that if the power goes off in one system, power may be immediately taken from the other. If the compressed air is allowed to fail, even for a short time, the water which has been forced from the ground will return and bring sand with it into the tunnel. The result then may be the loss of one or two days in removing the sand from the filled-in heading, erecting new timbering or filling the cavity left by the sand which ran into the heading.

When compressed air is used, air-locks are provided at the shaft to confine the air to the tunnel (Fig. 3). These locks consist of a section of sewer with a bulkhead at each end. The bulkheads each contain a steel door and frame. The doors are fitted with rubber around the edge in order that they may fit tight against the frame when shut. Sometimes a steel cylinder is used for a lock. This only requires a bulkhead at one end (Fig. 4). Generally enough sewer is built in open cut to contain the locks—60 to 70 ft. But sometimes this portion is constructed in tunnel, which is probably cheaper to begin with, but the work is never so tight and it is difficult to maintain the necessary air pressure. When the locks are built in open cut, the ground is all filled in again except the space left for a shaft between the two locks, if two are built. A concrete or brick lining is then erected in this shaft for about 10 ft. above the future sewer or above the possible water line.

Sometimes when high pressure is required, a wedge (Fig. 5) is forced into the solid ground at the end and over the lock to prevent the air from escaping back over the finished work. This wedge consists of a tight thickness of planks the width of the open cut forced into the ground horizontally with jacks, another row on the slant about 4 ft. above the horizontal row, the ends of these meeting the ends of the first. The earth is then removed between these layers of planks and the space rammed full of concrete.

Where the tunnel is for a small sewer, say, 4 ft. in diameter, the volume of air in the tunnel and the area for its possible escape will be comparatively small. Air pumps of 500 cu. ft. capacity will be sufficient. If an air pressure of less than 20 lbs. is required, motors of 40 h.p. are quite sufficient to operate the pumps. Where a larger pressure is required, larger pumps are necessary. In several cases where large sewers were built in Toronto, pumps of 900 to 1,000 cu. ft. capacity were used and these required motors of 50 to 75 h.p. to operate them. The horse-power depends on the load to be carried.

The following is a table of material and costs of a 1,500 cu. ft. capacity plant consisting of two units of 750 cu. ft. capacity each. This table was kindly furnished by Messrs. Jennings and Ross, who are contractors for a trunk sewer on West Toronto Street.

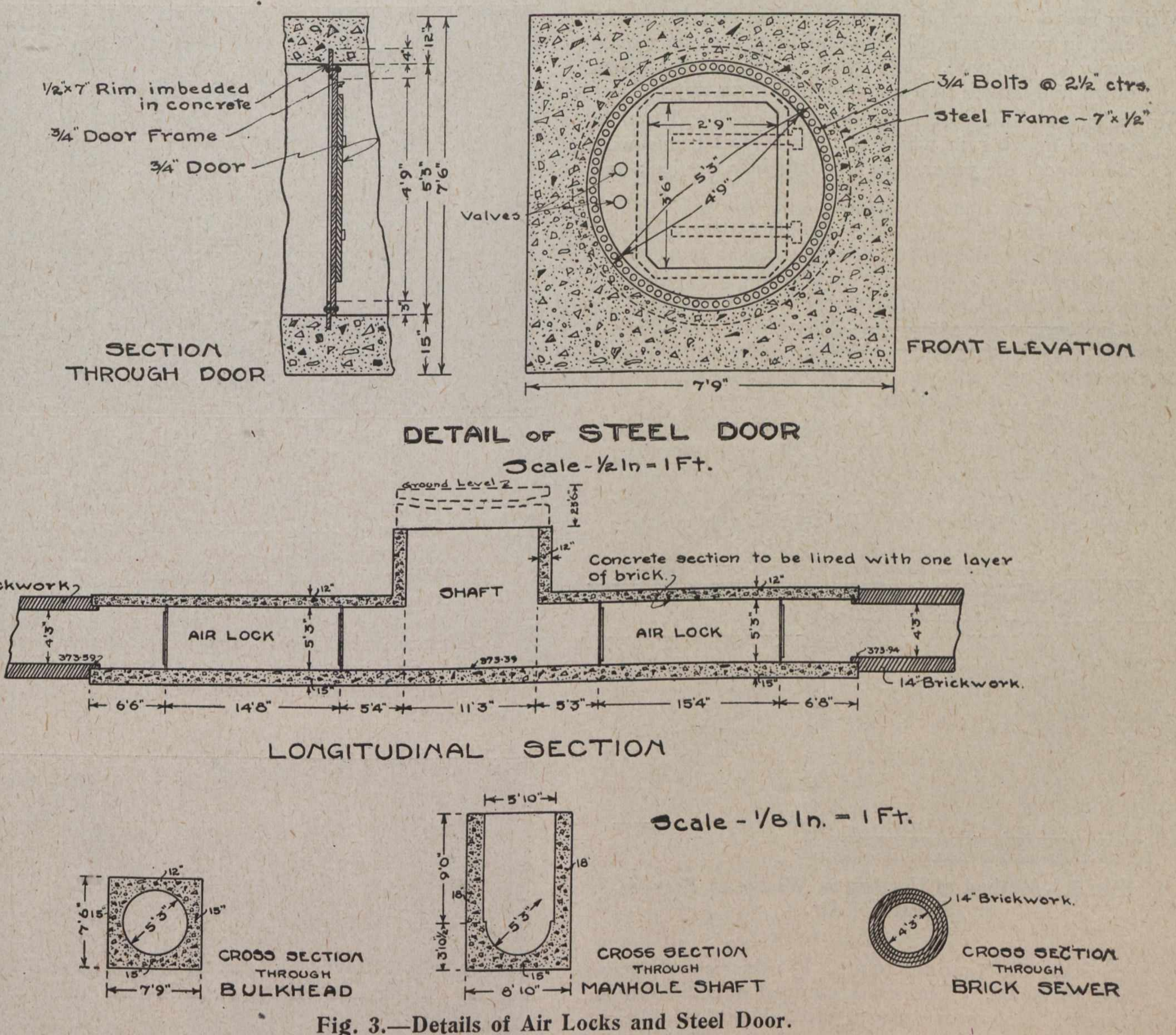

Fig. 3.—Details of Air Locks and Steel Door.