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THE NEW TAY VIADUCT.

This viaduct is designed to replace the metallic bridge over the same river, that was blown down in December, 1879, by a storm of extreme violence, carrying down with it a train which was crossing. The new work (see Fig. 4) is 10,800 feet in length. It comprises two approaches, the southern one, A, of which is horizontal and formed of 27 spans, while the northern one, B, consists of 45 spans, and has a falling gradient of 1 to 114. Between the viaducts there is a bridge, B, of 13 spans of 230 feet each, four of which allow a clear headway for shipping of 77 feet. The viaduct spans are naturally shorter than those of the bridge, and vary from 50 to 166 feet. At the south end the work connects with the shore by four brick arches of 50 foot span, the first of which forms an abutment. These arches support the junction of the tracks of the Newport branch with those of the Edinburgh main line, and they progressively diminish in width until they unite with the metallic part. At the north end the work crosses the extension of the Dundee esplanade, and for this reason an abutment could not be constructed; so two wrought iron skew arches supported by brickwork masonry have been substituted therefor. Beyond these are four spans of wrought iron girders supported by cast iron columns standing upon granite bases. All the other piers, 77 in number, that support the structure are of the same type—consisting of two cylindrical wrought iron caissons for the bridge and southern viaduct, and cast iron ones for the northern. These are internally lined with brickwork and filled in with concrete, which, in the first ones, reaches the level of low water, and in the second extends to the very top. The diameter of the bases of these caissons varies from ten to twenty-three feet, according to the length of the span. Each caisson is constructed of three cylinders, that diminish in diameter from base to apex. Except in a few cases where they are founded upon rock, the cylinders are sunk to depths varying from 20 to 30 feet below the bed of the river, so as to preserve them against the scouring action of the tide. Before going further with the foundations, they are tested by loading them with a weight which is 33 per cent greater than that of the two trains that they are calculated to support. The upper parts of the caissons of each pier are afterward connected at 1½ feet above high water by cast iron girders 8 feet in height, the interval being filled in, as in the caissons with brickwork and concrete. On top of the cylinders rise octagonal shafts connected by a semicircular arch upon which rest the principal girders. These latter are four in number upon the viaducts, properly so-called, and are cross-braced with diagonal stays, while on the bridge there are but two, which are much stronger, and are cross-braced above with secondary girders. The sections in Fig. 3 show these arrangements.

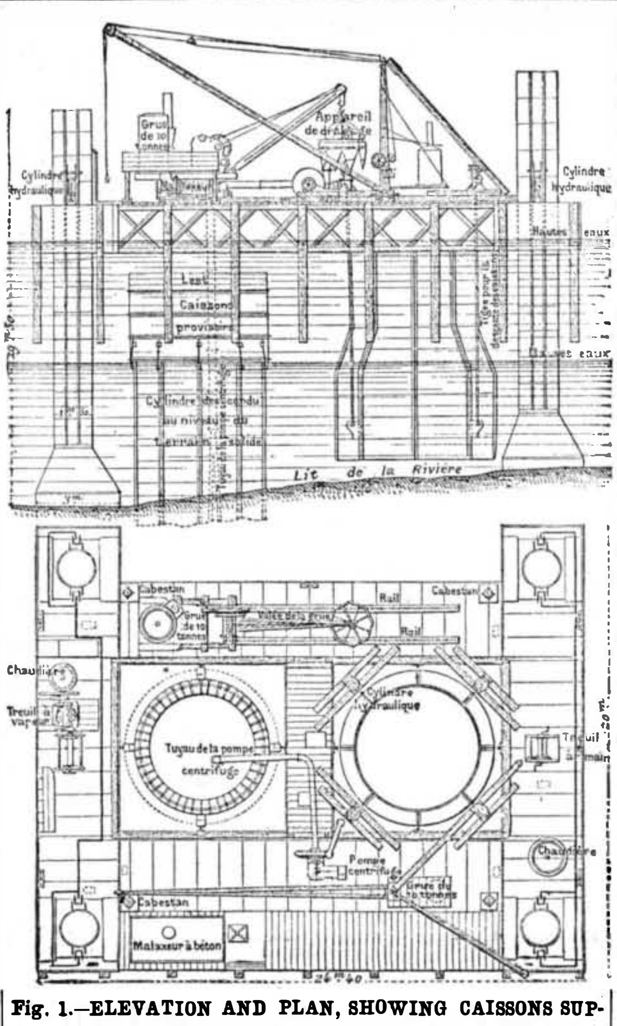

Fig. 1.—ELEVATION AND PLAN, SHOWING CAISSONS SUPPORTING COLUMNS AND MOVABLE PLATFORM.

The construction and sinking of the caissons is effected by means of an entirely new apparatus, whose arrangements are due to the Messrs. Arrol, the contractors for the work, who likewise have in charge the construction of the gigantic bridge over the Firth of Forth. The apparatus consists of a metallic platform composed of two main caissons of iron plate and a third one parallel with them. The three are connected by girders, which support a stage upon which are placed the pumps, hydraulic engine, material, etc. At each of the four corners of this pontoon thus formed is arranged a vertical wrought iron tubular leg, 5 feet in diameter and 64 in length. These cylinders are open below, and provided with a transverse partition 2½ feet above the cutting edge, in order to prevent them from entering the bed of the river to too great a depth. In the platform there are two large rectangular openings in which the cylindrical caissons, C, of the piers are constructed and submerged. In order to perform these operations at any height of the sea, it is necessary that the platform shall be capable of rising and falling *in situ*. To this effect, each of the four columns is provided with two double vertical guide bars, B, (Fig. 5), of steel, which are diametrically opposite, 15 inches apart, and contain apertures 6 inches apart. Between these two bars move two plates, D D, which are connected with

(*Continued on page* 20.)

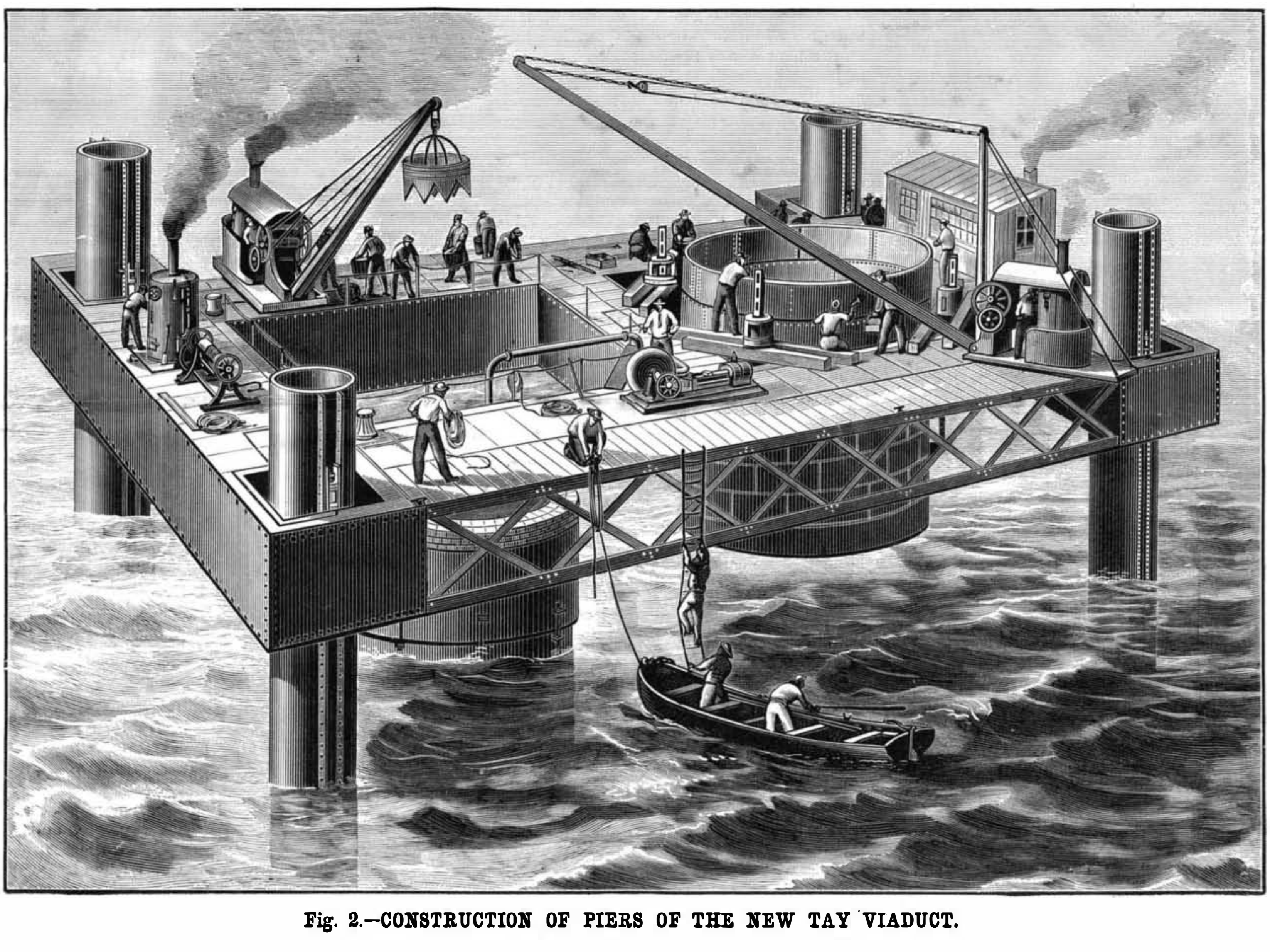

Fig. 2.—CONSTRUCTION OF PIERS OF THE NEW TAY VIADUCT.

THE NEW TAY VIADUCT.

(*Continued from first page*).

the platform, and are provided with apertures of the same diameter and spacing as the preceding. Moreover, the plates, D D, are provided with a longitudinal grove of a length equal to that of the stroke of the piston of the hydraulic engine. The ascent is effected as follows: Let us suppose the piston at the end of its stroke; the apparatus is keyed by passing a steel pin into the apertures of the guide bars, B, and into the head, I, of the piston. The admission of water above the latter presses the pin against the bars, B, and, as the column with which these are connected is bearing against the ground, the cylinder, E, is forced to rise and carry along the plates, D, along with the platform. When the entire affair has risen 6 inches, the apertures in the plates, D, come opposite those in the bars, B B, and a second pin is then passed into the corresponding apertures under the piston. The water contained in the cylinder, E, is then expelled, and the platform rests upon the lower pin that has just been inserted, thus allowing the other one to be removed. It is now only necessary to cause the piston to rise, and to replace the first pin, to prepare the system for an ascent. The descent is effected by proceeding in just the opposite way. The two cylinders, E, of each column are always conjugate, and can, when necessary, be joined to those of the other columns.

The method employed for submerging the cylindrical caissons is based upon the same principle. The caissons weigh, on an average, 50 tons, inclusive of the brick filling which is put in during the sinking. Four rods, L, of square section (Nos. 2 and 3, Fig. 5) are fixed at their lower end to a strong disk riveted to the caisson, and slide in a piston having a hollow rod, P, movable in a cylinder, A, on the platform. This cylinder is surmounted by a crosspiece, B (Fig. 5), which gives passage to the rods, L, which latter contain three rectangular apertures. When at rest, a bar inserted at K in one of these apertures holds the caisson. Let us suppose that each piston, P, has reached the end of its stroke; the cock, Q, that admits water is closed, and a bar is inserted in the hole, M that succeeds the hole K. Then the cock is opened so that the whole apparatus shall be supported by the piston, thus allowing of the removal of the bar inserted in the hole, K. Upon then opening the eduction, the piston and caisson descend together as far as the end of the former's stroke. At this moment a bar is inserted in the hole that has reached the level of the crosspiece, and everything is now ready for a second operation. The caisson thus gradually descends to the bottom.

From what precedes, it may be easily seen how the piers are constructed. The pontoon is set afloat, and hauled to the spot selected for the foundations by means of the service crane and of capstans around which wind cables fixed to the piers of the old bridge. Then the temporary supports that sustain the columns are removed, and allowed to rest upon the ground, care being taken to open the water valves of the caisson in order to prevent the pontoon from floating when the tide is rising. The platform is then raised to a proper height by means of the hydraulic cylinders. The stability of the whole is secured by means of anchors and chains.

The construction and submersion of the foundation caissons is performed as follows in the openings of the platform:

The rings are brought to the spot all prepared for being placed in position to be riveted together. While the riveting is being done, a lining of bricks is constructed in order to increase the caisson's weight. During the mounting of the sections, the entire affair is gradually let down by means of the hydraulic cylinders above described until the caisson touches bottom. The excavating apparatus are then set in motion, and the caisson sinks by its own weight (which, when necessary, is increased by a surcharge) until it reaches the proper depth. The interior is afterward filled in with concrete, and the foundation caisson is finished. When the second caisson has been finished in a similar manner, the platform is removed to another point of the work. This is done by lowering it to the proper level for floating, and then towing it to the desired spot.

When the pontoon has been removed, it remains to build the masonry pier up to the level of the octagonal metallic pier which is to surmount it. To this effect, temporary caissons are bolted to the main one before sinking it. These serve both for carrying the additional load above mentioned and for guiding the caisson during its descent. After exhausting the water from the latter the masonry is completed, and an anchor bolt two inches in diameter is inserted 20 inches beneath the summit. When the upper masonry is finished, the temporary caissons are unbolted, and those pieces are adjusted that serve to connect the metallic part of the piers with the masonry.

In short, the work is performed in the following order: 1. Putting the pontoon in place, descent of the caisson, excavation, and filling with masonry. 2. Tests of the strength of the foundation. 3. Construction of the upper masonry of the piers beneath the level of high water. 4. Finishing the pier up to the level of the octagonal metallic portion.

Four of these pontoons are now in use, the largest of which is 82 feet in length by 65 in width, and the smallest 55 by 36 feet. They are proportioned to the dimensions of the piers to whose construction they are to be applied. This very ingenious device can be economical only for large works, where there is quite a number of piers to be constructed. At the Tay viaduct it is giving excellent results. On the north shore (Dundee side), it has permitted of sinking and finishing one pier per week, consisting of two caissons 10 feet in diameter.

The work was begun in June, 1882. At present the masonry arches of the two extremities are finished, and nearly all the foundation caissons are sunk and filled. Half of these have received the octagonal piers, and part of the bridge, with its railway track, is now completed for a total length of 1,640 feet. The girders and superstructure of the 13 middle spans are being

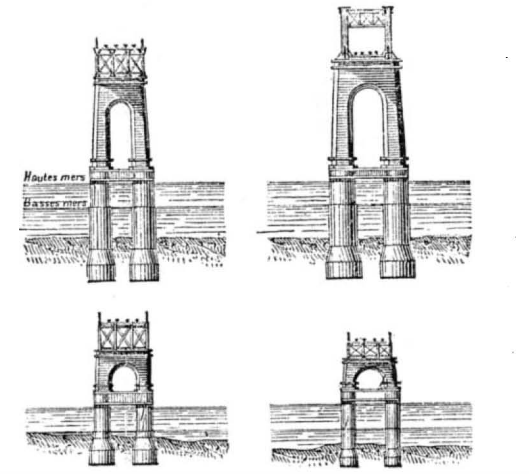

Fig. 3.—ELEVATIONS THROUGH A, B, C, AND D.

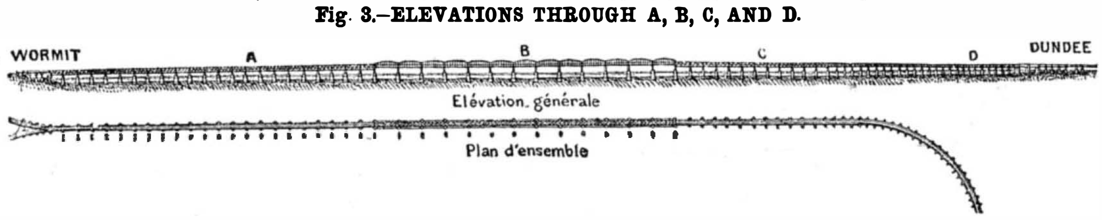

Fig. 4.—TAY VIADUCT.

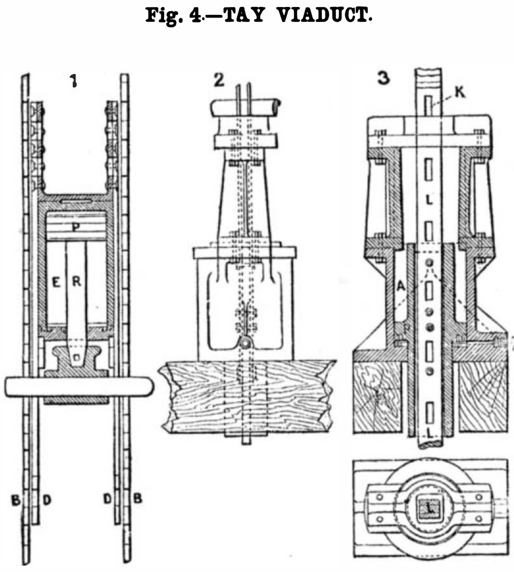

Fig. 5.—HYDRAULIC CYLINDER, FOR RAISING AND LOWERING MOVABLE PLATFORM.

put together upon a scaffolding at the extreme south of the work. When the parts for each span have been assembled, the irons will be placed upon the caissons already constructed, and will afterward be raised by hydraulic engines to the height that they are to occupy upon the octagonal piers.—*La Nature*.

The Sun's Corona.

Signor F. Tacchini, the successor of Signor F. Secchi at the Observatory of the Collegio Romano, has published a confirmation of the astronomer Forel's statement that the sun's corona is, in a clear sky, discernible on high mountains in a surprisingly distinct manner. He himself observed the phenomenon from the summit of Ætna at the beginning of July. At Rome, Naples, Messina, Catania, the sun appeared surrounded by a broad white crown; but from the top of Ætna, 3,300 meters above the level of the sea, in a very clear sky, it presented the appearance of a white ring surrounded by a splendid copper red corona. Near the horizon, the sun's appearance changed into an ill-defined arch of great span. He was able to observe all these phenomena at leisure on two different days. At sunrise and sunset he saw clearly the beautiful red light of the arch. But he is of opinion that those appearances are not as strong and brilliant this year as in 1833 and 1884.

Management and Care of Steam Boilers.

The following summary is issued by the Hewes & Phillips Iron Works, of Newark, N. J., and it comprises useful information to all in charge of engines:

"The first duty of an engineer, when he enters his boiler room in the morning, is to ascertain how many gauges of water there are in his boilers. *Never unbank nor replenish the fires until this is done.* Accidents have occurred, and many boilers have been entirely ruined, from neglect of this precaution.

"In case of low water, immediately cover the fires with ashes, or, if no ashes are at hand, use *fresh coal.* Do not turn on the feed under any circumstances, nor tamper with or open the safety valve. Let the steam outlets remain as they are.

"In cases of foaming, close throttle, and keep closed long enough to show true level of water. If that level is sufficiently high, feeding and blowing will usually suffice to correct the evil. In cases of violent foaming, caused by dirty water, or change from salt to fresh, or *vice versa*, in addition to the action before stated, check draught and cover fires with fresh coal.

"When leaks are discovered, they should be repaired as soon as possible.

"Blow off 8 or 10 inches at least once a week; every Saturday night would be better. In case the feed becomes muddy, blow out 6 or 8 inches every day. Never blow entirely off except when boiler needs scraping or repairing, and then not until fire has been drawn for at least ten hours, as boilers are often seriously injured or ruined by being emptied when the walls are hot. Where surface blow-cocks are used, they should be often opened for a few moments at a time.

"After blowing down, *allow the boiler to become cool* before filling again. Cold water pumped into hot boilers is very injurious from sudden contraction.

"Care should be taken that no water comes in contact with the exterior of the boiler, either from leaky joints or other causes.

"In tubular boilers the hand-holes should be often opened, and all collections removed from over the fire. Also, when boilers are fed in front and blown off through the same pipe, the collection of mud or sediment in the rear end should be often removed.

"Raise the safety valves cautiously and frequently, as they are liable to become fast in their seats, and useless for the purpose intended.

"Should the gauge at any time indicate an excessive pressure, see that the safety valves are blowing off. In case of difference, notify the parties from whom boiler was purchased.

"Keep gauge cocks clear, and in constant use. Glass gauges should not be relied on altogether.

"When a blister appears, there must be no delay in having it carefully examined, and *trimmed* or *patched*, as the case may require.

"Particular care should be taken to keep sheets and parts of boilers exposed to the fire perfectly clean, also all tubes, flues, and connections well swept. This is particularly necessary where wood or soft coal is used for fuel.

"Under all circumstances keep the gauges, cocks, etc., clean and in good order, and things generally in and about the engine and boiler room in a neat condition.

"Barium chloride and milk of lime are said to be used with good effect at Krupp's Works, in Prussia, for waters impregnated with gypsum.

"Soda ash and other alkalies are very useful in waters containing sulphate of lime, by converting it into a carbonate, and so forming a soft scale easily cleaned; but when used in excess they cause foaming, particularly where there is oil coming from the engine, with which they form soap. All soapy substances are objectionable for the same reason.

"Petroleum has been much used of late years. It acts best in water in which sulphate of lime predominates. As crude petroleum, however, sometimes helps in forming a very injurious crust, the refined only should be used.

"Rogers' tannate of soda is probably the best preparation for general use, but in waters containing much sulphate it should be supplemented by a portion of carbonate of soda or soda ash.

"For muddy water, particularly if it contain salts of lime, no preventive of incrustation will prevail except filtration; and in almost every instance the use of a filter, either alone or in connection with some means of precipitating the solid matter from solution, will be found very desirable.

"In all cases where impure or hard waters are used, frequent 'blowing' from the mud drum is necessary to carry off the accumulated matter, which if allowed to remain would form a scale."

BEWARE of long, crooked suction pipes, when erecting a pump. Bends, returns, and angles increase friction very rapidly. Also remember that doubling the diameter of a pipe increases its capacity four times.