THE CUP CHALLENGER "SHAMROCK."

English yachtsmen, as represented in Sir Thomas Lipton, evidently do not believe greatly in the old adage which tells us that one should not "swap horses in crossing a stream," for at the very climax of their plucky attempts to regain the "America" cup, and just when their yachts are proving to be very dangerous competitors, we find them substituting a new designer in place of G. L. Watson, who turned out the "Valkyries," famous in the later history of the "America" cup races.

Among the better known British designers of yachts there are two who stand out pre-eminently in the production of successful racing machines. Expert opinion is divided as to the respective abilities of G. L. Watson and William Fife, Jr., the designer of the "Shamrock," although the former is better known to the general public on both sides of the Atlantic, because of the large number of racing yachts of the larger size, 80 to 90-footers, which he has produced. Fife has made his reputation chiefly in the smaller classes, some of his boats having proved to be all but unbeatable. His first attempt at a large craft was made in 1893, that banner year in international yacht racing, when he designed the "Calluna," an 80-foot cutter, for a syndicate of yachtsmen. She was not a success, and scored only one or two firsts in the whole of that season, being easily beaten by the American centerboard sloop "Navahoe." Fife's next attempt was the "Ailsa," a big 149-ton cutter, which made her debut in the Mediterranean in the spring of 1895, and created quite a sensation by beating the "Britannia," "Satanita," and other crack vessels by handsome margins. It had been agreed between the New York Yacht Club and Lord Dunraven, for whom the challenger, "Valkyrie III.," was at the time being built, that he should have the option of substituting any faster yacht, which might prove its superiority to his new boat, and bring her over to race for the cup, and it was for awhile confidently expected that the "Ailsa" would prove to be the boat selected. She did not, however, fulfill her first promise, and was completely worsted by the three-year-old "Britannia," during the 1895 season, with the result that she was regarded as being only something less of a failure than the "Calluna." At the close of the season, Fife took the yacht in hand again and made changes to such good effect that in subsequent seasons she easily disposed of the other big yachts of her date and scored a brilliant series of victories. Another famous Fife boat in the larger classes was the 65-footer "Isolde," which, under the captaincy of Hogarth, who has been selected as the captain of the "Shamrock," achieved one of the most brilliant reputations ever made by an English yacht, winning in four successive seasons 180 firsts, 95 seconds, and about $20,000 worth of prizes.

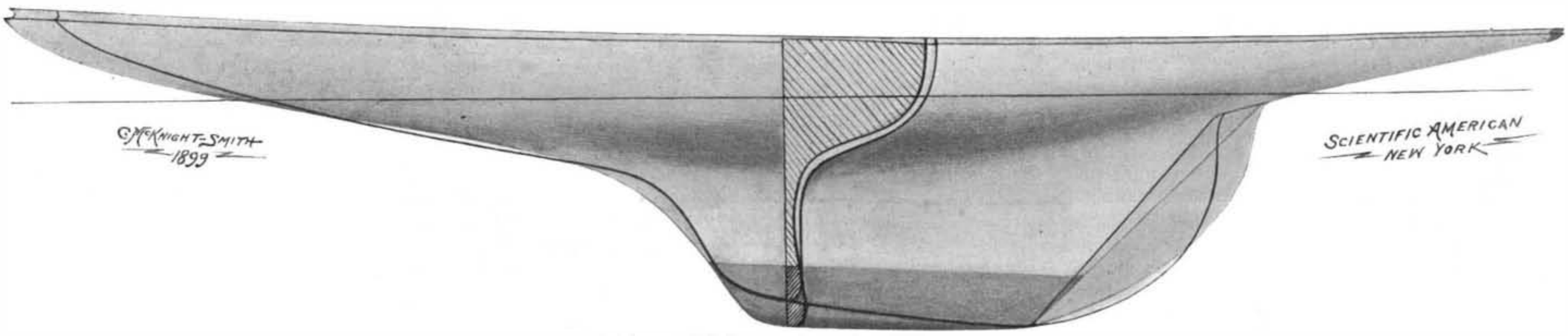
We have deferred publishing any data regarding the "Shamrock" until we were in a position to secure it from a reliable source, and we are now enabled to present a sheer plan and midship section of the challenger, with her leading dimensions. If the drawings are compared with those of the "Columbia," which appeared in the SCIENTIFIC AMERICAN of March 18, 1899, it will be seen that there is a striking general resemblance between the two yachts. The waterline length, 89 feet 6 inches, is the same, both boats being built up to the allowable limit of 90 feet, with half a foot allowance for change of trim and possible variation of the actual from the calculated displacement. Both boats have the same draught of 20 feet. The "Shamrock" has a few inches more beam and is about a foot longer over all. In sail area the "Shamrock" will have a slight advantage, although this is necessarily a variable quantity in both boats, and may be enlarged or reduced (probably the former) when they are in the course of "tuning up." A considerable addition was made to "Defender's" sail area after her first few trials under canvas.

A comparison of "Shamrock" with "Valkyrie III." shows that she should be a faster boat. Not only is her model finer and easier to drive through the water, but she is considerably lighter as the result of the materials used in her construction. Although her displacement is several tons less than that of "Valkyrie III.," her sail-spread is greater. This results chiefly from the

"VALKYRIE II'," AND "SHAMROCK" COMPARED.

	"Valkyrie III."	"Shamrock."
Length over all	130 ft.	132 ft. 2 in.
Waterline length	88 ft. 10 3/16 in.	89 ft. 6 in.
Beam	26 ft. 2 in.	24 ft. 6 in.
Draught	20 ft.	20 ft.
Displacement	158 tons.	147 tons.
Sail area	13,026 sq. ft.	14,125 sq. ft.
Construction	Steel and wood.	Nickel steel, and manganese bronze.

lightness of her hull, which weighs probably from seven to ten tons less than that of the "Valkyrie III." The weight saved in the hull can be put into the keel, where it adds immensely to the sail-carrying capacity. A reduction of nearly 2 feet in the beam, coupled with an addition of about a foot to the waterline length and 2 feet to the over-all length, means that "Shamrock" will have a form far more easy to drive than "Valkyrie III." With fairer lines, less displacement, less wetted surface, a lighter hull, and a considerably lower center of gravity (see sheer-plan), due to the absence of rise in the keel, and a larger sail-plan than "Valkyrie III.," the "Shamrock" should prove to be a very dangerous competitor—by far the most capable ever sent across the Atlantic. Whether she is as good a boat (having regard to the improved materials of construction) as Watson could have designed, remains to be proved; but there is no reason to suppose that Fife has failed to make as great an advance over "Ailsa" as "Ailsa," was over his first big boat, "Calluna."



THE CUP CHALLENGER "SHAMROCK."

Shaded hull and lined section show "Shamrock"; heavy outline shows "Valkyrie III."

THE BRIDGES OF NIAGARA GORGE.

By no means the least interesting feature of Niagara Falls and that stretch of the river whose scenic features have assisted to make this locality world-famous, is the number of picturesque bridges which span the gorge, and form important links between the American and Canadian shores. In our issue of May 27, we gave a lengthy description of the natural features of Niagara Falls and River, accompanied by engravings showing the peculiar topographical character of the country. A brief glance at these engravings is sufficient to reveal the causes which have led to the bridges being thrown across the river below and not above the falls. Above the falls the river though shallow is extremely broad, widening in places to from 2 to 3 miles, and a crossing would be necessarily very costly. Below the falls, however, although the river is either too deep or too swift to admit of piers or even temporary false work, it is comparatively narrow, the distance from bank to bank at the summit varying from 1,200 feet just below the falls to 700 or 800 feet at the railroad bridges a mile further down the river. By reference to the engraving in the article referred to showing a bird's eye view of Niagara, it will be seen that there are at present four bridges across the gorge. The first is the great steel arch structure, known locally as the Upper Bridge, and again as the Niagara Falls and Clifton Bridge, which spans the river with a single arch, 840 feet between abutments, at a point about a quarter of a mile below the American Falls. A mile below is the cantilever bridge which carries the tracks of the Michigan Central Railroad, while closely adjoining it is the handsome steel arch bridge recently opened which was built to replace the old railroad suspension bridge which stood on the same side. A few miles further down the gorge, at Lewiston and Queenston, a suspension bridge is nearing completion which will take the place of the wrecked structure, the cables of which have for many years been a familiar feature at this point on the river.

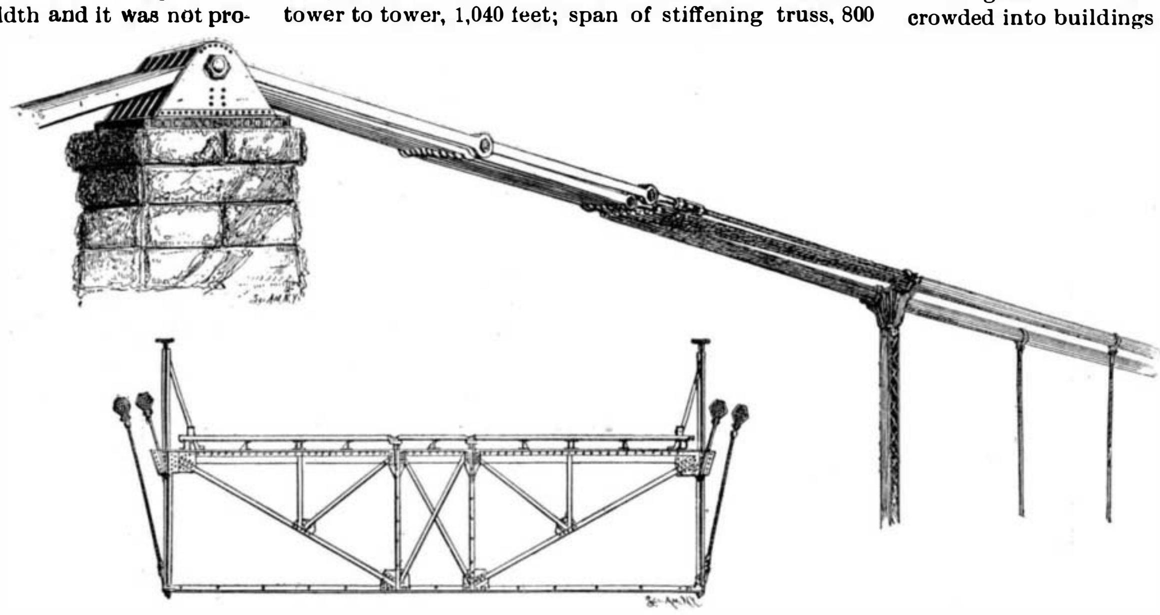
Although it is true that there are but four bridges at present in existence, no less than nine separate bridges have been built at Niagara at different times during the past fifty years, the earlier structures having been either destroyed by windstorms or rendered obsolete by the advance of engineering and the growing demands of traffic. The first bridge to be erected at the site of the new Niagara Falls and Clifton structure was a suspension bridge of wood and iron, opened January 2, 1869, whose span was over 1,200 feet. The cables were of iron wire, the towers and the roadway of wood. It was only 10 feet in width, and, as two carriages could not pass each other upon it, long delays were frequent at either end. In 1887 the bridge was enlarged to a width of 17 feet, new 2½-inch steel cables and additional anchorages being added. The work was finished December 15, 1888, and on the night of January 9-10, 1889, the bridge, scarce a month old, was swept away by a fierce southwesterly hurricane. The rebuilding of the structure was at once commenced, and on May 7, four months after the disaster, it was again open to traffic.

The development of the electric railways on each side of the gorge and the evident advantages of making a connection at each end, and so forming a continuous belt line, led to the erection of the present magnificent arch bridge opened in 1898, whose span of 840 feet far exceeds that of any other arch bridge in the world, the next longest being the center span of the highway bridge at Bonn, Germany, which measures 639½ feet in length. The total length of the bridge is 1,240 feet and the rise 150 feet, the main span being supplemented by two shore spans, one 190 feet and the other 210 feet in length, which serve to carry the superstructure to a connection with the top of the cliffs. The masonry abutments of the main span are built at the edge of the river banks, the distance laterally between centers being 68 feet 9 inches. The two trusses have an inward batter at the rate of $1\frac{7}{8}$ in 12, and the posts of the supporting bents which carry the roadway lie in the same plane. The bents rest upon the alternate panel points of the trusses and they are strongly braced against longitudinal and lateral distortion. The roadway, 49 feet in width, provides two electric tracks, two driveways, and two footwalks for passengers. The shore spans are inverted bowstring trusses of graceful proportions. It is scarcely possible to speak in too high praise of the beauty and general engineering merit of this structure, and great credit is due to Mr. L. L. Buck and his assistants for having treated this formidable problem with such excellent æsthetic results that it rather adds than detracts from the scenic effects at this part of the gorge. In our illustrations of the bridge the point of view is on the Canadian shore looking northeast toward the Hydraulic Power Company's plant, just beyond which is seen the cascades formed by the tailraces of various smaller factories. The outlet of the 7,000-foot tunnel which discharges the water from the Niagara Power Company's plant is seen just below the downstream abutment of the arch bridge.

It is not necessary to give any lengthy description of the cantilever railroad bridge, a mile below the arch—so well is it known to the public. It was built in 1883 from the designs of Mr. C. C. Schneider and opened in December of that year. The crossing is about 100 yards above the site of the new steel arch, and the gorge at this point is 850 feet in width at the crest and 425 feet at the river edge, the depth to the surface of the water being 210 feet. As it was impossible to use false work, Mr. Schneider designed a cantilever bridge, with towers located at the foot of the sloping cliffs, and built out the main span by overhang—a method he had already carried through successfully at the Fraser River on the line of the Canadian Pacific Railway. The structure, which carries a double track, consists of two cantilevers resting on the towers and a central suspended truss. The shore arms of the cantilevers are 195 feet 2 inches and the river arms 175 feet in length, while the supported span is 119 feet 10 inches long, the total clear span between the towers being 470 feet, and the total length of the bridge between the anchorages on the edge of each cliff is a few inches over 910 feet. Although later developments in cantilever construction have rendered the Niagara bridge insignificant in comparison, the spans of the Forth bridge, for instance, being 1,710 feet, the Niagara cantilever will always be notable as being one of the earliest successful applications of the cantilever system of construction. The structure carries a double track, and it was designed for a rolling load consisting of two 66-ton locomotives followed by a trainload of 2,000 pounds to the lineal foot.

This was ample in 1883, but now, after a lapse of sixteen years, we have locomotives on some American roads weighing, with tender, up to 167 tons, and trains that will average 4,000 pounds rolling load to the foot. To meet the changed conditions the Michigan Central Railroad is now strengthening the whole structure in an ingenious and novel manner. A new truss equal in strength to the other two is to be built through the center of the structure from shore to shore, new bents and masonry foundations being erected in the center of the towers. The reconstructed bridge is to have an increased carrying power of 50 per cent.

The adjoining bridge site, 300 feet down stream, is of special interest, exceeding indeed any other across the gorge. Here, in 1848, was erected the first bridge to span the then formidable chasm. It was a crude affair, though creditable to its designer, Mr. Charles Ellet, if we consider the early date and the lack of appliances. The floor was only 7½ feet in width and it was not provided with any stiffening truss. In 1853 it gave place to the famous railway suspension bridge designed by Mr. John A. Roebling, in which the theories of the strength of materials and the strains in framed and suspended structures received a more thorough application than had ever before been attempted in this country. It required all the courage of Mr. Roebling's convictions to erect a suspension bridge for carrying railroad trains at a time when opinion inclined to the more rigid systems for this class of bridge; but the structure, although it has now been replaced by a steel arch, proved to be fully adequate to its duties for several decades of very severe work. The span measured 821 feet 4 inches between towers. It was carried on four cables of iron wire, 10 inches in diameter, and the floor system was double-decked, the upper deck carrying a single railroad track and the lower being used for common travel. It was stiffened by two timber trusses, 18 feet in depth, the trusses being built on the Pratt system.

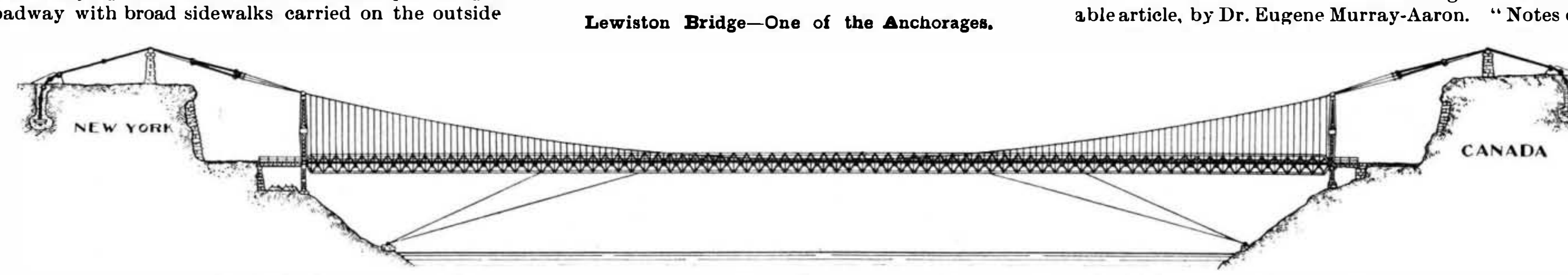


Lewiston Bridge—Tower, Eyebars, and Top of Rocker Bent.

It should be mentioned that the wires of the early Ellet bridge were incorporated in the Roebling structure, and when the latter was taken down after forty-two years of service, the original strands curled up, taking the set they had carried when in the reel. In 1877 it was found that corrosion of the wires had taken place, and the defective material was taken out and other wires inserted and spliced, and at the same time the wooden truss was replaced by one of iron. In 1886 the stone towers showed such signs of deterioration that it was decided to replace them later with new towers of steel. This difficult task was accomplished by Mr. L. L. Buck, who also was responsible for the repairs of 1877, without any interference with the traffic. The Niagara Railway Arch, as it is called, is a two-hinged, spandrel-braced arch of 550 feet span and 114 feet rise. The masonry abutments are built about half way down the slope of the gorge, upon a solid stratum of gray limestone, and the main arch is flanked by two connecting shore spans, 115 feet in length, which carry the floor system from the arch to the edge of the adjoining cliffs. The structure is double-decked, the upper deck carrying two tracks and the lower providing a roadway with broad sidewalks carried on the outside of the trusses. The bridge is proportioned for a live load on each of the tracks of two 128-ton engines, followed by a train load of 3,500 pounds to the foot, besides the live load due to travel on the road and foot ways on the lower deck. The bridge was erected by building the shore trusses upon false work, tying them back to anchorages on the shore and then building out the main arch by overhang, as shown in our first page engraving. The material was brought out upon the suspension bridge and handled by travelers which ran upon the top chords of the arch trusses. The new bridge was built and the old bridge removed without any interruption of the traffic—a result which is greatly to the credit of Mr. Buck and his assistant, Mr. Richard S. Buck, the resident engineer in charge of construction at the site.

Lewiston Bridge—One of the Anchorages.

The Lewiston suspension bridge, which is now nearing completion, will also stand upon the site of an earlier structure—the old Lewiston suspension bridge, which was built in 1851-52 and destroyed by a windstorm on the morning of February 1, 1864. The new bridge will connect the southern termini of the Gorge Railroad (electric) which follows the cliff and shore line of the river from Niagara to Lewiston, on the American side, and the Niagara Falls Park and River Electric Railway, which runs near the edge of the cliff from above the Falls to Queenston on the Canadian side. The new bridge with the upper arch bridge will thus enable the tourist to make a complete circuit of the most interesting portion of the gorge without a change of car. The general appearance of the bridge can be judged from the accompanying drawing, and the principal dimensions are as follows: Distance from tower to tower, 1,040 feet; span of stiffening truss, 800 feet; width, 28 feet; width of roadway, 25 feet. The bridge carries a single electric track with a roadway on each side of it; but no special provision is made for the limited foot passenger traffic. The connecting span on the New York side will be 34½ feet long and that on the Canadian side 19½ feet. Much of the masonry of the towers came out of the towers of the old bridge. There are four cables, each consisting of fourteen 2½-inch steel wire ropes, the ropes being those which formerly carried the upper suspension bridge, already described. They were long enough to allow of their being cut in half and used in the new bridge, and to piece out the necessary span between towers, 75 feet at the end of each cable will be made up of eye-bars. The cables are continued in the eye-bar form from the towers down to the anchorages, 150 feet back from the edge of the cliffs. Here the eye-bars are carried into a shaft, at the bottom of which they are connected to anchor plates, the hole being filled up with concrete. A view of the top of an anchorage is shown in the accompanying cut. At each of the points where the suspended structure connects with the short flanking spans a rocker bent is introduced which rests on a shoe below and extends up to the cables above. The bent is hinged at the shoe, at the end of the truss, and at the cable. This construction, and indeed the whole bridge, is novel and not by any means lacking in picturesque effect.



Lewiston Suspension Bridge, Niagara River—Span Between Towers, 1,040 Feet; Length of Stiffening Truss, 800 Feet.

THE BRIDGES OF NIAGARA GORGE.

Workingmen's Houses in Germany.

Vice-Consul J. F. Monaghan writes from Chemnitz, saying that there is a movement on foot to furnish workingmen with better tenements. Now, they are crowded into buildings which often look like barracks. The proposed houses will be built upon lots about 16½ feet wide by 102 feet deep, thereby allowing for a front yard for flowers and a back yard for a vegetable garden and shed, the latter for the keeping of poultry or some domestic animal. The houses will contain five rooms. A parlor and kitchen will be on the first floor, the parlor containing a porcelain stove and heating pipes, and the kitchen a wash boiler and stove. The three bedrooms on the second floor will easily hold five or six persons, and can be made to accommodate ten. In the largest an iron stove will be placed. A pump will provide water where the city waterworks do not extend to the house. In connection with the shed is a water-closet. The cost of such a house and lot, when a number are built at a time, will be between $850 and $940. It will rent for about $53 a year—that is, for the same price the workingman has to pay for two rooms in the barrack-like tenements of the large cities.

The Death of Isaac G. Johnson.

Isaac G. Johnson died at his Spuyten Duyvil home on June 3, in the sixty-eighth year of his age. He was born in Troy and graduated in 1848 at Rensselaer Polytechnic Institute. He soon entered upon the manufacture of malleable iron in Spuyten Duyvil, and in later years turned his attention to steel manufacture. He was well known as an inventor, and he secured a patent on a cap for armor-piercing shell. This was purchased by the Navy Department, and proved of the greatest value at the time of the destruction of Admiral Cervera's fleet.

The Current Supplement.

The current SUPPLEMENT, No. 1224, has many articles of great interest. "The School of Anthropometry at the Prefecture of Police" is an article fully illustrated. "Into the Heart of China" is the narrative of a journey through the center of China taken by Mr. W. Kirkpatrick Brice and is most interesting. "The Elephant and Its Ancestors" is an important article by W. Von Reichenau, and is freely illustrated. "The 'Wourali' Poison and Its Uses" is an original and valuable article, by Dr. Eugene Murray-Aaron. "Notes on the Abyssinians" is fully illustrated. "The Commercial Development of Germany" is continued, and an article on "Graphite, Its Formation and Manufacture," by Prof. Acheson, completes this very interesting number.

Contents.

(Illustrated articles are marked with an asterisk.)

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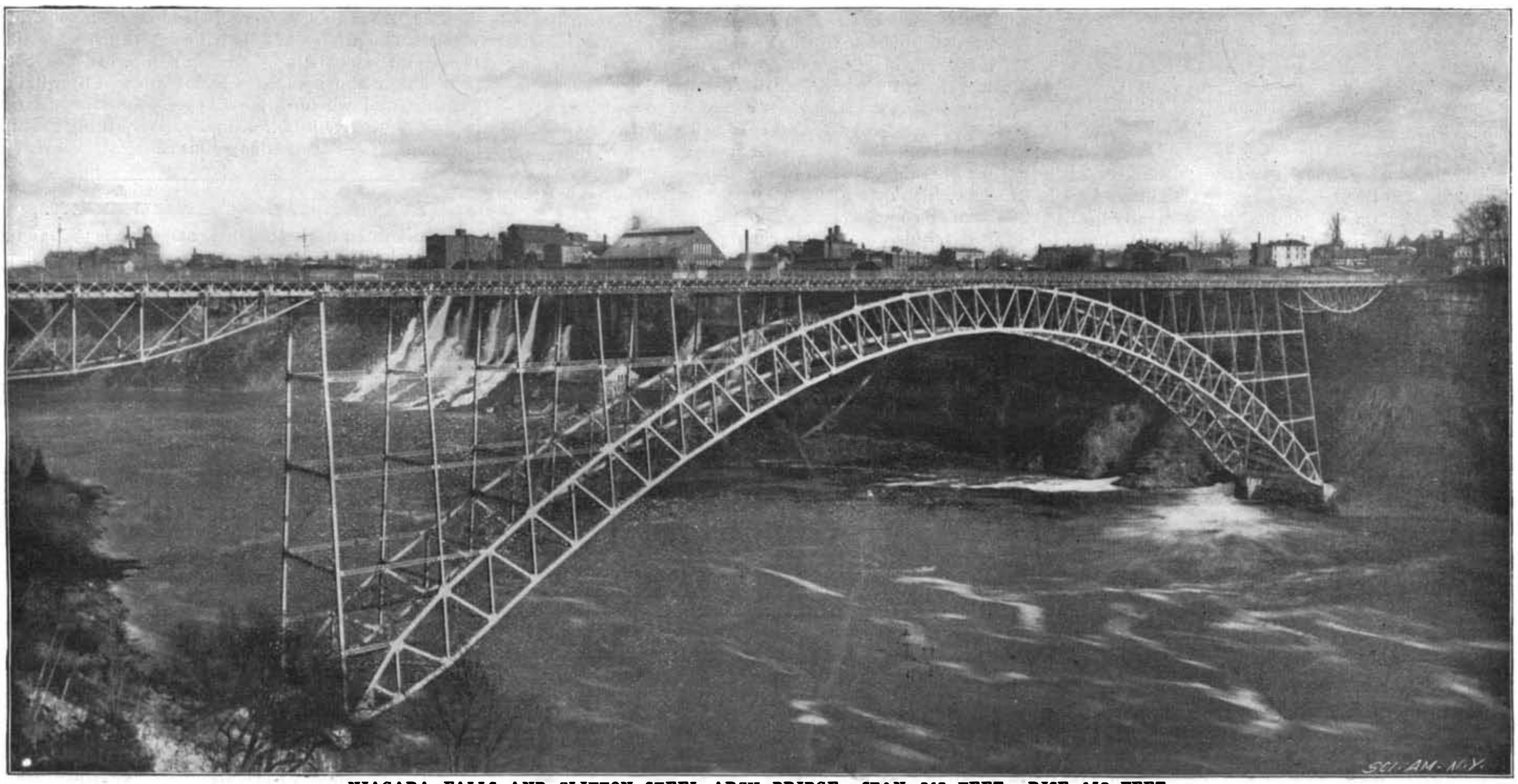

NIAGARA FALLS AND CLIFTON STEEL ARCH BRIDGE. SPAN, 840 FEET; RISE, 150 FEET.

THE BRIDGES OF NIAGARA GORGE—NIAGARA RAILWAY ARCH BRIDGE. SPAN, 550 FEET; RISE, 114 FEET.—[See page 396.]