a rise and fall movement and may be canted to suit the hook or rake (see A, G and M, Fig. 6) of the saw teeth. The shape of the teeth is governed by a cam operating the rise and fall of the grinding wheel. Cams are varied in their shape to suit different sizes of teeth and are easily interchanged. The saw is fed forward under the grinding wheel by a feed pawl or finger which engages against the face of the tooth being ground. The stroke of the pawl is adjustable to suit different pitches of teeth and positioning of the face of the tooth under the grinding wheel. The saw is mounted on a spindle fitted with a self-centering cone to suit the variation in diameter of the spindle hole in the centre of the saw. This spindle is adjustable both vertically (to suit the diameter of the saw) and horizontally, according to the varying rakes of saw teeth. The rate of feed is from 15 to 30 teeth per minute, according to the pitch of the teeth.

A similar machine is used for sharpening band saws. The saw during the grinding operation is stretched horizontally and passes round two pulleys as it automatically progresses forward to bring each tooth (or alternate teeth) under the frame holding the grinding wheel.

Automatic Cutter Grinder.—This is used for grinding and shaping cutterblock and planing knives. A knife is fixed horizontally to a travelling table which traverses to and fro under a rotary emery wheel which grinds the knife to the required bevel. In another type of machine the knives are not removed from the block, the spindle of which is supported at each end of a table which travels longitudinally during the grinding operation.

Mortise Chain Cutter and Hollow Chisel Grinder.—This is a small machine for conditioning the two cutting tools named. It is fixed to and driven by the mortising machine. The chain cutter is passed on to a sprocket mounted on a horizontal slide along which it passes to and fro under a specially shaped rotary emery wheel as the cutting teeth are ground. The machine also carries a cone emery wheel for sharpening hollow chisels.

Grindstone.—This is a cylindrical disc, 3 to 4-ft. in diameter and 6-in. thick, of Derbyshire grit or similar hard natural stone which is mounted on a spindle that is rotated during the grinding operation. A finer stone disc, which gives a keener edge, may also be mounted on the spindle in addition to the coarse disc. These rotate in troughs which contain water when wet grinding is required to prevent overheating. This machine is useful for general grinding, especially large hand tools.

A suitable machine for grinding smaller hand-cutting tools, such as chisels, gouges and planing irons, consists of a frame supporting a rotary spindle which carries four or six emery or sandstone (or both) discs which are 12-in. in diameter and of varying thickness. A water tap is fixed above each disc and a trough is provided below.

FLOORS

Single floors are detailed in Vol. I, pp. 59-68. The other two types of boarded and joisted floors there referred to, *i.e.*, double and framed floors, will now be described.

Attention is drawn to the fire-resisting types of contemporary construction in which reinforced concrete floors (see Fig. 9 and B, Fig. 10) and hollow block or beam floors (see C, Fig. 10) are extensively employed and in which the minimum amount of timber is used.

Double Floors.—It is usual to limit the clear span of softwood bridging joists to 16-ft.[1] and therefore when the width of a room exceeds this figure one or more relatively large members, called *binders*, are introduced to act as intermediate supports for the bridging joists. Economy in material thus results, and the bridging joists, being much reduced in size, are more convenient to handle.

[1] This depends upon the grade of timber used and the superimposed load to be carried (see p. 32). Thus, if graded timber ($f = 1{,}200$-lb. per sq. in.) is used and the superimposed load is 90-lb. per sq. ft., 11-in. by 3-in. joists are necessary for a span of 16-ft. Therefore this span is reduced if this load is exceeded in order that joists of stock size may be used.

These binders are spaced at from 6 to 10-ft. centres and are placed across the shortest span in order that their dimensions may be kept down to a minimum. Mild steel has largely superseded timber as a material for binders (see below) and flitched beams,[1] formerly used for long binders supporting heavy loads, are now at least obsolescent.

Plan, sections and details of a double floor are shown at A, B, C, D, E, F, G and H, Fig. 7. The plan at A shows the floor divided into three bays by the provision of two binders. Wood binders are still occasionally used, and they have therefore been detailed here (see below). With a view to reducing the over-all depth of the floor to a minimum and effecting an economy in the brickwork (to the extent of one or more courses), the bridging joists are cogged to the binders (see E, F and H). The depth of the sinking should not exceed two-thirds the depth of the bridging joists and their bearing need not exceed 1-in.; whilst such sinkings do not much reduce the strength of the binders, provided the workmanship is sound and the joists are a tight fit, the cutting and notching of bearing timbers should be restricted as much as possible. The binders are shown supported on stone pads. The latter provide sound bearings and effectively transmit the loads to the brickwork below; 3-in. thick stone lintels are also sometimes built-in above the ends of the binders. The necessary circulation of air round the ends of the binders is assured if pockets are provided, as shown at F and H.

Solid strutting of the bridging joists is sometimes resorted to, as shown at A and B, but this can safely be dispensed with (see p. 68, Vol. I), especially when the joists are cogged to the binders.

If the ceiling of the room is required to be flush with the soffit of the binders, the necessary construction is as shown. Small fillets, not more than 2-in. by 1-in., are securely nailed to the sides of the binders (see E, F and H) and plugged to the walls (see D and G). As shown, the ends of the 4-in. by 2-in. ceiling joists are notched to these fillets and nailed; plasterers' laths, spaced at "finger-distance" (about $\frac{3}{8}$-in.) apart, are nailed to the ceiling joists (see G).[2] Short pieces of thick laths, called *counter-laths*, are nailed at 15-in. centres to the soffit of the binders (see E, H and S); such provision should be made when timbers exceed 3-in. in width and so afford a proper key for the plaster (see A, Fig. 8, which shows the plaster that has been pressed through the spaces between the laths). Several alternative details, showing the ceiling attached direct to the bridging joists, appear in Fig. 8 (see pp. 35 and 36).

The size of the wood binders shown is much in excess of the normal stock sizes. The difficulty which may be experienced in obtaining sound timber of large size is one of the reasons why, as stated above, steel has largely supplanted wood as a material for floor members such as binders. A detail incorporating

[1] A flitched beam consists of two wood joists (as shown at L, Fig. 8), with a wrought iron or steel plate between, all bolted together.

[2] As the subject of plastering is usually taken in the third year of a course, it is described in Vol. IV.