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NOTES ON TUNNELLING FOR SEWERS

SOME INSTANCES INVOLVING DIFFICULT CONSTRUCTION THROUGH UNFAVORABLE GROUND — IMPROVISED METHODS TO COPE WITH UNSTABLE SOIL, HEAVY SURFACE TRAFFIC, ETC., MEETING WITH SUCCESS.

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IN the laying of sewers, according as the ground varies so must the systems of placing temporary and permanent support be changed to meet the particular conditions. It has been the author's good fortune to be connected with tunnels driven through all gradations of stability, from hard rock, shale and boulder clay down to glacial mud and quicksand. In the firmer ground the usual methods, such as top heading with crown bars, cap and leg, and so on, were adopted with brickwork and concrete as the permanent lining of the tunnel, but more difficult circumstances necessitated other means.

The low-level intercepting sewers of Glasgow were almost all near, and parallel to, the River Clyde, and on a grade below high tide level, while in the streets along which they passed there was very heavy traffic. In this case, when unstable ground was met with, a permanent construction of cast iron segments with a finishing inside lining of concrete was adopted.

Iron Segments or "Plates."—This form of cast iron tunnel is shown in Fig. 1, and sewers from 3 ft. 6 in. to 9 ft. in diameter were built of these "plates." Each tunnel ring measured 1 ft. 6 in. in length, and consisted of five or seven plates and a key, all having 5-inch flanges; the lower plates having radial flanges and the two upper ones each a non-radial flange to admit of the key being pushed up from below. The key had parallel flanges. The metal was ¾ in. thick and the flanges 1 in. thick, stiffened with feathers cast between the bolt holes. Both the plates and the key had a 1-in. diameter hole in the centre, to admit grout under pressure. The horizontal and vertical flanges had a fillet 1½ in. wide and ⅛ in. thick cast on the outer edge to form a joint of iron to iron. In the space, ¼ in. by 3⅞ in., between the flanges a slip of white pine ⅜ in. thick was placed, and as the bolts were tightened up this was compressed, forming a fairly close joint. All joints were bolted with 1 in. diameter bolts having hexagon nuts and a grummet of tarred string below each washer at the head and nut. Oak wedges 2½ in. by 2 in. were driven into the white pine packing at all joints which leaked, serving well the purpose of stopping these leaks.

On curves of sharp radius (50 feet) special radiated rings were used, but on those of flat radius the necessary curvature was obtained by double packing the outer side of the curve; or, if this gave the iron too great a lead, a strip of felt was used. Longer bolts were required on curves. Felt was also used to raise or depress the rings, and with double packings on curves a good deal of adjustment was necessary to keep the tunnel to gradient.

Excavation in Glacial and Mud.—This clay was of a brownish grey color, very finely divided, entirely free from stones or grit, and very uniform except as to the amount of water it contained. It varied a little in toughness, but in no case could it be got to drain. When freshly cut, this clay would stand for a very short time

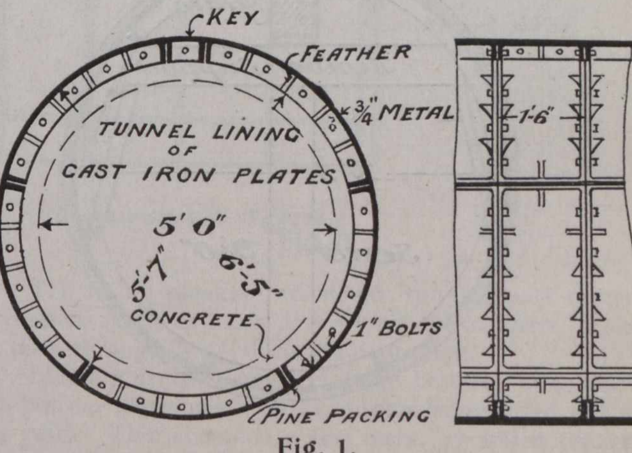

Fig. 1.

with a narrow face, five or six feet in height, but with exposure to air or the slightest amount of working, it became a tough slurry into which the miners sank to knees.

At the start of one section (5-ft. sewer) the miners, not being familiar with the good points of iron rings, attempted to take out a length of 9 feet on timbers instead of opening out ground for one ring at a time. The result was most unsatisfactory. It took them four or five days to get out a length, while a great deal of timber was used and unnecessary excavation removed, causing surface subsidence with a cover of 20 feet. The miners next tried a shorter length, sufficient excavation for two rings only being taken out, and the working conditions improved considerably, much lighter timber being used. After tak-