THE TRANSATLANTIC STEAMSHIP.

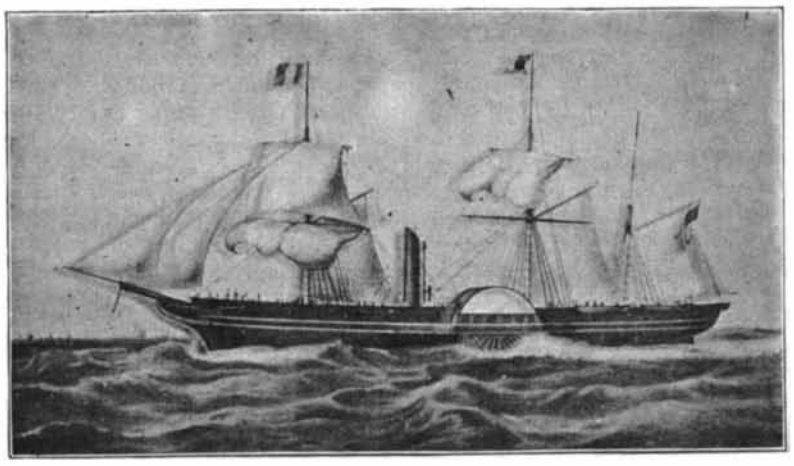
In tracing the history of the part played by the United States in the development of the transatlantic steamship during the past fifty years, it will be a pardonable inconsistency to run back some seventy-five years to an earlier date and make mention of the first steamship that made the transatlantic passage—the American-built Savannah. During the latter part of May, in the year 1819, this little craft of about 350 tons sailed from Savannah, Georgia, and, after a prosperous voyage of 28 days, lasting from May 22 to June 20, she anchored in the Mersey, having made use of steam for eighty hours of the time occupied by the trip to Liverpool. She was built on the East River, New York, and was originally designed as a sailing packet; and, if we may judge from the old engravings, her sail plan does not appear to have been cut down to any extent after the engines were introduced. This latter work was done at Savannah, Georgia, where she was prepared for her new venture by her owners, William Scarborough and others. The engines were direct acting, and the paddle wheels were so constructed that in stormy weather they could be unshipped and stowed on deck. She had stowage capacity for 70 tons of coal and 25 cords of wood.

The distinction of having built the first steamship that ever crossed the ocean, propelled all the way by steam, belongs to the western world. The feat was performed by a Canadian-built vessel, the Royal William, which, in 1833, made the passage from Quebec to London. This performance, together with the passage of the steam-equipped Savannah, fourteen years before, makes it evident that the credit of originating transatlantic navigation should be accorded to the New World. It was fitting and natural that it should be so. River navigation had proved so successful that the steamship builder naturally turned his thoughts to the ocean, and it was a logical step from the prudence which made only a partial introduction of steam in the Savannah to the more ambitious attempt to equip the Royal William with steam power and fuel capacity sufficient for an entire passage.

The first American steamer built expressly for the Atlantic trade was the United States. She was constructed at New York by William H. Webb for the Black Ball line of packet ships. Her first voyage was made to Liverpool in 1847, and lasted 13 days. She was a splendid steam vessel for those days, being of 2,000 tons burden and measuring 256 feet in length by 50 feet beam, and 30½ feet in depth. She has the distinction of being the first merchant steamship constructed for naval use as a cruiser, provision being made for arming her with two tiers of guns. Her life in the merchant marine, however, was short, for, after making one round trip to Liverpool, she was purchased by the Prussian government for use in their navy as a steam frigate.

Following the United States came the Washington, of 1,700 tons, and the Hermann, of 1,800 tons, built in 1847 to run between New York and Bremen; the Franklin, of 2,400 tons, built in 1848 to run between New York and Havre, to which, in 1850, was added the Humboldt, of 2,850 tons. These two ships were owned by the New York and Havre Steam Navigation Company, who received a subsidy of $150,000 a year for carrying the mails.

It was during this decade that a ship was launched on the other side of the water which, although it does not represent American development of the ocean steamship, gave so powerful a stimulus to ocean navigation that it claims a passing notice. This was the first iron transatlantic steamship, Great Britain. She was designed by that distinguished engineer Brunel, and, like many other of his creations, marked a great advance upon anything previously attempted. She was approximately a 3,200 ton vessel, and therefore as large again as any transatlantic ship of her day. Her length was 322 feet, beam 51 feet, and her depth 32 feet 6 inches. Brunel showed his far-sighted appreciation of the value of screw propulsion by discarding the paddle wheel and fitting her with a screw propeller; and by the substitution of iron for wood, and the screw for the paddle wheel in this one ship, he introduced two factors which have contributed immensely to the efficiency of the transatlantic steamship. An engraving and a detailed description of this remarkable ship is to be found in the first issue of the SCIENTIFIC AMERICAN, published by Munn & Company, a facsimile of which will be found on the front page of this issue. Her first passage was accomplished in 15 days, at an average speed of 9 knots an hour.



THE UNITED STATES—1847—THE FIRST AMERICAN STEAMER BUILT EXPRESSLY FOR THE ATLANTIC TRADE. TONNAGE, 2,000.

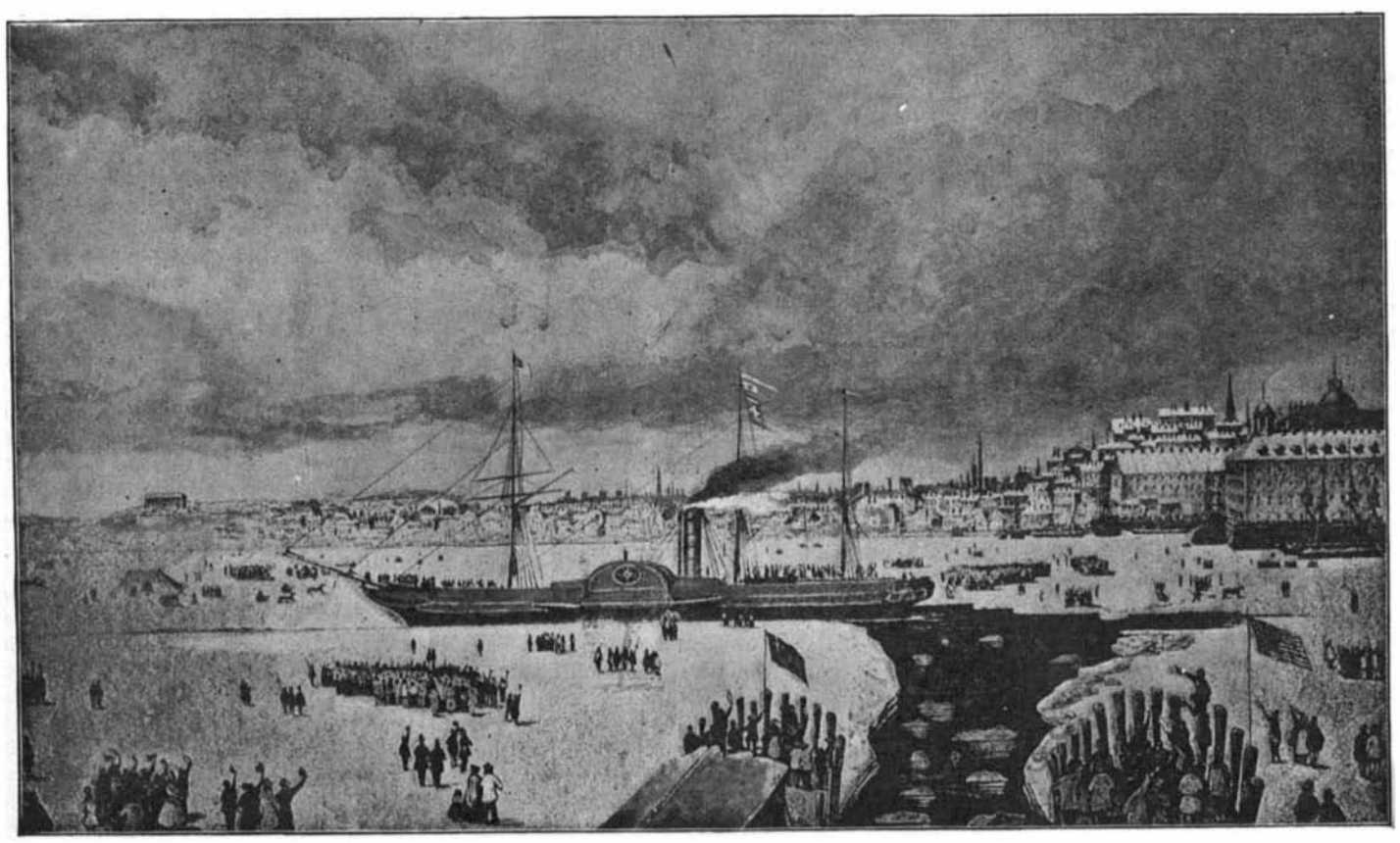
Before passing on to a consideration of the ships of the celebrated Collins line, and by way of introduction to this distinctively American venture, it is necessary to linger awhile on the other side of the Atlantic, and take note of the origin and early development of the famous Cunard line, which was the first company to bind itself to maintain a regular service with fixed dates of departure from each side of the Atlantic. Briefly told, the story of the foundation of this great enterprise is as follows: At the close of the fourth decade of the century, a Mr. Samuel Cunard, of Halifax, Nova Scotia, who was conducting a mail service between Boston, Newfoundland and Bermuda, received a copy of an Admiralty circular calling for tenders for a steam packet service across the Atlantic. Failing to get assistance in Canada, he crossed to Liverpool, where he fell in with Robert Napier, the engineer and shipbuilder, and through him met George Burns and David MacIver, who furnished the $1,350,000 required capital. A seven years' contract with the government was forthwith signed, by which the company were to provide four steamers and dispatch one of them from Liverpool for Halifax and Boston on the 4th and 19th of every month from March to October, and on the 4th of each of the four winter months. For this they were to receive $400,000 per year.

The ships were of 2,050 tons displacement, being 207 feet long, 34½ feet broad and 22½ feet deep. The engines were of 403 nominal horse power, and the coal consumption was 38 tons a day. They carried 640 tons of coal, 225 tons of cargo, and 90 first-class passengers, and their speed was 8½ knots an hour.

The Britannia, the first of the four ships, started on her maiden trip from Liverpool on July 4, 1840, and on July 19 was received in Boston with unbounded enthusiasm. The new line was immensely popular with the Boston citizens, and when, in February, 1844, the Britannia was frozen up in the harbor, the merchants of Boston, at their own expense, cut a channel seven miles long through the ice to the open sea, through which the ship sailed on the appointed day. This voluntary work cost no less than $20,000.

During the ten years 1840–50 the Cunard ships held all but undisputed control of the steamship traffic between America and England, and it was the inroads which they were making upon the trade of the celebrated American clippers which, in 1845, led the owners to equip one of these vessels, the Massachusetts, with an auxiliary screw. In 1847 the public enthusiasm in America was aroused by the dispatch of the Washington to Bremen by way of Southampton, on the same day as the Britannia sailed for Liverpool. The Britannia won the race by two days. "The popular enthusiasm on the subject was sufficient to overcome the reluctance of Congress to grant a subsidy, and a company was formed under the management of Mr. E. K. Collins, of New York, to establish a line of American steamers between that port and Liverpool."

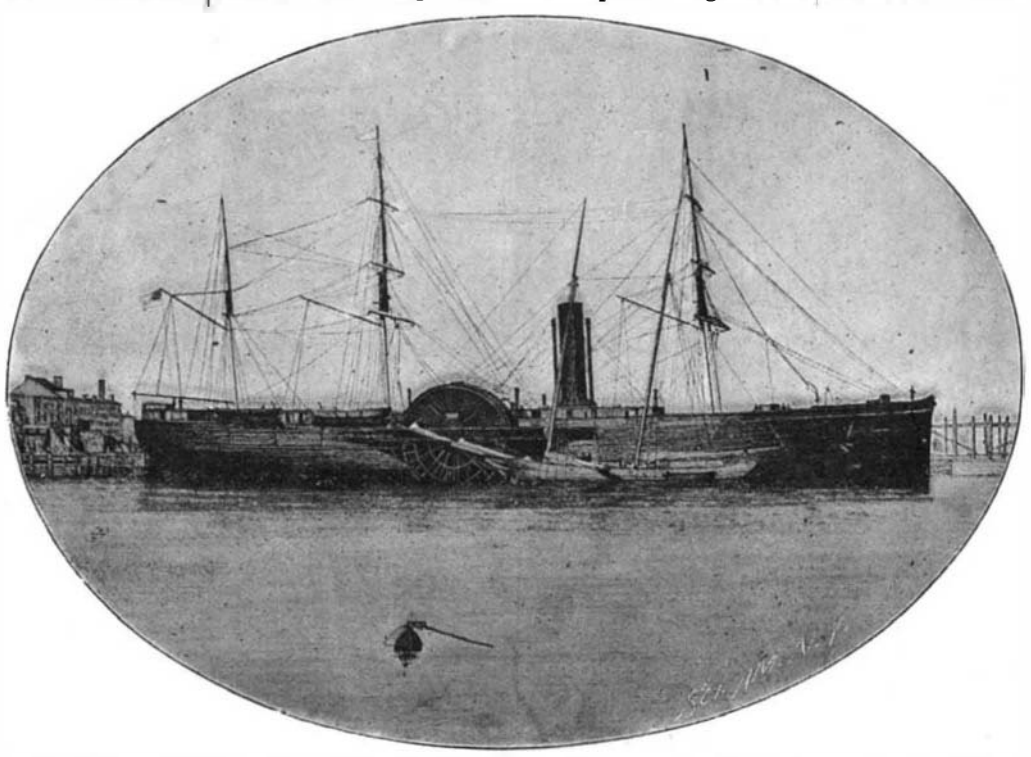
It was clearly foreseen that if the new American ships were to compete successfully against the powerful and popular Cunard line of steamers, they would have to surpass the latter in both size and speed. Four ships were determined upon; and encouraged by a government subsidy of $385,000, and the payment of $415,867 for carrying the mails, the company spared no expense to make them the finest specimens of marine architecture afloat. The splendid record of the Collins sailing ships made it certain that the model of the new ships would be suitable for high speed, and the design of the machinery was intrusted to Messrs. Sewell and Faron, chief engineers of the United States navy. Mr. Faron was sent to England to inspect the machinery and ascertain the boiler pressure of the largest Cunard boats, and on his reporting that they carried thirteen pounds to the square inch in the boilers, it was determined to give the new ships sufficiently larger engines, with the same boiler pressure, to insure their equaling the speed of the Cunard boats. The construction of the four ships was pushed through with all dispatch, and in 1850 the American company had four ships afloat, which in size, speed, luxurious accommodation, and general beauty of finish were admitted, even by the rival company, to be in advance of anything afloat at that time. Then began a fierce struggle for the blue ribbon of the seas, and the triumphs of the famous sailing ships of this company were repeated in the brilliant success of their steam fleet. To save time on the passage, the Cunard line ceased to call at Halifax; but in spite of this they were easily and consistently beaten by their competitors.



THE BRITANNIA—1840—FIRST CUNARD STEAMSHIP—LEAVING BOSTON FOR LIVERPOOL THROUGH A CHANNEL SEVEN MILES LONG, CUT THROUGH THE ICE BY THE MERCHANTS OF BOSTON, FEBRUARY 3, 1844.

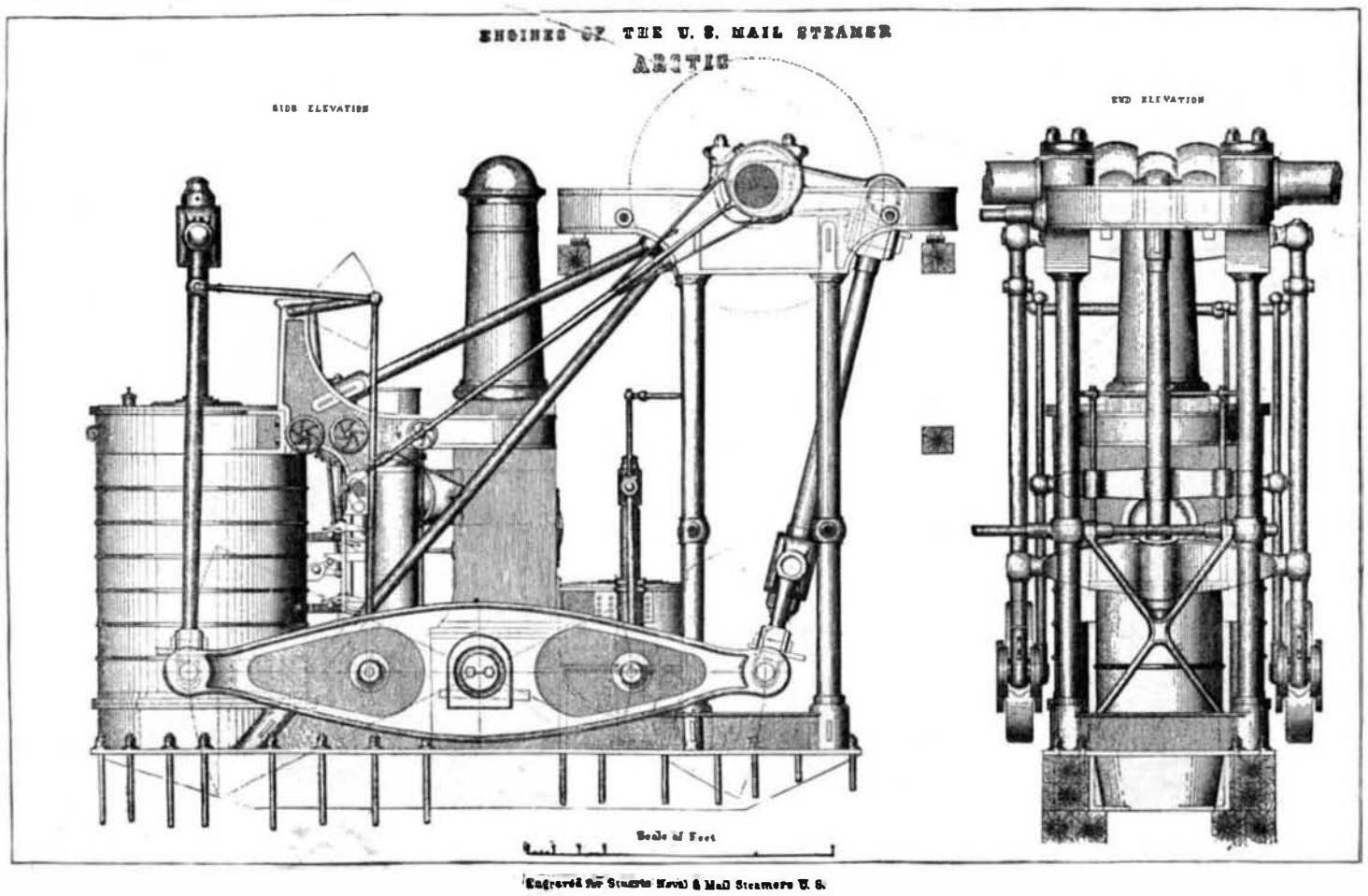
The Pacific of the new line was the first ship to make the passage from New York to Liverpool in less than 10 days, her time during a passage in May, 1851, being 9 days, 20 hours, 16 minutes, and in February of the

next year the Arctic broke the record by crossing in 9 days, 17 hours, 12 minutes. How complete was the supremacy of this line may be judged from the fact that the average time of the Collins boats in crossing from New York to Liverpool during the year 1852 was 1 day 6 hours and 18 minutes less than that of the rival line. The Collins line secured the larger share of the passenger traffic, carrying between January and November, 1853, 4,306 passengers, against 2,969 carried by the Cunard company. The illustration of the Arctic herewith reproduced from Stuart's "Naval and Mail Steamers" was originally engraved from a daguerreotype, which was taken as she lay at her moorings at the foot of Canal Street, New York, and may be relied on as a faithful representation of these vessels. It will be seen that they were characterized by the high freeboard which has always been an excellent feature of American practice, and this, no doubt, contributed largely to their seaworthiness and comfort in heavy weather. The Arctic was 282 feet long by 45 feet beam and 32 feet deep, and her tonnage was 2,860. The engines were of the side lever condensing type, with cast iron beams and wrought iron columns and braces. The valves were of the balance poppet variety. The boilers, which were specially designed by Mr. Faron for these boats, were square in cross section, and carried about 17 pounds of steam. To secure a powerful draught the smokestack was made unusually lofty, the top being 75 feet from the firebars. The average performance of the Arctic during February, 1852, was as follows: Boiler pressure, 16·9 pounds; revolutions, 15·8 per minute; coal consumption per day, 84·3 tons; speed, 316·4 knots per day. Her greatest day's run was 320 knots, at the rate of 13·3 knots per hour, a splendid record for those early days. The Collins venture, which opened so brilliantly, closed with disaster. The Arctic was sunk by collision in 1854, and went down with 520 souls. A year later the Pacific left Liverpool never to be heard of again. In spite of these losses, in the following year the company launched the Adriatic, of 4,144 tons, a superb vessel; but the persistent efforts of the Cunard company, who, in 1855, launched the Persia, a 3,870 ton iron steamer of about 14 knots speed, coupled with these heavy losses and the withdrawal of the government subsidy, finally brought about the dissolution of this famous company. The sailing of these ships was taken up by the Inman, now the American line, of which mention will be made later.



THE UNITED STATES MAIL STEAMER ARCTIC, 2,860 TONS, OF THE COLLINS LINE—GREYHOUND OF THE ATLANTIC IN 1852. TIME, 9 DAYS, 17 HOURS, 12 MINUTES.

American interests on the Atlantic subsequent to the decease of the Collins line were represented by the Fulton, of 2,061 tons, and Arago, of 2,260 tons, and the famous Vanderbilt, of 3,360 tons burden, the latter, launched in 1855, being the fastest ocean steamship of her day. She crossed eastward in 9 days, 8 hours, and westward in 9 days, 9 hours and 24 minutes.



SIDE LEVER CONDENSING ENGINES OF THE ARCTIC.

In the year 1853 a company was formed in England to construct a steamship which could make the round trip to Australia and back at a speed of 18 knots, and carry sufficient coal for the purpose. Mr. Brunel was intrusted with the designs, and the result was the Great Eastern, a ship which even to-day would dwarf our biggest ships by her huge proportions. Like the Great Britain, she showed the free hand and inventive genius of her designer. She was in every detail a splendidly built ship, both as regards hull and engines. Her dimensions were: Length, 680 feet; breadth over paddle boxes, 118 feet; beam, 83½ feet; depth, 58 feet; draught, 30 feet; displacement, 32,160 tons; tonnage, 22,500; cargo storage, 6,000 tons; coal storage, 12,000 tons; diameter of paddle wheels, 56 feet. She was driven by paddle wheels and a screw propeller, each of which was provided with separate engines and boilers. Launched in 1858, she cost complete no less than $3,650,000. Her maiden trip was made from Southampton to New York in 1860, her highest speed during the trip being 14½ knots an hour, and her longest day's run 333 miles. She consumed on the trip 2,877 tons of coal. The Great Eastern was of such colossal size that she was but little affected by wind and weather, and except on one occasion, when she was disabled and fell off into the trough of the sea, passengers testified to her easy motion in the heaviest storms that were encountered. Commercially considered, however, she was a complete failure from the very start. But though she was disastrous to her owners, she conferred an incalculable boon upon the world at large by successfully laying the first Atlantic cable in 1866. After doing various, but always unprofitable, work, she laid two more Atlantic cables in 1873 and 1874. She was finally, in 1888, sold for old iron and broken up at Liverpool.

Soon after the withdrawal of the Collins line there came the great civil war, with its disastrous effects upon American shipping interests. So effective were the depredations of the Confederate cruisers that the American merchant marine was practically swept from the seas, and at the close of the war we were not only weakened by actual losses, and the general discouragement of commercial enterprise, but foreign maritime nations were proportionately enriched.

A few official figures tell the story of this decline more eloquently than any multiplication of words. The total number of steam and sailing vessels built in the United States in 1847 was 1,597; this fell in 1862 to 864, and in 1895 to 694. On the other hand, the total tonnage of vessels sold to foreigners in 1847 was 16,969; in 1861 it was 26,649 tons; in 1862 it rose to 117,756 tons, and in 1864 to 300,865 tons!

It is not surprising that at the close of the war American capital looked with distrust at marine transportation, and directed its energies to the development of the vast internal resources of the country; and with what energy it did so is shown in the marvelous growth of the railroads during the next forty years. The development of the transatlantic steamship was left entirely in the hands of the English and European builders, and as the scope of the present review covers mainly the American share in this development, it will be sufficient to indicate the progress abroad by noting briefly its most important advances.

The screw was now rapidly driving out the paddle wheel, the Scotia, a 3,870 ton ship, being the last of the latter type built for the Cunard line. She was the first to make the passage in less than 9 days, covering the distance in 8 days, 3 hours, in 1863. To the Inman, now the American line, is due the credit of bringing the time of passage below 8 days, a feat accomplished in 1869, by the City of Brussels, a 3,747 ton screw steamer, whose time was 7 days, 22 hours, 3 minutes. The year 1871 was marked by the advent of the White Star line, whose boats, the Oceanic and Adriatic, introduced many new features conducive to the comfort of travel, and maintained a high standard of speed and regularity. The 7 days limit was first passed by the Alaska, of the Guion line, which made the trip, in 1882, in 6 days, 22 hours; and the credit of bringing the time below 6 days belongs to the City of Paris, of the Inman line (now the Paris of the American line), which, in 1889, made the westward passage in 5 days, 19 hours and 18 minutes. The present record of 5 days, 7 hours and 23 minutes is held by the Lucania, of the Cunard line.

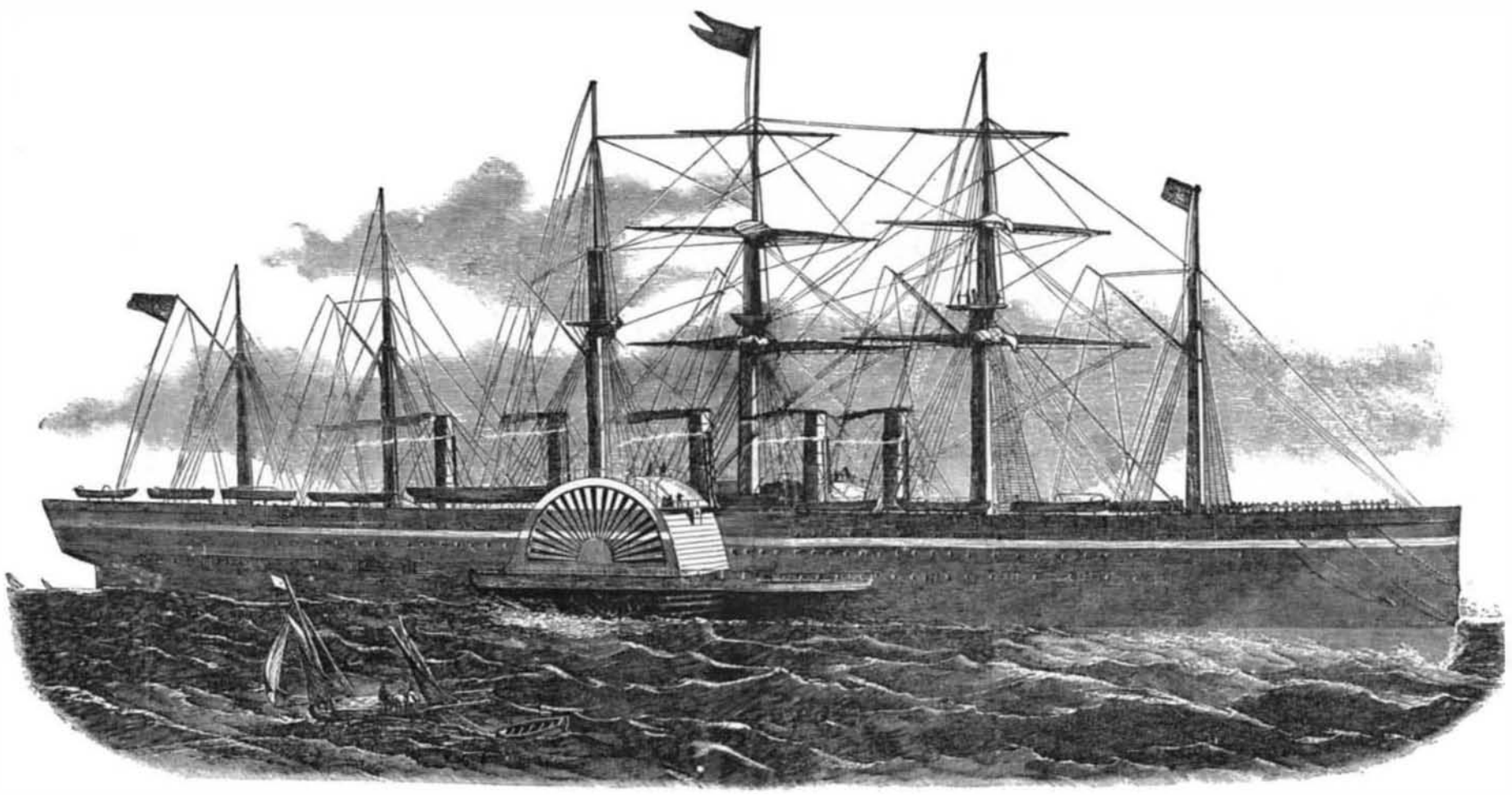
Although with the exception of the four ships built for the American line of 1870, we took little part in the construction of Atlantic steamships during these forty years, American capital was largely interested in the celebrated Inman line, which started out in 1850 with two iron, screw propelled ships. Since that time they have been fully abreast, if not ahead, of any other company in the adoption of the various improvements which have made the steamship what it is to-day Their early steamers were all of iron and fitted with the screw propeller; they adopted the compound engine with its higher boiler pressure and consequent economy in fuel; and in 1889 and 1890, after the company had been reorganized as the In-

man and International Company, they made another radical departure in that magnificent pair of ships the City of New York and the City of Paris, which were the first to be furnished with twin screws combined with triple expansion engines. These boats were, in every respect, a great advance upon anything built or planned at that date. Their 10,500 tonnage, their 20,000 indicated horse power distributed between two engines, in separate watertight compartments, their speed, and every detail of their furnishings and equipment, were a fresh evidence of the old time farsightedness and liberality of the Inman line.

In order to encourage the building up of the American merchant marine, the Congress of the United States, in 1892, passed a special law by which authority was given to this company, now known as the International Navigation Company, or the American line, to place under the American flag the City of New York and the City of Paris, provided other ships of an equal tonnage and speed were at once built in this country. The contract for the new ships was placed with the Messrs. Cramp, of Philadelphia, and the result was a noble pair of vessels, the St. Paul and the St. Louis, which both commenced active service in 1895. They are the second largest and fastest pair of ships in the world, being exceeded in these respects only by the Campania and Lucania, of the Cunard line. Their principal dimensions are: Length over all, 554 feet; breadth, 63 feet; moulded depth, 42 feet; gross register, 11,629 tons. They are built of steel, with a double bottom, and a minute cellular subdivision. They are so subdivided by athwartship bulkheads that, if two adjoining compartments were flooded, they would have an ample margin of flotation. The quadruple expansion engines which we illustrated in a recent issue aggregate about 20,000 horse power. An interesting comparison can be made between them and the Arctic's engine, shown on another page. The St. Paul has two sets of engines, each of which has six cylinders, arranged over four cranks, the first pair of cranks being driven by a pair of high pressure and low pressure cylinders in tandem, the remaining cranks being each driven by first and second intermediates. The screws are three bladed, each screw being driven by its own engine, as in the Paris and New York. Steam at 200 pounds pressure is furnished by six double-ended steel boilers, 15 feet 7½ inches in diameter and 20 feet long. The total heating surface is 30,000 square feet. The ships are so designed that they can be quickly converted into armed cruisers, carrying eight 6 inch rapid fire guns, the mail contract stipulating that they shall be so utilized in the event of war. During the twelve months that they have been on the route, the St. Paul and St. Louis have shown a steady increase in speed, and the former ship now holds the record from Southampton to New York, having crossed in 6 days, 5 hours and 22 minutes, at an average speed of 20·82 knots, the longest day's run being 521·9 knots, at an average speed of over 21 knots an hour. This performance has been exceeded, it is true, by the Lucania and Campania, ships of 13,000 tons displacement, the former of which has an average speed record of 22 knots an hour for the whole trip. As the latter is equipped with 30,000 horse power against the 20,000 horse power of the St. Paul, it will be seen that, judged as a relative performance, that of the St. Paul is the more creditable.

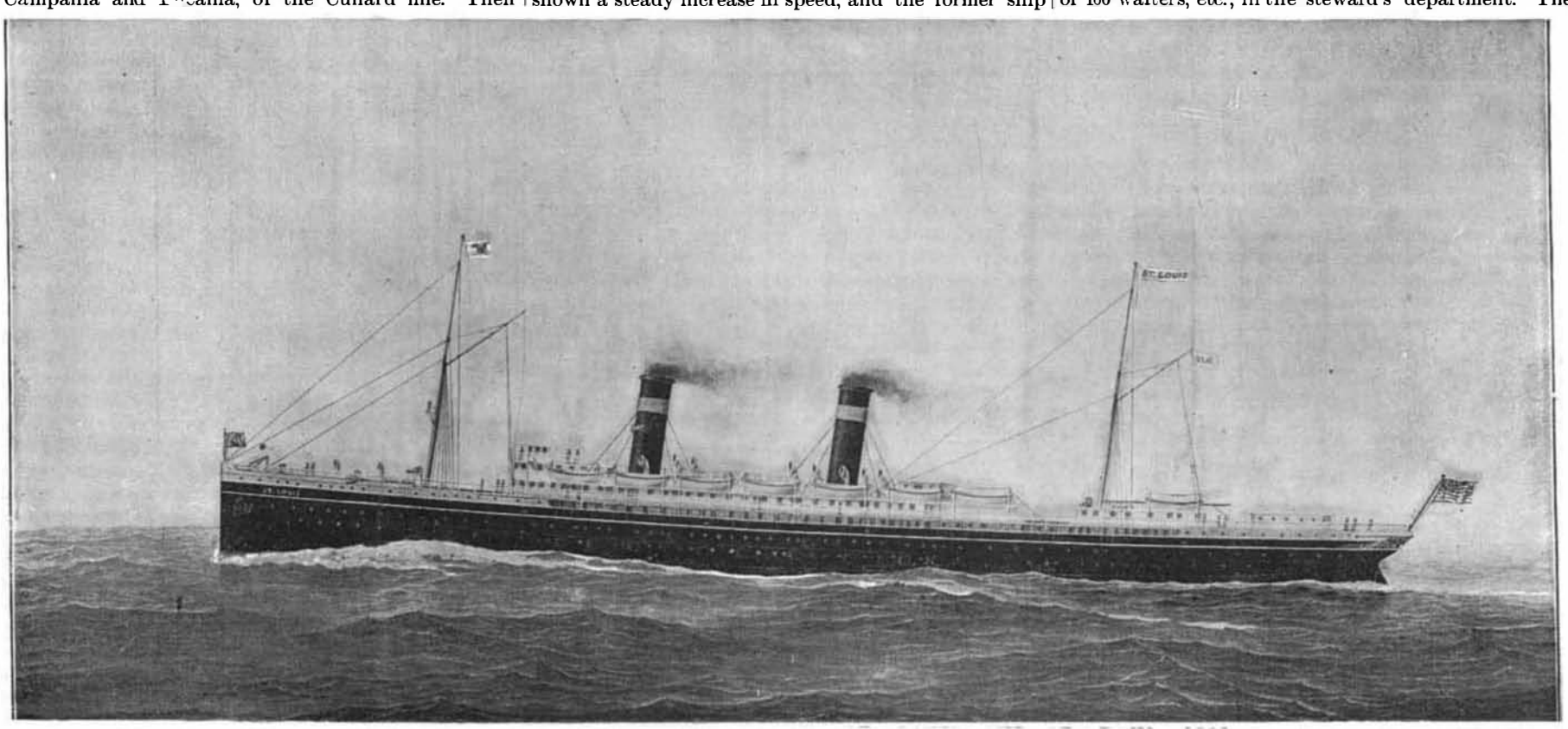
Space forbids a more detailed description of these, the latest additions to the great transatlantic fleet of steamships.

Fifty years ago, a few score passengers were carried in cramped, ill-lighted and stuffy cabins, upon small paddlewheel boats, which dragged wearily across the ocean at 8½ knots an hour; to-day, the St. Paul can carry 1,700 souls from port to port, at 21 knots an hour, and provides her passengers with accommodations rivaling those of the finest modern hotel. She can take care of 360 first-class, 175 second, and 775 third-class passengers, or 1,310 souls in all. For the navigation of the ship 60 officers and men are necessary; the engine and boiler rooms find work for 175 more; and there is a staff of 160 waiters, etc., in the steward's department. The



THE GREAT EASTERN, LAUNCHED 1858.

Length, 680 feet; breadth, 83½ feet; breadth over paddle boxes, 118 feet; depth, 58 feet; draught, 30 feet; displacement, 32,160 tons; tonnage, 22,500; average speed, 11·23 knots; time, Southampton to New York, 11 days; cost, $3,650,000.



THE NEW AMERICAN ATLANTIC LINERS ST. LOUIS AND ST. PAUL, 1895.

Length, 554 feet; breadth, 63 feet; depth, 42 feet; tonnage, 11,629; average speed of St. Paul, 20·82 knots; holder of the record, Southampton to New York, 6 days, 5 hours, 22 minutes; approximate cost, $3,200,000.

expenses of such a ship are, necessarily, enormous, one of the great English companies having recently admitted that they run as high as $5,000 a day with a full complement of passengers. To furnish the 20,000 horse power for the engines of the St. Paul requires the consumption of 310 tons of coal per day; and the consumption of provisions by the passengers can be judged from the list of supplies carried for one trip, some of the items being as follows: 30,000 pounds of beef, 10,000 clams and oysters, 500 pounds of coffee, 3,000 pounds of butter, 3,000 pounds of sugar, 16 tons of potatoes, 15,000 eggs, and 140 barrels of flour.

In tracing the various stages of the development of the transatlantic steamship, it is found that each decade was marked by some radical departure from the practice of the decade which preceded it. In the accompanying table it is attempted to mark this progress approximately, showing the most important changes in construction, the approximate rise in boiler pressure, and the approximate improvement in engine performance:

Decade.	Development in construction.	Approximate boiler pressure.	Approximate lb. of coal per horse power.
1845-55	Iron in place of wood	10 to 20	4·5 to 3·5
1855-65	Screw in place of paddle wheel	20 " 35	3·5 " 2·9
1865-75	Compound in place of simple engines	35 " 60	2·9 " 2·2
1875-85	Steel in place of iron, and triple expansion engines	60 "125	2·2 " 1·9
1885-95	Twin screws, quadruple expansion and forced draught	125 "200	1·9 " 1·3

Space forbids a more extended treatment of a subject which has an increasing interest for all patriotic Americans; but enough has been said to show that the part played by the United States in the development of the transatlantic steamship has been far more extended and important than is perhaps generally supposed. It dates from the earliest records, when the Savannah opened the very first chapter of its history by her memorable voyage to Liverpool; and the easy triumphs of the Collins line in the fifties bid fair to be repeated in the history of the American line of to-day.

RAILROADS AND BRIDGES.

The railroad system of the United States is remarkable, alike for the rapidity and proportions of its growth, and for the fact that it expresses the adaptiveness and ingenuity of the American people more, perhaps, than any other field of enterprise to which they have directed their energy and capital. In the whole range of engineering work there is nothing more distinctively American than the American railroad; nowhere is the national faculty of adapting the means to the end more consistently manifest than in the development of this vast system of transportation. From its cheap prairie track, built at $15,000 a mile, to its superb "limited" trains, with their full complement of costly parlor, sleeping and dining cars, the whole system is the outcome of an attempt to satisfy the luxurious tastes of a people who were scattered over a vast area of more or less undeveloped country.

It was realized at the outset that it was neither

RAILROAD POSTER OF 1845.

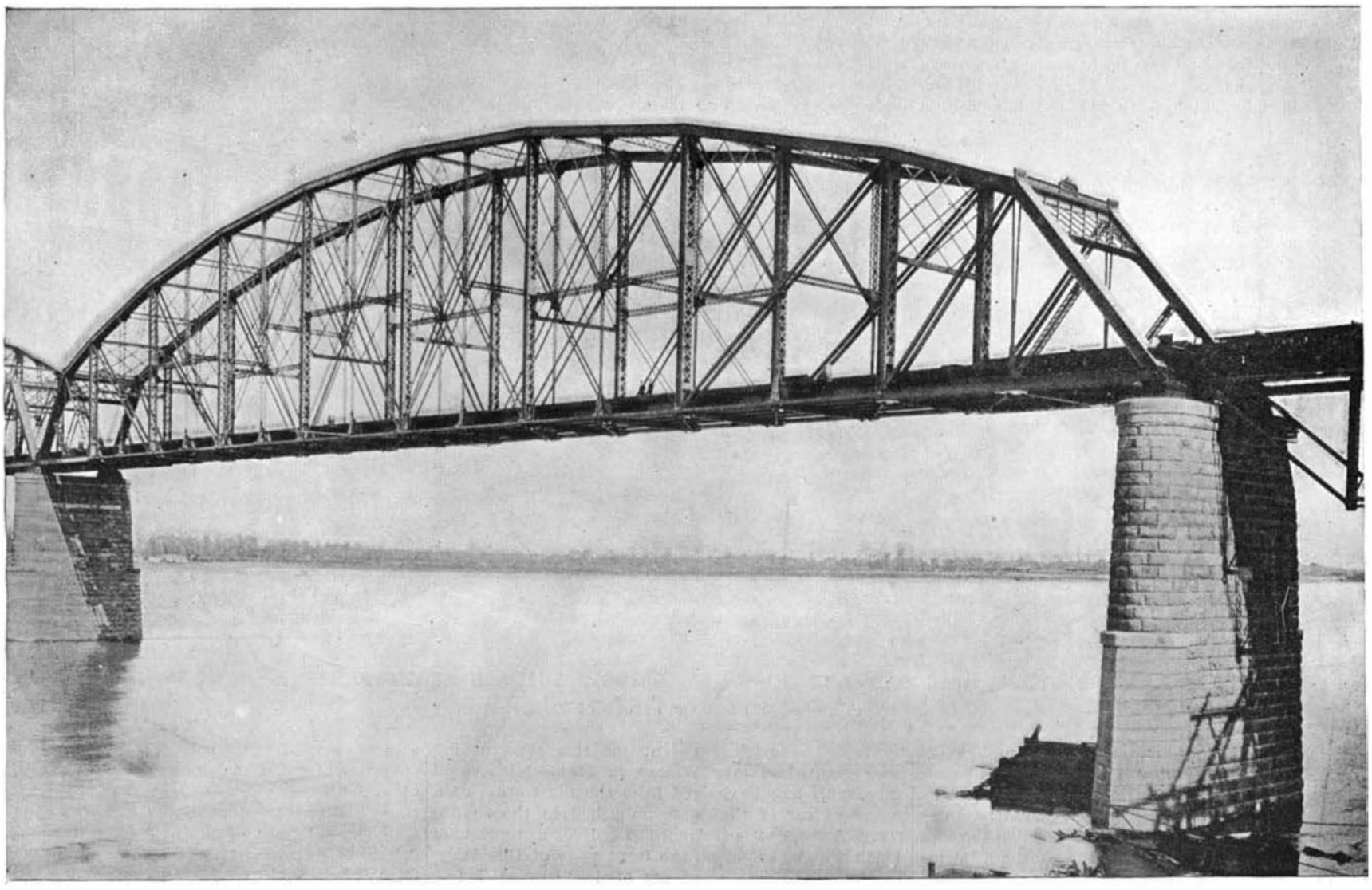
expedient nor possible to build American railroads according to the expensive methods of European engineers. The conditions in the two countries were entirely different. The early roads in England and on the Continent were built through populous districts, and between large cities, and the day of the opening of a new line found passengers on every platform and freight in every yard. Large receipts were assured and dividends were certain. Hence it was good policy to construct the roadbed in the most solid manner, and lay out the line with a view to economy of operation. Hills were tunneled, deep cuttings opened, massive embankments raised, and every expedient known to the engineer and contractor was used in the effort to produce a line that should be at once level and straight. The result, as in the Great Western broad gage line, of Brunel, was a magnificent road, built at an appalling cost per mile.

With the exception of those which were built in the more populous States bordering on the Atlantic seaboard, the early railroads of America have had to do pioneer work. In Europe the railroad followed the population, and was the result of it. In America the population followed the railroad, which in some cases has been pushed out a thousand miles ahead of the onrolling wave of emigration. These conditions, coupled with the natural freedom of the American engineer from the restraints of tradition, and his tendency to work out any problem from its own proper point of view, have given us the American railroad of to-day.

In the first place the engineer dared to believe that a locomotive could climb a hill and swing round a curve—Mr. Brunel and his associates notwithstanding. So when the locating engineer came to a hill he preferred to go round rather than tunnel through it; and, if that was impossible, he carried his line over it, skillfully adjusting his survey to the topography of the country, and keeping the grade within the desired limit. Where one or two feet in a hundred had been considered the practicable limit of grade, he did not hesitate to use three and four; and where four and five degrees was the limit of curvature in Europe, he boldly ran in eight and ten degree curves, and on certain lines in later years increased this to sixteen and even twenty degrees! When this undulating and sinuous roadbed had been graded, and it came to the question of laying upon it the costly rails, ties and ballast the "coat was" again "cut according to the cloth," and, in obedience to an imperative economy, these items were cut down to the lowest practicable limit. And here it was that the mechanical engineer stepped in, and with rare ingenuity produced a locomotive and cars that were admirably adapted to travel upon track that was neither level, nor straight, nor smooth in its running. The swiveling truck solved the problem of the curves, the coupled driving wheels and heavy engines the problem of the grades, and the equalizing levers smoothed out the inequalities of the track. And thus it was that, in the adaptation of the track to the country and of the locomotive and cars to the track, the civil and mechanical engineer made possible the enormous development which has characterized the past half century of railroad building in the United States. Had they attempted to build as Brunel built the Great Western road in England, the development of the vast internal resources of the country would have been thrown back a whole generation.

In speaking thus of the early American roadbed, it is not intended to imply that the best American track of 1896 is one whit inferior to that of contemporaneous European railroads, for its improvement has generally kept pace with the increase of the traffic which passed over it, until to-day it is safe to say that the main lines of such roads as the New York Central, the Pennsylvania, the New Haven, and other leading companies, is as fine, and in some respects better, than the best to be found in Europe.

As we look at the railroad map of the United States



THE MERCHANTS' BRIDGE, ST. LOUIS—TYPICAL MODERN DOUBLE TRACK STEEL RAILROAD BRIDGE.

Three spans, 517 feet 6 inches, and six spans, 125 feet long.