SCIENTIFIC AMERICAN

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THE ENGINES OF THE ST. LOUIS AND ST. PAUL.

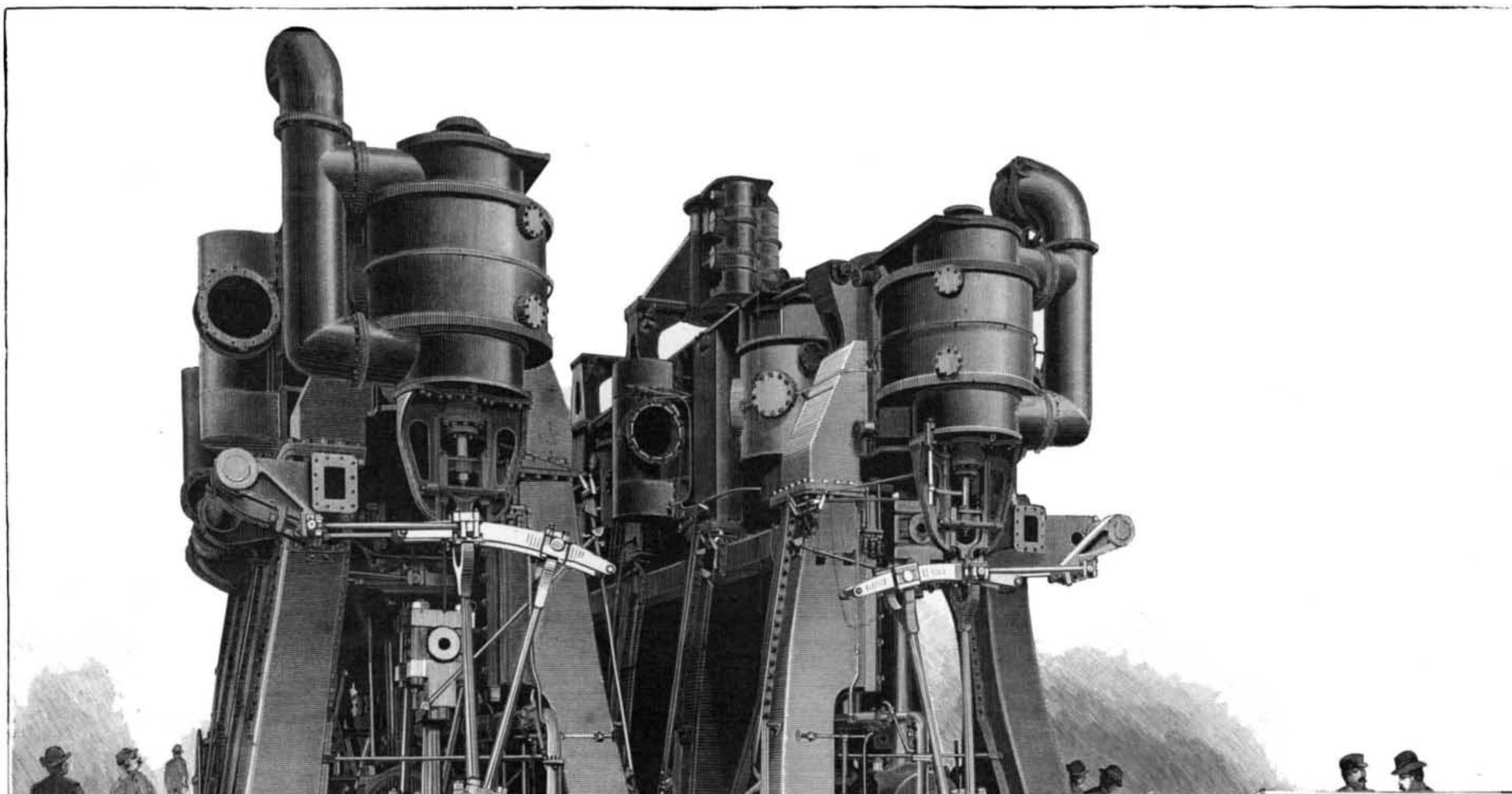
When it was first announced that an American shipbuilding firm had undertaken to construct a pair of 11,000 ton ocean mail steamers, and equip them with engines of 20,000 horse power, a doubt was freely expressed among the foreign shipbuilders as to whether so large an 'undertaking could be successfully carried through. The magnitude and novelty of the task is understood when we bear in mind that the tonnage was nearly four times and the horse power ten times as great as that of the largest steamers that this firm had hitherto built for the Atlantic trade. The four ships built by the Cramps Shipbuilding Company in 1872 for the American Steamship Company of that date were of 3,126 tons register and 2,000 horse power; and it was a great step from these ships, excellent as they were for their day, to the giant proportions of the later vessels.

The record of the St. Paul and St. Louis, however, has more than justified the expectations of their designers and builders. Both the horse power and the speed have exceeded the terms of the contract, and the St. Paul to-day holds the record on her own route, Southampton to New York, having crossed in 6 days, 5 hours and 32 minutes, at an average speed of 20·82 knots an hour.

The quadruple expansion engines of these ships are the largest on this system in the world, and they present many features of novelty in their design and construction. It is no light task that the engineer sets himself, when he sits down at his draughting board to make provision for the creation of 20,000 horse power, within the contracted limits of space which are assigned to the engines and boilers of a modern Atlantic liner. Mr. Thom, consulting engineer of the American line, who is responsible for the general design of these engines, has improved upon the common practice in large marine engines, by using a much higher pressure—200 pounds to the square inch—by adopting quadruple in place of triple expansion engines, and by transmitting the 10,000 horse power of each engine to the shafting by means of four instead of the usual three separate cranks.

These features in the engines of the St. Paul are directly in the line of development which marine machinery has been following since its earliest days, but they mark a long step in advance of anything yet attempted. The expansion of steam of the high initial tension of 200 pounds in six cylinders reduces the range of pressure in any one cylinder to a minimum, and thus gets rid of that most fruitful source of loss known as cylinder condensation. The distribution of the power among four cranks reduces the pressure upon the bearings, and keeps down the size of the low pressure cylinders. Of course, these advantages are in a measure offset by the fact that the number of surfaces in frictional contact, such as valves, valve gears, piston rings, etc., are multiplied, and the internal friction of the engine is theoretically increased; but the excellent working of these engines, which have now been twelve months in service, indicates that there is no difficulty experienced in actual practice.

From our engraving, which shows them as they appeared in the erecting shops after their completion, it will be seen that they are in duplicate, each set transmitting 10,000 horse power to its own screw propeller. The view is taken from the rear or thrust block end, the cylinder over the first crank being the second intermediate cylinder, of 77 inches diameter. The view of the engines from the forward end gives a greater impression of height, as the pair of low pressure cylinders are surmounted by a pair of high pressure cylinders, which can be seen in the engraving to the rear of the right hand or starboard engine. The distribution of the six cylinders is as follows: On the first crank is a 77 inch low pressure cylinder, surmounted by a 28½ inch high pressure cylinder; on the second crank are low and high pressure cylinders, duplicates of the first; on the third crank is a first intermediate, 55 inches in diameter; and on the fourth crank is a second intermediate, 77 inches in diameter. The ex-



TWIN QUADRUPLE EXPANSION ENGINES OF THE ST. LOUIS AND ST. PAUL.

Expansion in two high pressure, two intermediate, and two low pressure cylinders. Maximum horse power, 20,000.

pansion is as follows: Steam at 200 pounds is admitted to the two 28½ inch cylinders, from them it passes to a 55 inch intermediate, then to a 77 inch intermediate, and finally to two 77 inch low pressure cylinders. All the cylinders have a 60 inch stroke.

The condensers have three-quarter inch brass tubes, and are 7 feet 2 inches diameter, and provide a total surface of 26,000 square feet. The air pumps and circulating pumps are of the Worthington type, the same firm providing the feed heater and feed pumps. The feed enters at 210 degrees. The condensers and pumps are not connected to the main engines, as in the Paris and New York, but are located separately in the wings of the ship. Balanced piston valves and Cramps metallic packing are used. This latter consists of cast iron rings compressed by a coil spring. The starting and reversing is effected by means of a separate engine. The crank shaft is 21 inches in diameter and hollow, and the propeller shaft is 19 inches in diameter and is made solid.

There are ten boilers in all, six double-ended and four single-ended. They are all 15 feet 7½ inches in diameter, and are respectively 20 feet and 10 feet long, the plating being $\frac{7}{8}$ inch thick. They are fitted with Fox's corrugated flues and 2¾ inch tubes. An interesting feature is the fitting of the tubes with "retarders," which cause the gases to follow a spiral path in the tubes, and so remain longer in contact with their surface. The total grate area and heating surface for all the boilers are respectively 1,144 and 40,300 square feet. They are worked under the system of forced draught invented by Mr. Howden, which, in addition to the economy that it secures, is a positive blessing to the men in the stokehold, which can be left open. This may be considered as a great advance upon the closed stokehold system of forced draught, which, as its name implies, involves the closing up of all openings between the hold and the outside air, the interior of the stokehold being under a constant pressure of air.

In the Howden system, as installed on the St. Paul, the air is drawn by means of fans through heating chambers situated at the front end of the boilers, where it is heated by the gases from the furnace as they pass to the smoke stacks.

It must be borne in mind that, in addition to the main engines shown in the engraving, there are numerous auxiliary engines, such as those for driving the electric light dynamos, and the ventilating and refrigerating plants; not to mention the numerous steam capstans and windlasses, which form part of the equipment of a modern steamship.

There are certainly no large marine engines afloat whose performance is being more critically watched than those of the St. Louis and the St. Paul, and the fact that the record-breaking trip of the latter ship was made on a consumption of 310 tons of coal per day shows that they are very economical on fuel.

The Tennessee Centennial.

By proclamation of the governor and in accordance with the patriotic desire of the people of the State, June 1 and 2 were public holidays in Tennessee, and Nashville, the capital, was the scene of a series of public demonstrations of rare splendor, initiated and consummated in honor of the one hundredth birthday of the Volunteer State. The United States Marine Band and five regiments of the United States cavalry, artillery and infantry headed the magnificent parade, which was of such length that it was two hours and thirty minutes passing a given point.

The procession moved through the city and rested at the grounds of the Tennessee Centennial Exposition, which was formally inaugurated in connection with the centennial ceremonies. A striking feature of the occasion was the hoisting to the peak of a flagstaff 305 feet high of the flag of the United States, while the Marine Band played the "Star Spangled Banner" and the thousands of people were cheering. Congressmen, the United States Geological Survey, many State and Federal officials, the corps of Washington newspaper correspondents, and many prominent citizens from all parts of the country were present. Six of the great buildings that will fill the central plan of the exposition thus inaugurated are either finished or nearly so, and the construction of the remaining eight will be begun at an early date. To these will be added the countless smaller edifices, and the exposition, complete and beautiful in detail and in ensemble, will open to the public May 1, 1897, and continue six months.

THERE are in the United States, it is stated, 200,000 machinists, 10,000 tool makers, 25,000 boiler makers, 10,000 pattern makers, 750,000 carpenters and joiners, 200,000 masons and bricklayers, 50,000 contractors and builders, 50,000 plumbers, gas and steam fitters, 150,000 stationary engineers and firemen, 100,000 locomotive engineers and firemen, 50,000 electric railway and light employes, 50,000 cabinet makers, carvers and woodworkers, 50,000 civil, mechanical, electrical, and mining engineers.

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Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF SCIENTIFIC AMERICAN SUPPLEMENT No. 1072.

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OUR JUBILEE NUMBER.

We had hoped in this issue to announce the winner of the prize for the best essay on the "Progress of Science during the last Fifty Years," but the judges had not finished their examination of the numerous manuscripts at the time of going to press. Attention is called to this jubilee number, which will be one of unusual interest to all desirous of acquiring within small compass a resumé of what has been done in the department of science during the past fifty years. The next issue will be about four times the size of an ordinary issue. We hope our readers and friends will call the attention of their acquaintances to it, in order that they may apply for the paper in advance and therefore receive the paper without delay.

THE ARTISTIC ELEMENT IN ENGINEERING WORKS.

At a recent meeting of the commissioners of the proposed new East River Bridge, to join New York and Brooklyn, one of the members, Mr. Salem H. Wales, referring to its architectural features, said: "In this country this portion of the work has been neglected on almost all of the great bridges that have been built, and, whenever any attention has been paid to it, it has usually been considered of so little importance that it has been put in the hands of a draughtsman, or some one of little or no artistic ability." Mr. Wales concluded by stating that "at the proper time he would be prepared to present the name of an architect competent in every way to treat this matter in collaboration with the chief engineer."

Except that we think his condemnation of the architectural, or ornamental, features of our large bridges is too sweeping, we agree with the suggestions of the commissioner, and are of the opinion that there are many occasions, not merely in bridge building, but in various other departments of civil engineering, when the engineer and the architect could collaborate to good advantage. The question of the architectural embellishment of engineering work is as old as these arts themselves. The skillful treatment which marks the remains of those ancient structures which properly belong to the domain of engineering would seem to prove that the engineer and the architect were formerly combined in one individual. This was true of the days of the Roman Empire, as the remains of their aqueducts and bridges plainly testify; and in later mediæval days, the daring heights to which the builders of the Gothic cathedrals carried their lovely but fragile aisles and transepts, towers and spires, is clear evidence that beneath the monkish cowl was hidden both the constructive mind of the engineer and the artistic perception of the architect.

This dual capacity was rendered possible by the materials of construction in which the early builders wrought and the comparative simplicity of the problems with which they were confronted. They worked in the primitive materials, wood and stone; the thrust of the arch and the bearing capacity of the column were the most serious questions that occupied the engineer-architect of ancient and medieval times; and what these were he had learned from many a bulging wall and crumbling pier. When he raised those monumental piles of stone which are the despair of the modern architect, he was hampered by no considerations of mere utility; indeed, the uses to which a structure were to be put were often made subservient to the general architectural effect. Not content with grace and dignity of outline, he would often clothe his completed structure with a rich garment of delicately carved tracery, softening the severity of its outlines and adding beauty of detail to the dignity of the general effect.

But the coming of the age of steel has revolutionized the art of construction in all those departments to which it can be applied; and out of the crude theories which governed the age of wood and stone have been developed the exact scientific methods of modern engineering. The high cost of iron and steel forbade that prodigal use of material which marked the age of stone construction—nor was it necessary. The element of economy entered into the question of design, and led to a careful investigation of the stresses to which a structure was subjected, and an intelligent proportioning and disposition of the material to meet those stresses.

With the development of the art of steel construction, and the increase in the number and complexity of the problems which it involved, the line of demarkation between the engineer and architect began to grow more distinct, until to-day it is common practice for the architect to call in the aid of the engineer to design the structural steel work which gives stability to his buildings.

The primary motive—if we may so speak—of the engineer and the architect is different. The proportions which an engineer gives to a bridge, for instance (since this is the form of construction under consideration), are not primarily, if at all, determined by any abstract considerations of beauty. These proportions are determined by certain hard and fast principles of mechanics, which are as unchangeable as the fact that 2 and 2 make 4, or that the whole is greater than its part. It is quite possible that the result will not ap-