THE VICTORIA TUBULAR BRIDGE OVER THE ST. LAWRENCE, CANADA.

In connection with the superb cut of this wonderful monument of engineering skill, which we present in our pages this week, we give a detailed description of the gigantic structure, which is now a prominent topic of conversation, from the fact that the Prince of Wales has just inaugurated it, and made fast the last rivets. In a previous number we gave a full account of its business opening, since which period the traffic over it has been regular and constant. The rail car speeds its way with speed and safety, perfectly unconscious of the rushing St. Lawrence which roars beneath.

The history of this really stupendous undertaking cannot fail to be of interest to our readers, for it proves what can be done by individual energy and indomitable perseverance.

The idea of bridging the St. Lawrence River at Montreal is of older date than is generally known. The Hon. John Young, of Montreal, a gentleman well known in Canada, was perhaps the most zealous and untiring in his endeavors to bring the subject prominently before the public. More than one engineer of eminence in America had been referred to and consulted upon the subject by the city authorities from time to time. Surveys, examinations, and various reports resulted from these—differing, of course, somewhat in their details, but generally recommending timber structures similar to those invariably resorted to in the United States for bridging the great rivers encountered by their railways.

Nothing, however, in connection with the bridge had ripened into maturity until the project of the Grand Trunk Railway had been propounded and urged on by the Provincial Government in 1852. The Hon. Francis Hinckes (being then Prime Minister and Inspector-General), and Mr. Young (being at the same time a member of his Administration), after several fruitless endeavors to interest the Imperial Government to aid in furthering their objects, which had in view the accomplishment of an international railway, extending from Halifax to the western extremity of Canada, ultimately resolved to invite private English capitalists to undertake the great work of the Grand Trunk Railway—in so far, at least, as Canada was concerned. For this purpose the province undertook to provide thirty per cent. of the capital required.

At this juncture (April, 1852) Mr. A. M. Ross, the engineer, was sent to Canada by the English capitalists then consulted by Mr. Hinckes, to collect every information having a practical bearing upon the subject, more especially with reference to the approximate cost of railway constructions in Canada.

It soon became evident that the Grand Trunk Railway, as then projected, would be incomplete and unprofitable as a commercial speculation so long as five hundred miles of railway, which it embraced, on each side of the St. Lawrence, remained unconnected at Montreal, the common centre of the proposed grand arterial communication; and in this view Mr. Ross, having first satisfied himself of the practicability of building a permanent structure of the kind required, and sufficient to withstand the phenomena peculiar to the St. Lawrence on account of the ice, did not hesitate to regard the Grand Trunk Railway as a scheme which would be perfect with this bridge, but imperfect without it; hence a bill authorising its construction as part of the Grand Trunk Railway passed the Provincial Assembly, then in session at Quebec, in the autumn of 1852, the design and locality ultimately selected to be subject to the approval of the Governor in Council.

In December, 1852, Mr. Ross was proposed as engineer-in-chief for carrying out the works of the Grand Trunk Railway to completion. This was accomplished, but not without a good share of such abuse as the disappointed in every country usually level against men in any prominent position, or who are more successful than themselves. In March, 1853—being then in England upon matters connected with the Grand Trunk Railway, but more especially with reference to the Victoria Bridge—Mr. Ross had frequent interviews upon the subject with Mr. Robert Stephenson, with whom, and his late father, it had been his good fortune to be associated for more than twenty years in his profession; and, in conjunction with and subordinate to that gentleman, became professionally engaged in that great and important work.

In July, 1853, Mr. Stephenson visited Canada for the express purpose of finally fixing the most eligible site and determining the dimensions and general character of the design; and, having communicated his ideas to Mr. Ross, who, in accordance with them, prepared and arranged all the information required, the result, in a very little time, was the adoption of the structure now completed, and of which we this week present an engraving.

The contractors immediately engaged in preparing and procuring the extensive plant and machinery necessary for carrying on so large and formidable a work. Three steamboats and forty barges, specially adapted for the duty to be performed, were immediately ordered to be constructed by the builders and manufacturers in the country. Arrangements were also made for machinery of various kinds used in such works, and ordered from England. Rafts of timber, as they floated down the St. Lawrence on their way to the usual emporium at Quebec, were stopped in their progress, and purchased for the use and construction of the coffer-dams necessary for getting in the foundations. Until the spring of 1854 these preparatory measures were in progress. Quarries for stone were sought and opened for the immense supply required of this material, in the whole exceeding three millions of cubic feet—about two hundred and forty thousand tons.

On the 24th of May, 1854, the coffer-dam for pier No. 1 was floated into its place, so that from this day date the first operations in the river. On July 5th the dam for pier No. 2 was towed into its place, and on the 22d of the same month the first stone of No. 1 was set. The masonry of the north or Montreal abutment was commenced on September 4, and on the 26th that of No. 2 pier. Pier No. 1 was completed on the 27th of October. On Friday, December 1, the winter's inclemency came suddenly upon the country, and stopped all out-of-door operations; and on the 5th the ice had so increased in the river that all communication was cut off, and steamboats had ceased to run. The result of this rapid change in the state of the weather was that the dams of pier No. 1, which it had been intended to tow into dock, got fixed in the ice, and the contractors were obliged to abandon them to their fate. On the 4th of January, 1855, the usual "January thaw," as it is termed, occurred, and the water in the river rose fifteen feet, and dislodged and broke up the ice, which continued for some hours to come down with the current in large quantities. At midday it assumed so formidable a character in the vicinity of the bridge works that the dams and other temporary erections could no longer resist its force. Suddenly the whole gave way, and in less time than we take to write it there were not two sticks left together. The piers, thus suddenly stripped of their coverings, were now to be seen in their proper proportions, to all appearance untouched and unimpaired, which the result of closer examination proved to be the case.

Until the 26th of April the river was closed, but upon this day the ice began to break up, and on the 28th the steamboats were enabled to re-enter their element. Hence the commencement of the ensuing season's operations, which embraced five additional pier-dams, as well as the south abutment-dam. On the 10th of October the works were visited by His Excellency the Governor-General, on his way from Quebec. The foundation for [illegible] being ready, his Excellency did the company the honor to lay the first stone. [illegible] this season prevented that progress being made with the masonry which all engaged had hoped to accomplish; and, to make the matter worse, by the 30th of October the early indications of approaching winter obliged them to take down and remove their temporary erections, and suspend their works upon the river for the season, and not until the 2d of June following (1855) were they enabled to resume them. On that day the building of the south abutment was recommenced. Dam No. 3 was commenced on the 16th of July, and on the first of next month they set the first stone of No. 4 pier; and before the close of the month the first stones were set of Nos. 7 and 24 piers. By the 27th of September piers 3 and 5 were completed, and No. 23 pier was begun on the 23d of October. These were succeeded in November by the final completion of piers 23 and 24, and the south abutment, with which operations again terminated—comprising to this time nine piers and the two abutments.

Upon the 21st of December, 1856, Mr. Ross left Canada for England. He returned to Montreal on the 25th of May, 1857, and found to his satisfaction that the permanent works of the bridge were unimpaired by the winter that had passed. The ensuing season's work was intended to embrace piers 8, 9, 18, 19, 20, 21 and 22; and by the 31st of August, 18, 21 and 22 were completed, each within the brief space of five weeks from the time of the first stone being laid. By this time also the ironwork of the first span was in progress of erection and finished by the 31st of October. On the 8th of December the last of five piers out of the seven that had been designed for the summer's work had received the finishing touch. The remaining two were only partially built, on account of the difficulty that had to be contended with at the foundation. The dams were again secured for the winter, and sustained but little damage therefrom.

Towards the fall of the year tube No. 25 had been erected at the extreme south end of the bridge; and for this purpose a solid pier of timber and stone had previously been constructed for supporting in the middle scaffolding required to make it withstand the pressure of the moving ice. This expedient had been resorted to in order to push forward the completion of this great work.

In January and February of last year the erection of tube No. 20 had been finally completed; and also during these months—so as to enable the work of the autumn to stand good—certain portions of the remaining dams were framed and prepared upon the ice and sunk into their places, in the hope that their weight and extent would retain them there—which, under ordinary circumstances, might be confidently relied on; but in the present case the breaking up of the ice on the 1st of April last was the most extraordinary in its effects that scientific men have ever witnessed in the colony.

On the 30th of March the river was clear of ice to a certain extent above the bridge; but as yet no movement took place below; but on the following day, at one P.M., the river was rising fast, and on the 1st of April the general movement in the ice was observable, which continued for one hour, then suddenly stopped, the water still rising and continuing to do so till next day, and, as unexpectedly as before, a grand movement took place. The water was noticed to rise four feet in two minutes—the fields of ice accompanying this movement extending to an area of more than five hundred square miles, and so quick and overwhelming in its appearance that great numbers of the townspeople, who had congregated upon the quays in anticipation of what was to happen, had as suddenly to wheel about and run for their lives by gaining as quickly as possible the nearest heights in the adjoining streets. This movement lasted about twenty minutes, and destroyed several portions of the substantial quay walls along the river, where it pressed the hardest into atoms. The ice in its progress between the piers of the bridge was broken up by the force of the blow as soon as it came in contact with the cutwater. Occasional cakes of ice were strong enough to rise up and rear upon and against the pointed nose of the pier, until by the force of the water it was speedily made to roll over into the stream, and in a moment was out of sight. It was not until the 5th of April that the river was clear of ice, and as smooth as a mill-pond—the water having fallen seven feet. In a few days it fell to its ordinary level, and steamboats and other craft were once more able to resume their occupations on the river.

The engineers were now able to examine with minuteness the extent and effects of the winter upon the works of the bridge. They found the preparatory measures proceeded with upon the ice in the winter for facilitating the construction of the remaining dams were all more or less disturbed, some carried away altogether, others so completely injured as to render them useless. Happily the permanent works were found to have sustained no damage whatever, excepting one stone dispatched from No. 9 pier, which was left unfinished the previous year at the height of eighteen feet above water level.

Upon the river, and between the dams and piers, the constant movement of steamboats with barges in tow, laden with stone or other material, of which one thousand tons have been daily used, was not the least striking feature in the progress of the work. In this fleet alone—consisting of six steamboats and seventy-two barges, besides several small craft constantly plying upon the river—there were about four hundred and fifty men employed; the tonnage of the flotilla in the aggregate amounting to eleven thousand six hundred, and the steam[illegible] employed to that of four hundred and forty-five horses. The artisans and laborers engaged upon the works of the bridge numbered eighteen hundred and fifty, and in the two stone quarries there were five hundred men employed, numbering altogether two thousand eight hundred, including others variously distributed in the vicinity of Montreal, whose daily wages exceeded one thousand pounds sterling. To this list should be added one hundred and forty-two horses, and four locomotives, engaged in conveying stone by the railway from Point Clair quarries, about sixteen miles distant.

The enumeration of forces employed in carrying on the works of the Victoria Bridge—independent of the large number at work at Birkenhead, in England, in the preparation of the tubes—has never been equalled by any work of our day.

The labor upon the bridge was from this point carried on with wonderful activity and perseverance. Every portion of the works was urged forward, each department was pressed to complete its portion, and finally on the 17th of December, 1859, the great structure was completed, and the first train passed over the two miles of iron tubing which spanned the St. Lawrence, setting its roaring tide at defiance, successfully and triumphantly. A graphic description of the completed bridge, which appeared in the columns of a contemporary, will render perfect our description of the great Victoria Tubular Bridge over the St. Lawrence.

The Bridge—Description.

The bridge contains twenty-five openings of two hundred and forty-two feet, with the exception of the centre span, which is three hundred and thirty feet, hence the length of tube is six thousand six hundred feet, approached by embankments, the Montreal end being one thousand two hundred feet, the southern shore of eight hundred feet, which, including the abutments, makes a total of nine thousand and eighty-four feet, or one and three-quarter miles nearly. The abutments are, at the base, each two hundred and seventy-eight feet long, divided into cells of twenty-four feet, with intervening tie walls of five feet, but at the top they correspond exactly with the length of a tube two hundred and forty-two feet in length, and indeed are carried up to the same height, the cells being filled with gravel. To resist the thrust of the ice, both the abutments and piers are furnished with a cutwater, which meets the pier proper thirty feet above summer water, the whole height of the abutment being thirty-six feet above summer water, the centre pier being sixty feet; hence the bridge rises in a grade of one inch in one hundred and thirty-two, or forty feet to the mile, the centre again being a pure level. The centre pier is twenty-four feet in width, the remaining piers are but sixteen feet. These dimensions are directly under the girder, for at the foundation the piers are twenty-two feet in width, and at summer water sixteen feet. Transversely the piers are thirty-three feet under the girder. Thus the dimensions at the junction with cutwater, [illegible] by thirty-three feet, extending outwards to the foundation [illegible] stream, make the area of the course whence the cutwater is [illegible]mmenced sixteen by ninety feet.

Masonry.

Three m[illegible] of cubic feet of masonry in the Victoria bridge. That is to [illegible] if turned into lineal measure it would reach five hundred a[illegible]n miles, or as a solid would form a pyramid two hundred a[illegible]fteen feet high, having a base of two hundred and fifteen feet [illegible]uare. These figures will give some idea of the solidity of [illegible] structure, and the warrant that exists for its endurance for [illegible]time. The stone itself was mostly quarried from Pointe Clair, and forms the first in the series of the Lower Silurian, and is known by the geological term of Chazy, resting immediately on the calciferous sand rock and the Potsdam sandstone. At the quarry the stones were taken out in as large masses as in any quarry in the world. We shall be borne out in this statement of this fact in the dimensions of the piers. The courses being three f[illegible]t ten inches and three feet to two feet six inches above water level, and thence verging into a course eighteen inches under the plates, being in length from seven feet to twelve feet. One course of ashlar of three feet ten inches was examined by the engineer during the progress of the work. The perimeter of the pier at this point measured two hundred feet. It consists of thirty-two stones, the lightest of these weighed seven tons, the heaviest seventeen, the average weight of the whole was ten and a half tons. Each course, to the top of the cutwater, is fastened by a dogwedged bolt of one and a half inch iron—that is to say, a bolt with the base slit to receive a wedge into which an iron prism is inserted. Thus prepared, they were passed down until it reached the bottom of the hole drilled to receive it, when the bolt itself was driven upon the wedge, thus widening out the end of the bolt so that it never can be again drawn out, passing through the whole courses into the third below it. Thus every three courses are distinctly dowelled together, and the whole mass of work being likewise laid in the best water lime, and carefully grouted, is formed into one solid mass, for horizontally the joints are likewise kept cramped together by plates twelve inches by five inches of half-inch iron.

Tubes.

Each tube covers two openings, that is to say, it is fixed in position in the centre, and is free to expand or contract on the adjoining two piers. They are sixteen inches by nineteen inches at the ends, but they gradually increase to the centre, at which point they are sixteen feet by twenty-one feet eight inches. The length will accordingly be:

	Feet.
On centre pier	16
Two openings, each of 242 min	484
Resting on east pier	8
Resting on west pier	8
Total	516

The expansion rollers are seven in number, in each set of six inches diameter, in a cast iron frame rolling on planed bed plates; the rollers themselves being turned and the beds plated, they run as smoothly as on glass. The weight of each tube, with all its appurtenances of five hundred and sixteen feet, is about six hundred and forty-four tons that is to say, for each opening three hundred and twenty-two tons. The construction of this character of work is now so well known that much allusion is not necessary. Moreover it is simple in the extreme, being formed of boiler plate riveted together with angle irons and lateral and transverse braces. The skill laid in reducing this boiler iron to such dimensions that there was no unnecessary material to add to the weight and to the expense, and yet obtaining a sufficiency of strength

The immediate part of the tube resting on the pier is strengthened by increased lateral bracing.

The tubes themselves were constructed in position, and the difficult and expensive process of floating them from the shore and lifting them by hydraulic pressure was thus dispensed with.

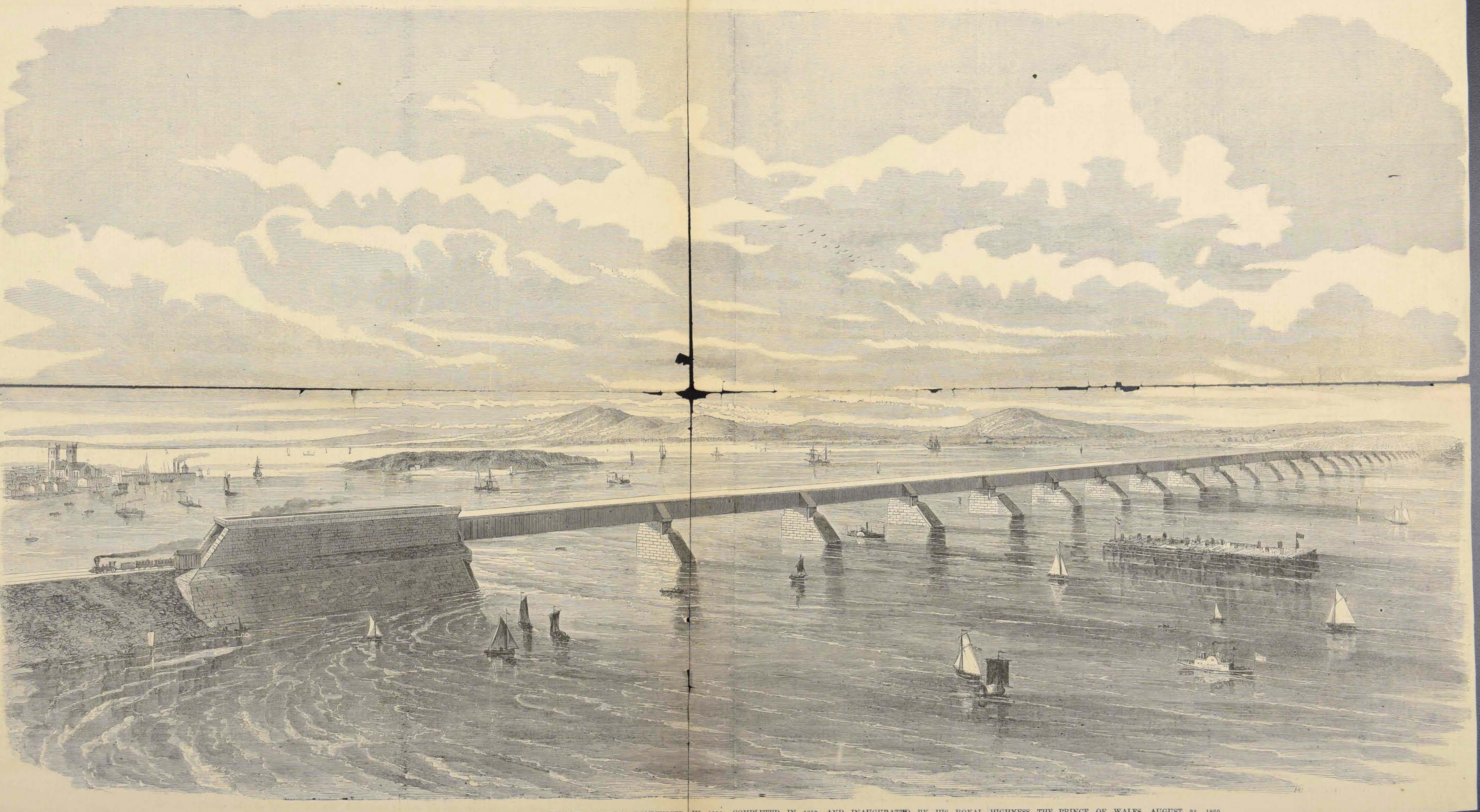
The Cost of the Bridge.

When we say that the cost of the bridge is $7,000,000, we give only a faint idea of the responsibility in directing so great a work. The force on the river during the last season of its construction was a small army. It consisted of six steamboats, seventy-two barges, besides several small craft. These measured about twelve thousand tons. The steamboats were in the aggregate four hundred and fifty horse power.

They were manned by	500 men.
In the two stone quarries were	450 "
On the various works engaged as artisans and laborers	2,090 "
Total laborers and artisans	3,040

To this strength must be added one hundred and forty-two horses, variously employed, and four locomotives; the amount of wages being daily $5,000.

In round figures there are three million cubic feet of masonry, ten thousand tons of iron in the tubes, two million rivets, each one fastened by a peculiar process, and one hundred and sixty-eight acres of painting. The tubes are painted four times in oil and color and each coat covers an area of thirty-two acres.



THE VICTORIA IRON TUBULAR BRIDGE, ACROSS THE RIVER ST. LAWRENCE, CANADA.—COMMENCED IN 1854; COMPLETED IN 1859, AND INAUGURATED BY HIS ROYAL HIGHNESS THE PRINCE OF WALES, AUGUST 24, 1860.

JAMES HODGES, THE BUILDER OF THE VICTORIA BRIDGE.

We publish the portrait of this gentleman, in connection with our view of the Victoria Tubular Bridge over the St. Lawrence river, as he has been a most prominent and energetic worker in the cause, and has contributed largely, by his business tact and untiring perseverance to effect the completion of the Bridge at an earlier date than was hoped for. As the representative of the great contractors, Peto, Brassey, Betts & Co., he assumed at once a prominent and important position, which he has maintained to his own honor and the best interests of his principals.

At the banquet given on the occasion of the business opening of the Bridge, on Saturday, December 17th, 1859, when the first train passed over, he took the chair on behalf of the contractors, and stated that although so large an assemblage was present this was not the opening of the Bridge, but that the real opening would be attended by much grander ceremonies, thus foreshadowing the coming of the Prince. He concluded his remarks thus: "The health of Her Majesty has been drank in many an extraordinary place, but I question if it has ever been drank in a place like this, through which a locomotive has passed a few moments ago, drawing a train with nearly a thousand souls in it. Ladies and gentlemen, I ask you to drink the health of the Queen."