required inside diameter of the pipe. Immediately below the packer wings is a kind of piston called a packer head, which, on revolving, produces the smooth inner surface of the pipe. The strong centrifugal force exerted by the packer wings packs the concrete hard against the corrugated outer mould or jacket. Below the packer head is the bell packer, which forms the bell of the pipe. All the packers revolve at the rate of 350 r.p.m.

The concrete is fed into the jacket of the pipe by passing through a chute from an endless chain of buckets. When more concrete is added, the packer head and wings are gradually raised until the top or spigot end of the pipe is completed. No inner form is used, as the concrete is so densely packed, and of a semi-dry mix, that it perfectly retains its true shape.

TABLE 1—CRUSHING TEST ON MCCRACKEN PIPE, BY CANADIAN INSPECTION & TESTING CO., LTD.

| Number of Samples Tested. | Diameter, Ins. | Length, Ins. | Thickness, Ins. | Capacity in Lbs. per Lin. Ft. (Average). | A.S.T.M. Requirements, Lbs. per Lin. Ft. |
|---|---|---|---|---|---|
| 3 ..... | 6 | 25 | ¾ | 2,477 | 1,430 |
| 2 ..... | 6 | 30 | ⅞ | 2,570 | 1,430 |
| 3 ..... | 10 | 30 | 1 | 2,440 | 1,570 |
| 2 ..... | 12 | 30 | 1⅛ to 1¼ | 2,235 | 1,710 |
| 3 ..... | 15 | 30 | 1½ | 2,338 | 1,960 |

When the pipe is made it is removed to a curing shed or kiln and the jacket removed. A system of sprinklers is operated in this kiln, and a mixture of water and steam, at 70 degs. F., in the form of a very fine spray or mist, is allowed to fill the kiln for 30 hours, thereby procuring perfect hydration of the cement. After two weeks, the pipes are ready for shipment.

The McCracken pipe is made in sizes from 6 ins. to 24 ins., and has been used extensively in many local works, including storm sewers for Toronto Harbor Commission and the cities of Guelph, Gault, Woodstock, Walkerville, London, etc. Also many English contracts have been supplied with this kind of pipe through McCracken machines installed there.

Table 1, giving some data of very recent tests made on these types by the Canadian Testing & Inspection Co., Ltd., show that the requirements of the American Society for Testing Materials are more than complied with. To obtain the crushing strength, divide the capacity in pounds per lineal foot by the barrel length, and multiply the result by ten-sevenths if a knife-edge test; if a sand test, multiply by one.

TABLE 2—ABSORPTION TEST ON MCCRACKEN PIPE, BY CANADIAN INSPECTION & TESTING CO., LTD.

| Diameter, Ins. | Absorption. | A.S.T.M. Requirements. |
|---|---|---|
| 6 ..... | 4.6% | 8% |
| 8 ..... | 4.6% | 8% |
| 10 ..... | 3.9% | 8% |

In the absorption test, a square piece of the broken pipe is used, about 12 to 20 ins. square, and thoroughly dried in an oven at 230 degs. F., then weighed and soaked in water for 2 hours. The excess globules of water are wiped off and the piece again weighed. The difference in weight is expressed as a percentage. The tentative specification of 1918, of the American Society for Testing Materials, is practically the same as the specifications used for vitrified pipe for many years in the United States. (See Table 2.)

All the pipe manufactured by the Independent Pipe Co., Ltd., is carefully inspected, both during and after manufacture, by the Canadian Testing & Inspection Co., and each length must bear their official stamp before shipment. This is a long stride towards overcoming the prejudice that engineers have against the use of concrete products in general. This prejudice, in the past, I am bound to admit, has been to a certain extent justified, due to carelessness in manufacture and lack of adequate inspection.

Lock joint pipe was designed by Coleman Meriwether. The original design for sewer pipes was in 4-ft. lengths to overcome various obstacles and objections to the plain monolithic concrete sewer. This was at Wilmington, Del., in 1908. It was found that the work proceeded more rapidly and that the excavation cost was considerably reduced owing to the fact that the pipe could be layed right up to the excavation. This meant that quite a proportion of the lower and more expensively handled dirt could be thrown back on the pipe without damaging the joints. The sheet piling could be pulled and the trench back-filled at the end of the day's work, thereby considerably reducing that well known, and often abused item, "engineering contingencies."

Lock joint pipes are made in sizes from 15 to 90 ins., with variations of 3 ins. up to the 72-in. size. Above 72 ins. vary in 6-in. steps. They are moulded vertically in well-oiled steel forms, spigot end up. The reinforcement, usually triangular wire mesh, protrudes about 2 ins. from each end of the pipe, and when the pipes are laid in position, this reinforcement overlaps in a recess formed in the interior of the joint, which is V-shaped, and formed by the spigot and bell ends of the pipe. A sealing form is then placed inside the pipe over this recess and a 1:1 grout is poured through a hole broken in the crown of the bell. The steel and the grout form the "lock." Sewer pipes are usually made in 4-ft. lengths, and branch connections moulded where specified. The reinforcement is concentric, with a double ring for the larger diameters.

### Lock-Joint Pressure Pipe

Two kinds of lock-joint pressure pipe are manufactured. For the smaller sizes, up to 54 ins. and 12-ft. lengths, cast-iron machined bell and spigot rings are cast in the ends. A slightly flattened lead pipe, filled with lampwick, and having its end soldered together to form a ring, is placed inside a groove and pressed against a shoulder of the casting, forming a reversed wedge inside the bell. When the tapered end of the spigot comes into contact with this lead gasket, it forces it radially against the shoulder of the bell and into the reverse wedge, with a pressure which increases as the tapered end increases. The pipe is forced home when the taper of the spigot has passed this gasket. This joint allows the spigot to move backwards and forwards on the lead gasket, through the extremes of expansion and contraction, without causing any leakage. The use of this joint was greatly appreciated by the American Reclamation Bureau. About 10% of the lead of the usual cast-iron pipe joint is required, and if necessary the pipes can be taken apart and the gasket used over again. The thickness of the walls vary from 3 ins. to 5½ ins. for the 54-in. diameter pipe.

For the larger pressure pipes, ordinarily 8 ft. long, a copper expansion joint, with a bead rolled into it, is used. The joint is similar to the sewer pipe joint except that the triangular mesh reinforcement projects from the bell end only, while the copper strip and its rolled bead project from the spigot end, half the width of the strip being previously moulded into the pipe. The mesh and copper, therefore, overlap in the recess of the joint. The grout is poured as in the sewer pipe, and adheres to the copper and mesh, but is prevented by paint from adhering to the concrete spigot of the other pipe.

When the temperature movement of the pipe occurs, the bead on the copper opens or closes without causing an opening in the joint.

### Leakage from Winnipeg Aqueduct

This joint was recently used in 10 miles of 66-in. diameter pipe for the Greater Winnipeg Water District. The head varied from 45 to 95 ft. The leakage allowed was 118,000 gals per diem, and when tested it did not exceed 43,000 g.p.d. Incidentally, for the remainder of the 95 miles of aqueduct, built in 45-ft. sections of the inverted horse shoe shape, a beaded copper strip was used at the joints with good success.

A good type of subaqueous pipe, rigid and non rigid, is also made by the Lock Joint Pipe Co. A modified type of

*(Concluded on page 412)*