(fig. 13, *E),* hence termed a “ boring head.” As lathe heads are fixed, the traverse cannot be imparted to the bars as in boring machines. The boring heads can be traversed, or the work can be traversed by the\* mechanism of the lathe saddle. The latter must be done when cutters are fixed in bars. A great deal of difference exists in the details of the fittings both of bars and heads, but they are not so arbitrary as they might seem at first sight. The principal differences are those due to the number of cutters used, their shapes, and their method of fastening. Bars receiving their cutters direct include one, two or four, cutting on opposite sides, and therefore balanced. Four give better balance than two, the cutters being set at right angles. If a rough hole runs out of truth, a single cutter is better than a double-ended one, provided a tool of the roughing shape is used. The shape of the tools varies from roughing to finishing, and their method of attachment is by screws, wedges or nuts, but we cannot illustrate the numerous differences that are met with.

*Saws.—*The saws are a natural connecting link between the chisels and the milline cutters. Saws are used for wood, metal and stone. Slabs of steel several inches in thickness are sawn through as readily as, though more slowly than, timber planks. Circular and band saws are common in the smithy and the boiler and machine shops for cutting off bars, forgings and rolled sections. But the tooth shapes are not those used for timber, nor is the cutting speed the same. In the individual saw-teeth both cutting and scraping actions are illustrated (fig. 14), Saws which cut tim­ber continuously with the grain, as rip, hand, band, circular, have incisive teeth. For though many are desti- tute of front rake, the method of sharpening at an angle imparts a true shearing cut. But all cross- cutting teeth scrape only, the teeth being either of triangular or of M-form, variously modified. Teeth for metal cutting also act strictly by scraping. The pitching of the teeth is related to the nature of . the material and the

direction of cutting. It is coarser for timber than for metal, coarser for ripping or sawing with the grain than for cross cutting, coarser for soft than for hard woods. The *setting* of teeth, or the bending over to right and left, by which the clearance is provided for the blade of the saw, is subject to similar variations, It is greatest for soft woods and least for metals, where in fact the clearance is often secured without set, by merely thinning the blade backwards. But it is greater for cross cutting than for ripping timber. Gulleting follows similar rules. The softer the timber, the greater the gulleting, to permit the dust to escape freely.

*Milling Cutters.—*Between a circular saw for cutting metal and a thin milling cutter there is no essential difference. Increase the thickness as if to produce a very wide saw, and the essential plain edge milling cutter for metal results. In its simplest form the milling cutter is a cylinder with teeth lying across its periphery, or parallel with its axis—the *edge mill* (fig. 15), or else a disk with teeth radiating on its face, or at right angles with its axis—the *end mill* (fig. 16). Each is used indifferently for producing flat faces and edges, and for cutting grooves which are rectangular in cross-section. These milling cutters invade the province of the single-edged tools of the planer, shaper and slotter. Of these two typical forms the