cabinet-makers, turners, stone-masons and allied tradesmen. These are mostly thrust by hand to their work, without any mechanical control. Other chisels are used percussively, as the stout mortise chisels, some of the gouges, the axes, adzes and stone-mason’s tools. The large family of planes embody chisels coerced by the mechanical control of the wooden (fig. 8) or metal stock. These also differ

from the chisels proper in the fact that the face of the cutting iron does not coincide with the face of the material being cut, but lies at an angle therewith, the stock of the plane exercising the necessary coercion. We also meet with the function of the top or non-cutting

iron in breaking the shaving and conferring rigidity upon the cutting iron. This rigidity is of similar value in cutting wood as in cutting metal though in a less marked degree.

*Drilling and Boring Tools.—*Metal and timber are bored with equal facility; the tools (figs. 9 and 10) embody similar differences to the cutting tools already instanced for wood and metal. All the wood-working bits are true cutting tools, and their angles, if analysed, will be found not to differ much from those of the razor and common chisel. The drills for metal furnish examples both of scrapers and cutting tools. The common drill is only a scraper, but all the twist drills cut with good incisive action. An advantage possessed by all drills is that the cutting forces are balanced on each side of the centre of rotation. The same action is embodied in the best wood- boring bits and augers, as the Jennings, the Gilpin and the lrwin— much improved forms of the old centre-bit. But the balance is impaired if the lips are not absolutely symmetrical about the centre. This explains the necessity for the substitution of machine grinding for hand grinding of the lips, and great developments of twist drill grinding machines. Allied to the drills are the D-bits, and the reamers (fig. 11). The first-named both initiate and finish a hole;

the second are used only for smoothing and enlarging drilled holes, and for correcting holes which pass through adjacent castings or plates. The reamers remove only a mere film, and their action is that of scraping. The foregoing are examples of tools operated from one end and unsupported at the other, except in so far as they receive support within the work. One of the objectionable features of tools operated in this way is that they tend to “ follow the hole,” and if this is cored, or rough-drilled out of truth, there is risk of the boring tools following it to some extent at least. With the one exception of the D-bit there is no tool which can be relied on to take out a long bore with more than an approximation to concentricity throughout. Boring tools (fig. 12) held in the slide-rest will spring and bend and chatter, and unless the lathe is true, or careful com­pensation is made for its want of truth, they will bore bigger at one end than the other. Boring tools thrust by the back centre are liable to wabble, and though they are variously coerced to prevent them from turning round, that does not check the to-and-fro wabbly motion from following the core, or rough bore. In a purely reaming tool this is permitted, but it is not good in tools that have to initiate the hole.

This brings us to the large class of boring tools which are supported at each end by being held in bars carried between centres. There are two main varieties: in one the cutters are fixed directly in the bar (fig. 13, *A* to D), in the other in a head fitted on the bar