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

THE OLD AND THE NEW.

In the broad field of engineering there is no single section that has had so much to do with the industrial growth of the world as the steam railroad. Furthermore, in all the seventy years of its growth, the steam railroad has never witnessed a change so radical, or destined to work such far-reaching results in promoting its development, as the impending substitution of electricity for steam in the operation of its trains.

By far the most important work being done in this connection—and we say it with full recollection of the pioneer work in the electrical equipment of some roads in Europe—is the wholesale substitution of electric for steam traction, which is now being carried out on the New York Central terminal, suburban, and express lines; for this is the first time that the problem of working all trains, express as well as local, by electric power, has been attempted. For, mark you, this is no mere experiment, carried out by some up-to-date but impecunious individual or company, upon a scale too limited to render the results of practical value. It is an experiment—if you please to call it such—that involves the reputation of the largest railroad system in the world, and forms the principal element of cost in changes that call for the expenditure of $50,000,000.

The success of this installation, of which there can be no doubt whatever, marks the first step in the gradual substitution of the electric for the steam locomotive in the operation of long-distance express trains. Very gradually will the change be made, and the electrical hauling of through expresses must ever wait upon the equipment of the local service. The enormous improvement in the latter, due to shorter, more frequent, and faster trains, will call for its continuous extension to other parts of the system. The New York to Croton equipment will be followed by an Albany to Hudson service; to be followed, in turn, by extensions of these circuits, say to Rhinebeck and Garrison, respectively. The next extensions would bring the two services to a connection at Poughkeepsie; and so the through electrical service from New York to Albany will be completed. Similar extensions, east and west from Chicago, Cleveland, and Buffalo, will in time link Chicago with New York.

But it must not be supposed that the steam locomotive, which must ever be reckoned as one of the most perfect mechanical inventions of any age, is destined to pass entirely from our midst. Only on lines that have a fairly heavy traffic can the electric locomotive compete with its older brother. For the steam locomotive carries its own power station; it does not depend for energy upon a power plant located many miles away; it does not have to string out behind it a costly copper transmission wire; nor does it necessitate the building of many substations along the track, wherein its life-giving food may be transformed, and converted, and otherwise doctored, so as to prepare it for easy digestion. Where stations are far apart, traffic light, and freight a scarce commodity, the whistle of the steam locomotive will long be heard in the land.

By the courtesy of the officials of the New York Central Railroad, we were recently given an opportunity to ride, during the same day, on the latest type of express steam locomotive and on the new electric locomotive, both of which are designed for the same class of service. In each case the load behind the engine was the same, and a unique opportunity was thus afforded for comparing the old with the new. The steam locomotive was the new balanced compound, recently exhibited at St. Louis, where it was tested on the Pennsylvania Railroad Company's testing plant. She is probably the most powerful express engine in existence, and she represents in her four balanced cylinders and connections, the most advanced ideas of our locomotive builders. Probably she marks the limit of size, power, and efficiency of the fast express type. When the engine was running at speed, the absence of vibration and concussion, as compared with the simple Atlantic type, was remarkable, although in this respect she could not, of course, compare in smoothness of running with the electric locomotive—the latter having no reciprocating parts whatever. The acceleration, when hauling the same weight of train, was markedly slower than that of the electric, and the sense of reserve power in the latter was made evident by the ease with which she "got away" with her load.

It is the figures, however, that tell the story; and here they are: The steam locomotive, on a total length of 62 feet and a total weight of 162 tons, can develop a maximum horse-power of 1,800; but the electric locomotive, on a total length of 37 feet, and total weight of only 95 tons, can develop a maximum horse-power of 3,000; or 31.5 horse-power per ton, as against 11.1 horse-power per ton. Again, the starting pull of the electric locomotive is 32,000 pounds, while that of the steam locomotive is 25,900 pounds. As the speed of the latter increases, the pull falls very rapidly, until —as shown on the testing plant at St. Louis—it is only 9,800 pounds at 56½ miles per hour, and 5,200 pounds at 75 miles per hour. This drop is largely due to back pressure of the steam—the difficulty of getting rid of the large volumes of steam that must pour through the cylinders when the engine is running at high speed. No such drop in the drawbar pulls occurs on the electric locomotive, which can keep on accelerating a train, long after the steam locomotive, when hauling the same weight of train, has reached its limit.

The elaborate tests now being carried out on the main tracks of the New York Central near Schenectady, are to include some literal "races" between similar trains running side by side, the electric on the local, and the steam trains on the adjoining express tracks. Thus, an Empire State express train, hauled by a steam locomotive, will start from rest on the express track, side by side with an exactly identical train hauled by the electric locomotive on the local track. Then we shall know exactly by how much the new excels the old system of traction, in point of hauling power and speed.

WIND PRESSURE ON BRIDGES AND BUILDINGS.

Many of us will remember the terrible accident on the Tay Bridge in Scotland, when, on a stormy night in midwinter, several spans were blown over into the estuary, carrying with them, caged in the steel trusses, a whole trainload of passengers, of whom not a soul escaped to tell of the disaster. The wrecking of this bridge afforded, or rather was supposed to afford, proof that engineers had greatly underestimated the overturning power of the wind. As a matter of fact, the bridge collapsed because of poor castings in the piers of the bridge, and the faulty manner in which they were braced. Nevertheless, the British Board of Trade, which takes cognizance of all accidents involving loss of life, laid down a sweeping law to the effect that in calculating the wind pressure on future bridges, a unit of wind pressure much higher than any previously used must be applied. The great Forth Bridge was then in contemplation, and before the plans were allowed, it was decreed that wind pressure must be allowed for at the rate of 56 pounds on every square foot of the surface of the side elevation of the bridge. The wind stresses were calculated accordingly, with the result that this noble structure is, and forever will be, the most massive and heavily braced bridge of large span in the world. As a matter of fact the wind bracing is much heavier, as subsequent tests have shown, than it need have been. Thus, Sir Benjamin Baker, the engineer of the bridge, gives the following stresses per square inch existing in the bottom members of the Forth Bridge, for the weight of the bridge itself, for the weight of the train, and for the wind pressure: the dead load of the bridge imposes a stress of 2.8 tons per square inch; the live load of the trains imposes a stress of 1.2 tons per square inch, while the calculated wind stresses amount to 3.5 tons per square inch. But since much of the dead load stress is due to the great amount of material worked into the bridge to resist the wind stresses, it follows that in this bottom member the stresses due to the wind, as calculated, account for more of the material than do the dead load of the bridge and the live load of the trains combined.

Now it is well understood that the excessive allowance for wind stresses was imposed on the engineers by the Board of Trade, and was not determined by their own judgment. At the time that the bridge was designed, however, reliable data as to wind pressures were wanting, and indeed, the first really reliable information of the kind that is now accepted by bridge engineers was acquired by the engineers of the Forth Bridge during its erection. Mr. Baker caused pressure gages of large and small area to be erected, and careful records of wind pressures made for a period of several years. The results obtained proved that such a thing as an absolutely even and uniform pressure over any large area affected when a strong wind is blowing is a thing unknown, the wind acting with pressures of widely varying intensity on surfaces that are adjacent or almost adjacent. Thus, the unit pressure on a gage at the Forth Bridge measuring 15 x 24 feet was only about 66 per cent of the unit pressure recorded on a gage having an area of 1½ square feet; and there is no doubt that on a gage measuring 100 x 100 feet there would have been a still greater reduction in pressure per unit of measurement. It is well established that the accepted formulas for determining wind pressure are much too high, being based on maximum pressures recorded on small areas. Thus Theodore Cooper, whose specifications for bridges are standard throughout America, is of the opinion that a pressure of only 25 pounds per square foot acting at the same moment on large areas would denude the district affected of all trees and buildings; and General Greely, of the United States Signal Service, has stated that there have been few cases recorded of wind velocities in the United States, where the pressure exceeded 16 pounds to the square foot; this, of course, being taken to mean 16 pounds over wide areas. The enormous pressures of which we have evidence in the destructive effects of a tornado, are now understood to extend over comparatively limited areas, not exceeding a few hundred feet at the widest. In an exhaustive study made of the St. Louis tornado by Julius Baier, it was stated that there was evidence of pressures as high as 60 pounds to the square foot, but that they extended over a breadth of not more than 180 feet. Another noted bridge engineer found, after following up and investigating the paths of several tornadoes, only a single case where a width of 60 feet was not sufficient to cover the path within which the estimated pressures exceeded 30 pounds. From this it follows that on spans of over 150 feet, the average pressure to be assumed in calculating the necessary strength of the wind bracing may be reduced, the reduction increasing with the increase in length of the span. Mr. Cooper, than whom there is no greater authority on this subject, suggests the following wind forces as sufficient to cover all cases: First, a wind force of 50 pounds per square foot, acting at the same moment over a width of 60 feet, striking any part of the bridge at any angle, within 30 degrees above or below the horizontal; second, a wind force of 30 pounds over a width of 600 feet; and third, a wind force of 15 pounds over a width of 2,000 feet; the maximum stresses from either of these requirements to be used for proportioning each member. Now, there can be little doubt that these estimates are perfectly adequate to meet the conditions of the severest storms, even of those of a cyclonic character. Although comparatively small areas of a 2,000-foot span might be exposed to the impact of a tornado that would tear the buildings of a city to pieces, the total pressure on the whole span at that instant would not rise much above that due to a steady wind of high velocity, but free from tornadic action. If we compare the pressure of 15 pounds per square foot over a width of 2,000 feet with the pressure of 56 pounds to the square foot, imposed upon the engineers of the Forth Bridge on a length of 1,700 feet, we can understand what a vast amount of unnecessary material was worked into that structure because of the heavy conditions imposed with the best intent by the Board of Trade. Were the bridge built at the present time, subject to the more accurate knowledge that we possess, its cost, due to the reduction in wind bracing, would be very materially decreased.

A large iron works has been erected by the Japanese government at Wakamatsu. When completely finished, it is to have an extensive blast furnace plant with all the necessary appliances, besides a steel plant for Bessemer steel and a second for Siemens-Martin steel. The latter is to be equipped with a number of sets of rolls. The plant is, however, far from being complete. In 1903 it turned out some 35,000 tons of finished product. The works uses coal which it obtains from three mines. The latter are worked in connection with the plant and lie 20 miles distant. Ores from different parts of the country are used, and a considerable quantity is brought from Corea and China, especially the latter. The cost of producing a ton of cast iron is stated to be $15 at present. It is expected to reduce this price by eliminating the ore which is sent from China, as this has a high price, and a ton of iron may soon be produced for $11. This will be $2.40 lower than foreign cast iron, which is obliged to pay a customs duty of 80 cents per ton. It is considered by those who are acquainted with the subject, that the difference in price between the home and foreign products is too small to allow the Japanese product to support the heavy charges coming from the first cost of the plant. These charges were not counted in the above price. The expense of installing the plant has been considerable, and is figured at $15,000,000. The government, according to some authorities, intends to turn the plant over to a Japanese company with foreign capital at a price which is only half that mentioned.