firm to "keep a good fire and oil his engine," had gone on evaporating water in blissful ignorance, and finally had burned the boilers so badly that they were to be taken out and consigned to the scrap heap. His friends agreed with him that there had been a lucky escape from a bad boiler explosion, and all felt that there might perhaps yet be a chance for experienced engineers who had learned their business in the good old way. Anyhow, so far as can be judged from present indications, it is not likely that there will be another opening for a "trained engineer" about the plant of Jones, Smith & Co. for some time to come.

Don't Touch any Valve Whatsoever!

Every little while there is a serious accident from the careless turning of steam into a boiler in which a man is at work. A man who enters a boiler that forms part of a battery, some of the other units of which are in service at the same time, always takes a chance that some stupid or careless or irresponsible person will scald him to death, and the wonder to us is, that fatal results do not occur oftener.

Not long ago there was an accident of this sort at Akron, Ohio. Our account reads thus: "While John Kabazas, partially stripped, was inside a boiler at the Diamond rubber plant, cleaning it, the engineer turned on the steam and scalded him before his cries were heard. The engineer knew Kabazas had gone inside, but he saw him come out again, and supposed he was through with his work. He had gone back into the boiler however. His flesh is parboiled, and he will not live."

Here is another recent accident of the same general order: "Andrew Gurko was scalded to death, on March 18, at Horatio, four miles from Punxsutawney, Pa. Gurko and William Coy were cleaning a pair of boilers, and Coy, thinking the blowoff pipe connecting the two boilers was closed, turned steam into one boiler. It escaped into the boiler in which Gurko was working, and before it could be turned off, Gurko was dead." Probably the reporter didn't get the details of this accident just right, for it is hard to understand why a man should turn steam into an empty boiler. But whatever the said details may have been, the final result was all the same,— one man was scalded to death by another one opening a valve upon him.

Many other cases, analogous to these, could be given. It will be observed that in each of the instances here cited the man who did the wrong thing "thought" something was so, when it wasn't so at all. It reminds one strongly of the old "didn't-know-it-was loaded" excuse.

The man who goes into a boiler should always notify the engineer in charge of the room that he is about to do so, and after that the engineer should make it his particular personal business to see that no valve whatsoever is touched by anyone until the man who entered the boiler has given formal notice that he is through with his work. This is a very simple and reasonable precaution to take, and its uniform observance would save many lives.

A still safer way would be, for the man entering the boiler to actually *lock* all the valves that could do him any harm, if opened;— unlocking them again upon finally leaving the boiler. This would require inspectors to carry chains and padlocks with them, as locks could not be expected at every plant visited. The lock plan would work very well on globe valves or gate valves, but it would not be easy to apply it effectively to plug cocks on blowoff pipes. We find, moreover, that some men object to using a lock on the ground that it is suggestive of timidity; but we consider that any sentimental objection of this kind, on the part of the man who is risking his life, springs from an unsound and unjustifiable view of the case. The man who puts a lock upon a valve does so because he knows, quite well, that every once in a while somebody gets killed because he didn't do likewise; the lock, therefore, doesn't show timidity — it only shows good horse sense.

Tags, bearing the words "Danger: Do not Touch," are sometimes affixed to the valves in the place of locks. These are good, so far as they go. They afford a considerable amount of protection, but they are less efficient than locks. Many plants employ men who cannot speak or read English, and against these the tag would be ineffective. Moreover, if any employee doesn't have his wits about him enough to remember the man in the boiler without having his intellectuals jogged up by a sign, there is always some doubt about his noticing the tag, or reading what it says.

On the whole, we strongly recommend the use of chains and padlocks; but if the man entering the boiler is unwilling to go to the trouble that they involve, or if he feels the sentimental objection to which we have already referred, and finds it unconquerable, then, as a substitute measure, we recommend the plan first suggested, of making the engineer in charge of the room personally responsible for every valve about the boiler. But it should be remembered that this plan is not absolutely effective, for however good the intentions of said engineer may be, his attention may be temporarily drawn to something else, or he may not see all that is going on, or he may be called from the room for a short time;— and any one of the few moments during which his vigilance is relaxed may be the fatal one.

"Some Boiler Mathematics."

Under this heading we published a problem in the January issue of THE LOCOMOTIVE, promising a solution of it in an early issue. This was the problem:

"A certain boiler had two available sources of feed water, either one of which was quite sufficient to supply all that was needed, under ordinary circumstances. One of the sources was a brook, and the other was a well. Experience showed that when the boiler was running on the brook water alone, it had to be opened and cleaned every eight weeks, while when it was running on the well water alone, it had to be cleaned every three weeks.

"The past summer being an unusually dry one in the locality in question, it was found that neither source would furnish enough water, by itself, to meet the needs of the plant. The two waters were therefore used together, being run into a storage tank in the proportion of 1,600 gallons of the brook water to 900 gallons of the well water. The problem is, to determine, from the data here given, how often it would be necessary to clean the boiler when running with the *mixed* feed."

Now for the solution, which is to be effected thus. First we find out how much solid matter will be thrown down *in one week* by each kind of water, when running *with that kind alone*. Then we find out, for each kind of water separately, how much deposit will be formed, in one week, by the quantity of that particular kind of water that is actually used when running with the mixed feed. By adding the respective quantities of deposit so calculated, we ascertain the total amount of solid matter that will be thrown down by the mixed water in one week, and having found this, we can tell, at once, how many weeks the boiler can run, with the mixed feed, before cleaning is required.

In the original statement of the problem we tried (and we hope with success) to make it plain that the boiler is to be cleaned when the total amount of solid matter that has been formed in it reaches a certain amount. That amount was not given, but it was supposed to be the same in all cases. For example, if the boiler, running with well water alone, has to be cleaned when (say) 800 lbs. of solid matter have accumulated, then it also has to be cleaned when 800 lbs. have been precipitated in either of the other cases,— that is, whether we run with the brook water or with the mixed water. Moreover, the total quantity of water used, per week, is supposed to be the same in all cases.

Now when running with the mixed water, out of every 2,500 gallons that are used, 1,600 are from the brook and 900 are from the well. In other words, 16/25ths of the mixed water come from the brook, and 9/25ths of it come from the well.

If the feed water were *all* taken from the brook, then in one week we should have a deposit equal to ⅛th of the greatest allowable quantity. But when running with the mixed feed, only 16/25ths of the supply is from the brook. Hence, in running one week with mixed water, the quantity of deposit that will be thrown down from that part of the feed that *comes from the brook* will be only 16/25ths of ⅛th of the greatest allowable quantity,— or 2/25ths thereof (since $16/25 \times 1/8 = 16/200 = 2/25$).

Similarly, if all the water were from the well, then in one week we should have a deposit equal to ⅓rd of the greatest allowable quantity. When running with the mixed feed we draw, from the well, only 9/25ths as much water as we do when we are using this water exclusively. Hence in one week of use of the mixed feed, that part of the water that is *drawn from the well* will deposit 9/25ths of 1/3rd of the greatest allowable quantity of solid matter,—or 3/25ths thereof (since $9/25 \times 1/3 = 9/75 = 3/25$).

Hence we see that when we run for one week with the mixed feed, that part of it which comes from the brook will deposit 2/25ths as much sediment as would call for cleaning, and that part of it which comes from the well will deposit 3/25ths as much as would call for cleaning. Together, therefore, the two parts of the mixed water would deposit 2/25ths plus 3/25ths, or 5/25ths (= 1/5th) of the amount of solid matter that would require the boilers to be cleaned. It follows that when running with the mixed water we should have to clean the boiler every five weeks.

Despite the uninviting remarks that we made in our last issue concerning correspondence about this problem, we received quite a number of solutions of it. We were glad to have them, and we looked them all over with interest. The majority were correct, but some of our friends, when they examine this present solution, will see that they didn't quite grasp the principle upon which the thing must be worked out.

An Instructive Boiler Explosion.

In the present article we shall treat of a recent boiler explosion which serves to illustrate the value of inspections, and the importance of attending to the verdict that is given by an expert inspector, when he has looked a boiler over and pronounced judgment upon it.

The boiler that exploded was one of a large battery, and when it gave way it wrecked all of the other boilers save two, and destroyed the boiler house and part of the mill. The total property loss was between $25,000 and $30,000. Several men were also killed. The two boilers that were still left in position had their steam pipes stripped off. Very little damage was done to the big engine, nothing but the governor attachments being injured. The engine room, however, was practically destroyed.

The exploded boiler was of the horizontal tubular type, and was built in three courses. Judging from an examination of the ruins, the initial rupture was at the longitudinal joint of the middle course, the fracture running the entire length of this course, along the calking edge of the plate. The tear then continued around the girth joints at either end of the middle course, the rivets of these girth joints splitting out through the edge of the plate for the most part. The middle course, being thus freed from the rest of the boiler, passed out through the end of the brick power house and landed about fifty feet away from the building, on the outside. Nearly all of the tubes of the boiler were pulled out, but the two end courses of the shell remained attached to their respective heads, and the heads themselves were held together by the through braces.

The exploded boiler was 60 in. in diameter, and by calipering along the fracture of the middle course at a point where no thinning could be detected, the thickness of the plate was found to be $\frac{9}{32}$ in. The rivet holes were $\frac{13}{16}$ in. in diameter, and the longitudinal joints were of the double-riveted lap type, with rivets pitched $2\frac{3}{4}$ in. from center to center. The plates were of iron, and while no stamps could be found, and no tests have been made, so far as we are aware, since the explosion, it is probably fair to assume that the material of the plate had a tensile strength of about 50,000 lbs. per square inch of sectional area.

Calculation will readily show that the longitudinal joint of this boiler is weakest as regards fracture along the ligaments of the plate, between the rivet holes. The length of one such ligament is $2\frac{3}{4}$ in. — $\frac{13}{16}$in. = 2.75 in. — 0.8125 in. = 1.9375 in. Hence the efficiency of the joint, as respects fracture along the ligaments of the joint, is $1.9375 \div 2.75 = 70.45$ per cent.

For the sake of simplicity in the calculation, we may take the efficiency of the joint as an even 70 per cent. Then with the other data as given above, we find the theoretical bursting pressure of the boiler as follows: Bursting pressure $= (50{,}000 \times 0.70 \times \frac{9}{32}) \div 30 = 9{,}844 \div 30 = 328$ lbs. per square inch. At a working pressure of 70 lbs. per square inch this boiler would therefore have a calculated factor of safety of 4.68, whereas at a working pressure of 100 lbs. per square inch (the pressure actually carried) the factor of safety would be only 3.28. The factor of 4.68 is as small as would be justifiable; while the actual factor of 3.28 was altogether too small, and (according to our lights) merely invited the destruction that actually came.

Sir Arthur Conan Doyle, in "The White Company", well says that "It is easy to sit in the sunshine and preach to the man in the shadow." We are going to indulge in a little preaching of this kind, but it is with a full knowledge of the ease of the thing, and our only purpose is to try and prevent a recurrence of certain of the incidents involved in the history of the present case. We are not simply saying "I told you so", but we are pointing out that an expert inspection has a real value, and we are appealing to all boiler owners to bear in mind such lessons as the present case may afford.

Some years ago three boilers that had been bought second-handed were offered to us for inspection, and although our inspector discouraged any consideration of them, the purchasers, who were then insured with the Hartford, insisted upon our making a record of our opinion, and we complied by making out the two following reports. The first covers two of the boilers, and the other one covers the third.

This is the first report:

"Internally: — The inner surfaces are practically clean. The laps of the seams and the flanging of the heads show no fractures nor other defects. The shell plates show some grooving below the water line. Some of the rivet heads on the longitudinal seams are partially gone, but not sufficiently to make it necessary to put in new ones at this time. New braces were being put in at the time of the inspection.

"Externally: — The fire surfaces are free from fire cracks, bulges or other effects of overheating. A new half sheet has been put on the No. 2 boiler, which has not been calked. The manholes in the rear heads are being closed with a patch, and new ones are being put in the top of the shell. The external surfaces are corroded, and the corrosion has thinned the plates considerably, the plates being less than ¼ in. thick in places. The boilers are not worth the repairs being made to them, and if a high pressure is desired, we would advise against their being set. After the repairs are completed, and the boilers are subjected to a hydrostatic pressure of 105 lbs., a pressure of 70 lbs. to the square inch can be allowed for the present."

Here follows the second report:

"Internally: — A light incrustation was noted on the plates and tubes, which is not sufficient to give any trouble at this time. The laps of the seams and the flanges of the heads show no fractures nor other defects. The braces are sound and taut. The shell plates below the tubes have been pitted through in four or five places, and the holes plugged with rivets.

"Externally: — The fire surfaces show no effects of overheating, and the seams and tube ends show no leakage. The three lower rows of tubes are getting thin and should be renewed before the boiler is put into service. We should advise that a fusible plug be placed in the rear head, two inches above the top of the tubes. The flange on the nozzle to the mud drum is entirely gone, and if the mud drum is to be used it will be necessary to put on a new nozzle. A pressure of 70 lbs. to the square inch will be allowed after repairs are completed."

Our position, at the time of the inspections, will be sufficiently clear after perusing the foregoing reports that were made upon the boilers. Nevertheless, the purchasers of the boilers were not satisfied that we were right, and they proceeded to spend very nearly the price of new boilers in fixing up these old ones, and they afterwards set them and connected them with a number of other high-pressure boilers, running the battery at 100 lbs. pressure per square inch. As we would not insure them at this pressure, the insurance was given to another company that was not so critical as to the pressure carried.

One of the old boilers exploded about six months after they were put in service, and now another one has gone up. We are not sure whether the third one is still doing duty, or not. Possibly it was one of those that were destroyed by the present explosion. At all events, the moral of the tale plainly is, that it is foolish to keep a dog and then do your own barking. If the inspector, who knows a lot more about boilers than you do, says your boilers ought not to carry the pressure that you want, you had better listen to him, and govern yourselves accordingly. It pays, in the long run.

How to Make a Locomotive.

Items having a combined theological and mechanical bearing are not very common, but here is one that has been making the rounds of the press, and we are going to add our mite towards its perpetuation. It emanated from Dr. Hiram C. Cortlandt, of Des Moines, Iowa.

"Thomas A. Edison tells us," says the doctor, "that he thinks the soul is not immortal. But, after all, what does this great wizard know about souls? His forte is electricity and machinery, and when he talks of souls he reminds me irresistibly of the young lady who visited the Baldwin Locomotive Works, and then told how a locomotive is made.

"'You pour a lot of sand into a lot of boxes,' she said, 'and you throw old stove-lids and things into a furnace, and then you empty the molten stream into a hole in the sand, and everybody yells and swears. Then you pour it out, and let it cool, and pound it, and then you put it in a thing that bores holes in it. Then you screw it together and paint it, and put steam in it, and it goes splendidly, and they take it to a drafting room and make a blueprint of it.

"'But one thing I forgot — they have to make a boiler. One man gets inside and one gets outside, and they pound frightfully; and then they tie it to the other thing, and you ought to see it go!'"

We don't know how this will strike the Baldwin Locomotive Works, but we guess it will hold Mr. Edison for a while, — if he sees it.

Legislation and Engine Accidents.

Many of the states have factory-inspectors, whose duty it is to inspect factories and call attention to conditions inimical to health and safety. The duties of these inspectors are often laid out with a precision which leaves them little, if any, discretion, and in most cases, beyond calling attention to actual violation of the law, they have no power to enforce their recommendations.

A matter which naturally receives general attention is the placing of guards about moving machinery, the prohibiting of projecting set screws upon revolving shafts, etc. One of the provisions directed at the reduction of injury from accidental entanglement with shafting, or from a machine gone wrong, is the requirement of a clutch upon each floor, by means of which the motive power may be cut off in case of accident. While this may occasionally serve its purpose (although the damage has usually been done before the clutch can be thrown), it has in it the possibility of aggravating trouble and precipitating a catastrophe which might otherwise be averted. If the engine commences to race and the machines to run wild, the natural impulse of somebody on every floor will be to throw the clutch, taking the load off from the engine and aiding it in its race to destruction. The fragments of a big fly-wheel plowing their way through the several floors may be the result.

A much more logical and safer arrangement is a number of reliable circuit closers or other devices conveniently distributed throughout the building, by the use of which the engine may be shut down in case of accident. The mechanism by which this is effected may be, and usually is, arranged to be operated automatically by a device attached to the engine itself, and independent of the governor in case the speed increases beyond a fixed limit.

In some of the states, automatic engine stops are required by law, but the law is not always sufficiently explicit to require an engine stop in the true sense. It might be maintained, for instance, that the usual safety-cams on a Corliss engine constitute an "automatic engine stop," preventing, as they do, the hooking on of the valves and the admission of steam when the govenor balls fall below a certain plane. But this is really a part of — an attachment to — the primary governor, and subject to derangement with that governor. If the governor belt breaks and the balls drop, it will act; but if the belt slips, so that the governor runs slowly enough to permit a late cut-off, but not so slowly as to bring the safety-cams into play, there may be an accident. It is a too common practice, moreover, to leave in place, while the engine is running, the pin which holds the safety-cams out of action while starting up, although most modern engines are fitted with latches which automatically drop out of the way when the governor collar rises away from them.

A rider upon the governor belt, arranged in any of the usual ways to shut off the steam when the belt breaks and the rider falls, might be construed as satisfying the requirements of the law; but it is far from a positive safeguard.

The law should require specifically, and every provident engine owner should install whether the law requires it or not, a device entirely independent of the main governor, which will positively cut off the supply of steam when the speed becomes excessive. The danger in a mass of swiftly rotating metal is very real, and destructive explosions of fly-wheels are not uncommon. Such an explosion may be far-reaching in its effects. The fragments of a wheel fly for hundreds of feet, and are ugly and destructive missiles. Persons who live and pass near industrial establishments, as well as those who are obliged to spend their working hours within the range of fly-wheels, should have the assurance that something more than a two-inch belt and a fallible ball governor stands between them and eternity.—*Power.*

The explosion of a kitchen range boiler at Racine, Wis., early in January, has brought about some legal complications. Mr. and Mrs. Joseph Kadowsky were killed by the explosion, and it is important to determine which one of them died first. This problem will have to come up before the court that is charged with the disposition of the Kadowsky estate, valued at $8,000. Each of the victims had been married before, and each left children from the earlier marriage. The two sets of children cannot agree, and the court's decision will probably turn upon which of the parents lived the longer. Even though the survival was but a fraction of a minute, it would suffice to determine the course of the inheritance.

A Few Home-Office Confidences.

Some time ago we received the following letter from a corporation that had a sort of lukewarm desire to insure its boilers, if the thing could be done without any great trouble:

"Our experience in the past with boiler insurance people and their boiler inspectors has been anything but satisfactory. At the beginning of the policy the inspectors are reasonable. On one occasion, however, we purchased a three-year policy, and some six or eight months ago an inspector was here and undertook to impose such unreasonable and unnecessary repairs and work on our boilers and furnaces that we refused to do the work and had the policy cancelled.

"We should like to carry insurance on our boilers if your inspectors will be men of common sense and reason, and provided also that all internal inspections can be made at a time that will not interfere with the operation of our plant. This can seldom be done when the plant is closed down, for the reason that we never close except on Sundays, or in the event of an accident.

Accidents are very unusual that will close us down for more than one day at a time, and in such cases we could not give you sufficient notice to have an inspector here. We have found it troublesome to have the manholes opened and closed on Sundays, as our men are not required to do work on Sunday except when it is absolutely necessary. We should not object to your making an internal inspection then, however, provided your men would remove the manhole plates and put them back again in time to fire up the boilers by midnight Sunday night. We have never had any insurance with your company, and therefore we know nothing of your manner of inspecting, nor of your general business methods. We shall be glad to hear from you with reference to same, unless you would prefer to send a man to see our plant and talk the matter over. This would probably be more satisfactory."

Here is a letter that came from a man who was about to insure his boiler. It is brief, but it bears a tale of hard luck:

"Yours received. Sorry to say we shall not need to have the boiler inspected, as the mill is burned and the boiler blown up. Didn't leave enough to inspect."

Here is something from a discouraged manufacturer in Tennessee, in response to a request from us for a date for inspection:

"Replying to your letter of the 16th in regard to coming here to inspect our boiler, I would say that we are not going to run our plant this season, and hence the inspection will not be necessary. From our experience it would seem that we, the stockholders, are the ones that need inspection, rather than the boiler; for we are certainly in danger of bustin', on account of the low prices of the products we make. If we run next season we will take up the matter of inspection then."

Here, again, is an extract from a report that we recently made upon a boiler that was in use in a hotel:

"All parts of the boiler are heavily coated, internally, with scale, and the fire sheets, in particular, are heavily coated with loose scale and mud. The tubes and shell are extremely corroded and pitted; the braces are tight, but they are small and poorly designed. The side seams are also poorly designed, and they are below the top tubes, and nearly inaccessible for inspection. From the condition in which we found the boiler we doubt if the manhole covers have been removed since the boiler was installed. Among the things that we found inside the boiler was a box containing a water-column with gage cocks and glass fittings, a steam gage, and two pieces of pipe.* These fittings were evidently in the boiler when it was shipped from . . . . three years ago, and had not been removed. The boiler is about twenty years old, and of poor design. Externally, the shell plates and tube ends are corroded and thin, and several of the tubes are leaking. As the boiler is practically worthless for any useful pressure, we advise that it be thrown out and a new one installed in its place." We can't help wondering whether or not the writer of the first letter quoted above would consider this report to be "unreasonable." Probably he would think it is conservative and excellent in all respects, if he were stopping at the hotel where the boiler was in use.

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* This reads as though the thing inspected was a *museum* instead of a boiler.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1911.

Capital Stock, . . . $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission,	$174,137.52
Premiums in course of collection,	209,440.08
Real estate,	91,400.00
Loaned on bond and mortgage,	1,140,810.00
Stocks and bonds, market value,	3,180,527.72
Interest accrued,	71,231.96
Total Assets,	$4,867,547.28

LIABILITIES.

Premium Reserve,		$2,010,733.76
Losses unadjusted,		130,809.04
Commissions and brokerage,		41,888.01
Other liabilities (taxes accrued, etc.),		45,149.16
Capital Stock,	$1,000,000.00	
Surplus over all liabilities,	1,638,967.31	
Surplus as regards Policy-holders,	**$2,638,967.31**	2,638,967.31
Total Liabilities,		$4,867,547.28

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The Hartford Steam Boiler Inspection and Insurance Company

ISSUES POLICIES OF INSURANCE COVERING

ALL LOSS OF PROPERTY

AS WELL AS DAMAGE RESULTING FROM

LOSS OF LIFE AND PERSONAL INJURIES DUE TO EXPLOSIONS OF STEAM BOILERS OR FLY WHEELS.

Full information concerning the Company's Operations can be obtained at any of its Agencies.

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The Locomotive

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SUGGESTIONS

For the Management and Care of

STEAM BOILERS

Used for Power Purposes, and Insured by The Hartford Steam Boiler Inspection and Insurance Company.

I.

Water Level. The first duty of the attendant, upon entering the boiler room in the morning, is to find out where the water level is in the boilers. ☞ *Never unbank nor replenish the fires until this is done.* Neglect of this precaution has caused many accidents, and ruined many boilers.

If there are valves on the pipes connecting the water-column with the boiler, make sure that they are open. Then open the mud valve at the bottom of the water-column, letting the water blow out freely for about one minute, so that the column may be thoroughly flushed. Then close this valve and open the pet cock at the bottom of the glass gage, letting water and steam blow out for some time, so that the gage connections may be well flushed. Blow out the column and the glass in this way, alternately, several times, to make sure that everything is in good order. See that the water returns to the glass gage freely. The entire operation here described should be repeated several times a day, or on each shift of the attendants.

See that there are no steam leaks from the upper part of the water column, nor in any of the piping between the gage glass and the boiler. Such leaks cause the water in the glass to stand at a false level, so as to indicate more water in the boiler than is actually present. For the same reason it is bad practice to draw steam from any part of the water column or its connections, for operating tube cleaners or injectors, or for any other purpose for which an actual flow of steam is required. The steam gage may properly be attached to the water column, however, because it does not call for such flow.

☞ Do not rely entirely upon the gage glass for determining the level of the water in the boiler. The gage cocks are there to verify the indications of the glass, and they should be used for that purpose, regularly. Try all of these cocks several times a day, to make sure they are clear and in good working order, and that their indications agree with those of the glass gage.

Keep the water in the boiler at as even a level as possible, at all times. Keep the glass gage clean, so that the position of the water in it can always be plainly seen. Have the glass gage and the steam gage well lighted, so that there can be no difficulty in reading their indications.

See also suggestion No. 8, below.

2.

Leaks

After having assured himself that the boilers contain plenty of water, and that the appliances for showing the position of the water level are in good order, the attendant, before starting up his fires, should open each door about the settings, and carefully look for leaks at every visible point. He should note particularly if there are any leaks about the tubes in the combustion chambers, or (if the boilers are of the water-tube type) around the tube ends or the covers of the openings on the headers, front and rear.

When leaks are discovered (whether it be before starting up the fires, or later, in the regular operation of the boiler) they should be located and repaired as soon as possible. (Give par- ☞ ticular attention, however, to the caution expressed in suggestion No. 9, warning against setting up bolts and nuts, calking, and making other changes and repairs while the boiler or pipe is *under pressure.*)

In water-tube boilers having cast-iron mud drums, if leakage appears at the mud drum ends of nipples entering the headers, the nipples should be removed and the drums thoroughly examined for cracks.

If leaking occurs at any time at the longitudinal (or fore-and-aft) seams, the boiler should be put out of service at once, and the HARTFORD STEAM BOILER company should be promptly notified, at its nearest office. (The addresses of its chief offices are given on the last page of this issue of The Locomotive.) *This is highly* ☞ *important*, whether the attendant considers the leakage to be serious or not; and it is *especially important* when the boiler has a single bottom sheet, or is of the two-sheet type.

3.

Filling up the Boiler.

When a boiler has been emptied of water, it should not be filled again until it has become cold. Cold water, when pumped into hot boilers, causes contraction strains that are very injurious.

4.

Tight Joints and Good Gaskets.

In preparing to get up steam after a boiler has been out of service, great care should be exercised in making the manhole and handhole joints tight.

Never use lead gaskets after they have become thin and hard, and avoid all gaskets of other metals, unless they are corrugated or soft and pliable. It is difficult to make a tight joint when using a hard gasket, without setting up the cover-plate bolt with great force. Bolts and cover-plates are often cracked by the severe strain thus thrown upon them.

5.

Getting up Steam.

First of all, the boiler should be vented in some way, to permit the escape of air. For this purpose the steam space may be put in free communication with the atmosphere by any convenient method. Opening the upper gage cock is sufficient, unless the bore of this cock is unusually small.

Water should next be run (or pumped) into the boiler, until it stands at the proper level. Special care should be exercised with regard to this point, because boilers are often fired up while empty, and thereby ruined. If the water column is correctly located upon the boiler, it is sufficient to bring the water level to a point just above the second gage.

Fuel may then be placed upon the grate, the damper opened, and the fire started. If the chimney or stack is cold and does not draw properly, the trouble may be remedied by burning some oily waste or light kindlings inside of the chimney, at the base. Start the fires in ample time, so that it will not be necessary to urge them unduly, in order to have the pressure up at the required hour. When steam issues from the vent opening, close this opening, and thereafter pay strict attention to the steam gage. If the boiler that is being fired up is to be cut in with others that are already under steam, pay careful attention to suggestion No. 7, below.

6.

Gas or Oil Fuel.

When gas or oil is used as fuel, care should be taken to adjust the burners so that the flame cannot impinge directly upon the heating surfaces. Checker-work, when used in such furnaces, must also be arranged so that it will not concentrate the flame upon the boiler surfaces. Suitable peep-holes should be provided for observing the fire surfaces during the operation of the boiler. When the settings or the flues running to the chimneys have blind pockets or spaces where gas can accumulate, suitable vent openings should be provided at the highest points of these pockets, to permit the gas to escape from them. In firing up a boiler with oil or gas, it is very important that steam be raised slowly: — that is, no faster than would be possible when using coal as fuel. Serious damage may otherwise be done.

In using gas or oil fuel, the greatest caution should be observed, before lighting the fire, to see that the drafts are open for a sufficient length of time to remove any gas that may have accumulated in the setting. Never turn on the fuel supply when starting up, nor after the snapping out of a burner, without first introducing a lighted torch, or a piece of burning waste, into the furnace. Disregard of these precautions is likely to result in a serious accident.

7.

Cutting In.

When a boiler is fired up after having been out of service for a time, extreme care should be taken in cutting this boiler in with others that are already in service, and communicating with the same steam main. It is a more or less common (though highly dangerous) practice, to cut in the boiler as soon as the pressure upon it comes within (say) ten or fifteen pounds of that prevailing in the steam main at the time. *This should never be done.* Many fearful explosions have resulted from management of this kind. In cutting in a boiler with others, it is of exceeding importance to be sure that the pressure upon it is *as nearly identical as possible* with the pressure that is prevailing, at the time, in the steam main. When the equality is judged to be exact, the stop-valve of the boiler that is to be cut in should be opened very carefully indeed,— opened just a bare crack at first, and then, as the slight outstanding difference of pressure equalizes itself, opened wider, very slowly, until it is open full. The complete operation should occupy a couple of minutes or more, and the attendant should hold himself in readiness, at every instant, to close the valve at once, if there is the slightest evidence of any unusual jar or disturbance of any kind, about the boiler.

Correctly designed steam pipe lines will not have pockets in which water of condensation can be trapped. If any such pockets exist, they must be provided with drain-pipes, and all condensed water must be removed from the piping by means of these drain pipes, before cutting in the boiler. Neglect of this precaution is likely to lead to water-hammer action, which may destroy the boiler, and perhaps the whole plant.

8.

Low Water.

In case of low water at any time, immediately cover the fire with ashes, or, if no ashes are at hand, use fresh coal. Close the damper and the ash-pit doors, and leave the fire doors open. If oil or gas is used as fuel, shut off the supply from the burners. Don't turn on the feed under any circumstances, and don't open the safety valve nor tamper with it in any way. Let the steam outlets remain as they are. Get your boiler cool before you do anything else.

See also suggestion No. 1, above.

9.

Repairs under Pressure.

No repairs of any kind should be made, either to boilers or to piping, while the part upon which the work is to be done is under pressure. This applies to the calking of pipes and joints, to setting up nuts and bolts, and to every other operation by which extra stress is thrown upon any part that is already under a steam load. Accidents of the most serious nature are common, from neglecting this caution.

Many water-tube boilers have their tube-holes covered by outside caps or plates,— that is, caps so fitted that the boiler pressure is exerted upon the bolts that hold the caps. If leakage should occur around such joints, do not screw up the bolts while the boiler is under pressure, and do not, under any circumstances, bring an undue strain upon the bolts, in order to stop the leakage. When the pressure is off, find out why the joint cannot be kept tight with a suitable tension on the bolt, and apply the proper remedy. The bolt itself may be faulty, and by tightening it beyond reason you may be merely aggravating the trouble, and you may bring about a failure that will result in loss of life or in serious personal injury. Similar caution should be used in manipulating the blowoff valve. If it does not open easily, do not exert unreasonable force upon it, but when the pressure is off, find out what the trouble is, and have it remedied.

10.

Care of Safety-Valves.

The safety-valve must not be set, upon any boiler, to blow at a pressure higher than that permitted by the HARTFORD STEAM BOILER company. The attendant should ascertain, from his employer, the limiting pressure permitted on each boiler, and should make a written memorandum of this limit, in order to avoid possibility of error with respect to it.

Try all safety valves cautiously, every day, easing them gently from their seats, until it becomes evident that they are free. Otherwise they are liable to stick, and thus become useless for the purpose for which they are intended. As a further test of the condition of the safety valve, it is well, under ordinary conditions, to run the pressure up, every day, to the point at which the valve is supposed to blow, and see that it does blow at this pressure. When the regular working pressure is a good many pounds lower than the blowing point, however, it is better to run up the pressure less frequently, though the valve should still be tried in this way often enough to make sure that it is always in good working order, and that it agrees with the gage. In case the actual blowing pressure as shown by the gage exceeds the pressure at which the valve is supposed to blow, inform your employer immediately, so that notice may be sent to the HARTFORD STEAM BOILER company promptly, at its nearest office. (The addresses of the HARTFORD'S principal offices are given on the last page of this issue of THE LOCOMOTIVE.)

The outlet of each safety-valve should everywhere have a diameter at least equal to the diameter of the discharge opening in the casing of the valve. There should be no attachment upon the safety-valve outlet, except the valve itself. In particular, there must be no stop-valve in the safety-valve pipe, between the safety-valve and the boiler, nor on the other side of the valve. The discharge pipe of the valve should preferably pass out of the boiler room horizontally, or with a slight downward inclination. Vertical discharge pipes, passing up through the roof, are objectionable unless thoroughly drained, because they will accumulate water of condensation in case the valve leaks.

11.

Use of Scale Solvents.

Soda ash is widely used as a scale solvent, when the feed water is hard enough to make a troublesome deposit of scale. It is effective under most circumstances, and it has the advantage of being cheap. The amount required will vary according to the nature of the feed water and the duty required of the boiler. If the water is of average quality, and the boiler to be treated is of the horizontal tubular type, 72 inches in diameter and with tubes 18 feet long, ten pounds of soda ash may be introduced at the start, when the boiler is first filled up, and after that two or three pounds may be introduced each day. The same amount may be tried in boilers of other types, but of like capacity. This suggestion is made for the guidance of those inexperienced in the use of soda ash, and it should be understood that the actual amount of solvent required is to be found by trial. If the water is bad and deposits an unusual amount of scale, the quantity of soda ash used should be greater than the estimate here given; and if it is unusually soft and pure, a correspondingly smaller quantity may be sufficient.

The soda ash should be dissolved before it is introduced into the boiler; and when badly scaled boilers are treated with soda ash, or with any other scale solvent, they must be frequently opened and cleaned, to avoid burning of the fire surfaces from the lodgment of fragments of loose scale upon them. (See suggestion No. 22.)

12.

Routine Use of the Blowoff.

The blowoff pipe is highly useful in the regular operation of the boiler, especially when the feed water carries a considerable amount of sediment, because it enables the attendant to remove large quantities of deposit without opening the boiler. In using it for this purpose, the blowoff should be opened in the morning, before steam is raised, and before the fires have been started up. The water having stopped circulating during the night, a considerable amount of sediment will have settled at the bottom of the boiler, and much of this will be removed if the blowoff is opened before the circulation has started up again. If the boiler is used night and day, the blowing should be done at the end of the noon hour, or at some similar time, when the sediment has had a reasonable chance to settle.

The blowoff valve should be opened and closed *gradually*, in order to avoid the violent shocks that are almost certain to be produced by opening or closing it suddenly. But when it is opened, it should be opened wide, if only for a few moments. This will give any fragments of scale that may have lodged in the pipe an opportunity of passing out through the blowoff valve. They might be trapped by it and retained in the pipe, if the valve were only partially opened.

In general, boilers should be blown down at least one gage daily, though no fixed recommendation can be made in this respect, that will apply to all the widely varying conditions of water and of duty required of the boilers. When the water is bad, and the duty of the boiler is heavy, the blowoff should be opened oftener than is necessary under more favorable conditions. When the feed water carries a large amount of scale-forming matter and considerable quantities of scale solvent are used, blowing should be frequent, fresh water being fed into the boiler to take the place of that so removed. This tends to prevent the water in the boiler from becoming unduly saturated with dissolved solid matter. Under any circumstances, however, the blowoff valve should be opened at least once a day, sufficiently to thoroughly flush out the blowoff pipe. Upon closing the blowoff valve, see that it shuts tight. If it is held partially open by the lodgment of some foreign substance upon its seat, the water in the boiler may quickly become low. If the blowoff pipe is so situated that there is a possibility of its discharge injuring passers-by, or children playing about, see that nobody is near it when the valve is opened. (Compare, also, suggestion No. 21, and the latter part of No. 9.)

When surface blowoffs are used, they should be opened often, for a few moments at a time.

13.

Foaming.

If foaming is observed, check the draft and cover the fires with fresh coal (or shut off the burners, if oil or gas is used as fuel). Then close the throttle and keep it closed long enough to show the true level of the water. If that level is sufficiently high to permit doing so, blow down some of the water in the boiler, and feed in some fresh water, repeating the operation several times, if necessary. If this does not remedy the trouble, draw the fires and blow and feed alternately. When the boiler and the brickwork are sufficiently cool, empty the boiler and wash it out, ascertain the cause of the foaming, and take such measures as may be necessary to prevent its recurrence.

14.

Oil in Boilers.

Care should be taken to prevent cylinder oil from entering the boilers with the feed water. It is very likely to get in from the exhaust of the engines, pumps, etc., when open feed-water heaters are used, and hundreds of boilers are ruined every year by lack of proper caution in this respect. Even a thin coating of cylinder oil (or other non-volatile or "heavy" oil) on the tubes or drums or shell sheets may cause serious damage, and lead to extensive repairs. Oil showing in the glass gage indicates oil in the boiler, and yet the attendant must not rely upon its showing itself in this way, because oil is often present in the boiler in large amounts, when none is to be seen in the glass.

When a horizontal tubular boiler is badly affected with cylinder oil, it may be treated in either of two ways:—(1) by the direct removal of the deposit by scraping and scrubbing, or (2) by "boiling out" the boiler with kerosene and soda ash. A combination of these two methods is useful in particularly bad cases.

In attacking the deposit directly, the handhole plates should be removed (or the manhole cover on the front head, if there be one), and the shell and all other accessible surfaces thoroughly scraped, and then scrubbed vigorously with a stiff brush attached to the end of a pole, and wet with kerosene. The boiler should also be entered from above, and the oil scum that has collected upon the side sheets about the water line scraped and scrubbed off in like manner. Thorough washing and ventilation of the boiler should follow. Oily deposits may be removed from the tubes of water-tube boilers by the use of a swab dipped in kerosene.

The method indicated above will remove considerable quantities of the oily deposit, but more or less of it will be lodged where it can be reached only by the "boiling out" process. To apply this process, put the boiler out of service, close its outlets, and fill it to the top of the gage glass (in order that the oily scum just above the normal water line may be covered) with water in which from 100 to 175 pounds of soda ash have been dissolved, and to which from 10 to 25 gallons of kerosene have been added. The boiler being of the horizontal tubular type, 100 pounds of soda ash and 10 gallons of kerosene may be used, if it is 60 inches in diameter with 18-foot tubes, and 175 pounds of soda ash and 25 gallons of kerosene if it is 72 inches in diameter and has 20-foot tubes. The proper quantities for use in horizontal tubular boilers of other sizes will vary with the capacities of the boilers, and may be estimated with sufficient accuracy from the data here given. If the boiler to be treated is of a different type,— for example, if it is of the water-tube type,— the quantities used should be the same as would be employed in a horizontal tubular boiler of similar horse-power. When the boiler has been filled as indicated, build a light fire under it (*all its outlets being closed*), and carry a low pressure (ten pounds per square inch or thereabouts) upon it for not less than 12 to 24 hours. If time will permit, it is better to continue the boiling for two or three days. Then run off the water, ventilate the boiler well, and wash it out thoroughly with a strong stream of water.

☞ When treating a boiler with kerosene, keep all open lights away from the handhole and manhole openings, both *when applying the kerosene and upon opening up the boiler again.* If strict attention is not paid to this point, serious vapor explosions may result. If incandescent electric lamps are not available, sufficient light for examining the internal condition of the boiler may be had by reflection from a mirror held at some distance (several feet) from the openings. A second, smaller mirror may be used inside the boiler, when necessary, to direct the light into the dark corners.

Distilled (or pure) water is a valuable scale solvent, and if the feed carries much scale-forming matter, it is well to recover a large amount of water of condensation for use in feeding, when it is practicable to do so. In putting this plan into practice it may be necessary to use serviceable oil separators and filters to remove the oil from the exhaust steam, and render the condensed water fit for use; and in such cases *all* the steam that is to be condensed for use as feed water should go through the separator, whether it comes from the engines or from pumps or other auxiliary devices.

15.

Blisters, Bulges, and Laminations. When a blister, bulge, or lamination appears, it should be carefully examined at once, and its exact nature determined. Small blisters are usually unimportant, calling for no special treatment except trimming; but an extensive lamination should receive such attention as its condition demands. A bulge usually indicates the presence of scale or oil inside of the boiler at the affected region, and any such coating or deposit should be removed before the boiler is again used. If a bulge appears upon a tube in a water-tube boiler, it is best to replace the tube as soon as possible, if the trouble is at all serious. Otherwise the bulge forms a lodging place for scale and sediment and is likely to give further trouble, because the tube cleaner will pass over the depression without removing the deposit that it contains.

16.

Suspended Boilers. When a boiler is suspended from overhead beams, see that each of the hanger bolts is kept drawn to a proper tension, so that each will carry its own fair share of the weight. To maintain this equality of tension it will probably be necessary to set up or slacken certain of the nuts on the suspension bolts from time to time.

In suspended water-tube boilers, see that the lower drums and boxes are free from contact with the floor of the setting, or with any other obstruction that may interfere with their free motion, as the boilers expand and contract in service. Otherwise, severe strains will be thrown upon the drums and their connecting nipples. The drums may have been correctly hung when the boilers were installed, and may have come in contact with the setting subsequently, through the settling of the supporting columns. Such settling should be detected as soon as it occurs. If it is slight in amount its effects may be neutralized by setting up the nuts on the suspension bolts, so as to raise the boiler again to its proper position.

17.

Fusible Plugs. Fusible plugs are often used in boilers, and in some states and cities they are required by law. In a horizontal tubular boiler the plug, when used, should be screwed into the back head, not less than two inches above the top of the highest tube. In any type of boiler they should be so placed that they will melt out, under the influence of the heated gases, before the water line has reached a dangerous low level. In a boiler of the locomotive type the fusible plug should be inserted in the crown sheet. In water-tube boilers having horizontal steam drums exposed to the heat of the fire, the plugs should be inserted in these drums at their hottest parts, and at least six inches (measured in a vertical direction) higher than their lowest points.

In the vertical tubular boiler it is a somewhat common practice to insert the fusible plug in the crown sheet. When properly set, such a plug will usually afford sufficient protection to the crown sheet in case the water becomes low, although the tubes (since they will then become uncovered throughout their entire length before the plug melts) may become hot enough to warp and make trouble. The HARTFORD STEAM BOILER company recommends that in the ordinary vertical tubular boiler the fusible plug be screwed into one of the outer tubes, as is required in marine practice by the United States Board of Supervising Inspectors. A handhole must then be cut in the shell opposite the plug, so it can readily be inserted, examined, and replaced; and the tube in which the plug is inserted should preferably be an extra-heavy one, so that the threaded joint between tube and plug may be made tight. When located in a tube, the plug should be *at least* one-fourth of the length of the tube above the crown sheet, and some authorities require it to be above the *lower third* of the tube. In a vertical tubular boiler having a *submerged upper head,* the plug should be inserted in the upper head.

Fusible plugs should always project into the water space of the boiler by three-quarters of an inch or more, and they should be filled with *pure tin.* Alloys are objectionable, because their melting points are liable to change upon prolonged exposure to heat. The fusible plug should be renewed or refilled every year, or as often as may be necessary in order to keep it in good, effective condition.

18.

Removing Ashes.

Ashes should not be allowed to accumulate in the ash-pit, because they obstruct the flow of air and check the radiation of heat, and so lead to the burning out of the grate bars. The combustion chamber back of the bridge wall of a horizontal tubular boiler should be kept clean at all times, since a heavy accumulation of ash in this space tends to choke the draft and prevent proper combustion, and so cuts down the efficiency of the boiler. When the blow-off pipe runs along the floor of the combustion chamber, many engineers consider it to be good practice to leave a light layer of ashes over the pipe for its better protection. We advise keeping the chamber well swept out, however. If protection is wanted for the pipe, lay a small brick channel for it, and use loose bricks for the covering-layer, so the pipe can be readily examined.

19.

Banking the Fires.

The fires should be cleaned previously to banking, and a good body of coals should be returned and pushed back against the bridge wall, and well covered with fresh coal. The ash-pit doors should be closed. The damper should also be nearly closed, but it must not be shut absolutely tight at any time when fresh coal has been placed on the fires, because coal gas would then collect in the combustion chamber and the other passages, and its sudden ignition will give rise to an explosion that will endanger the brick work, and perhaps lead to consequences even more serious. Many dampers are loosely fitted, to make it impossible to close them perfectly tight. The fire doors should be opened by a slight amount, so that air may enter to sweep out the coal gas. Leaving the fire doors *wide* open, however, is liable to strain the boiler by the contraction caused by the cold air striking the heated shell, and leakage at the joints is likely to result. *Be particular to see that the ash-pit doors are closed tight, and the dampers properly adjusted.*

20.

Cooling Off

In cooling a boiler preparatory to emptying it, first let the fire die out, and then close all doors and leave the damper open, until the steam gage shows that the pressure has fallen to the value at which it is proposed to blow off. (See suggestion No. 21, on this point.) Clean the furnace of all coal and ashes, and allow the brickwork to cool down for at least two hours before opening the blowoff valve. When it is desired to make the boiler ready for a man to enter it, first cool it as here indicated, and then, after the water has been drawn off, leave the boiler as it would be if it were in service,—the fire doors, the front connection doors, and the cleaning door or doors in the setting being closed, while the damper and the ash-pit doors are left wide open. By this means a good circulation of air is drawn through the setting, around the boiler, and through the tubes, and the cooling proceeds rapidly and effectively. If it is found that this procedure interferes too much with the draft of other boilers that are still in operation in connection with the same stack, check the flow of cold air as much as may be necessary, by partially closing the damper on the boiler that is being cooled. Many engineers, in attempting to cool boilers for entering them, open the front connection doors. This *retards* the cooling, however, because it prevents a proper circulation of cold air through the boiler, and heated air collects in all the high parts of the setting and passes out only very slowly.

21.

Emptying the Boiler.

When it is desired to empty the boiler, the boiler and its setting should first be cooled in the way explained in the first part of suggestion No. 20. A pressure exceeding ten or fifteen pounds per square inch, by the gage, should not be allowed when boilers are blown out. If they are emptied under a much greater pressure than this, the heat that is retained by the setting walls will subsequently cause the deposit in the boiler to bake into a needlessly solid incrustation upon the sheets and tubes. It is better to run the water out practically without pressure, when it is feasible to do so. The scale and deposit can then be washed out much more easily. The manhole plates and the covers to the other openings should be removed immediately after the boiler is empty. When the boiler that is to be emptied is one of a battery, care should be taken to *open the proper blowoff valve;* for if the wrong valve is opened, and the water is drawn off from a boiler having a fire under it, the sheets may become badly burned, or an explosion may result, before the mistake is discovered. (Compare, also, suggestion No. 12, and the latter part of No. 9.)

22.

Removing Deposit and Sediment.

The accumulation of scale and other forms of deposit in a boiler interferes with the economical generation of steam, and it is also likely to give rise to overheating of the boiler, with consequent burning, distortion, or cracking of the metal. Hence the boiler should be opened as often as may be necessary, for examination and cleaning. The frequency with which a boiler should be opened varies widely with the nature of the feed water and the duty required of the boiler. When the duty is heavy and the water contains a considerable amount of scale matter, it may be necessary to open the boiler and clean it every week. On the other hand, some plants are fortunate enough to have feed water so soft and pure that cleaning once in three or four months is sufficient. The engineer should carefully watch the internal condition of his boilers, and determine for himself how often he will have to open them up and clean them, in order to keep them in proper condition. When kerosene has been introduced for loosening up scale, or when a large amount of scale solvent of any kind has been used, or when the feed water becomes unusually soft (as almost invariably happens in the spring of the year), scale that may have formed upon the tubes and plates at other times is almost certain to be thrown down upon the fire sheets in considerable quantities. Under these conditions, therefore, the boilers must be opened much oftener than usual.

In cleaning the interior of the boiler, always remove the handhole and manhole plates, and use either the hose service or hand tools (or both) for removing the scale attached to the shell plates or deposited upon the fire sheets. It is highly important to remove all scale or sediment that may accumulate on the fire sheets, or upon any part of the boiler that is subject to an intense heat. Never rely upon water let in through the feed pipe in washing the boiler, because effective results cannot be obtained in this way. A hose should be used that delivers a stream of considerable force, and it is important to wash the tubes of horizontal tubular boilers from *above*, as well as from *below*. Always pass a light into the boiler after washing, to see that no deposit remains, and that no tools have been left behind. (Note, however, the caution in suggestion No. 14, respecting open lights about boilers that have been treated with kerosene.)

For advice respecting oily or greasy deposits, see suggestion No. 14.

23.

To Avoid Scalding Men in Boilers.

When the boiler that is opened for cleaning, or repairs, or inspection, is one of a battery, some portion of which is still under pressure, every care must be taken to prevent the scalding of any person who may be inside of the empty boiler, by the thoughtless opening of valves that might discharge steam or hot water into it. *Extreme caution should be exercised in this respect, because such accidents are by no means uncommon.* The man in charge of the boiler room should personally take it upon himself to see that *no valve whatsoever* is touched, *in any part of the room*, while anyone is inside of a boiler under his care, nor until all the men who may have been at work upon the boiler have personally reported to him that they have left the interior permanently. He should likewise see that all other persons in the boiler room are notified to the same effect. It is not sufficient to *see a man come out* of the boiler, because he may do so merely to obtain some necessary tool, and may be back inside again, a few moments later.

The blowoff valve upon the empty boiler should be closed before the boiler is entered, so that steam or water cannot back up through the pipe in case the foregoing suggestion is violated, and a blowoff valve is opened upon some other boiler.

Whenever a boiler is shut down and cooled off, its stop valve should be closed tightly, *under all circumstances.* If the boiler has an automatic valve, the hand valve should be closed, nevertheless; and when all the boilers of a battery are shut down, the stop valve should be closed upon each one separately. Furthermore, before anyone enters a boiler, he should make sure that *all* the valves to the boiler are shut tight.

24.

Cleaning the Tubes of Water-tube Boilers.

In water-tube boilers having horizontal or inclined tubes, the covers over the openings in the headers opposite the ends of the three lower rows of tubes should be taken off once a month, and the tubes thoroughly scraped and washed out; and *all* the tubes should be thoroughly scraped and washed out, at least once in four months. (The frequency here indicated is for feed-water of average quality. If the water is bad, the cleaning should be done oftener; and in some cases, when the water is exceedingly good, it may be safe to do the cleaning at somewhat longer intervals.)

The principle here given applies also to water-tube boilers in which the tubes are vertical, instead of horizontal or inclined. That is, the tubes that are most directly exposed to the fire should be cleaned far oftener than those that are less directly exposed.

25.

Mechanical Tube cleaners.

In either fire-tube or water-tube boilers, when mechanical hammers or cleaners are employed for removing scale from tubes, the pressure used to operate them should be kept as low as possible, consistently with doing the work. An unnecessarily high pressure is liable to damage the tube, by causing the cleaner to act upon it with excessive force. It is also important, in using these devices, to prevent the cleaner from operating for more than a few seconds at a time upon any one spot, as continuous application to one limited region is liable to injure the tube at that place. Whatever the type of cleaner used, always see that it goes entirely through the tube.

High temperatures should be avoided in the steam or water used to operate mechanical cleaners, as otherwise the tendency of the heat to expand the tube that is being cleaned, while the other tubes remain at their normal length, may give rise to severe strains, and bring about loosening of the tubes, or even cause fracture of some part of the boiler.

26.

Records of Cleaning and Repairs.

It is advisable to keep a complete written record of the work that is done in cleaning and repairing the boilers, including a full and definite statement of the condition in which they were found when opened, and the condition in which they were left when closed up again. Any defects that may have been found should also be described, and a statement recorded concerning such measures as may have been taken to remedy them, the exact nature and location of each repair being clearly described. Keeping a record of this kind will improve the character of the cleaning and repair service, and thus tend to reduce the number of accidents from bursting tubes and other causes. The record would be of almost inestimable value, too, in the event of a disaster, as it would enable the engineer to show that he had done his duty.

27.

Laying Up Boilers.

When a boiler is to be out of service for a considerable time, it should be cooled, emptied, and thoroughly cleaned, both inside and outside. All scale and deposit of every kind should be carefully removed from the interior, and the external surfaces should be scraped and swept so as to be entirely free from soot and ashes. All chambers and passages in the setting should likewise be cleaned out, the side walls of the setting being brushed down, and all coal and ashes removed from the grates and the ash-pit. The handhole covers and manhole plates should be left off. When the interior of the boiler has been cleaned and washed, it should be allowed to drain, and (if the boiler is an isolated one) it should then be dried out thoroughly by burning a few newspapers under it. This operation should be carried out by a man of good judgment, because it is easy to damage a boiler by building even a light fire under it, when it is dry. Use *newspapers,*— not shavings nor wood,— and be careful not to heat the metal hot enough to make it painful to the touch. If another boiler is under steam by the side of the one that is being shut down, and in the same battery with it, the newspaper fire may be omitted, because enough heat will then be conducted through the side walls to complete the drying-out process.

The boiler once being well dried out, care should be taken that no moisture can collect upon it or within it, or trickle down over it, either from leaky valves or from any other source. If the boiler forms one of a battery, some of the remaining members of which are to be continued in service, see to it that the stop valve, feed valve, and blowoff valve upon the boiler that is laid up are tight, so that no moisture can enter through any of them.

If the boiler is to be laid off in the winter season in our northern latitudes, take care to empty the siphon below the steam gage, so that the gage may not be damaged by freezing. It is better to remove the gage entirely, storing it in a safe place until it is again wanted.

28.

Corrosion.

Care should be taken that no water comes in contact with the exterior surfaces of the boiler at any time, either from leaky joints or otherwise. The furnaces of internally fired boilers should be carefully cleaned of ashes when put out of service, since such ashes, if allowed to remain in contact with the plates, are likely to absorb moisture and give rise to corrosion.

In water-tube boilers, external corrosion frequently occurs on mud drums, on mud drum nipples, at the rear ends of horizontal and inclined tubes, and in other places that are more or less likely to be overlooked or neglected by the engineer, by reason of their being out of the way, or not readily accessible. As such corrosion is usually due to leakage, and to wet sooty matter being allowed to remain in contact with the parts, it is important that leaks be promptly stopped, and that the affected surfaces be kept free from soot.

☞ If evidences of *internal* corrosion should be found, report the matter to the office, so that the HARTFORD STEAM BOILER company may be notified at once. Prompt attention to this may avert trouble.

29.

Baffle Walls

When cleaning water-tube boilers, examine the baffle walls carefully, and see that there are no bricks or tiles displaced, so as to allow any considerable portion of the furnace gases to pass to the chimney by a short cut, without following the course that the builders of the boilers intended. Attention to this point will tend to save fuel.

30.

Brickwork and Air Leaks

The brick-work of the setting should be kept in good repair at all times. For if the setting leaks air, either through the brickwork itself, or around the fire doors or the back connection doors, or if air can enter it in any other way except through the fuel on the grate, the hot gases from the furnace will be correspondingly chilled, and the result will be a loss of efficiency. That is, it will be necessary to burn more fuel in order to perform a given amount of work.

31.

Miscellaneous Suggestions.

Whenever boilers are laid off, the engineer should carefully examine them in all accessible parts, to see that they are everywhere in good condition. At all times he should keep the sheets and other parts of the boiler that are exposed to the fire perfectly clean both inside and outside. All tubes, flues, and connections should also be kept well swept. This is particularly necessary when wood, soft coal, or waste gases are used as fuel. In firing, remember that small quantities of fuel, fed into the furnace frequently, are more effective than large quantities fed at longer intervals. In water-tube boilers, the feed water should be introduced into the upper drum, and under the water-line. A mud pan or other suitable receptacle should be placed under its discharge end, and this should be provided with a blowoff pipe, so that sediment can be blown out of the pan.

Keep everything about the boiler room in a neat and orderly condition. See that all doors about the settings are kept securely fastened, except when the operation of the boiler requires them to be open. When anything needs repairing or renewing, see that it receives the attention it demands. Give especial care to the safety-valve, the feed pump or injector, the gage cocks, the glass gage, and the pressure gage. It is common to find the gage cocks in very poor condition. They are highly important, however, and should be kept in first class repair in all respects. Keep the face of the pressure gage clean, so that the pointer can be clearly seen, and have the gage glass and the pressure gage well lighted. If, at any time, you consider it possible that serious trouble is impending, shut down the boiler at once. Take no chances, and if you err, err on the safe side.

32.

Local Laws and Ordinances.

In many states and cities there are special laws and ordinances respecting the duties of engineers and firemen. The boiler superintendent, or engineer in charge, should inform himself, fully, with respect to any legal requirements that may apply to him or to the plant with which he is associated. If there be any such, he must obey them faithfully,—giving them unquestioning preference over the suggestions herein contained, in case the two should chance to conflict.

The **Hartford Steam Boiler Inspection and Insurance Company's** Inspectors Will be Pleased to Give Special Advice and Counsel, in Cases Not Covered by These Suggestions.

IF A BOILER SHOWS DISTRESS, OR ANY UNUSUAL BEHAVIOR, THE **HARTFORD STEAM BOILER** COMPANY SHOULD BE NOTIFIED AT ONCE, AT ITS NEAREST OFFICE. The addresses of its principal departments are given on the back page of this issue of THE LOCOMOTIVE.

Boiler Explosions.

April, 1911.

(160.) — On April 1 a section fractured in a cast-iron heating boiler in an apartment house belonging to the Allied Investors Realty Co., West 107th street, New York City.

(161.) — A hot water heater exploded, April 2, in the basement of Dr. B. A. Cheney's sanitarium, New Haven, Conn. The property loss was estimated at $1,000.

(162.) — A boiler exploded, April 3, in a sawmill at Louisville, Ky. A boy was killed.

(163.) — The boiler of a freight locomotive exploded, April 4, on the Puget Sound extension of the Milwaukee railroad, three miles east of McIntosh, S. D. Three men were killed and the locomotive was wrecked.

(164.) — A tube ruptured, April 5, in the State Insane Asylum at Athens, Ohio.

(165.) — On April 6 a tube ruptured in a water-tube boiler in the J. R. Williams Lumber Co.'s sawmill, Bay St. Louis, Miss.

(166.) — A boiler exploded, April 6, in Brumley & Jones's sawmill, near Mt. Washington, Ky. One man was killed and four others were injured. The building was also totally destroyed.

(167.) — A tube failed, April 7, in a water-tube boiler in the Algoma Steel Co.'s plant, Sault Ste. Marie, Ont. One man was injured.

(168.) — A cast-iron header fractured, April 7, in a water-tube boiler in the Philadelphia Rapid Transit Co.'s power house, at Thirteenth and Mt. Vernon streets, Philadelphia, Pa.

(169.) — On April 7 a blowoff pipe failed in the Hygeia Refrigerating Co.'s cold storage plant, Elmira, N. Y. One man was slightly injured.

(170.) — On April 8 two tubes ruptured and six cast-iron headers fractured in a water-tube boiler at the Union Ice Co.'s plant, Pittsburg, Pa.

(171.) — The boiler of a locomotive exploded, April 10, at Northfork, W. Va. One man was severely injured.

(172.) — On April 10 an accident occurred to a boiler in the Elizabeth City Cotton Mills, Elizabeth City, N. C.

(173.) — Five sections of a cast-iron heating boiler fractured, April 10, in a business block owned by the Geo. Q. Cannon Association, Salt Lake City, Utah.

(174.) — A tube ruptured, April 12, in a water-tube boiler at the Westinghouse Electric Manufacturing Co.'s lamp works, Bloomfield, N. J. One man was scalded.

(175.) — The boiler of a San Antonio & Aransas Pass railroad locomotive exploded, April 14, at Waco, Tex. One man was seriously injured.

(176.) — On April 14 a cast-iron header fractured in a water-tube boiler at the plant of the Philadelphia Rapid Transit Co., Thirty-third and Market streets, Philadelphia, Pa.

(177.) — A tube ruptured, April 16, in a water-tube boiler in the rod and wire mill of the Southern Iron & Steel Co., Alabama City, Ala.

(178.) — On April 16 an accident occurred to a boiler in the Hughes Eyelet Co.'s plant, Taunton, Mass.

(179.) — On April 18 a boiler exploded at the plant of the Thompson Lumber Co., Centerville, Ala. One person was injured, and the property loss was large.

(180.) — A copper boiler, used for heating water in the laundry, exploded, April 18, in the basement of the Christian Home for Working Girls, Pittsburg, Pa. The boiler passed up through the building until it was stopped by a steel girder in the ceiling of the second floor. The property loss was estimated at $1,000.

(181.) — A boiler exploded, April 18, in the Acme Laundry, West Pittston, Pa. Two persons were injured.

(182.) — Two sections of a cast-iron heating boiler ruptured, April 19, in Edwin Wilcock's apartment house, Boston, Mass.

(183.) — The boiler of an Oregon Short Line locomotive exploded, April 19, some four miles west of Shoshone, Idaho One man was killed, one was fatally injured, and a third was injured seriously but not fatally.

(184.) — On April 20 a slight accident occurred to a boiler in the plant of the Holmes Brick Works, Holmes, Pa.

(185.) — A boiler ruptured, April 20, at the Eddy Paper Co.'s plant, Three Rivers, Mich.

(186.) — Six cast-iron headers fractured, April 20, in a water-tube boiler at the plant of the Georgia Steel Co., Aubrey, Ga.

(187.) — A steam "cooker," used for cooking grain in the manufacture of yeast and whisky, exploded, April 20, in the Fleischmann Company's distillery, at Riverside, Cincinnati, Ohio. One man was killed, another was fatally injured, and four received injuries more or less serious, but not fatal. The property loss was estimated at $2,000.

(188.) — Two tubes ruptured, April 24, in a water-tube boiler in the rod and wire mill of the Southern Iron & Steel Co., Alabama City, Ala.

(189.) — A boiler ruptured, April 24, in the box factory of the Illinois Glass Co., Alton, Ill.

(190.) — On April 24 two tubes ruptured in a water-tube boiler in the State Insane Asylum, Athens, Ohio.

(191.) — A tube ruptured, April 26, in a water-tube boiler in the Ellicott Square Co.'s general office building, Buffalo, N. Y. One man was fatally injured.

(192.) — The boiler of a Baltimore & Ohio railroad locomotive exploded, April 27, at Parkersburg, W. Va. Two persons were fatally injured.

(193.) — Two tubes ruptured, April 27, in a water-tube boiler at the Lackawanna Steel Co.'s plant, Wehrum, Pa.

(194.) — On April 27 two tubes ruptured in a water-tube boiler at the blast furnace of the Southern Iron & Steel Co., Alabama City, Ala.

(195.) — A tube ruptured, April 27, in a water-tube boiler in the rod and wire mill of the Southern Iron & Steel Co., Alabama City, Ala.

(196.) — A boiler exploded, April 28, in La Carona factory, Callejon Pradito, Mex. Two persons were killed and four were seriously injured.

(197.) — On April 28 a tube ruptured in a water-tube boiler at the Sherwin-Williams Co.'s paint manufacturing plant, Pullman, Ill.

(198.) — The boiler of an Atlantic Coast Line locomotive exploded, April 29, at Ocala, Fla. One person was severely injured.

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(199.) — On May 1 a tube ruptured in a water-tube boiler at the Shawmont pumping station, near Manayunk, Pa. Three men were injured.

(200.) — On May 1 the cross connection between the drums of a water-tube boiler failed at the plant of the Schwartzschild & Sulzberger Co., Kansas City, Kans.

(201.) — An accident occurred, May 1, to a boiler in Daniel F. Water's dye works, Philadelphia, Pa.

(202.) — On May 2 a tube ruptured in a water-tube boiler at the Southern Iron & Steel Co.'s rod and wire mill, Alabama City, Ala.

(203.) — On May 3 a tube failed in a water-tube boiler at the blast furnace of the Southern Iron & Steel Co., Alabama City, Ala. One man was injured.

(204.) — A cast-iron header ruptured, May 3, in a water-tube boiler in the power house of the Philadelphia Rapid Transit Co., Thirty-third and Market streets, Philadelphia, Pa.

(205.) — A heating boiler exploded, May 3, at the plant of the Union Electric Light & Power Co., St. Louis, Mo. Three men were injured so badly that they died shortly afterward.

(206.) — A boiler exploded, May 4, on the steamer *State of Ohio*, at Cleveland, Ohio. Nine persons were injured, two of them being injured fatally.

(207.) — A tube ruptured, May 4, in a water-tube boiler at the Duquesne works of the Carnegie Steel Co., Duquesne, Pa.

(208.) — A boiler exploded, May 4, in the Manly & Colvin Mill, at Arcadia, La. Two men were injured seriously and perhaps fatally.

(209.) — The boiler of a traction engine exploded, May 6, near St. Joseph Ill. One man was injured.

(210.) — A hot-water boiler belonging to the *Tamaqua Courier* exploded, May 8, at Tamaqua, Pa.

(211.) — On May 9 a tube ruptured in a water-tube boiler in the Pittsburg Railways Co.'s Brunot Island power house, Pittsburg, Pa. One man was injured.

(212.) — On May 10 a tube ruptured in the water-tube boiler at the plant of the Allentown Portland Cement Co., Allentown, Pa. One man was slightly injured.

(213.) — A tube ruptured, May 10, in a water-tube boiler in the Larson Lumber Co.'s planing mill, Bellingham, Wash. Two men were injured.

(214.) — A boiler belonging to J. B. Wood exploded, May 10, at Peet, Burnett county, Wis. Two persons were killed and two others were injured seriously.

(215.) — On May 11 a boiler belonging to Grover Hall exploded at Temple Hill, Ky.

(216.) — A boiler exploded, May 12, in a sawmill at Grantsburg, near Green Bay, Wis. One man was killed, and two others were seriously injured.

(217.) — The boiler of a Milwaukee freight locomotive exploded, May 12, at Frontenac, Minn. One person was killed and one was injured.

(218.) — A boiler used for operating a pile-driver exploded, May 13, at Clinton, Iowa. One man was injured fatally, and another received lesser injuries.

(219.) — The boiler of a Chesapeake & Ohio locomotive exploded, May 15, at Frontenac, Minn. One person was killed and one was injured.

(220.) — The boiler of a locomotive attached to the Southern Pacific "Sunset Express" exploded, May 15, at Bryn Mawr, near San Bernardino, Cal. One man was killed and another was seriously injured.

(221.) — The boiler of locomotive No. 68, on the St. Paul road, exploded, May 16, three miles west of Lake City, Minn. One man was instantly killed, and another was fatally injured.

(222.) — The mud drum of a water-tube boiler ruptured, May 17, at the Lane Cotton Mills, New Orleans, La.

(223.) — A tube ruptured, May 18, in a water-tube boiler at the flouring mills of the Sparks Milling Co., Alton, Ill. One man was scalded.

(224.) — A boiler exploded at Port Fulton, Ky., May 18, on a boat belonging to the Monongahela Coal Co.

(225.) — On May 19 a small vertical boiler, used in excavating for a foundation, exploded at the corner of La Salle and Madison streets, Chicago, Ill. The engineer was fatally scalded, and five other men received serious injuries also.

(226.) — On May 20 a boiler, used in the construction of the White Rock reservoir, exploded at Dallas, Tex. The fireman was killed.

(227.) — A boiler exploded, May 23, at the Jones & Adams mine, Springfield, Ill. One person was injured.

(228.) — A boiler explosion occurred, May 23, at the Kosmosdale cement plant, West Point, Ky. Thu fireman was fatally injured.

(229.) — On May 23 two cast-iron headers of a water-tube boiler fractured at the pumping station of the Troy water works, Troy, Ohio.

(230.) — A blowoff pipe failed, May 23, in W. E. Parker's ice and cold storage plant, Winnfield, La.

(231.) — A boiler ruptured, May 23, at the Lake Erie Forging Co.'s plant, Cleveland, Ohio.

(232.) — A tube ruptured, May 24, in a water-tube boiler at the W. J. McCahan Sugar Refining Co.'s plant, Philadelphia, Pa.

(233.) — A flue burst, May 25, on a Lehigh Valley locomotive at Easton, Pa. One man was injured.

(234.) — A boiler exploded, May 26, at the electric power station of the Illinois Glass Co., Alton, Ill. Two men were injured, and one of them died a few days later. The property loss was about $4,500.

(235.) — A slight accident occurred, May 26, to a boiler in the plant of the Pennsylvania Warehousing & Safe Deposit Co., Philadelphia, Pa.

(236.) — On May 26 an accident occurred to a boiler at the plant of the Missouri Cotton Yarn Manufacturing Co., St. Louis, Mo.

(237.) — A tube ruptured, May 28, in a water-tube boiler owned by the Pocahontas Consolidated Collieries Co., Pocahontas, Va. One man was injured.

(238.) — A hot-water heating boiler exploded, May 29, in the residence of George E. Rogers, Springfield, Mass. A portion of the heater was blown up through the kitchen, and the house was otherwise damaged.

(239.) — On May 30 a flue burst in a boiler owned by Shaun & Uhlinger, Philadelphia, Pa. Two persons were injured.

(240.) — On May 30 a tube ruptured in a water-tube boiler at the Georgia Steel Co.'s plant, Aubrey, Ga. One man was scalded.

(241.) — A boiler exploded, May 30, in the electric lighting plant at Waynetown, Ind.

June, 1911.

(242.) — On June 1 a blowoff pipe ruptured at the Aurora Electric Co.'s electric light and water works, Aurora, Neb. One man was scalded.

(243.) — On June 1 an accident occurred to a boiler in the Johnson Service Co.'s plant, Milwaukee, Wis. One person was severely injured.

(244.) — The boiler of a Union Pacific freight locomotive exploded, June 2, six miles west of North Platte, Neb. Three trainmen were killed.

(245.) — The boiler of freight locomotive No. 672, on the Chesapeake & Ohio railroad, exploded, June 8, at Hurricane, Putnam county, W. Va. Three men were injured, and one of them died on the following day.

(246.) — The boiler of a donkey engine exploded, June 9, at Camp 23 of the North Coast Timber Co., near Orting, Pierce county, Wash. One man was killed outright, and another was fatally injured.

(247.) — A tube ruptured, June 10, in the Philadelphia Rapid Transit Co.'s power house, Beach and Laurel streets, Philadelphia, Pa.

(248.) — A boiler ruptured, June 11, in Charles F. Antz's ice factory, Jeffersonville, Ind.

(249.) — On June 11 a tube ruptured in a water-tube boiler at the blast furnace of the Southern Iron & Steel Co., Alabama City, Ala.

(250.) — A tube ruptured, June 12, in a water-tube boiler in the blooming mill of the Southern Iron & Steel Co., Alabama City, Ala.

(251.) — A cast-iron header fractured, June 12, at the plant of the Lawrence Portland Cement Co., Siegfried, Pa.

(252.) — A tube ruptured, June 12, in a water-tube boiler in the Chittenden Hotel, Columbus, Ohio.

(253.) — A tube ruptured, June 13, in a water-tube boiler at the power station of the Tri-State Railway & Electric Co., East Liverpool, Ohio. One man was fatally injured.

(254.) — The boiler of a Baltimore & Ohio locomotive exploded, June 14, at Fairmont, W. Va. One person was seriously injured.

(255.) — A boiler exploded, June 14, during the course of a fire at the Hurricane Lumber Co.'s mill, near Bay Minette, Baldwin county, Ala. The explosion scattered burning brands to every part of the structure, and the entire plant was destroyed, with a loss of $75,000.

(256.) — The boiler of a traction engine exploded, June 14, on the main street of Yoe, York county, Pa. Four men were burned and scalded — two of them so badly that it was considered doubtful if they could recover.

(257.) — A boiler exploded, June 16, on the steam yacht *Waterboy*, fifty miles east of Pensacola, Fla. The vessel took fire and sank in six fathoms of water. The crew was rescued by fishermen whose attention was drawn to the wreck by the flames.

(258.) — Two cast-iron headers fractured, June 17, in a water-tube boiler in the Lawrence Portland Cement Co.'s plant, Siegfried, Pa.

(259.) — A boiler ruptured, June 18, in the Columbia Manufacturing Co.'s plant, Dallas, Tex.

(260.) — On June 19 a cast-iron header fractured in a water-tube boiler in the Providence plant of the American Locomotive Co., Providence, R. I.

(261.) — A boiler exploded, June 19, in the J. F. Kamerer Co.'s sawmill, at Union City, Pa. Two men were slightly injured, and the property loss was estimated at $15,000.

(262.) — A boiler ruptured, June 20, in the plant of the New York & Penna. Co., Johnsonburg, Pa.

(263.) — The boiler of a passenger locomotive exploded, June 20, on the Chicago & Eastern Illinois railroad, one mile south of Kensington, Chicago, Ill. One man was severely scalded, the locomotive was wrecked, and traffic on three railroads was delayed some two hours.

(264.) — A boiler exploded, June 23, in the J. B. Berlin sawmill, at Cassandria, near Marksville, La. One person was killed and one was seriously injured.

(265.) — A small hot-water boiler exploded, June 24, in the Saranac Lake Laboratory, Saranac Lake, N. Y.

(266.) — A boiler exploded, June 24, on the Mississippi river packet *City of St. Joseph*, seven miles below Memphis, Tenn. Seventeen men were killed, and three others were fatally injured.

(267.) — On June 26 a tube ruptured in a water-tube boiler at the Monongahela works of the American Sheet & Tin Plate Co., Pittsburg, Pa. One man was scalded.

(268.) — A hot-water heater exploded, June 27, in the National Ice Cream Co.'s plant at Taylorsville, Ky. One man was badly injured (his skull being fractured), but it was said that he will recover.

(269.) — A boiler ruptured, June 28, in the Lexington Brewing Co.'s plant, Lexington, Mo.

(270.) — A boiler ruptured, June 29, in the Case & Martin Co.'s bakery, Chicago, Ill.

(271.) — On June 30 a cast-iron header ruptured in a water-tube boiler in the Philadelphia Rapid Transit Co.'s power station, Thirty-third and Market streets, Philadelphia, Pa.

(272.) — On June 30 a boiler exploded in the power house of the Marmet Coal Co.'s mine, at Hernshaw, near Marmet, W. Va. Two little girls were killed, two men were injured, and the power house was demolished.

Until within quite recent times, it was almost universal, whenever a boiler burst, to attribute the accident to low water. "Boilers never explode," said the wise ones, "unless the water is low." Of course this opinion, which we have been fighting for many years, has now pretty well died out, though it still crops up occasionally, and sometimes in the most unexpected places.

These remarks are prompted by an accident that occurred, March 1, at Roxbury, Mass. The account that we have received reads thus: "Several hundred gallons of beer in a Roxbury brewery proved too strong for a vat today, and in bursting its bonds the liquid hurled three workmen violently against the walls of the building, with the result that one man sustained a fractured skull and two others were severely injured."

We dare say some of the "old timers" would have been ready to argue that the *beer* was too low.

Vice President Allen's Seventieth Birthday.

Mr. Francis B. Allen, vice-president of the Hartford Steam Boiler Inspection and Insurance Company, reached the age of three-score years and ten, on June 1. Shortly before that date word was passed around, privately, and the employees of the company conspired to see that Mr. Allen was reminded of the day from many points of the compass. When he entered his office in the morning, he was surprised to find a silver loving cup there, bearing the inscription "Presented to Francis Burke Allen in respectful remembrance of his seventieth birthday by his office associates, June 1, 1911." At four o'clock the employees of the home office gathered in the vice-president's room, and President Brainerd made the formal presentation address. Mr. Allen thanked those assembled for remembering him, and then exhibited a second, similar cup that he had received during the day from Mr. J. M. Lawford, general agent of the company at Baltimore, Maryland. A very fine gold-handled umbrella was also received from Mr. Pescud, general agent at New Orleans, and telegrams poured in all day long, from every part of the country.

The Wooden Boilers of the "Argyle."

There was a slight accident, recently, on the steamer *Argyle*, near Toronto, Ont., and the report of it that was given in the Toronto *Globe* was far more interesting, in some respects, than the accident itself.

"The *Argyle*," said the *Globe*, "is equipped with two wooden and two steel boilers, and the wooden boilers (which are the easiest on the rest of the machinery) had been right through the season up to yesterday. Yesterday morning, however, the steel boilers, which cause much strain on the machinery, were installed, and this was the cause of all the trouble.

"When the *Argyle* started out, the greater vibration of these proved too much of a strain on the rest of the machinery, the trouble being made more apparent owing to a wooden patch with which one of them has been repaired. It was the added vibration of these that jarred the valve pin out of place, and thus cutting the steam off, caused the machinery to stop and the side wheels to come to a standstill. Had the steamer been kept going with the valve pin out of place, the piston rods would have knocked in among the cylinders and very serious consequences would have resulted.

"As soon as the passengers were landed, the six members of the engineering department of twelve, who were on duty, were at once put to the work of replacing the steel boilers with the wooden ones. Before morning they expect to have made the change, and with a new valve pin replacing the one that was shaken out, the machinery will be in good working order again. With the wooden boilers in place, it is stated that the machinery works in first class shape, and no further trouble is looked forward to."

This account, the reading of which gives one strabismus, was written by a guileless reporter who was innocent of any knowledge of steam engineering. Some of the fresh-water "old salts" on the *Argyle's* staff had merely been trying to see what he could be made to believe, and he swallowed the bait, hook, line, and sinker.

Wooden boilers *have* been used in the past, however, when the steam pressure carried was measured in ounces rather than in pounds. In the issue of The Locomotive for October, 1910, there will be found an illustration of a boiler of this kind, that did service in Philadelphia for nearly four years, about a century ago

The Melting Point of Tin.

Pure tin makes the best filling for the fusible plugs of steam boilers, alloys being objectionable because those that have been tried for the purpose appear to undergo a gradual change when exposed continuously to heat, so that their melting points do not remain constant. Four closely accordant and apparently quite accurate determinations of the melting point of tin have been made, with the following results:

Date.	Observers.	Melting Point.
1892	Callendar and Griffiths.	231.7° C.
1895	Heycock and Neville.	231.9
1900	Reinders.	232.0
1902	Kurnakow and Puschin.	231.5
	Average,	231.8° C.

This corresponds, on the Fahrenheit temperature scale, to 449.2° Fahr., which is likely to be within a few tenths of a degree of the true melting point of pure tin.

According to the formula given by Marks, on page 573 of the *Journal* of the American Society of Mechanical Engineers for May, 1911, the pressure of saturated steam at 449.2° Fahr. is 378.0 pounds per square inch, above a vacuum; so that it will be seen that a tin-filled plug will not melt out from the natural heat of the steam until the pressure of the steam becomes 363.3 pounds per square inch greater than the ordinary pressure of the atmosphere. The tin might perhaps soften at a somewhat lower temperature, sufficiently to blow out, but between the highest pressure now used in the generation of power, and the pressure at which pure tin will melt from the heat of the steam alone, there is evidently a margin wide enough to take care of any contingency of this kind, without the slightest uncertainty.

A Boiler Explosion in a Sawmill.

Our illustrations show the effects, in part, of a boiler explosion that occurred some months ago in the A. W. Allen Co.'s sawmill, New Bedford, Mass. The boiler that exploded was thrown through the roof of the building, to a height estimated at from sixty to seventy feet. Three men, including Mr. Allen, were badly injured, and four others received minor injuries. One account of the explosion says: "The center of the roof disappeared entirely, broken shingles and pieces of timber being scattered over surrounding roofs and in the street, and the sides of the building bulged outward in the middle. The two ends of the roof sagged toward the missing center, forming a sort of blanket to cover the scene of havoc within." The property loss was large, but we have seen no estimate of its amount.

The boiler was not insured in the Hartford.

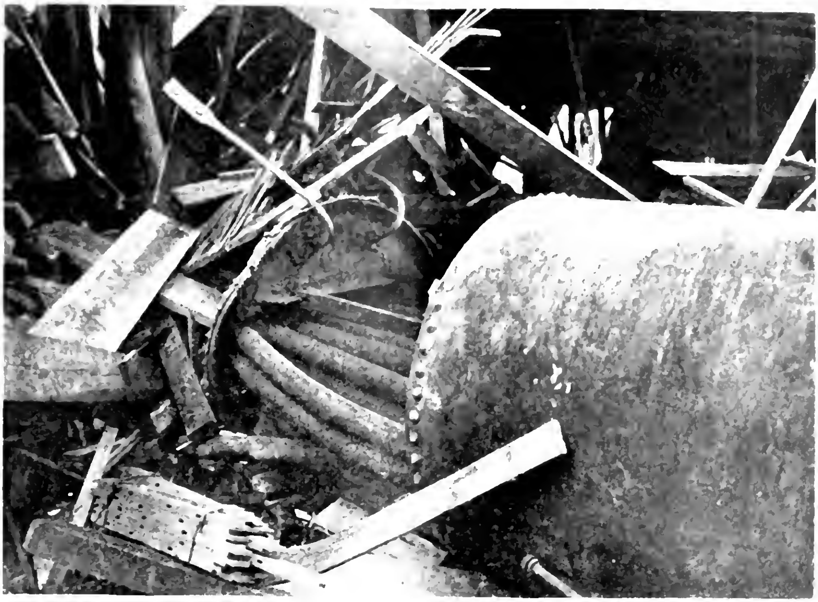

Fig. 1.— Showing the Exploded Boiler.

Fig. 2.— Some Details of the Wreckage.

On the Firing of Boilers Having External Furnaces.

In the issue of The Locomotive for March, 1891, we gave a description of the external furnace invented by President J. M. Allen, of this company, and in our issue for June, 1893, we gave a further illustration of the way in which this furnace may be applied to upright boilers. In both cases we had a few words to say concerning the best method of firing with these furnaces, but as we have learned by experience that firemen have some difficulty with handling waste tan bark, sawdust, and other such material, until they have served a considerable apprenticeship at the business, we have thought it well to print a short article dwelling especially upon the art of handling such fuel to the best advantage.

The main thing to provide for, in handling fuel of this kind, is an abundant supply of oxygen. When burning coal or wood in ordinary furnaces the oxygen is easily had, because the fuel is of sufficiently open character to allow air to be drawn through it by the chimney draft; but the refuse that is burned in external furnaces is ordinarily of such a character that it lies in heavy masses on the grates, and is so solid that no draft could draw air through it, unless it were strong enough to pull the whole mass up the stack. It is therefore necessary to burn this fuel largely from the surface. Some air should be admitted at the ash-pit doors, because there will be holes, here and there, in the mass of fuel, through which air can be drawn. Air should also be admitted, to a limited extent, through the fire doors, and through the feed openings. It is important not to admit too much air, however, because (just as in burning fuel of other kinds) an excess of air would chill the furnace gases, and so make the boiler less efficient. A brief experience will enable the fireman to estimate very well whether he is admitting the correct amount of air or not, if he will remember that the object to be attained is a good, bright fire, which is burning over every part of the mass that is upon the grates.

It is important to stir up the fuel from time to time, as it lies upon the grate, always drawing it up from the bottom as much as possible, so as to loosen the mass and expose fresh, unburned surfaces constantly to the action of the fire. Fuel is sometimes fed to these external furnaces through hoppers inserted in the feed openings, but while this practice may do very well with some kinds of fuel, with other kinds it is by no means advisable. When the fuel has been thrown into the hoppers in such quantity that they remain partially filled, it is impossible for air to pass down through them, unless the fuel is of a very porous nature. The result is that the hopper becomes heated and warped out of shape, and the fuel in it begins to char from the heat, and to distil off objectionable vapors, which form a source of unnecessary annoyance to the fireman. When the fires are managed in this way, it is also difficult to stir them up properly, and it is almost impossible to regulate the draft through the feed openings. It is much better to dispense with the hoppers altogether in most cases, and to cover the feed openings with cast-iron plates that can be slid about over the floor. The draft can then be regulated nicely by sliding the covers to one side far enough to admit as much air as is desired; and the fireman can easily introduce more fuel by pushing it across the floor and allowing it to fall into the opening. Care should always be taken to keep the floor around the feed openings swept up clean, after the furnace has been freshly fired, because if this is not attended to there is danger that the fuel on the floor will take fire, and the flames may then spread to the main heap from which the supply is being drawn. When the fuel is damp the sweeping of the floor is not so important, but it must not be neglected under any circumstances when the fuel is of a dry and greasy character, so that it burns readily.

Loss of Heat by Painting Radiators.

It is generally believed that there is a great loss in efficiency from painting radiators. We do not agree with this opinion, however, and it has long been our custom to require piping and radiators to be painted in colors appropriate to the finish of the rooms in which they are placed. Prof. C. L. Norton, of Boston, Mass., made a long series of experiments upon the transmission of heat through and from painted surfaces. His results are highly interesting, and are recorded in the nineteenth volume (1898) of the *Transactions* of the American Society of Mechanical Engineers. They have seemingly never attracted the attention they deserve. Taking the amount of heat radiated from a new pipe as 100, Professor Norton obtains the following relative values for the heat radiated, under similar conditions, from pipe treated as indicated:

LOSS OF HEAT AT 200 POUNDS PRESSURE FROM BARE PIPE.

New pipe,	100
Fair condition,	116
Rusty and black,	119
Cleaned with caustic potash, inside and out,	116
Painted dull white,	120
Painted glossy white,	100.5
Cleaned with potash again,	116
Coated with cylinder oil,	116
Painted dull black,	120
Painted glossy black,	101

It appears from the foregoing results that the color of the pipe has little or no effect upon the radiation of heat, though the condition of the surface with respect to glossiness or dulness has quite a sensible influence. Thus a dull surface, whether it be white or black, has a radiative power of 120, and a glossy surface, whether white or black, has a corresponding power of only about 101. These results accord well with our experience, which is to the effect that there is no loss in efficiency through making pipes and radiators harmonize with the general color scheme of the rooms in which they occur, provided glossy finishes are avoided.

Fly-Wheel Explosions.

(29.) — A fly-wheel burst, April 4, in the plant of the Hess Spring & Axle Co., Carthage, Ohio. One person was killed.

(30.) — On April 10 a fly-wheel exploded in the clock case factory at Pen Argyl, Pa.

(31.) — A fly-wheel accident, which resulted in the serious injury of one man, occurred, May 1, in the Simpson sawmill at Carbon, near Brazil, Ind. A block of wood which had been attached to the wheel, presumably for strengthening some part of it temporarily, broke away and struck the unfortunate man in the face, crushing a number of the facial bones.

(32.) — On May 13 a fly-wheel exploded in paper mill "A," at Franklin, N. H.

(33.) — A fly-wheel exploded, May 13, in the electric lighting plant at Temple, Tex. The fragments of the ruptured wheel tore off a large section of the roof of the building in which the engine was located. The property loss was estimated at $2,000.

(34.) — A fly-wheel exploded, June 23, at Wheeling, W. Va., severely injuring one person.

(35.) — On June 30 a fly-wheel exploded in the drying room at the coke ovens at Sault Ste. Marie, Ont. Two men were killed instantly, and a third died before he could be removed to the hospital. The damage to property was estimated at $1,500.

(36.) — Damage to the extent of $18,000 was done, July 4, by the bursting of a fly-wheel in the power house of the Fitchburg & Hudson division of the Worcester Consolidated street railway, at West Berlin, near Clinton, Mass. The engineer was also injured. The fragments of the wheel broke steam pipes, demolished the engine room, and passed through the roof and one end of the building. Some of them were found 200 yards from the engine.

(37.) — The plant of the Mooresville Water, Light, Heat & Power Co., of Mooresville, Ind., was wrecked, July 5, by the explosion of a fly-wheel on an ice machine. Large holes were torn in the walls and roof of the building, and the machinery of the lighting plant was badly damaged. The night engineer was also slightly injured. The flying wreckage destroyed an ammonia tank, and a number of persons living near the plant were obliged to flee in their night clothes, to avoid suffocation. The accident is said to have been due to the racing of the engine.

(38.) — A fly-wheel exploded, July 14, at Coshocton, N. Y.

(39.) — On July 27 a fly-wheel exploded at the Rome Brick Co.'s plant, Rome, Ga. The engines were wrecked, the building was badly damaged, and one man was injured.

The Plumber and the Kitchen Boiler.

[The following imaginative effort is from a book of humor that was published some years ago, and which is too often overlooked by readers in search of material for the beguiling of a few hours. The said book is called "Out of the Hurly-Burly," and it was written by a man known to librarians and to the police as "Max Adeler," but known to textile workers, to the Sunday school of which (we believe) he is superintendent, and to the registrar of voters, as Charles Heber Clark. Parts of this extract seem like passages from our own experience, for though this be fiction, yet the truth about the plumber is often stranger than the fiction.]

We have had a great deal of trouble recently with our kitchen boiler, which is built into the wall over the range. It sprang aleak a few weeks ago, and the assistance of a plumber had to be invoked for the purpose of repairing it. I sent for the plumber, and after examining the boiler he instructed the servant to let the fire go out that night, so that he could begin operations early the next morning. His order was obeyed, but in the morning the plumber failed to appear. We had a cold and very uncomfortable breakfast, and on my way to the depot I overtook the plumber going in the same direction. He said he was sorry to disappoint me, but he was called suddenly out of town on imperative business, and he would have to ask me to wait until the next morning, when he would be promptly on hand with his men. So we had no fire in the range upon that day, and the family breakfasted again upon cool viands without being cheered with a view of the plumber. Upon calling at the plumber's shop to ascertain why he had not fulfilled his promise, I was informed by the clerk that he had returned, but that he was compelled to go over to Wilmington. The man seemed so thoroughly in earnest in his assertion that the plumber positively would attend to my boiler upon the following morning that we permitted the range to go untouched, and for the third time we broke our fast with a frigid repast. But the plumber and his assistants did not come.

As it seemed to be wholly impossible to depend upon these faithless artisans, our cook was instructed to bring the range into service again without waiting longer for repairs, and to give the family a properly prepared meal in the morning. While we were at breakfast there was a knock at the gate, and presently we perceived the plumber and his men coming up the yard with a general assortment of tools and materials. The range at the moment of his entrance to the kitchen was red hot; and when he realized the fact, he flung his tools on the floor and expressed his indignation in the most violent and improper language, while his attendant fiends sat around in the chairs and growled in sympathy with their chief. When I appeared upon the scene, the plumber addressed me with the air of a man who had suffered a great and irreparable wrong at my hands, and he really displayed so much feeling that for a few moments I had an indistinct consciousness that I had somehow been guilty of an act of gross injustice to an unfortunate and persecuted fellow-being. Before I could recover myself sufficiently to present my side of the case with the force properly belonging to it, the plumbers marched into the yard, where they tossed a quantity of machinery and tools and lead pipe under the shed, and then left.

We had no fire in the range the next morning, but the plumbers did not come until four o'clock in the afternoon, and then they merely dumped a cart-load of lime-boxes and hoes upon the asparagus bed and went home. An interval of four days elapsed before we heard of them again, and meanwhile the cook twice nearly killed herself by stumbling over the tools while going out into the shed in the dark. One morning, however, the gang arrived before I had risen, and when I came down to breakfast I found that they had made a mortar bed on our best grass plot, and had closed up the principal garden walk with a couple of loads of sand. I endured this patiently because it seemed to promise speedy performance of the work. The plumbers, however, went away at about nine o'clock, and the only reason we had for supposing they had not forgotten us was that a man with a cart called in the afternoon and shot a quantity of bricks down upon the pavement in such position that nobody could go in or out of the front gate. Two days afterward the plumbers came and began to make a genuine effort to reach the boiler. It was buried in the wall in such a manner that it was wholly inaccessible by any other method than by the removal of the bricks from the outside. The man who erected the house evidently was a party with the plumber to a conspiracy to give the latter individual something to do. They labored right valiantly at the wall, and by supper-time they had removed at least twelve square feet of it, making a hole large enough to admit a locomotive. They then took out the old boiler and went away, leaving a most discouraging mass of rubbish lying about the yard.

That was the last we saw of them for more than a week. Whenever I went after the plumber for the purpose of pursuading him to hasten the work, I learned that he had been summoned to Philadelphia as a witness in a court case, or that he had gone to his aunt's funeral, or that he was taking a holiday because it was his wife's birthday, or that he had a sore eye. I have never been able to understand why the house was not robbed. An entire brigade of burglars might have entered the cottage and frolicked among its treasures without any difficulty. I did propose at first that Bob and I should procure revolvers and take watch and watch every night until the breach in the wall should be repaired, but Bob did not regard the plan with enthusiasm, and it was abandoned. We had to content ourselves with fastening the inner door of the kitchen as securely as possible, and we were not molested.

Finally the men came and began to fill up the hole with new bricks. That evening the plumber walked into my parlor with mud and mortar on his boots, and informed me that by an unfortunate mistake the hole left for the boiler by the bricklayers was far too small, so that he could not insert the boiler without taking the wall down again.

"Mr. Nippers," I said, "don't you think it would be a good idea for me to engage you permanently to labor upon that boiler? From the manner in which this business has been conducted, I infer that I can finally be rid of annoyance about such matters by employing a perennial plumber to live forever in my back yard, and to spend the unending cycles of eternity banging boilers and demolishing walls.

"Mr. Nippers," I continued, "I am going to ask a favor of you. I do not insist upon compliance with my request. I know that I am at your mercy. Nippers, you have me, and I submit patiently to my fate. But my family is suffering from cold, we are exposed to the ravages of thieves, we are deprived of the means of cooking our food properly, and we are made generally uncomfortable by the condition of our kitchen. I ask you, therefore, as a personal favor to a man who wishes you prosperity here and felicity hereafter, and who means to settle your bill promptly, to fix that boiler at once."

Mr. Nippers thereupon said that he always liked me, and he swore a solemn oath that he would complete the job next day without fail. That was on Tuesday. Neither Nippers nor his men came again until Saturday, and then they put the boiler in its place and went away, leaving four or five cart-loads of ruins in the yard. On Sunday the boiler began to leak as badly as ever, and I feel sure Nippers must have set the old one in again, although when he called early Monday morning with a bill for $237.84 (which he wanted at once because he had a note to meet), he declared upon his honor that the boiler was a new one, and that it would not leak under a pressure of one thousand pounds to the square inch.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1911.

Capital Stock, ... $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission,	$174,137.52
Premiums in course of collection,	209,440.08
Real estate,	91,400.00
Loaned on bond and mortgage,	1,140,810.00
Stocks and bonds, market value,	3,180,527.72
Interest accrued,	71,231.96
Total Assets,	$4,867,547.28

LIABILITIES.

Premium Reserve,		$2,010,733.76
Losses unadjusted,		130,809.04
Commissions and brokerage,		41,888.01
Other liabilities (taxes accrued, etc.),		45,149.16
Capital Stock,	$1,000,000.00	
Surplus over all liabilities,	1,638,967.31	
Surplus as regards Policy-holders,	**$2,638,967.31**	2,638,967.31
Total Liabilities,		$4,867,547.28

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L. F. MIDDLEBROOK, Assistant Secretary.
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Some Studies of Welds.*

By E. F. Law, W. H. Merriott, and W. P. Digby.

At the outset the authors feel it advisable to define the sense in which the word "weld" is used in this paper, — namely, as designating an actual fusing together of similar or allied metals. Mere intimacy of contact without such fusion cannot be regarded as a weld in its real sense. The common impression that tensile tests really give the last word on the subject is erroneous. The authors urge that other comparisons are necessary. Consideration should be given to the nature of the fracture, and to alterations in the character and

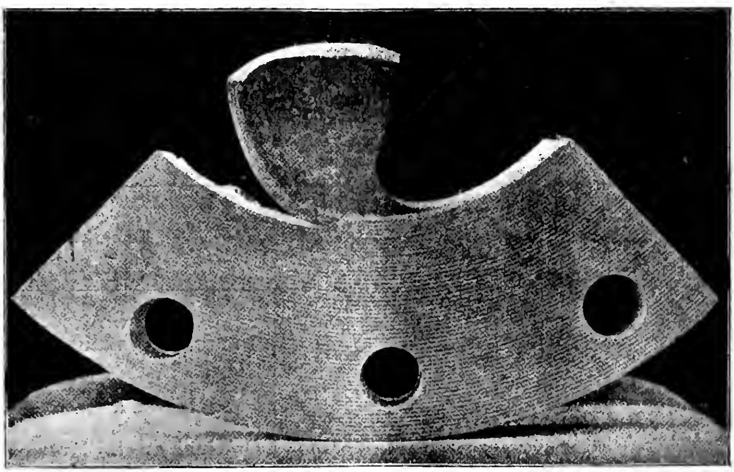


Fig. 1. — Welded Steam Pipe, Showing Defective Weld.

composition of the metals from the somewhat drastic thermal treatment. These alterations may not seriously affect the strength of the weld, and yet they may make themselves apparent by an increased liability to corrosion, and in other ways.

The present contribution to the study of this subject, by calling attention to the well-defined abnormalities peculiar to certain methods of welding when imperfectly executed, will, it is hoped, explain the reasons for the admittedly wide variations in mechanical properties, as well as indicate the points requir-

* Abstract of a paper read before the Iron and Steel Institute. Reproduced, here, from *Vulcan*.

ing special attention during the operations that the various processes involve. It is also hoped that the present paper will facilitate the enunciation of a metallurgical standard of excellence to which all welds should attain.

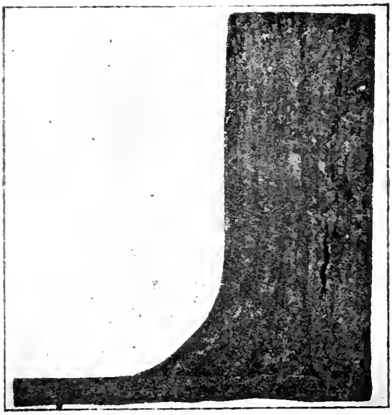


Fig. 2. — Section of Steam Pipe and Flange. (Etched.)

Resistance Welds. — The authors' investigation of resistance welds in steel began with some experiments upon bars that had been welded together with plain butt joints, some of these bars being round with a diameter of 1½ in., while others were rectangular, with a section 2 in. by 2½ in. A round test bar was turned from the center of each of the round specimens, the extruded metal of bulbous shape at the point of junction being thereby removed. The rectangular specimens, on the other hand, were first sawn longitudinally down the middle, and each half was then again sawn down the middle in a similar way. From each of the four rectangular bars thus prepared, a test piece was turned. None of the specimens described in Tables 1 and 2 were in any way worked or annealed after welding.

Table 1.— Tensile Tests of Resistance Welds on 2½ in. by 2 in. Bars, with Butt Joints.

Weld No.	Breaking stress. Lbs. per sq. in.	Elastic limit. Lbs. per sq. in.	Elongation on 2 in. Per cent.	Reduction of area at fracture. Per cent.	Remarks.
2A	55,400	36,330	15.0	31.25	Broke at weld. Fracture mainly crystalline.
2B	43,790	33,260	5.0	8.97	Splintered fracture. Slight crystalline area.
2C	61,150	45,400	35.0	65.70	Original steel. Normal fracture.
3A	36,780	31,250	4.0	7.61	Splintered fracture. Slight crystalline area.
3B	28,220	20,830	3.0	4.33	Splintered fracture. Slight crystalline area.
3C	59,400	41,840	34.5	63.30	Original steel. Normal fracture.
BA	39,310	32,300	4.0	12.09	Splintered fracture.
BB	60,700	44,910	33.0	65.60	Original steel. Normal fracture.

Two examples of resistance welds of wrought iron may be cited as typical of average practice. Upon etching, each of these showed a line of oxidation at the point of juncture (in one case distinctly pronounced), with large crystallization in the neighborhood of the weld. A test piece from the sample showing the oxidation less markedly broke at 51,400 lbs. per square inch, with an elastic limit of 34,500 lbs. per square inch, an elongation of ten per cent. on two inches, and a reduction of area of 15.65 per cent. The test piece from the specimen showing the distinct and pronounced line of oxidation broke at 37,900 lbs. per square inch, with an elastic limit of 26,630 lbs. per square inch, an elongation of only three per cent. on two inches, and a reduction of area of 2.95 per cent. The former sample showed a fibrous fracture with slight indication of crystallization. The latter sample showed more crystallization, yet its fracture was mainly of a fibrous character.

FIG. 3.— ARC-WELDED PIPE AND FLANGE.

Perhaps the best examples of successful resistance welds were found in a chain made by the acetylene welding process. Each link, upon etching, showed crystallization adjacent to the weld. The very effective working given while the link was still plastic prevented any tendency toward extrusion of metal.

HOT-FLAME WELDS WITH ACETYLENE.— Various examples of acetylene welding passed through the hands of the authors. Four tensile tests of one series, with butt joints, are given in Table 3. The average tensile strength of 54,020 lbs. per square inch and the average elastic limit of 38,100 lbs. per square inch are both fairly good.

TABLE 2.— TENSILE TESTS OF RESISTANCE WELDS ON 1½ IN. ROUND BARS, WITH BUTT JOINTS.

Weld No.	Breaking stress. Lbs. per sq. in.	Elastic limit. Lbs. per sq. in.	Elongation on 2 in. Per cent.	Reduction of area at fracture. Per cent.	Remarks.
4A	62,940	47,200	10.0	12.40	Crystalline fracture; overheated.
4B	48,880	43,680	3.5	5.34	Crystalline fracture; overheated.
4C	60,370	40,320	35.0	63.70	Original steel. Normal fracture.
AA	61,940	45,140	37.0	63.30	Original steel. Normal fracture.
AB	57,570	46,260	12.0	13.65	Crystalline fracture; overheated.

Another process in which acetylene is employed for welding boiler plates deserves mention. The plates are here shaped to a V end, and the weld effected by melting Swedish iron into the depressions on either side. Upon etching a section of a weld prepared by this process the iron and steel areas were found to be quite distinct. The tests given in Table 4 were made upon samples of this nature, sometimes without any treatment, and sometimes after heat treatment of the nature indicated in the table.

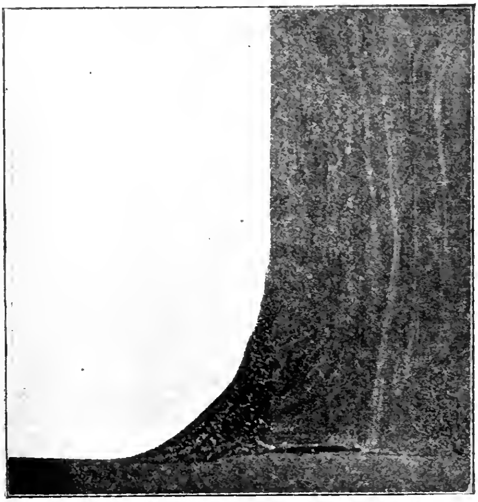


FIG. 4. — ARC-WELDED PIPE AND FLANGE. (ETCHED.)

Reviewing these results, it is apparent that mechanical irregularity of juncture, through imperfect fusion, far outweighs any improvements that may be introduced by the heat treatment. The differences between the two annealed specimens of either pair receiving a specified heat treatment exceed the difference between the means of the two pairs. The authors would regard this process as a good one for filling cavities in castings, or for other work of that general character, but they could not recommend it seriously for cases in which mechanical strength is of prime importance.

TABLE 3.— MECHANICAL PROPERTIES OF ACETYLENE WELDS (BUTT JOINTS).

Marks on sample	Breaking stress. Lbs. per sq. in.	Elastic Limit. Lbs. per sq. in.	Elongation on 8 in. Per cent.	Percentage reduction of area.	Remarks.
14542 A	58,780	43,680	12.50	50.60	Test-piece broke 1¼ in. from end of bar, and not at weld. Fracture silky fibrous.
14564 A	60,260	42,290	15.60	52.80	Test-piece broke 1 in. from center, and not at weld. Fracture silky fibrous.
25082 A	48,320	31,360	6.26	10.08	Fracture at center of bar. Crystalline fracture ; broke at weld.
25085 A	48,700	35,080	4.38	2.43	Fracture at center of bar. Crystalline fracture ; broke at weld.

Hot-flame Welds with Water-gas.— Out of a number of water-gas welds the authors have selected two normal good welds, and an abnormal one obtained with an oxidizing flame, all with scarfed joints. The mechanical tests of the series of plates from which the abnormal sample was selected would be generally regarded as corresponding to fair practice. The tensile stresses were low, but the elongations and the percentage reductions of area were good.

Coke-fire Welds for Steam-pipe Flanges. — For a long time certain consulting engineers have set their faces rigidly against the employment of welded flanges on steam pipes, preferring instead, screwed and riveted flanges. Two cases (one a coke-fire weld and the other an arc weld) coming before the

Table 4.— Acetylene Welds of Boiler Plates.

Marks on sample.	Breaking stress. Lbs. per sq. in.	Elastic limit. Lbs. per sq. in.	Elongation on 2 in. Per cent.	Percentage reduction of area.	Remarks.
A	56,400	38,440	31.7	54.60	Original steel, untreated. Normal fracture.
B	36,960	24,930	7.5	13.50	Welded joint, untreated. Swedish iron, visible as crystals. Imperfect juncture at point of V.
D	43,460	29,970	9.0	20.50	Welded joint, untreated. Fracture partly crystalline, but aminated.
A 5	52,980	33,490	32.0	51.65	Original steel, at 750°C. for 172 hours, and slowly cooled Normal fracture.
B 5	43,950	30,460	8.5	18.85	Welded joint, treated same as sample A 5. Bad fracture, of a burnt character.
E 5	44,460	30,960	9.0	24.90	Welded joint, treated same as sample A 5. Bad fracture, with marked cavities.
A 6	53,530	35,460	37.0	54.00	Original steel, annealed at a temperature rising from 850° C. to 900° C. for half an hour and slowly cooled. Normal fracture.
C 6	33,510	23,470	6.0	9.15	Welded joint, treated as sample A 6. Bad fracture; broke at weld. Junction of metal imperfect.
D 6	52,240	34,970	16.50	25.25	Welded joint, treated as sample A 6. Swedish iron, visible as crystals. Tendency to rupture noticed away from weld, where actual fracture occurred.

authors tend both to confirm and to illustrate the soundness of this view. A welded pipe flange may be mechanically imperfect in some obvious way, or it may be superficially perfect and capable of passing hydrostatic pressure tests. In this latter case ignorance as to its real internal condition produces a peace of mind which knowledge is likely to destroy.

Fig. 1 shows a segment of a wrought-iron flange nominally welded to a mild steel steam pipe. As shown, the pipe has been stripped away by the use of a drifting tool. There being no fusion of the metal, the weld is merely nominal.

Fig. 2 is from the other end of the segment, where the pipe had not been forced away mechanically from the flange. The clear demarkation of area shows that there has been no fusion of the metal.

Arc Welds for Steam-pipe Flanges.— A segment of an arc-welded flange on a steel pipe is shown in Fig. 3, in its condition as received. The welding is only partial, more than one third of the area of junction having an air space. In its entirety, this pipe would have passed all reasonable hydrostatic pressure tests. Fig. 4 shows the same section as Fig. 3, but after polishing and etching. This weld is an example of a perfect metallic fusion, but with a remarkable change in composition and structure of the fused material. It is evident that arc welds cannot be relied upon to unite the entire area of contact in cases of this character. At least one case is known, in which a consignment of pipes separated from their flanges owing to the action of atmospheric corrosion alone.

Conclusion.— No matter what the process is by which two metals are welded together, there must always be an area, more or less sharply defined, of altered molecular structure. Just as quenching and annealing alter steel in a manner which is quite unmistakable to those acquainted with the micro-structure of steel, so it is obvious that the local heating to the high temperatures required for mechanically satisfactory welds leaves its impress upon the steel. Each of the methods to which the authors have referred has its own hall-mark. For instance, it is possible, by merely polishing and etching, to say

Table 5.— Mechanical Properties of Water-gas Welds (Scarfed Joints).

Marks on sample.	Breaking stress. Lbs. per sq. in.	Elastic limit. Lbs. per sq. in.	Elongation on 8 in. Per cent.	Per-centage reduction of area.	Remarks.
G	49,390	33,060	17.80	59.20	Broke 2½ in. from one end of bar — not at weld.
32151 G	47,260	32,210	18.75	36.40	Broke near center of bar, at weld. Laminated fracture.
32151 G (6)	44,420	28,940	6.26	56.70	Broke near one end of bar. Fracture similar to cutting-end of a wood-turning chisel.
32151 G (8)	51,320	37,470	23.75	64.60	Broke near center of bar — not at weld.

whether an electric weld has been made by an arc or a resistance method; and acetylene and water-gas welds have each their own marked characteristics also, at least unless the specimen has been annealed so as to restore its original structure.

The authors have not entered into the practical applications of the respective processes, nor have they given descriptions of the apparatus required in putting the various processes into practice. Obviously an arc process, even were its results satisfactory, does not lend itself to the manufacture of welded boiler tubes; and on the other hand, a resistance process is not adapted, by its nature, to use in patching up a defective casting.

Resistance welds (with the possible exception of acetylene welds) are seemingly least prone to oxidation, but in these the extrusion of the metal makes good working, while the material is still plastic, of supreme importance. Arc welds are most prone to oxidation, and many will hesitate to rely upon a process of this kind, in positions where corrosion is likely to occur. Where the metal is not likely to be subject to corrosion, the excellent fusion obtained by the arc process renders it commendable.

Flame welds, except upon work such as patching up castings, should receive adequate working and manipulation while in their heated condition. Of the two methods investigated, water-gas welds may be abnormal through the use of oxidizing flames, while acetylene welds certainly require annealing to break down the crystalline structure in the vicinity of the weld.

The main sources of trouble to be avoided in order to do successful welding may be said to be: (1) Too low a temperature to secure true fusion of the metal, and (2) Oxidation of the metal at the point of welding. The first of these can be detected more easily than the second; while the second is more insidious than the first in its effects.

In connection with the foregoing article upon autogenous welding we may record that we had occasion not long ago to test a weld made by the oxy-acetylene process. The material was steel boiler plate, and the results of the test were as follow:

Size of cross-section of specimen	2.110 in. by 0.433 in.
Area of original cross-section	0.914 sq. in.
Ultimate stress in pounds (total)	43,130
Ultimate stress in pounds (per square inch)	47,190
Elongation in two inches (total)	0.38 in.
Elongation in two inches (percentage)	19 per cent.
Size of reduced cross-section	2.013 in. by 0.376 in.
Area of reduced cross-section	0.757 sq. in.
Percentage of reduction of area	17.18 per cent.

The specimen broke in the weld, and the fracture showed a full incorporation of the metal, except that there were a few little cells throughout the weld, not more than 1/64th in. in diameter.

Boiler Explosions.

JULY, 1911.

(273.) — A tube failed, July 1, in a water-tube boiler at the Southern Iron & Steel Co.'s blast furnace, Alabama City, Ala.

(274.) — Two flues collapsed, July 1, at the Allegheny Ore & Iron Co.'s blast furnace, Buena Vista, Va.

(275.) — The boiler of locomotive No. 3630, of the Salt Lake Route, exploded, July 3, at Lake Point, some twenty miles from Salt Lake City, Utah. The engineer and fireman were killed. The locomotive was almost entirely demolished, and the freight train that it was hauling was wrecked.

(276.) — On July 4 a boiler ruptured in the Frederick Railroad Co.'s power plant, near Middletown, Md.

(277.) — The boiler of a threshing outfit exploded, July 4, on Charles Martin's farm, at Millersburg, near Carlisle, Ky. One man was fatally injured, and the machinery was badly damaged.

(278.) — On July 6 the boiler of a threshing outfit exploded on Peter Ridgeway's farm, near Fulton, Ky. One man was instantly killed, and two others were seriously injured.

(279.) — A boiler exploded, July 6, in the Wileman & Helbing brick yard, at Beechwood Park, near Ironton, Ohio. One man was fatally injured and two others were injured seriously but not fatally.

(280.) — The boiler of Joseph Jackson's sawmill exploded, July 7, near Veedersburg, Ind.

(281.) — On July 7 a cast-iron header fractured in a water-tube boiler at the Philadelphia Rapid Transit Co.'s power house, Thirty-third and Market streets, Philadelphia, Pa.

(282.) — A tube ruptured, July 8, in a water-tube boiler in the water works and electric lighting plant at Fremont, Neb.

(283.) — A boiler exploded, July 9, at the Rees coal mine in Grass Creek canyon, near Coalville, Utah. One man was killed and another was seriously injured. The property loss was estimated at $4,500.

(284.) — A tube burst, July 11, in a water-tube boiler at the Lehigh & Wilkes-Barre Coal Co.'s No. 5 shaft, at South Wilkes-Barre, Pa. One of the firemen was severely burned.

(285.) — Two boilers of a nest of six exploded, July 11, at the McTurk colliery, Girardville, Pa. Three men were seriously injured.

(286.) — A boiler exploded, July 11, in William Beyer's sawmill, at Collomsville, near Williamsport, Pa. The mill was "literally reduced to splinters," and the owner's residence was damaged considerably.

(287.) — A boiler ruptured, July 12, in the plant of the United Kansas Portland Cement Co., Iola, Kans.

(288.) — On July 13 a boiler ruptured at the Munro Iron Mining Co.'s Hiawatha mine, Iron River, Mich.

(289.) — The boiler of a threshing outfit exploded, July 13, on Eliza Campbell's farm, near Morganfield, Ky. One man was killed and six others were injured.

(290.) — A boiler ruptured, July 14, at the No. 1 works of the Sunshine Coal & Coke Co., Martin, Pa.

(291.) — Five cast-iron headers ruptured, July 14, in the Terre Haute, Indianapolis & Eastern Traction Co.'s power plant, Terre Haute, Ind.

(292.) — The shell of a vertical tubular boiler failed, July 15, at the Bodwell Granite Co.'s Sands quarry, Vinal Haven, Me.

(293.) — A boiler ruptured, July 15, at the Horton Manufacturing Co.'s fishing rod factory, Bristol, Conn.

(294.) — Three men were injured seriously, July 17, by a boiler explosion in the American Ramie Manufacturing Co.'s plant at New Hartford, Conn. The boiler room was also damaged.

(295.) — A boiler exploded, July 18, in the Connell sawmill, Rusk, Texas. One person was killed and two others were injured.

(296.) — A boiler exploded, on or about July 18, on the bark *Max*, at Tacoma, Wash.

(297.) — A man was killed, and a woman fatally injured, July 19, by the explosion of a boiler used for drilling a well in the rear of the Campbell Hotel, Dallas, Tex. The boiler struck and damaged a neighboring building.

(298.) — A boiler exploded, July 19, on Lafayette boulevard, Detroit, Mich. Two persons were seriously injured.

(299.) — A boiler used for heating water exploded, July 21, in George Garvin's barber shop, McKeesport, Pa. Nobody was in the shop at the time. The property loss was estimated at $200.

(300.) — A tube ruptured, July 22, in a water-tube boiler at the Southern Iron & Steel Co.'s plant, Alabama City, Ala.

(301.) — A locomotive boiler exploded, July 23, on the Norfolk & Western Railroad at Batavia, Ohio. The engineer was killed.

(302.) — The boiler of a threshing outfit exploded, July 24, on A. Y. Reed's farm, near Elgin, Ill. Two boys were scalded.

(303.) — A boiler exploded, July 25, at the Forrester-Nace box factory, Kansas City, Mo. One of the firemen was critically scalded.

(304.) — A boiler tube burst, July 26, on the tug *A. B. Covington*, off Buckroe Beach, near Norfolk, Va. One man was killed.

(305.) — On July 26 a tube ruptured in a water-tube boiler at the Brunot's Island plant of the Pittsburg Railways Co., Pittsburg, Pa. One man was killed.

(306.) — A tube ruptured, July 26, in a water-tube boiler at the plant of the Federal Coal & Coke Co., Grantown, W. Va. One man was injured.

(307.) — On July 26 a boiler exploded in the Syracuse Reduction Co.'s plant, Syracuse, N. Y. One man was injured seriously and perhaps fatally.

(308.) — On July 27 a boiler exploded at Monterey, Ky., killing one person and fatally injuring another.

(309.) — The boiler of a threshing outfit exploded, July 28, on Theodore Rake's farm, two miles south of Sexton, Iowa. One man was instantly killed and another was seriously scalded.

(310.) — A boiler exploded, July 28, at George P. Blackwelder's sawmill, in Cabarrus County, near Mt. Pleasant, S. C. Miss Tina Blackwelder was killed, and her father, brother, and sister were badly injured.

(311.) — A boiler exploded, July 29, on Henry Bush's farm, at Grange, near Brookville, Pa. One young man was injured so badly that he died two days later. Two others were scalded seriously but not fatally.

(312.) — On July 29 a tube ruptured in a water-tube boiler in the Cape Girardeau Portland Cement Co.'s plant, Cape Girardeau, Mo.

(313.) — A tube ruptured, July 29, in a boiler in the Rogers Milling Co.'s flouring mill, Rogers, Ark.

(314.) — On July 30 a boiler exploded in the oil fields, some two miles south of Bowling Green, Ohio. One man was killed.

August, 1911.

(315.) — A boiler exploded, August 2, in the Painter Mills of the Carnegie Steel Co., Pittsburg, Pa. Three men were injured, and the property loss was estimated at $1,600.

(316.) — On August 2 a boiler ruptured in the Cooper Light Co.'s plant, Cooper, Tex.

(317.) — On August 3 a boiler ruptured in the Edgewater Hygeia Ice Co.'s plant, Edgewater, N. J.

(318.) — A blowoff ruptured, August 7, in the Monumental Brewing Co.'s plant, Highlandtown, Md.

(319.) — On August 10 a boiler exploded in the roundhouse of the Wabash shops at Moberly, Mo. Fire followed the explosion, destroying the machine shops and causing a damage estimated at $14,000 to $15,000.

(320.) — A boiler exploded, August 10, on Etienne Benoit's farm, three miles from Morse, La. The owner of the boiler was thrown 200 feet, and instantly killed.

(321.) — A boiler used for drilling a well exploded, on or about August 10, on the Mertens fruit tract, at Green Ridge, near Cumberland, Md. Three men were seriously injured.

(322.) — The boiler of a locomotive exploded, on or about August 10, near Raleigh, N. C. Three men were injured, and one of these has since died.

(323.) — On August 12 a boiler exploded in an ice plant at Tipton, Ind.

(324.) — On August 12 a boiler ruptured in the Newton Steam Laundry Co.'s plant, Newton, Kans.

(325.) — On August 14 a boiler exploded at the Paragon paper mills, Eaton, Ind. Two men were killed outright. The boiler house was wrecked and other portions of the plant were also damaged.

(326.) — A tube ruptured, August 15, in a water-tube boiler at the Brunot's Island plant of the Pittsburg Railways Co., Pittsburg, Pa. One man was injured.

(327.) — On August 15 a boiler ruptured in E. F. Griswold & Co.'s greenhouse, Ashtabula, Ohio.

(328.) — On August 16 a tube ruptured in a water-tube boiler at the Tri-State Railway & Electric Co.'s plant, East Liverpool, Ohio. One man was injured.

(329.) — A boiler exploded, August 16, on S. P. Campbell's farm, three miles south of Loami, Sangamon county, Ill. One man was killed and five were injured.

(330.) — The boiler of a threshing outfit exploded, August 16, on the A. Hunter farm, two miles from Wallowa, Ore. The engineer was injured so badly that it was believed he could not recover.

(331.) — A boiler used to operate a "merry-go-round" exploded, August 17, during the course of a picnic at Trotting Park, Fort Fairfield, Me. One person was killed and another was badly injured.

(332.) — A slight explosion occurred, August 17, at the Prison Chair Co.'s shops, Fort Madison, Iowa. Two men were painfully scalded.

(333.) — A boiler exploded, August 18, in the Chicago-Windsor laundry, Omaha, Neb.

(334.) — A small boiler, used for heating water, exploded, August 18, in Mouquin's restaurant on Ann street, New York City. Three waiters were scalded painfully but not seriously.

(335.) — A tube ruptured, August 21, in a water-tube boiler in the American Box Co.'s plant, Cleveland, Ohio.

(336.) — A boiler tube burst, August 22, at the Friend Paper Co.'s plant, West Carrollton, Ohio. One person was severely injured.

(337.) — The boiler of a traction engine exploded, August 22, on the Frank Burbridge farm, near Greeley, Iowa. The engineer was almost instantly killed.

(338.) — A boiling tank exploded, August 22, in the mercerizing department of the Aberfoyle Manufacturing Co.'s mills, Chester, Pa. The roof of the building was torn off and one of the side walls was reduced to a mass of debris. The property loss was estimated at $3,000.

(339.) — A boiler used for operating a "merry-go-round" exploded, August 22, at Atlanta, Ga. Three persons were severely injured.

(340.) — A boiler used for heating water exploded, August 23, in the boiler room of the Grand Laundry Co., St. Louis, Mo. Two men were seriously injured.

(341.) — A boiler exploded, August 25, at the Shawmont Pumping Station, Philadelphia, Pa. One man was fatally scalded.

(342.) — A boiler ruptured, August 25, in the Blue Grass Condensed Milk Co.'s plant, Harrisonville, Mo.

(343.) — A boiler exploded, August 27, near Simcoe, five miles west of Cullman, Ala. One man was instantly killed, and two others were fatally injured.

(344.) — The boiler of a Norfolk & Southern locomotive exploded, August 28, at Euclid, Va. One person was fatally injured and another was injured severely but not fatally.

(345.) — On August 29 a boiler exploded in the Tyrrel-Hitchcock sawmill at Van Zandt, near Deming, Wash. One man was fatally injured.

(346.) — A boiler exploded, August 30, on the Canadian Crude Oil Co.'s lease, Bakersfield, Calif Parts of the boiler were thrown 700 feet.

September, 1911.

(347.) — The boiler of a threshing outfit exploded, September 2, near DeGraff, Minn., on Michael Cavanaugh's farm. One man was killed.

(348.) — The boiler of a threshing outfit exploded, September 2, on Herman Schultz's farm at Davis, near Sioux Falls, S. D. The owner of the machine was killed.

(349.) — On September 2 a boiler belonging to Fulton & Witz exploded at Mt. Elliott Springs, Ga.

(350.) — On September 3 a boiler exploded in the pumping plant of the Grace zinc mine, Joplin, Mo. One man was seriously injured.

(351.) — A boiler exploded, September 3, in George W. Spencer's bakery, Madison, Wis. One man was killed and another was badly scalded. The damage to the building was estimated at about $1,000.

(352.) — A boiler ruptured, September 4, in the water works and electric lighting plant, Union City, Tenn.

(353.) — A small boiler exploded, September 4, in the Y. M. C. A. building at Lincoln, Neb. One man was seriously burned.

(354.) — The boiler of a threshing outfit exploded, September 5, on W. C. Freas's farm at Troutville, eight miles from Punxsutawney, Pa. One boy was killed, and three other persons were seriously burned. The property loss was estimated at $6,000.

(355.) — On September 7 a boiler exploded in R. J. Russell's sawmill, on Madeline Island, Big Bay, Lake Superior, near Marquette, Mich. One man was killed and four others were injured.

(356.) — The boiler of a locomotive drawing a Central Railway special train over a division of the Atlantic Coast Line exploded, September 8, near Troy, Ala. The engineer and fireman were injured.

(357.) — A tube ruptured, September 10, in a water-tube boiler at the plant of the Southern Iron & Steel Co., Alabama City, Ala.

(358.) — A boiler used to furnish power for cutting feed for a silo exploded, September 9, on Daniel Hunter's farm, near Frankfort, Ill. Two men were scalded and bruised.

(359.) — A boiler ruptured, September 10, in the Beatrice Poultry & Cold Storage Co.'s plant, Beatrice, Neb.

(360.) — On September 12 a tube ruptured in a water-tube boiler in the Southern Iron & Steel Co.'s plant, Alabama City, Ala.

(361.) — On September 14 a boiler tube ruptured in the Cullen Hotel, Salt Lake City, Utah.

(362.) — An explosion, apparently of a tube in a water-tube boiler, occurred September 14, in a planing mill on Godwin street, Paterson, N. J.

(363.) — A blowoff pipe ruptured, September 14, in the Chicago Stove Works, Chicago, Ill.

(364) — On September 14 a blowoff pipe failed at the plant of the Arcadia Cotton Oil Mill & Manufacturing Co., Arcadia, La. One man was scalded.

(365.) — A boiler ruptured, September 16, in S. M. Roberts's ice plant, Douglas, Ga.

(366) — A boiler ruptured, September 17, in the plant of the Farmersville Milling & Electric Light Co., Farmersville, Tex.

(367.) — A boiler ruptured, September 18, in the electric lighting and pumping station at Merrimac, Mass.

(368.) — On September 20 a bleaching kier exploded in the Newburg bleachery, Newburg, N. Y. The property loss was estimated at $15,000. Nobody was present at the time.

(369.) — On September 22 three cast-iron headers failed in a water-tube boiler at the plant of the American Steel & Wire Co., Waukegan, Ill.

(370.) — A boiler exploded, September 26, in the Scott-Lambert Lumber Co.'s mill at Micaville, Yancey county, N. C. Three men were seriously injured.

(371.) — On September 27 a boiler exploded in J. B. Niles's sawmill, near Oakdale, Tenn., killing one man instantly and fatally injuring another. The plant was almost totally demolished.

(372.) — On or about September 27 a boiler exploded at Freeborn, Minn. Two men were seriously injured.

(373.) — A tube failed, September 29, in the Sparks Milling Co.'s flouring mill, Alton, Ill.

(374.) — A tube ruptured, September 30, in a water-tube boiler at the newspaper plant of the Plaindealer Publishing Co., Cleveland, Ohio.

(375.) — The crown sheet of a boiler of the locomotive type collapsed, September 30, at the barge canal, near Mechanicsville, N. Y. The boiler was being operated by I. A. Hodge & Co., contractors.

Fly-Wheel Explosions.

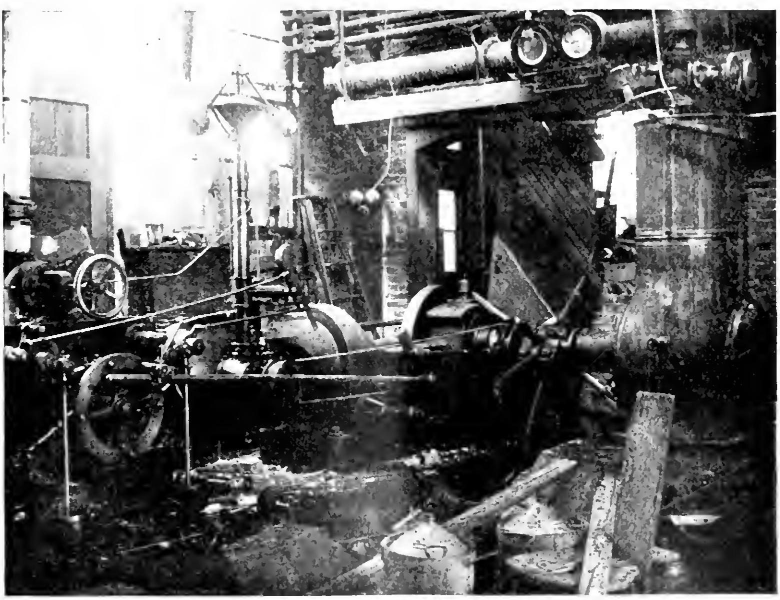
(40.) — A fly-wheel burst, May 22, on the Koontz ranch, at Eltopia, Wash.

(41.) — On May 27 a fly-wheel burst in the Republican Creosoting Co.'s plant, Indianapolis, Ind. Two persons were severely injured.

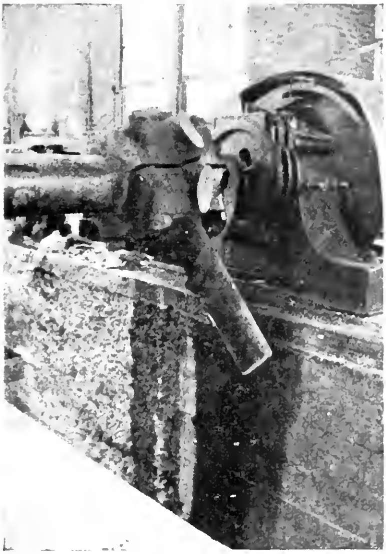
(42.) — A seven-foot pulley exploded, June 16, in the Cabot mill, Brunswick, Me.

(43.) — On July 15 a fly-wheel exploded in the Fowlerville Lighting Co.'s plant, at Fowlerville, Mich. The property loss was estimated at $2,000.

(44.) — The rotor of a Curtis steam turbine exploded, July 20, in the power plant of the Illinois traction system at Riverton, near Springfield, Ill.



Fly-Wheel Explosion No. 37. (See July Locomotive.)
(Mooresville Water, Light, Heat & Power Co.)



FLY-WHEEL EXPLOSION NO. 52.
(Salt Lake & Ogden Railway.)

Two men were killed and two were injured. The property loss was estimated at from $40,000 to $50,000. (We give this accident in our fly-wheel explosion list because the hazard in the case of the Curtis turbine is very similar to that in a fly-wheel,— the Curtis rotor being disk-like in form.)

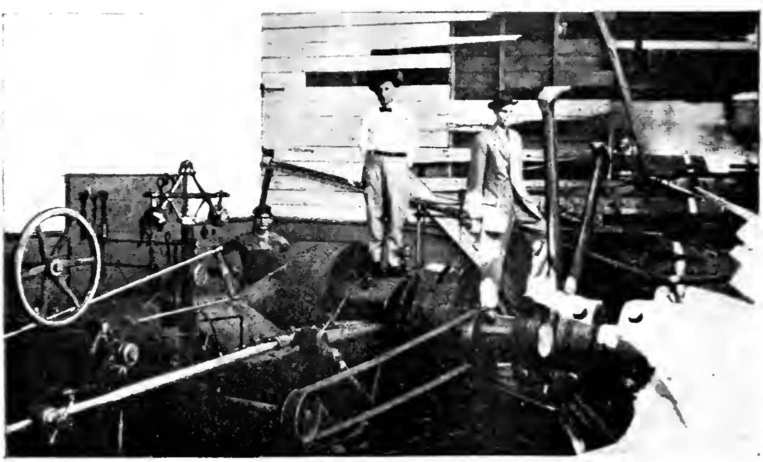
(45.) — The fly-wheel of a threshing machine exploded, on or about July 27, at Boswell, near La Fayette, Ind. A part of the wheel struck a boy on the head, fracturing his skull and injuring him so badly that he died.

(46.) — A fly-wheel burst, August 11, in the water supply station at White Hall, Ill. One man was fatally injured.

(47.) — On August 15 two fly-wheels exploded at the Barfield Lumber Co.'s plant, Ellentown, Ga. The property loss was large.

(48.) — A fly-wheel exploded, August 18, at the Friend Paper Co.'s plant, West Carrollton, Ohio. One of the fragments of the wheel severed a steam pipe supplying one of the engines. Fortunately most of the employees were at dinner, and nobody was injured.

(49.) — A fly-wheel burst, August 31, at the Aurora Furniture Co.'s plant, Lawrenceburg, Ind. One person was injured.



FLY-WHEEL EXPLOSION NO. 53.
(Muskogee Gas & Electric Co.)

(50.) — On September 8 the fly-wheel of Theodore F. Reynolds' automobile exploded at West Orange, N. J. The chauffeur was seriously injured, the automobile was wrecked, and the garage in which the machine stood was badly damaged. (Compare the next item.)

(51.) — The fly-wheel of an automobile belonging to E. B. Reynolds exploded, September 10, at Westhampton, N. Y. The chauffeur was badly cut about the face, and also received other injuries. (Note the extraordinary resemblance between this item and the one preceding. The two read like slightly variant accounts of the same explosion, and yet this is not the case.)

(52.) — On September 10 the fly-wheel of a Corliss engine exploded in the electric power plant of the Salt Lake & Ogden railway at Lagoon, near Farmington, Utah. Large fragments of the wheel were thrown through the roof of the power house. The property loss was estimated at from $5,000 to $6,000. According to the information at hand, the main belt broke, damaging the governor; and the engine then "ran away." A view of the wrecked wheel is presented herewith. (Note the governor belt, wrapped around the spoke.)

(53.) — A pair of fly-wheels, running on the same shaft, exploded simultaneously on September 11 in the power house of the Muskogee Gas & Electric Co., Muskogee, Okla. Fragments of the wheels were thrown high into the air, and the engine room was wrecked. The property loss was estimated at $8,000. Two views of the engine room are presented herewith.

Fly-Wheel Explosion No. 53.
(Muskogee Gas & Electric Co.)

(54.) — A fly-wheel exploded, September 16, at Bedford, Ind., in a quarry belonging to the Indiana Quarries Co. The powerman was badly hurt.

(55.) — On October 10 the fly-wheel of an engine used for sawing wood exploded on Miller's farm, Delaware township, Penn. The owner's ten-year-old son was killed.

(56.) — On October 16 a fly-wheel exploded in the power plant of the Consolidated Gas, Electric Light and Power Co., Westport, Md. The engineer was killed and two other men were scalded by the steam that escaped from pipes broken by the fragments of the wheel. According to *Power* (October 31, 1911, page 682), the accident was due to a piece of waste becoming caught in the gears of the governor, the engine then racing until the wheel was destroyed.

The Locomotive.

A. D. RISTEEN, PH.D., EDITOR.

HARTFORD, OCTOBER 25, 1911.

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Bound volumes one dollar each.

The twenty-eighth volume of THE LOCOMOTIVE, covering the two years 1910 and 1911, ends with the present issue. Indexes and title pages for the volume will soon be ready, and may be had without expense by those who save their copies for binding. Applications should be made by mail to the Hartford office of this company. Bound volumes may also be had shortly, at the usual price of one dollar each.

Obituary.

Mr. John Pelcher, a valued member of our New York inspection department, died on August 16th 1911, at his home at Ft. Richmond, N. Y. after a protracted illness. He was born in Brooklyn, N. Y. August 25, 1837. After an extended mechanical and engineering experience, part of which was spent with the Fletcher and Harrison Works as Chief Engineer, he entered the employ of The Hartford Steam Boiler Inspection and Insurance Company in 1886. Mr. Pelcher was high in Masonic circles and a man greatly esteemed by his friends and associates. He is survived by a widow and two children.

Some Minor Explosions.

Every little while we learn of the explosion of some small boiler, built by boys and operated by them for their own instruction or amusement. The consequences of these accidents are sometimes very serious. Two such explosions occurred, for example, on July 28,— one in Kentucky and the other in Texas. In the former case, two boys living at Owenton, Ky., had built a boiler and an engine, and had operated them successfully for several weeks. The boiler was constructed by using a ten-gallon oil can as a basis. As nearly as we can judge from the accounts at hand, a safety-valve had been provided, but it had become inoperative. The explosion killed one of the boys and fatally injured the other, and caused less serious injuries to three more. In the second accident, which occurred at Hearne, Tex., two boys were also involved, and the boiler consisted of a remodeled five-gallon can. The explosion scalded both of the boys badly.

Two persons were fatally injured, August 31, by the explosion of a peanut roaster at a prominent street intersection in Newark, Ohio. One of the injured men was struck in the head by a portion of the wreckage when he was walking in the street, a block away from the original position of the roaster.

Boiler Explosion at Weatherly, Pa.

One of the most destructive boiler accidents of the past year was that of December 12, 1910, at the silk mill of the Read & Lovatt Manufacturing Co., Weatherly, Pa. The event has already been briefly recorded on page 139 of the issue of THE LOCOMOTIVE for January, 1911; but because it so thoroughly illustrates the destructive possibilities of a boiler explosion, we present in this number a more complete account of the disaster.

The Weatherly mill consisted of a rectangular group of one-story brick buildings, containing the silk spinning machinery. At the rear of this group, and attached to it, were the engine and boiler houses. In one of the latter, and immediately adjoining the engine house, was a battery of five horizontal tubular boilers arranged with their rear heads parallel with and close to the

FIG. 1.—GENERAL VIEW OF WRECKAGE.

main mill. The battery was "pocketed", as it were, by the mill at its rear, by the engine house on one side, and by a second boiler house on the other. At its front a large amount of coal was stored, with a trestled track for its unloading.

At about 6.15 p. m. of December 12 the No. 2 boiler of the battery,— the second from the engine house wall,— exploded with great violence, killing two valued employees of the company and causing the damage that is partially indicated in our illustrations. Deplorable as was the actual loss of life, it was small in comparison with that which would most certainly have resulted had the accident happened for a few minutes earlier. The mill had shut down at six o'clock, and for several minutes thereafter the five hundred home-going employees were crowding the aisles and passages behind the boilers,— aisles

FIG. 2.— THE EXPLODED BOILER.

which were choked, after the explosion, with the heaped up débris of fallen walls. Nearly all had gone in time, however, and only Michael Mooney, the chief engineer, who was preparing, in the boiler room, to leave his charge, and Robert Beers, the night fireman on duty there, were exposed to the full force of the explosion and fell victims to its violence.

The destruction of property was very great, but even in this feature there were some fortunate circumstances which minimized the loss. The building containing the boiler was completely wrecked. Where it had stood there remained a mere heap of brick, wood, boilers torn from their settings, and tangled pipe and steel work. The engine house wall had been blown in and the roof had fallen, burying the main engine and its belt under tons of ruins. The spinning machinery at the rear of the boilers was bent and twisted under the load of brick from the wall which had separated that building from the boiler house, and throughout the main buildings quantities of silk were damaged, and glass and roofs were broken, by the flying bricks and mortar.

Of the five horizontal tubular boilers, those on either side of No. 2 were thrown from their settings and damaged beyond repair, though they did not themselves explode. The settings of boilers Nos. 4 and 5 were cracked and broken, and the fronts destroyed. A Manning vertical boiler, located in front of them, suffered only minor damage, and the second boiler house with its contents was practically unhurt. Had the engine and machinery been in operation when the boiler burst, or had the boiler taken flight through the mill instead of away from it, the loss, bad as it was, would have been greatly exceeded.

The No. 2 boiler burst in the rear course, the original failure occurring in the outer lap of the horizontal seam. The sheet was torn completely from the next course and partly from the rear head, and was whipped out nearly flat by the force of the explosion. It was found in the ruins of the walls, together with the rear head, and not far from its original position. The rest of the boiler (comprising the forward course and the front head with the tubes), driven by the reaction of the released steam at its rear, rose from its setting like a rocket, and, after a flight of three hundred feet in the direction it had faced, landed in a wood in the rear of the plant. The path of its projection was rather curiously marked by the height at which trees had been sheared off as it passed.

An investigation immediately following the accident cleared the owners and their employees of all suspicion of negligence in any way contributing to its cause. It was conclusively shown that immediately prior to the explosion the water was at the proper level in the boilers, and that the pressure was less than could presumably be allowed with due regard to safety. It was also shown that the safety-valves were adjusted to the proper pressure, and that they were in operating condition. An examination of the wrecked boiler (No. 2) failed to disclose any indication of low water or over-pressure as a possible cause. The examination made it certain, in fact, that the failure was due to one of those undiscoverable cracks to which a lap seam is occasionally liable.

The Read & Lovatt Manufacturing Company carried Hartford boiler policies,—not only the usual contract against direct loss, but also a "use and occupancy" contract, affording an indemnity for loss sustained because of the cessation of operations. The prompt payment that was made under both policies was an assistance greatly appreciated by that company in its time of trouble.

Repairs under Pressure, Again.

We have cautioned men, over and over, not to make repairs, nor to set up bolts or nuts, upon a boiler or other vessel that is under pressure. In our issue for April, 1911, for example, we gave a number of instances in which this procedure had resulted in serious accidents. Other cases are coming to our notice all the time. Thus in the issue of Power for July 4 we find the following item: "A serious accident occurred in the works of the Newburgh Rendering Company, Newburgh, N. Y., on June 20, in which one man was killed. A large boiler used for rendering purposes and carrying a pressure of

40 pounds per square inch began to leak around a 14-inch manhole cover. This cover was fastened by two lugs and shackles. A bar of iron with a large tee-bolt was used to tighten up the joint. On noticing the leak the engineer tried to tighten up the tee-bolt by placing a piece of pipe over the end, thereby overstraining the parts. One of the shackles gave way, the cover blew off, and the contents were strewn all over the engineer, resulting in his death. It appears that he had done this time and again, although cautioned to the contrary."

In connection with this item, we desire to call attention to following paragraph from our issue of July, 1911: "No repairs of any kind should be made, either to boilers or to piping, while the part upon which the work is to be done is under pressure. This applies to the calking of pipes and joints, to setting up nuts and bolts, and to every other operation by which extra stress is thrown upon any part that is already under a steam load. Accidents of the most serious nature are common, from neglecting this caution." We wish every engineer and fireman in the land would learn this paragraph by heart so that he could say it at once, if he were scared awake in the night.

An Air Receiver Explosion.

The writer is familiar with a power plant consisting, in part, of an old two-stage duplex belt-driven air compressor and an air receiver; the air is compressed to 80 pounds.

One afternoon the engineer was startled by a terrific report followed by a long and loud screech. The engineer examined the air receiver, where the disturbance seemed to be, and found that the spring pop safety-valve had burst. The compressor was stopped and a further investigation was made, when it was then noted that the lower section of the receiver was at a dull red heat and that the bottom head had been distorted so that the receiver stood some two inches off from its foundation, excepting at the center portion of the lower head.

A hurried investigation showed no rupture in the air piping or the receiver. The relief valve was then replaced and the compressor started. Everything was apparently in good order, except the receiver, which showed a few small leaks at the joints of the bottom head and shell. These joints were soon calked, and up to the present no further evidence of injury has appeared.

A mineral lard oil diluted with a large percentage of kerosene had been used during the previous winter with remarkably good results, and as its use was continued into the warm weather, the mixture undoubtedly caused the explosion.

In this case it is fortunate that the relief valve was weak and burst, because otherwise much greater damage would probably have resulted, as the pressure must have risen almost instantly.

Without doubt, compressed air is the safest kind of power and there is little or no danger in storing it, but the introduction of kerosene or gasolene into the oil to clean the cylinder and valves sometimes results disastrously. A solution of soft-soap and water is an excellent cleanser for an air cylinder and may be used without danger; it is even recommended where high-grade oils are used.

As the washing effect possessed by steam is lacking in air, it will be found that oil remains much longer in an air cylinder than in a steam cylinder; hence a surprisingly small quantity of good oil will lubricate an air cylinder without difficulty. Only the best oils of high flash and fire test should be used. They are the safest and also the most economical in the long run.

A frequent cause of explosion in compressed-air discharge pipes and receivers is an accumulation of carbon in the pipes or of oil in the receiver. Oil should be drawn off from all air receivers at frequent intervals.

Another cause of air-compressor explosions is the high temperature caused by the churning or continued recompressing of the air when the discharge valves leak.— ROBERT E. NEWCOMB, in *Power*.

Explosion of a Spanish Omelet.

Under the heading "Spanish Omelet Bursts: Big Scramble Follows," the *New York Herald* of June 22 records the following near-facts:

"That Spain is still a little bit hostile to the United States was demonstrated to a girls' class in cookery in Washington Irving High School, at No. 142 West Twentieth street, yesterday, when the rude behavior of a Spanish omelet resulted in the building taking fire. Miss Emma Crane, who was giving the lesson, sounded the alarm and all the girls went out with the idea that they were going through a fire drill. It was not until they reached the street that they learned of the perfidy of the omelet.

"Forgetting the 'safe and sane' admonition regarding fireworks, the girls yesterday decided on the preparation of a model Sunday night dinner that would make a man forget even a championship ball game. The dinner was to include the omelet, potato salad, strawberry shortcake, and tea.

"The glorious American hen had provided her best offering for the omelet, the tomatoes had been introduced into the mixture, the Spanish onion was feeling perfectly at home, and so were the peppers. The blow-up came when the Irish potatoes were put in. They swelled with indignation, and of course the omelet swelled with them. It began to look to Miss Crane as if her pupils had compounded a felony instead of an omelet. Finally the mixture, led by the potatoes, and desiring liberty or death, burst from the sheathing of yellow and landed on walls and ceiling. Much of the material landed against a blackboard on which the prescription for the meal was written.

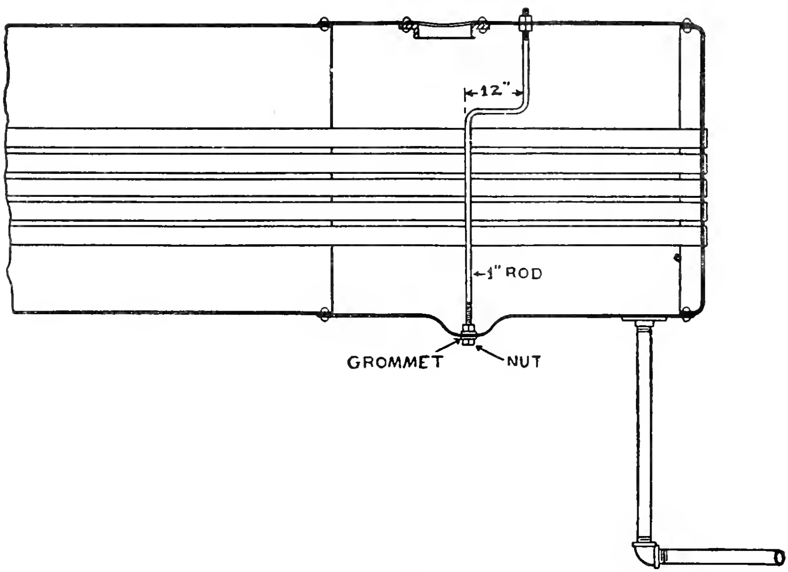
"When the alarm was given it was rumored that a meteor had fallen into the schoolroom, and all the meteor experts in town foregathered to look it over. They felt sure it was a composite of bronze, zinc, iron, and brass, that had been welded by a vitriolic solution, but they could not trace its relationship, and so put it in a class by itself.

"After the firemen had disposed of the omelet they found that the gas stove had also entered a protest by setting fire to the woodwork behind it, although this was protected by a sheet of iron. The scientists said there would be no loss on the menu meteor, as it could be melted down and used over again. The damage to the schoolroom itself is about fifteen cents, fully covered by insurance."

A Bulged Boiler Repaired.

In a certain plant below the Mason & Dixon line where the main purpose of operation is the extraction of a golden stream of oil from cotton seed, the attention of all hands was so firmly fixed on the main issue that less important details were slighted. Among these "details" happened to be the boilers. They had reposed for years in their allotted position, humbly digesting any and all of the fuel supplied and absorbing most of the water generously if spasmodically injected by the gentleman of color who attended their wants. As far as that end of the institution was concerned he was supreme and satisfied all requirements so long as enough of the mysterious gas was provided to drive the presses which produced the golden stream.

Whether the patient boilers ever suffered from indigestion or other complaint is not known, but one at least seems to have been afflicted by an irritation



HOW THE BULGE WAS BRACED.

of its enveloping cuticle which resulted in a "rise" or "bulge" of distressing dimensions. For when subsequent results finally forced attention the affected spot was about fourteen inches diameter and in it the material had been pressed out four and one-half inches from its normally smooth contour. It is probable that this trouble was of a gradual development unobserved by the aforesaid attendant amid the exactions of more important duties. Perhaps he did notice the swelling but either failed to realize its seriousness, or postponed too long the treatment for its alleviation. However this may be and however mixed our metaphors, the time came when boiler strength could endure no more, and either in a final spasm of distress or in one mighty effort for relief, the bulge was burst and one boiler's contribution to the golden stream interrupted.

Now up to this point the narrative may appear but the record of a commonplace and well understood boiler failure. We admit all this and that as such it is not of sufficient interest to justify its appearane in The Locomotive. But there is more to come, and as that "more" involves a most ingenious as well as a most ingenuous method of boiler repairs, we have felt it of value to our readers to set forth all of the circumstances.

Of course, the bursting of the bulge with its attending diminution of the stream of oil was a disaster that demanded immediate action, and the lack of an available substitute boiler clearly indicated that such action must be directed to the repair of the disabled vessel. Boilers, as a class, however, were scarce in that particular town and the demand for a specialist on their ills and remedies not sufficient to attract such a one to the neighborhood. Apparently, however, a general practitioner was at hand and his services secured.

To this man the remedy to be applied seemed obvious, or so his subsequent action would indicate. A hole had been blown through a bulge in the bottom of the shell and that hole must of course be plugged in some manner if the boiler was to again retain water and steam. But further that bulge was an evidence of weakness and that weakness must be reinforced or the bulge would continue to increase and eventually burst again. Clearly the steps to be taken must both stop the leak and prevent any further strain on the affected spot, and the scheme outlined in our illustration, appeared at once to successfully meet both conditions. The idea was evidently to prevent the bottom of the shell from straying farther by tying it to the top and by the method of securing the tie or brace to cover the rupture.

The general practitioner accordingly, with commendable skill, proceeded to prepare the hole in the center of the bulge for the passage of a one inch rod on which threads had been run at either end. This rod was then passed up through the hole and between the tubes to the top of the shell where a second hole was to be drilled directly over the bulge. But here the fates were against him, for on opening the man-hole the first thing that appeared was the end of the rod projecting vertically from the lower sheet to near the center of the man-hole opening. Clearly at this point no convenient material existed for drilling a hole. But the situation was not unsurmountable. If the rod could not be fastened at one point, why, of course, it must reach another where better conditions obtained. So a new rod was procured of a length sufficient to permit of the necessary offset, and this second rod secured by grommets, nuts and check nuts, both to the bulge and to the top of the shell at a point where the man-hole could not trouble.

The success of these repairs was unqualified, at least in the minds of those who continued the operation of the boiler through that season's production of the golden stream. The aforesaid attendant continued his attention to his charges with full confidence in the protection of that brace, and the general practitioner went on his way rejoicing at another deed well done. It is not surprising under such circumstances that an officious boiler inspector who visited the plant the following year, was generally criticised for requiring the removal of the brace and the heating and setting back of the bulged plate to its original position, with a patch covering the hole.

Explosion of a Dye Extractor in England.

[The British "Boiler Explosions Acts" of 1882 and 1890 require that an investigation be made, under the auspices of the British Board of Trade, whenever a boiler or other similar vessel carrying steam under pressure explodes. We reproduce one of these reports below. It relates to the explosion of a dye extractor, and is dated August 11, 1911. It contains lessons that can be profitably learned in this country, as well as in England.]

In pursuance of our appointment, dated the 12th day of July, 1911, we held a formal investigation in the above matter at the Broughton Town Hall, Broughton, Salford, on the 25th, 26th, and 27th of July, 1911, when Mr. George C. Vaux appeared for the Board of Trade, Mr. Cyril Dodd, Solicitor, of Manchester, appeared for the Winterbottom Book Cloth Company, Limited (the owners), Jonathan Barnes (their manager), and William Sutherland (foreman mechanic). Having heard and carefully considered the evidence, and having inspected the dye extractor which exploded, we beg to report as follows: —

The explosion occurred at 1.55 p. m. on the 19th October, 1910, at Broughton Dye Works, Blackburn Street, Salford, Manchester. The dye extractor was the property of The Winterbottom Book Cloth Company, Limited, 12, Newton Street, Manchester. Samuel Galloway, the person who worked the dye extractor, was so severely scalded that he died from shock the following day.

The apparatus, which was used for extracting dye from dye-wood, consisted of a vertical cylindrical cast-iron vessel 3 feet in diameter, and 7 feet 2 inches in height. The cover or top of the vessel was dome-shaped, and was secured to the body by means of internal flanges fastened together with 24 bolts originally 9/16 inch in diameter. The flanges had not been machined or faced in any way, but they were made steam tight with a rust joint the thickness of which varied from 1/8 inch at the inner edge to 5/16 inch at the outer edge.

There was a hole 12 inches in diameter in the center of the cover, which was fitted with a suitable door, and was provided for the purpose of charging the apparatus with dye-wood. An elliptical hole, 13¼ inches by 9¼ inches, with a suitable door, was provided in the side of the vessel near the bottom for withdrawing the spent charge, and which could also be used as a man-hole for internal examination. A perforated plate, having holes ⅛ inch in diameter, pitched 1 inch apart, was fitted near the bottom of the vessel to act as a strainer when the liquor was being discharged.

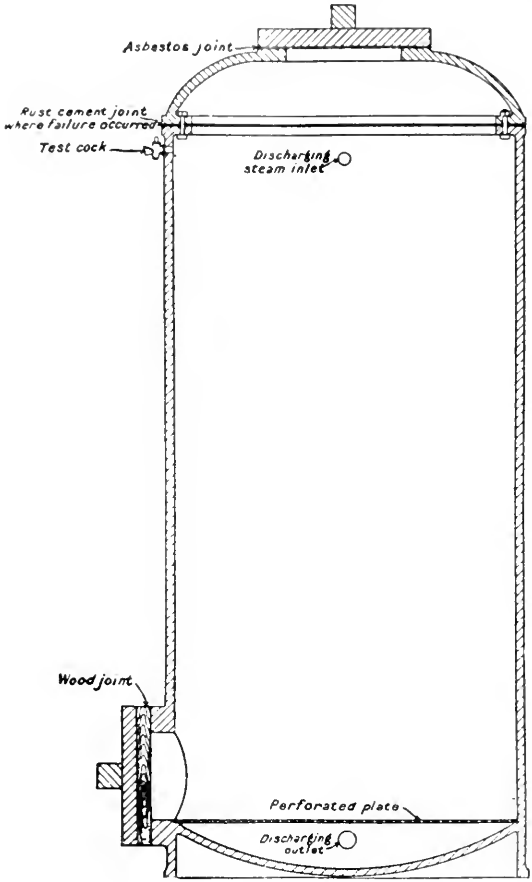
A branched wrought iron pipe, 1¼ inches in diameter, was fitted near the top of the vessel for the admission of hot water when preparing the charge, and steam when discharging the liquor. The branch leading to the water supply was provided with a cock, and a valve was fitted on the steam branch. The heating steam pipe, which was 1¼ inches in diameter, entered the vessel at the bottom, and was provided with a cock. A 2-inch pipe and cock was also fitted to the lower part of the vessel for discharging the liquor into a receiving tank overhead, the open end of the pipe being at a height of 15 feet above the bottom of the apparatus. There was a ½-inch test cock fitted on the front of the vessel near the top.

The apparatus was not provided with either a safety-valve or pressure gage.

The maker and the age of the dye extractor are unknown, but it came into the possession of the company in 1891. It was not insured, and the only person who inspected it was Mr. William Sutherland.

The rust joint under the cover of the dye extractor was partly remade in July, 1910, and entirely remade on October 3, 1910.

The cover was blown off, and the contents of the dye extractor were discharged from the top. The explosion was not violent, and was accompanied by



THE DIGESTER BEFORE THE EXPLOSION.

a dull report.

The cause of the explosion was that the pressure of steam in the dye extractor was more than it could withstand. Its strength when new was not equal to a pressure of more than 19 pounds per square inch, but when it exploded the bolts which held the cover were much corroded. Half were eaten through and the rest reduced from 9/16 of an inch to 3/8 of an inch in thickness, while the greater part of these were fractured.

At the conclusion of the evidence we stated as follows: —

The case we have had to inquire into is a little out of the common. The vessel which exploded is not a boiler in the common acceptation of the word, though it is a boiler within the provisions of the Boiler Explosions Act. It is called a dye extractor or kettle, and it was used in the extraction of dye. Steam was not generated in the vessel itself, but was admitted into it for two purposes: (1) for boiling the material from which the dye was to be extracted, and (2) for forcing the liquor from the kettle to tanks at a higher level after the dye had been extracted. The pressure of steam required for the latter purpose (which completed the process of extraction of the dye) did not exceed 14 pounds. The kettle was not calculated to bear a strain of more than 19 pounds to the square inch when it was new, so that neither in the pressure of steam the vessel had to stand, nor the use to which it was put, was it in the ordinary sense a boiler.

There were four of these kettles, and they form only part of extensive works for the manufacture of book cloth. The works as a whole require considerable steam power to drive the various machines used in this manufacture. The particular boilers from which steam was taken for the kettles at the date of the explosion, and from about the year 1904, were two Galloway boilers worked at a pressure of about 70 pounds. This pressure, being far in excess of anything required for the kettles, was reduced to 57 pounds by a reducing valve on the main steam pipe range, and further reduced by another reducing valve in a shed at the back of the kettles to 14 pounds. On this last-mentioned reducing valve a pressure gage was fixed, so that it could be seen whether the reducing valve was at all times in working order.

It is not necessary to refer to the description of the kettle, the particulars of which have already been given, but we should observe that there was no safety valve on any of the kettles. The age of the kettle which exploded is not known. It was taken over by the present owners in 1891, when they acquired the business from Messrs. Samuel Dewhurst & Company.

Perhaps it would be convenient to describe the staff at the works. There was the staff of workmen employed in the manufacture of book cloth, and there was the engineering staff. The engineering staff consisted of a foreman mechanic, Mr. Sutherland, and about 43 men, mechanics, joiners and laborers, and so on, and among them were five mill-wrights. Mr. Sutherland had had a very long experience, and had been 18 years with the present firm. He had charge only of the steam plant and machinery, including the upkeep and maintenance of the kettles. Mr. Jonathan Barnes was the manager. He was a chemist, and an expert in dyeing, and he depended upon Mr. Sutherland to advise him as to matters connected with the steam plant. The only person to whom it is necessary to refer in the manufacturing staff is Galloway, the unfortunate man who was scalded to death by the explosion. Galloway had to look after the charging and emptying of the kettles, and in that duty he acted under Mr. James Tomlinson, the foreman of the dye works.

The method of using the kettles is as follows: —

The dye-wood, in the form of coarse sawdust, is introduced through the small door in the top of the kettle, the amount usually put in for one charge being about 112 pounds. Hot water at a temperature of 212° F. is then run in until the vessel is three-quarters full. The kettle is then closed and heating steam blown in at the bottom to boil the liquor. The contents of the kettle are kept on the boil for 40 minutes. The pressure in the kettle must be 14 pounds above the atmosphere. This is necessary to force out the dye-wood extract. There is a ½-inch tap at the top, which should be kept open for the release of air in the kettle, and for the purpose of testing the liquor. After the contents of the kettle have been boiled sufficiently the steam is shut off at the bottom, and steam is then admitted at the top, and the discharging outlet at the bottom is then opened, by means of which the liquor is forced up the discharge pipe to the receiving tank on the floor above.

We can now describe the events which led up to the explosion. These kettles, during the 18 years that Mr. Sutherland had charge of them, had never required any material repairs. There had been one or two slight matters, but they are not worth mentioning. In July, however, of last year, the rust joint of the kettle that exploded gave way, and what is called "blew." Mr. Sutherland then gave orders to Halley, a fitter, to take out the joint of the part that had failed and re-joint it with iron filings and sal ammoniac. The kettle was allowed to stand for about a week, and after that it was worked. Later leaks developed between the joint of the part newly made and the old jointing, and Halley was instructed to take out the whole of the old jointing and re-make it without removing the cover (referred to in the evidence as re-calking), taking care not to touch the bolts in any way. Halley began this work on the 24th September, and finished it on the 3rd October. Nothing material happened that we are aware of until the 19th October, the date of the explosion. On that day, Galloway, about 12 o'clock, told Mr. Sutherland that the kettle had been blowing. As to what followed we prefer to rely on what Mr. Sutherland said at the inquest rather than on what he told us here. At the inquest he said: "About 11.33 a. m. on Wednesday last (the day of the explosion), Galloway again complained to me about the kettle leaking in the same place and asked me to have a look at it after dinner. I told him I would see it after the dinner hour, but the explosion occurred before I could get there." At a quarter past one, Halley, who had overheard part of this conversation, went and saw the kettle because, he said, he was anxious about it. He said he told Galloway not to use it, but said nothing about it being unsafe. At 1.55 the explosion took place. George Tomlinson (a boiler attendant) says that Galloway ran out and met him in the yard and told him the cover had blown off. Galloway, unfortunately, was very badly scalded, and subsequently died from his injuries.

We now come to the events after the explosion, and the inquiries which took place to account for the explosion. It was found upon an examination of the reducing valve, which was in the shed at the back of the kettles, that it was out of order, and it was demonstrated by experiment that steam would pass through it to the extent of 50 pounds pressure per square inch. The cause of this was that a locking pin which prevented the valve screwed on the spindle from gradually working off was not in its place, so that the valve unscrewed, and was, to all intents and purposes, useless. It was also found that the pressure gage which had been fitted on the kettle or reduced side of the valve had been removed, and so prevented anyone from ascertaining whether the reducing valve was working or not.

Upon an examination of the cover of the kettle it was found that only five bolts held it and these had been reduced to about ⅜-inch in diameter on an average, owing to corrosion, and that the remainder must have been fractured before the explosion. Altogether, 24 bolts ought to have secured the lid.

A curious feature of the evidence was that all the valves, both for inlet and outlet of steam, were found closed immediately after the explosion, so that it is difficult to understand how any explosion could take place if this were the fact, but there is no evidence before us as to what Galloway did. It may be that at the moment of the explosion he was on the pavement at the bottom of the kettle and suddenly closed the valve on the right hand side of the kettle. Whatever may have happened is a speculation, but we are inclined to think that the full pressure of steam was not being admitted into the kettle at the time of the explosion, because the explosion was not violent. All that was heard of the explosion by those who were a few yards away was a dull report. The cover was blown off and the contents of the kettle were discharged from the upper part and in this way Galloway was very severely scalded. David Barnes, a laborer, who was standing about 10 yards away from the kettle, was splashed with the liquid, but he was not injured.

The most important matter in all these discoveries was the removal of the pressure gage. Mr. Sutherland admits that he ordered it to be removed by a man named Allen. He, Mr. Sutherland, did so (he told us), because they were breaking up an old boiler in the shed where the gage was, and he wished to prevent the gage from being broken or destroyed. Unfortunately he never gave orders for it to be replaced, and it never was replaced, and he knew it was a serious matter. There was no reason for its removal because it could have been cased and protected from damage in a perfectly simple manner.

As regards the reducing valve. This was said to have been examined by Mr. Sutherland once a year, but the last examination was in July, 1909, a period of 15 months before the explosion. We find that Allen was the only person who touched the reducing valve, though he said other persons touched it.

As regards the bolts of the cover, these had never been removed or renewed during the whole period that Mr. Sutherland was in these works, and the cover during that period had never been taken off. In July, when part of the kettle lid was rejointed and later, when the whole was rejointed, Mr. Sutherland might have examined the bolts, but he told us he found the nuts quite sound, and thought the bolts would be equally sound.

No proper inspection had ever been made of this kettle as far as we have heard. Mr. Sutherland described how he inspected it, but this could not be considered in any way a thorough inspection. He merely looked through the small door at the top and examined the inside as far as he could see it with the light of a candle. We should have thought that the fact that leaks were taking place in the joint of the cover would have been sufficient warning to Mr. Sutherland to inquire carefully into the cause, but he appears to have attributed the leak to the perishing of the joint, and not to any increased pressure of steam.

We have now to consider who is responsible for the accident, and we come to the conclusion, without any doubt, that Mr. Sutherland was the person, and the only person, responsible. In the first place he took off this pressure gage and did not replace it, although he knew the danger of taking it away, and of the reducing valve being left without any pressure gage. Further than this, though he was asked by Galloway at about 12 o'clock on the day of the explosion to go and look at the kettle, which was blowing, and promised to go, he did not do so, as he ought to have done, and the explosion occurred.

Further, he failed to inspect the reducing valve for 15 months. Then there were what we might consider minor faults. He never made any proper examination of the kettle, and when the joint of the cover was remade he never tested the bolts.

Though not contributing to the explosion, we ought to call attention to the lax way he performed his duties in other ways. It appeared that Galloway had been tampering with the reducing valve (and Mr. Sutherland knew it), for over 15 months, by weighting the arm of the lever so as to increase the pressure of steam. During that period Mr. Sutherland never made any communication to Mr. Barnes, the manager, as was his duty to do, and it was only on the last occasion, in June, 1910, that he made any report, and that, he told us, he did in a mild sort of way so that Galloway might not lose his place. We have some sympathy with Mr. Sutherland in not wishing to see a workman discharged. At the same time, in matters of this kind, lives must not be risked for fear of causing a workman to lose his place.

The chief failure in duty, which it is impossible for us to overlook, was the removal of the pressure gage. Mr. Sutherland said that he would not be satisfied to work in front of a boiler in which there was a pressure of steam, without a pressure gage. In this case, by removing the pressure gage, he was not risking his own life, but the life of the man who had to attend to the kettles. There is this to be said, however, that Galloway was equally reckless, for while the pressure gage was there, and while he might have known what the pressure was, he weighted the valve so as to get more steam, entirely regardless of what the consequences might have been.

We have had an opportunity of inspecting the works, and we are pleased to find that abundant precautions have been taken by the owners for the safe working of these kettles in the future. Safety valves have been fitted on the kettles, and also on the pipe on which the reducing valve is fixed. Further, we desire to say we have every reason to believe that had the firm at any time prior to this accident been advised that any additional precautions were necessary, they would not have failed to take them. Mr. Sutherland, we were told, always had a perfectly free hand to get whatever repairs he thought necessary done, and he was in entire charge of the steam plant. The manager, Mr. Barnes, had no knowledge — no particular knowledge — of steam plant, and therefore he depended, naturally, upon Mr. Sutherland, who is the person to blame.

We have now to answer certain questions which have been put to us by Mr. Vaux, and we will do so in order. The first is: "When did the logwood kettle which exploded become the property of the Winterbottom Book Cloth Company, Limited?" The answer is: In 1891, but it was not new when they acquired it. "Was it provided with proper fittings?" The answer to that is: It was provided with the usual fittings, but these were insufficient for safe working.

The second question is: "When and by whose orders was the pressure gage on the reducing valve fitted on the pipe which conveyed steam to the kettle removed?" The answer is: By Mr. Sutherland, in July, 1910 "Was the reducing valve at that time in proper working order?" We cannot say. There was no evidence before us.

Question 3: "Did Mr. William Sutherland, foreman mechanic, take proper measures after the pressure gage had been removed to insure that the reducing valve was working properly? The answer is "No."

Question 4: "What was the cause of the joint of the cover of the kettle leaking in July and September, 1910?" The probable cause was either that the rust joint had perished, or that the bolts were giving way owing to corrosion, or both causes may have contributed to the leak. "Were proper measures taken by Mr. William Sutherland on those occasions to ascertain the cause of the leak, and to insure that the kettle was not again worked before proper repairs had been effected?" The cause of the leak was assumed by Mr. Sutherland to be due to the perishing of the rust joint. He took no steps to ascertain whether the bolts were corroded or not, or whether the leaks were due to excessive pressure of steam in the kettle.

Question 5: "By whose orders or sanction was the kettle worked on the 19th October, 1910?" With regard to that question we find it was with the sanction of Mr. Sutherland, for he knew on that date that it was being worked, and made no protest, and gave no orders for it not to be worked when he was told it was blowing.

In answer to question 6: "What was the cause of the explosion?" The cause of the explosion was that the pressure of steam in the kettle was beyond that which the kettle could stand.

Question 7: "Was the supervision and management of the kettle intrusted by the Winterbottom Book Cloth Company, Limited, to competent persons?" Our answer to that is "Yes."

Question 8: "Were the kettle and fittings periodically inspected by a competent person?" They were inspected by a competent person, but the inspection was insufficient for the purpose of ascertaining whether the kettle could be worked under safe conditions or not, and as we have already pointed out, the reducing valve at the date of the explosion was not in working order, while the pressure gage which would have denoted this had been removed 10 weeks before the explosion, and had not been replaced.

Question 9: "Did the Winterbottom Book Cloth Company, Limited, take proper measures to insure that the kettle was being worked under safe conditions?" Yes, by employing a competent foreman mechanic.

Question 10: "Are the Winterbottom Book Cloth Company, Limited, Mr. Jonathan Barnes, their manager, and Mr. Sutherland, their foreman mechanic, or is any, and which of them, to blame for the explosion? Should any, and which of them, pay any and what part of the cost of this formal investigation?" The only person we find to blame for the explosion is Mr. Sutherland, for the reasons we have already given, and we order him to pay £20 towards the cost of this inquiry.

TALKING about old boilers reminds us. We were recently called on to inspect a boiler that was not under insurance. We do not do this ordinarily, but we yielded in the present case, because of the unusual circumstances. "The boiler has quite an interesting history," says the inspector. "During the Civil War there was a battle just above this place, and several gunboats were sunk in the river. This was one of a pair of boilers on one of the gunboats. After the war it was fished out of the water and set up on the bank, by a man who had a contract to make coffins for the government, to bury the soldiers in. It has been in that same setting ever since, and has been run practically steadily, up to about three years ago. A colored man who said he fired it, told me that a pressure of 125 lbs. per square inch was often carried upon it." It is a wonder that the operators of this plant didn't have to use one of their coffins for their own engineer.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1911.

Capital Stock, . . . $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission, ...		$174,137.52
Premiums in course of collection, ...		209,440.08
Real estate, ...		91,400.00
Loaned on bond and mortgage, ...		1,140,810.00
Stocks and bonds, market value, ...		3,180,527.72
Interest accrued, ...		71,231.96
Total Assets, ...		$4,867,547.28

LIABILITIES.

Premium Reserve, ...		$2,010,733.76
Losses unadjusted, ...		130,809.04
Commissions and brokerage, ...		41,888.01
Other liabilities (taxes accrued, etc.), ...		45,149.16
Capital Stock, ...	$1,000,000.00	
Surplus over all liabilities, ...	1,638,967.31	
Surplus as regards Policy-holders, . .	**$2,638,967.31**	2,638,967.31
Total Liabilities, ...		$4,867,547.28

L. B. BRAINERD, President and Treasurer.
FRANCIS B. ALLEN, Vice-President. CHAS. S. BLAKE, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
W. R. C. CORSON, Assistant Secretary.

S. F. JETER, Supervising Inspector.
E. J. MURPHY, M. E., Consulting Engineer.
F. M. FITCH, Auditor.

Incorporated 1866. | Charter Perpetual.

The Hartford Steam Boiler Inspection and Insurance Company

ISSUES POLICIES OF INSURANCE COVERING

ALL LOSS OF PROPERTY

AS WELL AS DAMAGE RESULTING FROM

LOSS OF LIFE AND PERSONAL INJURIES DUE TO EXPLOSIONS OF STEAM BOILERS OR FLY WHEELS.

Full information concerning the Company's Operations can be obtained at any of its Agencies.

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BALTIMORE, Md., . . 13-14-15 Abell Bldg.	LAWFORD & MCKIM, General Agents. R. E. MUNRO, Chief Inspector.
BOSTON, Mass., . . 101 Milk St.	C. E. ROBERTS, Manager. F. S. ALLEN, Chief Inspector.
CHICAGO, Ill., . . . 160 West Jackson St.	H. M. LEMON, Manager. JAMES L. FOORD, Chief Inspector. J. T. COLEMAN, Assistant Chief Inspector.
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DENVER, Colo., . . Room 2, Jacobson Bldg.	THOS. E. SHEARS, General Agent & Chief Inspector.
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NEW ORLEANS, La., . 833-835 Gravier St.	PETER F. PESCUD, General Agent. R. T. BURWELL, Chief Inspector.
NEW YORK, N. Y., . . 100 William St.	C. C. GARDINER, Manager. W. W. MANNING, Chief Inspector.
PHILADELPHIA, Pa., . 432 Walnut St.	CORBIN, GOODRICH & WICKHAM, General Agents. WM. J. FARRAN, Chief Inspector. S. B. ADAMS, Assistant Chief Inspector.
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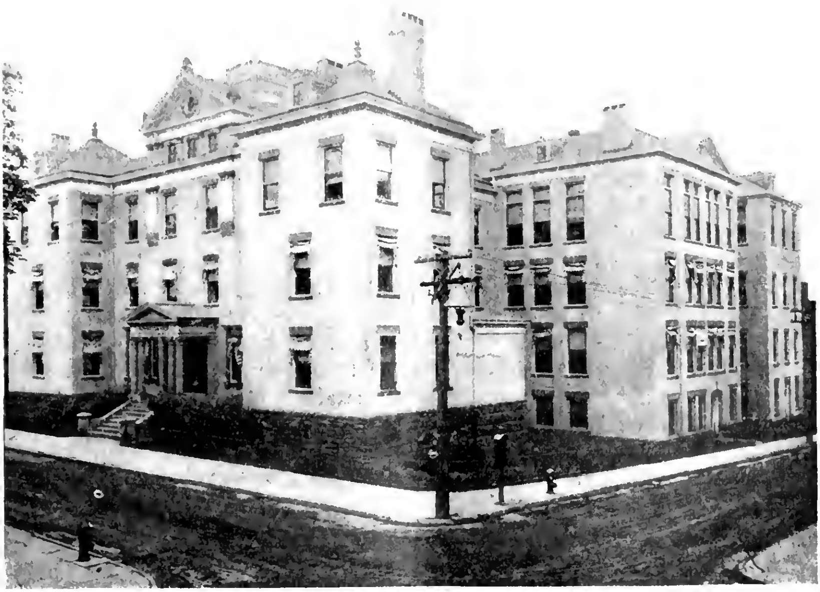
The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

Vol. XXIX. HARTFORD, CONN., JANUARY, 1912. No. 1.



HOME OFFICE BUILDING

Prospect and Grove Streets, Hartford, Conn

Water Gage Glasses.

CHARLES S. BLAKE.

The breaking of water gage glasses is of such frequent occurrence, that a few words concerning their attachment and use may, if heeded, prevent some accident and possibly personal injuries, besides the annoyance of frequent replacements.

The use of a visible gage as an auxiliary to indicate height of water in a steam generator has become a recognized necessity, and is required by authorities exercising jurisdiction over boilers. One municipality at least places such value on their use as to recognize a second gage glass as a substitute for the gage cocks and does not require the latter when two gage glasses are properly affixed.

The ordinary or customary gage glass is a plain cylindrical tube, ranging for ordinary use from ⅝ inches to ⅞ inches in diameter and of a length to suit the varying conditions and types of boilers. These diameters are outside dimensions. They vary slightly, but as the glasses are set in compressible washers such variation is not detrimental. They are made in this country and abroad, but those of Scotch glass are considered the best. The very nature of the material makes it brittle, and aside from its brittleness it possesses other peculiar qualities that when known should cause engineers and firemen to handle these glasses with more than ordinary care. A novice in examining a gage glass will almost immediately pronounce it defective, because of the fine lines running lengthwise in it; but such lines are usually indicative of good quality and are more pronounced in the Scotch glass than in the American.

All glasses are keenly susceptible to surface abrasions, even so minute as to be unobservable. If one receives the slightest scratch inside or out, it should not be used, and in handling or keeping them in stock, no metal of any nature should be allowed to come in contact with them. They are particularly liable to break if iron or steel touches them, and so should never be laid down even temporarily with tools, as is frequently done in preparation for a renewal.

It may sometimes be thought desirable to clean an old glass when it has every appearance of being whole and sound. In such an event waste or a cleaning cloth should be used and should be pushed through the bore by means of a wooden stick small enough to pass without force. As a rule, however, the price of gage glasses is too low to bother with the cleaning of old ones, and if one shows any deterioration at its ends, it should be discarded in any case.

In the prevention of accidents, not the least measure of importance is to have the receptacles for the glass properly attached before trying to insert it. Every one who has had occasion to put in gage glasses is familiar with the so-called gage glass "cocks," which form its support. They are not cocks, however, but valves. In some of the special types of water glass connections, cocks are used as a means of closing, but the percentage in use is very small. The valves are fitted in various ways,— sometimes directly into the boiler plate, more commonly into water columns of cast iron or those improvised from ordinary pipe and fittings. The openings to receive the valves should be parallel and threaded an equal depth, so that when the valves themselves are screwed in position the sockets in them for the reception of the glass will be in a direct line. Both top and bottom valves have these sockets bored out to a considerable depth. If the eye cannot detect the valves out of line, the glass should be inserted in them, to more clearly determine whether the valves are in true alignment or not. The glass should be cut to the greatest length that will permit its insertion, one cock or valve usually admitting it to a greater depth than the other.

In the selection of a glass, one should be used that will freely enter the valve receptacle and leave a little space around it when in position, and the nuts or glands for compressing the gaskets should be large enough not to touch the glass when screwed up. Only fresh, pure rubber gaskets or washers cut by machine, uniform in size, and prepared for such purpose should be used. After inserting the glass in the valves, it should be shifted so the washers will be at an equal distance from its ends. This is very important, for the writer in his investigations of boiler explosions has found two instances where a washer softened by the heat, under pressure of the gland, has squeezed out under the glass and closed the opening, thus permitting a false indication of the water level. The glands should first be screwed by hand, each a little in turn until they can no longer be moved by the fingers. Then a small wrench may be used on them alternately, until the glass is firm in the packing. Care should be taken that the glass does not shift in its vertical position, during this operation.

It may be needless to say that in renewing a glass with pressure on the boiler, the valves should be closed tight and the drip opened to release the pressure before attempting the removal. When a new glass has been put in, if the valves are not provided with means for opening at a distance, a board or sheet-iron shield large enough to protect one's head should be held between the face and the glass, and the valves then opened very easily and slowly to their full extent. When they are open, it is advisable to retire with the shield in front of the face to observe at a distance whether there are any leaks, and if any appear, to return to the glass with the face still protected, shut off the valves, release the pressure through the drip, and then tighten the nuts. Never under any circumstances attempt to tighten them with pressure on the glass.

In the writer's experience, he has found it possible to make the joints tight by only a slight pressure of the wrench and whenever he has found gage valves out of alignment he has trued them up. As a result of this practice during considerable experience with marine and stationary boilers never has he had a glass break under pressure.

If gage glasses are properly handled and used they will withstand great extremes of temperature, although it is well to guard against drafts from outside in cold weather. In the selection of glasses it is not necessary to pick out the ones with the heaviest walls, for those with slightly lighter walls are as strong and will last as long as the thicker ones.

The great precaution is to keep the surface from being scratched, for, as every engineer knows it requires but the slightest breaking of the skin of the glass in a circumferential way to cause it to almost fall apart. The peculiar phenomenon of the glass breaking which has lain next to iron or steel has never been explained to me, but I have a number of times as an experiment, taken a glass, run a smooth rod of iron through it and put it away. Sooner or later it has been found shattered in many pieces. My first observation of this phenomenon was when I placed a glass on a shelf in an engine room with a large pocket knife against it to keep it from rolling off. The next day I found the glass all in pieces but the pieces in their respective positions, showing that the breakage was not from violence else the pieces would have been scattered.

A Scotch Marine Boiler Explosion.

Because of the small number of Scotch marine boilers in the United States, it is comparatively rare that an explosion of one is recorded, and owing to this fact a layman often has the impression that this type is proof against explosion. That this is not the case, however, is shown by the following account of an accident to such a boiler which occurred at the plant of The Mt. Clemens Sugar Company, Mt. Clemens, Mich., on October 30, 1911. The photograph, Figure 1, gives some idea of the condition of the front of the boiler after the explosion, but the main damage was at its rear, where it was difficult to obtain a picture suitable for reproduction.

The vessel was what is known as a "wet back boiler." The general construction of such a vessel is shown by the line cut, Figure 2. The tubes and flues terminate in an internal tube sheet, "D," and communicate with a combustion chamber, "A," within the shell. The back of this chamber is formed by a sheet, "B," stayed to the rear head, "C." The space between sheet "B" and head "C" is filled with boiler water under pressure and gives the name "wet back" to the type. It was the bursting of this "wet back" and the consequent collapse of the combustion chamber that occasioned the disaster. Its initial cause was the pulling off of sheet "B" from the 172 staybolts which held it.

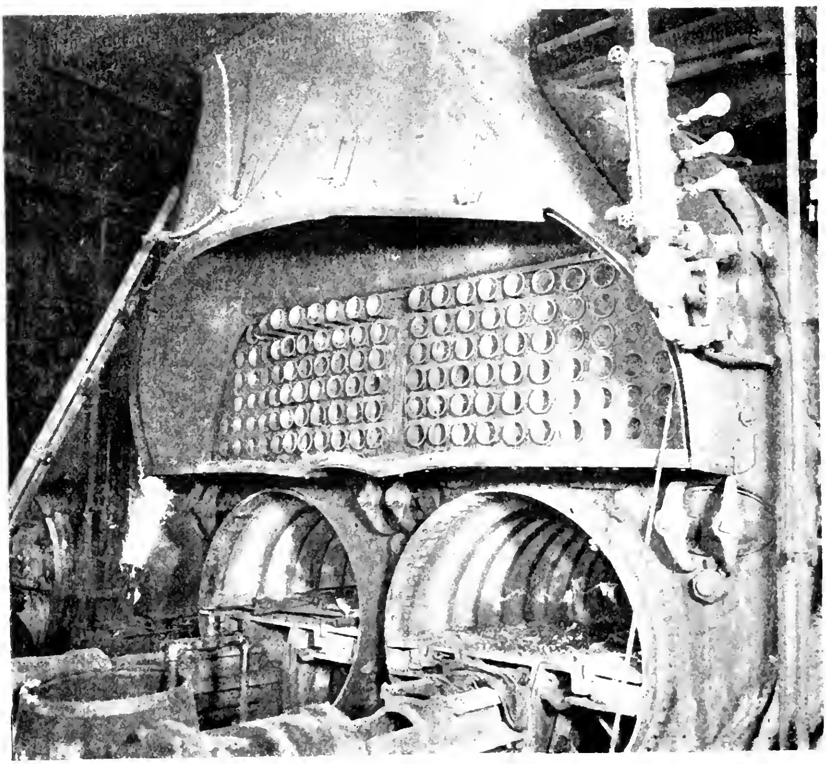


FIG. 1. DAMAGED FRONT OF BOILER.

An investigation disclosed the fact that the holding power of many of these staybolts had been greatly diminished by the buckling of sheet "B" between them, this buckling causing the staybolt holes to take a conical shape with the larger diameter of the cone on the water side of the sheet. This deformation of the holes disengaged the threads to such an extent that those remaining were unable to support the load imposed on them by the boiler pressure.

The boiler at the time of the accident was connected in line with seven others, on which all pop valves were set to 105 lbs. per square inch, so there is a reasonable certainty that the pressure did not exceed this amount. The staybolts on sheet "B" were $1\frac{1}{8}$ inches in diameter and spaced $7\frac{1}{4}$ inches apart each way, and the sheet was 15/32 of an inch in thickness. The only

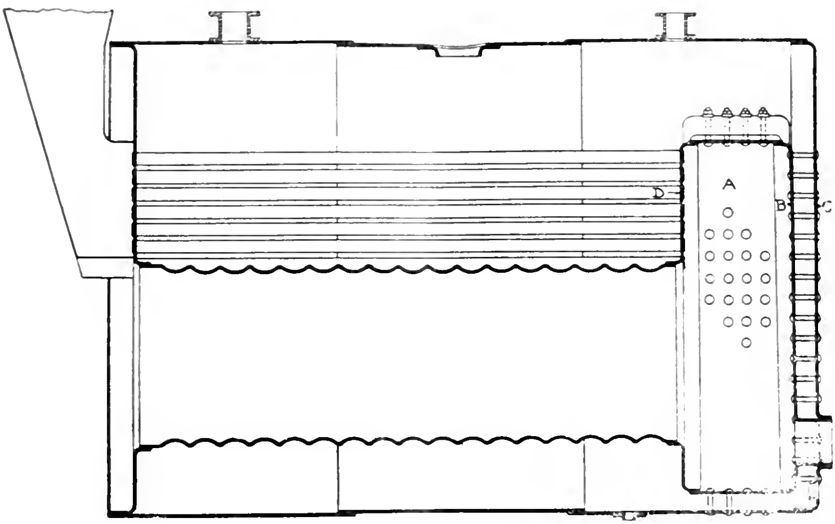


FIG. 2. SECTION OF BOILER.

plausible explanation as to how a pressure which did not exceed 105 lbs. could seriously buckle a sheet of this thickness held by stays in the manner described, is that the sheet was weakened by overheating.

From the data at hand the cause of this overheating cannot be definitely determined, but the boilers were reported clean, and if such was the case, forced driving or low water was probably responsible. Sheet "B" was thrown forward against the rear tube sheet "D" with such force that it drove a number of tubes through the front head, some of them extending as much as six inches from its face. This is shown on the accompanying view of the front of the boiler.

Three men were seriously scalded by this accident, one being so severely injured that he died shortly afterward. The property damage was chiefly confined to the boiler, with the exception of a brick wall located some distance in front, which was thrown down by the force of the explosion. The doors and hoppers of the boiler front were blown through a window twenty feet away.

An Investigation of Electrolysis in Boilers.

W. R. C. CORSON.

About a year and a half ago a case of abnormal tube pitting was brought to the attention of THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY and its assistance asked in seeking the cause and a relief for the trouble. The investigation which followed resulted in the discovery of so unexpected an electrical condition of the affected boilers that it is believed a description of it and of the apparently successful remedy which was applied will be of general interest and suggestion to those who may have steam vessels similarly circumstanced.

At first sight, the trouble appeared but the commonplace pitting which frequently occurs where a "pure water" is used for the feed, and an analysis of it promptly pronounced the water in that category. The action of such waters has been discussed at length in THE LOCOMOTIVE for June, 1896. It is here but necessary to say that it is attributed to the acids or oxidizing gases generated in a boiler from a water which does not carry alkaline salts to neutralize them. In the case in hand, tube pitting was to be expected from the "pure water," but the rapidity of the corrosion aroused the suspicion that some other influence existed to exaggerate that action and as the boilers were in the power house of an electric railway, electrolysis immediately suggested itself among the possibilities.

Now it should not be understood that those who were assigned to this investigation jumped at any conclusion thus suggested. One, at least, of these investigators (the writer admits identity) very much doubted the possibility of any such explanation. The general theory of the action of a current straying from the rails of an electric road was understood, but that it could wander into a boiler and cause any action there was not comprehensible. As THE LOCOMOTIVE once put it in doubting the responsibility of a stray current for the corrosion of an internal feed pipe, "It is hard to understand how an electric action from such a cause could take place within the closed conductor formed by a boiler shell." It was accordingly with a skeptical mind but in a spirit of thoroughness that preparation was made to investigate the electrical situation.

The boilers — three Manning vertical tubulars — were found in a power house typical of street railways of the smaller class. It was located in the rear of a car barn and repair shop which in turn fronted on the highway and main track of the railroad. In the power house a room containing the engines and dynamos was nearest the car barn, and immediately behind it the boiler room. In a rear addition a storage battery was installed for equalizing the load on the station.

Hydrants on the highway at either side of the car barn corroborated the statement of the superintendent that a water main was buried in the street and paralleled his rails for a considerable distance. These hydrants were the points selected for the first of the electrical tests. A low reading voltmeter was used and connected with one terminal in contact with the hydrant and the other with a rail. The object, of course, was to determine whether a difference of electric potential existed between these structures, and if it did, what its value was and which structure was of higher potential. The reading of the instrument fluctuated to some extent but was a maximum at about two volts, with the hydrant at the higher or positive potential. The condition thus indicated was expected, as it is characteristic of underground piping near a railway power house. The readings if anything were lower than usual, but served to show that the pipe and rail were not metallically connected in that vicinity, and that there was the tendency for a flow of electricity from pipe to rail through the earth.

In a pit near the front of the car barn access was possible to the pipe which supplied the plant with water and which appeared to branch from the main directly in front of the building. Similar tests with similar results were made between this pipe and the rails in the barn, but no sufficient length of this branch pipe was exposed to give opportunity for determining by test whether current was flowing on it or not.

Perhaps it is well here to say for the benefit of the non-technical reader that by potential is meant a sort of electrical pressure, and that where two potentials differ in value there will be — as there would be with two differing pressures of steam or air, for instance — a tendency of flow from the higher to the lower. If there is a path suitable for its conduction between such points, there will be an actual flow of current. Now a pipe, being of metal, is a suitable path for conducting electricity. If, therefore, two points on it are found at differing potentials there is clear evidence of the existence of a current in it. The tests thus far made had disclosed a difference in potential between pipe and rail, and had indicated the probability of a flow of current from the former to the latter, conceiving the ground as a suitable conducting path. It was probable that much of this current came from a distance along the structure of the water main itself, but it was essential to determine whether any flow actually existed on the branch pipe supplying the power house.

Opportunity was given by an exposed feed pipe in the engine room to make such a test and by using an instrument capable of measuring a milivolt (one one-thousandth of a volt), an indication over a short length was had that current was flowing and that it was in the direction of the street.

This was the first surprise for the investigator, for a flow in that direction meant from the boiler room, and his doubt of electrolytic action began to weaken. Further tests along the feed pipe followed — past the pumps and heater and up to the boilers. At the first of these — that in which the pitting was most aggravated — a distinct reading of nearly one milivolt was indicated between a point on its shell and the brass feed pipe near its entrance to the vessel. The instrument needle at this connection, however, was subject to frequent reversals; sometimes the shell was at higher potential, sometimes the pipe. The prevailing indication seemed to show the current flow from boiler to pipe, and the potential difference a maximum in this direction.

Then the instrument was connected between the entering feed pipe at the top of No. 1 boiler and the blowoff pipe at its bottom. The needle of the instrument swung promptly to a maximum of six milivolts and in a direction indicating that the blowoff was at higher potential. Here was certain evidence of a flow of electricity at least through the metallic structure of the boiler from its bottom to its top.

The blowoff pipes on the three boilers ran separately to a brick-lined well on the outside of the building, entering it horizontally about two feet below the surface of the ground. The ends of the pipes were well above the water in it, but from the boiler house they passed through earth which was maintained in a generally wet and conductive condition by the hot vapor with which the well was filled. Tests made by the milivolt meter between different points on the same blowoff pipe showed current flow from the well, and, while the theory was not proved, it was believed that the electricity was drawn from the earth through its wet contact with that pipe.

Here, then, existed one element of the situation which the writer had doubted. Current was wandering into and through a boiler, and that it was caused by the operation of the railway was evident from the behavior of the instrument used. Its needle, instead of remaining in any fixed and constant position, swung from one point to another as rapidly as that of the switchboard instrument which measured the current supplied to the trolley. The operation of the cars on the road accounted, of course, for the swing of the latter instrument, and it was a fair conclusion that the motion of the milivolt meter was due to the same cause. Had it been perfectly steady, a leak from the lighting wires or from the storage battery cables might have been suspected, but as it was the movement of the needle at times so exactly corresponded to the increments of current occurring when an electric car is started that one could note the steps of the operation as the motorman moved the handle over the controller. However, to be on the safe side, the run of all wires and of the cables from the battery were carefully looked over in an effort to locate any leaks which might reach the boilers and none was found.

It was clear from these tests, then, that an unexpected and unusual electrical condition existed in the boilers. But something unusual was necessary to explain the rapidity of the tube pitting, and so in spite of previous skepticism and present perplexity, the probability of a connection between the one situation and the other had to be admitted. It was still difficult to see how electrolysis "could take place within the closed conductor formed by a boiler shell," but it had been equally difficult to understand how a stray current from the rail could reach the boiler and that seemed to be a proven fact.

It had been shown by the tests that a difference in potential existed between not only the extreme pipe connections, but also between one of them and the boiler shell. Other tests showed similar differences of greater or less value between the other pipe and the shell and even between the pipe and its blowoff cock. The instrument readings were much higher in every case for the No. 1 boiler, but the same general situation was indicated on all three. Of course, these differences were most minute, but it began to be clear that if similar conditions existed in the internal structure of the boiler, the current which produced them might be an influence in the corrosion.

It has been stated that a difference in potential on a conductor is evidence of a flow in it. It is now best to further explain that the magnitude of this difference will depend on two conditions, viz., the amount of current flowing and the resistance offered to its flow by the conductor on which the difference is measured. A small current on a conductor of high resistance may produce a potential difference as great as that of a large current on a conductor of low resistance. This broad statement of these relations seems necessary to explain the reason for an experiment which the situation next suggested.

A piece of trolley wire of No. 0000 gage was bound and soldered at its one end to the feed pipe and at the other to the blowoff pipe of No. 1 boiler. If the difference of potential previously existing between these two pipes was due to a large current flowing over a comparatively low resistance in the boiler structure, the connection of this wire would have little or no effect, for it would not have influenced the amount of current, and its cross section was so small compared with that of the metal in the boiler that even though of superior conducting material it would but to a small degree reduce the total resistance. On the other hand, if the original potential difference was due to a small current traversing a comparatively high resistance, perhaps due to the various joints and seams of the vessel or the water in it, then the relative improvement of the path by the addition of the wire might be marked. The result proved that the latter situation was the case, for the bond formed by the trolley wire reduced the potential difference between the pipes to practically zero, the instrument needle moving perceptibly, but not enough to determine a value.

Strangely enough, however, the small reversing potential difference which was noted as existing between the boiler shell and the feed pipe did not seem to be affected by the connection. It remained in fact and was clearly indicated by the instrument after the power house had ceased operation for the night, and when all lights were turned off and the storage battery disconnected from its circuit. The only explanation offering was that it was due to galvanic action between the feed pipe, which was of brass, and the steel of the boiler.

Now this paper is more in the nature of a narrative of an investigation than an explanation of the phenomena discovered. It is not difficult to form a probable theory to account for current through the boiler, but to demonstrate it would require more space than is here available. There was such a current undoubtedly, but it may not be so assuredly stated that it by electrolysis produced corrosion. The further investigation showed that the boilers had accumulated a mass of magnetic oxide scale, and that oxide was in evidence at every hot water drip and leak. This substance was not only indicative of the action of acids in the boiler, but by its accumulation there, under the action of the heat, produced further oxidization of the metal parts. It did — and does now — seem probable, however, that there existed the elements essential to electrolytic action — water more or less acid for an electrolyte and metal parts of differing potentials for the electrodes — and that, therefore, there was cause for suspecting such action as an influence in this trouble.

Accordingly, it was recommended that for a time, at least, the wire bond which had been connected as an experiment be allowed to remain. Other remedial measures were also suggested, such as the thorough cleaning of the boilers and the neutralizing of the water in them by the use of soda ash. For while it was appreciated that if all were applied it would be impossible to determine from a resulting improvement which of the remedies had been most effective, it was thought more important to take every measure of protection at once. Those in charge of the boilers, however, apparently had a greater confidence in the wire bond, and took the responsibility of ignoring the other suggestions. That this confidence seems to have been justified by the result is indicated by the following quotation from a letter recently received from the superintendent of the railroad: "The bond which you put in between the blowoff and feed pipe still remains, and as we have had no more trouble from pitting would say the trouble was due to electrolysis. We ran the boiler from August, 1910, [the time of the investigation] until September, 1911, without repairs. Since that time the boiler has been shut down."

Now the facts stated in this quotation may not, perhaps, seem sufficient evidence to justify the superintendent's conclusion as to the responsibility of electrolysis. Taken with the other circumstances they would seem, however, to indicate a strong probability that such action occasioned the trouble. It is because of this probability, rather than of any positive conclusion, that it is hoped that this description may be suggestive to those who operate steam vessels under similar circumstances.

What's in a Name?

In our long service to the public as specialists in boiler inspection, we have become so familiar with a common form of repair used on return tubular boiler shells, and known as a "Horseshoe Patch," that we have felt we knew all about the matter. Probably many of our inspectors have assumed on account of their experience, that they know perfectly well how the name of such patches was derived, and have considered that the usual shape was the connection that linked the name with that of the metal protection usually attached to the hoof of the noble steed which has served mankind for generations past. It will doubtless be a great surprise to our other friends, as well as to our inspection force, to learn that the relation between the two is much closer than would be indicated by this reasoning. The discovery of the remarkably intimate connection between the name of the patch and the horseshoe was recently made by one of our representatives who was traveling in the south. He was riding on a train in Alabama, and with his head on the back of the car seat, was dozing and dreaming that he had discovered a new material for boiler shells of 100,000 lbs. tensile strength, and as ductile as gold, which would resist corrosion and all other ills to which boiler material is subjected, and that would also pass all state boiler laws, when he was rudely awakened by the sudden stopping of the train. He rubbed his eyes, and looking out of the car window discovered that he was at York; but there were many things missing beside the "New" that indicated he was not near Broadway. However, his eyes finally rested on a sign painted in large letters over the entrance of a brand new one story shop which interested him at once. This sign clearly illustrates how really intimate is the connection between the horseshoe and the boiler patch. The sign was as follows:

YORK BLACKSMITHING CO.

REPAIRS

WAGONS, BUGGIES, BOILERS, ENGINES.

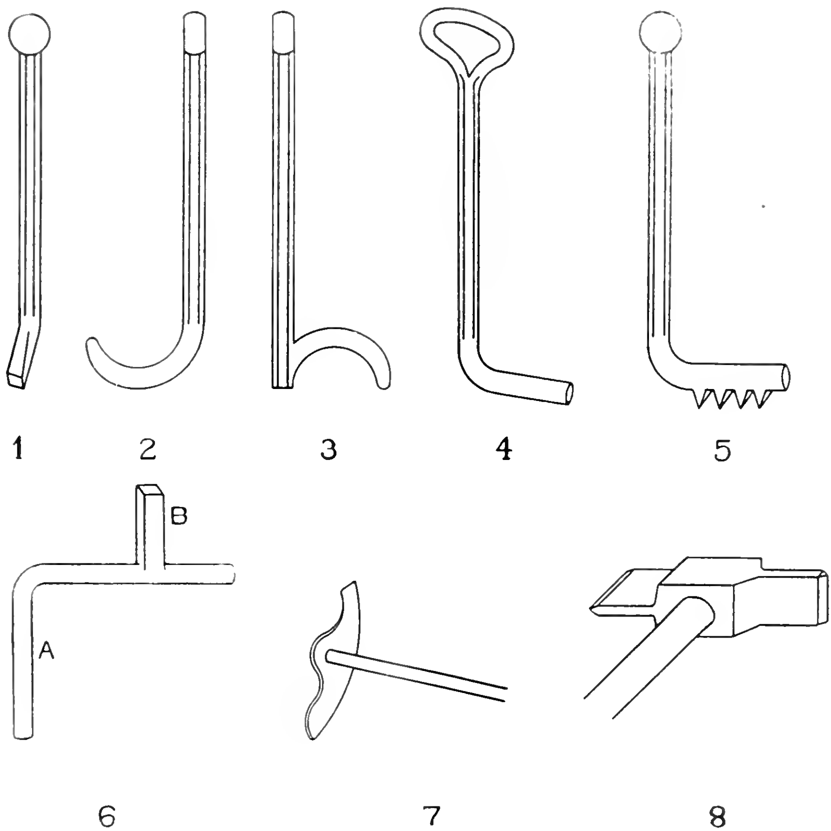
HORSEHOEING A SPECIALTY.

It is evident that the department store idea has penetrated every section of the country and many lines of business. For years past we have been thoroughly familiar with the department store methods used in the insurance field, and aside from the fact that we are not so accustomed to seeing it, the sign given above is not more incongruous than those of our competitors who advertise boiler and flywheel insurance along with an assortment of bonding, liability, accident, plate glass and burglary insurance. Reads like the description of a soup bunch purchased by the frugal housewife, doesn't it?

TOOLS FOR CLEANING BOILERS.

J. W. Hubbard, Inspector.

Much has been published in the mechanical press regarding the need of keeping boilers clean, but aside from descriptions of patented devices, little has been told of the forms of implements suitable for the purpose of cleaning. On account of the lack of information on this subject, many boiler operators are not familiar with the tools which experience has shown to be well suited to the purpose and they are so easily fashioned by a blacksmith that they should be readily procured anywhere.



Cleaning Tools.

The tools described here are not new and doubtless many engineers are thoroughly familiar with them, but they are described with the hope that more engineers may become acquainted with them and learn of their usefulness in keeping their boilers clean and free from scale.

Tool No. 1 is of general utility. The amount of angle near the point and the length of the handle can be varied to meet the requirements of each particular case. The chisel point should be ground sharp and tempered hard. The knob on the end forms a convenient handle, and adds weight to the tool at a point that makes its use effective. The knob should be left soft so that if there is occasion to use a hammer on it, the eyes of the operator will not be endangered by flying particles. All portions of the tube sheet, with the exception of the small surfaces on it between vertically adjacent tubes, can usually be reached for cleaning with this tool. One-half inch hexagonal steel is the proper size stock of which to form this implement.

Tools represented by Nos. 2, 3, and 4 are scrapers for removing the scale from the tubes and should be made of one-half inch hexagonal stock. Nos. 2 and 3 should be sharpened on the concave edges and No. 4 on both edges. By leaving off the loop handle on No. 4 and forming it of five-eighths inch steel, the cutting edge can be driven along the tops of the different rows of tubes against the head, breaking down a part of the scale which cannot be reached by No. 1. With one edge formed, as illustrated in No. 5, it is especially effective for this use.

Tool No. 6 may be used for breaking away heavy scale that may bridge the horizontal space between the tubes away from the heads. This is inserted in the vertical space between the tubes and is turned by the handle "A," which carries the projecting end "B" around in a horizontal plane and forces out the scale between the tubes. The leg "B" should of course be made of such size that it will pass easily between the tubes at points where no scale is adhering.

No. 7 is a convenient form of hoe, for removing loose scale or deposit from the bottom of the shell of horizontal tubular boilers. This tool is particularly convenient for this purpose where the boiler is only provided with a hand-hole communicating with the portion of the shell below the tubes. The points of the blade are cut away so that they may pass under the lower tubes at the side of the boiler and the edge of the blade is made to conform to the curvature of the boiler shell. This latter requirement is important, in order to make the use of this tool effective. The handle should be made of three-quarters inch pipe and the blade of one-quarter inch plate steel. The hole in the blade for the attachment of the handle should be tapped and the pipe screwed into it and held fast with a jam nut. If the space in front of the boiler is sufficient, it is preferable to have the handle of this hoe made of one piece of pipe, but if this is not practicable, it may be made of two or more pieces as required. When working with this hoe, it is often convenient to tie on the handle near the blade a small piece of waste saturated with oil, setting this on fire to light up the interior of the boiler in order to see where to reach for loose material.

A hammer of the type illustrated in No. 8 is very useful for cleaning plates, but for jarring the scale loose from the tubes a flat-faced hammer should be used.

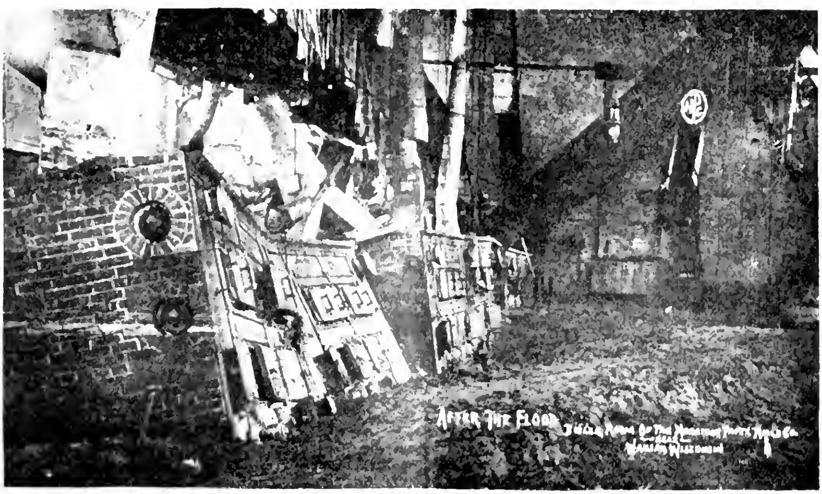
There are, of course, cases where the thorough cleaning of a boiler is impossible owing to either the hardness of the scale or inaccessibility due to design. Boilers in which the tubes are staggered or having poorly designed through bracing above the tubes or in which the tubes have been carried too far down, making the space below them cramped, are inaccessible for cleaning. In boilers of such design where the scale produced is hard, as is the case where the feed water contains sulphate of lime, it is practically impossible to properly clean them and as a consequence both safety and economy are affected.

The use of such boilers where the feed water supplied is necessarily bad, can only be attributed to lack of care or judgment on the part of those responsible for their installation.

In using the tools here illustrated or any others for a similar purpose, the greatest care should be exercised that the tubes or other portions of the boiler are not injured in the process of cleaning.

A Boiler Disaster From High Water.

The accompanying illustration shows the condition in which the boiler plant of the Marathon Paper Company was left by a flood of the Wisconsin River, on which at Wausau, Wisconsin, that company's mill is located. Unusually heavy rains in the early part of last October had caused high water in all the streams of that neighborhood, and on the sixth of the month the Wisconsin had burst its banks and overflowed the Marathon Company's property, cutting new channels between its buildings, and as it developed, undermining the boiler foundations. Late in the afternoon of that day, before the water had reached the boiler room floor and while steam was still maintained, an initial settlement occurred in the end one of a battery of six boilers. This caused a break in a feed pipe by which three of the attendants were seriously scalded. Soon after, the water invaded the room and operations had to be suspended. At 8:30 in the evening the foundation completely collapsed at the rear, wrecking the



WRECKED BY A FLOOD.

settings and steam piping and tipping the boilers on end as shown in the photograph.

These pages have frequently described the circumstances of a wrecked steam plant, the cause of which was attributed to low water, but it is quite a novelty to record in them a case such as this, where the opposite condition must be held responsible for the misfortune.

Another "Maine" Explosion.

It seems incredible that a foreign government should acquire its munitions of war from among the revered relics of a friendly nation, but that such has been the case at least in one instance, would appear probable from an account of a serious accident published by our English contemporary *Vulcan*. According to that paper, a working party at the Portsmouth (England) Dockyard was engaged in testing "a compressed air cylinder used for propelling torpedoes" when it burst "with a terrific report," killing or injuring eight men. The article continues: "At the inquest the evidence showed that the cylinder was not of the pattern generally used, but was of American make, and evidently came from the hospital ship *Maine*, which formerly belonged to the American Navy." No comment is made on this extraordinary circumstance, but perhaps as a warning to other pilferers of our national souvenirs it is added that the verdict of the jury recommended "the disuse of American cylinders." *Hospital ship, indeed!*

Boiler Room Card.

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY has recently published in condensed form a set of suggestions for the care and management of steam boilers under the title, "Boiler Room Card." As its name implies, this sheet is intended for framing or other mounting, so that it may be hung in the boiler room for the ready reference of the attendants. The "suggestions" cover broadly conditions of maintenance and preservation as well as of safe operation of steam vessels used for power, and embody methods which an extended experience has approved as best practice. They are legibly printed in short paragraphs with prominent captions, so that reference to any particular condition may be easily made.

The Boiler Room Card is, of course, published primarily for the benefit of its policy-holders to whom it is being distributed, but in the belief that it will prove of great value in every plant where boilers are used for power, the Hartford company is glad to furnish copies free to any bona fide boiler owners who will apply for them. If you have not already received one, address the Company at *Hartford, Conn.*, and ask for the "Boiler Room Card," stating in your communication the number and pressure of the boilers you own and where they are located.

Boiler Explosions.

October, 1911.

(376.) — A hot-water boiler burst, October 1, in a "Cafeteria" at Los Angeles, Calif. Two persons were injured and property damaged to the extent of about $500.

(377.) — On or about October 1, a boiler exploded at Mercer's mill, on the Suwanee river, near Branford, Fla. No one was injured.

(378.) — On October 2, a tube ruptured in a water-tube boiler at the Passaic River & Coal street plant of the Public Service Corporation of New Jersey. One man was scalded and died the following day. The property damage was small.

(379.) — A boiler exploded, October 2, in a confectionery store at Sutherland, Iowa. Three persons were injured and machinery and buildings were damaged.

(380.) — A number of cast-iron headers fractured, October 3, in a water-tube boiler at the Louisville Gas Co.'s plant, Louisville, Ky. Considerable damage was done to the boiler.

(381.) — A boiler in the butcher shop of J. A. Spaughy at Postville, Iowa, exploded October 6. Three persons were injured.

(382.) — A boiler ruptured, October 6, at "Waverly Hall," an apartment house at 115 Mount Auburn street, Cambridge, Mass. The damage, which was small, was confined to the boiler.

(383.) — On October 6, a boiler exploded in a school-house at Clark's Summit, Pa.

(384.) — A boiler exploded, October 6, in the Astoria apartment house, Brooklyn, N. Y.

(385.) — A sawmill boiler exploded, October 7, near Waynesburg, Ky. The engineer was instantly killed and several other persons injured.

(386.) — A blow-off pipe failed, October 7, at the Cisco Oil Mill, Carbon, Texas. One man was injured.

(387.) — A small water heater exploded, October 7, in the basement of the residence of M. C. Phillips, Oshkosh, Wis. The heater was practically demolished and considerable damage was done in the basement. No one was injured.

(388.) — A boiler exploded, October 8, in the Thirteenth avenue fire engine house, Oakland, Calif. No person was injured but the fire engine horses were thrown to the ground and the building was damaged.

(389.) — The boiler of a threshing engine exploded, October 8, on William Allen's farm, near Franklinville, N. Y. Mr. Allen was struck by a part of the boiler plate and was thrown about thirty feet. He was seriously but probably not fatally scalded. One other man was slightly injured.

(390.) — On October 9 an accident occurred to a boiler at the Citizens' Ice Co., Oswego, Kansas. The damage was small.

(391.) — The boiler of a locomotive engine exploded, October 10, in the roundhouse of the Los Vegas & Tonopah railroad, at Goldfield, Nev. One man was seriously injured and the roundhouse was wrecked.

(392.) — On October 11 a hot-water heater exploded in the basement of a two-flat building at 5042 Fulton street, Chicago, Ill. Three persons were injured.

(393.) — A valve on a blow-off pipe ruptured, October 12, at the plant of the Michigan Bolt & Nut Co., Detroit, Mich. One man was killed.

(394.) — The boiler of a locomotive on the Louisville & Nashville railroad exploded, October 12, near Knoxville, Tenn. Train Master H. M. Brownlee, who was riding in the engine cab, received scalds which caused his death the following day.

(395.) — A hot-water boiler exploded, October 13, in the residence of E. Augustus Rine, Caldwell, N. J. No one was injured.

(396.) — On October 13 a boiler exploded at the plant of the National Refining Co., Marietta, Ohio, causing large damage to property.

(397.) — A tube ruptured, October 13, in a water-tube boiler at the plant of the Consumers' Hygeia Ice Co., Union Hill, N. J. Three men were injured.

(398.) — A boiler exploded, October 13, in the Stack Block, Lestershire, N. Y., causing a property damage of $200.

(399.) — On October 14 a number of cast-iron headers fractured in a water-tube boiler at the North Delaware avenue power station of the Philadelphia Rapid Transit Co., Philadelphia, Pa.

(400.) — A blow-off pipe failed, October 14, at the Day Chemical Co.'s plant, Westline, Pa. One man was scalded.

(401.) — A cast-iron header ruptured, October 14, in a water-tube boiler at the plant of the American Steel & Wire Co., Waukegan, Ill.

(402.) — One man was severely scalded, October 15, by an accident to the boiler of the tugboat *John Mahar*, at Fulton, N. Y.

(403.) — On October 16 a tube ruptured in a water-tube boiler at the Joseph H. Bromley plant, Philadelphia, Pa.

(404.) — On October 19 one or more boiler tubes blew out on the torpedo boat *Wilkes*.

(405.) — A boiler ruptured, October 19, at the plant of Wm. Goodrich & Co., linseed oil manufacturers, Milwaukee, Wis.

(406.) — On October 20 a boiler exploded in the cellar of the Greenwich Cold Storage Co., Greenwich street, New York City. The boiler, which was located beneath the sidewalk, was blown some distance from its original position, breaking ammonia pipes, a gas main and a high pressure water main, and damaging the Ninth avenue elevated structure. Eight persons were more or less severely injured and the property loss was estimated at $30,000.

(407.) — The boiler of a locomotive engine exploded, October 22, on the Chicago, Milwaukee & St. Paul railroad, at North Homan and Grand avenues, Chicago, Ill. Four men were injured, one of them seriously.

(408.) — On October 22 three tubes ruptured in a water-tube boiler at the planing mill of the Cole Mfg. Co., Memphis, Tenn. The boiler was considerably damaged.

(409.) — A boiler tube burst, October 22, on the torpedo boat *Tingey*, while the vessel was off Charleston, S. C., proceeding to Hampton Roads, Va. One man was killed and another badly scalded.

(410.) — A boiler exploded, October 23, at the Sterling Sugar Refinery, Franklin, La. One man was seriously burned.

(411.) — On October 23 a boiler tube burst on the ferryboat *Peerless*, at Delta, La. One person was killed and seven others injured.

(412.) — A tube ruptured, October 26, in a water-tube boiler at the Guthman Laundry & Dry Cleaning Co.'s plant, Atlanta, Ga. Two men were injured.

(413.) — A cast-iron header ruptured in a water-tube boiler, October 27, at the Utah-Idaho Sugar Co.'s plant, Salt Lake City, Utah.

(414.) — The boiler of a traction engine, belonging to C. Anderson, exploded, October 27, near Waupun, Wis. Two men were severely injured.

(415.) — On October 28 a tube ruptured in a water-tube boiler at the State Hospital for Insane, Athens, Ohio.

(416.) — A boiler exploded, October 28, at the Hintze greenhouses, Fond du Lac, Wis. Damage to property was estimated at $2,000.

(417.) — The boiler of a locomotive on the Trinity & Brazos Valley railroad exploded, October 28, near Karen, Texas. Three men were killed.

(418.) — On October 30 a boiler exploded on the Pure Oil Co.'s steamer No. 5, at East Newark, N. J. One person was killed and five others were injured, three of them fatally.

(419.) — A boiler tube blew out, October 30, in the plant of John Diebold & Sons, Louisville, Ky. No one was injured.

(420.) — On October 31 a tube ruptured in a water-tube boiler at the sugar house of the St. Joseph Planting & Mfg. Co., Feitel, La.

(See also No. 427.)

(421.) — On October 31 the boiler of locomotive No. 852, on the Wabash railroad, exploded near Riverton, Ill. The engineer was killed and the fireman and head brakeman severely injured. The property damage was estimated at $10,000.

(422.) — The boiler of a freight locomotive on the Pennsylvania railroad exploded, October 31, at Elizabeth, N. J. Three men were severely injured.

(423.) — On October 31 a boiler exploded on the premises of Walter Oderwald, Clifton, Ill. One person was seriously injured.

November, 1911.

(424.) — The boiler of a freight locomotive exploded, November 1, on the Pennsylvania railroad near Lima, Ohio. Three men were seriously injured.

(425.) — A boiler exploded, November 1, at the plant of the Mt. Clemens Sugar Co., Mt. Clemens, Mich. Three men were seriously injured, one of whom has since died.

(426.) — A heating boiler exploded, November 1, in the basement of the high school at Niagara Falls, N. Y. One man was seriously and another slightly injured.

(427.) — On November 2 a tube ruptured in a water-tube boiler at the sugar house of the St. Joseph Planting & Mfg. Co., Feitel, La.

(See also No. 420.)

(428.) — A locomotive boiler exploded, November 3, on the premises of the W. R. Pickering Lumber Co., Pickering, La. One man was injured.

(429.) — A cast-iron elbow of a blow-off pipe failed, November 3, at the flax spinning mill of Smith & Dove Mfg. Co., Andover, Mass. One man was fatally injured.

(430.) — On November 4 a section cracked in a cast-iron heating boiler in the hotel of Rafter & Co., Nevada, Mo.

(431.) — The explosion of a small vertical boiler, November 4, at Zincite, Mo., near the Lincoln mine, seriously injured one man.

(432.) — A heater exploded, November 4, at 359 Massachusetts avenue, Indianapolis, Ind. One person was injured.

(433.) — A boiler belonging to the Standard Oil Company exploded, November 5, at St. Paul, Minn., causing a property loss of $150.

(434.) — A boiler flue failed, November 5, on the Cauvel farm, near Oil City, Pa. No one was injured.

(435.) — A boiler flue failed, November 6, on the Cauvel farm, near Oil City, Pa. One man was severely burned.

(Items Nos. 434 and 435 refer to the same boiler, the two accidents occurring on two consecutive days. After the first accident the boiler flue was repaired and the boiler again put in service, with the result noted.)

(436.) — A locomotive boiler exploded, November 6, on the Baltimore & Ohio railroad, at Brooklyn Junction, W. Va. Two persons were seriously injured.

(437.) — A tube ruptured, November 6, in a water-tube boiler at the plant of the Southern Iron & Steel Co., Alabama City, Ala.

(438.) — A boiler owned by W. N. McCann exploded, November 6, at St. Joseph, Mo. The property damage was estimated at $3,000.

(439.) — A boiler tube failed, November 6, in the power house of the Consolidated Company, Charleston, S. C. No one was injured.

(440.) — On November 8 a tube ruptured in a vertical boiler at the Oak Park Power Co.'s plant of the General Motors Company of Michigan, Flint, Mich. The boiler was used in connection with a producer gas plant. Considerable damage was done to the boiler and surrounding property.

(441.) — A Pennsylvania railroad locomotive boiler exploded, November 8, at Worthington, Ill. One person was seriously injured.

(442.) — A tube ruptured, November 8, in a water-tube boiler in the basement of the "Ellicott Square," one of the largest office buildings in Buffalo, N. Y. One man was scalded. (See item No. 444.)

(443.) — The boiler of the locomotive drawing the St. Louis & San Francisco railroad's fast train, "Meteor," exploded, November 9, near Fort Scott, Kans. The engineer and fireman were killed.

(444.) — On November 10 a tube ruptured in a water-tube boiler in the "Ellicott Square" office building, Buffalo, N. Y. Arthur Brady, a boiler maker, was killed. John Schrott, a boiler maker, and Bard Leavitt, an inspector for The Hartford Steam Boiler Inspection & Insurance Company, were severely scalded, Schrott dying a few days later.

(See Item No. 442.)

(445.) — On November 10 a boiler ruptured at the American Terra Cotta & Ceramic Co.'s plant, Terra Cotta, Ill.

(446.) — The boiler of the forward locomotive of a double-headed freight train exploded, November 11, twenty miles west of Lynchburg, Va., on the Norfolk & Western railroad. One man was killed, one critically scalded, and several other persons received minor injuries.

(447.) — A cast-iron heating boiler exploded, November 12, at the residence of Eber Downs, Kewanee, Ill. No one was injured.

(448.) — A blow-off pipe failed, November 13, in the hothouse of Hoerber Brothers, Des Plaines, Ill. Two men were slightly scalded.

(449.) — On November 13 a tube ruptured in a water-tube boiler at the Glen Allen Oil Mill, Glen Allen, Miss. One man was scalded.

(450.) — On November 15 three sections of a cast-iron heating boiler fractured at the Masonic Temple, Greenville, S. C.

(451.) — Four men were fatally scalded, November 16, by the bursting of a boiler tube in a boiler owned by Scott Brothers, canal contractors. The boiler was in use on the Seneca River section of the barge canal, near Seneca Falls, New York.

(452.) — A boiler exploded, November 16, on dredge No. 3, of the Fitzsimmons & Connell Dredge & Dock Co., at Madison street bridge, Chicago, Ill. Four men were slightly burned.

(453.) — On November 19 a mud drum, attached to a boiler, ruptured on the sugar plantation of the Estate of H. C. Minor, Houma, La.

(454.) — The boiler of the locomotive of the Overland Limited on the Union Pacific Railroad exploded on the morning of November 20 near Rawlins, Wyo., severely scalding the engineer and fireman.

(455.) — A heating boiler exploded, November 21, in St. James' Parish School, St. Louis, Mo. No one was injured.

(456.) — The boiler of a Big Four locomotive exploded, November 22, near Fortsville, Ind. Three trainmen were seriously injured.

(457.) — A tube ruptured, November 27, in a water-tube boiler at the Inman Mills, Inman, S. C. The fireman was injured.

(458.) — A boiler on the farm of Oliver Launstein, at Owosso, Mich., exploded, November 27. Mr. Launstein was painfully but not seriously injured.

(459.) — The boiler of a locomotive exploded, November 29, while standing in the yards at Creston, Ill. The engineer was badly burned and the fireman sustained slight burns and scalds.

(460.) — Two boilers exploded, November 29, in the Lower Merion Y. M. C. A. building, Ardmore, Pa. No one was seriously injured but the property loss was estimated at $5,000.

(461.) — On November 29 the boiler of a locomotive on the Lake Erie, Alliance & Wheeling railroad exploded, near Wattsville, Ohio. The engineer was seriously injured and the firemen was badly scalded.

(462.) — The boiler at the gin of C. L. Davis, near Bonham, Texas, exploded, on or about November 30. No one was injured. Damage to property was estimated at $1,800.

The record of boiler explosions for December, 1911, and the summary and statistics of such disasters for the past year, which have previously found a place in the January issue, will appear in that for April, 1912. The verification of the latest explosions and the compilation of the complete data would cause a delay in the current number which we believe unadvisable.

The Locomotive of THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

HARTFORD, JANUARY, 1912.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

We call attention to the enlarged title appearing on this, the first number of a new volume. The old familiar name of the periodical is retained, but incorporated with it is also the name of the institution responsible for its publication. This change from the shorter title of the past forty-four years is symbolic of our desire and purpose that hereafter THE LOCOMOTIVE shall be more closely identified with THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY and more representative of the activities of that corporation and of its views on the mechanical and insurance conditions essential to the protection of power apparatus.

The reason for the purchase of protection against loss from damages for personal injury in a boiler insurance contract, by the holder of a liability policy, obviously is to supplement the protection afforded by the latter in those cases of serious boiler disaster for which the liability policy limits may prove insufficient or inapplicable. It cannot be with any desire to assist the liability company by contributions from other insurance in the settlement of claims that such purchaser expends his money in additional premiums; and yet when he selects a boiler policy in which the personal injury insurance is made to contribute proportionately with the liability insurance, he may be defeating his very purpose and be practically reinsuring the liability risk in a manner which leaves himself not fully indemnified for personal injury claims, although with an unconsumed balance of liability insurance. Moreover, for the minor boiler accidents, such as tube, blowoff pipe, and water glass explosions, the limits of the liability policy alone would generally afford ample protection, without in any way diminishing the amount of liability insurance in force for future accidents; for while liability insurance policies limit the amounts payable for injuries or death of one person, or of several persons hurt in one accident, there is no limit to the number of persons or accidents covered and thus no limit to the amount the liability insurance company might have to pay during the term of its policy. On the other hand, steam boiler policies necessarily insure for a definite amount to cover all accidents during the period for which the policy is in force, and what is paid on one accident is deducted from this amount. Thus every time the boiler insurance is called upon to help the liability insurance company settle a loss, the boiler explosion protection that the assured has paid for is diminished for the benefit of the liability company, without any compensating benefit to the assured for the depletion of his insurance against subsequent loss from boiler explosions.

This situation is due to the provisions commonly incorporated in each form of contract that where other insurance is applicable the assured cannot recover a larger proportion of the loss under one policy than the insurance available under it bears to the total available under all policies. Such has been the commonly adopted provision of boiler policies.

The Hartford Steam Boiler Inspection and Insurance Company, realizing this deficiency in the older forms, has recently put out an improved contract which in addition to the usual indemnity against property loss, affords insurance against loss from death and personal injury in a manner which, while as fully as any other protecting the assured where no liability policy exists or where it is inadequate or inapplicable, does not force contributions from the assured's boiler insurance to the liability company's losses.

A complete discussion of this whole matter has been made by President Brainerd and published by The Hartford Steam Boiler Inspection and Insurance Company in a pamphlet entitled "The Excess or Non-Contributing Form of Policy versus The Concurrent and Contributing Forms." Every steam user who protects himself both by boiler and liability insurance should read this pamphlet and carefully consider its contents. It may be obtained from any of the offices of the Company, which are listed on the last (cover) page of this issue.

From time to time, we are asked for an opinion as to the relative responsibility of owner and tenant, with regard to the explosion of a boiler. As a general proposition, if, after the explosion, it can be shown that the boiler was in excellent condition, but care and management were bad, the tenant would be held liable. On the other hand, if, after the explosion, it can be shown that the care and management were excellent, but the design and construction of the boiler poor, the owners might be held, but it is one of those cases which depends entirely upon circumstances, which circumstances are brought out by the explosion, and cannot be predicted beforehand.

As a concrete case report No. 642 to the Secretary of the British Board of Trade is of interest. That report describes the explosion of a boiler in a corn mill, caused by the wasting of the shell plates due to corrosion. The Court blamed the owner for neglecting to have the boiler examined and he was ordered to pay. The tenant was blamed for neglecting to ensure that the boiler was working under safe condition, and he also was ordered to pay.

It is safe to say, therefore, that for full protection of both the owner and the tenant, the interest of each should be covered by a boiler policy.

No good business man would make a loan on property which was not protected by fire insurance, yet loans are made on property containing steam boilers, where no insurance protection against their explosion exists. This too in the face of the obvious fact that the effect of a boiler explosion is immediate and almost instantaneous with the event itself, while with a fire subsequent to its discovery efficient measures may be taken to minimize the resulting loss.

One explanation why boiler insurance is not carried in such cases lies in the mistaken idea that after a boiler explosion, fire will likely ensue, and the total loss will then be collectible from the fire insurance companies. This is not the case, however. A fire policy takes hold where the boiler policy leaves off, so that if a boiler explodes in a building which was worth say, $50,000, and if after the explosion the building because of its wrecked condition is worth but $4,000, the latter amount only would be collectible under a fire insurance policy for a fire which completed the destruction.

This is a matter which should receive the attention of bankers and others who, though not owning steam plants, may loan money on them. They should see that the property which secures the loan is itself secure from the effects of a boiler disaster by adequate insurance under a steam boiler policy.

Obituary.

Benjamin F. Cooper, late Chief Inspector of The Hartford Steam Boiler Inspection and Insurance Company, at Cincinnati, Ohio, died suddenly of heart failure in that city November 1, 1911.

Mr. Cooper was born in Kenton County, Kentucky, in 1844. Prepared by a good common school education and an apprenticeship to the machinist trade, he early took up the work of a stationary engineer. In this he became most proficient and held many important engineering positions. In 1883 he entered the service of the Hartford company at Cincinnati, and in 1909 received his appointment as Chief Inspector of that department.

Mr. Cooper served during the Civil War from 1862 to 1865 as a private in the 4th Ohio Cavalry, and ever after remained a loyal comrade of his associates in that great struggle and a zealous member of the Grand Army of the Republic. He was prominent in Masonic circles and held in high esteem for his many sterling qualities of heart and mind by a broad circle of friends and associates. Many of our assured, who have benefited by consultation with Mr. Cooper on matters pertaining to their steam plants, and who have thus come to know the value of his advice and his carefully formed opinion, will feel with the Hartford company that in his death has been lost a good friend, a painstaking official, and a conscientious adviser.

Mr. Cooper was buried with the honors of the Grand Army of the Republic by his comrades of the Cincinnati local post. He is survived by two sons, Cassius G. Cooper of Chicago, and Frank P. Cooper of Cincinnati.

Personal.

The Hartford Steam Boiler Inspection and Insurance Company regrets to announce that Allan D. Risteen, Ph.D., who for the last twenty-three years has been in the service of the Company as Assistant Editor and Editor of "The Locomotive," has severed this connection. Dr. Risteen is an expert mathematician and a versatile writer and lecturer in other branches of science. He has been a contributor to many technical journals and encyclopaedias and has now in course of preparation a new encyclopaedia of his own, covering in condensed form the fields of history, literature, and science. His articles in The Locomotive have been highly regarded from an academic as well as a practical standpoint, and have been a potent influence in obtaining for that paper a place of merited appreciation in the libraries of the higher technical schools and colleges.

In leaving the "Hartford" Dr. Risteen bears with him the high regard of its officers and of his associates and the sincere good wishes of all for his future success and happiness.

In December, 1911, Walter Gerner was appointed by The Hartford Steam Boiler Inspection and Insurance Company, Chief Inspector at its Cincinnati office, vice Benjamin F. Cooper, deceased.

Mr. Gerner's early career was largely connected with the sea, during which he advanced through the several grades of marine engineering to that of chief engineer of trans-Atlantic vessels, including in the duties of the latter position the supervision of construction and repair of the vessels of the line with which he was connected.

During his service with this Company, Mr. Gerner has acquired a broad experience with inspection work in field, shop, and office. By this and his engineering training he is well equipped to serve the interests of our patrons in his new territory.

William A. Craig, who has been connected with its inspection force since 1893, has been promoted by The Hartford Steam Boiler Inspection and Insurance Company to the position of Assistant Chief Inspector of its Pittsburg department. We are sure Mr. Craig's advancement will receive the general approval of his associates in our Company and of his many friends among the steam users of his district.

On December 31, 1911, Inspector Johnston Nolan resigned from the force of our Philadelphia department in order to engage more actively in the manufacture and sale of a blowoff valve which he has invented. We learn that his valve has met with favorable consideration, and we wish Mr. Nolan all success in his undertaking.

Boiler Explosion Injures Inspector.

Although not without precedent, it is rare that a boiler inspector is injured in an explosion. An accident with this result occurred on November 10th at the Ellicott Square office building at Buffalo, New York, when one of our local inspectors, Bard Leavitt, was seriously scalded by the bursting of a tube in a water-tube boiler next to one which he was inspecting. Two boiler makers, Arthur Brady and John Schrott, were working on the boiler with the inspector. Both lost their lives, Mr. Brady being killed outright and Mr. Schrott dying several days later.

Inspector Leavitt was particularly fortunate to escape with his life, as he was under the tubes in the back connection when the explosion occurred. In order to escape, it was necessary for him to crawl through a cleaning door about 18 inches square, into a narrow passageway which was filled with steam and hot water from the explosion. Mr. Leavitt was so blinded by the steam and the pain of his injuries that in leaving the boiler room he ran into a pumping engine which was in motion, and severely cut his mouth and nose on the connecting rod or the crank pin.

We are glad to state that Mr. Leavitt is on the road to recovery.

Inspection Work for the year 1911.

The activity of the inspection force of THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY for the year just closed is evidenced in the statistical tables of the following pages. This data is compiled from the record of the work accomplished and is published in this form that those who are interested in such matters may obtain a realization of the magnitude and value of the service which is performed by our inspectors in the boiler plants of the United States.

The summaries on page 25 are particularly interesting. From a comparison of their figures it appears that an inspector on the average found something defective at nearly every visit he made, and in every ten a condition which if continued was dangerous to the operation of the vessel. These figures are significant, for the breadth of the field covered by the tabulated experience is great enough to represent the average situation of the steam vessels of the country. If once out of ten visits to a boiler room a trained inspector discovers a dangerous condition the necessity and value of his visitation is emphasized, without mention of the benefit derived at every visit from his warning of a defect which may be remedied before it reaches a critical stage.

From the summary of defects the character of the several diseases which afflict boilers may be seen and an idea gained of the relative frequency with which each occurs and the probability of its attaining a dangerous state. The predominance of defects due to impure water is most marked.

These statistics are of the work among steam boilers, meaning by that term, steam containing vessels generally. In addition the inspection force of the company has made during the year 92 examinations of steam pipe lines, economizers, and miscellaneous apparatus, and 4,234 inspections of fly-wheels and pulleys.

Summary of Inspectors' Work for 1911.

Visits of inspection made,	180,842
Whole number of inspections (both internal and external),	352,674
Number of complete internal inspections,	140,896
Boilers tested by hydrostatic pressure,	12,724
Total number of boilers condemned,	653
Total number of defects discovered,	164,713
Total number of dangerous defects discovered,	17,410

Summary of Defects Discovered.

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	19,710	1,400
Cases of incrustation and scale,	42,879	1,690
Cases of internal grooving,	2,756	305
Cases of internal corrosion,	14,083	649
Cases of external corrosion,	9,755	898
Defective braces and stays,	2,485	545
Settings defective,	5,686	731
Furnaces out of shape,	7,191	397
Fractured plates,	3,479	440
Burned plates,	4,837	477
Laminated plates,	509	44
Cases of defective riveting,	3,026	636
Defective heads,	1,349	234
Cases of leakage around tubes,	11,188	1,627
Cases of defective tubes,	9,447	2,935
Tubes too light,	1,901	521
Leakage at joints,	5,417	373
Water-gages defective,	3,447	773
Blow-offs defective,	4,509	1,373
Cases of deficiency of water,	313	90
Safety-valves overloaded,	1,124	319
Safety-valves defective,	1,225	329
Pressure gages defective,	7,836	525
Boilers without pressure gages,	532	71
Unclassified defects,	29	19
Total,	164,713	17,410

Grand Total of the Inspectors' Work from the Time the Company Began Business, to January 1, 1912.

Visits of inspection made,	3,312,922
Whole number of inspections (both internal and external),	6,413,587
Complete internal inspections,	2,518,922
Boilers tested by hydrostatic pressure,	299,852
Total number of boilers condemned,	21,620
Total number of defects discovered,	3,987,980
Total number of dangerous defects discovered,	409,639

Inspectors' Reports for January, February, and March, 1911.

Nature of Defects.	January.		February.		March.	
	Total defects.	Dangerous.	Total defects.	Dangerous.	Total defects.	Dangerous.
Cases of deposit of sediment,	1,702	114	1,495	108	1,586	97
Cases of incrustation and scale,	3,761	127	3,315	106	3,452	122
Cases of internal grooving,	207	26	210	15	215	17
Cases of internal corrosion,	1,111	83	988	39	1,005	39
Cases of external corrosion,	791	86	675	62	795	71
Defective braces and stays,	227	41	177	67	194	44
Settings defective,	499	60	428	54	430	48
Furnaces out of shape,	600	30	531	25	608	30
Fractured plates,	312	30	322	43	300	42
Burned plates,	482	61	364	40	361	38
Laminated plates,	70	5	45	5	36	1
Cases of defective riveting,	325	82	341	77	255	46
Defective heads,	123	21	118	21	127	16
Cases of leakage around tubes,	1,071	150	990	136	955	146
Cases of defective tubes,	910	331	714	205	830	270
Tubes too light,	161	66	160	37	178	77
Leakage at joints,	505	43	451	31	537	29
Water-gages defective,	317	78	259	60	313	56
Blow-offs defective,	388	138	335	115	362	97
Cases of deficiency of water,	32	14	27	8	22	9
Safety-valves overloaded,	90	26	77	21	116	29
Safety-valves defective,	118	41	105	32	87	20
Pressure gages defective,	663	48	668	62	698	55
Boilers without pressure gages,	39	14	98	27	16	2
Unclassified defects,	1	1	2	1	0	0
Totals,	14,505	1,716	12,895	1,397	13,478	1,401

Inspectors' Reports for April, May, and June, 1911.

Nature of Defects.	April.		May.		June.	
	Total defects.	Dangerous.	Total defects.	Dangerous.	Total defects.	Dangerous.
Cases of deposit of sediment,	1,746	122	1,669	116	1,791	126
Cases of incrustation and scale,	3,959	270	3,802	131	3,957	112
Cases of internal grooving,	267	45	294	48	280	29
Cases of internal corrosion,	1,220	60	1,266	70	1,686	60
Cases of external corrosion,	841	82	790	65	969	88
Defective braces and stays,	294	60	242	48	187	39
Settings defective,	533	76	482	75	517	56
Furnaces out of shape.	736	46	523	26	655	45
Fractured plates,	304	38	288	32	252	42
Burned plates,	443	56	421	45	396	27
Laminated plates,	37	5	46	5	42	1
Cases of defective riveting,	287	65	269	41	243	39
Defective heads,	110	14	91	16	120	22
Cases of leakage around tubes,	1,025	132	1,004	112	861	113
Cases of defective tubes,	892	229	775	220	796	237
Tubes too light,	160	34	113	23	142	51
Leakage at joints,	503	37	461	23	431	36
Water-gages defective,	293	63	242	50	269	71
Blow-offs defective,	425	112	371	124	420	132
Cases of deficiency of water,	25	8	23	6	27	7
Safety-valves overloaded,	103	28	87	16	82	23
Safety-valves defective,	106	17	88	29	97	23
Pressure gages defective,	701	45	682	38	643	43
Boilers without pressure gages,	28	2	26	1	64	7
Unclassified defects,	4	4	8	2	2	2
Totals,	15,042	1,650	14,063	1,362	14,929	1,431

Inspectors' Reports for July, August, and September, 1911.

Nature of Defects.	July.		August.		September.	
	Total defects.	Dangerous.	Total defects.	Dangerous.	Total defects.	Dangerous.
Cases of deposit of sediment,	1,803	151	1,586	95	1,624	124
Cases of incrustation and scale,	4,083	170	3,519	119	3,378	135
Cases of internal grooving,	219	22	237	24	201	17
Cases of internal corrosion,	1,568	66	1,277	65	1,150	54
Cases of external corrosion,	950	81	959	128	762	60
Defective braces and stays,	190	31	180	48	194	43
Settings defective,	514	77	455	46	450	51
Furnaces out of shape,	738	43	601	43	583	30
Fractured plates,	284	36	283	34	268	32
Burned plates,	401	30	387	27	407	34
Laminated plates,	63	5	38	4	34	4
Cases of defective riveting,	200	43	181	39	275	62
Defective heads,	100	11	108	25	119	20
Cases of leakage around tubes,	826	156	918	121	876	129
Cases of defective tubes,	733	190	791	210	679	199
Tubes too light,	140	41	281	51	207	53
Leakage at joints,	413	29	396	25	396	27
Water-gages defective,	295	78	328	65	263	70
Blow-offs defective,	385	108	398	125	355	101
Cases of deficiency of water,	21	8	32	5	21	8
Safety-valves overloaded,	91	26	93	29	86	28
Safety-valves defective,	102	21	117	35	110	29
Pressure gages defective,	648	36	613	39	618	39
Boilers without pressure gages,	32	4	22	2	29	5
Unclassified defects,	2	2	2	2	2	2
Totals,	14,801	1,465	13,802	1,406	13,087	1,356

Inspectors' Reports for October, November, and December, 1911.

Nature of Defects.	October.		November.		December.	
	Total defects.	Dangerous.	Total defects.	Dangerous.	Total defects.	Dangerous.
Cases of deposit of sediment.	1,800	140	1,544	109	1,364	98
Cases of incrustation and scale,	3,412	151	3,200	123	3,041	133
Cases of internal grooving,	219	20	187	22	220	20
Cases of internal corrosion,	1,022	34	866	35	924	44
Cases of external corrosion,	739	58	786	61	698	56
Defective braces and stays,	205	50	189	35	206	39
Settings defective,	506	56	449	63	423	69
Furnaces out of shape,	584	24	573	24	459	31
Fractured plates,	253	25	330	39	283	47
Burned plates,	379	43	405	37	391	39
Laminated plates,	35	5	32	2	31	2
Cases of defective riveting,	167	31	276	63	207	48
Defective heads,	126	29	96	5	111	34
Cases of leakage around tubes,	918	160	943	160	801	112
Cases of defective tubes,	817	306	720	299	790	239
Tubes too light,	148	23	107	33	104	32
Leakage at joints,	443	28	488	31	393	34
Water-gages defective,	324	65	289	60	255	57
Blow-offs defective,	390	121	356	95	324	105
Cases of deficiency of water,	25	5	35	5	23	7
Safety-valves overloaded,	111	25	110	40	78	28
Safety-valves defective,	89	28	107	22	99	32
Pressure-gages defective,	731	47	653	32	518	41
Boilers without pressure-gages,	60	4	62	2	56	1
Unclassified defects,	2	2	0	0	4	1
Totals,	13,505	1,480	12,803	1,397	11,803	1,349

SUMMARY OF INSPECTORS' WORK SINCE 1870.

Year.	Visits of inspection made.	Whole number of boilers inspected.	Complete internal inspections.	Boilers tested by hydrostatic pressure.	Total number of defects discovered.	Total number of dangerous defects discovered.	Boilers condemned.
1870	5,439	10,569	2,585	882	4,686	485	45
1871	6,826	13,476	3,889	1,484	6,253	954	60
1872	10,447	21,066	6,533	2,102	11,176	2,260	155
1873	12,824	24,998	8,511	2,175	11,998	2,892	178
1874	14,368	29,200	9,451	2,078	14,256	3,486	163
1875	22,612	44,763	14,181	3,149	24,040	6,149	216
1876	16,409	34,275	10,669	2,150	16,273	4,275	89
1877	16,204	32,975	11,629	2,367	15,964	3,690	133
1879	17,179	36,169	13,045	2,540	16,238	3,816	246
1880	20,939	41,166	16,010	3,490	21,033	5,444	377
1881	22,412	47,245	17,590	4,286	21,110	5,801	363
1882	25,742	55,679	21,428	4,564	33,690	6,867	478
1883	29,324	60,142	24,403	4,275	40,953	7,472	545
1884	34,048	66,695	24,855	4,180	44,900	7,449	493
1885	37,018	71,334	26,637	4,809	47,230	7,325	449
1886	39,777	77,275	30,868	5,252	71,983	9,960	509
1887	46,761	89,994	36,166	5,741	99,642	11,522	622
1888	51,483	102,314	40,240	6,536	91,567	8,967	426
1889	56,752	110,394	44,563	7,187	105,187	8,420	478
1890	61,750	118,098	49,983	7,207	115,821	9,387	402
1891	71,227	137,741	57,312	7,859	127,609	10,858	526
1892	74,830	148,603	59,883	7,585	120,659	11,705	681
1893	81,904	163,328	66,698	7,861	122,893	12,390	597
1894	94,982	191,932	79,000	7,686	135,021	13,753	595
1895	98,349	199,096	76,744	8,373	144,857	14,556	799
1896	102,911	205,957	78,118	8,187	143,217	12,988	663
1897	105,062	206,657	76,770	7,870	131,192	11,775	588
1898	106,128	208,990	78,349	8,713	130,743	11,727	603
1899	112,464	221,706	85,804	9,371	157,804	12,800	779
1900	122,811	234,805	92,526	10,191	177,113	12,862	782
1901	134,027	254,927	99,885	11,507	187,847	12,614	950
1902	142,006	264,708	105,675	11,726	145,489	13,032	1,004
1903	153,951	293,122	116,643	12,232	147,707	12,304	933
1904	159,553	299,436	117,366	12,971	154,282	13,390	883
1905	159,561	291,041	116,762	13,266	155,024	14,209	753
1906	159,133	292,977	120,416	13,250	157,462	15,116	690
1907	163,648	308,571	124,610	13,799	159,283	17,345	700
1908	167,951	317,537	124,990	10,449	151,359	15,878	572
1909	174,872	342,136	136,682	12,563	169,356	16,385	642
1910	177,946	347,255	138,900	12,779	169,202	16,746	625
1911	180,842	352,674	140,896	12,724	164,713	17,410	653

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1912.

Capital Stock, . . . $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission,		$204,693.25
Premiums in course of collection,		263,453.33
Real estate,		91,100.00
Loaned on bond and mortgage,		1,166,360.00
Stocks and bonds, market value,		3,249,216.00
Interest accrued,		71,052.02
Total Assets,		$5,045,874.60

LIABILITIES.

Premium Reserve,		$2,042,218.21
Losses unadjusted,		102,472.53
Commissions and brokerage,		52,690.67
Other liabilities (taxes accrued, etc.),		47,191.65
Capital Stock,	$1,000,000.00	
Surplus over all liabilities,	1,801,301.54	
Surplus as regards Policy-holders,	**$2,801,301.54**	2,801,301.54
Total Liabilities,		$5,045,874.60

L. B. BRAINERD, President and Treasurer.
FRANCIS B. ALLEN, Vice-President. CHAS. S. BLAKE, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
W. R. C. CORSON, Assistant Secretary.

S. F. JETER, Supervising Inspector.
E. J. MURPHY, M. E., Consulting Engineer.
F. M. FITCH, Auditor.

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The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

Vol. XXIX. HARTFORD, CONN., APRIL, 1912. No. 2.

An Old Fly-Wheel.

An Old Fly-Wheel.

The cut on the first page of the present issue of The Locomotive illustrates the oldest fly-wheel, in point of service, in Pittsburg, and perhaps in the state of Pennsylvania. It is located at the rolling mill of Brown & Company, Incorporated, 10th Street and Duquesne Way. Mr. J. Stuart Brown, President and Treasurer of this company, informs us that the installation of this wheel antedates the remembrance of the oldest employe of the company.

At present this wheel is attached to an engine which was installed in 1866, and which is of the poppet valve lever type: previous to this time the wheel had been in service on two other engines.

Chief Inspector Ford, of the Pittsburg department, who has passed the "three score years and ten" mark, remembers visiting this plant, when a small boy, to see his father who was, at that time, Master Mechanic of the works. Mr. Ford states that the young men and boys employed at the plant used to watch the wheel closely in times of high water, as the mill is located near the Allegheny river, and at such times the water would back up into the wheel-pit. When it reached a certain height the mill, of necessity, would cease operating, resulting in one or more holidays for the employes.

The construction of this wheel is unique in that the spokes are of locust wood. It is twenty-five feet in diameter and makes thirty-two revolutions per minute; its estimated weight is twenty thousand five hundred-seventy pounds. The rim is of cast-iron, nine inches thick, with a nine-inch face, and is cast in sixteen sections and bolted together. The spokes — eight in number — extend from a hub, ten inches square, to the rim, to which they are fastened by pins, and, in order to add more strength, a flat band of steel is passed over the face of the wheel and down each side of the spoke, to which it is fastened.

The durability of these wooden spokes has been remarkable, as it has been necessary to replace but two of them in the last twenty years. The wheel, which is running day and night six days in the week, is regarded by the company as a tried and true friend; but we must not use the word "true" when we refer to the running of the wheel, as at each revolution it runs "out of true" at least four inches. As this has been a characteristic of the wheel since the oldest employe can remember, it occasions no alarm.

Boiler Inspection Law State of Ohio.

H. A. Baumhart, Member of Board of Boiler Rules.

In an endeavor to protect the public from the recognized dangers attending the operation of steam boilers, a few States and several municipalities have for years past had laws requiring the periodical inspection of boilers. Many of these laws were, however, practically worthless owing to the fact that no rules or regulations were prescribed to guide the inspector in determining what was safe practice.

Inspectors frequently held office without the least reference to their ability as boiler experts, their appointment often being the reward for political services rendered to the party in power. Under such conditions it would sometimes happen that an inspector who was not competent, but who had the force of law back of him, would make rules that were a hardship to the steam user and in no wise contributed to safe boiler operation.

Massachusetts was one of the first states to enact a law requiring the annual inspection of steam boilers used in that state. It was of the generally inefficient character just described as was proven by its use for several years. This law was amended in 1907 and made thoroughly efficient by a provision for a Board of Boiler Rules which was given authority to prepare rules and regulations governing the construction, installation, operation and inspection of practically all the steam boilers for use in the State of Massachusetts. In due time after this Board was appointed, a set of rules was prepared, and these rules as amended from time to time have now been in use for a sufficient period to demonstrate their general value.

In 1910 the National Association of Stationary Engineers of Ohio took up the subject of a boiler inspection law for their State, and after careful consideration it was concluded that a law similar to that in force in Massachusetts would afford the greatest safeguard to human life and property and be most likely free from political influence. The association accordingly prepared a bill which, after several amendments, became a law by the signature of Governor Harmon on June 14, 1911. This law provides for the establishment in the office of the Chief Examiner of Engineers at Columbus, of a department to be known as the Board of Boiler Rules, to consist of the Chief Examiner of Engineers as chairman, and four members to be appointed by the governor. One of these is to be an employe of the boiler using interest, one an employe of the boiler manufacturing interest, one an employe of the boiler insurance interest, and one an operating engineer.

The duties of this board are similar to the Board of Boiler Rules of Massachusetts; that is, to provide rules and regulations for the construction, installation, operation and inspection of steam boilers, and the devices with which they are equipped. The board was also to pass on any plans that might be deemed necessary to the safe operation of steam boilers, and to prescribe a standard form of certificate of inspection; also to examine all applicants for certificates as boiler inspectors.

It was provided in the law that on or after Jan. 1, 1912, all steam boilers and their appurtenances (with certain specified exceptions), should be thoroughly inspected, internally and externally, and under operating conditions at intervals of not more than one year. It was also provided that such boilers should not be operated at pressures in excess of the safe working pressure stated in the certificate of inspection and must be equipped with such appliances to insure safety of operation as may be prescribed by the Board of Boiler Rules.

The specific exceptions exempted from the operation of the law certain classes of boilers used in agricultural and other field work, locomotives and boilers, under the jurisdiction of the federal government. Boilers for heating were exempt if operated at pressures below 15 pounds per sq. inch and provided with approved safety devices.

In preparing the bill it was desired to avoid placing any hardship upon the steam user or boiler manufacturer in the construction and installation of new boilers. This was accomplished by making the rules which govern the construction of new boilers effective July 1, 1912, or nearly a year after the rules were prepared. This gave ample time to arrange contracts for future delivery.

The bill was introduced to the General Assembly and was known as House

Bill No. 248. In its preparation the Legislative Committee of the National Association of Stationary Engineers had in mind two objects, which to them, were of vital importance.

First: They desired boiler construction and inspection which would safeguard human life and property.

Second: They insisted that the inspection system be uniform and that the steam user should not be burdened with an expense or tax for similar services rendered by an insurance company.

To avoid such extra expense and also to standardize the inspection work, the bill was made to provide for two classes of inspectors: one to be known as General Inspectors, in the employ of the state, and the other to be known as Special Inspectors, in the employ of an insurance company authorized to insure boilers. These two classes of inspectors were to work under the same rules and regulations governing the inspection of steam boilers. Each inspector was to be examined and obtain a certificate of competency, and also a commission from the state authorizing him to inspect boilers.

The Ohio law differs slightly from that of Massachusetts in some respects. In Massachusetts an inspector, if employed by an authorized insurance company after passing a satisfactory examination, is granted a certificate of competency which permits him to make inspections of boilers for use in the State of Massachusetts. This certificate is granted without requiring a fee. In Ohio a fee of $10.00 must accompany an application for examination for a certificate, and after a certificate has been granted, the successful applicant is not authorized to inspect boilers for the state until a commission has been granted him by the Chief Inspector of Steam Boilers. In Massachusetts an inspector holding a certificate of competency can issue a certificate of inspection for a boiler which he finds to comply with all the requirements of the law, and no fee is charged the boiler owner for these certificates. In Ohio the certificate of inspection can only be issued by the Chief Boiler Inspector and the boiler owner is required to pay a fee of 50c. for each certificate.

In compliance with the law, the Board of Boiler Rules met on August 9, 1911, for the purpose of formulating rules governing the construction, installation, and operation of steam boilers. The subject was an important one, requiring careful consideration, as the State of Ohio ranks among the largest in manufacturing and mining industries, and probably has within its borders 25,000 steam boilers, 15,000 of which would on January 1, 1912, be subject to the rules governing the inspection of them. The State of Ohio up to this time had never had a boiler inspection law. Its steam users and boiler manufacturers, therefore, were familiar only with such inspection requirements as the steam boiler insurance companies imposed, and in most cases the pressure allowed was that determined by the boiler manufacturer or an insurance company's inspector, when insured. As power plants are designed to operate with a certain fixed minimum pressure, it was realized that any reduction to permit of a fully adequate factor of safety would, in many cases, cause a great hardship. The factor of safety under which some of the boilers were operated was problematical but, judging from personal observation, a considerable number, perhaps 40% of the total in the State, had a factor of safety of 5; about 30% a factor of safety of 4½; 25% a factor of safety of 4, and perhaps 5% a factor of safety of less than 4. The question most difficult for the Board to decide, was what should be the minimum factor of safety for boilers already installed, and at what time in point of service should the pressure be reduced, in order to maintain safe operation and not create an unnecessary expense or hardship, or perhaps in some cases, compel the mine or factory to close to avoid violation of the law.

The Massachusetts rule places the minimum factor of safety at 5, and this is increased when the boiler is ten years old. This high standard was obtained after several years of educational work in that state. It would seem to be an injustice to the steam users to extend that rule to Ohio at this time. The minimum factor of safety generally used in Ohio for the past ten years was 4. It was thought that this factor could be safely extended to cover all boilers already in use in Ohio until the steam users could become accustomed to a higher standard and arrange conditions to meet it. It was, therefore, recommended that the minimum factor of safety for boilers already installed be placed at 4, and that the inspector should increase this when the general condition of a boiler required it. This rule was unanimously adopted by the board. It is recorded in Part 1 of the book of boiler rules and is now a law.

When formulating the part of the rules governing boilers to be installed after July 1, 1912, the board considered in addition to safety, the question of standard boiler construction. Some states and several cities have boiler inspection laws, which differ in but small details, but sufficiently so to prevent a boiler designed for one locality being installed in another, although meeting all the requirements of the law at the first location. Boiler manufacturers are placed at a serious disadvantage because of this situation, for it thus becomes necessary to know where the boiler is to be installed before it can be designed, a condition which tends to increase the cost of production. Manufacturers and contractors whose business requires the use of temporary steam power are inconvenienced by being prevented from removing boilers from one locality to another because of this difference in the inspection laws. The boiler manufacturers and steam users generally requested that the rules covering the construction of Ohio standard boilers be made similar to those adopted by the State of Massachusetts and the City of Detroit, believing that if Ohio followed those rules, it would be an incentive for other States to follow them, when inspection laws were enacted. After carefully analyzing the Massachusetts boiler rules, the board found that they covered in detail practically all the requirements of safety, and with the exception of a few slight changes relating to minor details, adopted them, and they are found in Part 2 of the book of boiler rules.

These rules apply to all boilers installed in Ohio after July 1, 1912. To avoid delay, additional expense, and perhaps rejection of a boiler, steam users, when ordering a boiler to be installed in Ohio, should specify that it comply with the Ohio Standard Rules. The law states explicitly that no certificate of inspection shall be granted on any boiler installed in Ohio after July 1, 1912, which does not conform to these rules. Boiler manufacturers, dealers and steam users, should understand that new boilers in the state, which are installed before July 1, 1912, cannot be installed as Ohio Standard Boilers unless they have been constructed to comply with the Ohio rules.

Under the Ohio and Massachusetts law, all boilers must be inspected at the place of manufacture by an authorized inspector and stamped by the manufacturer in the presence of the inspector before shipment. This may appear an unnecessary expense, but it has been found in practice to be necessary to insure compliance with the rules.

A Peculiar Engine Accident.

Usually it is not a very difficult matter after an engine or boiler accident to determine the cause. The engine accident which we here describe is, however, an exception to this general rule. We were given ample opportunity to make a thorough examination after this accident before any of the parts had been disturbed.

The facts as stated by those in charge of the engine at the time of the accident were corroborated by the conditions found upon this examination. The engine was a cross-compound Corliss built by the Wm. Harris Steam

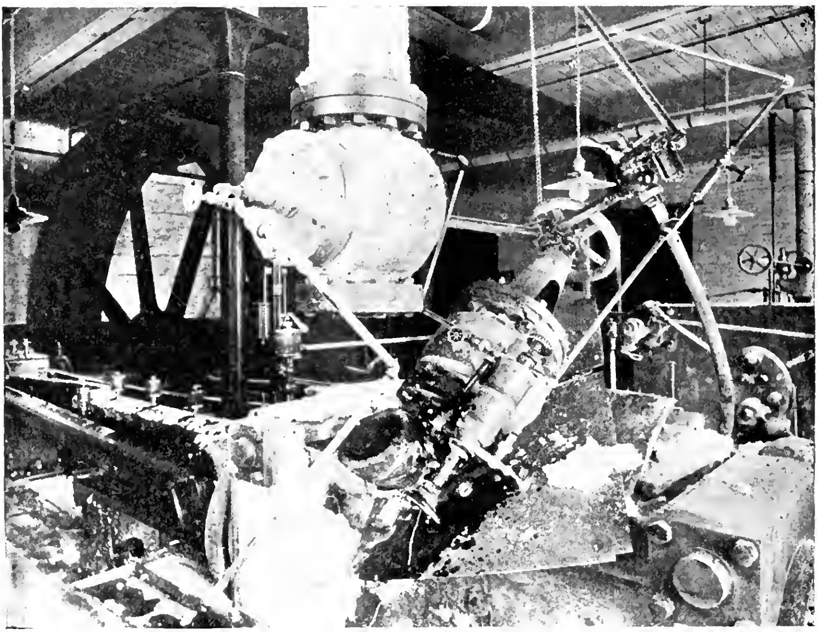


FIG. 1. A PECULIAR ENGINE ACCIDENT.

Engine Co. of Providence, R. I., and was used as an auxiliary drive for the No. 2 Mill of the Thorndike Company at Thorndike, Mass.

Under normal conditions the power for this mill is derived from the Ware River, and the engine is used in times of low water. On account of the variation in the load it is required to handle, the piping is arranged so that it may be operated single cylinder condensing, compound condensing, or as a simple engine.

At the time of the accident the connecting rod on the low pressure side had been removed and the high pressure cylinder was being used alone in connection with the condenser. The condenser is of the jet type, the pump being driven directly from the crank pin on the low pressure side.

The results of the accident, which occurred while shutting down the engine at 6 P. M., are clearly illustrated in Figures 1 and 2. Owing to the necessity for releasing a clutch on the main line shaft, the shutting down of the engine was rather a slow process, requiring about ten minutes to complete. At the time of the accident the engine had slowed down to a point where it was

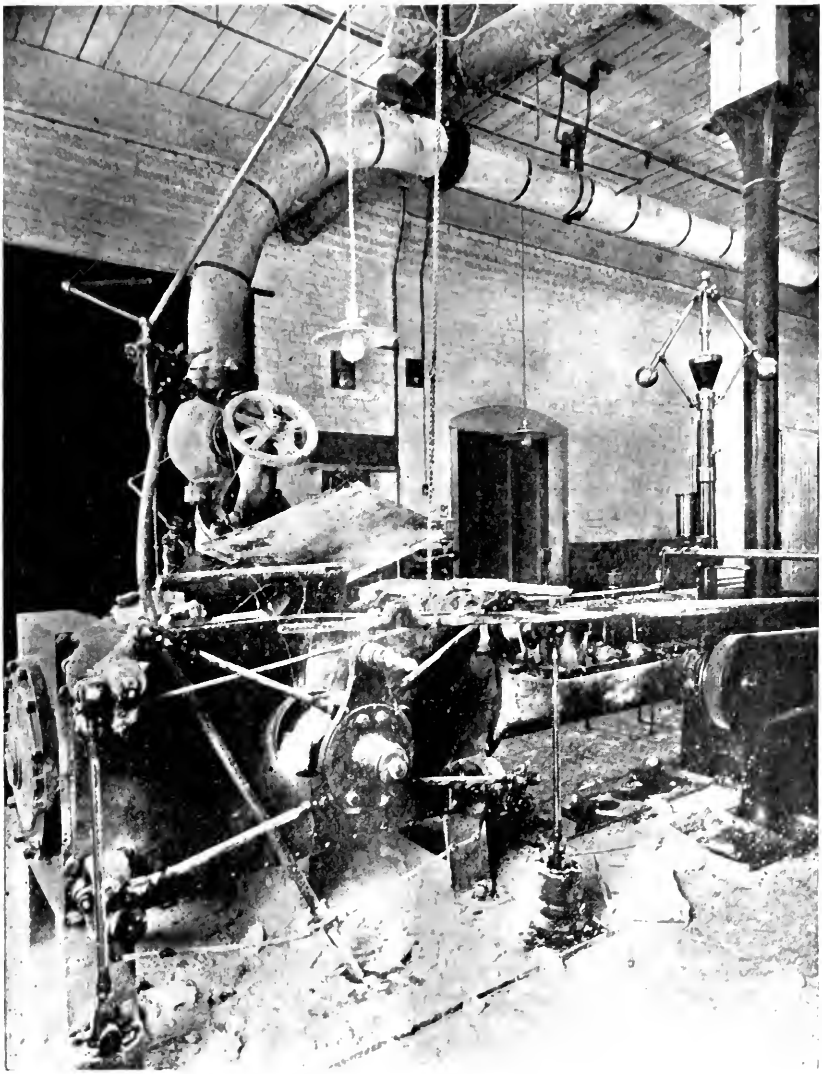


Fig. 2. A Peculiar Engine Accident.

judged that one or two more revolutions of the fly wheel would be the last, when an explosion occurred with the results as shown.

In an accident of this nature the first cause suspected is water, but this could not have returned by way of the cylinder, for the first thing done by the engineer in shutting down was to close the injection water valve. Even if this valve had not been shut, the condenser pump was operating as long as the engine continued to revolve. Also the reach rod was unhooked and the steam valves were closed as is clearly shown in Figure 2. There were no evidences of water in the steam chest, which contained considerable quantities of finely divided asbestos which was blown from the pipe covering, and if water had been present, the condition of this covering material would have indicated it.

It can be assumed that a slug of water came over from the steam main and delivered a blow on the elbow sufficient to break it; but if so, why were there no evidences of the presence of water?

Another objection to such a theory is that both the steam inlet valves and the throttle valve were closed and on this account there seems no good reason why water coming through the steam pipe should be moving with any considerable speed. The top of the steam chest was rather weakly constructed, being about 1 inch thick and 47 inches long by 14¼ inches wide and not stiffened in any manner by ribs.

The Master Mechanic of the mill thought that the elbow was broken in some manner by expansion of the pipe line, and that the main steam pipe was thrown up by the outrush of steam and fell back on the elbow, when the automatic valve closed, delivering a blow that broke in the top of the steam chest. This theory is very plausible as it would explain the position the parts were found in, but no marks could be found on the broken end of the elbow, or the flange attached to the Locke automatic stop valve, to show that such a blow had been delivered. That the steam pipe was thrown up quite a distance at the time of the accident is indicated by the bent hangers and broken air duct shown in the upper part of Figure 2.

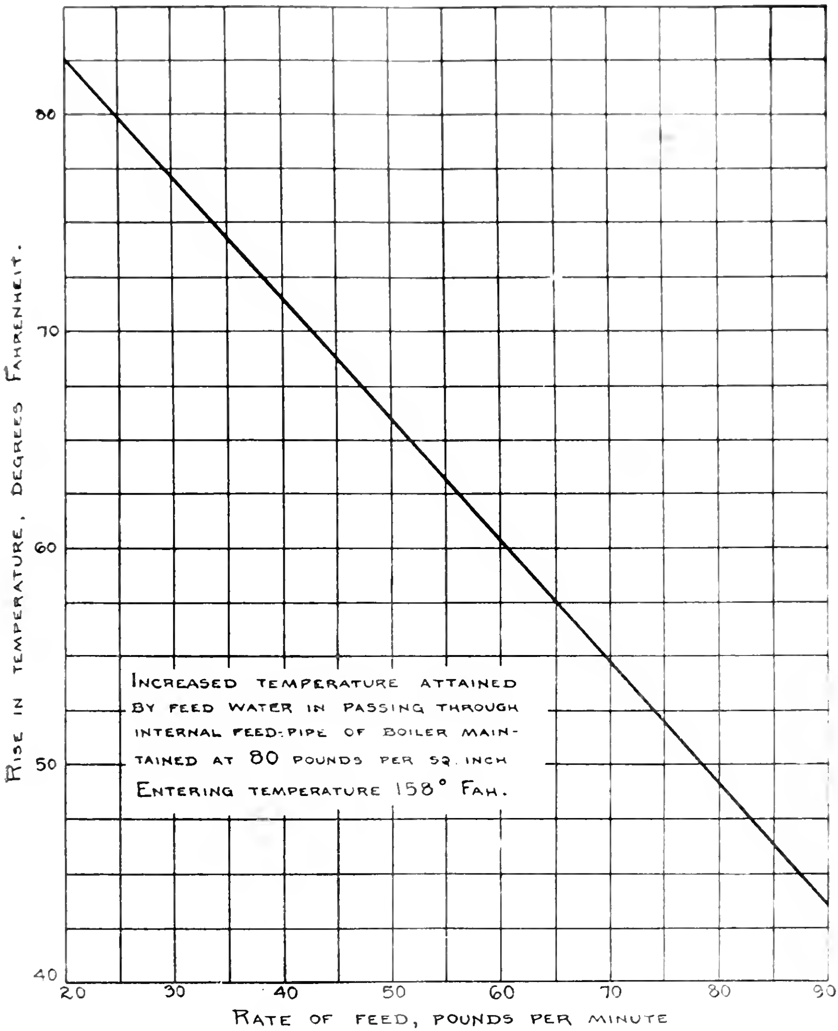
It is possible that owing to the weakness of the top of the steam chest the steam load of 80 lbs. per square inch acting downward on the elbow at the instant it broke, with the leverage of 15 inches between the center lines of the main steam pipe and the trottle valve, may have been sufficient to break in the top of the steam chest. The load applied to the elbow tending to throw it down in this manner would have been about 2,250 lbs. at the instant the elbow broke.

We will be glad to hear from any of our readers who may think that they have a better theory to suggest as to the cause of this accident than the ones here given. It was extremely fortunate that this engine was supplied with an automatic stop valve, for the broken parts were thrown in such a manner that the auxiliary valve operating this device was tripped and the main valve immediately closed. Without such a device several occupants of the engine room would probably have been scalded by the out-rushing steam.

Temperature Attained by Internal Feed.

V. Hugo.

The Locomotive for March 1882 and several more recent numbers of that paper have set forth the advantages of the method of supplying boilers with water by feeding it in at the top and through a length of internal pipe before



its final discharge into the body of water in the boiler itself. As these articles have pointed out, this method raises the temperature of the incoming feed to nearly that of the body of water before its discharge and thus to a great extent relieves the boiler of strains to which it would be subjected by local contact with cool water.

What temperatures may thus be obtained for the incoming feed by its passage through the internal pipe should be a matter of interest, and it is hoped that the results of a test made by the writer on the temperatures thus reached in one boiler may prove a contribution of value to the accumulated data on the subject.

Two boilers were used in a test, the purpose of which primarily was to determine the evaporative value of a certain coal. Boiler No. 1 was used for this purpose and all coal and water supplied to it were carefully weighed. Its feed water, however, was first passed through twenty-nine and one-half feet of 1½ inch internal feed pipe in No. 2 boiler which was fired only to maintain a constant pressure, and consequently a constant temperature of the water in it. Thus by the arrangement of its feed pipe connections No. 2 boiler became practically an independent heater for the feed water of No. 1, and as measurements of both rate and temperature of feed were constantly recorded the resulting data were available as evidence of the advantage of the internal pipe as a heater. This data is shown on the accompanying chart on which the rise in temperature attained at different rates of feed has been plotted. The average temperature of the water entering No. 2 boiler was 158 degrees Fahrenheit, and its steam pressure was maintained constantly at 80 lbs. per sq. in. corresponding to a temperature of 323 degrees Fahrenheit.

Autogenous Welding for Repairing Boilers.

By Henry Cave, President of "The Welding Co."

Autogenous welding is the uniting of metals into one solid mass by fusion without using any dissimilar metal and without pressure or hammering. It differs from other forms of welding, in that the metal is actually melted and flows together and is not merely brought to a plastic condition by heat and then hammered together as in the case of the blacksmith's weld or forced together by pressure as in the case of the ordinary form of electric welding.

The most common form of *autogenous welding* is that carried out by means of the oxy-acetylene flame, the temperature of which is 6300 degrees Fahrenheit. This high temperature is not required to fuse the common metals, but has the advantage of applying the heat so rapidly that the conductivity of the metal has not time to draw it away from the spot where it is applied, with the result that this spot very soon becomes red hot and is then fused, while the metal a few inches from the weld remains cool. The oxy-acetylene flame has the highest temperature of any known combustible, due to the fact, that it is produced by burning acetylene with pure oxygen. Acetylene having the largest amount of carbon in its composition that a gas can carry, has the greatest heat possibility and this heat is developed to its fullest extent when burned with pure oxygen.

This process of welding is a natural development of the last few years following on the heels of the commercial development of acetylene gas from calcium carbide which is now cheaply produced by means of the electric furnace. The process was first developed in France. It required a number of years of experimental work before a satisfactory torch was produced, but at the present time every metal working establishment of any importance in that country is equipped to carry out this class of work. The development in this country has been slower, but the equipment now obtainable here is equal if not superior to anything produced abroad, and the work performed by it is fully up to the foreign standard.

Two distinct types of equipment have been developed termed respectively, "High Pressure Positive Mixture" and "Low Pressure Injector Mixture." The low pressure torch was developed to use acetylene gas from an ordinary lighting generator, the pressure of which is only a few ounces per square inch. With it there was difficulty of obtaining a thorough mixture of the gases, a condition which resulted in poor economy and weak welds. The high pressure torch was then developed abroad to overcome this trouble. It had the disadvantage of requiring a supply of gas under pressure which at first was obtainable safely only by compresing it and storing it as "dissolved" acetylene in cylinders. When it was introduced into this country, however, "Yankee" ingenuity devised a "pressure" generator, which produces the gas under the required pressure (not over 15 lbs. per sq. in.) direct from the calcium carbide, and thus removed from the "high pressure" torch the principal objection to its use. As most of the repair work on boilers is carried out without moving them, the equipment used for that work must necessarily be portable. I will not, therefore, go into any further detail with regard to the "high pressure" generator, as its field is in the shop where portability is not a requisite quality.

Fig. 1. Welding Tube Sheet.

For portable use the apparatus consists of a cylinder of compressed pure oxygen and a cylinder of dissolved acetylene. Both are provided with reducing valves which limit the pressure of the gas to that required in the torch. The latter is supplied by a hose connecting with both cylinders so that it may be taken inside a fire-box or boiler and the welding carried out in any position and on any part of the boiler. Welds can thus be made on the vertical seams or plates of fire-boxes without any trouble, as well as on overhead surfaces as required. As these various positions have some influence on the efficiency of the work, only men used to these various conditions should be allowed to attempt it.

The oxygen is stored in the tank or cylinder merely by compression, it, of course, being necessary to have a sufficient number of cylinders on hand to supply enough gas for the particular job. This is also the case with the acetylene cylinders. These, however, are not merely tanks into which that gas is compressed,— for acetylene compressed above twenty-five pounds per square inch is dangerous,— but contain certain liquids which have the property of "absorbing" or "dissolving" acetylene, in which condition it is perfectly safe. The cylinders are first filled with an absorbant material such as asbestos, which holds like a sponge the absorbing liquid with its compressed and dissolved gas.

With this apparatus, the company with which the writer is connected has been most successful in the application of autogenous welding to the repair of steam boilers. The field for such application is almost boundless, and the saving that can be made over older methods by building up or strengthening corroded parts with new metal homogenously united with the old must be obvious to all.

The work to be successful must be most carefully performed and only by those who are equipped with suitable apparatus and are expert in its use. So much depends not only on having the gases of the applied flame properly mixed and in proper proportions, but also on the correct application of the flame and its heat to the metal that in so important work as boiler repairs, too great emphasis cannot be laid on these requirements. An inexperienced operator even with proper equipment could produce results which would be disastrous, and any one, whether experienced or not, may obtain the equipment if he can afford the price. For these reasons the writer is strongly advocating the licensing both of the equipments for carrying out the work and of operators to use licensed equipments in the repair of boilers. The work should further be carried out under the the direction and supervision of one who is not only informed in boiler construction but who has a broader knowledge of the nature of metals and their heat treatment than may be expected of even a most expert equipment operator.

As illustrating the character of boiler repairs that our company has successfully undertaken, the following examples have been taken:

1. A corroded section of the plate at the mud-ring of a Manning boiler was built up to its original thickness, the work being done without removing the boiler, whereas the boiler-makers required the shipment of the boiler to their shops for repair.

2. The welding of cracks in the ogee ring of three Manning boilers, the welding of which was carried out in a few hours. The replacement of these rings practically meant a reconstruction of the boilers, which would have been a very expensive operation.

3. The welding of the vertical seams in the fire-boxes of six Manning boilers and also the welding of the rivets, it being impossible to caulk these seams so as to produce a tight joint.

4. The welding of fourteen fire cracks in the girth seam of a horizontal boiler directly over the fire, this work being carried out overhead. Repeated efforts to take care of these cracks by ordinary means having proved unavailing.

5. The building up of the plates in the fire-boxes of six vertical boilers over areas approximately six feet in length and 8 to 10 inches in width from the mud-rings up. This method was adopted instead of the more expensive and less efficient method of riveting in patches, which would sooner or later prove a source of trouble.

6. The welding of numerous cracks in the neighborhood of fire door. This is a very common form of trouble on all types of boilers.

7. The building on of metal on the bottom edge of the fire-door flange, which had been worn thin by constant barring.

8. The welding in of a plate to form a new hand hole on a horizontal boiler, the hand hole having been enlarged to the limit to take care of the corrosions due to leakages. In this way at small cost, the necessity of replacing the tube sheet was avoided.

9. The welding of broken bridges in the tube sheet, it being practically impossible to satisfactorily repair these in any other way, though attempts are frequently made to plug them. (See Fig. 1.)

10. Bags can be put up with the help of the oxy-acetylene flame in a fraction of the time required by older methods and with more satisfactory results.

11. More extensive repairs were carried out on locomotive boilers. Fig. 2 shows the side sheets of the fire-box of a locomotive repaired by welding in the lower halves instead of riveting them. It can readily be seen that by adding rivets and seams as in the case of patches, future trouble is invited, particularly where these rivets and seams come in the neighborhood of the fire. By welding these half side sheets in, future troubles are avoided. In this same fire-box, as can be seen from the illustration, patches were put in the back sheet of each side. This boiler had been cracked between several stay-bolts on the back head and these had been repaired by riveting on patches. The cracks then extended beyond the patches, which were removed, the cracks being welded

up and blind rivets put in the hole. This repair materially reduced the length of time the locomotive was out of commission, which was an important item.

12. Another locomotive fire box had already had a riveted seam placed just above the line of the fire on the side plates and it became necessary to replace this seam, though the rest of the plates were in fair condition. The oxygen cutting torch was used to cut out a strip about 5 inches wide, including this seam, in each side plate. The patches were then welded in, the whole operation was carried out within two or three days. It would have required two or three weeks

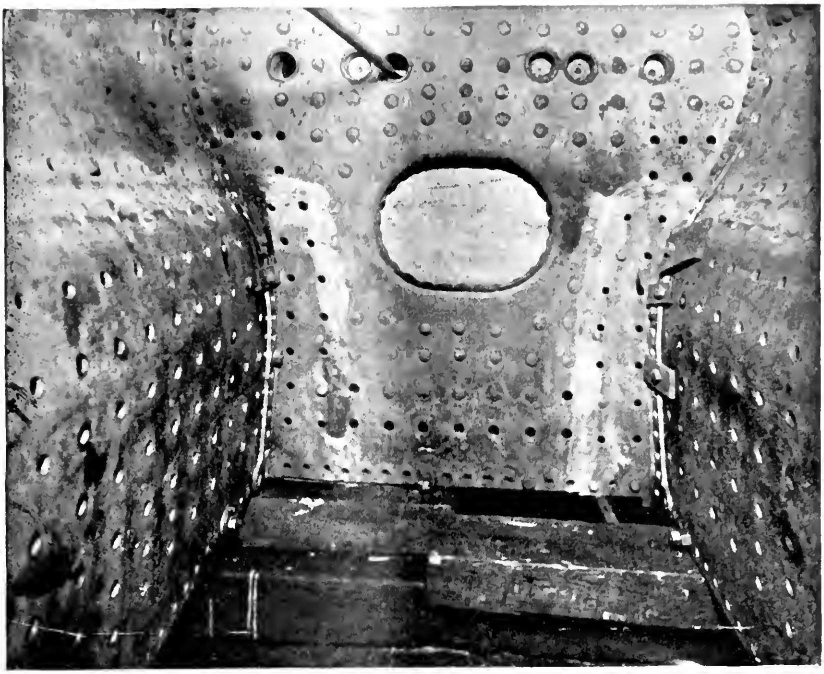


Fig. 2. Welded Fire-Box.

to repair it by ordinary means and the saving alone from this feature amounted to hundreds of dollars.

These examples are chosen from a large number of such repairs which have been thoroughly tested and proved satisfactory. They should give a general idea of the scope and character of the repairs that can be carried out by this means.

The foregoing article by Mr. Cave, abstracts briefly a most comprehensive lecture which he presented before The Hartford Steam Boiler Technical Club on the evening of December 27, 1911. The lecture was followed by a demonstration of the equipment and methods employed by Mr. Cave's company in the welding and cutting of metals by the oxy-acetylene process, and was most interesting and instructive to those who were present.

The HARTFORD company recognizes the possibilities which autogenous welding has opened for the economical repair of machinery and metallic structures of all kinds. We have felt, however, that in so important a matter as boiler repairs this new process should not be too hastily adopted for general application. We are accordingly pleased at the evidence in Mr. Cave's paper that he, as the head of a company which has done much in this line, appreciates the dangers involved in the performance of such repairs by unskilled operators or faulty apparatus. The success of a weld cannot be absolutely determined from its external appearance and when that success is so dependent on the skill of the operator and his manipulation of apparatus, we would hesitate to make use of this new process in a repair the strength of which was vitally necessary to the boiler's safety. There are many cases, however, where a defect appears which does not in itself lessen the boiler's strength. In the remedy of such defects the autogenous weld may be applied without much risk and in this class of repair the process should find a broad field of usefulness. Undoubtedly success in this work will gradually overcome any distrust of the weld for the repair of more vital defects.

Boiler Explosions, Their Causes and Prevention.*

S. F. Jeter.

It is a great pleasure to be permitted to deliver a paper before the representative boiler manufacturers of the country, and particularly so on this subject and occasion. New Orleans was the scene of the speaker's first entry into the steam boiler insurance field with the company that has had more to do with the prevention of steam boiler accidents than any other organization.

The causes of steam boiler explosions are so varied that it will only be possible to mention the more prominent ones in this paper. Broadly speaking, there is one explanation for all boiler explosions; namely, the boiler or some part of it is too weak to withstand the strain brought upon it. However, there are many causes contributing to such weakness.

The public and many engineers assume that most explosions are caused by some mysterious influence which cannot be foreseen or guarded against, but as an actual fact, a definite cause can be given for most explosions of considerable violence. That a large percentage of boiler explosions are from causes that might have been foreseen and prevented, is a well established fact.

The Hartford Steam Boiler Inspection and Insurance Company's business during the past forty-five years has been built upon this idea, and the Company's success and low loss ratio have demonstrated its correctness. Public opinion is being aroused to the fact that many boiler explosions are preventable, as evidenced by the present agitation for laws governing the construction and operation of boilers. The lead of the city of Philadelphia has been followed

* A paper delivered before the American Boiler Manufacturers' Association at New Orleans March 12-15, 1912.

and improved upon by the State of Massachusetts. Ohio and several municipal governments now have boiler laws patterned after those of Massachusetts, and similar action is being seriously considered by a number of other states and cities. I can speak from experience gained in the manufacture of boilers, and I am sure you will bear me out in the statement, that good laws on this subject of uniform character will be welcomed by the high-grade boiler manufacturer as a distinct aid tending to eliminate unfair competition.

The cause of boiler explosions which I will deal with first, because it is of particular interest to the manufacturer, is faulty design. Boilers are frequently constructed too weak for the pressure to be carried. This does not mean that the boiler will necessarily explode as soon as pressure is raised. Explosions from this cause usually occur after years of use, the overload on the parts having had time to gradually weaken them until they are no longer capable of resisting the excessive strain. Of course, a manufacturer has practically no control over the steam pressure to be used on a boiler, after he has delivered it to the purchaser. However, if the manufacturer should stamp his name and the safe working pressure for which it was designed on each boiler built, it would act as a protection to his reputation in the event of excessive pressure being used. Proper inspection and fixing of pressures by experts is the logical remedy for explosions due to this cause.

A fault of design which often leads to an explosion is the adoption of a shape which tends to deform under pressure. In such cases, if the movement produced occurs in narrow limits along fixed lines, grooving or cracking is almost certain to occur, finally causing an explosion, unless the defect is discovered before the structure has been weakened to the breaking point. The obvious remedy is to use shapes which internal pressure does not tend to change, and if this is impractical to use such forms that the movement produced will occur over considerable areas and not be confined to narrow limits.

Improper reinforcement of openings has occasionally been the cause of boiler explosions. If the openings in boiler work were not generally of such moderate dimensions this might be a more frequent cause of disaster. It may be well to say here that no definite information is available regarding the distribution of stresses around an opening in a cylinder when subjected to internal pressure; consequently, the design for the reinforcement of such openings is by rule-of-thumb.

A cause of boiler explosions, where the design is primarily responsible, is when the arrangement does not permit of accessibility for the inspection of all parts. This is especially so when the inaccessible parts are located where rapid deterioration is likely to occur. No portion of the boiler proper should rest directly on a foundation or have any of its parts buried in earth or ashes.

A design which does not permit free circulation of water in all of its parts is liable to produce rapid internal corrosion, for unless a current is produced by the circulation sufficiently strong to remove all bubbles of air that may attach themselves to the surfaces, rapid corrosion is almost certain to ensue, which if neglected may result in an explosion. Air, which is a mixture of about four parts of nitrogen to one of oxygen, together with very small quantities of other gases, dissolves to a certain extent in water. However, the oxygen, being more soluble than the nitrogen, dissolves more readily and the proportion of the gases found dissolved in the water are roughly one of oxygen to two of nitrogen, instead of in the proportions found in the air. When the dissolved air is liberated by the heat, the high percentage of oxygen causes the surfaces on which the bubbles may collect, to be rapidly corroded. This accounts for the severe corrosion of vessels containing water, which is merely heated without a strong circulation being produced.

A correct boiler design will provide uniform flexibility throughout. A stiff rigid part next to one which is flexible is a menace to safety if there is any tendency towards movement between the parts, either due to temperature changes or pressure.

Defective workmanship is responsible for some explosions. The barbarous practice of drifting rivet holes has doubtless contributed largely in the past to such accidents. The reputable manufacturer of today, however, will not knowingly permit such work.

Lack of properly flaring the tubes and nipples in water-tube boilers has frequently resulted in explosions. The Hartford Steam Boiler Inspection and Insurance Company have always advocated proper flaring, and sometimes manufacturers have taken issue with the Company on this point. Experience, which has cost the Insurance Company many thousands of dollars, has fully demonstrated the correctness of their position in this matter. The safety of the joints between a tube and plate when expanded and flared or merely expanded, is not a question of the relative strength of such connections newly made. When for some reason connected with the operation of a boiler a connection of this kind becomes loose due to a movement of the parts from expansion or vibration, together with the excessive weight sometimes sustained, the tube or nipple with a flared end is decidedly more safe than one which is merely expanded. The flared nipple usually gives warning of its looseness by leakage before it pulls out.

We all know from experience that the tendency is for employees to cover up mistakes in the shop. A manufacturer cannot guard his reputation from injury by this means too carefully. A loss of reputation for good work, after it has been well established, is many times more costly to the manufacturer in dollars and cents than the correction of errors before work leaves the shop.

Defective material is sometimes the cause of boiler explosions, and the boiler manufacturer is largely dependent upon the producer of the material entering his product for protection in this respect. Nothing but material of the best quality should be specified for all parts of a boiler which are called upon to resist the strains produced by the pressure of steam, and every precaution should be exercised to see that such material is obtained.

Cast iron should never be used in any part of a boiler called upon to resist tensile strains. This is in thorough accord with your views on the subject as expressed in your uniform boiler specifications.

A cause of explosions which is particularly reprehensible because of its being preventable, is due to an owner's willingness to pit his judgment against more competent or conservative advice. Often boilers are known to be in need of repairs, but the work is put off to a more convenient season. A feed pump refuses to start, and instead of fires being drawn as soon as the water reaches the lowest safe level, a chance is taken that it can be run a little longer. Pressures are sometimes carried higher than reasonable safety would permit, to avoid the expense of larger engines, or better boilers. Boilers are forced beyond a reasonable duty for the heating surface they contain. This is a feature that must be reckoned with more in the future than it has been in the past. Many engineers are apparently trying to discover by experiment the limit to the rate of transfer of heat from fire to water through the medium of boiler tubes and plate. In order to show minimum investments and other economies, resulting from high rates of driving, engineers are prone to advise overloads on both engines and boilers, and all seem to overlook the all-important question, Is it safe?

Boiler explosions are also the result of neglect or carelessness in operation. Scale and deposit are often allowed to collect in quantities that are dangerous Connections to water columns are allowed to become stopped. Oil is permitted to enter the boiler with the feed water. Repairs to settings which may affect the safety of the boiler are neglected. Safety valves are not regularly tested to ascertain if they are in operating condition. Occasionally a boiler owner who discovers his safety valve leaking, with an eye blind to every consideration except the prevention of loss of steam, places a stop valve on the connection to the safety valve or plugs the outlet. A steam gauge registers incorrectly and the engineer screws down on the safety valve in an endeavor to make the gauge show the correct pressure. The pressure of steam is not sufficient to produce the results desired with the machinery using it, and the safety valve is deliberately made inoperative to overcome the difficulty. All of these conditions have been the cause of boiler explosions in the past and they probably will continue to contribute their share in the future until the steam user is more thoroughly educated in the matter of the risk he runs by such carelessness.

Tube failures, which are chiefly confined to the water-tube type of boiler, are a source of grave concern to the boiler insurance interest on account of the difficulty to guard against the usual failure of this kind by inspection. A defective weld usually does not show on the surface of the tubes, and even where the surface indications would lead to suspicion, a large percentage of the tubes in water-tube boilers are beyond the reach or vision of the inspector. The thorough inspection of tubes before they are placed in the boiler, while very unsatisfactory, even taken in connection with the mill test, is about the only protection possible against accidents due to defective tubes.

The seamless tube, of course, will prevent accidents due to defective welding, but tubes made by this process are not always of uniform thickness, and with the cold drawn product there are apparently internal strains produced by the process of manufacture which sometimes cause the tubes to break when merely heated. If cold drawn tubes are used for boiler purposes, the annealed stock should be obtained. Hot drawn seamless tubes are meeting with considerable favor among engineers for boiler purposes. A considerable percentage of tube failures occur without the slightest evidence as to their cause. A welded tube frequently breaks through the solid metal away from the weld, without being corroded or weakened in any way that may be detected by the eye, and without evidences of overheating. There must be some reason for such failures.

It is a fact that while pressures and rates driving have been remarkably increased during the past 15 or 20 years, no increase in the thickness or strength of tubes has occurred. That the thicker tube is safer seems to have been demonstrated by a number of cases where heavy tubes have been put in place of those of standard gage at the recommendation of the Hartford Company, and the tube troubles have ceased. Of course, it can be contended that the theoretical factor of safety is higher on tubes even of standard thickness than on almost any other portion of the boiler. However, under operating conditions accompanying high rates of driving, is it not possible that there are decided fluctuations in the temperature of the material in the tubes? The rapid formation of steam bubbles removes for a certain interval of time the water protection from the inner surface of a tube, and the thinner the material, the higher will its temperature rise during a given time in which it is not protected. It is conceivable that the structure of the metal in a thin tube may be affected in time by the constant change in temperature until it gives out, while the thicker tube might not be affected to the same degree by this means.

This idea is only advanced as a possible explanation for some of the tube accidents which seem to defy definite causes being assigned for them.

The thicker material in the cases of welded tubes will make more certain that the required strength is obtained in the weld, also, surface imperfections in the material would not affect the strength to the same degree in the thick tube as it would in the lighter one.

The importance of the question of tube failures to the operator of boilers as well as to the insurance interest can be appreciated when I say as I believe I can conservatively, that the toll of loss of life and limb exactly by such failures probably exceeds other classes of boiler accidents when the relative number of fire-tube and water-tube boilers in use is considered.

Corrosion has been the cause of many serious explosions, but with boilers built accessible for inspection, explosions from this cause may be reduced to a minimum where the boilers are under the care of a competent inspection service.

A source of explosions, external to the boiler itself, but which has produced very serious disasters, is the improper arrangement of steam piping. It is very dangerous indeed to attempt to connect a boiler to a steam line where the piping is arranged so that water pockets may be formed. A water-hammer is likely to result in such cases which may break the pipe connections, and this in turn may produce an explosion of the boiler itself.

A source of very disastrous explosions has been the prevalence of the hidden crack or so-called lap-seam crack. The cause of these defects are either the form of seam, poor material, improper shape of the joined ends of the sheet, or the abuse of the material in the process of manufacture; or possibly a combination of some of these causes. That the form of seam alone is not the only factor is well demonstrated by the fact that all lap seams do not fail in this manner and also that some seams of the butt joint type have thus failed.

It is, of course, readily recognized that with every precaution which can be taken, boiler explosions cannot be entirely eliminated but their number may be lessened materially. A proper inquiry into all accidents of this kind by Government officials qualified and clothed with ample authority to get at all facts in each case, and the blame, if any, placed where it properly belongs, would tend to reduce the number of explosions materially. This is a feature we might profitably copy from our English cousins.

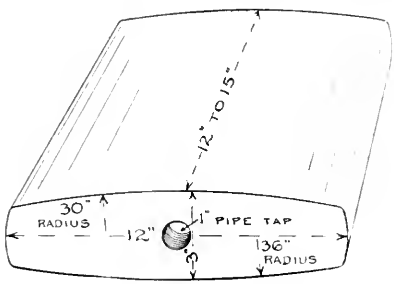
Repairing Bagged Fire Sheets.

J. P. Morrison, Inspector.

A very common occurrence in the operation of steam boilers is the bagging of the fire sheets, due to the presence of scale, oil, etc., that may prevent the proper cooling of the metal by the contained water.

It is very much the best, when possible, to repair such defects by heating and driving the metal back to its original position instead of resorting to patching. In driving up a bag it is, of course, desirable to prevent as far as possible the marring of the metal by hammer marks and to leave the surfaces straight and true to the original form. The success with which a repair of this kind may be accomplished depends largely upon the skill of the boiler-maker, but proper tools are almost indispensable if a first-class job is to be obtained.

The usual method of heating the sheet with a fire pot and bellows is familiar to nearly all boiler-makers and to many boiler owners who have had occasion to have such repairs made. The gasoline blow torch is now sometimes used instead of the old fire pot where compressed air is available, and the results obtained by heating in this manner are generally satisfactory.



The novice can appreciate that if an attempt should be made to straighten a bent piece of rod without an anvil of some kind to hammer on, it would be almost impossible to obtain satisfactory results, and in a measure it is as difficult to straighten a bagged sheet without some similar device. The block here illustrated can be used as an anvil against which the boiler sheet may be driven. It is made with one face to a radius of 36 inches and the other 30 inches, so that one face or the other will fit approximately any shell between 54 inches and 84 inches in diameter, and therefore, only one block is necessary. The width of the block is limited by the size of the man-hole opening to about 12 or 13 inches and the length of from 12 to 15 inches is generally sufficient. If 3 inches thick the weight will be about 85 to 110 lbs., which will permit good work without being difficult to handle. A hole is usually drilled in the end and threaded for a 1-inch pipe to facilitate handling.

By placing this block over the bulged part after each heat and using the proper kind of hammers, the metal may be driven to its original position without corrugations or hammer marks. A final heat and careful use of a flatter will leave the sheet in practically as good condition as before it was bulged.

The Locomotive of THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

HARTFORD, APRIL, 1912.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

Mr. Baumhart's paper in this issue on the Ohio Boiler Inspection Law we are sure will be read with interest by those who appreciate the need of governmental supervision over the operation of steam boilers. The danger to life and property which is inherent in every steam generating vessel is ample justification for such supervision and for legal enactments which will compel compliance with approved methods and practices.

In Ohio the legislature evidently realized that adequate measures of safety included both a frequent inspection of the condition of each boiler and the establishment of definite standards of structure, equipment, and installation. It appreciated that these were all strictly technical questions on which only those expert in such matters were competent to pass and it therefore wisely delegated to a commission of such experts authority to determine those standards and to establish them with the force of law. This is all very gratifying to the HARTFORD Company for it indicates a public realization of the necessity for those measures which for years this company has contended were essential to the safeguarding of boiler operation. It started on the theory that many a boiler disaster was preventable had the condition of the boiler been previously determined, and it organized and maintained a system of inspection which in the past forty-six years has proved that theory correct. The experience of those years enabled it to advocate certain standards of approved construction and installation and it is accordingly a matter of pardonable pride to the HARTFORD that the experts of the Ohio Board of Boiler Rules, following the example of Massachusetts, have given their endorsement to so many of those standards by including them in the legal regulations of their commonwealth.

Richard Teller Crane.

The April issue of *The Valve World* is devoted to an appreciative tribute to the memory of Richard Teller Crane, late president of Crane Company, whose death occurred on January 8th, 1912. In it is told the life story of the man whose genius as a mechanic and an organizer made possible the great commercial institution which bears his name and which is so well known to steam users throughout the land. Of him *The Valve World* writes,

"He lived a long and eventful life in the age of iron and steel and in the developments of that age he wrought not only a journeyman's but a master's part. He was a conspicuous member of that class of men to which this country has not yet paid its meed of praise simply because as yet it but imperfectly realizes the immense value to this country of the skilled and ingenious mechanics of great business ability whom the last century produced."

Boiler Explosions During 1911.

We desire to call attention to the statistics concerning boiler explosions which occurred during 1911. Great care has been exercised in the compilation of the chronologically arranged lists, upon which the appended summary is based, and it is our belief that we have accounted for by far the greater number of boiler accidents which has taken place in the United States in the past year. As the accounts are received, and usually several newspaper clippings or letters reach us in regard to each explosion, they are carefully scrutinized and compared so that the actual facts are determined as nearly as possible.

It happens occasionally that our source of information is unreliable and that our lists are correspondingly inaccurate. When this occurs we take pleasure in correcting any errors which are called to our attention, and greatly appreciate any information which will lead to greater accuracy in our lists.

We have been informed of one account, given in The Locomotive for October, which was incorrect, viz. Item No. 298, July 19, the explosion of a boiler on Lafayette Boulevard, Detroit, Mich. Our correspondent states that no explosion took place there.

The summary follows:

Summary of Boiler Explosions for 1911.

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January,	76	22	43	65
February,	44	31	52	83
March,	39	27	38	65
April,	39	14	22	36
May,	43	18	39	57
June,	31	30	17	47
July,	42	18	34	52
August,	32	13	29	42
September,	29	7	20	27
October,	48	14	53	67
November,	39	11	35	46
December,	37	17	34	51
Totals,	499	222	416	638

Boiler Explosions.

December, 1911.

(463.) — On or about December 1 the boiler of a locomotive on the Houston East & West Texas railroad exploded, near Houston, Texas. Three men were injured.

(464.) — A boiler exploded, December 2, at the McVeagh Lumber Co.'s plant, Reader, Ark. Three men were killed and three others injured. Property damage, due to the explosion and resulting fire, was estimated at $25,000.

(465.) — On December 3 the boiler of the towboat *Diamond*, owned by the the Diamond Coal & Coke Co., exploded on the Ohio river, about five miles south of Pittsburg, Pa. Five men were instantly killed, two seriously injured, and several other persons slightly hurt.

(466.) — A cast-iron heating boiler fractured, December 3, in the Southern New England Telephone Co.'s building, Meriden, Conn.

(467.) — The furnace of a vertical boiler collapsed, December 4, in the plant of the Jackson Co., Nashua, N. H. No one was injured.

(468.) — On December 4 a tube ruptured in a water-tube boiler at the mirror factory of The Zahn & Bowley Co., East Rutherford, N. J.

(469.) — A boiler exploded, December 4, during a fire at the United Express Co.'s stable in Jersey City, N. J. Two men were injured.

(470.) — On December 5 a blowoff pipe ruptured at the plant of the Electric Steel Elevator Co., Minneapolis, Minn. One man was slightly scalded.

(471.) — A tube ruptured, December 6, in a water-tube boiler in Public School No. 28, Scranton, Pa. No one was injured.

(472.) — On December 6 a hot-water boiler exploded in the plant of the North Pole Dye Works, Houston, Tex. No one was injured, but the building was wrecked.

(473.) — On December 7 two sections of a cast-iron boiler cracked in the Y. M. C. A. building, Frederick, Md.

(474.) — A blowoff pipe ruptured, December 8, at the plant of the Merrill-Springer Co., Bethel, Maine.

(475.) — On December 8 a tube burst in a vertical tubular boiler in the gas producer plant of the Southern Power Co., Charlotte, N. C. The explosion caused a fire which damaged property to the amount of $2,000. One man was killed and two others were injured.

(476.) — The boiler of freight locomotive No. 754, on the D. & H. railroad exploded, December 8, near Westport, N. Y. One man was killed and two others severely injured.

(477.) — On December 9 a sectional cast-iron boiler fractured in the apartment house at 80 St. Botolph street, Boston, Mass.

(478.) — A sectional cast-iron boiler fractured, December 10, in the Phœnix Hotel, Findlay, Ohio.

(479.) — A tube ruptured, December 11, in a water-tube boiler in the Bettendorf Axle Co.'s plant, Bettendorf, Iowa. The boiler was considerably damaged.

(480.) — On December 11 a tube ruptured in a water-tube boiler in the Waukegan, Ill., plant of the American Steel & Wire Co.

(481.) — A cast-iron header in a water-tube boiler fractured, December 13, in the Milford, Attleboro & Woonsocket Street Railway Co.'s plant, Franklin, Mass.

(482.) — On December 13 the boiler of a locomotive on the Trinity & Brazos Valley railroad exploded, near Dallas, Texas. Two men were killed and one other severely injured.

(483.) — A tube ruptured, December 15, in a water-tube boiler in the plant of the American Gas & Electric Co., Muncie, Ind.

(484.) — On December 15 a blowoff pipe burst at the plant of E. T. Steele & Co., textile manufacturers, Bristol, Pa. One man was scalded.

(485.) — A tube ruptured, December 18, in a water-tube boiler, at the Donora Wire Works plant of the American Steel & Wire Co., Donora, Pa.

(486.) — A boiler ruptured, December 19, in the American Sand & Gravel Co.'s plant, Carpentersville, Ill.

(487.) — On December 19 the crownsheet of a locomotive on the P. C. C. & St. L. railroad blew out near Jones station, east of Piqua, Ohio. One man was killed and two others injured.

(488.) — The boiler of McCormick Brothers' sawmill exploded, December 20, at Ideal, Ga. Seven men were injured, one of them seriously.

(489.) — On December 21 a boiler burst in the Beatty steam laundry, Roswell, N. M. One man was severely injured. The property loss was estimated at $500.

(490.) — A boiler exploded, December 21, in the Lowman mill, Apiary, near Rainier, Ore. Two men were killed and two others injured.

(491.) — On December 23 a blowoff valve burst at the plant of the Chicago Malleable Castings Co., Chicago, Ill. One man was fatally scalded, dying the following day, and another was severely burned.

(492.) — A heating boiler exploded, December 24, in the Flushing avenue police station, Brooklyn, N. Y. No one was injured. Property damage was estimated at $300 to $400.

(493.) — On December 25 a heating boiler burst in the Methodist Episcopal church, West Ocean Grove, N. J.

(494.) — A tube burst, December 27, in a water-tube boiler at the plant of the Cadoza Lace Co., Pawtucket, R. I.

(495.) — On December 28 a blowoff pipe ruptured in the Eureka Brick Co.'s plant, Lynnhaven, Va.

(496.) — A boiler exploded, December 28, in the basement of No. 4 engine house, Lexington street, Baltimore, Md. No one was injured.

(497.) — Several cast-iron headers in a water-tube boiler fractured, December 29, in the water and light plant of the City of Starksville, Miss.

(498.) — The boiler of a freight locomotive on the Wabash railroad exploded, December 29, at Thamesville, Mich. One man was fatally and another slightly injured.

(499.) — On December 30 a sectional cast-iron heater fractured in the metal working plant of the George Q. Hill Co., Boston, Mass.

January, 1912.

(1.) — On January 1 a small heating boiler burst in the plant of the Jackson Milling Co., Steven Point, Wis. No one was injured.

(2.) — A hot-water heating boiler exploded, January 2, in the basement of the Wren-Clancy department store, Altoona, Pa. Three persons were injured and the property damage was variously estimated at $5,000 to $10,000.

(3.) — On January 2 a sectional cast-iron boiler ruptured in the furniture store of Haglage & Hawkins, Kansas City, Mo. No one was injured.

(4.) — A boiler burst, January 2, in the basement of Plymouth Church, Brooklyn, N. Y.

(5.) — On January 2 the crownsheet of a boiler of the locomotive type failed in the Imperial Laundry, Hamilton, Ohio. The explosion and resulting fire caused a property damage of $50,000. The boiler was said to be thirty years old.

(6.) — On or about January 3 a heating boiler in the county jail at McAlester, Okla., exploded. The building was somewhat damaged but no one was injured.

(7.) — On January 4 a boiler burst at the Springfield, Ohio, water works plant. According to the newspaper account a patch blew off from one of the boilers.

(8.) — A blowoff pipe ruptured, January 4, at the cotton compress of the Warrant Warehouse Co., Birmingham, Ala.

(9.) — On January 5 the boiler of a locomotive engine exploded in the Southern Pacific roundhouse, Los Angeles, Calif. Two men were killed and three others injured.

(10.) — The boiler of a locomotive on the Bartlett & Western railroad exploded, January 5, near Georgetown, Texas. One man was killed and another injured.

(11.) — A hot-water boiler burst, January 5, in the basement of the residence of Ed. Rader, Allentown, Pa. No one was injured.

(12.) — On January 5 a hot-water boiler burst in the basement of a two-story brick dwelling at 281-283 Thirty-third street, Milwaukee, Wis. The explosion caused a fire which destroyed the building with a loss estimated at $12,000. No one was injured.

(13.) — Three cast-iron headers fractured, January 6, in a water-tube boiler at the Washington & Lee University, Lexington, Va.

(14.) — On January 6 a section of a hot-water boiler exploded in the boiler house of Z. G. Simmons, Kenosha, Wis. The loss was estimated at several thousand dollars.

(15.) — A hot-water heater exploded, January 6, in the mail car of a Rock Island train at the union station, Cedar Rapids, Iowa. One man was slightly injured.

(16.) — On January 6 a hot-water boiler burst on the premises of William P. Northrup, Buffalo, N. Y. Property damage was estimated at $5,000. One account of the explosion states that "Just what caused it to explode could not be learned yesterday, but it is thought that the boiler became too warm and burst, as is sometimes the case with new boilers."

(17.) — A boiler exploded, January 7, in the residence of Max L. Woolf, Chicago, Ill. The resulting fire almost totally destroyed the building. No one was injured.

(18.) — A tube ruptured, January 8, in a water-tube boiler at the Penn Central Light & Power Co., Altoona, Pa.

(19.) — A cast-iron heater burst, January 8, at the High School, Salisbury, Mo.

(20.) — The boiler of a threshing engine exploded, January 8, at Star City, Ind. One man was seriously injured.

(21.) — On January 8 a boiler exploded in a building being constructed at 84 Gates avenue, Montclair, N. J. One man was painfully injured.

(22.) — A vertical tubular boiler exploded, January 8, in the cellar of the provision house of George Doersch Co., New York City. Two men were injured. Property damage was estimated at $1,500.

(23.) — On January 8 a boiler, used in the process of cutting ice, exploded at Salem, N. Y. One man was fatally injured.

(24.) — A boiler explosion occurred, January 8, in the residence of William Hoagland, West Chester, Pa., causing considerable damage.

(25.) — On January 9 a tube ruptured in a water-tube boiler at the plant of the Inland Steel Co., Indiana Harbor, Ind.

(26.) — A boiler exploded, January 9, on the farm of Samuel Hadom, near Wheeling, W. Va. One person was slightly injured and the boiler house was completely demolished.

(27.) — A boiler exploded, January 9, in the cellar room of the Imperial Laundry, Hamilton, Ohio, causing a fire which destroyed the building.

(28.) — On January 9 the heating boiler of the Calvin College and Theological Seminary, Grand Rapids, Mich., exploded, making the entire heating system useless.

(29.) — On January 9 a tube ruptured in a water-tube boiler in the plant of the Ehret Magnesia Mfg. Co., Port Kennedy, Pa.

(30.) — A boiler flue burst, January 10, in the Fort Worth and Denver shops, Amarillo, Texas. Four men were injured.

(31.) — On January 10 a hot-water heater exploded in the residence of William S. Brace, West Hartford, Conn.

(32.) — A boiler exploded, January 10, in the parochial school of the Church of the Sacred Heart of Jesus, Allentown, Pa. The loss was estimated at $1,000.

(33.) — On January 11 a boiler exploded in the plant of the American Perfectile Co., Henry Clay, Del. Two men were slightly injured and considerable property damage was done.

(34.) — On January 11 an accident occurred to the boiler of a locomotive belonging to the Hope Lumber Co., Hope, Ark.

(35.) — A bolt blew out of a boiler, January 11, at the coal mine of E. J. Walker & Co., Brisbin, Pa.

(36.) — A hot-water heater exploded, January 11, in a trolley car of the Milwaukee Electric Railway & Light Co., Milwaukee, Wis. One person was fatally and several others severely injured.

(37.) — On January 12 a boiler exploded at the Clarence colliery of the Hillside Coal & Iron Co., Pittston, Pa. No one was injured.

(38.) — A tube ruptured, January 13, in a water-tube boiler in the plant of the American Steel Foundries, Alliance, Ohio.

(39.) — On January 13 a heating boiler burst in the Roberts Street School, Lestershire, N. Y.

(40.) — On or about January 13 a heating boiler burst on the premises of C. H. Mott, Adrian, Mich.

(41.) — A boiler tube burst, January 14, in the boiler in the Methodist Episcopal Church, Lestershire, N. Y.

(42.) — A section of a cast-iron heater fractured, January 14, in the apartment house of Mrs. Pauline Danere, New York City.

(43.) — On January 14 six cast-iron headers ruptured in a water-tube boiler in the Multnomah Hotel, Portland Ore.

(44.) — A hot-water heater exploded, January 14, in a trolley car of the Lehigh Valley Transit Co., at Fullerton, Pa. One man was injured.

(45.) — On January 15 a boiler exploded at the No-Name mine, on the L. B. Jones land in Newton county, near Joplin, Mo. Three men were killed and one other was injured.

(46.) — A blowoff pipe failed, January 16, at the plant of the Tremont Mfg. Co., Boston, Mass.

(47.) — On January 16 a boiler exploded at the plant of the American Silica Co., Richwood, Mich.

(48.) — A boiler exploded, January 16, at the grain mill of Harr & Cropp Co., Meadland, W. Va. One man was instantly killed and three others were fatally injured. The property damage was estimated at $1,000.

(49.) — The boiler of a locomotive on the Louisville & Nashville railroad exploded, January 16, near Longrun station, Ky. The explosion was caused by a collision of a Louisville & Nashville and a Chesapeake & Ohio train.

(50.) — On January 16 a boiler burst in the machine and plumbing shop of Fred Williams, near North East, Pa. No one was injured.

(51.) — A boiler exploded, January 17, at Colebrook, twelve miles south of Lebanon, Pa. The boiler was owned by the United Coal & Ice Co., and was being used in the process of ice harvesting. Six men were seriously injured, two of them probably fatally.

(52.) — On January 17 the boiler in the basement of the Holy Rosary Convent, West Hoboken, N. J., exploded. There was considerable damage to property.

(53.) — A boiler burst, January 17, in the residence of John B. Kates, Collingswood, N. J.

(54.) — Eight sections of a cast-iron heater ruptured, January 17, in Science Hall of Valparaiso University, Valparaiso, Ind.

(55.) — On January 18 a section cracked in a cast-iron heating boiler in the belt dressing plant of the Cling Surface Co., Buffalo, N. Y.

(56.) — On January 18 a boiler ruptured at Dr. W. B. Fletcher's sanatorium, Indianapolis, Ind.

(57.) — A heating boiler exploded, January 18, at St. Mary's Academy, Danville, Ill.

(58.) — On January 18 a hot-water boiler burst in the Lafayette apartment house, 320 Madison avenue, New York City. No one was injured.

(59.) — On January 19 the boiler of the river steamer *Sarah Dixon* exploded, four miles south of Kalama, Wash. Three men were killed.

(60.) — A tube ruptured, January 19, in a water-tube boiler in the stamp mill of the Baltic Mining Co., Baltic, Mich.

(61.) — On January 19 a tube ruptured in water-tube boiler No. 9 at the plant of the Monongahela Light Co., Rankin, Pa. Two men were injured. (See Items Nos. 62, 63 and 64.)

(62.) — On January 19 a tube ruptured in water-tube boiler No. 11 at the plant of the Monongahela Light Co., Rankin, Pa. (See Items Nos. 61, 63 and 64.)

(63.) — On January 19 a tube ruptured in water-tube boiler No. 13 at the plant of the Monongahela Light Co., Rankin, Pa. (See Items Nos. 61, 62 and 64.)

(64.) — On January 19 a tube ruptured in water-tube boiler No. 14 at the plant of the Monongahela Light Co., Rankin, Pa. (See Items Nos. 61, 62 and 63 These four accidents occurred at different times but all within an hour.)

(65.) — On January 20 a boiler failed at the Minden Edison Light & Power Co., Minden, Neb.

(66.) — A cast-iron sectional boiler fractured, January 20, in the restaurant of Housman & Co., Boston, Mass.

(67.) — On January 21 a tube ruptured in a water-tube boiler at the Fort Wayne Rolling Mills Co.'s plant, Fort Wayne, Ind. One man was injured.

(68.) — A hot-water boiler exploded, January 21, in the residence of J. G Danio, Kenmore, N. Y. The damage was slight.

(69.) — On January 22 a heating boiler exploded in the Cement Central Hotel, Allentown, Pa. No one was injured.

(70.) — A heating boiler exploded, January 22, in the residence of Captain J. F. Tibbetts, Athens, Ga. One man was seriously injured.

(71.) — On January 22 a tube ruptured in a water-tube boiler in the cotton mill of Swift Mfg. Co., Columbus, Ga.

(72.) — A cast-iron heater fractured, January 22, in a water-tube boiler at the plant of the Hill Clutch Co., Cleveland, Ohio.

(73.) — On January 23 a tube ruptured in a water-tube boiler at the planing mill of W. D. Young Co., Bay City, Mich. One man was injured.

(74.) — On January 23 a tube ruptured in a water-tube boiler at the plant of the Pee-Dee Mfg. Co., Rockingham, N. C.

(75.) — A tube ruptured, January 24, in a water-tube boiler at the plant of Marshall Field & Co., Chicago, Ill. Considerable damage was done to the boiler.

(76.) — Three sections of a cast-iron heating boiler fractured, January 24, in the hotel of Mary E. Schaefer, Findlay, Ohio.

(77.) — A blowoff pipe failed, January 24, at the cotton seed oil mill of Frank G. Kinney & Co., Kansas City, Kans. One man was injured.

(78.) — On January 24 a tube burst in the boiler of the lumber schooner *Arctic*, while the vessel was entering San Francisco harbor.

(79.) — Six sections of a cast-iron heater fractured, January 25, in the hotel of H. P. & Mary G. Canode, Amarillo, Texas.

(80.) — On January 25 a tube ruptured in a water-tube boiler in the paper mill of the Kimberly-Clark Co., Kimberly, Wis.

(81.) — A boiler exploded, January 25, at the Smith-Pane Lumber Co.'s plant, near Braxton, Miss. One man was seriously injured and four others slightly hurt.

(82.) — On January 26 the boiler of a New York Central locomotive exploded near Oneida, N. Y. The engineer was instantly killed and the fireman was severely injured.

(83.) — A cast-iron elbow on a blowoff pipe failed, January 26, at the plant of the Lynn Gas & Electric Co., Lynn, Mass. One man was injured.

(84.) — On January 27 a heating boiler exploded in the basement of the Continental, a boarding house, Rumford Falls, Me. One woman was seriously injured.

(85.) — A boiler exploded, January 27, on the farm of Israel Weilich, near Washington, Pa. One person was seriously and perhaps fatally injured.

(86.) — A steam heater exploded, January 28, in the residence of Randolph H. Chandler, Thompson, Conn. Property damage was estimated at $1,500.

(87.) — On or about January 28 a boiler burst in the offices of the American Cement Co., Egypt, Pa.

(88.) — On January 28 a boiler ruptured at the plant of the Wyoming Valley Lace Mills, Wilkes-Barre, Pa.

(89.) — The boiler of a locomotive exploded, January 29, in the Southern Pacific roundhouse at San Francisco, Calif. One man was seriously injured.

(90.) — On January 31 a cast-iron elbow failed at the Ridgespring Oil Mill, Ridgespring, S. C. One man was injured.

FEBRUARY, 1912

(91.) — On February 1, a blowoff pipe burst at the plant of the Lang Mfg. Co., West Point, Ga. One man was slightly scalded.

(92.) — A blowoff pipe burst, February 2, at the plant of the Lynn Gas & Electric Co., Lynn, Mass. One man was injured.

(93.) — On February 3 a blowoff pipe burst in the P. Echert factory of the National Candy Co., Cincinnati, Ohio.

(94.) — On February 4 a heating boiler burst in St. Mark's Lutheran Church, York City, Pa.

(95.) — A heating boiler burst, February 4, in the basement of the Brookline Presbyterian Church, Chicago, Ill. The property damage was estimated at $2,000.

(96.) — The boiler of a Lehigh Valley freight engine exploded, February 4, at Flagtown, near Somerville, N. J. Two men were killed and two others injured.

(97.) — On February 5 a boiler of the locomotive fire box type exploded at the quarry of the Royal Marble Co., near Knoxville, Tenn. Two men were killed, three others injured, and property was damaged to the extent of over $1,000.

(98.) — On February 6 a boiler exploded at the rendering plant of E. E. Frith, at Dubuque, Ia. Property damage was small.

(99.) — A slight accident occurred, February 6, to a boiler in the plant of the Hemingway & Bartlett Silk Co., Watertown, Conn. (See also Item No. 106.)

(100.) — Ten cast-iron headers ruptured, February 6, at the Ohio Electric Railway Co.'s power plant, Medway, Ohio.

(101.) — On February 7 a boiler exploded at the Pond Lily Laundry, Dyeing & Cleaning Co.'s plant, New Haven, Conn.

(102.) — A boiler burst, February 7, in the Glidden School, De Kalb, Ill.

(103) — Four cast-iron headers fractured, February 9, in a water-tube boiler at the Iroquois Co.'s "Chittenden Hotel," Columbus, Ohio.

(104.) — On February 10 a heating boiler exploded in the residence of George Golsener, College Point, N. Y.

(105.) — On February 11 a boiler exploded in the residence of M. W. Boyle, Elizabeth, N. J. The damage was slight.

(106.) — On February 11 a slight accident occurred to a boiler at the plant of the Hemingway & Bartlett Silk Co., Watertown, Conn. (See also Item No. 99.)

(107.) — A blowoff pipe burst, February 11, at the plant of the Watson Oil Mill Co., Starr, S. C. The boiler setting walls were considerably damaged.

(108.) — A sectional cast-iron heating boiler burst, February 11, in the apartment house of Louville Niles, Roxbury, Mass.

(109.) — On February 11 a tube ruptured in a water-tube boiler at the power house of the Charleston Illuminating Co., a plant of the National Light, Heat & Power Co., Charleston, Ill. One man was injured.

(110.) — On February 11 a boiler exploded during the progress of a fire at the patent leather factory of W. C. Welch & Co., Woburn, Mass. No one was injured.

(111.) — On February 12 a cast-iron heater failed in engine house No. 5, City of Bridgeport fire department, Bridgeport, Conn.

(112.) — A boiler burst, February 12, in the saw mill of E. Libby & Sons Co., Gorham, N. H.

(113.) — On February 12 a cast-iron heating boiler burst in a building owned by William Crane, at 3-5 Vassar street, Cambridge, Mass.

(114.) — A boiler explosion occurred, February 12, at the tobacco rehandling house of R. F. Wright, West Mayfield, Ky. One man was seriously injured.

(115.) — On February 13 a boiler burst at the plant of the Reed Colliery Co., Berwindale, Pa.

(116.) — A heating boiler exploded, February 13, in the residence of Dr. A. G. Humphrey, Galesburg, Ill.

(117.) — A boiler exploded, February 14, in a vacant building owned by the Church of St. Martin of Tours, Brooklyn, N. Y.

(118.) — On February 14 a cast-iron header ruptured in a water-tube boiler at the Thirty-third and Market streets station of the Philadelphia Rapid Transit Co., Philadelphia, Pa.

(119.) — A blowoff pipe burst, February 15, at the Milwaukee Downer College, Milwaukee, Wis. One man was slightly injured.

(120.) — A slight boiler explosion took place, February 15, at the plant of the Kennedy Laundry & Supply Co., Pullman, Ill.

(121.) — A boiler exploded February 15, in the garage of Charles Pradenhauer, Bernardsville, N. J. No one was injured.

(122.) — On February 17 a sectional cast-iron boiler burst at the Sedgwick Machine Works, Poughkeepsie, N. Y.

(123.) — On February 19 a water-tube boiler exploded at the saw mill of the Bond Lumber Co., Bond, Miss. The explosion was a very violent one, causing property damage amounting to over $27,000. Four men were killed and two others injured.

(124.) — Two cast-iron headers in a water-tube boiler fractured, February 19, at the plant of the Herman Zohrlant Leather Co., Milwaukee, Wis.

(125.) — On February 19 a tube ruptured in a watertube boiler in the plant of the U. S. Board & Paper Co., Carthage, Ind.

(126.) — A boiler owned by the Carter Oil Co., exploded, February 19, on the Carson farm at Trail Run, near Sistersville, W. Va. One man was killed and another probably fatally injured.

(127.) — On February 21 a boiler tube ruptured in the Glenwood power house of the Pittsburg Railway Companies. Four men were injured, one of them seriously.

(128.) — A tube in a water-tube boiler ruptured, February 22, in the plant of the Minneapolis Malt & Grain Co., Minneapolis, Minn.

(129.) — On February 23 a tube in a water-tube boiler ruptured in the stamp mill of the Baltic Mining Co., Baltic, Mich.

(130.) — A blowoff pipe ruptured, February 23, in the cotton bleachery of The Bronx Co., New York City. One man was slightly injured.

(131.) — On February 24 a blowoff pipe ruptured at the plant of the Lewiston Gas Light Co., Lewiston, Me.

(132.) — A hot-water heater exploded, February 24, in the residence of William Bower, on Red Lion Road, Philadelphia, Pa. The explosion caused a fire which resulted in a property loss estimated at $17,000.

(133.) — On February 26 a slight accident occurred to a boiler at the Medina County Infirmary, Medina, Ohio.

(134.) — A tube in a water-tube boiler ruptured, February 26, at the Inman Mills, Inman, S. C.

(135.) — On February 26 the boiler of a freight locomotive on the Trinity & Brazos Valley railroad exploded at Chambers Creek, about fifteen miles north of Corsicana, Texas. One man was killed and four others injured.

(136.) — On February 28 a boiler exploded in the flour mill of the Rea & Page Milling Co., Marshall, Mo.

(137.) — On February 29 three tubes ruptured in a boiler at the Fox Co.'s paper mill, Lockland, Ohio. Two men were scalded.

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY is now issuing to its policy-holders its "Vacation Schedule" for 1912. Like those of previous years, this schedule affords a most convenient form for arranging and recording the holiday period allotted to each of the clerks or other employees of an institution. From it at a glance may be determined how many and what members of the force will be absent on any given date and thus by a little foresight and care the assignment of the same days to those whose simultaneous absence would cause inconvenience may be avoided. That this publication is appreciated by its recipients is shown by the following quotation from one of many similar letters which the HARTFORD Company has received:

"We acknowledge receipt of your letter of 8th, and copies of your vacation schedule, which we received under separate cover and for which we wish to thank you very much. Your idea is the best we have seen for keeping record of the vacations, and your furnishing us with the blanks saves us considerable work in making them up for ourselves."

Copies may be obtained by our policy-holders on application to the nearest of the offices listed on the last page of this issue.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1912.

Capital Stock, . . . $1,000,000.00.

ASSETS		
Cash on hand and in course of transmission,		$204,693.25
Premiums in course of collection,		263,453.33
Real estate,		91,100.00
Loaned on bond and mortgage,		1,166,360.00
Stocks and bonds, market value,		3,249,216.00
Interest accrued,		71,052.02
Total Assets,		$5,045,874.60
LIABILITIES.		
Premium Reserve,		$2,042,218.21
Losses unadjusted,		102,472.53
Commissions and brokerage,		52,690.67
Other liabilities (taxes accrued, etc.),		47,191.65
Capital Stock,	$1,000,000.00	
Surplus over all liabilities,	1,801,301.54	
Surplus as regards Policy-holders,	**$2,801,301.54**	2,801,301.54
Total Liabilities,		$5,045,874.60

L. B. BRAINERD, President and Treasurer.
FRANCIS B. ALLEN, Vice-President. CHAS. S. BLAKE, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
W. R. C. CORSON, Assistant Secretary.

S. F. Jeter, Supervising Inspector.
E. J. Murphy, M. E., Consulting Engineer.
F. M. Fitch, Auditor.

Board of Directors.

The Locomotive
of
THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Vol. XXIX. HARTFORD, CONN., JULY, 1912. No. 3.

An Automatic Engine Wreck.

Another Automatic Engine Bursts its Fly Wheel.

The illustration on the front cover of this issue of THE LOCOMOTIVE shows the wreck resulting from the failure, May 10, 1912, of a fly wheel on an engine of the high speed, simple, automatic type. The engine in question was a 12" x 12", center crank, and was belted to a generator at the Higginsville, Mo., electric light plant. This illustration is of particular interest, because of the wide-spread notion among engineers, that engines of the "automatic" shaft governed type cannot run away. A somewhat similar instance was recorded in THE LOCOMOTIVE for April, 1911.

It would appear that in this case the governor pulley failed first, and we are told that fragments went through the roof with considerable violence. This failure may have been hastened by a blow delivered to the rim of the wheel by the governor weight. When relieved of the first wheel, the engine seems to have slewed around on its foundation, fouling the other pulley on the sub-base, and shearing its spokes free from both the hub and the rim. This rotation of the whole engine is in the right direction (left handed), to be explained by the principles of gyroscopic motion. If we consider the crank shaft balanced for weight by the two wheels, when running normally, it would become immediately unbalanced by the failure of one of them. This failure would probably occur at high speed, and so is favorable to such an assumption. It is of course well known to those who have experimented with the simple gyroscopic tops of their school days, that if the wheel is spinning, the top may

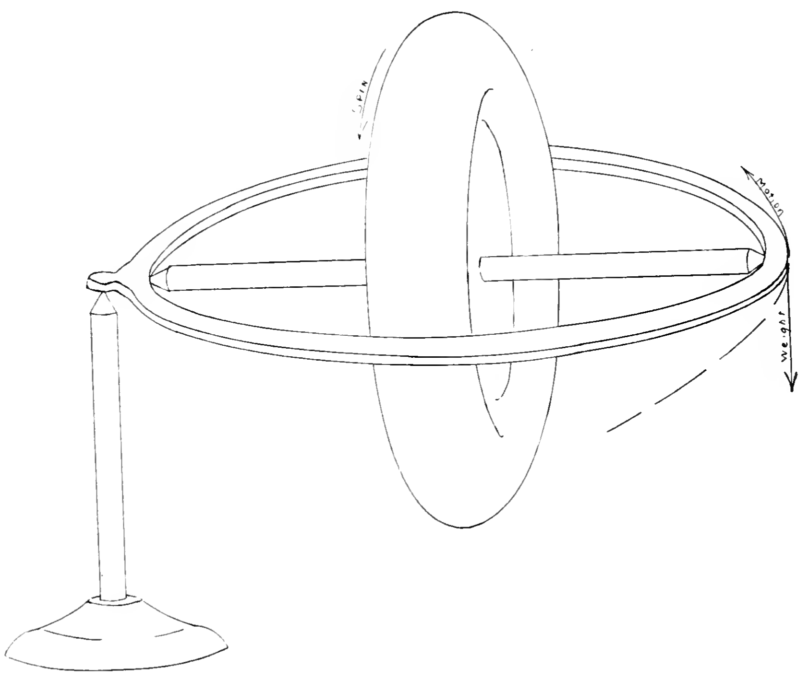


FIG. 2. SIMPLE GYROSCOPE.

be held at a point on the rim of the stationary ring, where it is unbalanced for weight, and in this position, instead of falling under the force of gravity, it rotates about a vertical axis, with a speed which depends on that of the wheel, and which will be greater, the heavier the top, or the more it is out of gravity balance. This appears to have been the behavior of the engine. Fig. 2, in which the directions of rotation correspond to those in the engine, will perhaps make clear our point of view.

A Disastrous Locomotive Boiler Explosion

The boiler of Locomotive No. 704 of the Southern Pacific Ry. Company exploded Monday, March 18, 1912, at 8:55 A. M., in the yards attached to the railway shops at San Antonio, Texas. This locomotive had been in the shops for repairs from February 12th to March 18th, and was being prepared for its initial run when the explosion occurred, but was still in the hands of the hostlers, inspectors, and shop men.

From the report of Chief Inspector Ensign of the Interstate Commerce Commission, as printed in "Power," the following facts and conclusions are abstracted, together with the results of tests on the sling stays made at the National Bureau of Standards.

The locomotive was of the heavy passenger 4-6-0 type, and was owned and operated by the Galveston, Harrisburg and San Antonio Ry. Co. It was built in March, 1908, by the American Locomotive Company at the Brooks Works. The firebox was of three-piece construction, crown bar type. The working steam pressure was 200 lbs. per square inch. The barrel of the boiler was made of ¾-in. steel, in three sections or courses, constructed with butt longitudinal joints having diamond shaped welts. The dome was located on the third course. The wrapper sheet was of ⅝-in. steel, the back head sheet and back flue sheet ½-in. steel, and the firebox door sheet, crown and side sheets, ⅜-in. steel. The firebox was stayed with rigid bolts ⅞-in. diameter at the ends, reducing to ¾-in. at the center of the bolts; four rows of Tate flexible bolts at the top of the firebox and two rows at each end, staggered at the top corners. The crown bolts were of a driving fit with countersunk heads 1⅛-in. diameter at the bottom end, and 1 in. diameter at the top end, extending through the crown bars with nuts on the top. The crown sheet was supported with 15 crown bars hung from the wrapper sheet by 168 sling stays, ⅝x3 in. and 12 sling stays 1½x 2¾ in. The flues numbering 355, were of 2-in. diameter. The boiler was equipped with three 3-in. Crosby safety valves.

The investigation brought out the following facts: During the time the locomotive was laid up, the following repairs were made to the boiler. Two hundred flues reset, one back head brace repaired, one front flue sheet brace and two throat stays repaired, eighty staybolts renewed, safety valves ground in, steam gauge tested, and hydrostatic pressure of 250 lbs. per square inch applied. Repairs were completed about 5:45 p. m. March 17th, and the locomotive fired up but no steam was raised. It was again fired up at about 6:10 a. m., on March 18th, and the safety valves began to blow when the steam gauge registered 50 lbs. pressure, at about 7:30 a. m. The safety valves were screwed down and again opened at about 8:00 a. m. The locomotive had a heavy forced oil fire from 8:00 to 8:55 a. m., at which time the explosion occurred.

Fig. 1. Showing Broken Sling Stays.

An employee of the railroad company, was engaged in setting the safety valves at the time of the explosion. The valves themselves could not be tested after the explosion owing to the damaged condition of the disks and springs, but the casings, with the adjusting screws and lock nuts were found and proved to be valuable pieces of evidence in unraveling the causes of the explosion. On one of the adjusting screws, the lock nuts were missing, another screw was bent, and the end burred over, and on all of them there was evidence that the corners of the hexagon heads had been rounded over in an attempt to tighten them, which resulted apparently in the subsequent application of a Stilson wrench in an attempt to further tighten the springs.

The steam gauge was shown to have been tested but there was no evidence to show that the siphon or connections were tested or known to be free from obstruction, and indeed, the government inspector found that on another locomotive of similar type, at the same shops, there were two valves between the gauge and the boiler, which when opened had their handles, one at right angles, and one parallel to the pipe. This arrangement was so confusing and unsafe that one of them was ordered removed.

Reference to Figure 1 will show the general character of the explosion which resulted in the immediate death of 26 men and we are informed, in the subsequent death of three more, making a total of 29. It will be noted that the explosion apparently started in the firebox, which was blown directly down. The front head with many of the tubes attached will be seen to have been projected forward and to the right, while the wrapper sheet and part of the third course, carrying the dome, were blown backward some three blocks and were said by observers to have attained a considerable height, estimated to have been some 500 feet. These sheets, weighing some 6,000 lbs. landed in a dooryard and are shown in Figure 2. A glance at Figure 3 will show at once the terrific character of the explosion, and also the fact that the damage was much greater at the rear end of the locomotive than at the forward end, as one of the after drivers is seen to have been completely forced from the axle.

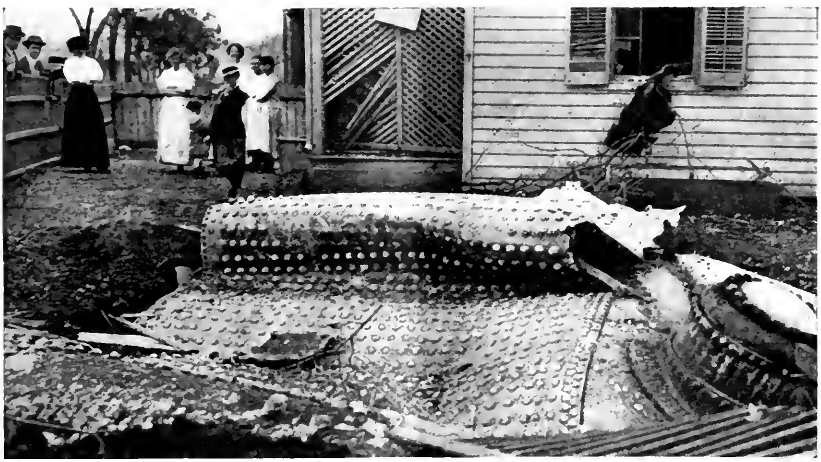


FIG. 2. WRAPPER SHEET AND DOME IN DOOR YARD.

The crown bar sling stays were shown on examination to have been made of wrought iron, where the specifications called for steel. It was further shown that five 1-in. bolts had been used to attach the sling stays to the crown bars and also to the wrapper sheet, where the specifications on the drawing had required 1¼-in. bolts. The crown bars were not supported on the side sheets as is customary in this type of boilers, therefore the whole strain was carried by the sling stays. It was further shown that the sling stays failed by stretching out the eyes, which were much reduced in section. This can be clearly seen by reference to Figure 1, and would seem to indicate that the stays failed by a gradual application of stress far in excess of that which they could safely carry.

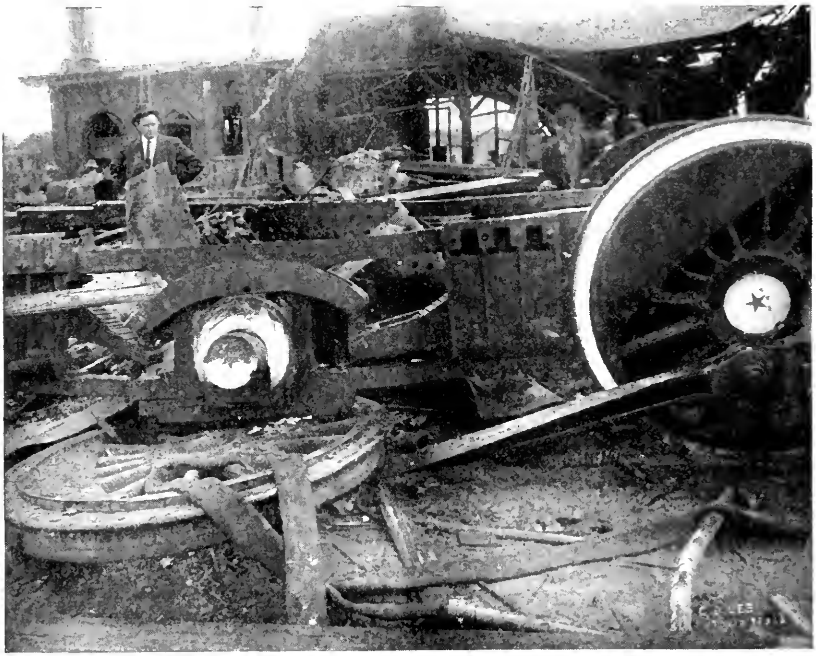


Fig. 3. Driver Blown from Axle.

Five crown bar sling stays from this locomotive were tested by the United States Bureau of Standards to determine the load the stays would support when 1 in. and 1¼-in. bolts were used. The bolts used were some taken from this boiler at the time of the explosion. Stays numbered 1 and 2, using 1-in. bolts, failed at total loads of 26,650, and 21,840 lbs. respectively, yielding for the lower value, a factor of safety based on the net section of only 2.67 while the higher figure would give a factor of safety of 3.26. Stays numbered 3, 4, and 5 broke at total loads of 30,000, 33,890, and 31,620 lbs. respectively. The 1¼-in. bolts were used with these specimens, and showed factors of safety varying from 3.67 to 4.15. The tensile strength of the material in the sling stays was found to be 43,200 to 48,300 lbs. per square inch, and the elongation from 18 to 40.5% in 2 inches. These tests are taken to indicate that the stays were drilled too near the ends.

The investigating inspector finds that the cause of the explosion was excessive pressure, due probably to a defective gauge, and the attempted setting of the safety valves by men of insufficient experience. He censures the railroad company severely for permitting such men to handle work of this character. He also finds that the local inspector had sworn to a report of the setting of the safety valves and the testing of the steam gauge on the day before, although it was clearly shown that the actual work of setting the safety valves was in progress at the time of the explosion. He finds further that the railroad company was negligent in keeping a boiler in service whose factor of safety as shown by test was far below the limits generally set in such cases.

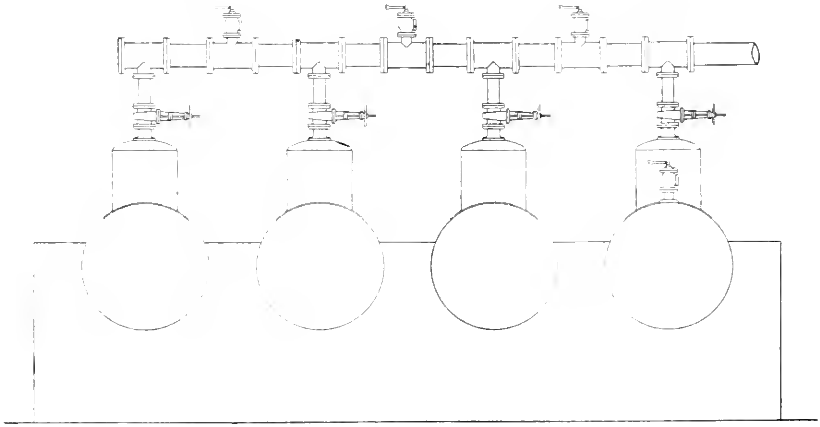
We understand from press accounts, that the Galveston, Harrisburg, and San Antonio railway company have made a public statement since the finding of the government inspector, in which they give the report of their own investigating board. This consisted of the following gentlemen: Col. Charles H. Clark, U. S. A., ordnance department; Capt. George A. Schreiner, U. S. A.; Lt. R. C. Burleson, U. S. A., expert on high explosives; J. H. Holmgren, president of the Alamo Iron Works, San Antonio, Tex.; G. W. Taylor, superintendent of motive power, S. A. & A. P. railway; W. B. Tuttle, manager, San Antonio street railway; Daniel Cleary, locomotive boiler inspector, S. A. & A. P. railway; A. M. Fischer, druggist, San Antonio, Tex.; F. McArdle, road foreman of engines, S. A. & A. P. railway; and T. H. Mooney, former master mechanic, G. H. & S. A. railway. This board differed widely in their conclusions. Four declared themselves of the belief that the wreck was due to overpressure. Two considered low water to have been the cause, followed in their estimation, by the pumping of cold water upon a hot crown sheet. One of the army officers expressed the opinion that "it is evident that the explosion was caused by some unusual, and extraordinary cause." All agree however, that the inspector of the Interstate Commerce Commission was at fault, in censuring the railway company as to the incompetence of its employees. We can understand something of the feelings of these gentlemen, especially as the accident occurred during a strike when rumors of dynamite and violence were prevalent, nevertheless, the photographs at hand, and the report of the tests made at the Standards Bureau, seem to give ample confirmation to the views of Inspector Ensign.

There seems to have been no member of the railway company's board who had a realization of the fact that a boiler full of water, when hot and under a considerable steam pressure, constitutes in itself, a high explosive of no mean order. These gentlemen base their arguments against over pressure, apparently upon the fact that the injectors were said to have been working just previous to the explosion, and refer to a statement of the makers, that about 240 lbs. is the limit at which this type of injector will continue to throw water into a boiler. They fail to realize, it seems, that a boiler with its safety valve "gagged," and with a heavy fire such as this locomotive is shown to have had, can accumulate a dangerous pressure with great rapidity, the time in this case, of course, being less than might have been expected on account of the weakness of the furnace sling stays, when used with one inch bolts.

A Dangerous Installation of Safety Valves.

The accompanying sketch of a steam pipe arrangement may be of interest as indicating the extreme of ignorance or carelessness in the installation of devices which are vitally necessary to the safety of a steam plant.

Our company had covered the boilers of this mill by a policy of insurance which expired in the latter part of 1911, and which we failed to renew because, as the assured stated, they had received much lower rates from a competitor.



UNSAFE ARRANGEMENT OF STEAM PIPES.

Sometime later the manager of the plant, meeting one of our inspectors, told him that he was not altogether satisfied with a rearrangement of piping which had been made, although he himself was not sufficiently expert in such matters to point out the defects. He made the request that our inspector visit the plant to advise him. Our inspector did so and found that since our coverage two boilers had been added and the steam piping remodeled in the manner shown by our sketch and that this had been done without remonstrance or criticism on the part of our competitor's inspector.

It is needless to add that when the absolute danger of the arrangement was pointed out, the management of the plant insisted that the competing policy be immediately canceled and that such premium be paid as was necessary to secure HARTFORD insurance and HARTFORD inspection service.

Furnace in Scotch Boiler Fails From Overheating.

The illustrations printed herewith show a dry back Scotch boiler after removal from the Dredge "Thor," one of the largest gold mining dredges on the Pacific Coast, used near Oroville, Cal.

The boiler is 8 ft. 2 in. in diameter, and 13 ft. long. The shell is of ¾-in. steel with the longitudinal joints of the triple riveted double butt strap type. The heads are ⅝ in. thick. The boiler is fitted with 128-3 inch tubes, and with a Morrison suspension furnace, 50 inches in diameter, and 13 feet long. The original thickness of the furnace plate was 9/16 in., but a measurement obtained by drilling at a point 4 in. from the end after the collapse, showed the actual thickness to be 17/32 in.

We are told that the ordinary working pressure was 135 lbs. and that this was about the pressure on the boiler at the time of the failure. Oil was used as fuel.

The failure which occurred on March 18, 1912, consisted in a flattening of the furnace, the top going down about 28 in. and the bottom coming up about 22 in., till the sheets met, forming a sort of figure 8 turned on its side, as may be seen by reference to Fig. 2. The front head was pulled in, so that a number of the tubes above the furnace, projected through the sheet, from ¾ to 1½ in. and of course resulted in severe leakage.

After the accident, the oil burner was turned off and the steam used up in propelling the dredger to the bank, getting its buckets on shore, and hauling the water and oil barges alongside, some twenty minutes being consumed in the operation. No one was injured.

FIG. 1. BOILER OF THE "THOR."

The boiler was removed and shipped to San Francisco, with the idea of putting in a new furnace, and making other necessary repairs. It was found, however, on inspection that the boiler was so distorted as to make this impossible. It was also found that the tubes and furnace were so heavily coated with oil as to indicate that the cause of the failure was due to the furnace sheet becoming overheated, a very frequent cause of trouble when such oil films are allowed to collect on the inside surface of those parts of a boiler directly exposed to the action of the fire. The dredger was operated condensing and apparently no effort was made to prevent the oil used in the cylinders for lubrication, from entering the boiler with the feed water.

It would seem that this case is one of those preventable accidents which need not have occurred if the boiler had received regular and thorough internal inspections, as it is difficult to believe that a competent inspector could have failed to detect this particular trouble long before it reached the danger point. We understand that the boiler was comparatively new. No insurance was carried.

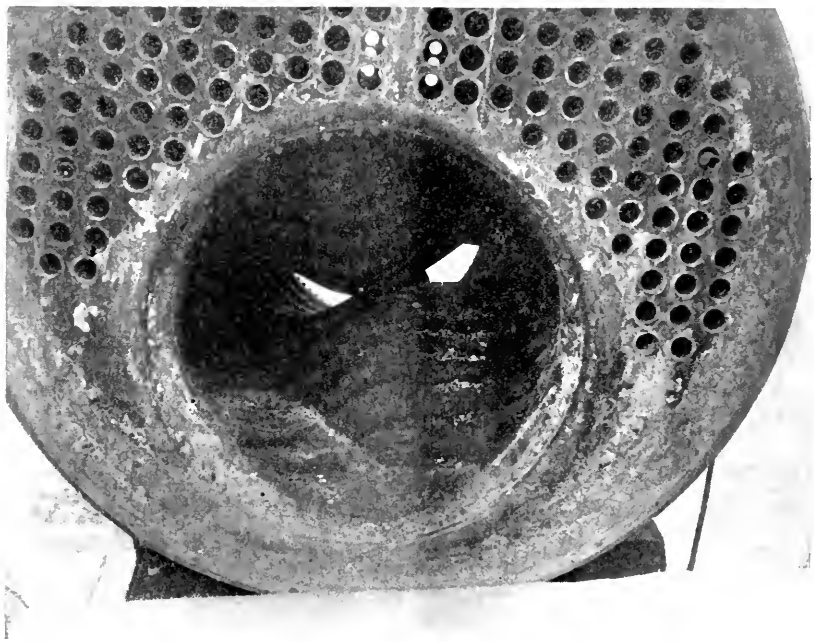


Fig. 2. The Collapsed Furnace.

Locking the Door After the Horse is Stolen.

W. B. Warner, Special Agent.

The accompanying illustration shows the condition of a boiler and premises, after an explosion which occurred recently, the location of which we do not mention for obvious reasons.

Our "Special" had solicited the insurance on this boiler periodically for several years, and at each visit had been given various excuses by the owner for not taking insurance. A few weeks ago the "Special" was again in the district, and having in mind this boiler and its owner as a possible prospect, made a stop on the chance that he would have better luck this time, as we feel that every uninsured boiler is a prospect, and that sometime we will get it.

When within a hundred miles of this place, he was advised of the explosion, and when he arrived at the town, he concluded to go over and see how serious the accident was, and incidentally, to speak of the folly of procrastination in matters of boiler insurance. As our "Special" approached the place, Mr. Owner spied him some fifty yards from it, and greeted him thus: "Hello Mr. ———, why the d—— didn't you make me insure my boiler the last time you were here?" "I did everything legitimate," replied the "Special," "to induce you to do so, and I thought I would come over and learn what new excuse you had to offer this time." "Well," said the owner, "my boiler blew up about two

THE BOILER WHICH DID NOT NEED INSURANCE.

weeks ago, and I am just getting this one ready to use. I am ready for the insurance now. I wish I had taken it before."

We now have a policy covering this plant, and if a similar accident occurs, it is our loss.

Boiler Explosions.

MARCH, 1912.

(138.) — The boiler of Locomotive No. 669 of the Philadelphia and Reading Railroad, attached to a through freight, exploded outside the station at Muncy, Pa., at about 9.30 p. m., March 1. Engineer William Fink, Fireman William Meyers, Conductor Boulton Whitenight, and Brakeman Harry Robinson, were killed. One man was injured.

(139.) — On March 2, a boiler in the factory building, at 794 Tenth Ave., New York City, exploded, during a fire which completely wrecked the building. Deputy Fire Chief Binns, and several firemen were in the boiler room just previous to the explosion and were injured seriously.

(140.) —A tube in a water tube boiler ruptured March 2, at the Allentown Portland Cement Co.'s plant, Allentown, Pa.

(141.) — On March 3, two tubes ruptured at the plant of the Fox Paper Co., Lockland, O., killing Frank Brunkamp and Ernest Williams. This was the second case of tube failure at this plant within a week. (See item 137 in the February list.)

(142.) — On March 3, a tube ruptured in a water tube boiler at the plant of the Illinois Steel Co., South Chicago, Ill. Geo. Novak and Alec Simon were injured.

(143.) —An accident occurred March 3, at A. Lisner's department store, the "Palais Royal," Washington, D. C. Considerable damage was done to the boiler.

(144.) —A tube failed March 6, at the Commerce St. power house of the street railway company, Milwaukee, Wis. Two men were badly scalded.

(145.) —March 7, the boiler at a stone crusher used in connection with the construction of a dam at Hamilton, Ill., exploded.

(146.) —A boiler exploded March 7, at the toy, and umbrella handle factory of Gilpin Bros., Greentown, Pa.

(147.) — The drum of a water tube boiler ruptured March 9 at the plant of the Sharon Tin Plate Co., Sharon, Pa.

(148.) — On March 9, a tube ruptured in a water tube boiler at the Ehret Magnesia Mfg. Co., Valley Forge, Pa.

(149.) — On March 9, boiler failed at the plant of the St. John Wood Working Co., Stamford, Conn. The damage was small.

(150.) —About March 9, the boiler in the old school building at Sellersville exploded.

(151.) —An accident to the boiler of the torpedo boat destroyer, U. S. S. Paul Jones, at San Diego, Cal., March 9, caused the death of Albert Grau, fireman, and the serious injury of Peter Wiera, fireman, and John J. Eberlein, coal passer.

(152.) — The boiler at the Belle Springs Creamery, Abilene, Kans., exploded on the morning of March 9, slightly injuring engineer Smart.

(153.) —A tube ruptured March 10 in a water tube boiler at the plant of the Columbia Chemical Co., Barbertown, O. Considerable damage was done to the boiler. (See also item 168.)

(154.) — On March 11, three sections of a cast iron sectional heating boiler failed at the Hotel Princeton, owned by Chas. M. Randall, Boston, Mass.

(155.) —A boiler ruptured March 11, at the plant of the Anderson and Middleton Lumber Co., Aberdeen, Wash.

(156.) — The boiler in the crating mill of Asa Smiley, Jamestown, N. Y., exploded March 11, seriously injuring the proprietor, and inflicting minor injuries to one other. The entire plant was wrecked.

(157.) — March 12, the principal building of the Columbus Contractors' Supply Co. at Taylors Station, near Columbus, O., was destroyed by fire following the explosion of the boiler. The loss was estimated at $60,000.

(158.) — The heating boiler in the home of Louis Muhs, Minot, N. D., exploded, March 12, fatally injuring Mr. Muhs, who was firing the boiler at the time.

(159.) — On March 13, the furnace of a vertical boiler ruptured on the Barge Canal Contract of Holler and Shepard, Ft. Edwards, N. Y.

(160.) — On March 15, a tube ruptured in a water tube boiler at the Western Branch, National Home for Disabled Volunteer Soldiers, National Military Home, Kans.

(161.) —A blow off pipe ruptured March 15, at the Port Huron Gas Co., Port Huron, Mich. Joseph Brown, fireman, was somewhat injured.

(162.) — On March 16, the boiler at the plant of the Mills-Ellsworth Lumber Co., Pine Bluff, Ark., exploded, doing considerable damage to the plant. One man was slightly injured.

(163.) —A tube ruptured March 18 at the plant of the Illinois Glass Co., Alton, Ill. One man was slightly injured.

(164.) —A locomotive boiler exploded in the yards of the Southern Pacific Railroad, at San Antonio, Tex., March 18. Twenty-five men were killed, four injured fatally, and many minor injuries inflicted. The damage to property was great.

(165.) — The internal furnace in a Scotch marine boiler collapsed March 18, on the gold mining dredge "Thor," near Oroville, Cal. No one was injured, but the boiler was so distorted as to be a total loss.

(166.) — On March 19, a boiler ruptured in the office building belonging to the estate of Thomas McGraw, Detroit, Mich.

(167.) — The boiler of a logging engine exploded March 20 at the saw mill of Jeams Bros., Rockland, Tex. Jesse Patrick and Lewis Furguson were fatally burned, and Jack Best, engineer, was slightly burned.

(168.) —A tube ruptured March 20 at the plant of the Columbia Chemical Co., Barbertown, O. This was the second accident within a month. (See also item 153.)

(169.) — The boiler of a locomotive attached to a coal train on the N. & W. R. R. exploded March 20, near Blue Ridge Springs, Va. One man, John W. Hunter, engineer, was killed, and two were injured, one fatally.

(170.) — On March 22, a wash-out plug blew out on a locomotive at the round house, Carthage, N. Y. The engine was under steam, and a workman was attempting to tighten the plug. He was fatally scalded.

(171.) — Five men were scalded, none fatally, when the boiler at the mine of the Turner Coal Co., Evans City, Pa., exploded March 23.

(172.) — On March 23, the boiler at the Cramer Creamery, Camden, N. J., exploded. No one was hurt, and the damage was confined to the boiler.

(173.) — On March 25 the boiler of a well drilling machine belonging to Denny & Cypher, Contractors, exploded at the Melarky farm near Marwood, Pa. No one was injured.

(174.) —A tube ruptured in a water tube boiler at the plant of the Victor Talking Machine Co., Camden, N. J., on March 25.

(175.) —A saw mill boiler owned by Stewart and Hardin, at Holcomb, Miss., exploded March 25, killing four men and injuring three more, one fatally.

(176.) —A boiler exploded March 26, at the McCormick Works of the International Harvester Co., Western Ave. and Thirty-first St., Chicago, Ill. Six were injured, one of whom died soon after the accident.

(178.) — On March 26, a boiler exploded at the saw mill of H. L. Hearn, Salisbury, Md. Five men were instantly killed and three more injured.

(179.) — On March 27, one man was slightly burned by the explosion of a boiler at the City power house, Wellington, Kans.

(180.) —A blow-off pipe failed March 25, at the Fall River Iron Works, Fall River, Mass. Antone Casmere, fireman, was scalded.

(181.) — The boiler of an engine used to run a circular saw at the farm of H. H. Peterson, Whiting, Ia., exploded March 27, killing one man, and injuring four others, one seriously.

(182.) —A Delaware and Hudson locomotive exploded March 29, near East Worcester, N. Y., killing Howard Wickham, engineer, and Jacob Houck, fireman. Three others were injured, one seriously.

(183.) — Two cast iron headers fractured March 30, in a water tube boiler at the plant of the American Laundry Co., Mobile, Ala.

(184.) — On March 30, the boiler of a locomotive exploded near Tuscola, Ill., on the Cincinnati, Hamilton and Dayton R. R. Alva Friddle, brakeman, was killed, and three others injured.

APRIL, 1912.

(185.) — On April 1st, a plate ruptured in a boiler at the Connors-Weyman Steel Co., Helena, Ala.

(186.) — A blow-off pipe ruptured April 2, at the plant of the Southeastern Yaryan Naval Stores Co., Brunswick, Ga.

(187.) — About April 2, two boilers exploded on David Hoover's saw mill operation, near Saxton, Pa.

(188.) — A heating boiler exploded in the high school building, Pewaukee, Wis., on April 28, just after the close of the session. No one was injured.

(189.) — On April 28, the boiler at the mill of the Ida H. mine, near Belle Center, Ill. Two men were seriously injured, a small dog is said to have been killed.

(190.) — A boiler in the cant hook factory of C. A. and M. E. Wellman, at South Boardman, Mich., exploded April 5. One man was killed, and five others injured, one perhaps fatally.

(191.) — On April 4, a locomotive belonging to the Southern Pacific R. R. exploded near Rice Hill, Ore. M. M. Bartlett, engineer, and Bert Anderson, fireman, were killed.

(192.) — A boiler at the plant of the Salisbury Ice Co., Salisbury, Md., exploded April 5. One man was killed, one fatally injured, and several others were slightly injured.

(193.) — On April 6, an accident occurred to the boiler at the Painted Post, N. Y., plant of the Ingersoll-Rand Co. Considerable damage was done to the boiler.

(194.) — On April 8, Solomon Burke was killed as the result of a boiler explosion at the saw mill of W. M. Walker, Linden, N. C.

(195.) — The explosion of a locomotive boiler on the Southern Pacific, at Stanwix Station, Ariz., April 9, resulted in the death of C. C. Vaughn, engineer, and the fatal injury of B. E. Norton, fireman.

(196.) — On April 9, a heating boiler in the Turkish Baths at 120-122 Ridge St., New York City, exploded, fatally scalding two persons.

(197.) — On April 10, the boiler at the mill of the Orillia Lumber Co., Orillia, Wash., failed, injuring three men, one fatally.

(198.) — A tube ruptured April 10, at the plant of the Virginia Portland Cement Co., Fordwick, Pa. John A. Harris, fireman, was injured.

(199.) — A cast iron header ruptured April 10, in a water tube boiler at the mill of the American Steel and Wire Co., Waukegan, Ill.

(200.) — A blow-off pipe failed at the Moxie Co's plant, New York City, on April 12.

(201.) — On April 12, a stop valve on the main steam line ruptured at the Western Branch, National Home for Disabled Volunteer Soldiers, National Military Home, Kans. John Ockerman, helper, was killed.

(202.) — A boiler ruptured April 13, at the plant of the Union Dairy Co., Rockford, Ill. The damage was small.

(203.) — On April 15, a boiler used for well drilling at New Martinsville, W. Va., exploded, killing Thos. S. McNight, a tool dresser, and injuring one other.

(204.) — On April 16, the crown sheet of a locomotive portable boiler pulled off the stay bolts at the Holran Stone Company's quarry, Maple Grove, O.

(205.) — On April 16, as the result of a boiler accident at the plant of the Pacific Coast Steel Co., South San Francisco, Cal., one man was fatally injured.

(206.) — A boiler exploded April 17, at an oil well near Cannonsburg, Pa. One man was injured, and will probably die.

(207.) — On April 17, a boiler exploded at a fertilizer plant near Seven Stars, Pa. One man was slightly injured.

(208.) — The boiler at the plant of the Powell River Milling Co. exploded April 19. Leonard Swanson and Henry Hollingsworth were killed, and some six others injured, one fatally.

(209.) — On April 19, a boiler failed at Newbill's saw mill, Lebanon, Pa. Three men were killed and three injured, one fatally.

(210.) — A tube ruptured April 19, in a water tube boiler, at the Donora, Pa., plant of the American Steel and Wire Co. Considerable damage was done to the boiler.

(211.) — A copper cooker failed April 20, at the Fleishmann yeast plant, Cincinnati, O. One man was killed and five were injured, two fatally.

(212.) — An Illinois Central locomotive boiler exploded in the yards at Bloomington, Ill., April 21. Weaver Hillerman, engineer, was killed and Orville Clay, fireman, seriously injured.

(213.) — A boiler ruptured April 22, at the plant of the Flower City Tissue Mills Co., Greece, N. Y. The damage was slight.

(214.) — On April 22, the boiler of a Western Pacific locomotive exploded near Elko, Nev., killing three trainmen.

(215.) — The boiler at the Butterfield saw mill, Kelso, Wash., exploded April 23. Three men were scalded, and property damaged to the extent of about $1,000.

(216.) — A tube failed April 25, in the basement of the Rike-Kumler store, Dayton, O. Two men were injured.

(217.) — On April 25, a tube failed in a boiler at the power house of the Sheboygan Railway and Electric Co., Sheboygan, Wis. Two men were slightly injured.

(218.) — On April 25, a tube ruptured in a water tube boiler at the Pickands Mather Co's furnace, Toledo, O. One man was injured.

(219.) — A tube ruptured on April 26, at the power house of the Metropolitan St. Ry. Co., Central Ave. and Water St., Kansas City, Kans.

(220.) — On April 27, the crown sheet of a locomotive collapsed on the main line of the Union Railroad Co., Port Perry, Pa. W. H. Watkins and W. F. Wesser, engineers, were injured.

(221.) — A plate failed in a boiler at a paper box factory, Thomas and Cambridge Sts., Milwaukee, Wis., on April 28. One man was scalded.

(222.) — A tube ruptured April 30, in a water tube boiler at the power plant of the Mobile Electric Co., Mobile, Ala. The damage was small.

(223.) — Several cast iron headers fractured April 31, at the plant of the Quaker Lace Co., Philadelphia, Pa.

May, 1912.

(224.) — On May 1, the furnace of a Scotch marine boiler collapsed at the plant of the National Biscuit Co., 409 Liberty St., Pittsburgh, Pa. The damage to the boiler was considerable.

(225.) — The heating boiler at Public School No. 1, Long Island City, N. Y., exploded May 2. Over 1600 school children were marched out of the building in less than three minutes, no one was injured.

(226.) — A heating boiler exploded May 3, in a residence at Ridley Park, Chester, Pa. One man was injured.

(227.) — On May 3, two concave heads in the steam drum of a water tube boiler collapsed, at the plant of the Ohio Iron and Steel Co., Lowellville, O.

(228.) — A tube ruptured May 5, in a water tube boiler, at the plant of the Tri-State Railway and Electric Co., East Liverpool, O. Clyde Jones, fireman, was injured.

(229.) — On May 5, the boiler of the launch Orin B., used by the Atlantic Gulf and Pacific Co., on the barge canal works near Glen Falls, N. Y., exploded. Charles Grilse, engineer, was killed and George H. Terry, injured.

(230.) — The boiler of a threshing machine exploded May 6, on the farm of Otto Drake, Dundee, Mich. Two men were killed.

(231.) — On May 6, the flanging of a vulcanizer failed at the plant of the Boston Woven Hose and Rubber Co., Cambridge, Mass.

(232.) — A tube ruptured May 6, in a water tube boiler, at the Diamond Crystal Salt Co., St. Clair, Mich.

(233.) — A water heater exploded May 6, in Hanscomb's restaurant, So. Ninth St., Philadelphia, Pa. The loss was estimated at $5,000.

(234.) — A tube ruptured May 9, at the rolling mill of Moorehead Bros. and Co., Sharpesburg, Pa. Considerable damage was done to the boiler, and Wick Velump, fireman, was injured.

(235.) — On May 11, a boiler at the Landingville knitting mill, Landingville, Pa., exploded. Harry Warmkessel, fireman was scalded.

(236.) — A tube ruptured May 12, in a water tube boiler at the plant of the Kenosha Gas and Electric Co., Kenosha, Wis.

(237.) — On May 15, a boiler failed at the Duquesne Steel Foundry, Kendall Station, Pa. The damage was confined to the boiler.

(238.) — A vulcanizer exploded May 16, at the Empire Rubber Co's plant, Trenton, N. J., killing one man, and fatally injuring two more.

(239.) — A blow-off pipe failed May 16, at the Lessing Apartments, owned by Chas. E. Rector and T. J. Tucker, Chicago, Ill. Chas. O'Conner, engineer, was slightly injured.

(240.) — On May 18, a flue in a dryer collapsed at the Kansas City, Kans. plant of the Swartzchild & Sultzburger Co. The damage was confined to the vessel itself.

(241.) — The boiler exploded May 18, at the saw mill of John de Frain, near Brownback's Church, Pa. Charles Smith and Chester Herzog were killed, and three others injured.

(242.) — On May 21, a steam pipe burst on the steamer James E. Davidson, in Lake Superior. Eight men were scalded, two fatally.

(243.) — A saw mill boiler exploded May 24, at Farina, Ill. One man died as the result of injuries received.

(244.) — The boiler of a well drilling machine exploded May 24, on the property of F. Marion Vanderveer, North Branch, N. J. Two men were injured.

(245.) — A tube ruptured May 25, in a water tube boiler at the blast furnace of the Upson Nut Co., Cleveland, O.

(246.) — On May 25, a flue failed in a boiler at the power house of the Wheeling Traction Co., Wheeling, W. Va. Charles Grubb was injured.

(247.) — A cast iron header failed May 30, in a water tube boiler at the plant of the Diamond Alkali Co., Fairport, O. No other damage is reported.

(248.) — On May 31, a boiler ruptured at the plant of the Dallas Portland Cement Co. The damage was small.

Fly Wheel Explosions.

(To Complete the 1911 List.)

(57.)— On September 16 an automobile fly wheel burst at the corner of Pico and Howard Streets, Los Angeles, Cal. One man was severely injured.

(58.)— A fly wheel at the plant of the Pittsburg Brewing Co., Connellsville, Pa., failed September 21, doing damage to property to the extent of $5,000.

(59.)— The fly wheel at the Transit Shoe Company's plant, Franklin, Pa., exploded October 9. One man was injured.

(60.)— October — a fly wheel burst at the plant of the United States Handle & Cooperage Co., Malden, Mo. Two men were killed and two others injured.

(61.)— On October 24 a fly wheel at the plant of the Hagerty Shoe Company, Washington Court House, Ohio, exploded, doing considerable property damage. (See Power for November 14, 1911.)

(62.)— On December 2 Harry Waldron was killed at the plant of the Standard Motor Construction Co. by the bursting of a gasolene engine's fly wheel. The engine was being prepared for installation in a motor boat.

(63.)— The fly wheel attached to an air compressor at the Ready Bullion Mine, Treadwell, Alaska, exploded about December 13. The compressor and building were demolished, and several hundred men thrown out of employment temporarily.

Fly Wheel Explosions, 1912.

(1.)— A fly wheel attached to a pumping engine used in connection with the construction of a sewer at Richmond Hill, N. Y., exploded January 1. One man received a broken arm as the result of the accident.

(2.)— On January 21 a large fly wheel failed at the plant of The Fox Paper Co., Lockland, Ohio. Oscar Cummins, an oiler, was attracted to the engine by the breaking of the main belt. The engine attained a dangerous speed, and he was killed by the bursting fly wheel while trying to close the throttle.

(3.)—The fly wheel attached to a deep well drilling machine exploded January 25 at the yards of the Paris Coal and Ice Co., Paris, Tenn. Will Dowe, engineer, received injuries which resulted in the loss of an arm.

(4.)—A fly wheel at the mill of the Friend Paper Co., West Carrolton, Ohio, exploded January 26. No one was injured, but the mill was closed one day as the result of the accident.

(5.)—On February 17 a fly wheel attached to the engine at the shingle mill of the Humbolt Manufacturing Co., Arcata, Cal., burst. Property was damaged to the extent of about $500, and one man, a saw filer, was killed.

(6.)—A wooden fly wheel at the saw mill of Triplett and McCann, Lost Camp, Mo., exploded April 17, killing John Triplett, one of the proprietors.

(7.)—On April 24 a fly wheel in the Westchester Lighting Company's power plant, Yonkers, N. Y., exploded. There was some property damage, but no one injured.

(8.)—The bursting of a fly wheel on April 28, at the plant of the Atha Tool Co., Newark, N. J., inflicted slight injuries to one man.

(9.)—On May 1 a 12-foot pulley burst in the dynamo room at the paper mill of Dill and Collins, Philadelphia, Pa. Property damage to the extent of from $3,000 to $4,000 resulted, principally through the rupture of a steam line, and the pipes of the sprinkler system by flying portions of the wheel.

(10.)—The fly wheel of an engine at the Higginsville, Mo., electric light plant failed May 13, doing property damage to the extent of about $3,000. (See front page of this number of The Locomotive.)

(11.)—On May 22 a fly wheel at the brick yard of Nevill Bros. and Mink, Llanwellyn, Pa., exploded, resulting in damage to the plant estimated at $1,500.

(12.)—A fly wheel attached to the engine at the Louisiana and Arkansas R. R. shops, Stamps, Ark., exploded June 4. The loss is thought to be under $1,000.

(13.)—On June 7 a pulley burst at the Rittersville Electrical Works, Allentown, Pa. One man was injured.

(14.)—A fourteen-foot fly wheel burst June 7 at the Phœnix Cement Works, Nazareth, Pa. The damages are estimated at $3,000.

(15.)—On June 10 the fly wheel of an engine at the East Jordan (Mich.) Electric Light and Power Co. burst, killing A. Z. Wilcox, the engineer, and damaging the plant to such an extent as to leave the town in darkness for a week.

(16.)—A fly wheel exploded June 11 at the power plant of the D. & H. R. R., Green Island, N. Y. The plant was damaged to the extent of $1,000.

A Narrow Escape.

W. J. Smith, Inspector.

The opportunity of witnessing a "real live" lap seam crack in action is seldom afforded boiler operators. This unique and rather undesirable experience was recently afforded several employees of The Anderson-Middleton Company, Aberdeen, Washington. The fireman, desiring to operate a valve in a steam line over the boilers, was attracted by the issuance of steam from the insulating material on top of the boiler. Removing this covering, the steam and water were seen to spurt from a crack about ten inches long, the edges of which vibrated under the pressure.

The Chief Engineer being called, with great presence of mind instead of shutting off the engines and turbines, which might have produced a shock or increase of pressure, immediately banked the fires, closed the draft and opened the feed water valves. In this manner the pressure was soon reduced to less than forty pounds. The main stop valve was then shut off. The boiler, being one of three fired in battery, a division wall was built in the furnace and the day following the other boilers were in operation.

The defective portions were cut out of the boiler and revealed a crack one eighth of an inch from the edge of the inner lap, and about 5 ft. 6 in. long, no portion of which was visible from the inside.

The boiler was about seven years old, had been operated at its designed working pressure and had frequent and careful supervision with good care and management.

It is needless to say there is considerable congratulation going the rounds among those interested, for aside from the probable heavy loss of life, the boiler was part of a very expensive plant and surrounded on all sides by high grade machinery and equipment.

We wish to commend the coolness and good judgment of the chief engineer, and firemen of this plant. This type of boiler defect is undoubtedly one of the most treacherous of the many possible causes for boiler explosions, as it too often reveals itself only after the property is destroyed.

Instead of stopping his engines, this chief had the good sense and nerve to cover his fires, and control his steam by using it up, thus saving not only the company's property, but perhaps many lives as well. EDITOR.

A "Mexican" for a Safety Valve.

We record on another page of this issue, an instance of safety valves being so erroneously installed as to become objects of danger, by the possibility of their leading to a feeling of false security, but it remains for the following, extracted from one of our inspection reports, to cap the climax, as a display of ignorance of the vital importance of this particular boiler accessory. We give the extract verbatim.

"Engineer (?) of above plant explained that his reason for removing the safety valve from boiler was that it leaked, and that he thought as long as he had a Mexican watch the steam and not let it get too high, that the boiler was safe. He stated further, that he had a perfectly good ash pit door, and that by closing it the steam would go no higher. I tried to make it plain to all concerned, that Mexicans, and ash pit doors, would not answer in any way the purpose of a safety valve." (The inspector found that the safety valve had been replaced with a solid plug.)

The Locomotive of THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

C. C. PERRY, EDITOR.

HARTFORD, JULY, 1912.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting of matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

On another page we print a news item and editorial comment from the *Hartford Courant* announcing the reinsurance of the boiler and fly-wheel business of The Casualty Company of America by THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY. Of course we are gratified at this event for many reasons, but perhaps especially because of the confidence in us which is thus signified by the management of so prominent an institution as the Casualty Company. Obligations to its assured required that the service which supplanted its own should be above criticism, and self interest demanded that its reinsurance should be placed only with a company of high financial standing. We accordingly feel a pardonable pride in the recognition of our standing implied by this selection and expressed by President DeLeon of the Casualty Company in his announcement of the change to his agents as follows:

"I need not call to your attention the standing and reputation of The Hartford Steam Boiler Company throughout the United States, or to the splendid service rendered by that company to its policy holders everywhere, which has made the Hartford company pre-eminently the *leading boiler insurance company of America.*"

Appreciation like that from a one-time warm competitor is a compliment indeed. We shall endeavor to justify it by a service to the boiler and fly-wheel owners whom President DeLeon has entrusted to us which will force their endorsement of his opinion. We welcome them all to the HARTFORD STEAM BOILER fold.

The Casualty Company of America has been one of the four larger multiple-line casualty underwriters in the boiler and fly-wheel field. In 1911 according to its official statement it wrote $117,594 in premiums of these two lines, and of this amount $108,229 was for boiler insurance. There were in 1911 twenty-four casualty companies competing with the HARTFORD in steam boiler underwriting. The total of premiums written by them was $1,101,922, an average of about $46,000 per company. The Casualty Company of America, writing more than twice as much business as its average multiple-line competitor, and exceeding all but three of those competitors in the volume of that business, would seem to have had a favorable position in the field. If it has become discouraged with the prospects and financial returns from such business what bright future can allure the twenty smaller companies?

The truth is that steam boiler insurance,— and this applies to fly-wheel insurance also — is peculiar and distinct from other lines of underwriting in that to experience a normal loss ratio a technical supervision of the apparatus covered is necessary. It is obvious that the expense of such a service must be proportionately greater with a company which insures a small number of widely scattered boilers than with one whose business is so great as to justify a broad distribution of inspection centers from which all its assured may be economically reached. To make the small boiler business successful. the company writing it must either be content with little or no profits, or it must charge more for its protection than its large competitor, or it must reduce the character and frequency of its inspection service at the risk of a higher loss ratio, more accidents, and the consequent annoyance and dissatisfaction of its assured.

The HARTFORD STEAM BOILER with a business of $1,300,000 annually and with over 100,000 boilers under its care, has been able to establish a standard of service which steam users generally have come to appreciate. It has been deriving from its business an average underwriting profit less than 9%. This is certainly a moderate return for the energy expended and the risks carried. Is it likely that an insurance company would be content with less? If not it follows that the small boiler underwriter must charge more for its protection or reduce the character of it. The public is too well posted to pay to others a larger premium than will purchase HARTFORD insurance, nor will it long permit a character or lack of inspection service which risks disastrous explosions. The result is the dilemma of the kind in which the Casualty Company of America found itself and which it has solved in the manner announced.

A correspondent sends us a newspaper clipping descriptive of the action of a New York tug captain in attempting after a collision to run his boat ashore before the water leaking in could reach the boilers "and cause an explosion". With it he writes that this "and numerous articles in relation to the 'Titanic' and other sinking ships leads me to ask you if there is any foundation whatsoever for the newspaper theory that boilers in sinking steamships explode because of being plunged into cold water".

We agree with the view of this gentleman as further expressed that the theory is not tenable and that even should a boiler under such circumstances fail locally the force of the explosion would be slight owing to the almost instantaneous condensation of the steam when submerged in the cold water. We admit that we have not ourselves been on a sinking steamship, but our company has had opportunity of examining boilers which have passed through that ordeal, and others which because of a fire have had cold water poured upon them. The evidence thus available would indicate that not always at least does submerging cause a boiler explosion, and further we do not see why it should.

It may be stated without fear of contradiction, that a boiler explodes because it is incapable of withstanding the internal pressure exerted in it. The disaster may be caused either by an abnormal increase in the pressure or by an equally abnormal decrease in the strength of the boiler material. Now, so far as we can see, none of the conditions necessary to an increase in pressure would be produced by submerging in water a boiler under steam. Such a treatment would naturally reduce the temperature and consequently the pressure very promptly. The treatment could have little effect, either, on the strength of a vessel made up of steel plate although it is probable that local contraction strains would be produced by a gradual rather than sudden submergence. The steel used in boilers is not usually a brittle material and withstands sudden and violent changes in temperature without cracking. Failing to discern among the conditions which attend the submerging of a boiler anything which would increase the pressure or decrease its strength and being to an extent backed by the slight experience already suggested, we will — pending evidence to the contrary — continue in the belief that a boiler explosion is not a necessary circumstance in the sinking of a ship.

It may be added that the tug captain first mentioned did not according to the clipping succeed in "beaching" his boat before it sank, and if in sinking the boilers exploded, the effect was too insignificant for the reporter to record.

Announcement.

Hartford, Conn., July 1, 1912.

In the January number of The Locomotive our Company announced with regret the resignation of the editor who had so ably conducted this paper for a number of years. Since then we have been seeking a man to fill the place thus made vacant and from a number under consideration have selected Mr. Clarence C. Perry, who commences his editorial duties with this issue.

We feel that Mr. Perry is especially equipped by his experience and education for a work which requires both a theoretical and practical knowledge of steam and allied engineering practices and also a wide acquaintance with the literature of those subjects. He is a graduate of The Sheffield Scientific School of Yale University, class of 1904, and since then as a member of the faculty of that institution has been instructing the students of the Department of Electrical Engineering in physics and steam engineering subjects. While in this position Mr. Perry was frequently called in consultation where expert advice on steam matters was desired and thus was brought in intimate contact with the practical problems of installation and operation.

I take pleasure in this opportunity of introducing Mr. Perry to those of our own organization who have not met him personally, as well as to our assured and other readers, and express my conviction that under his management our paper will continue in its position of authority and interest among technical periodicals.

Lyman B. Brainerd, *President.*

Obituary.

Sylvester W. Higgins, special agent for the Hartford Steam Boiler Inspection and Insurance Co., at Detroit, Mich., died May 7 at his home, 120 Euclid

Ave., in that city. His death came as the culmination of an illness of several months duration.

Mr. Higgins was born in Utica, N. Y., in 1834, but removed to Detroit with his family at an early age. The family were prominent both in the city and state, being associated closely with church work in Detroit. His father was at one time State Geologist of Michigan.

Mr. Higgins had been the Detroit representative of the Hartford Steam Boiler Inspection and Insurance for some twenty years, and his sterling qualities won for him the esteem and respect of all his business associates.

He is survived by a widow and three daughters, Frances E. and Ethel M. of Detroit, and Mrs. R. R. Strong of Pueblo, Col.

Personal.

Mr. Joseph H. McNeil, who, since 1898, has been connected with the boiler inspection service of the State of Massachusetts, first as inspector, and later as chief inspector, and chairman of the Board of Boiler Rules, tendered his resignation, to take effect July 8th, in order that he might accept the position of chief inspector in the Boston Department of THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY.

Mr. McNeil's experience has been both wide and varied, and is of such a nature as to fit him most admirably for the position he now enters with the HARTFORD. Born at Charlottetown, Prince Edward Island, in 1865, he was educated in the public schools, and Prince of Wales College. His experience has included railway work, both mechanical and executive, with the Prince Edward Island Railway and the various phases of stationary and marine engineering. He has held the position of chief engineer of ocean going vessels, under licenses, both from the United States government and from the British Board of Trade. Of his work for Massachusetts, it is perhaps only necessary to say that the well-known boiler inspection law of that state owes much of its success, if not its very existence, to his judgment, tact, and executive ability.

Chief Inspector Frank S. Allen, who has had charge of both the Boston and Hartford departments, will by this appointment be relieved of the detailed supervision of the large number of boilers in the former district. He will continue in immediate charge of the inspection service handled from Hartford, and will be able to devote his attention to the general inspection problems of the Home Office to a greater extent even than in the past.

The Boiler and Fly Wheel Insurance of The Casualty Co. of America Taken Over By the HARTFORD.

[From The Hartford (Conn.) Courant June 28, 1912.]

The Hartford Steam Boiler Inspection & Insurance Company has taken over and reinsured all of the steam boiler and fly wheel business of the Casualty Company of America of New York City.

The Casualty Company of America was organized and commenced business in September, 1903, as a multiple line company, and it has gradually built up and developed the numerous casualty lines to an extent that its aggregate net premium receipts last year exceeded $2,500,000. From the insurance commissioner's report of 1912, it would appear that it is one of the stronger and more progressive companies, having a paid up cash capital of $750,000, a net surplus over all liabilities exceeding $205,000, and total assets exceeding $2,801,000.

As relating particularly to the steam boiler line, the Casualty Company of America ranks as the fourth or fifth company in point of volume, its steam boiler premiums written last year exceeded $108,000, and the volume of business taken over by the Hartford Steam Boiler Insurance Company exceeds 12,500 boilers and about $100,000,000 of insurance liability. This is undoubtedly the largest transaction that has ever taken place in this particular line of insurance.

From an interview with President Brainerd of the Hartford Steam Boiler Insurance Company it was learned that conditions pertaining to the steam boiler line are in a very unsettled and unsatisfactory condition, and that competition is very keen. He further said that as the steam boiler line was so limited in volume as to render it impossible for any one company to develop and greatly expand it, in view of the fierceness of competition and the great cost of maintaining an inspection service, such as is now demanded by the insuring public and in many instances required by law, the management of the Casualty Company of America had reached the decision that the resources of the company and the time and energy of its officers could be better and more profitably employed in developing and building up its other and more prominent and more promising lines of insurance.

It appears that the total amount paid last year for steam boiler insurance throughout the United States amounted to but $2,303,104, and that of this amount $1,275,103 was paid to the Hartford company, notwithstanding there were no less than twenty-five companies competing for this small volume of business. It was further explained that because of the peculiar character of steam boiler and fly wheel insurance, their distinctive feature being the maintenance of an efficient inspection service, they are two of the most limited and most expensive lines to conduct of all the numerous casualty lines, and that unless a considerable volume can be controlled in each state throughout the Union, an efficient inspection service cannot be maintained with any promise of profit, in view of the expenses in maintaining an organization and an inspection service as today required, if the business is to be properly conducted.

It will at once be observed that if the premiums paid for steam boiler insurance should gradually become equally apportioned between all the companies at this time competing for it (and all things being equal, and each company maintaining an equal and as extended an organization and efficient inspection service, there is no reason why this condition should not obtain), there would be an average of less than $100,000 annually that it would be possible for any one company to secure, and that this sum would be barely sufficient to maintain one inspector in each state throughout the Union.

The Hartford Steam Boiler Inspection & Insurance Company was organized and commenced business in 1866, and on January 1 last its paid-up capital was $1,000,000, its net surplus over all liabilities exceeded $1,801,000, and its assets amounted to $5,045,874.60. It makes a specialty of steam boiler and fly wheel insurance and conducts no other class or kind of insurance.

This is the seventh instance in which the Hartford Steam Boiler Company has taken over the steam boiler line of other companies.

EDITORIAL COMMENT.

It is an important announcement that President Brainerd of the Hartford Steam Boiler Inspection and Insurance Company makes this morning — the acquisition of the steam boiler business of the Casualty Company of America. The amount of reinsurance is said to equal about one-tenth of the Hartford company's present business. It is a substantial business deal, comprehending an original premium income of over $300,000.

The steam boiler insurance business has been conducted profitably in Hartford and many small companies have been formed to enter the field. These companies find that an adequate inspection service, such as the Hartford company maintains, is a great expense and one sure preventative of large profits. It would not be surprising, therefore, if other companies followed the Casualty Company's lead. The Hartford company can take over this insurance with very slight increase in its working force. It means more business for Hartford.

Boiler Tubes Undergo a Marked Loss of Ductility.

By a Chief Inspector.

In the examination of boilers and other vessels operated under steam pressure, the inspector often meets conditions which to him at least are unexpected and peculiar. But while they may be new to him, generally on conferring with other inspectors, he will learn of similar instances. The present incident, with its tests showing the nature of the trouble, may be of assistance to some one in clearing up such a difficulty.

The agent for a large manufacturing concern desired an examination of one of his boilers, which were of the water tube type, and all duplicates. They had been in service but a comparatively short time. He requested this inspection not because of any trouble, but on general principles, as several months had elapsed since the last regular examination. The writer responded to this request, finding one of the boilers properly prepared for inspection. No ordinary defects were found. The boiler was clean and free from scale in all its tubes and drums. The tubes were of full thickness, and under the hammer test not the slightest indication of anything defective was conveyed to the examiner. He noted however, a peculiar appearance to those tubes which were accessible, and directly exposed to the fire. Touched with a fine file the metal was bright.

and its appearance was perfectly normal. The unusual color of the tubes however disturbed him very much, and he requested that some of them be removed for testing; since while they might prove soft and ductile, he was of the opinion that they were dangerously brittle, and feared from the general arrangement of the fire room that loss of life would follow the failure of a tube at the high pressure carried. He held this view notwithstanding the fact that these boilers were designed with a good factor of safety for the pressure carried, for he considered the danger of personal injuries greater than that of a property loss. The mill agent took up the question of testing the tubes at once. The first blow struck with a chisel in cutting off one of them close to the drum, caused the tube to break. Every tube was then removed and test specimens one inch wide cut from each. All were found to be practically as brittle as the first, and showed an entire absence of ductility. It was felt that if they had been continued in service, a shock, or even the vibrations of the engine would have been sufficient to have fractured a tube, and the reaction might well have caused the breaking of several more.

Samples of four of these tubes were sent for chemical analysis, the result of which is given in table 1.

Table 1.

	No. 1.	No. 2.	No. 3.	No. 4.
Carbon	.06%	.06%	.06%	.06%
Manganese	.02%	.02%	.02%	.02%
Phosphorus	.079%	.073%	.065%	.073%
Sulphur	.020%	.026%	.024%	.020%
Silicon	.154%	.159%	.143%	.154%

Compared with the requirements for fire box steel boiler plate the low percentage of carbon and manganese, with high phosphorus will be at once noted, and will indicate why the tubes were so deficient in ductility.

At about this same time, a similar change was found to have occurred in the tube cap bolts of another type of water tube boiler, from the same maker, but belonging to another firm. These bolts which were not exposed either to the direct action of the fire, or to so high a pressure as in the first case, were found by the inspector to be so brittle that on sounding them with his light hammer, many of them broke as if they had been glass rods. The chemical analysis of these bolts was very similar to that of the tubes mentioned above, though differing from it to a slight extent. The conclusion is obvious that the stock in both the tubes and bolts was of a very inferior quality and ought never to have been used in any place exposed to high temperatures or to strains due to pressure.

A new tube and several bolts from the same stock as those removed, were tested physically and showed good ductility, but analysis proved that the material was no better than that which had been rejected for its extreme brittleness.

It has long been a dream of the writer that all material used for boiler work should be plainly marked, the marks to be uniform with all manufacturers, and to indicate the quality of the material. These could be placed upon the head of a bolt in forging, at slight expense, and in welded tubes, could be made at the time of welding. Solid drawn tubes present of course, a slightly different problem, but that process itself would perhaps be a guarantee of a better quality of material than would be used for welding.

FIG. 1. THE OIL TANK, RAILROAD AND BOILER HOUSE.

An Alabama Mystery.

The accompanying photographs were sent us by a correspondent whose veracity we have no reason to doubt, in substantiation of the following most remarkable boiler accident. This mishap occurred to what was then the No. 2 boiler of the Eufaula Cotton Mill, Eufaula, Ala., early in 1897. This boiler is said to have discharged certain of its tubes bodily through the tube sheets, sending four of them out of a window, across a gulley and a railroad track, until they were intercepted by an oil tank which they pierced. The relative location of the track, gully, boilerhouse, and oil tank can be seen by reference to the photograph, Fig. 1, which shows the present appearance of this locality. A close scrutiny of Fig. 1 will show patches applied to the tank, and if one will turn to Fig. 2, which is a nearer view, one will see that they consist of a horseshoe, and three round patches, said to have been placed there in repairing the damage done by the flying tubes. A fifth tube missed the tank, but punctured the stack which occupied the site of that shown in Fig. 1, but has since been removed to a location such that it was impossible to obtain a photograph of it.

The accident happened early one Sunday morning, about 5 a. m., when no one except the watchman was about the plant. He was attracted by an unusual noise in the direction of the boiler house, but the performance was over before he could reach the scene. The cause of this peculiar action was never satisfactorily explained, and remains one of the mysteries of our Atlanta Department.

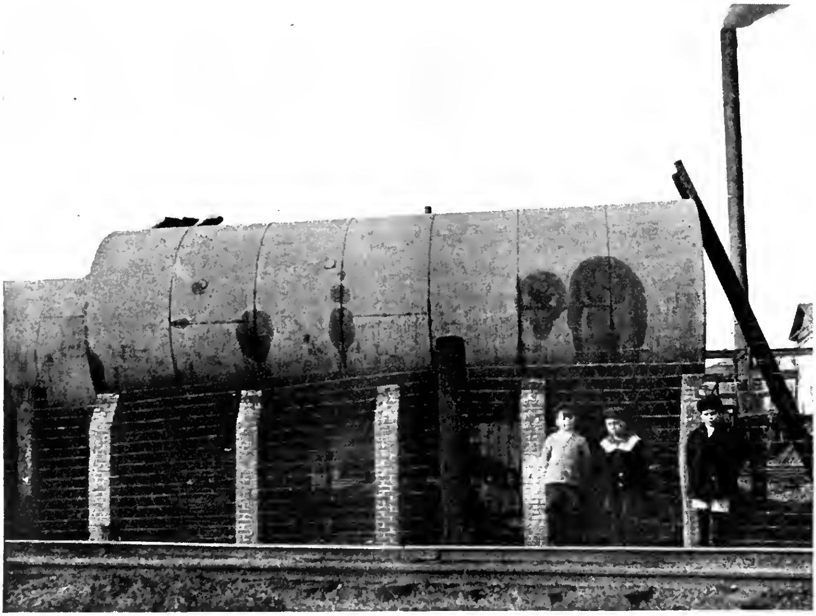


FIG. 2. THE PATCHED OIL TANK.

The boiler itself did not leave the setting, indeed it was not sufficiently disturbed to disconnect it from the steam pipe. Nine tubes left the boiler entirely, and seven or eight more were projected part way through the front head. Aside from slight repairs to the setting, the only work needed on the boiler was the replacing of these sixteen or seventeen tubes.

The question remains unanswered as to what made this boiler cut up this particular sort of caper, and if anyone can answer it, or cite a parallel case, we shall be very glad to hear from him.

Patching a Boiler Without Rivets, Bolts, or Welding.

E. J. ENOCH, *Inspector.*

Not long since a brother inspector, in reporting upon a patch applied to a boiler, remarked that "the job looked as though it had been done by a shoemaker."

The writer was recently sent to inspect a job of repair involving a patch, but as it was neither pegged, nailed or sewed, it could hardly be said to display the art of shoemaking, resembling more the handiwork of a bricklayer.

The patch in question was placed on the rear drum of a Hawley down draft furnace. This was attached to a horizontal tubular boiler which carried a working steam pressure of one hundred and twenty-five pounds. A crack had developed in the drum, starting at one of the tube holes in the upper row, near the center, and extending circumferentially to a point near the top, a length of about five inches. The boiler maker (?) who was called to make repairs prepared a patch of ⅜" plate, shaped like Fig. 1 to fit over the top of the drum, and down each side of the tube opposite the fracture. A liberal quantity of asbestos cement was spread over the crack, the patch placed over the cement, and the brick arch, or deflecting wall rebuilt on top of the patch to keep it in position.

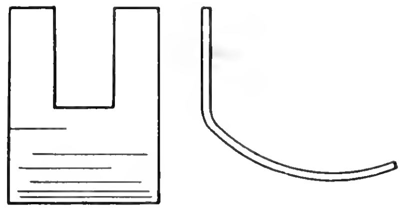


Fig. 1. The Patch.

It is not known what pressure was attained after the repair was completed, as the attendant was kept so busy in a fruitless effort to maintain a fire in the furnace against the flow of water from the fracture, that he failed to note the reading of the pressure gage. Nevertheless the patch was not blown out of the furnace, and the greatest damage was to the purse of the mill owner.

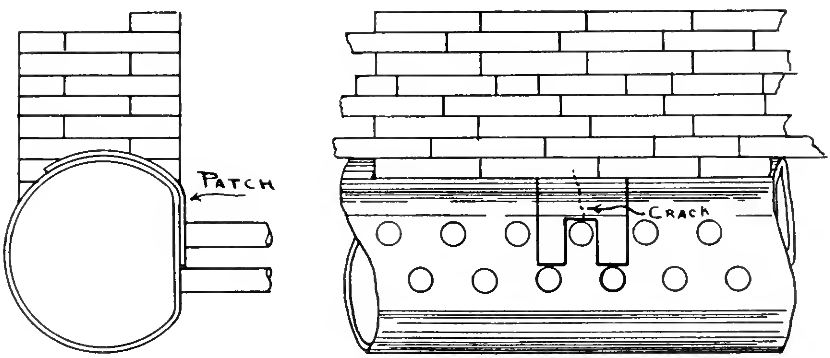


Fig. 2. Patch Bricked and Cemented in Place.

Queer Cause for an Erratic Steam Gage.

By Inspector J. J. McCurry.

One of our inspectors relates the following incident relative to an incorrect steam gage, and the queer cause which he found for its lack of truthfulness.

He was called to a plant to make a test as the gages were not reading together. There were two gages in the boiler room, one on each of two Stirling boilers, and one, a recording gage, in the engine room. On removing the gage from boiler No. 1, it was found to be 5 lbs. "slow", but on resetting, and replacing it, it agreed perfectly with the recording gage. The other gage on the No. 2 boiler was then found to be 12½ lbs. ahead of the one just reset, and it

(No. 2 gage) had been supposed to register correctly. This caused the engineer to question the inspector's test gage. The inspector, however, took down and tested the No. 2 gage, and found it to be 2 lbs. "fast" as compared with his test gage. The engineer was now certain of the inaccuracy of the test gage, and not too sure of the reliability and usefulness of boiler inspectors in general, but the inspector, loath to distrust his old and tried friend, sought for some obstruction in the gage connection, without however succeeding in his search. As he tersely puts it, "She was wide open, and so was the engineer." Still, unable to lose all faith in his pet gage and pump, he ordered the offender replaced on the No. 2 boiler, and there it stood with its hand quite still at 125 lbs. The inspector, now wholly aroused, climbed up on a ladder to obtain if possible, some additional information. The hand seemed clear of the glass and dial, but he finally noticed a slight bulge near the center of the dial, sufficient to cause the hand to hang up. He removed the face, set the dial back, and replaced the gage, only to find it still 10 lbs. off, as compared with that on the other boiler.

This set the inspector thinking. He was sure the hand was not resting on the dial when he set the gage, and tested it with his pump. He had also done all the work himself except taking it down, and putting it back, which fact at last lead him to the answer to his puzzle. He examined the screws which held the gage to the boiler front, and found them all set up tight, clamping the back of the gage securely to the boiler front. This, instead of being perfectly flat, was somewhat uneven, and thus caused the back of the gage to be pushed forward enough to make the dial encounter the hand, causing considerable friction, and explaining its erratic action. He found that he could easily vary the reading 10 lbs. by merely manipulating these holding screws, and when all tension was removed from the back of the gage, it fell into line, not only with the gage on the other boiler, but with that in the engine room as well, completely vindicating his pet test gage, and we are lead to judge, somewhat discomfiting the engineer.

A NOVEL METHOD FOR THE PREVENTION OF BOILER EXPLOSIONS.

We extract the following from a letter, written by one of our southern inspectors.

"Some few years ago a man in southern Arkansas owned and operated a small single boiler sawmill. The boiler after several years service, had developed a small steam leak at a longitudinal seam. The firemen reported the fact to the proprietor and stated that he, (the fireman) was afraid she would "bust." The German brains of the proprietor devised and executed the following idea. Securing several lengths of log chain, and fastening them together at the ends until a sufficient length was obtained. He wrapped the boiler in a spiral fashion with several turns of the chain, hauling it taut with a yoke of oxen, after which wedges were driven under the chains at several points."

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1912.

Capital Stock, . . . $1,000,000.00.

ASSETS

Cash on hand and in course of transmission,		$204,693.25
Premiums in course of collection,		263,453.33
Real estate,		91,100.00
Loaned on bond and mortgage,		1,166,360.00
Stocks and bonds, market value,		3,249,216.00
Interest accrued,		71,052.02
Total Assets,		$5,045,874.60

LIABILITIES.

Premium Reserve,		$2,042,218.21
Losses unadjusted,		102,472.53
Commissions and brokerage,		52,690.67
Other liabilities (taxes accrued, etc.),		47,191.65
Capital Stock,	$1,000,000.00	
Surplus over all liabilities,	1,801,301.54	
Surplus as regards Policy-holders,	**$2,801,301.54**	2,801,301.54
Total Liabilities,		$5,045,874.60

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Incorporated 1866. Charter Perpetual.

The Hartford Steam Boiler Inspection and Insurance Company

ISSUES POLICIES OF INSURANCE COVERING

ALL LOSS OF PROPERTY

AS WELL AS DAMAGE RESULTING FROM

LOSS OF LIFE AND PERSONAL INJURIES DUE TO EXPLOSIONS OF STEAM BOILERS OR FLY WHEELS.

Full information concerning the Company's Operations can be obtained at any of its Agencies.

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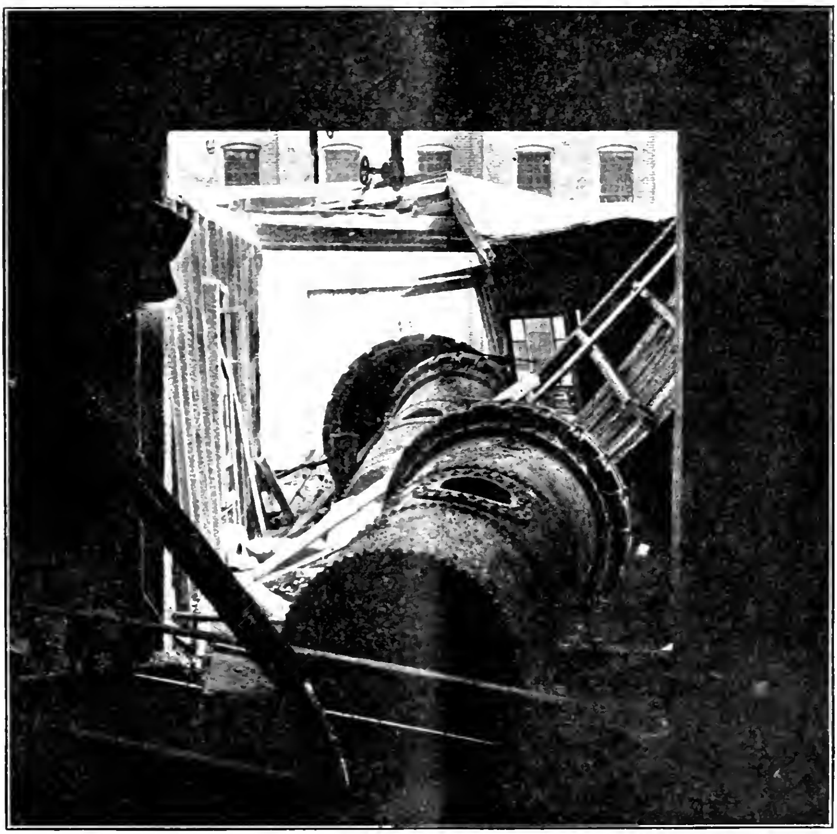
The Locomotive
of
THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Vol. XXIX. HARTFORD, CONN., OCTOBER, 1912. No. 4.



A Vulcanizer Explosion.

Vulcanizer Explosion.

Our front cover shows the failure of a vulcanizer May 16 at the plant of the Empire Rubber Company, at Trenton, N. J. This type of vessel presents an interesting problem in design because of its large size, and the necessity of providing it with a large cover, which shall be at once amply strong and capable of quick opening and closing, a feature which usually results in the use of some form of casting, with all the difficulties which that type of construction involves. The failure of one of these vessels is apt to be very destructive and is frequently attended by loss of life. In the present instance one man was killed outright, and two others were fatally injured. This was explosion No. 238 in our list for May, 1912.

Old Boilers.

The subject of a proper retiring age for old steam boilers is one which comes frequently to light, and which has been in the past a most fruitful source of controversy. Of course there can be no question as to the propriety of condemning to forced retirement those boilers whose diseases of one sort or another have reached the chronic stage, and are no longer curable, but there is at once the basis for a deal of argument when an inspector approaches the owner of a boiler with the statement that it must be replaced because of old age, especially if it is known to have all the apparent qualifications except youth, for many additional years of service.

In the past many curious properties have been attributed to old boilers. One of the most interesting was the notion that they could not explode violently. It was supposed that an old boiler would merely rupture, allowing the pressure to be relieved much as if the safety valve had opened. This idea was discussed at some length in the LOCOMOTIVE in 1881. It was definitely disproved along with many other fallacies, and much popular mystery concerning boiler explosions, by a series of experiments conducted by Mr. Francis B. Stevens, of Hoboken, the founder of Stevens Institute, and Prof. R. H. Thurston, at the Sandy Hook proving grounds in the fall of 1871. These tests consisted of a series of prearranged boiler explosions in which old boilers, and some new boiler elements were exploded by raising a steam pressure in them sufficient to produce failure. They gave the first conclusive proof of the fact that a boiler filled with water to its normal level could explode, and also that a boiler might explode violently when hot and under steam at a pressure less than that which it had successfully withstood under the ordinary hydrostatic test.

In 1881 Mr. W. B. LeVan, of Philadelphia, proposed to the American Society of Mechanical Engineers* that all steam boilers should be retired at the age of ten years arbitrarily, in much the same way that car wheels and axles are retired after a certain mileage. His reason for this view was his general distrust of boiler inspection, and although he admitted that the use and care a boiler received must influence its life, he was unwilling to believe in the probability of an inspector finding the extent of that influence, and so expected to forestall all danger by his ten year limit. Of course it was pointed out at that time that such a rule would work great hardship to the owner who

* "The Lifetime or Age of Steam Boilers." W. B. Le Van, Trans. A.S.M.E. Vol. II., Page 503.

used a good boiler well, and would unduly encourage the unscrupulous owner to push his poor boilers, by fair means or foul, to accomplish their utmost in the allotted ten years.

However there is a border line between the obvious defects an inspector can detect, and that gradual change in the physical character of the metal coming with advanced age and long use, which can only be implied by a knowledge of similar cases. Here it is that an insurance company must at times make a stand for the removal from service of an old boiler, or at least for a great reduction in the pressure at which it is worked. In order to prove the soundness of such rulings, old boilers have been tested from time to time, and it is the purpose of the present article to review certain of these tests, and show the character of the evidence upon which these old age retirements are based.

In general two sorts of tests can be made. One sort, of which the early tests of Stevens and Thurston are examples, consists in subjecting the entire boiler, considered as an engineering structure, to either a steam, or hydrostatic pressure great enough to cause rupture. The hydrostatic test is usually employed since it permits careful measurements of the strains at various points to be made as the test progresses, and with these an accurate record of the pressures producing them. The other class includes tests of the metal taken from different parts of a boiler, to show its physical and chemical properties, and if the original condition of the material is known, is of great value. It of course may very well form an addition to a test of the first sort. Within a short time, five old boilers, whose entire history is known, have been tested to destruction by the application of hydrostatic pressure. Three of these, the property of the Oliver Iron Mining Co., of Ishpeming, Mich., were tested by Mr. A. M. Gow, their assistant engineer. The other two were presented to the Bureau of Standards for test by Mr. Nicholas Sheldon, treasurer of the Kendall Manufacturing Co., of Providence, R. I. These boilers were tested to destruction at the plant of W. H. Hicks, boiler makers, Providence, R. I., by Mr. James E. Howard, engineer — physicist of the Bureau of Standards, assisted and advised by Mr. F. B. Allen, vice-president of The Hartford Steam Boiler Inspection and Insurance Co. All five of these boilers had been carried on the books of the Hartford, and had been removed from service at their request.

The boilers tested by Mr. Gow, were known in the records of the Hartford by the numbers 301, 302, and 303 and will be designated in this way. They were nearly identical in construction, of the horizontal return tubular type, 72 inches in diameter, and 15 feet long. The shells were in five courses, and were made of ⅜ inch plate. The heads were ½ inch in thickness. The longitudinal seams were of the double riveted lap type fastened with ¾ inch rivets, pitched 2 inches apart, and each boiler was fitted with a cast iron manhole frame on top of the next to the last course, with a clear opening of about 12×16 inches having its greatest diameter girthwise of the boiler. Two 4 inch cast iron nozzles were also fitted to each boiler, one on the rear, and one on the second course, for the attachment of the safety valves and steam pipes. The blow off connections were in the rear heads, and had been used for a long time for the introduction of the feed water. Reference to Fig. 1 will make clear the general arrangement of the boilers, and will indicate their only point of difference, namely that No. 302 contained 112 three inch tubes, while both No. 301, and No. 303 were provided with 83 four inch tubes.

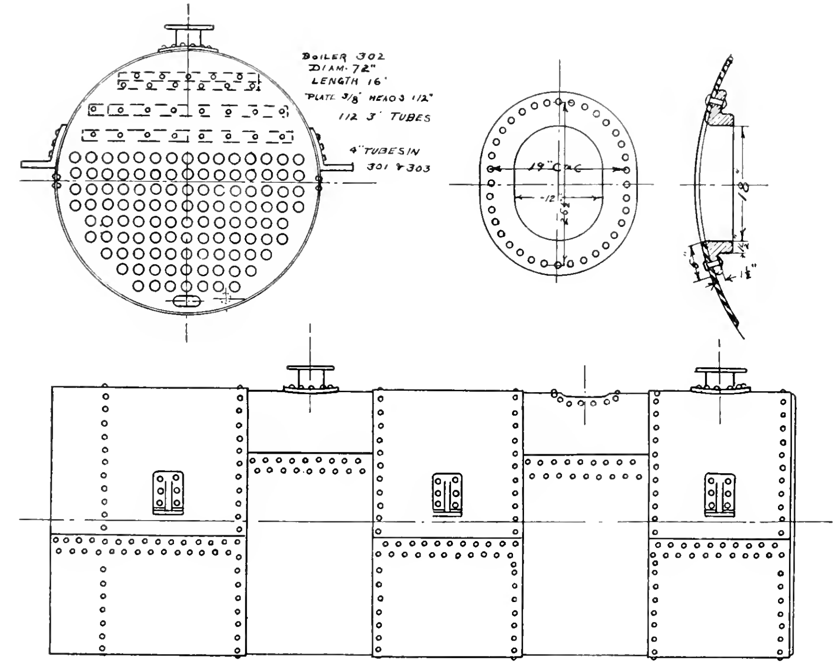


FIG. 1. DETAILS OF BOILERS 301, 302, AND 303.

The report of the HARTFORD'S inspector shows that these boilers, aside from age were in apparent good order. There was evidence that no rivets had been replaced, and that the seams had never been chipped and caulked. No fire cracks were visible, and although there was a slight indication of overheating on the bottom sheets of the rear courses, this was considered trivial. The only repairs known to have been made, were several complete renewals of the tubes.

All three boilers appear to have been made by Kendall and Roberts of Boston, No. 302 about 1877, and the other two about 1879. The steel plates in No. 302 were branded "Bay State Homo," while those of No. 301 and No. 303 bore the brand "Nashua Iron and Steel Co., Nashua, N. H." "Cast Steel 60,000 lbs.," and an encircled Indian's head. Mr. Gow in his report of the tests published in "Power" gives it as his opinion that these were among the first boilers to be made in this country of Siemens open hearth steel.

Boiler No. 302 was tested June 6, 1911. Pressure was applied gradually, and at 275 lbs., the manhole frame failed, tearing the adjacent sheet as shown in Fig. 2. A steel tape stretched around the boiler girthwise, showed a stretch of 3/16 inch in circumference just before the rupture, but on the release of the pressure, no permanent set was found, showing that the elastic limit of the plate had not been reached.

Boiler No. 303 was tested the following day, and in order to find if possible other sources of weakness, the manhole frame was removed, and the open-

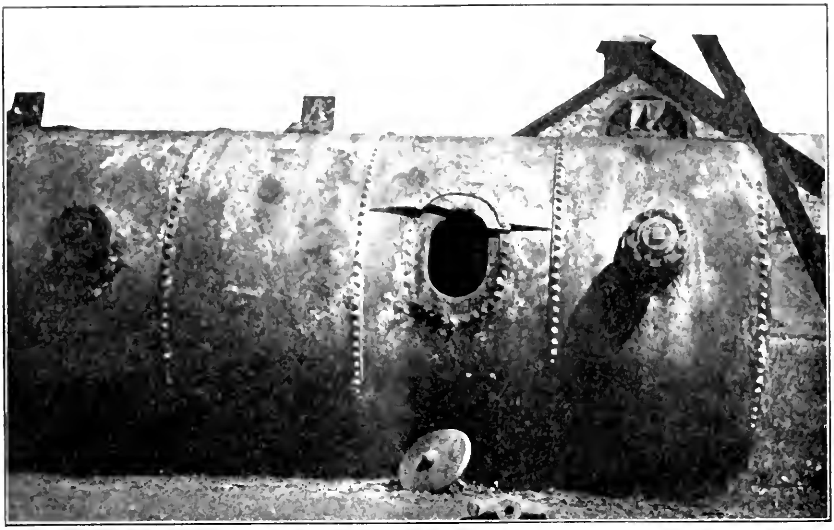


Fig. 2. Showing the Broken Manhole Frame of Boiler 302.

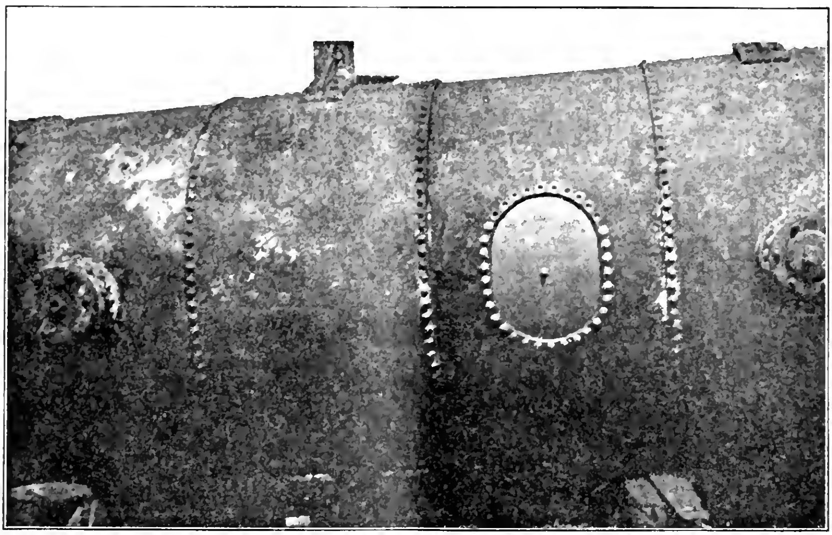


Fig. 3. Appearance of Boiler 303 After Testing.

ing patched with a 5/8 inch plate. This was secured to the shell with 3/4 inch tap bolts tapped into the patch, and passing through the holes where the manhole frame had been riveted to the shell plate. Pressure was gradually applied as with the other boiler, and at 207 lbs., the limit of the hand pump used was reached, so that the pressure had to be released, and another source of pressure connected. No permanent set was recorded up to this point. When the pressure was resumed and carried up to the 300 mark, the leakage was so general that the pump had to be stopped to enable a patch bolt to be caulked, and several plugs to be tightened. Pressure was applied for the third time, and at 300 lbs., 13 patch bolts sheared, the beading at the tube ends started, the tube sheets showed distress, and a permanent set of about 1/16 inch in the circumference of the boiler was recorded. After the release of pressure, the patch was found to overlap the bolt holes about ½ inch. Its appearance after the test is shown in Fig. 3.

Boiler No. 301 was tested in its original condition, and failed through the manhole frame at a pressure of 260 lbs. A set of ⅛ inch in the circumference was noted, along with evidences of distress in the longitudinal seams.

Test specimens were cut from these boilers, at points exposed to the action of the fire, and also on the top. These were tested for strength and elongation, and also submitted to a chemical analysis, the results of which are shown in Table I.

TABLE I.

	Boiler No. 302.		Boiler No. 303.		Boiler No. 301.	
	Over fire.*	On top.	Over fire.	On top.	Over fire.	On top.
Tensile strength.	60,460 lbs.	70,145 lbs.	60,186 lbs.	56,400 lbs.	60,780 lbs.	61,680 lbs.
Elongation......	22.5%	20.12%	21.5 %	27.25%	26.5 %	19.75%
Reduction in area	53.7%	47.05%	54.52%	64.88%	61.62%	50.80%
Elastic limit....	36,690 lbs.	39,060 lbs.	38,280 lbs.	37,230 lbs.	33,100 lbs.	38,820 lbs.

CHEMICAL PROPERTIES.

Carbon.........	0.13 %	......	0.17 %	0.25 %	0.13 %	0.18 %
Sulphur.........	0.026%	......	0.023%	0.121%	0.022%	0.022%
Manganese.....	0.27 %	......	0.29 %	0.37 %	0.20 %	0.28 %
Phosphorus.....	0.097%	......	0.097%	0.092%	0.105%	0.085%

* Bent cold to 180° without fracture.

These boilers had been designed for a pressure of 100 lbs., but owing to the low factor of safety which they would have at this pressure, due to the low efficiency of the longitudinal joints, they had been worked at a pressure of 80 lbs. At this pressure, the actual factor of safety, based on the pressure of 260 lbs. at which the manhole frame of boiler No. 301 failed was only 3.25.

The two old boilers tested at Providence by the Bureau of Standards were of a type very similar to those tested by Mr. Gow. They were also five course horizontal tubular boilers, 72 inches in diameter, by fifteen feet long between tube sheets, with the first course extending 12 inches at the front as a dry

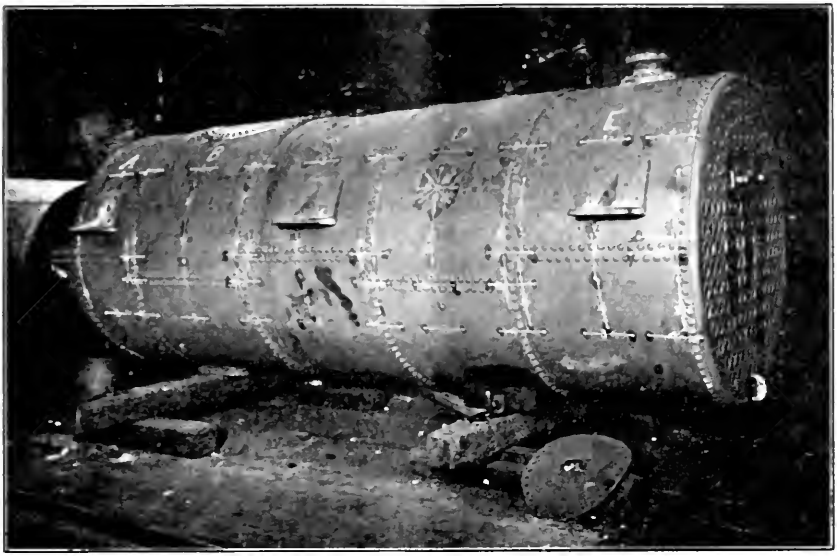


FIG. 4. BOILER 4092 PRIOR TO THE TEST. NOTE THE 10-INCH GAGED LENGTHS.

sheet. Their appearance prior to the test is shown by Fig. 4. The longitudinal joints were double riveted lap seams, ¾ inch rivets, pitched 2 inches, placed in punched holes. The plate thickness was ⅜ inch for the shell, and ½ inch in the heads. Both boilers contained 140 three inch tubes. Domes 2 feet 6 inches in diameter were provided on the second course, and cast iron man-hole frames and safety valve nozzles were fitted to the middle and rear courses, respectively. Both boilers were made at the shops of the Whittier Machine Co., Boston, Mass., in 1881, of "Benzon" steel. They were known as No. 4084 and No. 4092 on the HARTFORD'S records, and were designated by these numbers in the report of the test published in the November 1911 number of the Journal of the American Society of Mechanical Engineers.

In this series of tests especial attention was given to measuring the strains and deformations produced in the boiler sheets as the pressure was increased, because in this way a knowledge of the actual behavior of the boiler could be obtained, and so checked up with the strains which might be expected if the ordinary assumptions underlying calculations of boiler strength are justified. To this end small holes were drilled at different points in pairs, exactly ten inches apart as is shown in Fig 4. These were then reamed out with a conical reamer, so as to serve for centering two corresponding cone shaped points on a micrometer strain gage. This instrument could be applied to a pair of holes, and their exact distance apart compared to that between an exactly similar pair prepared at the ends of a carefully measured length in a standard bar. After a stress was applied to the boiler, the distance between any pair of holes could again be compared with the standard, and the difference between the two sets of readings would be the stretch. It was said that these measurements were known with a certainty of 0.0001 inch, which is about the stretch which we might expect to find in a bar of steel, 1 square inch in cross section and ten inches long, if it were subjected to a pull of 300 lbs. If we take the stress which will produce a given stretch in a piece of material 1 inch long, and divide this pull or stress by the resultant strain, we get a number known as the "Modulus of Elasticity." In the present case, a stretch of 1/10,000 inch in ten inches, would mean an increase of 1/10 of this, or 1/100,000 inch in a length of 1 inch, and if we were to divide the stress, 300 lbs., by this strain in a 1 inch length, 1/100,000, we should obtain the number 30,000,000 which is the modulus of elasticity for steel. (As a matter of fact the modulus must not be thought of as being obtained from these figures, for of course the pull to produce this stretch of 1/10,000 inch in ten inches was estimated from the modulus obtained by averaging a large number of tests, in which the length of the specimen, the pull applied and the resulting increase of length were carefully recorded.) Knowing the modulus then, we are in a position to predict the strain which ought to result from any given pressure applied to the inside of a boiler, and if in testing, the actual strains differ from these, we must look for the cause of the rigidity if the strains are too small, or of the yielding if they are too great, and see if the behavior of the metal can be attributed to any peculiarity in the boiler structure which causes a different distribution of stress from that expected. Having outlined the methods of investigation, we will not endeavor to review all the details of the measurements made, but refer the reader who desires to enter into these more fully to the published report, as we are concerned only with the results.

Boiler No. 4084 was tested first. At a pressure of 266 lbs., leakage along the longitudinal joint of the dome had become so great as to necessitate its removal. The shell was closed with a patch, double riveted, which made use of the same holes as had previously served for fastening the dome. At 270 lbs., the cast iron manhole frame ruptured across the middle of its length and a second patch, closing the opening, was applied in its place. When a pressure of 295 lbs. had been reached, 3-front head braces let go and the test was discontinued. The boiler was subsequently dismantled, in order to permit a detailed examination of its interior to be made. Certain regions of distress were revealed through the disturbance of the scale with which the metal was slightly incrusted. This distress was most evident in the dome, at its longitudinal seam, and also under the points of attachment of the lugs, by which the boiler had been supported during the test, and also when in service. Fig. 5 shows this disturbance under the lugs excellently, and also indicates the slip of the longitudinal joint.

The strain measurements were less comprehensive on this boiler than on No. 4092, and in general were very similar. One feature was noticed however, which was absent in the latter case. The gaged lengths, which spanned the longitudinal joints, and therefore measured their slip, decreased with great uniformity from the front towards the rear, suggesting that even though these seams were not directly exposed to the action of the fire, there was a greater range of temperature strain at the front than at the rear. This result is especially interesting in the light of the experiments, reported below, on a French boiler of considerable age, in which it was clearly shown that the deterioration of the metal was closely correlated to its position with respect to the direct action of the fire.

In the hope of attaining higher pressures, boiler No. 4002 was strengthened prior to the test, by removing the dome and manhole frame, and replacing them with patches. The safety valve nozzle was allowed to remain, but as the test progressed, it was found necessary to replace it with a soft patch, as it was impracticable to caulk the leaks occurring at its junction with the shell. Six 1 1/4 inch through stays were also added to give additional support to the segments of the heads above the tubes.

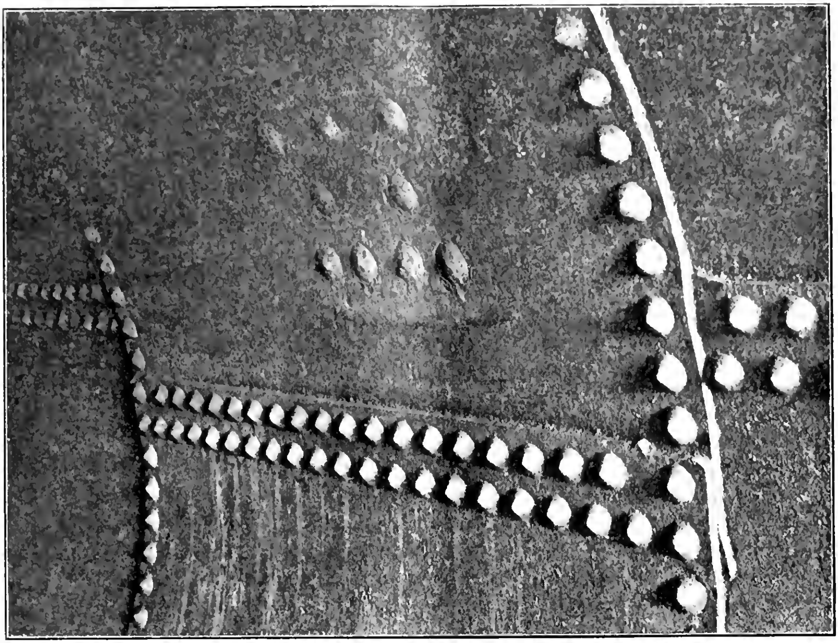


FIG. 5. SHOWING THE EVIDENCE OF DISTRESS UNDER THE LUGS AND AT THE LONGITUDINAL JOINT.

Pressure was raised, and at each increment of pressure, careful measurements of the various gaged lengths were made, in order to compute the strains. At 300 lbs. pressure, the safety valve nozzle had to be replaced, and at 335 lbs., the manhole patch failed, shearing its rivets, and tearing the sheet. A section of the sheet was cut out from girth seam to girth seam, and a double riveted patch inserted in its place. This patch was necessarily hand riveted, and at the time of publication of the results of these tests, higher pressures than 335 lbs., had not been attained due to excessive leakage at this patch.

The results of the strain measurements of which some 3,300 were taken, may be briefly summarized as follows: The well known stiffening effect of girth seams and heads were abundantly confirmed, as was the great weakness of the top center line of the boiler due to the presence of an opening in nearly every course. The double riveted lap joints, were found to give rise to an excessive slip, and the effect of this slip, in producing abnormal stresses in the solid plate abreast the ends of the seam were commented on. It was also evident that since the longitudinal seams in successive courses were only separated by three rivet pitches (6 inches), girthwise, a belt of great tangential weakness existed from end to end of the boiler, and on each side, through these seams.

If a plain cylinder is subjected to an internal pressure, the metal ought to contract in length, to make up for its tangential, or round-a-bout extension. Such a contraction occurred in the metal of the boiler shell, but was not uniform, indeed in the top part of the boiler, there was an actual extension. It is also obvious, that if a plain cylinder, like a boiler tube, is subjected to an external pressure, the tube should extend in length, to make up for the girthwise contraction. In the boiler tested, such an extension of the tubes was found, though it was modified to some extent, by the position of the tube in the shell. Those tubes situated in the center of the nest, were in every case extended more than those near the shell, as if the flanged head exerted a restraining influence. It was pointed out as a matter of fact, that this extension of the tubes, coupled as it was with a contraction lengthwise of the shell, imposed a considerable bending moment on the flanges of the heads.

Let us now, before attempting to form an opinion, or draw conclusions as to the results of these tests, pass on to a consideration of a series of tests of the second sort made with great care, in which samples of the material of some very old boilers of known antecedents were tested both physically and chemically. It is a point worthy of note that in these tests, especial care was taken to keep track of the part of the boiler from which the test specimens were taken in order that any peculiarity due to exposure either to extreme temperature conditions, or to unusual structural stresses might be observed.

These tests, made by Messrs. A. Olry, and P. Bonnet, form the subject of an extended report to the (French) Association of Owners of Steam Apparatus, at the 33d Congress of that society held at Paris in 1909.*

Their attention was called to this subject, by the fact that several more or less discrepant reports as to the effect of age on boiler plate, had been made from time to time, particularly, some tests on the material of very old boilers made by Walther-Meunier, and reported in 1903-1904, to the same Association. He had found some old plate so brittle that he was of the opinion that all boilers should be retired after from 30 to 35 years use, if worked 12 hours a day, and if worked 24 hours, he thought that a lower limit of useful life should be set, say 20-25 years. This raised a storm of protest and discussion among the French engineers. many of whom cited tests to the contrary, and the result was that his work came to be largely discounted because of lack of data as to the original condition of the material.

Olry and Bonnet were interested in this controversy and when they were presented with the opportunity of testing some old boilers whose history was available, they made the investigations which form the basis of the report we are considering.

La Société des Hauts Fourneaux, Forges et Aciéries de Denain et D'Anzin, a French steel works of considerable note, installed during 1873 and 1874, 14 boilers for use at their works. They were made by Schneider et Cie., at

* Comptes Rendus Des Séances Du 33e. Congrès Des Ingénieurs en chef Des Associations De Propriétaires D'Apareils A Vapeur. Tenu a Paris. 1909.

Creusot, and were of the type illustrated in Fig. 6, cylindrical, with internal furnaces and direct tubes, surmounted by a dome. The settings were such that the products of combustion passed first through the tubes, then returned under the right-hand side of the shell to the front, where they passed across, and back to the flue, under the left-hand side of the shell. A longitudinal baffle wall for this purpose was provided under the center line of the boiler as is indicated in Fig. 6. The boilers were designed for a pressure of 71 lbs., but were later tested and worked at 78 lbs. (5.5 kg. per sq. cm.). They had a heating surface of 1270 sq. ft., were oil fired, and forced day and night except Sundays, for more than 30 years. In 1900 the rate of firing, which is typical of the service they rendered throughout their life, was such as to consume about 150 kg. of oil per sq. meter of grate per hour, which is equivalent to 31 lbs. of oil per sq. ft. of grate per hour, a very high rate indeed. The evaporation obtained was about 6 lbs. of water per lb. of fuel. The material of which the boilers were constructed was Creusot wrought iron, designated by the following numbers: body of the boiler, No. 2; heads, lower furnace sheets, and domes, No. 4; upper furnace sheets and front tube sheets, No. 6. The entire battery was overhauled between 1905 and 1907, as the result of a general breaking down from old age, and has since been entirely replaced. This overhauling however gave the opportunity for obtaining test specimens, and the data given was obtained at this time.

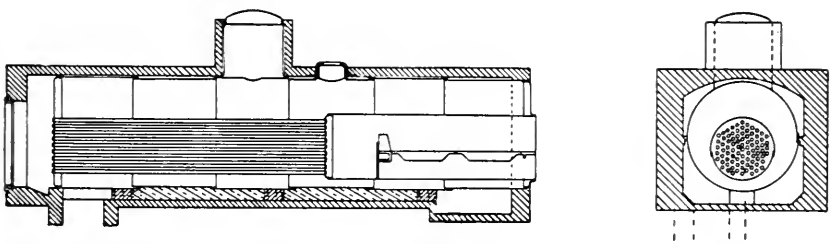


Fig. 6. Boiler Known as S-3.

The iron known as Creusot No. 2, was made to meet the following guarantee:

Tensile strength	47380 lbs. per sq. in. (Minimum.)
Elongation in 4 inches,	6.5%
Reduction in area,	6%

The original thickness of sheet was .55 of an inch.

In January 1905, a crack developed in one of the boilers, known as S-3, in the bottom of the third course, in the fourth girth seam, necessitating the removal of a portion of the sheet. Eight specimens for tensile test of standard (eight inch) size, were cut from this sheet and broken with the following average results:

Tensile strength, specimens cut lengthwise,	41700 lbs.
Elongation (4 ins.) " " "	3.1%
Tensile strength, specimens cut girthwise,	39000 lbs.
Elongation (4 ins.) " " "	1.7%

Fourteen specimens of the type and dimensions shown in Fig. 7 were also cut and tested for brittleness by the impact test, in which a ram or hammer, of known weight, is allowed to fall from a known height, striking the specimen fairly on its flat side, at the point of least breadth. As a sort of standard of comparison, by which one can gage the performance of the various specimens under this test, it may be well to state that a similar specimen of good modern boiler steel, ½ in. thick, is required by French standards, to withstand a blow from a ram of 28.7 lbs., falling 13.12 feet (13 kilograms, falling 4 meters). This means an expenditure of 374 foot lbs. of work without starting a fracture. These particular specimens were fractured on the average, by a blow from a 26.4 lb. ram, falling 19.7 inches, or with an expenditure of 43.8 foot lbs.

The deterioration of the material as indicated by these tests was so great, that another group of specimens was cut from the same shell, yielding the following average results:

Tensile strength	(long.)	38400 lbs.
Elongation, (8 in.)	"	2%
" "	(trans.)	Practically nothing.
Impact, complete fracture, 28.7 lbs., falling 19.7 in.		

A chemical analysis showed the following composition:

Carbon,	0.07%
Manganese,	0.05%
Sulphur,	0.046%
Phosphorus,	0.290%

This indicates rather more phosphorus than one would expect in first class boiler iron.

To see if this brittle condition extended to the entire battery, specimens from the same region were cut from three of the other boilers, and the results were so nearly like those given above, that it was not thought necessary to quote them specifically.

Specimens of the Creusot No. 4 iron, for testing were cut from both the front and rear heads of the boiler known as S-4. The original specifications for this iron called for the following properties:

Tensile strength	48800 lbs.
Elongation	14.6%
Reduction in area,	1.3%

The metal as tested from the front head of S-4, gave values for these quantities as indicated below:

Tensile strength	43400 lbs. 40700 " 41300 "
Average	41800 "
Elongation (4 in.)	10% 11% 18%
Average	13%
Reduction in area, average	2.2%

A weight of 37.45 lbs. falling 39.37 inches started a fracture, while modern steel of this thickness would be required to withstand the impact of a like weight falling 13.12 feet, without injury.

The specimens of the same (No. 4) iron from the rear head of boiler S-4, gave the following results:

Tensile strength	44500 lbs. 43400 " 45700 " 46000 "
Average	44900 "
Elongation (4 in.)	17% 13% 11% 10%
Average	12.75%
Reduction in area, average	1.42%

Subjected to the impact test, 3 out of 8 specimens failed under a blow from a ram of 44 lbs., falling 6.6 feet. Chemical analysis of the material showed its composition to be as follows:

Carbon	0.05%
Silicon	0.15%
Manganese, less than	0.10%
Sulphur	0.010%
Phosphorus	0.100%

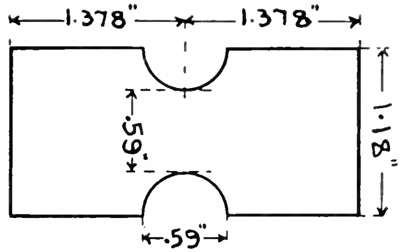


Fig. 7. Impact Test Specimen.

These tests indicate that the No. 4 iron, which was lower in phosphorus than the No. 2, had not deteriorated to so great an extent, although its condition was far from satisfactory. It is rather interesting however, in view of the tests of steel boilers reported later, to see that the front head, which in this case was always at a moderate temperature, since the boiler was internally fired, should have deteriorated more than the rear head, exposed as it was to contact with the hot gases from the tubes.

The authors state that they were unable to report the condition of the No. 6 iron, since, due to the many repairs which had been made to the furnaces from time to time, they were unable to positively locate any of the original iron of this grade.

In the consideration of these results, giving as they did such obvious evidence of impairment, the authors raised the question as to whether the iron might be made to regain some or all of its original ductility by reworking. To this end billets were made by piling up and welding small blooms from the scraps of test pieces of each sort of iron, the billets were rolled into bars, from which new test pieces of the reworked material were cut and tested. The results are tabulated below.

Reworked No. 2 iron.

Tensile strength	53500 lbs.
Elongation	23%
Reduction in area	2.8%

Impact test, 28.66 lb. ram, falling 4.88 feet, started fracture.

Bent cold through 135°.

Reworked No. 4 iron.

Tensile strength	51500 lbs.
Elongation	25%
Reduction in area	2.5%

Impact test, specimens cracked under blows from a 44 lb. ram, falling 12.3 to 13.12 feet.

Cold bend test, bent through 180° without cracks of any sort. These tables show that by reworking, a most astonishing improvement in ductility was produced. The No. 4 iron became a most excellent material, equal to good boiler iron, though somewhat inferior to the best boiler steel, while even the No. 2 iron showed properties sufficiently good for many purposes, though still rather brittle for boiler use.

The steel boiler from which specimens were tested was one of a battery of 22 fire tube boilers, with longitudinal bottom drums made by Carron-Delmotte at Anzin for the sugar refinery of C. Say, in Paris. The specifications called for Siemens-Martin basic steel with tensile strength greater than 51000 lbs. and not over 56000 lbs., elongation in 8 inches, not less than 26% nor more than 40%. The steel was made by Schneider et Cie. at Creusot, and branded "A. S. acier soudable." Acceptance tests of this steel were made by Cornut in 1887. For this work the specimens were heated up to a cherry red before they were broken, and in some cases quenched by plunging them in water. He found as an average value for the tensile strength, 53000 lbs., elongation in 8 inches, 31.6% when reheated simply, and 68000 lbs. and 18.7% respectively when reheated and quenched.

In reporting the results of the tests after the boilers had been in service, the authors classify their specimens in the same manner, that is, those untreated but tested just as they came from the boiler, those reheated to a cherry red, and those reheated to a cherry red and subsequently quenched by plunging them into water maintained at a temperature of 82° Fahr.

In 1908, the first two boilers of this battery were to be removed, and the owners gave the opportunity of testing the quality of the material, as they were anxious to see if the steel had deteriorated to such an extent as to render this removal unadvisable. They accordingly gave the lower or fire sheet of the right hand bottom drum of boiler No. 2 for the purpose. This sheet was cut up and tested through the courtesy of the steel works at Denain, who placed their equipment at the disposal of the authors. Fig. 8 will indicate the manner in which the sheet was divided, and will also serve to show how the specimens were placed with regard to the position of the sheet in the boiler.

These boilers had been in service 24 hours a day during the interval 1888-1908, with the exception of Sundays, and certain intervals for cleaning and inspection. No repairs of any moment were ever made. The records of the owner show that this particular boiler had been in service a total of 134172 hours, consuming 3898.13 metric tons of soft coal, and 13050.7 metric tons of coke. This gives for the average rate of combustion, 42 kilograms per square meter of grate per hour, or in the more familiar English units, 8.6 lbs. per square foot of grate per hour, certainly very moderate service. The averages of the tensile tests, classed in groups as to their location with respect to the fire, and also divided into the three sets mentioned above, depending on the treatment they received after cutting from the sheet, will be found in the following table.

TESTS OF STEEL FROM THE FIRE SHEET OF No. 2 BOILER.

	Untreated Specimens.	Reheated Specimens.	Reheated and Quenched Specimens.
SPECIMENS FROM PORTION OF SHEET PROTECTED BY FRONT WALL.			
Tensile strength................	53,500	53,900	none tested
Elongation......................	25.2%	26.5%	none tested
SPECIMENS FROM ABOVE THE GRATES.			
Tensile strength................	53,500	53,800	70,000
Elongation......................	23.0%	27.1%	20.6%
SPECIMENS FROM OVER BRIDGE WALL.			
Tensile strength................	51,300	52,900	70,700
Elongation......................	24.7%	26.5%	19.7%
SPECIMENS FROM BEHIND BRIDGE WALL.			
Tensile strength................	51,400	51,500	68,700
Elongation......................	24.8%	30.2%	21.2%

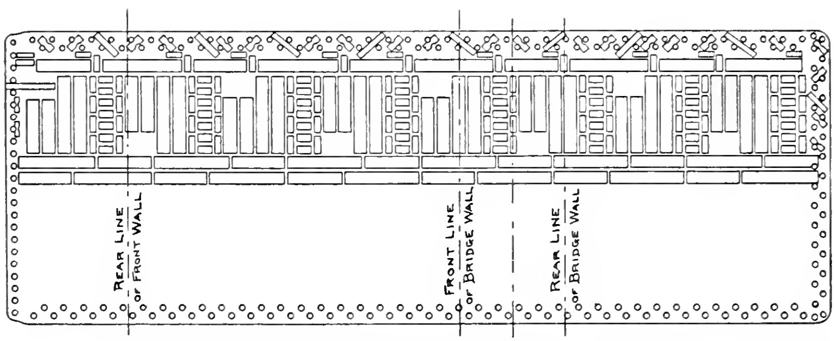


FIG. 8. FIRE SHEET OF C. SAY ET CIE. BOILER No. 2. SHOWING THE LOCATION OF THE SPECIMENS WITH RESPECT TO THE FIRE.

Cold bend test of 38 specimens, fairly satisfactory. The real extent of the change in this boiler steel was not disclosed until the impact tests were made. 162 impact specimens were tested all told, but as 10 of these were in the nature of special tests, to determine the effect of various sorts of abuse on this steel, such for instance as hammering it violently when at a blue heat, they were not included in the averages, or percentages to follow. Out of the 152 tests considered to represent the real condition of the material, there were 122 in which the specimens were untreated. Out of this number, 58 specimens failed to pass the test expected of new steel of this class and thickness (7/16 inch) that is to stand without cracking, the impact of a 22 lb. ram, falling 13.12 feet. It was found however, that none of the reheated specimens, whether quenched or not, failed, or that in other words, although the steel was found to have grown brittle, it could be made to fulfill the conditions of the impact test by heat treatment. If we now calculate the percentage failure, we find that based on the whole number broken, 38.1% failed, but if we consider only the untreated specimens, the percentage is seen to be 47.5%. It is also of interest to see where these specimens were located with respect to the grate, the bridge wall, etc., and to see if there is any connection between the percentage of failures, which must be taken to represent the average brittleness of the material, and the sort of treatment it received as regards temperature and heat transfer. It will be seen from the table given that there is such a connection, that it is identical with the changes in the elongation with exposure to the fire, as shown in the table of tensile tests, and that as we should expect, the metal over the grate suffered most, that over the bridge wall next, the metal located behind the bridge less, and that in the front wall and therefore entirely protected from the direct action of the flames, the least of all.

UNTREATED IMPACT SPECIMENS GROUPED AS TO THEIR LOCATION IN THE FIRE SHEET.

Location.	In Front Wall.	Over Grate.	Over Bridge.	Behind Bridge.
Total number tested	17	45	14	46
No. of Failures	6	26	7	19
No. Intact	11	19	7	27
% Failures	35.5%	57.8%	50%	41.5%

The work of Olry and Bonnet shows pretty conclusively that boiler plate, whether of iron or steel, will deteriorate with use. It is also well known that tubes, tube cap bolts, and other materials used in boiler construction suffer the same sort of depreciation. Such a case was discussed in the July 1912 LOCOMOTIVE, giving the experience of one of our own chief inspectors with tubes and bolts which had become very brittle with use. In all the cases which have come to our attention, the metal which has deteriorated very rapidly has been high in phosphorus. Olry and Bonnet also found that the metal which showed the greatest loss of ductility was the highest in phosphorus, and was least improved by either reworking or annealing. They also showed that iron suffers more than steel, although our experience with brittle tubes indicates that steel if it contains an excessive amount of phosphorus will change very rapidly. Exposure to intense heat is shown to be a factor so that there is some justification for basing the condemnation of a boiler on the kind of service it has given, as well as on its life.

Passing now to the hydrostatic tests first considered, in which five very similar boilers all of which had seen some thirty years of service, were tested after they had been condemned for old age by the HARTFORD, it was found that all of them showed structural weaknesses, especially about the cast iron manhole frames, which gave abundant evidence of the wisdom of their retirement from service. It is interesting in this connection to recall that all three boilers which were permitted to fail at that point (no patches being used) did so at pressures surprisingly close together, namely, 265 lbs., 260 lbs., and 270 lbs. It has been said with some emphasis however in the engineering press, that none of these boilers had suffered any deterioration from age.

It is true that the boilers of the Oliver Iron Mining Co. proved to be made of a material whose properties were still excellent at the time of the test. Tests of the material of the other two boilers are not yet available for discussion. The facts of the case however which seem to need emphasis as showing the real reasons underlying such a retirement as these boilers present. are these. The art of boiler making and designing has progressed materially in say thirty years, and the boilers of that period, if of good material, do not compare especially well as to safety with the product of the present of equal grade. It is also a matter of record that boiler steel undergoes a slow but certain loss in strength and ductility. To be sure these changes are slower for good steel than for iron, but the presence of even a moderate excess of phosphorus hastens the process materially.

Add to this the other equally obvious fact, that such deterioration can be detected by none of the ordinary inspection methods, and that even tensile tests may fail to indicate the extent of the change completely, and it would seem that the justice of the position which makes for old age retirements, was established beyond controversy.

Instructions for Placing Heating Boilers in Commission.

We have gathered together a few simple hints and instructions for putting a heating system in commission which may prove of value. No originality is claimed for them but it is hoped that they may assist some who have not learned through experience what method of procedure is best fitted to accomplish the desired end.

1. Clean the boiler thoroughly on the fire side if it has not been done when laying up in the spring. Remove all rust and soot. This is particularly important in the case of cast iron sectional heaters as rust and corrosion will form between the sections, accumulating moisture in the summer season, and if not removed will eventually swell sufficiently with moisture to fracture the sections. If this cleaning is neglected too long, it may become necessary to dismantle the boiler in order to remove the deposit. Remove all dry or moist ashes from the corners of the grate and ash pits. If this discloses rust, strike the iron a few smart blows with a light hammer and see if it shells off. If the corrosion proves to be extensive, steps to repair the damage should be taken at once. Any rust spots found on the outside of the boiler, including the heating surface, should be carefully cleaned and painted with a mixture of red lead and boiled linseed oil to stop the spread of the corrosion. For this external cleaning a wire brush will be found of service.

2. Clean thoroughly the inside of the boiler. Remove all rust, scale and sediment. If the boiler is of such a form as to prevent ready access to its interior, wash it out as well as possible with a hose, using a good pressure if available. Then empty the boiler, introduce a few gallons of kerosene oil and fill with water very slowly, letting the oil float up on the surface of the water and so reach all portions of the interior surface. Introduce a few pounds of *dissolved* carbonate of soda (soda ash) with the water used for filling. When the boiler has been completely filled in this way, let the water run out until it stands at the ordinary steaming level, close the blow off, and build a slow fire under the boiler. This fire should be kept up for several days, never letting the pressure rise higher than a few ounces. This will loosen and throw down the scale and sediment, so that on cooling off, the boiler may be washed out practically clean with a hose. *It is especially important that the boiler be washed out after this treatment, and before it is put into service, as the loosened scale and mud, if allowed to gather on the heating surface of the boiler, will inevitably cause over heating, and perhaps failure of the metal.*

3. Look over all the boiler attachments. Wash out the water column and its connections, taking it down if necessary to make sure that it is free from rust and mud and that its connections with the boiler and the glass water gage are free. If the water column is not provided with a drip cock, so that it may be drained from time to time, allowing steam and water to blow through its connections to free them, and incidentally to prove that they are free, one should be installed. Look over the glass water gage. See that the rubber grommets or rings with which a tight joint is secured between the glass and its supporting fixtures are "alive." If the rubber is hard and brittle it should be renewed. (See the article on Gage Glasses, in the January, 1912, Locomotive.) See that the gage cocks are clean and tight. Be sure their opening to the boiler is not clogged. (Blow through them.) Overhaul the safety valve, see that it is clean and free from rust or dirt. All pipes leading to or from the boiler, such as the steam supply, drip return, blow off and feed pipes should be tested to make sure that they are clear. All stop or check valves in these pipes should operate freely and shut off tightly, without leaking at the stems. Any defects in these important fittings should be remedied before raising steam. The steam gage connection should be known to be free and clear.

4. Extend the inspection of pipes, valves and fittings to include the entire heating system. After pressure is raised for the first time, visit each radiator or coil, and make sure that its air cock is operating properly. It should be clean, and should promptly free the raditaor of air, but should not permit steam and hot water to drip. This will insure against dead radiators.

5. Look over the run of the piping, both steam and return — and this applies equally well to hot water systems — see that there are no pockets in the steam supply line which can fill with water of condensation at night, to be violently expelled in the morning as a slug, forming a water hammer, which may rupture pipe or fittings, or even a radiator section. One should be especially careful to see that there are no such pockets or indeed any piping in the system so exposed as to be liable to freeze solid. This will cause the boiler to build up an excessive pressure and in case the safety valve is too small, or fails to operate, an accident is certain to result. It may be said that this is one of the very common causes for heater failure.

6. When it becomes desirable to shut off communication between the boiler and the rest of the system, close the valve in the return pipe first, then the steam valve may be closed. Upon resuming operations, the steam valve should be opened first, after which the return valve should be opened. This order of procedure will prevent all trouble due to the formation of a partial vacuum in the heating system from the rapid condensation of steam. Since if the return valve is closed first and opened last, the vacuum which is almost certain to be formed cannot suddenly drain the boiler of water.

7. In starting up a new system for the first time, it is important that the condensed water which first comes back to the boilers be thrown away, and any loose scale and core sand coming with it from the pipes, fittings, and radiators washed from the boiler. If this deposit is allowed to remain, the boiler will foam badly, and the heating surface will become coated with the material.

8. The smoke pipe and damper should be cleaned and examined for rust and corrosion. The grates should not be so distorted and burned as not to lie flat, or as to interfere with the proper operation of the dumping or shaking mechanism. If this point is looked to at the beginning of the season much waste may be prevented from fuel dropping through the grates, or being hauled out, when the shaking gear fails to work, in the effort of an unskilled fireman to clean the fires. Doors, both fire, ash pit, and clean out, should be examined to see that they turn freely, and are not warped enough to prevent their closing. A partly opened door may result in impaired draft and combustion, which is always attended by a waste of fuel.

9. In firing up a cold heating boiler, especially a cast-iron section boiler, care should always be taken to build a slow fire, and give the heater a chance to warm up gradually. If this method is neglected, great strains, due to the unequal expansion of the metal, may be brought upon the structure, frequently many times greater than the ordinary working stresses, and cracks are almost sure to appear as the result.

On the Location of the Fusible Plug.

The following extract from an inspection report, and the letter which accompanied it to the home office, from a department manager, are self-explanatory.

"Our recommendation to put in a fusible plug in the No. 2 was carried out, but instead of placing it two inches above the tubes in the rear head, we find it below them in the same head about two inches from the bottom of the shell. This should be changed.

"I enclose copy of report ——— Milling Co., which shows what a man will do with a strong back and a weak head. The engineer remembered that the inspector told him to put the fusible plug two inches above something — he forgot just what — so he put it two inches above the bottom of the boiler."

The Locomotive
of
THE HARTFORD STEAM BOILER
INSPECTION AND INSURANCE CO.

C. C. PERRY, EDITOR.

HARTFORD, OCTOBER, 1912.

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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

The season for starting the heater is at hand, and a word of caution and warning seems opportune to those who own or operate boilers for this purpose. Perhaps no class of steam apparatus receives less care, and yet is more deserving of thoughtful consideration. The general public seems so sure that a heating boiler is freed from all possibility of failure, because it is expected to operate at a low pressure, that it seldom stops to consider whether this immunity is borne out by statistics.

A study of the "explosion list" for 1911, and for the first five months of 1912 yields the summary below, and gives a striking angle from which to view this question. In 1911 there were reported 499 boiler failures, of these 56, or 12.2% were known to be either heating boilers or water heaters. In 1912, during the months from January to May inclusive, our list contains 248 explosions, of which 57, or 23%, are known to have been heaters. Taking January 1912, the mid-winter month, as representing the heating season at its height, we find 38 heater failures out of a total of 90, or over 42%! In this one month of January there were reported property losses amounting to $27,000 and injuries to six persons. What the total property loss would be, if we were able to evaluate such expressions as "the property was almost entirely destroyed," or "damages were estimated at several thousand dollars" is of course a matter of conjecture. Granting however that all the really large losses are given in the press accounts from which our list is of necessity very largely compiled, we would still expect a loss of say $250 to result on the average from each of the failures listed. On this basis, taking all the accidents for which no estimate of damage is given at $250, we get as a grand total $37,250 which may be accepted as a rough estimate of the damages resulting from the heating boiler casualties alone in this month. We are sure that these figures form sufficient evidence to enable any property owner to decide for himself whether he can afford not to place his heating plant under the skilled inspection service of an INSPECTION and INSURANCE Company.

Attention is directed to the instructions printed on another page of this issue which are intended to serve as a guide in placing a heating system in first-class order at the beginning of the season. As this important duty is often left to janitors and others whose knowledge of boilers and their appurtenances is somewhat limited it has seemed wise to enter into a considerable degree of detail. We believe however that these hints are worthy of the consideration of any one who has this work to perform.

We note with some surprise, in the July issue of a contemporary, published by a manufacturer of engineers' supplies, of excellent reputation, that one of our articles has been reprinted, without the slighest acknowledgment to the Locomotive, and used to exploit the wares of another concern.

We refer to the article on Gauge Glasses, from the January, 1912, Locomotive, by the Secretary of the Company, Mr. Charles S. Blake, which is printed with a paragraph added to call attention to the virtues of a particular brand of this important boiler accessory.

We are not opposed to the reprinting of Locomotive articles, but we must insist that proper credit be given for them, as they are protected by copyright, and we particularly dislike to have them appropriated without credit to exploit any particular article or brand of goods, as it is a well known fact that the Hartford does not, and indeed has never assumed to advertise any article of manufacture. It is the fixed policy of the Company never to favor the product of one firm over that of their competitors.

In the July issue we abstracted the finding of Chief Inspector Ensign concerning the probable cause of the exceedingly disastrous locomotive boiler failure which occurred last April in the Southern Pacific yards at San Antonio, Texas. It is of some interest in this connection, to note the recommendations now made to their locomotive boiler inspectors by the Inter-State Commerce Commission, which come as a direct outcome of this report. These instructions, for which we are indebted to the Locomotive Firemen and Enginemen's Magazine, follow.

"The latest instructions from the office of the General Boiler Inspector with regard to the setting of safety valves, as referred to in paragraph 35, page 9 of the Order of the Commission, are that two steam gages must be employed during the time that the safety valves are being set. One of these gages to be visible to the man adjusting the safety valves. Both gages must be tested and must correspond. The safety valves, however, must be set to the correct pressure to be carried as indicated by the gage permanently employed on the boiler. The second or temporary gage — that is the one visible to the man setting the safety valves — is simply to be used as a check or guard against over pressure in case the man in the cab, whose duty it is to inform the man on the boiler of the pressure indicated by the safety valves, should have his attention momentarily distracted from his duties. It will also be necessary hereafter although not so stated in the Order of the Commission, to see that the siphon pipe connected to the steam gage, together with the cock leading to the boiler and the shut off cock, are fully open, and that the pressure is not in any way obstructed by short kinks in the pipe, or partial stoppage of the cock or cocks. And where two cocks are used, the handles must both point in the same direction when the cocks are open or closed, preferably in line with the pipe when open, and across the pipe when closed."

Book Review.

PERKINS' TABLES. A few ready tables for the Calculation of the Safe Working Pressure on Boilers. Compiled by Lyman B. Perkins. 360 pages, printed on thin paper, with flexible leather binding, *published by the author at 38 Huntington St., Hartford, Conn. Price $5.00.*

This book consists of a most comprehensive set of tables for the assistance of those who have to calculate the various elements of boiler strength, such as the strength of seams, head bracing, stay bolting, the bursting pressure of drums, or the collapsing pressure of furnaces or flues. The tables are computed to include various values for the strength of plate and rivets, and are extended to cover the special forms of calculation made necessary by the Massachusetts, Ohio, and Detroit legislation. Their precision is of a high order. This work should prove of especial value to designers and inspectors, as much laborious computation may be saved by the use of the tables, and a thorough familiarity with the best method of utilizing the information they contain. The author, a graduate of the United States Naval Academy, has been connected with THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY for many years, and is particularly fitted to cope with the tremendous labor of calculation which such a work involves.

Boiler Explosions.

JUNE, 1912.

(249.)— The boiler at the saw mill of D. O. Pomeroy, near Creedmore, N. C., exploded June 1. The owner and two workmen were instantly killed, and one other fatally injured.

(250.)— On June 3, a cast iron header fractured in a water tube boiler at the Baltimore Hotel, operated by the Dean Hotel Co., Kansas City, Mo.

(251.)— An accident occurred to a boiler at the plant of the Akron Laundry Co., Akron, Ohio, on June 3.

(252.)— A tube ruptured June 3, at the National Plant of the American Sheet and Tin Plate Co., Monessen, Pa.

(253.)— A small portable boiler, used on construction work, by the International Contracting Co., exploded June 5, at Portland, Ore. Burt Webb, engineer, was seriously injured.

(254.)— On June 6, a boiler ruptured at Central Power Plant "A," of the Iola Portland Cement Co., Iola, Kans.

(255.)— The fur factory of Whitman and Krahn, at 406 Manhattan Ave., Brooklyn, N. Y., was destroyed by fire June 7, following the explosion of a boiler in the basement. Six men were seriously injured, and the property damage was estimated at $20,000.

(256.)—A number of cast iron headers ruptured June 9, in a water tube boiler at the plant of the Semet Solvay Co., Holt, Ala.

(257.)—The boiler of a traction engine, used in road construction, exploded June 10, in the town of Nasewaupee, Wis. Four men were injured, none fatally.

(258.)—A boiler exploded June 12, at the Gardiner Noble station in the Vinton oil field, near Lake Charles, La. No one was injured.

(259.)—A boiler at the plant of the Alexander Shingle Co., Elaine, Ark., exploded June 13. Chas. Carrier and William Jones were killed. J. N. Moore was seriously injured.

(260.)—A tube ruptured June 14, in a water tube boiler at the plant of the Tri-State Railway and Electric Co., East Liverpool, Ohio.

(261.)—On June 14, the boiler of a portable saw mill exploded at Ganado, Tex. John Schwartz was instantly killed, and C. F. Schneider, the owner, was badly scalded.

(262.)—A boiler burst June 14, at the Lautz Brothers' soap factory, Buffalo, N. Y. Two men were injured.

(263.)—On June 16, an accident occurred at the plant of the Inland Steel Co., Hibbing, Minn.

(264.)—A steam shovel boiler exploded June 17, on the Catskill Aqueduct Contract of the R. K. Everett Co. Edward Depew, fireman, was killed and Philip Grady, engineer, was seriously injured.

(265.)—On June 18, a blow-off pipe failed on a dredge belonging to the J. S. Packard Dredging Co., at Cuttyhunk, Mass. Michael Corcoran and Andrew Palo were injured.

(266.)—The boiler at a stone crushing plant near Bay Springs, Miss., exploded June 19, killing one man and seriously injuring five others.

(267.)—An accident occurred to the boiler at the plant of the Berger, Crittenden Milling Co., Milwaukee, Wis. Considerable damage was done to the boiler.

(268.)—On June 26, the boiler of Southern Pacific Locomotive No. 838 exploded near Hondo, Tex. E. F. Beaumont, engineer, was killed, and C. F. Connelly, fireman, was perhaps fatally injured.

(269.)—Three cast-iron headers failed June 27, in the Lower Union Mills of the Carnegie Steel Co., Pittsburgh, Pa.

(270.)—On June 28, the boiler of a locomotive exploded at Saltillo, Mexico. Sixteen persons were killed, and many injured.

(271.)—A tube ruptured June 29, in a water tube boiler, at the Bridgeport, Conn. plant of the United Illuminating Co.

(272.)—The boiler at the saw mill of the J. I. Monk Lumber Co., Headland, Ala., exploded June 29. No one was injured.

July, 1912.

(273.)—On July 1st, a blow-pipe failed at the "Champion Apartments," Atlantic City, N. J. Benjamin Fowden, night engineer, was injured.

(274.)—Several cast-iron headers failed July 2, in a water tube boiler at the works of the American Steel and Wire Co., Joliet, Ill.

(275.)—A tube in a water tube boiler ruptured July 4, in the plant of the B. F. Goodrich Co., Akron, O. J. D. Tkos, fireman, was injured.

(276.)—On July 6, a large fly-wheel burst, causing the failure of a small boiler, at the plant of the National Sulphur Works, Williamsburg, Brooklyn, N. Y. Fifteen men were injured, three fatally, by sulphur fumes in the fire which followed.

(277.)—A tube ruptured July 6, in a water tube boiler, at the Iowa State Hospital for the Insane, Cherokee, Ia.

(278.)—A boiler burst July 6, at the Ice, Light, and Water Plant of the Italy Water Co., Italy, Texas.

(279.)—On July 6, the boiler of a threshing machine exploded on the farm of the Misses Ward, near Little Creek, Del. William Boyd, Samuel Leat, and Elmer Harris were injured. Leat and Harris, if they recover, will be blind.

(280.)—A condemned boiler exploded July 7, at the Visalia Creamery, Visalia, Cal. Clyde Lisman was seriously, and perhaps fatally scalded.

(281.)—A boiler exploded July 8, at the plant of the Atlantic Ice and Coal Corp'n, Atlanta, Ga.

(282.)—A boiler in the Columbian Hotel exploded July 9, during the progress of a fire which swept Thousand Island Park, Alexandria Bay, N. Y.

(283.)—A tube ruptured July 9, in a water tube boiler at the Brunots Island power house of the Pittsburgh Railway Co., Pittsburgh, Pa. James McGreevy, boiler foreman, was injured.

(284.)—On July 10, a tube ruptured in a water tube boiler, at the plant of the C. A. Smith Lumber Co., Bay Point, Cal.

(285.)—On July 10, the boiler of Chicago and Alton locomotive No. 21 exploded near Normal, Ill. Joseph Orr was fatally injured, and several of the train crew received minor injuries.

(286.)—A tube ruptured July 11, in a water tube boiler at the 20th St. power house of the Pittsburgh Railways Co., Pittsburgh, Pa. Frank Weiher, William Reed, and John Enright, repairmen, were scalded. The damage to the boiler was small.

(287.)—A tube in a water tube boiler burst July 12, at the plant of the Philip Carey M'f'g Co., Lockland, O. Considerable damage was done to the boiler. Carey Spellman and Edwin Terell, firemen, were injured, the latter fatally.

(288.)—On July 12, the crown sheet of a locomotive collapsed at the State Phosphate Works of Swift and Co., Agricola, Fla. J. A. Oglesbee, engineer, was injured.

(289.)—A blow-off pipe failed July 13, at the plant of the Mariana Ice and Cold Storage Co., Mariana, Ark.

(290.)—A tube ruptured July 15, in a water tube boiler at the plant of the Columbia Chemical Co., Barberton, O.

(291.)—A steam pipe burst on a steam shovel, at the Potrero Gas Plant, San Francisco, Cal., on July 16. John Logue was fatally scalded, and John Vanni seriously burned.

(292.)—A saw mill boiler exploded July 17, at the mill of A. Foster, Waldo, Ark. Sid. Jackson, engineer, was killed.

(293.)—On July 18, a boiler exploded at the plant of the Peoria Stone and Marble Co., Peoria, Ill. John Molek and John Ruge were fatally scalded.

(294.)—A threshing machine boiler exploded July 18, at the Moon farm, near Culver, Kans. Arthur Atkinson, the owner of the machine was fatally injured.

(295.)—A tube burst July 18, in a water tube boiler, at the plant of Armour & Co., Sioux City, Ia. E. Lindgren, machinist, was injured.

(296.)—The boiler of locomotive No. 549, of the St. Louis, Brownsville, and Mexico Railroad, exploded July 20, near Bay City, Tex. Alfred E. Shiver, conductor, Daniel Fisher, engineer, and W. V. Shaw, fireman, were killed.

(297.)—A boiler ruptured July 22, at the plant of the Mississippi Glass Co., St. Louis, Mo.

(298.)—A hot water tank burst July 22, at the plant of the Union Gas and Electric Co., Cincinnati, O. James B. Hemphill, engineer, was fatally scalded.

(299.)—A fertilizer tank exploded July 23, at the plant of the Schmadel Packing Co., Evansville, Ind.

(300.)—The boiler at Daniel Bousman's rock crusher exploded July 23, at Rosedale, Mo. Frank Long was fatally injured, and James Clark very seriously injured.

(301.)—A boiler burst July 25, at the plant of the Maxinkuckee Lake Ice Co., South Bend, Ind.

(302.)—A boiler burst July 27, near Sharpsburg, Ky. Thompson Crockett was killed, Hal. Thompson fatally injured, and a negro helper seriously injured.

(303.)—On July 28, an accident occurred to the boiler of the Consumer's Ice M'f'g Co., Chester, Pa.

(304.)—The boiler of a peanut roaster exploded July 29, in Sigourny, Ia., almost instantly killing Chauncey Meyers, as he was entering an automobile.

(305.)—On July 29, a boiler ruptured at the plant of the Hays City Electric Light Co., Hays City, Kans.

(306.)—The boiler of the David Wiener saw mill, Joliet, Ill., exploded July 31. Thomas Carr, engineer, was almost instantly killed. The property damage was estimated at $15,000.

(307.)—A tube exploded July 31, at the plant of the Westinghouse Air Brake Co., Wilmerding, Pa. Mike Schmitt, water tender, was injured and died some six hours after the accident.

(308.)—On July 31, a number of cast-iron headers ruptured in a water tube boiler, at the plant of the Semet Solvay Co., Eusley, Ala. Considerable damage was done to the boiler.

August, 1912.

(309.)—On August 1st, a blowoff pipe failed at the plant of the Eldorado Electric and Refrigerating Co., Eldorado, Kans.

(310.)—On August 2, a cast-iron mud drum exploded at the power house of the Light and Traction Co., Fort Smith, Ark. The city was in darkness for two hours as the result of the accident, and a property loss of $4,000 is reported.

(311.)—A tube ruptured August 3, in a water tube boiler, at the plant of the New Orleans Railway and Light Co., New Orleans, La.

(312.)—On August 4, an accident occurred to the boiler of the American Coal Co., McComas, Allegheny. Co., W. Va.

(313.)—A steam pipe burst August 4, at the mill of the Menasha Paper Co., Ladysmith, Wis. S. McDonald and J. Olsen, firemen, were fatally scalded.

(314.)—On August 7, one of the flues of a dryer collapsed at the plant of Armour & Co., St. Joseph, Mo.

(315.)—A tube ruptured August 7, in a water tube boiler at the plant of the Lincoln Trust Co., Lincoln, Neb. Conrad Benner, fireman, was fatally injured.

(316.)—On August 9, a tube failed in a water tube boiler, at the Riverside Steam Laundry, Great Bend, Kans.

(317.)—An accident occurred to a water tube boiler at the Columbus Brewery, Columbus, Neb., on August 9.

(318.)—A tube failed August 12, in a water tube boiler at the Columbia Chemical Co.'s plant, Barberton, O.

(319.)—A threshing machine boiler exploded August 14, at the farm of John Marburger. Fire started in the barn and grain stacks as the result of the explosion, causing property damage estimated at $10,000. Three persons were injured.

(320.)—On August 14, a steam pipe burst at the plant of the Victor Talking Machine Co., Camden, N. J. One man was severely scalded.

(321.)—A boiler exploded August 17, at the ice plant of A. Eller and Sons, Greenville, O.

(322.)—On August 17, five sections of a cast-iron sectional heating boiler failed at the Clarke School for the Deaf, Northampton, Mass.

(323.)—A cast-iron sectional boiler failed August 18, at the "Fensmere" apartment house, owned by William Maynard, Boston, Mass.

(324.)—On August 20, four cast-iron headers failed in a water tube boiler, at Factory No. 2, of the Union Ice Co., Pittsburg, Pa.

(325.)—A steam header fractured August 21, at the power house of the Texas Light and Power Co., Waco, Texas. The accident resulted in the complete interruption of all electric service, light, power, and traction. One man, George Y. Bird, was scalded.

(326.)—An evaporator, for the conversion of salt water into fresh, burst August 21, at Sea Isle City, N. J. One man was slightly injured.

(327.)—A boiler belonging to the Kerbaugh Construction Co., exploded August 22, at Sand Patch, Pa. Four men were injured.

(328.)—A saw mill boiler exploded August 22, on the Provo River, fifteen miles from Kamas, Utah. Two men, W. S. Fuelling and H. G. Wade, were killed, and Mrs. Wade was seriously injured.

(329.)—A tube ruptured August 23, in a water tube boiler at the plant of the Dixie Portland Cement Co., Richard City, Tenn. Ben Jones, fireman, was killed. The property loss was small.

(330.)—A saw mill boiler exploded at the plant of the Pocahontas Consolidated Collieries Co., at the Jenkin Jones' operation on the Tug River, near Pocahontas, Va., on August 24. Four men were killed.

(331.)—A tube fractured in a water tube boiler August 25, at the plant of the Southern Iron and Steel Co., Alabama City, Ala. Joe Turner, fireman, was injured.

(332.)—A threshing machine boiler exploded on the J. J. Bush farm, Veteran, N. Y., August 27, injuring a boy.

(333.)—The boiler of a threshing machine exploded August 27 on the farm of Guy Ford, Witoka, Minn. August Waldo was killed, and Lynn Higgins seriously injured.

(334.)—A tube failed August 27, in a water tube boiler at the plant of the American Steel and Wire Co. of New Jersey, Waukegan, Ill.

(335.)—On August 27, a boiler burst at the plant of the Peoples Light and Ice Co., Ellsworth, Kans.

(336.)—A boiler ruptured August 27, at the flour mill of the Kill Milling Co., Vernon, Tex.

(337.)—The crown sheet of a traction engine boiler collapsed August 30, at Bay City, Tex. Bowie Ryman was seriously scalded.

(338.)—The boiler of a traction engine exploded August 31, on the W. F. Rankin farm, Tarkio, Mo. James Saylor and Fred Taylor were seriously and perhaps fatally injured.

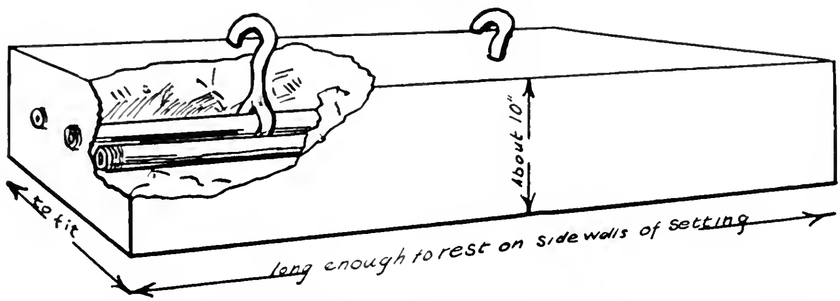

FIG. 1. CONCRETE BACK ARCH, FOR HORIZONTAL TUBULAR BOILER. CORNER BROKEN AWAY TO SHOW PIPE REINFORCEMENT.

A Useful Form of Concrete.

P. H. REPP, Inspector.

Quantities of broken fire brick are often seen about a steam plant, accumulating after repairs until they become a nuisance, when they are removed with the ashes and other refuse. This material may be far more valuable than it seems, for if broken up into pieces about the size of a marble, and mixed with an equal amount of neat portland cement (no sand), it will produce a form of refractory concrete which makes most excellent arches or furnace linings. Sufficient water should be used to thoroughly saturate every particle of the cement.

When it is necessary to renew the brick work over a furnace door, or the rear arch of a horizontal tubular boiler setting, a form of rough boards can be made, into which the concrete mixture may be rammed. If the boiler can be spared long enough for the cement to set properly, the work may be done in place, but in the case of a rear arch, it is a simple matter to cast the block in a form set up on the boiler room floor, and then it may be placed in position when ready, with very little loss of time.

For this purpose, a strong form should be prepared, long enough so that the completed arch will rest with a good bearing on the side walls of the setting. To give strength to the structure some lengths of old 1¼ or 1½ inch pipe should be secured in the form as indicated in Fig. 1, to serve as a reinforcement. Hooks may be forged up from round iron, and fastened in the mold so as to embrace the middle length of pipe, and will be found of service to secure lifting gear, when placing the block in position. Of course such an arch can be made in any shape necessary to meet local conditions, the only requirement being to so place the reinforcing material as to secure adequate strength.

Rear arches of this description have come under the writer's observation at plants in which soft coal is burned, and the boilers driven at a high rate. One in particular is in good condition after six years of such service, in a setting where the old form of brick work had given a great deal of trouble. Another difficult case was that of a brick arch over the furnace doors, in the setting of a horizontal tubular boiler, which seldom lasted as long as six months. Here the concrete was tried as a sort of forlorn hope. A form was arranged so that the work could be done in place, and an expansion joint, in the shape of a vertical space, was left in the center. No trouble with this construction has been experienced, and the concrete has been in place more than a year, with no signs of cracks, or other deterioration.

No particular novelty is claimed for this material, but the writer feels that there are many engineers to whom it is unknown, and who would be glad to avail themselves of it. He is sure that if the work is carefully done, the results will be both durable and reliable.

BOILER EXPLOSION AT SALTILLO, MEXICO. NO. 270 IN JUNE LIST.

On the Value of Skilled Operatives.

The rather picturesque illustration which heads this paragraph, and incidentally furnishes the text for it, represents what was left of locomotive No. 591 of the National Railway of Mexico, after its boiler exploded June 28th at Saltillo, Coahuila, Mexico. The report which reaches us is to the effect that fifteen persons were killed, and much property destroyed. It is also said that the indirect cause of this and four other similar explosions, is to be found in the fact that the skilled American engineers and firemen had been replaced by unskilled and inexperienced Mexicans, and this brings us to the subject upon which we wish to touch.

There are in general, assuming proper design and construction, just two causes for boiler accidents, both of which may really be included under the one head, over pressure. The subdivision into two classes which we have indicated, would be to cover first, over pressure proper, that is a pressure in excess of the ordinary working pressure sufficient to rupture a sound boiler, and second, such a deterioration of the boiler, that the ordinary working pressure becomes in reality an over pressure, resulting in a more or less serious accident. We are well aware that we are stating no novel fact, and will gladly confess our guilt if you insist that this is a mere truism, but we wish to complete the statement with another truism, that such conditions are the result of direct or indirect incompetence in the boiler supervision.

No inspection service, whether by city, state, or insurance company, can prevent an incompetent or careless operative from doing serious damage as the result of perhaps but a few moments' misuse of the apparatus placed in his charge. It is not our intention however to censure the operator himself, but rather the penny-wise policy of steam users and boiler owners, which frequently makes it possible for him to assume a responsibility for which he is in no wise fitted. The moral question of responsibility for the life and property of others need not be brought to bear, as it is easy to show that a purely selfish desire to earn a fair return on the money invested in a steam plant should be incentive enough to induce any steam user to first assure himself of the safe condition of his apparatus through the skilled inspection services offered by a sound Inspection and Insurance Company, and then to secure proper maintenance by hiring competent men at a fair wage, to operate his plant.

Boiler Shell Damaged by the Vibration of a Steam Header.

Geo. H. Ward, Resident Agent.

Some years ago, the writer, then an inspector in the Boston Department, examined a boiler in South Gardiner, Mass., which had been removed to make way for one of larger proportions. This boiler had been insured and inspected by a competent inspector, and the report of its condition had always been good. It is the custom of the Hartford to class such boilers as second hand, and as the owners had a customer in view, this special examination was made.

A thorough internal and external inspection was made, and the boiler was found to be fairly clean, and free from visible defects. As it was of the double riveted lap construction, the hydrostatic test was applied, under which it seemed absolutely tight. In going over the various seams and plates with the inspector's hammer, while under pressure, no evidence of leakage or fractures at the seams was noted. But upon applying the hammer to the plate surrounding the forward nozzle, after a few strokes, a fine spray of water was visible coming through what appeared to be solid plate. This spot was then vigorously attacked, and soon a fine spray fountain was at work. The pressure was then allowed to drop, the boiler emptied and the manhole plate removed, permitting a close examination of this plate from the inside. It was found to be as smooth as the day it was rolled, but by drying it with bunches of waste, and using a magnifying glass, it was noted that the entire plate for a distance of about eight inches around the nozzle had been fatigued, the fiber of the metal had been broken off and the plate was full of fine, irregular hair cracks. The inspector condemned the boiler. An investigation was then made to determine the cause for this cracking of the shell.

It was found that the boiler had stood in a battery, and that it had been connected to the header, which was some twelve feet above the nozzle, by a riser. While the writer was present, this line with a similar riser from a boiler standing adjacent to the former position of the one tested, was vibrating considerably. The cracking of the plate was therefore attributed to the effect of this vibration, transmitted to the shell by the riser, which was long enough to secure a good leverage, and hence cause a considerable movement of the shell at each swing of the header.

The above failure is a striking illustration of the serious consequences which may attend an improper or poorly chosen pipe layout. Such vibrations are well known to result more often from the intermittent demand for steam of a high speed engine, than from the purely mechanical shaking of unbalanced machinery. The cure for such a condition is usually to be found in a separator or other form of reservoir, placed between the header and the engine, of sufficient size to equalize these pulsations in the steam flow, and incidentally, it may be said that separators are cheaper than boilers.

EDITOR.

Steam Engineering About Sixty Years Ago.

B. FORD, Chief Inspector.

In thinking over my experience as a steam engineer for the past sixty years, I recall my experience in operating two cylinder boilers — 38″ in diameter and 24′ long — that had none of the modern appliances for safety or convenience. They were fitted only with a lever safety valve, no steam gauge. The end of the lever was handled with a rod, and to determine the rise and fall of the steam pressure, you pushed up on the lever. The amount of force used to lift the valve was the only way to determine the pressure. There was no mud valve. In the front plate over the grates, on the bottom, an inch hole was drilled and fitted with a tapered plug, driven from the inside and extending through the plate generally about an inch. To empty the boiler for cleaning, you used the heavy fire poker and knocked the plug back into the boiler. Some care had to be taken in using the poker to work the fires, as on several occasions the plug was knocked out, the boiler emptied of water, and the works stopped. The steam outlet was at the front head, and the water supply connection was also in the front head, through an equalizing pipe connected to both boilers.

When we consider the old style of equipment as compared with the present with its steam gauges, pop safety valves, mud valves, and glass water gauges, these additional fittings should encourage us to look for greater safety in the operation of steam boilers, and engineers of steam boilers should be proud of being trusted with the responsible position of having charge of a boiler plant.

But I would say, boys, with all these new appliances for your guidance, don't forget to push in your gauge cocks and notice what comes out — water or steam.

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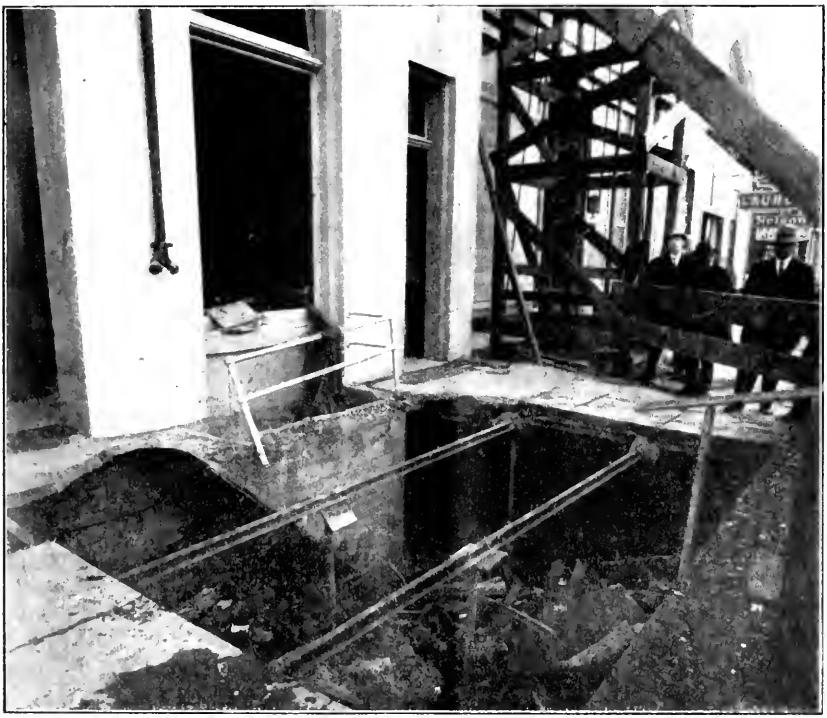


Heating Boiler Wreck.

Protection of Water Gauge Glasses

ALEX M. GOW.*

Under date of June 2, 1911 the Interstate Commerce Commission issued a set of rules and instructions relative to inspection and testing of locomotive boilers and their appurtenances. Rule No. 41 reads as follows:

> "All tubular water glasses and lubricator glasses must be equipped with a safe and suitable shield which shall prevent the glass from flying in case of breakage, and such shield must be properly maintained."

While the jurisdiction of the Interstate Commerce Commission in such matters extends only to locomotives operated by common carriers, nevertheless the precaution prescribed should be adopted by all users of all boilers whether they are upon locomotives engaged in interstate commerce or stationary boilers in power plants.

Glass tubes, when subjected to internal steam pressure on water gauges or lubricators will break. If the flying pieces of glass enter a man's eye the results are liable to be serious. That such glasses should be guarded, goes without saying. A general presentation of the question would appear, then, to be in order.

One of the causes that has been assigned for the breaking of glasses is "the inherent malevolence of inanimate objects." Against this cause all that can be done is to buy the best grade of glasses; the best being those that have the least "inherent malevolence." That there is a wide difference in the propensity to break of different makes, every engineer knows. What the best make is, the writer does not know.

Another, and very fruitful cause of breakage is the fact that the upper and lower connections are not true and in line. The result of this lack of alignment is that a sidewise strain is put on the glass where the packing glands are set up. Again, the gland nuts are necessarily set up with a wrench and a little too much pull will insure the breakage of a glass. In fact, when the fittings are too hot to touch, and the rubber ring is not a good fit, and the wrench is too big, and a leaky joint overhead is dropping hot water on the back of a man's neck, he is liable to have trouble getting the glass in just right. But if not put in just right, it will break again.

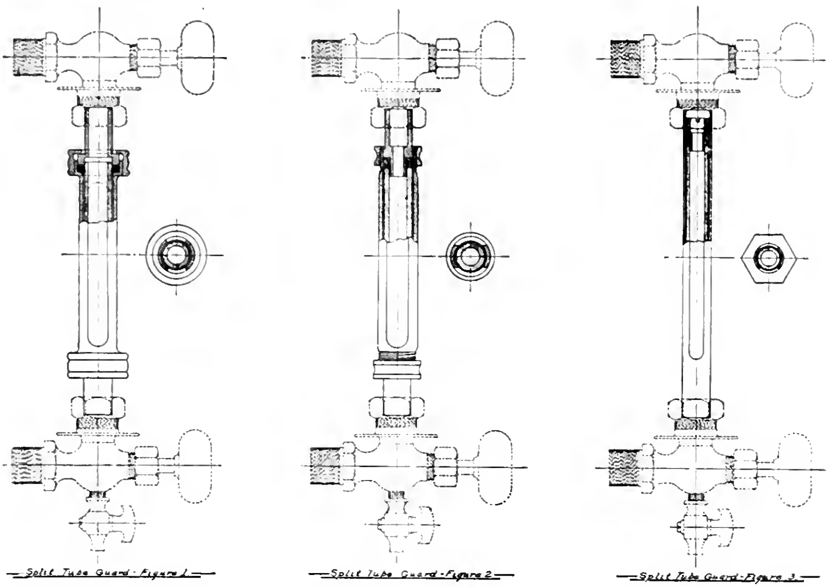
That the glasses have received improper and careless handling is another cause that accounts for many breakages. If the glaze or "fire polish" on the surface of the glass, inside or out, be scratched ever so slightly, the chances are that the glass will break. Speaking of this cause of breakage, Mr. Chas. S. Blake, in the January number of "THE LOCOMOTIVE," says: "All glasses are keenly susceptible to surface abrasions, even so minute as to be unobservable. If one receives the slightest scratch inside or out, it should not be used, and in handling or keeping them in stock, no matal of any nature should be allowed to come in contact with them. They are particularly liable to break if iron or steel touches them, and so should never be laid down even temporarily with tools, as is frequently done in preparation for a renewal.

"The great precaution is to keep the surface from being scratched, for, as every engineer knows, it requires but the slightest breaking of the skin of the glass in a circumferential way to cause it to almost fall apart. The peculiar

* Assistant Chief Engineer, Oliver Iron Mining Co., Duluth Minn.

phenomenon of the glass breaking which has lain next to iron or steel has never been explained to me, but I have a number of times, as an experiment, taken a glass, run a smooth rod of iron through it and put it away. Sooner or later it has been found shattered in many pieces."

The steam and water have a corroding action on the inside of the glass that tends to induce breakage. This action appears to be more active when the glaze or "fire polish" has been disturbed. For this reason it is thought best by some engineers to obtain glasses of exact length with fused ends, rather than to cut a long glass to the proper length, thus leaving a surface subject to the above-mentioned corroding action.

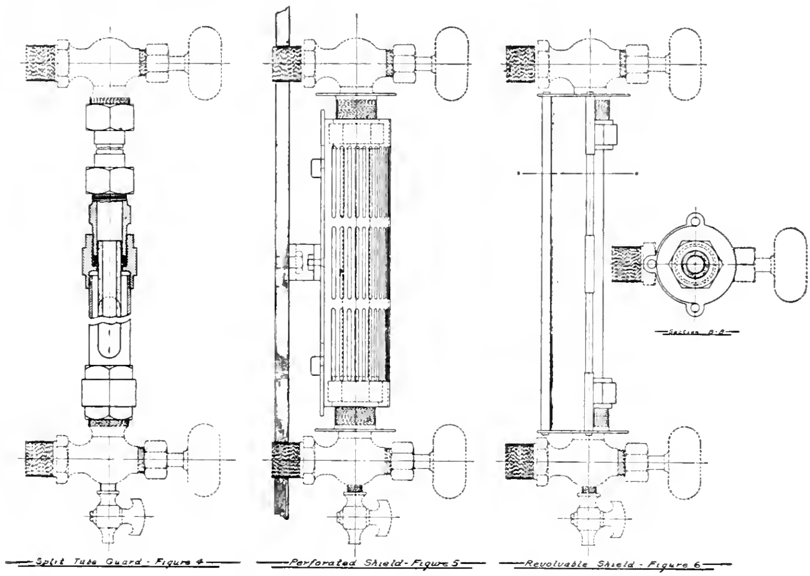


FIGS. 1, 2, AND 3.— SPLIT TUBE GUARDS.

Every engineer knows that he ought to close the top and bottom connections before attempting to tighten the stuffing box nuts. Occasionally a man has neglected this precaution and lost an eye in consequence. Every engineer knows, also, that after a new glass is put in the connections should be opened very slowly, to allow the glass to warm up. This is the time to guard the face and eyes.

For this purpose the shield shown in Figure No. 6 has been recommended, and is used on a great many boilers. It is a revolvable shield and can be brought around between a man's face and the glass when the valves are first opened, or after putting in a new glass. It also serves to protect a man in case any work has to be done on the water column or connections. The shield is made from a piece of light sheet steel and when not in use, is turned out of the way.

A modification of this idea is shown in Figure No. 7. Here the shield is made very large and substantial and runs in guides. When out of use it slides clear to the rear of the water column. It can be pushed into place from the floor of the boiler room by a long stick or any convenient poker. Neither of these shields protect a man from flying glass, except when he is working at the water column and has the shield in place. It is claimed, however, that inasmuch as that is the time when the danger is greatest and when most accidents happen, and furthermore, that the chance of a man on the boiler room floor being hit by a piece of flying glass is very remote, that this type of shield affords ample and sufficient protection.



FIGS. 4, 5, AND 6.— SPLIT TUBE, PERFORATED AND REVOLVABLE GUARDS.

Figure No. 5 shows a plain, perforated, metal guard. This type of guard has appeared in various forms and has the merit of cheapness. If the perforations are made small enough it offers an effectual resistance to flying glass. But most engineers will raise serious objections to the obstruction it offers to seeing where the water level is. And this is certainly a serious objection.

Another type of guard with which every one is familiar is the plain, slotted tube placed over the gauge glass. The objection raised to this type of guard is that if the slot is large enough to clearly show the water, it is also large enough to permit the glass to fly. But there is much to be said in favor of the slotted tube type. If loose on the glass it can be turned as a shield, similarly to the first type mentioned. Ordinarily the slot may be turned in the direction least liable to cause a man to be hit by flying glass, and the amount of glass to fly is certainly reduced.

Four modifications of the slotted tube idea are shown in Figures Nos. 1, 2, 3 and 4. All of these designs incorporate one most excellent feature, that will to a great extent reduce breakages: The gauge glass is inserted in the split tube and the top and bottom packing glands set up tightly, before the tube is inserted into the top and bottom connections. This entirely removes one cause of breakage mentioned above, the lack-of-alignment of the fittings.

In Figures Nos. 1 and 2 the nuts that tighten the glands onto the rubber

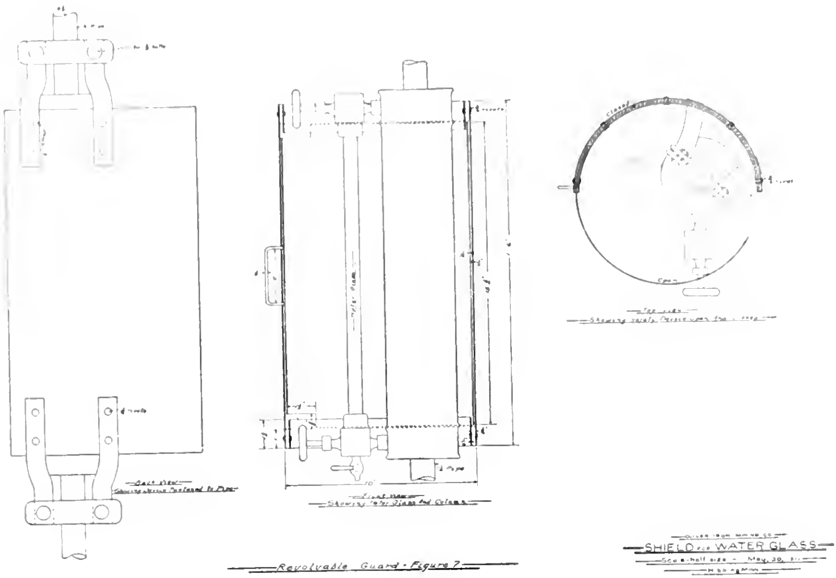


FIG. 7.— REVOLVABLE GUARD.

packing rings are knurled so that they may be screwed up by hand. In making connections to the top and bottom fittings on the water column a wrench can be used with impunity for no strain is put onto the glass by screwing up the packing nuts. The only essential difference in the designs of these two types is that in Figure No. 2 the glass is packed on the end while in Figure No. 1 it is packed in the usual way, on the outside.

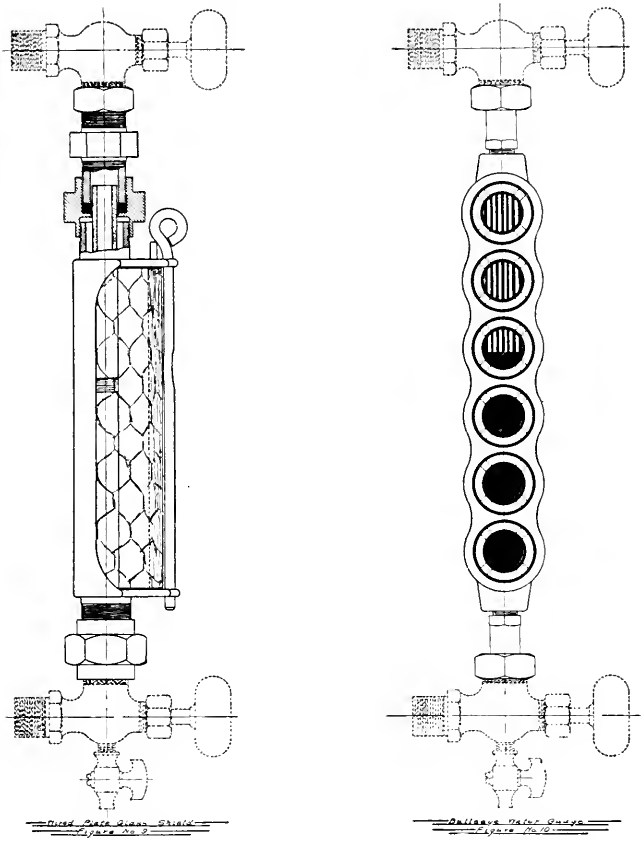
The claim made for the end-packing is that the glass is better protected from corrosion. This argument has little weight if glasses with fused ends are used. Objection can be made to packing on the end on the ground that the glass must be true and square and furthermore owing to the pressure required to make a tight joint, the glass cannot expand.

The writer considers all these objections more theoretical than practical and knows that this type of split tube guard saves a great many breakages. The slots are set parallel to the boiler fronts. The water is plainly visible. In case of breakage a man can go on a ladder to the front of the column with perfect impunity, and, having a spare guard and glass ready, put them in without danger, his face being protected by the uncut portion of the tube. Rarely will it be found necessary to increase the distance between upper and lower fittings to install this guard, as nearly always the glass is considerably longer than is required to cover the maximum variation in water level allowable.

In Figure No. 3 is shown a modified construction wherein the ends of the split tube are threaded on the inside and the packing nuts screwed down onto the glands that bear on the rubber packing ring, with a screw driver. This makes a very neat construction and is quite applicable where connections are short, as on lubricators.

Figure No. 4 shows a construction very generally used upon locomotives.

Another type of guard involves the placing of an auxiliary glass in front



FIGS. 9 AND 10.—WIRED GLASS SHIELD AND BULLSEYE WATER GAUGE.

of the glass tube. This idea has been worked out in various ways. This type of shield is particularly adapted to locomotive type boilers, where a fireman's face is necessarily in proximity to the water gauge.

In Figure No. 8 two heavy pieces of plate glass are set at right angles to each other in a hinged frame that may be thrown open either to replace the gauge glass or for cleaning.

In another form of this type of shield, light brass castings are fitted to the top and bottom connections and three pieces of heavy plate glass carried by these castings form a glass box, surrounding the gauge glass on three sides. The chances of the plate glass breaking would appear very remote, but to remove any doubt upon that score, wire glass has been used.

In Fig. 13 is shown a construction that any machinist can fabricate from a piece of sheet steel. The sheet steel is cut and bent so as to form a frame to hold three pieces of plate glass and the whole arrangement is then secured by the brass rods that are usually furnished with the top and bottom water glass connections. It is evident that this idea could be worked out to suit any particular case and is to be recommended for its simplicity.

Naturally, the use of flat pieces of heavy plate glass led to the use of one piece of heavy glass moulded to a semicircle. One form of this type of shield is shown in Figure No. 9. In this design the glass tube and the cylindrical glass guard are contained in a casting having screwed ends which make onto the top and bottom connections. In another form, light castings are secured to the top and bottom connections and support the cylindrical glass guard in the same way as the pieces of flat plate glass are supported in one of the guards previously described.

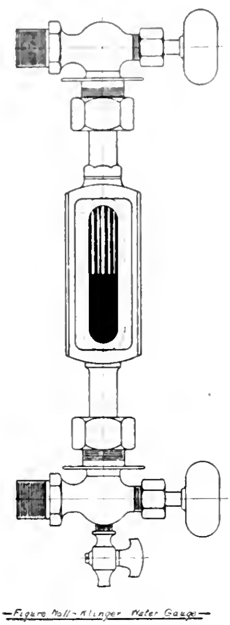


FIG. 11.— KLINGER WATER GAUGE.

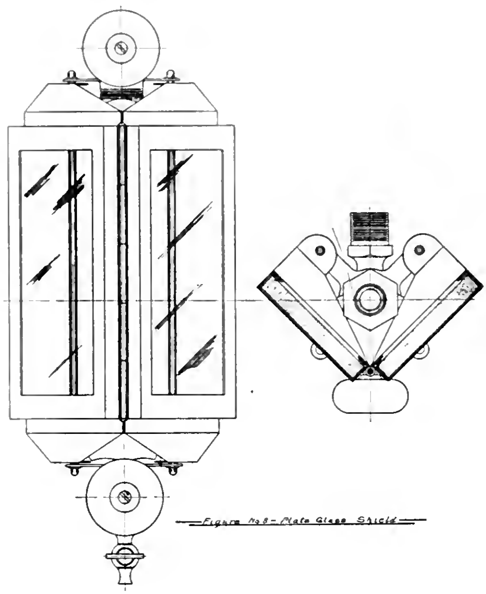


FIG. 8.— PLATE GLASS SHIELD.

The well known ' Klinger " or " Reflex " safety water glass is shown in Figure No. 11. The patent on this glass has expired. It consists of a brass casing having a plate glass front, the inner surface of the plate glass having upon it a series of prisms. Due to the refraction and reflection of the rays of light, the water shows black and the space above the water shows silvery. The glass does sometimes break, but rarely, if ever, flies. But the grooves get dirty and greasy and the glass corrodes, requiring the renewal of the glass. This is something of a job, necessitating the removal of a number of cap screws and the making of tight joints between the glass and the casing that contains it. The water level is not visible from the side and the observer must be nearly in front of the gauge to see the water clearly. The " Klinger " or " Reflex " idea is certainly a good one and its merits to a great extent offset its defects.

The use of glass bull's-eyes on lubricators in place of short glass tubes naturally suggested the use of bull's-eyes on water columns to take the place of the gauge glass. With the expiration of the " Klinger " patent which covered the use of the prism on the inside surface of the glass, there appeared the

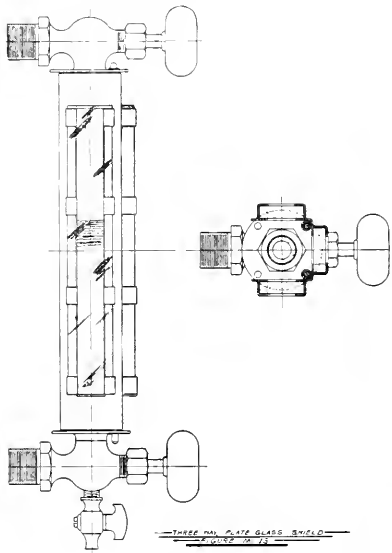


FIG. 13.— PLATE GLASS SHIELD.

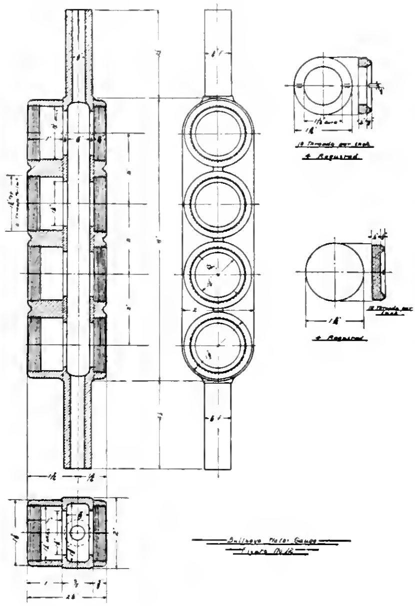


FIG. 12.— BULL'S-EYE WATER GAUGE.

arrangement shown in Figure No. 10. Here a series of bull's-eyes having prisms on their inner faces are set in a casing, similar to the "Klinger" or "Reflex" gauge. Objection has been made to this type of gauge on the ground that the exact water level, if it comes midway between two bull's-eyes, is not visible. As a matter of fact the exact water level is of very little consequence. Try cocks do not indicate the exact level. What the water tender wants to know is whether he has water or not, and about how much. The bull's-eyes will tell that.

A number of modifications of the bull's-eye construction have been proposed. When, as in locomotive practice, it is desirable that the water level be visible by both fireman and engineer, from opposite sides of the cab, two rows of bull's-eyes, staggered, and in a triangular shaped box, have been used. The prisms are prone to get dirty from the grease and scum that gathers in the water column and it is desirable that in the rear of the bull's-eyes should be located plugs to facilitate cleaning and removal of the bull's-eyes. Such a design is shown in Figure No. 12.

From the foregoing it will be seen that the matter of safety in connection with gauge glasses has been pretty thoroughly considered. What device or arrangement is the best in a particular case, is for the man in charge to decide. That the risk of knocking out a fireman's eye by flying glass can be reduced, there is no doubt. That the risk must be reduced to a minimum, goes without saying. The men who run the boilers and the men who own them must unite to this end. The guarding of glass gauges is just one little incident in the big safety movement that means much to employee and employer.

FIG. 1.— THE WRECKED BOILER ROOM, SALEM BANK AND TRUST COMPANY, SALEM, ORE.

Two Serious Explosions of Cast Iron Heating Boilers

A cast iron sectional heating boiler of a common and much used type exploded with great violence on October 29, 1912, in the basement of the Salem Bank and Trust Company's building, Salem, Ore. The explosion occurred about noon time. Three men, Mr. W. S. West, the cashier of the bank, Mr. Harry Ahler, the son of the bank's president, and Mr. J. B. Muchmore, were fatally injured, while two others, Mr. L. H. Roberts, and Mr. A. L. Brockman, were less seriously hurt. The circumstances leading up to the accident have been a matter of much mystery to the residents of Salem, so much so in fact, that the Coroner's Jury brought in a verdict of "explosion, cause unknown," but as is often the case in such casualties, when the facts are gathered and viewed in the light of experience gained by long familiarity with similar mishaps, their interpretation presents neither mystery or complication.

Briefly the story is somewhat as follows. The building of the Trust Company was being remodeled, and at the time of the explosion, was unoccupied with the exception of the first floor, which contained the offices of the bank, and of Mr. Roberts, an insurance agent. The boiler, which had been purchased at second hand, was installed during the summer and stood directly under the office of Mr. Roberts. (This is the room the windows of which are shown on our front cover.) As only the first floor required steam, and

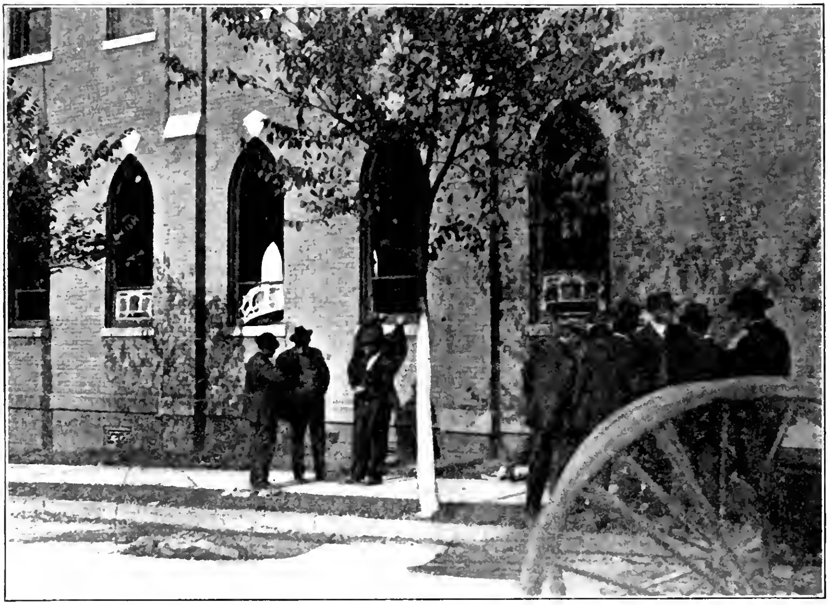


FIG. 2.— EXTERIOR OF CHURCH, SHOWING WRECKED MEMORIAL WINDOWS.

as the day was very warm, it is probable that many if not all the radiators were turned off. It is known that wood and other quick burning refuse were being burned in the boiler just before the failure. Mr. East and Mr. Ahler went to the basement to investigate a steam leak which was annoying the workmen, and arrived just as the explosion occurred. Both men were terribly scalded and mangled. Mr. Roberts, who was seated at his desk in the room above, was thrown out of the window, and landed in the débris between the two pieces of railroad iron, seen on the cover, which served to support the roof of the fuel room. Mr. Muchmore and Mr. Brockman were on the street directly above the fuel room. That the property damage was considerable is shown in the photographs. The sections of the heater were scattered. Some were thrown into the room above, while others remained in the basement. The steam drum lodged between the floor joists of Mr. Roberts' office. The fuel room, adjacent to the boiler room, and under the sidewalk, was entirely unroofed.

The cause of the explosion does not seem to be so very mysterious. It is well known that makers of heating boilers provide safety valves which are often entirely inadequate to relieve the boiler of steam as fast as it is formed. Makers of power boilers long ago realized that there should be relation between the size of a safety valve and the area of the grate, such that the valve would take care of all the steam which the furnace could produce, without a dangerous rise of pressure. With an inadequate valve, the other circumstances such as the closed radiator valves, and the hot quick fire, easily explain the rise of pressure which caused the explosion. Whether the steam leak which drew Mr. East and Mr. Ahler to the basement was due to a failure at a joint, or whether it was only the safety valve doing its best to relieve the situation, will of course never be known. Our representative, who was on the spot soon after the explosion, states that the sections showed no evidence of overheating but that the violence of the explosion pointed almost certainly to a condition of overpressure.

The other explosion occurred in the basement of a church at about 8 A. M. The boiler, also of a common type, is said to have been some ten years old, and to have seen service in a business block previous to its installation in the church. The janitor was killed by the force of the explosion.

Press accounts state that there were about 150 children at school on the second floor of the building, but they were fortunately uninjured. The church proper was badly wrecked. Our illustration, Fig. 2, showing the exterior with the memorial windows blown out, merely hints at the devastation inside, where the destruction of the interior and its furnishings was complete. In places the floor was raised some four feet from its former position.

We are told that a service was to have been held on this particular morning, but had been postponed because of the absence from the city of the parish priest. It seems certain that but for this fortunate circumstance there would have been a much greater loss of life.

We have been informed that closed valves were found in the connection between the boiler and the water column, but the violence of the explosion does not indicate any lack of water. A search for the safety valve is said to have proved fruitless, although the section to which it would ordinarily have been attached was found with a plugged opening, and seemed to have been in that condition for a considerable time. If this be true, and if in fact there was no other safety valve than an ordinary pipe plug, the cause of this explosion is not hard to conjecture.

These two explosions would seem to have been preventable had the boilers been subject to the inspection service of a boiler insurance company. Both resulted in loss of life. That only one man was killed in the second instance instead of scores either killed or terribly injured, was due solely to the fortunate absence from the city of the priest which prevented holding the scheduled service. We have had occasion, not longer ago than the October, 1912, number, to call attention to the danger of heating boilers which are improperly operated or installed. If that warning applies in general, with how much more force should it apply to the case of public or semi-public buildings, where the number of people exposed to an unsuspected hazard may be very great indeed.

On the Perversity of Inanimate Things

H. Converse, *Inspector*

There are times in the course of an inspector's work when he cannot but feel that his efforts to protect the Company's interest and the lives and property of the assured are a huge joke. It is rather discouraging to have a man tell you flatly that your theory and figures are at fault and then be able to prove it, not by more figures but by actually existing facts. The following may prove of interest, as representing such a case.

In the year 1889, one of the Hartford's inspectors condemned a boiler of the Horizontal Tubular type, and of double riveted lap seam construction, because of corrosion of the shell and weak, soft tubes, as well as grooving around the front head. At that time the boiler was in the neighborhood of twenty years old, and had seen very severe service.

As a result of the action of our inspector, the owner called in the representative of a competitor who at first accepted the risk and allowed some 75 lbs. working pressure. However, after about six months, another inspection was made by the new insurance company, with the result that the boiler was again condemned. The boiler was then thrown out and lay exposed to the weather, until this (1912) summer, when it was given to a man for hauling it away. Now this man has taken the boiler and with the aid of his son has cut the front head off and punched new holes for it, set it back a trifle so as to shorten the boiler, and inserted the same tubes. Today he is operating it at 150 lbs. working pressure. Now the former owner, a good friend of the Hartford, says "why don't it burst as you all say they do?"

We suppose that after all none of our readers will hesitate very long over the answer to the question propounded by the former owner of the boiler. We all know of instances in which a structure has been loaded to near the breaking point without instantly giving way. If we hang a weight on a string heavy enough to eventually cause the string to break, it does not follow that the failure will be sudden. What may actually occur is a gradual weakening and stretching of the string until it breaks at a time when it is least expected. So it is with boilers, because they are in an unsafe condition, does not imply that we can predict the exact hour and minute when the rupture will take place. We can, however, liken the operation of a boiler in the condition described by our correspondent to sitting at our desk, immediately under the heavy weight on its string; either case presents a hazard too dangerous to be undertaken knowingly. — EDITOR.

To Prepare a Boiler for Inspection

We have frequently had occasion to instruct boiler owners and attendants as to the best way to prepare boilers for inspection, but it seems necessary to reiterate these instructions from time to time. The whole substance of the matter may really be summed up in three statements: get the boiler reasonably cool, reasonably dry, and reasonably clean. A lack of information on the part of some of our assured as to the best method for attaining these three ends, as well as a desire to express exactly what we mean by "reasonably" are the excuses for bringing this matter again to the attention of our readers.

The best method for cooling a boiler is the one which we have often described before. First let the fire die down and burn out, or if the case is very urgent and time for burning down cannot be spared, haul the fire. Then close all doors and open the damper, allowing the boiler to remain in this condition until the gage shows no pressure. At this time the furnace should be cleaned of all ash, clinker or coal still remaining, in order that the brickwork of the setting may cool. It is very important that the water be allowed to remain in the boiler after the pressure has fallen to zero, while the brickwork is cooling to avoid danger of serious overheating of the boiler from the heat still in the brick. To cool the setting in the most effective manner, keep the damper open as above, and also open the ash pit doors, seeing that all other doors are closed. Under no circumstances open the front connection doors, as this will kill the draft, and interfere with the circulation of cool air through the setting. If the open damper interferes too much with the steaming of other boilers on the same stack, it may be necessary to partially close it, but it should remain as widely opened as possible. The length of time necessary for proper cooling, after the furnace is cleaned, and before blowing off, depends of course on the amount of brickwork which must cool. If the boiler has a light setting, three hours may be enough, but if the setting is massive, or if it is constantly receiving heat from adjoining furnaces, a longer time will be required. When a proper cooling has been attained the boiler may be blown down, and the hand and manhole plates removed. It should now remain with the doors and dampers exactly as before, as this arrangement will draw pure air into the upper manhole, and out through the hand and manholes which open into the setting, tending both to dry the interior, and to furnish pure air for the inspector to breathe.

As regards our second request that the boiler be reasonably dry, we need say very little if the cooling has proceeded in the manner we have suggested. It is a common practice to wash out a boiler as soon as may be after blowing down so that the mud and sediment may not bake on to form a hard scale, but if our directions have been carried out, the boiler will have been cooled slowly enough to permit washing out *after inspection* and so be dry enough for an inspector to really judge of its condition. Leaky stop valves on pipes leading to live boilers will keep a boiler very wet and uncomfortable, which might otherwise be excellently prepared for examination. It is also a fact, that if a boiler is quite warm, but dry and supplied with a good circulation of fresh air, it is in much better condition for inspection than if cooler and filled with vapor, as no man can remain in an atmosphere heavily charged with steam long enough to really do his work justice, unless he makes several trips into the boiler with a breath of air between, which is a tedious and exhausting procedure.

Our injunction to have the boiler reasonably clean was intended to apply particularly to the fire side. Rake the loose ashes from the back connection, or combustion chamber, so that the brick paving may cool. It is no real pleasure, as the writer can attest, to crawl over a foot or so of impalpable ash, when every time a hand or foot touches bottom, it encounters scorching hot brickwork. Then above all, do not forget to sweep the fire side of shells, heads, and exposed tubes with a broom. The inspector must examine these parts of a boiler minutely, and he is greatly impeded if he must brush soot and ashes off at the same time. This soot is frequently so charged with sulphurous acid as to be most irritating to the eyes, rendering good work very difficult.

So, to sum up in a word, we desire a boiler reasonably cool, which means sufficiently cool for a man to stay in it long enough to properly complete his examination without real difficulty, and as we have said the presence of vapor requires a boiler to be cooler than if it were dry. We desire a boiler sufficiently cleaned from ashes and soot, so that a careful examination of its vital parts can be made with eyes which are not irritated and inflamed, and last of all, the assured must realize that any preparation on his part which enables the inspector to do his work more comfortably and thoroughly, protects his interests to just as great an extent as it does the interests of the Company.

The Operation of Low Pressure Heating Boilers

In the October issue we published a short set of instructions for putting a heating system in commission. It is our purpose at this time to extend these instructions to cover the operation of such a system. We have tried as in the first instance to make our instructions clear and simple enough to be readily understood by any one who has this work in charge.

1. When starting a new fire, *raise steam slowly*. (See instruction 9 in the October 1912 LOCOMOTIVE.)

2. Open the steam valves first, and then the return valves, and in closing down a system, shut the return valves first, then the steam. (See instruction 6 in the October 1912 LOCOMOTIVE.)

3. On coming into the boiler room in the morning, the first duty of the fireman should be to make sure of the amount of water in his boiler. He should test this with the gauge cocks as well as by the water level shown in the glass. Both gauge glass connections and try cocks sometimes become plugged with rust and sediment. Trying the gauge cocks accomplishes two results in that it will keep the cocks flushed out clean, and also detect any discrepancy in the water level indicated by the glass. Then blow through both the glass and water column connections, by opening their drain cocks. One can tell whether the connections are clear by the behavior of the water level in the glass. If the top connection is plugged, the water will come back to a false high level, due to the condensation of the steam trapped above the column of water. A partial vacuum is formed which permits the water to stand at a higher level in the glass than in the boiler. If the bottom connection is not free, the water does not rise in the glass at once, but slowly accumulates from the condensation of the steam until it stands above the true water level, and indeed it will eventually fill the glass. Owing to the greater volume of the water column it will take longer for the water to return to its level, whether true or false, when the column drain has been opened, than it will if only the glass has been blown out. It is a good plan to blow out the glass alone first, to test its connection with the column, and then to blow down the column to test the connections with the boiler. The method given for detecting a plugged connection will apply in either case. If plenty of water is found, the fires may be brightened up, — or spread if banked and steam raised. When the boiler is steaming freely, there is still another indication of plugged connections about the water column or gauge glass. If all is clear, the water level is never entirely quiet, but surges slightly up and down. A perfectly motionless water line is a pretty good indication that something is stopped up, and the blowing out tests should be applied.

4. Try the safety valve cautiously while steam is being raised to make sure that it is free and operative. If it is found in good condition, it is advisable to cause it to open under pressure occasionally to make sure that it is correctly set. *Steam should never be kept on a boiler whose safety valve cannot be*

raised by hand to test its freedom, and this test should be made every day. In case the safety valve is found to be either jammed or corroded so that it cannot be raised, the boiler should be immediately cooled, the fires being first deadened with wet ashes or fresh coal and then drawn, after which the cooling may proceed in accordance with the instructions given elsewhere in this number for preparing a boiler for inspection. Under no circumstances should any attempt be made to repair the safety valve while even a slight pressure remains on the boiler, as serious scalding is almost sure to result from such a practice.

5. In case of low water, that is water level below the glass or the lowest try cock, at any time, the fire should be smothered with wet ashes at once, or if they are not available, with fresh coal. The ash pit doors should be closed and the fire doors open. *Under no circumstances should water be fed to the boiler, nor should the safety valve or any steam valve be touched.* When the boiler is quite cold, an inspector should be called to determine the extent if any of the damage.

6. See that the safety valve and damper regulator work at the proper pressures as indicated by the steam gauge. If the damper regulator fails to control the draft when the highest allowable pressure is reached, disconnect it from the damper and draft door. If it now operates freely the door or damper are sticking, and should be cleaned or repaired so as to turn more easily. If however the damper when relieved of its load still refuses to work, or is sluggish, the chances are that the trouble will be found in a choked connection between the regulator and the boiler, or the regulator itself may need repair. If the gauge, safety valve, and regulator all work, but do not agree in their pressure indications, they should be tested by an inspector at once and the proper remedy applied.

7. Whenever leaks are discovered, they should be located at once and repaired at the earliest opportunity. No repairs, however, should ever be attempted until the boiler has been properly cooled off. If the leak should exist at a lengthwise, or longitudinal joint in a cylindrical drum or shell, whether the attendant thinks it is serious or not, the boiler should be immediately cooled down as described above, and an inspector called to determine the best course of procedure. This latter course should always be adopted whenever there is the slightest doubt as to the immediate safety of the boiler, as it is exceedingly unwise to take chances with a defective boiler, no matter how insignificant the defect may appear.

8. Whenever two or more boilers are operated together on a heating system it is best that they be provided with an equalizer to maintain a uniform water level, that is so that no one boiler shall rob the rest of the returning water of condensation. An equalizer is a large sized pipe connecting the steam spaces of the several boilers of a heating battery, entirely separate from the steam supply header. The equalizer should not be made use of to supply steam to any portion of the system. It should have as straight a run as possible, and should be provided with stop valves to enable its connection with any boiler being shut off if necessary.

The return pipes of the various boilers should be connected to a common return line, with stop valves for each boiler. A check valve should be placed in the return line on the building side of the branches to the boilers as shown in Fig. 1, to prevent water flowing back to the radiators and piping when the main steam valve is closed, as discussed in the October 1912 LOCOMOTIVE. There

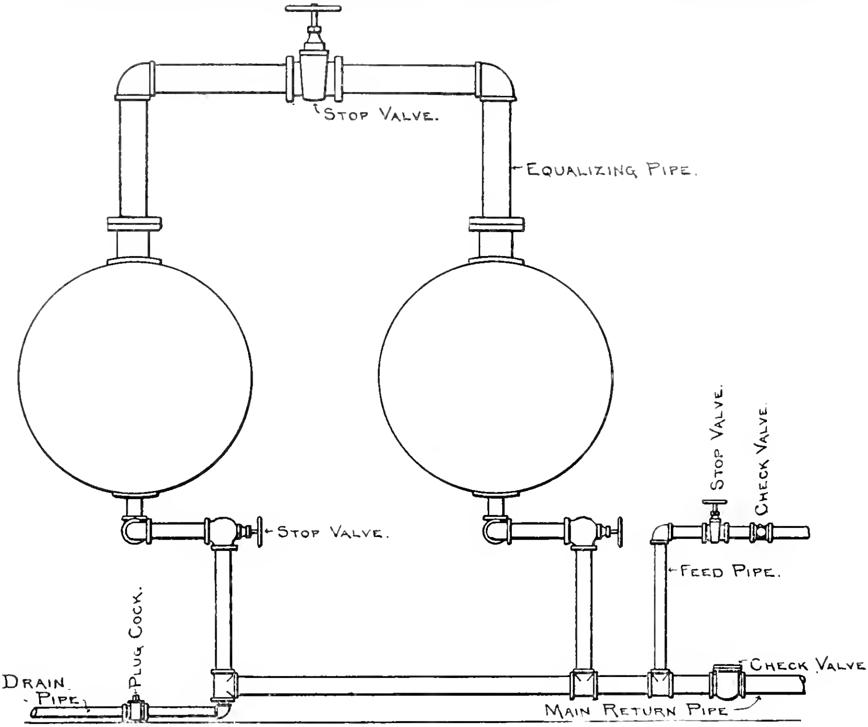


FIG. 1.—ARRANGEMENT OF RETURNS WITH EQUALIZING PIPE.

should not be any check valves in the branches to the boilers, since the return pipe acts as an equalizer below the water line and should afford a free connection between the boilers at all times unless the special condition described below exists, requiring the closing of the equalizer valves. *If only one of a group of boilers is working on the system, the equalizer must be shut off if the dead boilers are cut off from the steam and return lines. If, however, the dead boilers are still connected to the system whether or not their fires are burning, the equalizer (and return valve) must be open to prevent the dead boilers from filling with water at the expense of the one which is working.* This would probably result in serious over heating of the metal of the working boiler.

9. It is important that all surfaces exposed to the action of the fire or to the products of combustion, should be kept cleaned of all accumulations of soot and ash, by sweeping or other convenient means. Soot on the heating surface acts as a blanket, to retard the transfer of heat from the hot gases to the water in the boiler, and the work of cleaning will be well repaid by the resulting saving in coal.

10. To prevent pitting and corrosion, which are especially active in some heating boilers, it is well to keep the boiler water alkaline at all times. This can be accomplished by adding a few pounds (say five pounds to a boiler), of dissolved soda ash at the beginning of the season. This will be enough unless

the boiler is blown down and refilled before the end of the season, in which case the soda ash treatment should be again resorted to.

As a supplementary word of caution, in addition to the instructions already given in paragraph 3 above, we would like to emphasize the fact that sufficient water in a boiler in the morning, does not necessarily mean just enough to show in the gauge. When a large heating system is started in the morning there will be a large amount of condensation in the cold pipes and radiators, so that for a time the water level in the boiler will be steadily falling. Of course all this water will eventually come back, but in the mean time the boiler may have been left for some little time with entirely too little water in it. The man in charge of a heating plant must experiment for himself to determine how much water he must keep in his boiler, and he should be sure that he has enough so that the morning draft of steam will not take the water down below the bottom of his glass gauge.

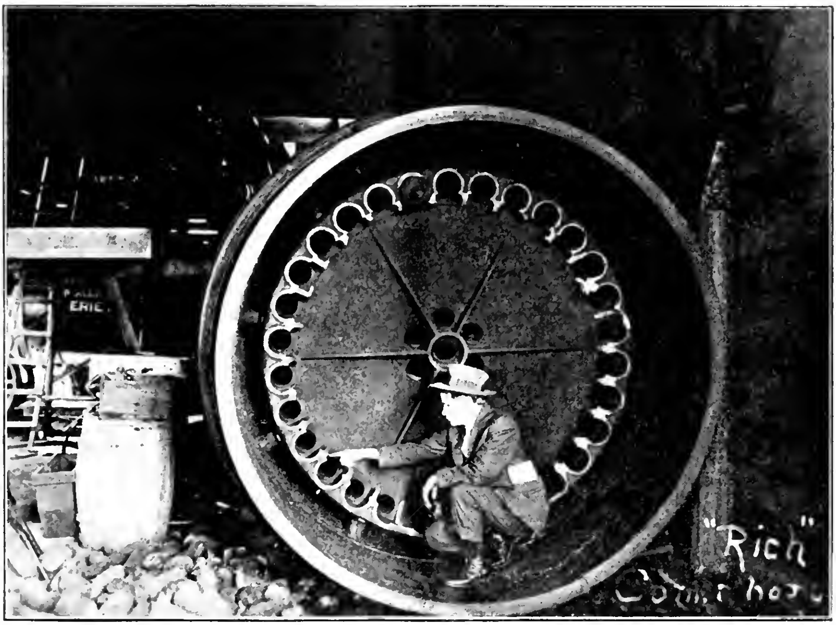


Fig. 3.—The Inside of the Exploded Dryer Head. The Man is Pointing to One of the Old Breaks.

The Explosion of a Rotary Steam Dryer

The accompanying photographs show the condition of a rotary drying cylinder after its explosion September 19, 1912, at the plant of the Wenig Feed and Stock Co., Coleman, Ill.

We are informed that the Wenig Feed and Stock Co., was a new concern formed for the purpose of manufacturing stock and chicken feed from spent

FIG. 2.— OUTSIDE VIEW OF OUTER HEAD.

malt and brewer's grain. The process consisted simply in drying the wet grain by means of the steam, the cylinder which exploded was made use of for this purpose.

The dryer consisted of a cylindrical shell closed by cast iron heads which were made in the form of hollow boxes or manifolds, and were connected together by boiler tubes. There appear to have been two sets of tubes, a row surrounding the central shaft, and another row lining the outer shell. Fig. 1 shows a view into the end of the dryer, and shows the inside of the outer head (the inside of the box, so to speak). The rows of tube ends are clearly seen, as are the ribs which were intended to stiffen and strengthen the large flat surfaces. The mode of operation seems to have been as follows: wet grain was placed in the shell between the cast iron heads, and in contact with the tubes. Then steam was turned into the tubes and heads so that they formed a large steam radiator. The shell of the cylinder proper, that is the space containing the malt, was not under pressure. Ordinarily such an apparatus is operated exactly like a radiator, steam being allowed to enter and circulate through the tubes and heads, while the water of condensation is removed as fast as it forms by a drain connection. Both the steam inlet and the water outlet or drain are carried through the central hub of the head which can be seen in Fig. 2, permitting the whole cylinder to be rotated so as to agitate the malt and hasten the drying process.

We are told that in this case, the dryer had been bought at second hand and without inspection. It had developed leaks at the tube ends a few days prior to the explosion which had been repaired by a boiler maker. It is also said that it was not provided with a pressure gage, reducing pressure valve, safety valve or proper drain connection. This would indicate several possible reasons for its failure. The fact that it was inadequately drained would have permitted it to fill with water up to the level of the central axis when idle, and when steam was turned on a violent water hammer might have been produced Then it could easily have been subjected to a severe and unknown over pressure, due to the absence of the ordinary safety devices. The very violence of the explosion, which killed three men and seriously injured a fourth, and which carried the heavy head seen in Fig. 2 a distance of 350 feet — the head was said to have weighed some 1200 lbs. — would indicate that the vessel must have contained considerable water which added its heat energy to that in the steam, when the explosion occurred. A number of old and deep cracks were found in the reinforcing webs which surrounded the tube ends in the outside row. The man seen in Fig. 1, is pointing to one of them.

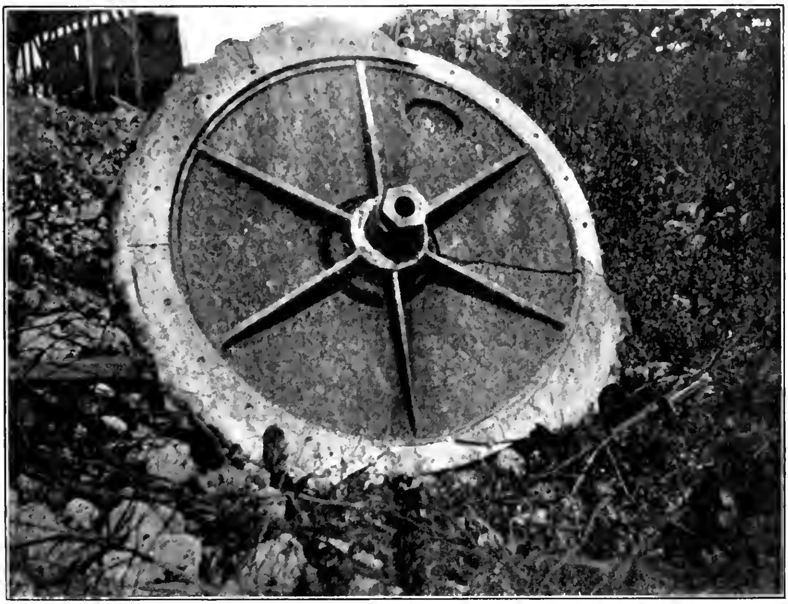


Fig. 3.— Reverse Side of Outer Head.

Cast iron is a treacherous material at best to use in vessels under steam pressure if it must carry any of the stresses involved. But the combination of cast iron, possible water hammer, and excessive pressure in an old and defective structure which had apparently been installed and operated without a knowledge of the precautions necessary for safety, proved, as was to have been expected, a very hazardous affair.

We can still furnish copies of our little book, "The Metric System." It is the best thing to be had, for comparing metric measures with our own. Bound in sheep, it costs $1.25. A special bond paper edition for $1.50.

The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

C. C. PERRY, EDITOR.

HARTFORD, JANUARY, 1913.

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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

Obituary

GEORGE BURNHAM

George Burnham of Philadelphia, for many years head of the Baldwin Locomotive Works, and the oldest director of the Hartford Steam Boiler Inspection and Insurance Co., died Tuesday, Dec. 10, 1912, at his home in that city, at the age of 95 years. His death came as the result of a general breakdown following an illness of about a year's duration.

Mr. Burnham was born in Springfield, Mass., on March 11, 1817. His early childhood was spent there, but at the age of fifteen he was taken to Philadelphia and found employment in the grocery store of a Mr. Simon Colton. It was while in that store that he first met Mathias W. Baldwin, who had some interest in Mr. Colton's business.

Shortly after Mr. Baldwin began the building of locomotives — as a result of the success of his initial engine, Old Ironsides, on the Philadelphia and Norristown Road,— he engaged Burnham as clerk and bookkeeper. From this beginning Mr. Burnham grew up in the financial and accounting side of the business and it was largely through his efforts that the business was preserved and developed through the panics before the war, when a single locomotive was a big contract.

After Mr. Baldwin's death in 1866, Mr. Burnham became a member of the firm, then known as M. Baird and Co. In 1873, on Mr. Baird's retirement, the firm name was changed to Burnham, Parry, Williams & Co., with Mr. Burnham as the senior partner. This firm, changed to Burnham, Williams & Co. on the death of Chas. T. Parry, continued until the incorporation of The Baldwin Locomotive Works in 1909.

In 1843 Mr. Burnham married Miss Anna Hemple, the daughter of Samuel Hemple, a Philadelphia merchant. Through his wife he became an earnest student of the works of Emanuel Swedenborg, and was instrumental in the erection of the beautiful church of that faith at the corner 22nd and Chestnut Streets. He was one of the early members of the Union League, a member of the Committee of One Hundred, and though seldom active in politics, was a generous contributor to reform and civic movements.

Mr. Burnham was elected to the Board of Directors of the Hartford Steam Boiler Inspection and Insurance Co., on Feb. 7, 1888, and served until his death, although for some years past, he had been unable to attend its meetings because of his advanced age.

Mr. and Mrs. Burnham had four children, William Burnham, George Burnham, Jr,. Mary A. Burnham, and Mrs. Theodore J. Lewis.

In the July, 1912, issue we announced the reinsurance of the steam boiler and fly wheel business of the Casualty Company of America by the Hartford Steam Boiler Inspection and Insurance Company. We remarked at that time that since the total amount of steam boiler and fly wheel business in the country was limited, and yet was divided between some 24 or 25 companies, we failed to see how all of them could continue to write this line, owing to the expensive inspection service required. In this number we reprint a news item from the "Hartford Times" of Monday, Dec. 16, 1912, giving the details of still another reinsurance of this character. In the present case the HARTFORD takes over the entire steam boiler and fly wheel business of the United States Fidelity and Guaranty Co., which retires from this field for exactly the same reason as that which influenced the Casualty Company of America. As is stated in the item referred to, this is the eighth instance in which the HARTFORD has underwritten the steam boiler line of other companies.

We trust that our readers will pardon the omission of the customary statistics of our inspection service from this number. It will be obvious, on a moment's consideration, that such statistics to be complete must be compiled after the beginning of the new year. It is therefore, necessary to choose between mailing THE LOCOMOTIVE on time and publishing the statistics. We have chosen the former alternative, as we deem it desirable to appear promptly, and so will print our statistics in the April number.

Messrs. Corbin, Goodrich and Wickham, general agents for THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY at Philadelphia, Pa., moved during the first week in December to their new offices in the new Fire Association building, corner of Fourth and Walnut Streets. The building is to be devoted entirely to insurance purposes. The four lower floors are to be occupied by the Fire Association, the fifth by the HARTFORD, and the sixth (top) floor by the Philadelphia Underwriters.

We are told that this building bids fair to become one of the show places of the city because of the simple beauty of its architecture, and feel that it is a matter of great good fortune that our Philadelphia Department is able to locate in such desirable quarters.

Personal

Mr. George H. Bartholomew, who has been connected with the drafting department of the Home Office for many years, left the Hartford on Dec. 1st to accept another position, in which we hope he will be most successful.

Hartford Steam Boiler Co. Takes on Another

HAS REINSURED THE ENTIRE STEAM BOILER AND FLY-WHEEL BUSINESS OF THE UNITED STATES FIDELITY AND GUARANTY CO.

IT IS THE EIGHTH INSTANCE

[From the Hartford (Conn.) Times, Dec. 16, 1912.]

The Hartford Steam Boiler Inspection and Insurance Company has re-insured and taken over the entire steam boiler and fly wheel business of the United States Fidelity and Guaranty Company of Baltimore, Maryland. From the insurance commissioner's report of 1912, it would appear that the United States Fidelity and Guaranty Company was one of the strongest and most prominent of the multiple line companies. It commenced business in August, 1896, and at the beginning of this present year it was credited with a paid-up cash capital of $2,000,000, a net surplus exceeding $1,022,000, and assets exceeding $6,798,000, while its total premium income pertaining to its various lines of insurance during the year 1911 exceeded $4,738,000.

AMOUNTS TO ABOUT $7,500,000

The number of boilers and fly wheels involved in this transaction is about 1,500 and the insurance liability taken over amounts to about $7,500,000. President Brainerd of the Hartford Steam Boiler Company stated that there was nothing surprising or strangely significent in this transaction, as it simply indicated that the management of the United States Fidelity and Guaranty Company recognized the fact, apparent to all dealing with the steam boiler and fly wheel line of insurance, that the entire amount to be had was too limited in volume to justify dividing it up among as many companies as are now engaged in writing this line of insurance, with any promise of profit.

WHAT COULD BE DONE

It requires a substantial volume of business in each state to justify the maintenance of a proper organization and a thorough and efficient inspection service in order to conduct this line of insurance with any hope of profit, and with no less than twenty-five companies competing for a volume of premiums amounting annually to only a little more than $2,000,000, it becomes very difficult for any one company to obtain and control a sufficient volume to make this line of insurance profitable. As a matter of fact, the Hartford Steam Boiler Company could, with its present organization, take over and carry the entire steam boiler and fly wheel business done throughout the United States without materially increasing its present operating expenses, other than possibly adding here and there an additional inspector.

THE EIGHTH INSTANCE

In June last the Hartford Steam Boiler Company likewise took over the entire steam boiler and fly wheel business of the Casualty Company of America, of New York, which ranked as fourth or fifth company in point of volume, and in taking over the business of the Baltimore Company it is the eighth instance in which the Hartford Steam Boiler Company has taken over the steam boiler line from as many companies.

A Decision by the United States Court of Appeals

On October 25th, 1909, an explosion of three Munoz boilers took place at the power plant of the Pabst Brewing Company, Milwaukee, Wisconsin. The boilers were insured by The Hartford Steam Boiler Inspection and Insurance Company under a schedule form providing indemnity in the sum of $50,000 for any one explosion. The assured construed the contract to mean a coverage of that amount on each boiler which exploded notwithstanding that they had ordered the insurance to apply as $50,000 on one loss.

An unsuccessful effort to settle the loss amicably in accordance with the limits as understood when the insurance was placed, was followed by a jury trial in the United States Circuit Court. The plaintiff, the Pabst Brewing Company, sued under two counts; first on the contract, alleging that three explosions had occurred, and the second in tort, both in an endeavor to secure the amount of total loss, in case one count or the other failed.

The jury in the Circuit Court found for the plaintiff. The case was appealed by the Hartford Company and argued before the United States Circuit Court of Appeals at Chicago, Judges Seaman, Landis, and Kohlsaat sitting in the case. This court on October 15th, 1912, handed down a unanimous decision reversing the judgment of the Circuit Court and holding that there was but one explosion within the meaning of the policy and that the plaintiffs had not proved the tort.

This case has aroused considerable interest in insurance circles and the decision of the Appeal Court seems to be in accordance with the views of expert insurance men who have studied the questions involved.

Boiler Explosions

(Received too late for the August list.)

(335.) — On August 12, three men were badly scalded when the failure of a bolt on a hot press released a quantity of hot tankage at the disposal plant of the Michigan Central Railroad, Toledo, O.

(336.) — A threshing machine engine was wrecked by the explosion of its boiler August 31, at Webster, N. D. John Brennan, engineer, was instantly killed, and George Gibbs, fatally burned. The machine was being delivered to a new owner at the time of the accident.

SEPTEMBER, 1912

(337.) — The boiler of a traction engine exploded September 2, at Canal Dover, O. Albert Miller was killed, and Harry Boltz perhaps fatally injured.

(338.) — On September 3, a boiler exploded at the plant of the Williamston Electric Co., Williamston, N. C. Considerable damage was done to the boiler and boiler room, and Alfred Sherod was slightly injured.

(339.) — The boiler of a freight locomotive belonging to the Michigan Central Railway exploded September 4, near Dowagiac, Mich. Charles Murrell, fireman, was fatally injured, and Charles Parr, engineer, less seriously injured.

(340.) — On September 6, the boiler of a hoisting outfit belonging to the Spaulding Logging Co., exploded near Black Rock, Ore. Charles Olsen was killed and G. Reynolds seriously injured.

(341.) — A tube ruptured in a water tube boiler September 6, at the plant of the Tri-State Railway and Electric Co., East Liverpool, O. The property damage was small, but Andrew Pullnis, coal passer, was injured.

(342.) — A tube ruptured September 6 in a water tube boiler at the Toledo Storage and Ice Co., Toledo, O.

(343.) — On September 6, a tube ruptured in a water tube boiler at the plant of the American Steel and Wire Co., Donora, Pa. Considerable damage was done to the boiler, and Charles Fisk, fireman, was scalded.

(344.) — The boiler of a Rock Island freight locomotive exploded September 7, between Argenta and Lonoke, Ark. C. E. Delaney, fireman, and Fred Stelter, engineer, were injured.

(345.) — On September 7, a blow off pipe failed at the Cisco Oil Mill, Cisco, Tex.

(346.) — An accident occurred September 7 to a boiler at the plant of the Jansen Steel and Iron Co., Columbus, Pa.

(347.) — Six cast iron headers failed September 8, in a water tube boiler at the Juniata Company's power plant, Mifflin, Pa.

(348.) — A boiler ruptured September 8, at the plant of the Batesville Ice and Cold Storage Co., Batesville, Ark.

(349.) — On September 9, a hydraulic press exploded in the dye room of the Germania Hosiery Mills and Dye Works, Phila., Pa. Steam was being turned on the press at the time. One man was injured, and property damaged to the extent of about $1,000.

(350.) — On September 10, a boiler ruptured at the plant of the McNeal Marble Co., Marietta, Ga. The damage was small.

(351.) — One man was injured by the collapse of a crown sheet on Locomotive 30 of the Delaware and Hudson R. R., at Saratoga Springs, N. Y., on September 13.

(352.) — On September 17, a boiler ruptured at the plant of the Plano Milling Co., Plano, Tex.

(353.) —A boiler used in connection with the manufacture of sausage at M. G. Reigel's meat market, Phila., Pa., exploded September 17. The building in which the boiler was located was considerably damaged.

(354.) — On September 17, a boiler exploded at the plant of the Wenig Teaming Co., Coleman, Ill. Two men were instantly killed, a third was fatally injured, and one man was less seriously injured.

(355.) — Three cast iron headers ruptured September 18, in a water tube boiler at the Kennesaw Paper Company's mill, Marietta, Ga.

(356.) — On September 18, a boiler exploded at the oil pumping station of the Prairie Oil and Gas Co., Osage Junction, Okla. A. M. Coyle, engineer, was killed, and F. L. Gordon and J. C. Luckfield were seriously injured.

(357.) — About September 20, a small boiler used for dairy purposes exploded on the farm of Arthur Pierpont, near Waterbury, Ct. Mr. Pierpont was scalded so seriously that he died from the effects of his injuries.

(358.) — The home of Harry E. Oliver, Rutherford, N. J., was wrecked September 20, by the explosion of a copper hot water boiler. Property was damaged to the extent of $5,000, and a dog was killed.

(359.) — A boiler ruptured September 20, at the plant of the Belt Line Elevator Co., Superior, Wis.

(360.) — On September 21, a boiler exploded at the South Madison St. plant of the Bloomington Railway Electric and Heating Co., Bloomington, Ill. One man, a fireman, was injured.

(361.) — The boiler of a traction engine exploded September 23, on the farm of Henry McConnell, near Centerville, Iowa. Four men were injured.

(362.) — A freight locomotive belonging to the Chicago, Milwaukee, and Puget Sound R. R. was wrecked by the explosion of its boiler September 24, at Pacific City, Wash. Four men were killed, and the engine was a total wreck.

(363.) — On September 23, an accident occurred to a boiler at the power house of the Crompton Co., Crompton, R. I.

(364.) —A water tube boiler exploded September 24, at the rolling mill of the Southern Iron and Steel Co., Alabama City, Ala. G. W. Williams was injured. The property loss is estimated at about $3,500.

(365.) — Several cast iron headers ruptured September 24, in a water tube boiler at the power house of the Waterloo, Cedar Falls, and Northern Railway Co., Waterloo, Ia.

(366.) — On September 25, a tube ruptured in a water tube boiler at the packing house of Hammond Standish and Co., Detroit, Mich. Joseph Lafata, a fireman, was injured.

(367.) — On September 25, a tube sheet of a water tube boiler ruptured at the Allen County Court House, Ft. Wayne, Ind.

(368.) — A tube ruptured September 30, at the mill of the West Virginia Pulp and Paper Co., Tyrone, Pa. Jesse Walker, fireman, and George Diehl, pipe-fitter, were scalded.

October, 1912

(369.) — On October 1, two sections of a cast iron heating boiler fractured in a business block owned by Helen F. Bradford, Allston, Mass.

(370.) —A tube ruptured October 1, in a water tube boiler at the plant of the Narragansett Electric Lighting Co., Providence, R. I. Bernard Dolan, water tender, was injured.

(371.) — On October 1, a boiler belonging to a contractor, and located at 170th St., in the Bronx, New York City, exploded with great violence. Press reports state that the boiler explosion followed the theft of 65 lbs. of dynamite, and that this was used in producing the explosion. We are somewhat in doubt as to this theory, as the accident has some of the characteristics of a genuine boiler explosion, and so include it in our list.

(372.) —Lieut. Donald P. Morrison, U. S. N., was killed, and eight men injured, on October 1, by the explosion of a steam turbine casing on board the torpedo boat destroyer, U. S. S. Walke, off Brenton's Reef Light Vessel.

(373.) — On October 2, four sections of a cast iron heating boiler ruptured at the Densmore Hotel, Kansas City, Mo.

(374.) — A blow off pipe failed October 2, at the quarry of the Hercules Slate Company, Pen Argyle, Pa. Alfred Henessbeck, fireman, was injured.

(375.) — The boiler at the Lawton, Okla., electric light plant exploded October 2, seriously scalding the engineer and fireman.

(376.) — On October 3, the mud drum exploded on a water tube boiler at the mill of The Wardlow-Thomas Paper Company, Middletown, O. George Baird, fireman, was killed, and considerable damage was done to the boiler and setting.

(377.) — The boiler of Union Pacific locomotive No. 2833 exploded October 3, fifteen miles east of Imlay, Nev. N. L. Robinson, engineer, and C. C. Cool, fireman, were killed, and the engine was a total wreck.

(380.) — A blow off pipe ruptured October 3, at the mill of the Aldrich Paper Company, at Natural Dam, near Gouverneur, N. Y. James Minore, fireman, was fatally injured, and Amos Corey was less seriously injured.

(381.) — On October 4, several headers in a water tube boiler ruptured at the plant of The Winchester Repeating Arms Company, New Haven, Ct.

(382.) —A tube ruptured October 5, in a water tube boiler at the Leeds Ala. plant of the Standard Portland Cement Co.

(383.) — On October 6, a mud drum ruptured in a water tube boiler at the packing house of Schwartzchild and Sulzberger, Kansas City, Kans.

(384.) — A cast iron header ruptured October 6, in a water tube boiler at the plant of the Kansas City Flour Mills Company, Kansas City, Kans.

(385.) — A blow off pipe failed at The Fork Township Oil Mill, Townsville, S. C., on October 8. Frank Williams, fireman, was slightly injured.

(386.) — On October 9, a section of a cast iron heating boiler fractured at the hotel of H. N. Bain, and Ella K. Jewett, Poughkeepsie, N. Y.

(387.) — A tube in a water tube boiler ruptured October 9, at the power house of the Worcester Consolidated Street Railway Company, Worcester, Mass. Arnold S. Allen, Chief Engineer, was killed, and two firemen injured.

(388.) —A locomotive belonging to the Belt Line Railway Company Chicago, Ill., exploded October 9, resulting in the fatal scalding of J. H. Howell.

(389.) —A tube ruptured in a water tube boiler at the Lorain, O., mill of the National Tube Company of Ohio, on October 10.

(390.) — The boiler of a saw mill exploded October 11, at New Point, near Americus, Ga. No one was injured, and the property damage was slight.

(391.) — On October 12, the boiler of a threshing machine exploded at Burlington, N. J. Elmer Mingen and William Slack were seriously injured, and a boy, Paul Sholl, was badly burned.

(392.) — A boiler exploded October 13, at the ice cream plant of Larmore and Co., Davenport, Ia. The damage was slight.

(393.) — Three cast iron headers ruptured October 13, in a water tube boiler at the power house of The Ohio Electric Railway Company, Medway, O.

(394.) — On October 13, a tube ruptured in a water tube boiler at the electric lighting plant of The Central Hudson Gas and Electric Company, Poughkeepsie, N. Y. Five men, Elliot Thompson, asst. engineer, John Houston, supt. of the fire room, James Doyle, fireman, Clarence Decker, coal passer, and Richard Collins, dust man, were injured. The property damage was confined to the boiler itself.

(395.) — A tube ruptured October 13, at the plant of the American Steel and Wire Company, Donora, Pa.

(396.) — On October 14, four cast iron headers ruptured, in a water tube boiler at The New Battle House, Mobile, Ala. Richard Wooten, fireman, was scalded.

(397.) — A tube ruptured October 14, in a water tube boiler located in an office building owned by John A. Orlando, and M., and Chas. S. Harper, Pittsburg, Pa.

(398.) — A boiler exploded October 14, at Mill No. 1, The Henrietta Mills, Henrietta, N. C.

(399.) — On October 15, the boiler of the saw mill of D. W. Eagle, near Keyser, W. Va., exploded. Two men were killed, and two injured, one probably fatally.

(400.) —A blow off pipe failed October 15, at the plant of The E. H. Clapp Rubber Company, Boston, Mass.

(401.) — A cast iron header fractured on October 15 at the power house of the Ohio Electric Railway Company, Medway, O.

(402.) — A blow off pipe failed October 15, at The Belleville Copper Rolling Mills, Soho, N. J. Fred. Myers, chief fireman, was killed.

(403.) — A tube ruptured October 17, in the Trenton plant of the American Bridge Company, Trenton, N. J. John Barcon, laborer, was injured.

(404.) — On October 18, a feed pipe burst at the wood working plant of Glines and Stevens, Franklin, N. H. One man was badly scalded.

(405.) — Thirty-two cast iron headers failed October 18, in a water tube boiler at the plant of the Semet-Solvay Co., Tuscaloosa, Ala.

(406.) — On October 19, the crown sheet of a locomotive, which was in service on the grading contract of John T. Lee, collapsed at Rivaire, Ind.

(407.) — A boiler exploded October 19, at the plant of the Mutual Mining Company, Cannelburg, Ind. One man was probably fatally injured.

(408.) — A boiler exploded October 19, at the Sucker Flat Mine, near Webb City, Mo. Two men were killed, and a third narrowly escaped serious injury. The boiler was blown through a greenhouse roof, two blocks away.

(409.) — The pressure tank, used in connection with an hydraulic elevator at Hotel Wilkes-Barre, Wilkes-Barre, Pa., exploded October 21.

(410.) —A boiler ruptured October 21, in the basement of the S. S. White Dental Company's plant, Phila, Pa. Two men were so badly scalded that they afterwards died.

(411.) — On October 22, a copper hot water boiler failed in a café in New Bedford, Mass. The cause for the failure is said to have been an inoperative safety valve, and a check valve in the cold water supply line. The property loss is estimated at $5,000.

(412.) — Seven cast iron headers ruptured October 23, in a water tube boiler, at the plant of the Louisiana Distillery Company, New Orleans, La.

(413.) — A tube ruptured October 24, in a water tube boiler at the power house of the Northern Ohio Traction and Light Co., Akron, O. Aley George, ash wheeler, was scalded.

(414.) — A tube ruptured October 24, in a water tube boiler at the plant of the Virginia Portland Cement Company, Fordwick, Va. Marshall Jackson, coal wheeler, was injured.

(415.) — A fitting burst on a blow off pipe October 24, at the store of The Sage-Allen Co., Hartford, Ct.

(416.) — A cast iron sectional heating boiler exploded October 25, in the basement of the Church of The Holy Ghost, Knoxville, Tenn. One man was killed, and property was damaged to the extent of $7,000. (Described elsewhere in this issue.)

(417.) — A cast iron heating boiler failed October 25, at the St. Paul, Minn., plant of Armour and Company.

(418.) — On October 25, a water tube boiler ruptured at the Rankin Works of the American Steel and Wire Company, Rankin, Pa.

(419.) — Two tubes burst October 28, in a water tube boiler aboard of a steam cutter attached to the U. S. S. Utah, near Bedloe's Island, in New York harbor. One man was burned about the face.

(420.) — On October 28, an exhaust pipe burst in a factory building at 49-51 Elizabeth St., New York City. A considerable panic among the factory employees followed, but no one was injured.

(421.) — A boiler exploded October 28, at the saw mill of B. Thearmond, Iuka, Miss. Two men were killed outright, and three others injured, one perhaps fatally.

(422.) — A cast iron sectional heating boiler exploded with great violence October 29, in the basement of the Salem Bank and Trust Company's building, Salem, Ore. Three men were killed or fatally injured and two more less seriously injured. (Described in detail elsewhere in this issue.)

(423.) — The crown sheet of a locomotive type boiler failed October 30, at Lima, O. The boiler was the property of the Miles Tighe Contracting Company.

(424.) — The boiler of a logging locomotive exploded October 31 at the plant of the McGehee Lumber Co., Ocala, Fla. One man was injured.

Fly Wheel Explosions

(17.)— On June 10 a fourteen foot fly wheel burst at the plant of the Phœnix Cement Co., Nazareth, Pa. The property loss was estimated at $3,000.

(18.)— A fly wheel burst about June 20 at Trudell's saw mill, Chateaugay Lake, N. Y. One man was seriously injured.

(19.) — On June 22, a large emery wheel burst at the plant of the Art Stamping Co., Philadelphia, Pa.

(20)— A fly wheel burst in the basement of the National Sulphur Company's works, Brooklyn, N. Y. on July 6. The fly wheel in bursting struck a small boiler, which in turn exploded, and set fire to the works, containing a large amount of stored sulphur. Fifteen men were seriously injured by the fire and sulphur fumes, two of them fatally.

(21.)—A fly wheel burst July 16, at the Hull and Draper Flour Mill, Salem, Ill. The wheel was 10 feet in diameter, and normally operated at 75 R. P. M. The failure is attributed to the breaking of a governor belt.

(22.)—On July 17, the fly wheel of the main engine exploded at the plant of Muhs and Co., Passaic, N. J., causing a complete shut down of the plant.

(23.)—The fly wheel of a gasolene engine set used to light two moving pictures at Fort Worth, Tex., exploded August 24. The engineer was seriously and perhaps fatally injured.

(24.)—A fly wheel exploded August 26 in the Bayer Process Dept. of the Pennsylvania Salt M'f'g. Co., Natrona, Pa. The entire plant was shut down pending repairs to the engine and engine room.

(25.)—On September 24, a pulley burst at a saw mill on the Nuckolls Plantation, Russel Co., Ga. One man was killed.

(26.)—One man was injured on October 2, by the bursting of an emery wheel at the plant of the United States McAdamite Metal Co., Detroit, Mich.

(27.)—A fly wheel burst October 2, at the sawmill of Eugene Graves, at Factory Postoffice, some ten miles from Leonardtown, Md. Mr. Graves was instantly killed by a fragment of the wheel. The accident is said to have been caused by the running off of the governor belt.

(28.)—On October 19, a fly wheel burst at the mill of the Mississippi Lumber Co., Quitman, Miss. The property damage was estimated at $5,000.

(29.)—A fly wheel burst October 28 at the stone crushing plant of the American Lime and Stone Co., Union Furnace, Pa. The accident was caused by the failure of the governor.

(30.)—A fly wheel exploded November 19, at the International Paper Company's mill, Fort Edward, N. Y. The property loss is estimated at over $10,000.

(31.)—On November 22, the plant of the Sweetwater Light, Ice, and Power Co., was wrecked by the bursting of a fly wheel. The property loss was estimated at about $2,000.

Is Your Engine Equipped With a Throttle Valve Governor Operated From a Counter-Shaft?

Thomas Dowd, Inspector.

When conditions compel the use of a counter-shaft with an additional belt to drive a throttle valve governor, it is very important that precautions should be taken to insure free action of the automatic safety stop. So that it will stop the engine if either of the two belts should break. So many cases have come under our observation where no provision has been made for such an emergency, that it may be well to call attention to the proper way to connect up governors operated in this manner. Of course, it will be understood that reference is now made to the throttling governor with an automatic safety stop attachment. This safety stop is designed to be operated by an idler pulley, which rides on the governor belt, and is so arranged that should the belt break, the idler will drop to a lower position, thus tripping the safety latch, and allowing the throttle valve to close.

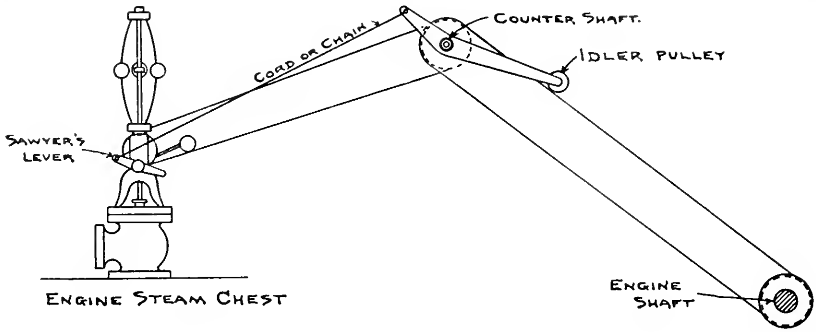

FIG. 1.— SAFETY DEVICE FOR A COUNTERSHAFT DRIVEN GOVERNOR.

When it is necessary to use two belts, as noted above, it is evident that the automatic safety stop on the governor will not operate if the belt that runs from the engine shaft to the counter-shaft should break. In this case, the governor would stop revolving and drop to its lowest position, allowing full steam admission to the cylinder, which would result in the engine racing. To obviate this danger, a second idler pulley similar to the one attached to the governor should be provided to operate on the belt leading from the engine to the counter-shaft, as shown in the accompanying sketch. This can be fitted with very little trouble or expense by the engineer or other mechanic about the plant, as the outfit only consists of the pulley and arm with cord or chain to attach to the Sawyer's lever on the governor, which also operates the safety stop. When thus connected, the governor can then be relied upon to stop the engine if either of the belts break.

Governors of this type are not always fitted with Sawyer's valve levers; but in nearly every case a point can be found where an attachment can be made which will produce the desired result.

Reuben, Reuben, I've bin thinkin'
What a glad world this will be
When them b'ilers cease their bustin'
And get safe for you an' me.

Laws don't seem to make us keerful,
Folks gits reckless jist ther same;
An' when we hev jined ther angels
Jury sez we was to blame!
— *Power.*

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1912.

Capital Stock, ... $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission,		$204,693.25
Premiums in course of collection,		263,453.33
Real estate,		91,100.00
Loaned on bond and mortgage,		1,166,360.00
Stocks and bonds, market value,		3,249,216.00
Interest accrued,		71,052.02
Total Assets,		$5,045,874.60

LIABILITIES.

Premium Reserve,		$2,042,218.21
Losses unadjusted,		102,472.53
Commissions and brokerage,		52,690.67
Other liabilities (taxes accrued, etc.),		47,191.65
Capital Stock,	$1,000,000.00	
Surplus over all liabilities,	1,801,301.54	
Surplus as regards Policy-holders,	**$2,801,301.54**	2,801,301.54
Total Liabilities,		$5,045,874.60

L. B. BRAINERD, President and Treasurer.
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L. F. MIDDLEBROOK, Assistant Secretary.
W. R. C. CORSON, Assistant Secretary.

S. F. Jeter, Supervising Inspector.
E. J. Murphy, M. E., Consulting Engineer.
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The Locomotive
of
THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

VOL. XXIX. HARTFORD, CONN., APRIL, 1913. No. 6.

FIG. 5. A NEAR VIEW OF THE WRECK. ECONOMIZER EXPLOSION AT SAYLESVILLE, R. I.

A Fuel Economizer Explosion

A fuel economizer exploded Tuesday, January 14, 1913, at the Glenlyon Dye Works, Saylesville, R. I. The accident occurred at about 3.50 o'clock in the afternoon. Beside destroying property to the extent of about $26,000.00, two men lost their lives, and some seven or eight others were injured more or less seriously.

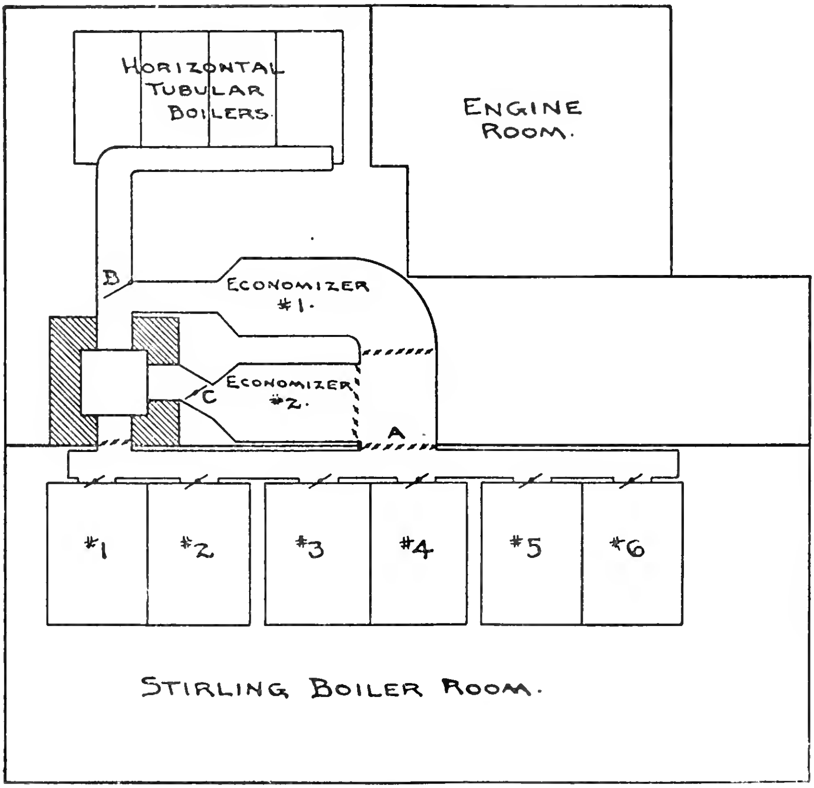


Fig. 1. Plan Showing Arrangement of Boilers and Economizers.

The arrangement of the boiler house and its equipment, as it existed before the accident, is shown in our sketch plan, Fig. 1. There were two boiler rooms, one containing six 325 horse-power Stirling boilers, and the other containing the stack, the economizers, and a battery of four horizontal tubular boilers, together with the feed heaters, pumps, fans, fan engines, and other boiler room auxiliaries. As will be seen, only the gases from the Stirling boilers could pass through the economizers, while those from the tubular boilers went direct to the stack. The economizers, two in number, were behind the stack, and side by side, parallel to the division wall. They rested on a platform about 10 feet above the floor. This platform consisted of longitudinal I beams, between which were turned brick arches, and these in turn rested on transverse I beams, supported on structural columns. A passage way separated the economizers lengthwise. Dampers were fitted as shown; dampers A, B, and C were operated by automatic regulators, while the others were only used when it became necessary to shut down and isolate an economizer.

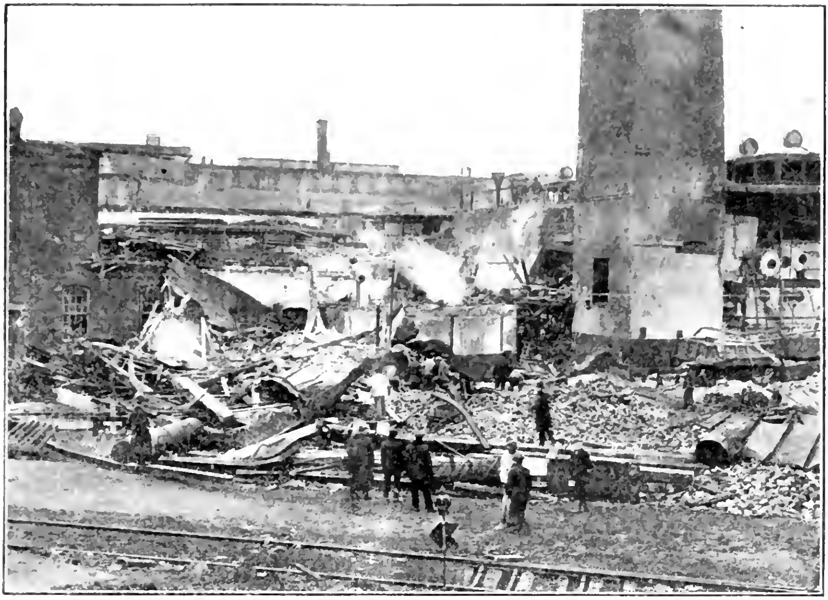
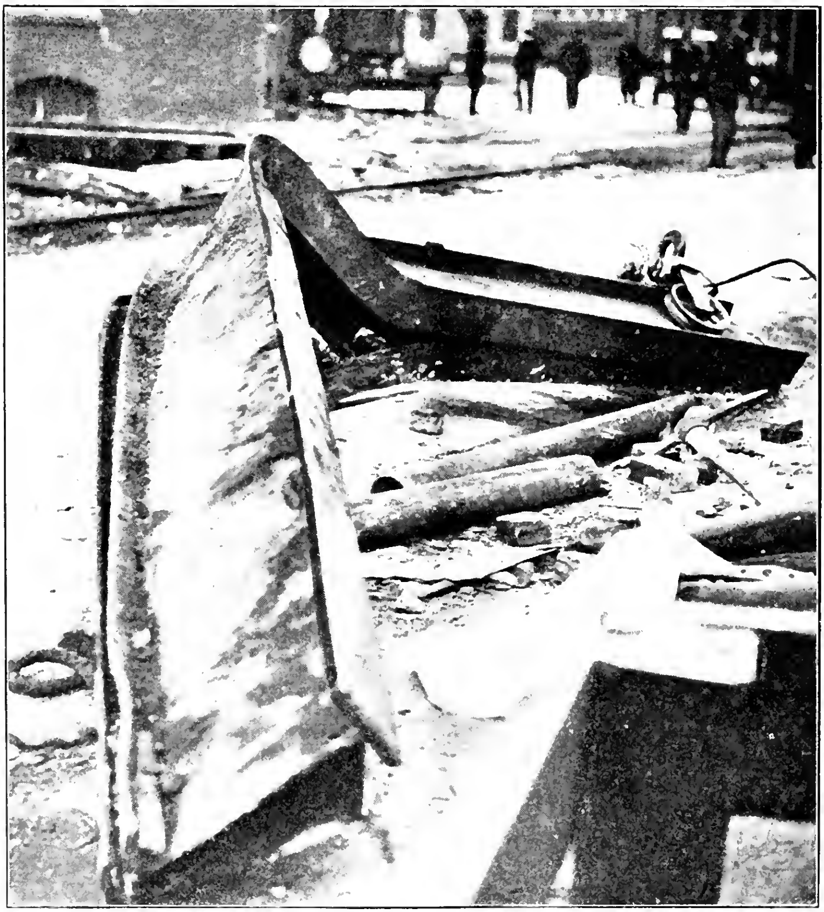


Fig. 2. General View of the Wreckage.

The economizers were installed in 1903, and were therefore 10 years old. They were operated in the customary manner, with a closed feed water heater arranged to heat the feed to a moderate temperature before it entered the economizers. Two feed pumps were used, one controlled entirely by hand, the other controlled by a pump governor actuated by feed water regulators at the boilers. A mixture of four parts buckwheat to one part bituminous coal was used, hand fired, and burned with the aid of a forced (fan) draft on the ash pits. As high a draft pressure as 2" of water was carried at times of peak load.

On the Saturday preceding the accident, a small amount of moisture was noticed coming from the soot pit of the No. 1 economizer. A leaking tube was suspected, so the chief engineer ordered this economizer cut out of service at noon time, and sent word to the makers for a man to come and make any repairs which might be needed. The operation of cutting out and draining, seems to have been properly performed according to instructions at this time. On Sunday both economizers were out of service and cool. The assistant engineer filled No. 1 with water under the city pressure (90 lbs.) and entered the casing by way of the flue, to find the leak. He discovered a slight weep in one of the tubes, determined its location, and noting that a flange joint at the inlet valve leaked, sent for a pipe fitter to repack the joint, and drained the economizer so that he might work on it. When the joint was packed, city water was again turned into the economizer to test the work. It was found to leak, the vessel was again drained, and a second unsuccessful attempt made to fix up this stubborn joint. On again filling and testing, this flange still leaked, but as it was about 6 o'clock, and the men were anxious for home, the piper made no attempt to repack, as he expected opportunity to do so during the week, while waiting for the man to replace the leaking tube. Judging by the fact that the drain or blow-off valve of this economizer was found in a closed condition after the explosion, it seems unlikely that the vessel was drained out after this last trial of the joint. It was probably forgotten in the hurry to reach home. Nothing further appears to have been done to the economizer up to the time of the explosion Tuesday afternoon.

Just before the accident, the demand for steam had been excessive, and to better meet the demand, a larger proportion than usual of soft coal had been served out in front of the fires. A 2 to 1 mixture was first tried, and just



(Courtesy of The Providence Journal)

Fig. 3. 15-Inch "I" Beams Bent by the Force of the Explosion.

Fig 4. Showing Portions of the No. 2 Economizer Standing on Its Platform Just Back of the Stack.

before the accident this was further enriched up to half and half. Whether or not some one opened the dampers through the idle economizer, in an effort to help out the draft over this peak load, will of course never be known, as the flues and dampers were so thrown about by the force of the explosion that no definite conclusion could be drawn from them.

The force of the explosion is perhaps best shown in Fig. 2. The walls of the tubular boiler room were all either thrown down, or so badly shattered as to necessitate being torn down afterwards. The end of the Stirling boiler room toward the roadway was also nearly all blown out. The idle or No. 1 economizer was blown all over the premises. Small pieces shattered ventilators, skylights, monitors, and roofs over a considerable area, while the roof over this boiler room was completely demolished. The platform which supported the No. 1 economizer was entirely blown down. Fig. 3, which shows a pair of 15 inch I beams, that served as transverse supports for this platform, at about the middle of the length of the economizer, will indicate somewhat the force of the blow. No. 2 economizer, which was working at the time, was shattered so as to be a complete loss, but it remained on top of its platform, which latter was practically intact. This is well shown in Figs. 4 and 5. It seems to prove quite conclusively that No. 1 was the actual exploding vessel. Furthermore, the resistance offered by No. 2 to the explosion, while it wrecked it (No. 2) completely, undoubtedly saved the Stirling boilers. Aside from some damage to their flue,— and that of a character which was easily repaired,—

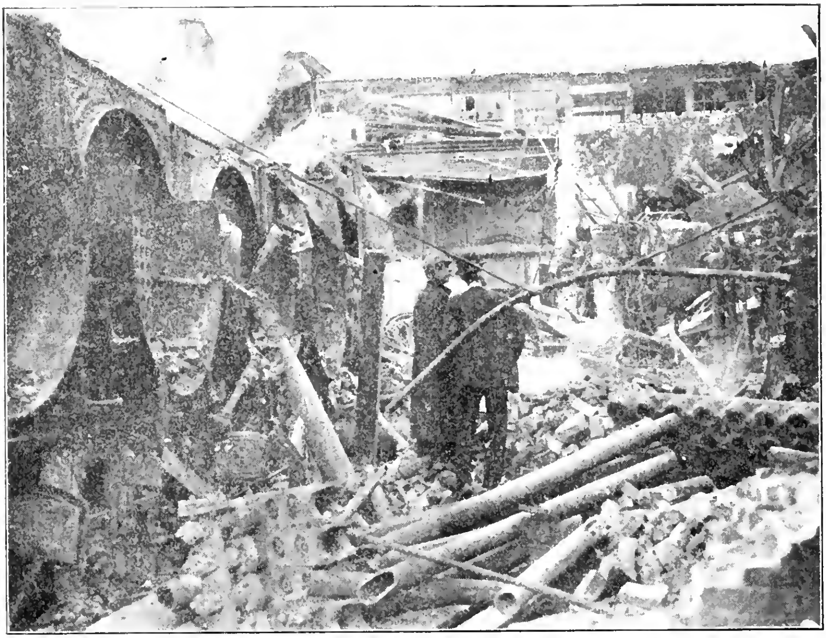

(Courtesy of The Providence Journal)

Fig. 6. Debris in Front of Tubular Boilers.

they were practically uninjured. The main blast of the explosion appears to have passed over the tops of the tubular boilers, so that, barring minor injuries to their fronts and attachments, they were undamaged. Their condition on the morning following the accident is shown in Fig. 6. A still further evidence that No. 1 was the actual exploding vessel, is offered by the fact that a large piece of top header, identified as belonging on the stack end of one or other of the economizers, was found in the coal pile across the railway track seen in Fig. 2. This fragment could not have reached its resting place from the No. 2 economizer without passing through the stack, or rising straight up in the air for a time, and then moving off sideways in direct defiance of the laws of falling bodies. It weighed 1177 lbs. and traveled horizontally about 160 feet.

It is very difficult when a cast iron structure is wrecked as completely as was this one, to determine the course of the explosion. Cast iron breaks with a clean fracture, and tells very little either as to the kind or direction of the blow. Steel boilers usually tell us a pretty direct story of what happens. but it was here impossible to tell from the fragments of the economizer, whether the explosion was caused by a source of energy *within* or *surrounding* the tubes. It was only from the evidence of the supporting structure that a conclusion could be drawn as to the cause of the explosion, and this seemed to point toward a steam pressure generated within the No. 1 economizer, a conclusion which is in accord with other known facts, notably the closed condition of the blow-off.

Explosion of Sulphite Digester

W. R. C. Corson.

On December 22, 1912, a sulphite digester at the plant of the Laurentide Company, Limited, at Grand Mere, P. Q., exploded with terrific violence. Three

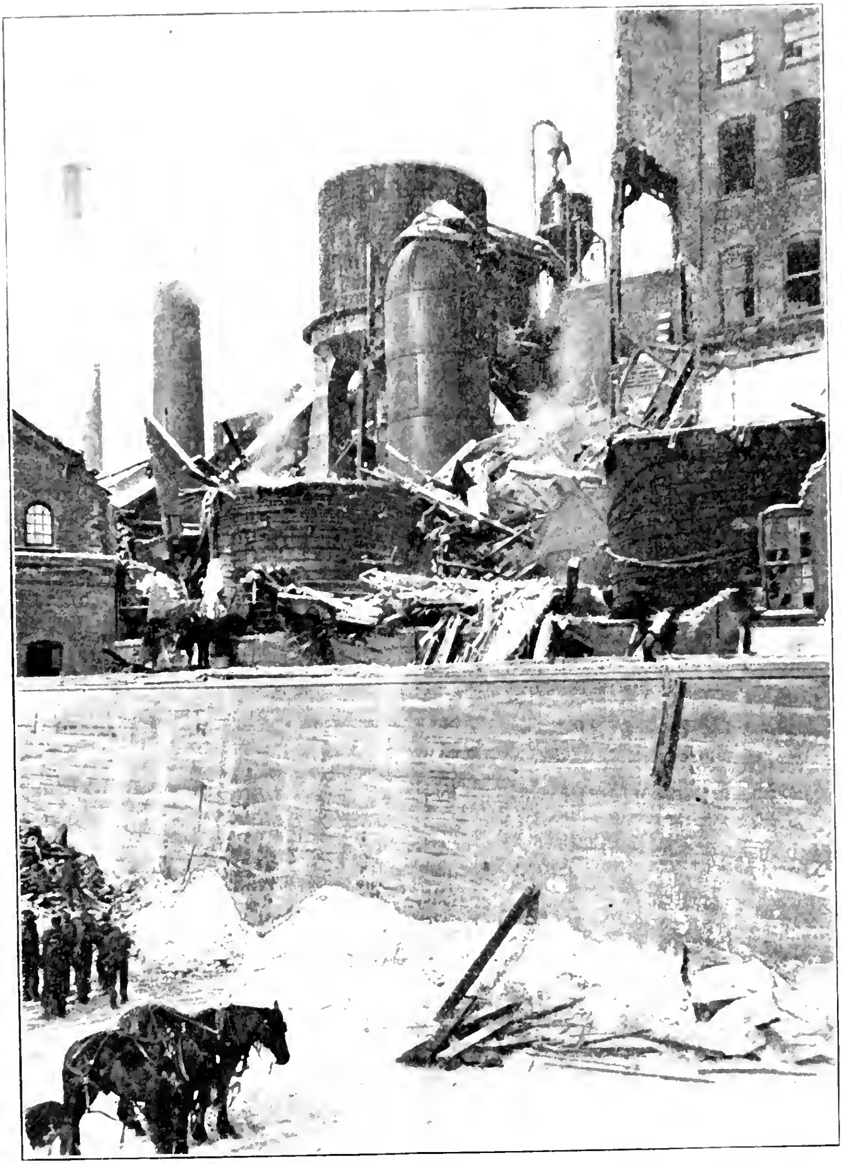


Fig. 1. General View of the Destruction at Grand Mere.

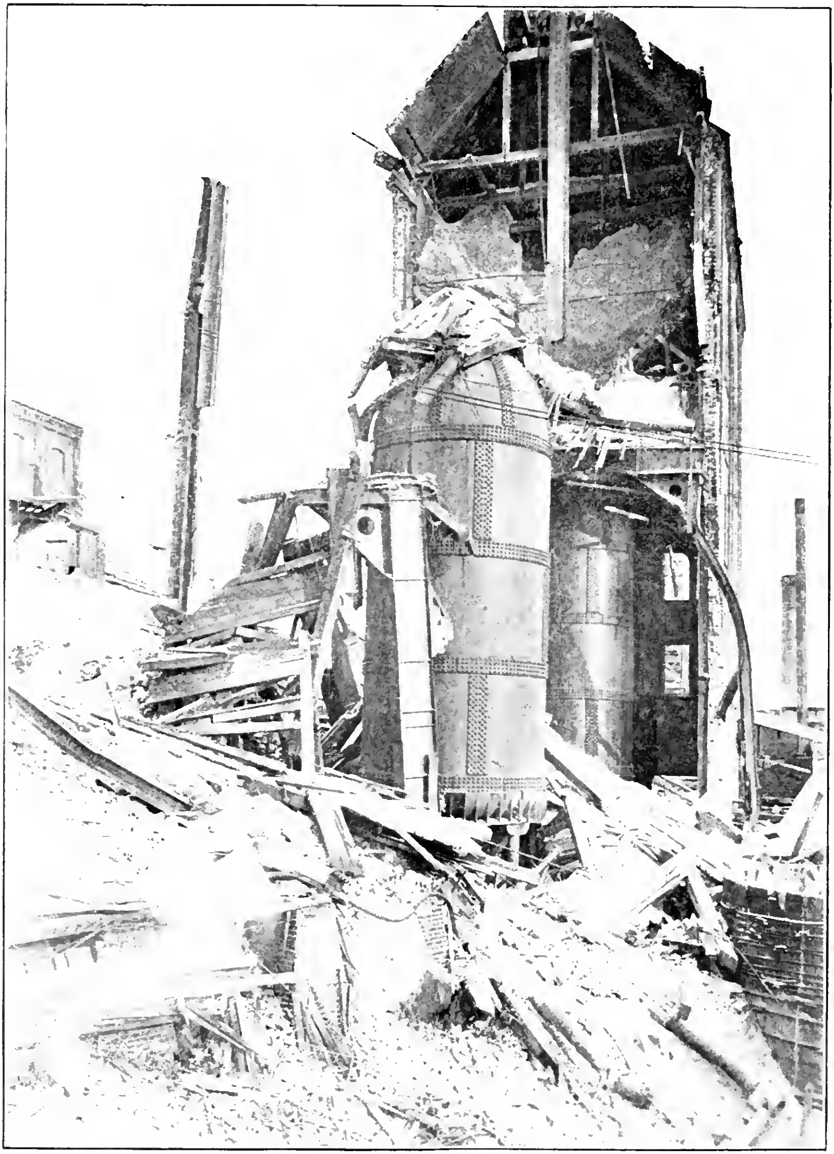


Fig. 2. View Looking into the Wrecked Digester House.

employees were killed and two were more or less seriously injured and property was destroyed to the value of eighty thousand dollars. That greater loss in killed and injured has not to be recorded is due to the fortunate time of the occurrence,— on a Sunday evening when the number employed in the mills was at a minimum. Figs. 1 and 2 will give a general idea of the extent of the damage.

A Sulphite digester is a vessel especially designed for the production of wood pulp by the acid process. It consists essentially of a vertical steel shell, lined with brick and cement, which is filled with the wood chips from which the pulp is to be made. Sulphurous acid is introduced and then the mass of acid and chips is brought to a "cook" by the introduction of live steam,— the final pressure reaching from 80 to 100 lbs. per sq. inch. The fact that these vessels are subject to the action of the corrosive acid, should the lining leak, added to the great size of the vessels themselves and the consequent large amount of energy stored in them, has always caused the fear that the explosion of one would be a disaster indeed.

Such proved to be the case with the Laurentide Company's digester. It was one of three such vessels which were installed about fourteen years ago. It was 14 ft. in diameter and 45 ft. high, protected by an inside lining of lead against the shell with two layers of vitrified brick inside the lead lining.

As was customary on Sundays the vessel had been shut down and allowed to cool so as to permit the entrance of an attendant to examine and repair the brick lining. At about five o'clock in the afternoon it had been filled with chips and steam was turned on. The cooking process was proceeding as usual and had reached a point where the internal pressure was about 80 lbs. per square inch, when at about ten p. m. the vessel exploded.

The digester house in which the vessel was located was almost completely destroyed, as was the adjoin-

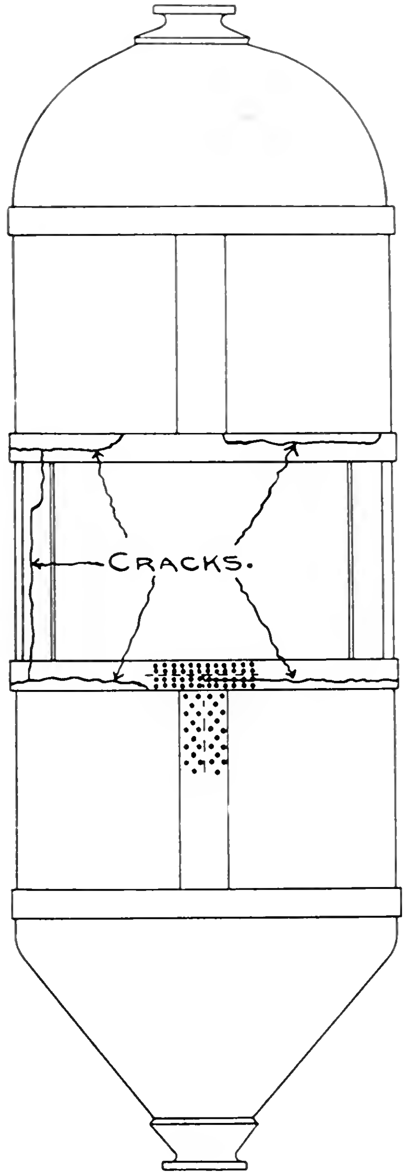


Fig. 3. Elevation of Digester Showing Location of the Lines of Failure.

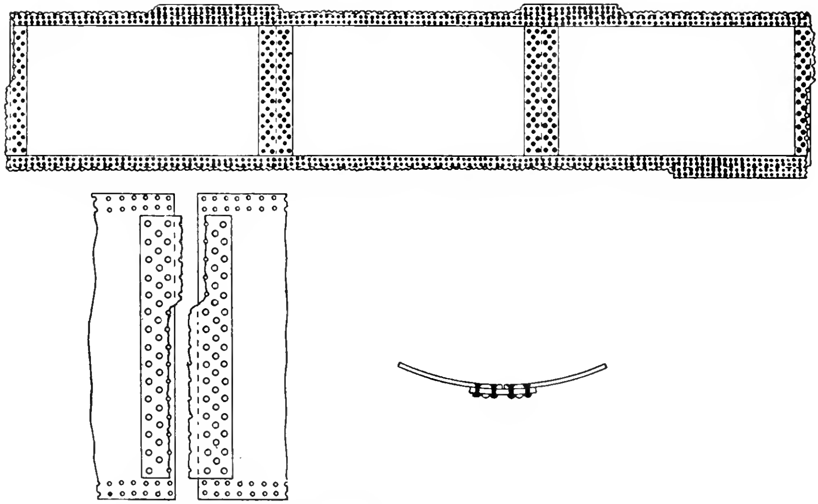


Fig. 4. Details of Course Which Failed.

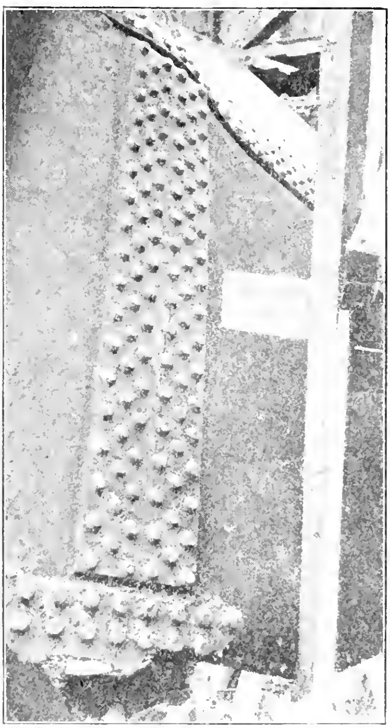


Fig. 5. Cracked Butt-Strap.

ing blowpit house with its contents. Others of the mill buildings in the vicinity were more or less badly damaged. One of the two old digesters remaining had its supporting columns so broken that, while it did not fall, it threatened to do so for days after the accident. The second of the old digesters however escaped with slight injury and a new digester, the erection of which was not quite completed, fortunately received no damage.

A close examination of the parts of the wrecked digester gave evidence that the initial failure had occurred at the cover plate of a longitudinal seam on the center one of the three cylindrical courses. These digesters were all of a construction common at the period when they were installed. Because of the lead lining, it was regarded as essential that the inside surfaces should be flush. The joints were accordingly made by butting the sheets and with a single outside cover plate over the joints. In the exploded digester one of these cover plates had failed by cracking along the line of the rivet holes, and from the direction in which the exploded sheet was thrown, it was evident that this cover plate was the place of initial failure. In tearing from the other sheets, in every case cover plates failed while the sheets themselves did not. This is well brought out in Figs. 3 and 4, which show the way in which these cracks ran along the straps. As these plates were thicker than the sheets and should have been expected to withstand the greater strain, their failure to do so suggested an inferiority of material which an analysis has confirmed. Fig. 5 shows one other strap on this course which cracked but did not let go. Strangely enough the interior of the steel shell showed no corrosion. The lead lining, in this case at least, seems to have protected the steel thoroughly.

The fact that the cover plates of the joints gave way as we have described, and that a close examination discovered evidence of similar cracks in the straps of other digesters will arouse renewed apprehension in the minds of owners and insurance companies for digesters of a similar construction built from twelve to twenty years ago.

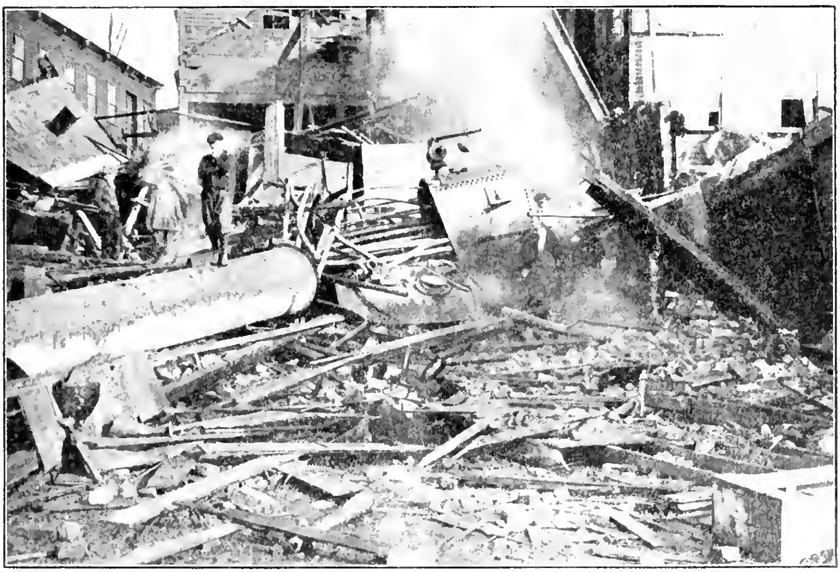


Fig. 1. Boiler Explosion at Keene, N. H.

Another Lap Seam Explosion

Our photograph shows the result of the explosion, on Friday, Dec. 6, 1912, of a boiler at the plant of the Keene Glue Company, Keene, N. H.

The boiler was of the horizontal return tubular type, in three courses 66 inches in diameter with tubes 16 feet long, and was made with double riveted lap seams for its longitudinal joints. We are told that there was plain evidence of an old lap crack, which extended nearly through the metal of the middle course, and which was located in solid plate, inside the inner row of rivets, but under the inner lap, so that it could not have been seen by either an internal or an external inspection. The boiler is said to have been otherwise in excellent condition for its age (twenty years) and to have been provided with the proper safety attachments in good order. The condition of the fusible plug, in conjunction with the violence of the explosion, confirms the statement of the fireman that there was an abundance of water.

The setting and boiler house, together with a frame addition to the mill were demolished, and a 42 inch steel stack was thrown down and considerably jammed. The boiler, however, did not move endwise, but dropped in its tracks as it were.

Press accounts state that the boiler was used only for heating, and that a pressure of 40 lbs. was carried at the time of the accident. The fireman had been called to another part of the mill to repair a belt, and probably owes his escape to this fortunate circumstance.

The report in the local paper states also that the boiler had been jacked up some six weeks previous to the accident so that repairs could be made to its setting. This may have had nothing to do with the explosion, but it is possible that a new distribution of stress on the supporting lugs, due to the resetting, may have opened up an old sore, and prepared the way for the explosion at this particular time.

Experience teaches that "second hand" lap seam boilers are, if anything, more given to explosions of this sort, than those which have been allowed to remain in their original settings. We are sometimes asked why we will permit an old boiler of this type to work at some stated pressure so long as it remains in place, but insist on a material pressure reduction if it is removed and reset. Our reason is a fear of the effects of just such a new distribution of stress as we have mentioned, and this position is abundantly supported by statistics.

Violent Boiler Explosion at Howland, Me.

On January 20, 1913, at about 8.30 A. M., two boilers exploded at the plant of the Howland Pulp and Paper Co., Howland, Me. The boilers which failed were Nos. 2 and 3 in a battery of five horizontal return tubular boilers used to supply steam both for power and pulp making. Two other boilers of the vertical fire tube type stood in an adjoining boiler room. At the time of the accident, boiler No. 2, which had been out of service, was being brought up to pressure to be cut in on the line. It is stated that its pressure was 65 lbs. a few minutes before the explosion.

The explosion destroyed the boiler house, pump house, electrical plant, and engine room. It knocked down two steel stacks, and did some damage to the ends of the acid and sulphur houses. In addition to the property loss two men were killed, and two others injured.

There is some doubt as to which of the boilers first gave way. Witnesses testified to a double report like two pistol shots in rapid succession. It is probable, from the appearance of the failures, that one of the boilers exploded first, and struck its neighbor a blow of sufficient violence to set it off. Both the exploded boilers were of lap seam construction, built in five courses with outside cast iron man-hole frames attached to the third course. Both of them failed through the man-hole frame, and each man-hole course was ripped longitudinally from girth seam to girth seam, through the center line of the man-hole open-

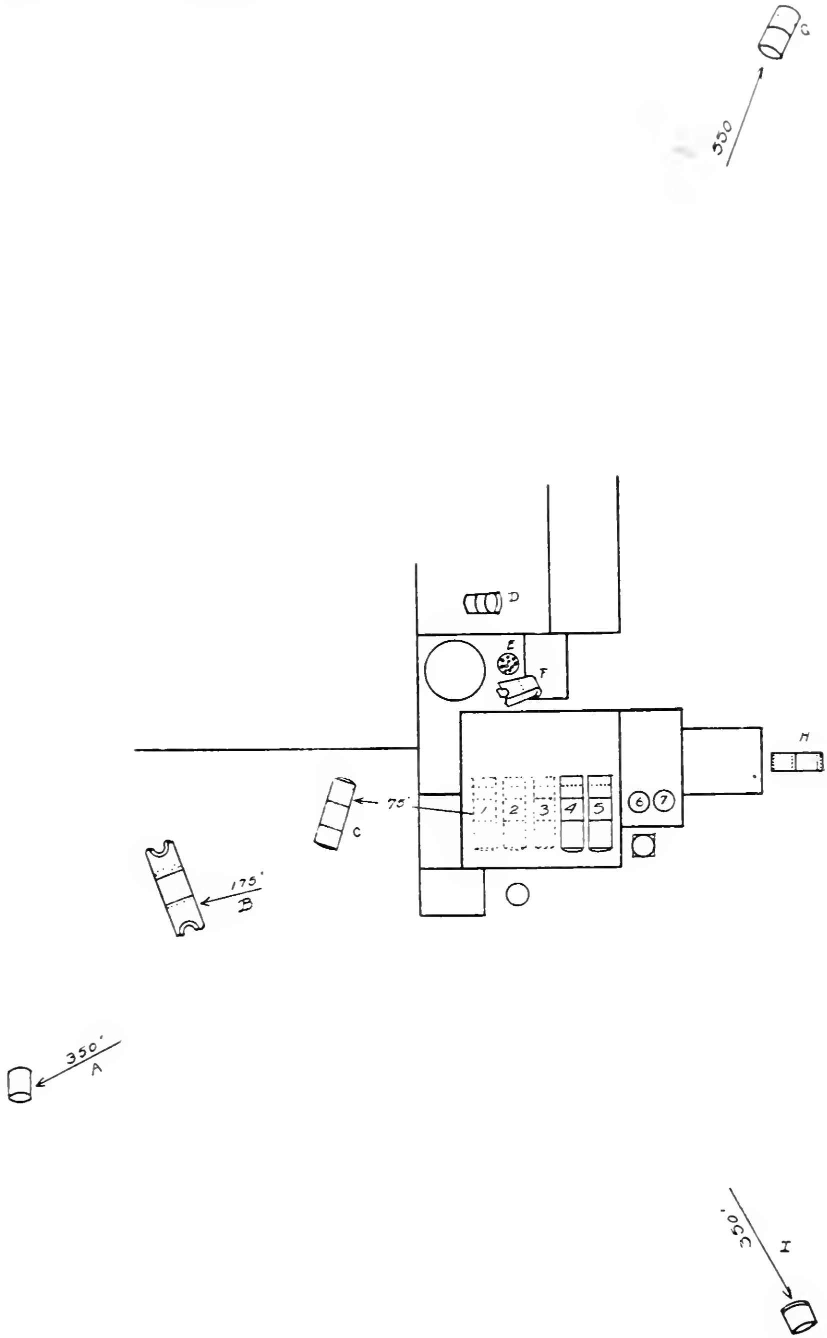


FIG. 1. PATHS OF PROJECTED BOILER COURSES.

Fig. 2. Course "E" and Its Load of Tubes.

ing. The other courses were in large part separated each from the other by the shearing of the rivets. Indeed, with the exception of a small fragment which was torn out and left attached to one course, no portion of any other sheet than the man-hole courses mentioned above was torn in any way.

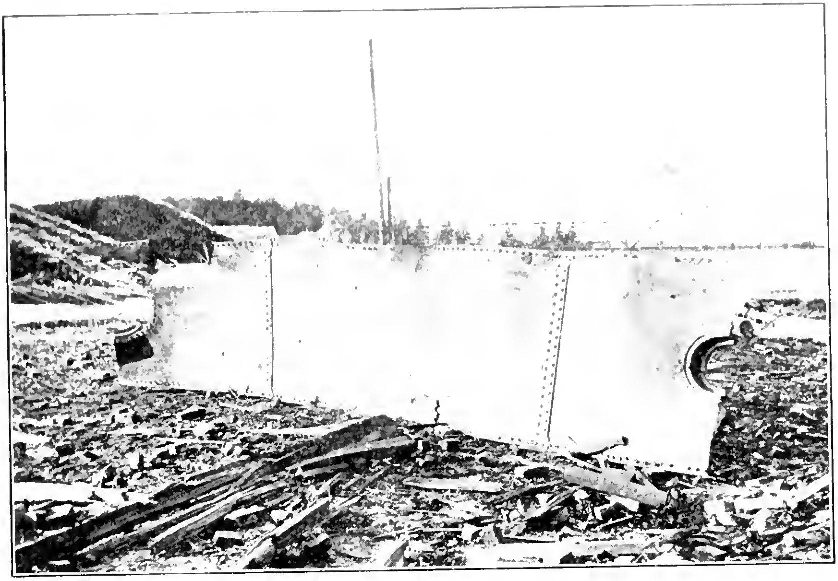


Fig. 3. Ruptured Manhole Course "B."

Fig. 4. Wrecked Boiler House.

The extent to which the boilers were disrupted and thrown about will be best shown by a consideration of the sketch plan. Fig. 1, which shows where the different portions fell after the explosion, with reference to their original position. The dotted lines in the boiler house show the boilers as they were previous to the accident. "C" represents boiler No. 1, which, although it did not itself explode, was blown out of its setting and thrown bodily for some seventy feet. "I", "G", "F", and "E", were identified as the remains of boiler No. 3, while "A", "B", and "D", were the parts of boiler No. 2. It is not absolutely certain that the man-hole courses "B" and "F" are properly identified in the above list, since there were neither torn edges nor any other means of matching them to the remaining courses. The course marked "E" in the sketch is that shown in Fig. 2. It apparently started off in company with the portion marked "G", but was not very firmly attached to it. When "G" had gotten well under way in its rocket-like flight, this course seems to have dropped at the place indicated, and carried with it practically all the tubes of the boiler as the photograph indicates. Fig. 3 shows the man-hole course marked "B" in the sketch plan. It gives an excellent idea, both of the way in which these man-hole courses failed and of the cleanness with which the girth seam rivets sheared. Fig. 4 shows the ruined boiler room, with boilers 4 and 5 under the debris of their settings, as well as the vertical boilers 6 and 7 still in position. One of the fallen stacks is seen in the foreground.

The safety valve of No. 2 boiler was found after the explosion, and was in good working order. It is also known that boiler No. 3 was connected with the rest of the battery, and that the safety valves were blowing freely a short time before the accident. These two facts seem to render any theory of over-pressure untenable. No thoroughly satisfactory explanation has yet been offered, and we doubt if the exact cause of the accident will ever be known.

On Laying Up a Heating Boiler for the Summer

During the summer season, the only enemy a heating boiler need face is corrosion. This enemy is, however, particularly active at that time, and must be fought vigorously, both inside and out.

On the fire side, soot and ash should be thoroughly removed. It is not sufficient to hit the high places with a shovel, but the whole external surface of the boiler should be swept clean with a broom, and this treatment should extend to the furnace, the ashpit, and if the boiler is set in brick, to every nook and cranny of the setting. The boiler surface itself should, in addition, receive a good brushing with a stiff wire brush, to remove all soot and ash, together with any loose iron rust, right down to the surface of the metal. The reason for this treatment is that soot and ash are great absorbers of moisture from the air, and have an excellent opportunity to do this in a cool cellar during the spring and summer. On damp days, the cool metal sweats exactly as a pitcher of cold water sweats in a warm room. This moisture, condensed from the air, is at once absorbed by the soot and ash, and in either case the result is a solution which is very corrosive to iron or steel. The corrosive action, begun in this way, will continue throughout the season, unless the cause is removed in the manner we have indicated.

The inside surfaces of boilers are also subject to corrosion in the summer time. If a boiler is left with the water at the steaming level, just as it was when the fire died out, corrosion will be much more active than it would be under steam, because the water is absolutely at rest, and little pits of rusting, once started, continue without interruption. It has been frequently stated that a boiler full of water will be free from corrosion. This statement, if confined to the inside surface, and applied to a boiler quite full of pure, air free water, is perhaps true. The difficulty, however, with a boiler laid up in this fashion, is the greatly increased tendency toward sweating which it exhibits, owing to the fact that a large body of water does not readily follow the fluctuations in the air temperature, and so remains for much of the season, not only colder than the air but colder than an empty boiler would have been. In this way a full boiler will be much more subject to external corrosion than if empty. So the safest method of procedure seems to be to first empty the boiler, propping open the safety valve, then leave the blow off open, and if there is any doubt as to the tightness of the feed valve, that is, if there is any danger of water getting back into the boiler from the city mains, it is perhaps best to make sure of this point by disconnecting the feed line. The boiler should be as carefully drained as possible, and in the case of a tubular boiler, the hand and man hole covers should be removed, because if small pools of water are allowed to remain in the bottom, corrosion will be especially active, from the fact that the water has, relatively, so great a surface exposed to the air, that it can dissolve up more air as fast as its supply is exhausted by combination with iron.

It is desirable for the man operating a heating system to go carefully over his valves, piping, and radiators, while still under steam near the end of the season in order that he may mark the location of all defects and leaks, so that new valve stem packings, new parts, leaking joints, etc., may be repaired during the summer and unpleasant delays avoided in the fall when, on some cold morning, the heater is wanted in a hurry.

Inspection Service Rendered During 1912

The tables below give, as is usual at this time of the year, the total number of visits of inspection, the total number of boilers inspected and other similar statistics gathered from our inspection records, for the year 1912. These figures are worthy of consideration, inasmuch as they show something of the frequency with which one may expect to find the various defects listed among any representative number of American boilers. These results are gathered from so many boilers, and these so distributed over the country, that the effects of local conditions largely disappear in the totals.

A glance at the table on page 178 will yield some interesting information. For example, in 17/18 of all the visits made, a defect was found which was deemed of sufficient importance to report. Further, of the 164,924 defects reported, 18,932, or just over 11%, were considered dangerous at the time of the inspector's visit. As we have shown many times before, by far the most frequent troubles have their origin in the feed water, or the method of using it, a fact which is evidenced by the large number of instances in which scale or sediment and corrosion are found.

Summary of Inspectors' Work for 1912.

Number of visits of inspection made	183,519
Total number of boilers examined	337,178
Number inspected internally	132,984
Number tested by hydrostatic pressure	8,024
Number of boilers found to be uninsurable	977
Number of shop boilers inspected	10,098
Number of fly wheels inspected	14,567
Number of premises where pipe lines were inspected	4,200

Summary of Defects Discovered.

Nature of Defects.	Whole Number.	Dangerous.
Cases of sediment or loose scale	26,299	1,553
Cases of adhering scale	40,336	1,436
Cases of grooving	2,700	252
Cases of internal corrosion	15,403	823
Cases of external corrosion	10,411	895
Cases of defective bracing	1,391	331
Cases of defective staybolting	1,712	345
Settings defective	8,119	768
Fractured plates and heads	3,288	510
Burned plates	4,965	517
Laminated plates	445	55
Cases of defective riveting	1,816	405
Cases of leakage around tubes	10,159	1,607
Cases of defective tubes or flues	11,488	4,780
Cases of leakage at seams	5,304	401
Water gages defective	3,663	816
Blow-offs defective	4,429	1,398
Cases of low water	447	151
Safety-valves overloaded	1,349	380
Safety-valves defective	1,534	419
Pressure gages defective	6,765	568
Boilers without pressure gages	633	102
Miscellaneous defects	2,268	420
Total	164,924	18,932

Grand Total of the Inspectors' Work from the Time the Company Began Business, to January 1, 1912.

Visits of inspection made	3,312,922
Whole number of inspections (both internal and external)	6,750,765
Complete internal inspections	2,651,906
Boilers tested by hydrostatic pressure	307,876
Total number of boilers condemned	22,597
Total number of defects discovered	4,152,904
Total number of dangerous defects discovered	428,971

Summary of Inspectors' Work since 1870.

Year.	Visits of inspection made.	Whole number of boilers inspected.	Complete internal inspections.	Boilers tested by hydrostatic pressure.	Total number of defects discovered.	Total number of dangerous defects discovered	Boilers condemned.
1870	5,439	10,569	2,585	882	4,686	485	45
1871	6,826	13,476	3,889	1,484	6,253	954	60
1872	10,447	21,066	6,533	2,102	11,176	2,260	155
1873	12,824	24,998	8,511	2,175	11,998	2,892	178
1874	14,368	29,200	9,451	2,078	14,256	3,486	163
1875	22,612	44,763	14,181	3,149	24,040	6,149	216
1876	16,409	34,275	10,669	2,150	16,273	4,275	89
1877	16,204	32,975	11,629	2,367	15,964	3,690	133
1879	17,179	36,169	13,045	2,540	16,238	3,816	246
1880	20,939	41,166	16,010	3,490	21,033	5,444	377
1881	22,412	47,245	17,590	4,286	21,110	5,801	363
1882	25,742	55,679	21,428	4,564	33,690	6,867	478
1883	29,324	60,142	24,403	4,275	40,953	7,472	545
1884	34,048	66,695	24,855	4,180	44,900	7,449	493
1885	37,018	71,334	26,637	4,809	47,230	7,325	449
1886	39,777	77,275	30,868	5,252	71,983	9,960	509
1887	46,761	89,994	36,166	5,741	99,642	11,522	622
1888	51,483	102,314	40,240	6,536	91,567	8,967	426
1889	56,752	110,394	44,563	7,187	105,187	8,420	478
1890	61,750	118,098	49,983	7,207	115,821	9,387	402
1891	71,227	137,741	57,312	7,859	127,609	10,858	526
1892	74,830	148,603	59,883	7,585	120,659	11,705	681
1893	81,904	163,328	66,698	7,861	122,893	12,390	597
1894	94,982	191,932	79,000	7,686	135,021	13,753	595
1895	98,349	199,096	76,744	8,373	144,857	14,556	799
1896	102,911	205,957	78,118	8,187	143,217	12,988	663
1897	105,062	206,657	76,770	7,870	131,192	11,775	588
1898	106,128	208,990	78,349	8,713	130,743	11,727	603
1899	112,464	221,706	85,804	9,371	157,804	12,800	779
1900	122,811	234,805	92,526	10,191	177,113	12,862	782
1901	134,027	254,927	99,885	11,507	187,847	12,614	950
1902	142,006	264,708	105,675	11,726	145,489	13,032	1,004
1903	153,951	293,122	116,643	12,232	147,707	12,304	933
1904	159,553	299,436	117,366	12,971	154,282	13,390	883
1905	159,561	291,041	116,762	13,266	155,024	14,209	753
1906	159,133	292,977	120,416	13,250	157,462	15,116	690
1907	163,648	308,571	124,610	13,799	159,283	17,345	700
1908	167,951	317,537	124,990	10,449	151,359	15,878	572
1909	174,872	342,136	136,682	12,563	169,356	16,385	642
1910	177,946	347,255	138,900	12,779	169,202	16,746	625
1911	180,842	352,674	140,896	12,724	164,713	17,410	653
1912	183,519	337,178	132,984	8,024	164,924	18,932	977

The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

C. C. Perry, Editor.

HARTFORD, APRIL, 1913.

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The Locomotive of The Hartford Steam Boiler I. & I. Co.

Victor Hugo

It is with deep regret that we record the death of Victor Hugo, manager of the Southwestern Department of our Company, which occurred on January 31st, 1913, at his home in St. Louis, Mo., after a brief attack of pneumonia. The news of this event when it reached us was so sudden and unexpected — many of us had his unanswered letters on our desks — as to leave us profoundly shocked and stunned and without full realization of the loss we had suffered. Now that a few weeks have passed we are better able to appreciate the void that has been made in our organization and the personal loss that those of us have sustained who were privileged to enjoy his friendship.

Mr. Hugo was born at Kingston, Ontario, on November 20th, 1873. He was the son of T. W. Hugo, who in 1881 moved with his family to Duluth, Minn., where he is, as he has been for many years, the valued representative of our Company. Victor Hugo received his education in the public schools of that city and at the University of Minnesota, from which he graduated in 1896, with the degree of Bachelor of Mechanical Engineering. He entered the Chicago inspection force of the HARTFORD Company in 1898. Late in the following year he was transferred to St. Louis and shortly after was appointed Chief Inspector of that Department. On January 1st, 1905, he was promoted to the position of manager.

Punctuality, order and unreserved loyalty were Victor Hugo's prominent characteristics and made for efficiency in his management of affairs. His education and experience were along engineering and mechanical lines and his ability and thorough acquaintance with the practice and technique of steam engineering made him especially valuable in his work for our company. But Mr. Hugo was not merely a technically trained man. He knew and enjoyed much of the best of art and literature and thus added the charm which we call culture to his more fundamental characteristics. In manner he was reserved but gave himself freely to those who were admitted to his friendship. He possessed a quaint humor which frequently found expression in his conversation and letters, and which was a delight to his friends and hearers.

Mr. Hugo was a member of the American Society of Mechanical Engineers and an active member of the Public Recreation Commission of St. Louis, where his advice and counsel was of the greatest value. He was married to Miss Virginia Magoffin in April, 1899, who with two children survives him.

At the time of the year when legislatures are in session, all business interests are subject to the caprice or deliberate attack of any one who can write out a bill and hand it for introduction to some member of a legislature. Some of these bills slip through without opportunity to the parties most affected, for a hearing, or a chance to have their side of the case properly presented before the members of the legislature who are not of a committee specially appointed to represent a particular interest.

The matter of the inspection of boilers is one that vitally affects every person or corporation using steam, whether for power or heating purposes, as well as persons employed with or in the vicinity of boilers. Every boiler should be inspected by a competent inspector. That is fundamental and obvious. Laws for this purpose have been passed in a number of states. Most of them recognize as sufficient an inspection by an insurance company that is authorized to insure and inspect boilers in the state. We feel that such recognition should be universal. Those who are familiar with boiler inspection, especially the owners of large boiler plants, know that the service of the insurance companies is beyond comparison with that rendered by the inspectors of the average state or city department, subject as they are to political selection and influences. The political inspector, whose efficiency is not influenced by the commercial necessity of his employer, is not obliged to work nights, Sundays, or holidays, and so, plants which he inspects are subject to the inconvenience of a shut down during business hours, or to a substantial addition to the statutory fee for such an inspection if it is made at a more convenient time.

It would seem that an interesting rivalry exists between associations of stationary engineers and boiler makers over the securing of boiler inspection legislation. The main difference between the bills introduced is that those presented by the engineers provide that the state inspectors shall have had many years' experience in the state as stationary engineers, while the bills put forward by the boiler makers make a similar limitation confining the appointees practically to boiler makers. The editor of the "Boiler Makers' Journal" says in the February number: "Boys get busy! Act at once, and let the editor know what action you have taken and the replies you get from the legislature;" "the engineers' society will continue their efforts and we may see the spectacle of an engineer trying to inspect boilers in this state!"

Many of The Hartford Steam Boiler Inspection and Insurance Company's inspectors and mechanical experts are or have been members of these several organizations. The Locomotive does not wish to appear as taking sides in this rivalry, nor as attempting to discourage efforts to secure the passage of proper inspection bills. We do feel, however, that an *additional* inspection of *insured* boilers by state inspectors, serves no proper purpose, places unnecessary trouble and expense on the boiler owners, and would be the cause of needless loss of time on the part of the employees of such establishments; and that the only unselfish object of any such legislation — the safeguarding of boiler operation,— would be best obtained by the rival interests laying aside their petty differences over the creation of lucrative positions for their members. They should act together, and with other interested business men and employees exert themselves for the passage of inspection bills which will best serve the interests of the whole community, and for the appointment to such positions as will necessarily be created thereunder of men whose recommendation is efficiency, and not membership in any particular organization.

Personal

We announce the appointment of Mr. C. D. Ashcroft to the position of manager of the St. Louis department. Mr. Ashcroft joined the forces of the Hartford as special agent in the Louisville, Ky., office in 1907. From there he went to the managership of the Pittsburg department in 1911 and now leaves to take charge of the Southwestern territory.

Mr. J. J. Graham, who has been connected with the Cleveland department since 1906, first as inspector and later as special agent, will succeed Mr. Ashcroft as manager of our department at Pittsburg.

In the St. Louis department, Mr. J. P. Morrison, who has served there as inspector since 1901, becomes Chief Inspector, a position for which his long field experience fits him admirably.

Summary of Boiler Explosions for 1912

We print in this issue, our usual summary of our explosion list for the year 1912. This list is made up from press clippings, and from our own loss files. It should not be considered, however, that these explosions are all of them from boilers that we insure, for, quite to the contrary, the majority of the violent explosions are the result of conditions which might have been foreseen had the boiler received regular and thorough inspections. We endeavor to make this list as complete and as accurate as possible, each item is considered in the light of all the information available, and an effort made to get at the real facts. In computing the number of persons killed and injured, we have, as heretofore, considered the fatally injured as killed, and wherever the statement is made in a press account that "several were injured" we have considered "several" to mean three. This number was arrived at some years since, as the average number injured in an explosion, and as our other lists have been based on this assumption, we have continued on that basis, so that our statistics will be comparable from year to year.

Summary of Boiler Explosions for 1912.

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	90	19	44	63
February	47	11	22	33
March	47	56	57	113
April	39	28	36	64
May	25	11	18	29
June	24	27	30	57
July	36	21	30	51
August	30	12	16	28
September	30	13	21	34
October	56	23	38	61
November	47	23	34	57
December	66	34	46	80
Totals	537	278	392	670

Boiler Explosions

November, 1912.

(425.) — On November 2, an accident occurred to one of the boilers on the U. S. S. Vermont, near Norfolk, Va. Two men were killed, and four others seriously scalded.

(426.) — Four sections of a sectional heating boiler ruptured at the armory owned by U. A. Woodbury, Burlington, Vt., on November 2.

(427.) — A traction engine exploded November 4, at Indianapolis, Ind. John O'Donnell, the engineer, was fatally injured, and one other was badly bruised. Three houses are said to have been damaged by the explosion.

(428.) — On November 4, an accident occurred to a boiler at the Chagrin Falls, O., power plant of the Cleveland, Youngstown, and Eastern Ry. Co.

(429.) — A severe accident occurred November 4 to a boiler at the mill of the West Yellow Pine Co., Olympia, Ga. Three men, P. M. Dorman, watchman; R. C. Wetherington, oiler; and Lucius Johnson, fireman, were injured.

(430.) — About November 5, an accident occurred to a cast iron sectional heating boiler at the Polish Catholic School, New Britain, Ct.

(431.) — A tube ruptured November 5, in a water tube boiler at the plant of the Baldwin Locomotive Works, Philadelphia, Pa. The damage was small.

(432.) — A boiler exploded November 6, at the saw mill of B. B. Saunders, Pine Bluff, Ark. The owner and Arthur Ray, fireman, were killed, while three others were injured.

(433.) — A tube failed November 6, at the plant of the Charleston Water and Light Company, Charleston, S. C. No one was injured, but the city of Charleston was left without water for a short time.

(434.) An escape valve ruptured November 7 at the State Normal School, Bridgewater, Mass. Some of the girls became panic stricken, but no damage was done.

(435.) — A boiler exploded November 8, at the Chickasha Gin, owned by the Chickasha Gin Co., Headrick, Okla. Two men were seriously injured, and considerable damage was done to the buildings and plant of the Gin.

(436.) — On November 9, a section cracked in a cast iron sectional heater in the office building owned by Mary S. Tuttle, Greenville, S. C.

(437.) — Three sections fractured November 9, in a cast iron sectional heating boiler at the store and apartment building of Samuel M. Samuels and Isaac Weinstein, New York City.

(438.) — Three tubes ruptured November 10, in a water tube boiler at the plant of the Carsten Packing Co., Tacoma, Wash.

(439.) — A tube ruptured November 11, in a water tube boiler at the plant of the Illinois Steel Co., Joliet, Ill. Mike Cervenok, fireman, was scalded.

(440.) — A boiler exploded November 11, at the mill of the Milltown Lumber Co., Milltown, Ga. The property damage was about $6,000. Two men were killed and five injured.

(441.) — On November 12, a tube ruptured in a water tube boiler at the Eureka Colliery, No. 36, of the Berwind White Coal Mining Co., Windber, Pa.

(442.) — The crown sheet of a locomotive type boiler collapsed November 12, at the Round House of the Great Northern R. R., Sioux City, Ia.

(443.) — A boiler ruptured November 12, at the plant of the Norcona Mill and Gin Co., Norcona, Tex. The damage was confined to the boiler.

(444.) — The boiler of Freight Locomotive No. 469 of the Virginian R. R. exploded November 15, near Lafayette, Va. Two men were killed, and one other seriously injured.

(445.) — On November 16, a tube ruptured in a water tube boiler at the plant of the Gutta Percha and Rubber Mfg. Co., Brooklyn, N. Y.

(446.) — On November 16, four tubes pulled out of a drum in a water tube boiler at the Auxiliary Power Plant of the Utah Light and Railway Co., Salt Lake City, Utah. Serious damage was done to the boiler, requiring expensive repairs.

(447.) — A boiler exploded November 18, in the wood fiber mill of Albert Widdis, East Tawas, Mich. Two men were killed, and two others seriously injured.

(448.) — Three sections ruptured November 18, in a cast iron heating boiler at the Theatre of the Utica Hippodrome Amusement Co., Utica, N. Y.

(449.) — Three cast iron headers ruptured November 19, in a water tube boiler at the Collinsville, Ill., plant of the National Lead Co.

(450.) — On November 19, a tube ruptured at the plant of The Connecticut Web and Buckle Co., Bridgeport, Ct.

(451.) — Locomotive No. 6378 of the Big Four was wrecked by the explosion of its boiler November 19, at Anderson, Ind. Three men were injured.

(452.) — A heating boiler exploded in the basement of the jewelry store of V. J. Pekor, Columbus, Ga., on November 19. There were no serious personal injuries, but the property loss was considerable.

(453.) — The boiler of a locomotive belonging to the Ten Mile Lumber Co., exploded November 19, near Gulfport, Miss. Four men were killed.

(454.) — On November 19, a boiler exploded at the plant of the Warren Dried Fruit Co., San José, Cal. No one was injured.

(455.) — A tube ruptured November 20, in a water tube boiler at the plant of the American Steel and Wire Co., Waukegan, Ill.

(456.) — A tube ruptured in a water tube boiler, on November 20, at the plant of the Minnising Paper Co., Minnising, Mich. Considerable damage was done to the boiler, and Michael Micholik, fireman, was injured.

(457.) — A boiler is reported to have exploded near Mobile, Ala., on November 20. Four men were said to have been killed. We have been unable to obtain any more specific information than this concerning this particular accident, but include it in the list, as the information comes from several sources.

(458.) — On November 22, a tube ruptured in a water tube boiler at the plant of the Aurora, Elgin, and Chicago Electric Ry. Co., Batavia, Ill. D. S. Stafford, laborer, was injured.

(459.) — A cast iron header ruptured November 22, in a water tube boiler at the plant of the Plankington Electric Light and Power Co., Milwaukee, Wis.

(460.) — A boiler exploded November 22, in the municipal power plant at Neosha River, belonging to the city of Iola, Kans. One man was injured, and the city was in darkness for several hours.

(461.) — A boiler ruptured November 23, at the plant of the Minneapolis Water Co., Minneapolis, Kans.

(462.) — On November 25, a section fractured in a cast iron sectional heater in the apartment building of M. Koblenzer, 136th St., New York City.

(463.) — A boiler exploded November 25, at the Hazelwood Sanatorium, Hazelwood, near Louisville, Ky. No one was injured, but there was a property loss of about $2,000.

(464.) — A boiler exploded at the Gas plant, at Pittston, Pa., on November 26. One man was injured, and considerable damage was done to the plant and to surrounding property.

(465.) — A boiler exploded November 26, in the grain elevator of L. R. Sellers, Blackburn, Mo. Mr. Sellers was killed and the elevator was destroyed.

(466.) — A tube ruptured on November 26, in a water tube boiler at the beet sugar plant of Charles Pope, Riverdale, Ill. H. Hampka, coal passer, and W. Hein, water tender, were scalded.

(467.) — On November 27, the crown sheet of a locomotive boiler collapsed at the plant of the American Steel and Wire Co., Worcester, Mass.

(468.) — A blow off pipe failed November 28, at the plant of the St. Croix Paper Co., Woodland, Me.

(469.) — A boiler exploded November 29, in a grist mill at Olive Hill, Ky. Three men were killed, one fatally injured, and three less seriously injured.

(470.) — On November 30, two tubes ruptured in a water tube boiler at the plant of the Scoville Mfg. Co., Waterbury, Ct.

(471.) — On the same day — November 30,— two tubes ruptured in another boiler at the plant of the Scoville Mfg. Co., Waterbury, Ct.

(These are separate and distinct accidents.)

Boiler Explosions

December, 1912.

(472.) — A boiler exploded December 1, at the plant of the Bristol-Myers Co., Brooklyn, N. Y. Two men were injured, one of them perhaps fatally.

(473.) — A heating boiler exploded December 2, in a garage belonging to Charles A. Sale, Victor, N. Y. No one was injured, but considerable damage was done to the building.

(474.) — The crown sheet of a locomotive collapsed on the Southern Railway, at Whittle's Station, Va., on December 2. George Robinson, the engineer, was fatally scalded.

(475.) — On December 2, two cast iron headers ruptured in a water tube boiler at Stern and Co.'s furniture store, Philadelphia, Pa.

(476.) — A tube failed in a water tube boiler on December 3, at the plant of the Southern Iron and Steel Co., Gadsden, Ala. R. L. Barnes, fireman, was injured.

(477.) — On December 4, a section ruptured in a cast iron heating boiler at the High School, Watertown. Mass.

(478.) — The Bristol Opera House, Bristol, Conn., was destroyed by fire December 4, said to have started from the explosion of a heating boiler.

(479.) — A boiler exploded December 4, in the lumber mill of J. Spragins and Sons, Fenwick, Miss. The property loss was estimated at $5,000, and four men were injured.

(480.) — Four sections fractured December 4, in a cast iron sectional heating boiler at the apartment house owned by the estate of J. D. W. Joy, Huntington Ave., Boston, Mass.

(481.) — On December 5, a boiler ruptured at the plant of the Sargent Coal Co., Newburg, Ind.

(482.) — A boiler exploded in a saw mill December 5, near Wilsondale, W. Va., killing five men. The only surviving member of the saw mill force fled from the scene, and according to press accounts has not been heard from since.

(483.) — A blow off pipe failed December 5, at the Wallingford, Ct., plant of the International Silver Co.

(484.) — On December 6, a boiler exploded with considerable violence at the plant of the Keene Glue Co., Keene, N. H. No one was injured, but the property loss was estimated at about $10,000.

(485.) — A cast iron sectional boiler ruptured December 9, at the Holyoke Club, Holyoke, Mass.

(486.) — On December 9, a boiler ruptured at the plant of the Hocking Valley Fire Clay Co., Nelsonville, O.

(487.) — On December 9, a cast iron header ruptured in a water tube boiler at The New York Mills, New York Mills, N. Y. Three men were injured.

(488.) — A boiler exploded December 9, at the plant of the Metal Stamping Co., Long Island City, N. Y. One man was seriously scalded.

(489.) — A heating boiler exploded December 10, in the basement of the Y. M. C. A., Knoxville, Tenn. The damage was practically confined to the boiler.

(490.) — A portable boiler exploded near Station 10, on the A. B. C. Ry., near Cleveland, O., on December 10. The boiler was the property of the Lake Drilling Co. One man was fatally injured.

(491.) — A boiler exploded December 10, at the construction camp of Hugh & Spaulding, a few miles south of Paris, Ky. One man was killed.

(492.) — A blow off pipe failed December 10 at the plant of the Farmers Oil and Mfg. Co., Blacksburg, S. C. Two men were injured.

(493.) — A cast iron header failed in a water tube boiler at the plant of the Semet-Solvay Co., Dunbar, Pa., on December 10.

(494.) — A cast iron header fractured December 11, in a water tube boiler at the plant of the Bath Portland Cement Co., Bath, Pa.

(495.) — A traction engine boiler, belonging to D. Newton Henson, a contractor, exploded December 11, near Hagerstown, Md. No one was seriously injured, but property was damaged to the extent of about $900.

(496.) — On December 11, a blow off pipe failed at the bending works of Scott Bennet, Medina, O.

(497.) — An eight inch steam pipe pulled out of the flange at the boiler, on December 11, at the plant of the Carnegie Steel Co., Greenville, Pa. One man was badly scalded.

(498.) — On December 12, an accident occurred to a water tube boiler at the plant of the Menasha Woodenware Co., Menasha, Wis.

(499.) — A blow off pipe failed December 13, at the Boston City Hospital, Boston, Mass.

(500.) — On December 13, a tube split in a water tube boiler at the power station of the Greenfield Electric Light and Power Co., Greenfield, Mass. H. W. Metzler, fireman, was injured.

(501.) — On December 14, a threshing machine boiler exploded, while threshing peanuts near Claremont, Va. Three men were injured, one fatally, and property damage to the extent of $1,000 was done.

(502.) — A blow off pipe failed on December 14, at the candy factory of The Wm. Lawther Co., Dubuque, Ia.

(503.) — On December 14, a cast iron sectional heater failed at the apartment house of The Associated Trust Co., Brookline, Mass.

(504.) — A tube ruptured December 14, in a water tube boiler at the Claypool Hotel, Indianapolis, Ind.

(505.) — A blow off failed December 14, at the Holler & Shepard contract on the Barge Canal, Ft. Edwards, N. Y.

(506.) — On December 15, a boiler ruptured at the Hartline Mill and Elevator Co.'s plant, Hartline, Wash.

(507.) — Two sections ruptured in a cast iron sectional heating boiler December 16, at District School No. 32, Morrilton, Ark.

(508.) — A tube failed December 16, in a water tube boiler at the plant of the Pickands Mather Co., Toledo, O.

(509.) — A tube ruptured December 17, in a water tube boiler at the plant of the National Tube Co., Benwood, W. Va. One man was killed.

(510.) — A boiler exploded December 17, at the Scott Sausage Factory, Jacksonville, Ala. One man was killed, and two others seriously injured, beside a considerable property damage.

(511.) — On December 17, a furnace flue collapsed in a boiler at the Y. M. C. A., Dallas, Tex.

(512.) — A boiler exploded December 18, in the saw mill of J. P. Germany, at Neshoba, Miss. The owner and one other were instantly killed, and several others were injured. The saw mill was completely demolished.

(513.) — A boiler exploded December 18, at a saw mill on the farm of Mrs. Lucy Dugas, Edgefield, S. C. Two men were killed, and four injured.

(514.) — Three cast iron headers ruptured December 18, in a water tube boiler at the plant of the American Steel and Wire Co., Waukegan, Ill.

(515.) — A saw mill boiler exploded December 20, at the plant of the Rust Lumber Co., Many, La. One man was killed, and several others injured. The mill was considerably damaged.

(516.) — A boiler exploded December 20, at the water works plant, Centralia, Mo. No one was injured.

(517.) — A boiler ruptured December 20, at the light and water plant of the village of Hibbing, Minn. The damage was small.

(518.) — On December 21, a boiler burst at the plant of the Ft. Worth Power and Light Co., Ft. Worth, Tex. One man was injured.

(519.) — On December 21, a boiler exploded at the mine of the Prospect Coal and Coke Co., Searight, Pa. The property damage was large.

(520.) — The lower tube sheet of a vertical boiler, pulled off the tubes at the plant of the Salmen Brick and Lumber Co., Slideil, La., on December 22.

(521.) — A tube ruptured December 22, in a water tube boiler at the St. Charles Hotel, New Orleans, La.

(522.) — A sulphite digester exploded December 22, at the pulp mill of the Laurentide Co., Grand Mere, Province of Quebec, Canada. Four men were killed, several injured, and property was damaged to the extent of about $80,000.

(523.) — A steam pipe burst at the paper mill of F. W. Bird and Son, East Walpole, Mass., on December 23. Two men were killed, and seven others injured.

(524.) — On December 23, ten sections of a cast iron heating boiler ruptured at the apartment house of Ida L. Higginson, Commonwealth Ave., Boston, Mass.

(525.) — Three cast iron headers ruptured Dec. 23, in a water tube boiler at the plant of the American Steel and Wire Co., Waukegan, Ill.

(526.) — On December 24, a cast iron sectional heating boiler ruptured at the University of Pittsburg, Pittsburg, Pa.

(527.) — On December 25, an accident occurred to a water tube boiler at the plant of the Mishawaka Woolen Mfg. Co., Mishawaka, Ind. The boiler was seriously damaged.

(528.) — On December 25, a large hot water tank exploded in the basement of the Coeur d'Alene Bank and Trust Co. building, Coeur d'Alene, Idaho. There were no serious personal injuries, but considerable damage was done to the building.

(529.) — On December 26, an accident occurred to a water tube boiler at the plant of the Morton Salt Co., Ludington, Mich.

(530.) — A tube ruptured December 26, in a water tube boiler at the plant of the Nichols Copper Co., Newton, Long Island, N. Y. Two men were injured.

(531.) — A boiler exploded December 27, in the saw and grist mill of O. M. Schultz, Wadesville, Va. Two boys were probably fatally injured, and a horse was killed.

(532.) — A boiler exploded December 28, in the round house of the Seaboard Air Line, at Raleigh, N. C. Nine were killed, and a large property damage resulted. Locomotives, machine shop equipment, and buildings suffered severely.

(533.) — A tube ruptured December 27, in a water tube boiler at the plant of the Montreal Mining Co., Hurley, Wis.

(534.) — On December 27, four sections of a cast iron sectional boiler cracked at the Hoffman and LaRoche Chemical Works, New York City.

(535.) — The boiler of a rotary snow plough exploded with great violence on the Great Northern R. R., near Seattle, Wash., on December 30. Five men were injured, and traffic was delayed for several hours.

(536.) — On December 31, a tube ruptured in a water tube boiler at the plant of the Doge Mfg. Co., Mishawaka, Ind.

(537.) — A mud drum ruptured December 31, in a water tube boiler at the plant of Schwarzchild and Sulzberger, Kansas City, Kans.

Boiler Explosions, 1913

January, 1913.

(1.) On January 1, a furnace mouthpiece, attached to a boiler at the plant of The E. T. Burrows Co., Portland, Me., exploded.

(2.) — A heating boiler exploded January 1, at the Portuendo cigar factory, Perkasie, Pa.

(3.) — An accident occurred to a boiler at the Dover, Del., light and water plant, on January 1. One man was injured.

(4.) — An elevator pressure tank burst January 2, in the Winston Building, Utica, N. Y.

(5.) — A compressed air tank exploded at the granite quarry of Reed and Vendret, Quincy, Mass., on January 2. Mr. Reed and an employee, Mitchell Lavoie, were killed, while Armand Vendret, the other partner, was seriously injured. This was a case of repairing a vessel under pressure.

(6.) — The boiler of a traction engine exploded January 2, on the farm of T. J. Hess, near Waller, Pa. One man was killed.

(7.) — A saw mill boiler exploded January 3, near Lawrenceburg, Tenn. One man was killed, and property was damaged to the extent of about $1,000.

(8.) — A tube ruptured January 4, in a water tube boiler at the Glen Allen Oil Mill, Glen Allen, Miss. One man was badly scalded.

(9.) — On January 5, the boiler of a Detroit and Toledo Shore Line locomotive exploded at Detroit, Mich. One man was killed and six others seriously injured.

(10.) — A heating boiler exploded January 5, in the basement of the residence of Dr. H. C. Mueller, Marshaltown, Ia. No one was injured, and the property damage was small.

(11.) — A water front exploded in a range at the Commercial Hotel, Gennesee, Idaho, on January 6. The explosion was due to the freezing up of the connections. The property damage was considerable, the rear of the hotel being completely wrecked.

(12.) — A hot water boiler attached to a kitchen range exploded January 6, in the home of a Mr. Humphrey, Oklahoma City, Okla. Mr. Humphrey was so severely injured that he lived but an hour after the accident. The trouble was due to frozen connections as in the case above.

(13.) — On January 6, a boiler ruptured at the plant of the Niagara Alkali Co., Niagara Falls, N. Y. One man was injured, but the property damage was confined to the boiler.

(14.) — A boiler exploded at the Pulaski Flour Mill, Anna, Ill., on January 7. This accident is also laid to a frozen pipe connection.

(15.) — The heating boiler at the Tivy High School, Knoxville, Tenn., burst January 7. The school was closed pending the installation of a temporary heating system.

(16.) — A blow off pipe failed January 8, at the plant of the Victor Lamp Co., Cincinnati, O. Chas. Weber, engineer, was injured.

(17.) — A saw mill boiler exploded at the mill of T. E. Smith near Augusta, Ga., on January 8. One man was killed and one injured severely.

(18.) — A boiler exploded January 8, at the plant of the Keystone Driller Co., New Castle, Pa. Five men were injured, one fatally.

(19.) — A boiler exploded January 8, in the refinery of the Kansas Oil Refining Co., Coffeyville, Kan. One man was slightly injured, and property damage to the extent of several thousand dollars was done owing to the fact that a large amount of valuable oil and gasolene was burned by fire as the result of the explosion.

(20.) — On January 9, a blow off pipe failed at the office building of the Spitzer Building Co., Toledo, O. One man was injured and considerable damage was done to the building.

(21.) — Two cast iron headers ruptured January 9, in a water tube boiler at the plant of the Salt Lake Tribune, Salt Lake City, Utah.

(22.)— On January 8, an accident occurred to a boiler at the plant of the American Locomotive Co., Schenectady, N. Y. A. Birdsey, engineer, was scalded.

(23.) — Three cast iron headers failed January 9, in a water tube boiler at the Marion Hotel, Little Rock, Ark.

(24.) — The river steamer James T. Staples was destroyed by the explosion of its three boilers January 9, on the Tombigbee River, three miles from Blanden Springs. Nineteen are reported killed, and twenty-two injured as the result of the accident.

(25.) — A heating boiler exploded in a garage in Rochester, N. Y., on January 9. The damage is estimated at several hundred dollars.

(26.) — On January 10, two cast iron headers ruptured in a water tube boiler at the plant of the Semet-Solvay Co., Ensley, Ala.

(27.) — A tube ruptured January 10, in a water tube boiler at the State Institution for the Blind, Columbus, O. Thomas Cranly, fireman, was injured.

(28.) — A boiler ruptured January 10, at the electric light and water works plant of Valley City, N. D.

Owing to lack of space, the January, 1913, List of Explosions is incomplete, but will be concluded in our next issue.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1913.

Capital Stock, ... $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission,		$186,187.28
Premiums in course of collection,		285,163.53
Real estate,		90,600.00
Loaned on bond and mortgage,		1,193,285.00
Stocks and bonds, market value,		3,506,178.40
Interest accrued,		75,600.51
Total Assets,		$5,337,014.72

LIABILITIES.

Premium Reserve,		$2,211,732.44
Losses unadjusted,		94,913.83
Commissions and brokerage,		57,032.71
Other liabilities (taxes accrued, etc.),		47,740.86
Capital Stock,	$1,000,000.00	
Surplus over all liabilities,	1,925,594.88	
Surplus as regards Policy-holders,	**$2,925,594.88**	2,925,594.88
Total Liabilities,		$5,337,014.72

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FRANCIS B. ALLEN, Vice-President. CHAS. S. BLAKE, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
W. R. C. CORSON, Assistant Secretary.

S. F. JETER, Supervising Inspector.
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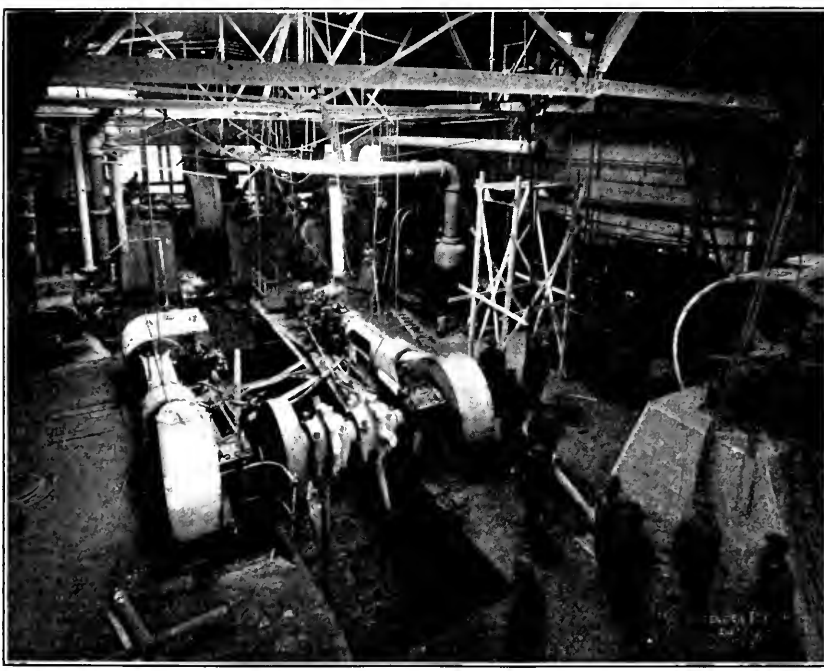
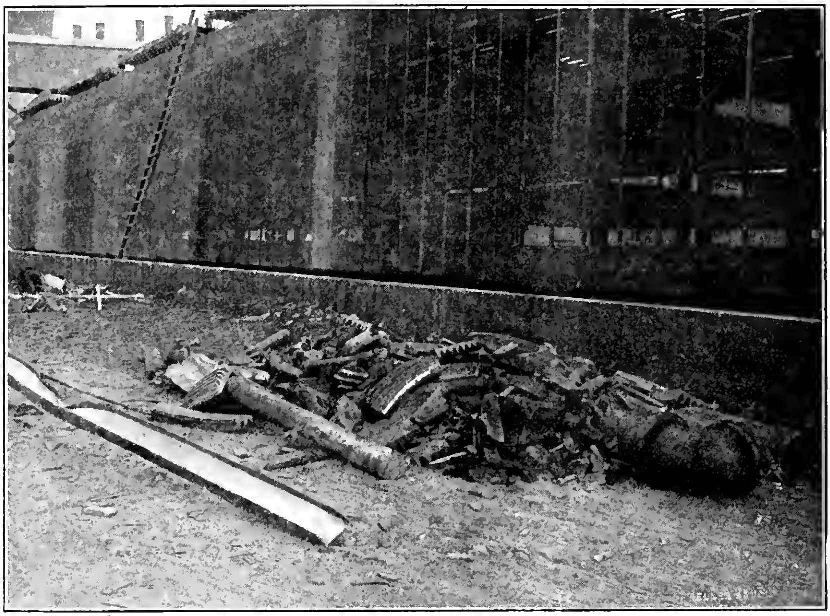
The Locomotive
of
THE HARTFORD STEAM BOILER
INSPECTION AND INSURANCE CO.

Vol. XXIX. HARTFORD, CONN., JULY, 1913. No. 7.



Fly-Wheel Wreck, Alpha, N. J.



The Remains of the Fly-Wheel, Alpha, N. J.

Fly-Wheel Explosion at Alpha, N. J.

A fly-wheel attached to a 750 horse power cross compound condensing engine, of the shaft governed, or automatic type burst June 9, 1913, at the plant of the Alpha Portland Cement Co., Alpha, N. J. The fly-wheel or rather wheels, for two wheels were used side by side to secure a wide face with two sets of arms for the better distribution of the load in a rope drive, were cast in halves and joined at the rim by flanges bolted together. In addition the two wheels were bolted to each other at their rims. The engine beside having a shaft governor, was equipped with an independent over-speed stop of approved design and construction.

We are told that about 2 A. M. on June 9, the night engineer was attracted to this engine by something abnormal. Just exactly what happened is unknown though the engineer is said to have attempted to bring his engine to rest. The wheel exploded tearing holes through the roof and sides of the building, and wrecked the engine as the photographs show. Two men received fatal injuries, the night engineer and an oiler, the latter died almost instantly while the night engineer lived but a few hours. Both these men received their injuries from escaping steam.

The wreck presents very interesting complications when an attempt is made to reconstruct the circumstances which preceded the explosion. There is excellent evidence that the governor operated, as the weights were thrown so forcibly against the rim of the governor case as to make deep and obviously fresh imprints in the crust of oil and cement dust with which it was lined. Moreover the over-speed stop appears to have operated, though whether it tripped automatically or was tripped by the engineer in an unsuccessful attempt to stop his engine is unknown.

It is known that the stop was tested and in good working order a few days before and the valve controlled by it was found closed after the accident. All this would seem to point to some agency disrupting the wheel during the beginning of a race which the control mechanism might have conquered if the wheel had remained intact. Perhaps the driven pulley failed first, then the engine relieved of its load would start to race. If in addition to this the fly-wheel was injured by fragments of the driven wheel it might have exploded at a speed far below that at which it should have failed if uninjured.

Here is another case of a destructive fly-wheel wreck on a shaft governed engine, fitted with a modern over-speed stop, and representing a typical installation of the sort popularly supposed to be outside the pale, so to speak, and quite immune to such a disaster. The present instance merely confirms the position we have taken so many times in The Locomotive, that no type of engine, no matter how well equipped, can be considered incapable of tremendous damage, when the necessary conditions for such an occurrence exists.

Fuel Economizers.

A fuel economizer may best be considered as an extension of the heating surface of a boiler, used so that the feed water may take up heat from the flue gases which would otherwise be wasted up the stack. This heat which the economizer transfers to the feed water is not always a total loss, as it furnishes of course, the motive power to drive the spent flue gases out of the stack when natural draft is used. Indeed, in many cases an economizer will so reduce the stack temperature that there is not enough of this motive power left to produce a satisfactory draft, and fans must be installed either to force cold air into the ash pits — forced draft — or to pull the flue gases through the furnace, boiler and economizer, expelling them up the stack — induced draft.

That there should be any economy in so reducing stack temperatures with an economizer that a fan becomes necessary for the production of a proper draft is due solely to the fact that a chimney is perhaps the poorest that is, the least efficient heat engine which is commonly used in engineering. To put the same statement in another way, a good steam engine or better yet, an electric motor, can produce a given draft for the expenditure of less heat than will be used to produce the same results at the furnace with a chimney It is the difference between the heat necessarily left in the flue gases to produce a stack draft, over that required in the form of steam energy or electric energy to drive the fan, which an economizer can save to do useful work in the power plant. It must be understood, however, that in both cases we are dealing with the available heat in the gases, that is, the heat which they can be made to give up by cooling them to the temperature at which the feed enters the boiler or, as a matter of fact, to a temperature as near that at which the feed enters the boiler as our economizer may be made to work, for all the heat energy left in the gases when cooled to this temperature is no more available to do work for us than is the energy in the water of a mill race after it has fallen to a level below that of the draft tube from the water wheel.

In the form commonly used, an economizer consists of a bank of vertical tubes connected at top and bottom by suitable headers and placed in the flue between the boilers and the stack. The commonest arrangement places the tubes in rows of say ten, connected at top and bottom with a cross box to form a unit not unlike one section of a large steam radiator. These units are then stacked up — again somewhat like a radiator — and connected together top and bottom by headers placed lengthwise of the flue, with outlets to take the ends of the top and bottom cross boxes. As many units are connected together as are required to furnish the desired amount of heating surface. Of course, variations exist between the designs and methods of installation of the different makers, but there are certain features in common, and as it is the purpose of this article to treat economizers in general and not the product of any particular maker, these differences will be neglected. We do not believe there will be any difficulty in applying the suggestions we propose to any ordinary economizer.

The method of operation usually adopted is for the feed to enter at the stack or cool end of the bottom longitudinal header, whence it is permitted to circulate through the tubes and headers, becoming hotter as it passes along, until it finally leaves at the boiler or hot end of the top longitudinal header. In a few cases, economizers have been designed to permit of a circulation which is up through the tubes of one part and down through those of another, or even up in one tube and down in the next. While these special arrangements require a different arrangement of top and bottom connections, they need not be specially considered at this time.

The material ordinarily used in economizer construction is a high grade of close-grained cast iron. This material is necessary because whatever corrosive elements a water may contain are liberated, as a rule, by heating. Therefore, that part of a boiler or feed water heating system in which the water is first heated to a temperature approximating that of the boiler will suffer most severely. As is well known, cast iron is much less affected by the various forms of corrosion than wrought iron or steel, so that it is practically the only material which may be used for the purpose. It is of course true that steel feed water heaters are widely and successfully used, but there is this important difference between them and economizers, that the water in the latter is heated to temperatures far higher than those attained by ordinary feed water heaters. Indeed, temperatures up to 350° F. are not uncommon.

The construction usually adopted for attaching the tubes to the top and bottom cross headers is a pressed or friction joint. The tube ends are machined to a true tapered surface, given a fine finish and then pressed into corresponding tapered holes in the headers. The joints by which the cross headers are united to the type of longitudinal top and bottom connection which happens to be employed are either flange joints, bolted up and made tight with some form of gasket, or else of pressed construction similar to that described for the tube ends. The top headers are provided in practically all cases with openings opposite the tube ends, large enough for the removal of a tube when one must be replaced. These openings also serve to gain access to the interior for cleaning and inspection. They are closed by internal covers having a tapered metal to metal joint, which are held tight by the internal pressure and pulled into place by some form of yoke and drawing bolt. One end of each top or bottom cross box is ordinarily closed, but the other end, where it is joined to the longitudinal connection, may usually be reached by some form of hand hole cap, secured by bolts, so that it may be opened for cleaning and inspection as well as the top ends of the tubes.

It has been found that the temperature or expansion strains at the junction between the longitudinal and cross headers are very severe if too many units are assembled rigidly together. To overcome this difficulty, it is customary to use sections of longitudinal header short enough to reduce the expansion strains to a safe value, and then these are connected end to end by "U" bends to give the desired flexibility, thus making one whole economizer of a number of little economizers connected in series.

The setting of an economizer is really an extension of the flue. It may be made of brick or steel, and must serve three purposes. First, it must furnish a satisfactory support for the economizer. Secondly, it must supply a tight path for the flue gases from the boiler to the stack, around the economizer tubes, so that excessive leaks may not dilute the hot gases, using up heat in raising the temperature of the leakage air which should go into the feed water. In the third place, the setting must act as a non-conducting shell to cut off as far as is practical losses by radiation. The setting must be so formed as to offer as little friction to the passage of the gases as is consistent with its other requirements, and to provide a pit into which the accumulations of soot may be scraped by the scrapers to be described later.

Whatever the type of construction adopted for the side walls of the setting, it is customary to make use of a layer of some insulating material such as asbestos or mineral wool as a roof over the top headers. To this end the top headers are generally so designed that when in place they make a continuous cover, touching each other and resting on the side walls at their ends, so that the addition of the non-conducting layer mentioned above is all that is necessary to make this setting roof conform to the conditions we have already outlined. Moreover, with the top headers covered in with an easily removed lagging, the top tube caps are readily reached for all purposes. If the sides of the setting are of steel, the usual arrangement consists of plates insulated with asbestos, and joined to each other by means of angle iron flanges, bolted together. Sometimes a combination setting is arranged, having a brick wall on one side with a sectional steel casing on the other, which gives greater accessibility than an all brick setting. In any case, clean-out doors to the soot pit are provided and access doors are fitted to the flue.

Mention has been made of the soot scraper gear. This consists of cast iron scrapers encircling each tube, arranged to be slowly moved up and down their full length, and ordinarily arranged to scrape on the up stroke. The scrapers on a group of neighboring tubes are fastened together in a frame and the whole frame is slowly pulled up and down by chains. Such a chain would pass up from one frame, over an upper sprocket wheel and down to a similar frame so spaced that when one frame is ascending the other is falling, reaching the ends of their strokes at the same time. In this way the driving gear is relieved of the weight of the scraping mechanism, and is only called upon for the actual work of soot removal. The sprockets are driven by gearing through an automatic reversing clutch which trips at the end of each stroke. The drive can be obtained from any convenient motor, engine, or line shaft. It is important that the scrapers be kept continuously at work, for if they stop for any appreciable time a deposit of soot gathers on the tubes, which not only cuts down the efficiency of the apparatus, through retarded heat flow, but which is liable to bake on in the form of a hard cake or incrustation, stalling the scrapers when they are next set to work. To rid the lower part of the structure of soot as fast as it is removed by the scrapers, the lower cross boxes are made enough narrower than the top ones so that a good passage is left between each pair to the soot pit below. Soot pits are generally provided large enough to hold from one to two months' accumulation, and of course the length of the interval between successive clean outs must be governed by the rate at which coal is burned.

For safety and convenience in operation, an economizer must be fitted with various valves and attachments. The arrangement which we describe has been chosen after a good deal of study and thought, and while it may differ in some respects from the general practice, we feel that it is worthy of very serious consideration. A stop valve, and frequently a check valve, are provided at the economizer outlet to the feed line. In ordinary operation, the stop valve is unnecessary, *and should be locked open.* Its only purpose is to permit repairs to the check and for this use it should be placed between the check and the boiler.

A stop valve should be provided at the inlet end, so that the vessel may be isolated for inspection and repairs, the boilers being fed meanwhile by a by-pass line direct from the pump. This by-pass connection must never be opened when the gases are passing through the economizer casing. A case has come to our attention where an economizer in normal operation began to show an unusually high temperature on the thermometer inserted in the flue at the stack end. The engineer tested his safety valve, and found that steam issued instead of water. On looking over the valves and connections he found that the by-pass had been opened, but that all the other valves and the dampers were as for ordinary operation. The pump of course, forced the water to the boilers by the easiest path, which in this case was through the by-pass. The economizer, when the circulation through it was so reduced, acted as a steam generator, and like any other water tube boiler the upper portion filled with steam forcing some of the water out into the feed line.

Under such circumstances there is a danger due to the difference in temperature between the top boxes and the tubes, that the pressed tube end joints will be loosened and the boxes blown off, starting a violent explosion, perhaps at a pressure equal to or less than the ordinary working pressure.

A blow-off or drain valve should be provided at the hot end of the lower longitudinal header. This valve should be placed in an accessible position, and piped so that it may be used daily when the apparatus is in operation, for the removal of sludge and scale matter while still soft and easily blown out, as well as for draining the economizer whenever it becomes necessary to open it for inspection or cleaning. As in the operation of boilers, much of the matter which if allowed to remain will eventually form a hard scale, difficult of removal as well as detrimental to the transfer of heat, may be blown out while still soft if the blowoff is operated frequently. A vent pipe of ample size, the end of which is opened to the air should be led from the highest point of an economizer in as direct a manner as possible to some place in the boiler room where it is easily visible. It should be provided with a valve at the open end. This vent will permit the entrance of air when draining the economizer, and its expulsion on refilling. Moreover, if a practice is made of opening this vent as soon as the pressure on the economizer has fallen to nothing, after cutting out of service, and if it is left open until it is desired to start the feed pump through the economizer again, a full economizer will have a relief to the atmosphere which it could only get otherwise by the generation of an internal pressure great enough to cause the safety valve to lift. With this in view, it should be made an absolutely inflexible rule that the economizer should never be left out of service, whether full or empty, unless this vent is opened as soon as the pressure has fallen to zero, and is left so until the vessel is wanted again.

The most important attachment for any pressure vessel is its safety valve, and this is especially true of economizers. We believe that in all large economizers, say of more than 3,000 square feet of heating surface, there should be *two* safety valves, one at either end. The valve at the inlet end may be a water relief valve, but at the outlet end a steam safety valve is preferable. These valves should be of the spring-loaded type, with lifting gear attached, as it is important that they be tested from time to time to make sure that they are not choked or set fast by scale. If in addition they are provided with a good secure "lock-up" attachment, so that their setting may not be tampered with, we feel that an additional safeguard is provided. These valves must be set to operate at a pressure slightly above that at which the boiler safety valves lift, because a slight excess over the boiler pressure must be carried on the economizer and feed line to overcome the friction offered by them to the water flow. This excess need not be over 10 or 15 pounds. That is, if the boiler safety valve is set at 150 pounds per square inch, the valves on the economizer should lift at 160 to 165 pounds. Difficulty has been experienced in keeping this excess within such narrow limits, and for this reason. It is a well-known fact that a relief valve on a hot-water line is a trouble maker, because it is so prone to leak. It is a common experience for some boiler-room employee to set down on the adjusting spring when a leak occurs, and to repeat this treatment from time to time in a vain attempt to cure it. His object is of course to save the hot water, and so lighten his labor at the fires. Such treatment is well known to be futile, but as the grinding in of an economizer safety valve is an unpleasant dirty job, which requires the shutting down of the vessel, it is only too frequently practiced. It requires but a moment's consideration of the causes for leaks in a safety valve to show the uselessness of attempting to correct them by an increase of the spring tension. A safety valve seat consists of one or more conical or flat surfaces, to which corresponding surfaces in the disk have been fitted by grinding. The tightness of the valve depends on the perfection of this contact, that is upon the accuracy with which the disk meets the seat throughout the entire bearing area. The purpose of the valve spring is to put a load on the valve disk equal and opposite to the load it will receive when acted on by the maximum internal pressure which the vessel is to carry. The spring load affects the tightness of the valve to only this extent, that it permits the seat and disk to remain in contact at pressures lower than this maximum. When a valve begins to leak, it does so from one of two simple causes; either there is a bit of foreign material lodged between the disk and seat, preventing closing, or else one or both surfaces have been injured by cutting. This results from water or steam passing through the orifice at high velocity, perhaps aided by some abrasive material, and is similar to the action of a sand blast. The presence of an abrasive substance is not necessary in the case of a valve opening to relieve the pressure within a vessel containing very hot water, because hot water will immediately turn to steam when its pressure is lowered to that of the atmosphere, if its temperature is above 212° F. The jet of fluid then, which we should expect to find flowing from the relief valve of an economizer, would be a jet of very wet steam, at least at the valve seat, before it has a chance to condense on the surfaces of the relatively cool escape pipe. We need go no further than the experience gained in the operation of steam turbines, for a proof of the fact that a stream of very wet steam, flowing at a high velocity will cut the surfaces of the blades and passages at a rapid rate. In the light of this reasoning, let us consider for a moment what takes place when some one attempts the monkey wrench cure for a leaking safety valve. If the leak has been caused by the pressure of some foreign substance, it will be either embedded in the seat, or crushed, depending on its hardness, and the only result to be expected from an increased spring tension, is that permanent damage may be done where none existed before. If the leak has resulted from cutting, the hole will remain, regardless of the spring tension, unless sufficient pressure can be brought to bear to squeeze the seat and disk into contact again, a process that could scarcely fail to ruin the valve, even if it were possible with the average valve spring. The proper treatment in the first instance, would have been, to lift the valve, allowing it to relieve freely for a short time, which would have washed the seating clean in all probability, allowing the valve to close properly. If the seat has been injured by embedding some foreign particles or by cutting, the only way to make it tight again is to re-grind it until it makes contact over the whole seating area. An overloaded spring, then, can have but one effect, that is to increase the possibilities of damage to property and of personal injury by permitting an over-pressure which is directly determined by the extent of the overloading.

The escape pipes of economizer safety valves, also need scrutiny. As in boiler practice, we feel that a safety valve is best installed when it need have no escape pipe at all. Nevertheless, since it is very important that water should not enter an economizer casing and produce external corrosion, some type of escape pipe is necessary for most economizer reliefs. It is essential that the escape pipe be the full size of the valve outlet. It should be as short and straight as possible, and it may well be installed so that the flow of water from it will be definitely *in the way*. This is the surest means of calling attention to a leaking valve, and in addition serves to impress on the minds of the attendants the fact that the relief valves operate. It is an undesirable practice, indeed it may be very dangerous, to pipe the escape pipe outlet to a sump, tank, or hot well, where the flow if any passes unnoticed. A tight valve is the safest way to save hot water.

The flues leading to and from an economizer casing should be provided with some form of tight-fitting shut-off damper. These dampers should be separate from the regulating dampers, and should not be used for draft control, either by an automatic regulator, or by hand adjustment. They should be of such a type that they will work easily and when closed they must be tight. It is quite important that the form of damper installed be such that it will retain both its ease of working and its tightness after long-continued service, so that it may be depended upon in an emergency. Whenever the shut-off dampers are closed the soot-pit doors should be opened immediately to prevent pocketing an explosive gas mixture in the casing.

Certain general principles may be applied to the care and operation of an economizer which will make for its safety and long life. The casing and external surfaces must be kept dry if external corrosion is to be avoided. Moisture may get to the outside surface of the tubes and headers in three ways: by leakage from within through tube ends or cracked and pin-holed tubes; by leakage from above of caps, pipe joints, safety valves, or even roofs; or by the sweating of the vessel when water is introduced at too low a temperature. To avoid sweating, some form of heater which will deliver water to the economizer at a temperature above 100° F. is required. In the absence of such a heater, it is possible to send back through a by-pass connection, a small amount of water from the hot end of the economizer, allowing it to mix with the cold water in the inlet pipe, and so regulate the inlet temperature to a point above 100°. When moisture does get at the external surfaces, the resultant corrosion is serious, for both soot and flue gas give rise to corrosive acid solutions when mixed with or dissolved in water.

When an average boiler water is heated in an economizer, it deposits a muddy sludge composed of the various scale-forming impurities contained in the water. Some of the sludge may bake on to the tubes and form a scale. It is not uncommon to find the tubes in an economizer which has been running for some time, coated with over an inch of soft sludge and scale. Under this material, the tubes may appear at first to be sound and of full thickness. A closer examination however, will generally show that the iron has undergone a change. It will be found spongy and soft, easily cut with a knife or scraper, and this condition may extend from a few 64ths of an inch to half the thickness of the tube or more. This decomposed iron, when freshly cut, has about the appearance and consistancy of the graphite "lead" in a lead pencil, and is, of course, the well-known spongy material to be found in most cases of cast iron corrosion. It is a slow process as compared to the corrosion of steel or wrought iron under similar conditions, and as we have said above, only cast iron can satisfactorily resist the corrosive action in an economizer, at least among the materials which are mechanically or commercially adapted to the service. When the interior surfaces of the economizer become coated over with corroded iron overlaid with sludge the action is greatly retarded, if not stopped. On the other hand this sludge layer retards the flow of heat into the water and so cuts down the efficiency of the vessel. A practice has prevailed among engineers of cleaning the tubes with the same sort of turbine-boring tools that are used for the tubes of water tube boilers.

If the boring process could be carried out without disturbing the layer of spongy, corroded iron, no harm would result, and the increased efficiency would warrant the treatment, but unfortunately this corroded layer is very easily detached and wherever it becomes loosened so that the water may penetrate to the freshly exposed surface of sound iron, active corrosion in the form of pitting will be found.

We feel that except in extreme cases, and where great care is taken with the work, this form of tube cleaner is not to be encouraged. It seems better to use some form of scraper similar to the scrapers used for soot removal in the tubes of fire tube boilers. We know of many plants where they are used with success, and a very satisfactory degree of heat efficiency may be retained in the apparatus, without any marked increase in the rate of corrosion. Of course, it is obvious that frequent internal washings with a hose will remove a large part of the soft material before scraping or boring are needed.

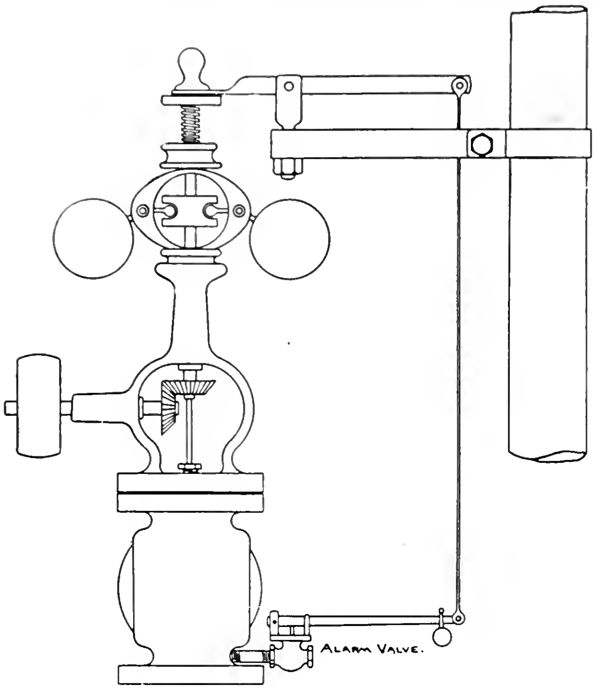
In conclusion, we desire to call attention to the fact that nearly every economizer explosion which has been brought to our notice has taken place in a vessel which was supposed to be out of service, and therefore was due to some abnormal condition, or set of conditions. The lesson to be learned from this fact would seem to be this, that it is of the utmost importance that economizer owners assure themselves that their vessels are provided with the right safety appliances, in good working order, and that the men in direct charge of the vessels be so thoroughly instructed in their work, and held so responsble for the details of manipulation, especially in cutting out of service, replacing in service again and making repairs, that these abnormal conditions will be made just as nearly impossible as the human factor will permit.

Safety Alarm Attachment for Throttle Valve Governors.

THOMAS DOWD, Inspector.

A type of throttle valve governor is in use which while not equipped with an automatic safety stop in the strict sense of the word will nevertheless stop the engine if the belt breaks or runs off provided the engineer has not forgotten to set it in the "safe" position after starting his engine. With governors of this type before the engine can be started it is necessary for the engineer to screw down the small knurled nut which is at the extreme top of the governor. This operation lifts the throttle valve from its seat and holds it in this position, admitting steam to the engine. When the engine has attained its normal speed the nut should be screwed back again. The governor is then at "safety" and will operate to stop the engine if the belt breaks or runs off. Should the engineer forget this and the governor belt break while the nut is screwed down the engine would run away, which would probably result in a wrecked fly-wheel, with consequent damage to the building and its contents.

When inspecting engines equipped with governors of this type a small safety or alarm valve has been recommended to be attached to the throttle valve chamber at a point below the valve seat. From the lever of the alarm valve a connection is made to a second lever which is provided with a forked end to hook under the knurled nut on the governor as is shown in the accompanying sketch.



SKETCH OF THE ALARM VALVE AND GOVERNOR.

This little device has given satisfaction wherever it has been installed as directed. It prevents the engineer from forgetting to set the governor in its safe position while his engine is running, for when he screws down the nut on top of the governor it opens the alarm valve from which steam continues to flow until the nut is set back again to the safe position.

An Unusual Explosion.

C. R. SUMMERS, Inspector.

We have had boiler explosions ever since the steam boiler was invented. Sometimes steam pipes explode or blow-off pipes rupture and even gases explode in the furnace or combustion chamber, as many a singed fireman can attest, but we would never have suspected an ash pit of having concealed within it the ability to blow up and do things to the plant.

Two 60 in x 16 ft. horizontal tubular boilers were recently set up in the basement of an office building. The settings were up-to-date in every particular and unusual care was taken to get a perfect installation. Only one boiler is used at a time, so on a certain day boiler No. 2 was fired up and took the load off the old boilers, which are to be abandoned. All went well until about four o'clock in the afternoon, when a terrific upheaval took place, all doors about the boiler setting were blown open and fire scattered all over the boiler room floor.

No time was lost investigating, but No. 1 was immediately gotten under way and about four o'clock the next morning, just to show that No. 2 had nothing on No. 1, another upheaval took place, though not nearly so violent as that of No. 2, and No. 1 was continued in service.

No. 2 had cooled down sufficiently by this time so that an investigation could be made and it was found that the concrete bottom of the ash pit had blown up, the grates being lifted off the bearing bars and piled up indiscriminately in the bottom of the furnace. Following this clue it was found that seepage from the outside had found its way under the concrete floor of the ashpit, which was about six inches thick, and since no water was intentionally put in under the grates, in the course of ten or twelve hours the concrete bottom had become hot enough to generate steam under it, with the result that when sufficient pressure had accumulated the bottom came up with remarkable force.

The same thing occurred with No. 1 in about twelve hours after it was fired up, only the concrete was not blown out to such a depth, only about an inch, and the fire was not seriously disturbed.

Who can tell that the insurance companies will not soon be requiring safety valves on our ash pits?

The Explosion of an Oxygen Tank, in Nürnberg, Germany.

Translated from the German by H. J. VANDER EB.*

An oxygen tank exploded last September in a boiler and machine shop in Nürnberg, Germany, where autogenous welding was used for repairing tanks, and to some extent on boilers. The oxygen was manufactured in the shop itself by means of an electric current, and stored in the upper drum of a cylindrical boiler in which the openings to the lower drum were closed by riveted patches. The boiler was buried so that only the upper drum to which the oxygen connections were fitted was above ground.

The explosion took place while welding was in progress, with appalling results. Six persons were injured, three of them seriously, while parts of the shell were thrown 200 feet.

The cause of the accident is attributed (by the Bayerischen Revision-Verein) to the following: Some weeks previous to the accident the commutator of the dynamo which furnished the current for generating the oxygen had been trued up. To do this the wiring connections were taken down. When the job was done, the connections were replaced incorrectly by some mistake, causing a reversal of polarity in the dynamo, so that the electrode which had previously given off oxygen, was generating hydrogen. This hydrogen then mixed with the oxygen still in the tank and formed an explosive mixture. It is further assumed that the flame of the welding torch, striking back through an imperfectly filled water seal, ignited the explosive gas within the tank. It appears, therefore, that even in a case of this kind, a part, at least, of the trouble can be blamed to the proverbial "low water."

Zeitschrift des Bayerischen Revisions-Vereins.

Concerning Stay Bolts Which are not Square With the Sheets They Support.

In submerged tube boilers, locomotive type fire-boxes, and in general wherever stay bolts are used to tie two sheets together whose surfaces are not parallel, it frequently becomes necessary to drill the stay bolt holes out of square with one or both sheets. If this lack of squareness exceeds a certain amount, then threads which start on one side of the hole leave the plate incomplete as is shown in Fig. 1. The difficulty with this sort of work is not so

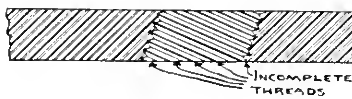


FIG. 1. INCOMPLETE THREADS.

much that it lacks strength as its tendency to leak. The interrupted threads cannot be made steam tight and so, unless several perfect threads can be secured, a permanent leak in the boiler results. With this in view we have worked out for several sizes of stay bolts, made with "V" threads twelve to the inch, the least angle that a stay bolt may make with a plate of given thickness and secure either two, three or four perfect and complete threads.

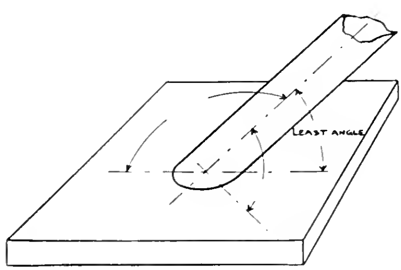


FIG. 2. ILLUSTRATING THE LEAST ANGLE BETWEEN THE BOLT AND THE SHEET.

The tables are nearly self explanatory, but perhaps a word is required to make clear what we had in mind as the "least angle." It is clear that if a stay bolt pierces a plate at any angle other than 90°, there is one least angle between it and the plate, while on the opposite side of the bolt from this least angle is a greatest angle. At any intermediate point the angularity of the bolt to the plate is somewhere between these limits, as is shown in Fig. 2. In every case the least angle has been used in making up the tables. In finished work, if it were accessible, this least angle would be the smallest angle that could be taken off with a carpenter's "bevel" held so as to touch both the bolt and the sheet fairly.

TABLES OF THE LEAST ANGLE A STAY BOLT MAY MAKE WITH A PLATE TO SECURE A GIVEN NUMBER OF FULL THREADS. — V THREADS — 12 PER INCH.

TABLE I. *4 Full Threads.*

Thickness of plate.	Diameter of Stay Bolt.							
	½″	⅝″	¾″	⅞″	1″	1⅛″	1¼″	1⅜″
¼ inch	....	....	....	....	....	....	....	....
5/16 "	....	....	....	....	....	....	....	....
⅜ "	....	....	90°*	....	....	....	....	....
7/16 "	90°	89°	88.5°	89.5°	89°	87°	90°	90°
½ "	83°	84°	83°	84°	84°	85°	85°	87°
9/16 "	76°	78°	78°	81°	84°	83°	83°	85°
⅝ "	54°	68°	71°	75°	77°	79°	80°	82°
¾ "	....	48°	56°	64°	68°	71°	73°	77°
⅞ "	....	....	28°	51°	60°	64°	67°	72°
1 "	....	....	....	30°	48°	61°	60°	64°

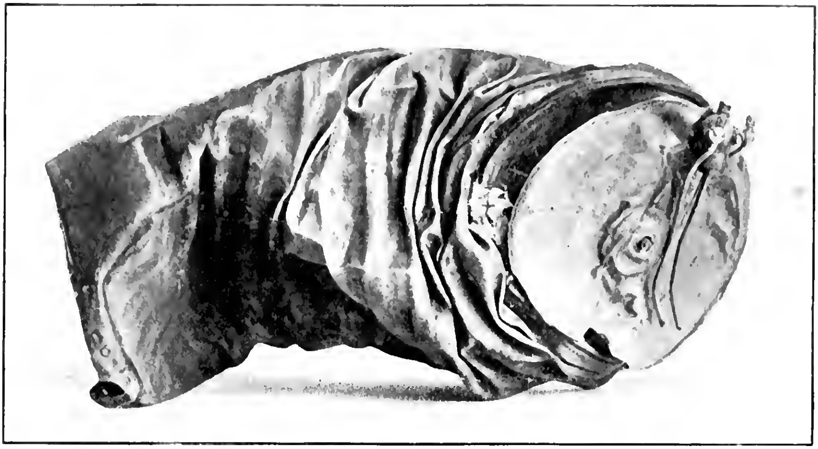
TABLE II. *3 Full Threads.*

Thickness of plate.	Diameter of Stay Bolt.							
	½″	⅝″	¾″	⅞″	1″	1⅛″	1¼″	1⅜″
¼ inch	....	....	....	....	....	....	....	....
5/16 "	....	90°*	90°	....	....	90°	90°*	....
⅜ "	87°	85°	85°	88°	88°	86°	89°	90°
7/16 "	80°	80°	82°	84°	85°	83°	85°	88°
½ "	70°	72°	75°	79°	80°	80°	83°	85°
9/16 "	62°	66°	71°	75°	78°	78°	80°	82°
⅝ "	....	55°	63°	69°	71°	71°	77°	78°
¾ "	....	....	46°	59°	64°	65°	70°	73°
⅞ "	....	....	....	43°	55°	58°	65°	68°
1 "	....	....	....	....	42°	48°	57°	61°

TABLE III. *2 Full Threads.*

Thickness of plate.	Diameter of Stay Bolts.							
	½″	⅝″	¾″	⅞″	1″	1⅛″	1¼″	1⅜″
¼ inch	....	....	90°*	90°	90°*	90°	90°	....
5/16 "	85°	85°	86°	86°	87°	85°	87°	88°
⅜ "	78°	78°	81°	81°	84°	82°	84°	87°
7/16 "	69°	73°	75°	78°	80°	79°	82°	83°
½ "	57°	65°	69°	72°	74°	75°	78°	81°
9/16 "	48°	60°	64°	68°	72°	73°	75°	77°
⅝ "	....	44°	55°	60°	66°	67°	73°	76°
¾ "	....	....	36°	50°	57°	61°	67°	69°
⅞ "	....	....	....	35°	48°	53°	60°	64°
1 "	....	....	....	....	35°	44°	52°	57°

An * signifies that the specified number of threads will be scant.



An Exploded Peanut Roasting Boiler.

The Explosion of a Peanut Roaster.

Explosion No. 304 in our list for July, 1912, referred to the failure of a peanut roaster in Sigorney, Ia., on July 29 1912. The roaster stood in front of a restaurant on one of the principal streets of the town. Just before the explosion, Chauncey E. Meyers of Washington, Ia., drew up to the curb in an automobile, and entered a store to make some trifling purchase. As he was returning to the machine, he passed in front of the peanut roaster at the instant when it exploded. The boiler hit him, breaking his back and rendering him unconscious, a condition from which he did not revive. The photograph which we print shows the boiler after the explosion, and at "X" is seen a portion of Mr. Meyers' clothing.

Peanut roasters, like many other small steam containers, are not usually classed as dangerous affairs, and yet we recorded in the Oct., 1911, Locomotive (page 241) a similar accident, which took place in Newark, O., and which resulted fatally to two people. If a mere peanut roaster possesses enough explosive energy to burst with fatal results, as in the two cases mentioned above, where is the power or heating boiler so insignificant and harmless that its insurance is unwarranted?

Fly-Wheel Explosions, 1912.

To complete the 1912 list.

(32.) — On October 31, a five ton fly-wheel exploded at the plant of H. S. Williams and Co., Wauseon, O. The damage was largely confined to the engine.

(33.) — The fly-wheel on a gasoline engine exploded November 8, on the ranch of John Laird, near Great Falls, Mont. Mr. Laird was instantly killed.

(34.) — A fly-wheel exploded November 20, at the Queen City Tannery, New York city. There was considerable property damage, but no one was injured.

(35.) — On November 28, a fly-wheel burst at the sawmill of Poutt and Foreman, Titusville, Pa. One man was seriously injured.

(36.) — A fly-wheel exploded November 29, at the Crystal Mine, Tilden, Ill. One man was injured.

(37.) — A fly-wheel burst at the plant of S. G. Flagg, Reading, Pa., on November 30. One person was seriously injured.

(38.) — On December 3, the governor belt slipped off on an engine at the plant of the Woodland Clay Company, Watseka, Ill. The engine raced, exploding its fly-wheel.

(39.) — A fly-wheel, and a wooden driven pulley both exploded December 6, at the plant of the William Coleman Co., barrel manufacturers, Jackson, Tenn. The accident was caused by the breaking of the governor belt. One man, Mr. E. P. Wray, was instantly killed.

(40,) — Albert Schultz was seriously injured on December 19, at North Tonawanda, N. Y., by the bursting of the fly-wheel on a gasoline engine used for cutting corn stalks.

(41.) — On December 23, a fly-wheel cracked on a gasoline engine belonging to the Lone Star Amusement Co., Fort Worth, Texas.

(42.) — A fly-wheel burst, December 26, on a five ton coal truck, gasoline driven, in New York city. A bystander was fatally injured.

Fly-Wheel Explosions, 1913.

(1.) — On January 7, a fly-wheel burst at the plant of the Southern Seating and Cabinet Co., Jackson, Tenn.

(2.) — A pulley exploded January 9, at the Peck plant for reclaiming copper from copper slimes, at Anaconda, Mont. W. M. Young was killed.

(3.) — The fly-wheel on a direct connected generator set exploded January 9, at the Clyde Coal Company's mine near Fredericktown, Pa. Martin Williams was killed.

(4.) — On January 17, a fly-wheel flew off at the power house of the Tacoma Railway and Power Co., Tacoma, Wash. Two persons were injured, one of them fatally.

(5.) — A fly-wheel fractured January 30, at the plant of the Hartselle Stave and Harding Co., Hartselle, Ala. One man was injured.

(6.) — On February 3, a fly-wheel exploded at the Gilbon quarries, Lambertville, N. J. One man was seriously injured.

(7.) — Several rim bolts failed February 3 in a fly-wheel at the Arlington Mills, Lawrence, Mass.

(8.) — On February 14, a large fly-wheel burst at the power house of the Charlottesville and Albemarle Ry. Co., Charlottesville, Va. The accident was due to racing of the engine when the governor belt broke, and was made possible by the failure of the governor to operate in its low safety position, through lack of adjustment. The property loss was estimated at $15,000.

(9.) — A fly-wheel exploded February 21, at the plant of the American Metal Wheel and Auto Parts Co., Toledo, O. The wreck was due to a deranged governor, injured through the bursting of a driven pulley on a line shaft.

(10.) — On March 1, a fly-wheel rim fractured at the plant of the Peoples Gas and Electric Co., Mason City, Iowa.

(11.) — The fly-wheel on an oil well engine burst March 4, near Butler, Pa. One man was killed.

(12.) — A fly-wheel burst March 6, at the mill of the West Yellow Pine Co., Olympia, Ga. The cause is given as an inoperative governor.

(13.) — A gas engine fly-wheel burst during a test on March 7, at Oakland, Cal. A machinist, engaged in testing the outfit, was instantly killed.

(14.) — On March 19, the fly-wheel of a variable speed engine driving a paper machine burst at the plant of the New Haven Pulp and Board Co., New Haven, Conn. The engine and paper machine were badly wrecked, the loss totalling about $6,000.

(15.) — During a storm which unroofed the buildings of the National Rolling Mill, at Vincennes, Ind., on March 21, the belts were stripped from two eight foot fly-wheels by the falling debris. The engine when relieved of its load ran away, and exploded both wheels. Two men were seriously injured.

(16.) — A fly-wheel burst April 18 at the Glens Falls, N. Y., plant of the International Paper Co. The wheel is 14 feet in diameter.

(17.) — On April 30, the fly-wheel on a small gasoline engine used for domestic purposes and owned by Joseph Havir, at Plattsmouth, Neb., exploded. Mr. Havir was instantly killed.

(18.) — A gas engine fly-wheel burst May 2, at an oil well on Morrison's Run, near Warren, N. Y. No one was injured.

On Fusible Plugs.

We have many inquiries from time to time concerning fusible plugs. These inquiries run all the way from requests for advice as to methods and materials for filling, to questions as to the best location in some particular type of boiler. The Locomotive has had little or nothing to say on this subject for many years and although we must admit that there is little that is novel to offer at this time, still it is possible that a general review of the subject may be of interest to some of our readers.

Fusible plugs are often misrepresented. Their true function is not to save a boiler in which the water has gotten dangerously low, but to act as a low water alarm, calling the matter to the attention of the boiler attendant, who can then take the necessary steps to save his apparatus.

Fusible plugs are ordinarily made of brass with a hexagonal head at one end to permit of their being screwed in with a wrench, and threaded with a standard tapered pipe thread. They are either inside plugs or outside plugs depending upon whether they are designed to be screwed in from the water or fire side of the sheet or tube they are to protect. A tapered hole is drilled through the center of the plug, from end to end, with the large end toward the water side of the sheet when the plug is in place. The tapered hole is then filled with a fusible metal, which will be crowded tightly into it by the boiler pressure. The operation of the plug when in good condition is about as follows: As long as the inner end of the plug is covered by water, it will remain at a temperature essentially the same as the water, or about at the boiling point corresponding to the pressure carried. The exact temperature will depend of course upon the cleanliness of the boiler, for there will be a much greater temperature difference between the metal and the water in a badly scaled boiler than in a perfectly clean one. When the water level falls low enough to expose the plug, the steam can no longer take heat away from the metal as fast as it is supplied by the hot gases with the result that the temperature rises and when the melting point of the fusible material is reached it softens and is promptly blown out by the steam pressure. Steam issuing from the orifice will tend to lower the boiler pressure somewhat, and will perhaps effect a slight deadening of the fire if the plug is located so that the jet can blow back into the furnace, but the principal effect as we mentioned above is to warn the boiler attendants that something is wrong in time for remedial measures to be adopted.

It will be seen that for prompt and certain action a fusible plug must be filled with a material whose melting point is but slightly above the temperature of the water in the boiler at its working pressure, allowing leeway enough for a moderate and quite safe rise in temperature of the metal above the water temperature when the boiler is somewhat scaled. Many different alloys are available for such a use, and nearly any desired melting point may be obtained by a proper mixture of metals. These alloys have been very carefully studied by the manufacturers of automatic sprinkler heads for fire protection, so that sprinklers may be had to fuse at almost any temperature which is thought desirable as a protection against incipient fires. There is one important difference however between the action of an alloy in a sprinkler head and in a fusible plug, namely that in the plug the metal is constantly exposed to the chemical action of the flue gases on the one hand, and the scale forming and corroding properties of the boiler water on the other. The result is that almost all metals when used as fusible plug fillers undergo a slow change. On this account most of the fusible alloys soon become worthless in service and reach a state of decomposition where it is practically impossible to melt them at all. This being true, and because a pure metal is much more stable and dependable under such conditions than any alloy, it has become the custom to fill all plugs with pure Banca tin. This metal will remain in serviceable condition longer than any other material whose melting point is at all suitable. It may be depended upon to melt promptly at about 449 degrees F. which corresponds to a pressure of about 365 lbs. gauge. Since tin will melt long before steel will be injured, but will remain solid at temperatures well above those corresponding to any ordinary steam pressure, it will serve in practice as a universal filling material, and it is required by law in many states, as well as by the United States Steamboat inspectors. One must not rest under the impression however that a tin filled plug will undergo no deterioration in service, for we frequently find cases in which the metal has become hard and crystalline with a thick coating of oxide at the ends, and in this condition the melting point may be very high indeed. Because of this fact, it is important that the plug be so placed that it is accessible both from the steam and fire side of the boiler at inspection, so that the boiler inspector or the engineer in charge may frequently observe if the metal is changing. So long as the metal is clean, and seems soft and malleable when struck with a light hammer, no serious trouble need be anticipated.

There is another reason, quite as important as the first why a fusible plug should be placed in an accessible location. It is the inborn tendency of some men to neglect or actually dispense with any attachment which is hard to replace. We have found fusible plugs with wrought nails driven in to take the place of the metal which had run out rather frequently, and many instances have been brought to our attention in which an ordinary pipe plug was found by the boiler force to be a ready substitute for the more useful trouble maker. A case in point is the location of the plug in a vertical tubular boiler. In all such boilers except the submerged head type, the plug if it is to be of service must be located in a tube. A hand hole is usually placed in the shell opposite the plug which must be screwed into one of the tubes in the outer row. With the tubes commonly used, a very small plug is required, and the boiler must be quite cold and empty to below the hand hole level before a plug can be replaced. We do not wish to reflect upon those laws, in force in many states, which require a plug in this type of boiler, but we do desire to show that its use is at least a debatable question.

As to the location which we would recommend with various types of boilers, we must first state definitely that wherever legal requirements have been adopted bearing on this important question, they should be accurately followed as a failure to do so may involve the boiler owner in serious difficulty. This is especially true in the event of an accident occuring to a boiler which is not equipped in strict compliance with the law. A general rule would be to place the plug at that level below which the water line should never be allowed to fall, even in an emergency, when there is a fire on the grate. Place it in the most accessible location which will satisfy the first requirement, and by accessible we mean easily reached from both the fire and water sides if possible. The third and last requirement is that the plug be as near the furnace as it may, so that it may be heated to the fusing point in the shortest possible time after being uncovered. Perhaps it may be well to illustrate this rule with a few typical plug locations in familiar types of boilers. In internally fired boilers of the Locomotive, Cornish, or Lancashire type, the plug is usually located in the furnace crown at the highest point, and it ordinarily projects through the crown about an inch, so that it will be uncovered before the crown sheet is entirely dry. In Scotch marine boilers of the wet back type, the plug would be located in the top of the combustion chamber, while in the dry back type of Scotch boiler, the plug is placed in the back tube sheet two inches above the top row of tubes. In the horizontal tubular type, the plug is placed in the rear tube sheet or head, two inches above the tube tops. In water tube boilers the plug is placed if possible in the steam drum at the lowest permissible water level, and if possible in the first pass of the gases. An access door in the setting opposite the plug is of great assistance in this case. With those water tube boilers in which vertical or nearly vertical tubes terminate in an upper drum, the fusible plug is usually placed in the lower head of this upper drum. Special cases of course require special treatment, but we believe that by intelligently applying the general rule which we have given, a satisfactory location may be arrived at for nearly every boiler type. One additional caution is necessary in the case of water tube boilers with regard to the level at which the plug should stand. In many of these vessels the tubes terminate in the upper drum, and are secured to it by a rolled or expanded joint. In such cases the fusible plug should be high enough so that the tube ends will still be covered when the plug operates, for if these tube ends are overheated, all the tubes in the boiler may be ruined.

The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

C. C. PERRY, EDITOR.

HARTFORD, JULY, 1913.

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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

The policies of all companies writing steam boiler insurance express in some way a provision which exempts the insurer from liability for loss due to the explosion of a boiler, the safety-valve of which is adjusted to blow at a pressure in excess of that approved for it by the Company and recorded either by the policy or otherwise. This is obviously a necessary condition of such an insurance contract for the setting of the safety-valve normally determines the limit of pressure which the boiler will carry, and a limitation in pressure to that at which the insurer is willing to undertake the risk, is but proper and just. It is generally so recognized and accepted.

But occasionally an incident arises which shows that while the right of the insurer to limit the pressure is admitted, there is a misunderstanding of what influences should determine the value recorded as the limit of that pressure. This misunderstanding arises with boiler owners,— and sometimes, too, with boiler underwriters, who should know better,— because of a failure to identify the recorded pressure as that of the *maximum safety-valve setting,* as distinguished from the pressure which the insuring Company might approve as within the limitations of safety for a particular boiler structure. Usually, it is true, the strength of a boiler, its condition or the character of its construction determines the pressure at which its safety-valve should be set, but this is by no means always the case. Very frequently it is the strength or condition of some other boiler that is the limiting factor. For the pressure in a number of boilers connected together is of course the same in all, and if one of them for any reason is weaker than the others, the pressure on all must be limited to that which that weaker boiler may safely sustain. To limit the pressure, the safety-valve must be adjusted to blow at not higher than that pressure and thus in accordance with the policy provision a pressure, less than the structure of some of the boilers would warrant, is recorded as approved. Other considerations, too, lead to the same result. For instance, a boiler may be strong enough for a pressure of one hundred pounds per square inch but the purposes of its operation may be best attained at 15 lbs, per sq. inch. Under such a condition the insuring company may feel it advisable that the safety-valve be set for twenty pounds, not because a higher pressure is unsafe, but because if set at a higher pressure the valve would seldom if ever operate under pressure, and it should occasionally be raised by pressure to demonstrate its condition. Under such circumstances it is the twenty pound pressure which the policy should record as approved.

All this, of course, is to show that an assured, under a steam boiler policy, should not feel himself aggrieved that some higher pressure is not recorded in his policy for a boiler which, he is confident may safely carry it, until he has learned the reason for the limitation. It will usually be found that there is a reason, and a sound one, too.

There seems to be still a strongly rooted feeling among engineers and engine owners that shaft-governed engines are free from fly-wheel accidents due to over speed. This notion is no doubt based on the supposition that since the governor is more nearly an integral part of the engine than the belt or gear driven pendulum type, it is unlikly to become deranged. Of course this is true as far as it goes. That is, a shaft governor is simple and positive. It is free from the menace of broken or displaced belts and it will shut down the engine in the event of many of the casualities which may occur to it. But shaft governors do go wrong in ways which permit the engine to race and as we have shown before the imprisoned weights may even cause a fly-wheel to disrupt if a break in the confining springs or linkage allows them to strike a heavy blow upon the inner surface of the wheel rim. Some engine builders have overcome this difficulty by placing the governor in a separate wheel or governor case, as they call it, which is attached to the crank shaft alongside the fly-wheel. This is unquestionably a step forward and yet the wreck illustrated on another page was on just this very type of engine.

The moral of all this is, that *all* engine wheels should have insurance protection. We do not for a moment desire to be construed as discrediting the value or desirability of stops and governors. Provide them by all means, get the best the market affords and keep them in first class order by utilizing to the fullest the expert knowledge available through an insurance company's inspection service. But do not lose sight of the *insurance* value of a fly-wheel policy for just these "impossible cases" and do not think that a special providence surrounds your particular engine with a sort of mysterious halo of safety.

Joseph R. Ensign was elected a director of the Hartford Steam Boiler Inspection and Insurance Company at a meeting of the board of directors held Friday, June 27, 1913, to fill the place made vacant by the death last December of George Burnham of Philadelphia. Mr. Ensign is a resident of Simsbury, Ct., and is the vice-president of the Ensign-Bickford Company of that place, manufacturers of safety blasting fuses.

Mr. Ensign was graduated from Yale University with the class of 1889 and received the degree of M.A, from that institution in 1891. In addition to his connection with the Ensign-Bickford Co., he is a director of The Arlington Company, Arlington, N. J., The Tariffville Lace Company, Tariffville, Ct., The Standard Fire Insurance Co., Hartford, Ct., and is a trustee of the Hartford Seminary Foundation. He represented the town of Simsbury in the legislative session of 1910-1911.

Boiler Explosions.

January, 1913 (concluded from the April Locomotive).

(29.) — A tube ruptured January 10, in a water tube boiler at the plant of the Inland Steel Co., Indian Harbor, Ind.

(30.) — On January 10, four sections of a cast iron sectional heating boiler ruptured at the plant of the Hunt Spiller Mfg. Corporation, South Boston, Mass.

(31.) — Several tubes failed on a locomotive attached to Bessemer and Lake Erie passenger train No. 21, at East Pittsburg, Pa., on January 10. Two men were slightly injured.

(32.) — A saw mill boiler exploded January 10, near Brinkhaven, O. One man was fatally injured, and several others less seriously injured.

(33.) — A header connecting two boilers burst January 10, at the Atlas Distillery, Peoria, Ill. No great damage was done.

(34.) — A tube ruptured January 11, in a water tube boiler at the plant of the Dixie Portland Cement Co., Richard City, Tenn. One man was injured.

(35.) — On January 11, a tube failed, and four cast iron headers ruptured in a water tube boiler at the plant of the Grasselli Chemical Co., Grasselli, Ind.

(36.) — On January 11, a tube ruptured in a water tube boiler at the plant of the John B. Stetson Co., Philadelphia, Pa.

(37.) — A greenhouse boiler exploded January 11, at the North Side Greenhouse, Minneapolis, Minn. Julius Rieck, the fireman, was pitched from his cot into a cellar, as the result of the accident, but he fortunately escaped with but slight injury.

(38.) — A tube ruptured January 12, in a water tube boiler at the Brand Brewery of the United States Brewing Co., Chicago, Ill. H. Buesing, fireman's helper, was killed.

(39.) — On January 13, a boiler exploded at the plant of the McMillan Lumber Co., Pine Barren, Fla. One man was killed, one injured, and the plant badly wrecked.

(40.) — On January 14, a boiler ruptured at the Buckeye Clay Pot Co.'s plant, Toledo, O.

(41.) — A fuel economizer exploded January 14, with great violence, at the Glenlyon Dye Works, Saylesville, R. I. Two men were killed, seven or eight injured, and property was damaged to the extent of about $26,000.

(42.) — A heating boiler burst in a school at Vidalia, La., on January 14.

(43.) — A heating boiler exploded January 15, in the basement of Joseph Harper's dry goods store, in the Bronx, New York City. One person was slightly injured.

(44.) — A cylinder head was blown from the main engine at the Farrel Foundry and Machine Co.'s plant, Waterbury, Ct., on January 15. Two men were severely scalded and bruised.

(45.) — A boiler exploded January 16, in a saw mill at a lumber camp a few miles from Booneville, Miss. One man was killed, and four others injured.

(46.) — On January 17, a water tube boiler failed at the University of Wooster, Wooster, O.

(47.) — Two boilers exploded January 17, at the north shaft of the Home-Riverside Mine, Leavenworth, Kans.; 150 miners were isolated in the mine for four hours, until spare boilers could be put in operation, and the hoists set working again.

(48.) — A tube ruptured January 18, in a water tube boiler at the plant of the American Water Works and Guarantee Co., Connelsville, Pa. One man was injured.

(49.) — A tube ruptured January 18, in a water tube boiler at the plant of the Miller Lock Co., Philadelphia, Pa.

(50.) — A water back in a range exploded January 18, in the home of Mr. J. A. Gray, Fort Collins, Kans. Mr. Gray was painfully injured by the explosion, which is said to have been due to the freezing of the pipe connections.

(51.) — Two men were killed and several injured, by the explosion, January 20, of a fuel economizer, at the Arragon Mills, Arragon, Ga. The property loss was estimated at $10,000.

(52.) — Two boilers exploded January 20, at the mill of the Howland Pulp and Paper Co., Howland, Me. Two men were killed and three injured, while the property loss was in the neighborhood of $18.000.

(53.) — A tube burst January 21, in a water tube boiler at the silk mill of A. G. Turner, Willimantic, Ct. The boiler was seriously injured through overheating, as the fire could not be hauled after the accident.

(54.) — A tube failed January 23, in a water tube boiler at the Lower Union Mills of the Carnegie Steel Co., Pittsburg, Pa. One man was injured.

(55.) — An air receiver exploded in the Pennsylvania R. R. yards at Youngswood, Pa., on January 24. A cap, blown from the receiver, broke a steam main, with the result that two men were seriously scalded, one of them probably fatally.

(56.) — A boiler exploded January 24, at an oil pumping station, near Bradford, Pa. One man was fatally injured.

(57.) — A tube ruptured January 25, in a water tube boiler at the plant of the American Steel and Wire Co., Waukegan, Ill.

(58.) — On January 28, a tube ruptured in a water tube boiler at the mill of the Lehigh Portland Cement Co., Mitchell, Ind.

(59.) — A boiler exploded January 29, at the Cleveland, O., plant of the Upson Bolt and Nut Co., injuring four men.

(60.) — A tube ruptured January 31, at the plant of the Allen and Wheeler Co., Troy, N. Y. William Lawade, engineer, and H. McAlpine. fireman, were injured.

(61.) — On January 31, a tube ruptured in a water tube boiler at the Glen Allan Oil Mills, Glen Allan, Miss.

February, 1913.

(62.) — On February 1st, a blow-off failed at the saw mill of T. A. Foley, Paris, Ill. C. O. Willison, the assistant engineer, was scalded.

(63.) — A boiler ruptured February 3, at the cotton mill of the Aiken Mfg. Co., Bath, S. C. The damage was confined to the boiler.

(64.) — A boiler ruptured February 4, at the plant of the Albert Hansen Lumber Co., Garden City, La.

(65.) — Twelve sections in a cast-iron heating boiler ruptured February 4, at the Elizabeth School, Worcester, Mass.

(66.) — On February 5, three sections fractured in a cast-iron heating boiler at the Lincoln and Maple Ave. School, District 95, Cook County, at Brookfield, Ill.

(67.) — On February 5, a cast-iron sectional heater failed at the warehouse of the Pittsburgh Plate Glass Co., Boston, Mass.

(68.) — A tube ruptured February 6, in a water tube boiler at the Congress Hotel, Chicago, Ill.

(69.) — On February 6, a blow-off failed at the plant of the Fort Henry Mining Co., Buhl, Minn.

(70.) — A boiler exploded at the saw mill of T. R. Ritchey, near Rusk, Tex., on February 6. Two men were killed and five others injured, while considerable damage was done to the mill property.

(71.) — A tube ruptured February 7, in a water tube boiler at the plant of the Scoville Mfg. Co., Waterbury, Conn. Joseph Paul, fireman. was injured.

(72.) — A tube rupured February 7, in a water tube boiler at the plant of the New Orleans Railway and Light Co., New Orleans, La.

(73.) — On February 8, a section cracked in a cast iron sectional heater at the Central Hotel, H. B. Dougherty, prop., Maysville, Ky.

(74.) — A blow-off pipe failed on February 9, at the plant of the West Virginia Pulp and Paper Co., Williamsburg, Pa. Considerable damage was done to the boiler.

(75.) — A heating boiler exploded February 10, at an apartment house located at 2117 Guilford Ave., Baltimore, Md. The building was badly wrecked both by the explosion, and the fire that followed. No one was injured, though several had rather narrow escapes.

(76.) — A fuel economizer exploded February 10, at the mill of the Jackson Fibre Co., Bemis, Tenn. Two were killed, and five or six others injured. The property loss was estimated at $25,000.

(77.) — On February 11, five cast-iron headers ruptured in a water tube boiler at the plant of the Ehret Magnesia Covering Co., Fort Kennedy, Pa.

(78.) — A boiler ruptured February 12, at the stone mill of W. McMillan and Son, Bedford, Ind.

(79.) — A tube ruptured February 12, in a water tube boiler at the plant of the Columbia Railway Gas and Electric Co., Columbia, S. C.

(80.) — A boiler exploded February 12, at the Star Mills, Eau Claire, Wis. Owing to the fact that the boiler was carrying but a low pressure at the time, the damage was slight.

(81.) — A boiler exploded February 12, at the mill of the Menominee White Cedar Co., Menominee, Mich. The property damage was estimated at $500, but the engineer and watchman were both badly scalded.

(82.) —A boiler ruptured February 13, at Wharf No 2. of the Maine Central R. R. Co., Portland, Me. The damage was confined to the boiler.

(83.) — On February 13, a tube ruptured in a water tube boiler at the plant of the Allegheny County Light Co., 13th St.. Pittsburgh, Pa. Marion Dilacombo and John Farr, ash wheelers, were injured.

(84.) — On February 13, the blow-off pipe attached to the No 5 boiler failed at the Protestant Episcopal Hospital, Philadelphia, Pa.

(85.) — A section in a cast iron sectional heating boiler failed February 12, in the basement of the Trinity Reformed Church, West New York, N. J.

(86.) —A boiler ruptured at the power house of the Edison Works, East Orange, N. J., on February 13.

(87.) — On February 14, the blow-off pipe attached to the No. 4 boiler failed at the Protestant Episcopal Hospital, Philadelphia, Pa. (This accident is distinct from No. 84, which took place to the blow-off of the No. 5 boiler the day before.)

(88.) — On February 14, eight sections of a cast-iron sectional heating boiler failed in the business block of the Snow Association, 105-107 Federal St., Boston, Mass.

(89.) — A boiler ruptured February 15, at the Sargent Coal Co., Newburg, Ind.

(90.) — A tube ruptured February 15, in a water tube boiler at the plant of the Studebaker Corporation, Carriage Works, South Bend, Ind.

(91.) — A boiler exploded with considerable violence on February 15, at the saw mill of C. R. Cummings, Wallisville, Tex. Four men were killed, five others seriously injured, and the property loss was estimated at $10,000.

(92.) — A tube ruptured February 16 in a water tube boiler at the plant of the Crescent City Stock Yard and Slaughter House Co., New Orleans, La.

(93.) — A boiler exploded February 17, at the saw mill of James Nevill & Son, Gaithersville, Ark. The plant was destroyed, but no one was injured, as the accident occurred just after the help had left for the night.

(94.) — On February 17, the boiler of a Delaware and Hudson locomotive exploded in the railroad yards at Mechanicsville, N. Y. Two men were badly injured, and the boiler was projected about 200 feet.

(95.) — A tube ruptured February 17, in a water tube boiler at the power house of the New Orleans Railway and Light Co,, New Orleans, La.

(96.) — On February 19, a boiler ruptured at the plant of the Milwaukee Western Malt Co., Milwaukee, Wis.

(97.) — The crown sheet of a locomotive type boiler collapsed February 19, at the plant of the Bridge Pasteurized Milk Co., Wichita, Kan.

(98.) — A section ruptured February 19, in a cast iron sectional heater at the Cleveland School, Special School District of Camden, Camden, Ark.

(99.) — A boiler exploded February 19 at the plant of the Carnick Junk Co., Oil City, Pa. The boiler, which was an old one, had been undergoing repairs, and was being tested under steam at the time of the accident. One man, Samuel Blythe, was on top of the boilers making repairs to a steam valve (according to press accounts) and was very seriously, and perhaps fatally injured. He was projected about 75 feet, receiving many broken bones, beside severe scalds and burns.

(100.) — On February 19, a heater exploded in the apartment house belonging to Annie Shaffer, Holyoke, Mass. One of the tenants in the building has brought suit for $1,000 for damage resulting from the explosion.

(101.) — An extracting machine exploded February 19 at the Park Woolen Mills, Chattanooga, Tenn. One man was killed and two others injured as a result of the accident, which was said to have been due to an over pressure of steam.

(102.) — On February 21, a boiler ruptured at the plant of the Jupiter Coal Co., Denver, Col.

(103.) — A boiler used for pumping out oil wells exploded February 21, at the wells of the South Penn Oil Company, near Unity, Pa. One man was seriously injured.

(104.) — A tube ruptured February 22 in a water tube boiler at the mill of the Piermont Paper Co., Piermont, N. Y. Steve Pauko and Brome Barfiero, firemen, were injured, while considerable damage was done to the boiler.

(105.) — On February 22, a tube ruptured in a water tube boiler at the blast furnace of the Pickand Mather Co., Toledo, O.

(106.) — On February 24, a boiler ruptured at the Brush Light and Power Co.'s power house, Brush, Col.

(107.) — A boiler ruptured at the mines of the Munro Iron Mining Co., Iron River, Mich., on February 25. The damage was small.

(108.) — On February 25, a tube collapsed in a vertical tubular boiler at the plant of the Pittsburgh Plate Glass Co., Crystal City, Mo. Three men were injured.

(109.) — A boiler, the property of the Henry C. Clark estate, coal dealers, ruptured February 25, at Providence, R. I.

(110.) — A tube ruptured February 28 in a water tube boiler at the plant of the Mahoning and Shenango Ry. and Light Co., Youngstown, O. Mike Murphy, water tender, was injured.

(111.) — A hot water boiler burst February 29, in the workshop of Nathan Somers, hat manufacturer, Philadelphia, Pa. One man was injured, and some damage resulted to the building.

March, 1913.

(112.) — A tube ruptured March 1, in a water tube boiler at the Waukegan, Ill., plant of the American Steel and Wire Co.

(113.) — On March 1, a tube ruptured in a water tube boiler at the plant of the Northern Texas Traction Co., Handley, Texas.

(114.) — A boiler ruptured March 2, at the wood alcohol plant of Riefler and Sons, Honesdale, Pa. S. Kisner, fireman, was injured, and the boiler was considerably damaged.

(115.) — On March 3, a boiler ruptured at the plant of the Western Cartridge Co., Alton, Ill.

(116.) — A tube ruptured March 3, in a water tube boiler at the plant of the Atlantic Ice and Coal Corp., Chattanooga, Tenn. Jesse Thomas, fireman, was injured.

(117.) — A boiler exploded March 3, in the cellar of the store occupied by the Robert Schmitt Co., Nyack, N. Y.

(118.) — A boiler exploded March 3, at the Moore saw mill, Gladewater, Tex. Two men were killed and three others were injured, probably fatally. The mill was badly wrecked.

(119.) — The boiler of a Pennsylvania R. R. locomotive, drawing a special train loaded with troops on the way to the presidential inauguration, exploded March 3, at East Rahway, N. J. The engineer was killed and the fireman so severely injured that his recovery was considered doubtful. The engine was a complete wreck.

(120.) — A cast iron header ruptured March 4, in a water tube boiler at the plant of the Voight Milling Co., Grand Rapids Mich.

(121.) — A boiler exploded March 4, in the plant of the Milwaukee Lithographing Co., Milwaukee, Wis. The damage was estimated at $3,500.

(122.) — Charles Denton, a 14-year-old boy, was severely scalded March 4, at Old Alton, Tex., by the explosion of a toy boiler which he had made. The small boiler is said not to have had any safety valve.

(123.) — A boiler exploded on March 4, in the greenhouse of J. S. Polland, Cedar Rapids, Ia. The damage was largely confined to the boiler and chimney.

(124.) — A blow-off pipe failed March 5, at the Omaha General Hospital, Omaha, Neb.

(125.) — On March 5, a tube ruptured in a water tube boiler at the plant of the Nichols Copper Co., Laurel Hill, L. I., N. Y. Paul Smegel, fireman, was injured.

(126.) — On March 5, a tube failed in a water tube boiler at the Helmbacher Forge and Rolling Mill Plant of the American Car and Foundry Co., St. Louis, Mo. Three men were injured.

(127.) — Ten cast iron headers ruptured March 6, in a water tube boiler at the plant of the El Dorado Light and Water Co., El Dorado, Ark. The boiler was seriously damaged.

(128.) — On March 6, a tube ruptured in a water tube boiler at the Isabella Furnace of the Carnegie Steel Co., Etna Boro, Pa.

(129.) — A boiler exploded March 6, at the plant of the Solvay Process Co., East Syracuse, N. Y. The explosion caused the destruction of a large caustic conveyor, and much damage was done by the caustic liberated.

(130.) — A water front in a kitchen range exploded March 7, at the home of William H. Gallagher, New Britain, Conn. The range was wrecked, and slight damage resulted to the house furnishings.

(131.) — A boiler using the waste heat from a steel furnace exploded March 7, at the Wilkes Rolling Mill, Sharon, Pa. Thirteen men were injured, three of them fatally.

(132.) — A tube ruptured March 8, in a water tube boiler at the plant of The J. S. Brill Co., car builders, Philadelphia, Pa. One man was injured.

(133.) — On March 10, an accident occurred to the boiler of a locomotive at the plant of the Fordyce Lumber Co., Fordyce, Ark.

(134.) — A boiler ruptured March 12 at the plant of the Princess Furnace Co., Glen Wilton, Va.

(135.) — A tube ruptured March 13, in a water tube boiler at the plant of the American Sheet and Tin Plate Co., Cambridge, O.

(136.) — On March 15, a tube ruptured in a water tube boiler at the Colorado Springs Light, Heat and Power Co. plant of the United Gas and Electric Corp., Colorado Springs, Col.

(137.) — A tube ruptured March 16 in a water tube boiler at the plant of the Plainville Mill and Elevator Co., Plainville, Kan.

(138.) — On March 16, a cast iron heating boiler ruptured at the Imperial Hotel, Atlanta, Ga.

(139.) — A cast iron sectional heater failed March 16, in the Price building, Florence, Neb.

(140.) — A blow-off pipe failed March 18, at the Hotel Montrose, operated by the Cedar Rapids Hotel Co., Cedar Rapids, Ia.

(141.) — On March 18, a cast iron sectional heater failed at the apartment house of Samuel Harris. 113-115 Leonard St., New York City.

(142.) — On March 20, a cast iron cross box failed in a water tube boiler at the plant of the Standard Roller Bearing Co., Philadelphia, Pa.

(143.) — The crown sheet of a boiler at the plant of the American Equipment Co., near Lebanon, Pa., failed March 21. One man was painfully burned, and the plant was shut down pending repairs.

(144.) — A boiler used for heating the Christian Church, Normal, Ill., failed March 22. The damage was slight.

(145.) — Two cast iron headers ruptured March 24, in a water tube boiler at the Friedman Mfg. Co. plant of Armour & Co., Union Stock Yards, Chicago, Ill.

(146.) — On March 24 a tube failed in a water tube boiler at the plant of the Ashaway Line and Twine Co., Ashaway, R. I.

(147.) — A boiler ruptured March 24, at the plant of the Worcester Salt Co., Ecorse, Mich. The boiler was badly damaged.

(148.) — A tube ruptured March 25, in a water tube boiler at the plant of the Tonawanda Board and Paper Co., Tonawanda, N. Y.

(149.) — On March 27, two sections of a cast iron heating boiler failed at the Irving School, Salt Lake City, Utah.

(150.) — A blow off failed March 27, at the plant of the Yolande Coal and Coke Co., Yolande, Ala. One man was scalded.

(151.) — A boiler ruptured March 29, at the Vinita Electric Light, Ice and Power Co. plant of the Middle West Utilities Co., Vinita, Okla.

(152.) — A locomotive boiler exploded on the Texas and Pacific R. R., between Fort Worth and Handley, Tex., on March 29. One man was killed and two others were seriously injured.

(153.) — A boiler burst March 31 at the plant of the Dominion Cloak Co., Toronto, Can.

APRIL, 1913.

(154.) — On April 1, a blow-off pipe failed at the laundry of Tiffany Bros., Aberdeen, S. D.

(155.) — The boiler of a Chicago, Milwaukee and St. Paul locomotive exploded April 1, near Franksville, Wis. Three men, the engineer, fireman and a tramp, were injured, the tramp fatally.

(156.) — A tube ruptured April 2, in a water tube boiler at the plant of the Crescent Portland Cement Co., Wampenn, Pa. Three men were injured, but the property damage was small.

(157.) — On April 5, a blow-off pipe failed at the plant of the Spring Perch Co., Bridgeport, Conn.

(158.) — On April 7, a tee in a steam pipe line failed at the plant of the Florsheim Shoe Co., Chicago, Ill. Ben Franklin, fireman, was injured.

(159.) — A tube ruptured April 8, in a water tube boiler at the plant of the Duquesne Light Co., Pittsburgh, Pa. Martin Flaherty, fireman, was injured.

(160.) — Two cast iron headers ruptured April 9, in a water tube boiler at the plant of the Alpha Portland Cement Co., Martins Creek, Pa.

(161.) — An ammonia boiler exploded April 10, at one of the plants of the Moore Ice Works, Pensacola, Fla. Four men were killed and the plant was demolished.

(162.) — A number of tubes failed April 11, in a water tube boiler at the plant of the Crescent City Stock Yards and Slaughter House Co., New Orleans, La.

(163.) — A kitchen boiler burst April 13, in the home of Frank W. Huff, Philadelphia, Pa. The accident is attributed to starting a fire in the range when the water supply to and from the boiler had been shut off. The cook was so badly injured that she was not expected to live.

(164.) — On April 13, a boiler ruptured at the plant of the Lovegren Lumber Co., Cherry Grove Ore.

(165.) — A boiler exploded April 13 on the property of the Barnsdall Oil Co., near Bartelsville, Okla. The boiler was attached to a well drilling outfit, and was completely demolished. One man was painfully, but not seriously injured.

(166.) — A boiler ruptured April 14 at the brewery of C. F. Bach, Sebewaing, Mich.

(167.) — On April 14, a boiler ruptured at the plant of the Indianapolis Abattoir Co., Indianapolis, Ind.

(168.) — A tube ruptured April 15, in a water tube boiler at the power house of the Terre Haute and Eastern Traction Co., Indianapolis, Ind.

(169.) — A blow-off cock failed April 16, at the plant of the Border City Ice and Cold Storage Co., Fort Smith, Ark.

(170.) — On April 17, a blow-off pipe failed at the power house of the Lake Erie and Western Railway Co., Lima, O. One man was scalded.

(171.) — On April 17, two men were trapped and severely scalded by the failure of a steam pipe in a manhole where they were working, at the plant of the New York and Philadelphia Package Co., Paulsboro, N. J.

(172.) — A man was seriously scalded April 17, by the bursting of a steam pipe in the boiler room of the American Ice Co., Philadelphia, Pa.

(173.) — On April 19, a tube failed in a water tube boiler at the Washington Hotel and Improvement Co.'s building, Seattle, Wash.

(174.) — A boiler exploded April 19 which was used for oil well drilling near Venice, Pa. Two young boys were killed, and two men seriously but not fatally injured.

(175.) — A boiler used for irrigation pumping near Selma, Cal., exploded April 19. Frank Rouch, the owner of the outfit, was instantly killed and his son was very seriously injured. The boiler was an old one which had formerly seen service on a traction engine.

(176.) — A steam boiler exploded April 21, on an oil lease at Tuna, Pa. One man was seriously injured.

(177.) — On April 22, a boiler exploded at the Thompson brickyard, Mount Pleasant, Mich. Four persons, one of them a nine-year-old girl, received injuries from which they died, while several others were more or less severely injured. The property damage was considerable.

(178.) — A tube ruptured April 22 in a water tube boiler at the plant of the Charleston Consolidated Railway, Light and Power Co., Charleston, S. C.

(179.) — A boiler exploded April 23, at the saw mill of A. E. Frankford, Columbia, Pa. Mr. Frankford and Henry Stotz were seriously injured, and the property loss was estimated as in the neighborhood of $1,000.

(180.) — A boiler rupured April 26, at the Monroe Mine of the Oliver Iron Mining Co., Hibbing, Mich.

(181.) — On April 28, a tube ruptured in a water tube boiler at the Trenton plant of the American Bridge Co., Trenton, N. J.

(182.) — On April 28. a cast iron sectional heating boiler failed at the Imperial Hotel, Atlanta, Ga.

(183.) — On April 30, a section in cast iron heater No. 1 ruptured at the Sixth Street School, Louisville, Ky.

(184.) — On April 30, a section in No. 2 cast iron heating boiler ruptured at the Sixth Street School, Louisville, Ky. (Two separate accidents on the same day.)

(185.) — A boiler exploded April 30, at the saw mill of George Rowsey, near Danville, Ky. The plant was completely wrecked, and two men were seriously injured.

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY is now issuing to its policy-holders its "Vacation Schedule" for 1913. Like those of previous years, this schedule affords a most convenient form for arranging and recording the holiday period allotted to each of the clerks or other employees of an institution. From it at a glance may be determined how many and what members of the force will be absent on any given date and thus by a little foresight and care the assignment of the same days to those whose simultaneous absence would cause inconvenience may be avoided.

Copies may be obtained by our policy-holders on application to the nearest of the offices listed on the last page of this issue.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1913.

Capital Stock, . . . $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission,	$186,187.28
Premiums in course of collection,	285,163.53
Real estate,	90,600.00
Loaned on bond and mortgage,	1,193,285.00
Stocks and bonds, market value,	3,506,178.40
Interest accrued,	75,600.51
Total Assets,	$5,337,014.72

LIABILITIES.

Premium Reserve,		$2,211,732.44
Losses unadjusted,		94,913.83
Commissions and brokerage,		57,032.71
Other liabilities (taxes accrued, etc.),		47,740.86
Capital Stock,	$1,000,000.00	
Surplus over all liabilities,	1,925,594.88	
Surplus as regards Policy-holders,	**$2,925,594.88**	2,925,594.88
Total Liabilities,		$5,337,014.72

LYMAN B. BRAINERD, President and Treasurer.

FRANCIS B. ALLEN, Vice-President. CHAS. S. BLAKE, Secretary.

L. F. MIDDLEBROOK, Assistant Secretary.

W. R. C. CORSON, Assistant Secretary.

S. F. JETER, Supervising Inspector.

E. J. MURPHY, M. E., Consulting Engineer.

F. M. FITCH, Auditor.

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Incorporated 1866. Charter Perpetual.

The Hartford Steam Boiler Inspection and Insurance Company

ISSUES POLICIES OF INSURANCE COVERING

ALL LOSS OF PROPERTY

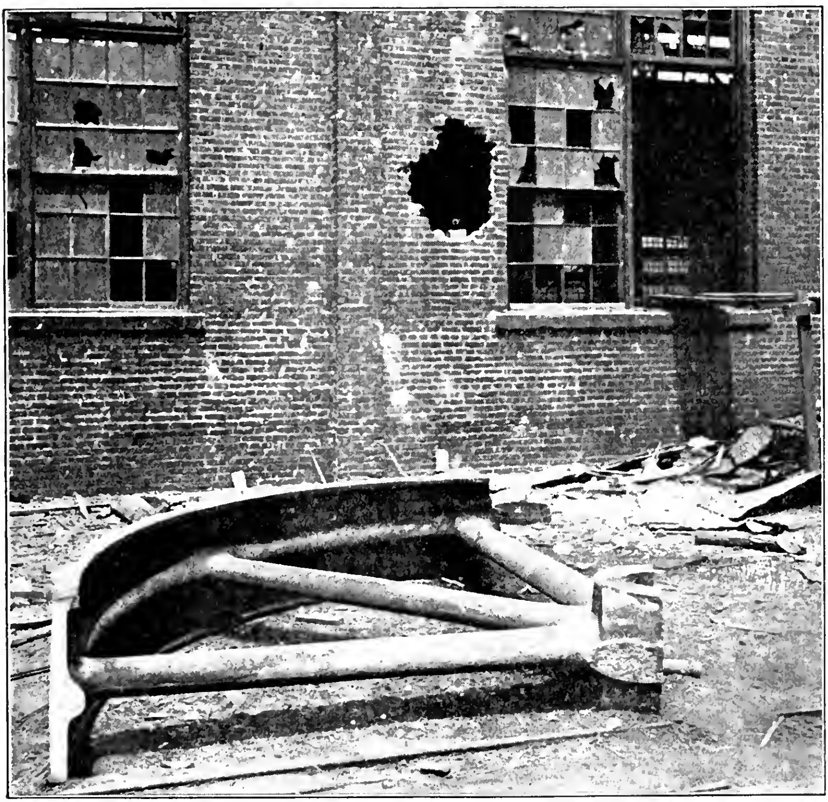
AS WELL AS DAMAGE RESULTING FROM

LOSS OF LIFE AND PERSONAL INJURIES DUE TO EXPLOSIONS OF STEAM BOILERS OR FLY WHEELS.

Department.	Representatives.
ATLANTA, Ga., 611-613 Empire Bldg.,	W. M. Francis, Manager and Chief Inspector.
BALTIMORE, Md., 13-14-15 Abell Bldg.,	Lawford & McKim, General Agents. R. E. Munro, Chief Inspector.
BOSTON, Mass., 101 Milk St.	C. E. Roberts, Manager. Joseph H. McNeill, Chief Inspector.
BRIDGEPORT, Ct., No. 1 Sanford Bldg.	W. G. Lineburgh & Son, General Agents. F. S. Allen, Chief Inspector.
CHICAGO, Ill., 160 West Jackson St.	H. M. Lemon, Manager. James L. Foord, Chief Inspector. J. T. Coleman, Assistant Chief Inspector.
CINCINNATI, Ohio, First National Bank Bldg.	W. E. Gleason, Manager. Walter Gerner, Chief Inspector.
CLEVELAND, Ohio, Century Bldg.	H. A. Baumhart, Manager and Chief Inspector.
DENVER, Colo., Room 2, Jacobson Bldg.	Thos. E. Shears, General Agent and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. Williams, Jr., General Agent. F. S. Allen, Chief Inspector.
NEW ORLEANS, La., 833-835 Gravier St.	Peter F. Pescud, General Agent. R. T. Burwell, Chief Inspector.
NEW YORK, N. Y., 100 William St.	C. C. Gardiner, Manager. W. W. Manning, Chief Inspector.
PHILADELPHIA, Pa., Cor. Fourth and Walnut Sts.	Corbin, Goodrich & Wickham, General Agents. Wm. J. Farran, Chief Inspector. S. B. Adams, Assistant Chief Inspector.
PITTSBURG, Pa., 1801-1802 Arrott Bldg.,	J. J. Graham, Manager. Benjamin Ford, Chief Inspector. W. A. Craig, Assistant Chief Inspector.
PORTLAND, Ore., 306 Yeon Bldg.,	McCargar, Bates & Lively, General Agents. C. B. Paddock, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. Mann & Co., General Agents. J. B. Warner, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. Ashcroft, Manager. J. P. Morrison, Chief Inspector.
TORONTO, Canada, Continental Life Bldg.,	H. N. Roberts, General Agent.

The Locomotive
of
THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Vol. XXIX. HARTFORD, CONN., OCTOBER, 1913. No. 8.



An Unusual Fly-Wheel Break. Birmingham, Alabama.

Fly-Wheel Explosion at Birmingham, Alabama.

A large fly-wheel burst Aug. 20 at the plant of the Payne and Joubert Machine and Foundry Co., Birmingham, Ala. The wheel, which was 15 feet in diameter, with a 26 inch face was of the split type, cast in two sections. It was joined at the rim by bolted flanges, and by the usual bolted construction at the hub. There were eight arms. The wheel served to transmit the load from an 18x36 inch Corliss engine to a generator, by means of a 24 inch belt. The speed was controlled by a fly ball governor of usual type, with a link type safety knock out, arranged for automatic operation in the event of governor belt breakage. The normal speed was 75 R. P. M.

We are told that a considerable peak load on the generator caused the circuit breaker to operate, relieving the engine very suddenly. The subsequent racing was noticed by the fireman and he called to the engineer who had stepped out of the engine room. The engineer, realizing what had happened, ran for the throttle, but only succeeded in getting in the path of one of the larger fragments of the wheel. He was instantly killed.

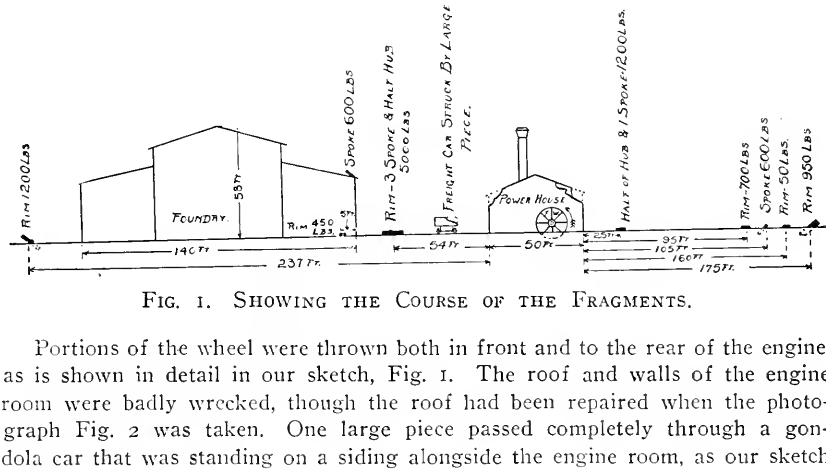


FIG. 1. SHOWING THE COURSE OF THE FRAGMENTS.

Portions of the wheel were thrown both in front and to the rear of the engine, as is shown in detail in our sketch, Fig. 1. The roof and walls of the engine room were badly wrecked, though the roof had been repaired when the photograph Fig. 2 was taken. One large piece passed completely through a gondola car that was standing on a siding alongside the engine room, as our sketch shows.

Perhaps the most unusual feature of this wreck is shown on the front cover. One large portion of the wheel composed of a section of the rim, three spokes and half the hub is seen to have remained intact. It is very unusual for a hub to leave the shaft in wrecks of this kind, indeed this is the first instance of such behavior which has come to the writer's attention.

The following explanation for this curious behavior has been suggested, and we believe that it is the most plausible view so far advanced. Let us suppose that the rim flanges were the weakest elements in the wheel's construction, and this is in line with the results obtained when wheels of this type have been speeded to destruction experimentally. Their failure might result in portions of rim adjacent to the flanges, with perhaps a spoke or so, leaving the wheel. If this should happen without wrecking those parts of the rim between two or three spokes, as in this instance, the whole stress due to the centrifugal force of the remaining material, would be transferred from the rim, which had carried it

FIG. 2. THE WRECKED ENGINE ROOM.

like a stretched hoop so long as it was unbroken, to the hub bolts. This would have the effect of stressing these bolts far in excess of their ordinary working load, and they might be expected to fail in tension, as these particular bolts evidently did, permitting the fragment of the rim with its attached spokes and half hub to be projected as a unit. Of course, it is difficult to see why the failure of the rim flanges did not wreck the entire rim, shearing the spokes and leaving the hub in place on the shaft, which is the ordinary mode of failure, but to this we can only offer the photographic evidence that in the present instance this did not happen. Perhaps some of our readers can suggest a more reasonable explanation.

Autogenous Welds for Boiler Work.

We are constantly requested to approve boiler repairs of various forms that have been accomplished by means of autogenous welding of the parts, and while we feel that there are many kinds of repair to which this process is admirably adapted, we have consistently refused to approve such repairs where the strength of the repaired part is of vital necessity to the safety of the boiler. We are not alone in our distrust of this method of joining metals for the purpose of boiler repairs or manufacture under the present condition of the art of autogenous welding.

Professor Theodore Kautny of Nürnberg, who is considered one of the leading authorities of the world on this subject, is using his influence to prevent the autogenous welding of boiler shells until some reliable method can be devised for ascertaining the probable strength of a weld without destroying it. We also understand that the United States Government does not approve of acetylene welding for boiler repairs where the parts welded are subjected to tensile strain.

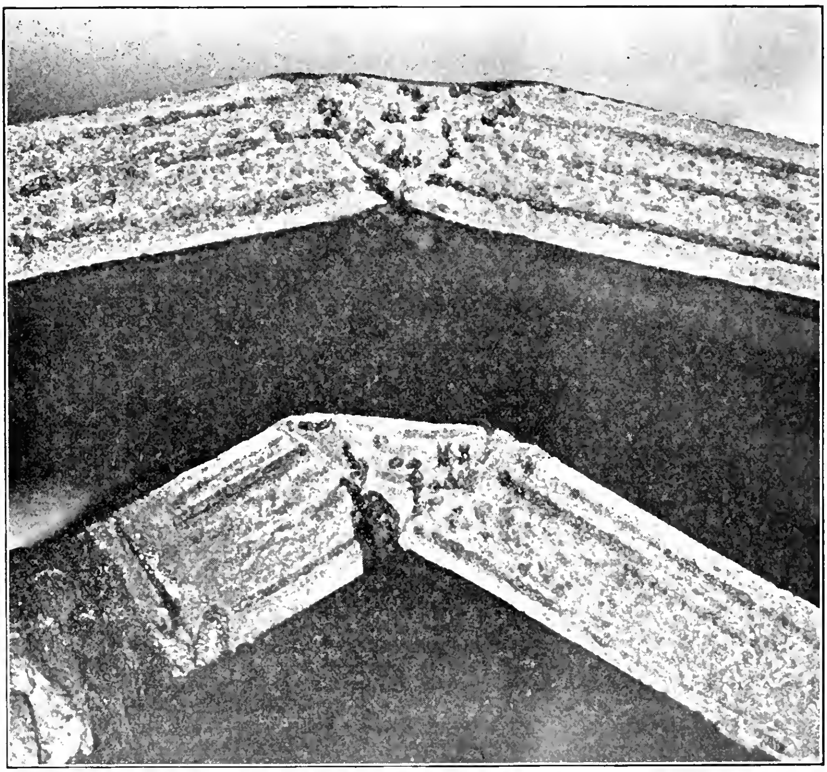


FIG. 1. (Upper.) ETCHED SECTION OF LONGITUDINAL SEAM.
FIG 2. (Lower). ETCHED SECTION OF WELD BETWEEN HEAD AND SHELL.

One of the most important companies doing general autogenous welding in this country advocates the licensing of equipment, operator and company where engaged in boiler repairing, to the end that greater skill may be brought to bear in making such repairs. There are so many conditions surrounding the making of a safe weld by this process that it hardly seems possible that all the improper ones can be guarded against except possibly in a few cases presenting difficulties of a fixed nature. In the oxy-acetylene process it is first necessary to obtain the right mixture of gas. If too much oxygen is present, the material is oxidized and the weld is left brittle and weak. Impurities in the oxygen used may also have a bad effect on the strength of the weld. If storage tanks are used as a means of supplying acetylene and the draught of gas from these tanks is too rapid, some of the absorbent liquid may be drawn through the connections to the burner and produce defects. A flame too rich in acetylene may also cause injury to the steel. The expansion of the parts adjacent to the weld, due to the heat necessary to make it, may leave tremendous internal stresses in the plate or other part that is welded which cannot even be estimated. This is such a variable factor that only the nicest judgment could be of any value in determining whether a given repair may be made with safety or not.

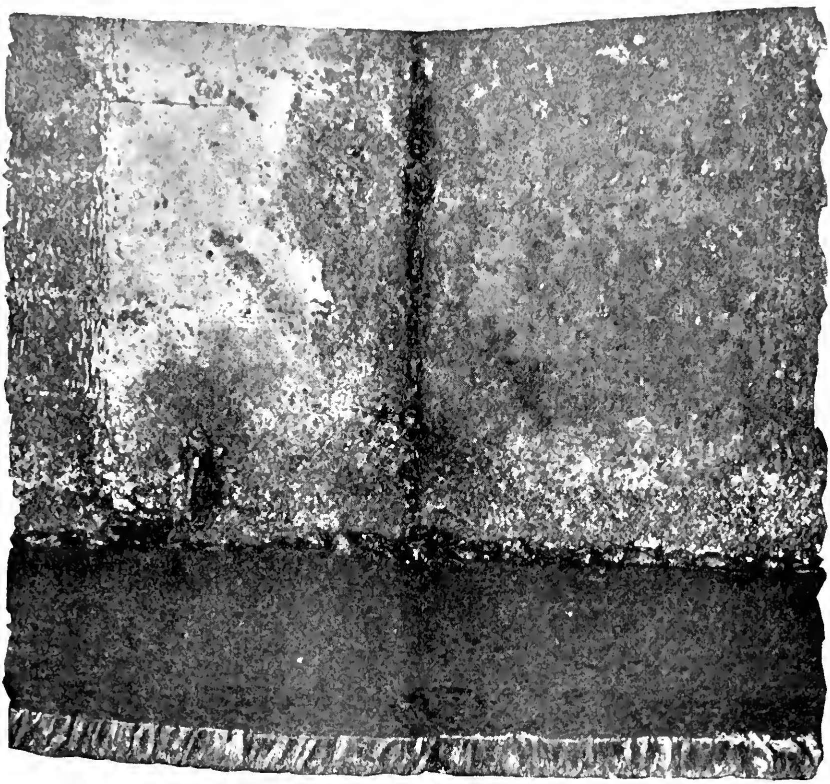


Fig. 3. Welding of Head to Shell. Note the Rough Character of the Work.

In a few instances, we have sanctioned the autogenous repair of cast iron sectional boilers used for very low pressures where the nature of the structure surrounding the defective part would seem to indicate that no severe local strains might be set up in the act of welding. However, our experience with this kind of repair has been very discouraging, for while the welding has held in most cases, subsequent breaks have developed which were produced by shrinkage strains at the weld.

One of the worst specimens of autogenous welding that has come to our notice was through the failure of a receiver separator connected to a turbine. While this cannot be taken as a fair sample of welded work, still it shows how poorly such work can be done, and aside from the poor design of this vessel, there was nothing to definitely show that the welding was not what it should be. For while the welds were roughly made, this does not always indicate that the surfaces are not properly joined. This receiver had been formed entirely by means of the autogenous welding process, the longitudinal seam, head seams and nozzles all being welded. The general dimensions of the vessel were 30″ in diameter by 5′ long, with 3-8″ shell and heads. The accident was due to the lower head of this receiver blowing out, the receiver operating in a vertical position, and after an examination of the parts the only wonder that it had ever remained together.

Figure 1 shows a section across the longitudinal seam which has been etched. By examining this section it will be seen that there is a line of holes at each side of the V representing the surfaces of the plate and there was very little sound metal bonded together along this seam. It will be seen from Figure 1 how poorly the contour of the cylinder was maintained at the joint, for by placing a rule on the cut, the shell will be seen to be perfectly straight, and while the cut only extends two inches across the seam, this flat space was five inches each side of the weld. With this misshapen seam and lack of bond between the parts, the only explanation that can be advanced to show why it held together at all (which it did for two years) is that the draft of steam was steady.

Figure 2 shows an etched cross section of the connection between the upper head and the shell of the receiver, the head being on the left-hand side of the figure. A close inspection of the weld at this point will show that there was almost no sound contact between the welding material and head at this point. It is evident from Figure 2 that the head was only dished and that no attempt was made to flange down the edges so as to bring the points of maximum bending stress away from the weld.

Figure 3 is a view of the inside of the separator showing a portion of the top head (at the bottom of the figure) and the longitudinal seam. Some idea of the roughness of the welding can be gained from this view but the parts themselves looked much worse than the cut shows.

Figure 4 shows a general view of the receiver with the top head lying towards the observer. On the ground at the left is seen the bottom head which was blown out. This head was dished outwards the same as the upper one, but when it failed, the force of the pressure forced it down over a pipe standard that supported it from the floor. The nozzle on the left-hand side of the receiver, which was stripped off by the explosion, was of 10″ size. This nozzle was made up of a flange butt welded to a short section of 10″ pipe and instead of flanging the opposite end of the pipe in order to attach it to the shell, a sheet steel collar was welded on, which in turn was welded to the shell of the receiver. The head and longitudinal seams on this vessel were bad, but the nozzle seams were worse. The welded on collars did not fit the contour of the shell, and numberless shims and many nails were used in filling the voids between the shell and collar on the nozzle. If Figure 4 is examined carefully, some of these shims may be seen around the opening on the left-hand side.

Such work as this is more likely than anything else to retard the progress of autogenous welding, which we believe has a real field of usefulness even in boiler work, but we are not yet ready to approve it for repairs where the safety of the boiler is directly affected.

Fig. 4. The Wrecked Separator.

Boiler Explosions in Great Britain.

We compile and publish as complete a list of boiler and fly-wheel accidents for the United States as possible, but the list is incomplete and to a certain extent in error because we are forced to take much of the information from the daily press, a source noted for its inaccuracy where technical matters are concerned. Furthermore, a great many minor accidents never reach the newspapers because they are not attended with personal injuries, and therefore have no especial "news" value unless the property loss is considerable. In marked contrast with this are the statistics gathered in Great Britain by the Board of Trade. Under the Boiler Explosions Acts of 1882 and 1890 every boiler casualty, no matter how trivial, even so small an occurrence as the leaking of a single rivet, becomes as much a case for official investigation as though accompanied by injury or death. The Board of Trade is required by this act to investigate fully every such accident and make a public finding as to its cause which must fix the responsibility for it. These inquiries extend not only to boiler accidents, but cover as well every type of steam containing apparatus, including piping. They include also all accidents occurring on ships of British registry. The effect of this act, is to reduce boiler accidents to a minimum, for all parties concerned, whether owners, operatives, manufacturers, designers, or those responsible for the inspection of the apparatus realize that the extent of their responsibility will be fixed without fear or favor.

The report of the Board of Trade for the year ending June 30, 1912, is at hand, and is particularly interesting in that it gives in addition to the statistics for the years 1911-1912, comparative figures for the thirty years during which the Act has been in force. Of these statistics we will reprint such of the summaries as seem to be of interest to our readers.

During the year ending June 30, 1912, there were 106 explosions. Of these 60 resulted in loss of life or personal injury. Thirty persons were killed, and 75 injured. The 30 deaths were caused by 14 explosions, 9 on land and 5 on ships. In 20 out of 27 explosions aboard ship no one was injured, while in the remaining 7 accidents 13 were killed and 4 injured. The number of deaths for the year is above the average for thirty years (26.3 per year), but this is largely due to two explosions in each of which six were killed. It is interesting to note that out of a total of ten accidents to heating apparatus, nine were caused by the freezing of pipes.

Classification of the Causes of Explosions, and the Types of Boilers which Exploded 1911-1912.

Causes.	No.
Deterioration and Corrosion	29
Defective Design, and Undue Pressure	17
Water Hammer Action	8
Defective Workmanship, Material, or Construction	16
Ignorance or neglect of attendants	24
Miscellaneous	12
Total	106

Types of Boilers.	No.
Horizontal Tubular	15
Vertical	7
Lancashire and Cornish	4
Locomotive	2
Water Tube	6
Tubes in Steam Ovens	10
Heating Apparatus	10
Steam Pipes, Stop Valve Chests, etc.	24
Hot Plates, etc.	4
Economizers	4
Calenders and Drying Cylinders	4
Steam Jacketed Pans	4
Rag Boilers, Kiers, Stills	4
Miscellaneous	8
Total	106

STATISTICS 1882–1912.

Year	No. of Explosions	Personal Injuries		
		Lives Lost	Injured	Total
1882–83	45	35	33	68
1883–84	41	18	62	80
1884–85	43	40	62	102
1885–86	57	33	79	112
1886–87	37	24	44	68
1887–88	61	31	52	83
1888–89	67	33	79	112
1889–90	77	21	76	97
1890–91	72	32	61	93
1891–92	88	23	82	105
1892–93	72	20	37	57
1893–94	104	24	54	78
1894–95	114	43	85	128
1895–96	79	25	48	73
1896–97	80	27	75	102
1897–98	84	37	46	83
1898–99	68	36	67	103
1899–00	59	24	65	89
1900–01	72	33	60	93
1901–02	68	30	55	85
1902–03	69	22	67	89
1903–04	60	19	45	64
1904–05	57	14	40	54
1905–06	54	25	21	46
1906–07	77	28	65	93
1907–08	73	23	50	73
1908–09	93	12	53	65
1909–10	103	14	62	76
1910–11	100	13	61	74
1911–12	106	30	75	105
Totals	2,180	789	1,761	2,550
Average of 30 years	72.7	26.3	58.7	85

Extraordinary Damage to Pipes of a Superheater.

(Reprinted from Vulcan, published by the Vulcan Boiler and General Insurance Company Manchester, England.)

Many thousands of steam superheaters are in use, and in almost every case it is found that the pipes will work for long periods with a negligible amount of loss or depreciation in the material. In ordinary cases this is steel of the highest quality and degree of maleability which is not found to suffer appreciably by contact with steam at a less temperature than 1100 deg. Fah. As this temperature is far above those which occur in ordinary practice, risk of damage on this account is most exceptional. We have, however, met with a case in which tubes which were exposed to steam of extraordinarily high temperature on both sides were therefore converted into black or magnetic oxide of iron.

An experiment has been practiced for probably the greater part of a century in which steam is passed through an iron tube which is heated to redness, or, say, to a temperature of 1300 deg. Fah. Under these conditions the steam suffers decomposition, and this method is sometimes adopted for the production of hydrogen. When the iron is used in a fine state of division, as in filings, the chemical action is sufficiently rapid to cause combustion and increased temperature. For 100 parts of iron lost 138 parts of magnetic oxide are produced, the chemical symbol for which is Fe_3O_4.

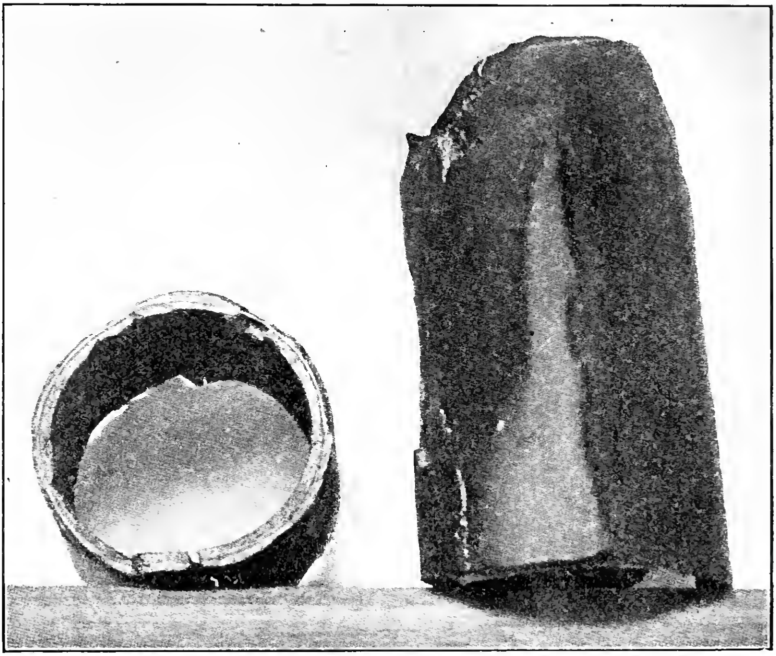


FIG. 1. FIG. 2.

In the case in question, the original thickness of the tubes was .080 in., equal to No. 14 standard gauge (B. W. G.) in a section shown in Fig. 1, the thickness of the remaining metal is .012 in. on one side and on the opposite side the metal has entirely disappeared. The thickness of the oxide is .047 on the outer side and .065 on the inner side. The total maximum thickness of the oxide and the residue of metal is .124 in., which it may be observed is considerably greater than the original thickness of the metal, the difference being due to the expansion of iron and steel in the process of oxidation. Therefore 80 to 100 per cent. of the metal has been converted into oxide, and 15 to 20 per cent. remains in its original condition. Fig. 2 shows the irregularity of the oxidized surface, probably due to the current of steam. Fig. 3 shows the black oxidized surface of the metal after the removal of the principal coating of oxide.

In the present case the boiler was heavily worked, and consequently the temperature in the downtake was high. (This refers of course to a Lancashire or Cornish boiler, where the gases pass *down* to the return flues. Editor.) Also only about one-third of the total amount of steam produced was passed through the superheater. By each of these conditions the temperature of the steam as delivered from the superheater would be increased, and in the combined result the temperature of the steam has been raised beyond the point of safety, as shown by the chemical change produced.

The case is a most instructive one, and imperatively shows that superheaters should not be made so large as to involve any risk of causing excessive temperature in the steam, which obviously is attended with grave danger in direct regard to superheater, pipes and engine; also indirectly in regard to the boiler.

Fig. 3.

Special caution is also required in cases where only one portion of the steam is superheated. Danger is incurred when a large demand for saturated steam occurs simultaneously with a total absence of demand for superheated steam. It is also conceivable that the maximum degree of danger would arise when a large demand for saturated steam coincides with a relatively small but continuous call for superheated steam.

It may also be noted that in some cases superheaters are fitted with a by-pass arrangement, and that this arrangement will allow a portion of the steam supplied to the engine to be in the saturated condition and thereby reduce the amount of steam passing through the superheater. This by-pass arrangement may be operated so that the entire supply to the engine passes the by-pass valve and the superheater is left to soak in the full temperature of the downtake, by which the superheater may suffer damage beyond possibility of restoration. Therefore, whenever steam is shut off from the superheater, the whole apparatus should be lifted out of the downtake, and steam supplied by temporary means to suit the case.

A Tank Explosion in an Iowa Laundry, with the Story Which it Inspired.

On August 11, a return tank or receiver exploded at the Sanitary Laundry, Mason City, Ia. No one was injured, but there was some property damage, no details of which escaped the efficient local news sleuth.

The tank itself was a lightly constructed affair some 3 ft. in diameter by 6 ft. high, built we are told of 1-8 inch plate. It served to collect the hot water returned by the traps attached to the various laundry machines, and as a receptacle for the necessary make up feed of cold water. The feed pump suction was connected directly to it. An ample vent pipe, leading to the atmosphere was provided, but at the time of the accident it was closed by a stop cock, and it is probable that a by-passed or defective trap permitted the entrance of steam so that a dangerous over-pressure could accumulate.

We do not wish, however, to detract from the freshness of the local story which we reprint in full from The Mason City Daily Times. We confess that we are frequently at a loss to express ourselves when confronted with the necessity of "writing up" an explosion. We cannot command such a wealth of glowing expression as our western friend, although we suspect that that familiarity which is the proverbial breeder of contempt may have taken something of the keenness from the sharp edge of our imagination.

Condenser in Laundry Hits High Places.

N. C. KOTCHELL'S SANITARY LAUNDRY SHOOK TO FOUNDATIONS BY CONCUSSION.

BOILER TEARS THROUGH ROOF 500 FT. TO STRAYER HOUSE.

Residence on Fifth Street Damaged When Huge Missile Strikes Gables on Roof and Rebounds to Street Missing Every Person Near in Its Flight — All Glass in Windows Shattered — No one is Hurt.

The condenser apparatus of live steam returning from the machines on the floor of the Sanitary laundry blew up at 4 o'clock yesterday afternoon, wrecking the condenser room addition, twisting the deep well pump, breaking many windows, but not so much as scratching a person. The iron pellet shot straight from the roof 200 feet in the air. The condenser has a six foot receptacle three feet in diameter for the returning steam. It is claimed there is no stop cock valve to let off steam when the pressure increases. Evidently the cold water was shut from the condenser. No one is held liable for blame in the matter. The K. P. building suffered $25 damage, two bricks hurtling through an upper window, a gas pipe was flung northwest in exactly the opposite direction as the course of the flying condenser and landed near the Tiss Drug store. Men standing near spoke of the sheet of glass bursting from the windows like fine snow. Seven inch walls crumpled up. The story would be ordinary was there a death list. As it is, it is one of the most extraordinary chronicles in Mason City's history.

BY HAROLD CLARK.

A condenser in the boiler room addition of the Sanitary laundry, N. C.

Kotchell, proprietor, located on the southeast corner of State and Michigan, blew up at 4 o'clock yesterday afternoon, wrecking the compartment in which it stood, and shattering about every window in the entire building, with the exception of those facing Michigan avenue on the east wall of the laundry proper. The body of the exhaust steam condenser spouted up through the roof as if the latter were made of tissue paper, and soared a hundred feet in the air, much like a shot from a coast defense mortar battery, directing itself southeasterly and hitting the roof of the J. A. Strayer residence, corner of Fifth and Michigan, in the next block east.

The missile struck the west foot of the second gable, tearing away the cornice to the peak, then dropped to the front gable of the dwelling, leaving a deep imprint in the shingles; caromed to the porch, cutting a gash in its roof; bounded to the sidewalk, the rim cutting through and rolled finally from the curb across the street resting in front of the residence of Mrs. Nancy Graves, directly opposite the Strayer residence.

Mrs. Strayer at Home.

Mr. Strayer is a railroad conductor on the Milwaukee and was not home at the time. Mrs. Strayer, an invalid, was present in the house, as was Miss T. Anderson. Neither lady realized what had happened until they were appraised of the part their house had played in the freakish turn of events.

Fate had kept a tight grip on the reins, steering the hurtling bricks and flying débris free of any person in the radius of the accident, contriving by subtle means, as remarkable as the average person lives to experience, that not one life was snuffed out and not even a scratch or splintered human bone left its scar on the story to relate. The natural consequence would have been a morgue filled with maimed and bleeding bodies, a hospital pregnant with suffering and a new supply of crape. Mason City wears a horseshoe collar.

The damage will amount to little when compared with the force expended in the explosion, and probably $1000 will leave a margin around the edges.

Prior to the Explosion.

The laundry had settled down to the quiet part of the day. Few of the machines were working and not many of the girls were on the floor. The building faces the north. The front is made up of medium sized glass windows. The office takes up a space about twenty-five feet square in the northeast corner. The machine department runs past the office on the west, having a partial frontage on State street, and runs back clear to the boiler and condensing room additions. The partitions around the office and that connecting the boiler room, are filled with glass paned windows. Engineer William Edgington had been up ten minutes from the boiler apartment, reached by a short flight of steps, and had thrown some coal under the 100-h. p. boiler and attempted to connect the belt on the deep well pump which supplies the laundry with water. Foreman Nels Hansen was walking toward the door leading down into the boiler room, and was within a step of it. Everything appeared running in the usual routine and there had been no sign of danger.

The Concussion.

A deep, rumbling report rolled out and reverberated through the building, mixed with a staccato of splintered tingling glass. It broke swiftly into a muffled roar as the sound was torn from the confined space, and as if a bomb had burst asunder, the walls of the boiler room split into fragments while a patch of roof opened and from its sagging cavity a steel balloon soared majestically a hundred feet skyward, finally alighting on the Strayer residence. Clouds of steam puffed out and the roaring of broken valves and escape vents made the wrecked pit a replica of charnel house indeed, from which a large crowd, drawn by the detonation, expected to see mangled bodies carried out. There was many a sigh of relief when it was whispered about that no one was hurt.

The Pit Found a Wreck.

The pit was a wreck. The walls of the condenser room were built of four inch hollow tile and a two and a half inch brick facing. The two outer sides were razed to a ragged edge. The roof, framed with lumber and covered with a felt waterproofing, sagged two feet — what was left of it. The boiler room's south wall was gouged with a hole, 8 by 6 feet, and the entire side was sprung. The boiler and condenser addition measured near 40 by 20 feet. The condenser stood close to the main building partition and shot straight up. The pump on the deep well was twisted sharply around and may be seriously damaged. None of the machinery on the main floor sustained injury.

A Glass Snow Storm.

Four windows in the partition between boiler and machine floor were smashed, four along the east wall were shattered, seven were broken in the front facing the machine room, five were splintered in the south partition of the office and four big ones in the office display on State were pounded to bits.

When the explosion occurred at the rear, there followed a puff outward, then a strong suction which drew part of the glass in. The floor from end to end was carpeted with fine particles. The first puff of air carried a sheet of fine glass over the front walk. A. O. Height, merchant policeman, was standing on the corner of the Tiss drug store and says the flying glass dusted out like a mist of snow. Mr. Height broke down hanging fragments which would prove dangerous.

The proprietor says they felt a little jar in the main office, and no one knew of the seriousness of the blast until they found themselves in the midst of a wreckage of glass.

Condenser Top Missed Buchanan.

There were many narrow escapes. James Buchanan, a plumber employed by the Boyd plumbing company, was working at the rear of the K. P. Building adjacent east. When he felt brickbats driving his way he dove through a cellar window of the new building. The top of the condenser three feet in diameter flew past his head, missing him by a scant ten inches.

Broke Through K. P. Windows.

Two bricks crashed through the last window facing west on the south side of the K. P. structure, tearing down an $18 electric light fixture within. Last Saturday Garfield Breese and family moved from the flats. The room in which the bricks lodged was the dining parlor. A couple other windows were broken in this building, the damage amounting to $25.

Team Not Frightened.

A team of grays hitched to a farm wagon stood facing the seat of the explosion, not thirty feet distant, and outside of prancing around a bit they were unmoved by the occurrence.

Tar Kettle Lost Stovepipe.

A tar kettle abutting the building used by a crew working for Mr. Stoddard at the K. P. building, lost its stovepipe. Luckily the men had just left the spot loaded with supplies.

A six foot, two inch gas pipe was flung northwest over the building lots and landed on the sidewalk just a step east of the Tiss drug store on State street. It hit the sidewalk and on the rebound deeply dented a steel signboard. This pipe flew 250 feet on a straight line.

An Eye Witness's Version.

Fred Eggers, of the Republican Printing company, in the basement of the building across the alley, saw the condenser shoot up from the building and says it was a most remarkable twist of good luck that no one was injured.

What the Condenser is.

Engineer Edgington says the condenser is really an exhaust device. The boiler keeps live steam in the wash tub, dryers and other apparatus of the business. This steam has an exit in the condenser, into which cold water is forced to turn the steam back into water. From some unknown cause the live steam did not condense building up a pressure which the contrivance was unable to withstand.

Explanation.

Those seeming to know, give the opinion that through some reason the cold water had been accidentally shut off, which would give the condenser the same pressure almost as was in the boiler. Its diameter was three feet with a length of six feet. Its weight would probably scale 175 pounds.

Men seated in the park claim the spiral ascension of the iron airship was plainly visible to them.

A Farmer's Luck.

A farmer whose team he held standing at the corner of Fifth and Michigan, when the explosion came, turned his frightened horses east on Fifth, when the condenser, caroming from gable to peak of the Strayer house, struck the curb and rebounding several feet high, leaped toward his team in big jumps. He got out of the way by turning short in on the Graves lawn and around the trees.

The condenser was of 14 gauge material, riveted with about three-quarter inch rivets an inch apart. Mechanics stated that it had not much more body to it than a rusty stovepipe.

Obituary.

EDWARD J. MURPHY.

Edward J. Murphy, for many years consulting engineer for The Hartford Steam Boiler Inspection and Insurance Company, died Tuesday morning, September 2nd, after a lingering illness. He had been in failing health for the last two or three years, suffering from heart trouble, but his hopeful disposition, and indomitable will had helped him to rally and get out many times, even to the extent of resuming his active work whenever he was able to make the trip from his home to the office.

Mr. Murphy was born February 5, 1829, in the province of Ulster, Ireland. He was educated in the private schools of Dublin. He studied drawing under the Royal Art Society of Dublin and afterwards was graduated from the Fanning Engineering Institute of the same city. His training was that of a civil engineer and he graduated with honor.

Mr. Murphy was predisposed by family history and environment to lung trouble and in consequence of this and his own impaired health was ordered by his physician to take an ocean voyage. He sailed for this country on the Cunarder America and after a two weeks' voyage from Liverpool he arrived at Jersey City somewhat improved in health. He then went to Canada and spent the first winter, that of 1849-50 with friends there.

In the year 1850 he made surveys in Ohio for a Philadelphia map publishing concern, later performing the same kind of work in the central part of New York. He was engaged in this work until the close of the year 1852. In 1853 he was brought in touch with the city surveyor of New York and was made first assistant under him during which time he assisted in laying out the street car routes of the city.

In 1854 he was married to Jane Major Cassolani at the residence of her brother, Henry Brougham Major, at Yonkers, N. Y. Soon after this he severed his relations with the Engineering Department of the city of New York.

In 1855 the Woodruff & Beach Iron Works were in need of a chief draftsman and Mr. Murphy was recommended in the highest terms. He came to Hartford in that year and although the work was somewhat different from civil engineering, he gave the best of satisfaction from the first. This engagement continued until the dissolution of the firm. Woodruff & Beach, as it is well known, did some of the most important work for the government that was transacted during the War. Beginning with 1861 Mr. Murphy was identified with the U. S. Navy Department at these works during the construction of boilers for U. S. S. Kearsage, Manitou, Minnetonka, and Piscataqua.

After this engagement he went West to further recuperate his health which had become impaired by too close application to business. He was placed at the head of a surveying party by a large company having a land enterprise in process of development. He crossed the plains by wagon train, braving the dangers of those days and at one time was obliged to have the protection of U. S. cavalry as a guard from hostile savages. Upon his return he spent six weeks in an open boat descending the Missouri River to civilization. In this manner he recovered his health and, though frequently given up for dead at the hands of savages, returned to Hartford in health and safety.

Mr. Murphy was secretary and treasurer of the Hartford Foundry & Machine Company from the year 1872 until the close of its existence. From 1872 to 1878 he was a member of the Board of Fire Commissioners a position in which he was specially useful by reason of his acquaintance with machinery, machine designing and the executive management of details. He was largely instrumental in obtaining for the city the first self-propelled fire engine ever made and used in this country if not in the world. The late Chief Eaton, then chief of the Fire Department, was also a strong advocate of the self-propelled engine and was of considerable assistance to Mr. Murphy in carrying through the plans for such an apparatus. In the latter part of 1878 he was chosen president of the Board of Water Commissioners and remained in the position two years when he resigned to accept the appointment of supervising engineer of the Colt's Patent Fire Arms Manufacturing Company. Here he remained until June, 1889 when he resigned to become the consulting engineer of the Hartford Steam Boiler Inspection and Insurance Company, which position he held until his death.

EDWARD J. MURPHY.

Mr. Murphy was honored with many places of public and private trust during his fifty-seven years of residence in Hartford and aside from his presidency of the Water Board and membership of the Fire Board he was a State's Prison director from 1887 to 1893. He was also trustee of St. Peter's Church Corporation and a director of St. Francis Hospital. He was a member of the American Society of Mechanical Engineers and an associate of the American Society of Naval Engineers, taking a lively interest in the activities of both organizations. In addition to the professional work already noted he was identified with the design and construction of large pumping engines used at Brooklyn, N. Y., and St. Louis, Mo., and the engines of the U. S. Cruiser Mohican and the sloops of war Pequot, Nipsic and Cayuga.

W. M. Boase.

W. M. Boase, an inspector in the Baltimore Department of The Hartford Steam Boiler Inspection and Insurance Company, died August 16, at St. Elizabeth's Hospital, Richmond, Va. His death came at the end of a long illness, and followed a critical operation, from which he was unable to rally.

Mr. Boase had been in the employ of the Hartford for about nineteen years, and was exceedingly well liked by the men with whom he came in contact. He was capable and energetic, and his loss will be keenly felt in the department.

Mr. Boase was born in the Sicily Islands, England, in 1861, and before coming with the Hartford, followed the sea, as an engineer. He held papers as a chief engineer of ocean going vessels from the British Board of Trade. He is survived by a widow and four daughters.

The Care and Lubrication of Air Compressors.

(Abstracted from an article in The Compressed Air Magazine.)

It is a fact that air compressors frequently pollute the mine air with dangerous gases, and sometimes explode, causing damage to persons and property. In either case the same may be generally attributed to the excessive heating in the presence of compressed air of the oil and foreign substances that have collected in the cylinder, discharge pipes and air passages and especially in and around the valves. Volatilization and ignition of oil and other carbonaceous matter occurs very rapidly in the presence of highly heated air.

It is therefore, important:

First. To keep the compressed air, while being compressed, at as low a temperature as possible.

Second. To prevent oil and other carbonaceous substances from collecting in any part of the machine or in the discharge pipes.

All ports and air passages should be as large as practicable and should be kept free from obstructions and incrustations. In addition to partly closing the ports, incrustation often causes the valves to stick resulting in disastrous consequences.

To avoid incrustation and collecting of oil and foreign substances in the machine and discharge pipes, high grade non-carbonizing oil may be used and should be properly fed into the cylinder. Petroleum oil, especially free from volatile carbon, with flash point of not less than 625 degrees F. is recommended. The oil should not be too dense nor contain animal or vegetable oil. Do not, in any case, use ordinary steam cylinder oil. Why? Because the heat in the steam cylinder is moist, and the surplus oil is washed out, whereas, the heat in the compressor cylinder is dry, thus causing the oil to stick and cake. For the above reason, and also on account of the difference in the character of the proper lubricant and the work it has to perform, the proper feeding of oil to the compressor cylinder, is very different from the oil fed to a steam cylinder. Too much oil causes incrustation. A surprisingly small quantity of good oil will give sufficient lubrication to air compressors. Watch your compressor and cut the amount of oil down to the minimum of its requirements. Oil should not be allowed to collect in the machine. In case it does, it should be drawn off immediately.

Even when using the best oil, properly fed to the cylinder, the machine should be cleaned frequently or when needed.

Do not use kerosene for cleaning! It is very dangerous. Kerosene has a flash point of about 120 degrees F. and the temperature of the compressed air may at any time reach 300 to 450 degrees F. and cause an explosion. The best and safest method of cleaning is to feed into the air cylinder, soapsuds, made of one part soft soap to 15 parts clean water. Feed a liberal amount of this solution into the cylinder instead of the oil for a few hours or even for a day, if necessary. The accumulation of this water and oil should be drained off from time to time during the process by opening the blow-off valve at the receiver.

To prevent rusting, it is necessary to run the machine and feed oil into the cylinder for an hour or so after the cleaning process is completed and the water drained off, so that the valves and all parts connected with the cylinder will become coated with oil before shutting down the machine.

The temperature of the discharged air should never exceed 250 degrees F. The machine should be watched and if the temperature exceeds the above it should be shut down and cooled. If possible the cause of overheating should be eliminated before starting up again.

The temperature increases as the pressure increases; therefore it would be well to equip all air compressors with an automatic pressure or temperature regulator, which will allow the compressor to run idle as soon as the pressure or temperature in the receiver reaches a predetermined limit and likewise bring the compressor into action again as soon as the pressure or temperature falls below this limit. There are regulators on the market which apply to compressors coupled direct to the engine, driven by electric motors, by belt or otherwise.

As an extra precaution a fusible plug may be placed in the discharge pipe near the compressor. This plug should be made to fuse and blow out at a temperature of between 325 and 350 degrees F.

The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

C. C. Perry, Editor.

HARTFORD, OCTOBER, 1913.

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The Locomotive of The Hartford Steam Boiler I. & I. Co.

The subject of boiler specifications is always of interest to the boiler insurance company. Indeed the extended use of specifications in boiler work has come about very largely from the practice of boiler insurance companies making specifications for new boilers for their assured in order that they may secure safer and better construction, with better workmanship and materials of known properties. The Hartford has followed this practice from a very early date and has done much pioneer work in the struggle for better and safer boilers. It is therefore, with special interest that we read the reports of the recent convention of the American Boiler Makers Association, held Sept. 1-4, at Cleveland, O., devoted as it was so largely to a discussion of this question.

We regret that we have been able to read Mr. Durham's paper on Uniform Boiler Specifications only in the abstract as yet. In his suggestions for uniform specifications, he advocates many of the measures long insisted on by the insurance companies, and which have heretofore served to distinguish between a "specification", and a "commercial" boiler, such as a minimum factor of safety of 5, with rigid requirements as to the reaming of rivet and tube holes, the planing of caulking edges, and the calculation of the safe load upon weldless braces and through stays based on a maximum stress of 7,500 lbs. per square inch. He also advocates very properly, the universal use of the double butt strapped joint.

Further, we are rather inclined to agree with him that in branding plate, the use of such numbers as will serve to definitely identify the mill test report of each individual plate is of more consequence than the designations "flange" or "firebox". (Assuming of course that the tensile strength stamping would be retained as at present.) For it is, after all, the definite physical and chemical properties of tensile strength, ductility, and freedom from injurious sulphur and phosphorus within sharply defined limits which we want, and if a plate fulfills the requirements for a particular use, it matters little from which pile it is taken so long as we are prepared to assert beyond peradventure that it actually does possess the desired properties. On the other hand, we are inclined to take issue with him in recommending 60,000 lbs. as the minimum value to be taken for the tensile strength of boiler steel. We believe that a degree of ductility and freedom from brittleness under shock can be obtained in steels of lesser tensility which will far outweigh the advantage in cost accruing to the boiler maker from the possibility of using slightly thinner plate. We feel sure that steel of from 55,000 to 60,000 lbs. tensile strength is still the best available material for boiler construction.

It has been our pleasant duty several times recently, to record the acquisition by the Hartford, of the steam boiler and fly-wheel business of other companies. This business, principally from multiple line casualty companies, has in each instance come to us because these companies could not afford to maintain the necessarily expensive machinery of inspection in the face of the small volume of business written. In this issue, we again reprint a news item from the *Hartford Times,* giving the details of two more transactions of this sort. The Locomotive is glad to extend a welcome to these new members of the family of Hartford assured.

The question of the probable behavior of boilers and steam containing apparatus in the event of fire is always one of interest. We have recorded in these columns from time to time, instances both of the failure and the survival of such vessels. That a serious explosion may be produced by a fire, especially if the vessel is not provided with adequate means of relieving itself from an undue pressure, or if its material is of such a nature as to be seriously affected by exposure to a high temperature is self evident.

A striking illustration of this comes to our attention just as we go to press, from the columns of *Safety Engineering.* On August 20th, Jersey City, N. J., was swept by a conflagration, starting in a collection of cooper shops, which resulted in a property loss estimated variously at from $500,000 to $1,000,000. One of the buildings consumed was a soap works, and in it was a rendering tank said to have been constructed of 3/8 in. plate, and to have been 4 ft. in diameter, by 9 ft. high. As is usual with this type of vessel, the bottom course was conical in shape, and was provided at the bottom with a cast iron nozzle, closed with a cast iron door. The tank was not however provided with a safety valve. On the morning of the fire, the tank was charged as usual. When the fire reached the building, the tank, subjected as it was to an intense heat, accumulated a high pressure of steam. In addition, the cast iron door and nozzle became so weakened by the high temperature, that they failed sooner than the steel plate of which the body of the tank was built. As a result the contents of the tank were expelled through the bottom, on the failure of the door, and the tank was projected, sky rocket fashion, some 100 ft. in the air landing about 400 ft. from its starting point.

Two important facts are forced upon our attention by this failure, first, that in spite of the knowledge which is in the possession of designing and operating engineers, there are still many vessels in daily use, operating under an internal steam pressure, with no effective provision to limit that pressure to a safe value. The other is the general unreliability of cast iron as a material for use in boilers where it may be subjected at the same time, to high temperatures and the stresses produced by high pressures. Of course cast iron in a rendering tank cannot be criticised from this standpoint, for rendering tanks are by no means designed to withstand conflagrations. The fact remains however, that there are many vessels in use where cast iron subjected to high pressures, is at the same time forced to suffer the consequences of high temperatures, and the failure of these cast iron parts furnishes all too great a proportion of the accidents recorded in our explosion lists.

One of the things that goes to make up Hartford service is the making of specifications and drawings for new work contemplated by our assured. The purpose of course is to secure for the purchaser, the best and safest boiler that he can get for his money. The specification helps him to secure this much desired result by supplying him in a usable form with the digested and applied experience of our specialists in the boiler field. A further benefit to the purchaser arises through the knowledge that all the makers bidding on the specification are competing for the building of the same identical job, which they know will be inspected, and must meet the specified standards of material and workmanship. This fact while it may not reduce the bids to the lowest figure at which *a* boiler might be purchased, will on the other hand secure the best terms for a *specification* boiler.

If, as is usually the case, he submits the specifications to several manufacturers for bids and finally lets a contract based on it, the specification becomes a part of that contract or agreement between the purchaser and the boiler maker. Our interest in the proceeding is over except in so far as we may be called upon by the terms of the contract to inspect and pass upon the workmanship and materials. In that event, our interest is strictly confined to seeing that the contract, already made, is properly fulfilled.

If the boiler is built and delivered in strict compliance with the specifications all goes well. Frequently however the makers will suggest changes either in the boiler itself or its attachments, and then a misunderstanding may arise as to our position in the transaction. Boiler makers very often refer these proposed changes to us, asking us to permit them or approve them, when really they are a matter between the makers and the purchaser only. If the purchaser is willing to permit alterations in the terms of the contract, that is his business, not ours. We can of course advise him as to our views of the value of the proposed substitution, but the decision must rest with him.

It is undoubtedly true that changes in a specification are often desirable, particularly when some substitute method or design, better suited to the maker's shop equipment may be used with no sacrifice in safety or strength, and with a gain in economy. On the other hand, the changes suggested are sometimes such as will result in a much inferior product, and any saving in cost may be dearly bought. But in any case, whether the changes are desirable or not, we wish to make it very clear that the matter is entirely between the maker and purchaser, that when we have given our best judgment as to what seems to us the proper construction, by drawing specifications, and if desired, seeing that they are carried out by inspection, we have fulfilled our entire part in the proceeding.

Personal.

Mr. James P. Hagarty, who was appointed a special agent in 1910, and who has very successfully devoted a portion of his time to soliciting since then, has now given up his work in the mechanical department, and will give his entire attention to the selling end of the business as special agent in the Hartford Office.

Hartford Steam Boiler Gets Tenth Acquisition.

Takes Over Business of Kansas City Casualty Co. For Which There Had Been Keen Competition.

SECOND WITHIN FEW WEEKS.

[From The Hartford (Conn.) Times, Sept. 3, 1913.]

It is understood that the Kansas City Casualty Company of Kansas City, Mo., has just closed a reinsurance contract with The Hartford Steam Boiler Inspection and Insurance Company, of this city, under which the Hartford company takes over and assumes all the Kansas City company's liability under its various outstanding steam boiler policies.

DESIRABLE BUSINESS.

President Brainerd of the Hartford Steam Boiler company confirms this statement and explains that while the volume taken over is not large, there has been keen competition between the companies to secure it, as it is of a very desirable character, compact and well located. The Kansas City company began business in 1910 and started with a paid up capital of $250,000, and undertook to do a steam boiler business in connection with its other various casualty lines, numbering some ten or a dozen of the more prominent ones. It stood well at home and was popular throughout the territory in which it operated, and its other lines will now be relieved of the burden of carrying the steam boiler line which in the absence of volume cannot be conducted with profit.

Another Only Few Weeks Ago.

It was only two or three weeks ago that the Hartford Steam Boiler took over the steam boiler business of The United Casualty and Surety Co., of Memphis, Tenn. This last acquisition makes the tenth company that has reinsured its entire steam boiler business with the Hartford company, and a part of the steam boiler business of two other companies has likewise been taken over quite recently. The Hartford Steam Boiler company makes a specialty of inspecting and insuring steam boilers, and of late the taking over of the steam boiler business of other companies has seemingly become a prominent feature of its business, as the steam boiler business of no less than seven companies has been taken over during the last six or seven years.

Fly-Wheel Explosions, 1913.

(19.) — A large fly-wheel burst May 9, at the saw mill of the Crookston Lumber Co., Bemidji, Minn. One man was killed, and considerable damage done to the mill property.

(20.) — An engine and its fly-wheel were wrecked May 23, at the plant of the Bay State Brick Co., Indian Orchard, Mass. No one was injured, but the plant was shut down pending repairs.

(21.) — A fly-wheel burst June 9, at the plant of the Alpha Portland Cement Co., Alpha, N. J. Two men were killed, and the property damage was large. A detailed account of this wreck was published in the July issue of the Locomotive.

(22.) — A centrifugal extractor exploded June 20, in the laundry department of the shirt factory belonging to the Rice-Stix Dry Goods Co., St. Louis, Mo. One man, the operator of the machine was instantly killed, while six others, four of them girls were very seriously injured. One of the girls had her shoulder literally torn from her body and was not expected to recover.

(23.) — A gear failed June 30, at the plant of the Scoville M'f'g Co., Waterbury, Ct.

(24.) — A fly-wheel, and another belt wheel exploded July 19, at the plant of the Davis County Canning Co., Syracuse, Utah. No one was injured, but the plant was forced to close at the height of the canning season, losing a large amount of perishable stock which they could not save.

(25.) — A. L. Reim, a farmer was killed July 22. by the explosion of a rotary ensilage cutter which he was operating. One of the knives is said to have been propelled with such force as to sever a tree.

(26.) — A fly-wheel fractured July 23, at the plant of the Cooks Linoleum Co., Trenton, N. J.

(27.) — An extractor burst July 24 at the Home Laundry, Passaic, N. J. Three men were injured.

(28.) — An extractor exploded Aug. 2, at the works of the Bangor Steam Laundry Co., Bangor, Me. One girl was killed, and three others hurt by the explosion.

(29.) — A fly-wheel exploded August 20, at the plant of the Payne and Joubert Foundry and Machine Co., Birmingham, Ala. One man was killed, and the property loss was considerable. (A complete description of this accident will be found elsewhere in this issue.)

(30.) — A fly-wheel attached to a sausage grinder burst August 28, at the butcher shop of Breitenbach Bros., Escanaba, Mich. One man was injured.

(31.) — A large fly-wheel, 22 ft. in diameter, exploded September 6, at the Liberty Mills, South Nashville, Tenn. One man was killed, three were injured, and a property loss sustained estimated at $5,000. The cause of the accident is said to have been the running off of a governor belt, allowing the engine to race.

Boiler Explosions, May, 1913.

(186.) — A boiler exploded May 1 at the planer of the Castleberry-Flewellen Co., Longview, Tex. Two men were seriously injured in addition to a considerable property damage.

(187.) — A slight accident occurred to a boiler at the power house of the Liberty Electric Light and Power Co., Liberty, Mo., on May 2.

(188.) — A tube ruptured May 3, in a water tube boiler at the plant of the King Paper Co., Kalamazoo, Mich.

(189.) — On May 3, a boiler exploded at the saw mill of G. W. Guthrie, Pine Creek, Va. Two men were killed, one critically injured, and the mill was a total wreck as the result of the accident.

(190.) — On May 4, the crown sheet of Missouri Pacific locomotive No. 93 blew down, near Tipton, Mo. Two men, the fireman and a brakeman, were injured.

(191.) — On May 5, a tube failed in a water tube boiler at the electric lighting plant of the City of Kalamazoo, Kalamazoo, Mich. Chas. Weisenberg, night watchman, was injured.

(192.) — Two flues burst in a boiler at the coal yard of Brewster and Abbott, Troy, N. Y., on May 6. The property was somewhat damaged by fire as a result of the explosion.

(193.) — A serious and unusual triple explosion occurred May 6, at the plant of the Lapeer Gas and Electric Co., Lapeer, Mich. The accident resulted from handling gasolene in some way so that its vapor passing over the boilers, exploded. This was followed in succession by the explosion of the boilers and a gas storage tank. One man was fatally injured, and property was damaged to the extent of some $60,000.

(194.) — The North Monroe Steam Mill Company's plant at Monroe, N. H., was wrecked May 6, by the explosion of a boiler. One man was injured.

(195.) — A cast iron sectional heating boiler ruptured May 8, in the apartment house of Alva Seybolt, Saratoga Springs, N. Y.

(196.) — A boiler exploded May 8, at the saw mill of Price and Kinslow, Glasgow, Ky. Three men were seriously injured, while the mill was badly wrecked.

(197.) — A boiler exploded May 10, at the grist mill of Thomas Mattingly, near Lebanon, Ky. Mr. Mattingly was seriously scalded, while the mill was badly wrecked, being unroofed by the explosion.

(198.) — On May 10, the bottom head of a vertical rendering tank blew off at the plant of the Smith Bros. Packing Co., Denver, Colo. J. Agarth, night engineer and tankman was fatally scalded.

(199.) — A tube ruptured May 10, in a water tube boiler at the plant of the Standard Steel Co., Alabama City, Ala. The damage was slight.

(200.) — An accident occurred May 10, to a boiler at the ice plant of Chas. R. Haskins, Winden, Ga.

(201.) A tube ruptured May 11, in a water tube boiler at the plant of the Standard Steel Co., Alabama City, Ala. (See item No. 199.)

(202.) — On May 11, a steam separator on the main steam line exploded at the Buckingham Ave. plant of the Public Service Corporation of New Jersey, Perth Amboy, N. J. M. Burke, oiler, was slightly injured, and the property damage was in the neighborhood of $2,000.

(203.) — A tube ruptured May 14, in a water tube boiler at the Orkin Bros. department store, Omaha, Neb. Three men were injured, one fatally.

(204.) — Three cast iron headers fractured May 14, in a water tube boiler at the plant of the Sandusky Gas and Electric Co., Sandusky, O.

(205.) — A boiler exploded May 14, on the lease of the Cash Oil Co., Humble, Tex. One man was killed.

(206.) — On May 15, a hot water heater exploded in the basement of the building occupied by the Boston Protective Co., Purchase St., Boston, Mass.

(207.) — A steam pump exploded May 17, on a boat belonging to the Western Kentucky Coal Co., Paducah, Ky. Two men were killed.

(208.) — A tube ruptured May 19, in a water tube boiler at the Bordentown Light Station of the Public Service Corporation of New Jersey. Bordentown, N. J.

(209.) — On May 19, a tube ruptured in a water tube boiler at the Oak Park Power Co. plant of the General Motors Co., Flint, Mich.

(210.) — On May 20, an accident occurred to a boiler at the planing mill of the Brooks Scanlon Co., Kentwood, Ga. Extensive repairs were necessary to the boiler.

(211.) — A tube ruptured May 20, in a water tube boiler at the N. Delaware Ave. plant of the Philadelphia Rapid Transit Co., Philadelphia, Pa.

(212.) — A boiler ruptured May 24, at the plant of the W. H. Glover Co., Rockland, Me.

(213.) — A tube ruptured May 24, in a water tube boiler at the plant of the American Steel and Wire Co., Waukegan, Ill.

(214.) — On May 29, a tube ruptured in a water tube boiler at the mill of the Minneapolis Malt and Grain Co., Minneapolis, Minn.

(215.) — A cast iron header ruptured May 31, in a water tube boiler at the plant of the Ohio Electric Railway Co., Lima, O.

JUNE, 1913.

(216.) — A boiler exploded June 1, on the farm of Eugene Houssiere, Pine Prairie, Tex. Henry Davis, engineer, was fatally injured, while Robert Hamilton, fireman, was less seriously injured.

(217.) — A boiler exploded June 3, at the plant of the Brooklyn Range and Boiler Co., Long Island City, L. I., N. Y. One man was injured, probably fatally.

(218.) — On June 3, a boiler ruptured at the plant of the Leonard Ice and Coal Co., Leonard, Tex. The damage was confined to the boiler itself.

(219.) — A tube ruptured June 6, in a water tube boiler at the plant of the Elmira Cotton Mills Co., Burlington, N. C.

(220.) — Two tubes ruptured June 6, in a boiler at the plant of the Berlin Brick Co., Berlin, Ct.

(221.) — On June 6, a tube ruptured in a water tube boiler at the South Jersey Gas, Electric and Traction Co. plant of the Public Service Corporation of New Jersey, Trenton, N. J. Eugene Holet, water tender, was injured.

(222.)— A blow-off pipe failed June 7, at the plant of the Lancaster Milling Co., Lancaster, Tex.

(223.) — On June 7, a tube pulled out of the tube sheet of a water tube boiler at the pulp and paper mill of the Thos. Phillips Co., Akron, O.

(224.) — A tube ruptured June 10, in a water tube boiler at the plant of the Pennsylvania Water Co., Nadine Station, Pa. Frank Sarretti, fireman, was scalded.

(225.) — A tube failed June 10, in a water tube boiler at the plant of the Great Southern Lumber Co., Bogalusa, La.

(226.) — A boiler exploded June 10, in the basement of the Beth Israel Hospital, New York City. A fire which followed the explosion created a panic among the patients. One man was killed in the fire.

(227.) — A boiler exploded on the coal steamer E. M. Peck, at Racine, Wis., on June 11. Six were killed and seven or eight seriously injured, while many more received minor injuries. The ship was a complete wreck.

(228.) —On June 12, a boiler ruptured at the plant of the Manhattan Ice, Light and Power Co., Manhattan, Kans.

(229.) — Three cast iron headers ruptured June 13, in a water tube boiler at the plant of the Princess Furnace Co., Glenn Wilton, Va.

(230.) — A cast iron header failed June 14, in a water tube boiler at the Northern Hospital for the Insane, Logansport, Ind.

(231.) — A tube ruptured June 16, in a boiler at the power house of the Municipal Water, Light and Power Co., Mackinac Island, Mich.

(232.) — On June 16, a header failed in a water tube boiler at the plant of the Miller Lock Co., Philadelphia, Pa.

(233.) — On June 16, the crown sheet of a locomotive collapsed on the dam construction work of J. G. White and Co., Stevens Creek, Ga.

(234.) — A tube ruptured June 16, in a water tube boiler at the plant of the King Paper Co., Kalamazoo, Mich. Two men were scalded, but the property loss was practically confined to the boiler.

(235.) — A 10 horse power boiler used for wood sawing exploded at the home of Frank Owen, at Swifts Mills, N. Y., on June 16. No one was injured, though five persons are said to have been gathered about the boiler just prior to the accident.

(236.) — A bleaching kier exploded at the James Thompson mosquito netting mill, Valley Falls, N. Y., on June 17. Two men were injured somewhat, and property was damaged to an extent estimated at from $5,000 to 310,000.

(237.) — A boiler tube burst June 19, in a boiler at the Rugby Distillery, Louisville, Ky. Three men were injured, one fatally.

(238.) — A large air tank exploded June 20, at the garage of T. J. Kennedy, Batavia, N. Y. One man was slightly injured, and the building was badly damaged.

(239.) — On June 20, a tube ruptured in a water tube boiler at the plant of the Brier Hill Steel Co., Youngstown, O.

(240.) — A boiler ruptured June 20, at the plant of the Burlington Sanitary Milk Co., Burlington, Ia.

(241.) — A tube ruptured June 20, at the plant of the Standard Steel Co., Alabama City, Ala.

(242.) — On June 20, a boiler ruptured at the bleachery and cotton mill of the Great Falls Mfg. Co., Somersworth, N. H.

(243.) — The boiler of an El Paso and Southwestern R. R. locomotive exploded June 21, at Fairbanks, Ariz. Two men and two women were injured.

(244.) — A tube ruptured June 21, in a water tube boiler at the plant of the Omega Portland Cement Co., Jonesville, Mich.

(245.) — One June 23, a cast iron header ruptured in a water tube boiler at Factory No. 2 of the Union Ice Co., Pittsburg, Pa.

(246.) — A small boiler exploded June 24, at the plant of the Good Luck Polish Co., Louisville, Ky. The damage was small, as the boiler is said to have been of but six horse power.

(247.) — On June 28, a tube ruptured in a water tube boiler at the Coal St. station of The Public Service Corporation of New Jersey, Newark, N. J.

(248.) — On June 29, a boiler ruptured at the ice and brick plant of Chris. N. Elling, Brush, Colo.

(249.) — A header was blown off the tubes in a water tube boiler June 30, at the lumber mill of C. L. Willey, Chicago, Ill.

JULY, 1913.

(250.) — On July 1, a steam heated retort exploded at the Ainsworth and Dunn Cannery, Blaine, Wash. The vessel was being tested under steam for the first time when the explosion occurred, killing two men. From press reports we are lead to believe that the accident was due to an effort to tighten the clamping bolts of the door, while under pressure.

(251.) — A tube ruptured July 2, in a water tube boiler at the Allegheny Steel Co's. plant, Brakenridge, Pa.

(252.) — A boiler ruptured July 2, at the plant of the Alacuky Lumber Co., Conasanga, Tenn.

(253.) — On July 6, a boiler ruptured at the Marion Brick Works, Montezuma, Ind. It was necessary to replace the boiler with a new one.

(254.) — A boiler exploded July 7, at the St. Clair County Gas and Electric Company's power house, Belleville, Ill. One man was injured, probably fatally.

(255.) — On July 8, a tube pulled out of the tube sheet of a water tube boiler at the plant of The National Lock Co., Rockport, Ill., doing considerable damage to the boiler.

(256.) — A tube ruptured July 10, in a water tube boiler at the plant of the Central Ice and Cold Storage Co., New Orleans, La. The damage was small.

(257.) — On July 11, a blow-off pipe failed at the Satinet Mill of the Aldirch Mfg. Co., Charlton City, Mass. Peter Jorgenson, engineer and fireman, was scalded so severely that he died the following day.

(258.) — On July 11, a tube ruptured in a water tube boiler at the plant of the Minneapolis Malt and Grain Co., Minneapolis, Minn.

(259.) — A tube ruptured July 12, in a water tube boiler at the plant of the Standard Steel Co., Alabama City, Ala.

(260.) — On July 13, a cast iron header ruptured in a water tube boiler at Factory No. 2 of the Union Ice Co., Pittsburg, Pa.

(261.) — A boiler exploded July 13, on the oil lease of the National Pacific Oil Co., Maricopa, Cal. One man was very severely scalded, though he is expected to live.

(262.) — A slight accident occurred to a boiler at the plant of the W. F. & John Barnes Mfg. Co. Rockford, Ill., on July 14.

(263.) — Through an accident to a boiler used for heating and pumping the city supply of road oil, July 15, Mayor Horwege of Petaluma, Cal., who was at the plant at the time, was very severely scalded.

(264.) — A valve blew out July 15, in the dynamo room of the U. S. S. Nebraska, at the Charleston, Mass., Navy Yard. Two men were scalded, one fatally.

(265.) — On July 16, a cast iron header ruptured in a water tube boiler at the plant of the Sandusky Gas and Electric Co., Sandusky, O.

(267.) — On July 16, an accident occurred to a boiler at the plant of the Polar Ice Co., Indianapolis, Ind.

(268.) — A boiler ruptured July 17, at the plant of Swift and Co., Clinton, Ia.

(269.) — Two men were killed and a third badly injured, July 17, as the result of an explosion in the boiler room of the British freight steamer Fair Mead, at Pier No. 3, Constable Hook, N. J.

(270.) — The boiler of a locomotive on the Texas and New Orleans Railroad, exploded July 18, between Beaumont and Houston, Tex. The engineer and fireman were instantly killed, and several passengers are said to have been injured.

(271) — A boiler exploded at a grist and saw mill near Trinity, Ala., July 18. Two people including the proprietor of the mill were killed outright, two were fatally injured, and a fifth was injured so severely as to make his recovery a matter of doubt. The mill was completely demolished.

(272.) — A large air compressor exploded July 18 at the plant of the Americus Automobile Co., Americus, Ga. No one was injured.

(273.) — A boiler ruptured July 18, at the plant of the Water Works Co., of Seneca Falls, N. Y.

(274.) — On July 18 a tube ruptured in a water tube boiler at the plant of Jacob Dold Packing Co., Wichita, Kans.

(275.) — A blow-off pipe failed July 20, at the plant of the Lake City Ice Co., Cleveland, O.

(276.) — On July 21, three cast iron headers failed in a water tube boiler at the plant of the Trenton Street Railway Co., Trenton, N. J. The damage to the boiler was considerable.

(277.) — A boiler ruptured July 22, at the mine of the National Fuel Co., Aguilar, Colo.

(278.) — A threshing machine boiler exploded July 22, near Bedford, Ky. Two men were badly injured.

(279.) — A valve failed on an Iron Mountain locomotive July 23, near Leola, Ark. Both the engineer and fireman were painfully scalded.

(280.) — A tube ruptured July 23, in a water tube boiler at the Suburban Plant of the American Gas and Electric Co., Scranton, Pa.

(281.) — On July 24, a tube ruptured in a water tube boiler at the power house of the Public Service Corp'n of Northern Illinois, Blue Island, Ill. Two men were injured.

(282.) — On July 25, a tube ruptured in a water tube boiler at the plant of the American Beet Sugar Co., Oxnard, Cal. Cecil Morgan, fireman, was killed and J. Sandoval, boiler cleaner, was injured. The property damage was small.

(283.) — Two cast iron headers ruptured July 25, in a water tube boiler at the plant of the Railway Steel Spring Co., Latrobe, Pa.

(284.) — Five cast iron headers ruptured July 25, in a water tube boiler at the licorice factory of the McAndrews and Forbes Co., Camden, N. J.

(285.) — A serious fire resulted from the explosion of a boiler at the New England Dyeing and Cleansing Co.'s plant, Malden, Mass., on July 26.

(286.) — A boiler ruptured July 30, at the plant of the United States Cast Iron Pipe and Foundry Co., Columbus, O.

(287.) — A water heating boiler burst July 30, at the Y. M. C. A. building, Dixon, Ill.

(288.) — On July 31, a tube ruptured in a water tube boiler at the plant of the Hamilton Otto Coke Co., Mamilton, O.

(289.) — A boiler exploded at the plant of the Briscoe Lumber Co., Grand Mound, Wash., on July 31. One man was killed, and two others seriously injured.

(290.) — A boiler exploded July 31 on the oil lease of the Sun Oil Co., near Tiffin, O. One man was perhaps fatally injured.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1913.

Capital Stock, . . . $1,000,000.00.

ASSETS.

Cash on hand and in course of transmission,	$186,187.28
Premiums in course of collection,	285,163.53
Real estate,	90,600.00
Loaned on bond and mortgage,	1,193,285.00
Stocks and bonds, market value,	3,506,178.40
Interest accrued,	75,600.51
Total Assets,	$5,337,014.72

LIABILITIES.

Premium Reserve,		$2,211,732.44
Losses unadjusted,		94,913.83
Commissions and brokerage,		57,032.71
Other liabilities (taxes accrued, etc.),		47,740.86
Capital Stock,	$1,000,000.00	
Surplus over all liabilities,	1,925,594.88	
Surplus as regards Policy-holders,	**$2,925,594.88**	2,925,594.88
Total Liabilities,		$5,337,014.72

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Incorporated 1866. Charter Perpetual.

The Hartford Steam Boiler Inspection and Insurance Company

ISSUES POLICIES OF INSURANCE COVERING

ALL LOSS OF PROPERTY

AS WELL AS DAMAGE RESULTING FROM

LOSS OF LIFE AND PERSONAL INJURIES DUE TO EXPLOSIONS OF STEAM BOILERS OR FLY WHEELS.

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