a map of the distribution system to be found, and where such maps do exist it is only occasionally that they show mains laid since the original waterworks installation. It is not strange, therefore, that extensions to the distribution system are generally unwisely made, that fire pressure is often lowest where most needed, and that there are many undetected leaks and thefts of water. In the hands of an expert all of these difficulties may be easily overcome simply by the maintenance of complete maps and plans, by periodic inspections, and by occasional tests for pressure, leakage, and waste.

Financial Accounts. — Waterworks accounting, especially in municipally-owned establishments, is usually in a chaotic state. About all that is ordinarily recorded are the gross receipts and gross expenditures, roughly itemized. Capital accounts are almost unheard of, and it is often impossible to get even approximately the cost of the plant. In many municipal plants large donations from public funds are calmly included as earnings. Such items as depreciation, allowances for taxes, interest on investment, sinking fund, rent, etc., are altogether ignored. If the gross receipts, no matter from what source exceed the gross expenditures, no matter for what purpose, a profit is proudly proclaimed. In some instances, on the other hand, large numbers of free service connections make a waterworks appear as a losing proposition, whereas suitable compensation for such services would place the plant upon a sound financial basis.

Correctly-maintained accounts should display fully itemized capital accounts, maintenance accounts, repair accounts, replacement accounts, sinking fund accounts, depreciation accounts, interest accounts, and, in fact, every item that enters into waterworks construction, operation, and maintenance should be carefully recorded in its proper place. In addition, there should be maintained accounts showing unit costs for operation and construction. These latter are very valuable in making comparisons with other plants and with the same plant in other years. Accurately-maintained accounts are particularly serviceable in the adjustment of water rates. The establishment of water rates is, at the present time, on a most unscientific basis, and it is common practice for small communities to adopt, parrot fashion, the rates established in some other community, regardless of the manner in which the water is obtained and the cost of delivering it to consumers.

Technical Skill.—But little can be said with respect to technical skill. It is primarily a matter of natural aptitude and experience, and it is needless to say that no one should presume to enter this field of consulting practice unless his natural aptitude and experience have rendered him fitted therefor. Aside from the maintenance of records and financial accounts it is necessary for the consulting expert to thoroughly instruct the men locally employed in their respective duties, and this necessitates, of course, skill and a thorough knowledge of such duties on the part of the expert. The analytical mind of the expert also enables him to discover opportunities for modifying methods of operation which the more or less untrained man would fail to see.

To summarize: The employment of consulting experts to supervise the operation of public water supplies and other public utilities in the small communities, constitutes a simple and the only practicable method whereby the operation of such utilities may be rendered efficient, whereby the design may be improved, and whereby there will accrue a distinct professional and financial advantage to the experts. Once this system is fairly tried it is hard to believe that it will not gain general favor.

BUCKET ELEVATORS.

By Reginald Trautschold, M.E.

ALL the material handling equipment so far considered in this series of articles has one and the same drawback—so serious that in some installations use of such apparatus is impossible or inadvisable—and that is its limitations in elevating operations. Flight conveyers, belt conveyers and to some extent even screw conveyers are used to raise material from one elevation to a higher one, but such operation necessitates the load being carried up a comparatively gradual incline so that considerable space for equipment is necessary before any relatively great lift is possible; even when the elevating system consists of a system of several inclined conveyers that deliver their load from one to the other and are arranged as compactly as possible, such as systems of criss-cross conveyers. The logical procedure is to place the load in a bucket and raise it in a vertical or nearly vertical plane—that is, when space is not available for the more cumbersome arrangement of elevating in slightly inclined planes. By substituting a succession of relatively small buckets, attached to an endless chain or belt running over suitable sprockets or pulleys, so that they may be raised continuously, the material may be elevated in small individual loads so that at the higher elevation it is practically delivered in a steady and uniform stream, thus greatly increasing capacity of elevating apparatus and supplying the material in quantities that can be easily and rapidly handled from that point, when further conveyance is necessary, by other conveying machinery, or can be efficiently disposed of by chutes, etc. Such a system for elevating materials comprises what is known as a "bucket elevator."

Two general types of bucket elevators are in common use, those in which the buckets follow one another in close succession (continuous bucket elevators) and those in which the buckets are attached to chains or belts so that there is an appreciable space between succeeding buckets. The continuous type is not now as commonly used as formerly nor as commonly used as the standard type of bucket elevator in which the buckets are spaced further apart and at regular intervals. Continuous bucket elevators, however, possess certain advantages over the more common type of elevator, so cannot be overlooked in a comprehensive discussion. They will be considered then, but after taking up a careful study of the standard bucket elevator.

Bucket elevators in which the buckets do not follow one another in close succession may be of three general classes: 1st, those in which the buckets are attached to a single endless chain; 2nd, those in which the buckets are attached to two matched strands of endless chain; and 3rd, elevators in which the buckets are attached to an endless belt. Bucket elevators in which only a single chain is employed on which to carry the buckets are nearly always installed at an inclination with the vertical in order that the load may be properly discharged from the buckets as they pass around the head elevator sprocket, for a vertical elevator of this kind would spill a large portion of its load between the two runs of buckets, or, if run at such a speed as to assure proper discharge of load as the buckets passed the top of the head elevator sprocket it would be impossible properly to fill the buckets, to say nothing of the difficulty of properly handling the load discharged at the necessarily high speed. Equipment employing two chains for carrying the buckets may be similarly inclined or may be run vertically if choke sprockets are employed to deflect the