THE NEW TOWER BRIDGE, LONDON.

June 30, 1894, was a gala day in London, the occasion being the opening of a new bridge over the Thames River, located near the Tower. No ceremony is considered of any consequence in England unless the Queen or her representatives take a conspicuous part therein. On this occasion Her Majesty was represented by the Prince of Wales and a galaxy of princesses, princes, dukes, duchesses, and other notables. There was a grand procession, then addresses, the Prince touched an electric key, which caused the draw to operate, and then declared the bridge opened, the Bishop of London pronounced a blessign, and a royal salute followed. A procession of gayly decorated steamboats passed through the draw, the Prince gave a reception on the bridge, the royal party embarked on a steamer and landed at Westminster Bridge, thence home in carriages. We are indebted to *Black and White* for our two photographic views and to the *Graphic* for our large drawing.

The act authorizing the work was passed in 1885, and the foundation stone was laid by the Prince of Wales June 21, 1886. As a whole, it is a heavy piece of work, occupying much more valuable space than was necessary. But it was considered by those who had the say that such a work, located, as it was, near the historical Tower of London, ought to be massive, and present a mediæval architectural look. So they sank a pair of great piers in the narrow river, erected strong steel frames thereon to carry the cables and other parts, and then clothed the steel work with a shell of stone, the work, as a whole, being thus made to represent a structure of massive masonry.

The London *Builder* denounces the work as a case of false pretenses. But there is no denying that the bridge looks well, and makes a solid, grand, and substantial appearance.

The construction is peculiar. The draw consists of two leaves called bascules, which open vertically to allow the passage of vessels. These bascules are weighted at their lower ends and turn easily on pivots arranged in the bases of the towers. The width of their span is 200 feet. Between the towers, at their upper ends, and 140 feet above high water level, extends a permanent bridge for the use of foot passengers. There are elevators in the towers to take up the passengers, so that when the draw is opened foot passengers may still use the upper bridge. It requires five minutes to open and close the draw and allow a vessel to pass. The bascules are operated by pinions that engage quadrants on the lower ends of the bascules. The entrance to the bridge on the Middlesex side is opposite to the Mint. The approach passes along the east side of the Tower to the shore, where the northern abutment is placed on the west side of the wharf belonging to the General Steam Navigation Company. The south abutment is

THE NEW TOWER BRIDGE, LONDON—THE BASCULES CLOSED.

THE NEW TOWER BRIDGE, LONDON—THE BASCULES OPEN.

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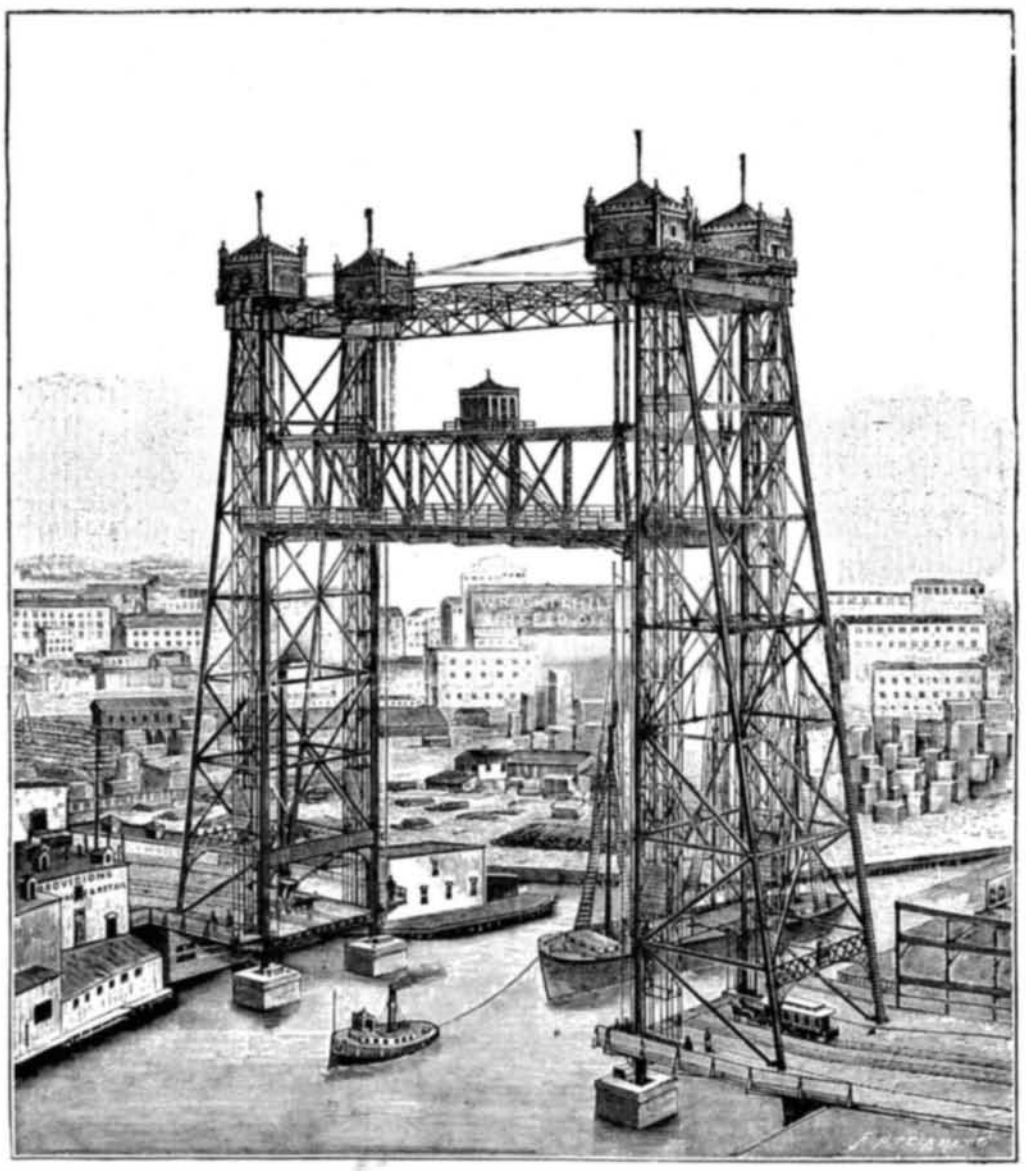
OPENING OF THE NEW TOWER BRIDGE, LONDON.—[See page 72.]

placed a little to the westward of Horselydown Stairs, and the approach on this side of the river is about 800 feet long, and runs in a straight line from this point, on a falling gradient of 1 in 40, until it meets Tooley Street. The north and south river piers are similar in all respects, and are, we believe, the largest of their kind in the world, the area of the two piers at the level of the foundations being about equal to the whole of the twelve circular piers carrying the Forth Bridge. The only other foundations of such dimensions are those of the Brooklyn Bridge, the two main piers of which support a roadway of 1,606 feet span. The total length of the bridge, including both approaches, is just half a mile. The total height of the towers on the piers, measured from the level of the foundations, is 293 feet. For the construction of this bridge some 235,000 cubic feet of granite and other stone, 20,000 tons of cement, 70,000 cubic yards of concrete, 31,000,000 bricks and 14,000 tons of iron and steel have been used.

The mode adopted for spanning the landward openings is the suspension system—that is, by stiffened chains anchored in the ground at each end of the bridge, and united by a horizontal tie across the central opening at the high level. This tie is carried by two narrow bridges ten feet in width, forming foot bridges, which come into use when the opening span is open for the passage of vessels. Above the landings from which the foot bridges start, and on which the foot passengers land from the lifts, come the roofs of the towers, the tops of which are 162 feet above the roadway level, or 264 feet from the bottom of the foundations.

The original design for a bridge on this plan is credited to the late Sir Horace Jones. But the modification and construction of the great work as it now stands is due to Mr. John Wolfe Barry, an engineer of great ability. The bridge has cost the enormous sum of $5,500,000.

Apropos of the way in which the Yankee sometimes deals with such jobs as the bridging a narrow stream like the Thames, we give a view of the new lift bridge over the Chicago River at Halsted Street.



THE NEW LIFT BRIDGE, HALSTED STREET, CHICAGO.

THE HALSTED STREET BRIDGE OVER THE CHICAGO RIVER.

We publish this week some further illustrations of the lift bridge, says *Engineering*, to which we are indebted for our cut and these particulars. (In some respects the problem to be solved was much the same as at the Tower Bridge, London. Some form of structure was required which, while giving when necessary a free way for high-masted ships, should obstruct the waterway and the river banks as little as possible. Hitherto the bascule type has been generally adopted under such conditions, and it was the favorite form of draw bridge during the middle ages, when such structures had a military rather than a commercial object. A moderate span was then all that was required, but when, at a more recent period, provision had to be made for the passage of large vessels, the swing bridge was invented, and up to the present it is still the favorite form where a large opening is required. In certain cases the swing has been as much as 450 feet long. A bascule bridge of similar span would be much more expensive, and, in fact, the Tower Bridge is, we believe, the only instance of a large bascule opening in existence. The increased expenditure in this latter case was considered justifiable on the ground that the bridges in a large city should be as picturesque as possible, and it would have been disgraceful for a wealthy community like that of London to have permitted the erection of a structure that would not harmonize with the old tower to which the new bridge is so close a neighbor. These latter considerations do not seem to have had much weight in the case of the Halsted Street Bridge, which, though a capital piece of engineering and a great credit to its designer, Mr. J. A. L. Waddell, can hardly be considered a success from the æsthetic point of view, though this defect is not inherent in the type, and we have no doubt Mr. Waddell will be able to embody his idea in a more graceful form whenever he finds a community ready to pay for the luxury. Apart from this, the lift type seems to have great advantages, and there is no reason why the system could not be applied to an opening of as much as 500 feet to 600 feet if desired, and the cost in such a case would certainly be considerably less than that of a swing bridge giving an equal opening, and if the foundations were difficult, it might cost less than a swing bridge giving two 250 feet openings.

In general plan the type of bridge under consideration consists of an ordinary truss span, resting on masonry abutment as usual, but so arranged that the truss can be raised from its seat and lifted high above the water level, so as to permit of masted vessels passing beneath. The truss is of the ordinary pin-connected type, 130 feet long by 23 feet high, connections being formed for the road way by prolonging the verticals below the bottom chord. This roadway is 34 feet wide between curbs, but the distance apart of the trusses, center to center, is 40 feet. The cross girders are of the plate type, and have the longitudinals, consisting of 15 inch I beams, riveted to their webs. The lower lateral bracing is fixed to the bottom flanges of these I beams. The pathways, 7 feet 8 inches wide, are carried on brackets, the pull of the top flange being carried round the vertical post. To guide the span while it is being lifted, two rollers are employed at each end of each top and bottom chord. One of the rollers is intended to take up side pressure, while the other checks any tendency to longitudinal swaying, but as provision must be made for expansion, this roller is fitted with powerful springs behind its bearings. The side pressure rollers are connected to the chords by a breaking piece, so that if the span is struck by a vessel the effect will be to shear this roller off, rather than to damage the span more seriously. A small hut for the bridge attendant is erected on the top of the lifting span.

The principal interest of the structure, however, centers on the lifting arrangements. As usual in the States, steam is employed for this purpose, an engine house being built on the river bank underneath one of the side spans of the bridge, and in this two 70 horse power engines have been erected, together with ample boiler power. These engines run at 240 revolutions per minute, and drive the pulleys for the lifting tackle by means of gearing. This tackle consists of 16 steel wire cables, ⅞ inch diameter, eight of which attach to the top of the span and the other eight to the counterweights, the lead of the cables being so arranged that as one set is wound on the winding drums the other set is wound off. The main sheaves on the top of the towers are 12 feet in diameter, and as the span and its counterweights each weigh about 250 tons, these four pulleys have each to carry about 75 tons each, and thus require a rather large shaft and long bearings. A 12 inch shaft has been adopted. To take the pull of the cables the two towers are connected together between the pulleys by a light truss. The abutment towers are very stiff, and consist each of two main vertical posts, which serve as guides for the lifting spans as well as taking most of the weight, while two raking posts support them against any end sway of the span when in its topmost position.

The bridge was designed by J. A. L. Waddell, C.E., of Kansas City, he having planned the same on a larger scale for Duluth Harbor. W. W. Curtis, engineer of the Pittsburg Bridge Company, made all of the working drawings of the structure, while the details of the lift gear were worked out by Superintendent T. W. Hermans, of the Crane Elevator Company.

The primary idea on which this type of bridge is based is the elimination of a center pier in cases where the bridge spans a navigable stream and a draw is necessary, thus securing the free use of the whole channel with very little obstruction of the docks in the immediate vicinity. This is accomplished by lifting the roadway to a sufficient height to allow passage of vessels with their spars and rigging, only for such time as is necessary, and immediately lowering to place, giving as little obstruction to street traffic as is possible. The bridge is so equipped as to be raised to full height in less than one minute, one engine being sufficient for the work, so that in this respect it is fully up to the ordinary center-pivot swing bridge, with the further advantage that in most cases it is only necessary to raise it part of the way, with the corresponding saving of time.)

An accident which caused not a little excitement occurred recently in the working of this bridge. When the bridge was raised on the morning of July 16, to allow a vessel to pass under it, a pinion in the hoisting apparatus broke as the bridge reached its uppermost position, and it was impossible to lower the structure until repairs were made, which it took thirty-six hours to accomplish. At the time of the accident, there were on the bridge eight passengers, of whom three, a policeman and two boys, were lowered in a chair tied to a rope, but five others, all men, were kept prisoners in their elevated position. A basket of provisions was sent up to them by a rope, and they passed the night as comfortably as they could in the signalman's little house.

Remarkable Fossils.

Prof. J. B. Hatcher and his party of students from Princeton College, who have just completed a tour through the Bad Lands of South Dakota, in search of fossils and petrifactions, have met with good success. The party has been in the Bad Lands between the Cheyenne and White Rivers since March 1. After completing their task, they started on an overland trip to Yellowstone Park. The collection of fossils has been shipped to Princeton. It weighs 9,000 pounds and consists of rare specimens of extinct animals.

The choicest and most valuable specimen was the elotherium, or extinct pig. The specimen was found protruding from a bank of one of the deep hollows in the Bad Lands. This is the only skeleton ever found of this character in that district, and was perfect, no bones being missing. This carcass is much larger than the modern pig; in fact, it is larger than the living rhinoceros.

One specimen was the titanotherium, or extinct rhinoceros, which was twice as large as the modern rhinoceros. They also found several specimens of the rhinoceros family and the metamydor, a relative of the rhinoceros. Then there are skeletons of numerous small animals. They found a few fish skeletons, the only fish skeletons ever found in those beds. Last year's expedition from Princeton succeeded in obtaining the only crocodile ever found in the Bad Lands. On this trip a good specimen of the amphisbaenold lizard was unearthed, the only specimen of this reptile ever found in the world. This has no limbs at all, and was a very low order of the lizard.

GERMANY is now the best educated nation of the Continent, yet only one hundred years ago German teachers in many parts of the country were so poorly paid that they used to sing in front of houses in order to add to their income by odd pence.