tools. Generally though not invariably the edge of the first is narrow, of the second broad, corresponding with the deep cutting and fine traverse of the first and the shallow cutting and broad

traverse of the second. The following are some of the principal forms. The round-nosed roughing tool (fig. 2) *B* is of straight- forward type, used for turning, planing and shaping. As the correct tool angle can only occur on the middle plane of the tool, it is usual to employ cranked tools, C, *D, E,* right- and left-handed, for heavy and moderately heavy duty, the direction of the cranking corresponding with that in which the tool is required to traverse. Tools for boring are cranked and many for planing (fig. 3)∙ The slotting tools (fig. 4) embody the same principle, but their shanks are in line with the direction of cutting. Many roughing and finishing tools are of knife type *H* Finishing tools have broad edges, *F, G, Η.* They occur in straightforward and right- and left-hand types. These as a rule remove less than 1/16 in. in depth, while the rough­ing tools may cut an inch or more into the metal. But the traverse of the first often exceeds an inch, while in that of the second ⅜ in. is a very coarse amount of feed. Spring tools, *G,* used less now than formerly, are only of value for imparting a smooth finish to a surface. They are finishing tools only. Some spring tools are formed with considerable top rake, but generally they act by scraping only.

*Solid Tools* v. *Tool-holders.—*It will be observed that the fore- going are solid tools ; that is, the cutting portion is forged from a solid

bar of steel. This is costly when the best tool steel is used, hence large numbers of tools comprise *points* only, which are gripped in permanent holders in which they interchange. Tool steel usually ranges from about ½ in. to 4 in. square ; most engineers' work is done with bars of from ½ in. to 1½ in. square. It is in the smaller and medium sizes of tools that holders prove of most value. Solid tools, varying from 2½ in. to 4 in. square, are used for the heaviest cutting done in the planing machine. Tool-holders are not employed for very heavy work, because the heat generated would not get away fast enough from small tool points. There are scores of holders; per­haps a dozen good approved types are in common use. They are divisible into three great groups: those in which the top rake of the tool point is embodied in the holder, and is constant; those in which the clearance is similarly embodied ; and those in which neither is provided for, but in which the tool point is ground to any angle. Charles Babbage designed the first tool-holder, and the essential type survives in several modern forms. The best-known holders now are the Tangye, the Smith & Coventry, the Armstrong, some by Mr C. Taylor, and the Bent. The Smith & Coventry (fig. 5), used more perhaps than any other single design, includes two forms, In one *E* the tool is a bit of round steel set at an angIe which gives front rake, and having the top end ground to an angle of top rake. In the other *A* the tool has the section of a truncated wedge, set for constant top rake, or cutting angIe, and having bottom rake or clearance angle ground. The Smith & Coventry round tool is not applicable for all classes of work. It will turn plain work, and plane level faces, but will not turn or plane into corners or angles. Hence the invention of the tool of V-section, and the swivel tool­holder. The round tool-holders are made right- and left-handed, the swivel tool-holder has a universal movement. The amount of projection of the round tool points is very limited, which impairs their utility when some oyerhanging of the tool is necessary. The V-tools can be slid out in their holders to operate on faces and edges situated to some considerable distance inwards from the end of the tool-holder.

*Box Tools.—*In one feature the box tools of the turret lathes resemble tool-holders. The small pieces of steel used for tool points are gripped in the boxes, as in tool-holders, and all the advantages which are derived from this arrangement of separating the point from its holder are thus secured (fig. 7). But in all other respects the two arc dissimilar. Two or three tool-holders of different sizes take all the tool points used in a lathe, but a new box has to be devised in the case of almost every new job, with the exception of those the principal formation of which is the turning down of plain bars. The explanation is that, instead of a single point, several are commonly carried in a box. As complexity increases with the number of tools, new designs and dimensions of boxes become necessary, even though there may be family resemblances in groups. A result is that there is not, nor can there be. anything like finality in these designs. Turret work has become one of the most highly specialized departments of machine-shop practice, and the design of these boxes is already the work of specialists. More and more of the work of the common lathe is being constantly appropriated by the semi- and full-automatic machines, a result to which the magazine feeds for castings and. forgings that cannot pass through a hollow spindle have contributed greatly. New work is constantly being attacked in the automatic machines that was deemed impracticable a short time before ; some of the commoner jobs are. produced with greater economy, while heavier castings and forgings, longer and larger bars, are tooled in the turret lathes. A great deal of the efficiency of the box tools is due to the support which is afforded to the cutting edges in opposition to the stress- of cutting. V-blocks are introduced in most cases as in fig. 7, and these not only resist the stress of the cutting, but gauge the diameter exactly.

*Shearing Action.—*ïn many tools a shearing operation takes place » by which the stress of cutting is lessened. Though not very apparent, it is present in the round-nosed roughing tools, in the knife tools, in most milling cutters, as well as in all the shearing tools proper—the scissors, shears, &c.

*Planes.—*We pass by the familiar great chisel group, used by wood­workers, with a brief notice. Generally the tool angles of these lie between 15° and 25°. They include the chisels proper, and the gouges in numerous shapes and proportions, used by carpenters,