gear with the steam engines and hydraulic engines. Fig. 8 is an enlarged section of one half of the engine-room, and Fig. 9 a sectional plan of the accumulator. Figs. 11 and 12 are a plan and elevation of the hydraulic engines for turning the bridge; and Figs. 13 to 16 show the gear at the two extremities of the bridge for working the adjusting supports and the locking bolts.

The total length of the bridge, fixed and movable, is 830 ft. The fixed portions consist of five spans of 116 ft. each from centre of piers, Figs. 1 and 2. The bridge being for a double line of railway, each span is composed of three wrought-iron plate girders, the centre girder having a larger section to adapt it for its greater load; these girders have single webs, and are 9 ft. deep in the centre. The total width of the bridge from outside to outside is 31 ft. Each of the piers for the fixed spans consists of three cast-iron cylinders of 7 ft. diameter, and about 90 ft. length. The depth from the underside of the bridge to the bed of the channel in the deepest part is about 61 ft. The headway beneath the bridge is 14 ft. 6 in. from high water datum, and 30 ft. 6 in. from low water.

The swinging portion of the bridge, Figs. 3 and 4, consists of three main wrought-iron girders 250 ft. long and 16 ft. 6 in. deep at the centre, diminishing to 4 ft. deep at the ends. The centre girder is of larger sectional area than the side girders, and instead of being a single web is a box-girder 2 ft. 6 in. in width (Fig. 8), with web plates $\frac{3}{8}$ in. to $\frac{3}{4}$ in. in thickness, and the top and bottom booms contain together about 132 square inches section. The roadway is carried upon transverse wrought-iron girders resting upon the bottom flanges of the main girders, Figs. 8 and 14. In the centre of the bridge the main girders are stayed by three transverse wrought-iron frames securely fixing them together; and over the top of these frames a floor is laid, from which the bridge-man controls the movements of the bridge.

An annular box-girder, A A, 32 ft. mean diameter, is situated below the centre of the bridge, and forms the cap of the centre pier, Figs. 5 and 8; this girder is 3 ft. 2 in. in depth and 3 ft. in width, and rests upon the top of six cast-iron columns, each 7 ft. diameter, which are arranged in a circle, and form the centre pier of the bridge. Each of these columns has a total length of 90 ft., being sunk about 29 ft. deep in the bed of the river. A centre column, B B, 7 ft. diameter, is securely braced to the six other columns by a set of cast-iron stays, which support the floor of the engine-room. This centre column contains the accumulator C, Fig. 5, and forms the centre pivot for the rotation of the bridge.

The weight of the swing bridge is 670 tons. There is no central lifting press, and the entire weight rests upon a circle of conical live rollers, E E, Figs. 5 and 8. These are 26 in number, as shown in the plan, Fig. 6; they are each 3 ft. diameter, with 14 in. width of tread, as shown in Fig. 10, and are made of cast iron hooped with steel. They run between the two circular roller paths, D D, 32 ft. diameter and 15 in. broad, which are made of cast iron faced with steel; the axes-of the rollers are horizontal, and the two roller paths are turned to the same bevel.

The turning motion is communicated to the bridge by means of a circular cast-iron rack, G, Fig. 8, 124 in. wide on the face and 63 in. pitch, which is shrived to the pitch line, and is bolted to the outer circumference of the upper roller path. The rack gears with a vertical bevel wheel, H, which is carried by a steel centre pin, J, supported in the lower roller path; and this wheel is driven by a pinion connected by intermediate gearing with the hydraulic engine. There are two of these engines, duplicates of one another, which are situated at K K in the engine-room, Figs. 7 and 8; and either of them is sufficient for turning the bridge, the force required for this purpose being equal to about 10 tons applied at the radius of the roller path. Each hydraulic engine is a three cylinder oscillating engine, as shown in Figs. 11 and 12, with simple rams of 44 in. diameter and 18 in. stroke. These engines work at 40 revolutions per minute, with a pressure of water of 760 lb. per inch, and are estimated at 40 horse power each. The steam engines for supplying the water pressure are also in duplicate, situated at L L, Fig. 7, and are double-cylinder engines driving three-throw pumps of 22 in. diameter and 5 in. stroke, which deliver into the accumulator. The steam cylinders are 8 in. in diameter and 10 in. stroke, each engine being 12 horse power. It may be mentioned that, for the purpose of confining within a small space the steam power required for charging the accumulator, the pair of boilers used were of the construction known as Field boilers, having vertical double water tubes, and each boiler was only 44 ft. diameter and 64 ft. high, so that they took up very little room in the limited space available within the centre pier of the bridge; they had also the advantage of raising steam much more quickly than other constructions of boilers. In the present instance the situation of the boilers did not allow of the usual vertical uptake passing out at the top; and the flue was consequently carried down at the side and continued horizontally to a chimney at the end of the stage adjoining the pier.

The accumulator, C, Fig. 4, shown also in the sectional plan, Fig. 9, has a ram 164 in. diameter, with a stroke of 17 ft.; it is loaded with a weight of 67 tons, composed of cast-iron segments suspended from a crosshead, and working down inside the cylindrical casing formed by the centre cylinder of the pier. A pair of cross beams, M M, are fixed to limit the rise of the weight.

For the purpose of obtaining a perfectly solid roadway