BREAKS IN CAST IRON PIPE LINES.*

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THERE is scarcely any community of size on this continent which has not, at some time or other, had failures in the mains of its water distribution system, which were, or seemed to be, inexplicable. It is apparent that the prevention of such breaks is an important matter, and a study of the incidents leading to these disasters will help us to understand the reasons for them. Knowing these, the search for remedies may begin.

Sometimes a pipe line seems to be afflicted with an epidemic of failures. These are generally confined to large pipes, usually supply mains. In such cases it would seem natural to suspect that the character of the pipe was at fault. Isolated breaks may, of course, be due to defective pipe, but they are more likely to be caused by defective workmanship in laying, or by local influences, such as settlement or excessive loading.

To the credit of the pipe founders it must be said that there is now seldom any fault to be found with the quality of the material of which their pipe is made. Between the foundry and the job there is an opportunity for pipe to become damaged in transportation. Care in packing for shipment, and inspection at the destination while unloading, will prevent transportation cracks, or detect them if they occur.

Once the pipe is delivered alongside the trench, the responsibility for a first-class piece of work rests with the engineer. Of course, it is a prime requisite that the pipe shall be of proper thickness for the pressure and loads to which it will be subjected. There is not much room for choice on this point, as practically all pipe is now made to conform to one of the standard specifications, which provide proper thicknesses for different pressures. After this, it is a matter of care in laying.

All pipe should be well bedded and have holes dug for the bells, so that they will be evenly supported throughout their entire length. There should be a space of a quarter-inch or so between the ends of the spigots and the bottoms of the bells, to allow for expansion. Failure to observe this precaution is thought to have been partly responsible for the very serious break in Cincinnati in 1913. The pipe should be securely anchored at changes of direction. The backfilling should be carefully and thoroughly rammed around the pipe to a point well above its top, for a pipe that is well supported by the earth at its sides will carry a much greater external load than will one in which such support is lacking. The location of the trench itself should be so chosen that the pipe will not be subjected to heavy loads from traffic or from other sources. The Cincinnati pipe line was located in ground which had been subject to land slips, as shown by the broken and folded strata through which the trench passed. It is possible that a fresh disturbance of the ground had something to do with this failure.

Water hammer is frequently blamed for pipe failures. This action is present in some degree and at some time in practically all systems, and may be due to faulty design or to faulty operation. A certain minimum amount is probably inevitable. In small direct-pumping systems the fluctuations in pressure are often very marked. Hydraulic elevators drawing from a small system will also produce similar fluctuations.

If water hammer alone were responsible for breakage to any great extent, one would expect to find such breaks in the small pipes near the source of the pressure fluctuations, and also that the breaks would be recurrent, unless the cause of the water hammer were removed in the meantime. As a matter of fact, failures in series have been most common in large supply mains and under circumstances which preclude the possibility of water hammer being responsible for them. Moreover, the accepted formulas for the thickness of cast iron pipes all make a liberal allowance for the effect of water hammer, so that, although the final touch may be given by it to a pipe which is already cracked, it is not likely that it is solely responsible for many failures of well-laid pipe of good quality.

To sum up, it is the writer's opinion that the answer to the question, "How shall breaks in cast iron pipe lines be prevented?" is to be found in inspection. Such inspection should cover:

1. The manufacture of the pipe, including the control of the mixture of the irons by analysis, the molds, the usual hydraulic tests, and particularly the drawing of the pipe from the molds and the subsequent cooling. Just what rate of cooling is permissible is a matter which should be within the knowledge of the foundryman. The best man for a position such as required by this inspection would be one who had served his time at pipe founding. The analyses should, of course, be made by a competent chemist. Such inspection is now required by some of the larger cities.

2. The inspection of the loading of the pipe into cars or vessel, to be sure that it is as well packed for shipment as is practicable. On arrival at its destination the pipe should be given a hammer test on unloading, and, if the work is of importance and the pipe is large, another inspection at the trench side would be quite in order.

3. Inspection of laying, which should be preferably in the hands of an engineer, or in those of a "practical" man under the immediate control of the engineer.

A complete system of inspection, as advocated above, will cost more than is now commonly thought allowable, but it appeals to the writer as being the only way in which it is possible to guard against inferior pipe and inferior workmanship. A city's water-supply is one of its best assets, and interruptions to it, even though they be unaccompanied by actual monetary damage or loss of life, expose the health of the citizens to grave dangers and their property to a greatly increased fire hazard, as well as contributing to an indirect financial loss through the stoppage or curtailment of industry.

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During the fiscal year ended June 30th, 1916, there was exported from the United States railway material to the value of $74,729,000, made up as follows: Railway cars, $26,660,000; rails, $17,687,000; steam locomotives, $12,-666,000; electric locomotives, $455,000; engine parts, $7,-274,000; switches and track material, $5,262,000; sleepers, $2,435,000; railroad spikes, $1,399,000; car wheels, $742,-000; telegraph instruments, $149,000. Two years ago the year's exports of railway material amounted to $34,919,000. Until recently Canada and Cuba were the principal markets for freight cars; Cuba, Canada and Brazil for locomotives, and Canada, Australia, Japan, Brazil, Argentina and Cuba for rails. Just now freight cars and other materials are also going to Russia, and important consignments to France and Spain. In June alone the freight cars for Russia valued $1,086,000; the rails to France $1,188,000, and the locomotives to Spain $272,000.