IX.—Operation of the Kennedy Pipe Scraper and Cause of Recent Failure—By F. W. W. Doane, M. Can. Soc. C. E., City Engineer, Halifax, N. S.

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On the inside of all water supply pipes which have been in use for any length of time there will be found a heavy incrustation of oxide of iron. This coating presents a very rough surface compared with the original finish. It consists of large tubercles or blisters which greatly reduce the internal diameter, and consequently the discharging powers of the pipes.

In designing a system of water works, engineers give special attention to two questions—cost and efficiency. The capacity must be sufficient for all present requirements, and the probable growing demands of the near future must not be overlooked. The question of cost fixes a limit, however, and the water mains are laid with sufficient capacity to deliver an adequate daily supply with provision for estimated increase in population and consumption during a stated period. The margin is not large, consequently it becomes a serious matter when the diameter of the pipes is reduced The domestic supply is unsatisfactory, the pressure for fire purposes is insufficient, and unless the pipes can be cleaned, expensive renewals and alterations in the system may be necessary.

The writer has been asked frequently if the oxidation on the inner surface of a pipe would seriously affect its capacity. The piece of three inch pipe exhibited to-night answers that question beyond the shadow of a doubt. It was cut from the main on Water Street, Halifax, near the Ordnance Yard. The original diameter of three inches has been reduced to half an inch, and as the capacity decreases in the ratio of the square of the diameter, the effect on the discharging power is apparent.

Lime has been deposited in the lakes for the purpose of preventing the rapid formation of rust in the pipes, but though it may retard the formation it does not prevent it.

When the pipes are cast they are coated with coal pitch varnish to prevent rust and afford a smooth surface The following clause is taken from the specification for pipe for our new supply main:—

Coating.—"All castings shall be coated inside and outside before any rust sets in with coal pitch varnish consisting of a good and suitable coal pitch of about the consistency of tar, deoderized, and freed from its naptha and volatile constituents, and an approved fixed oil, derived from coal pitch or linseed oil, in such proportions as shall make a firm and tenacious coating. The temperature of the castings shall be about 300 degrees F. when dipped, and upon removal from the bath they shall be so dripped as to leave a coating of uniform thickness, without retained puddles or pendant drops of varnish. The varnish coating when cool shall be smooth, tough, without undue brittleness, tenaciously attached to the castings and not liable to abrasion with ordinary handling."

This varnish is scratched, cut and broken by rough handling, and, as may be seen by the specimen before you, does not prevent rust.

In Halifax an attempt was made to clean the old 3-inch pipes with hand scrapers. Sections of pipe were cut out at convenient distances and the incrustation was bored or scraped out. The cost of the work was $750 a mile, the city supplying the necessary new pipe and sleeves to make connections. This process was too slow and expensive to be adopted for the large mains. The city must not be deprived of water for more than twelve hours at one time, and in case of fire, water would be needed at short notice.

The idea of utilizing the pressure in the mains to drive scraping machines originated with Mr. J. G. Appold, M. Inst. C. E., and the apparatus was invented by him. In 1873, Mr Thomas Kennedy, the Managing Director of the Glenfield Co., Kilmarnock, Scotland, devised a modification of the Appold Scraper, and this has been in general use up to the present time.

In 1880, a Kennedy Scraper was imported from Scotland by Mr. E. H. Keating, M. Inst. C. E., then City Engineer of Halifax,

and similar scrapers have been in use in this city ever since that date. Mr. Kennedy is using them in many cities in Europe under his own supervision. Mr. Keating made an improvement in the cutter or scraper. The spring which presses the cutting edge against the pipe and the cutter itself were in one solid piece on the imported scraper. Mr. Keating made the cutter detachable, and it can be replaced when worn by use. The scrapers are made in all sizes, from six inches to twenty-four inches, and weigh from 100 lbs. to 1,000 lbs.

The principal parts of the scraper are of iron or steel. The forward end is provided with eight cutters or scrapers so arranged that the whole inside surface is cleaned by their passage through the pipe. Two pistons of sole leather serve to steady and guide the scraper and the pressure of the water against the rear piston forces the machine ahead. The normal pressure of the water under gravity in our system has been sufficient to propel the scraper without aid from other quarters.

A section of pipe is cut out at each end of the mains, leaving an opening of sufficient length to admit the scraper. The machine is inserted at the end nearest the source of supply and the pipe replaced, the joints being made with a split thimble or sleeve. When all is in readiness the water is turned on and the scraper starts off with a rumbling noise by which it can be easily followed. The rate of speed varies from one quarter of a mile an hour on a flat grade under a small head of water, or going up a hill, to one mile in ten minutes going down hill. Where there are hydrants or blow-offs they are left open and the approach of the scraper may be detected first by a current of air followed by a rush of water which has accumulated in front of the machine. The water turns to a dirty brown color and as the scraper passes it is as black as ink. The pressure then increases rapidly, and if the water is allowed to run from the hydrant it gradually becomes clear. The hydrants are usually closed at once, however, so that the pressure on the scraper may not be reduced.

Pipes should be cleaned every year, as each succeeding formation becomes harder to remove. The greatest length of pipe

cleaned at one time is on the 15 inch high service main, the distance being 29,500 feet. The run has been made in about 100 minutes and at a cost of $8.30 or 3-100 of a cent. a foot. The 24 inch low service main, 13,400 feet in length, has been cleaned for $8.23 or 6-100 of a cent a foot. The cost of cleaning 3 inch pipes by hand, the work being performed by contract, was formerly 14 2-10 cents per lineal foot.

The object of this paper is not specially to describe the operation of the scraper, as it is not a novelty. The use of the scraper has been described by Mr. James Mansergh, M. Inst. C. E. (Proc. Inst. C. E., Vol. LXVIII, p. 258; Mr. M. B. Jamieson, (Proc. Inst. C. E., Vol. LXVIII, p. 323); and Mr. E. H. Keating, M. Am. Soc. C. E, M Inst. C. E., (Trans. Am. Soc. C. E, Vol. XI, pp. 127-45.) Before discussing the cause of failure, however, it was necessary to understand clearly what it would do when working successfully.

Many who are aware that the first mile of pipe laid from Spruce Hill Lake is 20 inches in diameter suppose that it would deliver more water than the 15 inch main, with which it connects. Such is not the case, however, for the first mile is level, and the pipe has very little fall, while the 15 inch pipe falls rapidly. The smaller pipe, in consequence of the heavier grade, is capable of delivering as much water as the larger. and it is necessary to clean both pipes in order to increase the discharging power of the mains. The 15 inch pipe has been cleaned every year since 1881 with a self-propelling mechanical scraper, but only once since that date, viz., in 1885, has the oxidation been removed from the 20 inch pipe. After the incrustation has been removed once the succeeding formation is tougher and the resistance to the scraper greater. It was expected that there would be some difficulty in forcing the scraper through after a rest of seven years, and the first attempt was made through the pipe from the gate house to the hatch box at the old screen chamber, a distance of about 100 yards. The work was begun on Thursday, November 3rd, 1892, at 9.30 a. m. A coil of stout rope had been provided and was floated through the pipe so that the scraper could be

pulled out at the hatch box, if it should stop. This precaution was unnecessary, however, as it went through without any difficulty. It was again inserted and started for the run of one mile and a quarter to the junction with the 15-inch pipe. It had only gone about one hundred yards when it stopped, but in a few minutes made another short run and stuck fast. No 1 Steam Fire Engine was sent out from the city and succeeded, with the aid of water rams from the gate house, in forcing the scraper to the foot of the grade, 2,200 feet from the dam, and about one hundred yards up the hill to the edge of the bog, but at this point it stopped again and could not be dislodged. It was about daylight on Friday, the 4th, when the scraper stopped altogether, and the men were at once put at work to uncover the pipe at the joints, in order to discover, if possible, the exact location of the machine. Its progress had been so slow that it could not be followed by the usual rumbling noise. The joints were opened along a quarter of a mile of pipe and the pressure tested, but it was not until morning that the proposed location was discovered. The pipe was immediately cut and the scraper withdrawn, but it was on Saturday midnight before the pipe was again connected. It was then decided to clean the 15-inch pipe. It was with some anxiety that the scraper was started at 3 30 a.m., but it travelled more rapidly than ever before, making the run of 29,500 feet to St. Andrew's Cross in about one hour and three-quarters; and before the house-holders on the high service required it Sunday morning, water was again running freely from the taps.

The surface of Spruce Hill Lake was 11 feet above the intake. The pipe falls for 2,200 feet from the dam, where a blow-off is placed, the head being about 27 feet. From this point it rises for 2,700 feet to Scotch Hill, where an air valve is located. The pipe at this summit is on the same level as the intake, so that the pressure on the scraper would be that due to the head at the gate house minus allowance for friction, etc, which would be increased by the foul condition of the pipe. The incrustation was very heavy and the pressure was barely sufficient to propel the scraper. After passing the blow-off the scraper moved so slowly

that it could not be traced, and the water passing through it accumulated ahead of it It is necessary that some water shall pass through to carry off the dirt as it is scraped off. In this case the water could not run off ahead, and the dirt piled up. The pressure available behind could not overcome the resistance of this load of dirt and water and the scraper became lodged in the pipe.

Profiting by experience, precautions were taken last November (1893) to prevent a repetition of the trouble. The scrapers were made smaller in diameter and the pistons made tighter to prevent the passage of water. The blow-off was left open so that the pipe would be empty and the run through that portion of the main cleaned the previous year was made without any difficulty. The blow-off was closed immediately after the scraper passed so that the full pressure would be exerted on the piston. The progress of the machine was slow, as the incrustation was very thick and at times it was difficult to hear it at all. However, it continued steadily up the hill and passed the summit, reaching the end of the 20 inch pipe, 6,712 feet from the dam, in about one hour from the time of starting. No difficulty is anticipated in future, as the pipe will be cleaned every year.