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 $\frac{9}{16}$ 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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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 medieval 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-

peal to the æsthetic sense of the artist; and this is more his misfortune than his fault. To the eye of the engineer, the combination of the straight lines of the bottom, and the curved lines of the top, chord of a truss bridge is strictly beautiful, inasmuch as it expresses in concrete and useful form those unchanging physical laws on which the equilibrium of the whole universe depends.

To a captious critic who called the giant cantilevers of the Forth Bridge ungainly, their eminent designer replied that the most lovely column from the Parthenon at Athens, if set up as the smoke stack of an Atlantic liner, would be grotesque in the extreme.

The various parts of any properly designed engineering construction are beautiful only so long as in shape and bulk they exactly represent the various functions which they are supposed to perform.

To attempt, for instance, to adorn the simple structural shapes of a modern steel truss with fanciful designs is to belittle its appearance, and turn the expressive and truthful simplicity of their outline into a hollow and meaningless sham. Scrolls and traceries, bosses, shields, and interlacing triangles, which are glorious in a cathedral, are grotesque on a steel bridge.

It is probable that the commissioner above quoted, in suggesting the co-operation of an architect with the engineer of the East River Bridge, had in mind merely the stonework of the piers and approaches; and here we think that there is a legitimate field for the display of architectural skill. Among the many architectural styles, that one should be chosen which most nearly agrees with the character of the bridge itself. In most cases however it may be safely laid down that whatever style be adopted, it is scarcely possible for the architect to err upon the side of too great simplicity or severity of design.

THE INTERNATIONAL GEOLOGICAL CONGRESS AT ST. PETERSBURG, AUGUST, 1897.

Professional geologists and all other persons interested in geology will be interested in the announcement which has just been made concerning the plans of the committee of arrangements having in charge the seventh triennial meeting of the International Geological Congress, which will take place in August, 1897, at St. Petersburg, by invitation of the Russian Emperor. A grand programme is proposed by the committee, and no effort is being spared to enable the members of the congress to take advantage of this unique opportunity to study the geological and topographical features of Russia in Europe, the Emperor himself offering all the visiting geologists free transportation, first class, over the Russian railways, before and after the sessions of the congress, including the excursions.

Membership in the congress is open not only to professional geologists, but also to other persons interested in the science, and may be obtained in accordance with conditions which may be learned by addressing the secretary, whose address is given below. The meeting will extend over eight days, and the sessions will be devoted to discussing general principles of geology and the present state of the science in the effort to bring about harmony among the geologists of the world. Much time will be given to the exposition of the geological work being done in Russia, especially in those regions covered by the excursions. The usual facilities will be given for the display of instruments, maps and books pertaining to geology.

The excursions offered before and after the congress are bewildering in their extent and attractiveness, and only the most meager outline of them can be given here. The principal tour proposed before the meetings is from Moscow, eastward to the Ural Mountains, crossing that chain and visiting several famous mineral and mining localities, including Ekaterinburg and Tagilsk and returning by way of Perm to Moscow. Persons especially interested in historical geology will, however, take the excursion into the province of Esthonia, while those who prefer crystalline rocks and glacial geology will spend six or seven days in Finland. A grand excursion which will occupy a month is proposed for the time immediately following the close of the congress in St. Petersburg. After visiting Moscow and its environs in a body the party will split up into three divisions, one section going by way of the Donetz valley to the baths of Vladikavkaz, the second going by the Volga River, and the third by the Dnieper valley to the same rendezvous. Thence the route leads over the Georgian military road to Tiflis, stopping on the way to visit some of the glaciers of the Caucasus Mountains. From Tiflis a visit will be made to Baku, the headquarters of the petroleum fields of the Caspian Sea, and afterward to Batoum, on the Black Sea, whence ship will be taken for Kertch, where a study of the Crimea will be begun which will end at Sebastopol, where the congress will finally dissolve. Six alternative and supplementary trips are offered in connection with the great tour, for those who are particularly interested in mines, in glaciers, in the ascent of Mount Ararat, etc.

Persons expecting to attend the congress are requested by the committee to notify the general secretary of the congress by next October as to which of the excursions they propose to take. The president of the congress is A. Karpinsky, director of the geological survey of the Russian empire, and the secretary, to whom all communications should be addressed, is Th. Tschernyschew, St. Petersburg.

The last meeting of the congress was in 1894, at Zurich, and the one preceding that was at Washington, in 1891, in connection with the American Association for the Advancement of Science and the Geological Society of America.

Steam Road Rollers and Gas Pipes.

The gas companies in England have found that the use of steam road rollers has had a bad effect upon gas pipes under streets. We have not heard this complaint from gas companies in the United States, says the Engineering Magazine, but it is the practice here, at least in the colder parts of the country, to place both water and gas mains deeper in the earth than in England. The trouble has become sufficiently pronounced in England to be made the subject of a paper by Mr. Norton H. Humphrys, Assoc. M. Inst. C.E., printed in Journal of Gas Lighting, who asseverates that, while the results of steam road rolling may be entirely satisfactory to civil engineers, the gas companies do not regard them with complaisance. An abstract of this article follows:

On good roads accustomed to carrying a large and heavy ordinary traffic, including four-horse vans and traction engines, and which have been well maintained and kept in good order, the steam roller does not put itself much in evidence. But, when one of these implements is for the first time put upon a by-street or a country road accustomed to small and light traffic, and which has received but little attention in the way of maintenance, beyond an occasional scrape in unusually wet weather and a sprinkling of stones from a cart at rare intervals, the gas engineer becomes more intimately acquainted with "The Luck of Eden Hall" properties possessed by the steam roller than is good for his own comfort or the prosperity of his undertaking. Difficulties from drawn services and fractured mains—ranging from the slight crack of a few inches long up to complete severance of the pipe—become common occurrences.

A comparison of gas pipes with water pipes with reference to their respective requirements shows that this is not because water engineers are more thorough in their work. Following on the lines of the usual rule that, if the gas gives a bad light, the company is at fault, it is agreed that, if the gas pipes break, they must be bad pipes; and many members of corporations, etc., arrive at the conclusion that there must be special negligence in putting down, or selecting, the sections or quality of the pipes to be used for the conveyance of gas. So far from getting any sympathy in their misfortune, which has arisen from causes that could not possibly have been foreseen, the unfortunate gas company is blamed for not laying down pipes at a reasonably sufficient depth, or for purchasing cheap stuff of a rotten or gingerbread character. A common argument in support of this view is the fact that gas pipes are injured more frequently than water pipes.

The relations between the shape of the roller, its weight and the mode of using it to the damage done upon the pipes is discussed at length, and the tendency toward using greater weight is deprecated. Water engineers have not been more prudent, nor have they exercised more care or foresight as to possible contingencies. Neither do they generally do their work in a stronger or more substantial manner than do gas engineers. The trouble is simply a natural consequence, due to the different natures of the services performed. The internal pressures to which the gas service is exposed is a mere trifle—a matter of a few ounces per square inch. But water pipes are subjected to heavy pressure in low levels, representing a large number of pounds per square inch. Gas pipes in themselves are not interfered with by frost, except as regards its effect on the soil surrounding them; but the formation of ice in water pipes must be prevented, as it not only stops the supply, but also fractures the pipe. It would be as reasonable to adduce the fact that the main sewers are never injured by the roller as to compare water pipes with gas pipes.

Life in the Animal Kingdom.

Man lives to all ages, but in the animal kingdom, on the contrary, the duration of life is almost exactly equal for all individuals of the same species. But we can know with exactness the real duration of life only for animals in servitude; we do not know whether it is the same in the savage state. Rabbits and guinea pigs live seven years; squirrels and hares, eight; cats, nine or ten; dogs, ten or twelve; foxes, fourteen to sixteen; cattle, fifteen to eighteen; bears and wolves, twenty; the rhinoceros, twenty-five; the ass and the horse, twenty-five to thirty; the lion, thirty to forty (a lion in the London Zoological Gardens reached the age of seventy years); the camel, forty. The length of life of the elephant is uncertain; according to Aristotle Buffon, and Cuvier, it lives two centuries; some authors say even four or five. After his victory over Porus, Alexander consecrated to the sun an elephant that had fought for the Indian monarch, and gave it the name of Ajax; then, having attached an inscription to it, he set it at liberty. The animal was found 350 years later. The ancients attribute to the stag a fabulous length of life, but Aristotle observes that what is reported on this subject has no good foundation. . . . Buffon says that the stag takes five or six years to attain full growth and should live seven times this period—that is, thirty-five or forty years.

Though precise observations are wanting, we know that fishes, especially the large species, live a very long time. According to Bacon, eels reach sixty years. Carps have been known to live at least 150 years, and they then seemed to Buffon as lively and agile as ordinary carp. Dolphins, sturgeons, and sharks live more than a century and attain huge size. Pikes have been seen weighing 1,000 lb., which indicates a very long existence. A pike caught at Kaisers-Lautern in 1497 was 19 feet long and weighed 350 lb.; it bore in its gills a copper ring with an inscription stating that it had been put in the pond of Lautern by order of the Emperor Frederick II—that is, 261 years before. Whale fishers have exterminated the huge whales of the polar seas; those that were formerly met with were of prodigious dimensions. It is supposed, with some probability, that they live several centuries and that they may even reach an age of 1,000 years. The longevity of fish is attributed to the long duration of the development, to their low temperature, and to their feeble vitality.

On the other hand we meet another class of animals whose passions are lively, whose vitality is very active, and who still live a long time—we mean birds. But it is not known with any degree of precision how long these live, except that their longevity is great. We see the same swallows returning to their accustomed nest for a considerable number of years. An eagle died at Vienna at the age of 103 years. According to Buffon the life of the crow is 108 years, and no observation authorizes us to attribute to it, with Hesiod, 1,000 years. A paroquet, brought to Florence in 1633 by the Princess Provere d'Urbin, when she went there to espouse the Grand Duke Ferdinand, was then at least twenty years old, and lived nearly 100 more. A naturalist whose testimony cannot be doubted, Willoughby, had certain proof that a goose lived a century; and Buffon did not hesitate to conclude that the swan's life is longer yet; some authors give it two and even three centuries. Mallerton possessed the skeleton of a swan that had lived 307 years. This is quite enough to prove that among the larger animals, and also especially among birds, the duration of life, relatively to their bulk and height, is very long: it is, on the contrary, very short with insects; many of these live less than a month, rarely a few years, while the life of the ephemerids is but seven to twelve hours, and in this brief space they accomplish the principal functions that nature requires of organized bodies: they are born, reproduce, and die.—Journal d'Hygiene, Paris.

Knots Tied by Machinery.

If inventions continue to multiply at the present rate, the day may speedily come when man will have to sit with folded arms while his work and even his pleasures are turned out for him by nickel in the slot devices. Science has lately given us a marvel in the shape of a card-counting machine.

Two of the most interesting automata now working within the limits of the United States are those used by the government for counting and tying postal cards into small bundles. These machines were made in Connecticut, and the two are capable of counting 500,000 cards in ten hours and wrapping and tying the same in packages of twenty-five each. In this operation the paper is pulled off a drum by two long "fingers" which come up from below, and another finger dips in a vat of mucilage and applies itself to the wrapping paper in exactly the right spot. Other parts of the machine twine the paper around the pack of cards and then a "thumb" presses over the spot where the mucilage is, and the package is thrown upon a carry belt ready for delivery.—The Argosy.

THE London correspondent of the New York Sun states that an Antarctic expedition has been arranged for next winter. It will be partly a trading and a scientific enterprise, and will be under the command of Capt. Svend Foyn, of Christiania. W. S. Bruce, of the Ben Nevis Observatory, will have charge of the scientific party, composed of himself and four other men. The scientific party will be landed on the Antarctic continent in Victoria Land in January next, and the vessel will then engage in whale and seal fishing, returning to Australia. The following season, in January, 1898, she will return and take off the scientific party, who hope by then to have obtained knowledge of the fauna, flora, geology, and topography of the Antarctic region. If found practicable, an attempt will be made to reach the south magnetic pole.