## COMPLETION OF VICTORIA FALLS BRIDGE.

BY THE SCIENTIFIC AMERICAN LONDON CORRESPONDENT.

In many ways the Victoria Falls bridge, over the Zambesi gorge in Central Africa, is an interesting piece of engineering work. In the first place, the structure can claim the distinction of being the highest bridge in the world. Again, the waters of the gorge which it spans have never been fathomed, and no one knows their depth. But the feat is deserving of more than ordinary notice, not so much on account of its engineering difficulties, but rather because the work has been carried out in the very heart of the Dark Continent. It was only fifty years ago that the gorge and the famous falls at their head were discovered by David Livingstone. Now it is not only possible to reach the Falls by rail, but to cross the Zambesi by the iron road, and proceed northward for another one hundred miles by the same train. The completion of the bridge means that another link—and the most important probably—has been forged in the great scheme proposed and started by Cecil Rhodes, namely, the Cape-to-Cairo railroad.

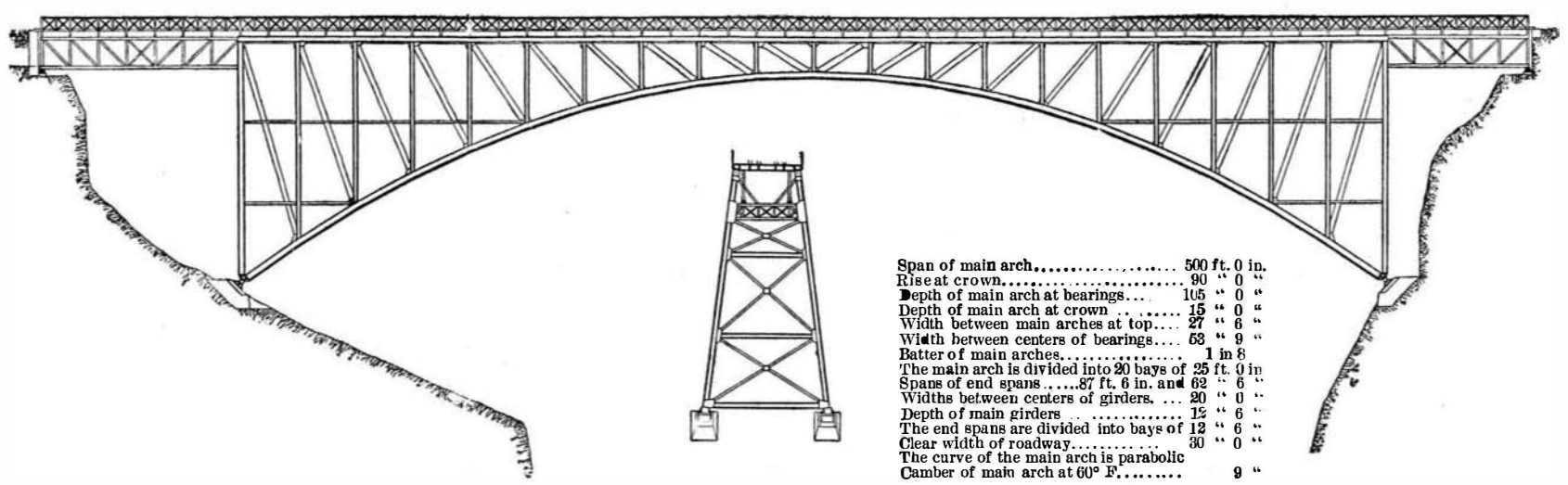
Before proceeding to a description of the bridge itself, a few facts about the railroad will not be inappropriate. The total distance by railroad from Cape Town to the Falls is 1,631 miles. Travelers from London are now carried right up to the Falls in twenty-one days, whereas prior to the opening of the line their transportation was a matter of months. At the Falls themselves there is a hotel where accommodation is provided for eighty guests. True, it is only a temporary building, but it will shortly be replaced by a permanent one. That tourists are now making their way to this spot in Central Africa to see for themselves the eighth wonder of the world, as the Victoria Falls have been rightly termed, is made clear after a chat with the present hotel proprietor. Last Christmas there were considerably over a hundred persons staying at the hotel, many of whom had to sleep in tents and temporary annexes, so crowded was the building itself. A large number of Americans visiting the Cape make the journey by railroad to the Falls, spending, as a rule, several days exploring the gorge and beautiful islands just above the great waterfall.

As to the Falls themselves, no attempt will be made here to describe them, with the exception of saying that they are the largest in the world, being about a mile in width and boasting of a depth of from 400 to 420 feet. After the waters of the Zambesi have plunged over the Falls, they continue their course for several miles in a comparatively narrow gorge, and it is this latter which has been bridged to carry the track of the Cape-to-Cairo railroad.

A word here may be said as to the site. It is a little way below the Falls themselves, on the borders of what is termed the "Rain Forest." During the rainy season the great volume of water dashing over the mighty chasm sends up five more or less distinct columns of spray to a height of 3,000 feet, which descends like heavy rain for an extensive area, whose limit is variable and is governed by the force and direction of the wind. This area is called the Rain Forest, and it is just within its full water confines that the bridge is located. It was Cecil Rhodes's wish that it should be so. He is said to have uttered the words: "Build the bridge where the spray from the Falls shall shower upon the trains as they pass." He also expressed the wish that a view of the great cataract may be obtained from the windows of the railroad carriages. The engineers have fulfilled the great man's wishes, and before these lines appear Rhodes's idea of the trains being drenched with spray from the Victoria Falls will have passed out of the region of poetic fancy to that of actual fact.

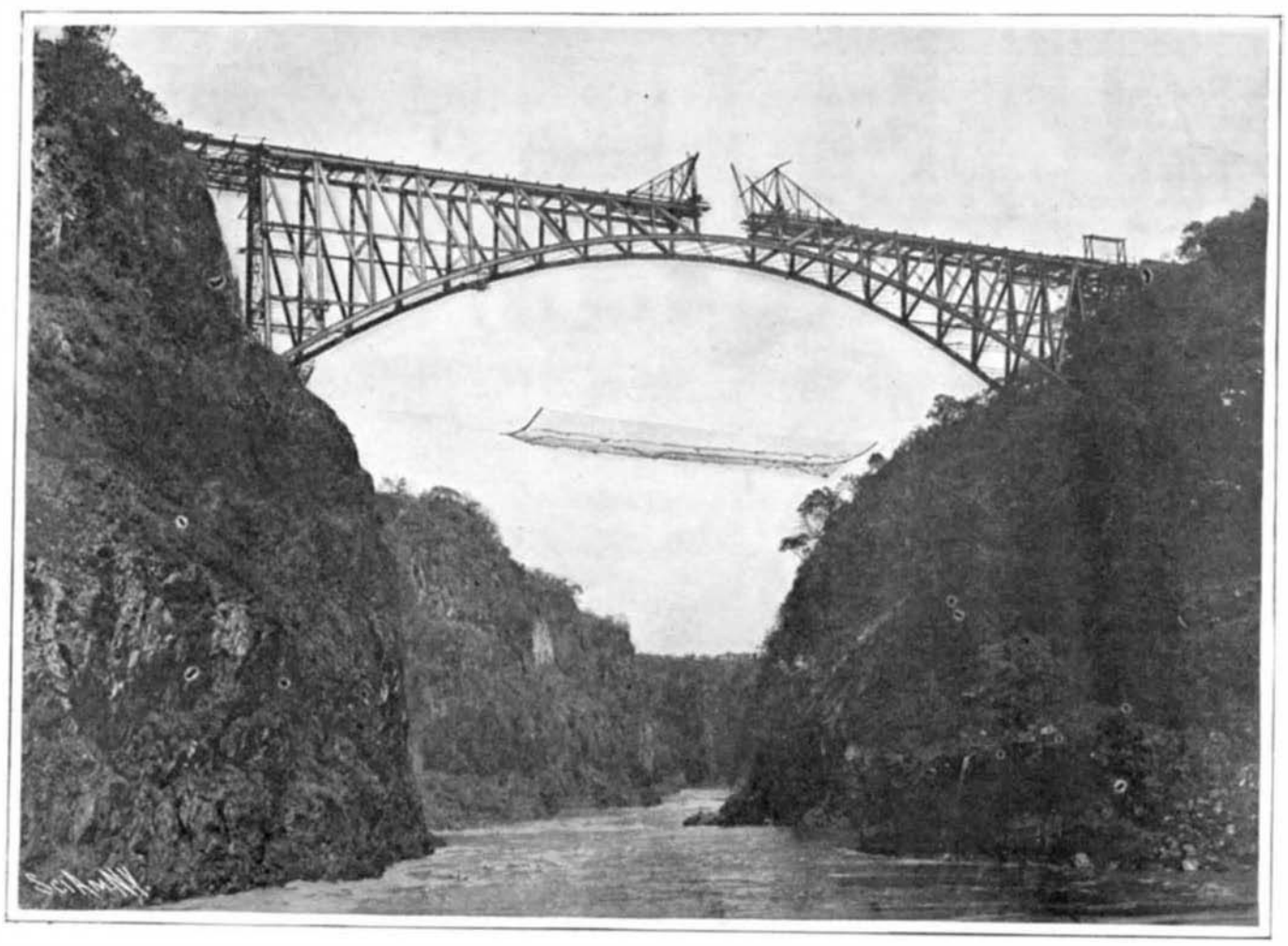
The bridge as it stands to-day represents a year's labor. It has been shipped from England, and erected on its remote site in this comparatively short space of time. It was only twelve months ago that the last section of the railroad reached the Falls. Until then nothing could practically be done. The gorge where the bridge has been built is some 650 feet in width and about 420 feet deep to the water level. The method adopted in building the bridge was as follows: It was built out simultaneously from each bank on the cantilever principle until it met in the center. To accomplish this, it was necessary of course to carry a large quantity of material to the other side of the stream. To get this across the river, an electric

EXCAVATING FOR THE ABUTMENTS OF THE VICTORIA FALLS BRIDGE.



| | | |
|---|---|---|
| Span of main arch | 500 ft. | 0 in. |
| Rise at crown | 90 " | 0 " |
| Depth of main arch at bearings | 105 " | 0 " |
| Depth of main arch at crown | 15 " | 0 " |
| Width between main arches at top | 27 " | 6 " |
| Width between centers of bearings | 53 " | 9 " |
| Batter of main arches | 1 in 8 | |
| The main arch is divided into 20 bays of | 25 ft. | 0 in. |
| Spans of end spans.....87 ft. 6 in. and | 62 " | 6 " |
| Widths between centers of girders | 20 " | 0 " |
| Depth of main girders | 12 " | 6 " |
| The end spans are divided into bays of | 12 " | 6 " |
| Clear width of roadway | 30 " | 0 " |
| The curve of the main arch is parabolic | | |
| Camber of main arch at 60° F. | 9 " | |

ELEVATIONS OF THE VICTORIA FALLS BRIDGE.



THE LATEST PICTURE OF THE VICTORIA FALLS BRIDGE OVER THE ZAMBESI GORGE.

Total length of bridge, 650 feet; height over low-water level, 450 feet.

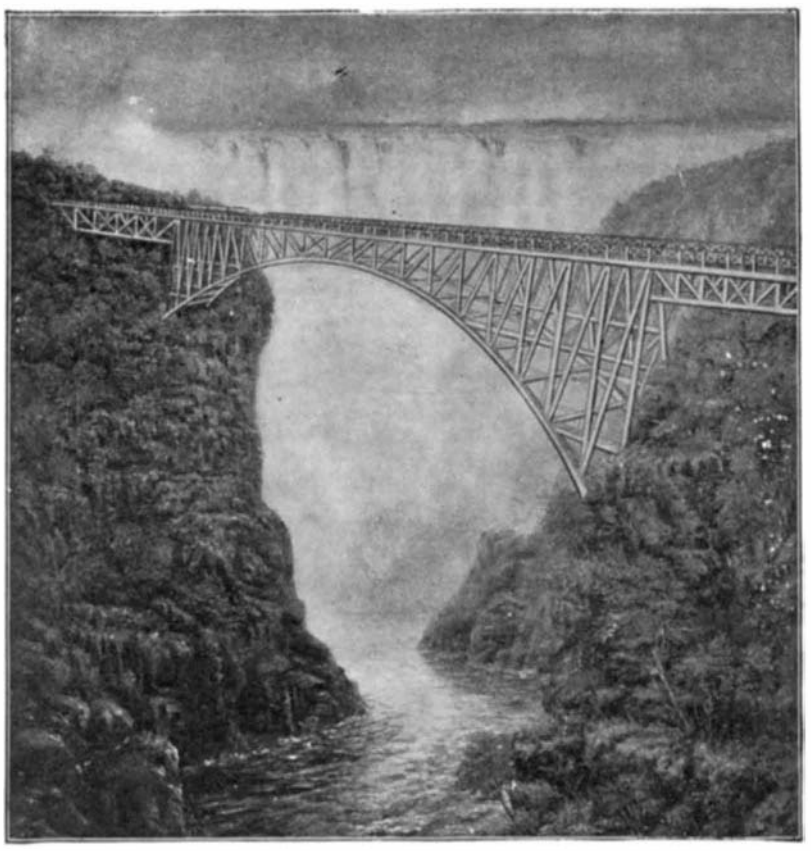
cableway was thrown across the gorge. Communication was first established between the two banks by firing a rocket across. To the rocket was attached a line, by means of which a stronger rope was drawn across, and again a stronger one, until a 2¾-inch diameter steel-wire rope was thrown over the site. A box kite was first tried as a means of carrying a string across, but the rush of air at this spot always drove the kite in the opposite direction to that which it was intended to travel.

The 2¾-inch steel-wire rope referred to was supported at one end by a fixed tower, 36½ feet high, and at the other by a swinging post, 79 feet in length. To prevent this latter being pulled over by the cable into the gorge, a counter-weight of about sixty tons was attached to it. On the cable ran an electric machine, from which was suspended a cage, which carried men and material across. The whole was controlled by the motorman from the platform of his machine, who could raise and lower his car at will. When it is remembered that the gap between the supports of the cable measured 870 feet, and the aggregate amount of material that had to be transported across amounted to many thousands of tons, it will be seen that the cableway played no mean part in the undertaking. In addition to carrying the weight of one half of the bridge across the gorge, all the material and rolling stock required for the construction of over fifty miles of railroad were also safely conveyed across the stream by the electric cable. The car and its machinery weighed about five tons, and the maximum weight of load it carried was ten tons. When the cable was first erected, many distinguished visitors to the Falls took a journey across in the suspended carriage, including Princess Victoria of Schleswig-Holstein and Lord and Lady Roberts. The journey occupied about four minutes. The railroad company also allowed passengers to cross the stream by the cable, charging $2.50 for the trip.

The bridge, which is a combination of girder and arch, has a total length of 650 feet, and consists of three spans, 87 feet 6 inches and 62 feet 6 inches in length respectively. As already stated, it was erected from each side simultaneously. On account of the weight of the structure, about 2,000 tons, it was necessary to tie back the weight to each bank in some way until a junction was made, as the bridge then, of course, would carry its own weight. The manner in which this was done may be said to constitute one of the most interesting features of the whole undertaking. Two bore holes were sunk on each bank, 30 feet deep and 30 feet apart, and the two extremities joined together by boring through the rock. Wire ropes suspending the weight of each half of the bridge were passed down one hole, along the passage connecting the two, and out at the other, so that the weight was sustained by this solid mass of rock; and to make assurance doubly sure, a weight of 500 tons of rails was piled also on the top of the rock. It was estimated that when the two halves of the bridge were on the point of meeting in the center, there was a pull of 400 tons on each of the four corners, and as the bridge was built out toward the center, additional ropes were added to withstand the increased stress.

The curve of the main arch is parabolic, and is divided into twenty bays, each 25 feet long, and has a 9-inch camber at 60 deg. Fahr. The two side spans are divided into equal bays of 12 feet 6 inches. The bridge has a clear width of roadway of 30 feet, sufficient for a double set of rails. A close inspection of some of our photographs will reveal the presence of a huge net, which was thrown across the chasm on two steel cables, and was erected, so the contractors declared, "to catch the boys and tools should they inadvertently drop into it." In addition to a staff of about twenty-five European erectors, a hundred Kaffir boys were engaged upon the work.

Before the scheme was put in hand, there were not a few complaints in the public press, declaring that the erection of a bridge at the Falls would mar the beauty of the surroundings. To ascertain the general feeling of the visitors on the site chosen, a book was kept at the engineers' camp, and a very large majority of the opinions are favorable to it, many visitors being converted from hostility to approval on seeing the facts of the case—in fact, one guest goes so far as to say the following: "The Falls in their present position cannot possibly detract from the beauty of the bridge." It is not without interest here to note that the South African Company, which owns the land on both banks of the river, has decided to reserve a large area of the forest, extending for some six miles on each side of the Zambesi, as a public park, to be preserved forever in its natural beauty.



THE ZAMBESI RAILROAD BRIDGE COMPLETED

The contractors for the bridge were the Cleveland Bridge and Engineering Company, of Darlington, England. The whole of the plant was erected in their yards, and exhaustive tests were made with it before it was sent out. It was shipped at Middlesborough, on the River Tees, to Beira, a port on the east coast of Africa, a little south of the mouth of the Zambesi, and here transshipped to the railroad, which runs through flat, swampy country, until it rises about 4,000 feet above sea level at Umtali, and thence through Matabeleland to Salisbury and Bulawayo, and from the latter place to the Falls, a total distance of close upon 8,000 miles. The engineers for the work were Sir Douglas Fox & Partners and Sir Charles Metcalfe, Bart. One of the members of this firm, Mr. G. A. Hobson, M. I. C. E., the designer of the structure, and to whom the writer is indebted for much assistance in the preparation of this article, has left London to inspect and pass the bridge.

THE VICTORIA FALLS BRIDGE IN COURSE OF ERECTION. THE MATERIAL WAS CARRIED BY CABLEWAY.

### A New Hardening Compound.

A Hungarian professor and chemist of the Brunn University claims to have rediscovered the secret of the ancient Greeks by which they were able to render mortar imperishable. The reason for the remarkable preservation and hard texture of this sealing material of the Acropolis, which is as good to-day as it was when first laid centuries ago, has always puzzled scientists and archæologists. This Hungarian some twenty-five years ago procured a piece of this flint-like mortar and ever since has been engaged upon ascertaining the secret of its manufacture. He has invented a chemical compound liquid in character and yellowish in color, to which he has given the name "zorene." The claims of this inventor are that by the application of this compound the density of nearly every description of stone, including granite, is doubled and is rendered absolutely impervious to water; it imparts to all metals the quality of resisting rust, and is a great, powerful germicide. These properties are not transient, but everlasting. Several practical tests to demonstrate the powers of the solution have been given in London. In the first instance, a piece of ordinary slag of a brittle nature after immersion in the liquid resisted a heavy blow from a hammer which before treatment had crushed the slag to powder. The same effect resulted when an ordinary brick was similarly treated. A block of Red Jarrow wood was then immersed in the solution and then placed in a bath of water for several hours. When withdrawn from the water, the wood was carefully weighed upon a delicate scale and found not to have absorbed a particle of water, testifying to the water-resisting qualities of this discovery. Two pieces of steel were then placed in the bath and after treatment were submitted to a severe ammonia test equivalent to an exposure to the outer atmosphere for five years. No trace of rust was observed on the metal. The professor has an ordinary steel table knife which was immersed in the compound six months ago and which has been exposed to the open air ever since; there is no trace of rust upon it. The professor will shortly give a lecture upon the subject before one of the scientific societies in London, and will carry out several demonstrations to substantiate the claims of his discovery.

An experiment with vacuum tubes of several kinds by Herr Hess showed that external friction of the tube, such as rubbing with the free hand, stimulates conductivity within.