

varies according to the spacing of the rafters, and 2-in. by 1-in. battens are commonly specified when, as shown, the spars are at 2-ft. centres.

The shingles are laid in random widths. Those wider than 10-in. should not be used, as these tend to curl, and such are therefore split in half. A gap of from $\frac{1}{8}$ to $\frac{1}{4}$ -in. should be left between the sides of adjacent shingles to allow for any swelling which may occur (see H). Each shingle is secured with two nails. Pre-boring (forming holes to receive the nails) of cedar shingles is unnecessary. As shown, the nails pass through the shingle immediately below and barely clear the head of the third. Copper (for best work) and galvanized iron nails are used; the length varies from $1\frac{1}{8}$ to $1\frac{1}{2}$ -in. These are driven at from $\frac{1}{2}$ to 1-in. from the sides and at least 1-in. above the *exposure line*. The "exposure" is the exposed portion or margin of a shingle, and, as in slating or plain tiling, the length of margin equals the gauge. The latter length is often referred to as the exposure.

The gauge varies with the pitch. A 30° pitch is common, for which a minimum gauge of 5-in. is recommended. This may be reduced to $3\frac{3}{4}$ -in. for pitches less than 30° .

On reference to E, it will be seen that the construction differs from slating or plain tiling in that there are at least three thicknesses of shingles (with a possible exception at the eaves, see below) and four thicknesses where the top shingles cover the nails immediately below. The lap is considered to be equal to the distance from the butt (tail) end to the nail holes; in the example the lap is shown to be 6-in.

EAVES (see G).—This is closed and has an overhang of 9-in. As in slating, a double course is provided, having a $1\frac{1}{2}$ -in. projection. Sometimes a triple eaves course is formed. Unlike slating, all the double eaves course shingles are of the full length of 16-in. The upper eaves course must break joint with the lower, and the minimum side lap is $1\frac{1}{2}$ -in. (see H). The battens are spaced at the gauge apart. It will be observed that the heads of the shingles in each course are at the centre of the batten and that the nails also pass through the middle.

Note.—In order to make the construction clear, in both details E and G a relatively wide space has been shown between each course. This has resulted in an exaggerated length of nail. Actually the shingles fit closely, and rarely is a longer nail than $1\frac{1}{2}$ -in. required, $1\frac{1}{4}$ -in. being common.

As the minimum spacing of ceiling joists for $\frac{1}{4}$ -in. thick plasterers' laths is 16-in., it is assumed that the ceiling is to be covered with wall boards (see p. 49.)

The plan at H shows a typical arrangement of the shingles and will help to make clear the above description. Note the random widths, minimum side lap, position of nail holes and the head lap.

RIDGE (see E and F).—The usual finish is shown composed of narrow widths of 12-in. shingles, each pair being butt jointed alternately.

An alternative treatment consists of *saddle boards*, which are long lengths of tongued and grooved oak or elm narrow boards (see D). The end joints should

be dovetail rebated or half-lapped. In addition, the joints of the saddle boards may be covered with a wood roll, as shown by broken lines.

Lead-covered ridges are also adopted. These are of the type shown at H, Fig. 73, Vol. I, a wood roll being covered with 5 to 6-lb. lead secured by lead tacks at about 3-ft. intervals.

HIPS.—One form is similar to the ridge shown at E and F, the shingles in adjacent courses being cut-mitred and covered with shingles, lapped alternately at their edges.

A cut and mitred hip with lead soakers is another type, wide shingles being used at the intersection and lead soakers introduced as explained for slating on p. 137, Vol. I. A wood roll may be added.

Lead-covered hips, similar to ridges, is an additional finish.

VALLEYS.—These may be of wide shingles, cut and mitred, with lead soakers. An open lead gutter (see p. 148, Vol. I) is another form, boards being provided at each side to receive the lead. Swept valleys, as described for tiling (p. 110), are also occasionally used.

ABUTMENTS.—Intersections at gable parapet walls, chimneys, etc., are treated with lead flashings, as described for Plumbing, Chapter Six, Vol. I.

VERTICAL SHINGLES.—External wall surfaces can be treated quite attractively and rendered damp-resisting by nailing shingles to battens plugged to the wall at 6-in. to 7-in. gauge (see vertical tiling, p. 110).

COPPER ROOFING

MANUFACTURE.—Copper is obtained from ores found, on a small scale, in this country (Cornwall) and extensively in the U.S.A. and elsewhere. There are several methods of extracting copper from its ores, depending upon their character. In one, a preliminary operation consists of roasting or calcining the ore which has been previously ground. This eliminates the excess of sulphur. The roasted ore is then smelted (reduced to a fluid condition by intense heat) in a furnace. The crude molten metal is run off into a special bogie or settler where the slag or scum is eliminated. The material which remains (a mixture of copper, iron and sulphur) is granulated in water, cooled, broken up and ground. It is again roasted, smelted and re-granulated. This refining process is repeated until the iron and sulphur are removed, when the final product is cast into bars, called *pigs*. The last operation depends upon the form required. For roofing purposes the copper is either hot or cold rolled into thin sheets. In hot rolling, which is usually required for roofing, the heated pigs or ingots are passed backwards and forwards between rollers until sheets of the required thickness are obtained.

CHARACTERISTICS.—Copper is exceedingly durable, tough, non-corrodible, very light in weight (see p. 130), resistant to fire, malleable, ductile, soft, and an excellent conductor of heat. It has a reddish-brown colour, which, when exposed to the atmosphere for several years, often assumes an attractive pale green colour