and as this boarding should be laid in the direction of the grain of the timber to ensure satisfactory drainage, the joists supporting it are laid across the shortest span. The fall is obtained by fixing rectangular (not tapered in section) firrings to the tops of the joists. These firrings increase in depth from a minimum of ½-in. at the lower joist to a maximum at the upper end (see A, P and T, Fig. 72); deep firrings are avoided at the upper half of the flat by using deeper joists as shown. The wood construction of the drips and rolls are detailed in Fig. 72, and will be more readily understood if consideration of this flat is deferred until the subject of leadwork is studied. The gutter is constructed of 2-in. by 1½-in. *gutter bearers* at 15-in. centres, which are fixed at different levels to give the necessary fall to the boarding. These bearers are supported by the wall at one end and by a 1½-in. thick longitudinal fillet or bearer nailed to the side of the lower joist (see P, Fig. 72). The construction of the cesspool is similar to that described on p. 145.

Flat roofs are suitable for sculleries, garages, tool-houses, bay windows, corridors, etc.[1]

(ii) *Lean-to Roof* (see H, Fig. 36).—This is the simplest form of pitched roof and consists of spars inclined at 30° [2] against a wall. An enlarged detail of J is shown at G, where the wall plate is supported by two brick corbel courses. Alternatively metal corbel brackets as shown at T, Fig. 32, may be adopted. A cheaper method consists of nailing the upper ends of the spars to a continuous 3-in. by 2-in. *wall piece* or *pitch plate* which is *plugged* with its 3-in. face next to the wall. Plugging consists of driving wood wedges (see F, Fig. 51) called *plugs* at intervals into the joints of the brickwork. The ends of the plugs are cut flush with the face of the wall and the wall piece is nailed to them. The construction at the eaves is similar to that at X, except that there is no horizontal tie. The spars are V-shaped notched at both ends and fitted to the wall plate; this is one form of a *birdsmouth joint*. Another form is shown at K, Fig. 37. The depth of the notch should not exceed one-third that of the spar. Notching the spars counteracts the tendency for them to slide downwards. The eaves detail is referred to on p. 74. The roof may be boarded as shown at X or battened as shown at Y.

This type of roof is adopted for similar buildings to those described for flat roofs.

(iii) *Double Lean-to, Pent* or *V-Roof* (see M and O, Fig. 36).—Pent means penned or closed in, and this form consists of two lean-to roofs which are enclosed by and sloped from the two outer parapet walls to a party or division wall over which a gutter is formed. Sometimes the lower ends of the spars are secured to a beam which runs parallel to the main walls, and, if necessary, is supported at intervals by brick, wood or steel pillars. A detail of the gutter is shown at T and a description of the slating and plumbing work is given in Chapters Five and Six.

[1] Flat roofs are now extensively adopted for factories, commercial buildings, etc. Such roofs are generally of reinforced concrete covered with asphalt.

[2] This slope is suitable if slating is the covering material.

This is a type of roof which is not now often adopted as it is expensive on account of the extra walling required and because the gutter is a potential source of weakness.

(iv) *Couple* or *Span Roof* (see E and F, Fig. 36).—It is so called as each pair or couple of rafters is pitched against each other and supported at the upper ends at the ridge, as detailed at P. A detail of the eaves at D is shown at W and described on p. 74. It should not be used for buildings having a greater span than 12-ft. unless the walls are exceptionally thick. The roof is of bad design as it has a tendency to spread at the feet (as shown by the thick arrows) and thrust out the walls. *It is not recommended.*

(v) *Close Couple Roof* (see L, Fig. 36).—This is a vastly better form than the last described, for each couple of rafters is closed by a horizontal tie—hence the name. This tie is connected to the feet of the spars and prevents them spreading outwards. The best form of connection between the ties and the feet of the spars is the *dovetail halved joint* (detailed at Z and described on p. 73) but in cheaper work the ties are just spiked to the spars. A plastered ceiling is often formed on the underside of the ties, they are then called *ceiling joists*. Such joists, when they exceed 12-ft. in length, should have 2-in. by 1¼-in. vertical *hangers* nailed to every third or fourth spar and to a horizontal 3-in. by 2-in. *runner* which is nailed to the joists (see Fig. 38 and p. 74); this prevents the sagging of the ceiling joists and cracking of the plaster. The span of this roof should be restricted to 16-ft. unless the size of the ties is increased or they are supported by hangers, when the span may be increased to 20-ft. According to some bye-laws, the following sizes of ties (redwood) must be complied with :—

TABLE V

Maximum span.	Size.	Maximum span.	Size.
8 ft.	4 in. by 2 in.	14 ft.	7 in. by 2 in.
10 ,,	5 ,, by 2 ,,	16 ,,	8 ,, by 2 ,,
12 ,,	6 ,, by 2 ,,	18 ,,	9 ,, by 2 ,,

If hangers or struts are used for spans of 12-ft. and upwards, the depth of the ties may be halved.

The detail of the open eaves K is shown at X and an alternative closed eaves is illustrated at Y. These are described on p. 74.

This roof conforms with sound principles of construction.

(vi) *Collar Roof* (see V, Fig. 36).—This is similar to the close couple roof, except that the horizontal ties are now placed higher up the roof, and are called *collars*. The latter may be placed at any height between the wall plates and halfway up the roof, the broken lines indicating the position when at the maximum height. Obviously the lower the collar the more effective it becomes in preventing the rafters from spreading and causing damage to the walls. It