

## TUBULAR RAILWAY BRIDGES.

IN the year 1850, a vast line of railway was completed from Chester to Holyhead, for the conveyance of the Royal mails, of goods and passengers, and of her Majesty's troops and artillery, between London and Dublin—Holyhead being the most desirable point at which to effect this communication with Ireland. Upon this railway are two stupendous bridges, which are the most perfect examples of engineering skill ever executed in England, or in any other country.

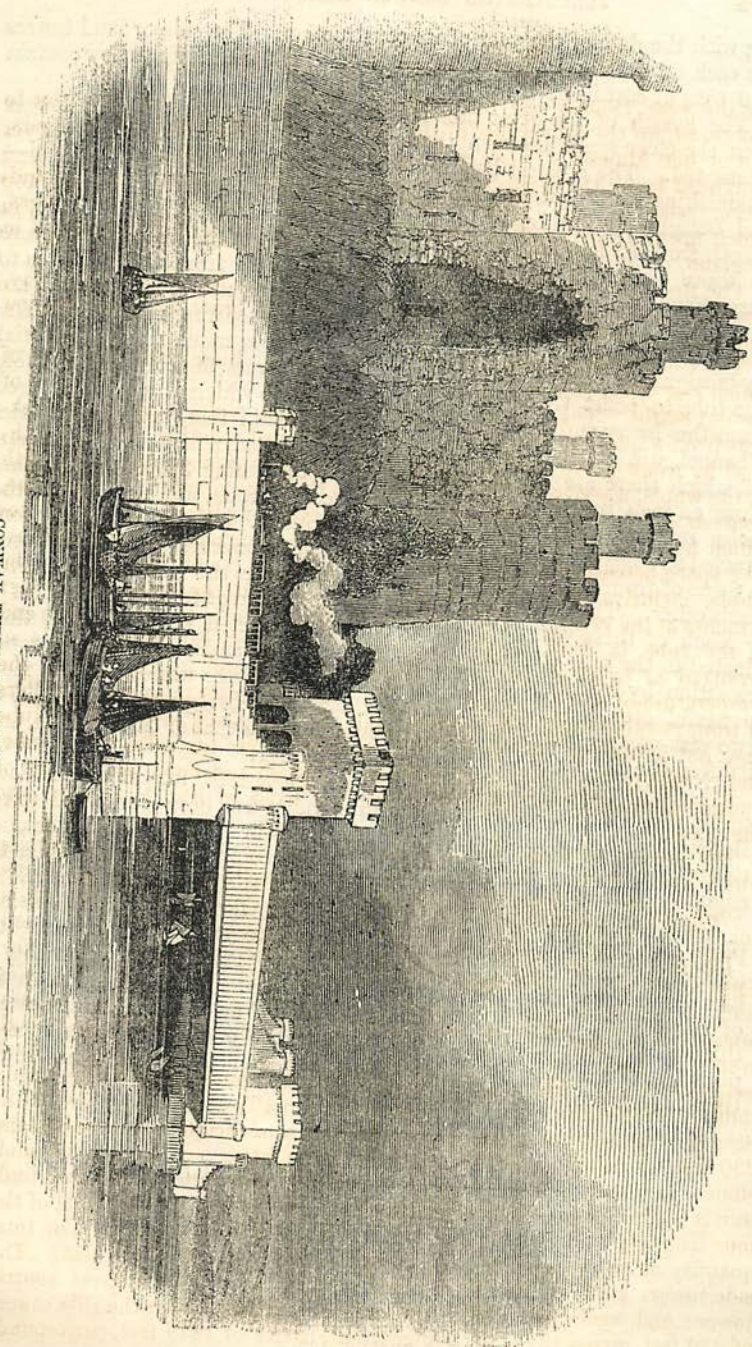
The first of these bridges carries the railway across the river Conway, close to the ancient castle built by Edward I. in order to bridle his new subjects, the Welsh.

The Conway bridge consists of a tube, or long, huge chest, the ends of which rest upon stone piers, built to correspond with the architecture of the old castle. The tube is made of wrought-iron plates, varying in thickness from a quarter of an inch to one inch, riveted together, and strengthened by irons in the form of the letter T; and, to give additional strength to the whole, a series of cells is formed at the bottom and top of the tube, between an inner ceiling and floor and the exterior plates; the iron plates which form the cells being riveted and held in their places by angle irons. The space between the sides of the tube is 14 feet; and the height of the whole, inclusive of the cells, is 22 feet  $3\frac{1}{2}$  inches at the ends, and 25 feet 6 inches at the centre. The total length of the tube is 412 feet. One end of the tube is fixed to the masonry of the pier; but the other is so arranged as to allow for the expansion of the metal by changes of the temperature of the atmosphere, and it, therefore, rests upon eleven rollers of iron, running upon a bed-plate; and, that the whole weight of the tube may not be carried by these rollers, six girders are carried over the tube, and riveted to the upper parts of its sides, which rest upon twelve balls of gun-metal running in grooves, which are fixed to iron beams let into the masonry.

The second of these vast railway bridges crosses the Menai Straits, which separate Caernarvon from the island of Anglesey. It is constructed a good hundred feet above high-water level, to enable large vessels to sail beneath it; and in building it, neither scaffolding nor centering was used.

The abutments on either side of the Straits are huge piles of masonry. That on the Anglesey side is 143 feet high, and 173 feet long. The wing walls of both terminate in splendid pedestals, and on each are two colossal lions, of Egyptian design; each being 25 feet long, 12 feet high though crouched, 9 feet abaft the body, and each paw 2 feet 4 inches. Each weighs 30 tons. The towers for supporting the tube are of a like magnitude with the entire work. The great Britannia Tower, in the centre of the Straits, is 62 feet by 52 feet at its base; its total height from the bottom, 230 feet; it contains 148,625 cubic feet of limestone, and 144,625 of sandstone; it weighs 20,000 tons; and there are 387 tons of cast iron built into it in the shape of beams and girders. It sustains the four ends of the four long iron tubes which span the Straits from shore to shore. The total quantity of stone contained in the bridge is 1,500,000 cubic feet. The side towers stand at a clear distance of 460 feet from the great central tower; and, again, the abutments stand at a distance from the side towers of 230 feet, giving the entire bridge a total length of 1849 feet, correspond-

CONWAY TUBULAR BRIDGE.



ing with the date of the year of its construction. The side or land towers are each 62 feet by 52 feet at the base, and 190 feet high; they contain 210 tons of cast iron.

The length of the great tube is exactly 470 feet, being 12 feet longer than the clear space between the towers, and the greatest span ever yet attempted. The greatest height of the tube is in the centre—30 feet, and diminishing towards the end to 22 feet. Each tube consists of sides, top and bottom, all formed of long, narrow wrought-iron plates, varying in length from 12 feet downward. These plates are of the same manufacture as those for making boilers, varying in thickness from three-eighths to three-fourths of an inch. Some of them weigh nearly 7 cwt., and are amongst the largest it is possible to roll with any existing machinery. The connexion between top, bottom, and sides is made much more substantial by triangular pieces of thick plate, riveted in across the corners, to enable the tube to resist the cross or twisting strain to which it will be exposed from the heavy and long-continued gales of wind that, sweeping up the Channel, will assail it in its lofty and unprotected position. The rivets, of which there are 2,000,000—each tube containing 327,000—are more than an inch in diameter. They are placed in rows, and were put in the holes red hot, and beaten with heavy hammers. In cooling, they contracted strongly, and drew the plates together so powerfully that it required a force of from 4 to 6 tons to each rivet, to cause the plates to slide over each other. The weight of wrought iron in the great tube is 1600 tons.

Each of these vast bridge tubes was constructed on the shore, then floated to the base of the piers, or bridge towers, and raised to its proper elevation by hydraulic machinery, the largest in the world, and the most powerful ever constructed. For the Britannia Bridge, this consisted of two vast presses, one of which has power equal to that of 30,000 men, and it lifted the largest tube six feet in half an hour.

The Britannia tubes being in two lines, are passages for the up and down trains across the Straits. Each of the tubes has been compared to the Burlington Arcade, in Piccadilly; and the labour of placing this tube upon the piers has been assimilated to that of raising the Arcade upon the summit of the spire of St. James's Church, if surrounded with water.

Each line of tube is 1513 feet in length; far surpassing in size any piece of wrought-iron work ever before put together; and its weight is 5000 tons, being nearly equal to that of two 120-gun ships, having on board, ready for sea, guns, provisions, and crew. The plate-iron covering of the tubes is not thicker than the hide of an elephant, and scarcely thicker than the bark of an oak-tree; whilst one of the large tubes, if placed on its end in St. Paul's churchyard, would reach 107 feet higher than the cross of the cathedral.

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## THE MARINERS OF ENGLAND.

YE mariners of England!

Who guard our native seas,  
Whose flag has braved a thousand years  
The battle and the breeze,  
Your glorious standard launch again,  
To match another foe,

CONSTRUCTING THE BRITANNIA TUBULAR BRIDGE.

