QUORN

TOOL AND CUTTER GRINDER

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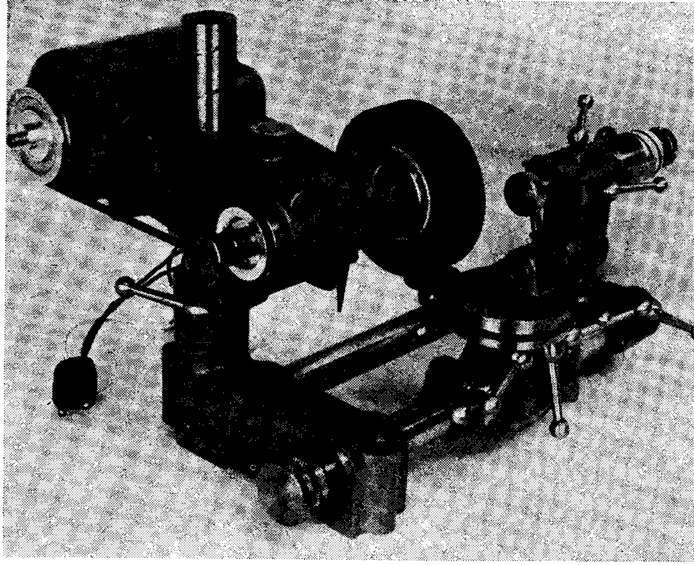

Fig. 2

SOON AFTER the acquisition of one's first lathe it is very soon realised that the beautiful turning tools bought from the shop do not last for ever and that it is essential to have some means of sharpening them. An early exercise for most of us therefore is the construction of a piece of apparatus, of greater or less crudity, which may or may not be dignified by the name of a tool grinder. With increasing experience in the use of a lathe, milling cutters begin to make their appearance and in conjunction with a vertical slide, milling becomes part of the regular workshop routine. More advanced workers who acquire a milling machine such as the Dore-Westbury will soon discover that the range of cutters of all sorts that they have bought, made or "acquired" far outnumbers the lathe tools that they possess.

But in all this there is one fundamental snag, seldom mentioned in the glossy literature, and that is that whereas it is perfectly possible with practice to sharpen lathe tools by hand, it is not so with milling cutters. So the beautiful new cutter which does an excellent job on brass or gunmetal is also used for steel. After that brass and gunmetal seem much tougher and the milled surfaces acquire a nasty fraze which requires a good deal of file work to remove. Steel requires more and more force to be applied to the cutter until finally it breaks, a new one is bought and the whole process begins all over again. The answer is of course that end mills, circular saws and milling

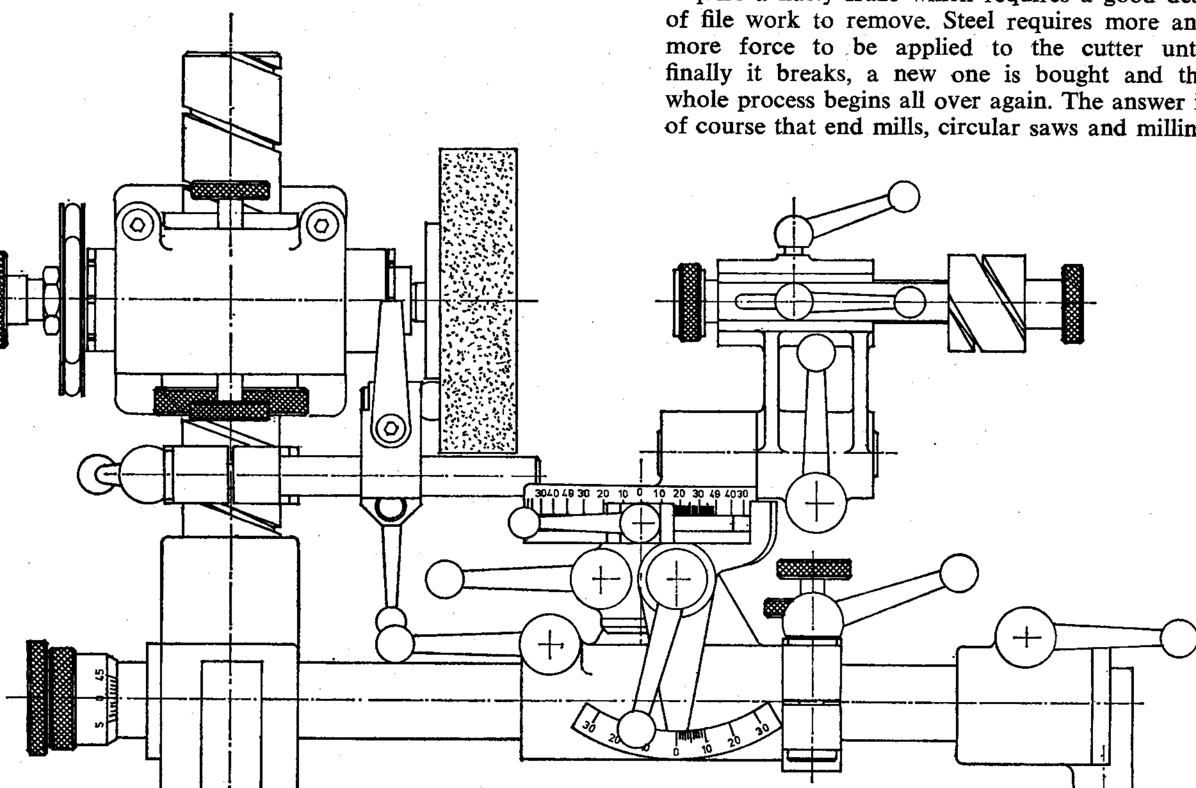

FIG. I.

cutters of all sorts require re-sharpening just as much as lathe or any other cutting tool if they are to be kept in good condition and to do good work.

It was this experience that finally convinced the writer that a cutter grinder was an essential adjunct to the home workshop if effective use was to be made of the Dore-Westbury light vertical milling machine with which it has been recently equipped. Now while there are excellent cutter grinders commercially available they are expensive — more expensive than the average lathe with which a model engineer's workshop is equipped. Furthermore there are also tool grinders — equally desirable but equally expensive. It seemed therefore that there was a need for a machine which would not only sharpen all the cutters normally used with a light milling machine but would also sharpen lathe tools, drills, reamers and taps at precision preset angles. For good measure it should also be simply adaptable to thread and cam grinding and be capable of being made in a workshop equipped with a 3½ in. lathe, with some help perhaps in light milling carried out in the lathe or on a milling machine.

Such was the specification of the QUORN Universal Tool and Cutter Grinder. An interesting design exercise resulted in the general arrangement drawing shown in Fig. 1 and the construction of a prototype machine shown in Fig. 2. It is designed around the use of three bars of precision ground round mild steel connected together by two iron castings which combine to give the machine strength, accuracy, rigidity, and freedom from distortion on a three-point support.

The vertical column at the rear carries the WHEELHEAD which is universally adjustable for height and horizontal angle and which, after it has been clamped to the vertical column, can be fine adjusted by micrometer screws over a vertical height of 1 in. The wheelhead is bored to receive a standard 1⅜ in. diam. grinding spindle quill at the front, and at the rear carries a self-contained fractional horsepower electric motor. The complete wheelhead is reversible on the column to enable side or periphery of the grinding wheels to be presented to the work in the most convenient position.

The REAR HORIZONTAL BAR connecting the two end castings and the vertical column are all permanently bonded together with Loctite. The rear horizontal bar also acts as a datum face for the workhead both in making fine adjustments and as the rear shear when the workhead is traversed.

The FRONT HORIZONTAL BAR carrying the workhead can be rocked to traverse work across the face of the grinding wheel and precision adjusted by micrometer screw and anti-backlash spring longitudinally over a range of ½ in.

The WORKHEAD BASE can be clamped in any position to the front horizontal bar and its angular position set by the ROCKING LEVER, which not only provides an accurate positive stop when the workhead is rocked, but also enables it to be precision adjusted over a range of ½ in. at the mandrel centre line, before the front bar is positively locked. The workhead base carries the TILTING BRACKET, which is adjustable by a pointer reading against a graduated scale over a range of 30 deg. either side of vertical. It enables accurate side and front rake to be given to both sharp-cornered and radiused tools and cutters. Used in conjunction with the swinging headstock, radiused tools with compound geometry, i.e. 7 deg. side rake, 5 deg. front rake, can be ground in a single continuous pass.

The tilting bracket supports the calibrated ROTATING BASE, which has full 360 deg. rotation. It can be freely rotated between ADJUSTABLE STOPS for radiusing or locked at any pre-set angle for grinding taper and angular cutters and tool faces.

The rotating base supports the SWINGING HEADSTOCK which, by displacing the centre line of the mandrel from the centre line of the rotating base, enables tools and cutters to be corner radiused as well as ball noses to be ground. A removable SETTING PIN enables the two axes and the work to be brought into any desired relationship with one another.

A unique and patented feature of the QUORN Tool Cutter and Grinder is the TRAVERSING MANDREL. By using HOBS of suitable pitch the numbers of start of thread, spiral fluted end mills and slot drills down to 1/16 in. dia. or less can be accurately and reliably ground and backed off without resetting. The hob engages an adjustable GUIDE PIN and STOP BAR, which enable the flutes on the cutter to be brought into accurate relationship to the grinding wheel. By using fluted hobs, change wheels etc. as temporary division plates, a wide range of side and face cutters, form cutters, circular saws and shell mills may be gulleted, ground and backed-off at a single setting. By using hobs of suitable pitch, e.g. 20 T.P.I. threads can be ground on plain shank cutters to make them usable in screw shank collets such as the Clarkson AUTOLOCK. For larger cutters a TOOTH REST can be used, which is attached to the vertical column, is universally adjustable for height and position and can be set to the face or periphery of wheels of any diameter. It can be used inverted if, in certain operations, this gives a better view of the work.

By replacing the headstock spigot by a BAR BED and TAILSTOCK, long reamers, taps and cutters can be ground between centres using either the tooth rest or a mandrel hob to index the work. In this case the workhead is not clamped to the horizontal bars but slides upon them as shears. The rotating head enables tapered reamers and die sinking cutters to be ground along their length.

By leaving the headstock free to rock on its spigot and using a RADIAL HOB or MASTER CAM on the mandrel and a FOLLOWER attached to the bar bed, cams can be ground and form cutters relieved.

Finally, by using radial and helical hobs in conjunction, taps and hobs can be thread relieved and fluteless tap forms generated.

By replacing the traversing mandrel by a TOOL HOLDER a wide variety of internal and external lathe tools, square and round shank, can be accurately ground to preset angles for side, front, top and back rake. Accurate radii perfectly blended with straight edges at any angle can be produced on form and screwing tools. Female radii can be ground by using the workhead with a DIAMOND or CRUSHER in the toolhead to trim a suitable grinding wheel to shape and then using it to form-grind the tool.

Before commencing to machine the base castings it is desirable to decide upon and obtain the material which will be used for the front and rear horizontal bars and for the vertical column as shown in Fig. 3, and to use the actual bars themselves, or pieces cut from them, as gauges in machining the castings. Centreless ground round mild steel is ideal and although it can normally be obtained in 13 in. lengths M.E. suppliers will no doubt be able to lay in a stock of the only three sizes required, namely $\frac{5}{8}$ in, 1 in. and $1\frac{1}{4}$ in. dia. and supply the requisite cut lengths for the machine. Silver steel is of course a perfectly adequate alternative but in these sizes very much more expensive. Failing ground stock of any sort a perfectly satisfactory machine could be assembled from ordinary bright drawn mild steel, particularly if care were taken to select pieces which were free from blemish or damage and they were given a preliminary lapping to correct any irregularity or out of roundness. Only advanced workers with sophisticated workshop facilities would want to contemplate case hardened, nitrided or chill cast bars ground and lapped to size which, however desirable they might be for commercial work, need not concern the amateur.

Whichever material is going to be used, therefore, the first step is to prepare the front and rear bars and the vertical column, Fig. 3. The former are very simple, merely 12 in. or 13 in. lengths of 1 in. dia. round stock. For neatness the ends can be faced flat and chamfered by setting

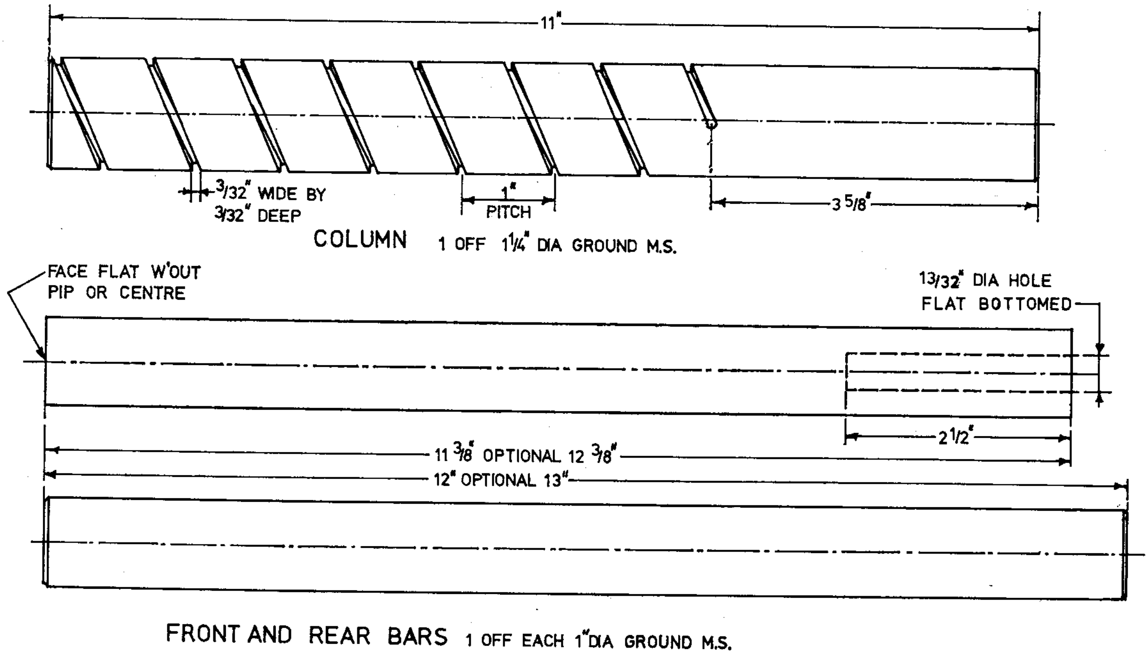

FIG. 3.

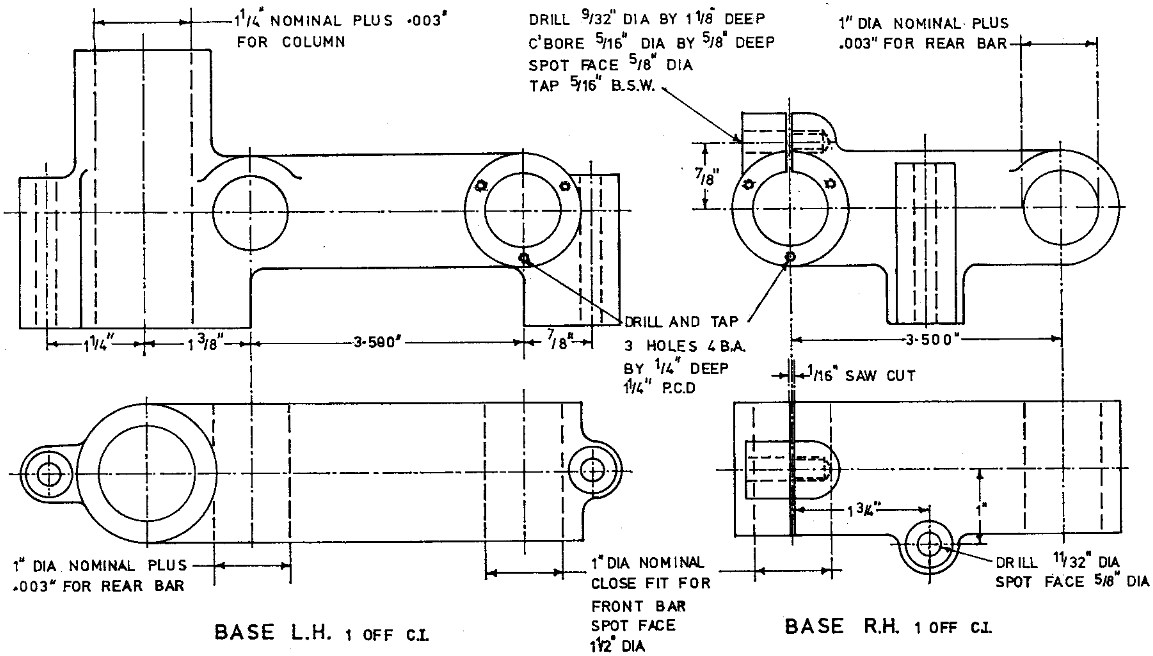

FIG. 4.

one end of the bar to run true in a four-jaw chuck and supporting the far end in a fixed steady. A digression here to mention that many workers when they do this find that even when securely gripped the bar tends to work out of the chuck jaws. The reason that it does so is because the end supported by the fixed steady, even if it appears to be running true, is not in fact truly in line with the lathe mandrel axis. It is the resulting orbital motion which causes the work, as it revolves, to creep out of the chuck. With centred work the tailstock, always assuming that it is true, can be used to check the alignment, but bars cut from stock will at this stage have no centres. The way to check alignment is therefore to mount a dial test indicator on the tool-post and by moving the lathe saddle back and forth to adjust the jaws of the fixed steady until there is no movement, back to front, or up and down in the length of the bar. If you can get it to 0.001 in. in 1 ft. both ways you are not doing badly.

The front bar needs a little more attention. At one end it should be faced as flat as possible, without pip or centre-hole because this face will be the anvil against which the micrometer adjustment screw will work. Posh workers can lap it flat but good clean facing will suffice. At the other end the bar is drilled 2½ in. deep by 13/32 in. dia. to accommodate the anti-backlash spring. No great precision is required here but the hole should be flat bottomed to provide a fair seating for the spring.

The vertical column 1¼ in. dia. by 11 in. long with the ends faced flat and chamfered is also shown in the general arrangement and detail drawing Fig. 3 with a quick start thread, which will terrify most amateurs and many professionals too. Straight away let us say that it is optional; the machine will function perfectly without it. Its only purpose is to provide an easy means of height adjustment and in the event that the wheel-head clamp should be slackened without first taking the weight, to prevent it dropping to the bottom of the column. For those who like a little luxury and are prepared to put in the effort to achieve it, the job can be perfectly well accomplished on a 3½ in. lathe and some notes will be given later as to how it can be done.

Having prepared the three bars, a start can now be made on machining the right and left base castings as shown in Fig. 4, which connect them together and form the basic foundation of the machine. The castings are too large to swing even in the gap of a 3½ in. lathe although if a larger lathe were available they could be clamped to an angle plate mounted on the faceplate and the holes bored in the time honoured way that "Live Steamers" bore their cylinder blocks.

To be continued.