CHAPTER IV.

PIPE-LAYING AND JOINT-MAKING.

Laying Cement-Lined Pipe—"Mud" Bell and Spigot—Yarn—Lead—Jointers—Roll—Calking—Strength of Joints—Quantity of Lead

CEMENT-LINED PIPE.

WROUGHT-IRON pipe after being lined with cement is not ready for immediate use. It should be allowed to dry for one or two weeks, the time varying with the weather, and the readiness with which the mortar sets, and a careful man will not subject the finished pipe in the trench to pressure for five weeks after laying, unless the pressure be very light. No derrick is needed in laying this pipe, for if circumstances do not allow the men on the bank to hand the lengths to their comrades in the trench as easily as they could lift a piece of stove-pipe, two pieces of rope will furnish means for easy lowering.

The cement bed and covering is "mud," in the language of a cement-pipe-laying gang, and is mixed sand and cement, three to two, in a mixing-box on the bank.

It may be conveyed in the trench in any convenient manner; in V-shaped troughs, ten feet long, with handles at

each end, or in pails, or in wheelbarrows. Before placing a length of pipe, a bed of a dozen pailfuls of cement is spread along the bottom of the trench, thicker than the covering desired, and the pipe, with the rivets down, is pressed firmly into it; "mud" is then brought in sufficient quantities to allow the pipe to be plastered an inch in thickness, leaving the joints uncovered. The cement is spread with rubber mittens, and the men in the trench who handle the "mud" wear rubber leggings.

The joints are covered with pure cement, and are often made by the foreman of the pipe-layers, who can easily keep ahead of his men, for to a practiced hand the operation is simple and rapid.

The exposed pipe-ends are first covered with cement even with the finished pipe, and a sheet-iron sleeve is then slipped along so that its centre is directly over the joint. A pin of ¼-inch wire stuck into the trench will locate the butt joint of the two pipes, and make the placing of the sleeve an easy and certain matter, and the sleeve is then in turn covered with the pure cement.

This pure cement will crack, perhaps, and must be patched, and for this the regular "mud" will answer.

To protect the covering from too sudden drying, the pipe should be lightly covered as soon as it is laid, but the final covering should be delayed forty-eight hours.

The specials for cement-lined pipe can be made by any good sheet-iron worker.

Tee and Y branches are to be soldered at their junction and strengthened by knees of ¼-inch flat iron, one inch wide, riveted to the metal.

Plugs are simple cylinders filled solid with "mud," but they are to be braced in the trench with a heavy stone.

JOINT-MAKING.

There is not, to my knowledge, any standard form for a cast-iron pipe-bell or socket. This is unfortunate. The lack of agreement in this particular is, it is true, not nearly so unfortunate as the still greater lack of uniformity which prevails

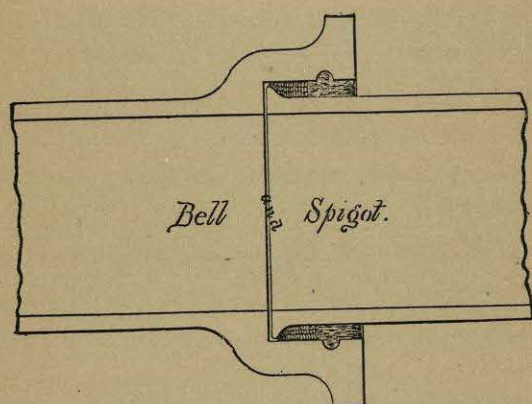

FIGURE 15.

in the thicknesses which are specified for cast-iron pipe, but a standard is desirable.

The general form of a bell and spigot pipe-joint is shown in Figure 15.

In practice, the two lines which in the sketch run through the word "and" should form one, and they will when the spigot end is pushed "home." A space is left in the sketch

to make the parts more distinct. A water-tight joint capable of standing great pressure is secured by using a soft compressible substance in combination with molten lead. For the first substance one may use jute, hemp, old rope, old rigging, oakum, or almost anything of this nature, as the principal office of the "yarn," as it is oftenest called, is to prevent the molten lead from running into the pipe. It has been suggested that the yarn in the joints of a distributing system may, by its compressibility, serve to mitigate the shocks which come from the water-hammer, and again that the yarn will in time decay and may then furnish feeding-ground for noxious animal or vegetable life which may appear at one time or another in any water-supply.

At present these suggestions belong to that class of problems which are of special interest to the investigator. Of the first we may say that it has a reasonable appearance, and of the second, that if it be true the elastic cushion is lost when decay is complete.

The writer's experience has led him to adopt for yarn the article known to the cordage trade as 12-thread Russia gasket, tarred.

A larger size may be needed for 24-inch and 48-inch pipe, but the 12-thread has worked well on all sizes up to and including 16-inch.

For lead, use any soft pig, such as the "Omaha" or the "Aurora" brands.

In a gang of fifty, one man can find enough to do in yarning and pouring the joints. Let the yarn be cut into pieces long enough to go around the pipe and lap a little.

The yarner takes a bundle of these "ends" as large as he can conveniently carry from one bell-hole to the next, a couple of cold chisels, a yarning-iron, and a hammer, and, going to the first joint that is ready, he should, to begin with, see that the joint-room is even, or alike all around the pipe, and if it is not the chisels should be driven into the small places so as to crowd the pipes into line. This, of course, provided the pipes are intended to be in line, and one is not trying to get around a curve by "taking it out of the joints." The relative amounts of lead and yarn to be used per joint do not seem to be determined by any hard-and-fast rule. Referring to Figure 15 we can see that there is little except stiffness gained by putting in more than enough lead to reach back of the semi-circular groove, say one-quarter or one-half an inch, so that the depth and form of the bell must determine to a great degree the exact depth of lead in the joint.

Yarn is cheaper than lead, but the time consumed in yarning may, with lead at a very low figure, make it cheaper to put in only a shred of yarn and save time by filling up the joint with lead.

I think some contractors have figured in this way, for joints of their making which I have had occasion to dig up seem to have been made upon that principle.

Tarred stuff of some sort packs better and is easier to handle than dry rope or strings. The tarred Russia gasket, bought in 100-pound coils, is convenient to use for slings and lashings, and is just as good as ever for yarning after any other use. To guide the molten lead into the joint, we must have either a "roll" made of ground fire-clay upon a rope-yarn core, or a jointer. If a jointer is used, the yarner carries

it with him in the trench, but a clay roll must be kept in shape and ready for use by the lead-boy. The patent jointers are made of canvas, rubber, and sheet-steel. They are very convenient, and can be obtained of dealers in water-works supplies. They are especially useful in wet places, for they do not easily blow out if a little steam is formed, and the clay roll will frequently give trouble in this particular. For making a good clay roll we require finely-ground fire-clay, a piece of board somewhat longer than the finished roll, a strand of rope, and a pail of water. Mix two double handfuls of the clay into dough, and after enough kneading to get out the lumps, roll the mass into a short thick club. With a stick or a chisel cut a slit lengthwise of the club and half-way through it, and lay therein a strand of rope a foot longer than the outside circumference of the pipe. Bring the two edges of the slit together, and then, by working, stroking, squeezing, wetting, and rolling, the roll may be drawn out to an inch in diameter, and eight or ten inches longer than the outside circumference of the pipe. This roll-making is the work of the lead-boy, who should keep the roll, when not in use, lying on the board covered with a wet cloth, and mend and wet it as the wear and tear demand. When he has packed the proper amount of yarn into the joint, the yarner should call out "roll" to the lead-boy, who will bring him the roll by the two rope-ends.

The roll is wrapped about the pipe close to the bell, bringing the two ends on top, and turning them out along the pipe, forming a convenient pouring-hole. The roll should be pressed firmly into place against the bell, and the molten lead poured in not too rapidly. The lead should be hot enough to run freely, and the furnace should be frequently moved, so that the hot lead need not be carried far enough to give it time to cool. After the joint appears to be full, and the roll has been removed, the yarner should examine the joint carefully all around, and especially on the bottom, to make sure that the joint *is* well filled ; and if a cavity is found it should be filled by a second pouring if possible, or by a plug of cold lead. The calker follows, and should begin on the joint by

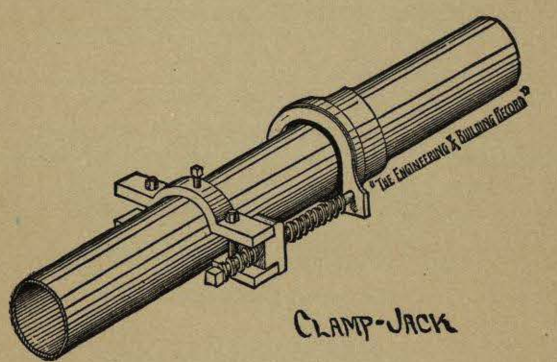

FIGURE 16.

using his chisel, cutting off the lump at the pouring-hole, and then driving the tool lightly between the lead and the surface of the pipe all around. Having, by this operation, lifted the lead away from the pipe, he begins with the smallest tool and drives back the lead, a little at a time, all round, and, following with the larger tools, sets the metal in firmly with strong, even blows.

Calking is hard work and needs a muscular man to follow it steadily, but it is not enough that he be—

> " Darbyshire born and Darbyshire bred,
> Strong in the arm and thick in the 'ed,"—

for he should know when a joint is right ; but above all he must be trustworthy and faithful, and certain to call attention to any joint that he cannot get into proper shape without help. The quantity of power required to pull apart a well-made bell and spigot joint will surprise one who sees it measured for the first time.

In the experience which the writer has had in endeavoring to pull apart such joints the amount of force applied has not been measured with exactness, but a heavy clamp-jack having a pair of 1¾-inch screws with four threads to the inch, worked with a lever about thirty-six inches long, was insufficient to pull apart any but pipe from which the rim or bead on the spigot end had been cut off so as to leave a smooth end.

Some notion of the force applied to the joints by this clamp-jack, Figure 16, may be had by using the formula for power exerted by screw given in *Goodeve's Mechanics :*

$$P = \frac{w\,r}{a} \tan(\alpha + \theta),$$

in which

P = power applied at end of lever.
r = mean radius of screw-thread.
a = length of lever.
α = angle of thread.
θ = angle of repose.
$\tan \theta$ = coefficient of friction.
w = force exerted by screw.

Then.

$$w = \frac{P\,a}{r \tan(\alpha + \theta)}$$

In Figure 17, let B A represent the developed circumference of the cylinder on which thread is traced, and P A the

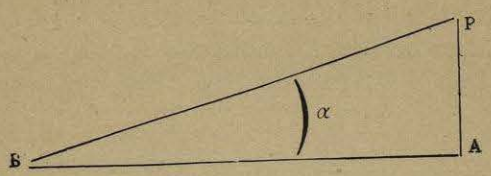

FIGURE 17.

pitch of the thread, and P B A $= \alpha =$ angle of thread. Then

$\tan \alpha = \frac{PA}{BA}$ and substituting the values for this case, calling 1½ inches the mean diameter of the screw thread,

$$r = \tfrac{75}{100} \text{ inch.} \quad PA = \tfrac{25}{100} \text{ inch.}$$

$$\tan \alpha = \frac{.225}{4.711} = .053 \text{ and } \alpha = 3^\circ \, 2'.$$

$$\tan \theta = .08 \text{ and } \theta = 4^\circ \, 35'.$$

$$\theta + \alpha = 7^\circ \, 37'. \quad \tan \alpha + \theta = .133724.$$

$$P = 100 \text{ pounds.} \quad a = 36 \text{ inches.}$$

$$w = \frac{P\,a}{r \tan(\alpha + \theta)} = \frac{3.600}{.75 \times .134} = 36{,}000 \text{ pounds.}$$

This formula makes no account of the power expended in overcoming friction at the pivot end of the square-threaded screw, and the result above given should be reduced 15 or 20 per cent.

The same clamp-jack has been found useful in pushing a hydrant off its branch for repairs.

As to the quantity of lead used in joint-making on cast-iron pipe the following notes are offered. Four streets having a

total length of 3,112 feet of 6-inch pipe consumed 1,997 pounds of lead, or $\frac{64}{100}$ pound per running foot. Two streets, 1,796 feet of 8-inch required 1,514 pounds of lead, or $\frac{76}{100}$ pound per running foot.

During the past season the writer has directed the laying of 10,000 feet of 16-inch, 1,915 feet of 8-inch, 1,479 feet of 6-inch, 1,817 feet of 4-inch pipe. For purposes of this calculation it is fair to say that the quantity of lead varies directly as the diameter of the pipe, and that the above is equivalent to 11,927 feet of 16-inch pipe, and to make the joints on this 23,579 pounds of lead were used, or 1.97 pounds per running foot. This is larger, as of course it would be, than the amount given by a single experiment on a short piece, for ten pigs weighing 96.7 each (average weight) filled the joints on 550 feet of 16-inch, or 1.75 pounds per running foot.

The quantity of yarn used is not large, comparatively speaking, and on the three small sizes, 4, 6, and 8 inch, with the price at ten cents per pound, $\frac{6}{10}$ of a cent per foot is a safe figure for estimating purposes.

The quantity of pipe laid and the number of joints made in a day will, of course, vary greatly in different cases. If a man is trying to see how many pipes he can get into a trench, with the minimum amount of thought as to how they are put in and jointed, he can make a wonderful record, and the man who comes after him, and has to take care of the pipe-line under the shocks of service, will appreciate more keenly than any one else the value of such a record.

The following notes of actual work are offered, not in any sense as instances of model performance, but as simple illustrations: Time, July 6, 1887; gang 60 men, 16-inch pipe, 2 yarners, 2 calkers, 4 to 10 men digging bell-holes, 30 beil-holes per day, 400 feet of pipe laid and jointed in ten hours.

CHAPTER V.

HYDRANTS, GATES, AND SPECIALS.

STREET intersections are obviously suitable places for hydrants and gates.

A hydrant so placed serves more territory than one placed midway between cross streets, and at the intersection of important thoroughfares and large mains the four-way hydrants carrying four hose-nozzles are in every way suitable, if post-hydrants are chosen.

For the narrow crowded streets of a large city the flush hydrants are better than the post, but, as a rule, the small water-works which have sprung up all over the country during the last few years are fitted with hydrants of the post pattern.

If a post hydrant is not placed near a street corner, it is well to put it on a division line between two estates, for the chances that it will in the future be an obstruction are smaller in this position than they can well be in any other. The distance apart for hydrants may be 200 or 500 feet, according to circumstances, but the larger distance should not be exceeded without the best of reasons.

It has become a well-established custom to place gates on street lines, and the ease with which gates so placed can be