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IMPROVEMENTS IN THE CABLE RAILWAY OF THE NEW YORK AND BROOKLYN BRIDGE.

Our readers who have not seen the great East River Bridge which connects New York and Brooklyn have been made familiar with its appearance and the details of its construction through the frequent and profusely illustrated articles on the subject which have appeared in these columns from time to time. It is not necessary, therefore, to go into minutiæ regarding the structure itself, but it will, perhaps, be well to repeat in brief some of the dimensions of the bridge, and give some facts regarding the traffic.

The bridge is 5,989 feet long, 85 feet wide, supported by four 15¾ inch wire cables. It is divided into five longitudinal divisions: the carriage ways being at the outside, the elevated promenade in the middle, and the two railways between the promenade and the carriage ways. An endless cable, 1½ inches in diameter, extends from the engine house in Brooklyn over sheaves at the center of the railway track to the New York terminus, thence across underneath the New York approach to the other railway, returning in the same manner.

The propelling plant, which has been in use upon the bridge from the day of its opening up to the present time, consisted of two horizontal steam engines, each having a cylinder 26 inches in diameter, a stroke of 48 inches, with a fly wheel 18 feet in diameter, weighing 30,000 pounds. These engines have been operated one at a time, jaw clutches being provided for throw-

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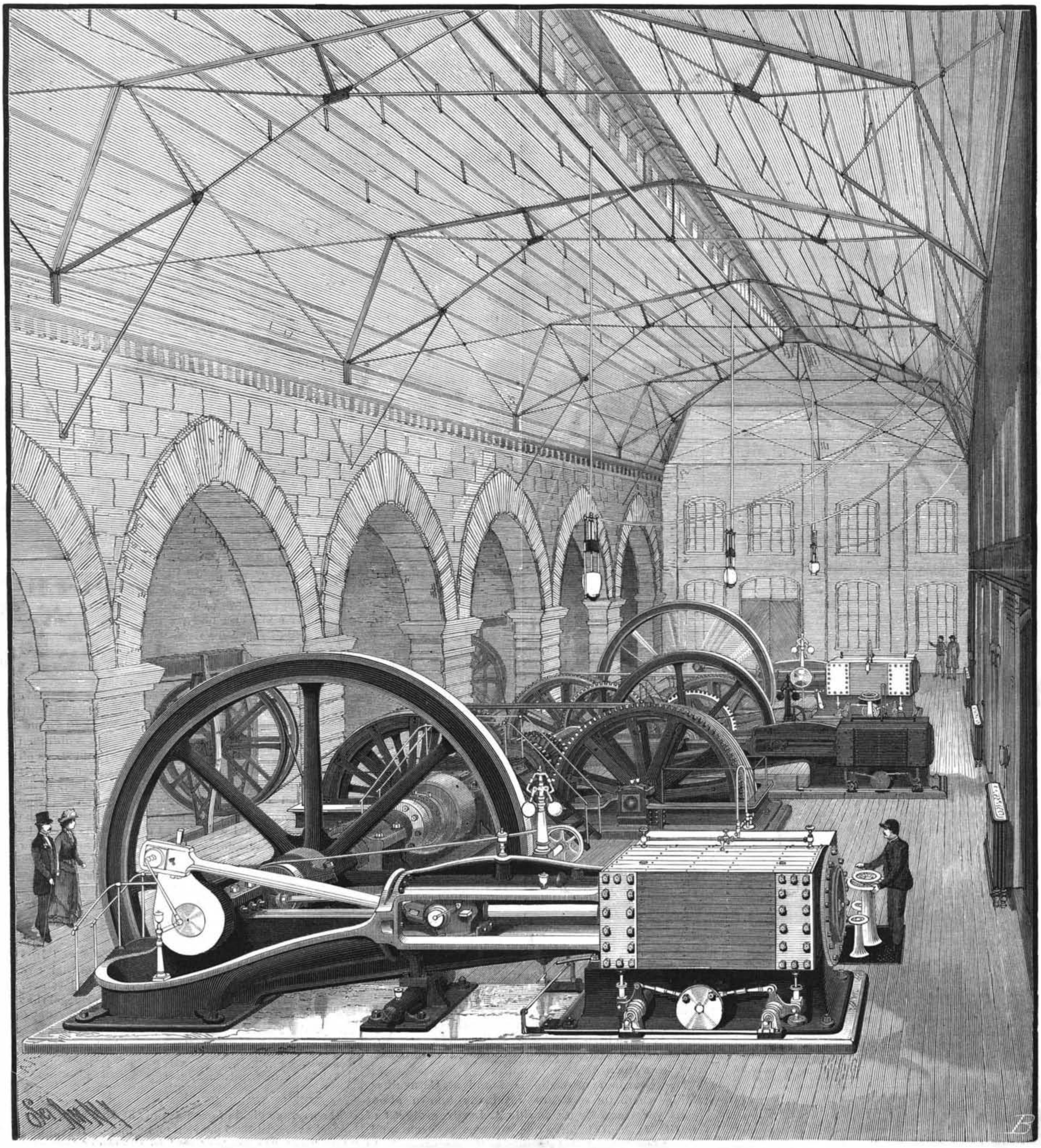

NEW CABLE DRIVING PLANT OF THE NEW YORK AND BROOKLYN BRIDGE.

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ing one or the other of the engines into gear with the cable drums, as required. The entire traffic of the railway has been carried on by means of 3-car trains, propelled by these engines through the medium of the cable.

Since the completion of the bridge, the growth of the traffic has been so regular and so rapid as to render apparent the necessity of increasing the carrying facilities. In April, 1884, 752,220 passengers were carried over the bridge. In April, 1888, 2,593,104 passengers were carried. If the traffic were evenly distributed through the day, the 3-car trains could readily carry the passengers for some time to come; but, as is well known, the traffic varies greatly with different hours of the day. For example: in the hour beginning at 8 o'clock in the morning, from 10,000 to 12,000 people are carried from Brooklyn to New York, while less than 1,000 are carried from New York to Brooklyn. In the hour beginning at 5 o'clock in the afternoon, from 9,000 to 10,000 people are carried from New York to Brooklyn, while only about 1,500 are carried at the same hour from Brooklyn to New York. In the middle of the day the average in either direction is about 2,000 per hour, and at midnight scarcely more than one-tenth of that number.

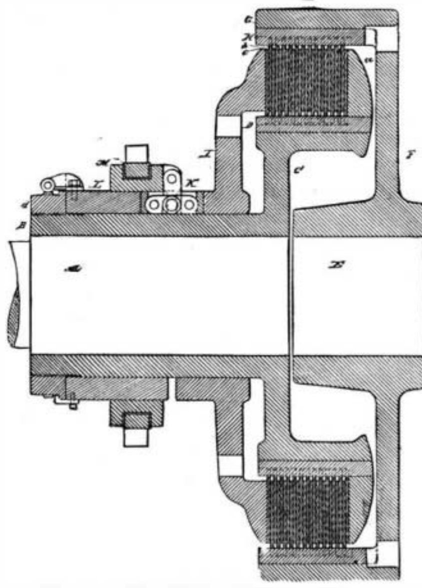

Fig. 3.—LONGITUDINAL SECTION OF FRICTION CLUTCH.

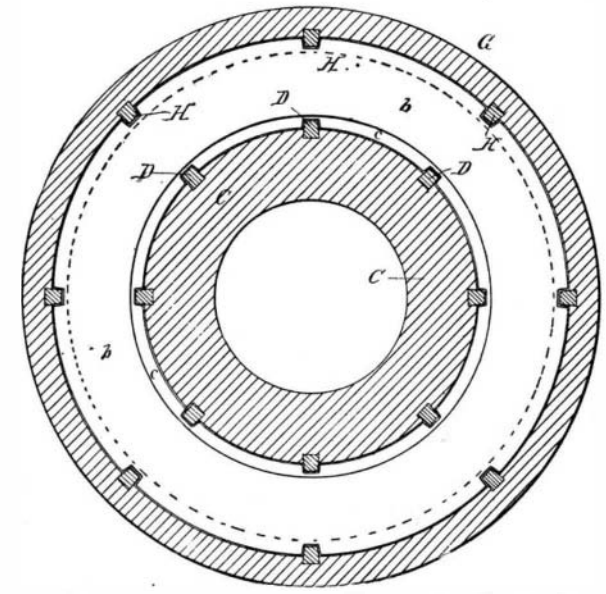

Fig. 4.—DIAGRAM SHOWING RELATION OF CLUTCH RINGS AND HUBS.

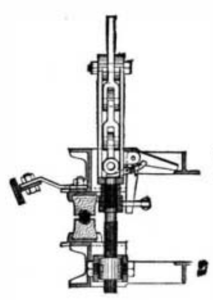

Fig. 8.—CROSS SECTION THROUGH VISE GRIP.

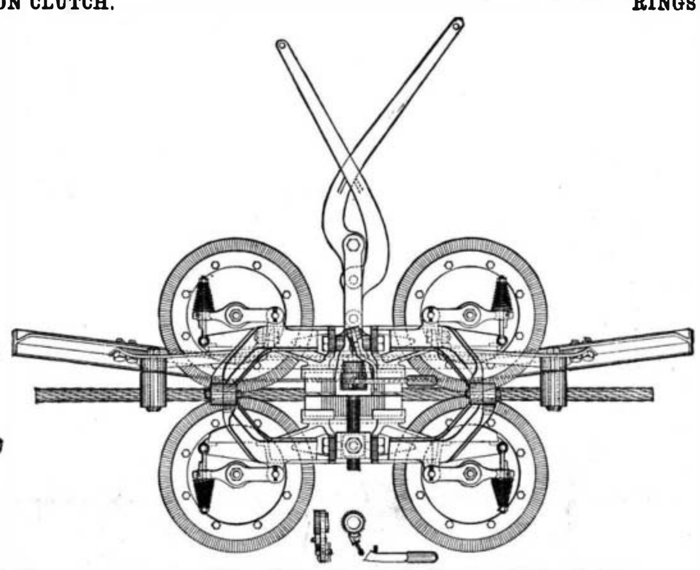

Fig. 6.—INVERTED PLAN VIEW—DETAILS OF GRIP.

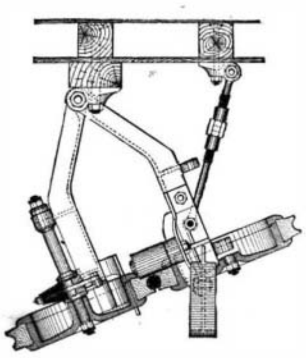

Fig. 7.—SECTION THROUGH SHEAVES.

This enormous traffic exceeds the original expectations, and the great and abrupt fluctuations of power required to propel the trains at these busy hours have severely tested the engines. One day's record showed that the power ranged from 303 h. p., as a maximum, to 12·9 h. p. negative, as a minimum. We are informed of one instance in which there was an increase of 190 h. p. within 15 minutes, and another in which the power was increased by 239 h. p. within 30 minutes.

To provide economically for the present traffic, to anticipate future increase, as well as to provide for various improvements which have been developed by conditions peculiar to this particular railway, and to guard against any suspension of traffic by any possible accident to a part of the machinery, a new driving plant has been constructed and put in operation.

The old machinery is located in one of the arches of the approach adjoining the Brooklyn station. The engines of the new plant are contained by a substantial brick building adjoining the north side of the approach, and abutting against the boiler house. In this building are placed three magnificent engines, built by William Wright, of Newburg, New York. They are of the girder type, of graceful design and elegant finish. These engines are placed parallel with each other, and arranged to be coupled independently with the cable drums. They are of three sizes; the largest one (625 h. p.), for propelling the trains at night and morning, has a cylinder 30 inches in diameter, with a stroke of 48 inches; the next in size (400 h. p.) has a cylinder of 26 inches in diameter, with a stroke of 48 inches; the smallest one (275 h. p.) has a cylinder of 22 inches in diameter, with a stroke of 36 inches. The fly wheel of the largest engine is 20 ft. in diameter, and weighs 50,000 lb.; the fly wheel of the next is 20 ft. in diameter, and weighs 40,000 lb.; and the fly wheel of the smallest engine is 15 ft. in diameter, and weighs 16,000 lb. The smallest engine is connected with the driving shaft by means of gearing and clutches; the larger engines are connected direct by means of clutches.

The driving shaft is made in sections, and arranged to be connected by jaw clutches and friction clutches, so that either of the engines may be brought into connection with either pair of cable drums. Each engine is provided with a friction clutch by which it may be thrown into engagement with the driving shaft while the cable and driving machinery is in motion, so that the engines may be shifted without loss of time.

One of these ponderous clutches is shown in Fig. 2. In the foreground of the picture may be seen the usual column and throttle valve wheel for starting and stopping the engine; also another wheel arranged upon a hollow shaft inclosing the throttle valve spindle, and connected with the clutch-operating mechanism. The operation of shifting the engines consists in starting the engine by means of the throttle valve in the usual way, and when the engine attains its normal speed, throwing in the clutch by means of the clutch-operating wheel, then disconnecting the clutch of the engine to be taken off.

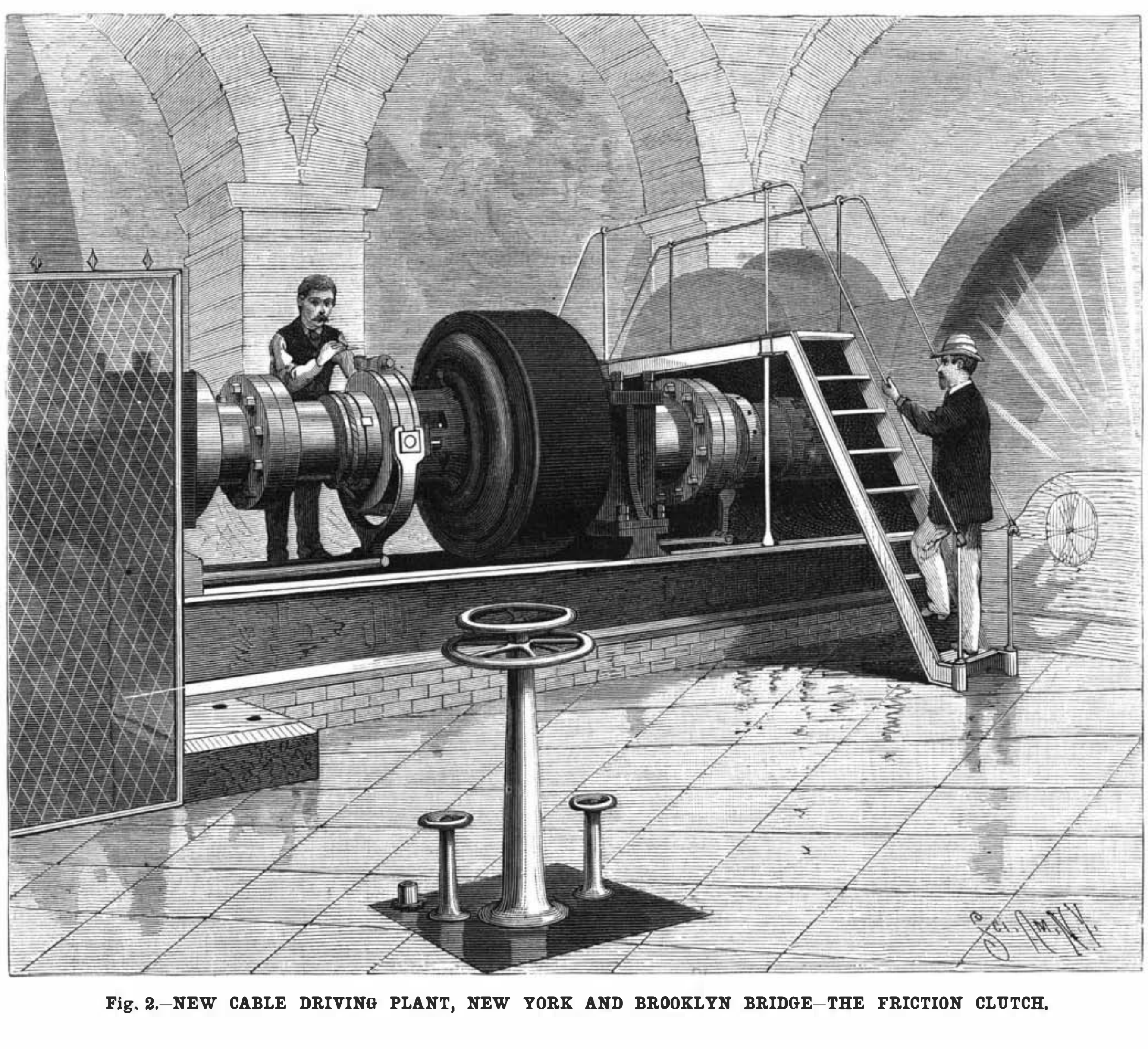

Fig. 2.—NEW CABLE DRIVING PLANT, NEW YORK AND BROOKLYN BRIDGE—THE FRICTION CLUTCH.

The details of the friction clutch are shown in Figs. 3 and 4, Fig. 3 being a longitudinal section of a clutch and Fig. 4 a diagram showing the relation of the clutch rings. To the engine shaft, A, is attached a sleeve, B, provided with a hub, C, which supports the friction rings, *b c*, the hub being provided with a flange, *a*, forming an abutment for the friction rings. In the hub, C, are inserted eight feathers, D. The rings, *b c*, are of two diameters, the rings, *b*, of smaller diameter being slotted to receive the feathers, D. The rings, *c*, which are of larger diameter, are slotted in their peripheries to receive eight feathers, H, inserted in the rim, G, of the hub, F, secured on the shaft, E. By this arrangement, it will be noticed that all of the rings, *b*, must turn with the hub, F, and all of the rings, *c*, must turn with the hub, C.

Upon the sleeve, B, is placed a clamping collar, I, which is capable of being forced into contact with the series of rings, *b c*, clamping them tightly against the flange, *a*.

On the sleeve, B, is placed a sleeve, L, which abuts against an adjusting ring, *d*, screwed on the end of the sleeve, B. The sleeve, L, forms an abutment for toggles, K, three in number, which serve to force the clamping collar, I, into contact with the rings, *b c*. On the sleeve, L, is placed a grooved ring, M, arranged to work the toggles, K, and in the groove of the ring, M, is placed a strap, which is connected through a system of levers with the clamping wheel before referred to. A is the driven shaft, E the driver. When the toggles, K, are loosened, the shaft, E, turns independently of the shaft, A ; but when the toggles are straightened, bringing the friction rings, *b c*, into forcible contact with each other, the shaft, E. will carry the shaft, A.

The capacity of the clutch is increased by increasing the number of the rings, *b c*. The clutch for the large 625 horse power engine has 27 rings, the clutch for the 400 horse power engine has 19 rings, and the clutch for the 275 horse power engine has 13 rings.

To guard against every possible emergency, all the important parts of the machinery have been made in duplicate. There are two sets of driving drums, two cables, one in motion and the other in reserve. The cable running out from the engine house passes over the deflection sheaves around sheaves carried by the tension car, thence outward, and the incoming or hauling end of the cable passes around a set of deflection sheaves, thence downward underneath the upper floor of the Brooklyn station to a large sheave revolving in a horizontal plane, and shown in Fig. 5, thence back to the propelling drums. The second cable, which is held in reserve, passes around an extra set of propelling drums, and is supported near the sheaves, in readiness to be transferred to them in case of necessity. The transfer of cables requires about one hour, and while it is being done the trains are carried over the bridge by locomotives.

The grip now used is shown in Figs. 6 to 8 inclusive ; Fig. 6 being an inverted plan view, Fig. 7 a section through the sheaves, and Fig. 8 a central cross section.

In the grip there are four sheaves placed in pairs, so that the cable is gripped between each pair. Each sheave has a heavy grooved rim with a cylindrical inner surface against which the brake presses. The rim is in two parts bolted together, and holds in a dovetail groove a packing of leather and India rubber belting in alternating pieces placed radially. The packing projects well out of the rim, and is grooved to receive the cable.

There are four brakes, one for each sheave. They are made of hard wood, with a curved outer face fitted to the inside of the rim of the sheave.

The main frame of the grip is in two parts, each hinged in a common line parallel to the cable, close under the car floor, one part hanging on each side of the cable. The sheaves are each carried by a small frame hinged to the main frame, on a line parallel to the shaft of the sheave. This small frame has a limited movement opposed by a coiled spring which tends to force the sheave away from its brake. Each of the four brakes is held by a projecting end of the main frame. The upper part of the main frame, from which the operating levers project, is fixed in position by adjustable stay rods. The movable part is connected to the operating levers by a coarse-threaded screw which is turned by a ratchet wheel and pawl.

As the grip is used the packing in the grooves of the sheaves is slowly compressed and worn, thereby permitting the sheaves to come more nearly together as the grip is closed, and the short arms of the operating levers approach more closely to a straight line, and as this continues, the pressure on the packed surfaces increases rapidly. Such action is prevented, when, as the grip is closed, a certain position of the levers in approaching each other is passed, by the pawl engaging with the tooth of the ratchet wheel, then, as the levers are separated, the screw is turned slightly, bringing the sheave surfaces and levers to their former and normal relative positions. As the grip is closed and the sheaves are brought into contact with the cable, they are revolved at cable speed, the car being at rest. As power is applied to the brakes, the sheaves are forced together with an increasing pressure, which is transmitted from the brakes to the sheaves, developing a frictional resistance which tends to prevent the sheaves from revolving. This action continues until the resistance in the four sheaves exceeds the tractive resistance of the car, when the sheaves cease to revolve and the car moves at cable speed.

The vise grip (which grasps the cable only as the frames and sheave packing yield) is intended to take full hold after the sheaves cease to revolve and the car is moving at cable speed.

To the frame holding the grip is applied an inverted rail, which comes into contact with flat-faced pulleys on the tilting frames of the sheaves which support the cable. This inverted rail causes the movable sheaves to hold the cable at the proper height to be received by the grip. The packing of the grips and sheaves forming the contact surface for the cable is made of alternating pieces of leather and India rubber. The packing is cut by machinery and the pieces are put together under pressure. The composite nature of the packing allows the leather to swell when moist and to shrink when dry, the elasticity of the rubber keeping the packing in proper shape.

Besides the hand brakes with which each car is provided, there are vacuum brakes operated by connection with reservoirs carried by the cars and exhausted of air by pumps operated by the eccentrics on the car axles. The brakes have proved very efficient, the vacuum being readily maintained by the pumps.

In the reconstruction of the propelling plant of the bridge great credit is due to Mr. C. C. Martin, chief engineer and superintendent, and to Mr. G. Leverich, assistant engineer, who have given to every detail of the new plant the utmost care and attention. Nothing has been omitted which would increase the efficiency of the machinery. On the other hand, nothing has been introduced that is without a practical bearing. The entire work has been done from plans and specifications furnished by the engineers. The engines were made by Mr. Wm. Wright, of Newburg, N. Y., as already stated. The cable drums and machinery are from the works of the Southwark Foundry and Machine Co., Philadelphia, Pa., and the clutches, including their operating gear, from the works of Poole & Hunt, of Baltimore, Md.

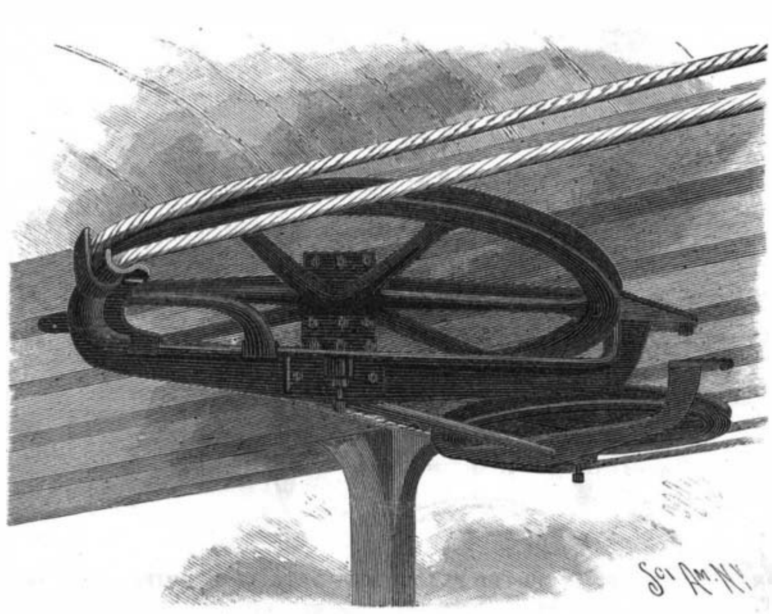

Fig. 5.—DEFLECTION SHEAVES AND AUXILIARY CABLE SUPPORT.

Electric Lights of Fishing Nets.

The Liverpool Marine Biology Committee lately made a three days' tour around the coast of Wales. The important feature of this cruise, says *Nature*, was the use which was made of the electric light for collecting after dark. On the first night, in Ramsey Bay, after the shore party had left and the ship was anchored for the night, an electric light of 1,000 candle power was hoisted a few feet above deck, and this allowed work to be carried on almost as comfortably as during the day. Captain Young, of the Liverpool Salvage Association, who was in command of the Hyæna, then kindly arranged for me a 60 candle power Edison-Swan submarine incandescent lamp in the mouth of a tow net. This illuminated net was carefully let down to a depth of three fathoms, and allowed to remain there for half an hour. At the same time another tow net without any light was let down to the same depth over the opposite side of the ship. When the nets were being hauled in, as the one with the electric light approached the surface, numerous small animals (crustacea probably) were noticed accompanying it, and darting about in the bright light. This tow net, when emptied into a glass jar of sea water, was found to contain an abundant gathering, consisting mainly of crustaceans, while the net in the dark on the other side of the ship had practically nothing.

The two nets were then put out again. The one had the electric light in its former position, but this time it was let down to the bottom at a depth of six fathoms, while the other net was placed in the dark at the ship's stern, and also reached the bottom. The tow nets remained stationary, but were kept distended by the tide. The outline of the illuminated net could be made out indistinctly at a depth of six fathoms. After being out for three-quarters of an hour, both nets were hauled in, with the same result as before. The illuminated net contained abundance of crustacea (chiefly amphipoda, schizopoda, and cumacea), while the dark net again contained practically nothing. These two experiments showed pretty conclusively the effect of the brilliant light in attracting the free swimming animals, the difference between the contents of the two nets being on both occasions most marked. Consequently, on the second night, in Port Erin Bay, both nets were illuminated, and while the one was let down close to the bottom, at a depth of five fathoms, the other was kept at the surface of the sea on the opposite side of the ship. This experiment was tried three times, with the same result each time; both the nets were found to contain abundance of animals, but the bottom and surface gatherings differed greatly in appearance and in constitution. The net from the bottom contained mainly large amphipoda and some cumacea, while the gathering from the surface was characterized by the abundance of copepoda.

Brief History of Timepieces.

At a recent meeting of the Balloon Society of Great Britain, an address was given by Mr. James Kendal on "The British Watch Industry." The lecturer stated that the sun dial of Ahaz is the first record of a timekeeper, that the obelisks of the Egyptians were intended as gnomons, and that the next record of a sun dial was the hemicycle of the Chaldean astronomer Berosus, 450 B.C. The clepsydra, or water clock, was the next contrivance for measuring time, used by the Chaldeans; but to whomsoever the early discovery of timekeepers may be due, he said that clocks were set up in churches as early as 1174, and in the reign of Henry VI. a pension was granted to the Dean of St. Stephen's for taking charge of a clock in Palace Yard, Westminster. In 1326 Richard Wallingford, abbot of St. Alban's, placed a clock in his monastery which showed the hours, the motion of the sun, the changes of the moon, the ebb and flow of the tide, etc., and the account of this clock is still preserved in the Bodleian Library at Oxford. In 1340 Peter Rightfoot, a monk of Glastonbury Abbey, made a clock which, at the Reformation, was removed to Wells Cathedral, and the original is now to be seen at the South Kensington Museum. The clock for the Strassburg Cathedral was begun in 1352, and finally completed in 1574 by Conradus Daspodius.

The use of the pendulum for securing accuracy of time was first adopted by Vincent Galileo, in 1648, and the anchor escapement, for regulating it, by Dr. Hook, 1666; and he stated that little progress was made since that time until Mr. Dennison, now Lord Grimthorpe, designed the clock for the Victoria Tower of the Houses of Parliament in 1854. The most remarkable episode in the construction of timekeepers is the lever escapement, invented by Thomas Mudge, in 1770, the last epoch in the history of the watch. The progress of the last fifty years in watch making has consisted rather in the perfection of proportions than in the introduction of new principles, for even the invention of winding from the pendant instead of a watch key is tardy appreciation of an invention patented more than half a century ago.

At the International Inventions Exhibition of 1885, Kendal & Dent exhibited a horological novelty of a watch with two dials placed back to back, with the movement between them. On one dial was marked the old divisions of twelve hours, and on the other the suggested hour circle with twenty-four divisions, and this invention attracted considerable attention from horologists and mechanicians. Mr. Kendal then referred to the important uses to which timekeepers are devoted by the use of marine chronometers to enable the navigator to ascertain his longitude as he travels over the sea. In 1714 the English government offered a reward of £10,000 for determining the longitude to within sixty miles, £15,000 within forty miles, and £20,000 within thirty miles ; and this reward was secured, after thirty years of unremitting labor, by John Harrison, a carpenter, of Faulby, in Yorkshire, who succeeded, in 1764, in producing the present marine chronometer.

Japanese Water Pipes.

The water supply of Tokio, Japan, is by the wooden water pipe system, which has been in existence over two hundred years, furnishing at present a daily supply of from 25 to 30 million gallons. There are several types of water pipes in use, the principal class being built up with plank, square, and secured together by frames surrounding them at close intervals. The pipes less than 6 in. consist of bored logs, and somewhat larger ones are made by placing a cap on the top of a log in which a very large groove has been cut. All the connections are made by chamfered joints, and cracks are calked with an inner fibrous bark. Square boxes are used in various places to regulate the uniformity of the flow of the water, which is rather rapid, for the purpose of preventing aquatic growth. The water is not delivered to the houses, but into reservoirs on the sides of the streets, nearly 15,000 in number.