SOME COMMON MISTAKES IN THE CONSTRUCTION AND MAINTENANCE OF WATER SYSTEM.

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In attempting a paper of this kind the writer does not wish to be understood as making a criticism of existing water systems. During an experience of some years in municipal work in the Province of Nova Scotia, one could hardly fail to notice some defects in the construction and maintenance of the water supply systems of the different towns, and it is more with an idea of bringing these deficiencies to the notice of the members of the Nova Scotia Society, in order that conditions may be gradually bettered, than a critical arraignment of the civic fathers of the different towns. My experience has been that in making provision for water supply and fire protection our civic authorities are imbued only with the very best intentions. The unfortunate thing is that their knowledge of engineering matters is not large enough to permit of their appreciating the best points of an engineering problem, and the result is that the point which has the greatest weight is the cheapness of first cost of anything, and all other considerations are apt to be lost sight of when there are dollars in question. The ordinary town council is quite satisfied when it is demonstrated that water is delivered in the streets of their town under good pressure, and they do not stop to reflect that they may want at some time a **very large quantity under good pressure,** and usually it is only when some entirely unforeseen occurrence happens, such as a large fire in the business district, that they are forced to the conclusion that the water service is not all that is desirable and necessary. I think that one of the most pitiable occurrences that one can imagine is to see a heavy fire well started in a row of wooden buildings, and a company of firemen around it almost helpless because of insufficient water supply to quench the fire with. At first thought one would say that this was almost impossible in any of our Nova Scotia towns, and yet practically this very thing has happened in two of our towns within the memory of all of us.

The question of adequate fire protection, too, I consider has not been dealt with altogether justly by the fire insurance companies, in that they have rated the efficiency of fire systems on the basis of the ordinary fire, instead of insisting on a demonstration of their efficiency for conflagrations, which, after all, is the real test for usefulness.

I do not intend either to criticize the manufacturers of waterworks goods for providing goods of light and cheap grades. After all, a manufacturing concern will provide just the goods most in demand by their customers. As a rule, they make light, medium and heavy goods of all kinds. It is only human nature, when goods are put up to tender, for any firm to want to quote as low a figure as possible, and to do this they often make a grade which they are fully aware is light for the service demanded of it; and if the purchaser is not as wideawake as he should be, he is only too apt to select the material he requires, judging it solely by its cheapness in price.

I purpose discussing briefly the different parts of a water system, and pointing out the usual mistakes made in construction.

Main Pipe Line.—Perhaps the most common error in the construction of water systems is the size of the main pipe line. This is usually the most expensive part of the system, as the pipe must often be of large size, and the temptation to use the smallest size possible is, therefore, correspondingly great. What I want to emphasize is that we do not look far enough ahead and provide pipe capacity enough, both for increased domestic consumption and ample fire protection. The tendency is to plan our water systems as regards fire pressure for the ordinary fire, while it is the **extraordinary** fire which ought to be considered. The size of the main pipe is really governed by the amount of water to be delivered for fire purposes, since the domestic consumption is small in comparison. Every small town of 1,500 to 2,000 inhabitants has some few blocks where the buildings are situated close together, and, as in all our small towns practically all the structures are of wood, there is almost as much danger of a conflagration as in a place many times as populous, since in the larger towns and cities brick structures are much more numerous.

The writer can recall at least three occasions on which he has seen eight fire streams used on a single burning building, and I think it would, therefore, be safe to assume that at least that number would be required in every town. Now, a good fire stream requires a pressure at the nozzle of 40 pounds, and, with hydrants as usually placed in our maritime towns, the streams on the average would be passed through 300 feet of hose. None of our departments would use less than one-inch nozzle for each of these streams, and to maintain a nozzle pressure of 40 pounds, while using 300 feet of hose, would require a hydrant pressure of 66 pounds, when best quality rubber-lined hose is used, and the amount of water used by each stream would be 160 imperial gallons per minute.

The total water used with eight fire streams would, therefore, be $160 \times 8 = 1,280$ gallons per minute. As the main in addition must be capable of keeping up the domestic consumption, they should be able to furnish a further amount of, say, 220 gallons per minute, thus making the total required capacity of the main 1,500 gallons per minute.

A 10-inch main supplying 1,500 gallons per minute would lose, in friction, 22 feet head per 1,000 feet of its length.

A 12-inch main supplying 1,500 gallons per minute would lose in friction 9 feet head per 1,000 feet of its length.

A 16-inch main supplying 1,500 gallons per minute would lose in friction 2 feet head per 1,000 feet of its length.

To put this in a little more comprehensive form, let us suppose that the main pipe line is exactly one mile in length, and that the conditions are as outlined above, namely, that the pipe is to deliver 1,500 gallons per minute and at the same time maintain a hydrant pressure of 66 pounds.

A 10-inch main, one mile long, would require a static head of 268.6 feet, equal to 116.3 pounds static pressure.

A 12-inch main, one mile long, would require a static head of 200 feet, equal to 86.6 pounds static pressure.

A 16-inch main, one mile long, would require a static head of 163 feet, equal to 70.6 pounds static pressure.

Eighty pounds per square inch is considered the best hydrant pressure for general use, and should not be exceeded very largely on account of the difficulty of managing fire hose under such heavy pressure and the danger of rupturing the mains by shutting off the water too quickly.

As very few of our towns have a less length of main than one mile, it can easily be seen that the main less than 12 inches is not large enough to give sufficient fire protection. It must be borne in mind that there is a further friction loss in the distribution mains, which cuts down the pressure considerably; and also, it must not be forgotten that the above calculations are for clean, smooth pipes, and that in actual practice after a few years' use the mains will not deliver anything like the above amounts. Discharging capacities of cast-iron pipes as usually tabulated are based on formulæ derived from experiments, in which the conditions, particularly as regard the smoothness of the inside of the barrel of the pipe, are much superior to those attained in average practice. The interior surface of cast-iron pipe, after a few years' use, becomes much rougher in character, due to the corroding and incrusting action of the water, and this tends to greatly impede the flow of water through the pipes. Hence, the necessity of selecting diameters of pipes capable of delivering quantities much in excess of apparent actual need.

As the pipe increases in size the discharging capacity increases very much more rapidly than the cost of installation, because the area of the circle increases "as the square," while the ring of metal constituting the pipe increases only in direct proportion to the increase of diameter. In a growing community, where the demand on the

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