

worked out it should be as closely maintained as possible. An unnecessarily high steam pressure, even though it gives a very uniform gauge line, is not economical.

On the Distribution System.—On gravity supplies or pumping plants, in cities of considerable size, a gauge, or gauges, should be placed on the distribution mains at some central point, or at typical points. If more than one service, high and low service, each should have a recording gauge. It is well, when practicable, to take gauge services off of large or leading mains, where they will not be liable to the great fluctuations in pressure frequent on smaller distribution pipes.

Of course, there should be a gauge in the office, where it will be under the eye of the superintendent when in the office, and, at other times, of some other officer or employee of the waterworks, of the night watchman, if one is employed; one in the superintendent's house, for reference at night, is convenient, but, with telephone connections, not so necessary.

The connection to the gauge should be entirely independent of all other service to the building in which it is located. It should be of good size, not less than $\frac{3}{4}$ inch, and placed where it will be in no danger of freezing, as there cannot be a circulation in the gauge service and an accurate record of pressure on the main at the same time, without the expense of a double service, in which a free circulation would be doubtful, unless it were very carefully planned, and even then there would be an item of friction in the smaller pipe, that would be difficult to account for. Of course, water cannot be allowed to run in the gauge supply pipe, in cold weather, without totally destroying the value of the gauge record.

The gauge service should be so arranged as to be easily blown out or flushed, to avoid all possibility of stoppage, by an accumulation of sediment. While a $\frac{3}{4}$ inch or larger service is recommended, the gauge operates with a very small opening; the object of the large service is to avoid stoppage.

Location of Gauges.—The pumping station gauge comes first, and, in smaller plants, is all that is required. Larger plants should also have an office recording gauge. Cities or towns with two or more services should have a record on each service. Large cities should have recording gauges at various points on the distribution system, notably near the congested value districts.

Gauges can be placed in the residences of employees of the works. They require little attention, winding of clock, changing of charts, and seeing that the pen, where ink records are made, is kept properly filled.

The fire department stations are convenient places for recording gauges, and the fireman's interest in the water pressure is enough to insure proper attention. For municipal plants, police stations can be utilized, if they are better located than the fire engine houses, that is, on larger supply mains.

Very long services should, naturally, be avoided, both on account of the expense and the danger of stoppage in long lines of small pipes. The service should be of durable material, and, with corrosive waters, iron services should be avoided, as an accumulation of iron rust would stop up the minute orifice of the gauge.

The Benefits of Recording Gauges.—The benefits of recording gauges are many; they have been known to stop law suits, where actions for damages caused by low pressure were threatened. The recording gauge settles many disputes concerning pressure at time of fires or other times. Often complaints of low pressure are made, not enough to supply the upper floors of some buildings. A nearby recording gauge demonstrates that it is a local

trouble, within the building. These complaints are frequently that the pressure is low at certain hours of the day or night, but a gauge chart showing a uniform pressure at those hours, demonstrates that it is local use of water, in the building itself, or in the distribution system near it, that causes the trouble.

The recording gauge charts show the effect of cold weather on the water supply, the low pressure lines on the chart in freezing weather indicate the extent to which water is being run to prevent freezing. They also reflect the hot weather use of water; a low pressure line on the chart at night tells of water allowed to run on lawns all night.

Portable Recording Gauges.—All parts of a city cannot at all times be covered by recording gauges, so that the story they have to tell is incomplete. Portable recording gauges set up in various places for short periods make a fairly complete record of the conditions of the supply at points on the distribution not covered by regularly established recording gauges. Such records in large buildings, factories, etc., where the fire hazard is great, are particularly useful.

A gauge set up for a single day gives a valuable record, as it shows a comparison between the day and night pressure at some particular point.

Portable gauges can, with advantage, be connected to fire services, as, on such services, they would be free from the fluctuations due to the use of water on the premises, or, if the fluctuations existed, they would reveal improper use of water from the fire services. With a small portable house or box to protect them, gauges can, in warm weather, be attached to fire hydrants, to make a record of the pressures on the mains at any point. Summer records of this kind, made on the outlying mains, mains in sparsely built-up parts of the city, on long runs of small distribution pipes, and on the outskirts of the town, are of great value and interest.

Preservation of Gauge Charts.—Charts should be permanently kept as a part of the records of the works; as part of the history of the plant. They should be conveniently filed for reference at any time. For straight line charts suitable albums or scrap books make a convenient file. For round charts the scrap book form, though suitable and convenient, is bulky, as a page would be required for each day's chart. Substantial pasteboard boxes of the right size to hold a year's charts, are convenient. These can be labelled with the year, and, where several recording gauges are in use, with the location of the gauge, making it convenient to refer to the charts from any gauge at any time.

It is interesting to look over the old gauge charts, also often instructive. A new waterworks, with new and clean pipes, with pumps not over-crowded, and ample size force and distribution mains should show a steady line, with slight fluctuations, and near the outer edge of the chart. As the consumption increases, the line grows less and less steady, and converges toward the centre of the chart, showing the reduced pressure due to greater friction in the mains. The raggedness of the pressure line on the chart also increases with the age of the plant, as the mains become tuberculated and clogged with sediment. Finally, the consumption has gone beyond the pump capacity; a new and larger pump is installed, and the pressure line again approaches the outer edge of the chart, and becomes more steady, but still shows greater fluctuation than when the plant was new and working at a comfortable rate.

Notwithstanding the new pumping engine, the results are not entirely satisfactory, when compared with the