standard screw is mounted somewhere on the lathe, at the rear, or in front, and a nut partly embracing this becomes a guide to a bar which is attached to the tool slide directly. These

are termed chasing lathes. Their value lies in the cutting of screws of but a few inches in length, of which large numbers are required, a familiar example being the screwed stays for the fire-boxes of steam boilers, hundreds of which are used in a single boiler.

The third method embodies the use of taps and dies in their numerous designs. The simpler forms used are those operated by hand at the bench, from which all the machine taps

and dies have been elaborated. The tap is the solid screwed cylindrical tool which cuts an internal thread

(fig. 5); the die is the hollow tool which cuts a thread on the outside of a cylinder ffisr. 6).

These taps and dies are, or should be, true cutting tools, and if we examine any of those of approved form we shall see that they are so in fact. But none of the early taps was in any sense a cutting tool. They ground, and scraped, and squeezed, but never cut. They were usually made of round steel rod, screwed, and having three or four flats filed down upon them. The angles therefore which abraded the work were always obtuse, and as proper backing off was often neglected, or insufficiently done, the labour not only of running them down, but also of running them back out of their holes, was very

great. This, combined with the inefficient form of solid screw plates used at the same time, made the work of fitting nuts and bolts one of constant trial and error, of easing and doctoring; and when this had been done, nuts and bolts were not interchangeable, but each nut was marked for its own bolt. The earliest screw plates were probably of the same forms which are used now for screws below 3/16 in. diameter—mere hardened plates of steel, having holes of graduated diameters, screwed to the various sizes required.

In all taps and dies the problem is to cut a screw, of which the angle of thread changes from point to root, with tools whose angle must remain constant. In taps there is no choice of angle, since they must be the exact counterparts of the tapped threads when finished. But in dies a compromise is made by cutting them with hobs, or master taps (fig. 5), one thread larger than the thread to be cut by the dies. Briefly, the practical effect is that the dies are only counterparts of the thread to be cut at about the middle part of their action (fig. 6, B).

Though the action of taps resembles in some respects that of common dies, the results achieved are better, partly because the backing off is generally superior, partly because taper taps are commonly used to start a screw hole. Tapered solid dies are also used in some kinds of turret work with the same object, namely, to facilitate the work of an inherently badly formed took With a tapered tap, or a tapered solid die, the full threads do not come into operation until after the tapered threads have started the cut. A properly made throughfare tap, or a tapered die, will cut an average­sized screw at one traverse, provided lubrication is ample. Taps are now made with very narrow edges and wider clearances than formerly, very different from the common taps with broad edges and narrow grooves. There is thus little friction, and there is plenty of clearance for the chips, essential conditions for cutting screws rapidly at a single traverse.

Dies are held in stocks. In the common die stocks one adjustable die is moved forward with a screw, which forms one of the handles of the stock, or a separate tightening screw is used at right angles with the handles, or the tightening screw is set diagonally in relation to the handle (fig. 6, D). Sir Joseph Whitworth’s well known "guide ” screw stock (fig. 7) is an example of the embodiment of the principle

just stated, the dies being cut over a hob two depths of thread larger than the screw; one, a broad die, is used for guidance only, and two narrow dies do all the cutting. The guide-screw stock derives its name from the fact that it embodies a guide *a* distinct from the cutters *b,b,* the guide doing very little actual cutting; it is one of the best tools for screw-cutting outside the lathe, but some of the American types of dies, such as in fig. 8, A and B, give very accurate results, especially when they are combined with a guide in advance of the dies, to keep them truly parallel on the work. The common dies arc inferior in operation to those used in the guide-scrcw stock. Nevertheless, the common die stocks are used most extensively. The reason is that, although they are of faulty construction regarded strictly from the mechanician’s point of view, yet they do their work in a very satisfactory manner if moderate care be exercised in their construction and working.

*Machine Work.—*Hand tapping and screwing has long been confined to occasional pieces of work done by the fitter at the bench, the

erecter and repairer. Screws and tapped holes required in quantities arc done on machines which include numerous types, at a rate of production which would seem incredible were it not so common. For cutting common screws of no very great length the lathe has long been superseded by the various screwing machines. The earlier forms were provided with clutch mechanism for running the solid dies back off the thread, in imitation of the action of the hands, and the dies could not cut a complete thread at one traverse, two or three traverses being necessary in the production of a full thread. In the modern screwing machines (fig. 3) the cutters are closed and released by cam mechanism, and all threads except those of large diameter are cut at a single traverse. Common bolts and nuts are cut in