sixty 1 $\frac{3}{16}$ inch bolts of best iron. The whole of these cylinders are alike, save in varying thicknesses, excepting the bottom three pieces. The bottom pieces A and B are telescopic, with outside flanges C and D, 6 inches and 7½ inches respectively; the bottom piece, B, was suspended to the upper piece by rods in No. 1 pit, and in No. 2 pit, by an internal flange which permits of the second piece (A) sliding downwards on the outside of the first piece. Whilst being lowered, the outside flanges of the bottom pieces, which are called the Moss Box (and which are the only two cylinders with outside flanges), are 5 feet apart, and the interval is filled with tightly compressed moss. When the lowest pieces rests on its bed, at the bottom of the pit, the remainder of the cylinders continue to descend, compressing the moss with the whole weight of the Tubbing, namely, over 400 tons.

In the middle of the third cylinder from the bottom there is an extra internal flange E, 3½ inches wide, on which is screwed, by sixty-four bolts, a flat ring or circle of cast iron F, 5½ inches broad. The ring admits of the False-Bottom G being withdrawn up the interior of the Tubbing to the surface, when the operation of lowering the Tubbing has been completed. A massive dish plate F, of cast metal 1½ inch thick, is bolted to the bottom, having a flange H on the upper side, for attaching the column of pipes. The object of the False-Bottom is to float the Tubbing whilst it is being lowered.

After carefully securing together by their respective flanges and attachments the three pieces of Tubbing intended for the bottom, they are lowered to the level of the water by an arrangement of screw-rods worked by six powerful winches, with two men to each; additional cylinders and central pipes are then added one by one, causing the whole of the Tubbing to sink until it floats by the displacement of the water. In the Marsden No. 2 pit the Tubbing floated when cylinder No. 9 was attached. The rods are thereupon removed, and as each additional cylinder is added, a certain quantity of water is run inside to cause the Tubbing to sink. In the Marsden No. 2 pit the addition of cylinder No. 10 caused the Tubbing to sink 1 foot 9 inches, and of cylinder No. 56 at the top 1 foot 1 inch.

In both pits this operation was completed without leakage, either at the joint of the cylinder, or of the central column of pipes, the work, however, requires great care and watchfulness, being attended with risk, as any leakage would cause the Tubbing to sink to the bottom.[1]

Concreting.

This operation consists in filling with concrete the annular space between the exterior surface of the Tubbing and the sides of the shaft, from the Moss-box upwards to the top of the Tubbing (I, p. 241, Figs. 6 and 7) The concrete is lowered simultaneously all round the pit by four rectangular boxes, 3 feet long 18 inches broad, and 4½ inches wide, shaped to the radius of the pit (p. 237, Fig. 15).

A large gullet was passed through in No. 2 Pit at a depth of 56 yards from the surface, the width of which was nearly the whole diameter of the shaft. When concreting at this point, 20 cubic yards of small stones and concrete were filled in, and 80 and 40 cubic yards at smaller gullets lower down (p. 261, Fig. 8), without sensibly raising the level of the concrete

Accidents.

The only accident that occured during the execution of the works at Marsden of special interest was the loss of one of the teeth of the small Trepan in the No. 1 Pit. The difficulty attending this accident arose from the tooth having been deeply embedded in the rock at the bottom of the borehole by repeated blows of the Trepan, before its loss was discovered, after having fallen from its socket Upon withdrawing the Trepan the Grappling Tongs were introduced, and the position of the tooth accurately determined, but so firmly was it embedded that the Tongs were unable to raise the tooth. It having been thus ascertained that the embedded tooth was at the edge of the pit, in the position occupied by the teeth at the extreme edge of the Trepan, these end teeth were removed, and the Trepan lowered again, and boring recommenced and completed to the depth of the height of the teeth of the Trepan, thus leaving a solid ring of stone round the edge of the pit; the Trepan was again withdrawn, and after the outside teeth had been replaced, the boring was recommenced close on one side of the embedded tooth, and continued until the other end of the Trepan reached it on the other side, when it was lifted over and commenced work again on the other side. This was continued until the whole of the ring of stone was removed, excepting two small parts opposite each other, on one of which the embedded tooth lay. A few sharp blows of the Trepan released the embedded tooth, which was then without trouble picked up by the Grappling Tongs. When it is remembered that this operation was performed at the bottom of a pit 258 feet from the surface, and full of water, the skilfulness of the arrangements will be appreciated.

General Results.

It will be seen from Tables in the Appendix that the absolute time taken from commencing to finishing the Boring was one year five months in No. 1 pit, and one year seven months in No. 2 pit. There was, however, a delay of several months in No. 2 pit on account of the Tubbing not being ready; the depth of boring was also 40 feet greater. The time occupied in lowering the Tubbing and concreting, etc, was three and a half months in No. 1 pit and four months in No 2 pit. The total time taken to complete each pit was one year eight and a half months in No. 1 pit, and a year eleven months in No. 2 pit

The average distance bored in No 1 small pit in the Limestone was 1 foot 3¼ inches per shift of twelve hours, and in the Coal-Measures 1 foot 8½ inches In No 1 large pit in the Limestone it it was 7½ inches, and 8¼ inches in the Coal-Measures. In the small No 2 pit the average distance bored in the Limestone was 10½ inches per shift of twelve hours, and in the Coal-Measures 1 foot 4 inches. In No 2 large pit in the Limestone it was 8½ inches, and 9¼ inches in the Coal-Measures.

The success of the Kind Chaudron process at Marsden may be attributed—

1st. To the primary adoption of a size of pit no larger than had previously been successfully completed by this process elsewhere.

2nd. The use of tools which had already been thoroughly tested in the sinking of a previous pit.

3rd. In the purchasing of the necessary additional tools from firms accustomed to their special manufacture.

4th. To the excellent workmanship and quality of the metal of the Tubbing supplied by the Elswick Ordnance Works.

5th. To the entire absence of soft strata in the shafts.

6th. To the efficient and experienced staff of officials supplied by the Kind-Chaudron Company for the carrying out of this work; and to the cordial co-operation of the Belgian and English Engineers, foremen, and workmen.

The terms of the contract were that no payment had to be made to the Kind-Chaudron Company for the patent right and superintendence unless the following conditions were fulfilled, —that the Tubbing when completed should not be more than 6 inches out of the perpendicular, and not let pass more than 40 gallons of water per minute. On the formal examination by the Engineers of the Whitburn and Kind-Chaudron companies, it was found that in No. 1 pit the Tubbing was only 1 inch out of the perpendicular, and let pass about 1 gallon of water per minute, and this only at the wedging joint below the Moss-Box. In No. 2 pit the Tubbing was only 2 inches out of the perpendicular, and no water passed. In both cases the Tubbing itself from top to bottom was absolutely dry.

The paper is accompanied by numerous diagrams and small scale drawings, from which plates 1, 2, 3, and 4, have been prepared.

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[1] In the deep sinking at Ghlin near Mons, now in operation, the depth bored is 1,026 feet, with an internal diameter of 14½ feet. The thickness of the Tubbing at the top being 1 inch, and at the bottom 3½ inches, the total weight being taken at 1,272 tons, at a cost of £12 per ton, brings the cost of the Tubbing alone for the two pits to more than £30,000. The bottom of the hard rock was bored through at a depth of 381 feet, and below this, before reaching the impervious Coal-Measure (in which the Moss-Box will be laid at a depth of 1,060 feet) 80 feet of running-sand, gravel, and clay were bored through, and a wrought-iron tube was inserted to protect the sides until the main Tubbing is lowered down.

Paper from Moss.—A new branch of industry has sprung up in Sweden lately—the manufacture of paper from moss, not from the living plant, but from the bleached and blanched remains of mosses that lived centuries ago, and of which enormous masses have accumulated in most parts of Sweden. A manufactory of paper from this material has begun operations near Joenkoeping, and is said to be turning out paper in all degrees of excellence, from tissue to sheets three quarters of an inch in thickness.