size and inclination of the connecting members and the appearance desired. Several examples of gussets are given in Figs. 47-50 and will be referred to later. If a member consists of double angles, gussets are always placed between them.

Small trusses are fabricated (riveted or bolted together) at the works and transported to the site. Owing to the difficulty of conveying larger trusses, these are fabricated in parts at the works and assembled together on the job (see the reference to Fig. 50 on p. 128). Sometimes trusses are made " piece small," *i.e.*, the various members, cut to length and holed for the bolts or rivets, are conveyed to the site and the trusses are there assembled.

Trusses are erected by a crane (or sheer legs) and connected by holding-down bolts to the building (see below). The distance between trusses up to 40-ft. span varies from 10 to 15-ft. Wider spacing results in heavy purlins and uneconomical sizes of members. The pitch of steel roof trusses, like those of timber construction, depends upon the nature of the covering material and the architectural effect desired.

Details of roof trusses up to 40-ft. span are given in Figs. 47-50. These are typical only, and several alternative details are provided for reference. It is appreciated that the sizes of the members are influenced by the weight of the covering material,[1] the distance between the trusses and purlins, the provision or otherwise of a plastered ceiling, and the degree of exposure of the building to wind pressure. Briefly, the sizes of the members, number and sizes of the rivets, etc., are dependent upon the forces in the members. The trusses illustrated in Figs. 47, 48, 49 and 50 have been designed to support ceilings, and in each example the covering material is slates.

TRUSS SUITABLE FOR A 20-FT. SPAN (see Fig. 47).—This is a slated roof, having a pitch of 30°. The effective span (distance between the centres of bearings) is 20-ft. and the maximum distance between the trusses is 12-ft. It is assumed that the building is of the single storied workshop type and the external walls are only required to be 9-in. thick (see S). Increased bearings for the trusses are provided by internal piers, as shown. If required to prevent the transmission of moisture, the walls would have to be rough-casted (or similarly treated) externally, or be increased in thickness as shown at C, Fig. 48, or be of cavity construction (see Fig. 49).

Sound sandstone pads of sufficient thickness and area must be provided to give a reliable and level bearing for the ends of the truss and to receive the steel fixing bolts. The pads course with the brickwork. The bolts are called *ragged lewis bolts* or *rag bolts*.[2] A sketch of one of these holding-down bolts is shown at B; its thickness is equal to the diameter of the upper threaded shank and the lower portion is tapered in its width; its edges are jagged as shown to afford a key for the fixing material, which is usually molten lead run in to secure the bolt when placed in the hole in the padstone. The lead should be well caulked, otherwise water may enter and set up corrosion which may split the padstone. These bolts, which are provided with nuts, are obtainable in overall lengths of 4, 6, 9, 12 and 15-in. and of $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$, 1 and $1\frac{1}{4}$-in. diameter. That shown at B is suitable for the truss illustrated in Fig. 50, but as indicated at C, Fig. 47, smaller bolts will serve for this small truss. Two are required at each end and these are fixed in readiness to receive the truss.

All of the members consist of single angles. These and the gussets are only $\frac{1}{4}$-in. thick, the minimum thickness stipulated in the aforementioned B.S.S. No. 449. The preferred maximum unsupported length of the wood spars is 8-ft. (see p. 73, Vol. I), and therefore only one purlin is required at each side.

The centre line principle has been observed in setting out, and, to prevent confusion, these lines have been shown to be those of the rivets.

> Although the centre lines of members are taken when drawing force diagrams, it should be pointed out that the details of a structural engineer's working drawing, on which the position of each rivet hole at every connection is indicated, show the intersecting lines of members to be what are termed *gauge lines*, *scratch lines* or *scratters*. These are the setting out lines which are " scratched " on the *backs* of members at the fabricating shop and along which the centres of the holes for the rivets are spaced. The following bracketed figures give the position (measured down the back from the intersection between the two legs) of the gauge lines for angles having 2-in. ($1\frac{1}{8}$-in.—see H, Fig. 48), $2\frac{1}{4}$-in. ($1\frac{1}{4}$-in.), $2\frac{1}{2}$-in. ($1\frac{3}{8}$-in.—see C, Fig. 47), 3-in. ($1\frac{3}{4}$-in.—see C), $3\frac{1}{2}$-in. (2-in.), 4-in. ($2\frac{1}{4}$-in.), etc., legs. The setting out of the details in Fig. 50 shows the intersecting lines to be those of the scratter lines.

It will be observed that at A, Fig. 47, in order to obtain symmetry, the rafters and inclined tension angles (known as *diagonal ties*) are fixed to the gusset plates on one side, and that the main tension angle, called the *main tie*, and the struts are fixed on the other. This results in a better balanced truss than if all the members were fixed on the same side.

Details of the foot or *shoe* of the truss are shown at C, D and E. A short angle *cleat* is fixed at each side of the gusset and these rest upon a *bearing plate* or *base plate* or *sole plate*. Both the cleats and the bearing plate are holed at a distance apart equal to that of the lewis bolts, *i.e.*, $3\frac{3}{4}$-in. (see E). The plates are placed in position and the truss is hoisted and lowered until the holes in the cleats are engaged by the shanks of the lewis bolts. The cleat holes are larger than the diameter of the bolts (see D) to facilitate fixing and allow a slight margin for any error in the setting out. This obviates an erection difficulty which would be otherwise caused if such an allowance was not made and a slight inaccuracy occurred in either the setting out of the lewis bolts or the position of the holes in the cleats. The nuts are finally tightened with a spanner. The section at E shows the rafter at one side of the gusset and the main tie at the other.

The details at the apex are shown at F and G. The ends of the rafters are mitred and those of the diagonal ties are square cut. The wood ridge is secured by two $\frac{1}{2}$-in. diameter bolts to two bent plates or flats which have been either

[1] The weight of asbestos-cement corrugated sheets is approximately $3\frac{1}{2}$-lb. per sq. ft. and that of clay tiles may be as much as $14\frac{1}{2}$-lb. per sq. ft. Thus, if the trusses are 12-ft. apart and the purlins are at 8-ft. centres, the difference in weight of these covering materials (ignoring that of the spars necessary for the tiles and not required for the sheets) over the area concerned is approximately half a ton.

[2] A " rag bolt," unlike a lewis bolt, is not tapered, and resembles an ordinary bolt shank, part of which is jagged and part threaded.