below would in consequence probably exceed the amount at which this tool-wagon could be built by contract.

ESTIMATE OF COST.

Set of wheels and pole	$31 00
Axles, $10; bolts, $3	13 00
Door-pulls, 50c., 4 bolts $1.40	1 90
6 pair hinges, $1; 4 pair back-flaps, 40c	1 40
7 pair strap-hinges, $1.33; 1 dozen hooks, 60c	1 93
3 chain bolts, 90c.; 10 feet chain, $1	1 90
Screws, $4.16; nails, $2.15	6 31
303 feet 1-inch matched pine, planed	15 58
153 feet 1-inch matched spruce	3 52
130 feet 2-inch spruce, planed	2 33
Blacksmithing	30 49
Labor and painting	105 00
Amount	$214 36

CONTENTS.

1.

4 sets of lead and gasket irons,
4 drilling hammers,
1 stone hammer,
2 dozen cold chisels,
6 diamond points,
6 cutting-out irons,
12 joint wedges.

2.

4 lengths hose.

3.

40 picks and shovels,
3 stone sledges,
6 striking hammers,
Hydrant key,
Goose-neck,
Paving-pounder and hammer,
3 stone chains,
3 wheelbarrows of wood,
2 buckets of clay,
6-foot measuring-stick.

4.

20 dinner-pails.

5.

Tackle,
Nails and hammers.

6.

Small locker for spare tools,
Plug drill box,
9 lanterns and oil-can.

7.

Can, powder and fuse, 3 hoes, coil gasket, 6 pigs lead, furnace, 2 barrels coke, lead kettle and spoon, bell pole, saw, tamping bar, 12 buckets, 6 lantern sticks, 4 iron bars, 14 blowing-drills.

CHAPTER VI.

SERVICE-PIPES.

Definition — Materials — Lead vs. Wrought Iron — Tapping Mains for Services — Different Joints — Compression Union Cups.

BY common consent and general usage, the term service-pipe is applied to the tube which conveys water from the street-main to the premises on which it is to be used. In the majority of cases the service-pipe proper ends just inside the cellar wall, and the term house-pipes is a suitable one to apply to the tubes which convey the water from that point to the various fixtures in the building.

There seems to be substantial agreement among those best qualified to judge that lead is the most suitable material for service-pipes, but in spite of this the first cost of lead pipe and the popular prejudice which is often found against it has prevented its adoption in many recently constructed works. This is not the place for a thorough discussion of the subject, but those who care to follow it are referred to a paper by Mr. Walter H. Richards, C. E., Engineer and Superintendent of the New London, Conn., Water-Works, which was published

in the transactions of the New England Water-Works Association for 1884, and to Professor Nichols' "Water-Supply from a Chemical Standpoint."

Lead pipe is to be preferred because it is the most durable, the most easily worked, and the smoothest pipe now in the market. Its substitutes are plain wrought iron, tarred or enameled wrought iron, galvanized iron, and wrought iron lined with cement.

One's choice really lies, then, between lead pipe and wrought-iron pipe with some protecting coating. Tin-lined lead pipe is not, to the writer's way of thinking, worthy of much consideration. The tin lining is thin and easily broken in working, and if the lead be exposed at any point the chance for some galvanic action, followed by the formation of lead carbonate or lead oxide, is too great to be taken. If any combination of chemical and physical reasons in some special case should render lead pipe unadvisable, a perfect though expensive substitute may be found in pure block-tin pipe.

The experience of every city and town which uses lead for service-pipe is, so far as I can learn, that a thin brownish insoluble coating soon forms on the interior walls of the pipe, and then all further action ceases. The cities of New York and Philadelphia; Boston, Worcester, New Bedford, Fall River, in Mass.; Denver, Col., Atlanta, Ga., Chicago, Ill., Wilmington, N. C., to go no further in this country, and Glasgow and Manchester abroad, use lead pipe, and this consideration would seem to dispose of the question as to its healthfulness, leaving only the question of cost to be considered, and upon this latter point Mr. Richards' paper referred to gives some interesting figures.

TAPPING.

Except for special reason, a main should not be tapped for service-pipes until it has been filled and, better still, if possible, not until it has been thoroughly flushed.

Cast-iron pipes must be entered by means of some sort of tapping machine. There are several machines for this work upon the market, and one will not make a mistake in buying any one of them, provided it is offered by trustworthy parties. It is well to bear in mind, in selecting a machine, that it is to be carried about, and perhaps knocked about; that it is to be used in all sorts of trenches, wet and dry, muddy, sandy, and rocky, and, therefore, that it should be light, strong, simple, and with as few wearing parts to collect sand and grit as possible. It will be well for any man who taps a pipe under pressure for the first time to choose, if he can, a section which can be easily shut off, for it will be nothing strange if he has to shut down and take off the machine to get the cock into the pipe. Printed directions for operating are furnished with each machine, and a week's work will make one independent of them.

That which is screwed, soldered, or driven into the main pipe is the corporation cock; at the sidewalk we have the curb or sidewalk cock, and just inside the cellar wall should be placed the house shut-off, or stop and waste cock.

In the early days of the Boston Water-Works sidewalk cocks were not used, and to shut off the premises wholly from the main the Water Department was obliged to dig down to the corporation cock. This condition of things was unsatisfactory, and, under the direction of Assistant Engineer Brackett, sidewalk cocks are being inserted.

As to the house shut-off just inside the cellar wall, there seems to be no good reason why the Water Department, or

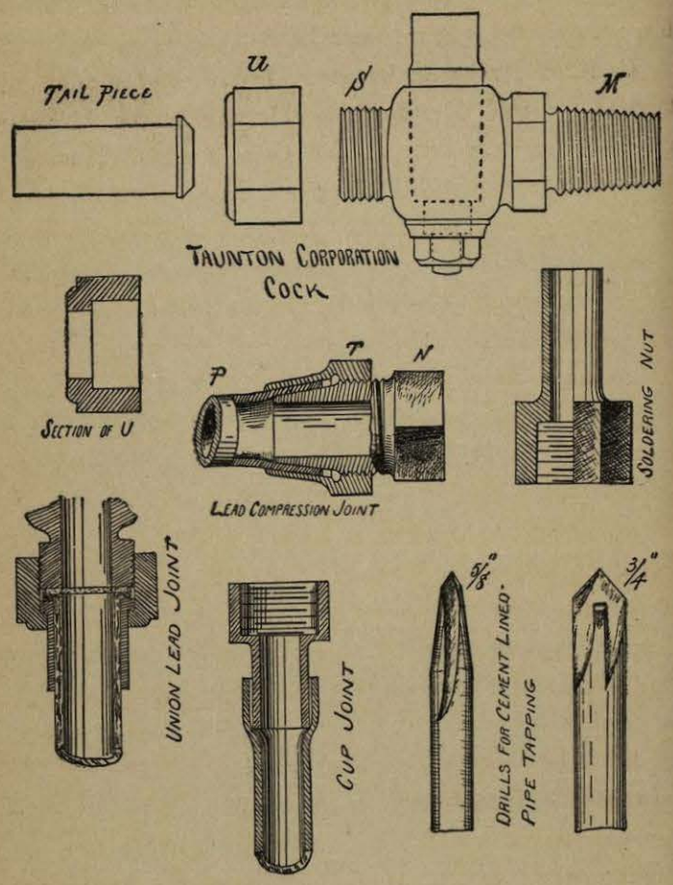

Figure 22.

the water company, should furnish that, except to secure uniformity and a first-class fixture. That there should be a good,

sound, easy-working shut-off cock at that point there is no sort of doubt, but who should furnish it may be left as an open question. In Taunton it is furnished by the consumer.

Referring to Figure 22, in which is represented the particular pattern of corporation cock, with full ¾-inch way designed by the writer, for use upon the Taunton Water-Works, the end M is the end which is screwed into the main. The general form of this end is the same no matter what is used for service-pipe. Something is saved in the cost of manufacture by using the same thread at S and M. Eleven, twelve, fourteen, or sixteen threads to the inch are admissible, but fourteen has been found to give good results in the practice of the writer. At the end S and in the parts immediately following there is room for great variation in form and method. With the nut *u* (shown also in section) and the tail-piece forming a ground union-joint at the end S, this form of cock may be used (1) with lead service-pipe by making a wiped joint or a cup-joint between the lead pipe and the tail-piece; or (2) with any kind of wrought-iron service-pipe by joining on to the tail-piece a short piece of lead pipe, perhaps 18 inches, just as if the service were to be of lead pipe, and then, by attaching a soldering nut, as shown, and continuing the line with screw-joint pipe.

There is a form of corporation cock in the market in which the end S has a female connection so that wrought-iron pipe may be screwed directly to the cock without the intervention of lead pipe, but this form cannot be recommended for general use, because the flexibility of lead pipe is needed to insure safety against overstraining from settlement in the trench.

In addition to the joints made with lead pipe by wiping or cupping, there is one which may be called the compression-joint. Some regard this joint as to be preferred to any joint which depends upon solder, but the writer's experience does not lead him to take this view of it.

The compression-joint was in use a few years ago in Taunton, but was abandoned for a cup-joint. The corporation-cock then in use was shaped at the end S like the projecting part of N in the compression-joint shown in Figure 22, and tightness was secured by scraping the outside of the lead pipe to a reasonably smooth surface, so that the cone-shaped nut would draw the lead pipe firmly over the conical projection; the lead pipe having been first spread by driving in a solid plug.

It is evident that this principle can be applied in a variety of ways, and that castings can be designed to fit any combination of materials. For example, the cup-joint in Figure 22 shows how a wrought-iron service-pipe may be joined to a lead connection from the corporation-cock. The lead pipe is attached by a wiped or cup joint to the soldering nut, which is tapped out to receive any size of wrought iron or brass pipe that one chooses.

Still another form of joint has been brought to my attention, by Mr. J. G. Briggs, Superintendent of Water-Works at Terre Haute, Ind., and shown also in Figure 22, as a union lead joint. Mr. Briggs says the idea is not a new one, but was used twenty years ago or more by an English company who did a large amount of work at Rio Janeiro, Brazil, and that in San Francisco the joint has been used for sixteen years with good results. The lead pipe is put through the

brass thimble, and the end hammered or riveted over on a pir made for the purpose, and tightness secured by a washer. I' this washer be of lead it will last, but it would seem as though a leather or a rubber washer would be too short-lived to be wholly satisfactory. As to the merits of this joint the writer has no practical knowledge, but the fact that Mr. Briggs favors it would, in the vernacular of the stock market, be counted as a "bull point" for it