SCIENTIFIC AMERICAN

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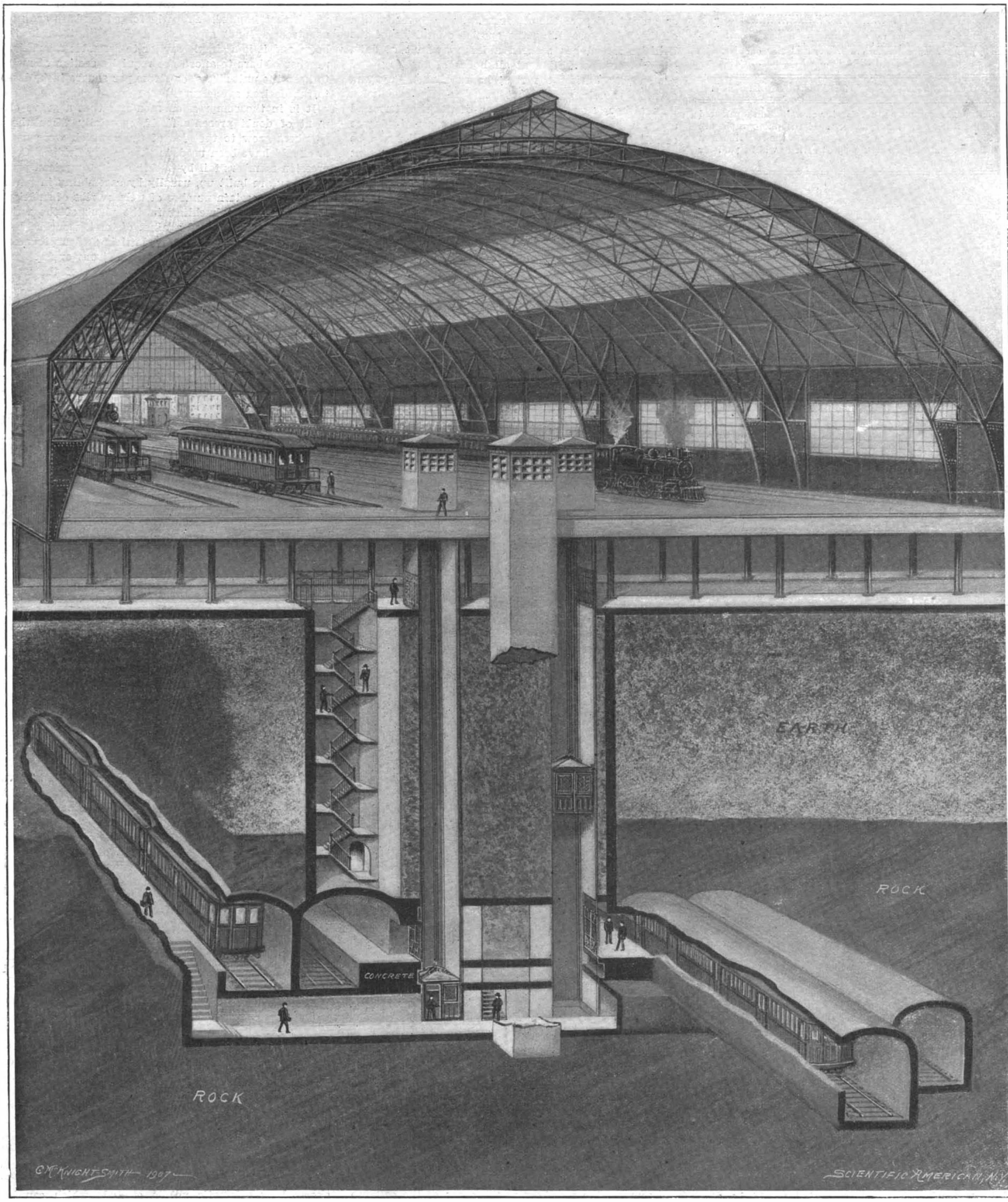

This station has been blasted out of the solid rock at a depth of 85 feet below street level. When the new Pennsylvania Railroad terminal at 33d Street, New York, is completed, the big trainshed shown above will be handed over to the Hudson Companies, who will operate it in conjunction with the tunnel station below.

THE JERSEY CITY TUNNEL STATION OF THE HUDSON COMPANIES. THIS STATION IS 1,000 FEET LONG AND IS BUILT BELOW THE PENNSYLVANIA TERMINAL.—**[See page 206.]**

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NEW YORK, SATURDAY, SEPTEMBER 21, 1907.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

VALUE OF TRANSATLANTIC SPEED.

The "Lusitania," whose advent to the port of New York has created a furor, for which one must go back several decades to the day on which that other giant ship, the "Great Eastern," entered this port, signalized her arrival by breaking the record from Queenstown to Sandy Hook and by having maintained the fastest average speed ever made on a maiden transatlantic trip. The best previous record over this course was that of the "Lucania," which in 1894 covered the distance from Queenstown to New York in five days, seven hours and twenty-three minutes. The "Lusitania" lowered the "Lucania's" figures by six hours and twenty-nine minutes, making the run across in five days and fifty-four minutes. Her average speed over the course of 2,782 miles from Queenstown to Sandy Hook was 23.01 knots. The best speed ever made on a westward passage was that of the "Kaiser Wilhelm II.," which averaged 23.58 knots over the distance of 3,050 miles between Cherbourg and New York, making the trip in five days and eighteen hours.

It is very suggestive of the high state of development reached by transatlantic steamship travel, that the schedule of the arrival and departure of the "Lusitania" on this, her maiden trip, should have been determined upon almost to the very hour, several weeks before she started from the other side. In response to the wishes of Mr. Vernon H. Brown, the general agent in this city, the Cunard Company decided to run the ship across at a speed which would bring her to the bar outside Sandy Hook at eight o'clock on Friday morning on a rising tide; and it is significant that in spite of several delays through fog, the reserve of speed of the "Lusitania" enabled the captain to bring the vessel to the bar at 8:05 on the morning designated. No attempt whatever was made to push the ship beyond a 23-knot average. We are informed by the captain and chief engineer that the vessel has proved during the trip that she is in every respect a perfect success. She is exceptionally free from vibration; and the whole of the elaborate motive power operated without the slightest mishap.

The question will naturally be asked: If a speed of 23 knots will bring the "Lusitania" to New York on Friday morning, why has she been crowded with additional boilers and engine power to enable her to steam 2½ knots faster than this? The answer is that when the ship has "found herself," that is to say, when all wearing parts have settled down to their perfect adjustment, and the whole of the boiler-room and engine-room staff of several hundred men are thoroughly familiarized with their duties, the "Lusitania" will be pushed to her full speed of 25.5 knots an hour, and will be in her dock by seven o'clock on Thursday evenings. This is the confident expectation of the officers of the ship, based upon the ease with which she made 23 knots when using about 75 per cent of her full power. This is a reasonable expectation; for the "Lusitania" has averaged 25½ knots on a trial trip of over 1,000 miles, and has made 26½ knots over shorter courses. During this her first voyage, the vessel was tried out for stretches of several miles, and logged a speed of over 26 knots.

The incidental advantages of high speed are that even though a ship may not make use of it throughout a whole voyage, it gives a reserve which can be utilized to make up for time lost through fog or heavy weather. Thus, because of her great size and power and lofty freeboard, the "Lusitania" would be able not only to maintain an average speed of 20 or 21 knots against heavy winds and seas, but when the storm had blown over, by utilizing her full engine power, she could readily pull up the average to the speed which would bring her into port on schedule time.

MOVING PLATFORMS FOR THE BROOKLYN BRIDGE.

Soon after the Public Service Commission began its active duties, the Board appointed a special committee to study the problem of adjusting traffic on the Brooklyn Bridge; and in the course of its investigations this committee has been giving serious consideration to the question of installing a moving platform, as affording the earliest and most effective relief. It is proposed to replace the surface and elevated cars with continuous moving platforms. If such a change is to be made, the time is opportune, as the lease of the bridge to the Brooklyn Rapid Transit has expired, and the question of its renewal is now before the Board of Estimate, which alone has authority in the matter. The final decision as to the lease will be made during the present autumn, and in the meantime the traction company is operating its cars over the bridge on an extension of the old lease. In its investigation of the bridge crowding, the special committee of the Utilities Board has secured a large amount of data, based upon observation at all hours of the day, and particularly during the rush hours of morning and evening travel; and it has come to the conclusion that, although on the completion of the new terminal and a rearrangement of the schedules, a certain degree of relief will be obtained, no permanent relief will be possible while the bridge is operated by the present mode of conveyance. In spite of the opening of the Battery tunnel, which of course will afford temporary relief by drawing away from the bridge a considerable amount of traffic, the growth of Brooklyn, and of travel thereto, is so rapid, that it would only be a question of time before the bridge would again be overcrowded. It is generally admitted that the provision of moving platforms would increase the carrying capacity of the bridge far beyond any possible maximum which could be secured by the proposed alterations in the trolley car and bridge railway service.

Should the platforms be adopted, the question naturally arises as to whether it would not be advisable to extend the moving platforms to the connecting loop, which is now being constructed between the Brooklyn and Williamsburg bridges. Should this plan be adopted, the question of providing platforms on the Williamsburg and the new Manhattan bridges will also come up for consideration. Even the most strenuous opponents of the proposed system have not attempted to deny that the moving platform provides a far greater capacity of travel in a given time than any other known form of conveyance. This capacity is so great, that it is reasonable to suppose that it would be sufficient to take care of all future increase in travel over the routes that would be covered.

There is one very strong argument against the substitution of platforms for car service, to be found in the fact that it would prevent the future institution of through car service, either by street trolleys or elevated cars, between Brooklyn and Manhattan Island by way of the bridges. The advantages of such service are too obvious to call for any explanation; and it is quite a question whether the carrying of passengers direct from any point in Brooklyn to any point in Manhattan, in other words the treatment of the bridges as part of the continuous thoroughfares of Greater New York, with the abolition of terminal congestion, would not be the most effective way to prevent, once and for all, the present crowding.

We are very largely the creatures of habit, even in matters of such vast import as the handling of the traffic of our great cities. In the matter of transportation over our bridges we have acquired what might be called the "terminal" habit. Because the first great bridge connecting Manhattan and Long Island was provided with terminals, and treated as a distinct and separate element in the transportation facilities, we grew into the way of thinking that not only this but all bridges should be so treated; and yet, if we look at the question broadly, there is no more reason for terminals at each end of the Brooklyn and Williamsburg bridges than there is for placing terminals say at Union Square and Madison Square on the Broadway lines. The true function of these bridges should be to serve as integral parts of continuous lines of travel, whether on foot, by vehicle, by trolley car, or elevated car, and it does seem to us that the sooner we recognize this fact; abolish the bridge terminal altogether; and establish unimpeded travel between Manhattan Island and Long Island, the sooner we shall arrive at the true solution of our bridge traffic problems.

COMPRESSION MEMBERS IN BRIDGES

At the present writing, the progress of the investigation of the Quebec Bridge disaster seems to point with increasing emphasis to the failure of one of the compression members as the cause of the collapse of the whole bridge. This is the view taken by our esteemed contemporary, Engineering News, whose candid admission of the serious bearing of the disaster upon the prestige of the profession cannot be too highly commended. It is of the greatest importance that the point of failure should be located beyond all question of doubt, for otherwise the whole system of design as applied to the largest bridges would be thrown under suspicion. Thus far the evidence seems to be conclusive that there was no failure of the tension members. If they also had given way, confidence in bridge design would have received an even ruder shock, and the whole fabric of the theory of framed structures of great dimensions would have tumbled to the ground. The eye-bar, however, as made to-day, is considered, and rightly so, to be the most reliable element in a bridge. Formerly, when the eyes were made separately and welded on, they were always regarded with more or less distrust, and, under test, frequently failed at the weld. Of late years, the eyes have been formed by upsetting the end of the bar and forming the eye, without the necessity of raising the metal to welding heat with all the risks of burning which that implied. Properly forged eye-bars are now as strong, if not stronger, in the eyes than in the body, and it is a simple matter to assemble a sufficient number of bars to afford the requisite section of metal to keep the unit stress, or stress per square inch, down to the desired safe figure.

It is in the compression members that a grave element of doubt presents itself, especially when these members grow to the size of those which were used, or should have been used, in the Quebec Bridge. Compression members fail by buckling. In American practice they are built up, usually by assembling in parallel planes a certain number of webs or ribs of sufficient depth to prevent buckling in the plane of the webs. The member is secured against distortion or buckling transverse to the webs, by latticing them together with a system of triangulated angle-irons or flat bars, riveted along the top and bottom faces of the webs. Now, it is in the nature of things impossible to estimate with accuracy what strength of latticing is necessary to hold the compression member in line. I the whole member as thus built up is mathematically straight, that is, if the webs lie absolutely in their true planes, there is theoretically no stress upon this latticework; but if, through unpreventable variations in manufacture, or, as in the present case, through careless handling, the member should be ever so slightly out of line, heavy stresses are set up in the latticework, these stresses increasing in proportion to the amount that the compression member is out of line. The work of holding a compression member in line when it is thus distorted falls almost entirely upon the lattice riveting; and it can be readily seen that, since the buckling stresses increase in a multiplying ratio with the increase of distortion, the point must soon be reached where the rivets of the latticing will be sheared and complete failure take place.

The failure of the bottom chord member of the Quebec Bridge will have the greatly-to-be-desired result of opening the whole question of the design of large compression members. We confess that for many years past we have regarded with no little anxiety the tendency among bridge builders to cheapen construction by using latticed stiffening, where solid and continuous covering plates and internal plate diaphragms would seem to be demanded to insure absolutely safe work. Furthermore, the tendency to reduce the diameter of compression members, with a view to facilitating shop work, field work and general erection, has led to the adoption of diameters altogether too slight. The compression member which seemed to have failed measured only 4½ feet by 5½ feet. In the Forth Bridge the corresponding member is 12 feet in diameter and, being circular, is an inherently stiffer section. Even in the new railroad bridge over the East River at Hell Gate, which is of only 1,000 feet span as against the 1,800 feet span of the Quebec Bridge, the main bottom chord members measure 6 feet by 9 feet in section.

NEW COMPOUNDS.

Some new compounds of iron and boron have been obtained by Binet de Jassoneix, of Paris. Prof. Moissan showed that amorphous boron when pure will combine with iron, and in the electric furnace he obtained specimens of iron combined with boron, up to the value of 20 per cent of the latter. He was able to separate a compound having a definite formula, Fe Bo. In the present researches M. Jassoneix produces a compound which has a lower percentage of boron. He mixes iron and boron in various proportions and compresses the mixture in tablets, placing these in pure magnesia troughs within a porcelain tube traversed by a current of hydrogen. In other cases the mixture is heated in magnesia crucibles in the electric furnace. In the first case an air furnace is used, and the resulting cast metal has a crystalline structure which is easily visible. The broken section shows long prismatic needle crystals which can be isolated by treating with acids. These are found to consist of a definite compound of iron and boron having the formula Fe_2Bo. Above 7 per cent of boron the crystals lose their definite character. As to the properties of the new compound, it appears in long prismatic crystals having a steel gray color and a density of 7.37 at 65 deg. F. The crystals oxidized in dry air only at a low red heat, but are more easily affected in moist air. Hot acids will dissolve them slowly, but nitric acid dissolves them in the cold. Another new compound, $FeBo_2$, has been obtained which appears to be the upper limit of the series. This body appears as a yellowish metallic mass. It is very hard, and will scratch quartz.

A GERMAN CHEMIST'S EXPERIENCES IN AMERICA.

In a paper read before the Märkische Bezirksverein Herr V. Samter, a young German chemist, has given a remarkably fair and impartial account of his American experience, which contains information of interest to all chemists in search of employment.

An American electrician connected with a great Berlin establishment wrote to friends on this side, recommending Samter as a man "who impresses me favorably." This phrase is quoted as characteristic of America, where personal appearance, manner, and dress are often more important than testimonials to special ability. A position as analytical chemist, at a small salary, in a factory near a large American city was offered to Samter, and he sailed for New York. He regrets that he did not come in the first cabin, where he might have made useful acquaintances, but he congratulates himself on evading the contract labor law, and warns others against betraying the fact that they have secured positions. At the factory he finds three other chemists and a German foreman, who furnishes him with excellent board and lodging for $4.50 a week. This experience suggests two interesting comments. One is on the great number of Germans in America who, like this foreman who had lived here twenty years, have almost forgotten German without mastering English, so that they cannot express themselves decently in any language. The second comment relates to the cost of living in America, and the exaggerated conception of it formed by those Germans who assert that a dollar will purchase no more here than can be bought in the old country for a mark (24 cents). Samter says this is sheer nonsense, as good board and lodging can be obtained in America for $5 to $8 a week in small towns and $7 to $10 in large cities, and there is no expense for "trinkgelder" or tips. The cost of living, however, is considerably higher in Western mining districts and some others and also in New York, "which genuine Americans have almost ceased to regard as an American city." The average German is too fond of his liberty to take kindly to a boarding house, but he can live cheaply in lodgings and restaurants unless he insists on unlimited beer and German dishes, which are to be had only at high-priced German restaurants. The comparison should be, not between German and American prices of German articles, but between the cost of living in German fashion at home and in American fashion here.

Samter was compelled to sign a contract for a year. This he did reluctantly, for he was eager to obtain higher and more remunerative work than analysis. He finds that employers prefer to make still longer contracts, at least with chemists who have proved their ability and learned the secrets of the establishment. He concedes that a contract for a year is, on the whole, advantageous for a young foreigner; for though it may delay a possible promotion, it removes the danger of being left stranded before becoming familiar with the language and customs of the country.

He quotes the average monthly pay of chemists in large American establishments at $60 to $75 for the first, $85 for the second, and $100 for the third year, with a gradual increase thereafter up to $200. Even managers of large factories demand only $4,000 to $7,000 per year. The payment of percentages on improvements is less common here than in Germany.

Nor is special knowledge so essential as it is in Germany. There are two reasons for this: the dearth of applicants possessing such knowledge, and the American habit of attaching paramount importance to general knowledge and intelligence. This trait is reflected in the remarkable breadth of the course of study in American technical schools, where a little of everything is taught, specialization being left to practice.

A good result of this system is that few American chemists betray the dense ignorance of matters not connected with chemistry that is so common in Germany. Every American chemist has some knowledge of machinery, mechanical drawing, and other things essential to the conduct of a factory. The German chemist is educated for a scientific career in a university or technical school or for the scientific solution of special problems in the laboratory of a great factory, while the American demand is for men qualified to act independently in positions of responsibility and to utilize the natural forces, circumstances, and men at their disposal.

Positions are most easily obtained through the scientific and technical schools, in which reigns a solidarity or *esprit de corps* that is absent from similar German institutions. The school, as well as the individual professors, looks out for the advancement of its graduates, and these, in turn, apply to their *alma mater* both for positions and for assistants.

The Massachusetts Institute of Technology, the Armour Institute in Chicago, and many similar schools have standing lists of situations, and some of them have more positions than their own graduates can fill. Hence young German chemists are advised to seek assistantships in such schools, through recommendations from German professors, for most professors of chemistry in those schools have studied in Germany, and Boston is said to harbor more of Ostwald's pupils than any other city except Leipzig.

The pre-eminence of Germany in the manufacture of dyes, medicines, and pure chemicals has created the erroneous impression that she leads the world in all chemical industries. But the most important of those industries are concerned with the production of staple articles on a large scale, or with processes that have been developed empirically and are not yet amenable to rigorous scientific treatment. The importance of science to industry is overestimated. Often science merely approves methods discovered empirically.

With the exception of the few branches in which strictly scientific methods are essential, applied chemistry is in a flourishing condition in America. The exception is due chiefly to the lack of thoroughly trained chemists, the high price of labor, and the more profitable employment of capital in the production of staples.

Paper, starch, sugar, glass, and the products of the distillation of wood are manufactured in large quantities. The production of cement increases fifty per cent annually, but fails to supply the demand. America leads, or will lead, the world in petroleum products, glucose, iron, copper, silver, and lead. American shoes and overshoes are sold throughout the world, and America's supremacy in electro-chemical industries is universally recognized. The meat industry, in which $175,000,000 are invested, offers unlimited possibilities in the chemical treatment of waste products. An important industry, almost unknown in Germany, is the preparation of cereal "breakfast foods."

There are opportunities for employment outside of factories. Governmental and municipal bureaus for analysis and research are certain to be multiplied in response to the awakening of public opinion by recent disclosures. Agricultural stations and laboratories connected with boards of health, which do many things left to private initiative in Germany, are already numerous.

In discussing the social and business rank of the chemist, which he finds lower here than in Germany, Samter says that we have little respect for scientific attainments. "Success" and "results" are mottoes of American life. "Successful business man" is a title of honor which assures its bearer general admiration and makes him eligible for the highest offices. Some of these idols have recently been thrown from their pedestals, and the American people are probably acquiring a better notion of greatness.

Some German chemists have been convinced by experience that chemists are regarded as common workmen in America. One, who was engaged to devise improvements in silvering mirrors, was put under a foreman and received weekly pay and a time card. In many factories chemists and ordinary workmen have the same hours. Samter fared better because his employer was a graduate of a technical school, but he resigned his position on account of continual friction with the manager, an energetic and intelligent but uneducated man, who, after working successively as shop boy, factory hand, and foreman, had been promoted to his responsible post over the heads of the chemists.

Samter heard of many similar cases. He ascribes them to the very high value put upon administrative talents, especially the ability to increase the output, largely because of the high price of labor and its poor quality, most of the workers in Eastern factories being Italian and other immigrants.

He found the condition of the working classes not quite as favorable as he had expected. He quotes the following daily wages in Eastern manufacturing districts: laborers, $1.25 to $1.50; non-union mechanics, $2.50 to $3.33; union mechanics, $4 and over. The workman is more independent and more prosperous here than in Europe, but he enjoys less protection against accident and less benefit from benevolence. If injured at work, he can obtain damages only by proving the negligence of his employer by means of a long and costly lawsuit. Hence he usually compromises for a small sum. Samter cannot understand why American workmen do not exert their great influence on law makers to improve these conditions.

He concludes with the diverting story of a sulphuric acid manufacturer who visited a tannery to investigate a complaint about the strength of the acid he had furnished, and asked the manager to produce the areometer for comparison with his own. The tanner, who had never heard of an areometer, bared his left arm and said: "See those blisters? They were raised by the old strong acid. Your acid is so weak that it only makes red marks like this."

BALLOON, AIRSHIP, AND FLYING MACHINE COMPETITIONS AT ST. LOUIS.

The second annual balloon race for the Bennett International Aeronautic Trophy is to be held at St. Louis on Monday, October 21, and in all probability ten balloons, at least, will compete. England and France will be represented by two balloons each, while Germany and America will each have three balloons. One of the American balloons will be piloted by Lieut. Frank P. Lahm, who won the trophy last year by his flight of 402 miles from Paris to a point on the eastern coast of England. Lieut. Lahm will use the same balloon with which he won the trophy last year. The other American representatives will be Mr. Alan R. Hawley in the "St. Louis," and Mr. J. C. McCoy in the "America."

In order that the proprietors and inventors of airships and flying machines may receive some financial encouragement, the Aero Club of St. Louis has raised the sum of $5,000, to be given in prizes to the best dirigible balloon, or airship; and to the best aeroplane or other gasless-type machine which competes in the trials that have been arranged for immediately after the balloon race. Half of this sum will be awarded to the successful dirigibles, and half to the successful aeroplanes, or other heavier-than-air machines. There are two classes, Class A being for the dirigible balloons, and Class B for all heavier-than-air machines which have no gas-bag attachment. Two thousand dollars is to be given to that competitor in Class A who, in strict accordance with the rules, shall make the round of the course in a dirigible balloon in the best average time, and $500 is to be given to the competitor who makes the next best average time. To win these prizes, the airship must cover the full course at least once in continuous flight without touching the ground. The heavier-than-air machines will be judged according to the distance they cover, the speed at which they cover it, and the general behavior of the machine. To win the first prize of $2,000 in Class B, the machine must make a continuous flight, without touching the ground, of at least 100 feet. A second prize of $500 will be given to the aeroplane or other heavier-than-air machine that makes the next best performance. For the airship tests, a triangular course three-quarters of a mile in length, and marked by captive balloons, will be provided. Competitors will be allowed to choose the direction in which to start, but they will be obliged to start from the home goal, turn around each of the outer goals, and return to the starting point. The average speed of the airships will be computed by the actual air-line distance over the ground. No allowance will be made for the wind or for deviations from the course marked out.

An entrance fee of $10 must be sent in to the secretary of the Aero Club of St. Louis before October 1, 1907, by anyone desiring to enter these contests. This fee is to be refunded if the contestant appears with his machine upon the date set. It is probable that the test will be held on October 22.

On account of the non-completion of the machines which were to compete for the Scientific American trophy at the Jamestown Exposition on the 14th instant, no competition was held on that date. It is expected, therefore, that the trial flight for the trophy will be made at St. Louis at the time of the other competitions. This trophy can, however, be competed for at any time, provided the inventor or owner of a machine can satisfy the Contest Committee of the Aero Club of America that he has ready an apparatus which is capable of flying.

BUTTERFLIES AND THE ROENTGEN RAYS.

Some very interesting experiments as to the effect of the Roentgen rays upon butterflies, at various different stages of their evolution, have recently been made by Dr. Hasebrook, of Hamburg. The pupæ of several moths, including one of the hawk-moth which had passed over the winter months (September to May), were not affected at all despite repeated intense exposure to the rays, and the Lepidoptera emerged in due course under perfectly normal conditions. The caterpillars, after casting their skins for the last time, were not affected by the rays, except that they remained a little smaller in size; the formation of the pupæ was not interfered with in any way, nor was any difference caused in the duration of the comatose or quiescent stage. On the contrary, the exposure to the rays, during the last caterpillar and first pupa stages, caused marked alterations in the Lepidoptera, the moths of several varieties being smaller, and showing marked degeneration in the formation of the scales and down on the wings and increase in the black pigment, although the characteristic markings were maintained. Another peculiar phenomenon was that the moths had entirely lost the power of flight. It is hoped that further experiments may be made in this direction, and that still more interesting results may be obtained.

REGARDING SPAR BUOYS.

BY C. H. CLAUDY.

The public hears a good deal about lighthouses and bell buoys, and of the mournful tone of the whistling buoy. But little has been written about spar buoys. They seem to be so common as to pass without notice. Yet the spar buoy is a most important factor. Without it navigation would be paralyzed; and were it not for the ships which look after them, the men whose lives are spent in making, placing, and repairing them, and the satisfactory service these sticks of wood render, the commerce of the world, as far as river and harbor navigation is concerned, would suffer materially.

A spar buoy is a stick of wood, anywhere from ten to sixty feet in length, anchored to the bed of a river or harbor, and its projecting end is painted in a way to tell the observer about certain formations of the bottom. Navigation laws of this country demand that red buoys, with even numbers, be on the right, and black buoys, with odd numbers, be on the left side of channels as approached from the sea. Buoys on wrecks or other obstructions, having a channel on either side, are painted with horizontal red and black stripes; mid-channel buoys, with perpendicular black and white stripes; and balls, cages, etc., on the top of buoys, indicate a turning point, the color and number indicating the course.

One might be led to suppose that once such a stick of wood was placed in position, it would remain there to the end of its days, but buoys have to be cared for in much the same manner as boats. Anywhere from six months to two years after being set, a lighthouse tender is sent out to pick them up and put new ones in their places. Then the old buoy is scraped, dried, painted and repaired, until finally it goes back to work again.

Not infrequently a buoy must be replaced because it has been broken. It is not an every-day occurrence, but occasionally it happens that a boat will run over a buoy at night and the propeller cut it off below the water line. Then, of course, there is trouble. Some boat comes up the channel, expecting to get its course from the buoy. It cannot be found. A report is immediately made and a tender ordered to the spot. What remains of the old buoy is found and removed, a new one being immediately put in its place.

But the greatest menace to the spar buoy is ice. It is possible for a well-moored buoy, if heavy enough, to cause an ice jam in a narrow channel, but usually the ice simply passes over the buoy as its head is forced down by the floe. Sometimes the ice is too quick for the spar and it is caught up and dragged from its moorings, accompanied by its anchor, provided the shackle holds.

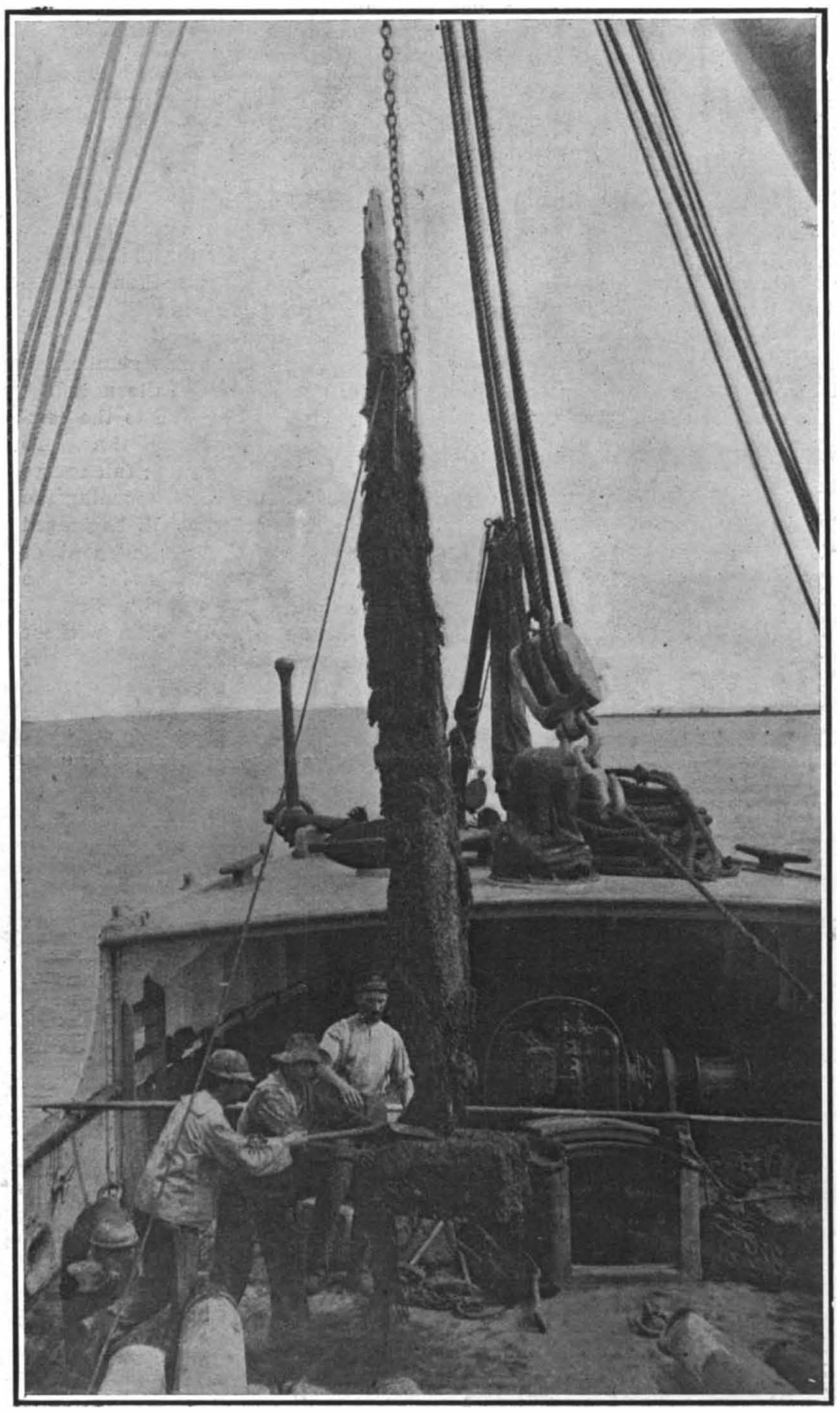
There is at present moored off the coast of Ireland a buoy which traveled to that point in six weeks, from its home in New York harbor. The government presented the buoy to the Irish Board, which, when they had added their distinguishing marks to it, anchored it where it had come ashore, in honor of its long and curious journey.

Wave and wind action is not the only factor which tends to move a buoy from its position. Ships, by being moored to them, though contrary to the laws of navigation, do their share of damage. To see the enormous iron anchors or the still larger blocks of rough stone with ring bolts through them, one would never imagine they could be moved by any outside agent, yet they not only drag tneir anchors, but often break off their shackles.

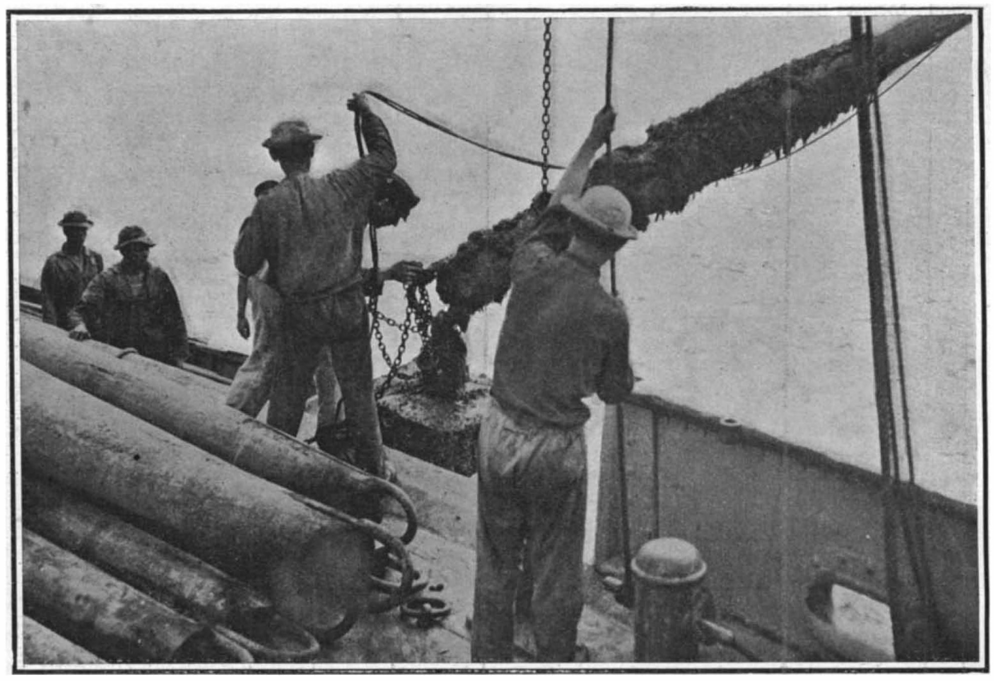
When the tender goes to replace a buoy, she runs up as close as possible. It is then caught by hand and a loop of chain thrown over its head. This, when drawn tight, bites into the wood and holds it firmly for the hoisting engine to raise. When six feet or more are out of water, another chain is slipped on, below the first, and as the other side of the hoisting engine hauls this in, the first chain is removed and adjusted below the second. So, little by little, the spar comes from the water, muddy, barnacled, and covered with seaweed. Then, before it is lowered to the broad deck of the tender, men with shovels scrape off the weeds and barnacles, often a foot or more thick, while others with brooms sweep off the debris and wash it clean with a hose. Two men with hammers loosen the iron-bound end of the spar from its anchor, while a third knocks out the connecting bolt. A fresh buoy, which is held in rope slings over the side of the tender, is always dropped beside the old one, before the latter is removed, unless, of course, the old one has dragged, in which case sextant sights are taken to locate the true position of the spar.

It is not often that a buoy is worked in bad weather, but in case a sea is running, the captain has to use extreme care. Should he tighten up on a firmly fastened buoy and a sea lift his boat, either the tackle will break or the buoy come up too fast. In either case, there is great danger of some of the men being injured.

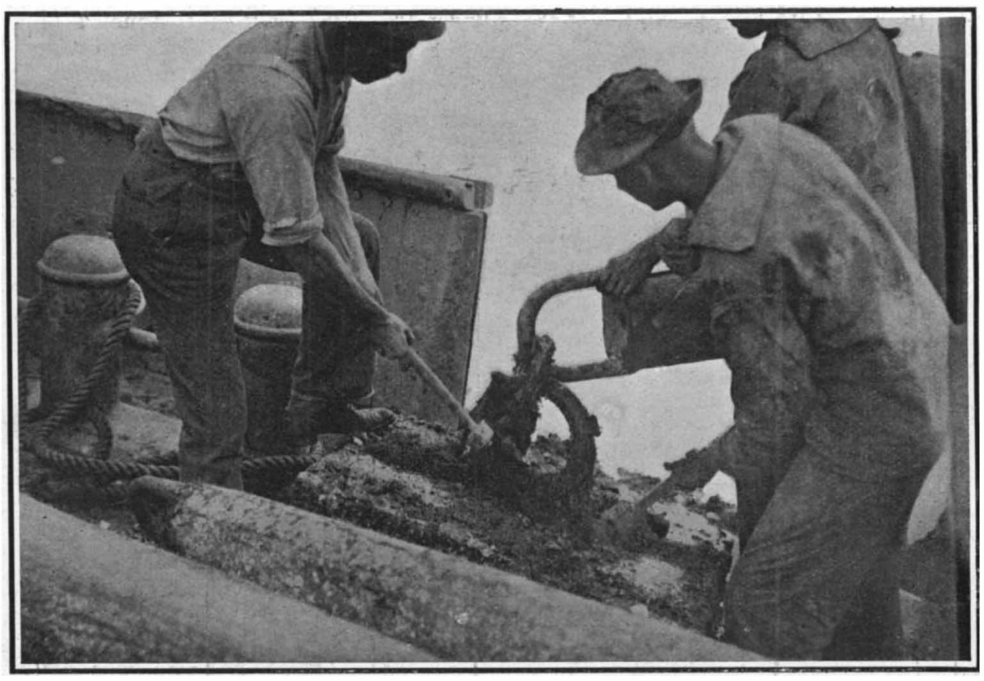
This buoy service, so little known to the public, has its own code of laws, both State and national. It has a fleet of steamers for its maintenance and a corps of private contractors to attend to buoys in places impractical to work from a tender. It has depots for the making, storing, and painting of both wooden and iron buoys, and an annual directory for the use of navigators, showing the position and distinguishing marks of the thousands of buoys which dot the navigable waters of the United States.



Cleaning a Broken Spar Buoy.



Hoisting a Spar Buoy Aboard the Tender.



Removing the Spar from Its Anchor.

REGARDING SPAR BUOYS.

According to arrangements made, the War and Navy departments will co-operate in maintaining wireless communication between Nome and St. Michael and Seattle and San Francisco. Next year the signal corps of the army, which already has wireless stations in the Alaskan cities, will establish one at Fort Gibbon, which will be in touch with a station to be erected by the navy at Valdez. The navy has several stations in Alaska. Steel towers 175 feet high are to be erected at Fairbanks and Circle, Alaska, to carry wireless telegraph instruments. These towers will be 140 miles apart, and regular communication is to be maintained between them.

An irrigating canal has just been completed in Hawaii. It will carry 45,000,000 gallons of water daily through sixteen miles of tunnel and open ditch. Its purpose is primarily to carry water for irrigation from the Waimea River to the Kekaha plantation, but on its way it will be used at two places for the development of electricity.

A BOY'S ENGINES AND HOW HE MADE THEM.

BY A. FREDERICK COLLINS.

While it may be no more true of engineers than of poets that the real genius is born and not made, certainly the work of Bion J. Arnold, the noted electrical engineer, when a boy living on the Nebraska plains, gave evidence that he was possessed of superior talents and sufficient perseverance to develop these talents regardless of all obstacles.

Young Arnold's first attempt at engine building was made when thirteen years of age, and the result was a small horizontal stationary steam engine about 7 inches in length; the main parts he cast out of lead and put them together with such tools as the local gunsmith shop afforded. At fourteen, he constructed a vertical steam engine about 15 inches in height, shown in the accompanying illustration, using for the boiler an old piece of iron pipe which had been thrown away by the railroad company, an old wagon-wheel hub for a firebox, an abandoned valve wheel for a flywheel, and a gas cock which had been given him served for a throttle valve. This engine is still in existence, and its dimensions are as follows: 13 inches from the base to the top of the cylinder; the boiler proper is 8¼ inches in height and 5½ inches in diameter; it sits on top of the firebox; the latter is 5 inches in height, 6 inches in diameter at the base, and 5½ inches in diameter at the top. This wagon wheel hub firebox was secured to the boiler by means of straps and hand-made bolts. The cylinder of the engine is 1⅛ inches in diameter, with a 1½-inch stroke, and the flywheel is 5½ inches in diameter. Not satisfied with a simple engine, the builder put on a link motion as shown in the illustration.

His next achievement in engine building was a year later, and that this engine might be more perfect than the preceding one he sent to a Boston supply house for four iron rods, each 1 foot in length, ¼ inch in diameter and threaded from end to end. With these as uprights and a supply of nuts threaded to fit and with castings made out of Babbitt metal he constructed his second vertical steam engine. This upright engine and the horizontal boiler with a kerosene barrel for a tank had the following dimensions: Engine cylinder 1½ inches in diameter by 2 inches in length inside measurement, mounted on four vertical rods 12 inches in length, thus making the engine from the top of the base to the top of the cylinder 12 inches in height; the flywheel was 5½ inches in diameter; the crankshaft was made of ⅝-inch round iron rod forged into shape and turned down to ½ inch in the bearings and crankpin.

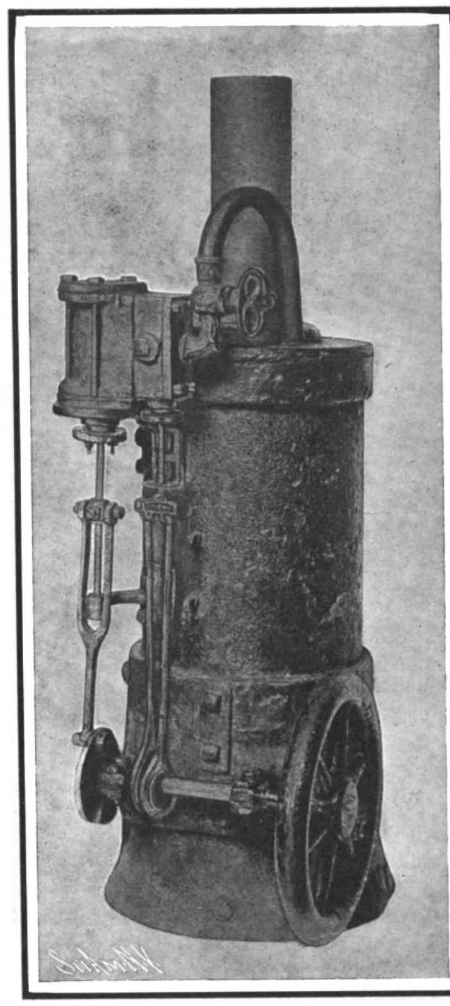
The boiler had a diameter of 12 inches, and was 2 feet 6 inches in length. It was made of ⅛-inch sheet iron, which he hammered into shape at the blacksmith's forge. It was provided with wooden heads held in place by four ½-inch rods extending through the boiler from head to head. It had no flues, as the youthful mechanic had no means of making them or even making heads to hold them; so heat was applied to the boiler underneath it by a crudely constructed brick furnace, while water was supplied to it from the elevated kerosene barrel when the steam pressure was low.

In the construction of this engine he devised and used the piston valve now in common use on locomotives and other engines and he believed himself to be its inventor, only to soon find, after a visit to the railway shops at Plattsmouth, that it had been invented long before he was born and was then in use on the steam engine driving the machinery of the railway shops.

Success having smiled upon his efforts, young Arnold began the construction of a much larger engine, one that he designed to develop about two horse power and by the use of which he fondly hoped to drive the wood saw, his particular *bête noir*, for supplying the weekly amount of wood for the kitchen stove; but with this ambition his father had no patience, and the machine was never completed, for lack of funds. Relics of it, however, can still be found in his boyhood home in Ashland, Nebraska.

Prior to leaving Ashland, Bion had acted as messenger boy at the railroad station, where he started to learn telegraphy, but the attraction of the locomotives was greater than that of the Morse alphabet, and in consequence he made the acquaintance of many trainmen running on the road. He had ridden repeatedly with the engineers, while the firemen allowed him to fire and clean the engine, and he otherwise assisted them until he was perfectly familiar with the construction and operation.

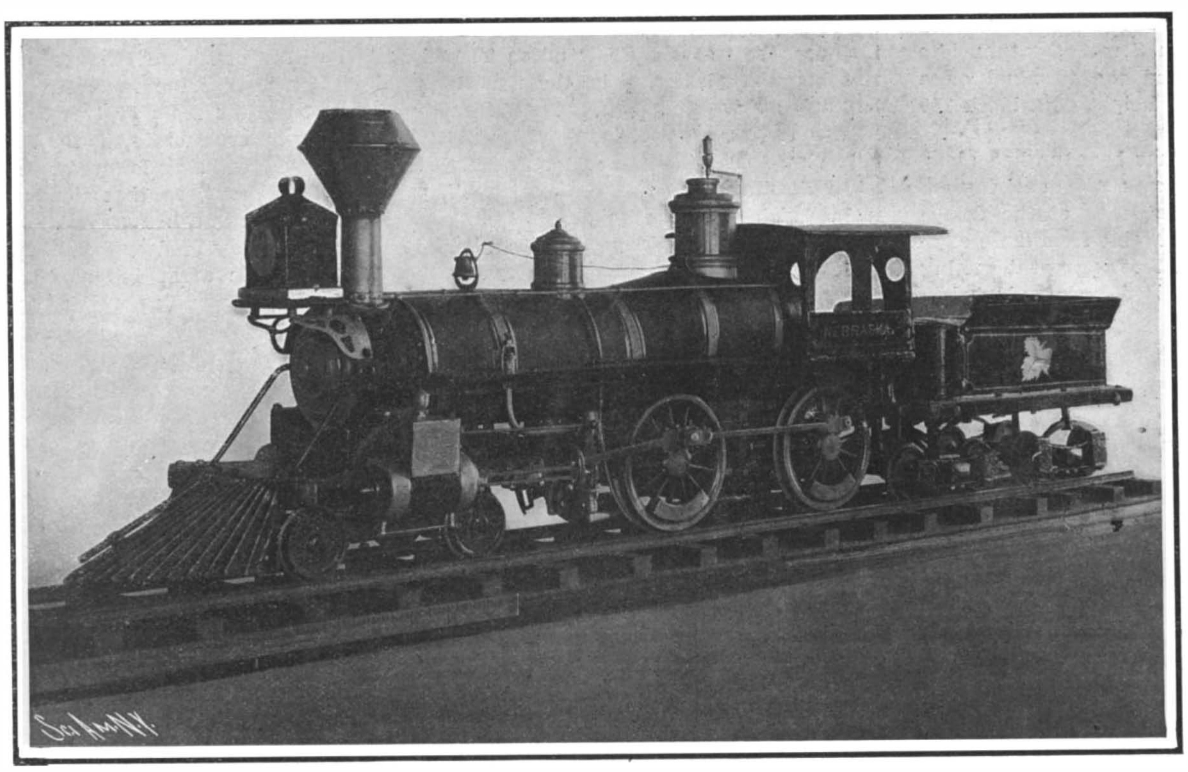
He had long cherished the desire to build a model locomotive, simply to demonstrate that he had the



One of Bion J. Arnold's First Attempts at Engine Construction.

ability to do so. Feeling that his father's consent could not be secured to so ambitious an undertaking, he remained silent about it while at home, but when he went to college at Lincoln he made frequent trips to the local round-house to secure measurements of locomotives, and set secretly to work during afternoons making the boiler in the tinshop of a hardware store, whose owner was kindly disposed toward him.

Bion, who was then just past seventeen years of age, soon produced a complete locomotive boiler one-sixteenth full size. It attracted the attention of a Union Pacific locomotive engineer and the secret was out, for he told the boy's father. The latter changed entirely his attitude toward his son's endeavors, and from that time on did everything possible to assist him in his chosen field. The next mail brought a letter from the father inclosing a check, with the request "not to neglect your studies," and a statement that "if the construction of the locomotive is worth doing at all it is worth doing well," and finally "not to waste money, but not to slight the machine for lack of it."



Miniature Locomotive Constructed by Bion J. Arnold When a Boy.

A BOY'S ENGINES AND HOW HE MADE THEM.

The result of the boy's labors, continuing over a period of many months, during which time he worked from sixteen to eighteen hours per day, was a complete locomotive three feet long, as pictured herewith, and this beautiful and brilliant testimonial of Bion Arnold's perseverance and skill now stands in a glass case in his offices in Chicago where its builder plans and executes gigantic traction schemes.

The locomotive was built on the plan of the 17 x 24 American type, such as was in common use on the Burlington & Missouri River Railroad of Nebraska from 1876 to 1880 or perhaps a little later. It has cylinders 1 inch in diameter, with 1½-inch stroke; driving wheels 4 inches in diameter; the boiler is fitted complete with pump, injector, whistle, steam gage, pet cocks, cylinder cocks, water-gage cocks, dampers, blowers, sand box, and bell—in fact, all the devices to be found on an engine of that date, except the air brakes and pump for the latter. These were partially completed, but never put on. Every part and parcel of the locomotive, from the cow-catcher to the tank bumper, is perfect, and every piece, down to the smallest screw, was made by young Arnold. At different times he had gotten up a few pounds of steam and set the engine into motion, to the great delight of the beholders.

Mr. Arnold's advice to all boys and young men who aspire toward engineering callings is to get the best theoretical schooling possible, but at the same time to learn to use tools and instruments like a skilled mechanic. The services of such an engineer will command the highest figures as long as there are problems to be solved in the engineering world.

Board to Test Block Signals and Automatic Stops.

The Interstate Commerce Commission has appointed a board of experts to conduct experimental tests of block signal systems and other safety devices used on railroads in the United States, as provided for by act of Congress last winter. The members of this board are Prof. Mortimer E. Cooley of the University of Michigan; Azel Ames, Jr., signal engineer of the New York Central Railroad; Frank G. Ewald, consulting engineer of the Illinois Railroad and Warehouse Commission, and B. B. Adams, editor of the Railroad Gazette. Prof. Cooley has been named as the chairman of the board. Mr. W. F. Borland, who has been designated by the commission as secretary of the board, has been employed by the commission for the past five years in charge of safety appliance work. A meeting of the board was called for Friday, July 12, when organization was completed and a plan of work outlined. In the appointment of this board of experts, the commission had the co-operation of the American Railway Association. A sub-committee of that association went to Washington and conferred with the commission with reference to the proposed tests and the composition of the board of experts. This sub-committee was composed of Mr. F. C. Rice, general inspector of transportation of the Chicago, Burlington & Quincy Railway; A. M. Schoyer, general superintendent of the Northwest System, Pennsylvania Lines West of Pittsburg; W. G. Besler, vice-president and general manager of the Central Railroad of New Jersey; A. T. Dice, general superintendent of the Philadelphia & Reading Railway; E. C. Carter, chief engineer of the Chicago & Northwestern Railway, and D. C. Moon, assistant general manager of the Lake Shore & Michigan Southern Railway. The committee has tendered the commission the use of railway tracks and other facilities for conducting the tests and will co-operate further, if necessary.

Massachusetts has a new law compelling railroads to clean up the brush on both sides of their tracks in order to lessen the danger from forest fires, and is also considering the need of spark arresters for locomotives. Other States are behind Massachusetts, for our loss in the needless destruction of our woods is enormously heavy.

THE DOUBLE-DECK SURFACE AND TUNNEL STATION OF THE HUDSON COMPANIES IN JERSEY CITY.

New York city is, at the present time, the greatest center for engineering works of magnitude in the world. In proof of this, it is sufficient to state that the work in the way of terminal railway stations, bridges, tunnels, and water supply now under construction in or near this city represents a total outlay of over $600,000,000, or about three times as much as the estimated cost of completing the Panama Canal. One of the largest of these public works is the elaborate system of tunnels and terminals, which is being built by the Hudson Companies to provide better transit facilities between Jersey City and Manhattan Island—a work, the cost of which, when fully completed, will probably be over $50,000,000.

This system of rapid transit (for such it is) has grown out of the abortive attempts, made some thirty years ago, to drive a tunnel from Jersey City to Manhattan, between Hoboken and the foot of Morton Street. Meritorious as was the original scheme in plan and purpose, it failed for mechanical and financial reasons. Considering that subaqueous tunneling was then in its infancy, and that modern methods of driving were unknown, it is surprising that the original company should have accomplished what it did; but lack of mechanical appliances, coupled with the treacherous character of the river silt through which the tunnels were being driven, to say nothing of the difficulty of securing the necessary capital, led to the abandonment of the work. Thanks to the far-sightedness and energy of Mr. McAdoo, president of the Hudson Companies, the work of completing the abandoned tunnels was taken up a few years ago, the necessary capital subscribed, and the work of driving the tunnels through to Manhattan commenced. Under the care of Charles M. Jacobs, chief engineer, who brought to the work a large experience and the very latest methods of driving with the Greathead shield, the tunnel soon began to make rapid progress toward the Manhattan shore.

Before the work had been long in progress, it was realized that, if the scheme for providing rapid transit between the two cities was to be adequately carried through, it would be necessary to provide additional tunnels at a crossing located in the latitude of the "downtown" financial district; and accordingly, the company laid out a route extending from the Pennsylvania Railroad Company's terminal station in Jersey City to Cortlandt and Fulton Streets in Manhattan. At the same time, the scheme was developed to its logical conclusion, by planning to build tunnel lines parallel with the Jersey foreshore, extending from the Hoboken terminal of the upper pair of tunnels to a connection with the Jersey City terminal of the Cortlandt Street tunnels. Also, with a view to placing Jersey City in direct touch with the uptown shopping district, it was planned to continue the Morton Street tunnels, easterly below Manhattan to Sixth Avenue and northerly below Sixth Avenue to Thirty-third Street, and build a branch line from Sixth Avenue to Astor Place. The plans also called for a huge terminal station and building, extending on Church Street from Cortlandt to Fulton Street, the tunnel to contain five parallel tracks, and the terminal office building to be twenty stories in height on a block 180 feet wide by 420 feet long.

This ambitious undertaking has been pushed along during the past two or three years with untiring energy, and with a remarkable absence of the delays which would seem to be so inseparable from large engineering works of this character. At the present writing the two upper tunnels are completed, and the Hoboken terminal station is nearly so. Also the extension of the tunnels below Manhattan Island has been fully completed to Sixth Avenue, and is nearly completed to Eighteenth Street. The work of excavation is well under way from Eighteenth to Thirty-third Street. As matters now stand, there is every indication that trains will be in operation from the Hoboken terminal to Eighteenth Street and Sixth Avenue before the winter sets in. The Cortlandt Street tunnels have been driven 82 per cent of the distance below the Hudson River, and the big terminal building is now up to the eighth floor. It is expected that this building will be completed by May 1, 1908, and that the tunnels connecting with it will be ready for service in the autumn of the same year.

From an engineering standpoint, one of the most attractive features of the Hudson Companies system is the large underground station, which has been excavated below the present terminal of the Pennsylvania Railroad Company in Jersey City. This station, which is 150 feet in width, and with its approaches nearly 1,000 feet in length, has been cut out of the solid rock at a depth of 85 feet below street level, and, as will be seen from our front-page engraving, lies immediately below the large Pennsylvania Railroad Company's train shed. The walls and roof are finished throughout with a heavy lining of concrete. The station provides for four, and in some places five, parallel tracks, two for through trains, and two for local trains. Access is had either directly from street level by a subway below the floor of the upper station, or from the station floor itself, by means of six passenger elevators. Two elevators lead directly to the street, and four elevators of exceptional size, each being capable of holding over a carload of passengers, lead directly from the platforms of the tunnel station to the platforms of the Pennsylvania station overhead.

Joint traffic arrangements have been made between the Hudson Companies and the Pennsylvania Railroad Company, according to which, as soon as the new Pennsylvania terminal station on Thirty-third Street is completed, the present terminal in Jersey City will be handed over for operation to the Hudson Companies. All long-distance travel on the Pennsylvania lines destined for upper New York will be carried directly through that company's tunnel to Thirty-third Street; while the long-distance travel on the Pennsylvania destined for lower New York will transfer at Harrison for the Hudson Companies' lines, and will enter New York by the Cortlandt Street tunnel route. Eventually, the Hudson Companies will be in a position to carry passengers to Newark and vicinity, either by ferry, and by surface lines over the present tracks of the Pennsylvania Railroad, or direct by tunnel beneath the Hudson River, said tunnel tracks emerging by an incline near Harrison.

An excellent feature in the operation of this system is the fact that a new type of car of absolutely uninflammable construction will be used exclusively. The cars, which were designed expressly for this service, will be entirely free from wood, and even the cushions of the seats will be of fireproof material. It is estimated that 250 cars will serve to maintain a constant succession of trains through the tunnels on a headway of one and a half minutes. During the rush hours there will be eight cars to the train. Operation will be by the multiple-unit system, and every car will be equipped with motors. Advantage was taken of the fact that the cars were to be built entirely of steel, to provide them with a wide margin of strength over cars of the ordinary construction. They are designed on the bridge or girder principle, which has been preserved in spite of the fact that in addition to the usual end doors, center doors are provided on every car.

These middle or side entrances are operated by compressed air; the impulse for operating which will be given by the motorman at each end of the car. At the proper moment, he will move a lever, which will close or open not only the doors on the end platforms, but also the double doors on the sides of the cars. The force of this impulse, however, will be controlled, so that there never will be any possibility of a person being caught between the doors. In other words, the force which closes the doors will be just sufficient to do so; and should a passenger be about to enter the car at that moment, it will be possible for him to stay the progress of the closing door with the hand.

These center doors are on both sides of the cars, and have been thus installed for the purpose of solving some of the rapid transit problems which always exist in any large terminal station in New York. For instance, the trains of the Hudson Tunnel system will run between platforms in the new terminal station building at Church and Cortlandt Streets; there will be five tracks running between six platforms. Alternate platforms will be used for the purpose of loading and unloading the cars. Passengers will pass out of a train just arrived on to an unloading platform, the side doors of the cars permitting them to discharge their passengers in a comparatively few seconds' time. The doors on that side of the cars will then be closed, and the doors on the opposite side will be opened to admit passengers from the loading platform, who desire to embark. Thus the incoming and outgoing passengers cannot collide, and there can be no congestion.

The cars are large and comfortable, and capable of seating over fifty persons each. There are no cross seats, as at present exist in the elevated and subway trains, because the side doors of the cars take up the space at present occupied by the cross seats; but for the convenience of those who may be compelled to stand on the three-minute run under the river, there is a series of posts extending from the floor to the roof of the car, to which one may conveniently cling or lean. The floors of the cars have been laid with cement which may be readily washed, thus giving it the highest sanitary efficiency. In the cement floors will be imbedded quantities of carborundum, which is a very hard abrasive material, impossible of wear under the feet of the passengers, and which makes it impossible for a passenger to slip.

A new method of cutting steel is said to have been patented by a Belgian engineer. The process consists in first heating the metal by means of an oxy-hydrogen flame and then cutting it by a small stream of oxygen gas, which unites with the steel and forms a fusible oxide, which flows freely from the cut. It is said that the cut is fully as smooth as that made by the saw, and is only 1-100 inch wide.

Coffee Substitute Culture in California.

A syndicate of Stockton capitalists has purchased a 500-acre tract of very rich land on Robert's Island, one of the numerous fertile river islands west of Stockton, and expects soon to commence the cultivation of "coffee."

They are going to put this large tract into "blackeye beans," which are used extensively in the manufacture of the cheaper grades of coffee. The bean takes a nice brown color, has a good flavor, and cannot be detected from the genuine coffee bean—the imported article—except by an experienced expert; and even such a person would find it difficult to detect the counterfeit in a ground mixture of the real article.

The blackeye bean owing to the demand for it in the manufacture of coffee sells readily for five cents per pound; much cheaper than real coffee can be purchased for. The blackeye bean is not at all injurious, as has been determined by repeated experimenting and chemical tests; but, on the contrary, it makes a very nutritious drink when mixed with real coffee, as is always the case, and the flavor is delicious. In fact, about the only thing against the blackeye bean is, that it is *not* coffee, and no enthusiastic coffee drinker would knowingly drink any substitute. This is the first attempt to cultivate the blackeye bean in California.

Prize for Lucerne Cultivator.

Consul-General J. G. Lay, of Cape Town, transmits the following information concerning a competition for a lucerne cultivator in South Africa, which should interest American agricultural implement manufacturers:

The endeavor to obtain the best cultivator for lucerne sown broadcast has led the Cradock Agricultural Society, of Cape Colony, to arrange a competition in 1908, at which a prize of $500 is offered for the successful implement. Practically no lucerne is sown by drills in Cape Colony, but thousands of acres are sown broadcast, and the acreage is increasing so rapidly that the cultivator awarded the prize will undoubtedly have a large sale. A "drag" implement, similar to that used for drilled crops, will not do for broadcast lucerne, owing to the damage done the crop in cultivation.

The trial is for a "general purpose" implement to be used on lucerne from one year old and upward, to produce a fine tilth of not less than three inches in depth (with the object of conserving moisture), to destroy grass and weeds, and which must leave the surface of the ground as even as it found it, and in good condition for irrigation. The judges will inspect the lucerne three weeks after and also six weeks after the trial to see the effects. Entries must be made not later than noon on January 1, 1908, and the implements must be on the grounds appointed for the trial by February 1. The selling price of the implement at Cape ports must not exceed $145.

Some suggestions as to the style of cultivator suited to the work have been given by the secretary of the agricultural society and embrace the following points:

The machine should run on wheels, which will admit of its traveling from place to place, and have a roller or drum revolved at a rapid speed by gearing from the main or traveling wheels, fitted with long spring arms or teeth, the roller being suspended and capable of being lowered or raised by the usual lever or quadrant, so that the teeth can be raised out of harm's way when traveling, and lowered for either very shallow or deeper cultivation. The chief difficulty will be in arranging so that the machine will not dig out lucerne as well as weeds. The principle will be best made clear to foundry and machine shopmen by stating that it would be the power wood-molding plane adapted to cultivation, where the traveling pace of the team would represent the "feed" of the molding plane, and the drum and teeth would represent the blade holder and the revolving blade. By adjusting the proportion of the speeds of the traveling wheels and the drum unquestionably any fineness of tilth can be produced in either dry or irrigated land. It must have teeth with spring or give in them both forward and backward, and also spring or give sidewise, or across the machine, sufficient to admit of a tooth slipping off a large lucerne root. Straight spikes seem to be best, of spring steel, an arrow at the point, say one-half or three-fourths inch in diameter, for just such a distance as they will enter the ground, and hooked or bent only at the extreme end sufficiently to make them enter the ground without having more weight in the machine than is necessary for strength. A spring tooth of flat section, with a half turn in the middle, seems likely to give the required spring in both directions, provided the tooth is fairly long. The principles involved are embraced somewhat in an English hay-tedding machine.

Further details concerning the cultivator, with the conditions of entry and trial, as well as the name and address of the secretary of the agricultural society, are on file in the Bureau of Manufactures for the information of those interested.

A New Locomotive Smoke-Consumer.

Travelers over the New York Division of the New York, New Haven & Hartford Railroad have wondered why no improvement has been introduced to stop the belching forth from the locomotives of clouds of black, sooty smoke when fresh coal-dust fuel is thrown upon the furnace fire.

After some preliminary experimenting a locomotive equipped with a new smoke consumer, the invention of Charles Schneider, the Railroad Commissioner of Austria, was attached to a train leaving New Haven, Conn., for Springfield, Mass., on the afternoon of September 12, and drew the train to its destination without the slightest appearance of smoke or cinders. Many of the passengers left the windows open and never experienced any disagreeable cinder sensation. The smoke and cinders are drawn from the firebox into a compartment where they are consumed, securing greater economy in fuel consumption as well as increased steaming capacity. It is stated, in view of the success of the invention, that other engines will be shortly fitted with the apparatus.

It is to be hoped the company will use every effort to eliminate this intolerable smoke nuisance, not only for the benefit of its patrons, but for that of the various towns and cities its road passes through.

Roman Antiquities in Austria.

The last few days of the month of July witnessed the discovery of some very interesting relics at Saifnitz, near Tarvis, in Austria, the excavations made (at the order of the Central Committee for Art and Historical Monuments—"Zentralkommission für Kunst und Historischen Denkmäler") there having brought to light several portions of an old Roman monument. These, when put together, formed a complete portion of a funeral monument of about twelve feet in length. A step-shaped pedestal carries a large block, cut rectangularly transversely and longitudinally, which served as a stand or base for an oval housing or niche crowned with a pine cone (so far not all found) and which contained half-length representations in *alto relievo* of some deceased Roman and his wife. The housing is covered in by a gable-like roof, and is ornamented on top with scroll work; the sides are decorated with figures in relief, while in the front there is an inscription to the memory of the deceased and to the giver of the monument. Although the new find is by no means equal, in solidity and artistic conception, to the famous tower-shaped and obelisk-like monuments (showing traces of Greek influence) found in the Rhenish provinces, it nevertheless ranks easily first among all the rare antiquities so far discovered on Austrian soil.

Radium in the Rocks of the Simplon Tunnel.

The rocks through which the Simplon tunnel has been driven have been found to contain radium, and for the most part in quantities much greater than has hitherto been ascribed to either sedimentary or igneous rocks. Speaking of this at the recent meeting of the British Association, Prof. J. Joly pointed out that such quantities of radium if generally distributed throughout the rocks of the massif would be sufficient to disturb any forecast of the temperature which under normal conditions would be encountered at the level of the tunnel. It is suggested that the radium was in fact the source of the discrepancy between the predicted and the observed rock temperatures.

As it is improbable that these results apply only to this particular sedimentary accumulation and locality, they appear to point to hitherto unsuspected quantities of radium (and its parent elements) in the immediate surface materials of the earth. It seems impossible to avoid the conclusion that these elements were precipitated along with the sediments entering into the composition of the massif. The question then arises whether the accumulation of such quantities of radio-active elements may not enter as a factor in the events attending mountain-building. It can be shown that an area of sedimentation whereon has been accumulated some 10,000 meters of sediments, having a richness in radium comparable with the Simplon rocks, must necessarily become an area of greatly lessened crust-rigidity, and would hence become the probable site of crust-flexure under tangential compressive stress.

Further investigation will be required before such views can be generalized and the importance of radium as a source of instability of the earth's crust be determined. Apart from any speculations as to the influence of radium as the cause of an energetic substratum, the shifting of radium and its parent elements by denudation must be regarded as a convection of thermal energy, and this convection, if the quantities involved are sufficient, must, under the conditions referred to above and the unceasing action of denudation, become rhythmic in operation, and at the same time must result in shifting the areas of high temperature and crust-weakness from age to age as the site of sedimentary accumulation changes.

Correspondence.

Permanent Way Construction.

To the Editor of the Scientific American:

May I crave the hospitality of your columns for the following suggestions as to permanent-way construction?

1. A substantial *longitudinal sleeper* under each rail.
2. *Cross ties* of timber bolted to the upper side of the sleepers, so as to preserve the gage.
3. The *rails* bolted on to these ties.
4. Short pieces of timber under the rails, with the grain running parallel with the ties.

In this way each rail is provided with a *continuous cross-grain bearing*, which transmits the weight of the wheels directly to the ground; while the ties at the same time secure a rigid fixity of gage.

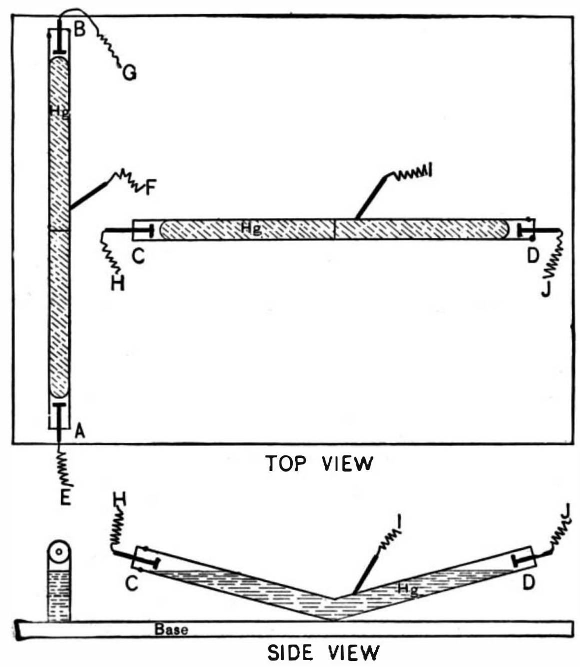
A. J. Allen.

London Institution, Finsbury Circus, London, E.C.

Controlling the Balance of Aeroplanes.

To the Editor of the Scientific American:

Referring to the article by R. W. Goddard in the Scientific American Supplement for June 29, 1907, on the use of the gyroscope with suitable electric connections in balancing and steering aeroplanes, it would seem to me that a much simpler scheme might be devised to do much the same work as that described. Two bent glass tubes partially filled with mercury, fitted at each end with an adjustable contact point, might be fastened at right angles to each other on a suitable mounting. (See sketch.) If the aeroplane should tip toward *A*, the mercury would run toward that end of the tube, forming an electrical connection between the wires *E* and *F*; *F* being a wire sealed in



ELECTRIC CONTROLLER FOR AEROPLANES.

the glass tube and always in contact with the mercury. In like manner tipping toward *B*, *C*, or *D* would form connections between *G* and *F*, *H* and *I*, and *J* and *I* respectively. By adjusting the contact points in the ends of tubes, it would seem to be possible to automatically keep the aeroplane on a level keel. Steering could be accomplished by tipping the mounting as described by Mr. Goddard. The above scheme would be much more simple than that described by Mr. Goddard, and as far as I can see, would produce practically the same results.

Clark L. Swezey.

West Haven, Conn., July 24, 1907.

The Current Supplement.

The current Supplement, No. 1655, is of more than usual interest. The first-page article is devoted to illustrations of devices for coaling vessels at sea, the coaling-vessel being self-propelled. An article on the test of alcohol lamps and stoves by S. M. Woodward and B. P. Fleming is timely, in view of the fact that we are now able to obtain denatured alcohol at a moderate price. The article is profusely illustrated. The utilization of waste products is admirably described in an article by Dr. Theodor Koller, entitled "Iron Slag." "New Problems of the Weather," by Messrs. Moore, Humphries, and Fassig, of the Weather Bureau, describes some of the recent work in aerial, meteorological, and magnetic observations. "Different Types of Ice Houses," by A. S. Atkinson, gives in a concise form valuable technical knowledge which will doubtless benefit many of our readers. "Recent Contributions to Electric Wave Telegraphy" is the substance of a lecture recently delivered at the Royal Institution by Prof. J. A. Fleming, F.R.S. "The Telescope and Its Achievements" by D. B. Marsh is interestingly written. The Engineering Notes, Electrical Notes, Trade Notes and Formulæ will be found in their accustomed places.

Production of Precious Stones in 1906.

The collection of statistics for the production of precious stones is one of the most difficult tasks performed by the Mineral Resources branch of the United States Geological Survey. Not only is the production made up of small lots and scattered finds brought in at different times and disposed of to different people, but often the persons mining gem minerals do not care to furnish figures showing production, which then has to be estimated or omitted entirely. Fortunately for the statistician, the men willing to furnish information greatly outnumber those of the secretive class.

In an advance chapter from "Mineral Resources of the United States, Calendar Year 1906," on the production of precious stones in 1906, Mr. Douglas B. Sterrett, of the United States Geological Survey, has brought together all available information concerning the gem production of the United States as well as that of other important producing countries.

In comparison with this country's vast production of the utilitarian minerals, its output of those used chiefly for ornament is insignificant. Of the precious stones of all kinds (except pearls) produced in the United States in 1906, the total value was but $208,000 and nearly $190,000 of this amount represents the value of six gems ranking as follows:

Tourmaline	$72,500
Sapphire	39,100
Chrysoprase	32,470
Turquoise	22,250
Spodumene (kunzite and hiddenite)	14,000
Beryl	9,000
	$189,320

The balance was distributed among various gem minerals, including garnets ($2,700), quartz gems of different kinds ($6,050), amethysts ($700), rubies ($600), and rarer or less well known varieties in small values.

Of the stones produced to the greatest value in the United States, the tourmalines come from California, Maine, Colorado, and Connecticut; sapphires from Montana, North Carolina, and Idaho; chrysoprase from California; turquoise from Arizona and New Mexico; the spodumene gems, kunzite and hiddenite, from California; and the beryls from California, Colorado, North Carolina, Massachusetts, New Hampshire, and Maine. The rubies were reported as scattered finds from North Carolina and Idaho.

The value of the diamonds in place, discovered in Arkansas in the latter part of the year, is not included in the statistical part of Mr. Sterrett's report, but a history of the discovery and a description of the manner of occurrence, prepared by Messrs. George F. Kunz and Henry S. Washington, is appended thereto.

Each year there is an unrecorded production of pearls from fresh-water mussels of many rivers of the United States, principally from the Mississippi Valley region, and pearls have also been found along the Atlantic and Gulf Coast States from Maine to Texas. The American pearls vary so greatly in color and tint that it is difficult to exactly match a number of them for necklaces and other jewelry. On the other hand, the exquisite color and fine luster of our pearls more than offset the disadvantages of such irregularities and make them much desired in the gem market.

The pearl industry is carried on in such a way that it is not possible to collect statistics of production, but one of the largest pearl dealers in the Mississippi Valley estimates the value of pearls and slugs produced in 1906 at $381,000, with prices ranging from $1 to $2,000 each for the pearls and $1.50 to $60 an ounce for the slugs. An estimate by the United States Fish Commission places the value of pearls produced in the United States in 1906 at about $500,000.

The chapter on precious stones above referred to will soon be ready for distribution and copies may be obtained free of charge by applying to the Director of the United States Geological Survey, Washington, D. C.

Plugged sleepers have been used with marked success in large numbers by Chief Engineer Fredericia, of the Danish State Railway. A plain 1½-inch cylindrical creosoted plug of beech or birch is driven tight in a 1 1-3-inch hole bored in the sleeper and the spike is driven in a hole bored in this plug. Worn-out sleepers plugged in this way have been found to give good service, as the rail seems to be held down with exceptional firmness, and deterioration due to the pounding of loose rails is prevented.

The Railway and Engineering Review states that the Erie Railroad has adopted a new form of steel pole for carrying overhead wires. It is of tripod construction instead of the four or more legs usually employed. It consists of special U bars arranged at angles of 120 deg. round the axis of the pole, and bound together by malleable castings. This method is said to give an absolutely rigid fastening without any hole being drilled in the U section.

NEW 14-INCH GUN FOR COAST DEFENSE.

BY CHARLES A. SIDMAN.

Plans have been perfected for the new 14-inch caliber guns which are to be added to the existing coast defense system now in place along the coast from Maine to Washington State, and Gen. Crozier, Chief of Ordnance, United States Army, has the Watervliet arsenal engaged in the manufacture of these new pieces.

The 14-inch gun will be something new in ordnance design, and although fully two inches larger in caliber than the standard coast defense gun of the first grade (a 12-inch caliber), the new gun will be shorter in length, and the outside diameter will be smaller. The powder chamber will be less than the gun now in use, and it will be lighter in weight.

It is proposed to make a weapon that will have a range and striking force at least equal to the present standard 12-inch gun, but which shall greatly exceed the very limited life of that gun. One strong point also in favor of the new gun is the fact that its first cost will be less than that of the 12-inch gun, while the addition to the life of the piece will result in a greater economy.

In speaking of the new gun, Gen. Crozier said:

"There will be a vast difference between the present standard 12-inch gun and the new 14-inch gun. The 12-inch gun fires a projectile of 1,000 pounds weight, with a velocity of 2,550 feet per second, using 366 pounds of powder, and only has a life of between sixty and seventy rounds, before it has to be relined. This necessitates dismantling and shipping back to the factory for that purpose. The new gun, which is much shorter in length than the 12-inch gun, will fire a 1,600-pound projectile, use nearly 100 pounds of powder less than the 12-inch gun, and only gives a muzzle velocity of 2,150 feet per second, while its life will be nearly four times that of the present standard.

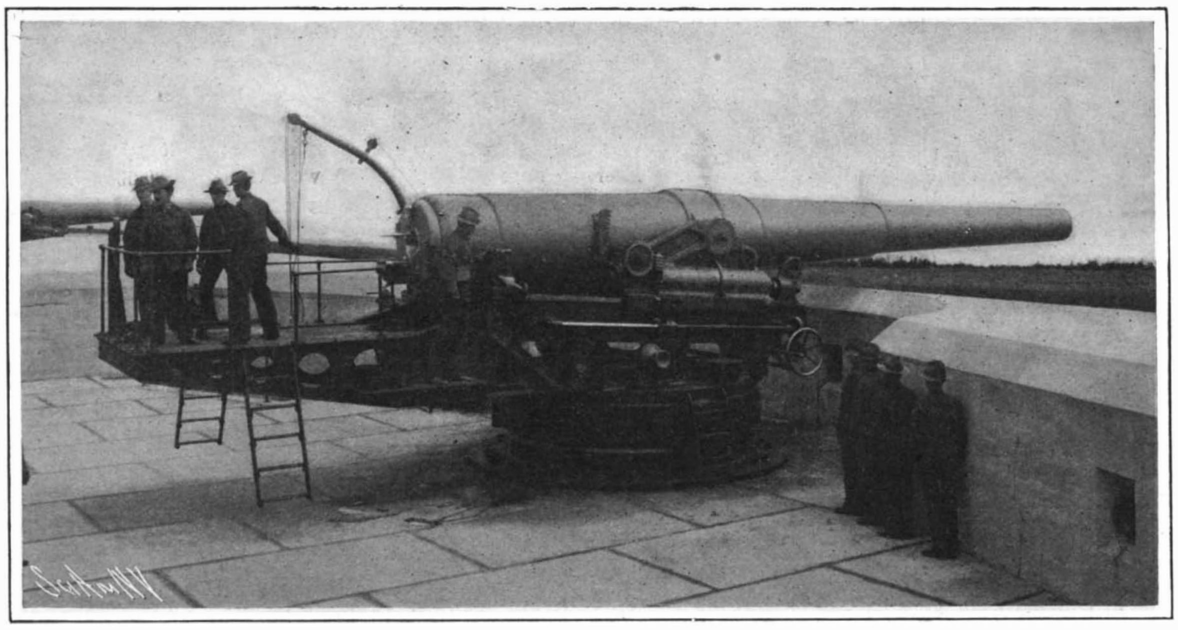
"By reason of the lower velocity required and the consequent smaller charge, it is possible to make the 14-inch gun proportionately shorter than the 12-inch gun, and the smaller charge of powder also involves a less diameter of powder chamber, and therefore, with the same thickness of wall of the chamber in caliber, a less exterior diameter of the gun over the breech. These elements of saving are so considerable that the weight of the 14-inch becomes actually less than that of the 12-inch; and as a lower maximum pressure is needed, it is possible to attain all the strength which will be used without employing the most expensive steel.

"The muzzle energy of the 14-inch projectile will be about 15 per cent greater than that of the 12-inch; and because of its lower velocity and its greater weight, the retarding influence of the air will be much less upon this projectile, so that the gain of energy will be in greater proportion with each increment of range. Because of its lighter weight and of the cheaper material of construction, the cost of the new gun will be less than that of the 12-inch gun, while the cost of powder will also be less than that for the 12-inch by about $70.

"The cost of the 14-inch armor-piercing shot will be about $100 more than that of the 12-inch shot, so that the total cost of a single round will be about $30 greater. Taking into consideration, however, the rapid deterioration of the 12-inch gun, and adding the cost of relining to that of the ammunition, which would correspond to the number of rounds making relining necessary, the cost per round, including the deterioration, for the 14-inch is only about 68 per cent of that for the 12-inch gun.

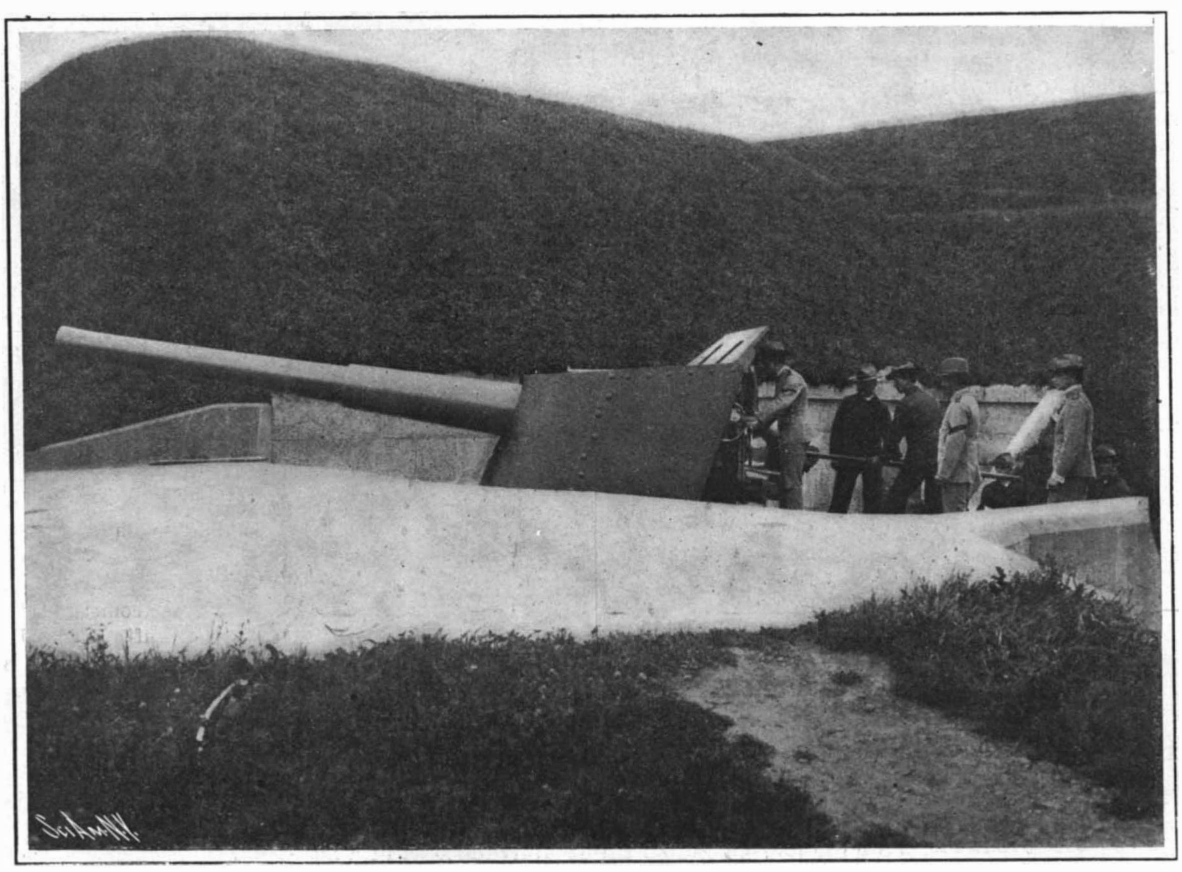
"The penetration of the 14-inch projectile through Krupp armor at 10,000 yards is about 11 inches, while that of the 12-inch is about 10½ inches; while the range at which the 14-inch projectile will penetrate 12-inch Krupp armor is about 8,700 yards, as against 8,500 yards for the 12-inch projectile.

"To sum up then, it appears that in situations requiring the greatest power, a 14 inch gun, with 2,150 feet per second muzzle velocity of projectile, instead of the 12-inch gun with 2,550 feet per second initial velocity, gives us a lighter gun, a cheaper gun, a heavier projectile, greater muzzle energy, a still greater proportion of energy at each distance beyond the muzzle, and a life four times as long."



A 10-INCH BARBETTE GUN READY TO FIRE.

Regarding the life of the 12-inch and 14-inch guns, it has been considered that, in attempting to run by fortifications guarding the entrance of a harbor, the period that would elapse from the time that the leading vessel of the fleet would come within range until the last vessel would pass beyond the range of the coast guns would be about two hours. It is therefore evident that a new 12-inch gun would not last through such an engagement; and considering that this gun is capable of firing for a considerable interval at the rate of forty-five rounds per hour, it is seen that the limit of its life would be reached in less than two hours. With the 14-inch gun, the life of the gun before its accuracy would show impairment would be about 240 rounds, corresponding to about six and a half hours of continuous firing at the rate at which it is thought it can be fired.



A 6-INCH ARMSTRONG RAPID FIRE GUN.

The weight of the new gun will depend greatly upon the manner in which it is built. It is yet to be decided whether the guns shall be of the ordinary built-up forged steel type or shall be of the more modern wire-wound construction. If wire-wound, the weight will be about 110,500 pounds, while the built-up type will weigh 12,500 pounds more. The present standard gun weighs about 1,500 pounds more than the average for the new gun. They will be mounted on the disappearing carriage, and will be installed wherever needed.

The Nature of Toad Venom.

In Knowledge and Scientific News reference is made to *bufotaline*, a toxic substance isolated by Herr Faust from the secretion that exudes from the glands on the back of the toad. This substance is probably identical with *phrynine*, a body of an alkaloidal nature, isolated some years ago by M. Fornara, and is not a true toxine like the active principles in snake venoms, since it does not produce a specific anti-toxine, and is not destroyed by a moderate degree of heat. The toads to which the chief attention has been given are *Bufo vulgaris* and *B. viridis*, and the poisonous secretions from these have been obtained by injecting a solution of barium chloride or stimulating the skin by means of an induction coil, either of which methods causes the glands to discharge the fluid. It is a milk-white juice, which, externally applied, has a strong irritant action upon the mucous membrane and causes burning of the eye, the effects disappearing after a few hours. Introduction of the venom into the blood kills dogs within an hour, and in the case of frogs, produces convulsions, ending in paralysis and death. Alcohol and opiates act as antidotes to the poison. Toads are not susceptible to the poisonous secretions of closely allied species, though they are so to the venom of the salamander and triton. An extract of the skin of the fire-toad, *Bombinator igneus*, causes only slight twitchings in frogs, so that the powerful poison secreted by the glands of the common toad is not present in the case of this reptile. In addition to the alkaloidal poison, which is the chief active agent in toad venom, there is also present in the skin and blood of certain toads a true toxine, which acts upon the red corpuscles of the blood. This belongs to the class of toxines known as "lysines," which change the hæmoglobin in such a way that it exudes and causes the blood to become "laked."

News of Capt. Mikkelson's Arctic Expedition.

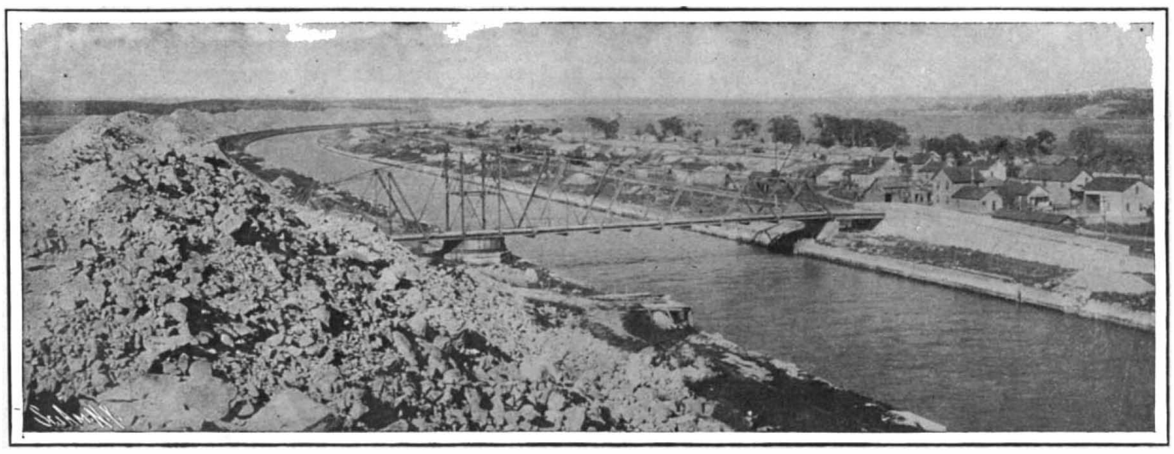
An unconfirmed report has been published that the Arctic exploration steamer "Duchess of Bedford" has been lost. This ship sailed from Victoria, B. C., in May, 1906, with the intention of penetrating through Behring Strait and seeking for a large tract of land believed to exist in the Beaufort Sea. Early this year Capt. Mikkelsen, the commander of the expedition, headed a party of 15 in a journey over the ice northward. According to the report, one of their trains of dogs has strayed back to the ship, and this is considered an ominous sign. Since the commander left her on his northward dash, it is reported that the ship has filled with water and has sunk, or may sink. The American Geographical Society has since received a telegram from V. Stefansson stating that Capt. Mikkelsen returned safe after a 500-mile sledge trip, during which soundings were made 50 miles off the coast to a depth of 2,060 feet. It would appear, therefore, that the supposed land does not really exist. As nothing was said about the return of the expedition, and as the message was sent 500 miles overland to Eagle City for telegraphic transmission, it is supposed that if the ship was damaged the captain hopes to repair it and continue his explorations.

THE CHICAGO-ST. LOUIS WATERWAY.

BY W. FRANK M'CLURE.

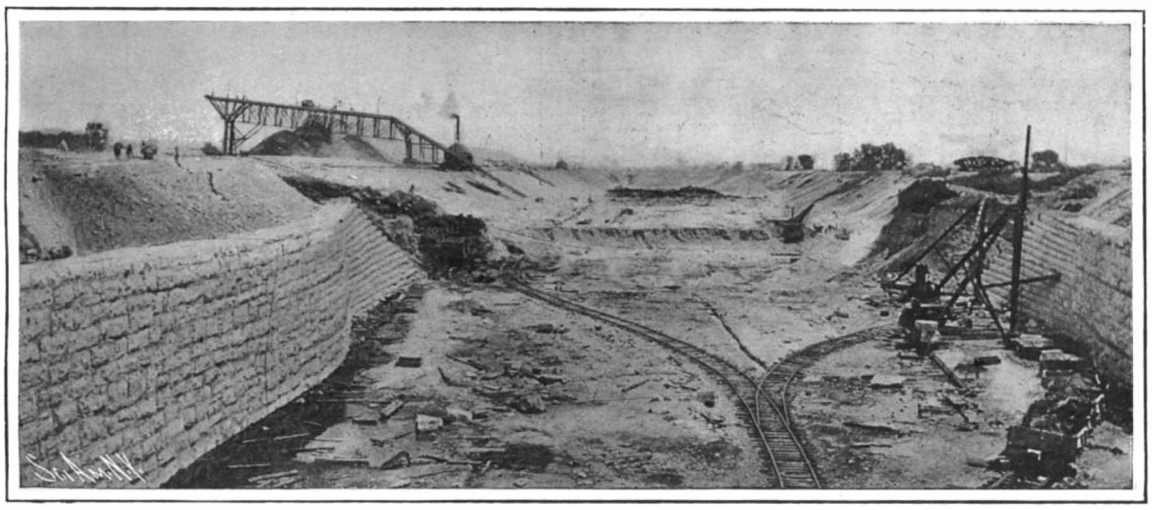
The Chicago to St. Louis waterway project *via* the Chicago drainage canal is attracting more attention to-day than at any time since its inception. Just recently it has gained a strong ally in the fact that St. Louis, for years hostile to the plan, is now urging its feasibility, and the Business Men's League of the city is taking an active interest in behalf of a navigable canal all the way from the Great Lakes to the Gulf. The recent developments with reference to this project may be summed up as follows:

About eighteen months ago the United States Supreme Court ended a long legal battle by its decision permitting Chicago to maintain its drainage canal. The present canal has a capacity of 10,000 cubic feet of water per second *via* the Chicago River, of which it is now utilizing a little less than 5,000 feet.



Two Mile Curve in Channel at Rome, Ill.

With a view to meeting all future needs of Chicago's sewerage and providing water for an adequate ship canal, the proposal to reverse the flow of the Calumet River, so that it will discharge into the Des Plaines River instead of into Lake Michigan, and for a part of the route follow the drainage canal already excavated, has recently been under consideration. By way of the Calumet, 4,000 additional cubic feet of water would be diverted. This proposition has been acted upon by the International Waterways Commission. The commission reported against the diverting of more than 10,000 cubic feet. In other words, its report was not favorable to reversing the waters of the Calumet. However, the commission stated its belief that 10,000 cubic feet is sufficient for all the future needs of Chicago from a sanitary standpoint, and in addition would provide a ship canal fourteen feet deep. Still more recently the government engineers and Secretary of War Taft have reported against the Calumet River project.



Work on Earth and Rock Sections at Willow Springs.

The whole matter came before Congress at its last session in the form of a bill to expend $31,000,000 in the completion of at least a fourteen-foot waterway to St. Louis *via* the drainage canal, and it will come up before that body again. In the meantime the Lakes-to-the-Gulf Deep Waterway Association and other organizations will actively keep the need for such an improvement in the public eye.

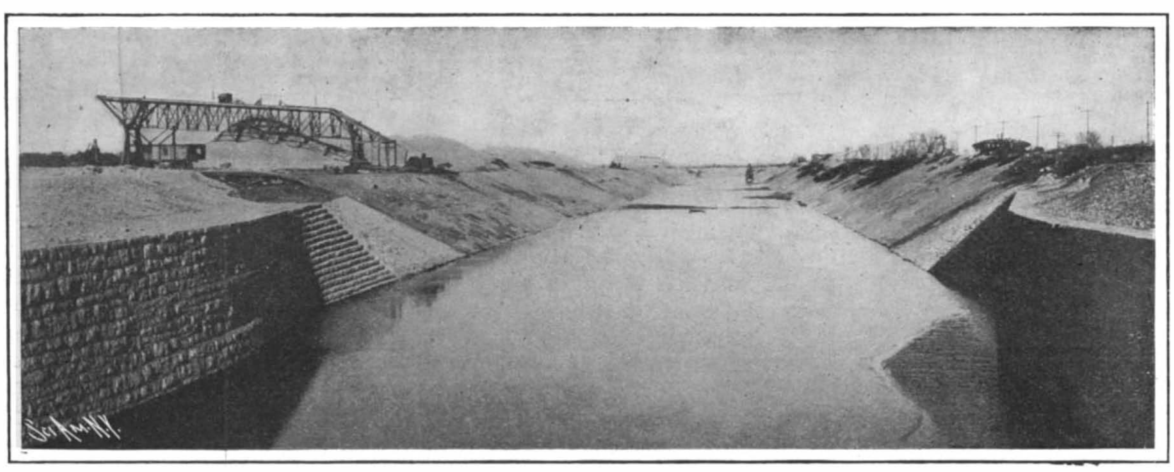
Active work on the Chicago drainage canal was begun in the year 1892. In 1899 it was completed sufficiently to be opened for use. The need for such a canal lay in the fact that the volume of Chicago's sewerage, as it emptied into Lake Michigan, was such as to pollute the city's water supply. The route of the drainage canal follows for six miles the Chicago River to its headwaters, where it pierces the watershed. Beyond this the digging was continued through both earth and rock for twenty-eight miles to the Des Plaines River. The Sanitary District also includes eight miles of this river.

The piercing of the divide between the Chicago and Des Plaines rivers was the most expensive and difficult work. In fact, the construction of the drainage canal is said to represent nearly two-thirds of the entire cost of the building of a fourteen-foot waterway between Chicago and St. Louis. The amount spent by Chicago on her drainage canal is close to $50,000,000; and, with a view to making it eventually a part of the deep waterway, the people of Chicago expended $18,000,000 more in its construction than would have been necessary for sanitary purposes only.

Such a connecting link between Chicago and St. Louis had long been talked of. In 1808 it was mentioned in Congress. In 1817 a resolution was presented to that body instructing the Committee on Canals and Roads to inquire into the feasibility of building a navigable waterway from Lake Michigan to the Mississippi. By treaty with the Indians some ninety years ago a strip of land between Chicago and Ottawa was secured, with a view to the establishment of a canal between the two points. Many years afterward, at intervals, portions of this route were improved at government and State expense.

When the rest of the waterway is completed to St. Louis, the government is to be given control over the drainage canal, for navigation purposes. In assuming this control the government will find that every precaution has already been taken against any obstruction to navigation in the drainage canal. Bridges which, as far as sanitary requirements are concerned, could have remained stationary, are all movable for the passage of boats.

The entire length of the proposed waterway from Chicago to St. Louis is 362 miles. From Chicago to the controlling works of the drainage canal at Lockport is thirty-four miles. Next comes the eight-mile section from Lockport to Lake Joliet. On this short distance, rock cutting enters into the construction to no small extent. In fact, the cost per mile is more than on any other portion of the route. Of the cost of $8,000,000 which it is estimated that this will reach, the city of Chicago expects to pay $3,000,000.



Junction of Earth and Rock Sections at Willow Springs.

Next comes the section between Lake Joliet and Utica, fifty-four miles in length and deeply cut the greater part of the way. The level of Lake Joliet is seventy-six feet below Lake Michigan, and there is a fall of sixty-six feet from here to the Utica level. On this length three levels or pools and three dams or locks will be necessary. A fourteen-foot waterway can easily be maintained here with a width of 300 feet.

From Utica to the mouth of the Illinois, 227 miles, is an alluvial stream of small declivity. The stream bed is from 600 to 900 feet wide. On the route are several locks and dams already built by the government. To obtain a fourteen-foot depth here, cheap hydraulic dredging will serve to increase the present depth by seven feet. This will necessitate the removal of 100,000,000 cubic yards, at a cost of $7,000,000.

From the mouth of the Illinois to St. Louis harbor represents a distance of thirty-nine miles with a total fall of twenty-one feet.

Ultimately, it is planned to extend this waterway to the Gulf. Already there are projects under consideration for the improvement of the Mississippi from St. Louis to Cairo, and Cairo to New Orleans. These projects, however, provide only for eight or nine feet depth as yet. On this account one of the

The Bear Trap Dam of the Chicago Drainage Canal.

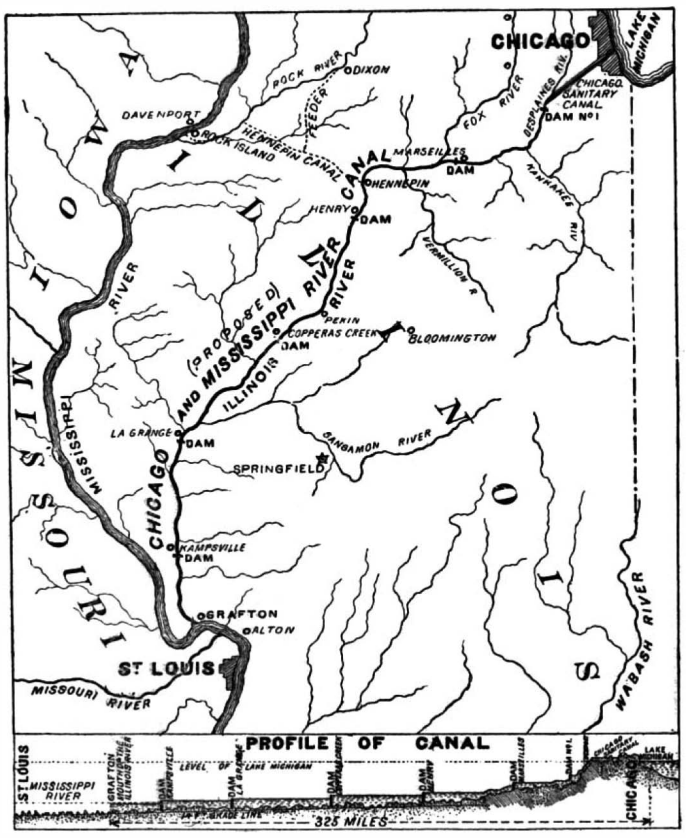
THE CHICAGO-ST. LOUIS WATERWAY.

boards of engineers recently sent to review the Chicago to St. Louis waterway situation recommends but an eight-foot channel between these two cities. The contention, however, has been made that the traffic between St. Louis and Chicago alone will warrant a fourteen foot depth, even though there is no plan at present to deepen the route from St. Louis to the Gulf.

With a waterway complete from the Great Lakes to New Orleans, and with the completion of the Panama Canal, it is contended that the States of the Middle West, with all their great industries and multiplicity of products, would be in communication with the Orient all the way by water. Freight rates would also be reduced, and much transferring of freight from cars to vessels would be avoided. Lake vessels running light could make their way *via* this canal to the ocean, and even light-draft war vessels, in case of necessity, could be brought to the lakes.

The international question in connection with this waterway arises over the diverting of water from the lakes. By a treaty of long ago, the Canadian government also has something to say about the regulation of these levels. The Lake Carriers' Association is also opposed to any lowering of lake levels, for the largest lake ships now draw twenty feet of water, and some of the big harbors offer none too great a depth for them. However, it is estimated that when Chicago utilizes the full 10,000 cubic feet for her drainage canal, or twice what now empties into it per second, the lake level cannot be affected beyond five or six inches. Remedial works of an international character are suggested to cope with any noticeable lowering of levels on the lakes.

As to Chicago's sewerage affecting the drinking water of St. Louis, time has obviated the objection at first raised; for in the intervening years St. Louis has suffered from no epidemic which is traceable to the water. The volume of water is so great, that it is found to be clear and odorless.



MAP AND PROFILE OF THE CHICAGO-ST. LOUIS WATERWAY.

THE "TURN-DOWN" ELECTRIC LAMP.

BY A. FREDERICK COLLINS.

An incandescent light has the advantage over the usual gas flame in that it cannot be blown out, but must be turned off; on the other hand, gas furnishes a much more flexible light than electricity, since its luminous values may be varied anywhere from minimal to maximal brilliancy, whereas the other usually has a fixed candle-power.

To overcome this untoward feature, which frequently, especially in the home, assumes the proportions of a real objection, an electric lamp has been invented that is adjustable, and gives, when turned on full, the usual 16 candle-power, or when turned down, 1 candle-power, as desired. The above statement is not intended to convey the impression that the turn-down electric lamp is a recent production, for the first one of this type was invented as early as 1892, but it was only recently that the lamp has been brought to what we may term a perfected state; and thus it will be observed that the turn-down electric lamp of to-day is an evolved product, rather than a new invention.

A good many years in the receding past, or to be more precise, shortly after Edison showed those of little faith that the electric current could be subdivided, the art of making filaments was in a very crude condition, and in consequence they were not only short-lived, but the making of the lamps was expensive. It was then that the Wizard of Menlo Park conceived the idea of inserting two or more filaments in a single bulb, and by a simple arrangement of contacts, when one of the filaments burned out another was brought into action, and so on until all were consumed.

This multiple arrangement of filaments in a single lamp may have been, and probably was, the cause that furnished George F. Melick with the inspiration of a double-filament turn-down electric lamp, which he devised in 1892. However this may be, he produced a lamp having both filaments connected in series, the free ends being permanently attached to the lamp terminals.

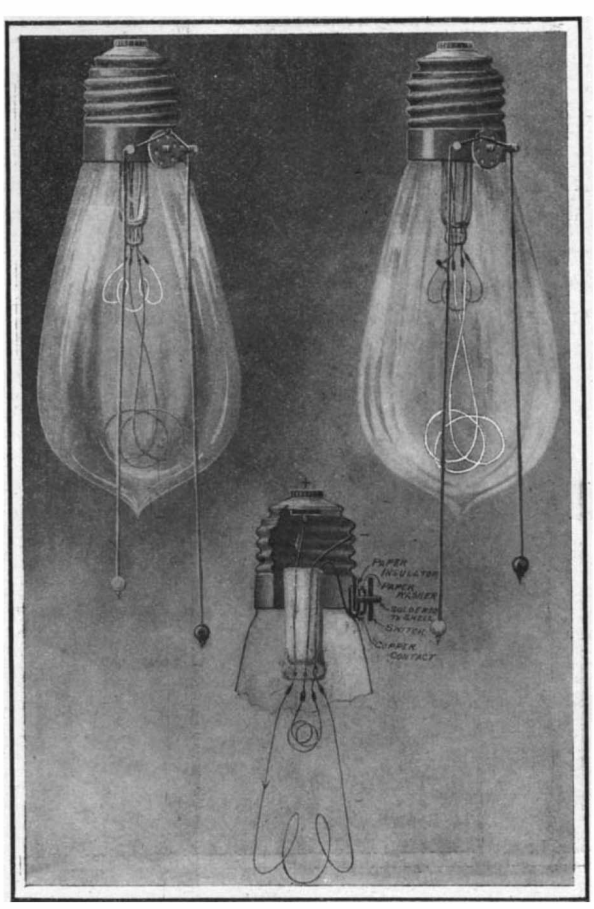
By means of a small switch in the base of the lamp, either one or the other of the filaments could be short-circuited without breaking the current, and in this way the danger of injury by sparking was eliminated. The best types of turn-down lamps manufactured at the present time still adhere to this plan of connecting the filaments together.

By this arrangement in Melick's lamp of the filaments (both of which were originally of the same size), the light given was reduced from its full candle-power to approximately one-half its candle-power. The switching mechanism was of course placed in the socket, and either a sliding switch or one having a screw was used to effect the desired changes.

After this invention other schemes were forthcoming to secure a wider range of adjustment in the light-emitting properties of the lamp, at least one of which depended upon a small resistance inserted in the base of the lamp socket; another had a similar rheostat on the wall, "conveniently located"; a third was provided with several filaments of different candle-power, mounted in the bulb and furnished with a multiple switch, so that the current would flow through one filament or two or more at once, depending upon the amount of light required; and finally two filaments have been mounted in a single lamp. These were under the control of a commutating switch arranged to burn either filament alone, both in parallel, or both in series, and in this way three different intensities of illumination were secured.

Now it so happens that the qualities of the incandescent filament are such that white light coincident with reasonable durability is only obtained through an exceedingly small range of electromotive force, which is the critical voltage for which the filament is designed. If a higher voltage is employed, the filament will give off particles that blacken the bulb, and if its use is continued for any length of time, the lamp will burn out; oppositely, if less than the critical voltage is used, the filament will emit a yellow light, then a red light, when the actinic properties will gradually decrease until there will be no effective light at all.

These disadvantages led William J. Phelps to use an auxiliary filament having a smaller cross-section than the main filament, so that the amount of current necessary to bring the auxiliary or smaller filament up to white incandescence is insufficient to make the main filament luminous. The idea is that the cold resistance of the main or 16-candle-power filament when added to the hot resistance of the 1-candle-power or auxiliary filament is just sufficient to pass the normal current required by the latter when both filaments in series are subjected to the electromotive force for which the lamp is intended.



"TURN-DOWN" ELECTRIC LAMPS.

In 1901 John McCullough designed a lamp in which either of the double filaments could be thrown into circuit by turning the bulb through a short arc. Hence this device of his relates more particularly to the switching mechanism than to the lamp proper, the arrangement of filaments used in connection with it having previously been patented by Levi Lohenthal in 1900, and which consisted of connecting one of the two like terminals of both of the filaments to one leading-in wire, while the opposite terminal of the 16-candle-power filament is connected to a plate making contact with the other leading-in wire when the bulb is turned to the right, and with the opposite terminal of the 1-candle-power filament when the bulb is turned to the left.

The above inventors, namely, Lohenthal and McCullough, then joined hands, and together they evolved, in 1903, a clever little switching device, so that there was no longer need to turn the bulb of the lamp, which experience had shown might very often be too hot to conveniently handle; and what was equally to the point, it permitted the lamp to be placed on the wall or ceiling at a height not readily reached, as well as the inclosing of it in a spherical shade. The lamps could nevertheless be turned down at will. This was accomplished by an improved switch which could be operated by cords attached to a small lever and passing through guides attached to the base of the lamp above or below the shade, to permit of its ready movement.

The latest type of turn-down incandescent lamp is due to the efforts of John J. Rooney, E.E., son of John Rooney, who was one of the founders of the Sawyer-Mann Lamp Company. In it the designer has taken advantage of all the improvements made in the incandescent lamp business up to this time, with several additional features included. In the "sun-star" lamp, as it is termed, the construction of the base with its switching device, called a turn-down base, is a permanent fixture, and will outlast a large number of bulbs.

The bulbs of all the standard candle-powers and voltages are made to fit these detachable bases. With the one base, for example, an 8-candle-power, 104-volt, or a 16-candle-power, 120-volt turn-down lamp can be made up, according as one or the other bulb is used. In all turn-down lamps prior to the advent of this one, it has been the practice to make the switch a permanent part of the structure of the lamp, the switch being mounted on the base of the lamp, and it has therefore been necessary to provide each lamp with an individual switch. In the present lamp the switch may be readily removed or attached as desired, so that the switch, which is really the expensive part of the lamp, may be transferred from one lamp to another. All that is necessary is to detach the base from the old bulb by loosening a milled screw, place the red pieces opposite each, and push the new bulb into the base with a twisting motion, when it is bolted together again with the milled screw. The bases are furnished with strings, and a pull on one or the other turns the light high, low, or out, to suit the exigencies of the case.

Anthracite Coal Production in 1906.

An advance chapter from "Mineral Resources of the United States, Calendar Year 1906," on the production of anthracite coal in 1906, prepared for the United States Geological Survey, by William W. Ruley, coal expert, is now ready for distribution, and copies may be obtained on application to the Director of the Survey at Washington, D. C. Mr. Ruley states that the production and consumption of anthracite in 1906, amounting to 63,645,010 long tons, shows a material decrease when compared with the tonnage of 1905 (69,339,152 long tons), which was the largest on record; but in view of the reported condition of the industry at the close of December, 1905, the results for 1906 should be regarded as better than had been anticipated.

The Boston Society of Civil Engineers has appointed a committee to consider the subject of rain-water run-off in populous districts, where the sewerage systems have to take care of rainfall. The secretary of the committee is Mr. Harrison P. Eddy, 14 Beacon Street, Boston, and he asks that engineers and others will send him any data they may possess bearing on the subject.

The battleship "Kansas" is being fitted with a wireless telegraph outfit. The sending radius is said to be about 500 miles.

BREAKING UP THE ILL-FATED BRITISH BATTLESHIP "MONTAGU."

BY HAROLD J. SHEPSTONE.

The first-class British battleship "Montagu," which went ashore on the southwest corner of Lundy Island, in the British Channel, in a dense fog on May 30, 1906, is now being broken up piecemeal by the shipbreakers, and gradually the huge warship is disappearing.

The gallant attempt made to salve the vessel, although a complete failure, was nevertheless a daring piece of work deserving of the highest praise. For months the Liverpool Salvage Association, and the most skilled workmen from the British dockyards, with the most up-to-date tackle at their disposal, endeavored to lighten the ship and get her off the rocks, but without success. The whole history of the operations was one steady and persistent fight against unsurmountable difficulties.

Twenty-four hours after the vessel grounded, practically every compartment in the ship was full of water. The capstan engine room forward, the compartments under the forward 12-inch turret, all the boiler rooms, the starboard engine room, and the steering compartments aft, were open to the sea, the water rising and falling with the tide. The port engine room was tight, but had to be flooded by opening the sluice valve between the two engine rooms to prevent the ship taking a heavy list. At high tide the water rose about two feet above the upper deck at its lowest part, while at low tide the water fell to about seven feet below the usual waterline of the ship.

The vessel rested on a rocky bottom, the general surface being fairly level, but with many pinnacle rocks. It was discovered by divers that the damage to the bottom was very serious. A large rock penetrated about ten feet into the ship under the capstan engine forward. Along the starboard side the bilge keel was more or less carried away, and several large holes were discovered. The port propeller, A bracket, and shaft had disappeared completely; the starboard A bracket was cracked, and one blade of the starboard propeller was carried away, and the lower parts of the sternpost and rudder were broken off. To repair the vessel and pump out the water so that she could be refloated was the task the British Admiralty assigned to Admiral Wilson, and every possible assistance was rendered him in his work.

After a complete examination of the ship, it was decided to pump the water out of the vessel as far down as possible by pumps driven by compressed air. Before this was done the battleship was lightened by removing the 6-inch and smaller guns, torpedo nets, chain cables, etc. Owing to the surrounding rocks and shallow water, only lighters or very small vessels were able to approach to the wreck. This added greatly to the difficulties of the operations, as in most cases heavy weights, such as boilers, etc., had to be first hoisted into lighters. One of these craft, containing four 6-inch guns and several torpedo nets, in being towed was carried by the current over the rocks and foundered. She was, however, successfully salved some weeks later.

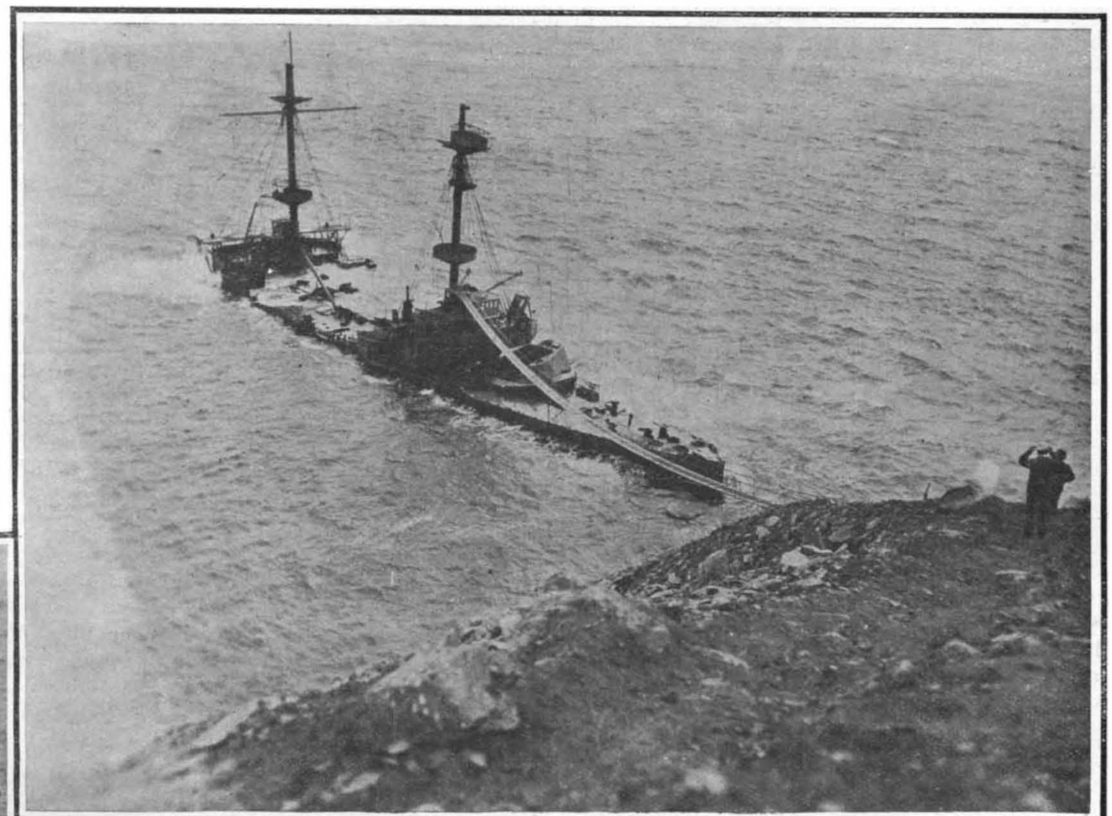
Within ten days from the disaster the following centrifugal pumps were in action: One 12-inch, three 10-inch, three 8-inch, one 5-inch, and one 3-inch, and an additional 12-inch pump was available on board one of the salvage boats supplied with steam from her own boiler. Three more 10-inch pumps and two 8-inch pumps were also in course of erection. A week later seven more pumps had been fitted up on board. They had a total pumping capacity of 8,600 tons per hour. Their object was to command the different compartments in which they were placed, and generally clear the water down to about two feet above the platform deck. Owing to the size of the rose-boxes they could not clear the water closer to the deck, and efforts were then directed to find compartments below this level which were tight, and which could be used as wells for pumping suctions. In the fore end of the ship this scheme had to be given up as hopeless, though it was partially successful in the after part of the vessel. Here a U-shaped pocket or well was lowered through the hatch of the submerged torpedo room, and guided into place under the deck and shored up by divers.

Although it was found that in many ways the minute subdivision of the ship helped the salvage work, it made the work of pumping the ship clear of water more difficult. To prevent the vessel bumping at high water, it was generally necessary to let her fill up with water then, and arrangements had to be made to pump out the various compartments rapidly, say in about eight hours. It was not practicable to provide special pumps or suctions for all the minor compartments, and time did not permit of the suction pipes being moved from one compartment to another. Drain holes had therefore to be cut—mostly under water—to enable the smaller compartments to drain into the larger ones, where pump suctions were fitted.

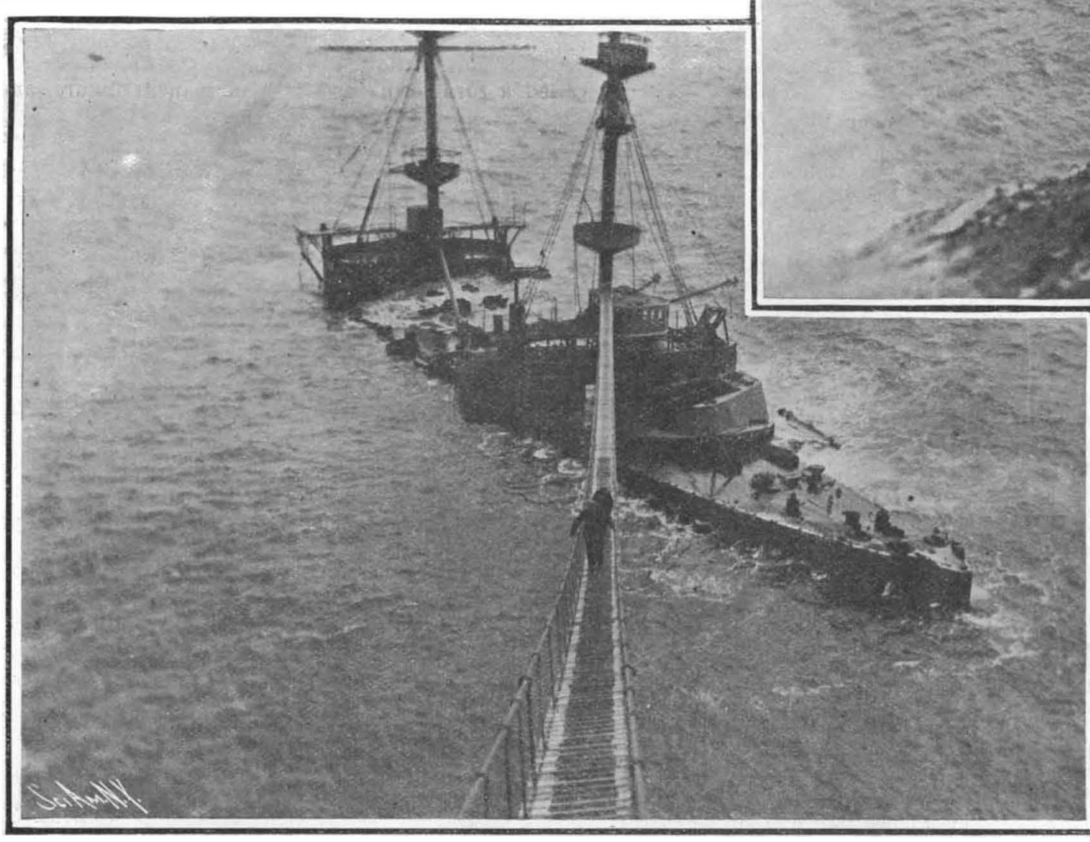
The next task was the covering over of the hatches to the engine and boiler rooms at the elevation of the main deck by plates. Then a number of camels, or tanks, were fixed along the side of certain portions of the ship. By experiments it was estimated that to float the vessel safely, a plant capable of producing 6,000 cubic feet of air per minute would be required to drive the water out of the ship. It was obtained, but failed to respond to the gallant efforts of the salvage operators.

On August 6 last the British Admiralty, after nearly fifteen months' strenuous efforts to refloat the warship, decided that the task was hopeless and abandoned it. Before doing so the vessel's heavy guns, a large quantity of her armor plates, boilers, machinery, and chain fittings, were removed. The wreck was then purchased by a South Wales syndicate for a lump sum, who hope to secure the valuable steel and iron composing the hull.

The syndicate at once established quarters on the island, where they have a staff of some fifty experienced workmen and a couple of small steamers and lighters. Their engineers have thrown an aerial footway, over 500 yards in length, from the top of Lundy's precipitous cliffs to the roof of the chart house on the wreck. Down this footway the shipbreakers pass to and from their work. The main deck of the ship is always awash at high tide; therefore work can only be carried on for a short time daily. When weather permits, lighters are brought alongside the battleship, immediately below the footway, and piece by piece huge sections of the armor plating are being removed from the huge carcass and transferred to the shore. The amount of work which has been done on the hull will be gathered from the huge "bite" which has been taken out of the bows on the port or seaward side, but it will be many months yet before the "Montagu" has been completely broken up.



The Wreck of the "Montagu" as It Appears To-day Off Lundy Island.



Workmen Coming Ashore by the Suspended Cable Footbridge Between the Ship and the Island.

BREAKING UP THE BRITISH BATTLESHIP "MONTAGU."

One result of this wreck will probably be that the British Admiralty will establish a salvage corps of its own. Hitherto it has had to depend upon outside assistance, whenever any of its vessels have met with serious disaster. So far the British Admiralty have not stated what the salvage operations have cost, but it is estimated to amount to no less than $500.000, while as to the ship herself, she was built so recently as 1903, was of 14,000 tons, and cost the British nation close upon $5,000,000. What the syndicate paid for the abandoned wreck has not been disclosed, but probably only a few thousand dollars.

Preserving Fruit in Nitrogen During Shipment.

At the Paris Exposition of 1900 there was exhibited a number of fish that had been preserved in nitrogen for seven years, without decay. Reading of this fact, Mr. Elwood Cooper, State Horticultural Commissioner of California, was impressed with the idea that if a suitable container could be furnished at a low cost, nitrogen could be profitably used in preserving California fruit during shipment to eastern markets. As the result of considerable experiment Mr. Cooper has now succeeded in producing such a container. The container is a paper box treated with bitumen to prevent the entrance of oxygen from the outside atmosphere. After the box has been filled with fruit it is closed except for a small opening. A number of these filled boxes are placed in a steel cylinder from which the air is exhausted. Then the cylinder is filled with pure nitrogen gas and by means of an automatic device the boxes are sealed. The boxes are of a size to fit the wooden cases or crates in which fruit is ordinarily shipped. The cases of fruit can be shipped in an ordinary box car which is considerably lighter than a refrigerator car and has twice the capacity. Mr. Cooper has packed pears, grapes, cherries, etc., in nitrogen, and taken them from the containers after five months in perfect condition. Fruit that was not in good condition when packed when removed from the containers showed that decay was arrested as soon as the oxygen was excluded.

RECENTLY PATENTED INVENTIONS.

Of Interest to Farmers.

BARN-DOOR.—S. Schooley, Tyro, Kan. The door is of the slid ig type and is divided horizontally in halves, or sections, one of which is suspended from the other and adapted to slide upon a rod or rail forming an attachment of the upper one. Thus the door may be opened or closed as a whole, or the movable section may be opened or closed independently. The improvement is in doors which are made double, or in two parts, or sections.

GRAVITY LITTER-CARRIER.—E. Jordalen, Pleasant Springs, Wis. The invention relates to loading and unloading devices, and its object is the provision of a new and improved carrier, more especially designed for conveniently carrying litter or other material from a barn or other building to a distant wagon or cart for carrying the material away.

SELF-FEEDER FOR CORN-HUSKERS.—O. C. Moore, Morrow, Ohio. One purpose of the invention is to improve upon the device for which Letters Patent were formerly granted to Mr. Moore; to such an extent as to provide a construction wherein a band cutter is associated with a bundle-carrier, said cutter being so constructed as to cut the wrappings of bundles and also loose material fed on the carrier, but which cutter will separate the material; and to provide a form of spreader, used in connection with the lower feed which receives material from the carrier, which spreader serves to distribute and thin out material from the center toward the sides of the lower feed-carrier.

Of General Interest.

FOLDING RACK.—J. J. Ronan and J. F. Barry, Jersey City, N. J. In this case the invention has for one of its objects the provision of means capable of general use, but especially adapted to be attached to the back of a theater chair, to be extended therefrom to form a shelf for supporting a woman's hat or other object, and to be folded up and out of the way when not in use.

SADDLETREE-HORN.—L. L. Nelson, Paducah, and E. L. Reeder, Little Cypress, Ky. This horn comprises a body portion, and outwardly and downwardly projecting side plates extending from the body portion and having the latter provided at its lower end with a depending tongue and sloping upwardly on opposite sides of the tongue and then returned, forming inner faces of the plates and having front and rear of the tongue downwardly facing shoulders arranged above the tongue and on lines in front and rear of the plates.

WATCH-PROTECTOR.—J. Fierz, Jersey City, N. J. The purpose of the inventor is to provide novel details of construction for an attachment to be placed and secured in the interior of a vest pocket, and that is adapted for quick and reliable adjustment, whereby the pendant of a watch may be detachably connected with said attachment and held in the pocket until designedly released by the owner.

HOLDER FOR PASTE.—O. Dreher, Stroudsburg, Pa. This invention relates to improvement in holders for paste, mucilage, and the like, and more particularly to means whereby the paste and brush may be supported in the same receptacle and the brush kept moist at all times. Means provide for holding the brush in the same receptacle which contains the paste and whereby it may be automatically moistened as it is withdrawn for use.

CARTRIDGE.—C. N. Dilatush, Hagerman, Idaho. The object of the invention is to provide a cartridge arranged to increase the penetrating power and carrying capacity of the cartridge. By using a loose filling material between the wads the slightest crevices on the side of the shell or casing are completely filled and hence a tight joint is produced.

COMPOSITE STRUCTURE.—A. De Man, New York, N. Y. The aim of the inventor is to provide a structure in which the reinforcing members are held against movement in the cementitious body, to insure a total transmission of the stresses from the metal members to the surrounding concrete, it being understood that in order to obtain a perfect even transmission the anchoring device should be continuous and uniform in amount or effect throughout the entire length of the reinforcing member.

GRAIN-DISTRIBUTER.—N. L. Heckman, Springfield, Ohio. Grain is moved outward, descending through the cup by the portion of the movable wall of the sleeve, which is of gradually increasing diameter, so that, when descending grain reaches a point where the inclined wall begins to closely approach the end of the fluted roll it has passed outward beyond the end of the roll, which end is covered by the sleeve so that grain cannot be pocketed or squeezed between the wall and the end of the fluted roll, and preventing the uncontrolled escape of any grain.

Heating and Lighting.

GAS-BURNER.—G. S. Andrews, Butler, Pa. The improvements are in incandescent gas burners, the invention relating more particularly to construction and means for supporting the various parts going to make up the burners. The object is to so construct and connect the various parts that any of them may be removed for the purpose of cleaning or to permit the insertion of new parts without interfering with or removing adjacent or coacting parts.

FURNACE ATTACHMENT.—J. R. Moler and R. G. Moser, Denver, Col. The invention pertains to improvements in furnaces, and the object is the prevention of smoke when the furnace is charged with fuel by admitting air and steam into the fire box. By attaching the mechanism to the boiler front instead of to the door it is not subject to jar and strain when the door is opened and closed.

Household Utilities.

STAND.—H. C. Chamberlin, Olyphant, Pa. In this patent the invention relates to stands, such, for instance, as are used for supporting boilers and analogous members in connection with heating stoves and furnaces. It relates more particularly to a type of stand used in households for supporting a vertical boiler of the type commonly used in connection with the ordinary range or cooking stove.

CLOTHES-DRIER.—E. A. Thornton, Omaha, Neb. This drier is of a style capable of suspension from a stable support. It is easily assembled into usable form and raised or lowered at will. The parts are adapted for quick detachment from each other so as to permit them to be placed in contact and wrapped together, forming a compact bundle for storage out of the way, when the drier is to be removed from its support.

CARPET-BEATER.—C. S. Phoenix, Oberlin, Ohio. In this instance the intention is to provide a new and improved carpet or rug beater, arranged to afford the desired flexibility, to stand rough usage for a long time without danger of breaking, and to prevent injury to the threads of the carpet or rug on which the beater is used.

WINDOW-WASHING DEVICE.—W. G. Himrod, Washington, D. C. The design in this invention is to provide a simple and practical device for washing the exterior of windows without exposing the workman to danger, or even the discomfort of the outside air, the device being worked from the inside of the window and without opening the window except for a small space at the bottom.

BEDSTEAD.—Elihue Blacknell, Ferris, Texas. In this case the object of the invention is to provide a new and improved bedstead which is simple and durable in construction, capable of being easily and noiselessly moved about, and conveniently passed in or out of a narrow door of a room whenever it is desired to do so.

Machines and Mechanical Devices.

REGISTER.—Louise A. Salter, Niles, Cal. The object is to provide a register or counter, more especially designed for registering the strokes or revolutions of engines, pumps, and other machines and devices, and if attached to a pump, to indicate the amount of liquid pumped in a given time, the register being arranged to permit of conveniently stopping or starting it at any time without stopping the machine on which it is applied, and to allow of setting it quickly back to zero.

DENTAL PLUGGER.—G. H. Shannon, Cambridge, N. Y. The plugger has an exterior surface free from projections, and in which all of the operative mechanism is so far removed from the mallet section and is in such angular relation thereto as to be well without the mouth of the patient being operated upon, thus rendering it possible with this instrument to reach cavities in teeth which by reason of the limited space in the mouth and close approximation of the jaws have been heretofore more or less inaccessible.

MAGAZINE-PHONOGRAPH.—A. A. Pratt, New York, N. Y. The object of the inventor is to provide a phonograph arranged to carry a large number of record rolls, to enable the user to select any one of the rolls to be played, to provide a simple mechanism for accurately bringing the selected roll in playing position, to automatically start and stop the machine at the end of the piece.

PROPELLING MECHANISM FOR BOATS.—W. T. Mooney, Parsons, W. Va. An object of the invention is to provide a device which will act in a direct line with the length of the boat and directly against the water, the propeller being so constructed that it will automatically open and close during backward and forward movements thereof, so that it in forcing the boat ahead will be opened or expanded and present a large area to the water and during its forward movement will be folded or closed in order to present little surface and resistance to the water.

AIR-SHIP.—C. McCormick, Russell, Iowa. The invention is in the nature of a mechanical substitute for a balloon. The air current generated by the fan of this flying machine will, on being deflected downward by the curved aeroplane, have a tendency to raise the same. Also, this lifting operation will be aided by the elasticity of the air, the fan having a tendency to rarefy the air above the craft and compress the air beneath the craft in the practical operation of the invention.

BRIDLE-BIT.—F. Guédez, Caracas, Venezuela. The purpose of the inventor is to provide a construction of bit particularly adapted for use upon mules; and further to provide a simple and conveniently-operated adjusting mechanism whereby to adapt the bit for an effective service in a hard mouth as in a soft or normal mouth by increasing or decreasing the leverage at the driving end of the cheek pieces.

Note.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

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AND EACH BEARING THAT DATE

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