lower edge is parallel to the slope of the rafter. The tenon should not exceed 1¼-in. in depth otherwise the strength of the post will be impaired. The joint is reinforced by two wrought iron or mild steel straps (see O), one being fixed at each side as shown at B by means of seven ½-in. diameter bolts, 6-in. long, secured by nuts. This is sometimes known as a *single abutment tenon joint*; a double abutment joint may be used as an alternative (see below).

(c) *Joint between King Post and Tie Beam.*—This joint may consist of an ordinary shouldered mortice and tenon as shown at C and G, Fig. 40, or the width of the tenon may be reduced to form a *stump* or *stub tenon* (see C, Fig. 41). A ¾-in. diameter bolt is the most common form of fastening (see C, Fig. 40), a hole being formed through the tie beam and foot of the post to receive it and a hole being cut at the side of the post to permit of the insertion of the nut and washer (see G).

An alternative to the bolt and a stronger but more complicated fastening is shown at C and F, Fig. 41. This consists of a mild steel or wrought iron *stirrup strap* with steel *gibs* and *cotters* (wedges). The gibs and cotters are passed through the slots in the strap and mortice formed in the king post (see section DE). The joint is tightened by driving in the cotters which bear upon the gibs to force the strap (with the tie beam) upwards. This movement is only possible if three clearances are provided, *i.e.*, a space between the top surface of the upper gib and the top of the mortice, a space between the bottom surface of the lower gib (which bears on the bottom of the mortice) and the lower edge of each slot in the strap, and a space between the shoulders of the king post and the tie beam. These three clearances are shown in the section. This joint is used occasionally, but it is questionable if the cost is worth while.

(d) *Joints at the Head and Feet of Struts.*—The joint at the head of each strut has an oblique tenon which is housed into the rafter to form a vertical abutment (see F and L, Fig. 40).

The foot of each strut is connected to the king post as shown at C and G, Fig. 40. It is a single abutment tenon joint and is similar to the joint between each rafter and the post, the latter being shaped to form a good abutment, and the lower edge of the tenon has a horizontal cut. Another form of this joint is shown in the elevation at C, Fig. 41. The post is splayed to form a *square* abutment for the lower half of the strut, and as the upper half has a vertical abutment, the joint is called a *double abutment tenon joint* to distinguish it from the type at C, Fig. 40. As stated in paragraph (*b*) above, the joint between the head of each rafter and the king post may have a double abutment. This is similar to that at C, Fig. 41, the square abutment being provided by the post for the upper half of the rafter and a vertical abutment for the lower half.

The portion of the king post which has been reduced in width between its head and foot is called the *shank*. The square head is grooved as shown at H, Fig. 40, to receive the ridge, any scarfed joint to lengthen the ridge (see p. 73) being formed over the head of the post. The tie beam shown in the example will be in one length. For larger spans the beam may be in two pieces when a scarfed joint similar to that at R, Fig. 37, would be employed.

Purlin Details (see F and L, Fig. 40).—The purlins are cogged for a depth of 1-in. over the backs of the principal rafters (see L). The shaped blocks, called *cleats*, are securely spiked to the rafters to prevent the purlins from tilting; in good work they are tongued and grooved as shown.

GUTTERS.—In Fig. 40 the walls terminate as parapets and gutters are therefore required. There are two forms, *i.e.*, (*a*) *parallel* or *box gutters* and (*b*) *tapered gutters*.

(a) *Parallel Gutter.*—An application of this type is shown at A, Fig. 40. The feet of the spars are birdsmouthed to a horizontal beam, called a *pole plate*, which is notched out and spiked to the principal rafter. The gutter consists of 1-in. boarding laid to falls and supported by 3-in. by 2-in. *gutter bearers* at 15-in. centres which at one end are tongued and nailed to the pole plate and at the other end they are notched over and nailed to a *gutter plate* which is spiked to the tie beam. The section at B and plan at C, Fig. 71, should be carefully studied. Note how the bearers are fixed at varying levels to give the requisite fall to the boarding. An enlargement of the cross section through the gutter is shown at A, Fig. 71, and indicates the levels of the necessary roll, drip, etc. The timber details should be further considered when the subject of Plumbing (Chapter Six) is being dealt with.

(b) *Tapered Gutter* (see J, K and N, Fig. 71).—This is so called because of its shape on plan. The boarding is supported by 2-in. by 1½-in. bearers which are nailed at varying levels to the sides of the spars and 2-in. by 1½-in. uprights which are half-lapped to the bearers. This construction will be better understood when the lead details in Chapter Six are studied.

CEILING JOISTS.—If a plastered ceiling is required, the ceiling joists would be secured as shown at A and B, Fig. 40, where a 2-in. by 1¼-in. fillet is securely nailed at each side of the tie beam and the ends of the joists slotted or notched over them.

Construction of Truss.—The various members are usually morticed and tenoned at the shop and these are assembled on the job. The tie beam should be slightly cambered (the ends being lower than the centre) to ensure that it will not sag when the covering material is fixed or the joints become loose owing to shrinkage of the timber. This is accomplished by cutting the king post short by an amount equal to ½-in. for every 10-ft. of span (or approximately 1-in. for the roof shown in Fig. 40). After the members have been assembled, the truss is hoisted into position by a "block and tackle" or other means. The fastenings should not be tight during this operation, otherwise the members may be strained and the joints damaged. The trusses are fixed temporarily by cross stays until the ridge, purlins, pole plates, etc., are fixed. It will be found that the weight of the covering material will cause a slight settlement which will result in the joints closing up. The fastenings are now finally tightened up, the tie beam being brought closely against the shoulders of the king post either by tightening the nut on the bolt or by driving in the cotters, depending upon the type of fastening adopted. This makes the truss rigid, causing the ends of the members to fit closely against the abutments as the feet of the rafters are drawn slightly nearer together.