The concrete foundation for a drain referred to on p. 76 is formed in the following manner : The bottom of the trench is laid to fall as explained on p. 75, additional depth being allowed for the concrete. Wood pegs are driven in along the trench bottom at 9 or 10-ft. intervals with their tops 4 to 6-in. (according to the thickness of the concrete) above the ground. The concrete forming the rectangular bed is placed in position and screeded off (see p. 60) level with the tops of the pegs. The top of the concrete is thus given a fall parallel to the line of sight. The pipes are then laid by either the boning or gauge-board methods with their flanges resting upon the concrete. The concrete benching is formed after the joints of the drain have set, the concrete being well packed under the pipes and neatly flaunched midway up the drain pipes or to the crown (see M and N, Fig. 29). Some prefer to provide additional room for making the joints by laying the barrel of each pipe on a brick laid flat upon the concrete bed near to the socket, followed by packing and benching. A better method is to embed bricks flat at 2-in. depth and 2-ft. centres (or socket intervals) in the concrete foundation during formation ; these are removed before the concrete has set, and the holes thus formed for the sockets are filled in with fine concrete after the joints have set and during benching.

Testing Drain Pipes.—No drain shall be covered up before it has been tested and approved by the local authority.

The test most generally applied to new drains is the *hydraulic* or *water test*. Briefly, after the joints have set, the lower end is plugged, the drain is filled with water and allowed to remain for about an hour. Any drop in the water level at the end of this period (after allowance has been made for slight absorption) indicates leakage. Examination will show the cause of this. Any cracked or otherwise defective pipes are replaced by sound ones, and cracks in joints are made good.

Another test, now falling into disfavour because of the cost entailed, is the *smoke test*. Smoke from burning oily cotton waste is pumped by a machine into the lower end of the drain, the upper end is plugged, and pumping is maintained until a certain pressure is reached. Any defects are exposed by escaping smoke. These and other tests are fully described in Vol. IV.

Ball Test.—A drain may be airtight and watertight and pass either of the above two tests and yet be of defective construction owing to the presence of jointing material within the drain and an improperly aligned invert. It is for this reason that many authorities now apply the ball test to newly constructed drains in addition to the hydraulic (or smoke) test. This test merely consists of passing a solid rubber ball down each length of drain. The diameter of the ball is $\frac{1}{4}$-in. less than that of the drain. The ball is put into the drain at the top end, and if it emerges at the lower end it is a sufficient indication that the drain is true in bore and free from cement ridges. If the ball does not traverse the full length of the drain, the cause of the stoppage is ascertained and any defects remedied. This is an important test.

Refilling Trench.—After a drain has been approved, the trench should be carefully refilled in 6-in. thick layers. The finer earth is placed with care next to the drain so as not to damage the pipes and joints. This is spread and lightly consolidated, after which the remainder of the refilling is completed, each layer being well rammed.

DRAINAGE SCHEMES

The drainage plan of a building (with certain exceptions) must be submitted to and approved by a local authority before building operations are commenced. The following is usually required to be indicated on such a plan : (1) The position of rain water pipes, gullies, and the various sanitary fittings such as lavatory basins, baths, sinks and water closets ; (2) arrangement of the various drains, the sizes of which must be specified ; (3) inspection chambers, and, if necessary, the intercepting chamber (see p. 82) ; (4) means of ventilation ; and (5) the position of the public sewer (or other outlet) to which the main drain is shown connected.

A typical plan showing the drainage scheme for a small house is shown at A, Fig. 30, and a part system is shown at A, Fig. 31. These are referred to on p. 84.

Principles of Drainage.—The essential principles of drainage applied to these and similar schemes are :—

1. Drains must be airtight and watertight, constructed of sound materials and workmanship, with an even invert and a clear bore, and all traps must be self-cleansing and have an adequate seal.
2. They must be provided with a sound foundation, laid with an adequate and uniform gradient and in straight lines between points and where the direction changes.
3. Adequate means of inspection and cleaning must be provided, inspection chambers being constructed at change of direction points and in convenient positions to receive the maximum number of branch drains.
4. A drain *may* be required to be disconnected from a sewer (or cesspool) by the provision of an intercepting chamber (see p. 82).
5. Adequate ventilation must be provided.
6. Branch drains should be as short as possible and preferably laid in straight lines to the nearest inspection chamber.
7. Bends must be slow and junctions oblique.
8. Rain water pipes, and sink, lavatory basin and bath waste pipes must discharge over gullies outside.
9. Water closets must be connected direct to drains, upper water closets being connected to soil pipes which must be ventilated.
10. Unless unavoidable, no drain shall pass under a building. If laid under a building, the drain must be either of ware completely encased with concrete not less than 6-in. thick (as shown at P, Fig. 29) or be constructed of cast iron.

Several of these principles have been already referred to,