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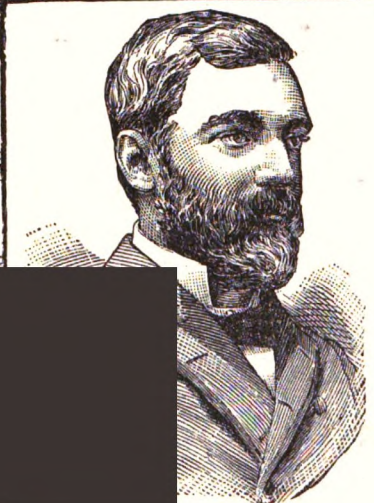
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JOHN A. ROEBLING.

THE New York AND Brooklyn Bridge



*The New York
and Brooklyn Bridge ...*

Alfred C. Barnes



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Introductory.

"If it were done, when 'tis done,
Then 'twere well it were done quickly."—SHAKESPEARE.

ALTHOUGH, unlike Macbeth's dastard deed, it was not done quickly, yet it is done, and *well* done. The Great Bridge, after thirteen years weary waiting and anxious watching, is at last finished, and of the thousands who will cross this broad pathway which connects the two cities, we venture to assert not one will disagree with us in the statement that it is "well done;" and when generation after generation shall have passed to "that bourne from whence no traveler e'er returns," our Great Bridge will still stand, enduring as the Pyramids, and as a monument of the greatest engineering work the world has ever seen.

In the preparation of this little book, our object has been to give our friends at a distance as clear and correct an idea as possible of this great structure.

Our views were taken by the camera. These photographs were redrawn by careful, trained artists, and their drawings reproduced and reduced to the present size by photo engraving.

If our friends derive as much pleasure in perusing this little work as we have in its preparation, we shall be at least gratified.

THE PUBLISHER.

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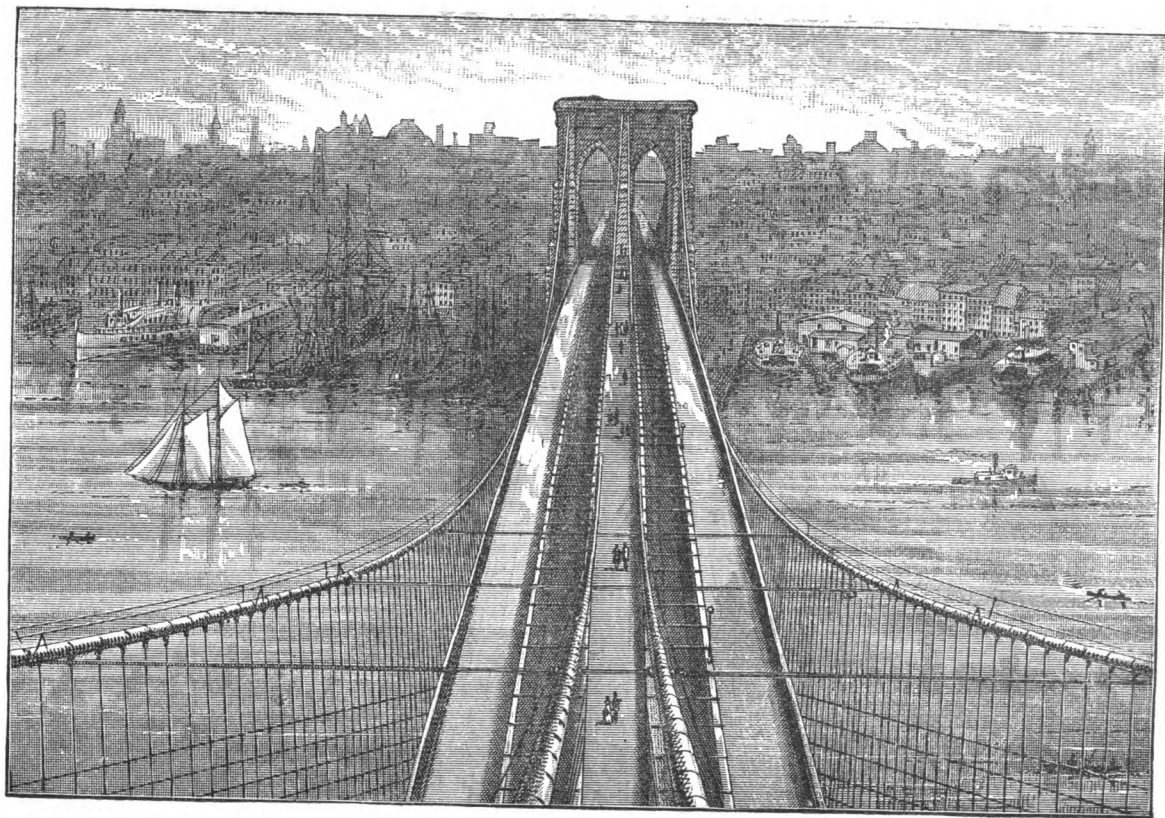
No. 1.—A general view of the Bridge, taken from Columbia Heights, Brooklyn. New York in the distance.

THE
NEW YORK AND BROOKLYN
SUSPENSION BRIDGE.

ALFRED C. BARNES.

The great Bridge is done. Few realize the fact. Many amiable people have gradually formed the idea that this enterprise was a gift in benevolent preparation for posterity, and often inquire, with Sir Boyle Roche, what posterity has done for us. There are even some who have looked upon the grim towers as useless monuments of an impracticable scheme. But through so many years of waiting, the work has crept slowly on. In all human probability, the van of the unending procession of passengers for whom it is designed will cross the completed structure in thirty days from the present time.

Twenty-five years ago the subject of a suspension bridge between New York and Brooklyn began to be agitated. Its earliest advocate,



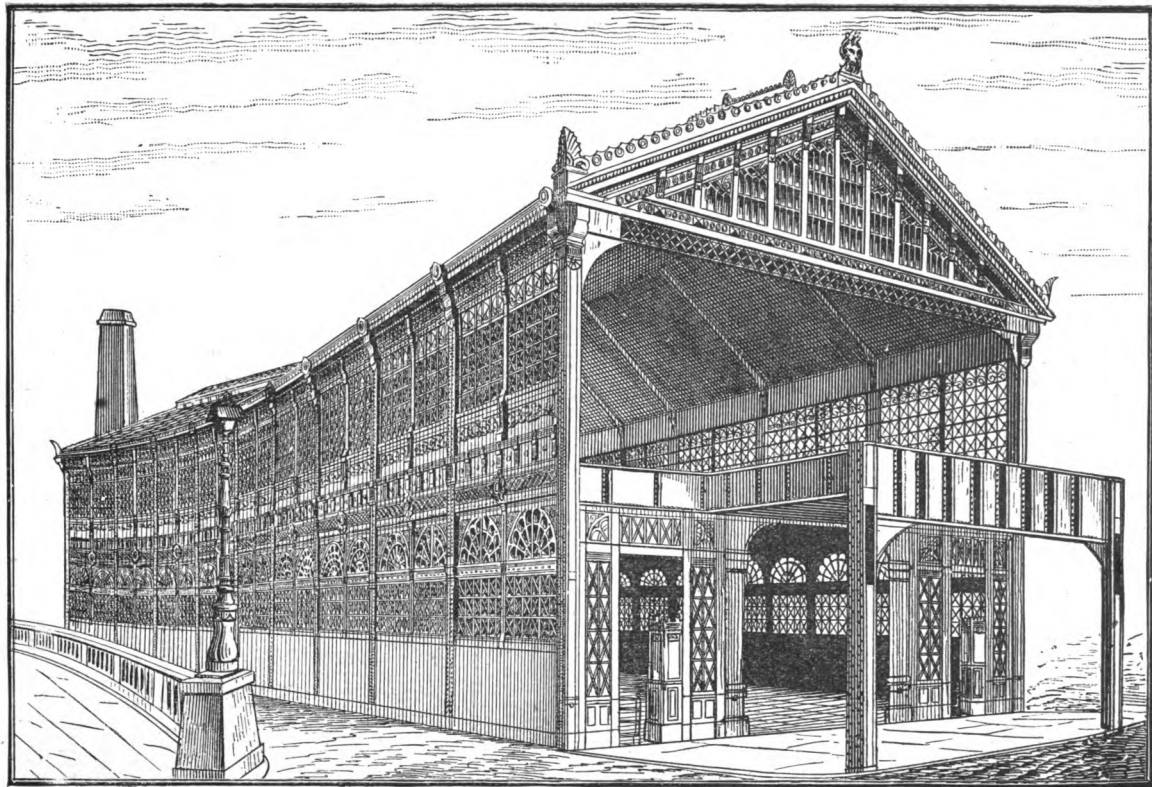
No. 2.—For description, see last pages.

and probably original projector, was Colonel Julius W. Adams of this city. His first idea was to span the river from Brooklyn Heights, at Montague street, to Broadway in New York. But money and courage, practical science and population, to justify such a vast undertaking were wanting in that day. Nevertheless, Colonel Adams never lost interest in the subject, and finally found an appreciative listener in the person of Mr. William C. Kingsley. Being accustomed to enterprises of great magnitude, and withal a public spirited citizen, Mr. Kingsley became convinced of the advisability and practicability of a suspension bridge. He interested a few other gentlemen, among whom were Senator Henry C. Murphy, and Hon. J. S. T. Stranahan, and steps were immediately taken to forward the project.

A new plan was then devised by Colonel Adams, which contemplated a bridge from Fulton Ferry, Brooklyn, to Chatham Square in New York. It was a light and comparatively inadequate structure, but the friends of the enterprise took the drawings to Albany, and so stoutly argued their case, that, in 1866, the legislature granted a charter to the New York and Brooklyn Bridge Company. Privilege was thereby given to the company to expend five millions of dollars, of which \$3,000,000 was to be appropriated by the City of Brooklyn as the greatest beneficiary, \$1,500,000 by the City of New York, and \$500,000 by private stock-holders. An Act of Congress was also obtained, giving the company permission, under certain restrictions for the protection of navigation, to bridge an arm of the sea.

The gentlemen composing the first board of directors were deeply impressed with the responsibility imposed upon them. An enterprise of such magnitude, and involving engineering problems of unprecedented difficulty, required the most skilful professional supervision. As soon as the sanction of the law and the favorable verdict of the two cities had been obtained, all eyes were turned toward John A. Roebling, the master bridge builder of the world. Mr. Roebling was then in the prime of his powers, and in possession of the most valuable experience; at the time having just completed the great bridge at Cincinnati, which, excepting the subject of our present sketch, is the most remarkable structure of its kind.

Mr. Roebling's services were engaged; he removed to Brooklyn, and the office of the bridge company was formally established in the



No. 3.—For description, see last pages.

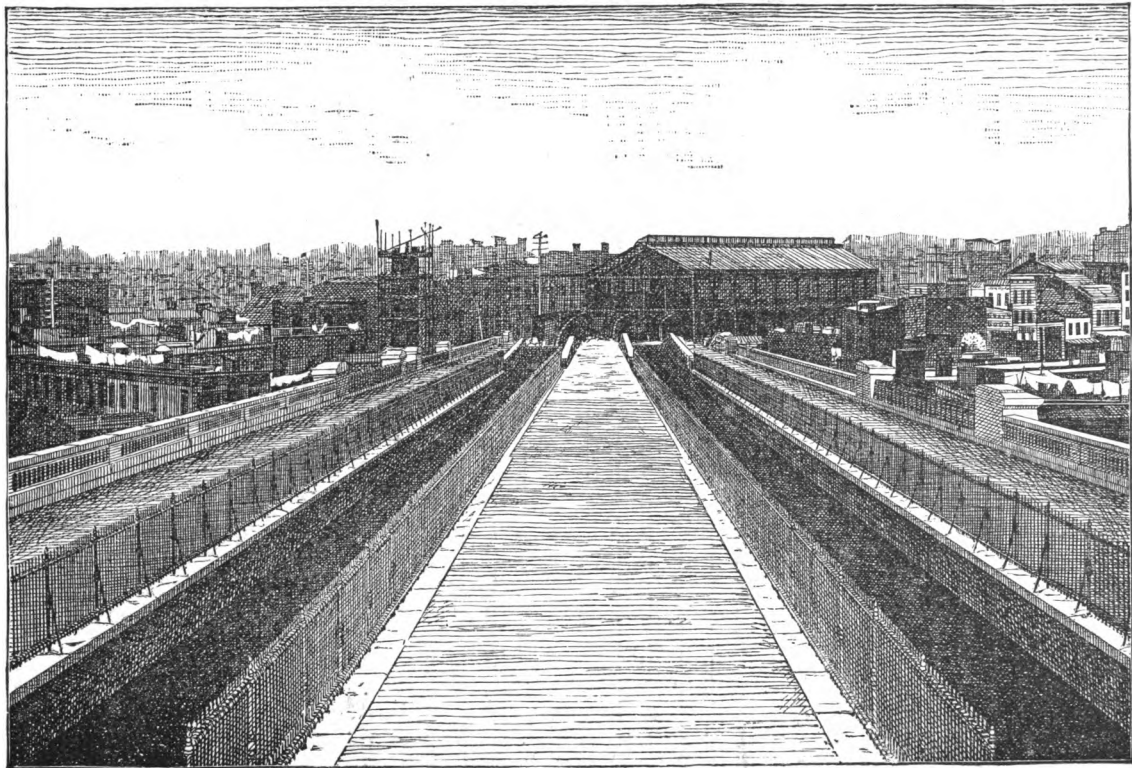
building of the *Daily Union*. The newly appointed engineer-in-chief then devoted himself for months to close calculation, and finally produced the plans and specifications which have been substantially followed to the present day. Their wonderful accuracy was never doubtful; but the modest Mr. Roebling insisted upon a council of engineers to revise them. The bridge company accordingly summoned the best talent which the profession could afford.

A little scientific congress thereupon assembled in Brooklyn. In the hands of these experts Mr. Roebling's papers were placed, and with great zeal and fidelity the entire work was reviewed and proved. The consulting engineers expressed their complete satisfaction.

Between the completion of the bridge on paper and the inauguration of construction, a distressing event took place. This was the death of Mr. Roebling, in 1869. It was difficult to believe that the loss would not prove irreparable, and yet in fact Providence had preserved him to be the real builder of the bridge, although not a hammer had been lifted when he died. His son, Colonel W. A. Roebling, who was already associated with the work, enjoyed the confidence and shared the ability of his father. The board of trustees appointed him chief engineer—the position which he has held during the entire progress of construction. Associated with him were, and still are, the following professional staff: Mr. C. C. Martin, principal assistant engineer; Colonel W. H. Payne, in charge of superstructure; Messrs. F. Collingwood and S. Probasco, in charge of the New York approach; Major G. W. McNulty, in charge of the Brooklyn approach.

All being now in readiness, the work of actual construction was commenced January 2d, 1870. The huge caissons, or platforms of timber and iron on which the towers now rest, were built (that for Brooklyn at Greenpoint, and that for New York at the foot of Sixth street), and towed down the river like rafts. The Brooklyn caisson arrived first, and was securely anchored in its place. Upon its broad surface, 102x168 feet, an army of masons at once began to place granite blocks from Maine, slowly sinking the caisson; while an army of diggers in the interior removed the earth and boulders, seeking a solid foundation for the prodigious weight that was to be imposed.

The romance of life in the caisson had a certain fascination for



No. 4.—For description, see last pages.

people above ground, but it was in fact a rather unpleasant reality to the laborers below. To resist the pressure of water it was necessary to force a condensed atmosphere into the great chamber. In the New York caisson the pressure of air at the last was equal to 35 pounds to the square inch. Breathing was a labor, and labor extremely exhausting. Yet brave men subjected themselves to physical suffering of this sort day after day, that the great work might go on, until in many cases nervous diseases and paralysis would follow.

One afternoon word was brought to the upper world that the Brooklyn caisson was *on fire!* The engineers were at once notified, and set themselves resolutely to confront the unexpected and, indeed, appalling danger. Some workman's candle had ignited the oakum with which the seams were caulked. Unnoticed at the time, the fire crept upward and attacked the mass of timber, 15 feet thick, of which the roof of the caisson was composed. Here it was almost inaccessible, by reason of the superincumbent mass of granite, and the fact that the ceiling of the caisson was as yet unaffected. The workmen were not themselves aware of the fire, when they were quietly summoned to come up, and firemen took their place.

Streams of water were directed upon the fire through auger holes drilled for the purpose, but unsuccessfully. Then exhaust steam was used in the same manner, and, to the great relief of the anxious watchers, the flames disappeared. But the carpenters, who were directed to ascertain the extent of the damage, upon removing a portion of the ceiling, found that the fierce element was still raging with what appeared to be inextinguishable fury. If it could not be checked the whole tower, which was then pretty well advanced, would soon tumble in ruin through the smouldering caisson to the river's bed. Colonel Roebling was summoned at midnight, and at once resolved to flood the work. The pressure of air was withdrawn; the water oozed through every seam, assisted by a deluge from above, and in a few hours the caisson was thoroughly saturated.

This occurred on a Thursday. On the following Monday the waters had been expelled, and an examination revealed the welcome fact that the damage was not irreparable. It is alarming to think what the result might have been if the presence of fire had not been accidentally discovered before it was too late. To avoid a similar



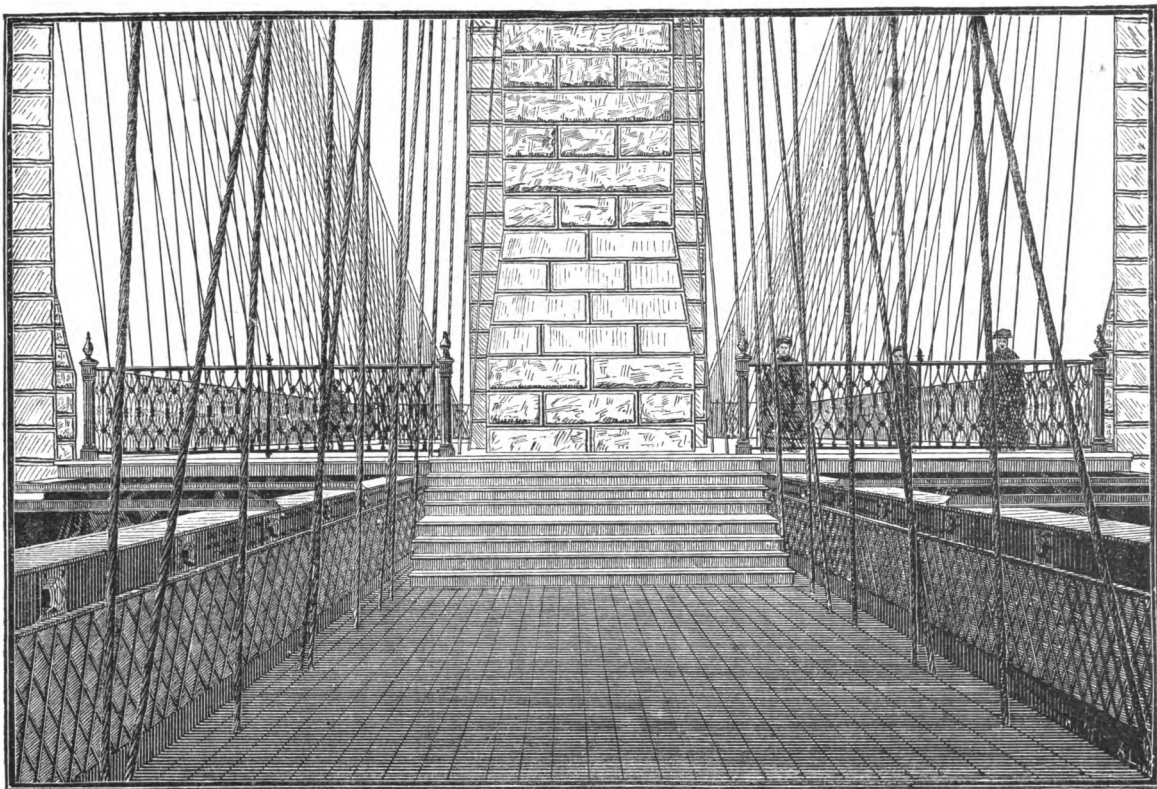
No. 5.—For description, see last pages.

danger, the interior of the New York caisson was lined with sheet iron.

The Brooklyn caisson rests upon a firm bottom, at a depth of 45 feet below high water. On the New York side, however, a satisfactory foundation could not be found at a less depth than 78 feet. When the caissons had finally settled in their permanent bed, they were filled with concrete laid in sections, before which the workmen gradually retired, until the whole was a solid mass as enduring as the granite above them. So true and substantial are the foundations, that the great towers, each weighing about 90,000 tons, have not deflected in the slightest degree from the perpendicular, and have only settled about one inch, which is accounted for by the greater compression of the wood in the thick roofs of the caissons.

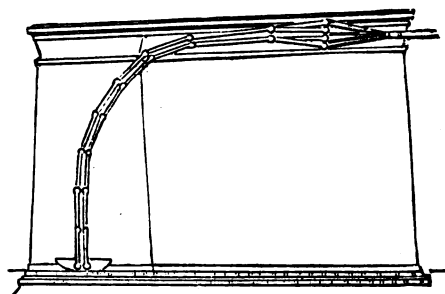
And now, while the towers were growing apace, the money gave out in the treasury. Since Mr. Roebling's plans were accepted, it had been well known that the amount appropriated in 1866 would be grossly inadequate for the completion of the bridge. Thirteen millions, instead of five, were required. Nevertheless, it was determined to proceed with the work, and make a practical demonstration under the public eye, before asking for more. It was not until 1875 that Mr. Kingsley, on behalf of Brooklyn, and Mr. John Kelly, on behalf of New York, went to Albany as commissioners to solicit legislation granting an additional eight millions. By this time every one realized that a work so important and promising must not be allowed to lag for want of funds. The law was readily passed, and the cities voted the money in the same proportion as before—two-thirds of the amount from Brooklyn, and one-third from New York. At the same time, and in the same manner, the cities assumed the stock of the private stockholders (\$500,000), that the bridge might remain an absolutely public work forever.

The details of constructing the towers have been performed under the eyes of all Brooklyn people. Since the tower of Babel and the great pyramid of Egypt, there have been no more massive structures. Block upon block the granite tiers were laid, until a total height of 278 feet above high water was attained. The New York tower is thus 356 feet high from the foundation. Further inland the equally ponderous anchorages were progressing, and although not so



No. 6.—For description, see last pages.

familiar because largely concealed by the surrounding buildings, are not the least important or least expensive details of the bridge. Still lower, structures of solid masonry support the approaches.

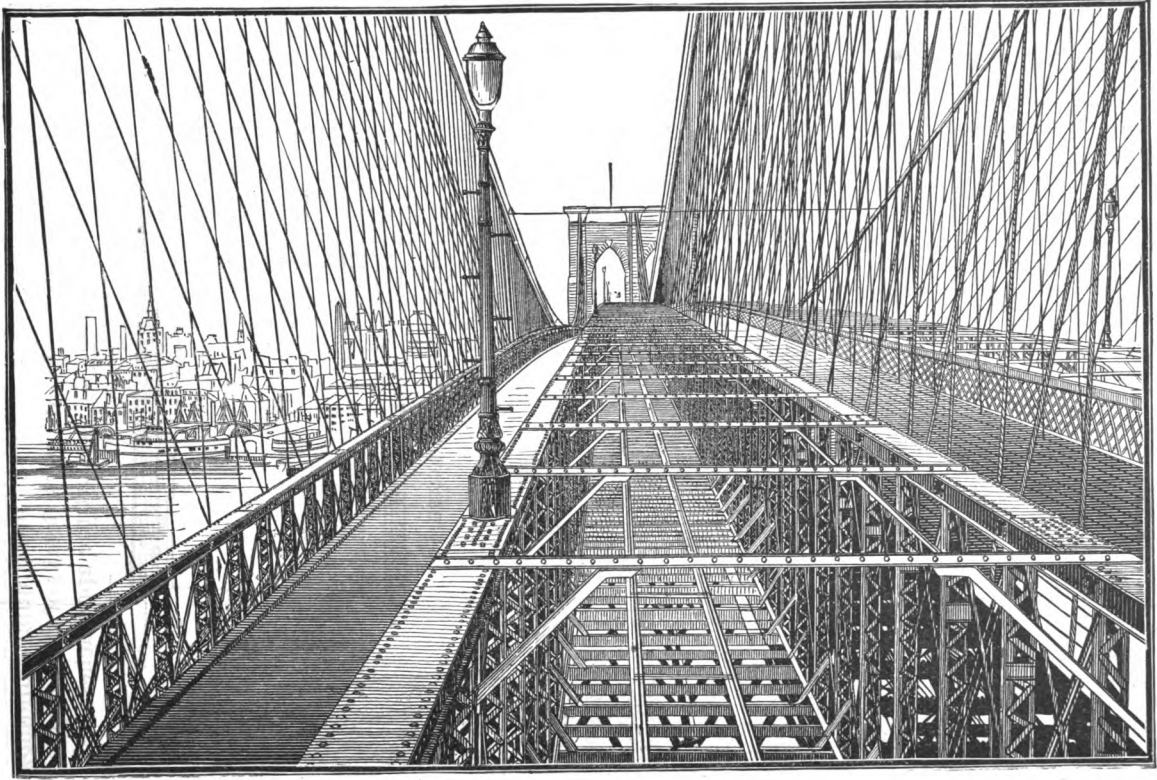


OUTLINE OF ANCHORAGE.

In October, 1878, a sensation was created by a communication to the *N. Y. Sun*, purporting to reveal a plot for blowing up the bridge. It was alleged that a certain stone-mason, inspired by the ambition of the "youth who fired the Ephesian dome," had secreted charges of dynamite between the courses of stone at the base of the tower on which he was engaged. The explosive was connected by wire with the exterior at points known only to the wicked mason, and at a suitable time, probably while the cities were celebrating the completion of the bridge, it was his intention to wreck the structure. A mysterious diagram was also published, said to be a copy of the working plan of the unprincipled wretch, showing the places of deposit and the line of connecting wires.*

On May 29th, 1877, a single wire was carried across the river, attracting much attention as the first connecting link, with the "promise and potency" of greater things. The process of cable-making now commenced. Each cable is composed of 5,296 thicknesses of wire laid parallel. The wire is continuous in varying lengths, joined by a

* Lest apprehension of real danger should exist in any timid mind, it may be well to add that no such workmen as "John Parker" has ever been employed on the Brooklyn Bridge. If he had been there with the worst intentions in the world, his scheme was utterly impracticable. The whole story was a newspaper hoax, nearly as barefaced as the *Herald's* celebrated outbreak of wild animals in Central Park.

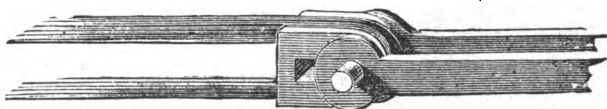


No. 7.—For description, see last pages.

small screw coupling, which can never unscrew, the invention of Colonel Roebling and A. V. Abbott. At the anchorage the wire "re-

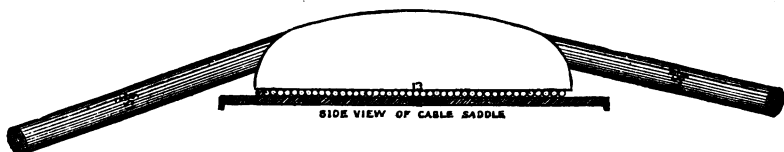


turns " around a "shoe," and so is carried from shore to shore until the cable is complete. It is then closely wrapped, forming a solid

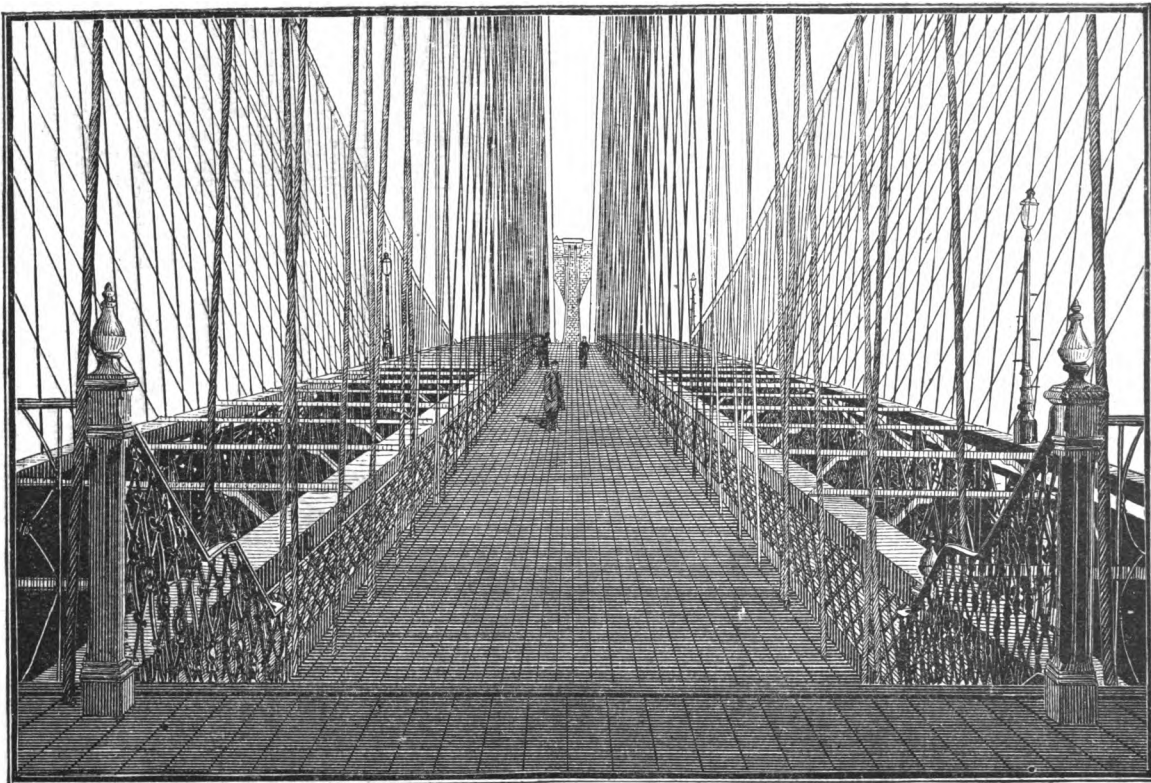


cylinder $15\frac{1}{4}$ inches in diameter. The total length of each cable is 3,578 feet, and it contains 3,589 miles of wire.

Upon the four great cables thus composed, the suspended superstructure depends. To avoid any lateral strain upon the towers, the cables are in no way fastened to them, but rest on movable "saddles" at the point of contact. These saddles, with their burdens, move to and fro upon 45 iron rollers of $3\frac{1}{2}$ inches diameter, which readily yield to the varying tension of the wires as the weight is shifted from the land to the river span, or *vice versa*.



A temporary structure called the "foot-bridge," was thrown across the river during the cable-making, for the convenience of construction. It was much higher than the roadway of the permanent bridge, following the cables over the summits of the towers, instead of passing through the arches. A trip across the foot-bridge on a clear, cool day, afforded an exciting and pleasurable novelty. The unaccustomed head would be dizzy, and both hands nervously clutch the wire hand-rails. Between the slats on which one walked were glimpses of gleaming water, and decks of toy ships and ferry boats



No. 8.—For description, see last pages.

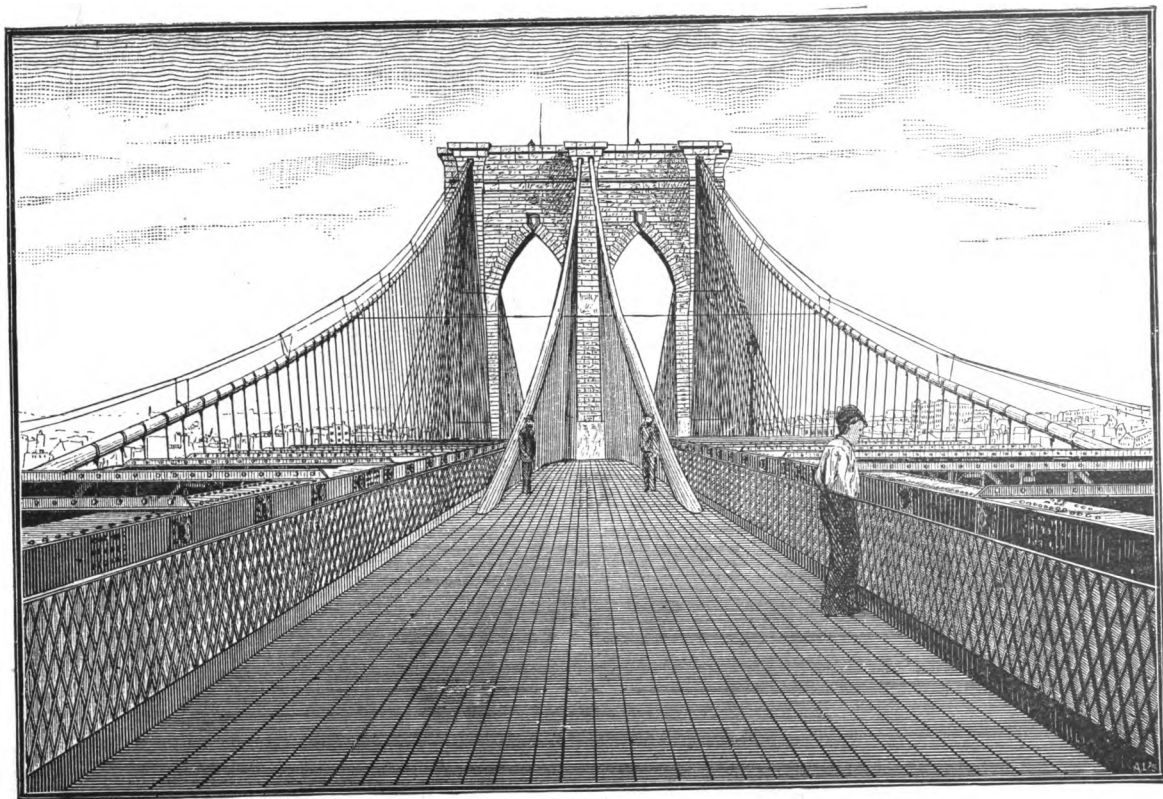
with pigmy passengers. As our walk was but three feet wide, a ribbon through the air, it easily suggested a reminiscence of the narrow bridge Al Sirat, over which Mohammedans believe that the spirits of the departed must pass to paradise. The faithful tremble, but cross in safety, while unbelievers topple over into the fearful gulf. To avoid such thoughts, the traveler could look abroad and get distraction and delight from the wide panorama which the vicinity of New York affords.

How does the bridge look? is a question frequently asked. Its external appearance from a distance is familiar from engravings which were exhibited everywhere before either one of the towers had reared its head above the tide. Some new ideas of details may perhaps be obtained from an imaginary trip to New York in July, 1883.

Descending from the horse car (or more happily the elevated railroad?) at the corner of Fulton and Sands streets, we notice no especial change from the present aspect of Fulton street, but moving up Sands we find the southwestern corner of Washington street converted into the head of a busy thoroughfare, which closes abruptly at narrow Sands street; but the pressure there will soon be relieved, for a portion of the block bounded by Sands, Washington, High and Fulton has been taken as a public square, that will be worthy the dignity of our bridge, and conduce to the convenience of its traffic.

The broad way that opens before us presents an elevated walk 16 feet wide in the center for foot passengers. On either side 13 feet is allotted to a railway, on which cars are constantly arriving and departing, propelled by an endless chain. Outside of this are the main roadways, each 19 feet in width, adapted for the ordinary vehicles of our streets. A substantial stone parapet bounds the whole thoroughfare, which is 100 feet wide at this point.

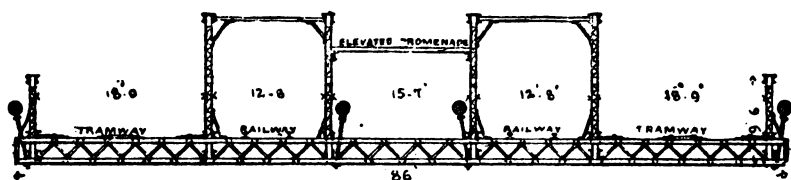
As we move on the inclined plane running parallel to Washington street, we hear beneath our feet the rumbling of the machinery (located between Main and Prospect streets) by which the cars are kept in motion. If we look over the parapet we see in the streets below trucks laden with merchandise, for storage in the great warehouses afforded by the arched recesses of the anchorage and approaches, where thieves cannot break in and fire insurance is superfluous.



No. 9.—For description, see last pages.

At the intersection of Prospect street the approach turns rather sharply to the left, the only deviation from an air line in the whole route. Crossing the anchorage, we enter upon that portion of the bridge proper called the Brooklyn land span, abandon stone for wood and iron, but retaining the same division and arrangement for travel.

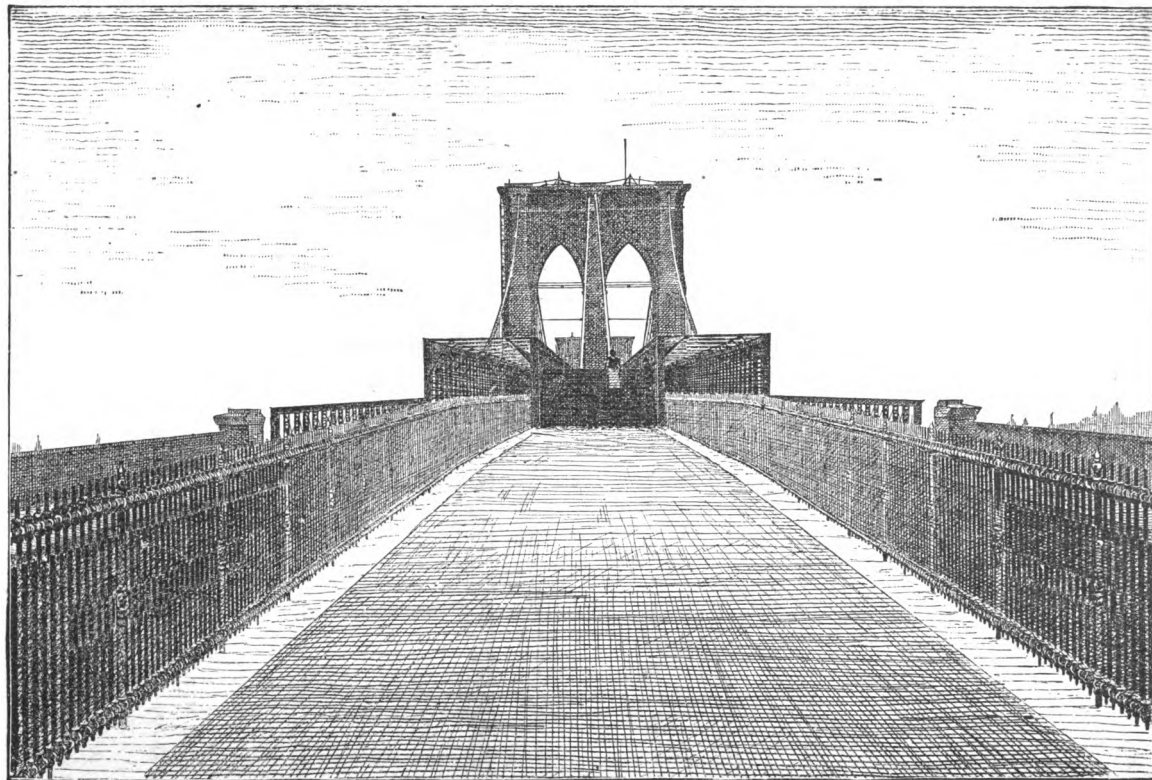
The width of the bridge is here reduced to 85 feet. The grade of ascent is henceforth $3\frac{1}{4}$ feet in the 100.



CROSS SECTION OF SUPERSTRUCTURE.

At 1,900 feet from the entrance at Sands street the Brooklyn tower is reached. Foot passengers here come squarely against the great column of masonry between the arches, but passing around on a gallery thrown over the endless-chain road, find their central way continued on the other side. From a superior height they look over and beyond the vehicles to view the widespread scene. The suspended structure still ascends to meet the cables, until, at the center, the maximum height of 135 feet is attained.

Now descending, the New York tower is reached, completing the river span of 1,595 feet. A land span of 980 feet brings us over Franklin Square, where an elevator, perhaps, or certainly a stairway, connects with the rapid transit road beneath, and at 2,492 feet from the New York tower, and precisely 5,989 feet from the Sands street entrance in Brooklyn, we *debouche* opposite the Hall of the Records in the New York City Hall Park, and just above the *Tribune* building. The whole distance traversed has been a little more than one mile, and the time, if in the bridge company's cars, *four minutes*.

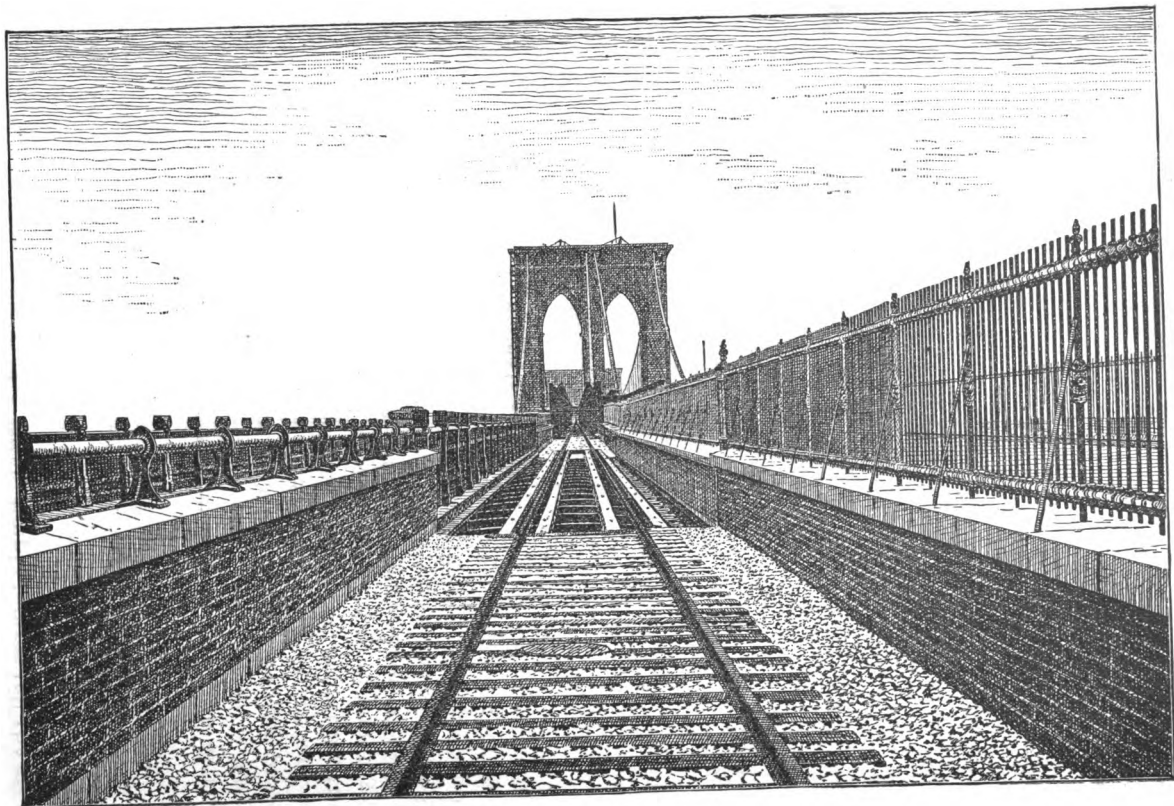


No. 10.—For description, see last pages.

What has the bridge cost? A few simple figures tell the story:

For construction, about	-	-	-	-	\$11,000,000.
For real estate, about	-	-	-	-	4,000,000.
Total,	-	-	-	-	<u>\$15,000,000.</u>

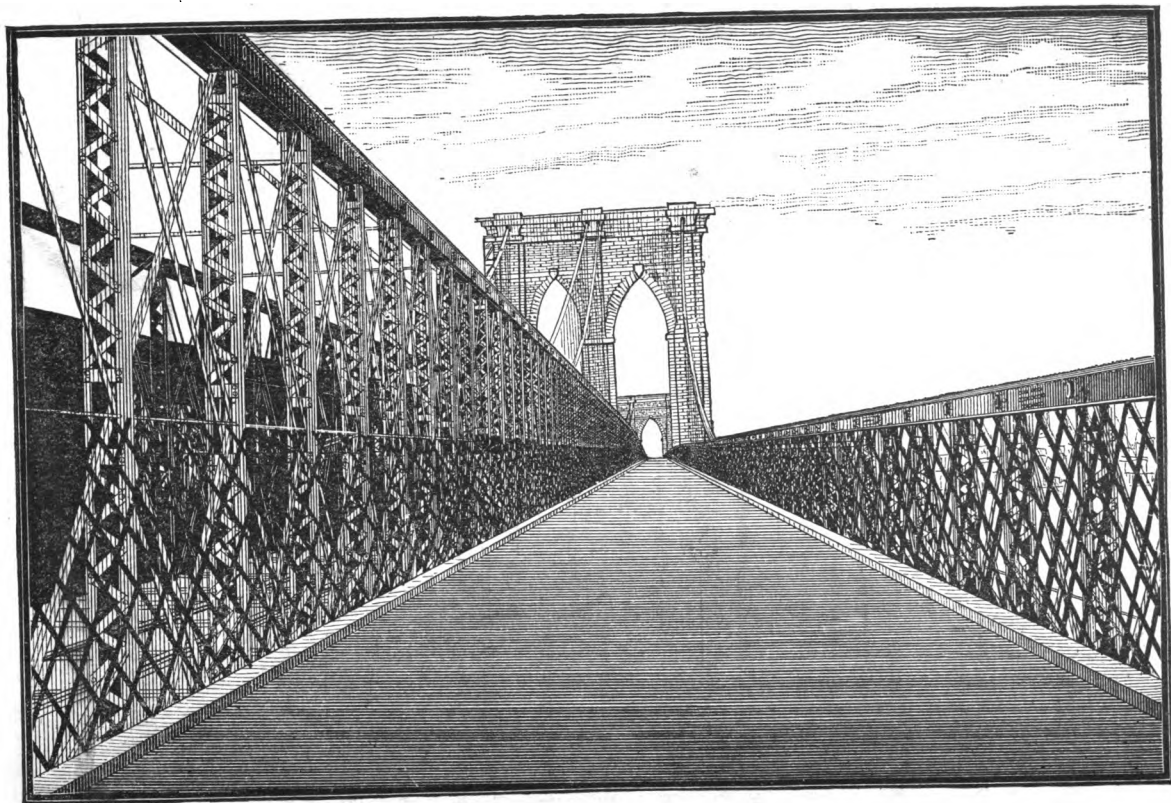
Will the bridge pay? In the way of benefit to real estate and convenience to the public, no doubt. It should also return a modest revenue to lighten our taxes withal. Presuming that 60,000 passengers would cross daily in the company's cars at three cents fare, and after allowing \$200,000 per annum for expenses of operation, there would remain from this source alone a dividend sum of about 3 per cent. on the capital cost of \$15,000,000. This may be considerably increased by the rent of warehouses, and (if thought advisable) the imposition of a toll on foot passengers and vehicles. The probability that the bridge will prove a successful business investment forms, we trust, a not unpleasant sequel to this Tale of Two Cities.



No. 11.—For description, see last pages.

Table of Dimensions and Quantities.

Construction commenced Jan. 3, 1870.	Weight of 4 Cables, inclusive of wrapping wire, 3,588½ tons.
Size of New York Caisson, 172x102 feet.	Ultimate strength of each Cable, 12,200 tons.
Size of Brooklyn Caisson, 168x102 feet.	Weight of wire [nearly], 11 feet per lb.
Timber and Iron in Caisson, 5,253 cubic yards.	Each Cable contains 5,296 parallel [not twisted] galvanized steel, oil-coated wires, closely wrapped to a solid cylinder, 15½ inches in diameter.
Concrete in well-holes, chambers, etc., 5,669 cubic feet.	Depth of Tower foundation below high water, Brooklyn, 45 feet.
Weight of New York Caisson, about 7,000 tons.	Depth of Tower foundation below high water, New York, 78 feet.
Weight of concrete filling, 8,000 tons.	Size of Towers at high water line, 140x59 feet.
New York Tower contains 46,945 cubic yards masonry.	Size of Towers at roof course, 136x53 feet.
Brooklyn Tower contains 38,214 cubic yards masonry.	Total height of Towers above high water, 278 feet.
Length of River Span, 1,595 feet 6 inches.	Clear height of Bridge in center of river span above high water, at 90 degs. F., 135 feet.
Length of each Land Span, 930 feet, 1,860 feet.	Height of floor at Towers above high water, 119 feet 3 inches.
Length of Brooklyn Approach, 971 feet.	Grade of Roadway, 3¼ feet in 100 feet.
Length of New York Approach, 1,562 feet 6 in.	Height of Towers above Roadway, 159 feet.
Total length of Bridge, 5,989 feet.	Size of Anchorages at base, 129x119 feet.
Width of Bridge, 85 feet.	Size of Anchorages at top, 117x104 feet.
Number of Cables, 4.	Height of Anchorages 89 feet front, 85 feet rear.
Diameter of each Cable, 15½ inches.	Weight of each Anchor Plate, 23 tons.
First wire was run out May 29, 1877.	
Cable making really commenced, June 11, 1877.	
Length of each single wire in Cables, 3,579 feet.	
Length of wire in 4 Cables, exclusive of wrapping wire, 14,361 miles.	



No. 12.—For description, see last pages.

Trustees.

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Wm. C. Kingsley, Vice President.

James S. T. Stranahan.

Wm. Marshall.

Alfred C. Barnes.

James Howell.

J. Adriance Bush.

Thos. Kinsella.

Erastus W. Smith.

John Kelly.

Allan Campbell.

A. Williard Humphreys.

Abram S. Hewitt.

Jas. M. McLean.

Lloyd Aspinwall.

Frederick A. Schroeder.

Arthur Leary.

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Chas. H. Haswell.

Edward Cooper.

Herman Uhl.

Wm. H. Wickham.

Jas. M. Motley.

Thos. C. Clarke.

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Thos. Hitchcock.

Wm. B. Maclay.

Wm. G. Steinmetz.

Isaac Newton.

Henry Clausen.

John W. Hunter.

Wm. R. Grace.

Chas. Macdonald.

Chas. J. Canda.

Otto Witte.

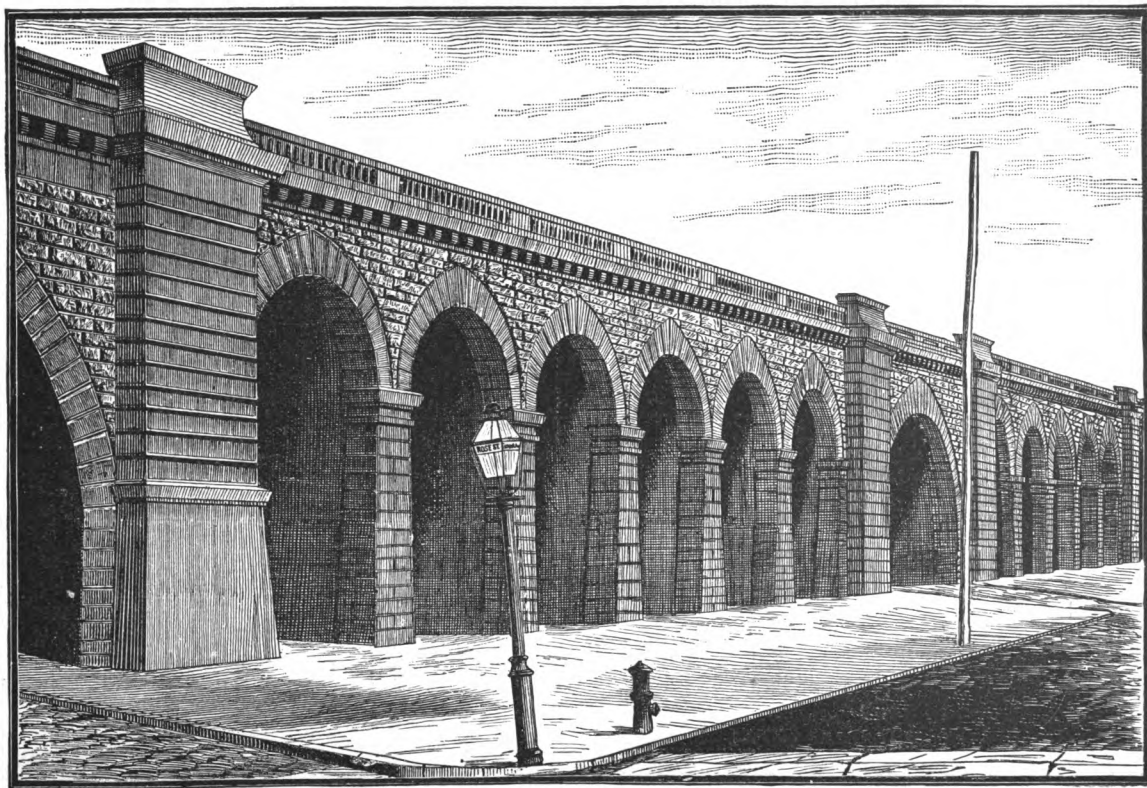
Isaac Van Anden.

H. K. Thurber.

Franklin Edson.

Seth Low.

*Died Nov. 30, 1882.



No. 13.—For description, see last pages.

Trustees and Officers,

JANUARY 1, 1883,

AND AT THE OPENING OF THE BRIDGE MAY 24, 1883.

—:O:—

TRUSTEES:

NEW YORK.

John T. Agnew,
John G. Davis,
J. Adriance Bush,
Henry Clausen,
Thomas C. Clarke,
Charles Macdonald,
H. K. Thurber,
Jenkins Van Schaick,
Franklin Edson, Mayor, *Ex-officio*.
Allan Campbell, Comp., *Ex-officio*.

BROOKLYN.

William C. Kingsley,
William Marshall,
Henry W. Slocum,
James S. T. Stranahan,
Alfred C. Barnes,
Alden S. Swan,
Otto Witte,
James Howell,
Seth Low, Mayor, *Ex-officio*.
Aaron Brinkerhoff, Comp., *Ex-officio*.

—:O:—

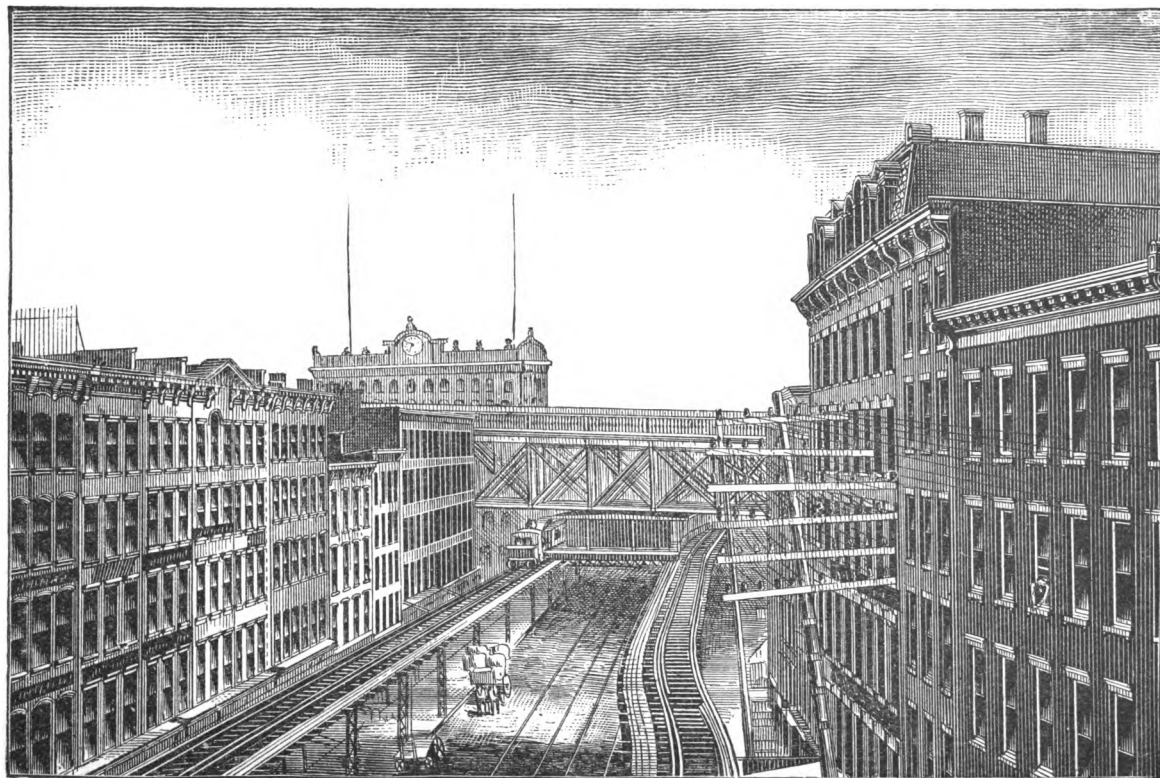
President.
William C. Kingsley, Vice-President.

Otto Witte, - - - Treasurer.
Orestes P. Quintard, - - Secretary.

ENGINEERS:

*John A. Roebling, *Chief Engineer*.
Washington A. Roebling, *Chief Engineer*.
Charles C. Martin, *First Assistant*.
Col. Wm. H. Paine, *In Charge of Superstructure*.
Major George W. McNulty, *In Charge of Brooklyn Approach*.
Francis Collingwood, } *In Charge of N. Y. Approach*.
Samuel R. Probasco, }

*Died in 1869.



No. 14.—For description, see last pages.

Description of Plates.

No. 2. View from top of Brooklyn Tower, looking down upon the Bridge and towards New York; the center promenade is for foot passengers; on either side of the center, and adjoining it, are railway tracks for cars; the two outside roadways are carriage roads. This is the only point from which all five roadways can be taken in one photographic view.

No. 3. Station building at the Brooklyn entrance to the Bridge, corner of Sands and Washington streets. The entrance for vehicles is on either side of the building. Foot passengers enter the front of the building, passing through it lengthwise, on to the Bridge. Cars come into the second story of the building, which is reached by two stairways from the inside.

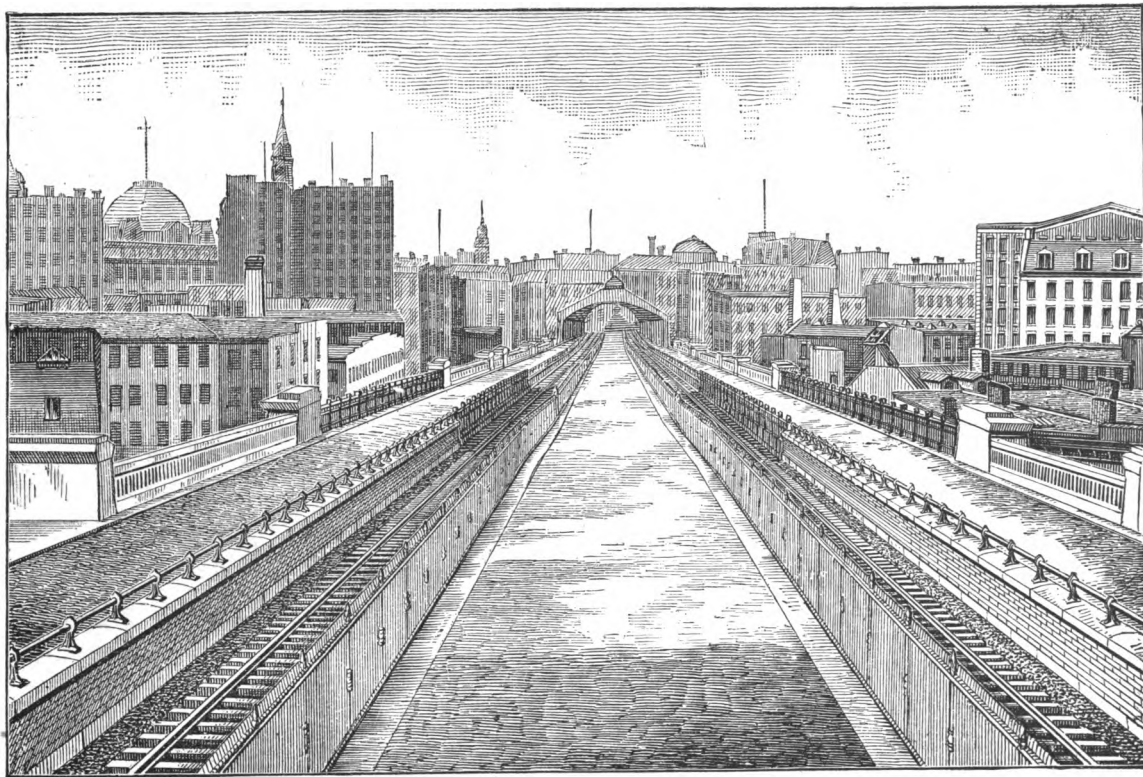
No. 4. View on the Brooklyn approach looking towards the Brooklyn entrance to the Bridge. Just before reaching the Station building, the approach curves to the right, which is the only deviation from a parallel line in the whole structure.

No. 5. View from the commencement of land span on Brooklyn side, looking towards the towers. On the right and left is the trestle-work over the railways; through the archway can be seen the New York Tower in the distance.

No. 6. This view is taken to show the platform around the center pier of the Towers. To continue his course, the foot-passenger must pass around the pier, and down corresponding steps on the other side. The railway tracks pass under the platform on either side.

No. 7. View from platform around central pier of Brooklyn Tower, looking towards New York. On the left is seen one of the carriage-ways; adjoining it, one of the railway tracks; adjoining that, is the promenade for foot-passengers. On the extreme right, can be seen the trestle-work over the other railway track; the other carriage-way cannot be seen from this view.

No. 8. View from the platform around the central pier of the New York Tower, looking down the center of the bridge, (promenade for foot-passengers). In the foreground is the balustrade on either side of the steps leading to the river span. On either side of the center is the trestle-work over the two railways; in the distance, the Brooklyn Tower.



No. 15.—For description, see last pages.

No. 9. This view was taken from exactly in the center of the Bridge, looking towards Brooklyn.

No. 10. View taken on the New York approach. On either side, through the railings, can be seen the railway tracks. In the distance, in the center, are steps leading to the land span; on either side of the steps is seen the commencement of the trestle-work through which the cars pass.

No. 11. View of one of the railway tracks. On the right, the other side of the railing, is the roadway for foot-passengers, passing between the two railways. On the left, is one of the carriage-ways.

No. 12. View of one of the carriage-ways. On the left is the trestle-work, through which one of the railways pass; looking through the archway of the New York Tower, the top of the Brooklyn Tower can be seen in the distance.

No. 13. View showing the New York approach, passing over Rose, Vandewater and Chatham streets, with the archways between those streets, which it is proposed to use for warehouse purposes.

No. 14. View looking down Pearl street, New York, showing the New York approach passing over the Third Avenue Elevated Railroad at Franklin Square Station.

No. 15. View on the New York approach looking towards the entrance to the Bridge. In the center is the promenade for foot-passengers. On either side are seen the railway tracks, and on either extreme outside, are the carriage-ways

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