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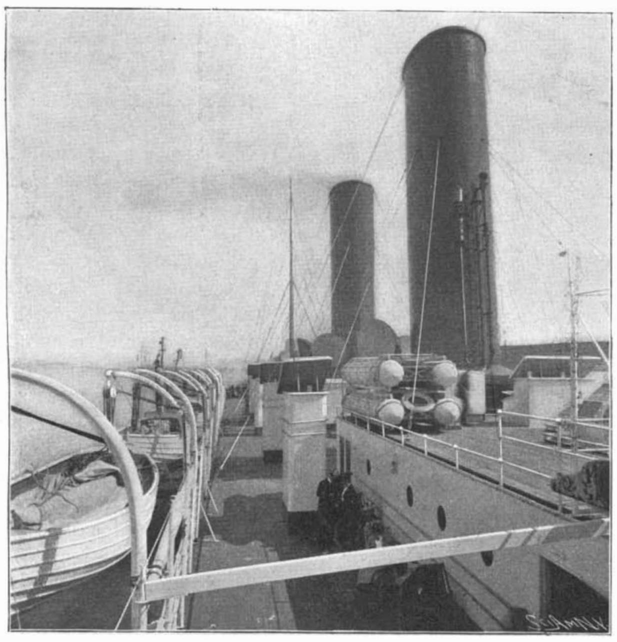
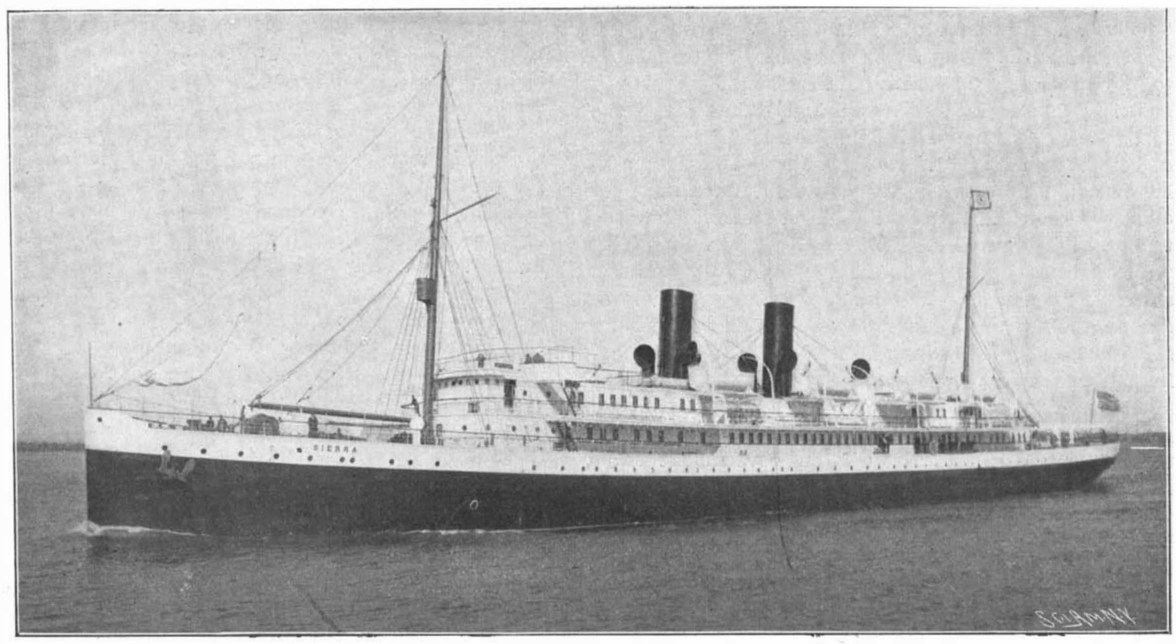


Boat-Deck of the "Korea," Looking Aft from the Bridge.



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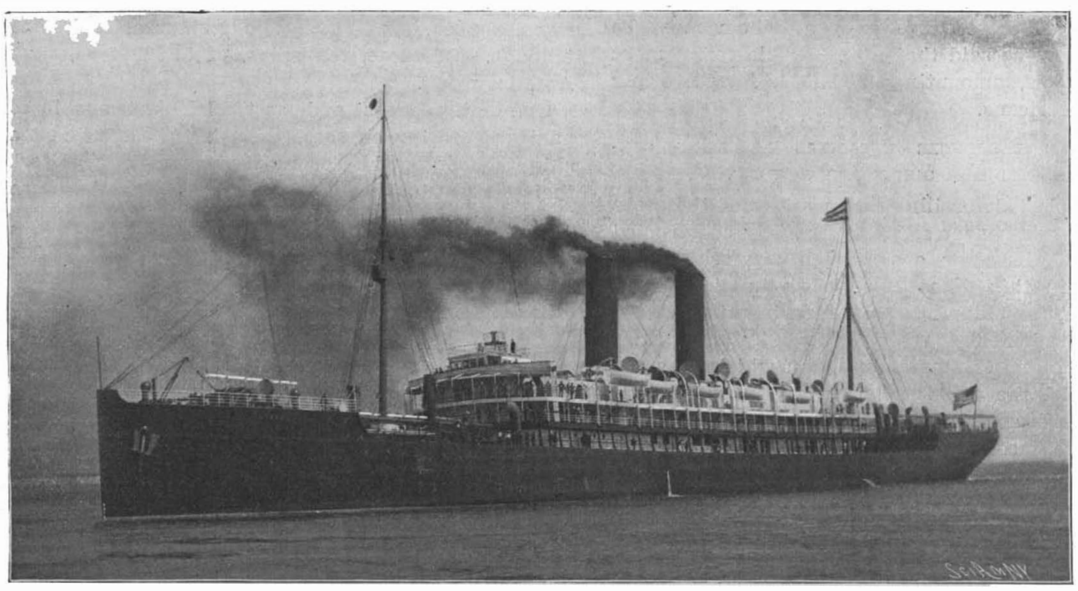
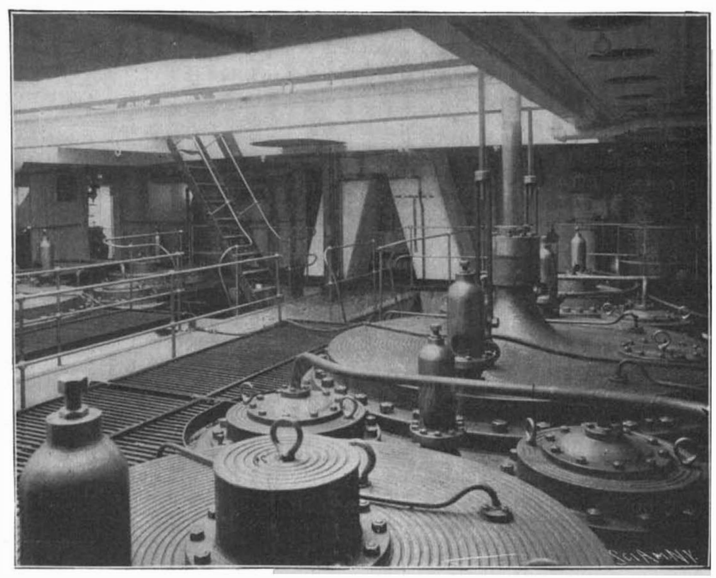
Steamship "Sierra" of the Oceanic Line. Route: San Francisco, Honolulu and Australia.

Length, 400 feet; beam, 50 feet 2 inches; depth, 37 feet 2 inches; speed, 17 knots; tonnage, 6253 tons.



Pacific Mail Steamship "Korea." Route: Panama, San Francisco and Hong Kong.

Length, 572 feet 4 inches; depth, 41 feet 10 inches; speed, 19 knots; tonnage, 11,276.



Engine Room of the "Korea."

Music Room, "Korea."

Boat-Deck of the "Korea," Looking Forward.

LATEST TYPES OF AMERICAN-BUILT PASSENGER STEAMERS.

SCIENTIFIC AMERICAN
ESTABLISHED 1845
MUNN & CO., No. 361 Broadway, NEW YORK

Marine Transportation.

THE AMERICAN MERCHANT MARINE.

In almost every review of the American merchant marine that has been written during the four decades which have passed since the great civil war, all comparisons of our standing and progress have referred back to the year 1861, in which the total tonnage of the United States had reached the figure, particularly remarkable for such an early day, of 5,539,813 tons. The war almost swept our merchant marine out of existence, such of it as was not hastily transferred to the protection of a foreign flag being captured or sunk by Confederate cruisers; and it has taken just forty-one years for our shipping to reach the standard of comparison of 1861. In 1902, for the first time we have passed the earlier mark, the total tonnage, foreign, coasting and fisheries, sail and steam, amounting to 5,797,902 tons. From 1898 to 1902 the world has witnessed a period of extraordinary shipbuilding activity, in which our own shipbuilding yards have shared, the average annual output for this period being some 400,000 gross tons. The revival in our shipping industry is to be attributed primarily to the encouragement given by the government when it set about the great work of constructing our new navy. In anticipation of a steady run of work on government ships, new plants equipped with the most modern appliances were laid down, and with the experience in steel shipbuilding thus acquired, our yards were soon in a position to receive orders for merchant ships also.

Although the present article is devoted particularly to the merchant marine, the totals given above include every kind of shipping, whether coast line, inland river, lake or foreign, and before proceeding further it will be of interest to give the geographical distribution and the nature of this tonnage as printed in the Report for 1902, of the Commissioner of Navigation. The distribution is as follows: Atlantic and Gulf coasts, 2,978,876; Porto Rico, 6,180; Pacific coast, 741,825; Hawaiian Islands, 32,386; Northern Lakes, 1,816,511; and on the western rivers, 222,124 tons. Of the total shipping, 2,621,000 tons consists of sailing vessels and 3,177,000 tons of steamships; while the balance, to the extent of 679,000 tons, is made up of canal boats and barges.

To-day the shipbuilding industry is in a flourishing condition. During the past year 1,491 vessels of a gross tonnage of 468,831 were built in this country. A list of all vessels of a thousand tons and upward, built during the year, shows that there were launched for the merchant marine sixteen vessels ranging from 2,036 to 12,760 tons, making a total tonnage of 95,105 tons. Five steel ferry, river and bay steamers were built, of a total tonnage of 5,479 tons, and seven square-rigged vessels, aggregating 12,336 tons, together with twenty-one wooden schooners, aggregating 36,122 tons, and four rigged barges of 7,359 tons. It is interesting to compare these totals with those of the Great Lakes. The total seaboard tonnage in vessels of a thousand tons and over included fifty-three vessels of 156,431 tons, while the total tonnage built on the Great Lakes was made up of forty-one vessels of a gross tonnage of 158,631 tons, thus showing that in point of total tonnage, shipping on the Great Lakes exceeded in new construction last year that built for the deep sea service. Among the vessels included in these totals are the "Kroonland," of 12,760 tons—the largest ocean steamer ever built in this country. The sister ship, the "Finland," was launched during the year and is now in service. The "Korea," of 11,276 tons and 19 knots speed, launched last year and now in service, has been followed this year by her sister ship the "Siberia." These two are the largest and fastest merchant steamers of any nationality running on the Pacific Ocean. Another notable fact is that the two largest cargo steamers ever built in America, the "Shawmut" and the "Tremont," both of 9,606 tons, are plying regularly on their routes between Puget Sound, Japan, China and Manila; while another notable fact is that the "Alaskan," of 8,716 tons, built at San Francisco and now trading between Hawaii and the Atlantic coast, is the largest merchant steamer ever launched on the Pacific Ocean. Another noteworthy vessel is the seven-masted schooner "Thomas W. Lawson," of 5,218 gross tons, which is the largest schooner and the second largest sailing vessel in the world.

At the commencement of the fiscal year, there were under construction or contracted for, in our yards twenty-five steel steamships of 1,000 tons and upward. For the transatlantic trade there were seven large vessels, which included two 600-foot ships for the Atlantic Transport Line, of 13,400 tons; the "Finland," of 12,760 tons, for the International Navigation Company; the "Missouri" and "Maine," of 9,800 tons, for the Atlantic Transport Line; and for the same line, two vessels of 8,900 tons, making a total of 76,960 tons for this trade. For the Trans-Pacific trade, there were two great vessels of 20,000 tons building at New London, Conn., to sail under the flag of the Great Northern Steamship Company. For the Trans-Pacific trade by way of Hawaii there was building the "Siberia" of 11,276 tons, to sail under the flag of the Pacific Mail Company; while for the Hawaiian coasting trade, two vessels of 8,600 tons were under construction. For the coasting trade there was a 9,000-ton vessel for the Standard Oil Company, a 6,250-ton vessel for the New York and Texas Steamship Company, and a 5,252-ton ship for the Ocean Steamship Company, in addition to nine vessels of from 1,000 to 4,577 tons, making at total under construction for the coasting trade of 48,679 tons.

In considering the important question of the manning of our ships, it is gratifying to learn that there is a marked increase in the percentage of American over seamen of foreign nationality. The returns compiled from the reports of shipping commissioners showing the nationality of seamen shipped on American vessels for the past nine years, prove that there has been an increase in the percentage of Americans from 31 per cent in 1894 to 35 per cent in 1901, and to 46 per cent in 1902. Out of a total of over 71,000 shipped in 1894, 22,000 were Americans, 22,000 Scandinavian, 10,000 British, 6,000 Germans, 865 Italians and 628 were French; while various other nationalities together represented a total of 9,000. In 1902, out of a total of over 108,000 shipped, 50,000 were Americans, 16,000 Scandinavians, 14,000 British, 5,600 Germans, 2,300 Italians, 576 French, and there were about 20,000 of mixed nationality. It must be understood that while there is a total of about 108,000 shipments, they really represent only about 24,000 seamen. Further proof of the greater interest of Americans in their merchant marine and their tendency to seek employment therein is afforded by a table given by the Commissioner of Navigation, showing the nativity of men employed on 654 sea-going American vessels. Out of a total of 13,879 men, 5,455 are Americans by birth or naturalization, 2,347 are British, and the balance is made up of various nationalities. As the table does not include the masters of these vessels, all of whom must be citizens, it may be said that of the whole complement of these vessels, amounting to 14,536, forty-two per cent were Americans.

SOME NOTABLE PASSENGER STEAMERS RECENTLY CONSTRUCTED FOR OUR FOREIGN TRADE.

We have selected for illustration a few of the more notable of the passenger steamers recently constructed in American yards for our foreign steamship companies, and in this connection we give a list of the principal deep-sea shipping companies, in this country, showing the number of vessels owned by each, their gross tonnage, and the main routes on which they are employed. Of the vessels herewith illustrated, the largest, and because of the unexpectedly high speed developed the most notable, is the "Korea," one of two sister ships built by the Newport News Shipbuilding Company for the Pacific Mail Steamship Company, in service between San Francisco, Japan and China. She has shown an average sea speed on the Pacific of 17.78 knots an hour. She is 572 feet 4 inches in length, 41 feet 10 inches in molded depth, and on a draft of 27 feet she has a displacement of 18,400 tons She has a coal bunker capacity of 2,600 tons and is driven by twin engines of vertical, inverted, quadruple-extension type, with cylinders, 35, 50, 70 and 100 inches in diameter, and 66 inches stroke. Upon the trial trip they indicated 17,902 horse power and drove the ship during the trial at a speed of 18 to 19 knots an hour. The boiler plant consists of six double-ended and two single-ended Scotch boilers arranged in two compartments. The boiler pressure is 200 pounds. The vessel contains accommodations for 210 first-class passengers, while the steerage has accommodations for 54 white passengers and 1,144 Chinese. Limitations of space prevent any detailed descriptions of the accommodations and reference is made to the accompanying illustrations, which explain themselves. As will be seen from the deck views, there is ample promenade space afforded on the boat deck. This vessel will shortly be joined on the route by a sister ship, the "Siberia." The fleet of the Pacific Mail Steamship Company contains seventeen American-built vessels with a total of 70,970 tons.

TABLE SHOWING NUMBER AND TOTAL TONNAGE OF AMERICAN-BUILT SHIPS IN THE VARIOUS ROUTES.

Name.	No. Vessels.	Gross Tons.	Main Routes.
International Navigation Co	10	81,929	New York—Southampton. Antwerp.
Pacific Mail	17	70,970	San Francisco—Panama. Honolulu. Hongkong.
New York and Cuba Mail	16	59,465	New York—Havana. Mexico.
American Hawaiian	9	58,000	New York—San Francisco. Honolulu.
Southern Pacific	18	55,993	New York—New Orleans. Galveston. Havana.
Clyde Lines	18	41,528	New York—Santo Domingo. Philadelphia. Jacksonville.
Merchants & Miners.	16	34,460	Baltimore—Boston.
New York & Texas	10	31,935	New York—Galveston.
Massachusetts SS. Co.	5	3 ,135	Puget Sound—China. Japan.
Oceanic (Spreckels)	7	30,296	San Francisco—Honolulu. Australia.
Old Dominion	30	27,890	Baltimore—Boston.
Pacific Coast SS. Co.	13	21,848	San Francisco—Mexico. Brit. Colum.
Atlantic & Caribbean	5	9,398	New York—Porto Rico. Venezuela.
North American Mail	3	9.150	Puget Sound—Japan. China. Hongkong.
American Mail	4	8,400	Boston } Philadelphia } Jamaica.
Panama Railway	3	8,193	New York—Colon.
Ocean Steamship Co.	5	15,914	New York—Savannah.
U. S. & Porto Rico SS. Co	6	15,318	New York—Porto Rico.
Metropolitan Steamship Co	6	14,505	Coasting.
Cromwell Steamship Co	4	14,155	New York—New Orleans.
Boston & Phila. SS. Co.	7	11,544	Boston—Philadelphia.

Although the most speedy of passenger vessels recently constructed, the "Korea" is not so large as the "Kroonland," the "Korea" being of 11,276 tons, and the "Kroonland" is 12,760 tons. The "Kroonland" and her sister ship the "Finland" were built at Cramps' yard, Philadelphia, Pa., for the International Navigation Company. She is a steel vessel of an over-all length of 580 feet, a molded breadth of 60 feet and a molded depth of 42 feet, while her displacement is 23,100 tons. She is driven at a speed of 17 knots by two sets of triple-expansion engines with cylinders 32½, 54 and 89½ inches, by 42 inches stroke. Their indicated horse power is 10,200. The boiler plant consists of nine single ended Scotch boilers working under a pressure of 170 pounds. Their heating surface is 22,400 square feet, and their grate area 643 square feet. The passengers are carried on the promenade, the upper and saloon decks amidships. There are berths for 364 first-class passengers, 190 second-class possengers and about 1,000 third-class passengers. These fine vessels are sister ships to the "Vaderland" and the "Zeeland," which were built on the Clyde for the same company in 1900. The fleet of the International Navigation Company consists of twenty-four ships of 180,639 total tonnage. Of these, ten ships, of 81,929 tons, fly the American flag.

One of the largest and most efficient steamship companies operating on the Pacific is the Oceanic Steamship Company, who for a great many years worked their service to Honolulu, New Zealand and Australia by two ships, the "Alameda" and "Mariposa," built at the Cramps' yard. With the rapid expansion of our southwestern Pacific trade the company completely overhauled these two vessels and gave an order to the Cramps for three much larger and faster sister ships, one of which, the "Sierra," is herewith illustrated. This very handsome craft is a twin-screw ship of 6,253 tons. She is 400 feet long, 50 feet 2 inches broad and has a molded depth to the spar deck of 37 feet 2 inches. Her engines are of the triple-expansion vertical type, with cylinders 28, 46 and 75 inches diameter by 48 inches stroke, with a total indicated horse power of 8,000 and capable of driving the ship at a speed of 17 knots an hour. The distance from San Francisco via Honolulu, Samoan Islands, and New Zealand is 7,200 knots, and the trip is made at an average speed of 15 knots for the whole distance. These vessels were constructed under Lloyds' rules and in accordance with the requirements of the United States Navy laws as regards auxiliary cruisers. They are of the very first class in every respect, having a double bottom, electric light, and cold storage. To render them thoroughly comfortable during the hot weather in crossing the line, there are no staterooms below the main deck, all of these being on the upper and promenade decks, and they are provided with specially large square port holes and a perfect system of ventilation. There is a particularly large deck space for promenading. A steamer sails from San Francisco to the Samoan Islands, New Zealand and Australia once in three weeks; to Honolulu every ten days; and to the island of Tahiti once a month. The fleet consists of seven steamers of a combined tonnage of 30,296.

The increase in our trade with the West Indies consequent upon the Spanish war necessitated the construction of several new vessels to meet the increased demand of both freight and passengers. As representative of these new vessels we present illustrations of that very fine ship "Morro Castle," a vessel of 6,004 tons gross and of 8,280 tons displacement. The "Morro Castle" is 416 feet long, 50 feet broad and 36½ feet in molded depth. She was built by the Cramps in 1900. She is built with a double bottom and seven steel bulkheads to the main deck. The main engines are of the vertical, four-cylinder, triple-expansion type, designed to indicate 8,000 horse power at 100 revolutions under a working steam pressure of 170 pounds. The cylinders are 32, 52, 60 and 60 inches diameter by 42 inches stroke. Accommodations are provided for 104 first-class, 60 intermediate and 44 second-class passengers, and the ship carries a crew of 117 persons. The average sea speed of this vessel is 17 knots per hour. In closing this article, attention is drawn to the fact that the two largest and most important vessels building in American yards for an American company are the great unnamed vessels now upon the stocks at New London, Conn. As these remarkable vessels call for more lengthy treatment they are described in a separate article of this issue.

THE TWO GREAT FREIGHTERS FOR THE PACIFIC TRADE.

It is a curious fact that the two most notable ships under construction in American yards for the American merchant service are probably the two least known to the American public. This is to be explained by the fact that both the owners and the builders of these ships have gone about their great task in a very quiet way, and made no effort to draw attention to its importance, and the somewhat unprecedented character of the enterprise which has called these vessels into existence.

The last of the transcontinental lines to be built to a deep-sea terminus on the Pacific coast was the Great Northern Railroad. This road, which owes its existence to the energy of Mr. James J. Hill, is reputed to be the best constructed and equipped transcontinental line across the United States; for being the latest to be constructed, it naturally embodies the most modern ideas and improvements in railroad construction. The road has a terminus at Seattle, perhaps the finest harbor on the Pacific coast, and it was natural, in view of the easy grades, heavy steel and solid roadbed of the new line, and its consequent facilities for handling a voluminous and heavy traffic, that its owner should look to a furtherance of its interests by building a line of steamers to share in the undoubtedly large future trade with the Orient. An unexpected feature of the new shipping venture was the enormous size of the ships that were proposed and quickly contracted for. For instead of these vessels being, as one would expect in what might be termed an infant enterprise, of moderate proportions, Mr Hill ordered two vessels which will be about equal in total carrying capacity to the largest vessels ever constructed.

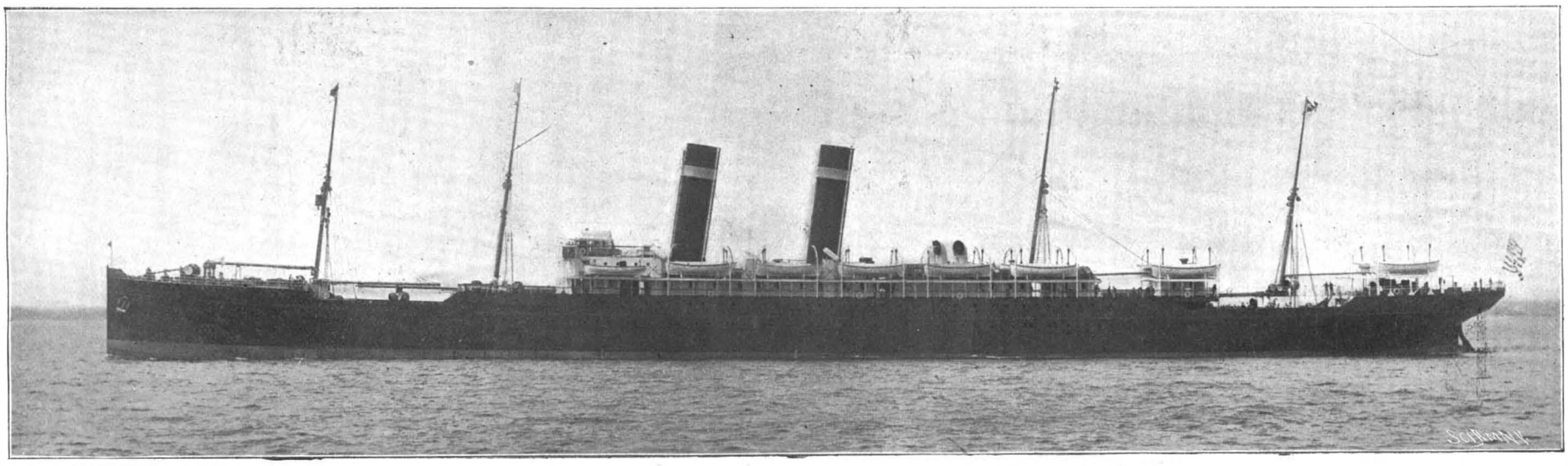
Another curious feature in connection with these ships is that an entirely new company, the Eastern Shipbuilding Company, was formed expressly for the purpose of constructing them, and that this company took the contract before it possessed plant, or equipment, or even the ground on which to build them. After a thorough survey of the Atlantic coast line, a site was chosen opposite New London, Conn. The vessels were designed by Mr. William A. Fairburn, naval architect, under the supervision of Mr. C. R. Hanscom.

Apart from their great size, "the New London ships," as they are popularly called, embody several features of construction and internal arrangement which render them of special interest. Their dimensions are, length 630 feet, breadth 73 feet, and molded depth 56 feet. On a draft of 33 feet the displacement will be 33,000 tons, and on a maximum draft of 36½ feet the displacement will be 37,000 tons, or within 870 tons of the displacement of the "Cedric" on the same draft, the "Cedric" being the largest vessel afloat. In length and breadth the New London ships are less than the "Celtic" and "Cedric," which are 700 feet in length by 75 feet in breadth; but the plated or molded depth will be greater by 6 feet 8 inches, the plating being carried up everywhere to the upper deck, which is flush throughout the whole length of the ship. The greater depth and more bulky model of the new ships account for their nearly equaling the longer and broader White Star boats in displacement.

We present an inboard profile of the vessel, with the various decks and compartments filled with freight or occupied by passengers and crew, as they will be when the vessel is traveling with a full cargo and passenger list; and from this drawing one gets a very graphic idea of the enormous proportions of the vessel. From the outer bottom to the navigating bridge there are no less than eleven distinct decks or platforms. First we have the outer bottom of the ship; 6 feet above that is the inner bottom, which forms the floor of the ship; then follow, all within the plated structure, the orlop, lower, between, main, and upper decks. All these decks are of steel plating, and the whole inclosed structure is 56 feet in height. Above the upper deck, and in their order, are the promenade deck, the upper promenade deck, and the boat deck, the boat deck being 25½ feet above the promenade deck, or 81½ feet above the keel; while another 8 feet above this, or say 90 feet above the keel, is the navigating bridge. Now, since the vessel at her full draft will draw 33 feet, it follows that the navigating bridge will be 57 feet above the waterline; and since she draws only 17 feet in the light condition, the same bridge, when the vessel is running light, will be 73 feet above the water, and the passengers on the upper promenade deck will be 65 feet above the waterline. This means that at a medium draft of say 22 feet, the passengers can promenade at a height of 60 feet above the sea level. Now, it has been ascertained by observations that the very heaviest waves seldom exceed 30 feet in height; and hence passengers on these ships, even in the stormiest weather, will be able to look down upon the Pacific rollers from a point of observation 30 feet above their crests. The decks above the upper deck, which do not extend the full length of the vessel, but only for a certain distance amidships, are devoted entirely to the first and second class passenger accommodation. The passengers are not only separated from the noise and general inconvenience incident to the operation of the vessel; but being amidships, they are removed from the vibration of the propellers, and are subject to but little of the pitching motion of the vessel. Accommodations are provided for 150 first-class passengers, 100 second-class passengers, 100 third-class passengers and 1,000 steerage. There are also quarters for the accommodation of 1,200 troops. The total cargo capacity is 20,000 tons.

Referring to the inboard profile, the vessel is proportioned as follows: First we have the 6-foot double bottom, which contains the trimming and ballast tanks for trimming the vessel and giving her ample stability in the light condition. The engine and boiler space and the coal bunkers are amidships, extending between the double bottom and the main deck. With the exception of the space occupied by engines, boilers and coal, the space below the main deck is given up entirely to cargo, one series of compartments on the boat being devoted to cold storage and the storage of silk from the Orient. The main deck forward of the engines and boilers is occupied by the crew, cargo and cattle, and the space aft of the engine is devoted to second-cabin passengers and to the steerage passengers. Forward on the upper deck is a deck-house filled with refrigerating machinery, and aft on this deck are the second cabin smoking room and ladies' room, while astern is the laundry and steering gear. Amidships on the main deck are the first-class dining saloon, lavatories, first cabin staterooms, galley, and the officers' rooms. On the promenade deck amidships are the library, a series of first-class passenger staterooms, and a children's room. On the upper promenade deck are the first cabin staterooms, smoking room and barber shop, while on the boat deck are the chart house and accommodations for the captain and officers.

It is claimed that the new vessels are in their construction considerably stiffer and stronger than any vessels built for the American merchant marine. The outer plating of the ship's bottom is of 1¼-inch steel, and the shell plating is strengthened by an additional strake of 1-inch plating at the main and upper decks, while continuous, 1-inch stringer plates are worked from stem to stern along these two decks as a stiffening to the regular deck plating, which on the main deck is 16-20 of an inch in thickness, and on the upper deck is 18-20 of an inch. The ship is strengthened against hogging and sagging strains by a continuous central, longitudinal bulkhead reaching from keel to upper deck. Longitudinal bulkheads have been used between adjacent engine rooms in other ships, but this is the first vessel that we know of that has a complete web of steel from upper deck to keel, and from stem to stern. This bulkhead is of ½-inch plating at the top and bottom, and a ⅜-inch plating throughout the intermediate decks. The vessel also receives great longitudinal strength from a new system of stanchions and girders. Instead of using a large number of ordinary pipe or tube stanchions spaced at frequent intervals, there are three lines of heavy box section stanchions, measuring 13x24 inches in section. These stanchions are spaced 20 feet apart, longitudinally, and the deck loads of the deck above them are carried by means of continuous lines of 13x24-inch box girders. This is not only an economical distribution of material, but it adds enormously to the longitudinal stiffness of the vessel. The longitudinal bulkheads necessitate double hatches, and there are in the ship no less than fourteen cargo hatches. As we have stated, the vessel is designed to meet the special requirements of the Oriental trade, and one pair of hatches is made of sufficient length to enable a locomotive to be lowered complete into the hold. Under a horse power of 11,000 the sea speed of the ships is expected to be about 14 knots an hour.



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THE AMERICAN-BUILT STEAMSHIPS "KROONLAND" AND "FINLAND" OF THE INTERNATIONAL STEAMSHIP COMPANY.

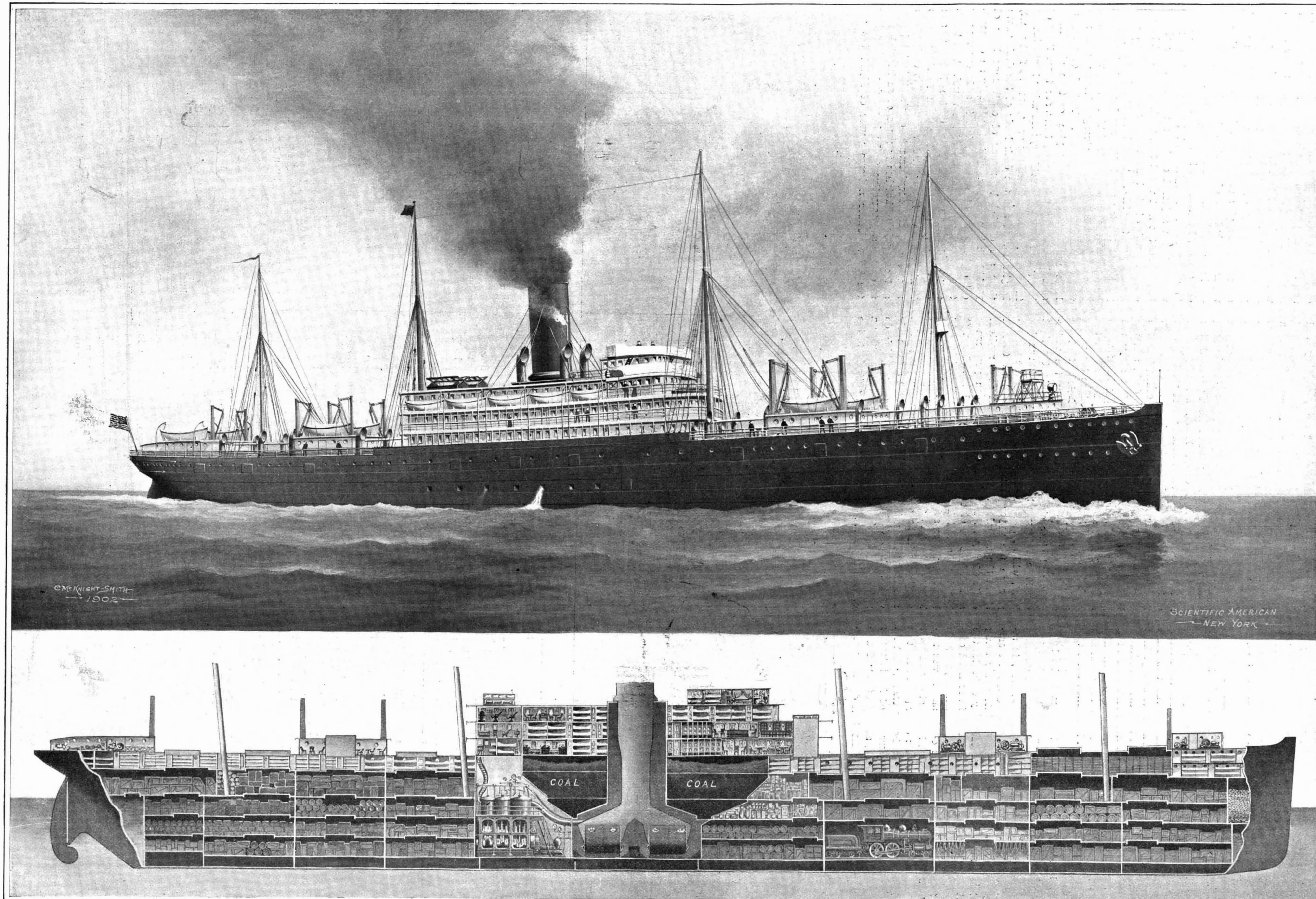
Length, 580 feet; beam, 60 feet; depth, 42 feet; speed, 17 knots; tonnage, 12,760 tons.

THE LATEST OF THE FAST TRANSATLANTIC LINERS.

The "Kaiser Wilhelm II.," which will shortly sail for this port, was built at the Vulcan yards, Stettin, by the same firm that has built the "Kaiser Wilhelm der Grosse," the "Deutschland" and the "Kronprinz." It is for this reason, and because of the uniformly good results obtained with these vessels, that the new ship is expected to develop the horse power and to show the high speed contracted for. Indeed, if she lives up to the record of her predecessors, she will greatly exceed her contract requirements in these respects. Her advent, moreover, should serve to settle all doubts as to whether high-speed transatlantic liners of this type are paying investments. On a round trip made in the "Deutschland" of the Hamburg-American Line by a representative of this journal, a sum of $200,000 was taken in for passenger fares alone. As the total expenses including every fixed charge of the round trip were $100,000, or slightly under, there was a profit of about $100,000 for the single trip to Europe and back.

The building of high-speed liners is first and last a business proposition, and although it has been claimed that the companies that run these vessels are willing to suffer a financial loss on the ships themselves, for the sake of the great prestige and the advertisement which they secure, it may be taken for granted that if the ships already constructed had not been a paying proposition *per se*, the "Kaiser Wilhelm II." would never have been built.

The new vessel is constructed with the usual double bottom. The molded depth is 44 feet 2 inches, and it includes four separate decks, the plating extending to the upper deck. This portion of the hull is divided by sixteen transverse bulkheads, all of which extend to the upper deck, while there is a longitudinal bulk-

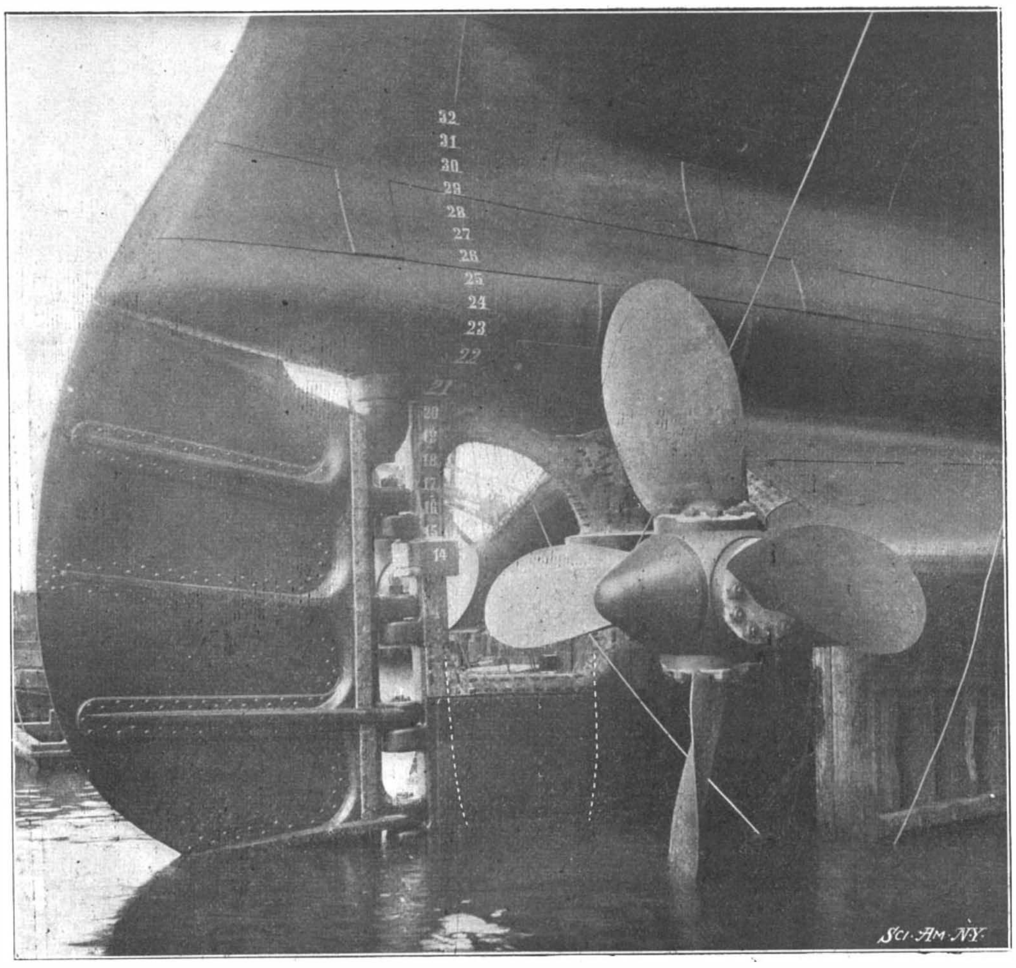


Length, 630 feet; breadth, 73 feet; depth, moulded, 56 feet; displacement on 33 feet draft, 33,000 tons; on 36½ feet draft, 37,000 tons.

THE 20,000-TON STEAMSHIPS BUILDING AT NEW LONDON FOR THE GREAT NORTHERN STEAMSHIP COMPANY—PACIFIC TRADE.

These vessels are only slightly exceeded in size by the "Celtic" and "Cedric," the largest vessels afloat.

head extending throughout the length of the two engine rooms, thus forming four separate compartments for the engines. The large accommodations of the vessel are accounted for both by her great length and beam, and by the fact that she carries one deck more than is usual in vessels of this class. Above the upper deck, which is, as we have seen, flush with the top of the ship's plating, there is first a spar deck, carrying a midship deck-house which is 49 feet in breadth and 443 feet in length, and a poop-house which is 79 feet in length. The roof of the midship deck-house extends for the full width of the ship and reaches over the poop, which it entirely covers, thus forming a promenade deck, which is 538 feet in length. Upon this there is a deck-house 438 feet in length. Above this deck there is the upper promenade deck, and over this is the boat-deck. It will thus be seen that these four decks above the upper deck provide several wide and sheltered promenades at the sides of the deck-houses, a feature which will be greatly appreciated by those who have traveled on previous steamers when they carried a full passenger list.



The dotted line indicates size of opening between hull and sternpost in the "Deutschland" (as first built) whose sternpost and rudder were carried away last spring. Note the extension of ship's plating to sternpost across lower half of opening, with a view to strengthening construction and guarding against similar injury to "Kaiser Wilhelm II."

THE PROPELLERS AND STERN CONSTRUCTION OF "KAISER WILHELM II."

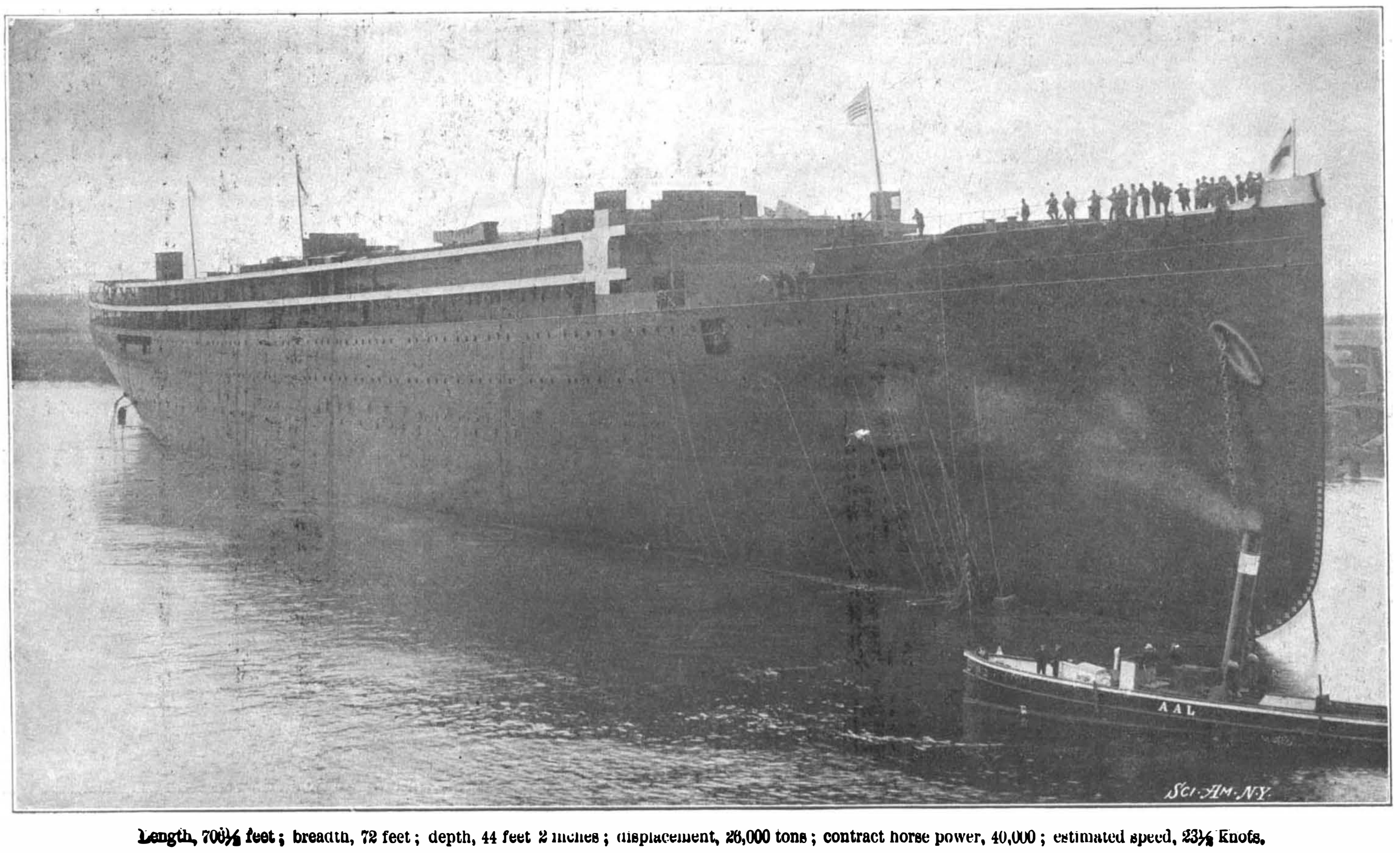
The dimensions of the "Kaiser Wilhelm II." are length 706½ feet, breadth 72 feet, molded depth 44 feet 2 inches, and displacement 26,000 tons. Comparing these figures with those given in the table for the other great transatlantic liners, it will be seen that she is 2½ feet longer than the "Oceanic;" but she has 3 feet less beam than the "Cedric" and about 10.000 less displacement than the latter ship. Her estimated speed of 23½ to 24 knots is half a knot greater than that of the next two fastest vessels, the "Deutschland" and the "Kronprinz Wilhelm." The ship will accommodate a large number of passengers, 775 being carried in the first class, 343 in the second class, and 770 in the third class. The ship's complement is the largest of any ship in the world, consisting of 48 engineers and greasers, 229 stokers and trimmers, 170 stewards and waiters, 61 cooks and 46 sailors. Other novelties are a children's saloon, a Vienna café and a grill room, placed on the uppermost deck of all. The first-class dining room will be the biggest afloat, having accommodations for 554 people at one sitting. The greatest interest in this ship naturally centers in the engine and boiler rooms, and on the accompanying page we present a fine view of the engines as they will appear when completely erected on board the ship. It became evident, both when the engines of the "Deutschland" were constructed and during their subsequent operation, that in them the builders of marine engines had reached the limit of desirable size. There are on that ship two engines, one on each shaft, and together they have indicated under favorable conditions as high as 38,000 horse power, or 19,000 horse power on each shaft. When it was determined to make the "Kaiser Wilhelm II." the fastest vessel afloat, it was necessary to provide engines of 40,000 contract horse power, which, judging by the performance of previous engines, meant about 45,000 horse power in actual service. It was realized that this great power would have to be subdivided among more than two engines, in order to keep down the size and weight of individual parts. The plan determined upon was to use four engines in four separate water-tight compartments, two engines being coupled in tandem on each shaft. As arranged, there is in each engine room a complete four-cylinder, quadruple-expansion engine working on three cranks. The accompanying view is taken from the front end of one pair of engines, and shows them in the relative position they occupy in the ship. Steam is admitted to two high-pressure cylinders, 37.4 inches in diameter, which are set immediately above the first intermediate cylinders, which are 49.2 inches in diameter, the common piston-rod of these two cylinders being connected to a common crank shaft. From the first intermediate the steam passes to the second intermediate adjoining it, which is 74.8 inches in diameter, and thence it is led to the low-pressure cylinder, which is 112.2 inches in diameter. The common stroke of the four cylinders is 70.8 inches. As may be imagined, the dimensions of the shafting are very large, the crank shaft of the forward engine being 20.87 inches in diameter, and that of the after engines 25 inches in diameter. Each engine is provided with its own separate condenser, containing 11,732 square feet of cooling surface. The bronze screw propellers are 22 feet 9½ inches in diameter. It should be mentioned that particular attention was paid to the construction of the crank and propeller shafting, the former being made of nickel-steel with a breaking strength of 38½ tons per square inch, the complete crank of one set of engines weighing in all 114 tons. The thrust shaft is also of nickel-steel, while the intermediate shafts are of Siemens-Martin steel and the propeller shaft of crucible steel. The ingot for the propeller shaft, which weighs 80 tons, was cast with the contents of 1,768 steel-smelting crucibles, the work requiring the attention of 490 men for half an hour's time.

PARTICULARS OF RECENT TRANSATLANTIC LINERS.

Name of Ship.	Lucania.	Kaiser Wilhelm der Grosse.	Oceanic.	Deutschland	Kronprinz Wilhelm.	Cedric.	Kaiser Wilhelm II.
Date	1893	1898	1899	1900	1901	1902	1902
Length over all	625 ft.	648 ft. 6 in.	704 ft.	684 ft.	663 ft.	700 ft.	706 ft. 6 in.
Breadth	65 ft. 3 in.	66 ft.	68 ft. 4 in.	67 ft.	66 ft.	75 ft.	72 ft.
Molded depth	41 ft. 6 in.	43 ft.	49 ft.	44 ft.	43 ft.	49 ft. 4 in.	44 ft. 2 in.
Draught	29 ft.	28 ft.	32 ft. 6 in.	29 ft.	29 ft.	36 ft. 6 in.	29 ft.
Displacement	19,000 tons	21,880 tons	28,500 tons	23,620 tons	21,300 tons	37,870 tons	26,000 tons
Horse power	30,000	30,000	27,000	38,000	36,000	16,000	*40,000
Speed	22.01 knots	23 knots	20.7 knots	23.5 knots	23.5 knots	16 knots	*23.5 knots

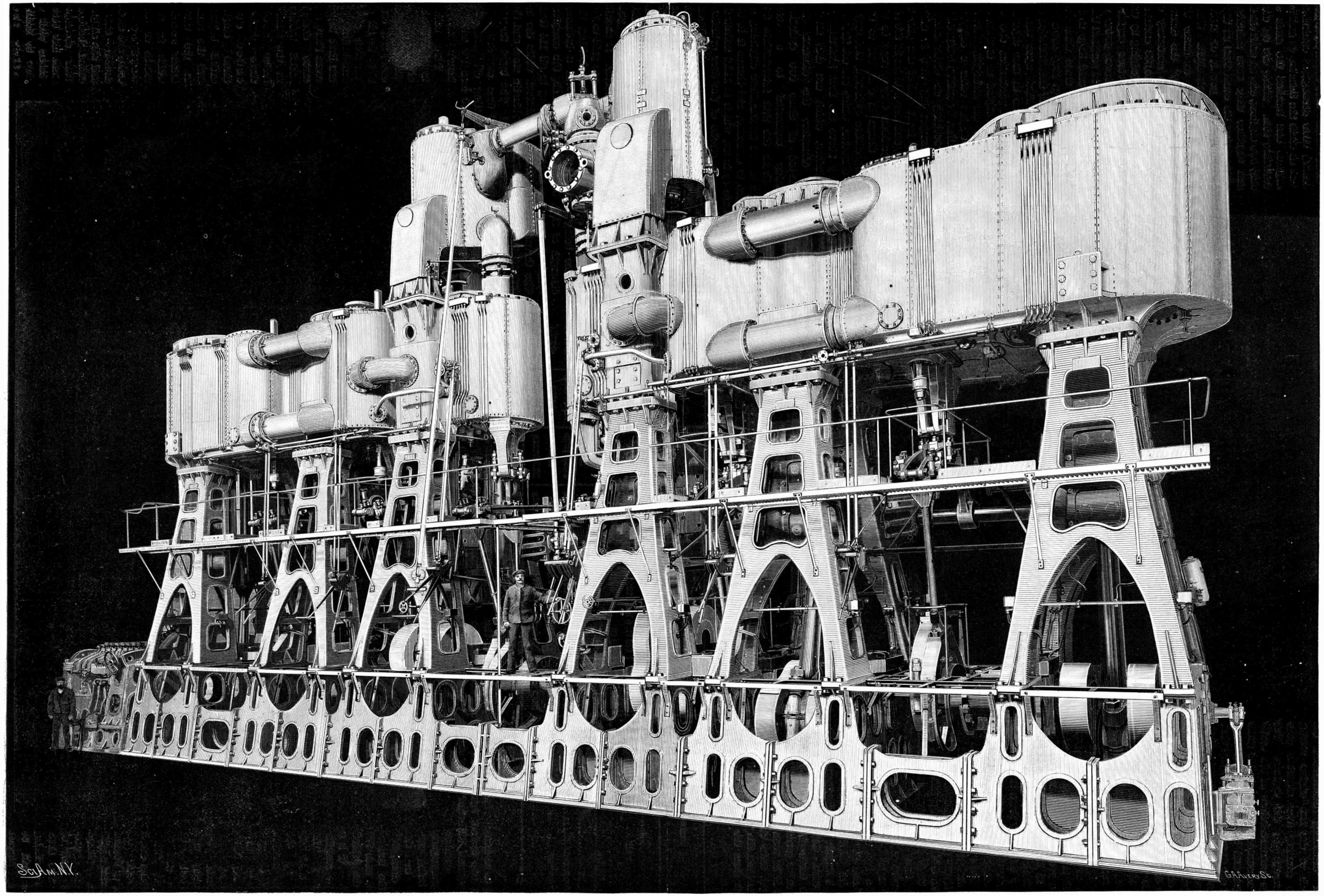
* Both likely to be exceeded in service.

The boiler installation is, of course, a very powerful one, and consists in all of nineteen separate boilers. In the first boiler room there are three double-ended boilers, in the second boiler room three double-ended and three single-ended boilers, and the same in the third boiler room, while in the fourth or forward room there are three double-ended and one single-ended boilers. This arrangement has been chosen with a view to facilitating the transportation of the



Length, 706½ feet; breadth, 72 feet; depth, 44 feet 2 inches; displacement, 26,000 tons; contract horse power, 40,000; estimated speed, 23½ knots.

"KAISER WILHELM II." WHICH WILL BE THE FASTEST STEAMER AFLOAT.



ENGINES OF THE "KAISER WILHELM II."

coal from the bunkers to the foot-plates—a most important consideration in a ship of this size. The boiler pressure adopted is 225 pounds per square inch. The total grate area is enormous, being 3,121 square feet, as is also the total heating surface of 107,643 square feet.

It is an interesting fact that this new vessel will not make use of forced draft, but wi'l be driven entirely under natural draft, the North German Lloyd Company being strongly opposed to the use of forced draft in any form whatever. This, of course, necessitates a proportionately larger grate surface and heating surface, and a more liberal allowance of space for boiler room installation. Thus the Hamburg-American liner "Deutschland," which has indicated 38,000 horse power under forced draft, has only 2,188 square feet of grate area, and 85,468 square feet of heating surface, as compared with the "Kaiser Wilhelm II.," which for a contract horse power of 38,000 to 40,000 will require 50 per cent more grate surface, and about 25 per cent more heating surface. It is easy to see from the figures we have given that the new ship is likely to exceed her contract horse power and speed by a very wide margin, and we fully expect that after a voyage or two she will be indicating not less than 45,000 and possibly as high as 47,000 horse power, with a corresponding speed of 24 to 24½ knots an hour.

PROVISIONING A LINER FOR A SINGLE TRANS-ATLANTIC TRIP.

The Book of Genesis does not record the tonnage of the huge vessel which finally stranded on Mount Ararat, after finishing the most wonderful voyage ever described in the annals of mankind. But it is quite safe to assume that the dimensions of the Ark, that old-time floating storehouse, are exceeded in size by the largest of steamships now crossing the Atlantic.

Not the least striking evidence of the size of these modern monsters of the deep is afforded by the vast quantities of food which must be taken aboard for a single six-day trip across the Atlantic. For the 1,500 passengers and the several hundred men constituting the crew, carloads of food and whole tanks of liquids are necessary. To enumerate in cold type the exact quantities of bread, meat, and vegetables consumed in a weekly trip would give but an inadequate idea of the storing ·aity of a modern liner. We have, therefore, pr a picture which graphically shows by compar th the average man the equivalent of the meat,] . and breadstuffs, as well as the liquors used. kind of food has been concentrated into a giant unit, compared with which the figure of the average man seems puny.

On the "Kronprinz Wilhelm," of the North German Lloyd Line, which steamship we have taken for the purpose of instituting our comparisons, some 19,800 pounds of fresh meat and 14,300 pounds of salt beef and mutton, in all 34,100 pounds of meat, are eaten during a single trip from New York to Bremen. This enormous quantity of meat has been pictured in the form of a single joint of beef, which, if it actually existed, would be somewhat less than 10 feet high, 10 feet long, and 5 feet wide. If placed in one end of a scale, it would require about 227 average men in the other end to tip the beam.

For a single voyage the "Kronprinz Wilhelm" uses 2,640 pounds of ham, 1,320 pounds of bacon, and 506 pounds of sausage—in all, 4,466 pounds. Since most of this is pork, it may well be pictured in the form of a ham. That single ham is equivalent in weight to 374 average hams. It is 7¼ feet high, 3 feet in diameter and 2 feet thick.

The poultry eaten by the passengers of the steamer during a trip to Bremen or New York weighs 4,840 pounds. This being the turkey season of the year, suppose that we show these 4,840 pounds of poultry in the form of a turkey, dressed and ready for the oven. The bird would be a giant 10 feet long, 8 feet broad, and 5 feet high.

Sauerkraut, beans, peas, rice, and fresh vegetables are consumed to the amount of 25,320 pounds. Packed for market, these preserved and fresh vegetables would be contained in 290 baskets of the usual form, which piled up make a very formidable truncated pyramid.

The quantity of eggs required is no less startling than the quantity of vegetables; for some 25,000 are needed to satisfy the wants of passengers and crew. Eggs are usually packed in cases, 30 dozen to the case. The "Kronprinz Wilhelm," when she leaves New York or Bremen, must therefore take on board 69 of these cases, which have been shown in a great pile, 23 cases high and three cases wide.

The bakers of the ship find it necessary to use 33,000 pounds of flour during the trip. In other words, 169 barrels are stowed away somewhere in the hold of the big ship.

Besides the foods already enumerated, 1,980 pounds of fresh fish and 330 pounds of salted fish are eaten during the six-day voyage. The total amount of 2,310 pounds would be equivalent to a single bluefish 20 feet long, 5 feet in greatest diameter, and 1½ feet broad. Such a fish compares favorably in length, at least, with a good-sized whale.

The potatoes required far outweigh any other single article of food contained in the storerooms; for their entire weight is 61,600 pounds. If it were possible to grow a single tuber of that weight, it would have a height of 14 feet and a diameter of 7 feet.

The butter, too, if packed into a single tub, would assume large dimensions. This single tub would contain 6,600 pounds and would be 6 feet high.

Of dried fruit, 2,640 pounds are eaten, and of fresh fruit 11,000 pounds, in all 37,400 pounds. If this fruit were all concentrated into a single pear, its height would be 7 feet, and the width at the thickest part 5 feet.

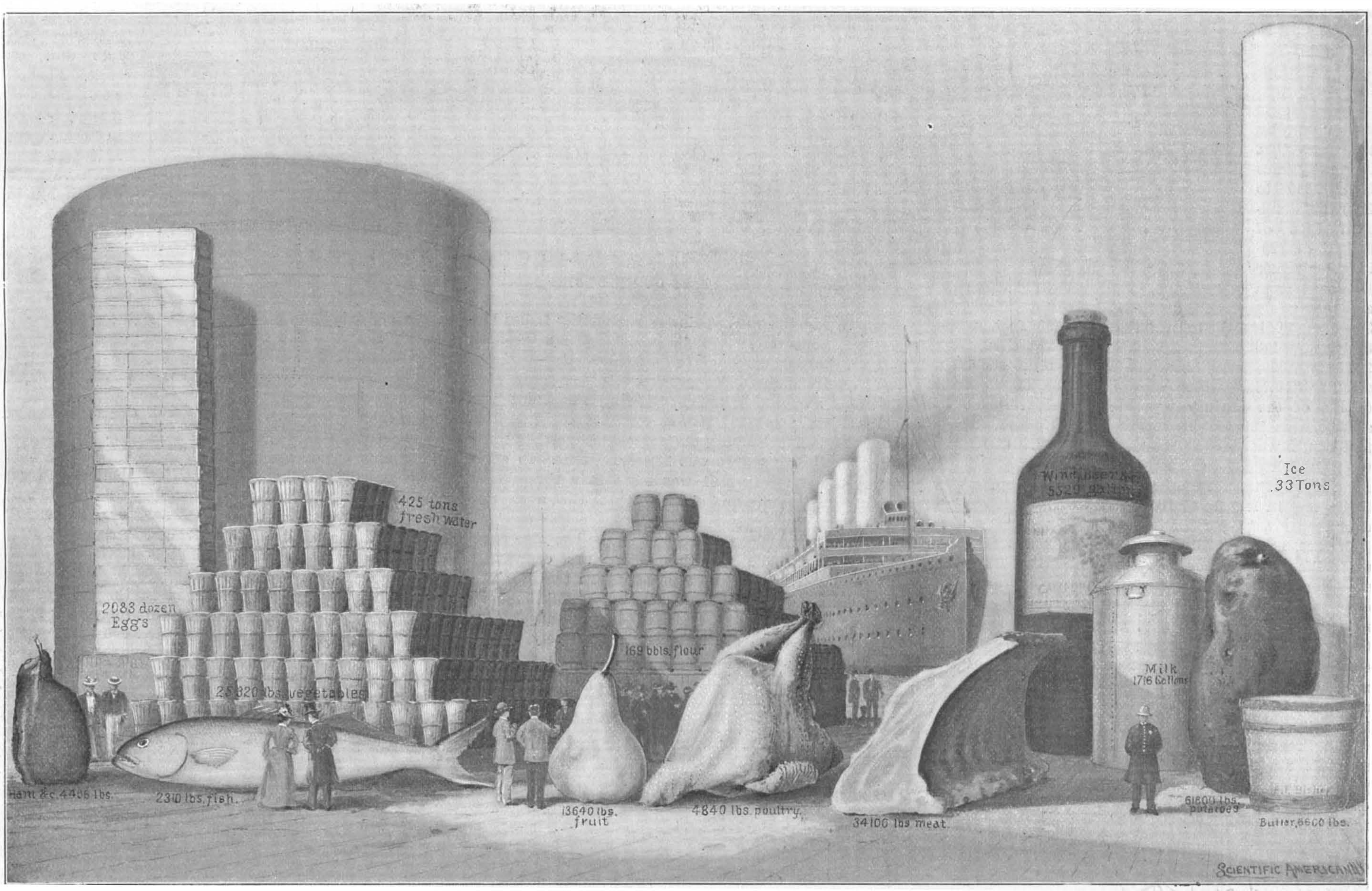
Whole lakes of liquids are drunk up by the thirsty passengers and crew. No less than 425 tons of fresh water are required, which occupy 14,175 cubic feet and would fill a tank 25 feet in diameter and 30 feet high. The 1,716 gallons of milk used for drinking and baking would be contained in a can 6 feet 1 inch in diameter and 11½ feet high. The gallons and gallons of wines, liquors, and beer consumed should dishearten the most optimistic temperance advocate. Under the joyous title of "beverages" the following items are to be found in the purser's account-lccck:

Champagne	850 bottles.
Claret	980 bottles.
Madeira, sherry, etc.............	135 bottles.
Rhine and Moselle wines........	1,700 bottles.
Rum and cordials...............	760 bottles.
Mineral water	5,250 bottles.
Beer in kegs....................	2,960 gallons.
Beer in bottles.................	600 bottles.

Suppose these things tc c.i:.k were contained in one claret bottle. Some idea of the hugeness of this bottle may be gained when it is considered that its height would be over 24 feet and its diameter over 6 feet.

In order to cool the wines and the beer, as well as to preserve the fresh meats, vegetables, eggs and fruit, 33 tons of ice are needed. That seems a small quantity, and, in truth, it is. But the "Kronprinz Wilhelm" has also refrigerating machines, which have cut down the quantity of ice which it is necessary to take on board. The 33 tons of ice actually consumed, however, would make a column 37 feet high.

Compared with these vast quantities of food, the live stock of Noah's Ark must pale into insignificance. It must not be forgotten, however, that in provisioning a liner an allowance is made for accidents, which may prolong a voyage over many days. For that reason not all, but only the major portion of the food taken aboard is consumed.



A GRAPHICAL COMPARISON OF THE PROVISIONS OF A TRANSATLANTIC LINER.

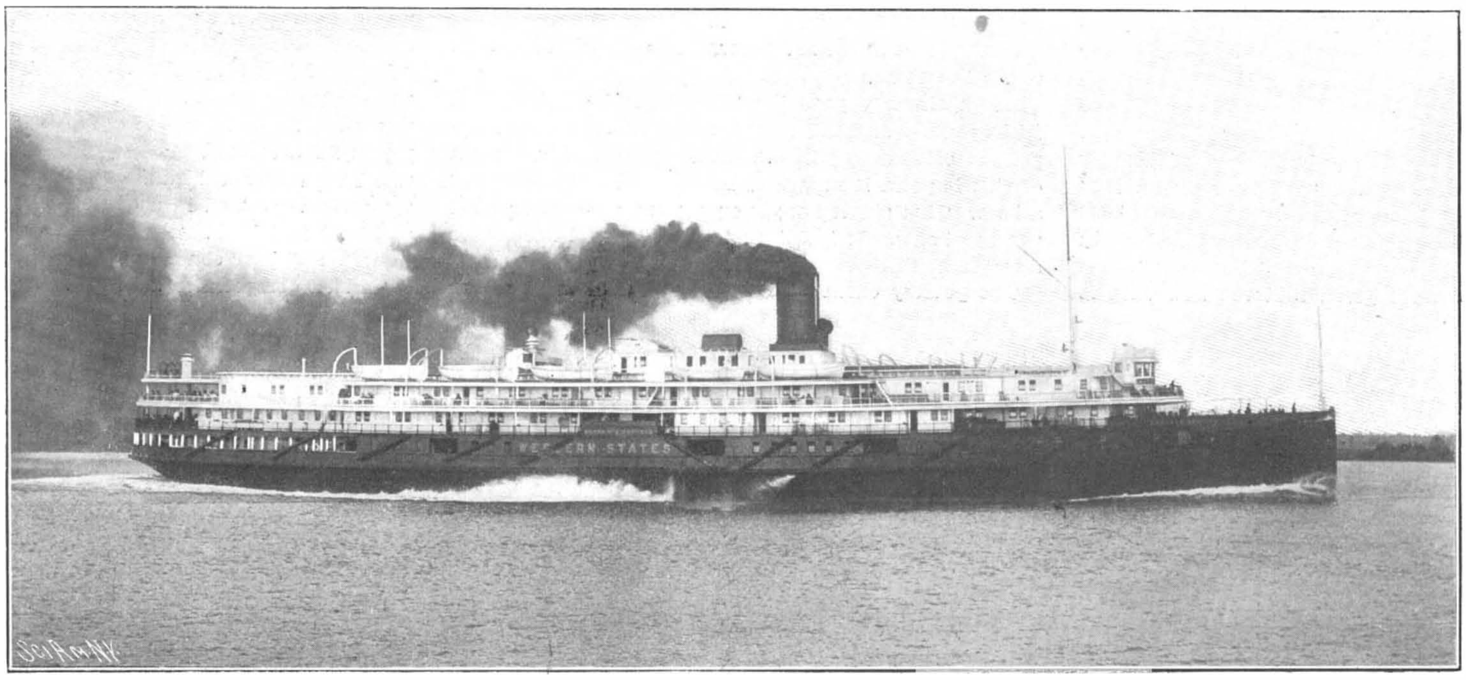
Lake Transportation.

THE DEVELOPMENT OF TRANSPORTATION ON THE GREAT LAKES.

BY WALDON FAWCETT.

The commercial chronicle of the United States records no more remarkable evolution than the development of transportation on the Great Lakes, extending as it does over little more than half a century, yet characterized by a series of radical innovations in the types of craft employed.

During the latter part of the last century the whole tendency on the Great Lakes, as in the realm of salt-water shipping, was toward a gradual increase in the size of vessels. The extent of this progression is evidenced by the fact that in the ten years from 1890 to 1900 the standard type of freight-carrying steamer increased from approximately 300 feet in length to a length of 500 feet, while the dead-weight carrying capacity was extended from 2,500 to 7,000 gross tons. In other words, the steel steamer "Matoa," which at the opening of the final decade of the century was the largest freighter in service, was 290 feet in length, 40 feet beam and 21 feet depth, whereas the steamer "John W. Gates," the vessel which upon her completion in 1900 marked the attainment of the maximum size in lake cargo carriers, is 498 feet in length, 52 feet beam and 30 feet molded depth.

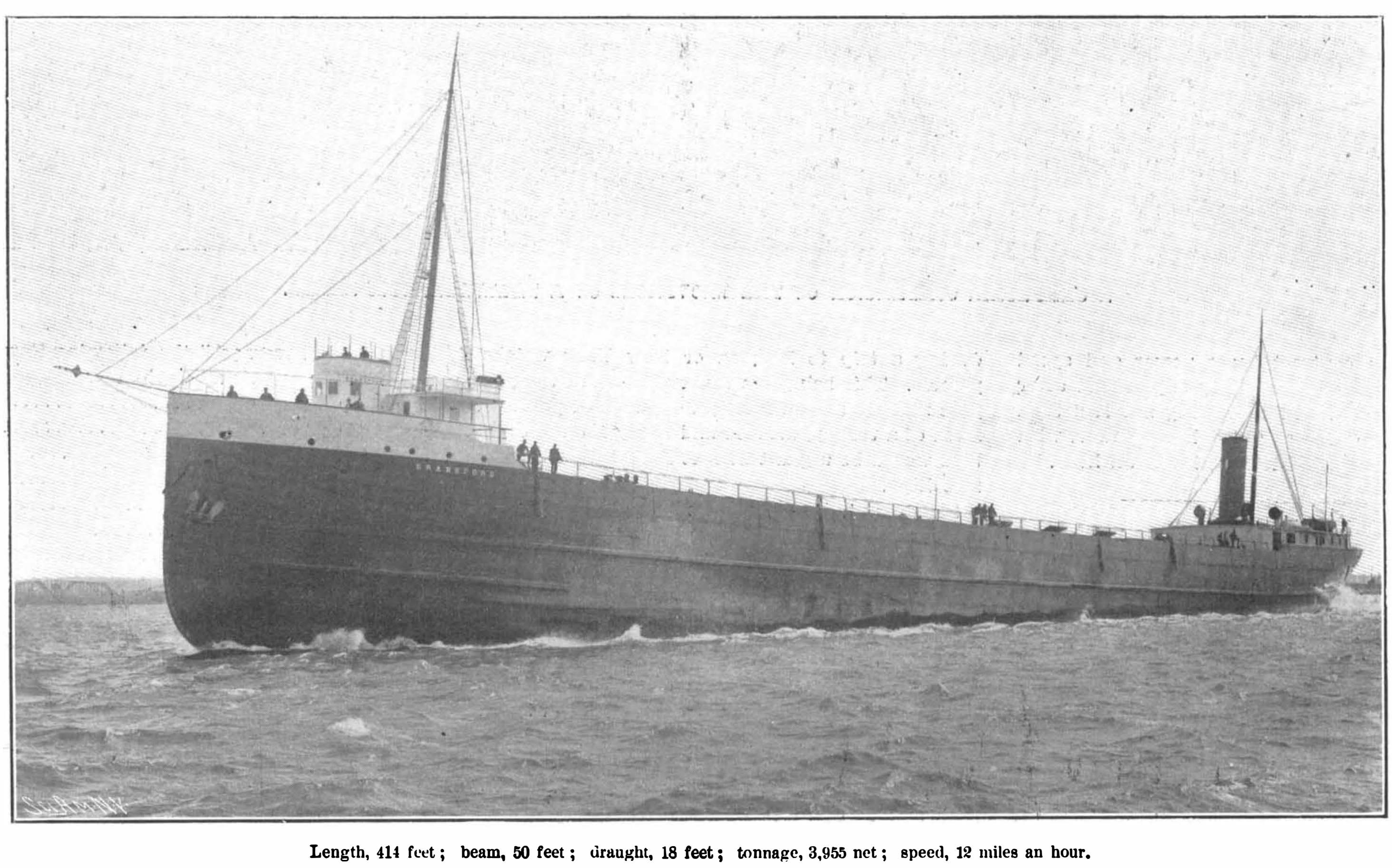


Length over all, 386 feet; breadth, 44 feet; depth, 26 feet; tonnage, 5,000; horse power, 8,000; draught, 16 feet 8 inches; speed, 22 miles an hour.

"WESTERN STATES," ONE OF THE LATEST OF THE LAKE PASSENGER STEAMERS.

Of late, however, there has been a change of ideas as to the best size for lake cargo carriers. The construction of freighters, 500 feet in length, was abandoned and there was a return to the vessel of more moderate size. Few, if any, of the vessels added to the lake fleet during the past year or two have exceeded 450 feet in length, and a considerable number of the new ships are under 400 feet in length.

The reason for this unexpected change of policy is found in the navigation conditions on the Great Lakes. The 500-foot ship was planned in the day when a channel twenty feet in depth throughout the entire length of the lakes was regarded as a certainty of the immediate future; and when shipbuilders and owners realized that they could not hope, for a long time to come, for more than eighteen feet depth of water under the most favorable conditions, they began to build smaller vessels. The largest of the later vessels are 436 feet in length over all, 50 feet beam and 28 feet depth. A steamer of this size has, on a draught of 18 feet, a carrying capacity of approximately 6,200 gross tons and costs complete $260,000. Another class of freighters is made up of 400-foot vessels of the same beam and depth as the carrier previously described. The reduction in length reduces the carrying capacity to 5,600 tons, but each hull entails for construction an outlay of $20,000 less than that mentioned as the cost of the vessel 436 feet in length.



Length, 414 feet; beam, 50 feet; draught, 18 feet; tonnage, 3,955 net; speed, 12 miles an hour.

TYPICAL LAKE FREIGHT STEAMER "BRANSFORD."

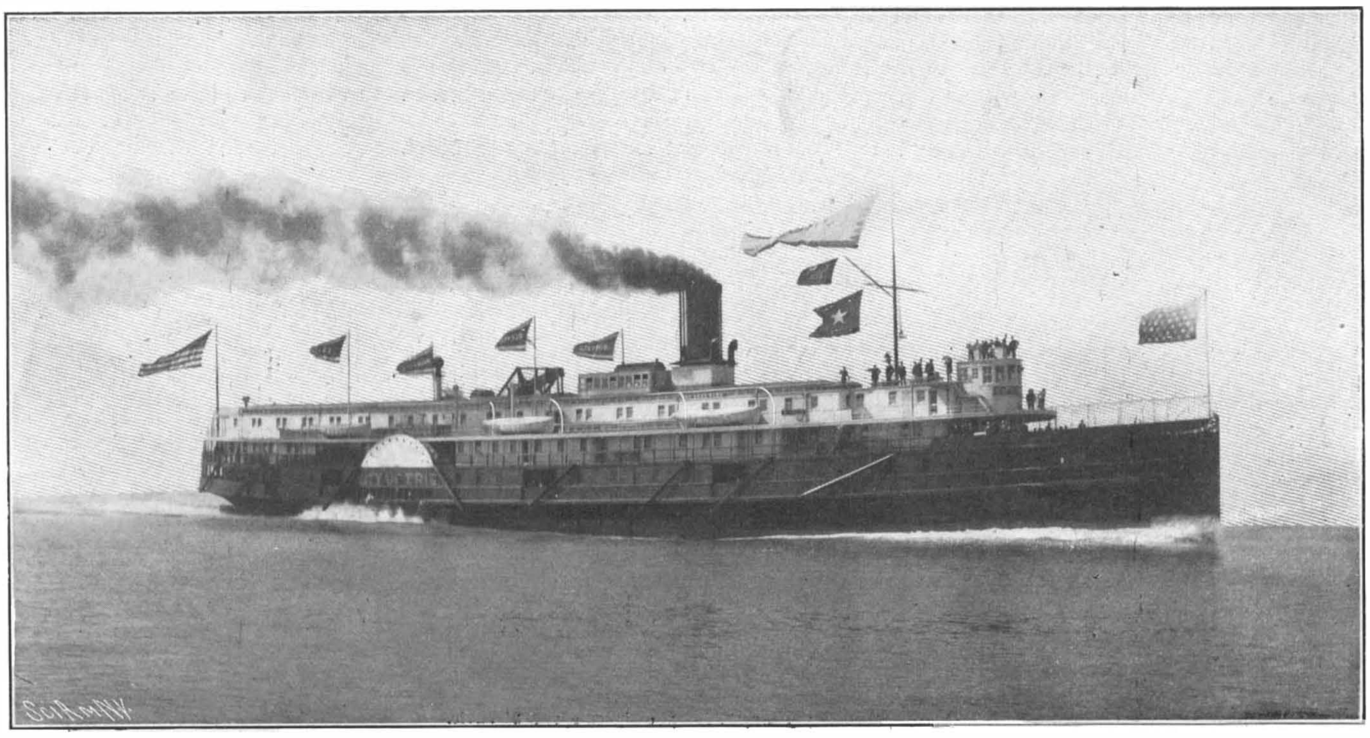
Unfortunately, it has never been found possible to accurately measure the entire water-borne commerce of the Great Lakes, but the statistics compiled by the United States government officials at the Sault Ste. Marie Canal—the water gateway connecting Lakes Huron and Superior, through which passes perhaps half of the commerce of the unsalted seas—indicate how rapid has been its growth. In the year 1881 the total amount of freight passing the Sault was 1,567,741 tons; in 1891 it was 8,888,759 tons; and in 1901, the last calendar year for which statistics are available, the aggregate was 28,403,065 tons. In other words, the traffic in 1901 was more than three times that a decade before and eighteen times that a score of years since.

Passenger travel on the Great Lakes has also experienced remarkable growth. There are connecting lines of fast passenger steamers between the principal cities, such as Buffalo and Cleveland, Buffalo and Detroit, Cleveland and Detroit, and Chicago and Milwaukee, and also there are in service exclusively passenger steamers which make regular through trips between Buffalo and Chicago. The Sault Ste. Marie statistics, which recorded the passage through the canals during the season of 1901 of upward of 60,000 passengers, chronicle, of course, but a fraction of the whole passenger travel, and it is estimated that the passenger steamers of the vast inland waterway carry annually between a quarter of a million and one-third of a million people. The side wheel steamer is still favored for passenger service on the lakes. Some years since there were constructed at Cleveland two very large and magnificent steel passenger steamers of the ordinary propeller type, which are in many respects counterparts of the best modern ocean liners, and these vessels now carry annually about 20,000 passengers between Buffalo and Chicago; but the innovation in design was not generally adopted by lake navigation interests. Indeed, there have been completed during the past year the two largest side-wheel steamers ever constructed for fresh-water service. These vessels are the steamers "Eastern States" and "Western States," and they are now in daily service between Buffalo and Detroit. Each is 366 feet in length, 55 feet in beam and 19½ feet deep. Each vessel is driven by inclined, three-cylinder, compound engines, to which steam is supplied from eight boilers, and this machinery is designed to enable the vessel to make the run of 256 miles from Detroit to Buffalo in twelve hours under almost any weather conditions. Each of these steamers represents an investment of about $640,000.

An interesting demonstration of the sustained speed of the typical side-wheel steamer in lake service was made upon the occasion of the memorable race on Lake Erie something over a year ago, in which test of speed the steamer "City of Erie" defeated the "Tashmoo," another side-wheeler, by the narrow margin of 45 seconds in a run of one hundred miles. It may be noted for purposes of comparison that both vessels are of the same length. The "Erie" has a displacement of 2,000 tons as against 1,200 tons in the case of the "Tashmoo," but counterbalancing this inequality is the fact that the winner has engines of 6,000 horse power as compared with machinery of 2,800 horse power possessed by the "Tashmoo." The "City of Erie," which by reason of her achievement upon this occasion is claimed to be the speediest passenger steamer on the Great Lakes, attained a record speed of 22.93 miles per hour.

The growth of steel shipbuilding on the Great Lakes has, of course, more than kept pace with the expansion of the fresh-water fleet. In the spring of 1899 the seven or eight principal shipbuilding corporations on fresh water, including the largest plants where steel tonnage is constructed, were merged into a combination known as the American Shipbuilding Company. Five of the plants were put in at valuations close to or exceeding $1,000,000 each and the lowest was $750,000. The consolidation gave the company control of eleven of the leading drydocks on the lakes, for, as on the Atlantic coast, each yard of any size has one or two drydocks connected therewith.

The plants and property of this particularly interesting combination or "trust," located at Detroit, Lorain, Cleveland, Bay City, Mich., Chicago, West Superior, Wis., and Buffalo, are now estimated to be worth more than $15,000,000. During the fiscal year ending June 30, 1902, the corporation built at its several plants forty-one vessels having an aggregate of 198,500 net tons capacity on 18 feet draught, while there were yet under construction and uncompleted on that date thirty vessels of 139,000 tons aggregate carrying capacity. At the time of its formation the combination above mentioned absorbed all the leading steel shipbuilding institutions on the lakes; but so rapid has been the growth of independent plants since that time, that these individual establishments now have in the aggregate a building capacity equal to upward of one-half of that of the consolidated shipyards.



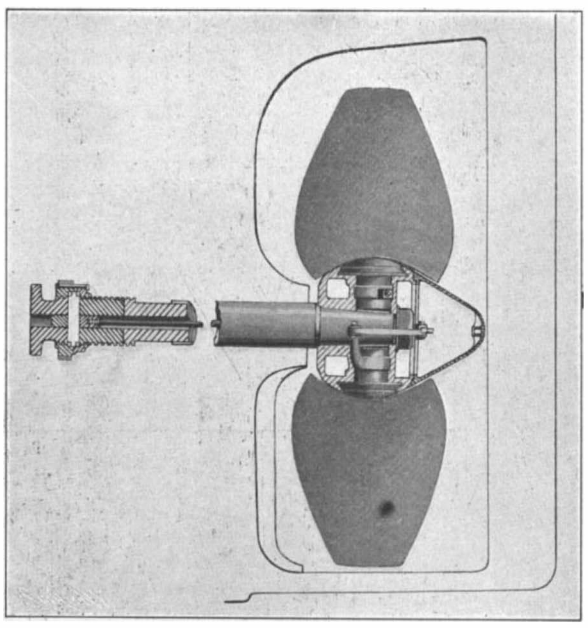
Tonnage, 2,000; speed, 22.9 miles an hour.

"CITY OF ERIE," THE FASTEST STEAMER ON THE LAKES.

A most interesting phase of the development of transportation and kindred activities on the Great Lakes is found in the increasing degree of attention given by the powerful steel-vessel building interests of the interior to the construction of steamers designed for salt-water traffic or for both lake and ocean service. Vessels of this type are proving particularly profitable to their operators by reason of the fact that they may be transferred to the Atlantic coasting trade during the winter months, when navigation on the lakes is impossible. In order to pass through the Welland and St. Lawrence canals, a vessel must not exceed 270 feet in length, and the carrying capacity of such a craft is approximately 3,000 tons. It may be noted in passing that the season of navigation on the lakes has been lengthened materially of late years. Many vessels are put in service earlier than formerly, and with the gradual disappearance of the old craft has come a disposition to have the carriers brave the elements until late in the autumn.

THE DEVELOPMENT OF THE AUXILIARY YACHT.

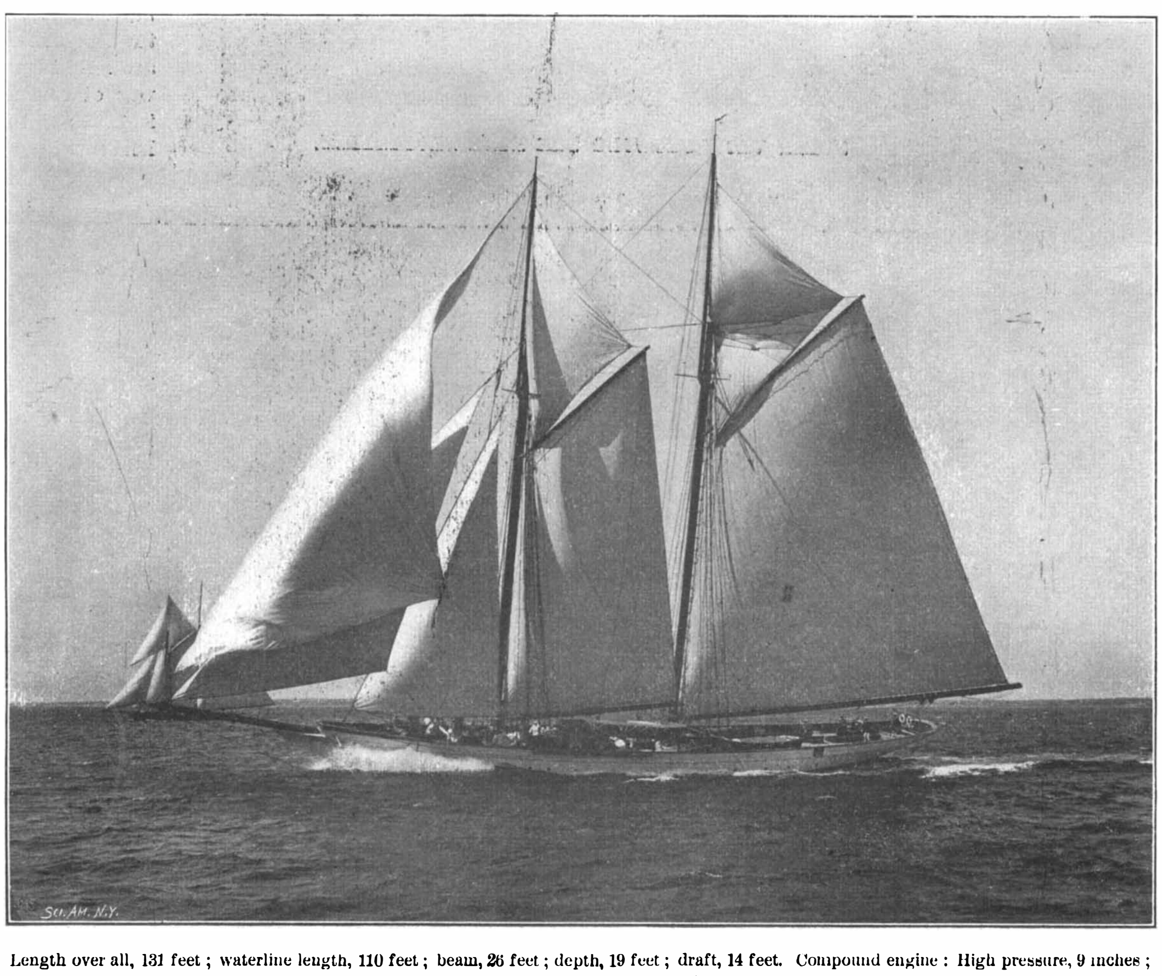
Your true sailorman, with his inborn love of the sea, always looks askance at a yacht that depends for its motive power upon anything more than well-trimmed sails and nature's own motive power, the wind. To him it is the very fickleness of the breezes, the uncertainty of the tides, currents, and various elements that go to render navigation difficult, that constitute half of the charm of yachting, for is it not in the careful observation of these, and in the accumulated experience of many seasons' cruising in foul weather and fair, that he develops that confidence, resourcefulness, forethought and presence of mind that go to make up the successful yachtsman? On the other hand, in this busy, workaday age, when we are in such a hurry to accumulate our store, big or little, as the case may be, of this world's wealth, we have come to begrudge even the all-too-brief hours that we give to recreation; and the long delays which are inevitable on a sailing yacht through failing winds, or foul tides, have led to the experiment of introducing a limited amount of steam or other mechanical motive power on sailing yachts. The great convenience of being able to continue on one's course in calm weather at from one-half to two-thirds the ship's sailing speed, or of being able at the close of a day's sailing to enter a crowded harbor and come to one's mooring, with canvas all stowed and everything made snug before the mooring is picked up, has appealed so strongly to a large number of yachtsmen, that the auxiliary sailing vessel is becoming increasingly popular. The auxiliary power varies from the small gasoline engine of the knockabout to the large steam engine of the big cruising schooner.



Feathering Propeller of the "Ariadne," With the Blades Thrown Parallel with the Keel for Sailing.

The accompanying illustrations show one of several large auxiliary cruisers which have recently been built in this country for American yacht owners. The "Ariadne," which is from designs by Tams, Lemoine & Crane, is a steel vessel 110 feet in length on the water line, 131 feet over all, with 26 feet beam, a molded depth of 19 feet and a draft of 14 feet. Her sail plan is such as would be given to a large cruising schooner of the ordinary type, and in her cruises with the New York Yacht Club this summer she has shown that in a strong reaching breeze she is capable of overhauling and passing such fast racing schooners as the "Muriel" and "Elmina." In addition to her ample sail plan, she carries a compound engine with cylinders 9 inches and 19 inches in diameter, with a stroke of 14 inches. Steam is provided by an Almy water-tube boiler with 17 square feet of grate surface; and under steam alone she is capable of a speed of 8 knots an hour, or say two-thirds of her sailing speed under favorable conditions.

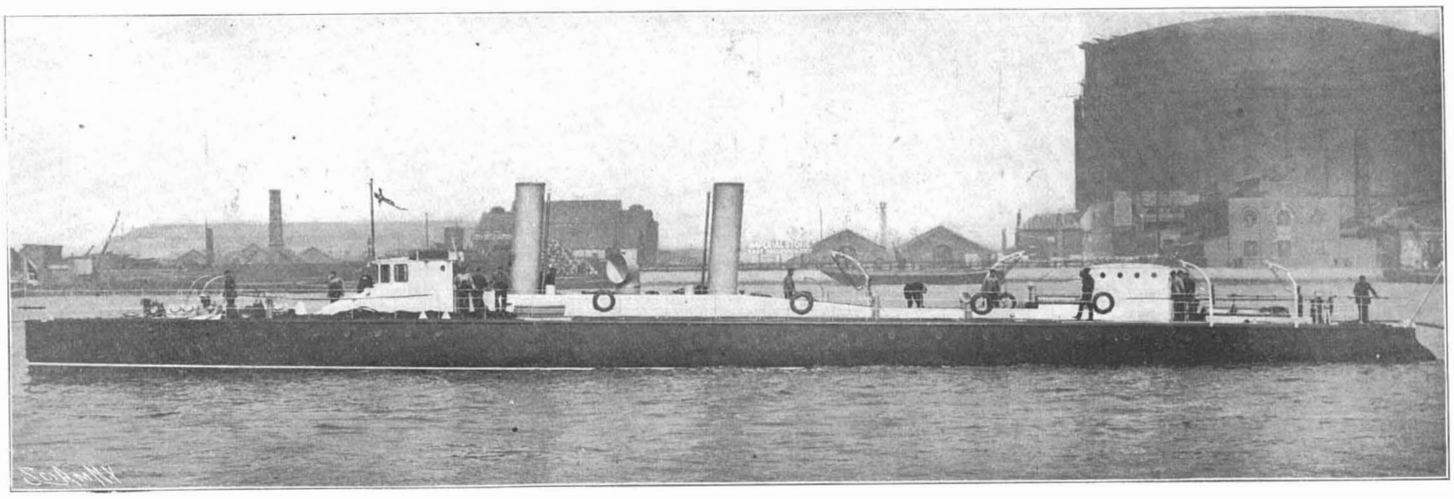
The accommodations of the "Ariadne" include five staterooms, three bathrooms and a main saloon for the owner, and five staterooms, a messroom, and a bathroom for the officers, besides twelve swinging berths in a large forecastle for the crew. The main saloon is located just forward of the mainmast, while adjoining it and extending aft is the owner's 12 by 12 stateroom, and a connecting bathroom. The headroom throughout is 7 feet 6 inches. The engine space, the coal bunkers, with a capacity of 23 tons, the galley, pantry, and the working end of the vessel are forward of the main saloon. She has water tanks with a capacity of 3,500 gallons, and ice-boxes capable of holding four tons of ice. She is also furnished with an electric light plant, an evaporator, a distiller, and a complete system of steam heating.



Length over all, 131 feet; waterline length, 110 feet; beam, 26 feet; depth, 19 feet; draft, 14 feet. Compound engine: High pressure, 9 inches; low pressure, 19 inches; stroke, 14 inches.

THE AUXILIARY SCHOONER YACHT "ARIADNE" MAKING 12 KNOTS UNDER SAIL ALONE. SPEED UNDER STEAM, 8 KNOTS.

Of course, the placing on board of boiler, engine, coal bunkers, and a screw propeller was done with a sacrifice of some sailing speed when the vessel is under canvas; but the sacrifice is not large considering the great convenience secured in cruising, the estimated difference being from a knot to a knot and a quarter per hour. One of the most difficult problems to solve in a vessel of this type is that of reducing the resistance offered by the propeller, owing to its drag upon the water when the vessel is under sail alone. From the time when auxiliary power was first introduced on sailing vessels, various expedients have been resorted to in the endeavor to reduce this drag, such as allowing the propeller to revolve idly, or providing a well at the stern through which it could be uncoupled and lifted clear of the water. The method adopted on the "Ariadne," of which we present a detailed drawing, is one that was designed and patented in 1868 by Mr. R. R. Bevis, a former manager of Messrs. Laird's building establishment in Great Britain. This type was fitted by that firm to several auxiliary cruisers in the British navy, among which was the corvette "Calliope," which it will be remembered, was present at the terrific hurricane at Apia in the Samoan Islands, when so many American vessels were lost, and barely managed to steam out against the hurricane into deep water. The object of the device is to enable the angle of the blades of a propeller to be altered, while they are in place under water, to the pitch most suitable for working with steam under varying circumstances, as well as to feather them in a fore-and-aft direction when the vessel is under sail, and the steam power is not in use. The propeller blades are rotatable on their axes, and they are moved by a pair of levers which are attached to a yoke at the outboard end of a rod that passes entirely through the propeller shaft into the engine room. Here the interior rod is coupled by means of a pin, sliding in a slot cut through the propeller shaft, to an outer, threaded sleeve, which is capable of fore-and-aft movement on the propeller shaft by means of a thread cut on the shaft. This sleeve is formed with a pinion on its outer periphery which is engaged by a spur wheel that can be operated by hand. To feather the blades, that is, to place them with their surfaces approximately parallel with the keel of the ship, the sleeve is moved forward into the position shown in our drawing. When it is desired to use steam power, the sleeve is screwed back upon the propeller shaft, forcing the interior rod to the rear, and by means of the connecting levers swinging the propeller blades around to the proper angle of pitch. The connecting levers, arms, etc., are entirely inclosed with the hollow boss of the propeller, and it will be seen that when the blades are in the fore-and-aft position, the drag or friction of the propeller is reduced to a minimum.



Length, 160 feet; beam, 16 feet; designed speed, 24 knots.

ENGLISH TURBINE YACHT "TARANTULA."

STERN VIEW SHOWING THE NINE PROPELLERS.

ENGLISH TURBINE-PROPELLED YACHTS.

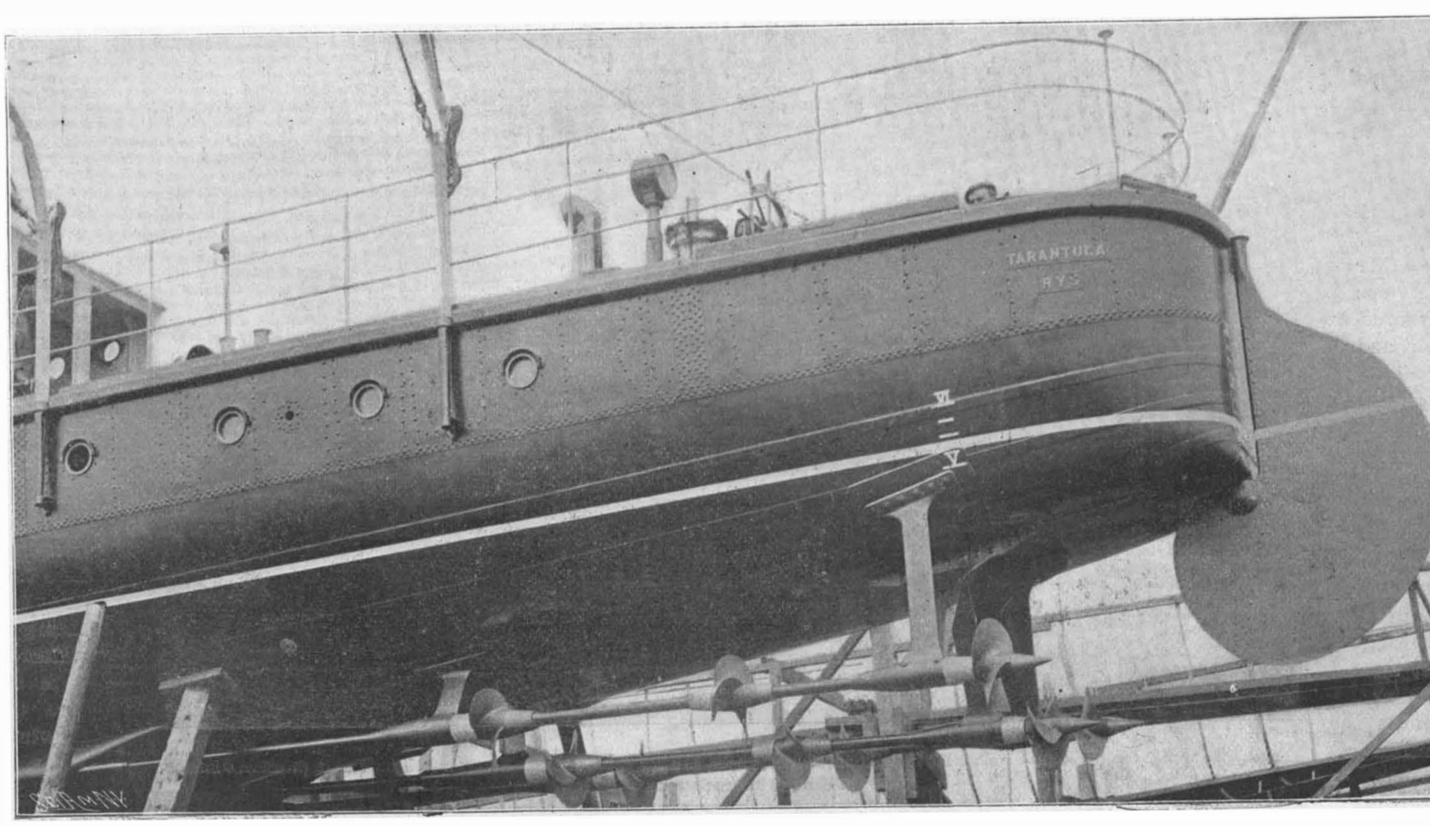
BY THE LONDON CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Of the three high-speed yachts to be fitted with the Parsons marine steam turbine, two have up to the present been launched. They are the "Tarantula," owned by Col. H. McCalmont, M. P., and the "Emerald," belonging to Sir Christopher Furness, M. P. The "Tarantula" is of very special design, having been built on the lines customary to all vessels of the torpedo - boat class. As regards the hull and boilers the "Tarantula" is in fact identical with all first - class torpedoboats. The boiler is of the Yarrow water - tube type. She is driven by three turbines, one high-pressure and two low-pressure. The high-pressure turbine is placed on the central shaft and the two low-pressure turbines on the two outer shafts. There are thus three propeller shafts in all and three screws on each shaft, making nine screws in all.

The "Tarantula" is 160 feet long and 16 feet beam. Her designed speed was 24 knots and her horse power is estimated as a little over 2,500.

The "Emerald" will displace 756 tons and her indicated horse power is expected to be about 1,500. The propelling machinery consists of three sets of steam turbines, each driving one length of shafting—one central and two side shafts—one propeller of about 3 feet diameter being attached to the center, and two propellers, each of about 20 inches diameter, to each of the side propeller shafts. All the propellers of the "Emerald" are of manganese bronze. The hull has been specially strengthened to prevent any vibration in the structure from the great speed at which the shafts will revolve. Her over-all length is about 236 feet, beam 28 feet 8 inches and molded depth 18 feet 6 inches, giving a tonnage of about 756 tons yacht measurement, and her speed will be 16 knots. At her launching her owner, Sir Christopher Furness, remarked that about all the Hon. C. A. Parsons, Messrs. Stephen and himself had in view in fitting the "Emerald" with turbines was to put into the vessel such power as would enable her to steam at the highest rate compatible with entire freedom from vibration. He believed that object would be attained and, still further, he believed as a business man, and as one engaged with ships and shipping, that the steam turbine would practically revolutionize yachting and yacht owning in the United Kingdom.

The third yacht, the "Lorene," is being built to the order of Mr. A. L. Barber, of New York. She will displace about 1,400 tons and she will be 260 feet 8 inches long and 33 feet 3 inches beam. The hull and boilers are being constructed by Messrs. Ramage & Ferguson, of Leith, Scotland, and her turbine machinery will come from the Parsons Marine Steam Turbine Company. Mr. Barber's yacht is expected to be launched shortly.



VIEW OF PROPELLERS, SHAFTING AND BRACKETS OF "TARANTULA."

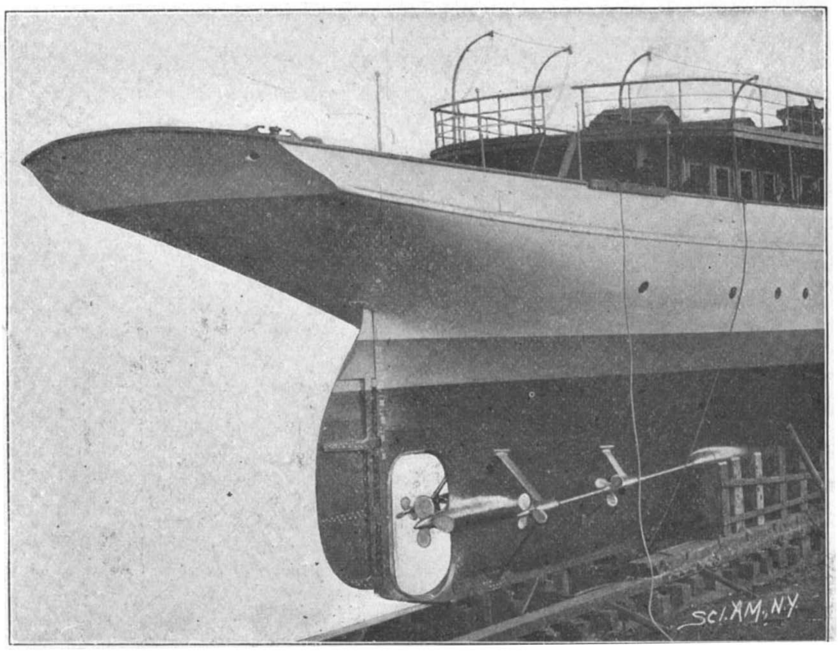
THE APPLICATION OF TURBINE PROPULSION TO PASSENGER VESSELS.

BY HERBERT C. FYFE.

Up to the present moment there have been built eight vessels that have been fitted with the Parsons marine steam turbine, while five are now in process of construction. The first was of course the little "Turbinia," launched in 1896 and in her day the fastest vessel afloat, her maximum horse power being 2,300 and speed 34½ knots. Next came H. M. S. "Viper," whose maximum speed was 39.113 knots or nearly 43 statute miles, the horse power being 12,300; and H. M. S. "Cobra," whose maximum was 35.6 knots. The "Viper" was lost during the British naval maneuvers in the summer of 1901, owing to her striking a rock in a thick fog, while the "Cobra" went down off the outer Dowsing Shoal while on her way from the Tyne to Portsmouth on the 1st of September, 1901. In 1901 the "King Edward" was built, the first passenger vessel to be fitted with the Parsons turbine. This year (1902) a companion vessel to the "King Edward," the "Queen Alexandra," has been built, as well as a destroyer, H. M. S. "Velox," fitted both with reciprocating engines and turbine machinery, and two turbine yachts, one for Col. McCalmont, M. P., the "Tarantula," and one for Sir Christopher Furness, the "Emerald." The turbine boats under construction are H. M. S. "Eden," destroyer, H. M. S. "Amethyst," third-class cruiser, one yacht for Mr. A. L. Barber, of New York, and two passenger steamers of about 8,000 horse power for the Chatham & Dover and Southeastern Railway Company, for the Dover-Calais Channel service, and the other for the London, Brighton and South Coast Railway for the Newhaven-Dieppe service.

It is to the "Queen Alexandra" that we desire to draw especial attention in the present article. The "Queen Alexandra" was built by Messrs. William Denny Brothers, of Dumbarton on Clyde, Scotland, who also built the "King Edward" and who are building the two new turbine cross channel boats of about 8,000 horse power. The machinery was made by the Parsons Marine Steam Turbine Company, of Wallsend-on-Tyne. When the "King Edward" started running in 1901, the Earl of Glasgow said that she would create a revolution in the coast passenger carrying trade on the Clyde, and she has certainly proved very successful, both as regards speed and coal consumption. On one season's work she ran ten more miles than a paddle-boat of about the same dimensions and speed (the "Duchess of Hamilton") with a coal consumption of 480 tons less. The "Queen Alexandra" is generally very similar to the "King Edward," but of larger dimensions, her length being 270 feet, breadth molded 32 feet and depth to promenade deck 18 feet 9 inches, and to main deck 11 feet 6 inches. In appearance she strongly resembles a small cross-channel steamer. A long shade deck, on which the boats are carried and upon which passengers are allowed to promenade, is a new feature of the vessel. The boiler, which is a large double-ended one having a funnel at each end, was supplied by Messrs. Denny & Company, and the turbines, of which there are three, by the Parsons Marine Steam Turbine Company, Wallsend-on-Tyne. The total ratio of steam expansion is about 125 fold as compared to the 8 to 16 fold in triple-expansion reciprocating engines. There are one high-pressure and two low-pressure turbines, the high-pressure one being in the center line. Each drives one shaft, the center one having one propeller and the outside ones two, making five propellers in all. At ordinary steaming rate the revolutions of the center shaft are 900 and each of the side shafts 1,000 per minute.

The "Queen Alexandra" on her trial made 21.63 knots, with the central turbine making 750 revolutions and the outside turbines 1,100 revolutions, thus beating the "King Edward," whose maximum is 20.40 knots, and proving herself to be the fastest excursion steamer in the world. Her usual speed is 21 knots. Both vessels only run on the Clyde during the summer months, and their running was regular and without a hitch. The "Queen Alexandra's" astern turbines which are placed inside the exhaust ends of the low-pressure turbine cylinders, reverse the action of the two outer shafts.

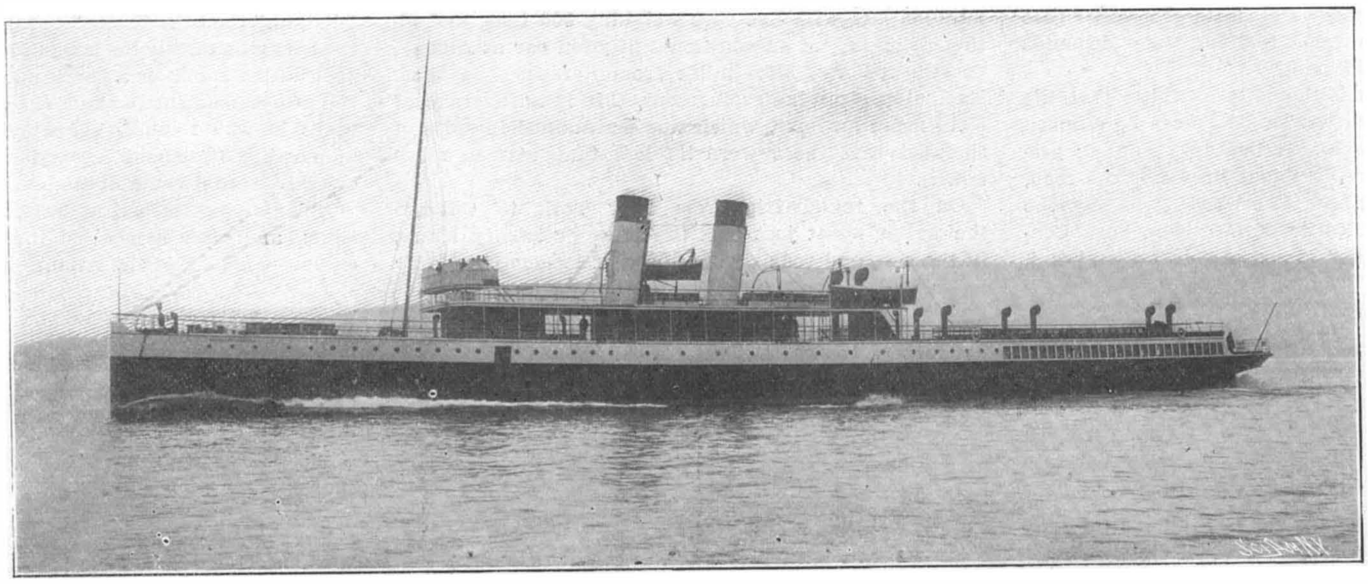


THE FIVE PROPELLERS OF TURBINE YACHT "EMERALD."

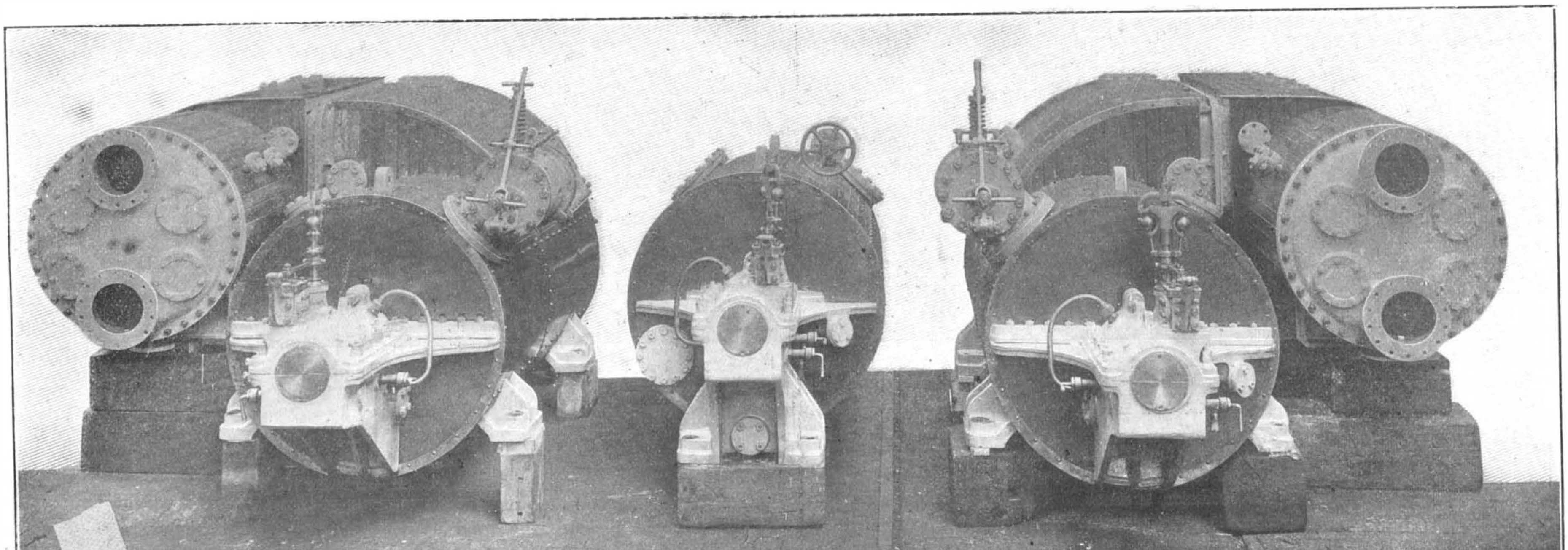
At the autumn meeting this year of the British Association at Belfast, the Hon. C. A. Parsons said that the adoption of the steam turbine system in vessels of large size, such as Atlantic liners, cruisers and battleships, would be attended with greater proportional advantages than in the case of smaller vessels. The large turbines would be cheaper to build, would be lighter, and would occupy less space in proportion to power. The design of such large turbines presented no difficulties beyond those already surmounted, and the greater size permitted the adoption of important features for the further reduction of coal consumption. He said that if the "King Edward" had been fitted with balanced twin triple-expansion engines of the most improved type, and of such size as would consume all the steam the existing boiler could make, the best speed she could possibly have obtained would have been 19.7 knots against the 20½ knots actually done by the "King Edward," showing an increase of speed of eight-tenths of a knot. This difference corresponds to a gain per indicated horse power in favor of the turbine steamer of 20 per cent. It would hardly have been possible to drive the "King Edward" at 20½ knots with ordinary engines, owing to the extra weight of the machinery and the necessarily increased displacement. The attempt to do so could only have resulted in the speed being obtained at an enormously increased fuel cost and a ruinous expenditure of coal and the like on service. The "Queen Alexandra's" coal consumption, it may be mentioned, has proved quite as economical as that of the "King Edward."

It may be interesting to mention that the Lancashire and Yorkshire Railway Company has recently sent an invitation to shipbuilding firms throughout the kingdom for designs and tenders for a new steamer for their Irish Sea service. Proposals are invited for the ordinary twin-screw reciprocating engines and also for steam turbine propelling engines. The speed desired is 19 knots. The question of propellers is one to which Mr. Parsons has devoted considerable attention, and he has made many experiments in order to discover both the right number of propellers and the best shape for each different class of vessel. The "Turbinia" originally had but one screw, which was driven by a single turbine engine at a speed of from 2,000 to 3,000 revolutions per minute.

Many experiments were made with screw propellers of various sizes and proportions, but the best speeds were quite disappointing. Mr. Parsons found that the excessive slip of the propellers beyond the calculated amount and their inefficiency indicated a want of sufficient blade area upon which the thrust necessary to drive the ship was distributed; in other words, that the water was torn into cavities behind the blades. A radical alteration was made in the "Turbinia." Three separate turbines were installed, one high pressure, one intermediate pressure and one low pressure, each of which drove one propeller shaft, with three screws on each shaft. The "Turbinia" was therefore driven through the water by nine screws, and the result was that she showed a great gain in speed; and held for a while the distinction of being the fastest vessel of any type in the world.



TURBINE PASSENGER STEAMER "QUEEN ALEXANDRA."
Length, 270 feet; beam, 32 feet; depth, 11 feet 6 inches; speed, 21.63 knots



TURBINES OF THE "QUEEN ALEXANDRA."

Railroad Transportation.

A RIDE TO CHICAGO AND BACK ON THE LOCOMOTIVE OF THE TWENTIETH CENTURY LIMITED.

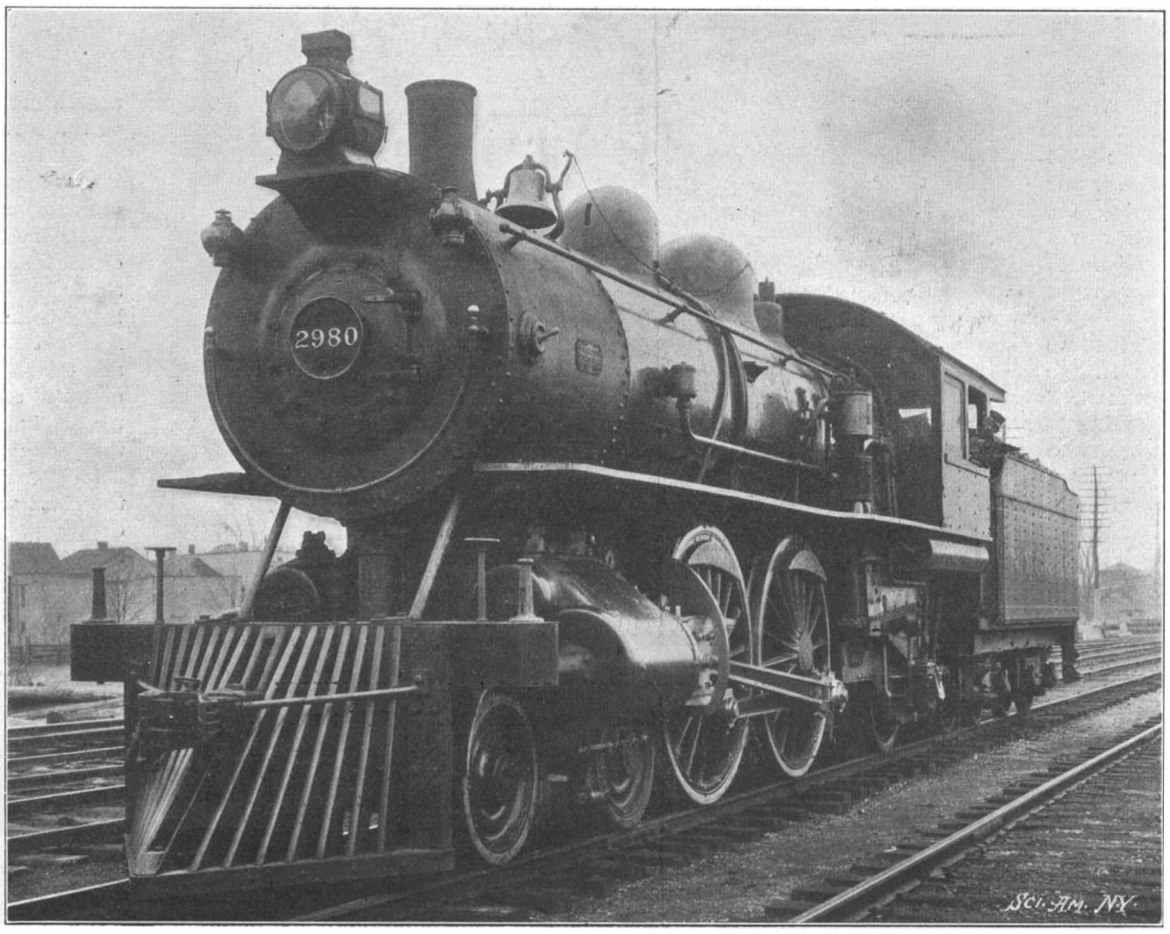
Time was when a passenger who wished to ride on the locomotive could obtain a seat in the cab for the mere proffer of a cigar. That, however, was long before the day of mile-a-minute trains. With the increasing speed and growing density of modern traffic, the restrictions that guard the "man at the throttle" have grown in severity, until to-day the private office of the president of the railroad is more easy of access than the locomotive cab of the humblest work train on his road; while as for a seat in the cab of an Empire State Express or a Twentieth Century Limited, it is a positive fact that the letters of request for a trip of this kind on file in the company's offices—all politely refused—are often subscribed by names that are not unknown to fame on both sides of the Atlantic.

Just how necessary is this precaution, the writer realized when he was flashing by the three hundred and thirty signals between Albany and New York, at from seventy to seventy-five miles an hour, and noted that no sooner was one signal seen by the engineer and verified by his fireman, than he was watching intently for the next; the successive signals swinging into sight around the curves, often at less than minute intervals. The man who holds that $400,000 train and the priceless lives of its passengers in his hand, must have no inquisitive and loquacious layman at his elbow; nor must the fireman, who is satisfying the hunger and thirst of a boiler that is eating up, hour by hour, the fuel and water demands of a 1,500-horse power locomotive.

It was with some such thoughts as these that the Editor of the Scientific American recently climbed into the cab of the Twentieth Century Limited, presented a letter from Vice-President Brown of the road, shook hands with Engineer Sherwood (who, by the way, has been at the throttle of fast New York Central trains for an unbroken period of thirty years) and, comfortably settled at the front end of the fireman's seat, commenced the first stretch of 143 miles of his 980-mile trip to Chicago.

A word just here as to these Twentieth Century trains. For several years past the fastest expresses have taken twenty-four hours to run from New York to Chicago; but last spring the New York Central and Pennsylvania roads agreed to run a train each way daily in twenty hours. The Pennsylvania road has the shorter but more hilly route, covering 920 miles; the distance over the New York Central and Lake Shore route being 980 miles. The trains are ordinarily made up of four cars weighing 240 tons, although, as we shall see, they include, over a large portion of the distance, a diner, and on the New York Central system an extra sleeper, which bring up the total train load to over 350 tons. The running speed on the latter road, including stops, is slightly under fifty miles an hour; but as the enginemen are expected to make up, if possible, any time lost through unavoidable delays, some remarkable running has been done. Thus, the Pennsylvania train on August 4, 1902, ran from Fort Wayne to Crestline, 131.4 miles, with one stop for water, in two hours and nine minutes, an average speed of sixty-one miles per hour; while even finer was the performance of the New York Central train, when with four and five cars it made up fifty-eight minutes from Rhinecliff to Buffalo, a distance of 350.4 miles, the speed, excluding seventeen minutes in stops, being 59.4 miles an hour. On another occasion this train left Syracuse fifty-one minutes late with five cars weighing 300 tons, and although taking on an additional fifty-ton car at Albany, passed Yonkers, 275.5 miles from Syracuse, on time. Excluding six minutes in stops, this is an average of 60.74 miles an hour, which was maintained in spite of the fact that there were no less than sixteen slowdowns.

On the round trip from New York to Chicago the writer spent just half the time, or twenty hours, in the cab, and rode on six different locomotives. For the whole round trip of 1,960 miles a dozen locomotives are required, the average distance of each run being about 163 miles. For the run to Albany one of the magnificent Central Atlantic type engines, designed last year especially for the heavy express service of the road, was coupled on. These are the most powerful fast express engines in the world. The object aimed at in the design was to provide a huge boiler with sufficient heating surface to insure a plentiful supply of steam at 200 pounds pressure, under the most exacting conditions of service. Ample grate and firebox surface are secured by extending the firebox across the frames, the internal width being 6 feet 3¾ inches, and the length 8 feet. The barrel of the boiler is 6 feet in diameter, and the heating surface reaches the enormous total of 3,505 square feet. The 21x26-inch cylinders would, at maximum effort, easily slip the four-coupled drivers; and, accordingly, by means of an air cylinder acting on a lever, an additional 10,000-pound load can be thrown on the drivers, increasing the tractive effort to 25,350 pounds.

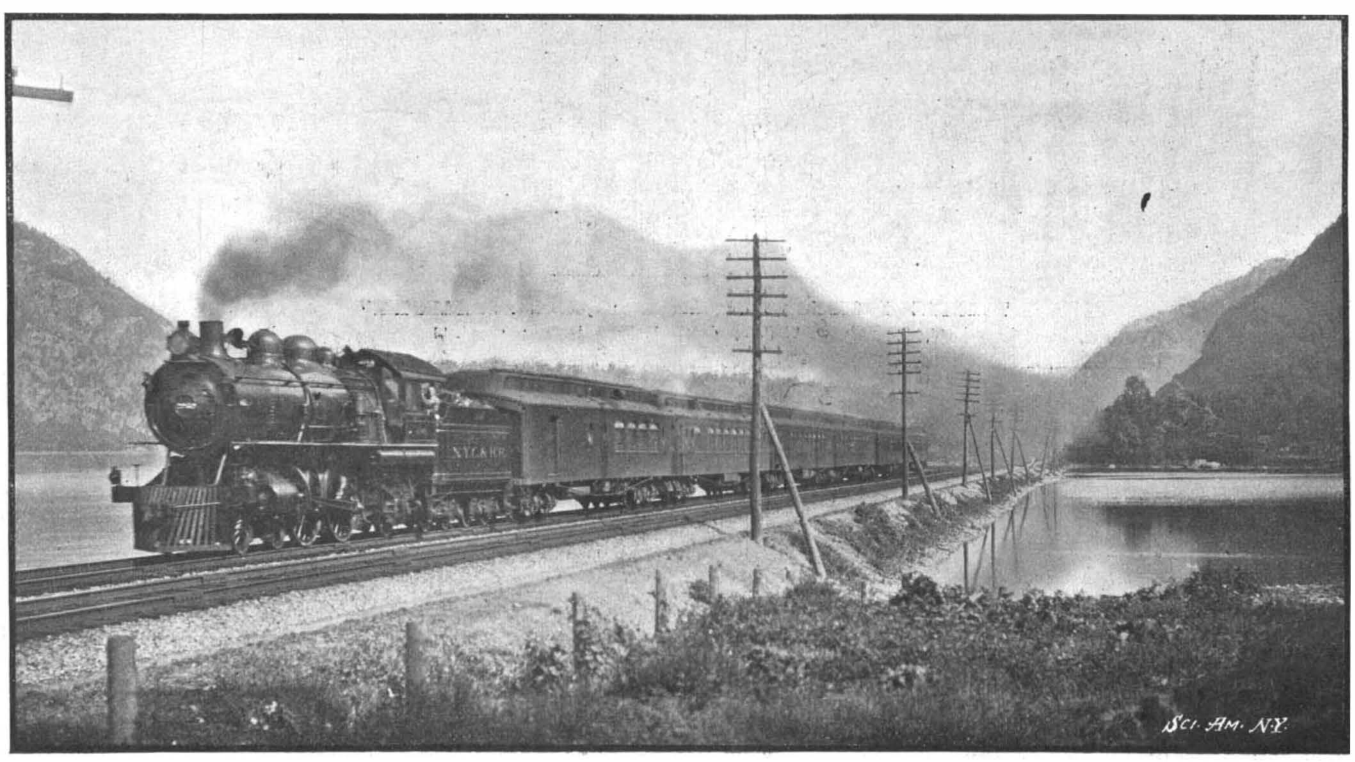


Cylinders, 21 by 26 inches; drivers, 79 inches diameter; weight of engine, 176,000 pounds; heating surface, 3,505 square feet; grate area, 50.3 square feet; steam pressure, 200 pounds; tractive effort, 25,350 pounds.

THE LOCOMOTIVE ON WHICH THE FAST RUN FROM ALBANY TO NEW YORK WAS MADE.

Of course, for such an engine a schedule speed of fifty miles an hour with a 227½-ton train was mere play; the opportunity to see what these engines can do when called upon for a supreme effort was to come on the return trip. Mr. Sherwood expressed regret that, being on time, he had no chance to "show what she could do," and on our nodding approvingly at the gage, which, in spite of the easy labors of the fireman, stood steadily at 200 pounds or slightly over, the latter patted the huge boiler affectionately as one might a favorite horse, remarking that the difficulty was "to keep her cool"—which the fluttering pop-valve proved to be true. The predominant impression, apart from the locomotive, left by this ride up the beautiful Hudson Valley, is of the magnificent condition of the roadbed and the faultless disposition of the signals. As we swung grandly around the curves or swept into the stretches of tangent, the signals stood out—first the "distant," then the "home"—sharp and insistent against the background. By the law of the road the fireman must verify each signal as a check upon the engineer; and at the proper moment to catch the earliest sight of a "distant," he would step to the window and shout "Right," announcing the signal, if it stood on a curve, a second or two before it came in the line of the engineer's vision.

Albany was reached at 5:33, two minutes ahead of time; and after a meal in the diner we boarded the engine—another of the Atlantic type—at Utica, for the experience of a dash by night in a crack express. The fifty-three miles to Syracuse are timed to be done in sixty-three minutes; but as some ten minutes are lost through the streets of Syracuse, and other minutes in various slowdowns, some very fast miles are covered. We were a trifle late in starting, and the engineer explained that as it was election night, and he would have to run "dead slow" through the crowded streets of Syracuse, he would do some fast running so as to have a few minutes in hand. Here then was the chance of a lifetime—a seat in the most powerful express engine in the world; a heavy train of 300 tons behind it; an engineer vouched for by the conductor as "nervy and fond of fast running;" a stretch of downgrade just a few miles ahead for a racetrack; and a night of impenetrable darkness to lend the last touch of half-fearful suspense to the trip. We gathered way quickly to a speed of a mile a minute, and before one



Albany to Spuyten Duyvil, 131.7 miles, was run in 131 minutes. Excluding the time lost in eight slowdowns, the average running speed was 68 miles per hour; weight of train, 352$\frac{7}{10}$ tons; of engine, 144 tons.

THE TWENTIETH CENTURY LIMITED MAKING UP TIME BETWEEN ALBANY AND NEW YORK.

had got his nerves quite to the sticking point, the fireman shouted that we were on the downgrade. The acceleration was rapid, and our stop-watch timing (the fireman calling off the mileposts) soon showed that we were making eighty-three miles an hour. That six-mile run by night was certainly the most thrilling experience in high-speed travel of a lifetime. We have stood at night on the bridge of the "Deutschland" when, with the "Kaiser Wilhelm" at her heels she was rushing at 27 miles an hour through a fog that shut the forecastle deck from view; and again when, to test her rough-weather ability, she was making twenty-four miles an hour against a full southwesterly gale; but from the standpoint of pure sensationalism those experiences were tame compared to this wild ride by night through the Mohawk Valley. To the writer, who was not by any means a stranger to locomotive riding, the experience was simply terrific—impossible of adequate description to the traveler whose gage of greater speed is the slightly increased swaying of a Pullman car. The sensations of such a ride strike at every avenue to the emotions; ear, eye, and touch are violently assailed. For the ear there is a "clang and clash and roar," so loud that one has to shout into the ear to be heard—there is the concussion of the moving parts of the engine—the jangling of metal against metal—the crashing impact of the driving wheels and trailers upon the track—while above all this strident orchestra, like some great organ note, is heard the deep, sustained roar of the exhaust from the smokestack. For the sense of touch there is the amazingly rough riding of the engine which, compared with a nicely-poised Pullman car, is as the movement of a springless farm wagon to a rubber-tired carriage. The unevenness of the track, slight as it is, is but little absorbed by the stiff locomotive springs, and when the driving wheels and the massive reciprocating parts—side rods, connecting rods, crossheads, pistons, weighing tons in the aggregate—are threshing round and darting to and fro to the tune of over 300 revolutions a minute, the great mass of the engine vibrates and lurches and rolls, until one feels that the only logical outcome would be for the structure to rend itself into a thousand fragments! Then, for the eye, there is the sense—at eightly miles an hour by night—of incredible speed. By day, objects approach slowly out of a far perspective; but by night they rush at you out of the near darkness in one mad whirl of ghostly shapes, punctuated by horizontal, rocket-like streaks of fire—the signals and station lights.

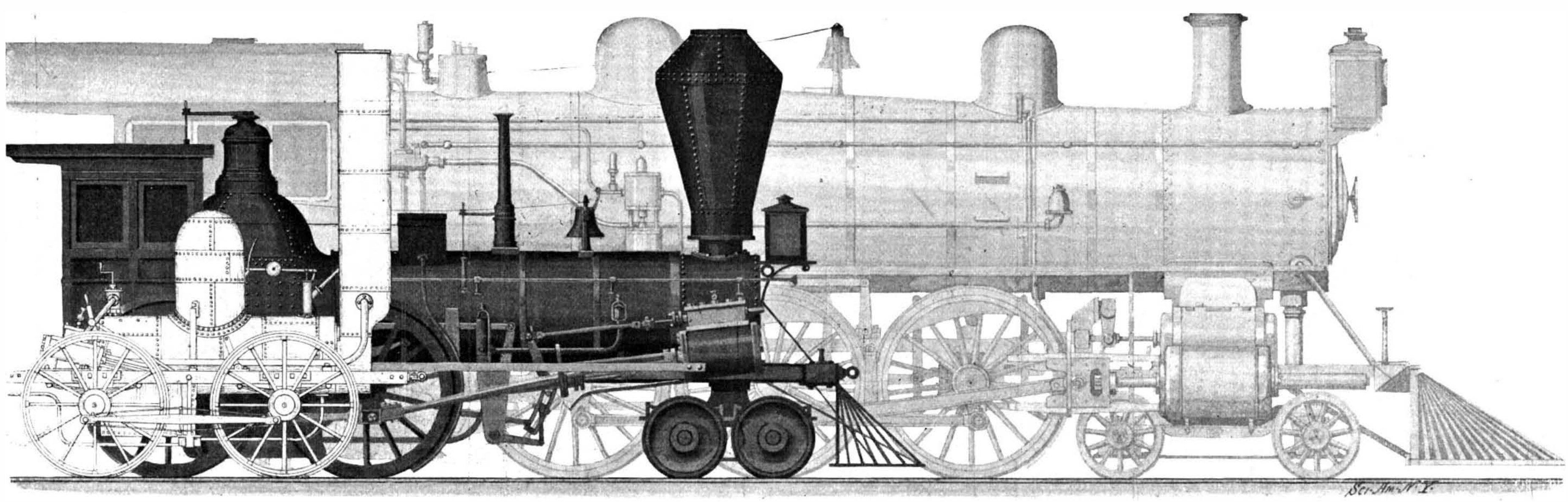
To the novice, the most thrilling moments come with the headlong dash through a station yard, where the tail-lights of a side-tracked freight train glare with their evil red eyes at you from the distance—surely they are on your own track—and you sweep down upon a mass of white lights, red lights, headlights, whirling hand lamps, dwarf signal lights below, and arc lights above, with two or three switching locomotives to heighten the crowded effect! Clear track? Absurdly impossible! I tell you, gentle passenger, lounging back there in the cushioned security and comfort of a Pullman, that should you sit here just now with me at the very front end of this roaring cataract of steel and fire, and realize that it is hurling you into that bewildering yard at over one hundred feet a second, with a stored-up energy back of you equal to that of a shell from a 13-inch gun—if you realized, as I did, that to develop that energy requires only a misplaced switch, a careless signalman, a broken rail or axle, you would understand how sublim[illegible]t be the faith of that quiet man at the throttle [illegible]e clean-cut profile you can just see silhouetted against the window of his cab) in the material, the men, and the management of that most wonderful of modern creations, a first-class trunk railroad.

The perfect faith of the engineer in the system was strikingly brought home on the return trip from Chicago. A delay in Cleveland had put the train twenty-five minutes late, and time was being made up with a powerful, Prairie-type, six-coupled, ten-wheeled engine with 20 x 28-inch cylinders and boiler to match. The engineer had congratulated us on the fact that because of the delay we should see some fast running, and we had just snapped the stop-watch on a two-mile run at seventy-eight miles an hour, when "Red" shouted the fireman, and with brakes hard down, we pulled up at a wayside station signal for orders. As we were starting again, the fireman courteously showed us the order, which read that from So-and-so to So-and-so the east-bound track was closed, and east-bound trains would use the west-bound track; No. 26 (our train) to have right-of-way over all trains. "What! Does this mean that we shall run against the traffic?" "It does." "But, surely, not at this speed." "Indeed, we shall." And indeed we did; for full out came the throttle, and soon we were sweeping into darkness (on the other fellow's track, mind you) with nothing between us and Heaven-knows-what but the faithful watchfulness of a train dispatcher, sitting in his office a hundred miles or more away. Sublime faith in a marvelous system, we thought, as we settled down for the only uncomfortable quarter of an hour of the whole trip. Twelve miles further on we passed the obstruction—a disabled freight train—and switched back to our own track.

Leaving the engine at Buffalo we crept at midnight, from the dirt and din of the cab, very tired, into the comfort and sweet linen of a lower berth, for a six-hour sleep to Albany. Here our letter made us known to Mr. Ryan, another New York Central veteran, who started in 1865 as a fireman, and for thirty-three consecutive years as engineman, has run heavy express trains through the Hudson Valley. The engine, another of the splendid Atlantics, was to make the record run of the whole round trip. With six cars of 352 tons total weight and a handicap of twenty-nine minutes, we set out to make up time. It was an ideal morning as we pulled out at 7.04, with a slightly favoring wind, and a dry rail. Two or three minutes were lost in going slow over the bridges and through the yard, and then we straightened out to what we judged to be fifty, sixty, and seventy miles an hour. Out came the stop-watch, and the next mile was made in forty-eight seconds. It did not seem like it, so as there were no slowdowns ahead, we timed for a complete five-mile stretch, which was done in exactly four minutes; and for the next five, which were also covered in exactly another four minutes, making eight minutes for the ten miles, or seventy-five miles an hour. Then came a slowdown to twenty-five miles through Hudson, then two slowdowns in succession for water, another for a sharp curve through Poughkeepsie; a slow to 12 miles an hour through a rock cut in the Highlands, another at Croton for water, and at Peekskill for signals. Each of these from a seventy to seventy-five mile speed meant a loss of one-half to two minutes before the high average was reached again; and yet we passed through Spuyten Duyvil, 131.73 miles from Albany, at 9:15, having covered the distance in 131 minutes.

To appreciate this performance we must remember that though the line is level, it is full of curvature, forty-eight miles, or over one-third, consisting of curves that vary from one degree to eight degrees. It is estimated that every degree of curvature is equal to 3-100 of a foot of rise in every 100 feet. Therefore, the resistance of dragging a train round a six-degree curve is equal to a rise of about ten feet to the mile. The estimate, however, is made for the fifteen-mile speed of freight trains, and for an express at seventy-five miles an hour it will be vastly greater. Exactly what it amounts to can only be conjectured; but its equivalent in grades would represent a track with decided gradients and with no downgrade to compensate. The engine was handled with the consummate judgment born of long experience. For the most part the throttle was three-quarters open, and the cut-off at one-third stroke. At the running speed, which finished with a burst from Yonkers to Spuyten Duyvil of 14.13 miles in 11:5 minutes (73.72 miles an hour over heavy curvature), the engine, under 203 to 204 pounds of steam, which she carried steadily, must have been indicating her maximum of 1,450 to 1,500 horse power.

It is a popular delusion that the engineers who run such trains soon break down under the strain; yet the two partners on the New York-Albany run of this train are to-day fine-looking men in the best of health. The work calls for nerve, of course, but as more than one of them told us they kept their nerves right by right living. A more temperate, intelligent and courteous body of men than these trainmen one must travel far to find; and it was with his usual insight into character that President Roosevelt went among their trusted representatives to select one of the arbitrators in a notable industrial controversy of the day.



DEWITT CLINTON. 1831.		ENGINE OF 1850.		ENGINE OF 1902.	
Cylinders, 5½x16 inches.	Boiler pressure, 80 pounds.	Cylinders, 16 x 20 inches.	Pressure, 100 pounds.	Cylinders, 22x28 inches.	Boiler pressure, 200 pounds.
Drivers, 54 inches.	Tractive effort = 919 pounds.	Drivers. 66 inches.	Tractive effort = 7758 pounds.	Wheels, 72 inches.	Tractive effort = 32,000 pounds.

SEVENTY ONE YEARS' GROWTH OF THE AMERICAN LOCOMOTIVE.

NOTES ON THE HISTORY OF THE AMERICAN LOCOMOTIVE.

BY HERBERT T. WALKER.

In the following notes on the History of the American Locomotive, we will pass over the various attempts to produce self-moving road carriages, and begin with the year 1802-3 when Richard Trevithick, of Cornwall, England, who is known as "the father of the locomotive," laid down the plans for an engine to run on the Merthyr Tydvil tramway in Wales. This, the first railroad engine in the world, embodied some of the salient features of the modern locomotive, namely, high pressure steam and a horizontal cylinder, the exhaust steam being turned into the chimney. This engine, which is illustrated in Fig. 1, hauled passengers and freight weighing about 10 tons at a speed of 5 miles an hour, and is said to have once attained a speed of 16 miles an hour, when running without a train. Its weight, 5 tons, was found too heavy for the cast-iron rails or "plates," and this objection, coupled with the fact that it was more expensive than horse traction, condemned it for commercial purposes. Like other great men, Trevithick was in advance of his time, and the world was not ready for him. He was, moreover, too easily discouraged by partially successful experiments, and, although he subsequently built improved locomotives—some of them having such familiar features of our modern engineering practice as a fusible plug in the crown sheet of the fire-box, and means for superheating the steam—he was unfortunate, and failed to command the capital necessary for developing his ideas. The antagonism of Watt also told heavily against him, and after a series of reverses he died in obscurity, and was laid to rest in a pauper's grave. It was only recently that the Institution of Civil Engineers reminded the nation of his true position among engineering heroes by erecting to his memory a memorial window in Westminster Abbey.

Passing over Blenkinsop's and Hedley's engines, which were but little more than continuations of Trevithick's designs, we come to the advent of George Stephenson, who built his first locomotive in 1813. Stephenson did not show the originality of Trevithick, and

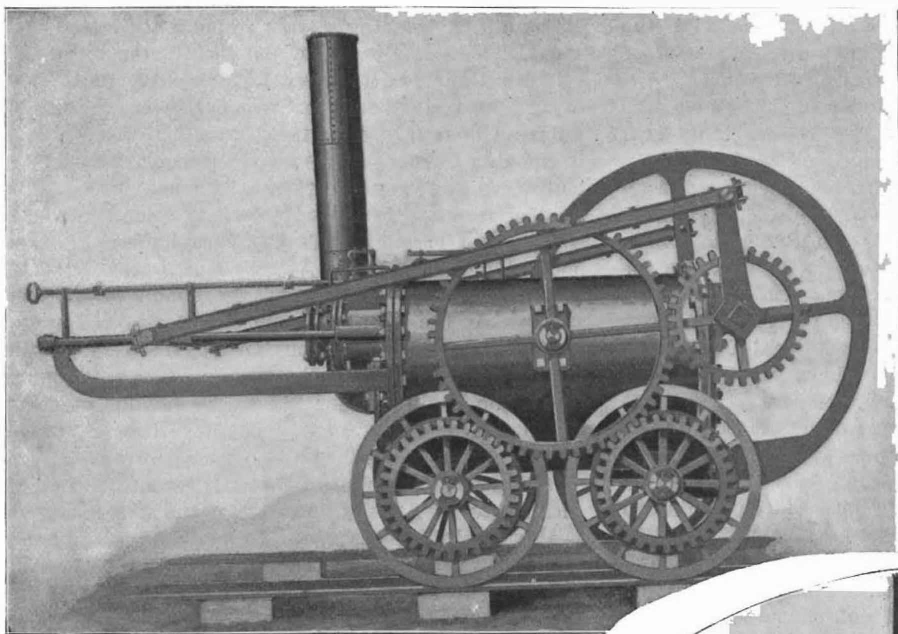


Fig. 1.—Trevithick's Engine. 1803. First Locomotive to Run on Rails.

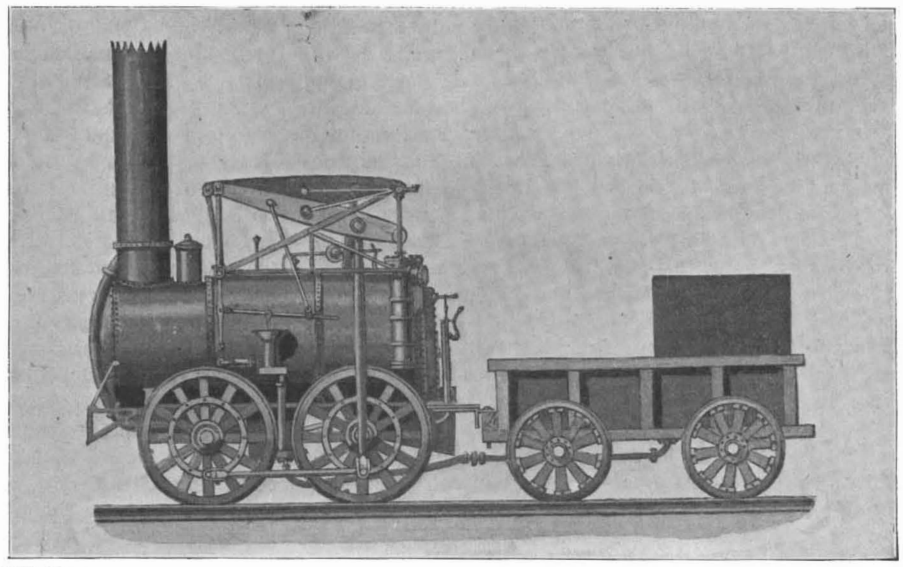


Fig. 2.—"Stourbridge Lion." 1828. First Locomotive to Turn a Wheel in the U. S.

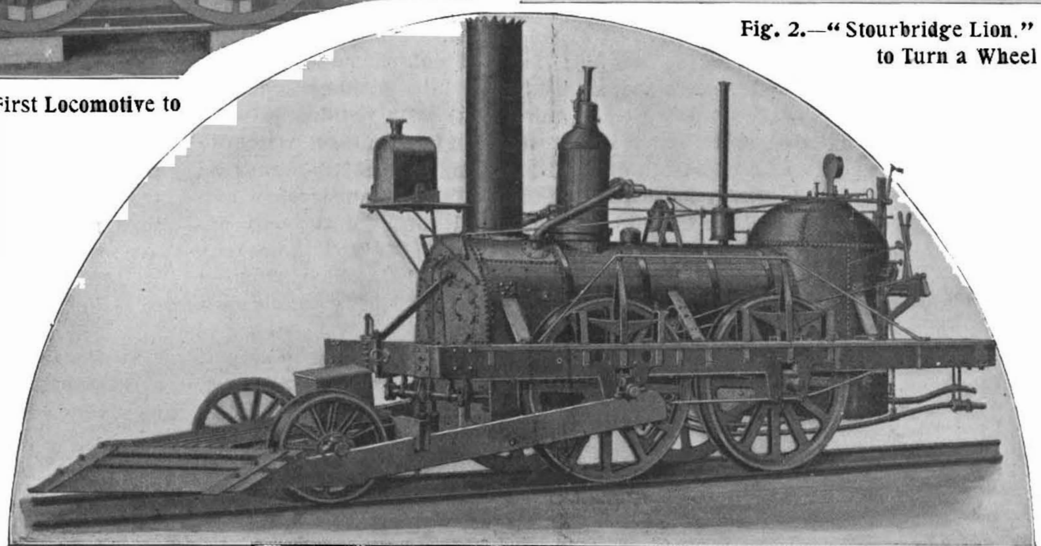


Fig. 5.—The "John Bull." 1831. Camden & Amboy R.R.

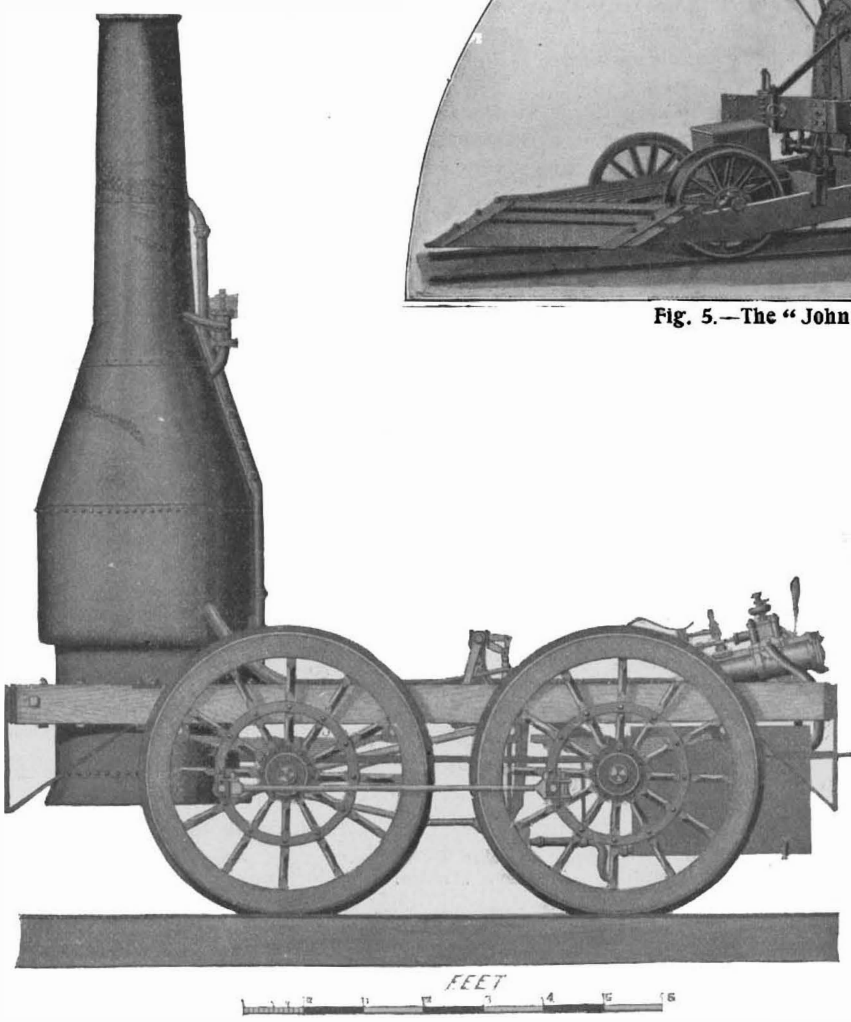


Fig. 4.—"The Best Friend" First Locomotive in Actual Service in U. S. 1830.

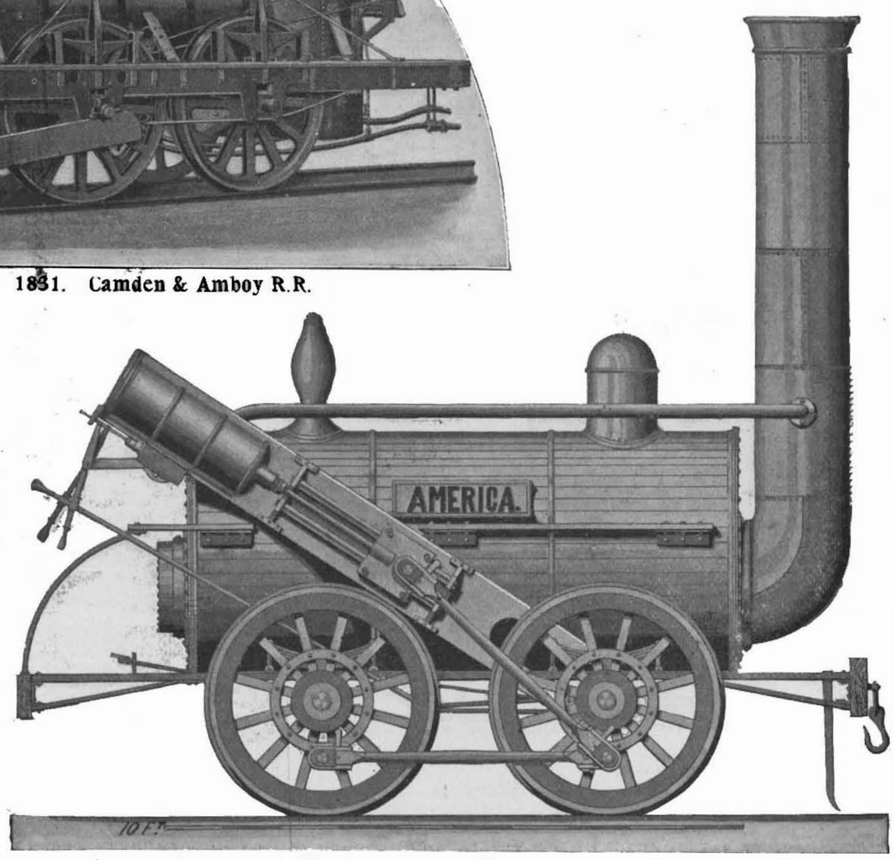


Fig. 3.—Stephenson's Engine. 1828. First Locomotive Seen in America.

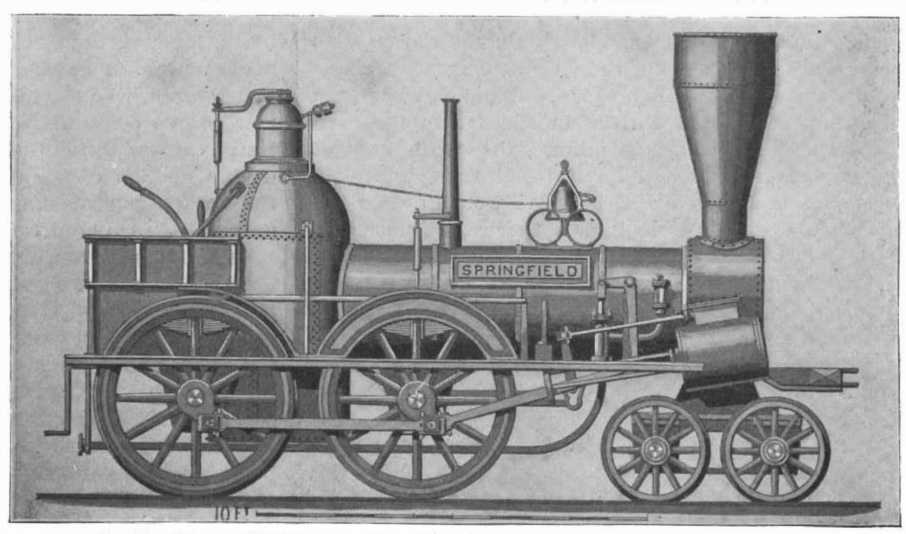


Fig. 7.—Rogers' Passenger Engine. 1845. Hartford & New Haven R.R.

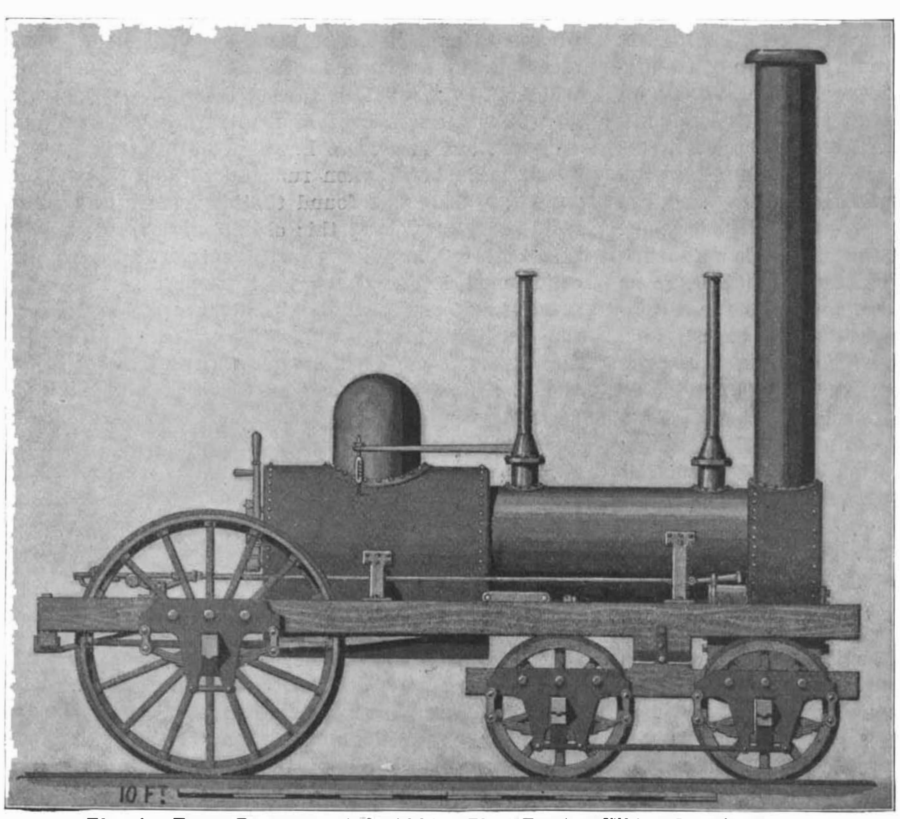


Fig. 6.—The "Experiment." 1832. First Engine With a Leading Truck.

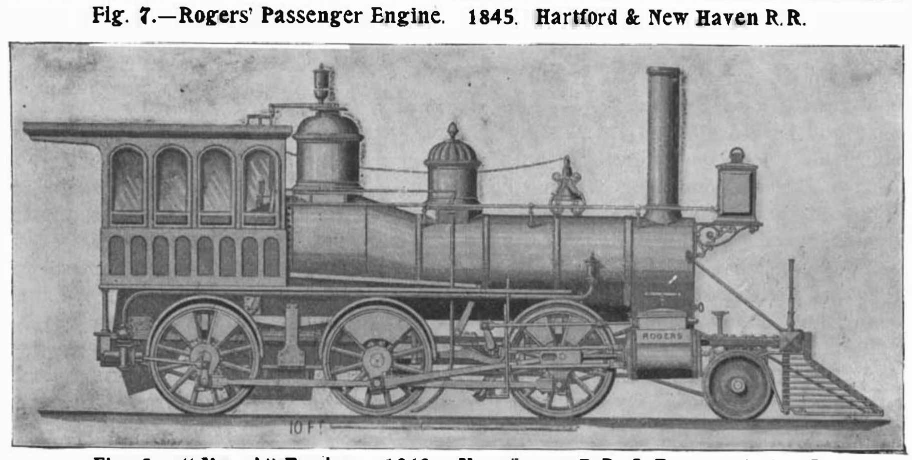


Fig. 8.—"Mogul" Engine. 1863 New Jersey R.R. & Transportation Co.

SOME TYPES ILLUSTRATING THE DEVELOPMENT OF THE LOCOMOTIVE.

cannot be said to have been a great inventor, but he was a man of indomitable energy and perseverance, possessing the rare combination of the engineer and the man of business. He also had the faculty of selecting the crude ideas of other inventors, putting them into practical shape and combining them with his own designs. This not only placed him at the head of his profession but enabled him to command the capital to build his own shops, which he opened at Newcastle-upon-Tyne in 1824. This factory is running to-day, and is the oldest locomotive works in the world.

SIX COUPLED WHEELS.

Here Stephenson developed some historical engines, among them being the "Experiment" for the Stockton and Darlington Railway, having six-coupled wheels and directly-connected inclined cylinders, the piston rods giving motion to the cranks by connecting rods, without any intermediate gearing. This engine was built in 1826 and was a landmark in locomotive history, introducing as it did one of the essential features of the modern locomotive; for up to this time Stephenson's designs showed no practical improvement over those of Trevithick and other makers. A fair example of the locomotive of this period was the "Stourbridge Lion," illustrated by Fig. 2. It was built by Foster Rastrick & Co., and was sent to the United States in the year 1828 for the Delaware and Hudson Canal Company's railroad. As it was too heavy (7 tons) for the rails it was soon withdrawn from traction service; but it was the first practical locomotive to turn a wheel in this country. In the same year Stephenson built the engine "America" (Fig. 3), which was also sent to the Delaware and Hudson Canal Company, and was the first practical locomotive seen in the United States, inasmuch as it arrived four months earlier than the "Stourbridge Lion;" but it was never used for traction service. This engine was of the same design as the "Experiment," except as to the number of coupled wheels.

THE "ROCKET."

Events followed quickly at this period, and in the year 1829 Stephenson produced his world-renowned "Rocket" for the Liverpool and Manchester Railway. This remarkable engine embodied a multitubular boiler, a blast pipe, direct-acting pistons (as in the "Experiment" and "America") and a water-surrounded fire-box. Stephenson appears to have originated these two latter features, and, by combining them with the others, he produced a locomotive which, aside from improved valve gear and some minor details, was substantially the same engine that is in use to-day. As a basis of comparison with modern engines we will note the chief dimensions of the "Rocket": Cylinders 8 inches diameter by 16½ inches stroke; diameter of driving wheels, 4 feet 8½ inches; boiler, 3 feet 4 inches diameter by 6 feet long; heating surface of tubes 117.75 square feet; fire-box heating surface, 20 square feet; total 137.75 square feet. Area of firegrate, 6 square feet; working pressure, 50 pounds per square inch. Weight of engine in working order 4 tons 5 hundredweight. Weight of tender loaded, 3 tons 4 hundredweight; total, 7 tons 9 hundredweight. At the celebrated Rainhill trials this engine hauled a coach filled with passengers at a speed of 24 miles an hour, and its average speed with a load of 13 tons was 15 miles an hour. On a later occasion it is said to have covered a mile in 60 seconds when running without a train.

Turning again to the United States it appears that the design of Stephenson's "Rocket," which established for all time the elements of the practical locomotive, had either not reached or had failed to impress American engineers, for we find in the years 1830-31 a variety of experimental locomotives having but little historical value. The most noteworthy engine of this group was that built by Peter Cooper, having an upright boiler with gun barrels for tubes; the cylinder was vertical and the exhaust was into the atmosphere. This engine was tried on the Baltimore & Ohio Railroad in 1830 and was the first locomotive built in America; but it was only run experimentally.

FIRST AMERICAN LOCOMOTIVE.

An important engine, historically considered, was the "Best Friend," designed by Adam Hall and constructed at the West Point Foundry, N. Y., which was put to work on the South Carolina Railroad in 1830. This, the first locomotive built in America for actual service upon a railroad, is shown in Fig. 4. The cylinders were 6 inches diameter by 16 inches stroke; driving wheels 4 feet 9 inches diameter; weight 4½ tons. The boiler was vertical and multitubular. This engine attained a speed of 35 miles an hour without a train, and with four or five cars filled with passengers it ran at the rate of 20 miles an hour.

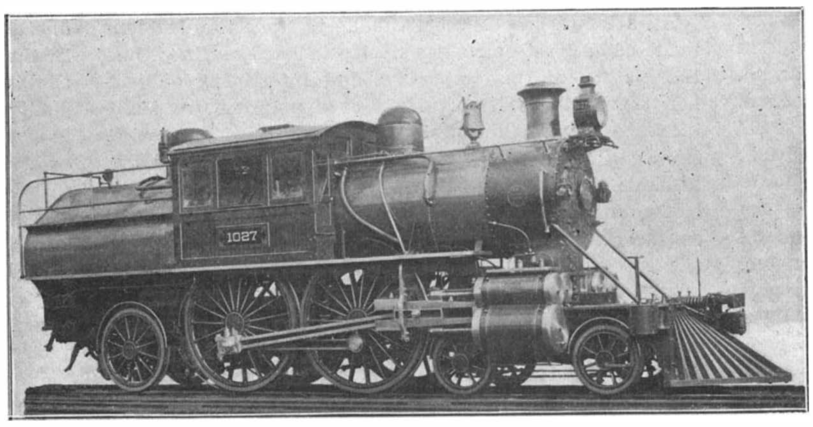


Fig. 9.—Vauclain Compound Engine. 1895. Atlantic City Railroad.

All the engines of American design built up to this date, while they were bold and original, possessed inherent defects which prevented their adoption for practical railroad work, so that engines of the Stephenson and Bury types continued to be purchased from England, in spite of the fact that they were ill-adapted to the sharp curves and rough tracks of our railroads. An example of the foreign-built engine of this period was the "John Bull," purchased of Stephenson & Co., which embodied an improved position of the cylinders, namely, inside connected and placed at the smoke box end of the boiler. This engine, shown in Fig. 5, ran for many years and is now in the Washington Museum.

THE LEADING TRUCK.

As before stated, the English engines were not adapted to American conditions, their rigid wheel bases causing constant derailments. Ross Winans and John B. Jervis experimented with swiveling, four-wheel trucks in 1831-32, and although trucks or "bogies" were used in England for many years prior to the period under notice, it appears that John B. Jervis is entitled to the honor of having first applied a leading truck to a locomotive. This engine, named "Experiment," is illustrated in Fig. 6. It was built in 1832 and did satisfactory duty on the Mohawk & Hudson Railroad, frequently attaining a speed of a mile a minute.

In this same year William T. James, of New York, invented a very important improvement in the locomotive engine, namely, the link motion. This valve gear is now used the world over and is the standard form of reversing and expansion gear. James's engine was totally destroyed by explosion of the boiler, and the link motion was lost sight of until ten years later, when it was reinvented in Stephenson's shops and applied to several English engines with complete success. The advent of the "Experiment" marked a period in American locomotive practice at which a departure from English designs commenced, and a process of adaptation to the peculiar conditions of the railroads in this country quickly followed. Among these changes we note the adoption of the bar frame in preference to the plate frame, although the bar frame was used in many early English engines.

EQUALIZING LEVERS.

The next step with a view to increased flexibility and more even distribution of weight, was the introduction in 1837-38 of equalizing levers in Eastwick & Harrison's "Hercules." With the bar frame, the leading truck and equalizing levers, the American locomotive became the best machine in the world for heavy loads and high speeds on a track that caused nearly every imported engine to come to grief sooner or later.

At about the same period the ever-increasing loads demanded an increase of adhesive weight, and the so-called "American eight-wheeler" appeared in 1837 built by Campbell and used on the Philadelphia, Germantown & Norristown Railroad. This engine had inside cylinders, but one of this type, with outside cylinders, was built by Norris in 1838 for the Baltimore & Ohio Railroad and was one of the earliest of that class, a good example of which is illustrated in Fig. 7. It was built in 1845 by Rogers, Ketchum & Grosvenor for the Hartford & New Haven Railroad. The cylinders were 11½ inches diameter by 18 inches stroke. Driving wheels 5 feet diameter. This engine was followed by Winans' "Camel" engine of 1848, having eight coupled driving wheels and weighing 25 tons. In order to ascend heavy grades Winans brought out his "Centipede" in 1852. This engine had eight coupled driving wheels and a four-wheel truck. The total weight of the engine was 45 tons, but it was eclipsed in 1857 by Milholland's twelve-wheel engine "Pennsylvania," its enormous weight of 50 tons being distributed over twelve coupled wheels of 3 feet 7 inches diameter. The cylinders were 20 inches diameter by 26 inches troke, and the heating surface was 1328 square feet. These, however, were special designs and were in advance of the common practice, the average weight of passenger engines in the early fifties being 20 tons, and of freight engines 30 tons. At the close of this period the domed fire-box gave place to the wagon top boiler, so that by the year 1853 the American passenger engine had assumed the form which it has to-day, the only difference being in matters of dimensions and weight.

The increasing weight of trains now demanded a tractive power beyond the capacity of the eight-wheeler, and additional coupled wheels came into use, the year 1846 marking the appearance of Norris's 10-wheeler "Chesapeake," the six coupled driving wheels of which were 3 feet 10 inches diameter and the cylinders 14½ inches diameter by 22 inches stroke; weight 20 tons.

At the beginning of the sixties the rapid increase in train loads called for heavier locomotives, and the "Mogul" engine (Fig. 8) built at the Rogers Works, with six coupled driving wheels and a two-wheel truck was adopted for freight purposes. The weight of this engine was about 35 tons When it was found that the

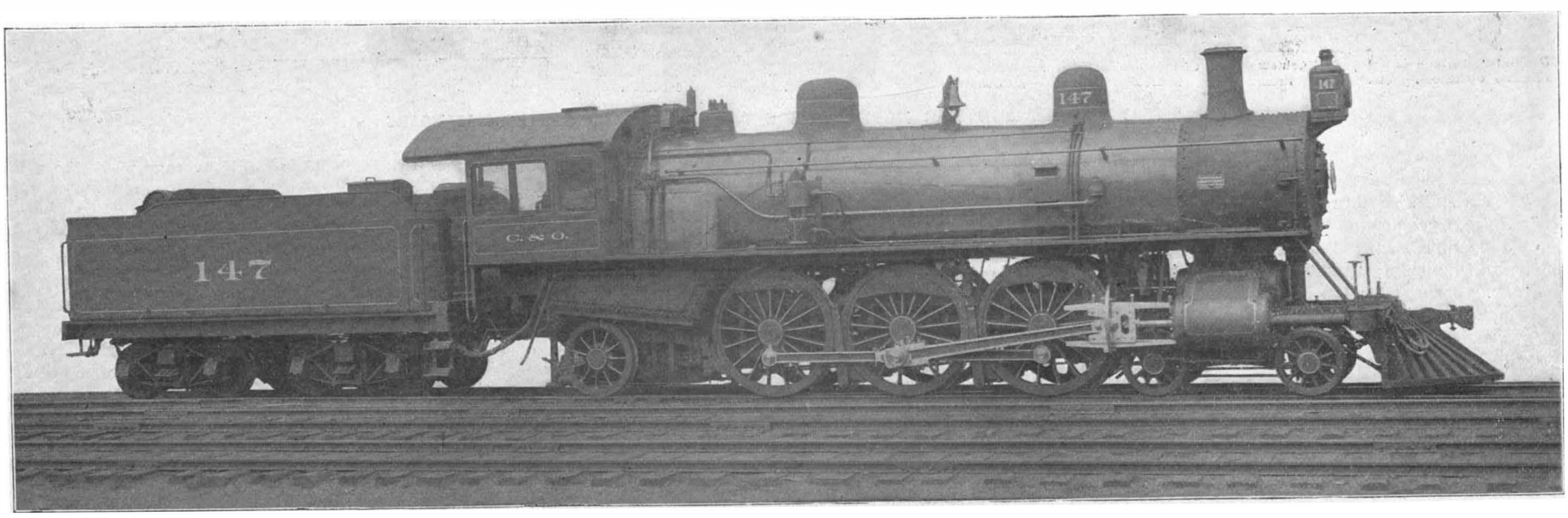


Fig. 10.–Largest Passenger Locomotive in the World. 1902. Chesapeake and Ohio Railroad.

SOME TYPES ILLUSTRATING THE DEVELOPMENT OF THE LOCOMOTIVE.

Moguls would haul more cars than the average freight engine, additional cars were soon forthcoming—the transportation department always keeping ahead of the motive power—and a fourth pair of driving wheels was embodied in the engine "Consolidation," built by Baldwin in 1866. This engine weighed about 45 tons, but in 1881 the "Mastodon," an engine with the same number of coupled wheels as the "Consolidation" but with a four-wheel truck made its appearance. This engine weighed about 50 tons and did some remarkable hauling at that time, its tractive effort being about 14 tons.

THE LOCOMOTIVE'S GROWTH.

It is of interest thus to note the enormous growth of the locomotive engine, for by referring to the dimensions of Stephenson's "Rocket," previously recorded, we find that the tractive effort of that engine was about 785 pounds, and compared with one of the latest powerful freight engines (No. 940), built at the Baldwin Works for the Atchison, Topeka & Santa Fe Railroad, not only Stephenson's locomotive, but all the others herein noticed are as pigmies to a giant, for "940" weighs 133½ tons; the diameter of the boiler is 6 feet 6¾ inches. The total heating surface is 5,390 square feet; grate area 58.5 square feet. Working pressure 225 pounds per square inch. The compound cylinders, four in number, are 19 inches and 32 inches diameter, with a common stroke of 32 inches. The drawbar pull is no less than 31 tons, sufficient to lift as a dead weight a passenger engine of thirty years ago.

Since the days of Watt, the question of the economical use of steam has been one of the most important, and much has been done by expanding the steam in a plurality of cylinders; but in the case of the locomotive it is a problem of peculiar difficulty by reason of the small compass within which the extra parts must be inclosed. Within recent years, however, many well designed compound engines have been built, a notable example being illustrated in Fig. 9, which shows an engine of the "Atlantic" type built at the Baldwin Works under the Vauclain patents. It will be seen that the cylinders are arranged in pairs, the high pressure above the low pressure, the piston rods engaging a common crosshead. The cylinders are 13 inches and 22 inches in diameter by 26 inches stroke. Piston valves are used, being placed on the inner sides of the high pressure cylinders. The driving wheels are 84 inches diameter, and the engine and tender together weigh 227,000 pounds. An average speed of 71 miles an hour has been maintained by this engine on a run of over fifty miles with a train of five or six coaches weighing 200 tons.

The latest of the "Atlantic" type are some fine engines built for the fast passenger service of the Pennsylvania and New York Central lines between New York and Chicago. Illustrations and particulars of the performance of the latter are given elsewhere in this issue.

As in 1836 it was found necessary to build four-coupled engines for "heavy" freight service, so about twenty years ago six-coupled engines for heavy passenger service came into the field, and it is noteworthy that some of the fastest speeds recorded have been attained by engines of this class, and in order to maintain high speeds with the heavy modern passenger coaches some remarkably fine engines have been placed in service, a striking example being illustrated in Fig. 10, which shows the largest passenger locomotive in the world. This engine was built for the Chesapeake & Ohio Railroad by the American Locomotive Company at their Schenectady works, and certainly does great credit to her designers. The cylinders are 22 inches diameter with a stroke of no less than 28 inches, so that with the 72-inch driving wheels and a steam pressure of 200 pounds on the square inch, the tractive power of this magnificent locomotive is 16 tons. The total heating surface is 3533.28 square feet, and the weight of the engine and tender in working trim is 154½ tons.

This class of engine is known as the "Mountain" type, and is coming rapidly to the front for hauling the fastest trains over exceptionally heavy grades.

On page 399 we give a graphic illustration of the growth of the American locomotive from 1831 to 1902, which, with the data given below the cut, needs no further explanation.

An attempt has thus been made to trace the development of the American locomotive in bare outline; but the history of this important and interesting subject has yet to be written. If it ever appears, we shall incline to share the opinion of John Bright expressed in one of his speeches in the House of Commons, when he said: "Who are the greatest men of the present age? Not your warriors, not your statesmen; they are your engineers."

THE RAILROAD SYSTEM OF THE UNITED STATES.

If one were called upon to name the field of engineering in which the vast scale upon which things are done in this country is most strikingly shown, he would be safe in pointing to the colossal railroad system of the United States. In respect of the total length of track, the total number of locomotives and cars, the veritable army of employes, and the gross value of capital invested, our railway system is so huge that it stands absolutely in a class by itself among the railroad systems of the world. It is equally true that in respect of the character of its track, rolling stock, its general equipment, and methods of operation, it is marked by national characteristics which distinguish it far more sharply from the great European and Asiatic roads, than they are distinguished from each other.

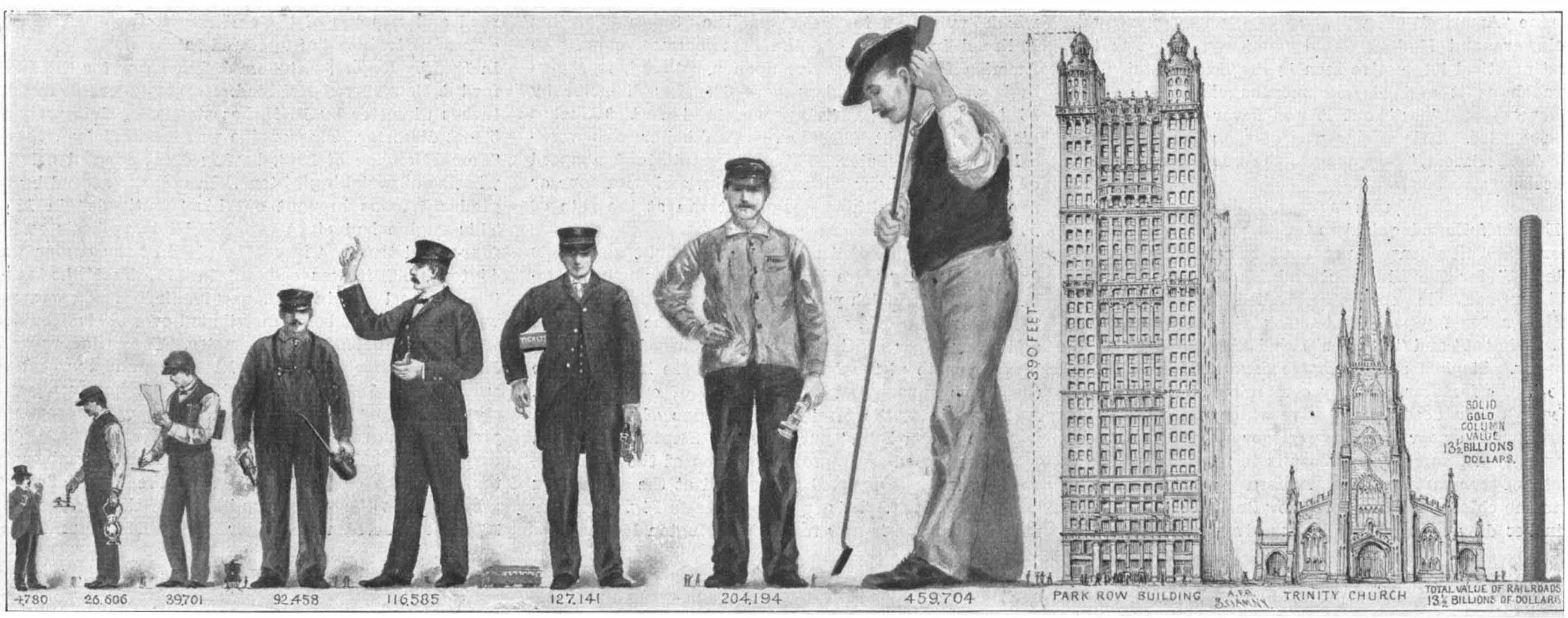
In attempting to impress upon the mind the magnitude of the properties and the operations represented by the statistics of such huge interests as the railroads of the United States, where the figures run into the millions and billions, it is necessary to translate these figures into concrete terms and refer them to some widely-known standard of measurement, whether of distance, weight, or bulk. In the present instance, our artist has endeavored—and we think very successfully—to transform the statistics of our railroads into concrete form by taking as a unit of measurement the greatest single constructive work of man, the great Pyramid of Egypt, with whose dimensions every voting American citizen is perfectly familiar, or if he is not, ought to be. From time immemorial the great Pyramid, being one of the original seven wonders of the world, has been a favorite standard of comparison with other great constructive works. It measures some 756 feet on the base by 481 feet in height, and contains about 91½ million cubic feet. Now, before we can use even this well-known standard and be sure that it will convey its full impression to the average reader, we must compare the Pyramid itself with some big and well-known structure, and for this purpose our artist has drawn the Capitol of Washington at the side of the Pyramid, both on the same scale. If it were possible to take a shell of the Pyramid, composed merely of the outer layer of stone, and place it over the Capitol, it would practically shut it out from view, and the apex of the Pyramid would extend 200 feet above the highest point of the Capitol's dome.

The total length of the railroads in operation in the United States at the close of the fiscal year 1901 was 195,887 miles, this total not including track in sidings, etc. If these railroads could be stretched out in one continuous line, they would be sufficient to girdle the earth at the equator more than eight times; or, if started from the earth and stretched outward into space, they would reach four-fifths of the distance from the earth to the moon.

STEEL RAILS.—Now, to arrive at an estimate of what it has taken in material to build this length of railroad, let us assume that a fair average size of rail is one weighing 75 pounds to the yard. Much of the track in the Eastern States weighs 80, 90 and 100 pounds to the yard, while most of the track west of the Mississippi weighs 70, 60 and in some instances as low as 56 pounds to the yard. On this basis it is an easy calculation to determine that the total weight of these rails is over 25,000,000 tons; and if the mass were melted and cast in solid pyramidal form it would contain 105,540,000 cubic feet, and would be over fifteen per cent larger than the great Pyramid itself. If the rails were cast in one rectangular block, it would form a mass 436 feet square on the base and equal in height to the Washington Monument, which towers 550 feet above its base.

RAILROAD TIES.—The railroad ties used in this country vary in size from a tie 8 inches wide, 6 inches deep and 9 feet long to ties as much as 12 inches in width and 8 inches in depth. A fair average would be a tie 10 inches in width and 7 inches in depth and 9 feet long, and a good average spacing would be 24 inches, center to center of the ties, or say 2,600 to the mile. On this basis we find that, could all these ties be gathered together on the Nile desert and piled one upon another into a pyramid of the same proportions as that at Gizeh, it would form a mass twenty-four times as great as the Pyramid of the Pharaohs, measuring 2,200 feet on its base and reaching 1,390 feet into the air.

ROCK AND GRAVEL BALLAST.—After the ties and rails have been laid in the construction of a railroad the ballast cars pass over it and unload their broken rock or gravel, which is tamped beneath and filled around the ties to form a solid but well-drained foundation. On some of our eastern roads the depth of the ballast will exceed 18 or 20 inches; on the other hand, some of the western roads have none at all, although of late years a vast advance has been made in the ballasting of the more cheaply constructed systems. Assuming an average depth of 12 inches of ballast, we find that if the railroad builders of the United States had concentrated their efforts, as did the Egyptians of old, on a single structure on the banks of the Nile, they would, in a period of years not much greater than that required to build the Pyramid, have raised a pyramid of their own 135 times greater in bulk than the tomb of Cheops. This vast pile would measure 3,900 feet on each side at the base, and would lift its head nearly half a mile into the air, or to be exact just 2,500 feet. Were the spirit of the great Cheops to return to earth, and attempt to pace off the distance around the base, it would have to step out some 5,000 paces, or say three miles, to make the circuit; and should it climb to the summit, it would have to make a journey of about three-quarters



General officers. Telegraph operators. Clerks, etc. Enginemen and firemen. Conductors and brakemen. Station agents and stationmen. Machinists and shopmen. Trackmen and laborers.

THE EMPLOYES AND THE MONEY VALUE OF THE UNITED STATES RAILROADS.

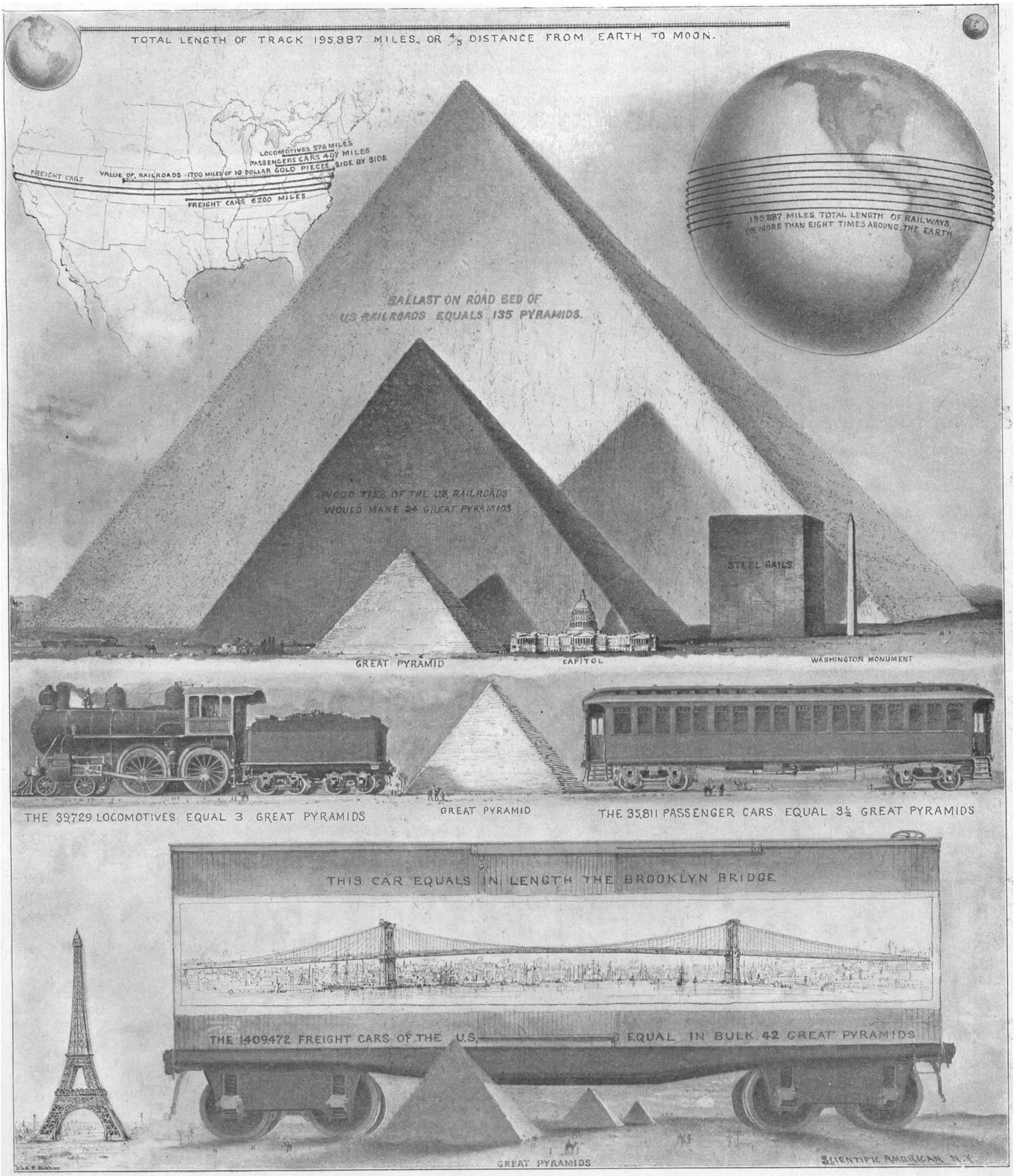
of a mile. So much for the roadbed and the track. Now let us turn our attention to the equipment.

LOCOMOTIVES.—At the close of the fiscal year 1901, there were in service on the United States railroads 39,729 locomotives. Assuming that the average locomotive fills a block 10 feet wide by 15 feet high by 50 feet long, and that all these locomotives could be brought into review at Gizeh and there piled up into one great block, a locomotive that would fill that block would be 510 feet in height and 1,700 feet, or say a third of a mile in length, its smokestack towering 29 feet above the summit of the Pyramid.

PASSENGER CARS.—There are 35,800 passenger, mail and baggage cars on our railroads, and a typical car representing the space occupied by these would be 500 feet high and 1,950 feet in length, and it would take 3½ great Pyramids to equal it in bulk.

FREIGHT CARS.—As far as the equipment is concerned, it is in the extraordinary number of the freight cars employed that we get the best idea of the great scale upon which our railroads are operated. The total number of cars is 1,409,472. They vary, of course, considerably in size, capacity and type, there being in addition to the familiar box car, the coal cars of various sizes and type, the freight cars, and a small number of miscellaneous cars for railroad construction and other purposes. A single box car representing the space occupied by all these freight cars would be two-thirds of a mile in length and one-quarter of a mile in height. The Pyramid of Cheops would reach about to the floor of the car. Were the Eiffel Tower set alongside of it, it would reach only two-thirds of the distance to its roof, while the whole Brooklyn Bridge, with its anchorages, could be placed bodily inside the car, and if the foundations of its piers rested upon the car floor, the summit of its towers would still reach only half way to the roof of the car.

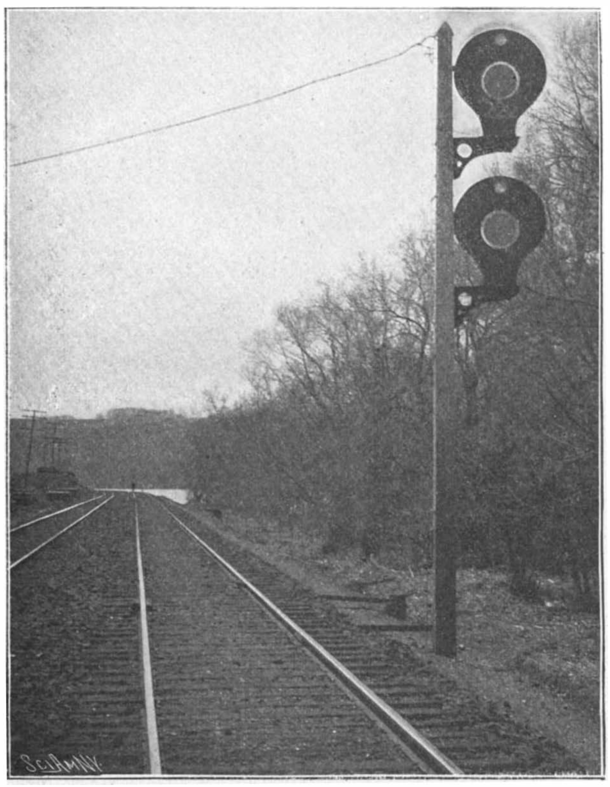
EMPLOYES.—It requires over one million employes for the maintenance and operation of our railroads. Of these nearly one-half are engaged upon the track and roadbed, in proportions made up as follows: There are 33,817 section foremen, each of whom has a stretch of a few miles of track under his charge, and a gang of from five to eight or ten section men, his duties being those of maintaining the track in proper level and line, seeing that the track bolts are kept tight, the joints in good order, and that the roadbed is properly trimmed, graded, and drained. The total number of trackmen employed in the section gangs, as they are called, is 239,166. There are also 47,576 switchmen, flagmen, and watchmen, who are engaged in switching work at the yards, in guarding the level crossings, and in patrolling the track. There are also over 7,423 men employed on work trains and other work incidental to track maintenance. In addition to these there are 131,722 laborers engaged in construction and repair and maintenance work of various kinds,



Comparisons Showing Length of Railroads and Bulk of Track and Equipment.

THE GREAT RAILROAD SYSTEM OF THE UNITED STATES.

making a total engaged on track work and general labor connected therewith of 459,704 men. Carrying out our system of comparison with some standard of bulk, we have chosen the Park Row Building, New York, which has a total height of 390 feet. If this army of trackmen and laborers were combined in one typical giant, he would be some 385 feet in height and of proportionate weight and bulk. The next largest item is the machinists, of which there are 34,698, the carpenters, of which there are 48,946, and various other shopmen engaged in the repair and general maintenance of the rolling stock to the number of 120,550, making a total number of skilled and unskilled men in the railroad shops of 204,194. The next largest total is that of the station agents, baggage masters, porters, etc., there being 32,294 station agents and 94,847 baggage masters, porters, etc. Then follow the conductors and brakemen, 32,000 of the former and 84,493 of the latter. There are 92,458 enginemen and firemen, 45,292 of the former and 47,166 of the latter. Employed in the general offices of the various railroad companies, in performing the vast amount of clerical work required, there are 39,701 clerks, while sheltered under the same roof is a body of men upon whom as much as or more than any other in the whole army of railroad employes falls the responsibility of the safety of trains and passengers—the telegraph operators and dispatchers, of whom there are altogether 26,606. The smallest in number, but controlling the whole of this vast organization, are the general officers, presidents, vice-presidents, treasurers, secretaries, etc., of whom there are 4,780.



The upper disk is a red home signal; the lower is a distant signal, green. Both indicate that their respective sections are occupied.

Fig. 1.—Hall Automatic Block Signals on the Philadelphia and Reading Railroad.

Money Value.—Perhaps, after all, the most remarkable figures are those which show the total value of the railroad system of the United States, which expressed in figures is 13,308,029,032 dollars. If this sum were represented in ten-dollar gold pieces, and these pieces were set on edge, side by side, they would reach more than half way from New York to San Francisco, or 1,700 miles. Or were this coin melted and run into a single casting, it would form a column 15 feet in diameter and 259 feet in height.

Railroad Signals.

BLOCK AND INTERLOCKING SIGNALS.

BY B. B. ADAMS.

Signals have come during the last dozen years to be an important feature on many railroads, where, a short time ago, there were but scattered plants here and there. The great increase in traffic has necessitated the introduction of block signals to space fast trains; and at terminals, junctions and large yards interlocking signals are now necessary to celerity and safety, to say nothing of economy. Over 25,000 miles of American railroad are now worked by the block system, and the interlocking machines in yards and at crossings and drawbridges aggregate over 40,000 levers; and it may be remarked in passing that the next few years ought to witness the doubling of these figures. On about 4,000 miles of the 25,000 the signals are automatic, and the more recent installations of these signals embody numerous ingenious refinements in this class of machinery. There is a healthy rivalry between the makers of the different designs, so that within a hundred miles of New York one may see four or five different kinds of automatic signals. The automatic signal is a distinctively American development, the railroads of Europe having only recently begun to take an interest in it, and our illustration, Fig. 4, shows four signals in one of the latest installations—that on the Pennsylvania Railroad westward from Philadelphia. This is a four-track railroad, each track being used only for trains in a given direction.*

As the reader already knows, the essential feature of the automatic block signal is an electric current flowing through the rails of the track. The signal being at the entrance of a block section, which is, say, three-quarters of a mile long, the battery for the current is at the outgoing end; and when the rails of the track, throughout the section (and also the rails of side tracks and crossovers, so far as they foul the main track) are clear—not occupied by wheels at any point—the circuit of the battery is through the right-hand rail of the track to the electro-magnet at the signal, thence to the left-hand rail and by that back to the battery. This circuit being closed, the electro magnet at the signal is energized and holds the signal, through the medium of a stronger electro magnet, worked by a local battery, in the *all-clear* or go-ahead position. The entrance of a train short circuits the current through the wheels and axles, de-energizing the electro-magnet (relay); and the signal, by force of gravity, assumes the stop position, thus warning the next following train not to enter the section. The signal remains at "stop" until every pair of wheels has passed out of the section. The signals marked *A* 17 in the illustration Fig. 4 are for the two westbound tracks of a four-track railroad; those on the right-hand mast being for the right-hand or outer track, and those on the left-hand being for the inner track. The lower arm on each post is a distant or cautionary signal, informing the engineman of the position of the "home" or stop signal at the entrance of the next succeeding block section.* This provision is made for the purpose of avoiding loss of time during fogs, or whenever the engineman can not see a stop signal until he comes within a short distance of it. With the distant signal, he has notice about 4,000 feet before reaching a home signal whether or not he is to expect to a stopped by it; so that in spite of fog or darkness he may run as fast as he pleases,

* The upper arm (home signal) on the right-hand mast is at "stop," protecting from following trains the train seen in the distance. The lower (distant) arm, being also horizontal, indicates that the home signal of the next succeeding block section may be expected to be found in the stop position. The arms on the left-hand mast are for the second track. Both of these indicate "all clear," showing that on that track the next two block sections are unoccupied. The signals at the extreme left of the photograph, which are for the two eastbound tracks, indicate that both those tracks are occupied in the section immediately ahead, and also in the one next beyond. The train on one of the tracks is seen in the illustration, the arm having assumed the stop position immediately after the first wheels of the engine passed the signal.

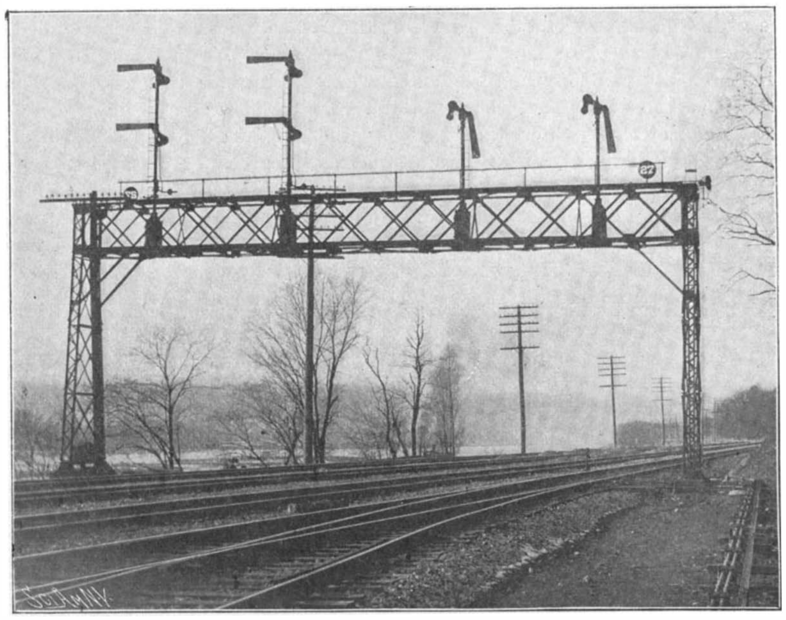


Fig. 2.—Grafton Three-position Automatic Block Signals on the Pittsburg, Fort Wayne and Chicago Railroad.

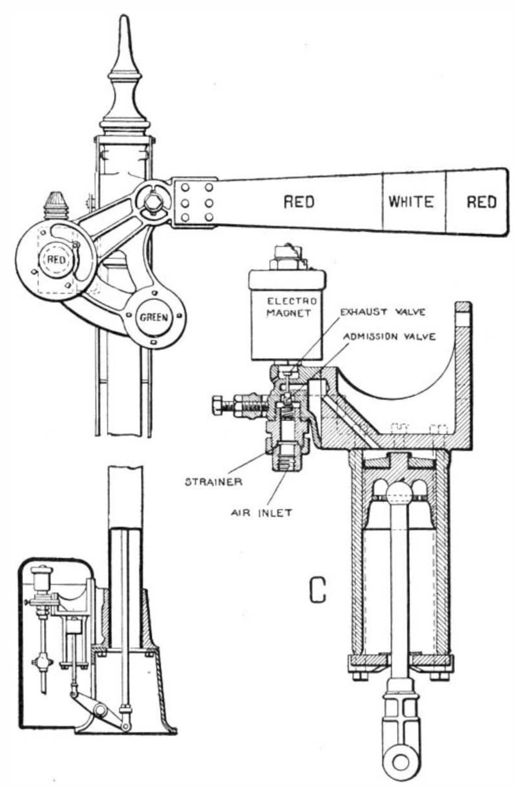


Fig. 3.—Details of Electro-Pneumatic Semaphore.

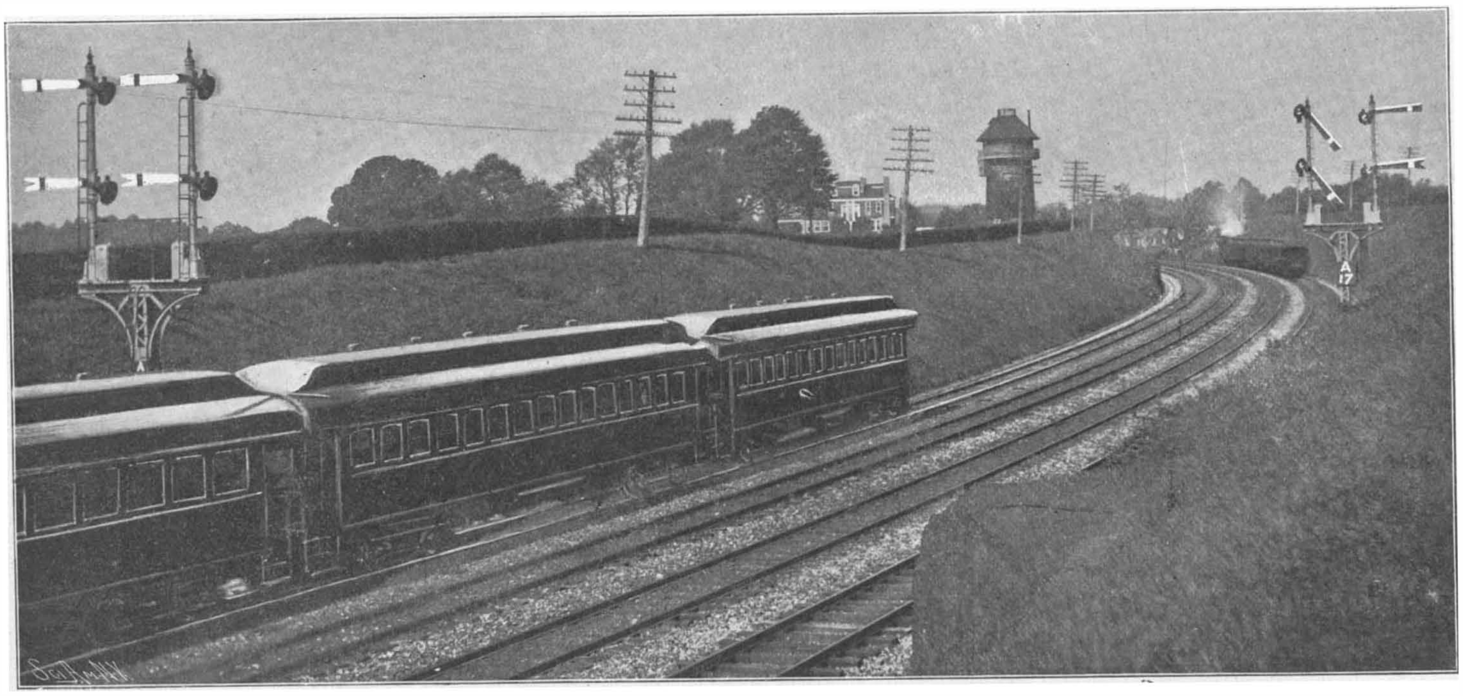


Fig. 4.—Westinghouse Electro-Pneumatic Semaphore Block Signals on the Pennsylvania Railroad.

BLOCK AND INTERLOCKING SIGNALS.

The New York Air Brake Co.

C. A. STARBUCK, President.
J. C. THOMPSON, Secy-Treas.

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BEST MATERIALS.

They are in constant use on many thousand freight cars, locomotives and passenger cars, and

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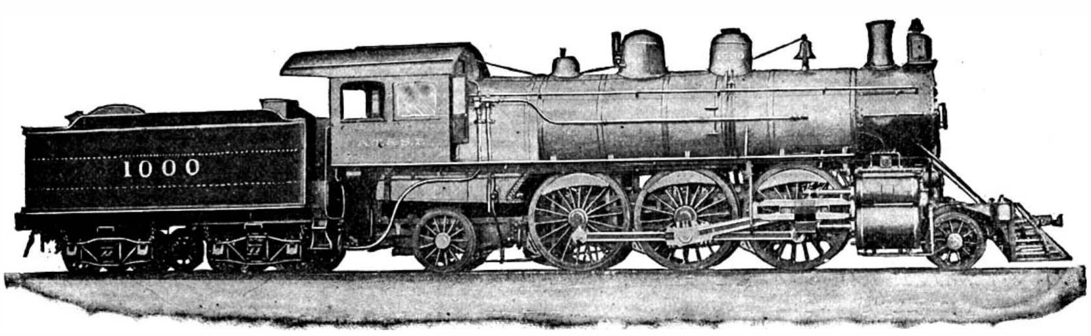
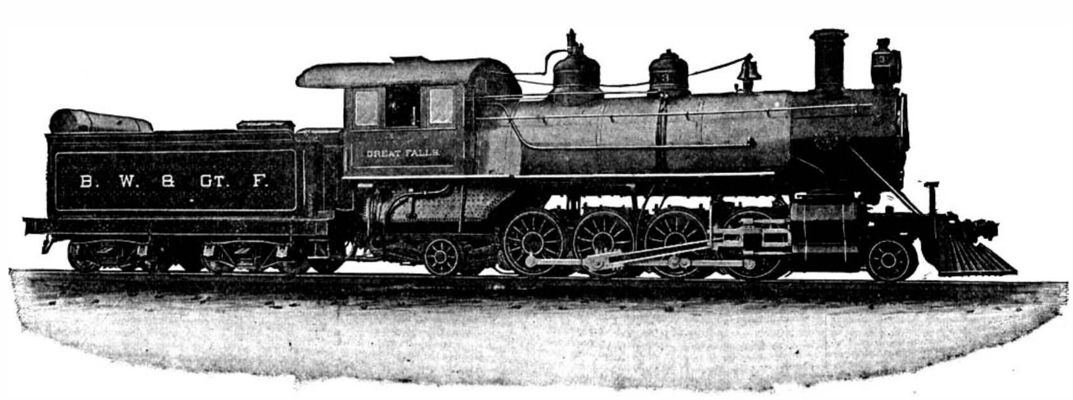
BALDWIN LOCOMOTIVE WORKS



SINGLE EXPANSION
AND COMPOUND
HEAVY OR LIGHT

LOCOMOTIVES

FOR BROAD OR NARROW
GUAGE
FOR MINE, FURNACE
PLANTATION
OR INDUSTRIAL PURPOSES



Electric Locomotives with Westinghouse Motors and Electric Trucks

BURNHAM, WILLIAMS & CO., PHILADELPHIA, PA., U. S. A.

within a limit of a rate of speed which will permit him to stop within a distance of 4,000 feet. The distant signal is controlled by the movements of the corresponding "home" through the medium of a wire on poles; or, by means of a polarized relay, it can be controlled by the track circuit of the section between the home and its corresponding distant. This does away with the line wires and obviates certain disturbances by lightning.

These signals are the Westinghouse electro-pneumatic; the power for moving the arm to the downward or all-clear position being compressed air, at about 70 pounds per square inch, acting through a cylinder fixed in an iron box at the foot of the mast. This cylinder is shown in section at *C*, Fig. 3. The pneumatic pressure is conveyed from a compressor to the several signals along the line, for a distance of 10 to 20 miles, by means of an iron pipe buried in the ground. As will be seen from the detail view, the air, entering the cylinder at its upper end, forces downward a piston which by its lever pushes up the signal rod (inside the cylindrical iron mast) and thereby moves the arm of the signal downward. On the release of the pressure from the cylinder, which occurs when a train enters the block section, the signal arm flies to the horizontal or stop position by gravity, the casting on its left-hand end, with the vertical rod within the post, furnishing the weight to do this. An accidental failure of air would have the same effect, throwing the signal to the stop position, thus bringing to a stand any train which might come along, and compelling the engineman to report the cause of the failure, which the inspector then finds and removes. The construction of the electro-magnetic valve whereby the track circuit, when closed, keeps the cylinder *C* charged with air, will be understood from an inspection of the drawings. The de-energizing of this magnet, on the entrance of a train, is due to the fact that nearly all of the electric current flows from one rail to the other through the wheels and axles of the cars, as before explained. In Fig. 4 the lamps on the left-hand mast of signal *A* 17 show an uncolored ("white") light indicating at night "all clear." When the arm of a home signal assumes the horizontal or stop position a red glass comes in front of the light, giving the stop indication. On a number of prominent railroads the all-clear indication is now green instead of white; and in such cases the distant signal also shows green for all clear, while for the caution indication the distant is made to show, on some roads yellow, and on others a combination of red and green, a red light and a green light being fixed close together, side by side.

Fig. 5.—Signal Cabin at the Grand Central Station, Chicago.

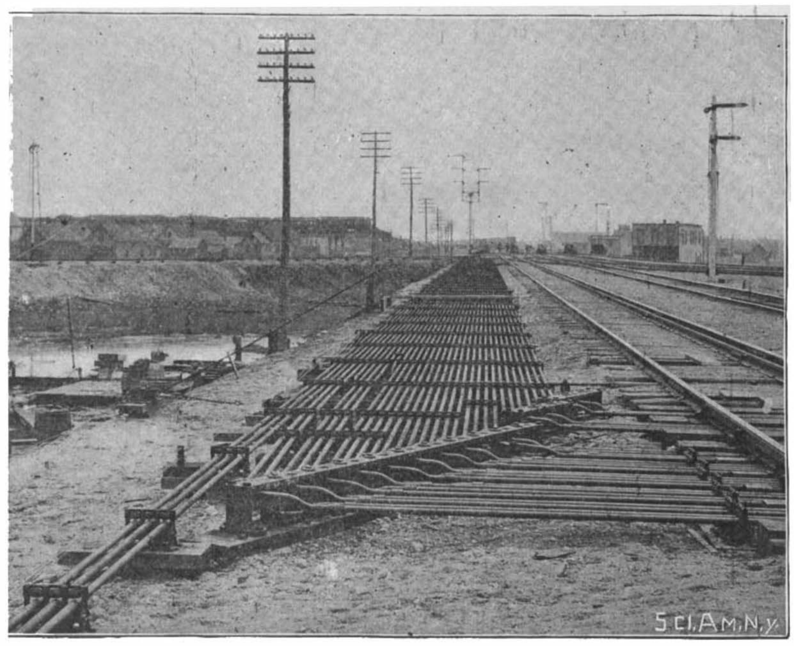
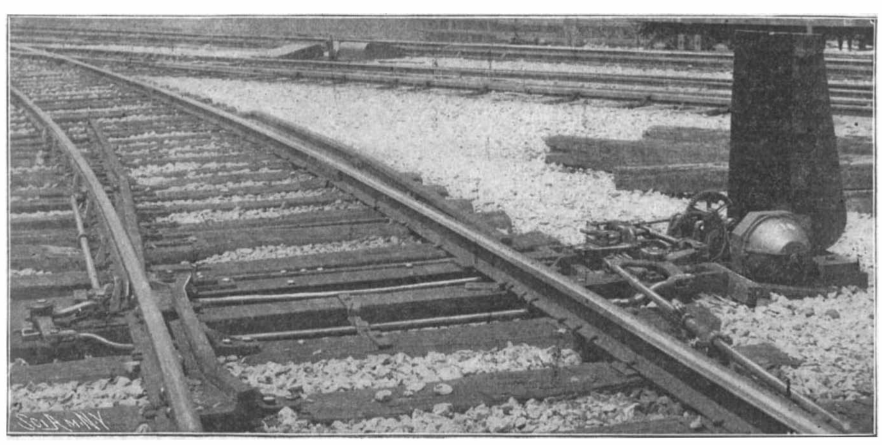


Fig. 6.—Connections from Cabin to Switches and Signals.

The signal just described is the semaphore. This is the type most extensively used, because it is easily discernible under adverse conditions; but on a number of roads the disk is the favorite for automatic signals. Fig. 1 shows Hall automatic disk signals—a home and distant—on the Philadelphia & Reading. The Hall signal was the pioneer of its kind, and so well was it designed that those of the latest designs are substantially identical in their main features with those put up more than thirty years ago. The disk signal is worked wholly by the power of the electro-magnet, requiring no compressed air or other costly force. The disk, which is of silk or other light fabric, stretched on a ring, is balanced on a pivot and is controlled by the armature of the electro-magnet. In the engraving both disks are visible. The upper (home) indicating stop and the lower (distant) indicating caution. They remain in this position by force of gravity. The section of track covered by this home signal is now occupied by a train (beyond the curve). When this train clears the block section the energizing of the magnet lifts the disk so that it is concealed within the case, and its absence, showing the white interior of the case, indicates "all clear." As in all automatic signals, a failure of the electric current or the presence of a pair of wheels on the track within the section, withdrawing the current, will cause the stop signal to be displayed.



The switch in the illustration is a derailing switch. The detector bar is seen at the left of the left-hand rail.

Fig. 7.—Electric Motor for Switch.

In Fig. 2 we see the three-position signal, which has found considerable favor during the past few years. In this arrangement the single arms serve both as home or positive signal and also as a distant or cautionary. For example, the one at the right, in the cut, when horizontal, indicates stop; when hanging downward at an angle of 45 deg. from the horizontal it indicates all clear for this section, but means also (the same as a distant signal) "be prepared to stop at the next signal;" when downward in a practically vertical position, as shown in the cut, it indicates all clear for its own section and also indicates (performing the function of the distant signal) all clear for the next succeeding block section.

These signals are worked by an electric motor fixed in the box at the foot of the post, a motor for each post. All of the motors along a stretch of 10 to 20 miles of line are actuated by energy from storage batteries, which are kept in wells sunk in the ground near the signal, and the batteries in turn are charged by a dynamo situated at a central point. The double copper feed-wire is strung on the telegraph poles. Signals moved by electric motors are now made by a number of different companies and are in use on half a dozen roads.

INTERLOCKING.

Block signals are noticed and appreciated by everybody, because their beneficent office in preventing collisions is at once understood; but interlocking is equally important in its sphere; and it is often a more direct money-saver. In a crowded yard the *concentration* of the switch and signal levers in one cabin saves innumerable steps and enables one man to do work formerly done by five or more; and the interlocking of one lever with any other lever in the same frame prevents this one man from becoming confused by the multiplicity of operations that he has to perform, and giving conflicting signals which would lead to a collision of trains; and the two—concentration and interlocking—are the advantages for which a railroad will spend from $25,000 to $200,000 at a large yard.

The most common form of interlocking is that in which the several switches are connected to levers in the cabin by rods (gas pipe) supported on rollers close to the ground. The levers moving these rods, perhaps twenty, fifty or a hundred in a single frame, are all mounted on the same axis. For signals (but not for switches) wires may take the place of the rods. The common types of interlocking are no doubt familiar to the reader. Fig. 6 shows a part of the "lead-out" and connections of a large plant in Chicago. Such large bodies of rods as that here shown are usually covered with wooden boxing, so that the yardmen will not stumble over them.

In crowded yards it often occurs that the space occupied by the signal rods is needed for tracks or buildings, and for this and other reasons compressed air and electricity have been introduced for working the switches and signals, the air pipes or electric wires being buried in the ground. The most familiar type of the power switch-and-signal machine is the electro-pneumatic, in which the functions are performed on the same general principles as with the block signals shown in Fig. 4; the signals of an interlocking plant being worked by pneumatic pressure as shown in Fig. 3. A cylinder for a switch is fixed horizontally on the sleepers at the side of the track. The completion of the movement of a switch is made to convey an electrical

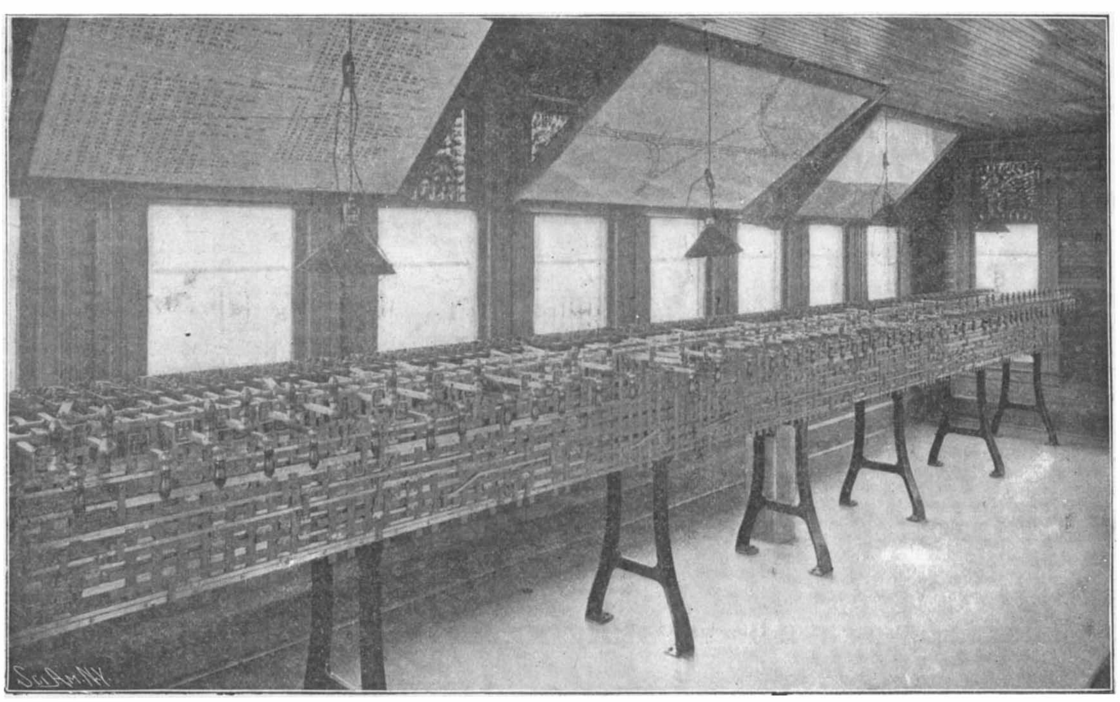


Fig. 8.—Taylor Signal Company's Electric Interlocking Switch and Signal Machine with Case Removed

BLOCK AND INTERLOCKING SIGNALS.

"indication" to the cabin to insure that the go-ahead signal for that switch shall not be given prematurely. Besides the usual mechanical interlocking of one lever with another, the electro-pneumatic machine provides numerous additional safe-guards in the way of magnetic locks. With a power machine the work of the signalman is reduced from that of pulling levers, weighted with heavy loads, to the turning of the extremely light handles at the front of the machine. By these handles long horizontal rods are rotated on their axes, and these in their revolution close the electric circuits (thereby actuating the air valves) in proper sequence. The interlocking is effected by longitudinal and transverse rods at the top of the machine. In some machines a diagram of the yard is attached to the machine, and metal strips represent the tracks; and these are movable, so that every operation which takes place on the ground, by the act of the signalman, is repeated before his eyes in the cabin.

At the Grand Central station, in New York city, and at various other large yards, the switches and signals are worked by the low-pressure pneumatic system. With this no electric power is required, the electro-magnet at the operating cylinder being supplanted by a diaphragm valve. The air-valve—one at each signal cylinder and one at each end of each switch cylinder—is opened or closed by the movement of a circular flexible diaphragm, moved up or down a quarter of an inch, by air at a pressure of seven pounds per square inch conveyed in a half-inch pipe from the cabin.

In the operating pipes the pressure is 15 pounds per square inch. When a switch or signal is not in use, its operating pipes are under atmospheric pressure only. The interlocking is similar to that in other types of machine.

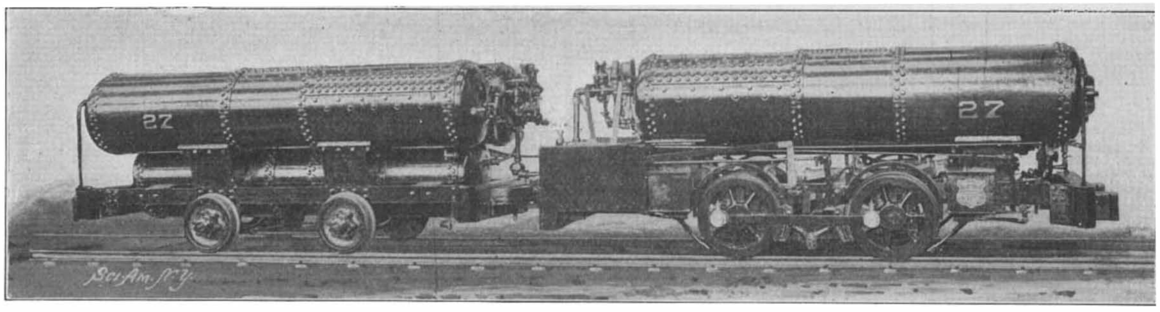
Fig. 5 shows the signal cabin containing a low-pressure ("all-air") switch and signal machine recently erected at the Harrison Street station, Chicago. The cabin is supported on the six metal columns, in the way shown, for the purpose of economizing ground room; one of the subordinate tracks of the yard occupying the space beneath the building. The air pipes, extending from the cabin to the ground and there branching to the various switches and signals, are seen in the center of the drawing.

The most recent development in the interlocking signal field is the "all-electric" system of the Taylor Signal Company, of Buffalo. In this system all the switches and signals are moved by small electric motors—a motor for each switch or signal; and the work of the signalman consists of opening or closing electric circuits. The interlocking is mechanical, as in the other types described, and is placed vertically on the front of the machine, as in the well-known Johnson type of mechanical interlocking. Extensive installations of this system have been made at Chicago, and in numerous other Western cities. Electric power is provided from a 60-volt storage battery, and as the current is required only while switches or signals are being moved, the consumption of power is small. A gasoline motor is usually used to run the generator to charge the storage battery. Fig. 7 shows a Taylor motor with the cover off. The connection at the right moves the detecter bar. The motor, through a suitable train of wheels, is made to revolve the large main gear one revolution for a single movement of the rails. The horizontal rod moving the rails receives its motion from a cam fixed to the main gear. When a switch movement is completed, the motor circuit is automatically broken and the motor at that moment is converted into a generator; and by its function as a generator, which lasts but a fraction of a second, it sends a current back to the cabin giving to the signalman the "indication" that the switch movement has been fully accomplished. For a single switch a 1 horse power motor is used, and for a signal a motor of 1-6 horse power. The dwarf signals (used for slow yard movements) are in the Taylor system moved by a pair of solenoids. The solenoids, fixed vertically at the bottom of the signal post, are energized by a current from the cabin and lift a vertical rod which forces the signal downward. In case of failure of any part, the rod is forced downward by a spring, throwing the signal arm up to the stop position.

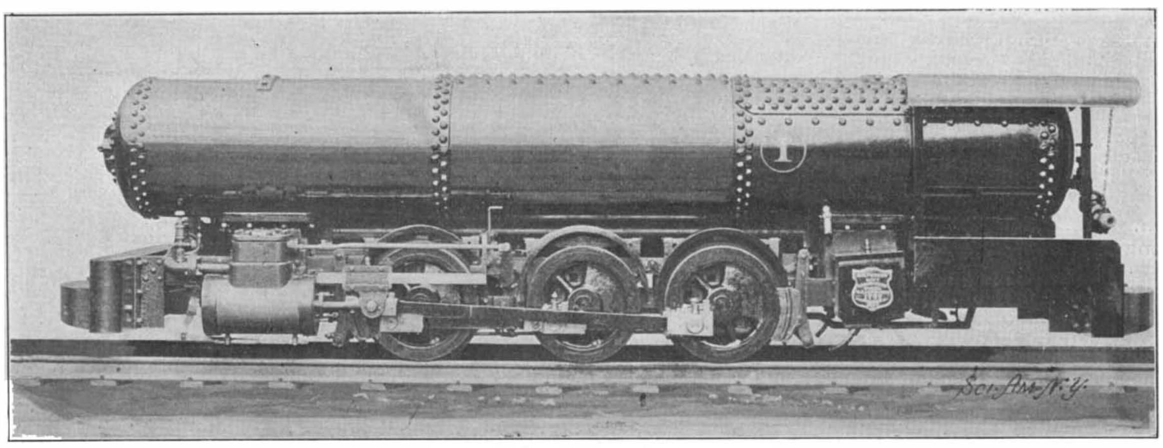
COMPRESSED AIR AS A TRANSPORTATION AGENT.

BY WALDON FAWCETT.

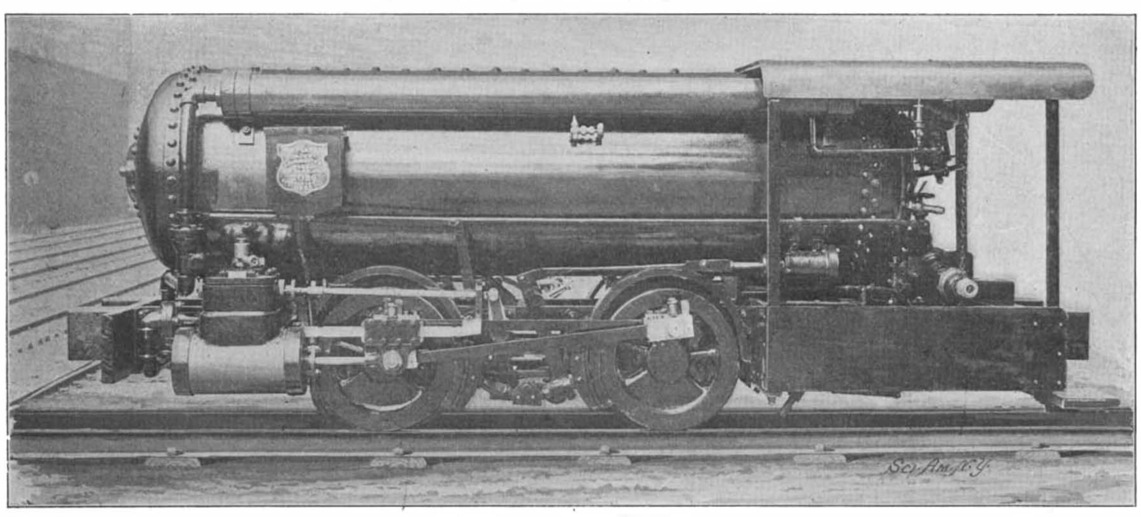
With a more extensive use of compressed air for power purposes has come a corresponding broadening of the scope of its employment as a transportation agent, and indeed it has been conclusively proven that pneumatic traction has decided advantages over all other forms of mechanical haulage for a large variety of operations. Prominent among these are the various phases of underground haulage. For coal mines where there is danger from mine gas its utilization is almost essential, whereas the advantages which commend its employment in non-gaseous mines are almost as potent. A rather unique field has been opened by the introduction of compressed air locomotives in railway tunnels, where the smoke, vapor and gas from steam locomotives are objectionable.



Pneumatic Locomotive.



Locomotive Driven by Compressed Air.



A Compressed Air Locomotive.

COMPRESSED AIR AS A TRANSPORTATION AGENT.

For the ordinary compressed-air haulage plant there are five essential features, namely, the locomotives, constructed to carry stored-up energy in the shape of compressed air, a charging station, a stationary reservoir, usually consisting of one or more storage tanks in which the air is compressed, an air compressor capable of compressing any desired number of cubic feet per minute to any pressure desired, and power for operating the compressor, either steam or water power being applicable for this purpose. The compressed air locomotives now most generally used are made by the H. K. Porter Company, of Pittsburg, Pa.

The general machinery of an air locomotive, cylinders, frames, wheels, etc., is usually very similar to that of a steam locomotive, save that the weight is greater, the bearings larger and the details of construction stronger than in a steam machine of the same power. The main points of difference are found in the fact that instead of the usual boiler with its fuel and water accessories for developing power, the air locomotive is equipped with one or more strongly constructed main storage tanks, which are charged with compressed air at high pressure, a combination regulator and automatic stop-valve and an auxiliary low-pressure reservoir in which the air is carried at a uniform working pressure for distribution to the cylinders. The cubic capacity and the pressure of air in the main storage tanks on a motor are determined, of course, by the amount of stored energy required by the length of the run which such a locomotive is to make and the weight of the train which it is called upon to draw. Not infrequently locomotives are built to carry an air pressure of 800 or 1,000 pounds, but relief valves make it impossible to charge the motor tanks to a higher pressure than is required. The initial storage pressure decreases, of course, while the locomotive is working. As illustrating the capabilities of the compressed air motors, it may be mentioned that there are in service in this country a few locomotives which are fitted with seamless steel tubes and carry a pressure of from 1,500 to 2,500 pounds per square inch.

The combination regulator and automatic stop-valve through which the high-pressure air passes from the main storage tank to the low-pressure or auxiliary reservoir is provided with mechanism which can be instantly adjusted for maintaining whatever pressure is found most economical in the operation of the motor. Ordinarily 140 pounds per square inch is satisfactory, but in case of an emergency, such as getting derailed cars on the track, the pressure may be increased by immediate adjustment to 150 or 160 pounds. Not only is the regulation of air between the high-pressure and low-pressure reservoirs automatic, but it is at all times uniform, the air being admitted as rapidly as it is needed and at the required pressure.

For charging the locomotive storage tanks previously referred to, there are provided the charging stations, which are connected with the stationary receiver or reservoir by a pipe. It is customary, when the reservoir or storage system is a pipe line, to have a charging station at each end of the line, so that the motor may take a charge of air at the end of each single trip or each round trip as required. Air locomotives may be charged either direct or by a reservoir. However, direct charging is very wasteful, and consequently the method most generally accepted involves the use of the stationary reservoir.

The reservoir for a compressed-air transportation line usually consists of either a pipe line or one or more storage tanks of construction similar to the locomotive storage tank, although usually designed to carry a somewhat higher pressure. By means of the reservoir system the compressor may be kept in nearly continuous operation at a fairly uniform speed. By an automatic system of governing the compressor, when the work is light, slows down in speed, whereas when the demand for air increases, the speed is quickly brought up to the required capacity.

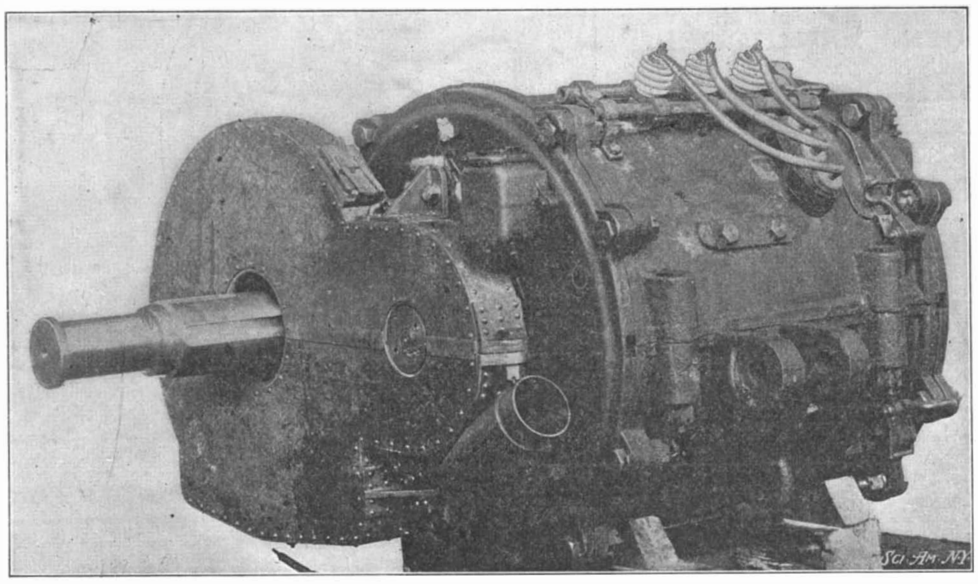
In a pneumatic street car the storage reservoirs are carried on the car trucks and occupy the space under the seats. The operating, brake and controller stands on the platform are very similar to the corresponding stands on an electric car. In the operation of the car, the air leaving the storage tank on the car passes through a reduction valve, where the pressure is reduced from 2,000 pounds to a working pressure of 150 pounds. It then passes into and through the water in the heater, where it takes up the moisture and heat of which it was robbed after compression and before the air was permitted to enter the station storage tanks. This is the principle that was employed on the cars experimented with on the Metropolitan system, New York. In ordinary service an air car weighing somewhat less than 10 tons will consume 400 cubic feet of free air per car mile, and in some classes of service the consumption is double that.

Electric Traction.

A 10,000-VOLT ALTERNATING CURRENT LOCOMOTIVE FOR THE BERLIN-ZOSSEN EXPERIMENTS.

The Berlin-Zossen experiments are about to be resumed with an alternating current locomotive designed by Herr Walter Reichel. It will be remembered that it was the Reichel car, described in the columns of the Scientific American and Supplement, which attained a speed of 155 kilometers and even 160.2 kilometers an hour during the tests, speeds equivalent to 96 miles and 99.5 miles. It will, furthermore, be remembered that the tests were abandoned, because the track construction was defective, the rails being too weak and the substructure not solid enough.

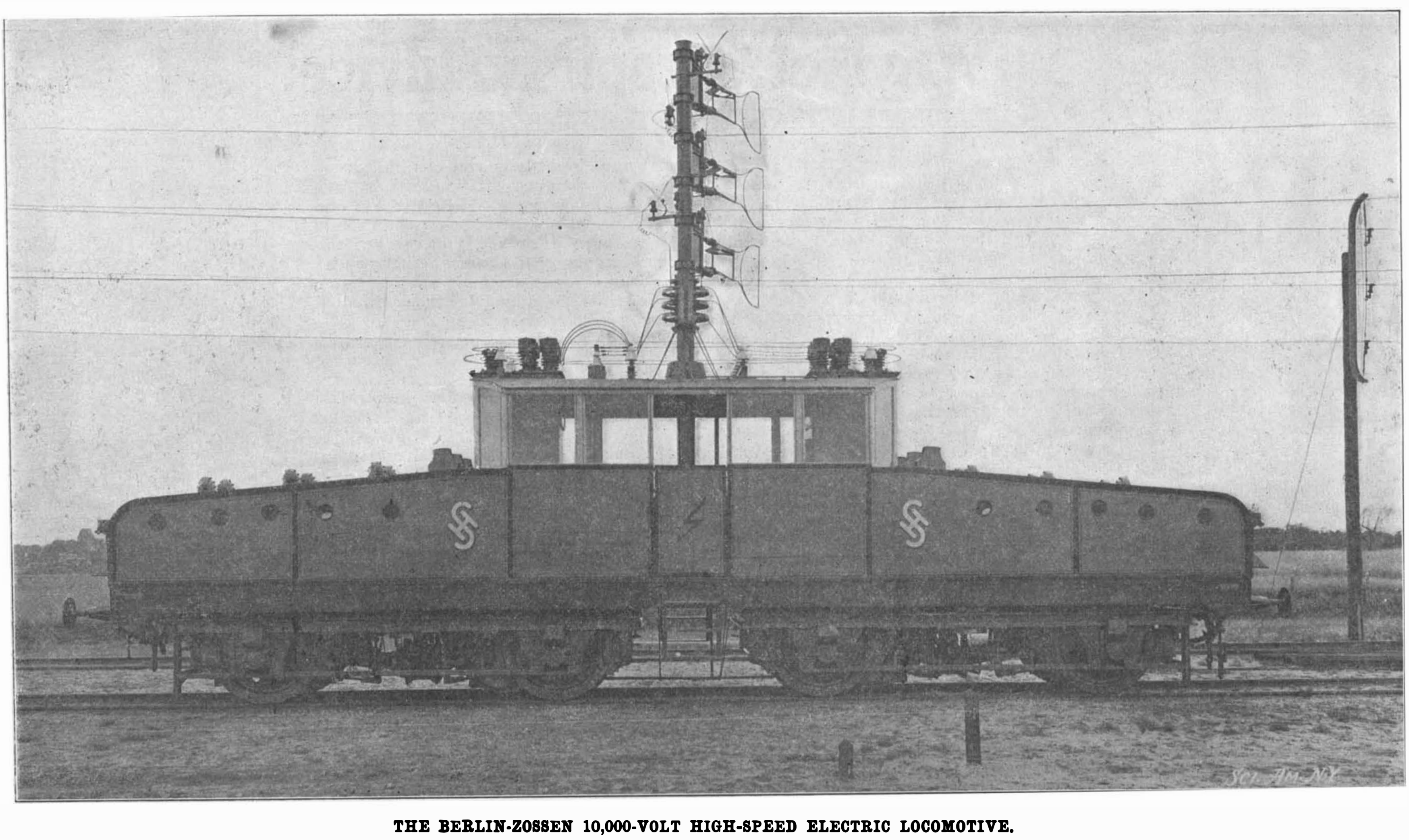
Reichel's locomotive is intended to reduce weight. With this end in view, he has abandoned transformers on the vehicle and supplied the line voltage of 10,000 volts directly to the motors. The old car weighed 96 tons; the new locomotive 20 tons less, including passengers. The total horse power has been diminished from 1,000 to 920. These reductions will result in a saving of power, will diminish wear and tear and lighten the cost of maintenance. Moreover, the current flowing in the line will be diminished so that a considerable saving of power to be transmitted will be effected when running at full speed and when starting at the terminal points.



ONE OF THE MOTORS OF THE 10,000-VOLT HIGH-SPEED ELECTRIC LOCOMOTIVE.

The locomotive's underframe has four axles, similar to those of the old experimental car. The gage is the standard German; the wheels have a diameter of 49 inches and meet with the requirements of the Prussian State Railways. Each bogie has a wheel base of 10 feet 8 inches. There is room on each bogie for two motors; but only one has been mounted. The bearings are placed within the motor windings, for the reason that it is necessary to make the utmost use of the space between the wheels. In order to equalize pressure on the two bearings, the motor shaft is geared at each end to the car and axle.

It was necessary to carry on experiments for the purpose of determining what system of lubricating would be most effective. When it is considered that the velocity of the gear teeth is about 59 feet per second, and that there are 147 teeth in the larger wheel, and 69 in the smaller wheel, the reason for these experiments is apparent. It was finally found that a system of forced lubrication with compressed air would answer the purpose best. The oil is driven out of the reservoir at a distributing cock which is turned to the right or left, depending upon the direction of the locomotive's travel. The oil flows through pipes to nozzles above or below the toothed wheel. After lubrication, the oil is pumped back to the oil reservoir. It is only with the higher velocities, obtained with a gear ratio of 2 to 1, that such a system of lubrication is necessary. For smaller velocities the ordinary methods are quite adequate.



THE BERLIN-ZOSSEN 10,000-VOLT HIGH-SPEED ELECTRIC LOCOMOTIVE.

The cast-steel motor case is composed of two parts. The bearings are made in one part, bronze-lined with white metal. The active iron upon which the primary winding is mounted, is screwed into the motor case, while the rotor of the motor is fastened to the motor shaft by means of a sleeve. From this it follows that the motor can subsequently be arranged on the car axle for direct driving.

The secondary winding is carried on the active iron of the rotor. A second sleeve holds two collector rings on the rotor, from which rings carbon brushes collect the current. The motor itself is lubricated by means of oil and wicks, a special arrangement having been here devised for the purpose of saving space.

The primary winding on the experimental car was on the rotor, a construction possible only with bar winding. In the present case it was not necessary to construct the motor for a very high turning moment, since for the small starting torque required the rotor could be made smaller, and the primary winding placed on the stator.

For the purpose of obtaining as much cooling space as possible, the cores of both rotor and stator were designed in a peculiar way. The slots are quite deep, and the coils within are wide. The laminations for the rotor are in one piece; those of the stator are made in segments. For the winding 72 open slots are used; with 77 wires per slot of the primary. The wires are run through mica tubes. In order to prevent the passage of sparks from one phase to another and to save space, the coils are placed alternately in longer and shorter tubes so that the longer ends lap over the shorter ones.

Experiments were carried out for the purpose of determining what insulation would be most effective. As a result of these experiments an insulation was adopted which has withstood a voltage of 22,000. The winding of the motor is a wave winding connected in star and placed in 90 half-closed slots. It consists of a number of single, flat copper wires arranged in series, four to the slot. Two of the free ends go to the collector rings, while the third is fixed to the core of the rotor. The pressure in these rotor windings is 700 volts at starting. The use of bars for this winding facilitates the application of bronze rings to hold the winding against centrifugal force. Air enters near the shaft and is directed out through openings in the rotor casing by vanes. This current likewise cools the stator coils. Air pressure thus obtained is equivalent to several millimeters of water.

Naturally the leading-in of the three high-pressure cables has been done with care. Cables insulated to stand 15,000 volts pass through three soft rubber brushes placed inside hard-rubber brushes. Ending in the three terminals, these cables are mounted on corrugated porcelain insulators attached to saddles which are supported on mica-insulated iron tubes fixed to the casing of the motor.

The weight of the motor and gear is 9,000 pounds. The connections of the motor and controller are substantially those previously described in the Scientific American Supplement. The speed at starting is regulated by varying resistances in the rotor or secondary circuit which is insulated from the earth. The rotor resistance has twenty-four stops. The resistance coils are spirals of Kruppin wire held by porcelain insulators. This resistance is controlled by a hand wheel on a vertical spindle. The switches for the primary high-pressure circuit are worked by air pressure.

On the completion of the locomotive, tests were made at a gradually increasing pressure, starting at 6,000 volts and about 50 alternations. The final test was made at 11,000 volts and 95 alternations. With a 31-ton trailer 65 miles an hour was the speed obtained. About 260 kilowatts were developed which corresponds to a load of about 280 horse power on the driving wheels. This agrees substantially with previous experiments at 62 miles per hour.

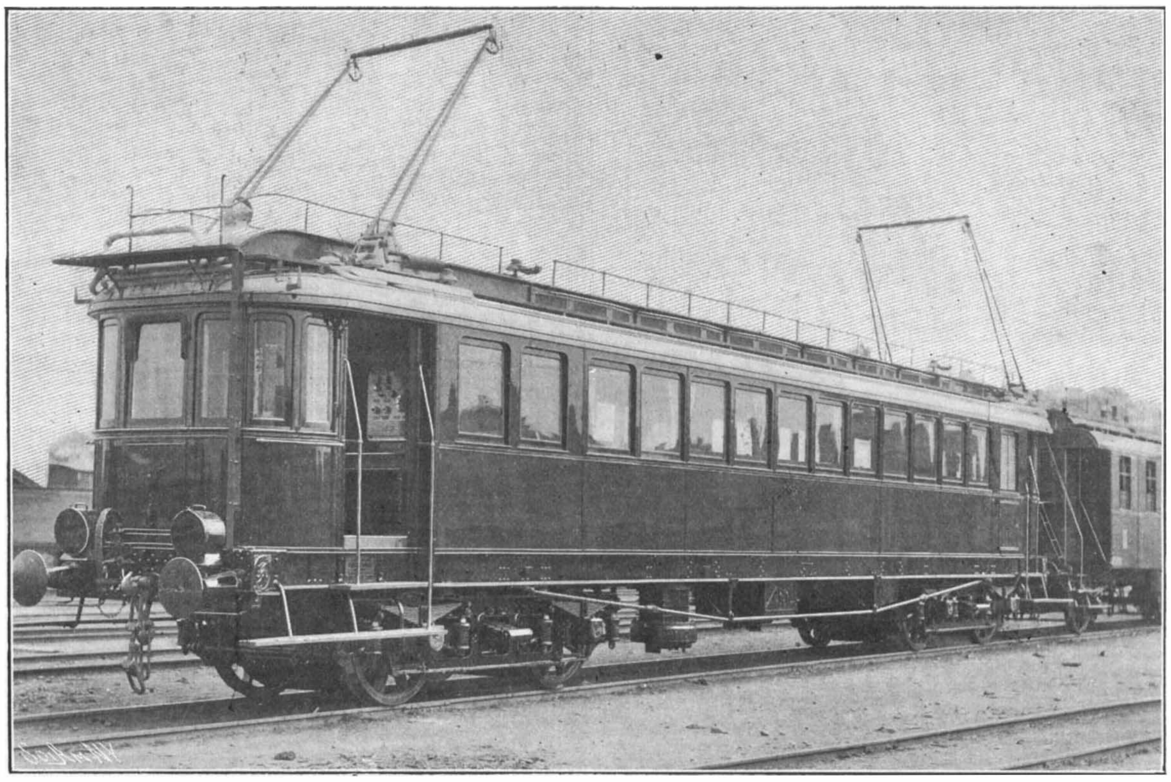
It now remains to be seen whether the high speeds for which this road was built can be attained with a lighter locomotive. Probably not before the coming spring may definite results be expected.

THE VALTELLINA RAILWAY—THE FIRST STANDARD THREE-PHASE ROAD.

Readers of the Scientific American are more or less familiar with the electric railway built by Ganz & Co., of Budapest, along the shores of Lake Como. The road was opened for regular traffic on September 4 last, since which time it has been running faultlessly.

The Valtellina line is 66 miles long, and of standard gage. It runs along Lake Como and the River Adda, with three branches extending from Lecco to Colico, from Colico to Chiavenna, and from Colico to Sondrio.

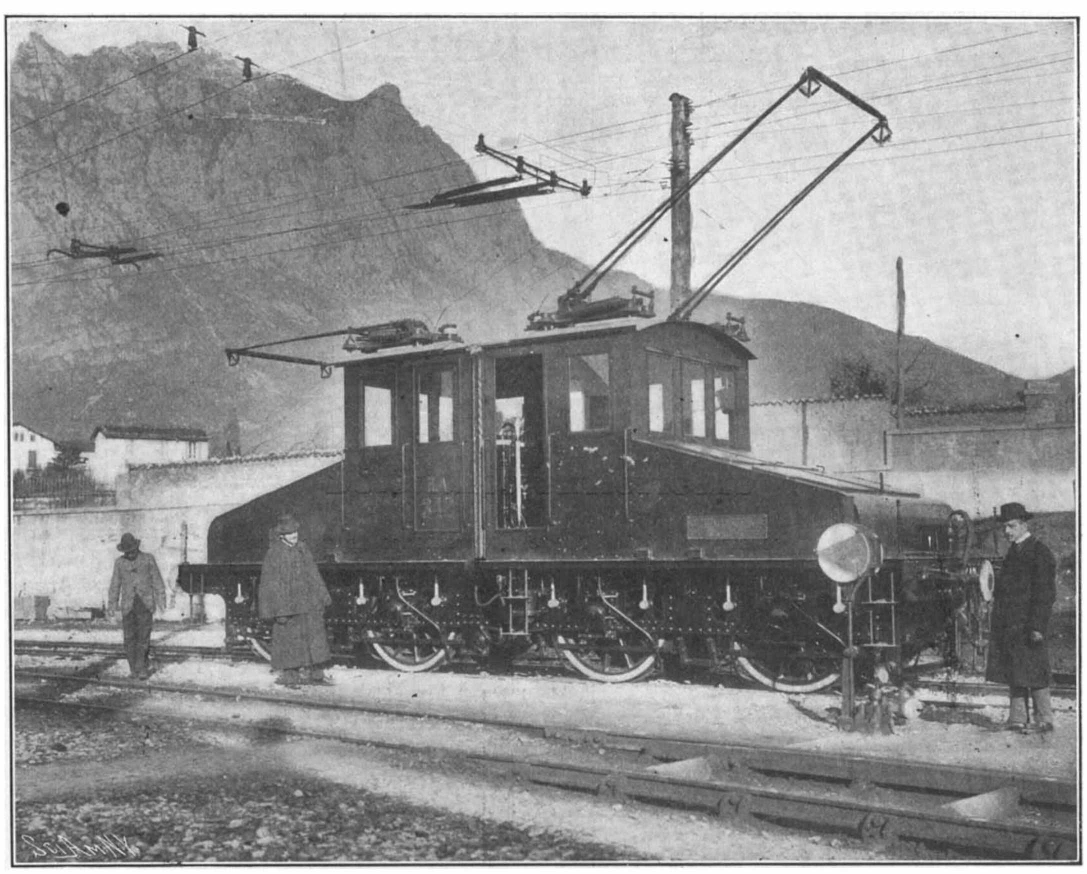
The central power station is situated at Morbagno, the water power of the River Adda being utilized to drive the turbines. The effective head of the turbines is 30 meters (98.4 feet). There have been installed three turbine dynamos, each with a capacity of 2,000 horse power at 150 revolutions per minute. The three-phase alternating-current generators coupled directly with the turbines generate current at a tension of 20,000 volts at the terminals. This high-tension current is led to the primary conductors of the line through a switchboard, and is transformed into three-phase alternating current at 3,000 volts by means of step-down transformers situated along the line. This stepped-down current is led to the contact wires, and thence directly to the motors of the vehicle. The primary conductors are extended along the line on the same poles which carry the contact wires.



A PASSENGER CAR OF THE VALTELLINA ROAD.

For the line at Lake Como the motor cars are 18.1 meters in the carriage body and 19 meters (62¼ feet) over the buffers. The cars rest on two bogie-trucks, each having a wheel-base of 2½ meters. Without passengers a car weighs 50 tons, including the motors. The wheels are 1.17 meters (3.8 feet) in diameter, while those of the electric freight locomotives supplied to the same line have a diameter of 1.4 meters (4.59 feet). The locomotive motor weighs 3.8 tons; its rotor about 1½ tons. The car-motors with a smaller size wheel weigh 3½ tons approximately. Each series pair of these motors develops a full-load horse power of 150, while the high tension motor itself, when running at full speed with the low tension motor cut out, yields about the same horse power. Thus, 300 horse power are developed in one truck carrying two pairs of motors, or 600 horse power (450 kilowatts) on one train with front and rear driving cars.

The current generated at the central station has a frequency of 15 per second. When running synchronously the high tension motors make 300 revolutions per minute. In the rotor of the same motor the periodicity currents vary according to the slip. During the start, when the high tension is switched into series connection with the low tension motor, after the speed has risen to "half speed," or 150 revolutions per minute—above which speed the series connection ceases—the periodicity of the currents in the rotor of the high tension and in the stator of the low tension is about 7½ per second. The speed of the locomotive motors is 125 revolutions per minute. The Valtellina locomotive motors are not geared in series; they are all high tension.



FREIGHT LOCOMOTIVE OF THE VALTELLINA LINE.

The line will be used for the transportation of both passengers and freight. Passengers are carried by the cars at a speed of 60 kilometers (37½ miles) per hour. The electric locomotives are used for hauling freight trains. Each train has a net weight of 250 to 300 tons. The speed attained is about 30 kilometers (18½ miles) per hour.

The commercial merits of the system are many. The initial outlay was not inordinate. The cost of maintenance is said to be comparatively small. For railways of considerable length and heavy traffic, less maximum power is required in the central station with the Ganz high tension distribution than with the necessarily low tension of continuous current distribution, the ratio of maximum to average load at the central station being less.

The electrical merits of the system are no less noteworthy, especially when the length of transmission from one central station is considered. By reason of the high voltage no large currents are used. The loss involved in converting to continuous current by rotary converters is eliminated. The use of pure induction motors without commutators, and the coupling of these in series pairs, results in a high motor efficiency.

The French Patent Office has granted a patent for the "penetration" process of glass coloring. Applications for patents have also been made in other countries of Europe, so we are informed. The process is described thus: Silver salt is put on the surface of the glass, which is then heated to 500 deg. or 550 deg. Cent. The excess of salt having been removed, the surface appears yellow, the color penetrating to a depth of 0.17 mm. when the baking has lasted for about five minutes. After an hour, a layer of double that thickness would be colored; after eighteen hours the color would have penetrated through a glass plate 1.6 mm. in thickness. In reflected light this yellow displays a beautiful greenish or bluish fluorescence. Silver and copper give a red. Gold and iron salts have also been used. When the baking is continued for a long period, the coloring matter is renewed from time to time, say every six hours.

THE HON. SALEM H. WALES.

It is with sincere sorrow that we record the death on the 2d instant in this city of our old associate and partner, the Hon. Salem H. Wales.

Mr. Wales was born in Wales, Mass., on October 4, 1825. At the age of twenty-one he came to New York and entered a mercantile house in this city. In December, 1848, he became a member of the firm of Munn & Co., and became associated with Mr. O. D. Munn and Mr. Alfred E. Beach as one of the managing editors of the Scientific American. He continued to be identified with the publication until 1871, when he retired from business.

In 1855 he was appointed Commissioner to represent New York at the Paris Exposition of that year, and also served on the Executive Committee of the Christian Commission during the civil war. After his retirement from business he became interested in several public institutions and served New York city in a number of positions.

In 1873 he was appointed president of the Board of Park Commissioners, and again in 1880 and 1888 was a member of the same board. In 1874 he received the regular Republican nomination for Mayor of New York. He was not elected, but in the same year he was chosen president of the Board of Commissioners of Docks and in 1895 he was appointed one of the Commissioners of the new East River Bridge, which position he held for several years.

He was a director in the Hanover Fire Insurance Company, in the National Bank of North America, in the Southampton (L. I.) Bank and the Southampton Water Works. He was a charter member of the Union League Club, organized in 1863, and had always been one of its most prominent and active members. Mr. Wales was also a member of the Century, Press and Church Clubs, the Meadow Club, the Golf Club of Southampton, the New England Society and the Metropolitan Museum of Art, and a member of the Executive Committee of the latter. He was prominent in promoting the success of the New York Homeopathic Medical College, and of the Hahnemann Hospital, and was president of both institutions for a number of years.

Mr. Wales was a man of sterling integrity, possessed a most amiable character, and was widely known and esteemed. His loss will be mourned by a large circle of friends and acquaintances.

He leaves two children, Mrs. Elihu Root, wife of the Secretary of War, and Edward H. Wales. Mr. and Mrs. Wales celebrated the fiftieth anniversary of their marriage on February 12, 1901.

The Scientific American Building Monthly.

There is probably no better illustrated or printed architectural periodical than the Scientific American Building Monthly. In its pages the architect will find photographs and plans of houses, of all styles and costs. To the man who is not an architect, but desires simply to build, it is a treasure-house of suggestions. By glancing through each number he is sure to find a picture of the very house which meets his ideas. A page of bright comment discusses current architectural topics. The "Talks with Architects" are not the least valuable feature of the paper; for often enough the architect interviewed gives information by which even the experienced designer of houses may profit. Each month there appear notes under the captions "The Garden," "The Country House," "The Household," "Legal Decisions" and "New Books," in which new information is presented in an attractive manner. Especial attention is given to formal gardening as an adjunct to the modern mansion.

Electric Traction on Long Distance Railways.

BY ALTON D. ADAMS.

After a long series of experiments, electric railways reached the present standard type at Richmond, Va., in 1888, a type that includes essentially a stationary, continuous-current dynamo connected to car motors by a single circuit made up of the trolley wire on one side and the rails on the other. On the Richmond railway the dynamo voltage was approximately 500, while the motor voltage ranged downward from this figure according to line loss. This pressure remains standard at the present day and is varied from only to the extent of using dynamos up to about 600 volts where long lines involving a large loss of pressure are to be supplied.

The great development of electric railways since 1888 has consisted almost entirely of the application of principles and methods then in use or well understood. Dynamos of much greater capacity have been applied to street railway work, longer lines have been built, and larger cars driven by more powerful motors have been put into operation. In spite of all this extension, almost every electric railway in the United States includes substantially the continuous current dynamo and motor and the single circuit uniting them, working at a pressure of approximately 500 to 600 volts or less.

If the purpose of electric railways had remained merely what it was in 1888, to furnish transportation in city streets, there would be little reason to depart from present standard practice. Instead, however, of a series of tracks in city streets, none of which are more than five miles from the generating station, a single electric railway system now often extends between cities and towns that are 25 to 50 or more miles apart. An electric railway of such length cannot be economically operated from a single generating station when the pressure of transmission or distribution is not above 600 volts. High pressures running into thousands of volts for a distance of 25 miles, and into tens of thousands of volts for a distance of 50 miles are absolutely necessary for efficient transmission of energy, if the cost of conductors is to be held at permissible figures.

Besides the demands of extending street railways for higher voltages, there is a similar demand from quite a different source. Steam railways have suffered a great diminution in their suburban business through the competition of electric lines. Many of these steam roads are ready to adopt electric traction on parts of their systems if it can be shown that the resulting advantages would warrant the expense.

A number of expedients have been adopted to provide for electrical distribution on long railway lines. One of the first solutions of the problem was to build additional generating stations at intervals along an extended railway line, and supply a section of the line from each station. This plan of several generating stations spaced along an electric railway line has been carried out in a number of instances, each station delivering continuous current at 500 to 600 volts. The great objection to this arrangement lies in the fact that such stations must each have a capacity much below that required for the highest economy of operation, because the low voltage permits each station to supply the motors on only a few miles of railway. The voltage at continuous current dynamos, between the trolley wire and track and at the car motors might be increased somewhat, say to 1,000, but there are legal objections to the use of this voltage in city streets, and the difficulty of insulation at car motors would thereby be much increased. Moreover, a pressure of 1,000 or any other number of volts that could be made reasonably safe in the streets and practicable at the motors would be far below the requirements for efficient transmission to long railway lines. Another plan for transmission and distribution to long-distance electric railways involves the development of alternating current at any desired voltage, its transmission to sub-stations each of which contains transformers and rotary converters, and the supply of continuous current at about 500 volts from these converters. This plan has already been put into operation on a number of long-distance electric railways. It should be noted that this adoption of alternating generators and transmission does not avoid the use of continuous current dynamos, distribution lines and motors operating at the old pressure of about 500 volts. The rotary converters are simply a special type of continuous current dynamo in which alternating current may be used for driving, instead of mechanical power. In some cases alternating motors and ordinary continuous current dynamos are used at sub-stations to furnish current at 500 volts for electric railways. The rotary converter simply combines the motor and dynamo in one machine.

Obviously the converters at sub-stations must have capacities at least equal to those of the continuous current generating stations which they displace. It follows that the system just considered adds to the capacity necessary for continuous current dynamos in any event the entire electrical equipment of the alternating station, the transmission lines and the transformers at the sub-stations. On many long-distance electric railways this large increase in capacity of operating machinery is warranted by the high economy of a very large generating station and by the advantage of any desired voltage on the transmission lines. The distance from the generating station at which cars may be operated by this system of combined alternating and continuous current equipments seems to correspond to the limits of electrical transmission at any practicable voltage. At the present time such electric railways are operated that extend more than fifty miles from their generating stations. Though American practice has clung to continuous current motors for electric traction, induction motors have been adopted on a number of railways in Europe. Where the generating station is so far from parts of the railway line that the permissible voltage at motors is not great enough to allow economical transmission, rotary converters may be avoided by the use of induction motors. Furthermore, when converters are not used, the expense for the operation of sub-stations disappears, because mere transformer stations do not require the services of attendants. On European railways where the induction motor is used, the generating station is operated at any voltage desired for the transmission and the alternating current is delivered at a number of transformers spaced at suitable intervals along the tracks or carried by the cars. These transformers lower the voltage to as little as 400 in some cases and as much as 3,000 in others for distribution over trolley wires and tracks to the car motors. Ordinary single phase alternating motors lack sufficient starting power for railway purposes, for which reason three-phase motors are employed on these European roads. With three-phase motors the single trolley wire must be abandoned and two trolley wires with the rails, or three wires without the rails as a conductor must be employed. This use of two or three trolley contacts is a disadvantage in operation compared with a single trolley, but it may be worth while in some cases to add one or two trolley wires and do away with rotary converters. A generating station at high voltage, transformer sub-stations, and distribution from these sub-stations at 400 to 3,000 volts to three-phase car motors make it possible to operate a railway at any distance from the power station that can be economically covered by high voltage transmission. As to the length of railway that may be operated from a single generating station, it thus appears that the system with transformer and converter sub-stations using continuous current motors is on a par with the system having only transformers at sub-stations and using three-phase motors. The Bergdorf-Thun Railway in Switzerland is 25 miles long, its most distant end is 31 miles from the generating plant which operates at 16,000 volts, 14 transformer sub-stations reduce the voltage to 750, and the three-phase current at this pressure is distributed to the car motors.

Whether continuous current or induction motors are employed, a voltage as low as 500 or even 750 for distribution from sub-stations to car motors implies a large expenditure for conductors on long railways. Though it is not thought advisable to exceed the voltages just named at continuous current motors, the same limitation does not apply to induction motors. Hence there is a movement in Europe toward higher voltages at car motors. An illustration of this fact is seen in the Valtellina Railway in northern Italy. This line has 65 miles of track, the voltage at the generating station is 20,000. Twelve transformer sub-stations along the line reduce this pressure to 3,000 volts, three phase, and current at this voltage goes directly to induction motors on the cars.

A further effort to utilize high voltage for distribution right up to electric cars has been made on the European railway from Marienfelde to Zossen, fifteen miles long. On this railway the voltage of transmission and distribution is 10,000, and three-phase current at this pressure is received at transformers carried on the cars and there reduced to a low voltage for the induction motors. But in the new locomotive built for this road, the transformers have been discarded. On another page will be found a full description of this locomotive.

Though little has been done with induction motors for electric traction in the United States, especial attention has recently been turned here to the use of single-phase alternating current for railway work. The Oerlikon Works in Switzerland are building a 44-ton locomotive to be operated by single-phase current on a system devised by an American engineer. This locomotive, which is to develop 700 horse power, is fitted with continuous current motors for driving, and also with a single-phase alternating motor connected to a continuous current dynamo. This locomotive is going into service on a railway in Europe where single phase current will be distributed along the single trolley line and rails at 15,000 volts. After entering the locomotive at this pressure the alternating current will drive the single phase motor, and this motor the dynamo Continuous current from this dynamo will then pass to the motors that do the work of traction. In this system any desired voltage may be employed for the distribution without regard to the continuous current motors.

On a railway now under construction in Michigan single-phase current is to be distributed to the cars at 15,000 volts and there reduced by transformers to 200 volts for the single-phase motors. On each car the motor operates constantly, doing traction work when the car is in motion and compressing air when the car is standing still. The compressed air is used to start the car and also to aid in its operation on heavy work or grades. Like the previously named single-phase system, this one using compressed air permits any desired voltage to be employed between the single trolley wire and track.

A third and apparently very important plan for the operation of railways with single-phase current is soon to go into operation on a road extending from Washington to Baltimore, a distance of 31 miles, with a branch 15 miles long to Annapolis. Single-phase alternating generators working at 15,000 volts will furnish the energy to operate this railway, and current from these generators will be reduced in pressure to 1,000 volts at nine transformer substations along the line. At each car a regulator and transformer will receive the single-phase current at 1,000 volts and deliver pressures ranging from 200 to 400 volts at the motors. This range of voltage will give all necessary motor speeds from starting to 40 miles per hour for the cars. The motor to be used for this work is the most notable feature of the system. This motor is substantially a continuous current series-wound machine with its magnetic circuit laminated throughout. It has long been known that a continuous-current series motor if supplied with alternating current of single-phase will start and operate as though supplied with continuous current, except that very destructive sparking usually occurs at the commutator in motors of large capacity. It is claimed that this trouble has been overcome by a new method of construction, and one of the large electrical manufacturers has contracted to furnish the motors mentioned for the Washington and Baltimore line. Each motor is rated at 100 horse power and there are to be four motors on each car.

It thus appears that while Europe is trying to solve the problems of electric traction on long railways with induction motors and three-phase current, America is going about the work either with a combination of three-phase and continuous currents, or with single-phase current alone. As to the important feature of high voltage for transmission the three-phase and single-phase systems are equal. In the delivery of energy at very high voltages to cars the single-phase current has a great advantage because of the single trolley wire required. On the other hand the development of power with the single-phase current is not yet certainly solved for traction work.

To Our Subscribers.

The Scientific American is fast nearing the completion of its fifty-seventh year. During that time it has faithfully chronicled the scientific progress of the times and has described new and important discoveries and inventions. From the first number to the last which has so far appeared, the Scientific American may be regarded as a weekly history of the world's progress in science, industry and invention.

With the close of the year many of the subscriptions will expire. In order that the paper may be received uninterruptedly, subscriptions should be renewed promptly. An expired subscription will not be continued. To those familiar only with the Scientific American, it may be well to speak of the purpose of the Scientific American Supplement. The Supplement presents papers and articles too long for insertion in the columns of the Scientific American, and contains translations of scientific articles in foreign tongues, which would otherwise be inaccessible to those who read only English. By subscribing both to the Scientific American and the Scientific American Supplement, it is possible to obtain a most complete survey of scientific work on both sides of the Atlantic. By taking both papers the subscriber obtains the benefit of reduced rates.

The Current Supplement.

The current Supplement, No. 1406, contains a wealth of varied information. The opening article deals with the new augmented water supply and reservoirs of London, and is very fully illustrated. The Pacific cable is made the subject of an article accompanied by sectional views of the cable at various points. The Berlin-Zossen Road, now famous in electrical history for the high-speed tests carried out upon it by the two great German electrical companies, has for its counterpart in this country the Aurora, Elgin and Chicago Railway. In the current Supplement an article is published which fully describes this American road. Francis J. FitzGerald continues his discussion

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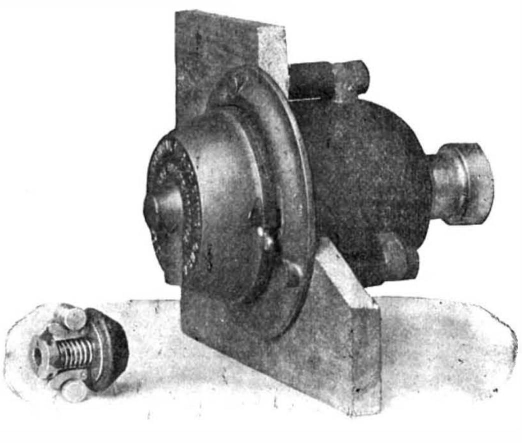

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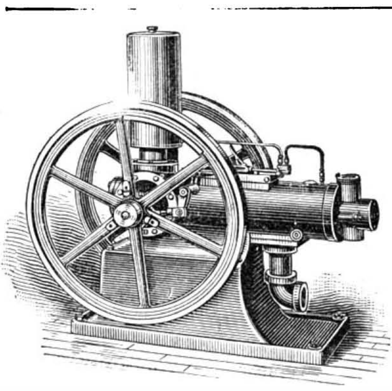

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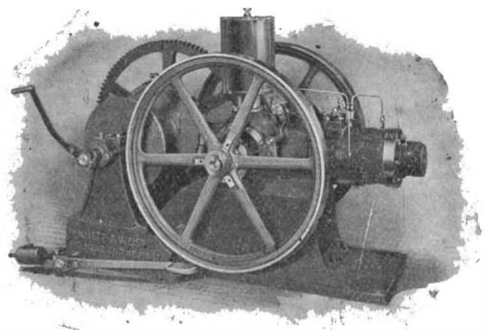

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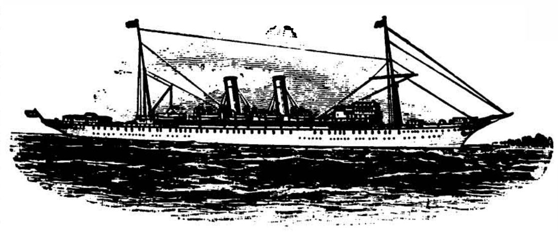

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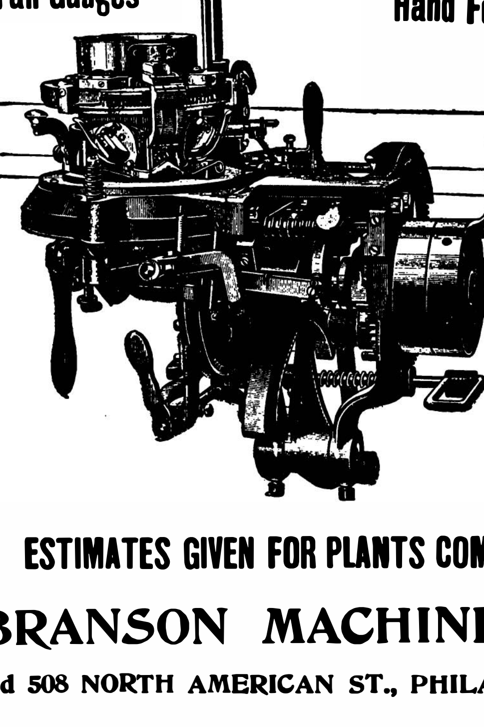

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WRITE FOR INFORMATION AND CATALOGUE.

of the conversion of amorphous carbon into graphite. A brief resumé of Prof. J. J. Thomson's lecture before the British Association on Becquerel rays and radio-activity will doubtless be welcomed. How the oxides of nitrogen could be reduced directly by the contact process is likewise told. We have, from time to time, published accounts of the efforts of Americans to exterminate mosquitoes. In Europe no less activity has been shown. It may, however, not be without interest to our readers to learn from Dr. Louis W. Sambon, of Naples, something of the life history of *Anopheles maculipennis* (Meigen), and the methods employed in Europe for its extermination. Prof. Edwin G. Dexter describes interestingly quaint superstitions and proverbs relating to weather influences.

AIR BRAKES

The compressed air brake bears a very important relation to the subject of railway transportation; for it has a direct effect upon the economical operation and speed of trains, as well as upon their efficiency as carriers of merchandise, live stock and passengers. Without the general adoption of the air brake in the past few years the long, heavy, fast freight trains and speedy passenger trains, so comfortable, luxurious, and safe, would not now be running. For the most important consideration is the safe transport of passengers and merchandise, and this requires a brake of great power and always reliable, to control the speed of the train or stop it in a short distance with comfort and safety.

Few people realize the enormous energy stored up in these trains, giant catapults as they are, moving through space with tremendous force and speed. A very reasonable example is a train of freight cars loaded with grain, the total weight of which is about three million pounds. The energy stored up in such a train, when running twenty-five miles per hour, is greater than that which can be imparted to a projectile by the largest of modern guns. It takes a very efficient brake to check this enormous inertia in a short distance, smoothly and safely.

With the air brake, these trains are perfectly controlled. The air brake has kept pace with the great increase in weight, length, and speed of both freight and passenger trains. Much that is interesting could be said about the magnitude of the air brake business, and the details of construction, manufacture, and use under the different circumstances of operation. The employes of railways who have to do with the air brake apparatus are carefully instructed how to handle and care for it, through the publication of instructive literature. There are scattered all over the country, instruction rooms maintained by the railways, where illustrative samples of air brake apparatus are available to the men, and in which traveling air brake inspectors frequently give lectures. There are also instruction cars traveling from place to place in which sample brakes are set up, explained, and operated.

While the subject is technical and of considerable detail, the principles of the air brake can be described in few words. Briefly, the air brake comprises a pump for compressing air, a reservoir on each car for storing the air, a brake cylinder on each car in which the air is allowed to exert its force when it is desired to have the brakes act upon the wheels, and a triple valve on the car, connected with both reservoir and cylinder and controlling the flow of air in and out of each.

The triple valve piston is normally subjected to air pressure of equal intensity on both sides. A reduction of pressure in the train-pipe side moves the piston one way, and restoring the pressure in the train pipe pushes it back again. The former opens connection between reservoir and brake cylinder; the latter discharges brake cylinder air and allows the reservoir pressure to be replenished. An engineer's valve in the cab of the locomotive enables the engineer to cause the rise and fall of train pipe pressure referred to. The rest of the apparatus is the piping, cocks, and connections.

We give a more detailed description of some parts of the brake, selecting those that are representative of the most modern construction and in general use.

The air pump, mounted upon the engine, just forward of the cab, is operated by steam from the locomotive boiler, and compresses the air required for the air brake system throughout the train. The air compressed by the pump is delivered into the main reservoir, which is a large tank mounted somewhere about the engine and storing sufficient air to relieve the pump from excessive work, when more air is suddenly required in the brake system. Otherwise the pump would be subject to violent fluctuations; at rest one moment, and in violent operation the next.

The engineer's valve, or "brake valve," mounted inside the cab of the locomotive, permits the engineer to control the movements of the train by applying and releasing the brakes as the operation of the train may require. This valve controls the flow of air from the main reservoir into the brake apparatus upon the other vehicles, and also controls the discharge of train pipe air when the train is to be stopped, or its speed reduced. The engineer has perfect control of all brakes in the train by moving a small handle. The positions of this handle are: "running," "lap," "service applications," "emergency,"

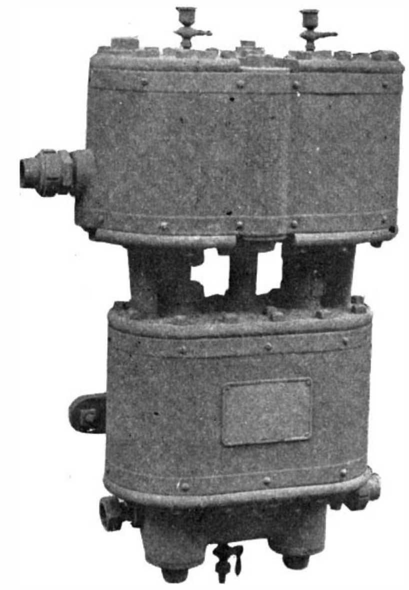


Fig. 1.—THE DUPLEX PUMP.

and "release." "Running" is the normal position of the handle while the train is speeding along and the brake system is charged with air at the proper pressure. In this position, air from the main reservoir, generally about twenty pounds higher in pressure than the rest of the brake system requires, is slowly fed through the engineer's valve into the rest of the system, thus taking care of leaks and keeping the air pressure up to standard.

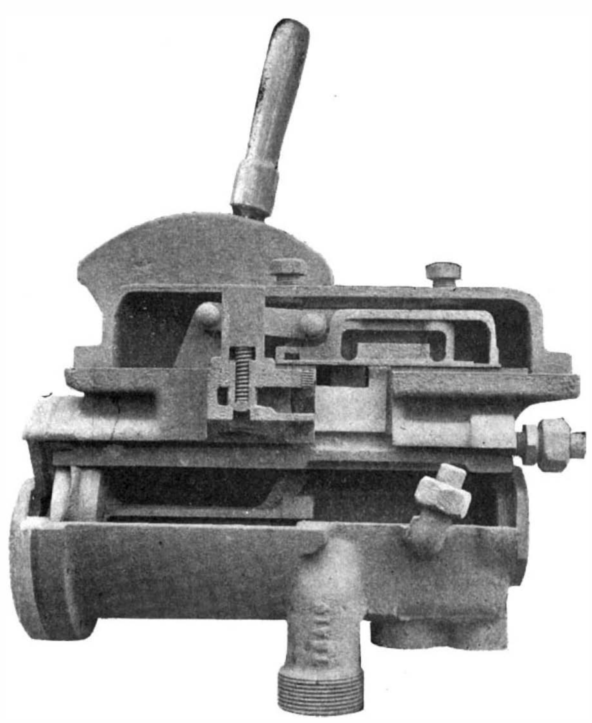


Fig. 2.—THE ENGINEER'S VALVE.

The other positions for the handle are explained by the names given them. The several positions for service applications, set the brakes with different degrees of force. With the handle in emergency position, brakes are instantly set with their greatest power. In release position, air that has been used to set brakes, is replenished from the main reservoir and pump, restoring all parts of brake system to normal condition. A modern type of engineer's valve is illustrated on this page.

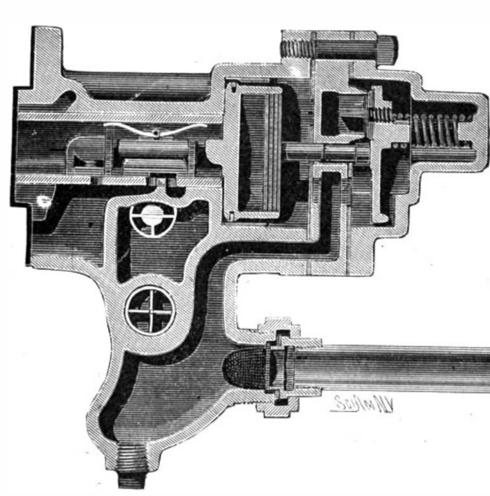


Fig 3.—THE TRIPLE VALVE.

The engine equipment includes a gage for showing the air pressure in both train piping and main reservoir, the pressure in the latter being kept higher than in the rest of the brake system; and a simple governor which controls the working of the air pump, automatically stopping the pump when standard air pressure has been accumulated in the brake system, and automatically starting the pump when the air falls below the desired standard.

The principal parts of the brake apparatus, mounted upon each car, are an auxiliary reservoir, for storing upon each vehicle sufficient air to operate the brakes thereon; a brake cylinder, ordinarily open to the atmosphere (through a port in the triple valve), and a quick-action triple valve.

When air brakes are applied, the triple valve allows air from the auxiliary reservoir to flow into the brake cylinder in sufficient quantity to give the brake-force intended by the engineer. The piston-rod of the brake-cylinder is connected to the levers and shoes by which the power delivered by the brake cylinder is evenly distributed to the wheels of the vehicle. When the brakes are released and the triple valve opens the port that lets the air escape from brake cylinder to atmosphere, a spring, surrounding the piston rod of the brake-cylinder, pushes the cylinder piston back to normal position, the forward movement of the piston having compressed this spring.

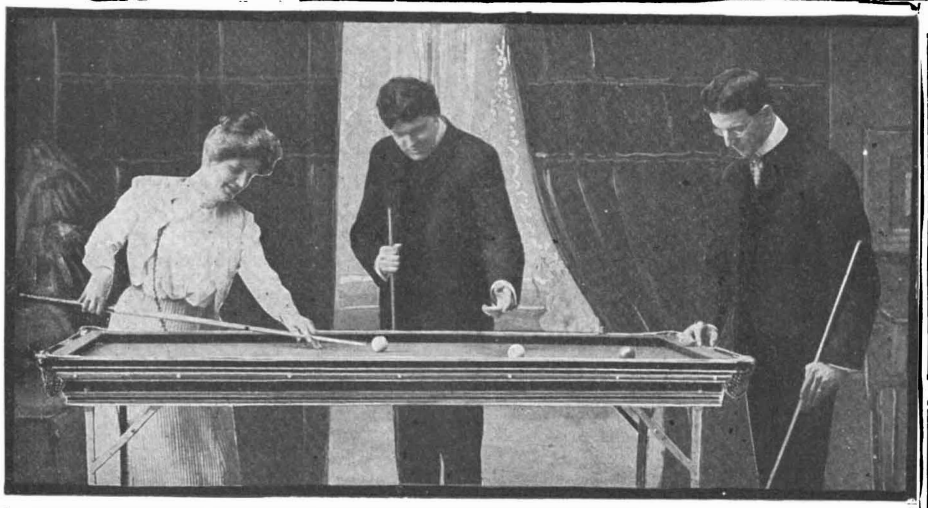
Fig. 1 is an external view of the duplex air pump, which is a construction peculiar to the New York Air Brake. The pump is constructed in a very simple manner and delivers sixty-seven per cent more air than other air brake pumps do with equal consumption of steam. The lower half of this pump is comprised by the steam cylinders, the upper half by the air cylinders, quite the reverse of former air pump construction. Thus the drainage of the steam cylinders is collected at the lowest point. The casual observer of this pump might suppose that it was merely a pair of ordinary pumps connected together, side by side, and that the total volume of air would simply be twice as much as would be delivered by one of the pumps alone. Closer inspection shows that this is not the case and that this pump compresses three volumes of air with two similar volumes of steam. One of the air cylinders has twice the volume capacity of any one of the other three cylinders. Its contents are compressed into half their original volume and delivered into the smaller air-cylinder. The smaller cylinder, which has the same volumetric capacity as the steam cylinder below it, will then contain three volumes of air, viz., the free air originally confined within it, plus the two volumes just received from the larger cylinder. The final compression of these three volumes of air is caused by the steam cylinder on that side of the pump, the air being delivered into the "main reservoir."

All working parts of this pump can be examined and replaced without taking the pump off the engine.

Fig. 2 is a photograph of the New York Air Brake Company's engineer's valve cut in half longitudinally. The novel feature of this valve is, that it discharges a definite quantity of train pipe air in each of the several positions for applying brakes, and is therefore called a "positive discharge" valve. An engineer having this valve on his engine, can apply brakes throughout the train with exactly the force that he knows, from experience, should be applied to the wheels to give the retarding power wanted at just that moment, and is not obliged to watch the pressure gage, in the cab of the locomotive, but can keep his eyes upon the rails, signals, or crossings ahead of him.

Fig. 3 is a sectional view of the quick-action triple valve. One is used upon each freight or passenger car. It is by the perfect working of this ingenious, yet very simple valve, that the brakes are all applied at the same moment on the long freight trains, of fifty to one hundred cars, now in use. The quick-action triple valve is really two valves combined in a single casing, one portion operating to make the brakes apply instantaneously and with maximum force throughout the train, as required in emergencies, and the other portion moving to produce a more gentle action and of varied force, as required by slow-downs, station stops, and other conditions of ordinary service operations. In service action the emergency parts remain inert. They are always at rest, except when emergency requires stopping a train at once and in the shortest distance possible.

The action of the brakes is transmitted from the engine to the first car, and from car to car, by an impulse that travels like a sound wave. When the engineer moves his brake handle so as to cause the brakes to apply for emergency, this wave, or impulse, travels through the air brake piping, from car to car, with great rapidity. A train of fifty freight cars of the standard box type is about a third of a mile long, yet brakes upon the last car apply within two seconds of those at the front end, and, therefore, instantaneously with all other brakes in the train. This is quite necessary, for if the emergency action was slow in reaching the rear cars, the forward part would be stopping, with the rear cars running into them. One can imagine the shocks that would result.



((Cut shows corner pocket covers in position for billiards.)

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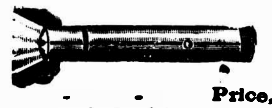

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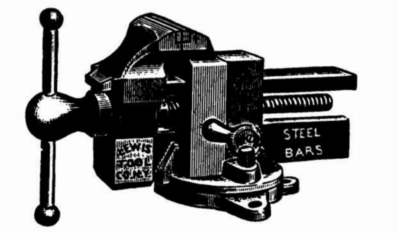

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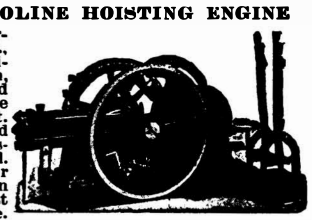

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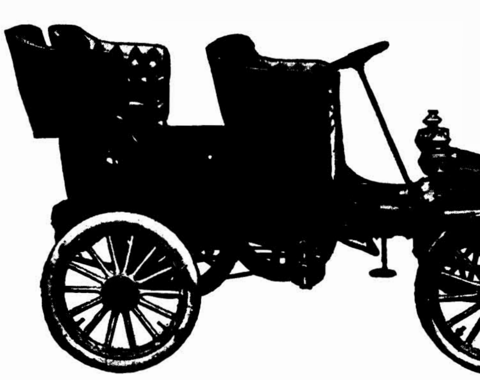

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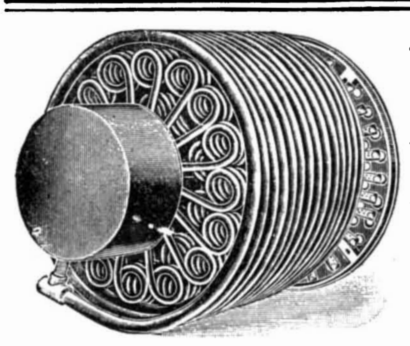

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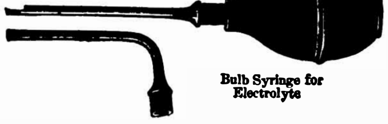

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For Regulating the Quantity of Acid above the Plates or Filling Storage Batteries with Electrolyte.

For Testing the Specific Gravity of the Acid of Storage Batteries or Making the Electrolyte.

Automobile News.

Recognizing the importance of the new transportation and the fact that it will endure, the faculty of Columbia University has added a course in automobile mechanics to the curriculum. Instruction will be given by a competent gas engine expert, and the course will cover gasoline and steam carriages only, the electric vehicle being included in the regular electrical course.

By the death in Paris recently of M. Elie Buchet, aerial transportation has lost one of the men who did much toward bringing it to its present stage of advance. Originally interested in the designing and manufacturing of light motors for automobiles, M. Buchet had his attention drawn to the needs of aeronauts for gasoline motors of this type. He finally succeeded in building the lightest motors per horse power in the world, and nearly all the airships that have succeeded or come to grief within the last few years were equipped with Buchet motors.

Col. John Jacob Astor has offered to give $10,000 toward the construction of the proposed road from New York to Chicago, if the Automobile Club of America will change the route to the east instead of the west side of the Hudson River. Mr. Astor also intimates that other wealthy men owning estates on the east bank will probably follow suit if the route is changed, as the road would benefit them as well as the many other inhabitants on this side of the river, whereas the west bank is but sparsely settled, and a road there would not be of so much use. If the east bank is chosen, vehicles will be ferried across the Hudson from Rhinebeck to Kingston, at which point the road strikes westward to Binghamton, Elmira, Erie, Cleveland, Toledo, Elkhart, and Chicago.

English automobile enthusiasts have formed a Volunteer Corps to be used by the government in time of war for carrying dispatches and bringing into communication distant points not reached by the railroads. Of late, to get themselves in training, they have organized several balloon pursuits. In these novel chases, an aeronaut starts skyward in a balloon, carrying some dummy dispatches, while at the same time the automobiles start in pursuit of the huge gas bag on *terra firma*. If a good breeze is blowing, the aeronaut gives the automobilists a lively chase; while if he is aided with clouds in or above which to hide himself, he keeps the modern "knight of the road" guessing as to his whereabouts. The one who reaches him first after his descent is declared the winner of the chase, which is said to be much more exciting than "hare and hounds" or a fox hunt.

The annual hill-climbing test of the Automobile Club of New Jersey was held at Eagle Rock, Orange, on Thanksgiving day. The road that winds up this rock is of hard macadam, with grades of from 3½ to 16 2-3 per cent. On the day of the test it was slippery and muddy. Notwithstanding adverse conditions, Mr. O. P. Nestman, in a Stevens-Duryea 8 horse power gasoline car, succeeded in reaching the summit of the hill—a distance of a mile and one-eighth—in 2 minutes 45 seconds. This was 1 minute 8 4-5 seconds better time than that made by one of the Duryea Power Company's gasoline machines last year, and but 3 seconds less than the record made then by Mr. W. J. Stewart in a locomobile. For the present test, Mr. Stewart installed a larger boiler in his machine, but with unsatisfactory result, as he only succeeded in making the ascent in 2:58¾. The third and fourth best times were made by Mr. Newton in a locomobile and Mr. Wells in a Prescott steam carriage, in 3:36¾ and 3:43¼ respectively.

The year 1902 has been a record-breaking one for automobiles. Following closely upon Fournier's reduction of the straightaway mile and kilometer times to 47 2-5 seconds and 29 1-5 seconds respectively on November 6 (each of which figures was robbed of its fraction several days later by the Frenchman's compatriot, M. Augieres) comes the smashing of Winton's new track record, made by the world renowned "Bullet," by Henry Ford, of Detroit. Mr. Winton, on the Glenville track at Cleveland, September 16 last, made a new track record of a mile in 1:02¼, against his previous record of 1:06 2-5, made about a year ago. Mr. Henry Ford, of Detroit, on a gasoline racer built by himself and Tom Cooper of that city, has just succeeded in beating Mr. Winton's time by more than a second, having established a new record December 1 on the Grosse Point track, Detroit, of a mile in 1:01 1-5. This brings the much-sought-for speed of 60 miles an hour, or one mile in exactly one minute on a track, within slightly over a second of being attained; so the probabilities are that before long the feat will actually be accomplished.

A fact that shows the remarkable development of the gasoline automobile is that during the past eight years the average speed of such machines in the long-distance road races held in Europe has risen from 15 to 60 miles an hour. It is interesting to note the course taken by the different countries and municipalities abroad in regulating the speed of machines capable of such space-annihilating capabilities. The general tendency seems to be to have government inspection and approval of the automobiles as to their brakes, steering gear, and various safety appliances, before these leave the manufacturers' hands; then to grant the owner a certificate of capacity, when he has demonstrated his capability to properly operate and manage the machine, which can always be identified by its number plate. The speed limits range from 6 to 12 miles an hour in cities and towns, to from 18 to 31 miles per hour in the open country. The punishment for violation of the speed laws is a fine and imprisonment according to the magnitude of the offense and the amount of damage done. In Germany, special restrictions on the use of steam boilers practically prohibit steam carriages. The idea of government inspection, as above outlined, is a good one, for if manufacturers are compelled to place thoroughly safe and efficient brakes and steering gear on their machines, there is much less likelihood of accident, even if speeding in the open country is occasionally indulged in.

To prevent the freezing in cold weather of the water in the tank, piping, and water jacket of the engine on a gasoline automobile, besides glycerine and chloride of calcium, which has already been proposed, chloride of magnesium and chloride of sodium can also be used. The following figures, from La Locomotion, give the temperatures at which different mixtures of the latter (sea salt or ordinary table salt) with water, freeze:

Sea salt (NaCl), 25 parts + water, 75 parts = temperature of congelation of —15 deg. C. (5 deg. F.).

Sea salt (NaCl), 22 parts + water, 77 parts = temperature of congelation of —12 deg. C. (8.6 deg. F.).

Sea salt (NaCl), 10 parts + water, 90 parts = temperature of congelation of —12 deg. C. (10.4 deg. F.).

At the same time, the writer adds, chauffeurs should mistrust the use of saline solutions of any kind, because of their corrosive action on metals. It is possible, according to the chemist Keller, that the chloride of calcium solutions, for instance, may have no action on metals, such as iron, copper, steel, etc., *when isolated;* but it is true, nevertheless, that when these metals are combined in the presence of this solution, as they are in the different parts of the water circulating system, a voltaic couple forms and one of the two metals corrodes rapidly in its presence. This may readily be seen if strips of iron and copper, fastened together, are dipped in a solution of calcium chloride. The iron, which forms the negative electrode, will be attacked and disintegrated. It is therefore prudent to employ exclusively for this purpose neutral liquids, such as glycerine or even the heavy oils.

Notes and Queries.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.

Special Written Information on matters of personal rather than general interest cannot be expected without remuneration.

Scientific American Supplements referred to may be had at the office. Price 10 cents each.

Books referred to promptly supplied on receipt of price.

Minerals sent for examination should be distinctly marked or labeled

(8760) J. A. D. asks: What kind of a composition can I use to build a castle for fish aquarium, that I will not have to bake as the potter does? It should be white or light stone color. Aquarium cement is too dark, and it does not dry without litharge in it, and Portland cement does not hold for so small an object. I have used plaster Paris for a castle and soaked it in melted paraffin, but it softens in a short time under water. The composition must not contain lead or other poisonous substance. A. Following are two formulæ for a non-poisonous aquarium cement: 1. Melt together over a gentle heat 3 parts of linseed oil, 4 parts of tar, and 16 parts of resin; if not sufficiently firm, keep simmering for a short time. Use warm. This, of course, would be dark-colored. 2. Take 8 ounces of a solution of good glue and 1 ounce of Venice turpentine and boil together, stirring until mixture is complete. The joints after cementing should be held together for several days to secure the best result.

(8761) F. C. P. asks: 1. What is the specific gravity of acetylene gas? A. The specific gravity of acetylene gas, referred to hydrogen as unit, is 13; referred to air as unit, it is 0.92. 2. What is the specific gravity of illuminating gas? A. No definite specific gravity can be given for illuminating gas on account of its variability; whether coal gas or water gas, how largely carbonized, etc. In general, its specific gravity will be between 0.5 and 0.6, referred to air as the unit. 3. If a cylinder of aluminium, 60 feet long, 10 feet diameter, 1/8 inch thick, be exhausted of air, would it float in the surrounding air, or what would happen? A. As the weight of such a cylinder of aluminium is 3,433 pounds, and the volume of air it displaces weighs only 380.7 pounds, it would not float in the air. In order that an object may float in liquids or gases, it must weigh less than the weight of the volume of fluid it displaces. 4. How much is a cubic foot? A. A cubic foot is the equivalent of 6.23 English imperial gallons, or 7.48 ordinary Winchester gallons.

(8762) H. P. A. asks: 1. What is the mean spherical candle power of a 1,200 candle power arc lamp (direct current), and what part is utilized in lighting the street or radiated below the horizontal? A. Foster, Pocket Book, gives an empirical formula for determining mean spherical candle power approximately, as half the horizontal candle power plus one-fourth the maximum candle power. Thus a lamp which gave 1,240 candles as a maximum, gave 240 in a horizontal direction. Its mean spherical candle power was 385, the rule giving 370 or very nearly the same result. You will find several papers in the transactions of the American Institute of Electrical Engineers on this difficult subject. 2. What is the wattage required for the above lamp? A. Such a lamp may take 300 or a little more watts. 3. How does an inclosed arc compare with an open arc for efficiency? A. The inclosed arc is preferred to the open arc principally because it costs less to operate. It runs 100 to 120 hours on one trimming. A single lamp can be cut out of circuit without disturbing others. If ordinary open arcs are used, two must be turned off together. The light of the inclosed arc is more evenly diffused than that of the open arc. They consume less current than the open arc. 4. What is the wattage required for a 25 candle power incandescent lamp used on a direct current series line? A. An incandescent lamp is usually made 2½ to 3½ watts per candle. 5. In the July 26 SCIENTIFIC AMERICAN, I find that the cables of the new East River Bridge are made up of 37 strands arranged in a hexagonal cross-sectional form, five strands lying on each side of the hexagon. Now, my query is. How are the 37 strands arranged to form a hexagon with five strands on a side? A. As to the shaping of the cables of the new East River Bridge, we beg to refer you to the engineers. Address Engineers' office. New East River Bridge, Brooklyn, New York.

(8763) E. L. T. writes: I have several paper-bound books which I would like to

(Continued on page 420)

cover with cloth, but cannot find any paste which is just the thing. Can you suggest something? It should attach cloth to paper securely, be somewhat flexible when done and dry quickly. A. Bookbinders generally use ordinary flour paste for covering board or paper with cloth. It is best made by stirring up the flour with a small amount of cold water, and then running it into hot water to which a little alum has been added, stirring until smoothly swelled. If this be not found strong enough, make a little starch paste in same manner and add some Venice turpentine.

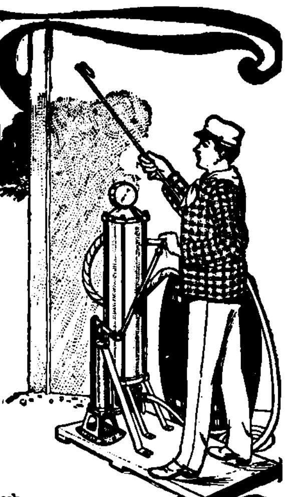
(8764) A. M. says: If you take 2 drachms of sugar of lead, dissolve in ½ pint of water, then take 6 drachms of hyposulphite of soda, dissolve in ½ pint of water, then mix the two solutions, you will get a precipitate. Now what I want to know is, What is the precipitate and what is the solution I want to use? Does it contain lead enough to be injurious to the human system? A. Sugar of lead (lead acetate) and hyposulphite of soda (thiosulphate of soda) react with the formation of lead thiosulphate and sodium acetate. If the sugar of lead and hypo be taken in molecular ratios, that is, 379 parts of crystallized lead acetate to 248 parts of crystallized hypo, there will be an almost complete precipitation of lead thiosulphate; this precipitate is at first white, but it turns black by standing or by warming, owing to its conversion into lead sulphide. By using a larger amount of hypo, the precipitate of lead thiosulphate at first formed will redissolve as a double sodium lead thiosulphate. These reactions should all be conducted with the cold solutions; heating will always cause blackening. The amount of lead that will remain in solution will depend upon the greater or less excess of hypo used. It is always a risky thing to introduce lead into the human system; its effect is cumulative.

(8765) H. F. P. asks: I have a 50-kilowatt general electric alternator which I use for incandescent lighting with primary circuit at 1,150 volts and secondary at 104 volts. I wish now to put in a few arc lamps; if I put constant potential lamps in parallel on the secondary circuits, will it make the incandescent lamps flicker? A. The ordinary series arc lamp cannot be used on constant potential mains. An arc lamp provided with a suitable resistance can be. Such lamps are furnished by lamp manufacturers, both open and inclosed arc, and are in use in very great numbers in many places. We do not think the incandescent lamps will flicker so long as they are bridged across the secondary circuit.

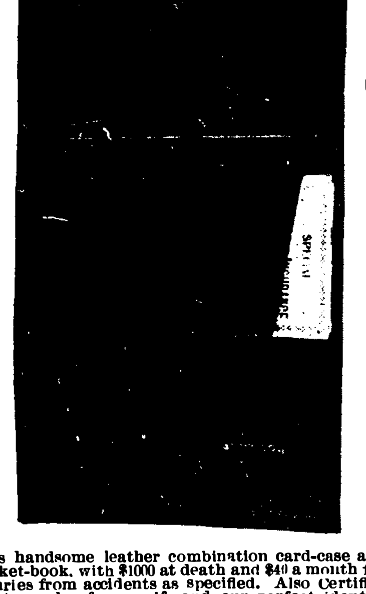
(8766) W. M. B. asks: Which is the more healthful underwear—pure wool or linen mesh? A. This is a matter that cannot be settled by anyone's dictum. The advocates of wool claim this to be superior, while the advocates of linen are equally insistent they are correct. In favor of wool may be said that it is the more natural body covering, as it is chemically allied to hair, in fact, the hairy covering of all animals is much alike. Also, wool gives undergarments of greater warmth; linen does not retain the body heat as well, and in this climate it is very probable that linen mesh would be pronounced too cool to wear by very many people. In favor of linen we have the fact that the linen fiber is a cellular fiber, and hence very resistant to any decomposing action; while wool is a nitrogenous fiber, and hence not as stable or resistant. Also, linen allows the perspiration of the body to pass through and evaporate more freely. It would seem as though the advantages of both kinds of undergarment are pretty evenly balanced, and that preference is really a matter of choice and comfort, not of health.

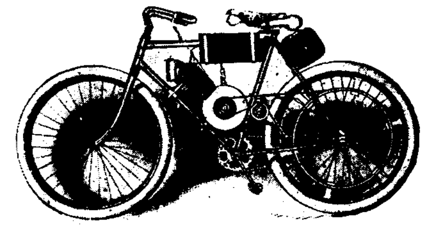
(8767) T. A. K. says: I have some selenium in the powdered or precipitated form with which I want to spread a thin coat over a plain metallic surface, after which I want to anneal the selenium and make it sensitive to light. Will you please give me detailed directions for doing same? Is there anything that will dissolve the selenium so that it can be flowed over the surface so that the solvent will evaporate and leave the selenium, which can be annealed afterward. A. There are two allotropic forms of selenium. The one is soluble in carbon bisulphide; the other is insoluble, but if it be melted and then cooled rapidly, it also becomes soluble. Both forms will dissolve in selenium chloride.

(8768) M. F. S. asks: 1. What would a barometer register in a perfect vacuum? A. A barometric perfect vacuum should correspond absolutely with the atmospheric pressure, less the elastic force of the vapor of mercury. A nearly perfect vacuum applied at the base of a barometer should register at equal levels of the mercurial surfaces. 2. When it registers at ½ inch is it near a perfect vacuum? A. One-half inch of barometric height is only a partial vacuum and is equal to 0.245 of a pound pressure per square inch absolute. 3. About what would a barometer register in an incandescent electric lamp globe? A. The residual volume of air in the best incandescent lamps is about 1-1,000,000 of the volume at atmospheric pressure. When charged with gas free from oxygen the vacuum may be much less. 4. Can a perfect vacuum be made? A. We understand that a perfect vacuum has not yet been accomplished. The most perfect vacuum yet claimed is 1-500,000,000 of the volume.



THE BICYCLE: ITS INFLUENCE IN Health and Disease.—By G. M. Hammond, M.D. A valuable and interesting paper in which the subject is exhaustively treated from the following standpoints: 1. The use of the cycle by persons in health. 2. The use of the cycle by persons diseased. Contained in SCIENTIFIC AMERICAN SUPPLEMENT, No. 1002. Price 10 cents. To be had at this office and from all newsdealers.





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By JOSEPH V. WOODWORTH

This book is a complete treatise on the subject and the most comprehensive and exhaustive one in existence. A book written by a practical man for practical men, and one that no diemaker, machinist, toolmaker or metal-working mechanic can afford to be without.

Dies, press fixtures and devices from the simplest to the most intricate in modern use, are shown, and their construction and use described in a clear, practical manner, so that all grades of metal-working mechanics will be able to understand thoroughly how to design, construct and use them, for the production of the endless variety of sheet-metal articles now in daily use.

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Scientific American Patent Department.

For a period of fifty years Munn & Co. have acted as solicitors of patents, and during this period have filed more applications for patents than any other attorneys in the United States. The following extracts from letters recently received will give some idea of the manner in which the professional services of Munn & Co. have been appreciated by those who are best qualified to judge of this matter, and this evidence of satisfaction is all the more noteworthy, inasmuch as these words of commendation have been uttered without any suggestion or solicitation on our part.

I have received the patent papers for my storage battery and I assure you I am very much pleased with the treatment received from you in every particular. You were frank to point out my errors, and careful to draw out all of the little points and details which I now see the importance of and which would have been left out. If inventors knew the interest you take in their work in connection with your experience and ability, which no one questions, I am sure they would not so dread making applications for fear of errors nor be at a loss to know whom to employ.
H. P. King, Electrical and Machine Works, Osgood, Ind.

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Emile Weidig, Crockery, Glassware and Stoves, New Orleans, La.

We are pleased to note that you have been successful in obtaining our patent, and we again thank you for the interest you have shown and for the able manner in which you have conducted our case.
Hibbard Brothers, Gas and Gasoline Engines, Sandy Hill, N. Y.

Permit me to thank you for your care in looking after my interest in the case while pending, coupled with your great courtesy in all of our correspondence. I also received copy of the SCIENTIFIC AMERICAN. It affords me pleasure to say that I have been a reader of this valuable paper for many years and expect to continue during life.
C. P. Brown, M.D., Spring Lake, Mich.

I thank you very much for the mention made of my invention in the SCIENTIFIC AMERICAN, and I think this ought to bring it before the manufacturing public in pretty good shape, and I hope I may see my way clear to placing a standing advertisement with you in the near future.
W. J. Smith, Lumber, Detroit, Oregon.

Permit me to thank you for your promptness and accuracy, by which you so earnestly endeavored to protect my interest. I trust that I may have not the privilege alone, but the pleasure of other business relations with you.
Charles H. West, Eastabuchie, Miss.

I thank you for the ability with which you conducted my case before the Patent Office.
John Carter, Malden, Mass.

Both Mr. Orr and myself are very much pleased over the prompt manner you have looked after this matter for us. I shall be pleased to recommend you to clients who may be interested in patent applications.
William A. McDonald, Counselor at Law, Gloversville, N. Y.

We thank you for the diligent manner in which you have prosecuted our claim, and its successful termination.
Heman, Hyde & Co., Ridgway, Pa.

I beg to express my appreciation of your successful efforts in securing for me claims that are so broad and fundamental in their character.
George L. Dale, New York, N. Y.

We shall be pleased to give you all the work we have of this kind in future and are much obliged to you for your courtesy in this matter.
Treat & Converse, Dry Goods Commission Merchants, New York, N. Y.

We are greatly pleased with the service which you have rendered us and wish to thank you for your promptness and honorable dealing throughout.
Frank I. Post, Michigan Portland Cement Company, Coldwater, Mich.

Am well pleased with the way that you carried through the full number of claims, thereby getting for me a good, strong patent, and you can feel assured of getting my patronage in the future should I decide to have any other patents.
Edward M. Howell, Denver and Rio Grande Railroad Company, Denver, Colo.

Please accept our thanks for your masterly treatment of our case, and the perfection of your work.
S. M. Salisbury & Bro., Booksellers and Stationers, Aberdeen, S. D.

We were most agreeably surprised to learn that you had secured such broad claims in spite of the action of the Patent Commissioner. We wish to say that in every case you have conducted for us the results have been greater than we anticipated.
H. S. Kidd, Kidd & Depue, Inventors, So. Norwalk, Conn.

This makes the fifth Letters Patent that have been granted to me through you during the past year. I wish to thank you for your promptness and the careful attention which you gave to my business.
Fred Menzer, The Menzerette Vehicle Company, Flint, Mich.

I thank you kindly for your promptness and honesty, which I appreciate highly.
John R. Kirk, East Las Vegas, New Mexico.

Let me give you my best thanks for the masterly way in which you procured for me my Patent, as you got me more concessions than I ever hoped for, and for this there will be only one Patent Agency for me and that is MUNN & CO. As far as in my power I will recommend you to one and all that have any aspirations for patents.
Emil P. Datow, New Orleans, La.

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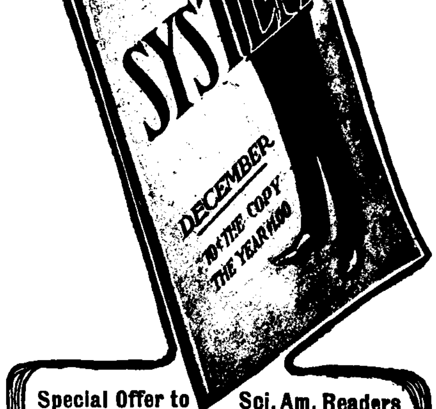

Engineering Notes.

The British Admiralty are carrying out numerous experiments at Devonport with a view to ascertaining the most suitable means of preventing torpedo craft from "jumping" obstacles placed across a harbor entrance as a defense against torpedo attack. The obstacles for the purpose of the experiments will comprise steel hawsers, nets, and balks of timber. A torpedo boat with powerful engines and a strongly-built hull has been specially selected for the tests.

The new steam pilot boat "New Jersey," built for the New York, New Jersey and Sandy Hook Pilot's Association, had her trial trip November 12. The run was made from the whistling buoy to the Sandy Hook lightship, 4¼ miles, and she covered the distance in 16 minutes. The New Jersey is equipped with electric lights that are operated from the pilot house. She is constructed of oak, and her cabins are finished in white enamel, with mahogany trimmings. She has fore-and-aft compound engines, and her builders guarantee a speed of eleven knots. The "New Jersey," when on station, will carry twenty pilots and will cruise off shore. Her crew consists of a captain, one mate, two engineers, three oilers, four firemen, one boatkeeper, and four deckboys. Capt. Hennessey has command. She will put three sailing vessels out of the service. Her dimensions are 135 feet over all, 125 feet keel, 28 feet beam, 17.6 feet deep, and 13.6 feet draught.

The directors of the Nord, Ouest, and Orleans railway companies of France, and representatives of Belgian, Dutch, German, Austrian, and English roads recently met at Paris, in order to make arrangements for a through-train service from Paris to Pekin. It was shown at this meeting that the trip could be made by way of St. Petersburg and Siberia in eighteen or nineteen days, while the sea route, either by the Suez Canal or the Atlantic and Vancouver, requires from thirty-two to thirty-three days. All that seems necessary at present is an arrangement of time-table connections and the selection of cities in which through tickets may be purchased. It is said that through tickets will be delivered at both Havre and Cherbourg, and trans-Atlantic companies will be able to state before boats leave New York whether or not connection will be made with through trains to the Orient. The same arrangement will be made for the daily service between Southampton and Paris. It was also decided at the recent meeting to form a combination with the trans-American railroads and trans-Pacific lines, so that round-trip tickets from New York to Pekin could be sold at the former city, with the privilege of going by the Pacific and returning by the trans-Siberian route, or *vice versa*. The time required from New York by either route is about the same.

A further important step toward the realization of the late Cecil Rhodes' great transcontinental railroad across Africa, linking Cairo with Cape Town, has been completed by the opening of the track between Bulawayo and Salisbury via Gwelo, a distance of 300 miles. By the completion of this section 2,000 miles of track of the Colonial gage is open to through traffic from Cape Town to Beira. The South African war somewhat retarded the progress of the work, as it was not possible to forward the material northward from Cape Town, so that work had to be suspended at the Bulawayo end of the section. However, other portions of the route were proceeded with meanwhile. As this section is now open to traffic, it will appreciably facilitate the progress of the through Cape to Cairo road, as it will now be possible to forward the constructional material from the landing quays from the Cape Colony and Beira ports direct to the railroad head. The Cape to Cairo track is laid for eighty miles north of Bulawayo in the direction of the Victoria Falls. It is anticipated that the road being laid will reach the Wankie coal field region by the beginning of 1903.

The Russian government has completed the surveys for the railroad from Odessa via Nicolaieff and Kherson to Jankoi, on the Sevastopol road, with a branch of about thirty miles to Ochakof. Although this road is principally of strategical value, it will be highly beneficial to the commercial development of the region by opening up a large tract of grain-producing country that has hitherto been severely handicapped owing to the lack of railroad communication. The dredging of the Ochakof bar and estuary of the River Boug—work forming a portion of the general scheme—has been completed. The fairway between the commercial port at Nicolaieff and the sea is now 25 feet deep by 350 feet wide at the bottom, and as it is now buoyed, will be officially thrown open to navigation. By the completion of this dredging nearly all the steamers that visit the Black Sea will be able to load cargoes at Nicolaieff, so that the latter port will become a powerful rival to Odessa in the grain-exporting trade.

Experiments have been carried out on a railroad near Frankfort with a device to prevent collisions, with conspicuous success. The invention consists of a small apparatus fitted to the locomotive, which gives visible and audible signals if another locomotive is approaching on the same line of rails, or if a switch is misplaced, while in addition it also renders telephonic communication between locomotives possible. For the purpose of the experiments two locomotives were started for the same point on the same line of rails. When they were a certain distance apart, the apparatus on each locomotive gave signals to the engineers, who were then able to enter into communication.

Some time ago the Scientific American described the Tehuantepec Railroad scheme, by which President Diaz hopes to divert the commerce of the Atlantic and Pacific oceans across this narrow part of Mexico. The plan has received still another setback. Dispatches from Salina Cruz, the Pacific terminus of the road, tell of a terrific series of earthquakes and tidal waves which wrecked the harbor improvements at that point and have involved a loss of half a million dollars. Although President Diaz still firmly believes in the feasibility of his scheme, capitalists will probably shrink from investing their money in a region which is likely at any time to be destroyed by a volcanic eruption. The ruined road was built and thrown open to traffic in 1885, after seventeen years of alternate failures and renewed attempts to complete it.

A new type of propeller for ocean steamships has been invented by Count Rudolph von Westphale, of Vienna. In this new design the four blades that usually run out from the boss at the end of the shaft are substituted in straight and flattened supports by blades that are attached to their ends. The propelling blades have their outer ends at the same general angle of the screws, while the inner ends, instead of coming together at the center of the boss, meet at the outer extremity of the boss, where they are held in position by a circular band. The wheel practically has eight propeller blades. The outer blades are only half the width of the ordinary blade, and six inches shorter than the regulation wheel on the port shaft. Practical tests with this new propeller have been carried out on the North German Lloyd steamer "Frankfort;" and it was found that in the revolutions of the two types of screws the new propeller made 68 revolutions per minute as compared with 70 revolutions of the ordinary propeller, though the speed was the same in each instance. The main objects claimed for this new propeller are less vibration, and greater economy in coal consumption and steam power than are possible with the present type of propeller.

Electrical Notes.

The Northern California Power Company, which furnishes power to a great variety of industries in one of the most prosperous sections of California, has recently installed a 4,000 horse power generating plant at the Cow Creek station, which is situated in the high Sierras and is typical of the many transmission plants which have recently been installed in California. The ultimate capacity of the station will be 8,000 horse power when the demand for power reaches this amount. The company has already installed 3,000 horse power at another generating station, known as the Battle Creek station, thus making the present total capacity of the company's electrical installation 7 000 horse power. Among the industries supplied with power by this company are ore-smelters, the city waterworks at Red Bluff and Redding, and the operation of large air compressors at the Mount Copper Company's mine at Iron Mountain. For lighting current is also furnished to the cities of Redding, Red Bluff and Willows, and the towns of Keswick, Cottonwood, Anderson, Corning and Vina. These towns lie along the Sacramento River and are located in one of the most fertile valleys in California. Irrigation is necessary on most of the land in this valley, and electrically-driven centrifugal pumps are employed to raise the water to the irrigating ditches. This cheap method of placing in the hands of the farmer the ability to obtain water away from streams and creeks has made him independent of the great water companies, and has rendered it possible to develop large areas of land which would otherwise be practically desert wastes. Many thousands of motors are already in operation in California driving pumps for irrigation work, and immense developments are yet to ensue from this application of electric power. The apparatus which the Northern California Power Company has recently installed in its Cow Creek station consists of two 1,500-kilowatt, three-phase, Westinghouse alternators, which will be driven by impact waterwheels supplied with water under a head of approximately 900 feet.

Electric traction is especially active in Italy at the present time. One of the most important electric railroads, the Milan-Varese system, has recently completed an important branch from Varese to Porto Cerisio, and the tests which have been made on the line from Gallarete to the last named point proved quite satisfactory. The grades are considerable over the new branch and in many places reach as high as 20 per cent. The electric locomotives, however, have no difficulty in making the trip at a speed of 35 miles an hour, which could not be reached before by the steam locomotives. The train makes the run from Porto Cerisio to Varese, or 8.4 miles, in 17 minutes in spite of the grades and sharp curves. The Milan system, which has already been described, contains a line from Milan to Gallarete, 24 miles, and from this point are three branches to Porto Cerisio, Laveno and Arona, of 20, 15.6 and 18.6 miles respectively. Trains have been running from Milan as far as Varese, or 35.4 miles, for some time past, but it is only recently that the line has been extended to Porto Cerisio, 8.4 miles, making the total distance 43.8 miles. The work on the other branches has not yet been completed. On this road motor cars and trailers are used, and trains are generally made up of two motor cars and two trailers. An electric locomotive is also used for freight and postal cars and several new locomotives are to be built. At last accounts there were 32 trains running over the Milan-Varese section, among which were 7 direct trains which made but one stop between the terminals and cover the 44 miles in 53 minutes. In view of the success of the recent tests and the completion of the new branch, the project for electric traction from Naples to Rome, which has been discussed for some time, is being actively taken up. Besides this, there will be several

(Continued on page 424)

branches such as Velletri-Terracina and others in the south of Italy. The extensive system which is contemplated will take a large plant, this being estimated at 40,000 horse power, of which the Naples-Rome system alone will require 25,000. A number of hydraulic plants are to be erected to supply the roads, and these will use the falls of the Liri and the Volturno, as well as the Anione, the Pescara and several other streams.

When a small E.M.F. is applied to an ozonizer, no ozone is formed, but as the E.M.F. is increased, ozone begins to form at a certain point, and a further rise of E.M.F. causes a very rapid increase in the amount of ozone formed. When the E.M.F is high, the power of the current to produce ozone is proportional to the square of the potential difference which exists between the armatures. As this law is not applicable until a certain E.M.F. is reached (which depends on the size of the apparatus), Mr. A. Chassy, in a recent paper, introduces the idea of a dielectric inertia to explain the irregularity.

The value of waterfalls has greatly increased since the electrical era, says the Mining and Scientific Press. Time was when a cataract was valuable only for scenic purposes, but now it is useful as well as ornamental. Niagara is worth one thousand million dollars more as a source of electrical power than merely as a sight. California waterfalls are increasing in value in a commensurate degree. Snoqualmie Falls, in Washington, has enhanced in value 5,000 per cent in the last few years.

The city of Bombay, India, is to be equipped with an extensive system of electric traction and lighting, while another scheme for operating a stretch of railroad is to be carried out. Water is to generate the necessary power for both projects. For these purposes two huge water-power plants are to be constructed. The machinery for supplying the electricity to work the railroad is to be installed on the Doodh Sagar River, about 300 miles north of Bombay, at a waterfall which is about 2,500 feet in height. It is anticipated that with the projected machinery for this installation 50,000 horse power will be generated—available throughout the year—sufficient to operate some sixty miles of track. The power for lighting and working the street railroads of Bombay is to be transmitted from Neral, about forty miles distant from the city.

A comprehensive scheme of electric traction is to be installed upon the roads of the foreign settlement of Shanghai. Competition for the construction contract was very keen between American and British firms, but the order for the equipment has been placed with two English houses. Work is to be commenced immediately. The present contract comprises the construction of nine and a half miles of double track, and eight miles of single track, the necessary equipment and cars. The work is to be completed by the end of 1904, and the cost is estimated at $3,500,000. The Shanghai Municipal Council reserves the right to take over the roads at the end of twenty-one years on specified terms.

A system of electric heating has been adopted in the cars of the electric railway to Versailles. In each car of the central corridor class, ten heaters are placed on the floor between the seats, so that they act as foot-warmers. The heaters are of the Parvillée type, in which the resistance consists of a mixture of metallic powder, quartz, kaolin, and a flux, and are connected five in series—being supplied from the third rail at 550 to 600 volts. At 110 volts each takes one ampere, and the total power for each carriage, which seats forty passengers, is therefore 1,100 watts. Assuming a cost of 15 centimes per kilowatt hour, it follows that the expense of sixteen hours' use will be 2.64 francs. The mean temperature obtained at the surface of the heaters is 70 deg. when the external temperature is 0 deg.

Scientific American

ESTABLISHED 1845

The Value of a Paper

to its readers is seldom determinable, for the reason that, beyond an occasional letter of praise from "an old subscriber" or "an admirer"—who is influenced by some particular article that coincides with his own views—editors and publishers rarely receive any commendation for their work.

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I began to read your valuable paper when I was ten years of age, and, although it has not made a scientific man of me, it has helped to make me an American.

I have been a constant reader of the Scientific American for many years, and find that it keeps pace with the growth of the country and the development of knowledge and ideas.

It is the most valuable, up-to-date scientific publication of its kind published. Its articles are always fresh and reliable, and written in such a popular style as to be easily comprehended by even the layman in scientific matters.

The following are a few comments received by the Editor from subscribers when renewing their subscriptions. These letters were entirely unsolicited on our part, and are valued as showing the appreciation of readers from various sections of the country, both young and old.

I have been a reader of the Scientific American for twenty-seven years, and every issue is just as new and interesting to me as the first copy was when I was a young man.
J. L. Painter, Bellevue, O.

A long story short is this: My son, eleven years, over one year ago could not be interested in his school work. We had tried every means. Just why I cannot say, one year ago I ordered the Scientific American in his name. He was interested, became studious and did so well his teacher called to ascertain what was the reason. I thought I could not afford the paper for the coming year, and my son has earned the money and wishes to have his Scientific American continued another year. G. B. Royer, Elgin, Ill.

I have taken the Scientific American for fifty years, ever since it was first started. I intend taking it while I live. I am only eighty years old now, and may live some years longer in this healthy climate.
Wm. Burnet, San Francisco, Cal.

I cannot do without your paper, having had it for 40 years.
G. J. Van Duyne, Monroe, Conn.

Your paper is a grand instructor for any young man, and were I a young man, and had time to read, I would not be in want of the Scientific American and Supplement for $20 per year, as everything in the paper is good, moral and instructive.
W. M. King, Germantown, Philadelphia, Pa.

This makes the twenty-third year of my continuous subscription to your valuable paper, and I cannot be without it. I always count it my Christmas present.
T. L. Charman, Oregon City, Oregon.

I have nearly complete volumes of the Scientific American for some thirty-five years, and consider myself a life member.
T. J. Howe, Owatsuna, Minn.

I have subscribed for your paper over forty-eight years, and have not missed a copy, and would not be without it.
F. M. Wiser, New Haven, Conn.

Pres. Angell, of the University of Michigan, when questioning students in an important examination, said, "I would trust any boy anywhere that reads the Scientific American."

A subscriber for twenty-eight years writes: I have two sons, both occupying lucrative positions in the East as electrical engineers. They were made such by reading the Scientific American.

Your paper ought to be in every home where the English language is spoken.
John Kerstein, Clarson, Iowa.

I cannot afford to be without the Scientific American and Supplement, as they have become a part of my life, a perfect library up to date every week. I cannot speak too highly of them. A. C. Winch, Saxonville, Mass.

I have taken the Scientific American for the last twenty-five years, and have every issue to date. I would not think of doing without it. It is the best paper published in the world. L. G. Murray, Converse, Ind.

I have taken your interesting and valuable paper for more than twenty-five years, and probably shall continue as long as I live, and I wish that every young man could be a constant reader of it.
B. M. Gunston, Oswego, N. Y.

Science Notes.

A. Winkelmann states that as a result of his experiments on the diffusion of hydrogen with platinum, he finds that the rate of diffusion increases after the platinum has been treated for some time. It is proved that this is not due to expulsion of occluded air, but to the crystalline structure assumed by the metal. When the platinum has passed into this state, it persists therein. The diffusion of hydrogen through red-hot platinum is not proportional to the pressure of the gas, but it is probable that the diffusion is accompanied by a dissociation of the molecules, and only the atoms of hydrogen pass through metal. The results agree with the formula obtained in previous experiments. The present experiments were made with a platinum tube 19 cm. long, 1 mm. in diameter, and 0.1 mm. thick in the walls. The metal was heated electrically.

A writer evidently versed in the practical manufacture of mantles contributes to a contemporary the information that the chemicals in 1,000 mantles cost $17.50; the fabric prepared, $13; the shaping, $14; coating, $3.75; boxing, labeling and packing, $3.75; profit, and selling expenses, $6; total, $60. Or the manufacturer cannot sell a reliable mantle for less than 6 cents apiece.

It has been found that when photographic dry plates are cut with a diamond on the side opposite the film, and then developed, the film turns dark along the edge of the plate to the breadth of a few millimeters. The film always develops first on the side next the glass. This effect has been traced to a momentary fluorescence along the line traced by the diamond, the radiation penetrating the plate.

The formation in the gold fields of South Africa is peculiar. The gold is in reefs. According to the Mining and Scientific Press, these reefs are massive and made up of coarse granite conglomerate and sandstone, with here and there large or small cement seams. The gold is not in the quartz or sandstone, but in the cement. The streaks which carry the gold are from 6 inches to 60 feet in width, and almost invariably widen with depth. When the outcropping is first discovered it looks like a vertical vein, but soon flattens out on depth. The mining there is more like coal than gold mining anywhere else. Shafts are nearly all 16 x 8 or 16 x 6.

During the progress of some excavations in Alexandria, Egypt, the workmen came across several huge blocks of masonry, some as much as three yards square. The remains of the entablature of a large edifice, which probably consisted of two stories, were also found. Some of the blocks bear quarry marks difficult to decipher. These masonry blocks, which have been examined by experts on the spot, are believed to be the ruins of the ancient theater of Alexandria described by Strabo. The discoveries are to be carefully investigated by expert Egyptologists to ascertain their exact origin and the era to which they belong.

The so-called gutta-percha tree which has been grown experimentally in the island of Zanzibar appears to be of doubtful economic value, as the latex obtained from it loses its plastic character after a few months, and becomes friable.

A series of experiments has been made by Schaible to determine the effect of diminished air-pressure on the growth and germination of plants. The apparatus used is fully described and illustrated and details of numerous experiments are given. The results arrived at were that, as compared with similar plants grown under normal barometric pressure, those under the diminished pressure—in most cases about one-quarter atmospheric pressure was employed—(1) grow more rapidly; (2) germinate more slowly; and (3) excrete drops of water from their leaf surface.

Prof. Exner, founder and director of the Technological Museum of Vienna, re-

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cently declared that the five million technical experts of all grades throughout the world had too small a share in law making and the administration of the various states. He maintained that technical knowledge was of such importance as to warrant the creation of politically independent technical departments in every country.

Dr. Oliver P. Hay of the American Museum of Natural History has found the humerus or upper wing-bone of a great auk's wing among a number of bones and shells sent to the Museum for examination by the State Geologist of Indiana. The bird has been extinct since 1844. The most remarkable thing about the discovery is that the bone was dug from a mound at Ormond on the south coast of Florida. The north coast of Massachusetts is generally supposed to have been the most southern point the bird ever reached.

Some interesting experiments in the interest of science have recently been undertaken at the Turin Physiological Institute, with the object of ascertaining the proportion of carbonic oxide necessary in the air to destroy human life. Signor Teodoros Scribante of Turin placed himself unreservedly in the hands of Prof. Mosse for the purpose of the investigation. On three successive occasions Signor Scribante was confined in a hermetically-sealed iron chamber, the air of which was mixed first with 1-333 of carbonic acid, then with 1-285, and lastly with 1-233. At the third experiment the courageous patient ceased to breathe, and was found to be in a cataleptic state, from which he was restored only by means of oxygen.

The London County Council has been carrying out for several months interesting experiments for the purpose of ascertaining the degree of effect different gaseous and liquid disinfectants exercised upon microbes. Various materials, including cloth, unvarnished wood, linen, and wall paper, all of which in ordinary practice often require to be disinfected, were experimented upon. As regards fluid disinfectants, it was found that corrosive sublimate, one part in one thousand, with 24 hours' exposure, destroyed all microbes, including the spores of anthrax and the tubercle bacilli; carbolic acid in five per cent solution, with 24 hours' exposure, failed to destroy anthrax spores, but was efficacious in all others. One teaspoonful of Condy's fluid to a pint of water, with 24 hours' exposure, gave a negative result; when used in five times that strength it was still practically of no value. Bleaching powder, generally speaking, only destroyed the less resistant forms of microbes, though in the case of anthrax spores on paper and on linen it was more effective than carbolic acid. The typhoid bacillus was killed by all disinfectants used, except Condy's fluid and bleaching powder. The diphtheria bacillus was killed by formalin and sulphur dioxide. Anthrax spores were only destroyed with certainty by the perchloride of mercury, the other disinfectants either failing occasionally or being uncertain. For tubercle bacilli carbolic acid and perchloride of mercury were the only disinfectants efficacious on each occasion, and it is especially deserving of notice that neither formalin nor sulphur dioxide was efficacious for wood or cloth infected with this bacillus.

According to the Lancet, evidence is accruing that the practice of adding artificial coloring matter to milk is increasing. Samples are commonly met with thus colored to give them a rich but false creamy aspect. The natural color of milk bears no relation necessarily to the amount of cream present. It is very desirable that this practice should be stopped. We believe that annatto is the dye commonly employed and it is fortunate that it is harmless, though that fact does not justify the device. Certain coal-tar dyes have, however, been detected in milk and among them methyl-orange, or, in chemical nomenclature, the sodium salt of dimethylaniline-azobenzene sulphonic acid.

RECENTLY PATENTED INVENTIONS.

Agricultural Implements.

HARROW.—H. H. LARSEN, Crookston, Minn. Mr. Larsen's present invention is an improvement upon a construction previously patented by himself. The improvements consist in making provisions for the operation of the front and rear axles by a single adjusting lever having operative connection with both axles. The axles are also constructed so as to bring the running wheels within the limits of the frame. The middle rank of teeth are grouped in such a way that the operation of the individual teeth does not interfere with other teeth or the teeth of other ranks in front or at the rear.

Dental Improvements.

DENTAL FORCEPS.—W. T. MARTIN, Yazoo City, Miss. The beaks of these forceps are thin and sharp and yet strong, and are adapted to be forced into the tooth sockets around tooth roots, whereby a very firm hold is obtained on the latter, so that they may be easily removed. By the use of this instrument it is unnecessary to cut away the alveoli in order to obtain access to tooth roots whose tops are broken off, since the beaks can be forced into the sockets, whereby they cut away and press outward the surrounding bone or tissues, and this is done with less injury to the sockets than by the ordinary method of extraction.

DENTISTRY.—G. G. MARTIN, Pecos City, Texas. Dr. Martin's invention is an improvement in dentistry which has for a primary object to provide means whereby the natural teeth which have become loosened from any cause, such for instance as pyorrhea and Riggs disease, may be tightened and held in place in the jaw.

Engineering Improvements.

ROTARY ENGINE.—F. C. JEWELL, Seattle, Wash. Mr. Jewell is the inventor of an improved rotary engine, the distinguishing feature of which consists in providing two intermeshing pistons operated in a double cylinder and actuated in connection with certain peculiar devices for controlling and supplying the admission of steam, whereby a relatively high speed may be obtained.

ROTARY ENGINE.—M. D. KALBACH, Lebanon, Pa. Mr. Kalbach's invention provides an engine whose direction is readily controlled and in which devices are employed for so controlling the cut-off valve as to secure advantage of the direct action and expansion of the steam in a simple and effective manner.

ROTARY ENGINE.—G. M. WALKER, Lincoln, Neb. The objects attained by this invention are the provision of means for utilizing the steam expansively in a rotary friction engine; to automatically adjust the abutments of the rotary piston for operation according to the direction in which the engine is des'red to be driven; to provide fluid pressure means for reversing the positions of the abutments, and consequently the direction of rotation of the piston; to provide a simple valve mechanism for controlling the admission of steam to the pistons, and the exhaust therefrom, and to simplify the construction whereby, without detracting from its efficiency, the engine may be manufactured at a moderate cost.

ROTARY ENGINE.—J. M. WILLIAMS, Krebs, Ind. Ty. This invention is an improvement in that class of rotary engines in which a piston is eccentrically mounted on a shaft adapted to be rotated within a circular drum and to co-operate with a swinging or otherwise movable abutment located in a chamber forming a circumferential enlargement of the steam chamber of this drum.

TRACTION-ENGINE COUPLING.—J. W. BULLER, Jansen, Neb. Mr. Buller's invention relates to means for detachably connecting a traction engine to the tender, and likewise for connecting the fuel and water supplying tender with a portable threshing machine or other wagon for its progressive movement. The construction of the device is such as to adapt it for very reliable and convenient service, permitting the automatic connection of the engine with a vehicle to be drawn thereby and also facilitating their disconnection.

Mechanical Devices.

BREAD-CUTTING MACHINE.—C. J. VANN, Brooklyn, N. Y. The object of this invention is to provide an improved device of simple construction which is more especially designed for use in hotels, restaurants, boarding-houses and the like, and which is arranged to cut slices of bread to any desired thickness and trim the same to a uniform shape.

CASH-REGISTER.—H. POTTIN and LUCIE MOUSSIER, 100 Rue St. Lazare, Paris, France. The improvements which are provided in this invention consist in so arranging a cash register as to automatically prevent the key levers indicating the number to be added to those already registered, from getting out of order during the counting operation from the moment this operation commences until the moment when the partial number indicated by each lever is registered and totaled. Each lever after registration of the partial number is automatically freed and brought back to zero position.

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SALTING-MACHINE.—J. W. GHEEN, Astoria, Ore. Mr. Gheen's invention relates to machines for supplying salt to cans used for canning meats, fish, and other foods. The object of the invention is to provide a machine of simple construction by means of which measured quantities of salt may be rapidly fed into the cans.

STAMP-AFFIXING MACHINE. — C. J. FANCHER, Granby, Conn. The machine comprises a mechanism for moistening the corners of the envelopes, for feeding the stamps to a point adjacent to the moistened corners, for detaching the stamps from each other, and for pressing the stamps upon the moistened corners of the envelopes by a peculiar rolling motion.

TUMBLING-MACHINE.—H. E. BARTON, Attleboro, Mass. This machine is designed more especially for treating jewelry such as chains, parts thereof and the like, to clean and polish the same in a very inexpensive and thorough manner. Mr. Barton's invention provides a very simple and durable construction for effectively performing this operation.

MOTION-TRANSMITTING DEVICE.—G. G. BEITZEL, Copenhagen, Denmark. In sewing machines with rotating shuttles, it is very advantageous to impart to the shuttle shaft a variable rotating motion in order that the upper thread may have sufficient time to be drawn away from the catcher before the new stitch is made. This may be effected by means of specially shaped cog-wheels: but by such an arrangement the parts are subjected to considerable wear, and therefore in this invention the cog-wheels are replaced by a peculiar form of angle lever capable of turning around two axes at right angles to each other, the one arm of the lever being connected with the driving-shaft, while the other arm is connected with the catcher.

Railway Improvements.

CAR-BRAKE.—J. RUNNOE, Crested Butte, Colo. An improvement in car brakes is provided by this invention, which relates particularly to slack-adjusters for such brakes. The slack-adjuster is so constructed that it may be quickly set to take up the required slack. This operation may be performed by operating the take-up block by means of the foot of the operator, thus leaving his hands free.

Miscellaneous.

DRAFTING INSTRUMENT.—C. H. QUIMBY, JR., Confluence, Pa. Mr. Quimby's improved drafting instrument is more especially designed for the use of railroad engineers in the work of railroad location. The instrument provides a railroad-curve projector, a curved scale being arranged to permit the user to readily select such curve or combination of curves as will best suit the conditions shown on the plan or contour map and to obtain the length of the curve without further calculation.

CHANGEABLE-ADDRESS HOLDER.—D. E. WERTS, Grants Pass, Ore. Mr. Werts is the inventor of a changeable address holder which will be found useful for trunks, valises and other kinds of baggage. The holder comprises a clamping-plate, which is adapted to clamp the address label in place. The clamping-plate is held in a frame-plate by an eccentric disc which may be rotated out of engagement with frame-plate when it is desired to remove or change the address label.

DOG ATTACHMENT FOR LOGGING-CARS, ETC.—G. T. HUDGENS, New Waverly, Tex. Mr. Hudgens provides by this invention, an improvement in dog attachments for loggin cars, sleds, wagons, etc., and the invention has for its object to provide a device which will securely retain logs on a car, sled or wagon, and also readily release the same for unloading when required.

BOOK-HOLDER.—B. A. JONES, Indianola, Neb. By this invention books are held on the shelves of bookcases in an upright position and are prevented from leaning or falling over when the shelves are only partly full or when one or more books are removed from a full shelf. This is accomplished by long and narrow bars placed horizontally and attached to the inside of the back part of the bookcase between the shelves and by projections which are attached to these bars and project between the books to hold them in place.

STOCKING.—M. LAMOND, Oakland, Cal. Mr. Lamond's invention seeks to overcome the objections and difficulties incident to the use of ordinary stockings and stocking-supporters, such, for instance, as the insecure connection of the supporters with the stockings, the inconvenience of application and adjustment, the tendency of the top of the stocking to swerve one side or the other, and the sagging of the stocking between the points of suspension.

GAME APPARATUS.—H. J. FRYSINGER, Baltimore, Md. The invention is an improvement in game apparatus, being especially in the nature of an apparatus for playing what the inventor terms "royal pin ball," involving some of the principles of ten pins. In playing the game a ball which swings on a cord must be so struck as to clear certain fixed posts and knock down the pins beyond.

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.

NEW BOOKS, ETC.

Sixth Annual Report of the Forest, Fish and Game Commission. Albany, New York. 1900. Pp. 532, 8vo.

This Sixth Annual Report has been most elaborately prepared. We have rarely seen in any work of the same character so many illustrations so well selected and so well executed. The color illustrations have been particularly tastefully designed and printed.

Twenty-Second Annual Report of the New Jersey State Agricultural Station and The Fourteenth Annual Report of the New Jersey Agricultural College Experiment Station for the Year Ending October 31, 1901. Trenton, N. J. 1902. 8vo. Pp. 587.

Report of Tests of a Thwaite Power Gas Plant at a Textile Factory. Thwaite Power Gas Syndicate, Westminster, S. W. Pp. 11.

Report of the Bureau of Mines, 1902. Toronto: Printed and Published by L. K. Cameron. 1902. Pp. 309. 8vo. Four maps.

An Experimental Study of Field Methods which Insure to Stadia Measurements Greatly Increased Accuracy. By Leonard Sewal Smith, B. C. E., Madison, Wis. Published by the University. 1895. Pp. 101-145. Price, 35 cents.

Annals of the Astronomical Observatory of Harvard College. Vol. xxxvii. Part II. Observations of Fifty-eight Variable Stars of Long Period During the Years 1890-1901. Prepared for publication by Oliver C. Wendell, assistant professor of astronomy, under the direction of Edward C. Pickering, Director of the Observatory. Cambridge, Mass.: Published by the Observatory. 1902. Pp. 149-281.

The Neglected Side of Trade-Unionism—The Boycott. By Walter Gordon Merritt. Pp. 11.

Studies from the Yale Psychological Laboratory. Edited by Edward W. Scripture, Ph.D. Vol. X. Yale University, New Haven, Conn. 1902. Pp. 117. Plates.

The Profitable Utilization of Power from Blast-Furnace Gases. By B. H. Thwaite, Assoc. M. I. C. E., F. C. S., London: Published at the offices of the Institution. 1901. 8vo. Pp. 48.

Compilación de Leyes, Decretos, Reglamentos Informes y Resoluciones. Concernientes á la Instrucción Primaria y Normal en la Republica Argentina. For Los Vocales del Consejo Nacional de Educación. Dr. Rafael Ruiz de los Llanos, Lidoro J. Avellaneda, y Dr. Ponciano Vivanco. Buenos Aires. 1902. Pp. 718. Plates.

A Nebulo-Meteoric Hypothesis of Creation. By Herbert W. Pearson, revised and edited by William F. Phelps, M. A. Duluth, Minn. 1902. Pp. 38.

Le Protoplasma de Métaphosphate de Chaux. A. L. Herrera, M. S. A. Mexico. 1902. Imprimerie du Gouvernement Fédéral. Pp. 201-213.

The Maryland Constitution of 1851. By James Warner Harry. Baltimore, Md.: The Johns Hopkins Press. 1902. Pp. 86.

Trust Companies in the United States. By George Cator. Baltimore, Md.: The Johns Hopkins Press. 1902. Pp. 113.

International Catalogue of Scientific Literature. First Annual Issue. D. Chemistry. Part I. London. 1902. 8vo. Pp. 718.

Botany. International Catalogue of Scientific Literature. First annual issue. Published for the International Council by the Royal Society of London. London: Harrison and Sons. 1902. Pp. xiv-378.

Industrial Conciliation. Report of the Proceedings of the Conference held under the auspices of the National Civic Federation. At the rooms of the Board of Trade and Transportation in New York. G. P. Putnam's Sons, New York and London. 1901. 12mo. Pp. xiii-278.

Modern Iron Foundry Practice. Part L. Foundry Equipment, Materials Used, and Processes Followed. By Geo. R. Bale. With numerous illustrations. London. 1902. 16mo. Pp. 387. Price, $2.

The Treatment of Steel. Crucible Steel Company of America. Pittsburg, Pa. 1902. 16mo. Pp. 156.

Thwaite-Gardner Blast Furnace Power System. Vol. I. Published by The Blast-Furnace Power Syndicate, London. Pp. 30.

Heating and Ventilating Buildings. A Manual for Heating Engineers and Architects. By Rolla C. Carpenter,

(Continued on page 430.)

M.S., C.E., M.M.E. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. 1902. 8vo. Pp. xv. 562; 227 figures. Price $4.

Since the appearance of the first edition of this book in 1895, the advances made in the art of heating and ventilation have been such that a thorough revision was found necessary. Three chapters have been added, one relating to the fan or blower, and another to the general subject of mechanical systems of heating and ventilating, and a third to schoolhouse heating and ventilating. The book probably describes the latest improvements in both heating and ventilating. Particularly meritorious features are the directions for the construction and installation of the various systems now in use.

The Manual of Business. By Sidney P. Johnston. Chicago: Daniel Stern. 1902. Pp. 263. 12mo. Price $3.50.

In the main this book presents a mass of business information that is not usually included in the commercial writer and business handbook with which most of us are familiar. The book is not very well printed and has been carefully proofread.

An Introduction to Celestial Mechanics. By F. R. Moulton, Ph.D. New York: The Macmillan Company. London: Macmillan & Co., Ltd. 1902. Pp. xv, 384. Price $3.50.

Dr. Moulton has prepared an admirable text book on a subject which most college students find peculiarly difficult. All problems are stated in advance and where the transformations are long an outline of the steps which are to be made is given. The volume is the outgrowth of a course of lectures given annually in the University of Chicago. Not the least valuable portion of the book is an introduction to the problem of three bodies.

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AND EACH BEARING THAT DATE.

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SYNCHRONOGRAPH.—A NEW METHOD of rapidly transmitting intelligence by the alternating current. A full description of the interesting apparatus of Crehore and Squier. 13 illustrations. SCIENTIFIC AMERICAN SUPPLEMENTS 1114 and 1115. Price 10 cents each. For sale by Munn & Co. and all newsdealers. Send for new catalogue.

SENSITIVE LABORATORY BALANCE. By N. Monroe Hopkins. This "built-up" laboratory balance will weigh up to one pound and will turn with a quarter of a postage stamp. The balance can be made by any amateur skilled in the use of tools, and it will work as well as a $125 balance. The article is accompanied by detailed working drawings showing various stages of the work. This article is contained in SCIENTIFIC AMERICAN SUPPLEMENT, No. **1184.** Price 10 cents. For sale by MUNN & CO., 361 Broadway, New York City, or any bookseller or newsdealer.

Scientific American Building Monthly

VOL. 33.

JANUARY--JUNE, 1902.

278 Illustrations. 120 Pages, 6 Tint-Blocks.

The Thirty-Third Volume of this beautifully illustrated and finely printed Monthly Magazine, comprising the numbers January to June, 1902, is now ready.

. . . SPECIAL FEATURES . . .

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The volume contains 6 tinted cover pages and 278 illustrations, including many fine examples of recent dwellings, gardens, views of groups and estates, interiors, exteriors and plans. Photographs of agricultural details, porches, doorways, mantels, etc., are especially helpful and suggestive. The illustrations of the Building Monthly are made from specially taken photographs and are not obtainable elsewhere. Most of the houses are accompanied with full sets of plans.

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This interesting series of conversations with eminent architects by Mr. Barr Ferree comprises important talks with Mr. Thomas Hastings on "Some Suggestions for New York"; Mr. William J. Fryer on "The New Tenement House Law of New York"; Mr. Charles A. Rich on "The Development of the Small College"; Mr. John Galen Howard on "The Beaux-Arts Architects"; Mr. J. Monroe Hewlett on "The Architect and the Municipality"; and Mr. George L. Morse on "The Durability of Steel Construction."

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DEPARTMENTS. . .

The Departments of the Monthly cover a wide range of topics and summarize the latest advance in current architectural thought and practice: "Monthly Comment"; "The Household"; "The Garden"; "Legal Decisions"; "New Books"; "Country Life"; "The Country House"; "Fire Protection"; "Sanitation"; "Civic Betterment"; "New Building Patents"; "Publishers' Department."

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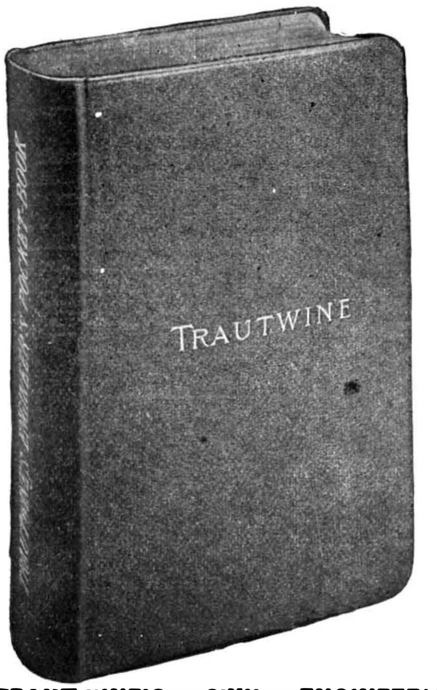

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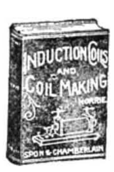

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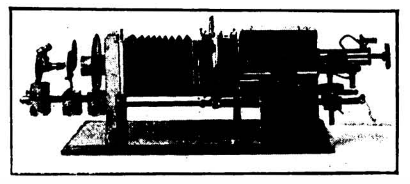

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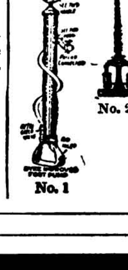

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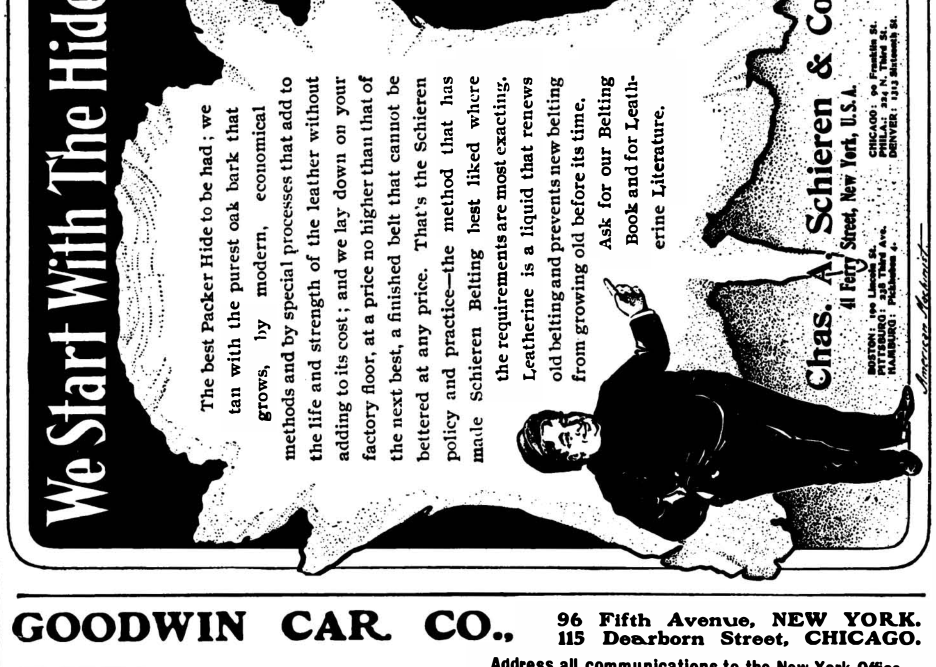

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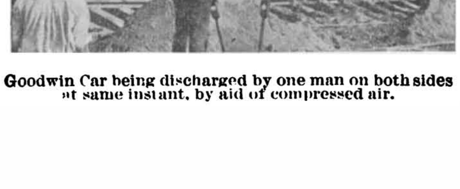

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