mortar is packed in by hand to completely fill the annular space, and this is neatly finished by a fillet splayed by a trowel at an angle of about 60°. The object of the yarn is twofold, as it prevents the entrance of the cement to the inside of the drain and assists in centering the pipes to maintain a properly aligned invert.

Some jointers prefer to omit the preliminary packing of the joints with yarn. Accordingly, unless the mortar is of a stiff consistency, much of it will pass within the drain and a " dropped invert " will result as the pipes, because of their weight, will subside and squeeze out some of the material. Such a faulty joint is shown at H. If the projecting mortar is not removed, as explained in next column, paper and solids may accumulate to cause an obstruction in the drain; lodgement may also be caused by the dropping of the spigot. The unsightly appearance produced by an excess of mortar and the absence of a fillet is also shown.

2. *Bituminous Joint*.—Of the many patent joints on the market that shown at J, K and L, Fig. 29, and known as the Hassell's Double-lined Joint, is one of the oldest and best. Each pipe has two solid bituminous rings moulded on the inside of the socket with a 1-in. space (for a 4-in. pipe) between, and two similar rings are cast on the spigot (see K). Two holes are provided in the socket (see L). The joint is made in the following manner: Plastic cement (provided by the pipe manufacturers) or a mixture of 2 parts tallow and 1 part resin is applied on the surface of the inner ring of the socket and the dovetailed ring on the spigot (see K); the spigot is inserted into the socket and pressed against the shoulder (see J), and waterproofed cement grout is passed down a funnel, held at one of the holes, into the groove or annular space, driving out the air until it appears at the second hole. This is an excellent joint as it is air and watertight, is quickly made, a truly aligned invert is assured, and no cement can enter the bore of the pipe.

These and similar jointed pipes are especially useful for the construction of drains in waterlogged trenches where water seriously interferes with the laying of pipes with ordinary cement joints unless pumping is resorted to.

Bituminous joints, not of the moulded ring type, are also made by using hot bitumen as the jointing material. This gives a more elastic joint than that made of cement, but it is not often used.

FOUNDATION.—A drain must have a firm foundation, otherwise settlement may occur and cause cracked or broken pipes, cracked joints, an irregular invert, etc. The Model Bye-laws require that ware pipes within " a distance of 50-ft. from a building shall be laid on a bed of concrete unless the nature of the soil renders this unnecessary." In best work a concrete bed is provided even if the ground is firm. This bed should be 6-in. thick (or not less than the internal diameter of the drain) and from 8 to 12-in. wider than the internal diameter of the pipe. It is then benched or flaunched to midway up or to the crown of the pipe, as shown at M and N, Fig. 29 (see p. 78 and C and H, Fig. 31).

CONSTRUCTION OF DRAINS

Both the (1) *boning* and (2) *gauge-board* methods are adopted in the laying of drains.

The following is how these methods are applied to a drain which is laid directly on the ground. The construction of a drain is proceeded with, commencing at the lower end, after the trench has been excavated and the bottom formed to the required gradient as described on p. 75. The sockets are therefore facing upwards and against the flow. As the barrels of the pipes should have a firm bearing on the solid ground, it is necessary that holes be formed in the bottom of the trench under the sockets (see E and F, Fig. 29). These are formed as each pipe is laid, sufficient earth being removed by the pipe layer to enable him to get his hand under the sockets to form the joints.

1. *Boning* is the more accurate method. The boning rod used is similar to that referred to on p. 75, except that it is provided with a projecting wood or metal shoe as shown at B, Fig. 29. It is held on the invert of each pipe in succession, as indicated at E, any adjustment of the pipes being made until the head coincides with the line of sight. Thus, the position of each pipe is fixed independently and therefore any errors are not accumulative. The formation of sinkings under the sockets as mentioned above is often omitted, and instead a brick is placed under each barrel near the socket; this is an undesirable practice as such partially supported pipes may be fractured by the weight of the earth above or by traffic. The pipes are jointed as described on p. 75. Any cement which may have entered the drain must be removed before it has set. This is done immediately each joint is made by using a wood scraper Q or scraper R (consisting of a disc of rubber bolted between two wood discs) or a *badger* (having two discs similar to R with a steel spiral spring between) or a bag containing shavings.

2. *Gauge-board or Straight-edge Method*.—This is illustrated at F, Fig. 29. The board is tapered as required. Thus, if the drain is to be laid to a fall of 1 in 40, a 5-ft. long board will be $\frac{5}{40} \times 12$ in. = $1\frac{1}{2}$-in. deeper at one end than the other; a thin block is nailed on the splayed edge at each end so that the board will clear the sockets. The gauge-board is used as each joint is formed, the level of the pipe being adjusted until the bubble of the spirit level is in the centre of its run when the level is placed on the board as shown. This method should only be used for short lengths and branches of drains. It is not so accurate as the boning method, for, unlike the latter, any errors are accumulative. Also, as the thickness and bore of pipes may vary slightly, it follows that the invert may not be parallel to the required gradient. Special care must therefore be taken when using this method to a drain having only a slight fall.

The gauge-board is often used without blocks, and is then laid upon the sockets; when so applied, errors may occur by irregularly shaped and eccentric sockets. A straight edge, having a projecting screw at one end which is adjusted as required, is sometimes used instead of the gauge-board. A lath, having a small fillet attached at one end of a thickness equal to the required difference in level, is a further substitute.