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THE ASSOCIATION was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of over **1 000** men. Its membership is divided into two principal classes, viz.: MEMBERS and ASSOCIATES. Members are divided into two classes, viz.: RESIDENT and NON-RESIDENT, — the former comprising those residing within the limits of New England, while the latter class includes those residing elsewhere. The INITIATION fee for the former class is FIVE dollars; for the latter, THREE dollars. The annual dues for both classes of Active membership are THREE dollars. Associate membership is open to firms or agents of firms engaged in dealing in water-works supplies. The initiation fee for ASSOCIATE membership is TEN dollars, and the annual dues FIFTEEN dollars. This Association has six regular meetings each year, all of which, except the annual convention in September, are held at Boston.

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HARTFORD'S DISTRIBUTION SYSTEM.

BY FRANK BRAINARD, ASSISTANT ENGINEER.

[*Read September 13, 1917.*]

Previous to 1854, there was a small water-works system in this city owned by private parties. A small reservoir was located near what is now Park and Putnam streets. It received most of its water from springs, and the main pipes used to conduct it were principally wooden. These were evidently made by simply boring a hole lengthwise through a piece of wood about six feet long, then tapering one end and making a deep socket in the other, similar to the bell-and-spigot style in present use, while the outside received no other treatment than the removal of the bark. A length of this pipe was taken out of Kinsley Street in 1911, when we were laying a new main, and may now be found at the house of the Veteran Firemen's Association, where it is kept with other curiosities. It was originally about 6 ft. long and 8 in. in diameter, with a 2-in. hole or waterway. About two feet of this pipe was badly decayed and has since been cut off; the remainder, however, is in a good state of preservation.

In 1854 the present distribution system was started, and the Garden Street Reservoir built for distributing water pumped to it from the Connecticut River through 6 879 ft. of 16-in. cast-iron pipe, which is still in service. The engine and pump are also in a semi-serviceable condition, having been overhauled this spring, and run for a few hours, and are now in as good condition for use as possible in case of emergency.

Ten years after the system was started, — that is, in 1864, — there were 2 434 service pipes and approximately 32 miles of main pipe, which was of cast iron, with the exception of about 4 000 ft., the latter being cement with a sheet-iron lining.

But the new system had not been in use long before it became apparent that the Garden Street Reservoir was not large enough for the needs of the city, it having a capacity of only a little over

8½ million gallons. So, in 1866, the present reservoir system was commenced, and a 20-in. supply main was laid from Reservoir No. 1 into the city, where it was connected with the system already in use. Most of this new main was cement, lined with sheet iron, but in ten years' time a part of it was replaced with cast-iron pipe, owing to the number of leaks which developed, especially at the joints.

Between the years of 1864 and 1872, a large amount of this cement-lined pipe was laid, ranging from six to twenty inches in diameter, the last being laid in 1883. The greatest amount in service at any one time was about 18¼ miles. Because of the numerous leaks developing from time to time, it was decided in 1885 to replace all of this pipe with cast iron, so that at the present time the only cement-lined pipe still in service is about 700 ft. on Sumner Street, and this is to be renewed in the near future.

Because of the increased demand for water, two additional supply mains, a 20-in. and a 30-in., were laid in 1874 and 1896 respectively, and by 1895 the sixth reservoir had been built, their total capacity being 2 billion 100 million gallons. But, for all this rapid addition of reservoirs and supply mains, the city was constantly in danger of having to resort to the Connecticut River during every dry season, because of the great waste of water by consumers. To overcome this difficulty, it was decided in 1899 to meter all water except that used for fire purposes. Previous to this time, meters had been installed only in hotels, livery stables, and some manufacturing plants, the first ones being installed in 1877.

In 1901, with nearly 30 per cent. of the services metered, the average daily consumption was about 7 million gallons, or 84.6 gal. per capita, while in 1906, with 98 per cent. of the services metered, the average daily consumption was only 6.09 million gallons, or nearly a million gallons less. It was not until 1909, or eight years later, that the seven million mark was again reached, at which time the per capita consumption was 71.6 gallons, or 13 gal. per capita less than in 1901. It has not been necessary to resort to any other supply since the general installation of meters, but we have been very close to it, and without question would have been obliged to do so if it had not been for the meters.

As it was suspected that some of the factory fire-services were leaking underground, and that the privileges for the use of same were being abused, in 1907 twelve detector meters were installed on as many fire services. By the installation of these meters, it was estimated that 19 million gallons of water were saved, and that the revenue was increased about $330 the following year.

In 1907 we awoke to the fact that our system was in constant danger of pollution from the fire pumps located in several factories. These factory fire-systems are operated at a pressure much greater than that of the city, and the only protection in use at that time was a single check valve. If this should fail, the fire pump would discharge directly into our system. As most of these pumps receive their supply from the Park River, which is highly polluted, it was decided in 1907 that all these connections must be equipped with double check valve systems, fourteen of which are now in service.

These double check valve systems consist of two check valves so connected and fitted up that each one may be tested separately for leaks under any pressure we may see fit to use. There is also an automatic electric alarm system connected with them, that rings a bell in the office of the factory in case one of them is leaking when the pumps are in operation. These check valves were installed under our direction by the factory owners, who bear all cost of inspection and repairs. A monthly inspection is given them by men from the water department, and they are taken apart and cleaned once a year.

For some years previous to 1908 it was known that the small mains in the center of the city could not furnish adequate protection in case of a large fire. It was therefore proposed to lay a 24-in. main, or belt line, around the Conflagration Area, as defined by the New England Insurance Exchange in 1906. The inside of this area was to be gridironed with mains ranging in size from 8-in. to 16-in. This work has now been completed, so that it is possible to concentrate about ten thousand gallons of water per minute on any block in this area.

On Prospect Avenue, south of Albany Avenue, there is a sudden rise of ground known as Prospect Hill. This is one of the highest points in the city, and during periods of maximum draft

the water does not reach the top of the hill. In order to furnish fire protection to this section, check valves have been installed in the main pipe each side of the hill between two hydrant connections which are about 25 ft. apart. In case of fire, water is pumped by fire engines from the hydrants connected below the check valves into the hydrants connected above, and is thus forced up the hill through the main pipe, where it is made use of by hydrant streams.

With the introduction of the electric railway cars came the danger of electrolysis to our underground system. The greatest damage from this source occurred between the years of 1907 and 1912, at which time the railroad had twelve steel rails that were laid underground from the State Street car barn, through Grove and Commerce streets, to their power station, for a negative return system. These rails were not insulated, and as the water pipes were highly positive to the rails, the electric action was very great. It was necessary in 1909 to replace eight service pipes in the vicinity of Grove Street, which were leaking badly, due to this action. One of these pipes had been in service only three years, although their average age was ten years.

In 1909 the trolley company installed several wooden insulating joints in our mains near this danger section, in an attempt to break up the flow of electric current on our mains toward their power station. While these were partially successful, in that they stopped the flow on our mains at that point, they did not, however, help the situation to any great extent, as the current passed these joints by means of other underground structures, and returned to our pipes again, after passing. These joints consisted essentially of an ordinary pipe joint, with the lead space filled with wooden wedges, and a wooden ring slipped inside of the bell end of pipe, to keep the spigot end from "bottoming." A double joint of this kind was used for greater security, being made up in as small a length as convenient.

Five years ago the rails were removed and overhead wires substituted for their negative return system, since which time the conditions have been much improved, and to-day we have very little damage from this source.

Owing to the need of additional space in which to store pipe

and special castings, a tract of land situated at the corner of New Park Avenue and Flatbush Avenue, containing about six acres, was purchased in 1909. This storage yard is adjacent to the main line tracks of the New York, New Haven & Hartford Railroad. A spur track has been run into it from the railroad, and a trolley system constructed for the handling of pipes delivered there. All pipe and special castings for the use of this department are now received at this place, which we call the New Park Avenue Yard.

The meter department is located at the old storage yard on Union Street. All meters are tested here before being installed; they must register not less than 98 per cent. and not more than 100 per cent. of the water passing through them on a full flow, and the smaller sizes must register on a ½-in. stream. It is planned to remove all meters at least once in three years, for cleaning and testing. The machine, carpenter, and blacksmith shops are also located at this yard, as well as the garage for the auto trucks and the barn for the horses used by this department.

On March 1 of this year there were in service 199.41 miles of main pipe, ranging in size from 1½ in. to 30 in., with about three miles less than 4 in. in diameter. All mains 4 in. or over in size were cast iron with the exception of 700 ft. of 6-in. cement-lined pipe, and all less than 4 in. in diameter were galvanized wrought iron; there were 4 042 stop gates, 15 404 service pipes, and 15 077 meters. The service pipes were principally galvanized wrought iron, although there were some brass, lead-lined, and cement-lined pipes in use. The average life of a service pipe is about twenty-five years.

The estimated population supplied during the past year was 163 000, with an average daily consumption of 10.6 million gallons and a per capita consumption of 65 gal.

The pressure ranges from 10 to 100 lb. during periods of minimum draft, but is about 20 lb. lower during periods of maximum draft. This variation will be overcome, however, when the 42-in. supply main now under construction is completed.

DISCUSSION.

MR. MCFARLAND. I am interested in your statement that over 90 per cent. of your service is metered, which is a large percentage. Have you a meter of water which is pumped or delivered at your station, so as to determine what percentage of the water is accounted for through meters?

MR. BRAINARD. The water is all delivered by gravity; there is no pumping station. There is a master meter located at the reservoir, which meters all the water which comes into the city.

MR. MCFARLAND. What percentage of that water is lost? How much is the loss between the meters?

MR. BRAINARD. There is about 85 per cent. of that which is accounted for on the small meters; about 15 per cent. is not accounted for.

MR. MCFARLAND. You stated your service pipes were wrought iron. Do you mean wrought iron or steel?

MR. BRAINARD. Galvanized wrought iron.

MR. MCFARLAND. You don't use the steel pipe at all?

MR. BRAINARD. No, sir.

MR. L. M. HASTINGS. I was interested in what Mr. Brainard said about the electrolysis and the loss and injury to pipes from that cause. Now, we have suffered from that cause very greatly. The services that we put in will sometimes not last more than a year, and then be entirely corroded in that time. The Boston Elevated Company has taken some steps to regulate it, but there has been nothing that has been very effective. Now, as I understand it, you said there was an overhead return wire laid from your danger district back to the power station. Can you explain that a little more fully, so that we can see what that return feed is, and how it is arranged to reduce the leakage?

PRESIDENT SAVILLE. On that matter of electrolysis, I should like to say that we have had very little trouble. Previous to about five or six years ago, that matter was handled by some electrical engineers that were employed spasmodically by the board. Within the last four years we have been handling that through another assistant than Mr. Brainard, and I will ask Mr. Garratt if he will kindly reply to that question which has just been asked, — about the back flow.

MR. GARRATT. The railroad return feeders consist of twenty-one 1 000 000 circular mill cables, which connect with the rails and take the current back from six different points. These points are located within a half mile north and south of the center of the city and between the railroad and the river. Since they have installed those return feeders it has changed the danger area, the positive area in the city, from the southern end of the city to points near those bond connections.

MR. HASTINGS. What do you say as to the danger from electrolytic action?

MR. GARRATT. The danger has been reduced in area. It has changed the locations, and whether we are going later to have bad conditions in those areas, we don't know.

MR. H. F. DUNHAM. Have you made investigations to know how much you are carrying on your pipe lines?

MR. GARRATT. Yes, we have current load stations where we take measurements each year. The current has been materially reduced by the installation of this new return feeder system of the railway.

MR. DUNHAM. Is there any difference between summer and winter?

MR. GARRATT. I have not looked into that. We have taken observations in winter as well as in summer.

PRESIDENT SAVILLE. I will say, regarding the double check valve system Mr. Brainard spoke of, that within a year the board — recognizing the rather ridiculous and illogical condition which arises from a city which is about to spend hundreds of thousands of dollars to safeguard its water supply and filter it and see that there is no pollution in any way whatsoever — has passed a vote prohibiting the extension of the double check valve system, so that there shall be no more physical connection with polluted sources even if it is governed by a so-called safeguard.