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# Small Capstan Lathe Tools

**Notes on " tooling up " for repetition work, with special application to the small capstan attachment recently described in the " M.E."**

**BY " Ned "**

IN the description of the capstan attachment for a 3 in. lathe, which was published in the issues of the " M.E." dated from April 15th to May 10th last, the subject of cutting tools for use with this appliance was briefly referred to, and it was suggested that, if there was found to be a general demand for further information on the subject, it would be discussed in detail in a later series of articles. As several readers have asked that this should be done, the following notes have been prepared, and it is hoped that they will be found useful, not only to users of the particular attachment referred to, but also to all readers who are faced with repetition tooling problems on light capstan lathes.

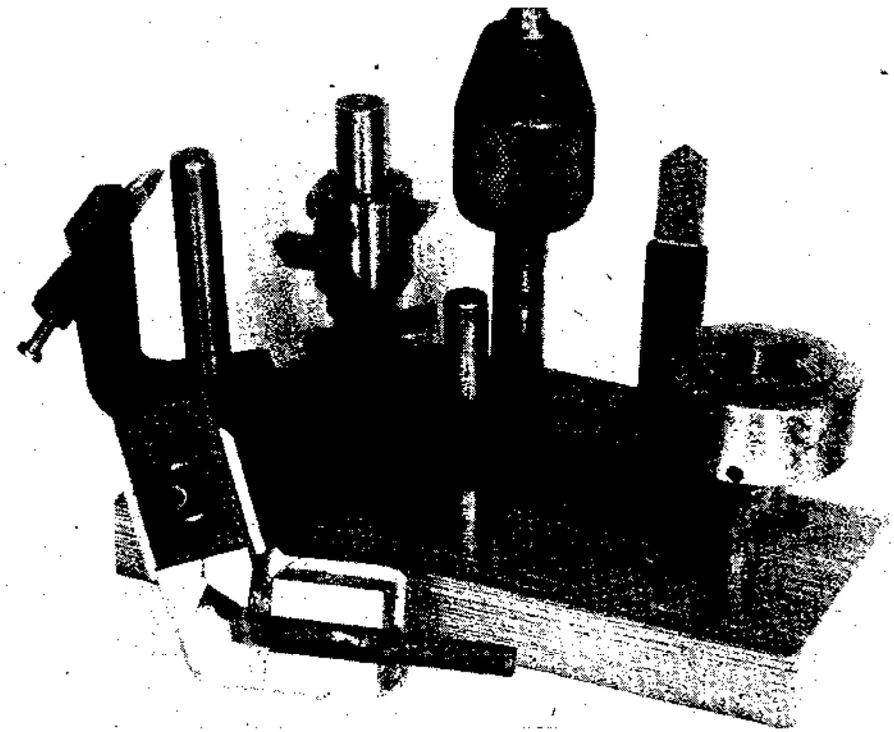
The subject of capstan lathe tools has already been dealt with fairly completely, in a series of articles entitled, " Capstan and Turret Lathes," which was published about eighteen months ago in the " M.E." ; and the information given therein has been republished in the form of a practical handbook bearing the same title.

This contains information on practically all standard types of repetition tools, and the principles of operation hold good. whether the lathe on which thev are used is simple or complex ; but in many cases the tools used on modern production lathes are of a very elaborate and expensive nature, justified by the requirements of intensive quantity production, but quite out of place in the more mod&t production schemes likely to be encountered by readers of this journal. This applies particularly in the case of "adapted" lathes, or capstan lathes of a primitive type. It is proposed, therefore, to show how the desired results may be obtained with quite simple forms 0f tools and tool holders. such as can be made up fairly easily, and as occasion requires, to suit the work in hand. Such tools do not necessarily impose any practical disadvantages if discreetly applied, and may be used for work demanding the highest accuracy ; neither do they, restrict rate of output to any serious extent, except on work which calls for a very high cutting efficiency, Such work, however, is hardly within the scope of the" adapted " lathes with which we are mainly concerned.

It is just as well here to point out that whereas it is necessary, for the utmost efficiency in quantity output, to use machines which are capable of high spindle speeds and heavy cuts, the advantages of these features do not always weigh very heavily when light components, which do not entail the removal of a great deal of metal, are being produced. In such cases, the general handiness of the tool layout is the more important feature, and speaking from experience, it is quite possible to produce such parts as small terminal studs and nuts, ferrules, nipples, union nuts, etc., on a light adapted lathe, at a rate which is by no means incomparable with that attained by a specially-equipped factory lathe.

**Motions Required**

In the present case, it is assumed that the lathe to be tooled up is equipped with a six-station revolving turret, having stops for limiting the travel of each individual tool, and a cross-slide fitted with front and rear tool-posts, and at least one end stop, for limiting the depth of cut is one of these tools. With regard to these tool-posts, it is suggested that something of the nature of the type illustrated in the issue of July 10th, by Mr. Ian Bradley, should be employed. Two of these, attached directly to the lathe cross-slide by bolts in the appropriate tee-slots of the latter, enable front and rear tools to be carried, and provide the utmost rigidity. In some cases it may be found necessary to fit the top swivelling slide, to deal with work which calls for taper turning, but the majority of small capstan operations can be managed without it, and its removal is an advantage. Longitudinal adjustment of the saddle is also unnecessary in most cases, and it may be locked to the lathe bed by tightening up the slide adjusting gib screws. A very sound rule in small repetition work is to elimi-



**A group of tools suitable -for use on a light capstan lathe or capstan attachment.**

nate unwanted movements and adjustments, as they only complicate operation ; but it is important that slides which are not in use should be firmly locked against inadvertent movement, or they may introduce errors in the work. If full advantage is to be taken of the principle of "automatic accuracy," which is the most important consideration in any machine tool used for quantity production, every tool-slide in use must necessarily be equipped with some form of locating stop or registering device to ensure that the tool finishes its motion at exactly the right position.

### Tool Steels

It is very often thought that capstan lathe work demands the use of special high-speed steels and cutting alloys. This question is, however, inter-related-with the matter of spindle speeds and cutting rates, which we have considered above. If it is allowed that useful work can be done without forcing the speed or the cut to the utmost, then it is fairly obvious that it can also be accomplished without the aid of special tool steels either. It is, however, desirable to take all reasonable steps to ensure that the tools work under the most favourable conditions: and well within the limits of their endurance. Heavy cuts should always be taken with roughing tools, which should be capable of standing up to a fair amount of_ heat, and the finishing tools should be as hard as possible, and required to take only light cuts. The popular tool holder bits, made of such high-speed steels as " Bullet," " Stag Major," " Toledo." " Eclipse." and so on. will give good results on most materials likely to be handled in the home workshop, including medium alloy steels. But in cases where these are unobtainable, quite good work can be and has been done on small capstan lathes with carbon steel tools. particularly in machining brass and aluminium alloy components. Silver steel bits are particularly suited for taking finishing cuts, as they can de tempered to a high degree of hardness without risk of the edges chipping, and thus wear longer than most ordinary high-speed steels so long as they are not overheated or overloaded. The facility with which such bits can be made is also an important consideration, and round silver steel rod is easily the handiest material for making up such tools as flat drills, sizing cutters, D-bits, etc:

It is proposed to classify the various tools used on capstan lathes in the order corresponding, more or less, to the normal sequence of operations on which they are used. In order to give a comprehensive explanation of general procedure, reference will be made to all the tools used in a complete operation, whether they are cutting tools in the true sense or not. Finally, some examples will be given of typical light capstan operations to illustrate the application of appropriate tooling systems.

### The " Drudgery " of Repetition Work

Until about two years ago, the question of repetition work in any shape or form might have been considered entirely outside the concern of model engineers, and, indeed, there are some readers, even at the present time, who may feel almost insulted at the suggestion that they should undertake work of this nature. Model engineering being primarily a pastime and a recreation, the prospect of turning out numbers of' parts. all as much alike as so many peas, may sound anything but inviting. But quite apart from the fact that war conditions have forced upon many readers the necessity of regarding their workshop as a means of helping the nation, rather than of satisfying their own creative instincts, it is quite possible to apply repetition principles, with advantage, directly to model engineering workshop practice. Every model engineer has at some time or other experienced difficulty, or even a complete hold-up, due to the lack of some particular type of bolt, nut, rivet or other standard part, which has not been commercially available in the exact specification required. Many readers have solved the problem by making the required items one at a time by the usual individual or " one-off " methods ; but while some of them may regard it as a matter of principle to adhere to these methods, it is by no means certain that the extra speed and efficiency of repetition methods would entail less interest, or be incompatible with the spirit of model engineering.

Repetition work is very commonly regarded as drudgery, but this idea is to a great extent associated, not so much with processes as with numbers. The idea of making large quantities of simple and more or less uninteresting parts is related to the prosaic tasks of washing up so many dishes, or hoeing so many rows of turnips ; but, allowing that such tasks are necessary, surely the logical thing is to find ways and means of speeding them up, and reducing the number of manual manipulative motions required for dealing with each individual part. Work in which one is really interested never becomes irksome, and drudgery can only exist if it is encouraged by the mental attitude which regards work merely as a sordid means to a prosaic end. As a matter of fact, there is quite a fascination in carrying out any process efficiently, and this applies in no small measure to the operation of a small capstan lathe. To see each tool carrying out its allotted task with speed and precision, and to know that each part made fulfils a vital, even though perhaps a minor, purpose in the assembly to which it contributes, are sources of pleasure and satisfaction which every true engineer can fully appreciate.

*(To be continued)*

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## For the, Bookshelf

**Machine Shop practice.** By W.C. Durney, A.M.I.Mech. E. London : Sir Isaac Pitman & Sons Ltd. 7s. 6d. net.

In any machine shop production job the sequence of the cutting operations in the lathe or other machine tool is of importance for two reasons. In the first place it affects both the convenience and accuracy with which. the work can be accomplished, and secondly it affects the time taken to do the job, a not unimportant consideration in these days when rapid production is essential. This question of operational sequence is a distinguishing feature of Mr. Durney's book, and in the various examples of turning. shaping and milling he has selected for treatment, he not only explains the technical details of the tools and machining processes involved, but clearly sets out the order in which the various portions should be machined, and the reasons for this procedure. This course is also adopted in an excellent chapter on exercises in fitting and gauge and tool making: The book has been designed for the use of Ministry of Labour trainees, apprentices and students, and will amply repay a careful study of its well-chosen series of representative jobs, which are all in keeping with modern workshop practice. The large number of sketches and. dimensioned drawings add much to the value of the book. and instructors in training centres might well consult its pages for beneficial examples of work for their pupils to undertake, or for subjects for detailed exposition at lecture times.

# * Small Capstan Lathe Tools

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**BY " Ned "**

## Chucking

THE form of chuck employed for capstan lathe work has an important bearing on the facility and speed of handling the work. No form of chuck can be ruled out as absolutely unsuitable ; when dealing with awkwardly-shaped castings, a four-jaw independent chuck may be very useful or even indispensable, but the time taken in setting up the work in this type of chuck can ill be spared when handling round or symmetrical work. This can usually be dealt with much more expeditiously in a self-centring chuck, but for small bar work which will pass through the mandrel of the lathe, a collet chuck is strongly to be recommended. Many small lathes are fitted with socket adaptors to take standard " pull-in " collets, but the usual type of 3 in. lathe with a mandrel having a 3/8 in: hole through the bore will only take an 8 mm. (A size) collet, the largest " through " bore of which is only about 3/16 in. Thus, only very small bar work can be handled by this type of chuck.

Larger collets can be accommodated by using an external adaptor screwed on the mandrel nose. An excellent adaptor of this type was described some time ago by Mr. Ian Bradley. It should, however, be noted, that in any case where the collets are pulled through the mandrel by a draw spindle, it is impossible to utilise the full bore diameter of the mandrel, and in practice, the largest size of work which can be taken by a 3/8 in. bore mandrel is about 1/4 in. The only way in which bars up to the full bore diameter can be used is by using either a jaw chuck or a collet chuck of the " push-in " type, closed by means of a ring nut over the nose adaptor. A simple form of this chuck was shown in the article dealing with the conversion of a small lathe to vertical milling, published about two years ago *in* THE MODEL ENGINEER.

The outstanding advantage of a split collet chuck over the jaw type is that it can generally be guaranteed to hold the work true within very close limits, and this may be a very important advantage when dealing with bar work, in which the necessity for machining all over arises only when concentric accuracy must be corrected. Many parts, such as screws, studs, nuts, nipples, etc., can only be made economically by using bar of the exact diameter of the largest portion of the component, and running it truly, so that external machining is dispensed with. This applies *even more* strongly when hexagonal *or* other special section bar is used, as the external machining to the required shape and accuracy would be very laborious and expensive. It is thus profitable to take every care to ensure that chucks run perfectly true, or to construct special chucks or other fixtures whereby the true mounting of work can be facilitated. Time spent in this way is never wasted, as these appliances are invaluable in general turning practice, quite apart from their application to repetition work.

Jaw chucks can often be adapted to quick and accurate chucking by the attachment of soft pads or jig blocks to the jaws. An old and worn self-centring chuck may have the jaws softened and the steps cut away, mild steel blocks then being firmly attached by screws, and then machined in place to suit the particular work to be handled. Even if the scroll of the chuck is strained or worn out of truth, it will hold the work dead truly so long as it does not have to accommodate varring diameters.

If a number of -irregular-shaped parts have to be held, a four-jaw chuck can be adapted as a rapid chucking jig by removing three of the jaws and replacing them with one or more blocks shaped to fit the component (Fig. 1). The one remaining jaw is then used to clamp the latter firmly against the blocks ; some kinds of work may demand the use of two adjustable jaws, but the advantages of using only one wherever possible will be obvious.

It is obviously impossible to explain or illustrate the design of fixtures necessary to deal with every type of component likely to be handled, and the example illustrated is intended only to show the principle. Many cases arise in practice which call for some ingenuity in the design of chucking fixtures, but there are few problems of this nature which cannot be solved by careful thought and practical common sense.

Other chucking fixtures to hold various kinds of work, such as parts which have to be held by a previously-machined surface, which is at an angle to the required centre, eccentric, or screwed, may also be made up and attached to the chuck of faceplate. As to the amount of trouble to which it is advisable to go in making these fixtures, much, of course, depends on the quantities of components to be handled. While it would not be worth

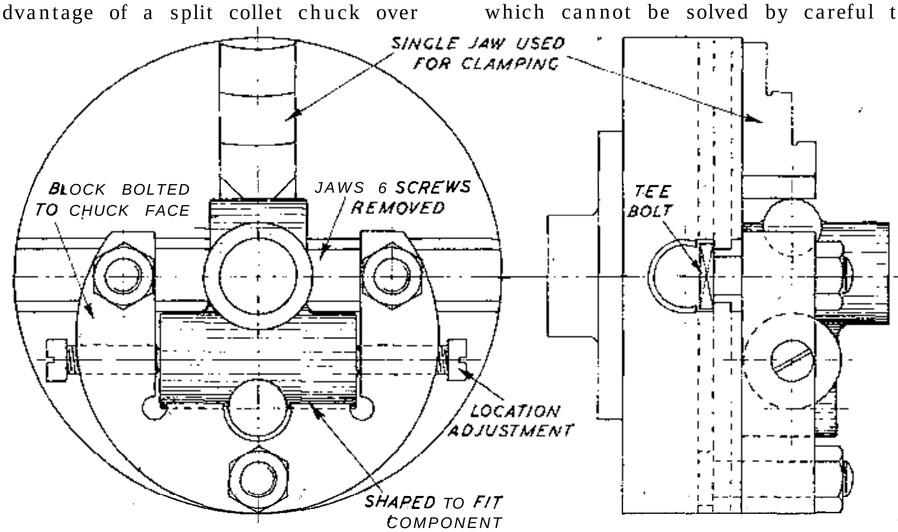


**Fig. 1. An example of how the four-jaw chuck can be adapted as a chucking jig *for* awkwardly-shaped components.**

* *Continued from page* 256, " *M.E.,*" *September 25, 1941.*

while to make an elaborate fixture to deal with one or two dozen parts, almost any trouble would be worth while if the number of parts runs into thousands.

The reliability and security of any chucking device used for capstan work must be beyond question. Nothing wastes time worse than a chuck which slips during a heavy machining or screwing operation, and in some cases either the work or the tool may be spoiled by a mishap of this. nature.

When handling bar, work of too large a diameter to pass through the lathe mandrel or chuck, it is, of course, necessary to saw the parts to a suitable length for chucking. It is sometimes possible to save both time and material in such cases by " double-ending " that is, by cutting each piece sufficiently long to make two parts, and machining one end of a batch first, then reversing (in a special chucking fixture if necessary) to machine the other end and part off.

## Work stops

When working with long bars, which are fed through the chuck as each piece is completed and parted off, the first capstan tool which must be brought into action is the

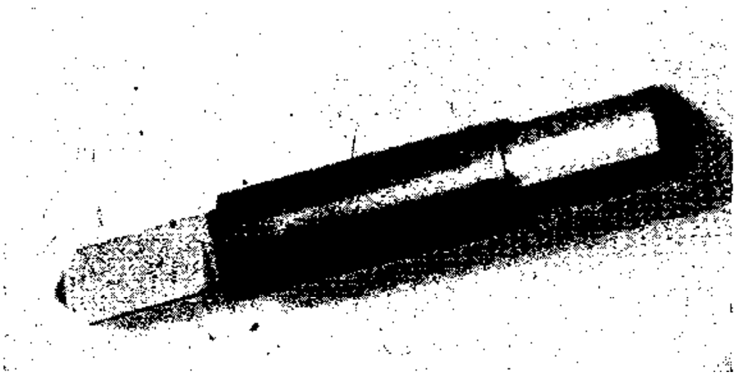

**Fig. 2. Solid spear-point drill made to fit the capstan holder for centre-drilling.**

"work stop." This consists simply of a flat-ended abutment, which at the forward limit of the capstan slide travel, is brought into such a position that it forms a gauge for the length of bar required to project from the chuck for making a single piece. Any piece of steel rod, turned to fit the capstan holder socket and faced off truly on the front end, may be used for a work stop, but it is an advantage to case-harden the face if it is intended to use it for a large number of parts.. Special work stops having ball or roller thrust bearings are often used in production practice, where the chucks are automatic and the work is fed up against the stop while rotating at full speed ; but the necessity for such elaborate fittings does not arise in the case under discussion.

The position of the stop is adjusted by means of the appropriate capstan slide end stop, or by moving it in and out of the holder socket. It is usually the first tool to be adjusted, and the positions of other tools, both in the capstan slide and the cross slide, are related to it. To use the stop, it is advisable to push the work through the mandrel a little further than is required, and partially tighten the chuck. The capstan slide is then brought forward to the limit of its travel, so that the work is pushed back into the chuck by the work stop ; after which the chuck is fully tightened, and machining commenced.

It will often be found, when using collet chucks, that the action of drawing up the collet to tighten it will slightly withdraw the work from the stop, and thus affect accuracy in respect of length. Allowance may be made for this when setting the stop, but where exact accuracy is necessary, a more reliable method would be to allow for machining the end of the work by means of a facing or end-forming tool. The length of screws or bolts is sometimes adjusted by means of a stop fitted to the turning or " running-down " tool holder, in which case, any error in the action of the ordinary work stop would affect the length of the head, instead of the shank.

### Facing

Bar work, which is cut off by means of a parting tool when completed, does not ordinarily call for a facing operation, because the surface left by the parting tool is, or should be, sufficiently true and smooth for most purposes. When starting work on a new bar, therefore, it is generally necessary to part off a short length so as to-provide an accurately faced end to make contact with the stop, and form the. end face of the new piece. The setting of the parting tool is of high importance in this respect, and will be dealt with in its appropriate section.

Facing operations are, however, necessary in some instances in bar work, and invariably so when machining castings and forgings. The facing tool is sometimes mounted in the cross slide, especially when a tool-post turret is employed ; but more often it is used in the capstan-head, and in order both to save time and economise in the use of the capstan stations, it is usual to combine it with another cutting tool, such as that used for centring or end-forming.

### Centring

Quite a large proportion of the work carried out on capstan lathes calls for internal drilling or screwing, and in such cases the forming of an accurate centre to start the drill is a very important operation. The drill used for this purpose should be held in the capstan socket as rigidly as possible and should not project farther than is necessary. A Slocumb type of centre-drill, fitted to a short stub holder, may be used for this purpose, but its comparative fragility, and the difficulty of re-sharpening it after the point has become dull, are disadvantages. It is often stated that the acute angle of the countersink formed by a centre-drill is unsuitable for starting a drilled hole ; but the writer considers on the contrary, that this is actually helpful in keeping the lips of the drill central before the point (which is always the least efficient part of the cutting edge) begins to cut. Be that as it may, however, it is more common to use a form of drill which is more easily set and sharpened in the present case. A flat spear-point drill such as that shown in the photograph (Fig. 2) may be made from silver-steel to fit the capstan holder, and combines the utmost rigidity with reasonable cutting efficiency. It will be seen that the extreme tip of the drill is ground off to a diamond point ; in this way the indentation made is sufficiently sharp for starting the smallest drills.

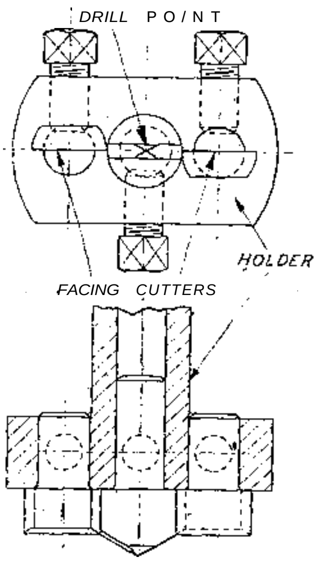


**Fig. 3. A combined centering and facing tool holder, for inserted cutters.**

(Continued on page 296)

equivalent focal length, being the resultant focal length of the eyepiece, when using two lenses of different focal lengths.

$$\text{Equivalent focal length} = \frac{F_1 \times F_2}{F_1 + F_2 - A}$$

where $F_1$ = focal length of one lens.
$F_2$ = focal length of other lens.
$A$ = distance apart of lenses.

In our case, the lowest-powered eyepiece has an equivalent focal length of 1 in.

$$\text{Therefore } 1 \text{ in.} = \frac{F_1 \times F_2}{F_1 + F_2 - A}$$

But $F_1 = 3F_2$
and $A = 2F_2$

So, if we substitute $3F_2$ for $F_1$
and $2F_2$ for A in the above formula,

$$\text{We get } 1 \text{ in.} = \frac{3F_2 \times F_2}{3F_2 + F_2 - 2F_2}$$

$$= \frac{3F_2^2}{2F_2}$$

$$= \frac{3F_2}{2} = 1\tfrac{1}{2}F_2$$

$$\text{Thus } F_2 = \frac{1 \text{ in.}}{1\frac{1}{2}} = \frac{2 \text{ in.}}{3}$$

$$\text{and } F_1 = 3F_2 = \frac{3 \times 2}{3} = 2 \text{ in.}$$

$$A = 2F_2 = \frac{2 \times 2}{3} = \frac{4}{3} = 1\ 1/3 \text{ in.}$$

Thus, for an eyepiece of 1 in. equivalent focus, we require two lenses, having focal lengths of 2 in. and 2/3 in. respectively, and their distance apart must be 1 1/3 in.

Similarly, for an eyepiece having an equivalent focus of ½ in., the separate lens must have focal lengths of 1 in. and 1/3 in. respectively, and their distance apart will be 2/3 in.

For an-eyepiece having an equivalent focal length of ¼ in.. the separate lens must have focal lengths of 6 in. and 1/6 in. and a distance apart of 1/3 in.

For the above eyepieces, spectacle lens and smaller magnifying glasses will be found suitable, and a friendly optician will probably be able to rind those required and supply very cheaply. By using copper tubing, or even stiff cardboard tubing, the eyepieces may be made as shown in Diagram 22.

The parts now made will enable the telescope to be finally assembled, when it will appear as shown in the photograph of the finished instrument. A small flap door will be noticed, and I consider that this is well worth while, as, after using the telescope, any dew which has collected on the large mirror, can be soaked up through this flap door, doing away with the necessity of dismantling the mirror housing. This prevents the mirror tarnishing, and it is recommended that a pad of cotton wool be obtained, and placed over the large mirror, when not in use, this pad being held in place by means of two spring clips fixed to the part B of the mirror housing. Mirrors should never be wiped, as even the softest cloth will scratch the silver reflecting surface. The pad of cotton wool, placed on the mirror is sufficient.

For those who wish, I suggest 'that a finder be fixed to the barrel. This consists of a small telescope, and may be made from two small object glasses, fixed in a tube, and enables an object to be found quickly, being most useful with high-powered eyepieces as, due to the large magnification, the object quickly passes across the field of vision, and in the case of small objects, may be difficult to find in the telescope.

When completely assembled, the instrument requires adjusting before being ready for use. This should be done as follows :-Take out the eyepiece and look through the bore of the eyepiece mounting, when the reflection of the large mirror should be seen in the flat mirror. If this is not so, adjust the large mirror by means of the four 1/4-in. dia. bolts, holding the mirror housing to the barrel, and slackening or tightening to suit. When this has been done, replace eyepiece, and three concentric circles should be seen, the outer circle being the large mirror, the centre circle being the flat mirror, whilst the small inner circle is the eyepiece. Until all these circles are exactly concentric, no image will be possible. Adjustment of both large and flat mirrors may be necessary to obtain perfect concentricity. The other adiustment needed is to obtain a correct focus, which can only be done under actual viewing conditions. This will probably be managed by screwing the eyepiece mounting in or out of its slide, so that the exact focal length is obtained, the clearness of the image being a reliable guide, when approaching the correct position. If this does not give the desired result, the large mirror will require adjustment along the length of the barrel. These adjustments are, of necessity, correctly accomplished only by means of trial and error methods, but only need doing once.

After viewing through the telescope such things as the mountains of the Moon, or Saturn's rings, all the trouble and time spent on making the telescope will be felt to have been worth while, as they appear literally to come to life, and it is seen that they are solid worlds similar to our own, instead of flat, uninteresting bodies, as seen with the naked eye.

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## Small Capstan Lathe Tools

*(Continued from page 294)*

Short lengths of twist drills, fitted in suitable stub holders, may be used for centring. It is not, however, advisable to use a drill much smaller than 1/4in. diameter in this way. as its rigidity may be dubious. In no case should a centring drill be fitted to a drill chuck, or allowed to project a long way from the capstan socket. If the alignment of the capstan slide is inaccurate, it may be found advisable to grind the point of the drill off centre, so that it definitely finds the centre of the work, and does not scribe a circle on it when it first makes contact.

Fig. 3 shows a simple form of combined centring and facing tool which can be made up to suit the class of work in hand. It comprises a holder which carries three bits turned from silver-steel and held in place by set-screws. The centre bit is shaped to form a drill point, and the other two, which constitute the facing cutters, are ground or filed half awav. like D-bits. If thev are to be used on steel, these fades can be given top rake ; a clearance angle is, of course, provided on the front face. When these bits are made or subsequently reground, great care must be taken to set the faces absolutely dead square with the axis of the holder, and projecting equally from the face of the latter. The drill point is shown with its flat face in line with the plane of the cutting edges for convenience in drawing, but it is really preferable to set it at right-angles, as this allows of making the edge sufficiently broad to overlap the path of the facing cutters slightly, and thus ensure that the entire surface of the work is properly machined. This form of tool may be used for facing only, or centring only, by removing the cutters not required ; and it is also adaptable to bevelling and end-forming operations bv modifying the form of cutter. Generally speaking, tools with inserted cutter bits such as these are preferable to solid tools, as they are much easier, to sharpen and re-set, besides being much more adaptable to varying requirements.

*(To be continued)*

# Small Capstan Lathe Tools

## Notes on " tooling up " for repetition work, with special application to the small capstan attachment recently described in the " M.E."

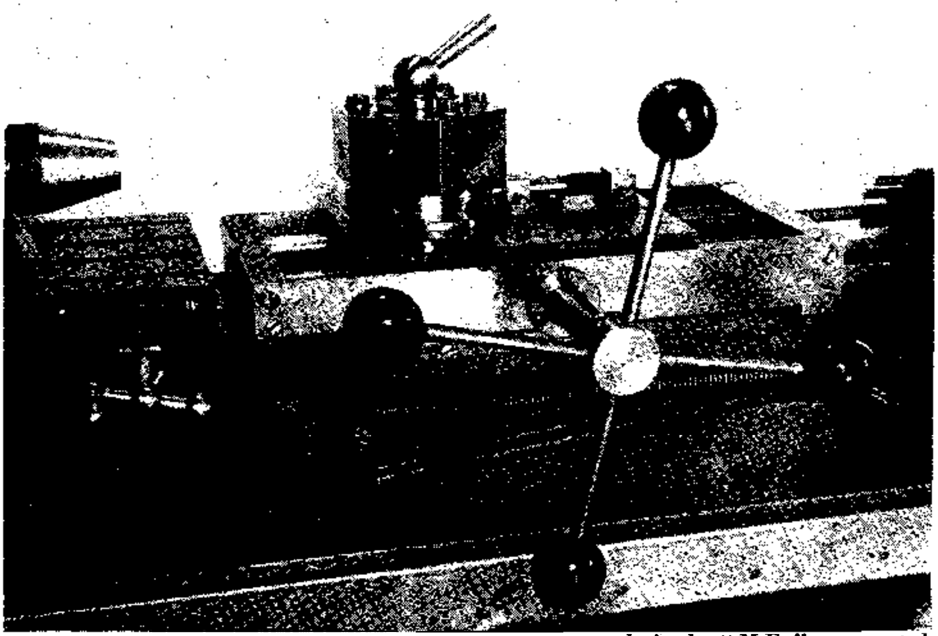
BY " Ned "

### The " M.E." Capstan Attachment

IT is evident, from the opinions expressed by readers, that this device has been given a warm welcome, and reports have been received of several attachments, either under construction or completed. As might naturally be expected, some constructors have adapted the idea to their own requirements, and in one case, it has been considerably elaborated and improved in detail ; the result is highly successful, and is illustrated here as an example of how this simple utility design can be developed into a piece of high-class machine-tool equipment.

The constructor of this attachment, Mr. A. L. Steels, of Cheam, Surrey, has adapted it to a 3-1/2-in " Grayson " lathe, which, by reason of its particular features of design, called for some modification in the method of mounting the slide frame. It was thus found desirable to enclose the latter completely with side plates, and a logical addition to the scheme consisted of a rack and pinion traversing gear, using the conventional " windlass " in place of the simple lever feed. A rather interesting detail is that the primitive form of gear described for indexing the capstan stops has been found perfectly satisfactory for working the slide ; the rack, which is attached to the underside of the latter, consists simply of a flat bar with holes drilled at even intervals to engage the pinion teeth.

A further improvement in the device consists of automatic indexing gear for the capstan head, which is devised on the principles illustrated in the " M.E." handbook, " Capstan and Turret Lathes," and works quite satisfactorily. It is understood that Mr. Steels will be submitting a full description of this attachment in due course, but in the meanwhile, the photograph will undoubtedly serve to assist other readers who may be contemplating similar improvements.



A capstan attachment, based on the design published recently in the " M.E.," constructed and fitted to a 3-1/2-in. " Grayson " lathe by Mr. A. L. Steels.

### Tips on Toolmaking

One or two readers have enquired whether the toolholders and bits for capstan lathe work can be obtained ready-made, and, if so, where to obtain them. It is, however, very difficult to give helpful advice on this matter because although a wide range of accessories of this nature is listed by most manufacturers of capstan lathes, and miscellaneous items are supplied by makers of small tools, all such parts are now controlled by Ministry of Supply Regulations and can only be obtained by special permit. Even if this were forthcoming, however, it is doubtful whether the firms concerned, already overwhelmed with urgent orders, would welcome enquiries from small users for items of non-standard equipment. In any case, the practical advantages of being able to obtain the tools ready-made are by no means as considerable as they seem, even apart from the inevitable delays in delivery, because there are so many small jobs where a simple tool, knocked up quickly to serve a particular purpose, is far more handy and efficient for that purpose than a very elaborate ready-made tool which has been designed to suit general, rather than special, requirements. In production practice, although there may be all sorts of tool holders and equipment available, and kept fully occupied, too, the works tool room finds plenty to do in making up simple tools for special purposes, and it may be said that inability to cope with such work would seriously reduce production efficiency in any factory.

In the small production schemes contemplated within the scope of these articles, there is very little excuse for the user of the lathe or attachment not being able to produce such tools as are required. Model engineers so often have to be their own toolmakers that few of them will even anticipate serious difficulty in this respect. But to those who say that they have never attempted any toolmaking, well, here is a

* Continued from p. 296, " M.E.," October 9, 1941.

good chance to make a start. You remember the classical advice given by the officer on the sinking. ship to the passenger who couldn't swim-" Now's your dash blank chance to learn ! " Which may- be interpreted as a terse, brutal way of expressing the old saying that necessity is the mother of invention.

The holders which are described in these notes can be made up from various odd bits of, material which may be available ; in most cases the exact size and shape, except as regards the shank which fits the capstan holder, are immaterial, so long as the tool bit can be held in the appropriate position, and any steadies provided can be applied to the range of work for which the tool is designed. It is fairly certain that, whenever it becomes necessary to make a tool for a special job, that tool will be found useful for another job later on, possibly with slight adaptation ; SO that the possibility of making all tools more or less adaptable should always be kept in mind.

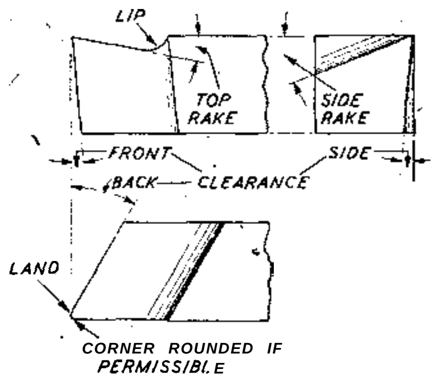



**Fig. 4. Form of cutter suited for most capstan lathe operations.**

## Making Cutters

Tool bits can most economically be made from short pieces cut from stock tool" steel bar ; many grades of high-speed. steel are supplied ready tempered, and require only to be cut off and ground to shape, with due care to avoid drawing the temper. The common practice of nicking the steel on the corner of an ordinary grinding wheel and breaking it off is rather wasteful of material and time as it necessitates a good deal of work in grindmg, and increases the risk of overheating. the steel in the process. It is best to obtain a special narrow wheel, of a grade designed specially for cutting off, and use it in the prescribed manner. By cutting the bits off at a slight angle in one or both planes, the amount of grinding required can be very much reduced. Most classes of capstan work call for a tool ground to cut on the side-practically a right-hand " knife tool " ; (Fig. 4) the front edge being bevelled away to a fair angle of clearance, leaving a narrow " land " or facet at the tip which can readily be honed with a hand slip to keep the edge keen. Besides helping to produce a clean finish, this treatment also reduces the prevalent tendency of a knife tool to snatch forward and dig in when machining certain kinds of materials. Very often minor adjustment of the size of the work can be made more readily by honing the edge of the tool while in the holder than by shifting it. The sharp corner of the tool should also be very slightly rounded by honing, unless the specification of the work definitely calls for a sharp internal angle. Rake and clearance angles follow exactly the same rules as those for ordinary turning tools, but it may be noted that the common errors of excessive clearance and insufficient rake should be studiously avoided. Generally speaking, a fine clearance angle is conducive to. long wear and fine finish.

In view of the small size of the bits, the use of some form of grinding gauge or jig will be found very useful, not only to facilitate handling, but also to economise. tool steel and reduce the time taken in regrinding. Tools used for working steel, and thus having. top rake, may with advantage be " lipped "by grinding on the corner of the wheel, so that they turn the chip as-it comes off the cutting edge. This helps, to throw the swarf clear of the work and promote smooth Cutting action, also to counteract the tendency, which is often encountered in box tools and other enclosed holders, for the swarf to pack or jam round the work.

Tools made from carbon or silver-steel will, of course, have to be hardened and tempered. For instructions in carrying out this work, the writer cannot do better than refer readers to the " M.E." handbook, " Hardening and Tempering,"which explains all the necessary processes for dealing with any kind of tool steel likely to be encountered.

One-final hint about tool bits will not be out of place : always smooth off the reverse end of the bit which projects out of the holder. Rough, jagged edges left here account for many accidents, and the most carefully laid scheme for quick production is liable to go sadly awry if the operator is laid up with a septic finger.

## Clamping Screws

It will be noted that some of the tool holders illustrated are equipped with headless, socketed screws of the type which are supplied, under various trade names, especially for such purposes as these. On the grounds of safety and security, these can be strongly recommended, but under present conditions there may be some difficulty in obtaining them, and they are by no means easy to make in the amateur workshop. The next best thing is a square-headed steel set-screw, as shown in some of the fittings, and these can be made up as required from square steel bar stock. A good quality steel is advised, and in view of the desirability of reducing the size of projecting parts, the heads may be only slightly larger than the screw diameter, or even the same size. The points should be faced off dead square, and well bevelled off so "that the threads do not get burred over by end pressure. It is an advantage to case-harden the heads and points of the screws, but the threads themselves are best left soft, in case they become brittle when hardened and thus tend to break away from the core. Of course, high-tensile screws, tempered all over, would be better still.

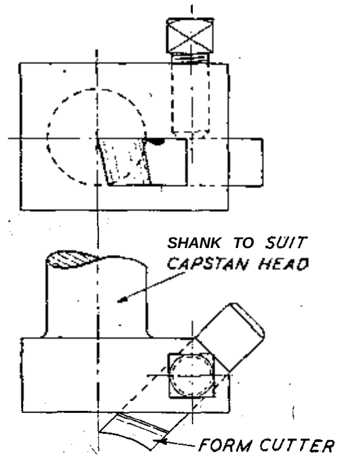



**Fig. 5. Simple end-forming tool holder and cutter.**

It will usually be found that B.S.F. threads are more suitable than Whitworth for these set-screws, mainly because, if they are stressed to the point of breakdown, it is better that the threads should strip than that the screw itself should twist off in the hole.

## End-forming Tools

When producing such parts as small screws and bolts, it is often necessary to round or bevel off the end face ; this may be done either before or.after turning down, and with a tool applied either from the capstan or the cross-slide. The facing and centring tool holder shown in Fig. 3 may be adapted for end-forming by equipping it with suitable cutters in place, of the plain flat-facing cutters shown.

(Continued on next page)

# Soldering Fluxes for Soft Solders

By Ashley J. T. Eyles

AMONG the many metallurgical processes with which we have to do in model engineering, the process of soldering is one of the most familiar. As ordinarily defined, soldering is a process whereby two pieces of metal are joined by another metal or alloy, having a lower melting point than the metals joined.

In order that metals soldered together may be securely held, it is necessary that there be more than mere adhesion between the solder and the metal. There must be an alloy formed between the metal and the solder. In order that this alloy may be formed, the surface of the metal must be entirely free from any foreign substance as oxides, oils or various solid matter. Since it is not always convenient, or we do not care to take the time to clean mechanically the metal surfaces to be soldered, we resort to the use of various chemicals to clean the surfaces.

There are many soldering fluxes in practical use, and each has its peculiar advantages and disadvantages. Soldering fluxes should not be used indiscriminately, but, should be determined by the nature of the model work. If brass, copper, bronze, gunmetal, tinplate or steel is to be soldered, zinc chloride, resin, or ammonium chloride (sal-ammoniac) may be used, for galvanised iron or steel, or zinc, hydrochloric acid, or a strong chloride of zinc solution may be used. The rapidity with which a soldering flux acts is an important factor in its usefulness. If the flux be in the form of a dry salt, a comparatively high heat is necessary to fuse it. If an aqueous solution be used, a certain amount of heat is essential to evaporate ‘the moisture. The essentials in a soldering flux are : (1) that it shall be a deoxidiser, i.e. it must attack and remove the oxide film on the surface of the metal ; (2) it must remain fluid at the temperature of the molten solder, so that it may float away any impurities ; and (3) it must have a purifying effect on the metals themselves,

Zinc chloride has several properties which make it a valuable soldering flux for most model work, as it remains liquid when the solder is molten, thus being in a condition to act upon the oxides very readily. Some model engineers add a small quantity of water to zinc chloride flux, but that is detrimental, because the stronger the flux can be made and still remain liquid, the better it will be.

To make zinc chloride solution, dissolve clean metallic zinc (preferably in small pieces) in hydrochloric acid until the acid will not take up more. An earthenware or lead vessel should be used and, if possible, the operation should take place in the open air, because immediately the zinc is placed in the acid, violent " boiling " takes place and choking fumes (hydrogen gas) are given off. The zinc, should lie in the acid for several hours, when any excess may be removed, and the flux is ready for use. Zinc chloride is corrosive and it has a burning action on the skin, it should not be used when soldering electrical models, as it frequently contains free acid. In all model work where this flux is used, the surfaces should be thoroughly washed and dried after soldering to prevent the acid action after the job is done.

On the market are several non-corrosive fluxes. Some have zinc chloride as a base. This is dissolved in a fluid or semi-fluid which will not form an electrolyte. Vaseline is a favourite in this respect. The materials are worked together, a little water being added to emulsify the whole. If the experiment be tried the peculiar thickening effect of a few drops of water will be observed. Sometimes flux of this kind is used in the form of sticks. Paraffin is the base in this case. Of the many other fluxes, resin, tallow, glycerine, olive oil, and phosphoric acid are a few. In the soldering operations the writer has had to do he has come across only one (except the proprietary flux Fluxite) that is truly non-corrosive, namely ordinary resin ; but as a flux this leaves much to be desired ; with resin the solder has frequently to be coaxed to flow freely. Generally, the resin is dissolved in alcohol, methylated spirits.

Aluminium solders are best applied without a flux, after preliminary cleaning and tinning of the surfaces to be soldered. Stearin may be used for the tinning operation. Many patent fluxes for soldering aluminium containing Venice turpentine, capaba balsam, paraffin oil, etc., in specified proportions, have been tried by the writer without good results. In fact, as mentioned in the article "Practical Hints on Solders and Soldering," published in August 1, 1940, issue of this journal, " No soft soldering flux has yet been discovered that will allow aluminium to be soldered with the same speed and reliability as can be attained in soldering brass, copper, etc., with ordinary commercial fluxes."

# Small Capstan Lathe Tools

(*Continued from previous page*)

It is, however, simpler to shape the end with a single cutter in cases where it requires to be rounded or otherwise formed to a particular shape, because the matching up of two form cutters is always somewhat difficult. The tool shown in Fig. 5 will be found very suitable for this job, and can be made up quickly from a piece of rectangular bar, with the shank end either turned down or inserted, according to which is, the more convenient. It may be remarked here that when building up these holders, the shanks will be quite satisfactory if pressed in, provided that they are really well fitted. They may be taper-pinned or set-screwed for further security, but for a really sound permanent job, brazing is recommended.

The cutter, which may be either of round or square section, should be a close fit in the hole in the holder, so that it is not liable to shift when clamped by the set-screw. It may be filed up on the end to the required radius form, using a standard radius gauge for reference. There is something to be said for using round section cutters on such jobs (although they are rarely used in production practice), as it-is possible to turn them slightly, to adjust the point to coincide with the work axis, and thus avoid leaving a " pip " in the centre. An advantage of setting the cutter in the holder at an angle is that a comparatively small diameter cutter will cover a much larger radius of work than is possible with an axial-located cutter, and is also adjustable towards or away from the centre.

End-forming tools, or as they are generally termed in machine-shop vernacular, " ending tools," are in some cases combined in a single holder with other tools, such as turning or running-down tools, by the addition of an extra cutter which operates only at the end of the travel. In some kinds of work it is found convenient to end-form the work by means of the parting-tool, which is made of special shape, so that it leaves the end of the bar suitably formed before it is advanced up to the stop ; or alternatively a form tool may be used opposite the parting-tool for the same purpose. Again, screwed work may-call for two ending operations, one before screwing, and the other afterwards, to remove the burr thrown up by the die.

*(To be continued)*

# * Small Capstan Lathe Tools

## Notes on “ tooling up ” for repetition work, with special application to the small capstan attachment recently described in the u M.E.”

By u Ned ”

### Running-down Tools

THE process of reducing the diameter of work, by means of tools applied axially from the capstan head, is generally referred to as “ running down,” and is one of the most common operations in capstan lathe practice. In such components as screws and bolts, the running down of the shank, to a more or less exact diameter for subsequent screwing, constitutes the heaviest single operation, and in many cases it is necessary to remove the major part of the material in performing it. There are several forms of running-down tools, all of which have their particular merits and limitations, some being best suited to very heavy cuts, while others are capable of producing work of high accuracy and finish. In order to ensure that both the cutting efficiency and accuracy produced by the tool is independent of the inherent rigidity of the work, it is common to equip the running-down tool holder with some form of steadying device, which travels with the tool point, either in advance of or slightly behind it.

### Plain cc Knee ” Tool Holder

This is the simplest form of running-down tool holder, which is not equipped with any form of steady, and is therefore only applicable to work which is known to be very firmly held in the chuck, and sufficiently rigid in itself to stand up to the required cut without perceptible deflection. It is most useful on work of comparatively large diameter, as the holder, unless specially designed for the purpose, is not adapted to withstand heavy frontal (axial) load, and therefore may tend to spring when taking deep cuts. The accuracy of work produced by this form of tool, in respect of diametral dimensions, depends on its own inherent rigidity and that of the work itself, in conjunction with the accuracy of indexing which can be obtained on the capstan head. This is a most important point, which is sometimes overlooked by operators and setters, but it will be obvious that if the capstan head, by reason of wear on the locking bolt, or other causes, cannot be relied upon to index to an undeviating angular accuracy at the particular station where the holder is used, any error in this respect will be multiplied at the tool point, and thus produce varying diameters on successive samples of work. Care taken in eliminating backlash when indexing the capstan will reduce the effect of such error, but it is fairly certain that this form of tool is not the one best suited to producing work to close limits of dimensional accuracy.

In large capstan and turret lathes, “ knee ” tools are often used in conjunction with an overhead steady bar, attached to and extending from the lathe head-stock, which engages with a close-fitting bush on the tool holder, and guides it in true axial alignment and location relative to the lathe axis. By this means the inaccuracy referred to above can be almost or completely eliminated. The method is, however, scarcely applicable to the lathes and the class of work which we are now considering, being mentioned only to illustrate possible means of improving accuracy ; but in the case of work which has a hollow centre, there is a practical method of improving accuracy by the use of a pilot or “ plug ” steady, which will be referred to later.

Fig. 6 shows a simple form of “ knee ” tool holder suitable for the machines and the class of work now under discussion. The angle bracket which holds the tool may be cut from the solid rectangular bar, or bent up from square material, according to which is the more convenient, and is made of a size and shape to accommodate the radius of the work to be dealt with. It is not advisable to make the tool capable of dealing with an abnormally large diameter of work unless

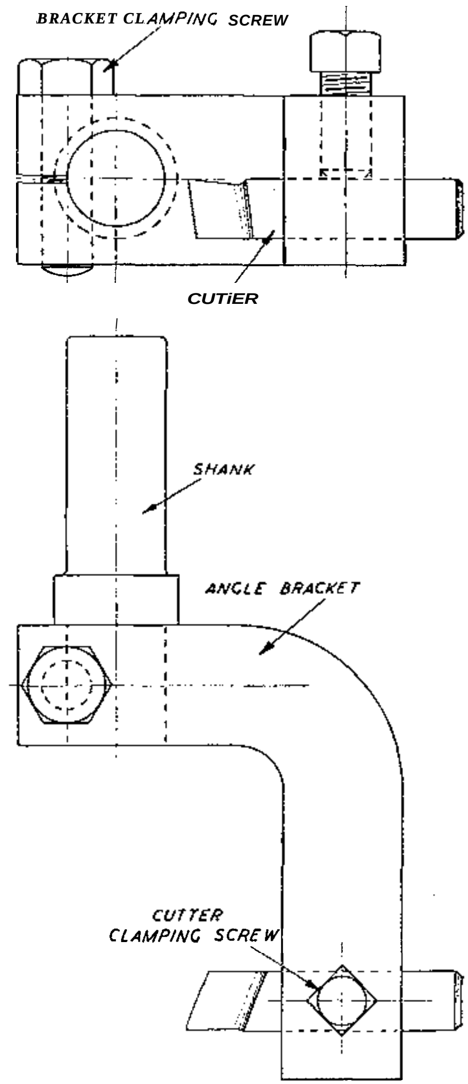



**Fig. 6. A simple form of Cb knee ” running-down tool.**

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* *Continued from page 333, “ M.E.,” October 23,* 1941.

it is definitely required or anticipated, as the rigidity of the cutter will suffer when it is set for working on smaller diameters. The bracket may be clamped or otherwise attached to the shank, and the hole for the cutter may either be set square with the axis, as shown, or sloped forward for greater facility in dealing with the machining of shoulders, or getting close up to the chuck.

An important point in the design of tool holders which are not equipped with steadies is the avoidance of unnecessary overhang from the capstan head. The distance of the actual tool point from the point of support should be kept to the bare minimum necessary, and the components of the holder built as stiffly as possible. As there is bound to be a certain amount of spring in the stalk of the holder, there is much to be said for eliminating the latter, and mounting the holder by means of a flange bolted to the face of the capstan head. This, of course, can be done fairly easily when a polygonal capstan head is used, and constitutes the principal advantage of the latter over the round head, which has hitherto been the more popular on

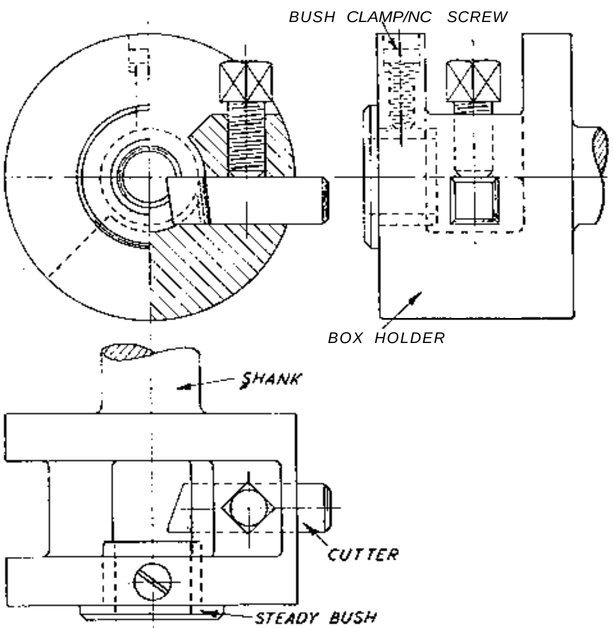



**Fig. 7. Box type running-down tool with bush steady.**

the smaller types of capstan lathes. Flange mounting of the holder is now almost universal practice for heavy work, and practically all large capstan and turret lathes have polygonal heads.

### Box Tool Holder with Bush Steady

The simplest form of running-down tool holder incorporating its own steady is the " box " tool, which is made in a wide variety of forms, and is most popular in screw-making and similar light production, of the class in which readers are most likely to be interested. Fig. 7 shows a tool of this type, in which the steady takes the form of a hardened steel bush. which is located in advance of the tool point, and is a running fit on the outside diameter of the stock being turned. It is thus only suitable for use on bar work, in which the stock is fairly accurate to size and runs truly in the chuck, or alternatively, for work which has already been run down over the outer diameter in a previous operation. The bush must, of course, be made up to suit the size of work for which it is to be used ; it is common practice to make up a set of bushes in stock sizes, so that the tcol is adaptable for various jobs at short notice.

In the form of holder shown, the cutter is simply clamped in a square cross hole in the body, and thus the adjustment of the size of the finished work is a somewhat haphazard procedure. The provision of a more elaborate method of feeding the tool in, for initial setting of diameter, is, however, at the option of the constructor ; but it is worth while to mention that comparatively few such holders used in production practice are equipped with any such adjustment. Capstan tool setters acquire considerable skill in setting cutters to fine limits of precision, simply by partially slackening the clamping screw and tapping them lightly through the hole in the holder.

In most work to which this form of holder is likelv to be used, it is capable of reducing the stock in a single cut and leaving it with a good iinish, fairly accurate to size. If special accuracy is necessary, a second cut with a finishing tool in another holder may be advisable ; but it should be noted that it will be impracticable to use the same form of steady for the finishing tool, as it cannot bear on the outside of the stock, and if fitted to bear on the turned-down portion, it will prevent the cutter from running right up to the shoulder.

Despite its limitations, which have caused it to lose popularity in modern practice, this simple form of tool is capable of quite good work in intelligent hands, and it may be mentioned that its use need not inevitably be associated with capstan practice ; it could be used in the ordinary lathe tailstock, as a rapid means of accurately sizing small work. It always runs down the work concentric with the outer diameter, unless forced out of truth by heavy work badly chucked, and it may be used on long, slender bars without fear of chatter or inaccurate sizing. The bush steady gives little trouble and wears quite well if it is properly finished and hardened, and kept lubricated with oil or cutting compound when in use ; it even has some merit as a burnishing tool, especially if heavy cuts are taken. Some forms of this tool are liable to give trouble by the packing of the swarf as it comes off the'cutter, but this can usuallv be overcome by modifying the design of the clearance space or the shape of the cutting edge. The cylindrical form of holder shown is the simplest type to make, but in some cases it is desirable to allow more room in the aperture in the box, at the back of the cutter, for the above reason.

(To *be continued)*

# For the Bookshelf

**The Lathe Operator's Manual. By** Richard Hilton. London : Sir Isaac I'itman & Sons Ltd. Price 6s. ; postage $3\frac{1}{2}$d.

This book is intended principally as an introduction to the use of lathes of the type employed in engineering industry, including centre lathes of various types, turret and other forms of manufacturing lathes. It deals with the design and mechanism of these machines, cutting tools and accessories used in conjunction with them, tool layouts and methods of dealing with typical examples of work. A chapter is devoted to reference data and calculations applicable to lathe practice, including conversion of fractions to decimals, inches to metric measure, to peripheral speeds at various diameters, and calculations of change-wheels for cutting English and metric threads. The subject matter is of interest to the professional rather than the amateur lathe operator, and should be particularly useful to trainees or other beginners in engineering machine shop practice.

# * Small Capstan Lathe Tools

Notes on "tooling up" for repetition work, with special application to the small capstan attachment recently described in the " M.E."

**By "NED "**

APOLOGIES are due to readers for the long break in, this series of articles, caused by an unusually heavy spell of war work. It would appear, from the queries received as to when the articles would be resumed, and also on several specific points regarding production tooling, that many readers have found the subject interesting and helpful. Although it-has not been possible to reply individually to these queries, they have been carefully noted, and it is hoped that, in due course, some information on the matters in question can be included in these articles.

**An "Automatic" Collet Chuck**

One or two readers have asked for a design for an " automatic " collet chuck (that is to say, one which can be opened and closed without stopping the mandrel) applicable to model engineers' lathes which have been equipped with a capstan attachment, or otherwise tooled up for production. It is true that nearly all modern bar-turning capstans are equipped with such a chuck, and that it saves several seconds in the time taken for producing each individual piece, thus saving a good deal of time on a long production run. But most of such lathes have the mandrels specially designed to accommodate the chuck mechanism, which usuallv incorporates a draw or compression tube passing right through from the nose to the tail end.

As most small model lathes have onlv a small bore through the hollow mandrel, it is clear that the use of such a tube would seriously reduce the bore capacity. The only alternative is to employ a chuck in which all the mechanism is incorporated in a self-contained unit on the mandrel nose. It is by no means easy to arrange this without introducing excessive overhang, but it is not impossible, and some rough sketches have already been made of such a chuck, which is suitable for application to most of the small lathes used by readers, and is within their ability to produce. Should there be a general demand for a chuck of this type, the design will be completed and submitted for publication.

**Running-Down Tools (continued)**

The last tool of this type to be dealt with was a simple box tool with a bush steady, which, as pointed out, is capable of quite accurate and well-finished work within its capacity, but has certain limitations in respect-of the range of sizes of stock it is capable of handling. As the steadv bush must necessarily engage the work in advance of the tool, its use is also confined to operating on smooth, true-running stock, of sizes within close limits of that of the standard bushes, or work which has already been run down to an accurate standard dimension.

In order to extend the range of application of the running-down tool, a form of steady which is universally adjustable to any size

* *Continued from page 378, Vol. 85, " M.E.," November 6, 1941.*

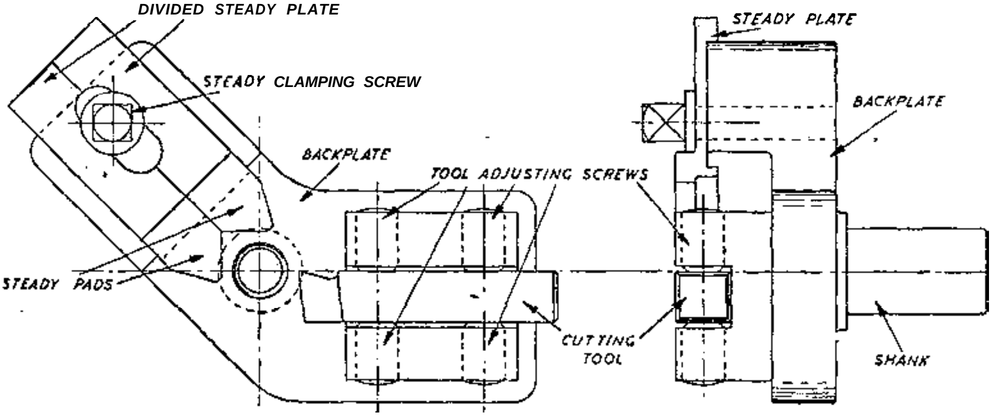
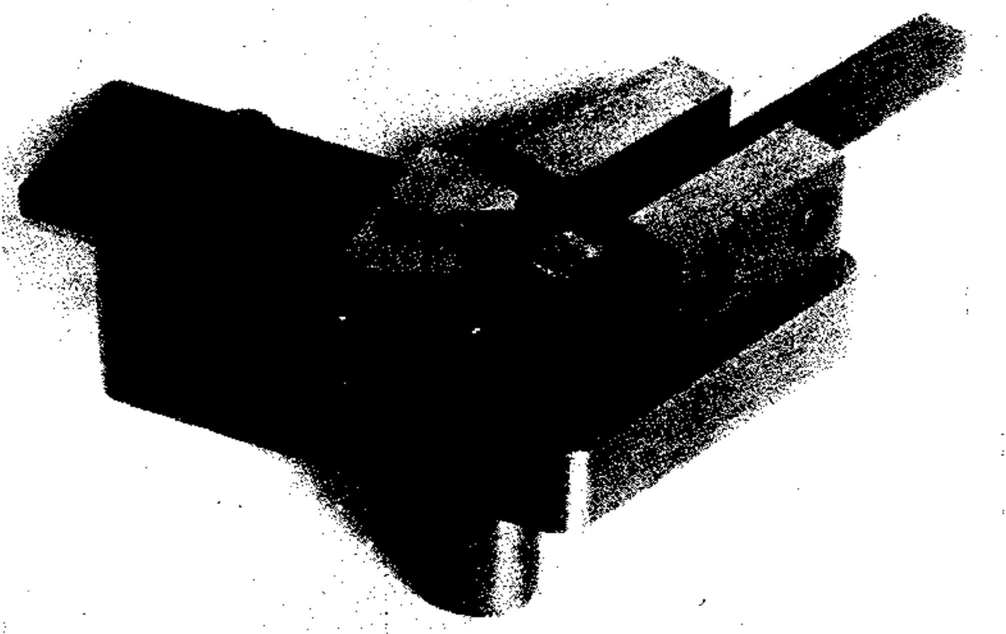



**Fig. *8.* Vee steady open tool-holder.**



The vee steady tool-holder, seen from the underside.

of work within its capacity, and may also be adjusted in the direction of the work axis, so as to either " lead " or " follow " the tool point, must be employed. There are innumerable varieties of such tools in continuous use on production work, most of them incorporating vee or roller steadies, and in many cases having provision for carrying more than one cutting tool, so that roughing and finishing operations, or stepped diameters. may be carried out simultaneously. Generally speaking, the single-point tool will be the most useful for the class of lathe we are discussing, because quite apart from additional power requirements, and torque strains, imposed by multi-tooling, there are other disadvantages in making and maintaining adjustments of the tool-holder, which may more than cancel out the advantages which they offer in increasing the speed of production.

**A Vee Steady Open Tool-holder**

The device illustrated in Fig. 8 is an example of a tool-holder which has proved successful in actual use and is of quite simple construction, Being of the open type, it gives less trouble in respect of swarf clearance than the usual form of box tool, and also promotes accessibility. The shape of backplate used is of little importance, so long as the relative positions of the tool point and the jaws of the steady are maintained. It will be seen that one jaw of the steady makes contact with the work dead opposite the tool point, while the other rests on-the top of it, i.e. at right-angles, so that the normal 90-deg. vee angle of the jaws is employed. This is the logical setting of the steady, as it thus prevents the work either. from bending away from the tool, or " riding " over the top of it, but occasionally one encounters steadies having a different included angle, or angular setting in relation to the tool, for which certain advantages are claimed. These should be judged on their merits, as proved by actual test ; most tool-setters, however, would, it is believed, endorse the view that the normal arrangement of the steady is difficult to improve upon.

**Refinements**

There are one or two minor refinements in the design of this steady which may be worthy of comment. It will be seen that the steady-plate is divided, so that the jaws may be adjusted individually up to the work. and simultaneously clamped bv a single set-screw having a collar or washer under the head. This feature is not necessary in cases where the true axial aiignment of the holder with the work axis is beyond suspicion, and may even be a positive nuisance in these circumstances, but it is very useful when errors of alignment exist.

The jaw-plate is stepped or "joggled," so that it may be used either in the position shown, which brings the steady pads slightlv in advance of the tool point. or turned over so that they come slightly behind the tool point.

In the former position, the tool provides the maximum support for dealing with heavy cuts on slender work, provided that the stock runs truly and is well finished ; in the latter, the stock must be sufficientlv riaid to enable the tool to cut properly for the short distance before the steady is engaged (unless this_ is done by a separate operation) ; but when once properly started on the cut, the follow steady produces the highest dimensional and concentric accuracy, and is independent of the external condition of the stock.

## Hardening and Polishing

The steady jaws must be hardened and highly polished to avoid the possibility of scoring of the work, or seizure, in the event of lubrication being inadequate ; they should be as wide as Dossible to increase bearing surface, subject to the limits imposed by end room, or the need to bring the tool close up to the chuck, or a shoulder on the work. Generally, however, narrow jaws are a sheer necessity, for these reasons.

Both the steady-plate and the cutting tool are carried in slotted blocks, which may be bolted, riveted, brazed or welded to the backplate, and the latter similarly secured to the shank, or bolted to the capstan face. It will be seen that the tool is secured in the tool block bv two sets of Allen or other sunk set-screws, one above and the other below. This is a very useful refinement, as it allows the tool to be adiusted to correct height after regrinding, a'provision which is sadly lacking in the simple box-holder, and may cause trouble after some wear of the tool has taken place. Some users, however, may prefer to use packing under the tool for this purpose.

Another way in which height adjustment of the tool may be effected is to make the tool block with a turned spigot or shank, which is clamped in the backplate instead of being rigidly attached to it. Adjustment is thus effected by loosening the" clamp and turning the block slightly: this method is satisfactory, so long as the clamp can be securely tightened and the tool is not overloaded.

Vee steady tools generally are better suited for machining brass and bronzes than steel, as the surface of the latter may " pick up" and score, under the pressure of the pads with very little provocation, and the same applies to certain aluminium alloys. The steady must be kept well lubricated, and not allowed to remain in contact with the work when the cut is completed. With proper setting, heavy cuts may be taken, leaving a good finish and accurate dimensions, but a second tool for finishing is recommended in high precision work.

(To be continued)

# An Electric Fire for the Workshop

(Continued from page 196)

should be made by connecting the earth wire of the cable to a nut and bolt in some convenient part of item 3.

Before fitting the cover plate (item 4) I wrapped the cables with asbestos tape, just to be on the safe side ; the cover is then fitted and held in place by two 4 B.A. bolts, 1-1/4 in. long, passing through the holes provided.

Attachment of the feet (item 5) was made, in my case, by two 2 B.A. "Dolts, with a double spring washer between the feet and the sideplates, the bolts being tapped into the side plates and locked by a nut on the insides. They are tightened up sufficiently to allow the fire to be swivelled to any position and stay put. An alternative scheme would be to fit somewhat larger bolts with knurled locking-screws on the outside.

Before attaching to the base it is advisable to give the sides and back a coat of good quality enamel. It is now only necessary to fit the element and the job is complete.

The photographs show the finished fire, and, as can be seen, it can be either used standing on the floqr or mounted on the wall ; if floor space is limited, the latter position is better, as it can be adjusted to reflect the heat downwards.

# *Small Capstan Lathe Tools

## Notes on " tooling up " for repetition work, with special application to the small capstan attachment recently described in the " M.E."

By "NED"

AS in the case of vee-steady tools, there are Innumerable varieties of tools which employ roller steadies, and except for the fact that independent adjustment of the roller holders must be provided for, there is much in common in the essential features of the two respective types. The reason why independent adjustment of the rollers is necessary is so that the line of contact of the rollers may, when adjustment is made to suit various diameters, always fall on the true diametral line of the work. In the case of the vee steady, the jaws of the vee make a tangent to the surface of the work, irrespective of its diameter, within the normal range of the tool, and thus adjustment in one plane, at an angle which exactly bisects that of the jaws, is normally sufficient.

The rollers are usually mounted on short rigid pivots, attached to short bars or plates, which are fitted to radial slide ways at the top and back of the work respectively. Some special forms of roller tools have been devised, in which provision is made for moving the roller slides in or out simultaneously, thus affording a " self-centring " motion, but this is a refinement which is hardly necessary in general work ; in fact, there are occasions when it becomes desirable to set one of the rollers a little harder on the work than the other when adjusting the tool to produce work exactly to size or to avoid a scratch when it is withdrawn.

It is most important that the rollers should be hardened and finished, to a very high polish ; the corners should be slightly, but smoothly rounded, so that they cannot dig in and cut the work under any circumstances. They must rotate freely on their pivots, as the slightest friction will impair their proper rolling action, but they must not be so slack that tilting or wobbling can take place.

As in the case of vee steadies, the rollers may be set either in advance of or behind the tool point, and the respective positions produce the same characteristic results. The burnishing effect of the rollers when they are used in the latter position is, however, very useful in commercial work, as it enables a high finish to be maintained, even when the tool has lost its initial keenness or is not meticulously set. Only metals which produce long chips or " curls " can be operated on with roller tools, as short chips or splinters are liable to cling to the rollers and become rolled into the surface of the work, with disastrous effects to the finish. Thus it may be said that mild and free-cutting steels, tough aluminium alloys, copper and certain types of bronzes, nickel alloys, etc., work well with roller tools, whereas cast-iron, and castings in comparatively brittle brass, gunmetal and aluminium alloys, also free-cutting

* *Continued from page 204, " M.E.," February 26,* 1942.

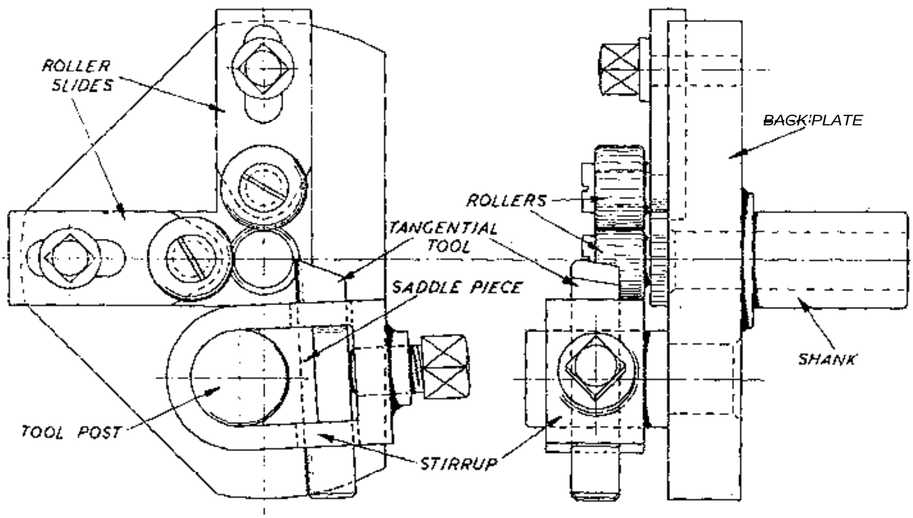



**Fig. 9. Roller steady tangential tool-holder.**

brass bar or " screw rod " are generally unsuitable. But blind reliance on generalised rules in this respect, or other matters concerning the machining of various metals, is not desirable ; the successful tool setter is he who is not afraid to find out for himself. by actual experience, the best tool or method of tooling, for a particular material or class of operation.

The roller steady tool illustrated in Fig. 9 embodies at least one feature of interest, which happens to have proved quite successful in the operation to which it was applied. This consists of the use of a tool which is presented tangentially to the work, so that the end face becomes the cutting face, and is the only face which needs regrinding to keep the tool sharp. In this wav the actual working life of the tool is much ionger than one which is presented to the work in the normal way.

This particular feature was of particular value in the operation to which this tool was applied, because tool wear had proved to be heavy, and resetting frequently required, when using an ordinary tool. The, job in question was a light cut over a bar of tough alloy steel, leaving a surface highly finished and accurate to size. As the surface of the raw material was hot rolled, it contained a certain amount of dirt and hard scale, which accounted for heavy tool wear ; the chip was also somewhat erratic, and did not clear itself perfectly when a normal form of tool holder was used. The tangential tool proved to be able to penetrate the outer skin and peel off the scale readily, besides throwing the chip clear of the holder, whether it was short or continuous.

In this particular instance the tool steel employed was 1/4-in. square section " Toledo " brand. but " Eclipse " steel was also used successfully, and undoubtedly many other well-known brands of high-speed steel would be quite satisfactory. As a radius was required at the end of the cut, a suitable radius was ground on the corner of the tool, throughout its entire length, and thus remained constant when the cutting edge was reground ; this, by the way, is another advantage of tangential tools, when any kind of forming operation is to be carried out.

The method of mounting the tool in the holder is of interest, as it provides ready adjustment of the cut, or the height of tool point, with only a single set-screw. It is hardly to be recommended for taking heavy cuts, but no tendency for the tool to slip has so far been observed. A particular feature is that any spring of the tool-post which may possibly take place tends to relieve the cut rather than causing the tool to dig in ; this helps to avoid damage either to the work or the tool on the occasions when the cut does not go quite according to schedule.

The tool-post consists of a short cylindrical spigot, 1/2 in. diameter, turned down to 3/8 in. dia., and fitted to the back-plate by pressing in and riveting. It must, of course, be quite firm and rigid, and brazing or welding may possibly be preferred as a means of ensuring this. A steel stirrup is cut from the solid, having the surface which embraces the spigot made to fit accurately against the latter, and a saddle-piece, shaped equally accurately, is fitted into the gap with a groove across its flat side to seat the tool. These parts should be case-hardened when finished.

For most operations which involve the use of a square-nosed tool cutting on the front (leading) face, it would be necessary to provide front clearance on the tool ; and in order to avoid the necessity of grinding it on this face, the logical thing to do would be to incline the tool forward (in the direction of traverse) at the required clearance angle. This would be quite easy to arrange by cutting the tool slot in the stirrup and the seating groove in the saddle piece a little out of square with the axis of the tool-post.

A certain amount of lateral sliding adjustment of the stirrup on the tool-post is provided, so that the tool point can be set either slightly in advance of or behind the rollers, as required. There is little else in the design of the holder which calls for detailed explanation. It will be seen that the back-plate is made from a circular disc, with the unwanted portions of the edge cut away ; this is, in general, a good policy, as any encumbrances to access, vision or chip clearance are best removed, so far as can be done without structural weakening of the holder. The roller slides are let into grooves just sufficiently deep to provide guidance on the true radial line, and held by-a single set-screw in each case, the slotted holes in the slides being long enough to provide adjustment to cover the range of diameters of work with which the tool will have to deal.

Tangential tools enable the utmost degree of top-rake to be used without weakening the bit and the clearance angle to be adjusted or varied when setting. High finish often demands using a verv fine clearance angle, so that the tool point practically burnishes the work. In some cases the tool is arranged to be fed into the work on the tangential line, i.e. parallel with the length of the tool, or nearly so in this case the top-rake increases, and the clearance diminishes to zero as the cut progresses, the completion of the operation being a true burnishing action. This method has proved very effective in forming and chasing operations which demand high accuracy and finish.

(TO be continued)

# *Small Capstan Lathe Tools

## Notes on "tooling up" for repetition work, with special application to "M.E."

By "NED"

ALTHOUGH the vee and roller steady toolholders, described in the preceding instalments of these notes, may be regarded as the most efficient means of running down solid stock for such purposes as making screws, bolts, rivets, etc., and are applicable without difficulty in the great majority of cases, there are occasions when their use is either entirely impracticable or inconvenient, and some other method of steadying the work against deflection under the pressure of the cutting tool must be adopted.

The use of bush steadies. in connection with the simple box toolholder, has already been mentioned (see Fig. 7) ; in this particular case, however, the construction of the toolholder allows of only one position for the steady bush, that is, in advance of the cutting tool. This undoubtedly limits the usefulness of such a toolholder, but it is, of course, possible to modify its design so as to allow of using a steady bush behind the tool point if desired. Either the box form of toolholder, or the open type, such as the simple knee toolholder shown in Fig. 6, may be thus equipped, and in cases where the finished diameter of the work is very small, the shank may be bored out and used as the bush holder. The use of such expedients is comparatively uncommon, but may, in certain circumstances, help to solve many a practical problem.

### "Plug" or Pilot Steadies

In work which is turned from tube, or has been drilled with a central hole, it is possible to invert the principle of the bush steady by equipping the toolholder with a centre pilot which fits the bore of the hole and supports the work from the inside. This method is very extensively used in the production of light bushes, sleeves, ferrules, and pipe connections ; it is most useful when the bore of the hole is comparatively large and the finished work rather thin in the wall. The hole must, of course, be parallel, and within fairly close limits of diametral accuracy ; for this reason a reamered bore is preferable, but plug steadies are often employed successfully in holes which have just been drilled in one operation.

The normal practice with hollow work, whether produced from solid stock or otherwise, is to drill or bore the inside at an early stage in the operation, before turning the outside, or between roughing and finishing cuts. In such cases, it is very convenient to use a plug steady tool for finishing, and the latter will often be found to give the most

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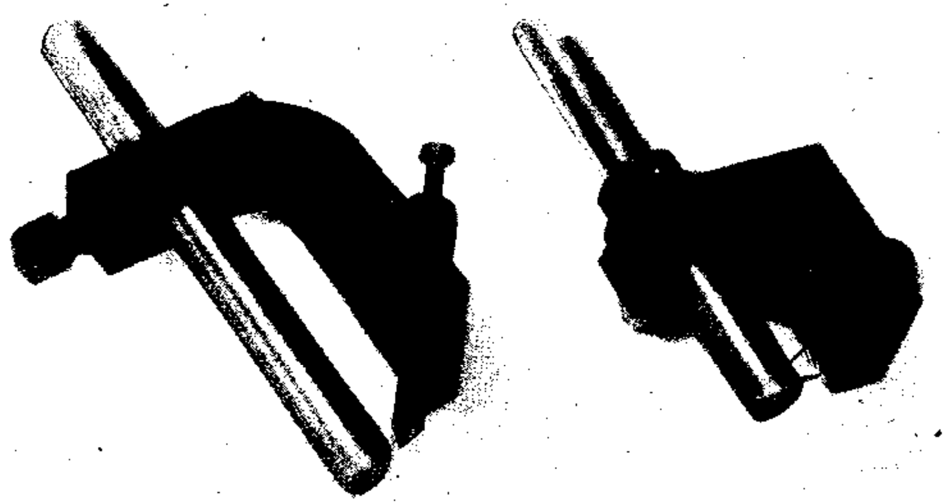
* *Continued from page* '254, "*M.E.: March 12, 1942.*



Toolholders with pilot steadies, for operating on centrally drilled work.

satisfactory results in respect of accuracy and finish. The most common form of toolholder for this purpose is an ordinary knee toolholder with the shank extended in front of the yoke to carry (or act as) the pilot.

If it is desired to make the tool adaptable to deal with a range of bore sizes, it would be a sound- policy to use a hollow shank, with provision for the insertion of variously sized pilots. This course, however, does not appear to be very commonly adopted in practice, probably, because it is so easy to turn a shank and pilot in one piece to suit the work in hand. The working surface of the pilot should be case-hardened, and in common with other forms of steadies, highly polished. If the pilot is intended to work in a blind hole, it is-in theory at least-necessary to provide a passage for the escape of air or lubricant trapped in the hole. There are many cases where this is neglected, and nothing very terrible seems to happen ; but the provision of an oil way, for preference a steep spiral groove, in the surface of the pilot, is always an advantage, whether it is used in blind or open bores.

Fig. 10 shows a simple plug steady toolholder suitable for use on a short running-'down cut. The knee is in this case cut from solid mild steel, and is clamped to the shank by means of a single set-screw, being thus capable of endwise adjustment on the shank so that the distance of the end of the pilot in advance of the tool may be varied. It is usual to allow a fair length of the pilot to enter the hole before the tool begins to cut, in order to provide ample bearing surface for steadying ; but in many cases, where the depth of the bore is limited, the pilot can only be allowed a small amount of advance.

The tool point is set obliquely in the yoke, so that its cutting edge can be brought at least flush with the front end of the latter. This is a useful provision in cases where it may be necessary to work close up to the chuck jaws, or to a flange on the work ; it also improves general accessibility and visibility, besides facilitating the regrinding of the tool point without undue waste of material. The top face of the tool is ground obliquely away in both planes to provide front and side rake, the latter being the more important, as the tool does most of its work on the leading edge.

Note that in order to maintain proper rake and clearance angles, the slot for the cutter must be below the centre line of the yoke, so as to bring the cutting edge exactly on the plane of diametral adjustment. An error which is frequently made by amateur tool-makers (and is not unknown among professionals) is to slot toolholders symmetrically on the centre line, so that the top edge of the tool is well above centre when it is in position. It is true that the rake and clearance angles can be adjusted by grinding to suit this position, but some waste of tool steel is involved by this method, and the angles thus produced are only correct for one diametral setting.

Similar tools to that shown in Fig. 9 have been used by the writer for bevel and short taper forming, or with two tools in tandem,

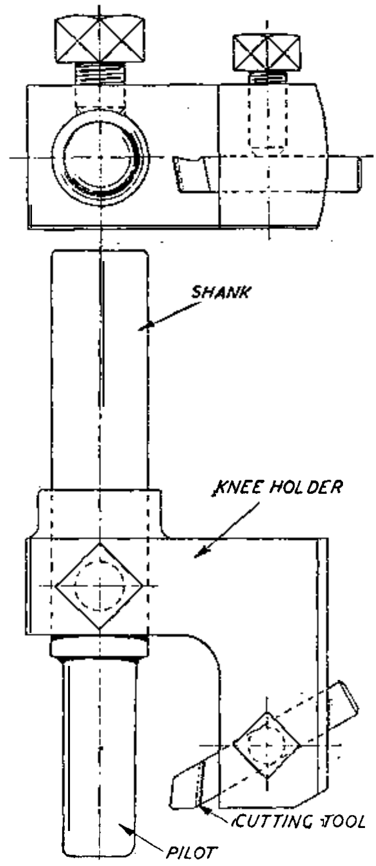



**Fig. 10. Knee toolholder with pilot steady for short running-down cuts on hollow work.**

for stepping the outside diameter of the work. In one case a cutter similar to that shown was used for running-down, while a second cutter inserted at about 45 deg. in the angle of the yoke, and shaped to a concave radius at the point, was used for producing a rounded corner, accurate to specified radius, on the corner of the work.

The holder shown in Fig. 11 is generally similar to the preceding example, except that it is lighter in construction and intended to deal with a greater length of cut. A refinement in its design, which may be found useful when it is required to produce finished work of accurate dimensions, is the provision of a feed screw behind the cutter. The clamping of the latter is effected by means of a long set-screw which passes longitudinally through the holder ; this is more complicated than the more usual cross screw, but is a more secure method of ensuring the correct positioning of the tool point, and also leaves the nose of the holder absolutely clear of all obstructions, so that it would be possible to use the tool in a recess or shallow hole of large diameter.

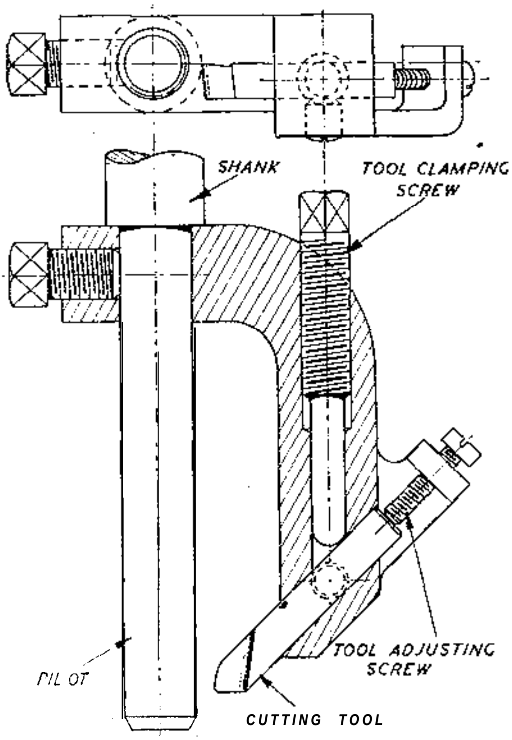



**Fig. 11. Another pilot steady toolholder, equipped with screw adjustment to the cutting tool.**

In order to form the carrier for the tool-adjusting screw, a bent strip of 1/8-in. sheet steel is brazed on to the bottom face of the holder leg, which in this case is made from square bar material by hot bending. This strip, incidentally, forms the " floor " of the slot which holds the cutter, so that the operation of forming the slot is facilitated, as it is simply a square groove cut diagonally across the square leg.

If desired. height adjustment of the tool may be provided by sunk set-screws above and below the cutter. These screws have only a light duty to perform, as they do not have to clamp the cutter, thus ordinary slotted grub-screws may be used. In the example illustrated, only one such screw was used, on the underside of the slot, to take up clearance under the cutter.

**Other Forms of Steadies**

Both bush and pilot steadies are often used in capstan and turret lathe practice, apart from their application in conjunction with running-down toolholders. That is to say, the steady alone is carried in the capstan or turret head, and brought up to engage the work, the traversing slide then being locked, and the work operated on by tools carried in the cross slide. Such operations as forming, chasing, or parting-off may be considerably speeded up or facilitated in this way, especially if the work has little inherent rigidity or extends some way from the chuck. In parting-off small parts at high speed, the use of a steady in this way has the additional advantage that it reduces or entirely eliminates the " pip " on the cut end, and also retains the part after separation, so that the operator does not have to search for it among the swarf.

Centres of more or less orthodox type, both male and female, are sometimes used in a somewhat similar manner, to support the overhanging end of work while it is being operated on by cross slide tools. In production practice, both centres and steadies intended for use in this way are often equipped with ball- or roller-bearings to withstand heavy and continuous duty. There is, however, little advantage in thus mounting a bush or plug steady if it is used in a traversing toolholder, as it will slide more freely endwise if prevented from rotating.

Fixed and travelling steadies of the type usually applied to centre lathes are not used a great deal in capstan or turret lathe practice. There are, however, occasions when their use is justified ; for instance, long lengths of work which have to be operated on internally and call for no external machining, may be supported at one end in a collet or jaw chuck, and at the other by the conventional three-point steady, or an improvised bush or pad steady of any kind which can be clamped to the lathe bed.

The use of any kind of steady in lathe work is bound to increase friction to some extent, and therefore to affect the amount of power required to drive the lathe. In most cases the increase is inappreciable, but its possible effect should not be neglected ; neither should it be forgotten that the friction will increase the heat generated in the operation, and for this reason, if no other, a copious supply of lubricant should always be maintained. Ordinary cutting oils and soluble compounds are usually effective in keeping steadies lubricated, but there are cases where the use of a steady will call for applying a coolant of more " body " or lubricating quality than would otherwise be necessary.

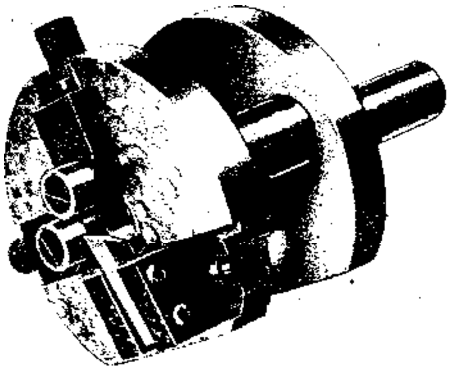
(To *be continued)*

# *Small Capstan Lathe Tools

## Notes on " tooling up " for repetition work, with special application to the small capstan attachment recently described in the " M.E."

By " NED "

IN the early part of this series of articles some advice was given on the subject of ready-made capstan lathe tools, in response to enquiries from readers as to where such tools could be obtained (see the issue of the MODEL ENGINEER dated October 23rd last). Since then, a good deal of information about ready-made tools has been furnished by manufacturers, and it is understood that the position with regard to the supply of tools is steadily improving, though the private user of a small capstan lathe would probably still find it difficult to obtain them without an official permit. The size of most tools listed by manufacturers is also well on the large side for adaptation to lathes within the scope of these articles. Nevertheless, it has been decided that descriptions and illustrations of available tools are justified on. the grounds of general interest ; most of them are very ingenious in design, and embody refinements not usually found in the tools which are made "on the spot " to cope with immediate machining problems. A study of these tools will prove profitable to the user of any small production lathe, whether he makes his own tools or otherwise ; and the interests of the manufacturers, even though they may not be directly served by the promotion of sales, will certainly not be harmed by publicity given to-their products.



A tangential roller steady topl, as manufactured by Messrs. R. G. Boardman & Co., Birmingham.

### A Roller Steady Tangential Tool-holder

Messrs. R. G. Boardman & Co.. 44, Summer Row, Birmingham, have furnished particulars of a very ingenious roller steady tool, which happens to possess several features in common with the tool illustrated in Fig. 9 (March 12th issue), though considerably more elaborate in design. It is made in two sizes, the " Minor " having a work capacity up to 1/2 in. diameter, and the " Major," with a capacity up to 3/4 in. diameter. Shank diameters may be varied to suit requirements.

An interesting feature in the design of this tool is that the cutter and rollers are not mounted directly on the backplate, but on an extra plate which is carried in front of the backplate on rigid spacing pillars. The advantage of this method of construction is that work up to the full capacity of the tool in diameter may be operated on for a greater length than is possible where the ordinary backplate mounting is adopted. This length is, in any tool of this nature, limited by the distance from the front edge of the cutter to the backplate, though the use of a hollow shank enables small diameter work of much greater length to be run down.

Both the roller slides, and also the tool slides, have positive screw adjustments to suit the diameter of work to be turned. The tool box, in which the cutter is secured by two sunk set-screws has its groove set at the required angle to provide clearance in both planes. It is claimed, quite justifiably, that this form of tool holder gives exceptional swarf clearance, maximum tool life, and a wide capacity range. There are no projections in front of the tool point, so that it may be used right up to a large diameter flange or shoulder on the work.

### Drilling and Boring Operations

Work requiring a centre hole should first be centred by means of a centre-drill, or a flat drill, as described in the October 9th issue, and may then be drilled in the customary manner by any form of drill held axially true in the capstan head. Small twist drills may be mounted in a standard drill chuck the shank of which is turned to fit the capstan head socket. The cheapest and simplest types of drill chucks are quite suitable for this purpose, and can be obtained with parallel shanks of a standard diameter,

*Continued from page 292, " M.E.," March 26, 1942.*

which involve the minimum work in adapting them. If, however, no suitable chuck is available, a length of mild steel rod of the required diameter, or turned to suit, may be concentrically drilled to fit the drill, and the latter secured in place by a grub screw (Fig. 12). The drill shank should fit the hole closely so that it is not forced out of centre by the screw ; in some cases tool setters prefer to make the drill a drive fit in the holder, or sweat it in, to provide maximum security.

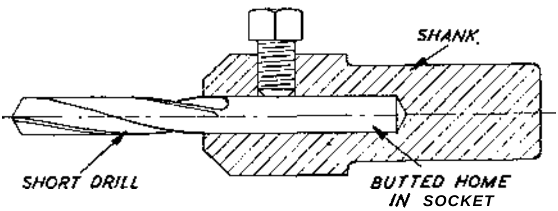



**Fig. 12. Short twist drill mounted in stub holder to fit capstan head.**

Drills should not project farther beyond the chuck or holder than is necessary, as a long slender drill lacks rigidity and is more liable to damage in every way than a short one. Very often drill stubs which have worn down too short for efficient use in a drilling machine can be given a new lease of life in a capstan lathe. If possible, the shank of the drill should bottom in the chuck, so that it cannot possibly slip back to destroy end-stop adjustment ; sometimes it is necessary to use a short piece of metal rod as a packing piece behind the drill to ensure positive location.

In cases where holes have to be drilled very deeply, it is often an advantage to start with a short drill and follow up with a longer one, so that the maximum rigidity is obtained at the beginning of the operation, when the drill is most likely to wander out of truth. It may even be desirable to do the operation in three or more stages, and crowding of the capstan stations may be avoided by using a form of drill chuck which permits easy and rapid changing of the drill.

It is of the highest importance to run the lathe at the right speed for efficient drilling ; small holes require a higher speed than most users seem to realise, and deficiency in this respect results in slowing up of output, excessive drill wear, and liability to concentric inaccuracy. The use of a rotating drill spindle in the capstan head is justified in some special cases, though the complication of arranging a suitable drive, which can be unshipped'to allow for the rotation of the capstan head, rules it out for the majority of simple production lathes.

**Reamering and Boring**

When holes have to be highly finished internally, or to a close accuracy in size, simple drilling may fail to produce the desired results, and in these cases an undersize hole will have to be drilled, to be opened out to size by a reamer or boring tool. The ordinary hand reamer, which cuts mostly on the sides, near the leading end, is not really a suitable tool for this purpose, as the holes are usually blind, and in such cases it cannot produce a parallel hole ; neither is it sufficiently free in its cutting and clearing action. An old hand reamer, broken or ground ofr fairly short, and reground so as to cut on the nose end, will serve the purpose much better, but a simpler tool to produce is a small D-bit or flat sizing cutter.

The amount of material left to be removed by the reamering operation should be as small as possible, and it is advisable to use, in the preliminary drilling operation, a size of drill which is found to leave just a mere scrape for the reamer to take out. Conventional rules in reamering sizes do not necessarily apply, as the exact size a particular drill will cut cannot always be predetermined.

Boring operations, as distinct from reamering, are often required in small capstan lathe work when it becomes necessary to open out a hole to a fairly considerable extent. It often happenes, when producing a large hole, that it is more efficient to drill a small pilot hole and bore it out, than to attempt to drill the required size of hole at a single operation, with a large drill. The latter may require more power than is readily available, and will set up a very heavy end thrust, which may be bad for the lathe headstock bearings. When a large drill is not used at its proper cutting efficiency, violent chattering may be set up, and the

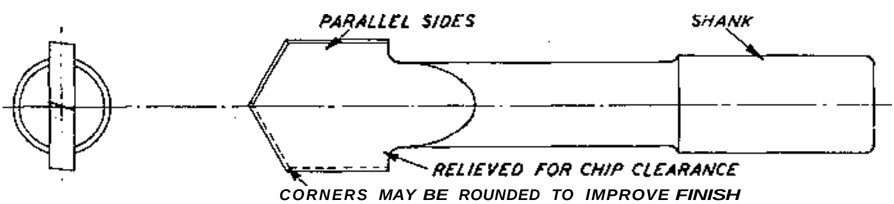



**Fig. 13. Form of flat drill recommended for opening out and sizing holes.**

hole produced may be far from circular.

Single-point boring tools can be used for capstan lathe work, and are in certain cases useful or indispensable ; but for most purposes, double-edged tools are preferable, not only because of their greater cutting efficiency, but also in order to ensure accurate sizing. The cutting pressure is

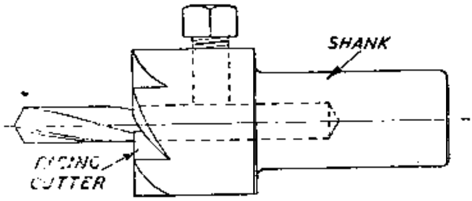



**Fig. 14. Combined drill and face cutter, suitable for shallow counterboring.**

balanced so that side thrust on the work is eliminated. A common form of boring tool is the good old-fashioned flat drill, but instead of being made diamond-pointed, the diametral edges are ground parallel for a certain distance back from the lips, as shown in Fig. 13, so that regrinding of the latter does not affect the size of hole the drill will produce. It is not, however, invariably an advantage to grind the sides to produce cutting edges ; indeed, better results are often obtained when they are not backed off, providing that the front edges are kept properly sharp. The form of drill shown in Fig. 2 (October 9th issue) would be quite suitable for opening out short bores, but would clear better in deep holes if the diameter were relieved from about half an inch behind the cutting edge.

Inserted-cutter tools, with flat, square section or even round cutter bits, are also quite extensively used in capstan lathe practice, and are easily made up to suit the work in hand. The cutter bar may be made of mild steel bar of a suitable diameter to fit the capstan head socket, and it may be desirable to form a pilot on the leading end. The only disadvantage of such tools in production work is that the size of bore which they produce is altered when they are reground, unless an elaborate form of " expanding " cutter is employed.

Cored holes in castings are often troublesome to bore out properly, owing to the fact that they are initially out of truth, and the scale or sand in them causes heavy tool wear. It is usually best to open them out in not less than about-three stages, using flat drills with obtuse-angled lips, so that the tendency of the drill to follow the eccentricity of the hole is reduced. The first drill should take a sufficiently heavy cut to get well below. the " skin " of the metal, and should be ground with clearance on the sides ; it will probably call for frequent regrinding, so it should be mounted in such a way that it can be removed and replaced quickly with as little disturbance to the setting as possible.

**Counterboring Tools**

When the depth and annular dimensions of the counterbore are considerable, a flat drill, either with or without a pilot, is the most efficient form of tool to use for the job. In some cases drilling and counterboring are carried out in one operation, either by a special one-piece combination drill or by means of a facing cutter equipped with a twist drill in place of the usual pilot (Fig. 14). The small capstan lathe user, however, will generally find it better to carry out the drilling and counterboring in two distinct operations, as this is not only lighter on the lathe, but also on the tools ; it simplifies tool setting, and enables a better check to be kept on the accuracy of both operations.

For shallow counterboring, in cases where the tool must be kept keen and adjusted to produce an accurate diameter, the form of tool shown in Fig. 15 will be found useful, and is easy to make. The cutter is of square

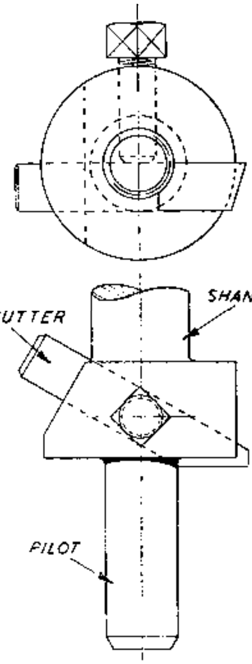



**Fig. 15. An efficient single-point counterboring tool.**

section, fitted in a diagonal slot at about 60 degrees to the axis, an arrangement which facilitates re-grinding and size adjustment. It is, of course, important that the front edge should be ground too so as to set exactly square with the axis (unless some other angle is called for in the job being dealt with) and for this reason some kind of grinding jig is advisable for this operation.

A pilot is provided to guide the cutter concentrically with the hole, and if the tool is required to cut over the entire annular area, both the cutter and the slot to which it is fitted must be arranged so that the entire radial face is operative ; any dead space between the inner end of the cutting edge

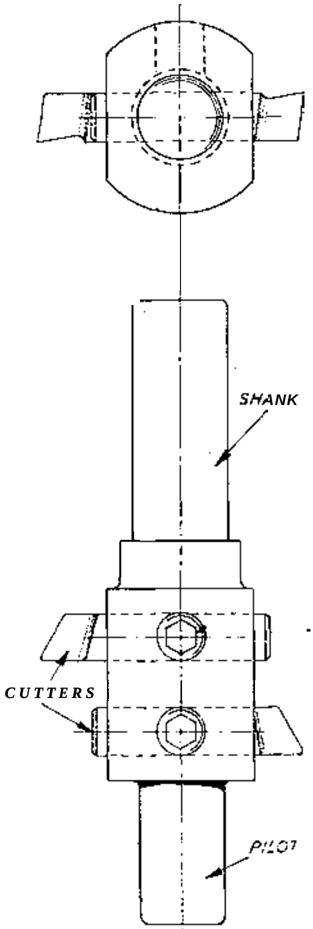



**Fig. 16. Two-step counterboring tool, suitable for light operations.**

and the pilot will prevent the tool from cutting properly. Incidentally, this is quite a common fault in the design of counter-boring tools, but one which is quite easily avoided by the exercise of a little common sense. It will, of course, be clear that if the counterbore is required to penetrate to any great depth, the cutter must be shortened so that the back end does not foul the enlarged bore.

Step counterboring of different diameters is very frequently necessary in capstan lathe work, and although it is possible to do this by taking successive cuts with counterbores of different sizes, a single tool to do the job is more convenient and expeditious in cases where the amount of metal to be removed is not very great. Fig. 16 shows a simple two-step counterbore for use in a hole which has already been opened out with a flat drill to a size sufficient to clear the largest

**The two-step counterbore shown in Fig. 16.**

diameter of the holder. If, however, it had to be capable of opening out the pilot hole directly, the leading cutter could be arranged similarly to that of the preceding example.

This tool was made for use on a gunmetal electrical fitting, and saved a good deal of time, compared with that taken up with separate tools, without imposing excessive strain on the lathe. Its general construction calls for no special description, as it is adequately explained in the illustrations.

(To ***be continued)***

## MORE SOLDERING HINTS

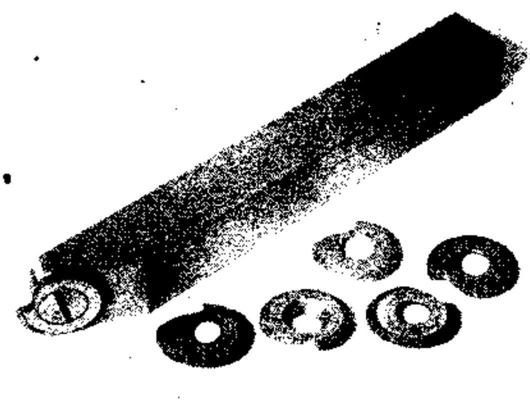
Soldering-up a leaky or spring joint does not offer any special difficulty, as the solder (tin-lead or tin-lead-antimony alloy) can usually be made to flow over the defective area, but in the case where it is necessary to solder up a fair-sized hole, it is not so simple, as the solder will not flow over and cover up the hole, but flows around it, merelv reducing its diameter a little. For such jobs it is useful to keep in the workshop an assortment of various small sizes of tinned iron or copper rivets, or even brass paper-fasteners ; cut off nearly all the shank of one that is a suitable size just to fit over the hole and apply zinc chloride or Fluxite over the rivet head. Then use a well-tinned soldering bit, and a sound and neat soldering job will result. A good way to prevent solder from getting into places where it is not wanted, such as tubes, joints, etc., is to fill them with a fairly thick paste made by mixing powdered chalk and water.

To prevent solder straying over model parts where it is not wanted, cover the parts with a paint made by mixing lampblack and water to which a little weak glue or size has been added.-A. J. T. E.

# "NED" describes the making of

# *DISC SCREWCUTTING TOOLS*

THE use of circular cutters for forming and screwcutting is quite common in capstan and automatic lathe practice, and has also been applied on centre lathes to a certain extent, though not, in the writer's opinion, to the extent it deserves. Its advantages are obvious, as the correct form of the cutting edge can be maintained throughout the working life of the tool, without being affected by regrinding, while the life is long, because almost the whole circumference of the disc is available for progressive use. Some excellent examples of disc tools are, or have been, available in ready-made form, but quite apart from the difficulty of obtaining anything in the way of special tools nowadays, the standard form of tool is often less suitable for model engineering purposes than might be desired.



**The toolholder for external screwcutting, and some spare cutters.**

Speaking from experience with a well-known disc screwcutting tool of American manufacture, it was found that the shank was too large to be accommodated properly in the tool-post of a 3-in. lathe, and it was only possible to set the tool point to centre height by turning it into a position which gave excessive front clearance, and little or no top rake. The thickness of the cutter was also excessive for any threads of finer pitch than about 12 t.p.i., and it was impossible to work close up to a shoulder, owing to the thickness of the cutter, and the means adopted for clamping it to the shank. It is quite probable that these features might not constitute any serious disadvantage in the majority of tool-room or "full-size" engine lathe work, but they were very troublesome when dealing with the small jobs and fine threads normally encountered in model engineering.

It was therefore decided to make up some disc cutters, together with holders for both internal and external screwcutting, of a size and type more suitable for model work. These proved to be quite simple and straightforward to make, and the results obtained were so successful that it has been thought worth while to describe them for the benefit of other readers.

**Making the Cutters**

To consider the production of the cutter discs first, it may be mentioned that there is no essential difference in the discs used for external and internal work, except in the grinding and, possibly, in the size of the latter, which may, of course, have to be limited in case they are required to work in small diameter holes. There is no such limitation in the size of the external cutters; the larger they are, within reason, the better, as they provide more wearing material. It will, however, be found in most cases that a very large disc cutter is inconvenient to accommodate in a small lathe, and it also requires more secure fixing than a small cutter, owing to the greater leverage applied to it by the cutting thrust. Many readers will have difficulty, also, in obtaining suitable tool steel for making large diameter cutters.

In the particular case under discussion, the discs were turned from $\frac{5}{8}$-in. diameter silver-steel to the shape and size shown in Fig. 1, and this size proved to be quite suitable for use as external cutters, besides covering most requirements for internal work as well. Any kind of tool steel, in an annealed condition, could be used instead of silver-steel, so long as the appropriate methods of hardening and tempering for the particular steel are subsequently employed. The cutters may conveniently be machined up in batches, as a spare cutter or two will always be found handy; it is also a good policy to make up a set of cutters varying in thickness, and having different nose radii, for cutting threads of different pitch.

A sufficient length of steel to make up about half-a-dozen cutters at one setting was held in the four-jaw chuck, running fairly truly so as to avoid unnecessary wastage of material. A number of deep grooves were made in this with a parting-tool, leaving "lands" of the width required for the cutters (see Fig. 2), and the latter were then roughly shaped by means of an ordinary solid vee screwcutting tool to within a few thousandths of an inch of finished size. The end of the stock, which

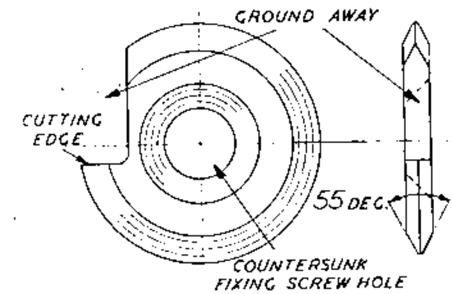



**Fig. 1. Form of disc cutter recommended for model engineering purposes. (Twice full size.)**

was, of course, truly faced before shaping the cutters, was then centred and drilled concentrically with a 3/16-in. drill, to a depth sufficient to pass through all the cutters being turned. This hole was very carefully countersunk, deep enough to enable the screw which will be used for fixing to be sunk at least dead flush with the surface. It is most important that the angle of the countersink should exactly correspond with that of the screw head, and that the surface should be smooth, and free from burrs or chatter marks.

The next operation consists of finishing the vee edges of the cutter, which is done by setting the top slide over at an angle of $27\frac{1}{2}$ deg. to the cross plane (for Whitworth form threads), and using a side-cutting tool of the appropriate "hand." All the cutter blanks can be dealt with on one side flank first, before re-setting the slide for machining the other flank. The tool used in each case should be oilstoned to a keen and smooth edge, so that it produces a high finish on the work. It is not an easy matter to finish a hard material like tool steel nicely "straight off the tool," but it can be done with care and patience, together with correct tool setting. It is not desirable to attempt to make up for the deficiencies of tool finish by the use of file and emery cloth, but it is permissible to use a fine India oilstone slip to produce a final finish, so long as care is taken not to round off or alter the angle of the edges. When finished, the flanks should bear inspection through a fairly powerful magnifying lens such as a watchmaker's ocular; this will show up any minute scratches or roughness which would be liable to interfere with the efficiency or smooth working of the finished cutters. The tip of the vee is then rounded off very slightly with the oilstone; in the event of cutters made to suit various pitches, the radii of the respective tips should also be made to suit. A standard thread pitch gauge can be used as a form template, viewing against a light or a reflector placed at the back of the work, and with the aid of the lens.

It will be found that the exercise of these rather elaborate precautions to ensure correct form and finish of the cutters will be amply repaid by the ease with which accurate and well finished threads can be produced with them eventually.

The end cutter may now be parted off with a keen parting-tool, using plenty of lubricant, so as to produce as fine a finish as possible. It may be found advisable to support the work with the back centre during this operation, to avoid spring or chatter. When the first disc has been separated, it may be found necessary or desirable to take a light facing skim over the end face of the next disc, after which it is countersunk, and parted off in the same manner as before; all the discs are subsequently treated in the same way. The surface left by the parting-tool on the back of each disc should be cleaned up by rubbing

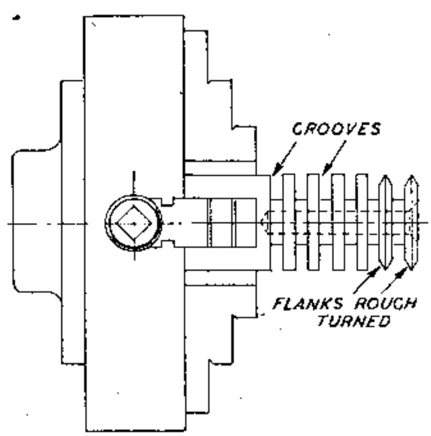



**Fig. 2. A batch of cutter discs in course of machining. (Not to scale.)**

on a sheet of emery cloth, and the burr round the centre hole carefully removed.

### Hardening and Tempering

It is advisable to string the batch of discs together on a mild steel bolt for this operation, as this not only simplifies handling, but also helps to ensure that they are uniformly heated. If the cutters are dealt with singly it is very difficult to ensure that they all attain the same temperature. Assuming that they are made from carbon- or silver-steel, care should be taken not to overheat the thin tips, and for this reason, some method of heating which avoids a direct flame impinging on the discs, such as a small gas muffle or electric furnace, is very much to be recommended.

For quenching out, cold water with a layer of thin oil about ½ in. thick floating on it has been found very effective for securing the requisite hardness, and at the same time avoiding the formation of water cracks. The bolt with the pack of discs on it is held vertically in a pair of tongs and plunged into the centre of the quenching vessel, then stirred round until the cooling is complete. By this means even cooling is ensured, and the trapping of water or steam in the interstices of the discs is prevented.

The discs are now taken off the bolt and mounted individually on a mandrel for polishing all over with fine emery cloth. They should be kept dry and free from oil, and should be handled as little as possible at this stage. Tempering may then be carried out by laying each disc in turn on a piece of asbestos and inserting in the centre hole a conical rod heated almost red hot. The "temper" colours will run from the centre outwards, and are under good control; as soon as the flanks of the disc arrive at the correct temper the hot rod is removed, and the disc quickly quenched out again in clean cold water. It is best to let the temper down slightly more than is usual for ordinary lathe tools, as the extreme tip of the tool takes very heavy loading, and is liable to chip badly if it is too hard.

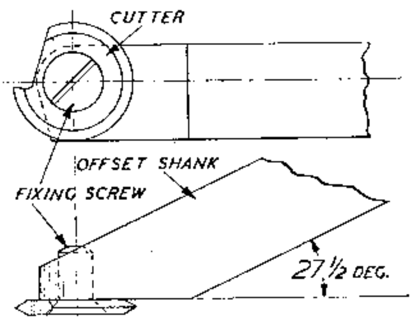
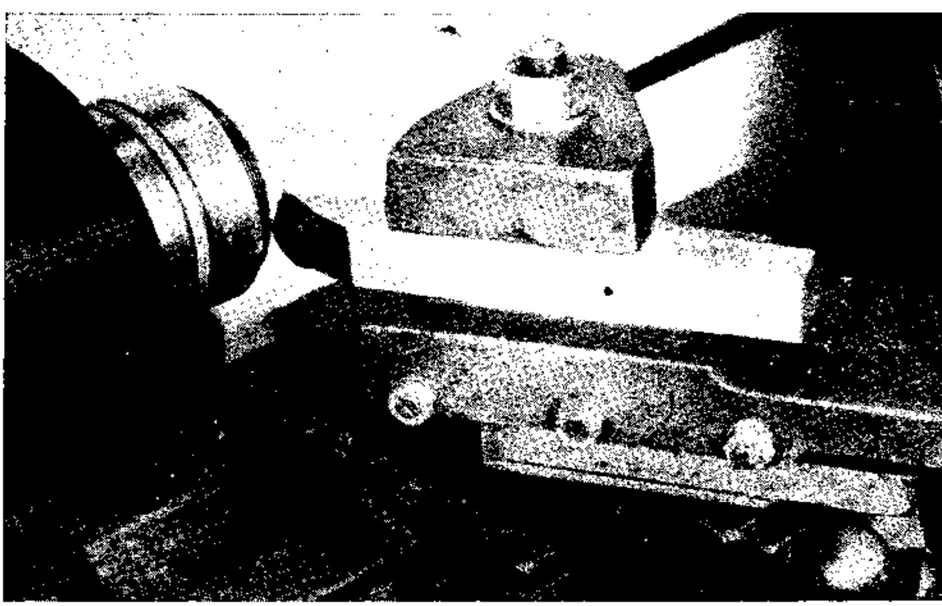



**Fig. 3. Offset toolholder for external screw-cutting. (Full size.)**

The flanks of the vee should reach a dark straw colour before quenching; silver-steel will stand a rather greater hardness than most ordinary forms of carbon tool steel, without becoming unduly brittle, but even so, it should be let down to at least medium straw colour at the outer edge.

In the event of high-speed steel being used, the directions furnished by the makers for hardening and tempering it should be carefully followed.



**Cutting a fine thread (36 t.p.i.) on a lens cell for an optical instrument. (Note the way the top slide is set over to correspond with the flank angle of thread.)**

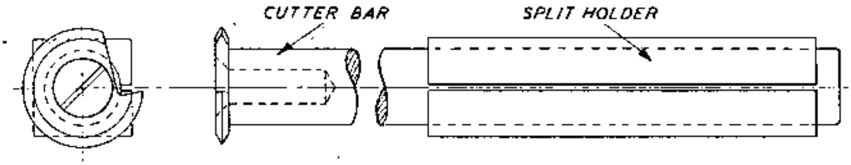



**Fig. 4. Holder for internal screwcutting. (Full size.)**

**Grinding**

When grinding the notch in the cutter, great care must be taken not to overheat it and draw the temper. Few model engineers, it is presumed, will have access to a grinder equipped with water service for keeping the work cool, and in the absence of this provision, the only thing to do is to proceed cautiously, and cool off the disc in water as soon as it becomes uncomfortable to handle with the bare fingers. It might be thought that time and trouble would be saved in grinding by *filing* the notch in the cutter before it is hardened; but it has been found by experience that the presence of this notch while hardening and tempering is liable to lead to irregularities in the temperature flow, and thus make it difficult to ensure perfectly even hardness all round the cutter. These difficulties are not insuperable, perhaps, and they have to be faced in the case of milling cutters, and similar tools, but it is best to avoid them if possible.

With the ordinary tool grinder, it is impossible to form the notch to an angle more acute than 90 deg., unless the wheel is specially dressed to shape; it is thus necessary to take away nearly a quarter of the circumference in the initial grinding. Most grinding wheels will normally have a slight radius on the corner, which will produce a fillet in the corner of the notch; this is desirable, to avoid undue weakening of the disc at this point. If the side of the notch is ground exactly to the radial line, the cutting edge will have no top rake; in fact, if the tool is set as recommended, the rake will be negative. It is thus advisable to grind this edge well past the radial line, so as to produce an undercut.

**Holder for External Screwcutting**

This is simply a piece of ½-in. square mild steel bar about 3½ in. to 4 in. total length, with the end suitably shaped for the mounting of the disc as shown in Fig. 3. It may be left quite straight if desired, and the disc simply attached to the side, but the "offset" form of holder shown will be found much more handy to use, especially when working close up to the chuck jaws or other obstructions.

The side of the bar is bevelled off at an angle of 27½ deg., for a reason which will be apparent later, and the end face rounded off at the top and sloped away below to provide clearance. It will be seen that the disc is attached to the bar by a single 2 B.A. countersunk screw, and this feature may be strongly criticised as insecure—indeed, a good deal of comment has already been encountered on this point from people who have seen the tool. The answer, however, is that, provided the contact faces of the disc and its holder are truly flat, and the screw head fits the countersink properly, sufficient friction grip is provided to hold the disc rigid against all normal cutting strains; this is not conjecture, but ascertained in actual practice. If the tool point should be overloaded, it is obviously better that the disc should slip than that it should break.

The clamping face of the holder is square with the top face of the bar, which is satisfactory for general work, cutting both right- and left-hand threads of fine or moderate pitch angle. If only right-hand threads are to be cut, there would be some advantage in sloping this face slightly to provide better clearance, but the most suitable angle cannot be predetermined unless all threads to be cut have the same pitch angle—a condition which seldom, if ever, obtains in actual practice.


**Fig. 5. Form of tool recommended for small internal screwcutting.**

In order to obtain front clearance with this form of cutter, it is necessary to set the cutting edge slightly below the centre of the securing bolt, as shown. This does not mean below lathe centre height, however, so the bolt must be a corresponding distance *above* the latter position. The size of stock, and the position of the screw, may be chosen so that it suits the particular lathe in which the tool is used, avoiding the necessity for packing or other height adjustment.

The tool point should be only slightly below the disc centre, because otherwise the angular form of the thread will be affected to a greater or less extent. In the case of the ⅜-in. dia. cutter, it was found that good results were obtained by setting the point 1/32 in. below centre. This position, it will be found, also avoids digging in, as any slip or spring of the tool point relieves the cut.

Setting of the tool, to ensure that the vee angle is square with the axis of the thread, is extremely simple and does not require the use of a gauge. It is only necessary to run the slide rest up close to either the driver plate or the chuck face, according to which is in use at the time, and set the side of the disc in contact or exactly parallel with it before clamping down.

Many turners like to follow the very sound practice of feeding the tool in at an angle corresponding to one side of the vee thread, thus taking the cut on the leading side of the tool and relieving the load on the extreme point. To set up the tool for this method of feeding, the shank should be disposed exactly parallel with the ways of the top slide before clamping in the tool post. The slide is then swivelled until the disc face is square with the lathe axis, using the method of testing above described. In this way, the necessity of using a protractor to set the angle of the top slide will be avoided—assuming, of course, that the offset face of the holder has been correctly shaped to the specified angle of 27½ deg. When cutting threads in steel by this method, the cutter should be ground with a side slope, to produce side rake on the leading edge.

**Holder for Internal Screwcutting**

Many model engineers use the popular form of boring tool which comprises a round tool or cutter-bar held in a split holder. To adapt this device for holding disc screwcutting tools it is only necessary to provide a mild steel bar of suitable diameter to fit the clamp, with the end truly faced, drilled and tapped to take the screw which secures the disc, as shown in Fig. 4. Other forms of holders which will take round-shank tools are equally adaptable; or, if desired, the disc may be attached to a solid shank formed by turning down the end of a square bar. As previously mentioned, it may be desirable to use smaller diameter discs when screwcutting small holes, but for work of this nature it will often be found best to turn the vee-pointed disc on the end of a small diameter tool steel bar, reducing the portion behind the cutting edge for a sufficient length to clear the depth of hole to be dealt with. The edge is notched as before, and the bar is held directly in the split clamp. (Fig. 5.)

The time spent in making simple tools of this nature will be amply compensated by that saved in using them, to say nothing of the improved quality of workmanship which they make possible.

# Producing a Crystallised Black Finish

CRYSTALLISED black finish can be effectively produced on model parts, optical instruments, etc., either by spraying or hand brushing. The thickness of coat applied has a considerable bearing upon the final finish obtained; thus, a thin coat will give a dull finish with a fine crystal pattern, while a fairly heavy coat will give a glossy finish with a large pattern.

To secure proper adhesion of the lacquer or enamel coating, make sure the model parts are perfectly clean and dry. After applying the enamel, place the parts in an oven or other suitable appliance and heat for one hour at a temperature ranging between 140 deg. and 170 deg. F., and in order that the enamel will crystallise.

The heating appliance should be of the foul type, that is to say, the products of combustion must be allowed to come into contact with the work, and the ventilation should be controlled to keep the products of combustion in the heating appliance at a high production. Gas heat seems to be essential to good results, the theory being that the gas flame burns out the oxygen in the appliance and leaves a neutral atmosphere.

Another good finish for model parts, etc., which has an attractive effect, is the modern cracking enamels. These materials are entirely air drying and their application needs little skill. The process is, briefly, as follows: (1) The model parts are given a coat of special primer, and sand-papered smooth. (2) A base coat of any desired colour is then applied by spray; drying time 30 to 60 minutes. (3) A full coat of cracking enamel is sprayed on; drying time 10 to 15 minutes. As this enamel dries it splits up spontaneously and shows a myriad of cracks, through which the base coat colour is revealed. The size of the cracks formed is largely governed by the coating applied, a heavy coating causing large cracks to appear, and a light coat forming only small cracks. Specimens may be obtained from the I.B.I. (Paints) Ltd., Alma Street, Smethwick, Birmingham.—A. J. T. E.

# *Small Capstan Lathe Tools

**Notes on "tooling up" for repetition work, with special application to the small capstan attachment recently described in the "M.E."**

**By "NED"**

THE methods which have been described for dealing with drilling and boring processes will cover nearly all general requirements in small capstan lathe work, as it is usual, in production practice, to design small components so that they can be machined by straightforward methods, and, if possible, at one set-up. Occasions sometimes arise, however, when special machining problems have to be tackled, and these are usually more difficult when they apply to internal work than external. Whereas, in the latter case, the tools can be applied, either alternatively or conjointly, in two directions-either endwise, from the capstan-head, or radially, from the cross slide-it is obvious that only endwise motion can be applied to the internal tools, unless some special and additional devices for feeding them are adopted.

#### Undercutting or "Chambering" Operations

An example of a special internal machining problem, which may be encountered by the small capstan lathe user, occurs when it is necessary to produce a blind hole which is "bigger on the inside than it is on the outside," like the traditional pair of ladies' shoes ! This feature is occasionally specified on small tapped components, to produce an "undercut" or clearance space beyond the end of the thread, and. is quite a sound measure from the point of view of mechanical ethics, though more often a pain in the neck to the tool setter. The process is usually termed "chambering" in machine shop vocabulary, and the problem which it presents is in inverse proportion to the size of the entering hole, and directly proportionate to the relative enlargement of the bore to be produced by the chambering tool, and the depth at which it is required to operate.

In large capstan and turret lathes, the problem may be dealt with by using an internal recessing tool mounted in a holder equipped with a short cross slide ; or, in some cases, the lathe is provided with means of cross-traversing the turret-head itself. It is thus possible to bore and "chamber" the hole at one. tool setting. But very few, if any, small capstan lathes are provided with any standard equipment for cross-traversing capstan-head tools, yet some means of effecting this end is obviously a necessity, to enable the operation in question to be carried out. The only thing possible, therefore, is to devise a special tool-holder for the purpose.

#### Expanding Boring Tools

A method which will occur to many readers is to use a form of "expanding" boring tool, the cutter of which can be retracted within a holder sufficiently small to be inserted into the initial bore, and brought forward into the cutting position by suitable mechanism when required. There have been many such tools introduced at various times, and some of them have been fairly successful in' practice. The writer had some experience with a particularly ingenious type of double-edged expanding tool, in which the cutters were normally retracted by springs, but were brought into action by a collar, adjustable on the outside of the bar, which abutted against the end face of the work when the required depth had been reached.

#### Mechanically Complicated

The disadvantage of tools of this nature, however, is that they are mechanically complicated and must be constructed to precision limits to work effectively. The entry of a minute chip or bit of swarf into the gear is disastrous, and it is by no means easy to make it proof against such an occurrence. There is obviously a very definite limit to the smallness of diameter of the tool bar. But an even more serious objection to them is that the cutters must be so small that their regrinding is difficult and their wearing life short ; it is even necessary in many cases to make them integral with parts of the operating mechanism. For these reasons, therefore, a more robust form of tool, with the operating gear entirely outside the hole, and a simple form of cutter, will be found more generally useful and durable. A more or less normal form of internal recessing tool, mounted in a holder which is capable of cross movement, is the simplest solution ; but a small cross slide is not easy to make or incorporate in a capstan socket tool-holder, and examples of two comparatively simple alternative devices are given herewith.

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* *Continued from page 352, "M.E.," April 9,* 1942.

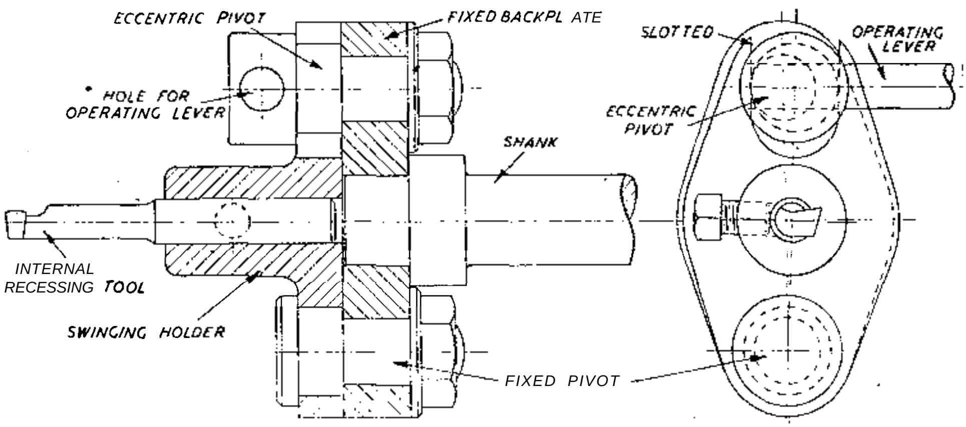


**Fig. 17. A boring tool holder with side swing movement, for internal recessing or chambering operations.**

**A Swing Tool Holder for Chambering Tools**

The device shown in Fig. 17 is an adaptation of the well-known " swing " recessing tool-holder which is very extensively used in automatic lathe practice ; the only essential difference being that it is equipped with means of hand operation. It consists mainly of two plates or flanges, one of which is rigidly attached to the shank which fits the capstan socket (or, better still, bolted against the face of the capstan-head), while the other is fitted in contact with it, on a pivot which enables it to swing in a limited arc to either side of the central position. The swinging motion may be controlled in any convenient way ; if desired, a lever may be attached to the swinging Aange for direct action, The method of operation shown, however, is by means of a lever-actuated eccentric pivot engaging a slot in the flange, and this will be found to produce a sensitive and finely-controlled feed.

As with every device of this nature, the fitting must be good and working clearances fine in order to ensure successful working. It will be seen that the pivots are of robust proportions, and they must fit very closely both sideways and endwise ; a slight " nip " to produce a certain degree of friction is all to the good. The backplate and swinging holder may be made of any convenient material, as their external shape is of no great importance, but the shape shown is selected, as it is often fairly easy to obtain cast-iron or steel pipe flanges which conform to it more or less closely.

No means of limiting the amount of swing, so as to produce a definite depth of undercut, have been provided on this tool, as it was found best to work to the full swing of the eccentric. It would, however, be a fairly simple matter to fit a limiting stop to it if desired. The lever employed for turning the eccentric was simply a 3 in, length of 1/4 in. mild-steel carefully rounded off at one end and tapered slightlv at the other, to drive into the hole in the eccentric collar. A more elaborately-shaped handle would have improved the appearance, and would undoubtedly have been justified on the grounds of good workmanship ; but the purposes of utility were quite adequately served by the simpler fitting.

**Eccentric Rotating Tool Holder**

This is a somewhat simpler form of tool holder in which the actual cutting tool is rotated eccentrically to the bore of the hole to bring it into action. In some respects, this motion is inefficient, since it involves variable rake and clearance angles on the cutting tool, but it appears to work quite effectively in practice. and it has the further advantage that the degree of eccentricity, and thus the limit of feed, is readily adjustable.

As will be seen from Fig. 18, this holder is also built up from two flanges, but in this case they are rigidly bolted together, though with some latitude of relative position. provided by elongated bolt holes in the front flange. The latter incorporates a tubular extension which forms a bearing for an internal " quill," capable of partial rotation therein. This auill constitutes a holder for the cutting tool which is held in its socket by a set-screw, and it has an enlarged collar at the rear end, which is primarily intended to prevent its endwise movement, and also to take a cross bar or lever which can be operated to provide partial rotation. A slot is provided in the flange through which the lever projects, and allows the latter to move through an arc of not less than 90 degrees.

The action of this tool holder is as follows :

Assuming that the device was adjusted so that the centre of the rotating holder was coincident with that of the work, the cutting edge of the tool would obviously have the same radial projection at any point of rotation, and no feed would be possible. But as it is mounted eccentrically to the work centre, the radial projection of the tool point will be greatest when it is in

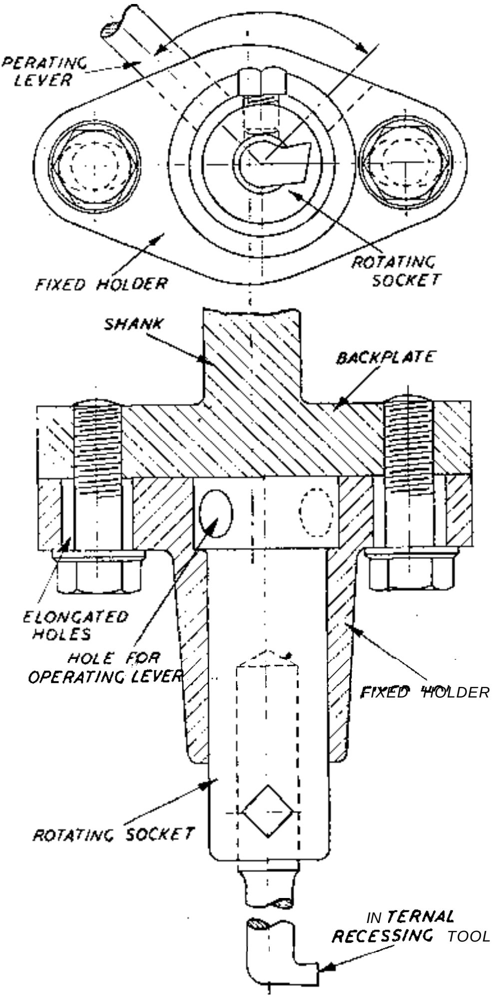


**Fig. 18. An eccentric rotating holder for chambering tools.**

line with the plane of eccentricity ; if it is turned out of line with this plane (i.e. the horizontal position) it will be retracted. In lathes rotating in the normal direction, the tool should be turned downwards to retract, so that it is brought into action *against* the cut ; if the reverse method is adopted, it is liable to snatch or dig in. The position of the cross hole in the quill, when the tool is retracted, is shown by dotted lines in the plan view. When chambering very small holes with a tool of this type, it is an advantage to bore the tool socket in the quill eccentrically, so that the shank of the tool is in line, more or less, with the centre of the hole when it enters.

**End-Traversing Chambering Tools**

In most cases, chambering tools are simply fed into the hole to a specified depth, and cross-traversed to produce an undercut to the width of the tool face. This is sufficient in most cases, where the object is to relieve the end of a thread, but it is sometimes necessary also to traverse the tool endwise by the capstan slide motion, to produce a longer undercut. As the capstan slide is only provided with end stops to limit motion in one direction, it then becomes necessary to provide some form of additional stop to work in the other direction, but capable of being put out of action to allow of the withdrawal of the tool from the hole. The exact design of such a stop must necessarily depend upon the type of capstan slide fitted, but in most cases the simplest and handiest device consists of a piece of rectangular bar, cut to the appropriate length or fitted with a jack-screw in the end, which can be introduced in the slide-ways between fixed and moving elements. In the case of THE MODEL ENGINEER capstan attachment, the stop bar can be inserted between the back of the slide and the rear frame cross bar.

Internal forming is in some cases carried out by means of a chambering tool with mechanically interconnected cross and end feed gear, but such work is hardly likely to come within the province of readers of these articles, and further description is therefore not warranted.

**An Adjustable Boring-Head**

Messrs. B. Elliott & Co. Ltd., Victoria Works, Victoria Road, Willesden, London, N.W.10, have furnished particulars of the " Crown " adjustable boring-heads, in which radial feed is provided for by means of a totally enclosed cross slide with micrometer screw adjustment. These tools are by no means specifically or exclusively intended for use on capstan and turret lathes, though their usefulness in this field is beyond question ; they are, however, equally adaptable to boring operations in vertical and horizontal milling machines, jig borers, and many other machine tools.

The boring-head comprises a mounting shank to which is attached the fixed element of the cross slide, and the traversing

(Continued on page 415)

Even with quite fair wear and tear, milling cutters inevitably need re-sharpening in course of time, and very few amateurs have proper facilities for carrying out this work. It is quite hopeless to attempt to regrind a cutter unless a form of grinder is available which is equipped with means of indexing the teeth of the cutter and grinding them all to exactly the same angle and radius. The single-point cutter, on the other hand, can be reground just as easily as an ordinary lathe tool, and in as little time. It is quite practicable, and indeed often advisable, to slip the cutter out and hone or grind it to a keen edge for the final cut, on work which requires to be accurate and well finished. Some idea of the finish possible may perhaps be gathered from the photograph, which shows a face milling operation in progress. The reflections on the surface indicate the degree of finish attained, which, it is ventured to suggest, is better than that usually produced by a conventional milling cutter used under the same conditions.

The ability to set the cutter out from the holder to any radius within its range is also a great practical advantage. Not only does it enable various face widths to be dealt with at maximum efficiency, but in many cases it avoids the necessity for precise accuracy in packing up the work to the required height, For instance, in the case of a face having a projecting rim either above or below it, the radius of the cutter can be set to clear the rim, or to take a side cut along its edge. It is quite possible to carry out slot milling operations with a cutter of this type if the holder is made small enough to pass into the slot without fouling the sides.

One of the great virtues of the less expensive types of model engineers' lathes is the facility with which the cross slide can be " cleared for action " and work bolted down to it for face milling. Assuming that the top of this slide is reasonably parallel with the lathe axis-and if errors in this respect should be found to exist, they are by no means impossible to rectify-any work bolted down and milled on the vertical face is bound to come out at a right-angle.

If a vertical slide is available the scope of the face milling cutter is still further extended ; but even without the aid of this useful device its applications are innumerable. The writer has used it consistently for such purposes as surfacing slide-valve faces on steam engine cylinders, and the slide-valves themselves ; the feet and slide bars of engine columns ; crankcase flanges and bearers, edges of cylinder base flanges, and port faces, on model petrol engines ; and operations too numerous to mention on accurate jigs and fixtures for use in engineering production.

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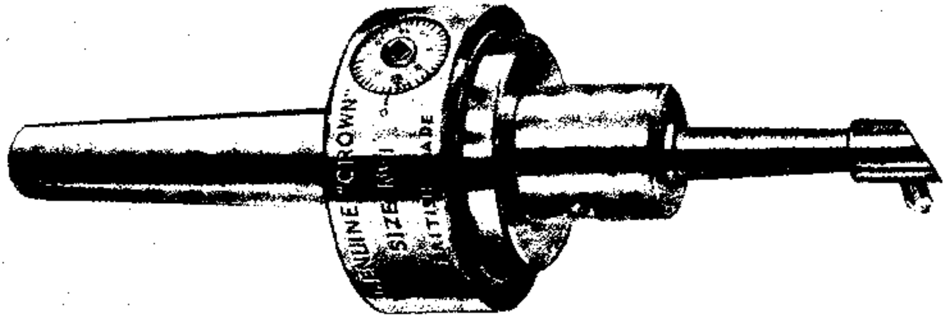
## Small Capstan Lathe Tools

(Continued from page 412)

element is equipped with a socket to which the cutter bar is demountably fitted. It is possible to set the cutter bar dead concentric with the shank, or at any degree of eccentricity within the range of the tool, by means of a socket-head screw equipped with a micrometer index giving readings in 1/1,000 in. of radial motion. The slide can be locked when it has been set to the required eccentricity, but this is only needed when very heavy cuts have to be taken, as the head is fitted to close limits and has high inherent rigidity.

Two sizes of heads are available, one of which bores to a maximum diameter of 2 1/4 in., and the other 3 in. On the larger tool, it is possible to mount a special tool attachment for dealing with larger holes up to 10 in. diameter.

*(To be continued)*




**The " Crown " adjustable eccentric boring-head.**

# "Small Capstan Lathe Tools

**Notes on "tooling up" for repetition work, with special application to the small capstan attachment recently described in the " M.E."**

By " NED "

IN cases where holes have to be finish-bored to a very precise limit of dimensional and parallel accuracy, there are certain advantages in holding the reamer or sizing cutter in such a way that it is free to find its own alignment with the centre of the hole. This can be done in either of two ways : one, by using a more or less standard form of machine reamer the shank of which is held in a " floating " holder instead of being rigidly fixed in the capstan- head , and the other, by using a holder with its shank mounted in the usual way, but having a " floating " cutter or cutter-head. For obvious reasons, the first is best suited for dealing with small holes, and the second for larger holes.

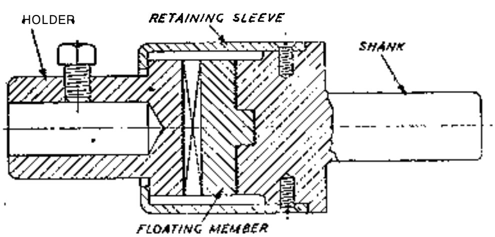



**Fig. 19. Floating holder for reamers and sizing cutters, to compensate for errors in axial alignment of mandrel and capstan head.**

One form of floating reamer holder is shown in Fig. 19. It embodies a well-known mechanical device known popularly as an "Oldham's coupling," which enables it to accommodate a fairly considerable amount of axial (not angular) misalignment. Note that the more common form of " universal joint," the object of which is to deal with angular misalignment, is not suitable in this instance unless it is used in duplicate.

The part of the holder which is attached to, or integral with, the shank, has a key groove cut across its end face, and a similar groove is cut across the, flange of the loose holder. Between these two parts is interposed a disc-shaped floating member, having tongues on each of its faces, disposed at right-angles to each other. These engage the grooves of the fixed and loose holders, and the parts are kept in their proper relative positions. by means of a retaining sleeve, which prevents end play but allows of a limited amount of eccentric motion.

In a modified form of this type of holder, the retaining sleeve is screwed on to the body, so that it can be drawn up to clamp the loose holder when once the correct location of the latter has been determined. It thus becomes a rigid tool-holder, adjustable to any degree of eccentricity within the limit of motion allowed by the annular clearance in the sleeve.

**Holder for Floating Cutters**

A simple type of floating cutter holder for large diameter holes is shown in Fig. 20. This has the holder integral with or rigidly attached to the shank, and provided with a cross slot in which the solid double-ended cutter can slide freely, but with no perceptible play, either endwise or up and down. It is advisable to make the holder as large as possible in diameter, so as to provide the maximum bearing surface for the cutter. A retaining pin through the centre of the holder, and through an elongated hole in the centre of the cutter, is a desirable provision to prevent the cutter becoming inadvertently detached and possibly mislaid.

The cutter should have parallel and carefully ground cutting edges, and its length from edge to edge must correspond exactly with the finished diameter of the hole to be bored. The corners should be eased or rounded off as shown, particularly at the leading edges. It should not be expected to take out more than a mere scrape-to be more precise, not more than two or three thousandths of an inch on diameter-and the work should run at low speed, whether the material is hard or soft. Regrinding, of course, alters the diameter which the cutter

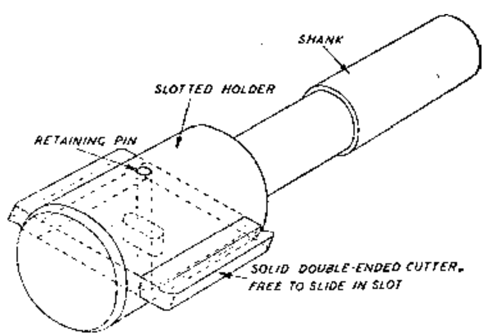



**Fig. 20. Rigid bar holder for floating flat *sizing* cutter.**

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* *Continued from page 415, " M.E.," April 30, 1942.*

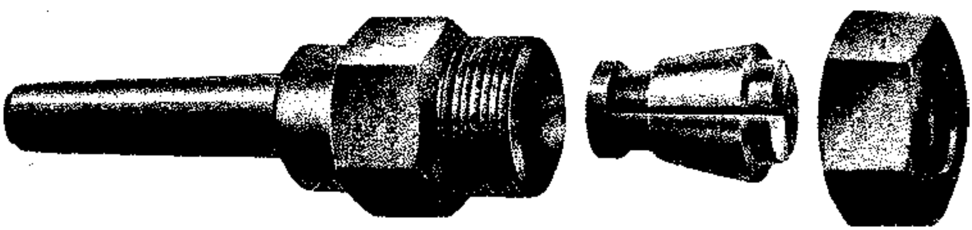
produces, but if used only for fine finishing, it will deal with a considerable number of holes before this becomes necessary. The application of a honing slip to the leading edges from time to time will help to keep it up to working efficiency without affecting accurate sizing.

It should be understood that a cutter mounted in this way is only truly self-aligning in one plane-that of the sliding motion of the cutter. If the holder should be eccentric to the work axis in the vertical plane, that is, at right-angles to the cutter, it will produce a circular error , in order to guard against this, however, it is, usually possible to find in what plane the maximum misalignment lies, and set the holder accordingly. Most capstan and turret lathes, whether initially inaccurate or having become so through wear, will be found to have the maximum error in a horizontal plane, so that the horizontal position of the cutter will usually be in order.

While the usefulness of floating and self-aligning tool-holders for certain special jobs is beyond question, they are used much less in modern practice than they were some years ago. The main reason for this undoubtedly is the improvement which has taken place in machine tool construction. Much higher standards in the accuracy of alignment of the lathe mandrel and the capstan-head are observed nowadays than they were a few years ago-indeed, they are in many cases rigidly enforced by the modern system of acceptance tests. Despite what is often said about the tender care and attention which was bestowed on the finish and adjustment of lathes in the " good old days," one is inclined to wonder how they would show up according to " Schlesinger limits." On the other hand, however, the skill and care exercised by the modern operator can hardly be said to have undergone a similar improvement, and as floating cutters nearly always call for careful handling in the initial stage of the cut, their use is not always successful in these circumstances. This objection, of course, does not apply to the one-man shop, where planning, toolmaking, setting and operating are all carried out by one pair of hands.

But in modem practice it is almost universal to arrange the system of production so that all work allotted to capstan lathes is capable of being produced with normal tools and methods. Anv work which requires specially accurate boring, assuming that it is in other respects suitable for capstan lathe production, is usually dealt with most efficiently by a second operation in a precision boring, internal grinding, or honing machine. It is safe to say that there are many tool setters at the present day who have never seen a floating reamer or boring tool in the course of several years' experience.

Readers of these notes who encounter the need for a more precise finish in bored work than can be obtained with normal fixed-axis tools may find that the simplest solution lies in hand-reamering or infernal lapping. A suitable and not excessive allowance should be left in the hole for the particular operation adopted, and the work accurately re-chucked in any simple lathe or polishing headstock, taking precautions to avoid any possible distortion by the pressure of the chuck jaws.



**The components of the " Crown " collet chuck.**

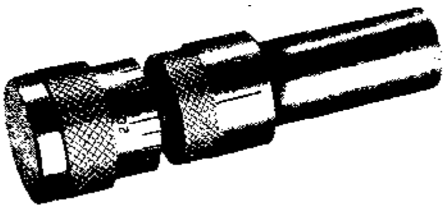
Incidentally, it may be noted that rigidly mounted reamers, flat drills and D-bits have been proved capable of boring holes to within a limit of accuracy of 0.0005 in. on a light model engineers' lathe equipped with a properly made capstan attachment of the type which has been described in these pages. There is, in the circumstances, some justification for the view that special floating tools are hardly necessary in general work , but should further information on their design or construction be considered of general interest, it will be forthcoming.

**Collet Chucks for Drills and Reamers**

Since the subject of capstan-head chucks was dealt with, information has been received that sets of high-precision collet chucks are available for this purpose, and Messrs., B. Elliott & Co. Ltd. have furnished particulars of the " Crown " collet chucks, an entirely British product bearing a name with which most readers are familiar in connection with the more orthodox self-centring and independent-jaw lathe chucks.

Collet chucks have many practical advantages, as they enable an extremely tight and rigid grip to be obtained without marking or distortion of the bar or tool shank held in them, and maintain their accuracy under the most arduous conditions of service. They also take up less room, both in diameter and length, than most other types of chucks having a similar capacity.

The " Crown " collet chucks are made in sets covering a range of drill sizes from 5/32 in. to 5/8 in. diameter. Various shank sizes are available, including Morse and Brown and Sharpe tapers, and the ends of



**The " Euco " micrometric work stop.**

the shanks can be supplied internally tapped for draw bolts. It will be noted that both the bodies and the caps of these chucks are hexagonal, so that they can be operated with ordinary spanners. The loose collets are tempered steel, precision ground, and are split six ways, so that they are sufficiently flexible to accommodate slight variations of diameter.

Besides being readily adaptable for use in a small capstan-head, these chucks are also suitable for use in milling and drilling machines. It would also be possible, by modifvina the design of the bodv. to screw it directly on the mandrel nose of a small lathe, this enabling lengths of small diameter bar to be chucked firmly and accurately.

### Other Capstan Lathe Specialities

Messrs. Engineering Utilities, Rosedale Works, Rosedale Road, Richmond, Surrey, have furnished particulars of a number of useful tools designed specially for use on small capstan lathes. The first of these is the " Euco " Micrometric Rotating stop, the principal application of which is as a capstan-head work stop to limit the projection of work from the lathe chuck to the correct length required for the finished piece.

The special features of this device are : first, the rotating face, which is mounted on a ball-race so that it rotates with the work as soon as contact is made, thus preventing any scoring of finished surfaces, such as may occur when a fixed stop is used. Should the work not be fed properly up to the stop, or if it is drawn back slightly by the action of the collet chuck, this is immediately apparent by the fact that the face of the stop ceases to rotate. Secondly, the initial adjustment of the stop is facilitated by the provision of a graduated micrometer screw. The standard shank diameter is 3/4 in. dia., and that of the rotating face 1 in. dia.

### The " Euco " Knee Tool

This development of the simple knee tool for running down parallel work (an example of which was fully described in the issue of the " M.E." dated November 6th, 1941) is of interest mainly by reason of the simple but effective means of providing fine adjustment of the cutter. As seen in the illustration, this consists of a micrometer screw with a large diameter graduated head, the flat underside of which bears directly on the end of the cutter itself. The screw has 40 threads per inch, so that one complete turn represents a radial adjustment of 0.025 in., or 0.050 in. on work diameter. It is divided in 25 parts, each of which represents 0.002 in. on work diameter. The cutter is of 1/2-in. by 1/8-in. tool steel, held in an open-fronted slot in the knee bracket by two set-screws, which must, of course, be slackened off to adjust the setting by the micrometer screw.

**The " Euco" knee tool with micrometer sizing adjustment.**

This tool is made at present in one sizeonly, having a 3/4-in. dia. shank bored with a 3/8-in. hole, to enable the turned down end of work, up to this diameter, to be accommodated for a much greater length than would otherwise be possible. The maximum diameter which can be turned, in front of the shank, is 1 in.

It is quite obvious that the facility of setting the cutter to fine limits by the micrometer screw is a great advantage over the common method of tapping it through the holder especially when work of the utmost accuracy is required and it is bound to save considerable time in tool setting.

(To be *continued)*

# *Small Capstan Lathe Tools

## Notes on "tooling up" for repetition work, with special application to the small capstan attachment recently described in the "M.E."

By "NED"

THE majority of the components produced on small capstan lathes call for either internal or external screwcutting operations, which have to be carried out with a speed and efficiency comparable with those of the normal cutting operations in order to avoid undue delay and slowing-up of output. The methods of producing screws employed in normal practice include the use of more or less normal types of taps and dies, special " releasing - tap and die-heads, and generating methods, in which either single-point screwcutting tools or chasers are positively fed by means of an ordinary lead screw, or a hob attached to the tail end of the lathe mandrel. Occasionally some form of thread milling device is used for heavy or coarse-pitch screwing on a large capstan lathe, and there are also instances where thread rolling processes have been employed ; but these.are few and far between, and it is extremely unlikely that such methods will come within the scope of readers for whom these articles are intended.

Most small capstan lathes employ nothing more elaborate than solid taps and dies for all screwing operations ; not necessarily from choice so much as necessity or economic expediency. Expanding tap and die-heads are wonderfully efficient tools, but quite apart from their high cost, which in many cases would render their use unprofitable for short runs of varied work, it is almost impossible to obtain them at present except for work of extreme urgency. In any case, internal screwing of small work cannot be carried out in this way, as the smallest " collapsing " tap will only deal with holes down to about I-in. diameter. Furthermore, the room taken up by expanding die-heads is considerable, and even on certain types of regular production lathes-not the smallest of them, by any means-special devices have to be adopted to raise the die-head to clear the capstan slide as it swings round.

In these circumstances, it is not considered worth while to devote space to describing these devices in detail ; if further information about them is desired, it may be found in THE MODEL ENGINEER handbook, " Capstan and Turret Lathes," which also includes some details of chasing and other generating methods of screwcutting.

### Tap and Die Holders

The common types of holders for taps and circular dies, as applied from the tail-stock in centre-lathes, can be adapted for capstan lathes simply by making the shank of the holder to fit the capstan head socket. It is, however, very desirable, if not absolutely necessary, to arrange the holder so that it may be disengaged, to allow the free rotation of the tap or die, when the required length or depth of thread has been reached. This applies particularly when the thread is required to approach closely up to a head or shoulder on the work, or to the full depth of a blind hole, as the inertia of the running parts of the lathe makes it impossible to ensure that it will stop at exactly the right place, even under the most skilful control ; and an overrun is more than likely to result in breakage of the tool, or even more serious damage to the lathe itself.

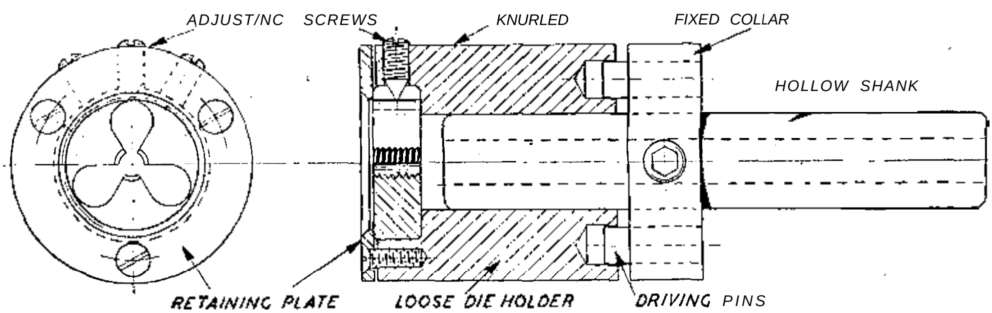



**Fig. 21. Simple form of " slip " holder for small circular dies.**

* *Continued from page 477,* " M.E.," *May* 14, 1942.

The simplest method of disengaging the screwing tool is bv means of a two-part holder incorporating some form of positive engagement clutch, which can be uncoupled simply by the drawing apart of the two elements ; in short, any one of ‘the various forms of jaw or “ dog ” clutches. If the travel of the main part of the holder is limited, by appropriate setting of the capstan slide end-stop, or any other means, the loose die or tap holder will move forward on the thread when this point is reached, and eventually disengage the clutch. The tap or die will then rotate with the work until the lathe is stopped to enable it to be unscrewed by hand, or reversed so that it can be re-engaged and run back under power.

With this simple device, the length of thread cut depends on the position at which the endwise feed of the holder is stopped, plus the distance which the tap or die must move to disengage the clutch-in other words, the depth of the clutch jaws or pins. The general form of the holder is the same for either taps or dies, except for the provision necessary for the accommodation of these respective tools.

## A Simple “ Slip ” Die Holder

In Fig. 21 is shown a form of holder adaptable to ordinary circular or “ button ” dies, which is very,, simple to make and entirely satisfactory in use. The shank of the holder is simply a length of round mild steel stock drilled through the centre to allow the passage of small screwed work, on which is pressed a collar, from the outer face of which projects two or more equally-spaced tool-steel pins. These engage in holes or notches in the back of the cylindrical die-holder, which is a free-running fit on the projecting end of the shank. The pins must be faced off dead square at the ends, and to exactly the same length, so that they disengage simultaneously as the die slides forward on the shank.

In some holders working on this principle, the die-holder, instead of being driven by pins or dogs, has an internal keyway which engages with a feather key fitted to the shank. This form is more compact, and may be fairly satisfactory in practice, but is less durable than that shown, as the key, being nearer the centre, takes a higher torque leverage than the pins employed in the other type, and it is not uncommon for the end of the key or keyway to get burred up or damaged as the drive is disengaged. Much the same applies to holders in which the driving element consists of a round cross pin driven through the shank, engaging a cross slot in the back face of the die-holder. There is a further objection to the use of a round cross pin, as it is liable to cause a sudden jerk forward of the die at the moment of disengagement, due to the wedging action of the rounded driving face of the pin ; and this may cause damage to very delicate screwed work. The effect can, of course, be remedied by filing the pin D-shaped at its projecting ends, so that the front face is square and disengages cleanly and completely. These are small details, but experience in the setting of machines for all sorts of industrial production has proved that anything which cuts out potential causes of trouble, even in very minor points, or saves split seconds in setting or operating, is worth considering. For this reason, the form of holder shown, with the driving pins set in the collar, is strongly recommended. The pins may be very simply and quickly renewed if and when necessary. and their number may be increased, if desired, to deal with extra heavy stresses. It is not necessary to harden them, as a general rule, providing that thev are made of good material, neither is it necessary to harden the engaging notches in the die-holder, though these measures may be adopted. to improve the general quality and durability of the tool if desired.

A further point about this type of holder is that, as the die-holder is bound to be butted firmly back against the face of the collar when the thread is started, it is always held quite truly, even when the working clearance on’the shank has become abnormal as a result of wear and tear.

## Die Holder Design

The die holder is provided with a recess at the front to take standard circular dies, and equipped with the usual screws for adjusting them. Most of the work on small capstan lathes can be carried out with the popular 13-16-in. dia. ranee of dies. but it is. of course, practicable to bore ‘the holder to take any other size that may be available. In some cases, provision is made for fitting more than one size of die in a holder, by the use of adaptors, but in view of the difficulty of holding these reallv securely and trulv. it would be better, and entail little more work, to make separate holder elements, interchangeable to fit the same shank.

It is by no means easy to hold a circular die so that it is always presented quite truly with the axis of the work. Concentric truth might be assured if it were possible to make the diameter of the holder recess to fit the die closely ; but this is not practicable with the simple form of dies, as they have to be capable- of being expanded or contracted within certain limits bv the adjustment screws. In many cases the die is forced out of truth by the screws, and there does not appear to be any simple way of providing a remedy for this. A slight degree of eccentricity, however, is of much less practical importance than tilting of the die in the holder so that its axis is out of angular alignment with the work. The usual result of this fault, even when the main part of the die holder is accurately set and guided to travel truly axially, is to produce a " drunken " thread, or else one in which the flanks of the thread are unduly cut away and weakened.

To ensure that dies are held truly in the axial plane, some means of drawing them back so as to bed firmly into the bottom of the recess is clearly called for ; but any device used for this purpose inevitably restricts the ability of the die to approach closely up to a shoulder, and for this reason is often found undesirable by tool setters. In a general way, however, some means of keeping the die true is a great asset to accuracy, and providing that it is capable of being detached when its use restricts the scope of operation, it is always well worth while.

In Fig. 20, it will be seen that the front of the holder is fitted with a thin flat washer, pulled up against the die by three screws. This method is as satisfactory as any other ; but there is unfortunately one eventuality with which it is almost impossible to cope, namely, the case of the die which is initially inaccurate in respect of the squareness of the face with the thread. Such dies are all too commonly encountered ; mainly due to the fact that, in the cheaper classes of such tools, it is common to finish the faces bright after hardening, on a linisher or similar rough surface grinder, in which there is no check on the production of errors of this nature. Assuming that the only dies available are found to be out of truth on the face, and that the work to be produced is exacting, they can be corrected by screwing them on to a true-running screwed spigot and trueing the faces in turn with a tool-post grinder.

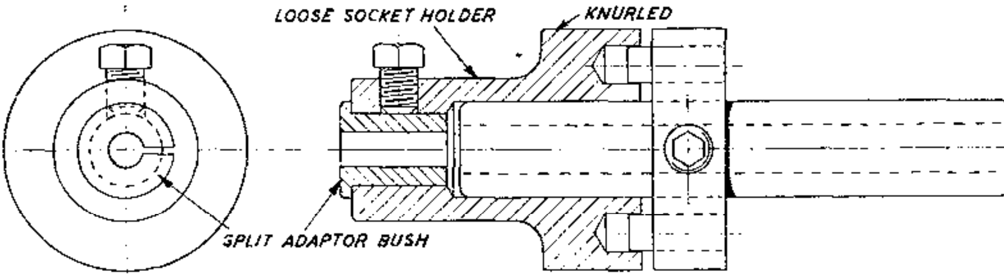
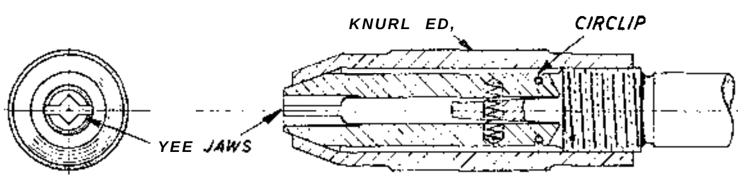



**Fig. 22. Slip tap holder, with socket for split adaptors, to fit same type of capstan-head holder as Fig. 23.**

**Tap Holders**

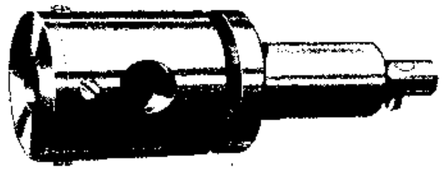
Any means whereby the various sizes of taps may be held truly and securely will be suitable for this purpose, if applied to a similar form of " slip" clutch holder as used for dies. The most common device in industrial use is a plain socket holder with a set screw, either made up as required to suit the size of tap in use, or fitted with adaptor bushes or split collets, which grip the tap by the pressure of the pinching screw (Fig. 22). It should be noted that most " machine " taps differ from those generally made for hand use in not having squared ends ; sometimes they have plain round shanks, but more often are equipped with a single flat, or a " tang " like that of a Morse taper drill, to fit a special form of socket. If hand taps are used, as will usually be the case in the home workshop, the most satisfactory form of tap holder is one which *will* not only grip the round part of the shank to provide true axial guidance, but also provides positive engagement with the square to resist torque.

**Fig. 23. Type of two -jaw chuck suitable for holding taps with squared shanks.**




The more common forms of cheap drill chucks are almost useless to hold taps, as they do not provide a sufficiently firm grip to prevent rotation, even when screwed up almost to bursting point. A much more suitable form of chuck is the type which is employed in Tee-handled adjustable tap wrenches ; it is similar in design to the chuck of a carpenter's brace, having two vee-grooved jaws hinged at the inner end

(Fig. 23). This type of chuck will hold a wide range of taps quite positively, but often leaves much to be desired in keeping them axially true. It is not certain whether chucks of this type are commercially available at present, but if not, they are not really difficult to construct.



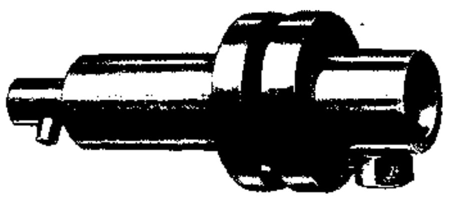
**The "Euco" reversing clutch holder for circular dies.**

**"Euco" Tap and Die Holders**

Messrs. Engineering Utilities, whose products have been referred to in a previous issue, also supply tap and die holders which conform to the principles referred to above, and are intended particularly for use on capstan lathes equipped with reversing gear to the mandrel.- In these appliances, the part of the holder which is attached directlv to the capstan head consists of a hollow shank with a broad flange, which in this case is termed the housing. A single clutch pin is fitted to the face of the flange, and engages with a hole in the back of the body, which incorporates the actual tap or die holder. This element has a central shaft which passes right through the tubular housing and has a cross pin through the end.

In this appliance, not only is provision made for driving the holder positivelv and disengaging it when necessary, but also for picking up the drive on the reversal of the lathe spindle, and backing it out under power as the capstan slide is withdrawn. This is effected by the engagement of the cross pin in the centre shaft with a notch in the rear end of the hollow shank.

The die holder is equipped with the usual three adjustment screws, and also a retaining plate to ensure that the die is held truly on the face. Holes are provided in the sides of the body for swarf clearance. The tap holder is of the plain socket type to take a range of adaptors. These tools are made with shanks of 3/4 in. and 1-1/4 in. dia., to take dies up to 1 in. and 1-1/2 in. maximum outer dia., and taps up to 1/2in. and **1** in. maximum dia., respectively.



**The "Euco" reversiiig clutch socket type tap holder.**

*(To be continued)*

# Preventing Explosions when Repairing Petrol Tanks

A GREAT many model engineers possess their own motor cars or motor cycles, and may have been troubled with a leaky petrol tank. Unfortunately, many accidents have occurred through mechanics and inexperienced motor owners endeavouring to solder leaky petrol tanks which contain small quantities of spirit or petrol vapour and employing such unneccessary heating appliances as paraffin or petrol blowlamps.

Before attempting to repair a petrol tank it is essential to steam it out thoroughly (or even to submerge it in water kept at boiling point for some time), the air inside the tank should then be scavenged out until the vapour is entirely removed. All traces of petrol vapour can be removed by utilising air from a compressor, or if this is not available, the foot pump or hand appliance used for inflating motor-car tyres may be employed.

It is not generally realised by many engineers that when petrol or other inflammable liquid has been completely poured from a tank, sufficient vapour is left inside to form an explosive mixlure with the air which has entered the tank. In addition to scavenging the air from petrol tanks after the steaming process, safety-first methods suggest squirting fire-extinguishing fluid or pouring a small quantity, of carbon tetrachloride into the tanks and allowing it to vaporise. These chemicals should be washed out after welding or soldering repair operations with petrol.

Not infrequently, petrol tanks get punctured and badly indented, especially after collisions. If the tank is holed, get a piece of thin sheet metal and place it in position over the hole. The piece of sheet metal should be carefully soldered around the edges and the superfluous solder filed smooth. The patch and the soldered joint, after repainting, should be practically indiscernible.
A. J. T. E

# *Small Capstan Lathe Tools

## Notes on " tooling up " for repetition work, with special application to the small capstan attachment recently described in the " M.E."

By "NED"

THE cutting efficiency of taps and dies is a vital factor in rapid production, and it is more than likely that the reader whose screwing equipment is not of the highest quality may encounter difficulties in this respect. It is highly desirable, if not absolutely essential, that all threads should be completed in one cut ; while it may be permissible to take more than one cut in certain circumstances (by using separate pre-adjusted dies, or by the use of taper, second and plug taps, all of which are fitted to their own holders, so that they can be slipped on the shank in turn as required), this method is bound to absorb more time than is desirable, and is likely to slow up output considerably in a long run. Sometimes, the best and quickest way, when two cuts are found necessary for clean and accurate screwing, is to make the finishing cut an entirely separate operation, re-chucking the parts after all other operations are completed, and holding the tap or die in a hand holder or die-stock, so that it can " float," in case the work does not run quite truly. But this is not always practicable, as the nature of the work may make re-chucking difficult.

One thing which definitely cannot be tolerated in capstan lathe practice is the " cut-and-try " method, in which the adjusting screws of the die have to be manipulated for each individual cut. Apart from the time factor, it would be extremely difficult to ensure uniformity of size in this way.

### Correcting Faults in Taps and Dies

Suppose that the only taps and dies available for the screwing operations in hand are of the " cheap and nasty " class, and will not cut a thread at one go without serious risk of jamming or stripping-what can be done about it ? First of all, it is necessary to examine them minutely to ascertain the cause or causes of inefficiency. The main characteristics of ordinary taps and dies are illustrated in Figs. 24 and 25. If the thread faces, under inspection with a fairly high-power lens (such as a watchmaker's ocular) appear rough or ill-formed, or the points of the threads are worn away, there is little that can be done to remedy matters, and it is best to scrap the tap or die ruthlessly. An exception to this rule may be made in the case of a tool which is known to be of good quality originally, but has become blunted by continuous use, or by an attempt to use it on excessively hard material ; it may be possible to re-condition this so that it is quite useful and efficient for a roughing process, though the incorrect thread profile may render it useless for finishing. There is, as a matter of fact, some advantage in roughing out threads to a shallow profile, and correcting the shape in a subsequent finishing process.

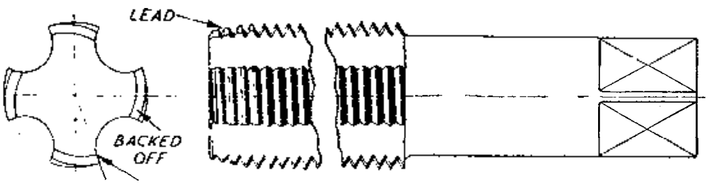



**Fig. 24. Enlarged view of small second tap, illustrating general characteristics. (Backing - off (exaggerated.)**

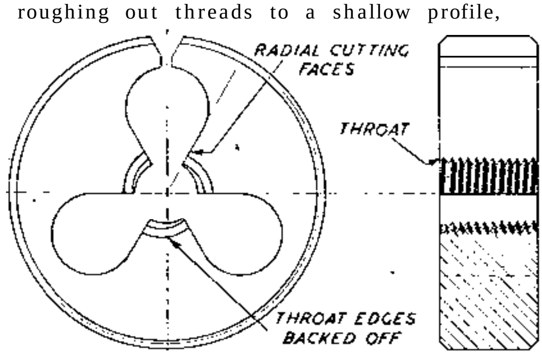



**Fig. 25. Enlarged drawing of small circular screwing die, illustrating general characteristics. (Backing-off exaggerated.)**

### Regrinding.

Taps or dies which tend to jam are usually blunt on the cutting faces (the leading edges of the flutes), or the latter may

** Continued from page 526, " M.E.", May 28, 1942.*

he incorrectly shaped, so that they cut inefficiently and do not clear the swarf properly. This will also have the effect of -interfering with the thread already cut, and possibly cause stripping. Regrinding the cutting faces is the remedy in this case. It is not a difficult matter to grind the flutes of a tap, unless it is a very small one, but it requires the use of a grinding wheel of the correct shape, and preferably some form of iie or holder to ensure that the flutes are ground uniformly and to the correct angle. The ideal method, of course, is to employ a fully-equipped cutter grinder, but presumably few readers will have one.

Reerinding the die is a more difficult matter, as This can onlv be done by the insertion of a tiny wheel in the holes around the threaded bore. (See Fig. 26.1 Suitable wheels are, however, available, usually mounted on arbors for use in small electric motor tools, or flexible shaft tools of the " dental drill " type ; they must be run at extremely high r.p.m. to be effective, but this should not 'present an insuperable difficultv. even to those who do not possess the special equipment for which they are primarily intended.

It should be remembered that taps and dies, like all other cutting tools, work most efficiently when proper rake and clearance angles are observed ; but in small dies, and most small taps, it is impracticable to back off the thread faces to produce proper clearance, and wear of the cutting face not only blunts the cutting edges, but also produces, in effect " negative " clearance. The rake angles of these tools, or at any rate the cheaper types, are often very inefficient. and this is where a great improvement can be made by regrinding.

If the cutting faces are exactly radial in either taps or dies, the effect is similar to that obtained bv grinding a lathe tool dead flat on the top-face--in"other words, zero top rake. The cutting edge thus produced is durable, and will deal fairly effectively with materials which produce short chips ; it is thus satisfactory for general purposes, where the rate of cutting is not excessive, and the chips can be broken bv " backing out " from time to time. But if it is necessary to take a continuous cut, especially in tough material, this form of cutting edge is inefficient, and it is an advantage to grind the face so as to produce " top rake." The shape of the flute or slot should also be arranged so as to curl the swarf into tight coils, and thus facilitate its clearance from the work and the tool, instead of jamming it up. (See Fig. 26.)

## " Throat " and " Lead."

Circular dies usually have the first two or three threads at the entering end bevelled awav slightlv to facilitate starting the die on a blank piece of work, and also to distribute the cutting load over several threads. This is usually known as the " throat " of the die, and is equivalent in its effect to the " lead " or taper of a tap. The longer the throat, the more gradual is the cutting action, and not only the wear on the die, bu; also the load imposed in the cutting operation, may be reduced by careful shaping at this point. If, however, the thread has to be cut close up to a shoulder, a long throat is not permissible, and in many cases it is necessary to use a die with hardly any throat at all. Sometimes this eventuality is met by reversing the die back to front, but it should be noted that a die which is ground to cut with maximum efficiency will not cut at all when reversed.

Similarly, a tap with a long lead or taper will cut verv freelv. as the cutting load is shared equally by a' large number of teeth, but it is frequently necessary to use a (' plug " tap, with practically no lead, in order to get right down to the end of a blind hole.

A slight backing-off of the throat or lead is beneficial to cutting efficiency, but should on no account be overdone, as it tends to make the die or tap cut too fiercely at the start, and thus produce a rough, eccentric or drunken thread.

## Prevention of Stripping

The measures above specified will assist very largely to prevent- the stripping of threads, but sometimes a die or tap which cuts efficiently in all other respects may still be an incurable " stripper." This is usuallv caused by seizure of ihe thread faces, or of minute particles of metal adhering to them and causing excessive friction on the finished work. The underlying cause is invariably roughness of the thread faces, which may be so slight as to be hardly perceptible on the closest inspection. Sometimes- it may be cured by shortening the thread faces (i.e., widening the slots or flutes) but this also weakens the threads and thus may not always be desirable. Easing or rounding off the points of the threads at the trailing edges as shown in Fig. 26, nearly always helps, but it is a rather delicate operation, as it is so easy to run into the leading edges of the threads while carrying it out.

Very slight roughness of threads may be corrected by lapping, using a piece of soft metal such as copper or aluminium for a lap, and cutting a thread in or on it with the tap or die requiring treatment. The lapping should be carried out before grinding the cutting faces.

**Honing Taps and Dies**

It is possible to restore lost cutting edges on taps and dies by means of a honing slip of suitable shape and size. Fine grade Carborundum or India oil-stone is suitable for this purpose, the latter being the more durable, but also slower in action. This process is applicable mainly to the " maintenance " re-sharpening of such tools ; it is scarcely efficient enough for correcting cutting angles, or other drastic alterations, to put right errors as described above.

**Re-Tempering**

Sometimes taps or dies are found to be too soft or too hard to cut efficiently, and it is practicable to re-harden and temper them, so long as the steel they are made of is known, and due care is taken in the operation. If it is not certain whether they are of carbon or high-speed steel, the simplest way to find out is to use the " spark test," with the aid of a grinding wheel applied to some

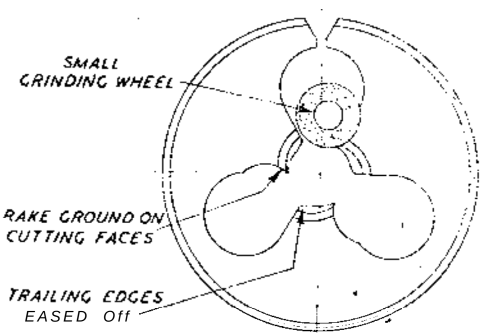



**Fig. 26. Showing how cutting faces of die may be ground to produce " top rake " by means of a tiny rotary grinding wheel. (Rake exaggerated.)**

part of the tool. As most readers are aware, carbon steel, when ground on a high-speed wheel, produces brilliant " rocket " sparks, while those emitted by high-speed steel are less profuse and spectacular, and dull red in colour. High-speed steel requires to be heated to a much higher temperature than carbon steel for hardening, and is generally most satisfactorily cooled off in an air blast. Carbon steel taps may be tempered in the same way as drills, end-mills and similar cutters ; the shanks should always be " let down " beyond the blue, or in other words, dead soft. Dies of the same material, if made uniform in hardness all over, are liable to be brittle in the parts which are required to be flexible for adjustment ; it is thus advisable first to harden them by quenching in thin oil, then polish the faces, insert a piece of screwed stock in the threaded part of the die, and lower it into a heated piece of tube to let down the temper. When the edges of the threads reach a light straw colour, quench out in water.

Even in normal times, when taps and dies of fairly satisfactory quality are obtainable very cheaply, it sometimes pays to spend some time in ensuring that they are in a condition to cut with maximum efficiency ; and this care may save many times the cost of the tools in its ultimate effect on rapidity and quality of output. The elaborate directions given above for correcting the deficiencies of poor quality screwing tools will not therefore, it is hoped, be regarded as superfluous.

In cases where commercial taps and dies are not available at all, it is by no means out of the question to make them. Instructions for doing so have appeared in THE MODEL ENGINEER at various times, and it is known that some of these home-made dies have been quite equal in every respect to the average commercial product. There has long been a tendency in some engineering circles to rely on being able to obtain everv tool and piece of equipment required through commercial supply channels, and while this is all right as long as it works, the policy tends to make one rather helpless when an emergency arises, and it is not possible to " reach everything down off the shelf."! Model engineers have always been noted for resourcefulness and self-reliance, and these qualities are more than ever in demand under the present circumstances ; never let it be said that they should fail to rise to the occasion.

*(To be continued)*

## " DOLLY"

(Continued from page 560)

inconvenience. In the drawings, the wiring diagram and the water line have been omitted for clarity.

My idea in building this little craft was not with any purpose-of racing or breaking speed records. but simply to have a boat realistic in appearance and performance, and I think I can claim to have obtained both such requisites.

This hydroplane can be confidently set to any desired circular course and will steer steadily without being tethered, and with no fear of a sudden change of her course planing at a speed of a good 20 m.p.h., and has given outstanding performance with very strong wind or current. I have launched her at full speed in the wake of a passing motor boat, and it was a great thrill to see her jump clean out of the water over the waves and still keep her deck dry maintain her course.

# *Small- Capstan Lathe Tools

## Notes on " tooling up " for repetition work, with special application to the " M.E." small capstan attachment

By " NED "

IN order to use taps and dies efficiently, the mandrel must be run at a very much lower speed than that used for normal cutting operations ; and in this respect, the user of a small " converted " lathe is at a great disadvantage, as the latter is not usually equipped with any quick or facile means of changing speed. Nearly all modern production lathes either have all-geared headstocks, or are otherwise equipped in such a way that a shift of a lever is sufficient to change from cutting to screwing speed, or to reverse the mandrel for backing-out.

### An Easy Problem

The problem of providing a power reverse on a small lathe is not a difficult one, as it can be done by means of a reversing switch, in cases where an individual motor is' employed ; *if* the lathe is driven from a line-shaft: the use of two belt drives to the countershaft, one open and the other crossed, and each having its fast and loose pulley, will provide a rather more cumbersome but still serviceable solution. But the only means normally available for reducing speed in such cases is by shifting the belt from one step of the cone pulley to the other, or by engaging the back gear. Neither of these methods is really expeditious, especially the latter-which is nearly always the only way of getting a sufficiently slow speed for anything but the very lightest screwing. In most lathes, the engagement of the back gear involves a double operation-namely : (a) the release of a bolt, clutch, or other means of positive coupling between the cone pulley ,and the mandrel, and (b) meshing of the back gears by means of an eccentric or sliding shaft. On re-changing back to high-speed drive, these processes must, of course, be reversed. and the total time occupied thereby may be more than that taken up in the actual cutting operations. Quite clearly, some more expeditious means of speed changing may be regarded 'as almost a necessity for serious production work.

For the cutting of threads which are neither very heavy nor very long, some workers manage tolerably well by turning the lathe mandrel. by hand for the screwing operation. The usual procedure of hauling away at the belt, however, is not very satisfactory. and is liable to be rather tiring if much of it has to be done. In at least one case within the writer's experience, the use of a crank handle, so designed as to be capable of being quickly applied to the tail end of the mandrel, and as quickly unshipped, has been found quite satisfactory. In practice, quite heavy threads can be cut by this means, and incidentally, it may be mentioned that this simple lathe attachment is often found useful, apart from its application to production work, as it can be used to simplify and facilitate the generation of heavy threads, or to provide an emergency slow-speed reversible drive for other purposes.

There can be no doubt, however, that the provision of a quick-change gear would be a great boon on any small lathe intended for production. Instances have been brought to light where lathe users have contrived to make use of motor-cycle or car gearboxes, or other variable speed mechanisms, in the lathe driving gear, in the attempt to achieve this end. But in spite of the ingenuity often displayed in these schemes, their success is not what it might be for this praticular purpose, mainly because the gear-changing mechanisms in question, being designed for a very different type of duty, do not provide the most suitable gear ratios, or a sufficiently wide range of speeds.

### A Simple Slow-speed Power Drive

It is, however, possible to obtain a very satisfactory slow speed on a simple lathe by slightly modifying the arrangement of the back gear and providing a small auxiliarv motor The way in which this is done is shown in Fig. 27, and it can be applied to most back-geared lathes in which the gears are engaged either by eccentric or sliding shaft ; the modification required is only a temporary one, allowing the back gear to be refitted in its normal form in a few minutes when required. If, however, it should happen that the back gears are not individually removable, but are made integrally with the shaft or quill. it is a little more difficult to apply this' method. However, the provision-of a spare shaft or quill, equipped with the ninion and belt nullev as shown. would effectively surmount this'obstacle. Indeed, it would-be quite practicable to apply the idea to a lathe not equipped with back gear at all, by mounting a large change-wheel on the tail of the mandrel, and a sleeve carrying a small pinion and a large belt pulley, running on a pin attached to the change-wheel quadrant. For rapid operation, it

* *Continued from page* 563, " *M.E.," June* 11, -1942.

would be desirable, however, to provide an eccentric tumbler, or other means of quick engagement.

The belt pulley, which should be as large as possible within the available space limits, is used to transmit the drive from a small electric motor mounted in any convenient position in line with same. Quite a small fractional h.p. motor (say about 1/20 h.p.) will provide sufficient power, provided that it can be geared down sufficiently an ordinary " universal " motor which can be reversed by simply changing over the field or armature connections (not both) will be the simplest type to apply.

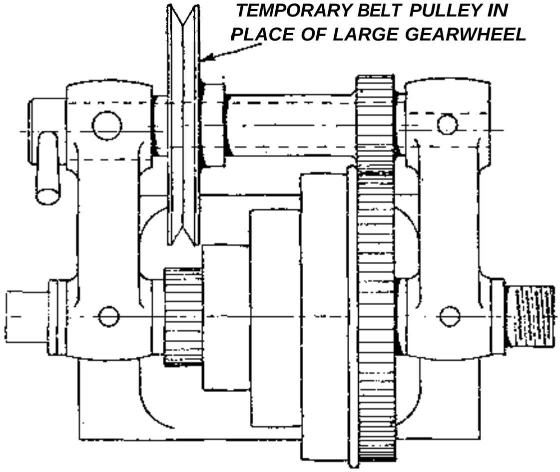



**Fig. 27. Back gear of lathe, modified to provide a quick-change slow_speed gear from an auxiliary motor or countershaft.**

In use, the procedure is as follows : The lathe is first stopped, either by switching off the main motor or by shifting the belt over to the loose pulley ; the back-gear pinion is brought into mesh, and the auxiliary motor switched on, so that it drives the back gear shaft bv means of the belt, and from thence the drive is transmitted to the mandrel through the pinion and spur gear. When the screwing operation is completed, the auxiliary motor is reversed to back out ; after that it is switched off, the gears disengaged, and the lathe driven normally until slow speed is again required.

If an extra auxiliary motor'is not available, or if its use is objected to, it is possible to obtain the same result from lineshaft drive, by fitting up a small auxiliary countershaft-quite apart from the lathe countershaft-and equipping it with two-way beIt shifting gear.

**Limitations of Small Capstan Lathes**

A question which arises frequently in connection with the use of *small* lathes for production work is that of their maximum capacity for producing screwed parts. It is, of course, readily appreciated that screwing imposes the maximum strains on both the mandrel and the capstan mechanism, and in regular production lathes it is customary for the makers to specify some definite figure for the maximum size of thread which can safely be cut in them with normal types of taps and dies. The torque load depends not only upon the toughness of the material and the efficiency of the tools, but also upon the form and pitch of the thread being cut. Obviously, a coarse pitch thread requires more power to cut than a fine one, because both the depth of cut and the rate of traverse are greater.

So far as actual experience goes, the " M.E.". capstan attachment, fitted to a 3-in. lathe of a type very common in model engineering workshops, has cut threads up to 3/8in. B.S.F. (20 t.p.i.) in free-cutting mild steel, using a cheap (but, nevertheless, fairly good quality) circular die, and lubricating with soluble oil. While this may not represent the maximum screwing capacity, it is fairly certain that higher torque loading would impose unfair strains on the capstan gear, and eventually lead to unduly rapid wear or other mechanical trouble.

To some readers, this arbitrary limit may seem a *very* low one, but if one compares it with that specified for regular capstan lathes of somewhat similar sizes, in respect of bed, slides and mandrel, it does not show up at all badly. Lathe makers are, 'quite rightly, very cautious in rating maximum capacities of their products for continuous production work, and the user' of a " converted " lathe will be wise in adopting conservative estimates as to its capabilities.

**More about Floating Tool Holders**

With reference to my notes on these appliances, in the May 14th issue, a Glasgow reader has written to tell me of his experience with them, and also to raise some practical questions in the use of both fixed and floating boring cutters. He has observed that in actual practice the behaviour of both types of cutters does *not* invariably conform to what it should be from purely theoretical considerations, and asks for an explanation of the discrepancies.

The problems which he has propounded (in order to state them concisely, his actual words have been freely paraphrased) are as follows : It is assumed that a hole has been bored out by means of a single-point boring tool to within a few thousandths of finished size, and proves to be tapered (say, small at the back end) through faulty alignment of the tool slide. The question now arises :

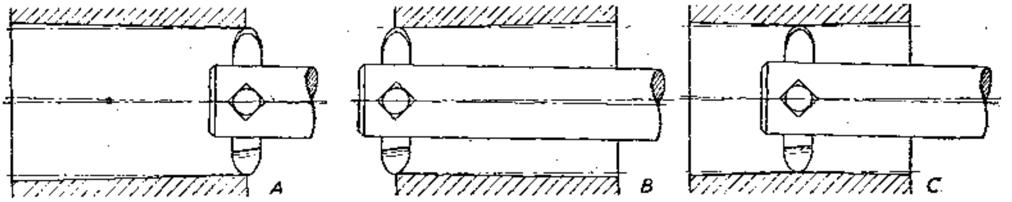



**Fig. 28. Action of fixed double-edged boring cutter, when traversed on a line not truly parallel to work axis. Cutter centred, (A) at front of hole ; (B) at rear end of hole ; *(C)* midway through hole.**

if this hole is finished (a) by a double-edged cutter, fixed rigidly in a solid tool bar, or ***(b)*** by a double-edged cutter free to float in its holder-will either or both-produce a perfectly parallel hole ?

To understand these questions properly, it must be appreciated that the terms " fixed" and " floating" can only be applied in a relative sense ; in practice, no cutter can either be fixed absolutely rigidly, or perfectly free of any constraint.

**Centring the Cutter**

But assuming, for the purposes of argument, that we have, in the first case (a) a cutter which is definitely fixed in its relation to the cutter bar, and thus in relation to the tool slide by which the bar is traversed. (Although not expressly stated, it is tacitly assumed that the bar is attached to the same slide as that used for the boring tool used in the preliminary operation, and therefore subject to the same error of alignment). ***Now,*** the first question which must inevitably arise, is with regard to the centring of the cutter. If its line of traverse is not exactly parallel with that of the mandrel, it can only. intersect it at one point of travel ; and thus, if it should be exactly centred at one end of the bore, it will be out of centre at the other, and vice versa. (See Fig. 28.)

Therefore, it follows that in the event of the cutter being set exactly central with the bore at the front end, so that both edges cut equally, it will in every case cut large at the rear end, irrespective of the direction in which ***the slide traverse is out of alignment.*** If it is set central at the rear edge of the hole, it will cut large at the front ; and if set central half-way through 'the bore, it will cut a double taper, large at each end, and small at the middle. (By the way, it may be mentioned that this principle has been used deliberately for producing a double Yaper by the straight traverse of a single tool, in automatic lathe practice.) The moral of the whole thing is, that it is quite impossible to produce a parallel hole by any form of fixed cutter unless the line of traverse is dead parallel with the work axis.

In the case of the second cutter ***(b)*** which is free to float, the exact centring of the cutter does not depend upon the slide alignment, unless there is some impediment to its free movement in the slot of the bar. As a matter of fact, there often is, in practice; either traces of dirt or swarf, or just mere rubbing friction, will impair the floating action sufficiently to produce slight errors, which are probably not constant in successive holes bored. If, however, free floating is not interfered with, the cutter is bound to produce a perfectly parallel hole, so long as both its cutting edges cut efficiently, and do not snatch, tear or dig in.

But although the hole produced may be parallel-that is, constant in diameter from end to end-and also constant in diameter at any position around the circumference, it may still, be out of circular accuracy; as pointed out in my previous comments on floating cutters. While this has no special bearing on the questions raised by our Glasgow correspondent, it is a point which should be very carefully watched, in cases where such components as cylinders have to be bored. A two-point cutter can never be depended upon to produce circular accuracy, and an odd number of teeth, unevenly spaced, should be used for this purpose. This does not mean to say that true cylinders cannot under any circumstances be bored by means of two-point cutters, but simply that the latter, in themselves, have no power to generate true circular accuracy.

**Causes of the Trouble**

It should be mentioned that, in practice, many of the difficulties encountered in boring truly circular and parallel holes arise from failure of the cutter edges to cut efficiently and freely. Wrong rake and clearance angles, local wear, or chipping of the edges, and clogging with swarf are prolific causes of trouble. In modern production, close control of the, grinding and setting of tools, and the use of rose reamers and similar special sizing tools, assist greatly in holding work to close limits.

*(To be continued)*

# *Small Capstan Lathe Tools

## Notes on " tooling up " for repetition work, with special application to the " M.E." small capstan attachment

By "NED"

MANY of the components produced on small capstan lathes have to be knurled on some part of the diameter, and this operation is one which is often found by no means so simple as it looks. Out of a mixed batch of commercially produced components recently examined, several specimens had the knurling very badly executed, the most common fault being " double-pitching " of the knurl, producing in effect a knurled pattern twice as fine as that of the knurling wheel which produced it. But in some cases the alleged " knurling " was little more than a mere roughening of the surface, which may possibly have served the purpose for which it was intended-more or less-but was certainly not so effective in this respect as a properly knurled surface, to say nothing of its slovenly appearance.

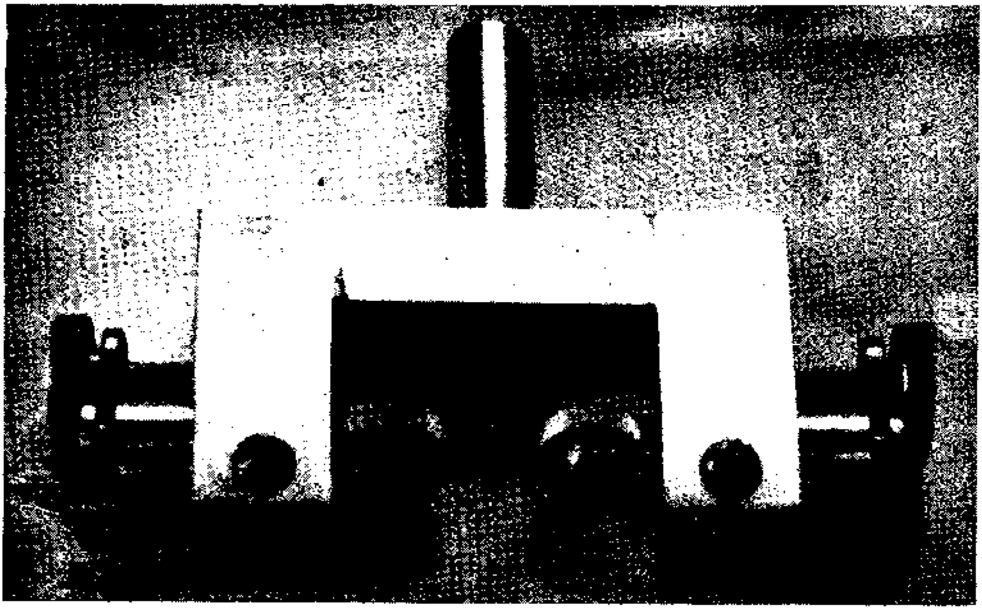
Incidentally, no information exists as to the equipment with which the samples mentioned were produced, and it is not easy to state definitely the causes of the faults noted. They may have been due to inefficient tools, bad setting, or careless operating-or possibly, a combination of all three,

* *Continued* **from page** 606, *Vol.* 86, " *ME.*," *June* 25, 1942.

### Knurling Processes

As most readers are undoubtedly aware, knurling is not a cutting process, but is effected by impressing or indenting the surface of the work, by rolling contact with a serrated and hardened wheel, which is mounted so as to be capable of revolving freely in its holder (Fig. 29). A fairly considerable pressure is necessary between the knurl and the work, in order to ensure the full depth of indentation, depending upon the coarseness of the knurl and the nature of the material worked upon.

In cases where a single knurling wheel is used, this pressure, no. matter from what direction it is applied, represents a heavy side thrust on the work, which may cause it to be thrown out of truth in the chuck, or if fragile, to be bent or even broken off. Consequently, it is the usual practice in production lathes to use two wheels diametrically opposed for preference, for practically all kinds of knurling, in order to balance and neutralise the side thrust. The two wheels must obviously be mounted so as to be capable of simultaneous radial adjustment (see photo.), to suit the diameter of the work, and this adjustment may be arranged so as to be operable during the course of the



**A capstan-head diametrically-opposed knurling tool made by Mr. A. T. Steels, for use with the " M.E." capstan attachment.**

knurling operation, enabling the impression to be progressively deepened, or pre-set to the size required for dealing with a batch of identical components.

The latter course is the more commonly adopted in production practice, for fairly obvious reasons, but as will be seen later, it is possible to apply a pre-set knurling tool in such a way as to obtain a progressive depth feed-though it is a matter of dispute whether it is any advantage, or even desirable, to do so.

Knurling may be applied to produce a wide variety of patterns on the circumference of turned work, but the most common forms are " straight " (i.e. axial), diagonal (spiral), and " diamond " (crossed), knurling. Any of these may be produced by means of a single knurling wheel. if the latter is designed for its individual purpose ; but in the case of diamond knurling, this method is inefficient, and will only operate over a length of work not exceeding the face. width of the wheel. In other words, the knurling tool cannot be traversed endwise along the work.

By using two knurling wheels at once, however, diamond knurling can be carried out over any reasonable length of work by traversing the tool-holder endwise. Furthermore, if the wheels are mounted so that their pivot axis can be adjusted at any angle to that of the work, it is possible to carry out either straight, diagonal, or diamond knurling with one pair of straight knurling wheels.

**Causes of Faulty Knurling**

By far the most common fault encountered in knurling is due to the failure of the knurling wheel to " follow in its own footsteps " as it were, the result being that the impression produced on one revolution is confused or partially obliterated on the next.' It is not difficult to understand how this happens, but some readers may be sadly perplexed as to how to avoid it !

When the knurling wheel first comes into contact with the work, and makes its initial impression, it is driven round by the engagement of its teeth with the niches which they produce-though its action cannot be regarded as quite so positive as that of a spur gear engaging with another gear having properly formed teeth. Undoubtedly, a certain amount of slip takes place, depending upon the friction of the knurling wheel running pivot and also the depth of the first impressions produced. But whether this is so or not, it is possible that in a complete revolution of the work, the impressions produced by the wheel do not divide out exactly, and it may finish up with half a tooth space to spare. If this happens, the wheel will produce a second set of impressions when the work goes round again, the result being " double pitching " of the knurl -or in some cases, triple or quadruple pitching may occur.The worst form of this fault is encountered when the metal displaced by the wheel is pushed into the serrations formed on preceding revolutions, so that it breaks away and the resultant surface eventually presents a " chewed " appearance, sometimes made all the worse by the presence of patches of more or less clean knurling.

**A Complicated Problem**

If, however, the diameter, and thus the circumferential length. of the work could be adjusted to correspond exactly with the pitch length of a certain riumber of teeth in the wheel, and if slip between the two on the first revolution could be completely eliminated, this fault would not occur. But in practice, it is difficult to ensure this, and the problem is complicated by the fact that the circumferential length on the original outside surface of the work is obviously greater than that on the rolling pitch line when the wheel has penetrated to part or full depth. Undoubtedly. the diameter of the work at the beginning of the operation does influence matters, and there are many cases where a slight adjustment of diameter makes all the difference between success and failure ; but an even more important factor in ensuring a certain start is to make the first impression sufficiently deep to give the wheel at least some encouragement to follow its own tracks.

This, it is believed, is where many operators go wrong. The " cautious approach," which is definitely to be commended in many, if not most, machine tool operations, is far more likely to cause trouble when applied to knurling. Instead of feeding the tool into the work gradually, and increasing the pressure according to the " feel," it is best to start deliberatelv. and with practically full contact pressure: This does-not mean slamming the tool in by sheer brute force ; the exercise of caution is just as much desirable, but in other ways. It will be obvious, for instance, that if the knurling wheel is brought into contact with the work when the latter is revolving at full speed, the inertia and friction of the wheel will cause it to lag, causing slip and scraping. If it is not practicable to reduce speed for knurling, it should at any rate be started at a low speed by stopping the lathe, feeding the knurling tool up, and pulling the belt round for the first two or three revolutions.

It is obvious that if a fairlv deep impression can be formed in the word right away, the liability of the wheel to form a second track on the next revolution is much reduced ; any slight inequality is generally averaged out as the work progresses, and once a good, full-pitched impression is formed, it can usually be maintained to the full depth. If the knurling tool is to be traversed endwise, it is advisable to make certain that it is properly pitched before applying end feed ; very often it is advisable to start off by engaging about half the width of the wheel on the extreme end of the work, when the nature of the latter permits. To many readers, these instructions may seem to indicate that knurling is a haphazard, hit-and-miss sort of process, but if one considers the regularity with which excellent work can be, and is, produced in production practice on all sorts of machines. it is evident that like all other machine tool processes, it depends only upon reasonable care and skill, in conjunction with the correct methods.

Copious lubrication is essential for efficient knurling, not only to reduce the friction of the wheel with the work, and to carry away the considerable heat which is inevitably generated, but also to ease the burden of the very heavily loaded knurling wheel pivots. Wear of these pivots is a prolific cause of erratic action of the wheels; and every care should be taken to keep the latter working as freely and smooth as possible. The effect of chips or swarf becoming jammed between wheel and holder is obviouslv anvthing but good, and a careful watch should be kept to avoid or correct it.

The most suitable lubricant for knurling is a fairly heavy body tapping oil, but where soluble oil is used for the cutting operations, it will serve in this case also, so long as it is not too thinly diluted. Sometimes the use of oil in knurling is objected to because it leaves the work looking rather dirty, but subsequent cleaning of machine parts is not a big job, and is usually a matter of regular routine in production shops.

**Effect of Materials**

The metals which are the most ductile are generally the easiest to knurl. Copper-which in other respects is often regarded as the bane of the turner's existence-takes an excellent impression, though it is not used a great deal in production, except in certain electrical components.

Most aluminium alloys knurl very nicely, and much the same applies to bronzes and naval brass, but some of the extruded brasses and screw rods, which are very considerably used in production, are liable to produce some queer little snags in knurling, due to their brittle nature and the splintery chips which are liable to become imbedded in the wheel and mar the work. Mild and alloy steels knurl quite well, but call for very heavy contact pressure, depending on their hardness and toughness. Cast-iron is liable to be difficult, but fortunately knurling of this material is not at all common.

Plastic materials, such as vulcanised fibre, ebonite, and the various phenol compositions (bakelite) are liable to be troublesome ; the most important precaution to observe when knurling them is to conduct heat away very promptly, to avoid any local rise of temperature. Thin soluble oil, or even plain water, is advisable for this purpose. The knurling operation should not be unduly prolonged, or the surface of the material may become spongy from the " kneading " action of the tool, and possibly break away in patches. It is often impossible to make a really deep knurl on these materials for this reason.

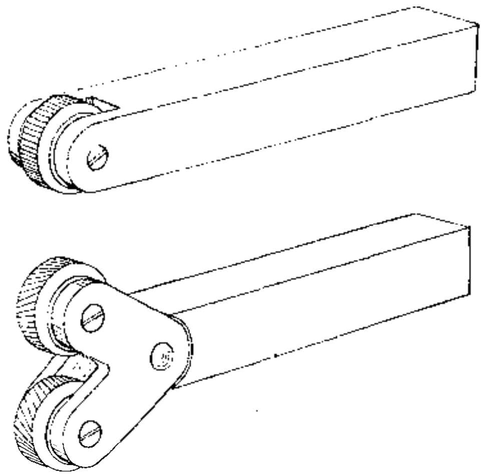


**Fig. 29. Standard type of single- and double-wheel knurling tools for cross slide application.**

**Effect of Knurling on Work Diameter**

As knurling is not a cutting process (a certain amount of material is usually removed, but this is only incidental, and is to be regarded as a sign of inefficiency in the action of the knurl rather than otherwise) it follows that the metal displaced to produce the serrations in the work is thrown up so as to increase the diameter of the ridges. The exact amount by which the overall diameter is increased is not easy to determine beforehand, and will vary in the event of the knurling action being erratic. If it should happen that the knurled work must pass an upper limit test, it will be necessary to reduce the diameter before knurling to an extent which can only be determined by experiment.

(To be continued)

# *Small Capstan Lathe Tools

## Notes on u tooling up " for repetition work, with a special application to the " M.E." small capstan attachment

*By " NED "*

SOMETIMES definite upper and lower limits for knurled work are specified, and if these are less than about 0.005 in. altogether they may be found difficult to comply with. Sometimes small nuts are made with a straight knurl, with the object of moulding or pressing into plastic material, and this is the reason why their size is important.

Knurling also burrs out the material where it overlaps the ends of a turned diameter, and for this reason the knurling operation should in practically all cases be followed by a chamfering or undercutting tool.

### Knurling Tools for Capstan Work

Knurling may be carried out in small capstan lathes either by means of a single or double slide-rest knurling tool, or by means of a balanced double-knurling tool held in the capstan head. The former method may be the simpler in many cases, as it enables standard forms of knurling tools, such as those illustrated in Fig. 29, to be employed, but the capstan head holder has several practical advantages, and is generally preferred for production work. In the first place, it eliminates side thrust on the work or lathe mandrel, and as it is generally preset to suit the diameter of the work, it produces uniform results in the minimum time.

The usual form of capstan head knurling tool-holder consists of a U-shaped bracket, mounted on a shank by the centre of its yoke, and having two individually-adjustable holders for the knurling wheels mounted in the arms (Fig. 30). In addition to radial adjustment, it is usually possible to turn the holders so as to present the edges of the knurling wheels at a variable angle to the axis of the work. Thus it is possible to produce straight, spiral or cross knurling with only a single pair of straight knurling wheels mounted in the holders. The photograph of the tool-holder made bv Mr. A. L. Steels represents a home-made example of this type of tool, which has been entirely successful for dealing with a wide range of production work. The main holder is built up from mild-steel bar by pinning and brazing the two arms to the yoke, but readers who are experienced in forge work would probably find it easier, and certainly no less satisfactory, to bend it up from a single piece. It is most important that the section of the material used for the U-piece should be sufficiently heavy to ensure rigidity, as the working stress tends to spread the arms apart, and the holes in which the individual holders are fitted should be exactly opposite each other and square with the axis of the shank. A close fit of the holders in these holes is also essential, otherwise they will tend to cant over when working, and thus the knurling will be tapered, i.e. deeper at one side of the wheel than at the other.

### " Wangling "

Although the form of tool illustrated is undoubtedly very satisfactory for its intended purpose, it has a rather serious disadvantage for use in small capstan lathes, in that it takes up an abnormal amount of room, making it difficult to accommodate without cramping or impeding access to other tools, or interfering with the rotation of the capstan head. It is often found necessary to resort to " wangling " of the sequence of the capstan tools, or to rotate the knurling holder around its shank axis until the most convenient position has been arrived at.

In the attempt to reduce the amount of room taken up by the knurling tool-holder, several special types of holders have been devised and introduced as items of equipment on various makes of small capstans and autos ; but, generally speaking, what these tools gain in compactness, they lose in adaptability. It is nearly always necessary to sacrifice the individual swivelling adjustment of the knurls so that different wheels are necessary- to produce various forms of knurling; but this may not constitute a very serious drawback in practice. The range of sizing

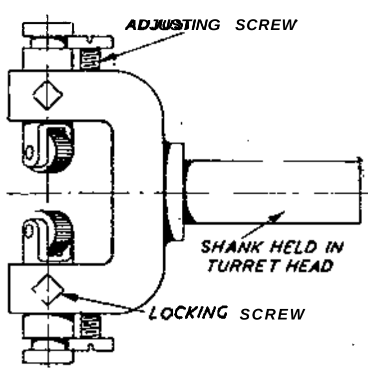



**Fig.** 30. **Capstan-head knurling tool, with radially adjustable and swivelling knurling wheel holders.**

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* Continued from page 45, *" M.E.," July 9, 1942.*

adjustment to suit work diameter is nearly always reduced.

One form of knurling tool-holder consists of a cylindrical head similar to an expanding die-head, and resembling the latter in other respects, as the knurling wheels are fitted to holders in radial slides and their radial movement is controlled by a double scroll cam. This type of tool is not only automatically centred and capable of being pre-set to fine limits, but can also be released to clear the work entirely, so that it becomes possible to carry out knurling operations behind a plain collar of larger diameter than the knurled portion, which would not otherwise be possible with a capstan head knurling tool.

**A Modified Capstan Head Knurling Tool-holder**

Fig. 31 illustates a simple form of holder which has a good deal less overhanging bulk than the U-bracket type, and is adaptable to all usual forms of knurling, either by changing the wheels or the individual holders in which they are fitted. It will be seen that the latter are made in the form of small die-blocks, which slide in slots in a faceplate adapted to fit the capstan-head socket, and are controlled by screws in the same manner as the jaws of a four-jaw chuck. By way of improvement, the die-blocks may be made self-centring. by using a single adjusting screw with right- and left-handed threads, passing right through the mounting plate, to control the radial adjustment. The use of independent screws, however, enables the shank to be left hollow to admit small diameter work.

In order to adapt the device for spiral or cross knurling, either the wheels may be changed, or different die blocks, having their mounting slots machined to an appropriate angle, may be fitted to the plate. As nearly all spiral and cross milling specified in production work calls for a 45-deg. angle, it would only be necessary to provide one spare pair of die-blocks,

When the knurling wheels have been set for work of a given size, they can be locked rigidly by clamping up the nuts at the back of the die-blocks. This form of holder also embodies the advantage that the knurling wheels can be run up very close to the chuck, or a shoulder on the work, without risk of fouling projections on the holder.

**Limitations of Capstan Head Knurling Tools**

There are some instances where the use of a knurling tool applied endwise from the capstan head is either impossible or inconvenient. This may occur, for instance, in complex work, where the capstan-head stations are fully occupied with other tools ; another, and more common case, is when it is necessary to leave a collar on the end of the work, of the same diameter as, or larger than, the part to be knurled (the special " expanding " knurling head, referred to above, would, however, overcome this difficulty). Occasionally it is necessary to use some form of knurling which definitely precludes endwise traversing of the knurling tool ; electric terminal nuts sometimes have convex knurling, and there are also instances of concave knurling on some components.

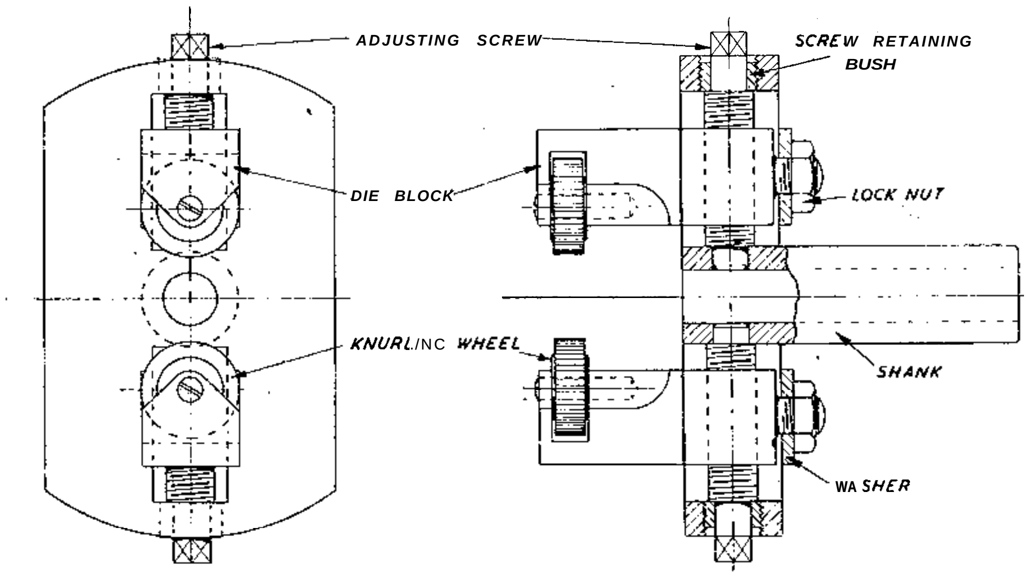



**Fig. 31. Modified form of double knurling tool for capstan head.**

These operations can only be dealt with successfully by means of a slide-rest knurling tool, in which case the standard forms of such tools as illustrated in Fig. 29 are quite suitable. The double knurling tool in this figure does not provide a balanced action, but there is one standard form of double knurline tool which has the knurl holders mounted in a slide, with vertical adjustment by right- and left-hand screw. This type is much to be preferred, as it enables the knurls to be preset to the size of the work, and to be run " over the dead centre," thus producing uniformly-sized work, and eliminating side thrust. Another standard form of 'knurling tool incorporates a rotating turret head. which enables different kinds of knurls to be brought into operation instantly-it is important, however, to watch that the knurling pattern is not changed by accident in this case !

**Features and Advantages**

All the special forms of knurling tool holders have their own particular features and advantages, but very often their usefulness is limited by the amount of room which they occupy on the cross slide, and therefore, the plain single knurl holder is often the most practical type to apply. Another problem which arises in cross slide knurling is that it is often necessary to carry out both forming and parting-off by cross slide tools, and thus both front and back tool-posts are fully occupied.

The use of a turret tool-post is often cumbersome and inconvenient in a small lathe, though in some cases it is practically the only way out of such a problem. If the knurling tool can be run over the dead centre, it is sometimes practicable, by the use of a special tool-post, to mount a forming or parting tool ***behind*** it, so as to come into action at the limit of its travel. Some capstan lathes have been fitted with a swinging arm which can be used to carry an additional tool, such as a knurling tool, for radial application. One hears occasionally of knurling being done with a hand tool-holder, but speaking from personal experience, the writer has never seen this done successfully, and there would appear to be several practical arguments against it in production work.

**Capstan Slide Traversing Gear**

Some questions have recently been put to me by readers regarding the respective merits of different methods of traversing the capstan slides. The majority of capstan lathes in modern production practice are equipped with a windlass, having a pinion which meshes with a rack on the capstan slide ; this method has been proved _by experience to be efficient and to provider a fairlv sensitive control of the feed of the capstan tools. But in THE MODEL ENGINEER Capstan Attachment, a simple lever feed has been specified, and the question arises whether any advantage would be gained by altering this to a rack system. It may be observed that the attachment recently described by Mr. A. L. Steels was so equipped, and another contributor, Mr. E. W. Fraser, who described a very useful steady tool for use with this attachment, suggested that rack feed would constitute an improvement.

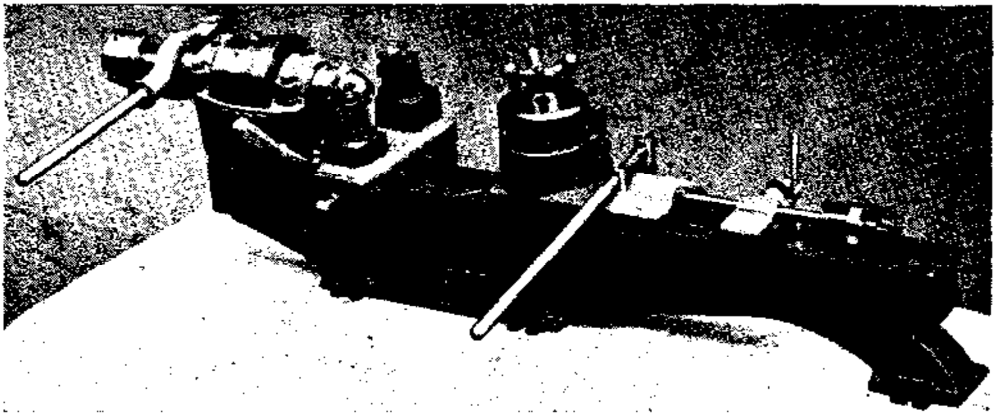
Although it is frankly admitted that the main object in specifying lever-feed in the original design was to-simplify construction, it does not necessarily follow that the more elaborate traversing system would invariably constitute an improvement. The main advantage in the use of the rack system is that it enables any desired leverage to be applied over any desired length of travel. These properties may be very useful when the stroke of the capstan slide tools is long, and the power necessary to feed them is fairly considerable..

**More Sensitive**

But in the work for which the attachment was primarily designed, the stroke is usually quite short and the cutting resistance light, and for such purposes the lever-feed is quite well suited. Its main advantage in this case is that, apart from mechanical simplicity, its action on the slide is more direct than the rack-and-pinion gear, thus feed control is more sensitive, and backlash more completely eliminated. Backlash in the feed gear may be troublesome, especially when the cutting tools have the least tendency to snatch ; and in order to eliminate it with rack-and-pinion gear, the latter must be very accurately made and fitted. It may be observed that in capstan lathes used for horological and instrument manufacture, lever feed to the capstan slide is often preferred, even in quite elaborate and expensive lathes.

**Duties**

It is clear, therefore, that the pros and cons of the respective methods of traversing must be considered in terms of the kind of duty they have to perform ; as a general rule it may be said that rack-and-pinion traverse is better suited to the heavier classes of work, entailing moderate speeds and deep cuts, while lever feed is at its best on small jobs, running at high speed, and taking fairly light cuts. Both kinds of work often have to be dealt with in small production shops, but the latter is likelv to be the more freauentlv encountered by the user of the attachment in question.



**The Myford light capstan lathe.**

**An Interesting Light Capstan Lathe**

The photograph herewith shows a small capstan lathe produced by a firm well known to all model engineers, as their name is associated with a very successful but inexpensive lathe which forms the backbone of many an amateur workshop. The production illustrated, which is in extensive use for the production of small components in armaments factories, embodies many features in which full advantage has been taken of the experience gained in catering for that very exacting and discriminating user, the model engineer.

The capstan lathe embodies a very sturdy headstock with a large diameter hollow mandrel, fitted with two-speed cone pulley. It incorporates an automatic collet chuck, operated through toggle mechanism, and an -internal push-tube, from a lever at the tail of the mandrel. A six-station rotating tool head is provided, with hand indexing and lock-release.

**A " Turret " Lathe**

In view of the terminology accepted largely in the machine tool trade, it would seem that this type of machine tool should correctly be termed a " turret " lathe, as the tool slide is fitted directlv to the lathe bed, instead of being carried oh a subsidiary slide clamped thereto, as is usual in capstan lathe practice. (But apart from mere pedantry, the term " capstan lathe " will undoubtedly be universally accepted in defining any small machine tool in this class.) The slide is lever operated, and a rotating stop holder is attached to the rear end, the stops abutting on a fixed stop mounted in a small slide clamped to the bed. It is thus possible to operate the slide over any portion of the lathe bed. within the limits of travel provided by the feed lever.

A massive cross slide, also adjustable on the bed for longitudinal position, is provided, with front and rear tool posts, and is operated by means of a lever. Travel in one direction is limited by a screw-adjusted end stop.

**The Bed**

The bed of the lathe is of similar general design to that employed in the model engineering lathes, but is stiffened up, and in addition to the mounting feet under the centre of gravity of the bed, it is further supported by an additional foot at the tail end; This highly practical little production machine tool is produced by the Myford Engineering Co. Ltd., Neville Works, Beeston. Notts. Although. in common with all machine tool manufacturers, they are extremely busy these-days, their policy of works expansion to cope with increasing demands enables them to offer fairly early deliveries of this and other tools for urgent war work, though their ability to oblige private customers must necessarily be curtailed under present conditions.

*(To be continued)*

# Ironfounding at Home

With reference to Mr. C. B. Carlyle's article on this subject, published in our issue of June 4th last, we understand that the Morgan Crucible Company has had a number of enauiries for their Salamander No. 6 Crucibles. This size is one that the company is now not able to deal with in small quantities, but we are pleased to inform readers that arrangements have been made whereby Messrs. Grilfin and Tatlock Ltd., Kemble Street, Kingsway, London, W.C. 1, can supply crucibles of the type and size mentioned. Readers are requested, therefore, to send enquiries to Messrs. Griffin and who can ensure delivery.

# "Small Capstan Lathe Tools

**Notes on " tooling up " for repetition work, with special application to the " M.E. small capstan attachment**

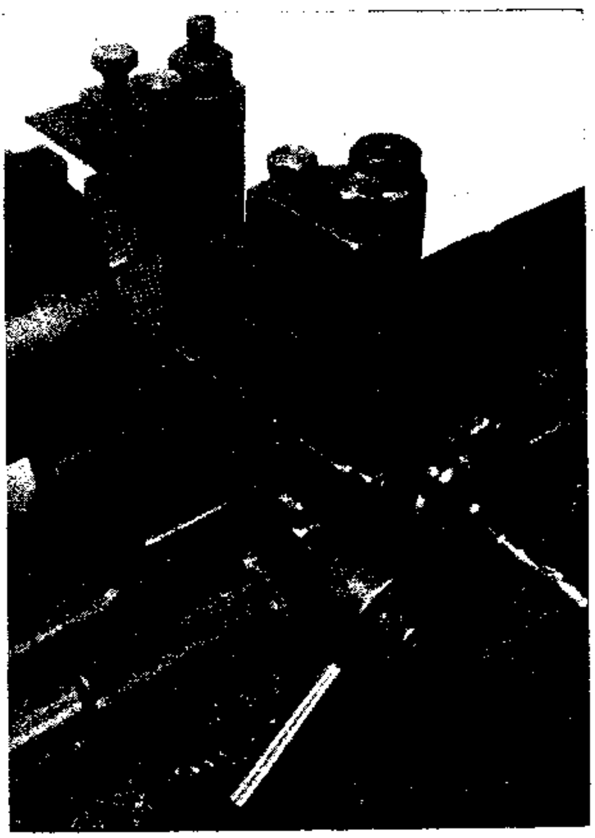
**BY " NED "**

THE majority of small capstan lathes, are equipped with a cross slide having tool posts at front and rear, so that either direction of cross traverse will bring one of the tools into operation. In some cases the usual form of screw feed is employed to traverse the slide, and in others a lever is used, operating the slide either through a link, or a rack and pinion. The cross slide is usually mounted on a short saddle which is adjustable in the longitudinal plane of the lathe bed, but is not normally equipped with any means of traversing in this direction. Certain types of capstan lathes, however, can be provided with attachments whereby one of the cross-slide tools may be traversed, sometimes by means of a supplementary swivelling slide, comparable to the usual " top slide" of a centre-lathe; but this motion is but rarely required in normal production of small parts.

In lathes which have been converted or adapted for production work, the normal cross-slide motion can be utilised, provided that an extra tool post can be fitted at the rear end of the slide. The front tool may be carried in the usual way, by the tool post on the too slide. and this' method enables the latter to be used as an extra traversing motion. But in the majority of cases, its use is neither necessary or desirable ; very often the room taken up by the top slide and its feed handle may seriously impede the movement of the capstan head tools, while there is always a possibility of the slide being moved inadvertently, -thereby interfering with the setting of front tool, and possibly spoiling a run of work before the discrepancy is discovered.

From many points of view, therefore, the use of a solid tool post, bolted to the front end of the cross slide in place of the top slide, is much to be recommended. Thus it is worth while to make up two special tool posts, one for the front and one for the rear tool, and attach them to the cross slide in the manner most convenient in the particular case. The saddle carrying the cross slide should be clamped to the lathe bed ; in most small lathes the only way of doing this is by tightening up the slide- adjusting jib strips.

The most essential features of the tool posts are that they should be capable of holding the tools rigidly, and in the required positions. Exact drawings of suitable tool posts are not given, as the requirements of different types of lathes vary considerably ; but in most cases their design is

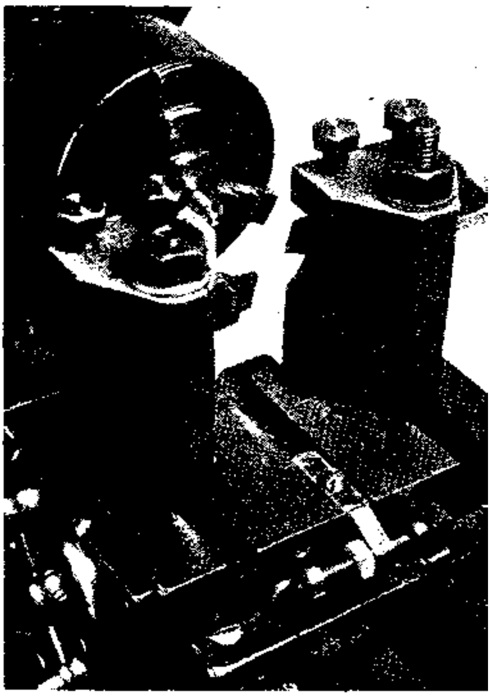


**Specially made front and rear tool posts mounted on a 3-in. lathe.**

* Continued from page 93, " *M.E.,*" *July* 23, 1942.

quite simple, and they may be made either from mild steel bar of square or rectangular section, or from iron castings. It will, of course, be clear that the slot or groove to carry the tool must be higher in the rear tool post than in the front one, as the tool is set in an inverted position in the former case ; apart from this, the two tool posts may be practically identical, so long as the cross slide design allows of mounting them both in the same way.

Most of the popular model engineers' lathes have a flat-surfaced cross slide, provided with tee slots ; and generally speaking, nothing could be more convenient



**View of tool posts from tailstock end, also showing adjustable cross-slide end stop.**

for mounting the special tool posts. The 3-in lathes, which are perhaps the most popular. and for which the " M.E." capstan attachment was primarily designed, have three tee slots in the cross slide, and the bolts holding the tool posts may be anchored in the front and rear slots respectively. This arrangement is inclined to be a little cramped in cases where simple forms of tool posts are employed, but allows sufficient room between the tools for dealing with bar work up to about 1/2 in. diameter, and has the merit of avoidmg excessive overhang of the tool from its support. It is, however, necessary to consider how much room is required between the tools to allow the capstan head tools to operate on the work.

If, however, it is necessary to deal with work of larger diameter, some provision for offsetting the tool posts will be found desirable; but this should never be overdone, as offsetting the tool post from its centre of support is bound to impair its rigidity to a certain extent. It may be 'found that only the rear tool post needs to be offset to obtain a sufficiently wide span for dealing with all the production jobs likely to be handled.

Another limitation, which is likely to be found in small lathes when using two tool posts, is in respect of the length of cross slide traverse. It mav be found that in the 3-in lathes, the rear slide cannot be run back far enough to enable the tool to clear the work ; offsetting one or both tool posts is only a partial remedy, because extra clearance entails the need for longer traverse, as a matter of course.

In lathes of the type under consideration, however, it is possible to extend the normal travel of the cross slide without drastic alteration. As expedients for this purpose have already been described by other contributors in the " M.E.," it is unnecessary to deal with this matter in detail ; but briefly, it may be said that the only alteration to the slide consists of fitting a new bridge, or keep plate, to take the thrust of the feed screw: The keep plate, on the lathes in question, is simply a flat plate attached to the front of the slide, and bored in the centre to form the feed screw bearing. If this fitting is altered so as to form a bridge. to carry" the feed screw bearing some distance beyond the front of the slide, the latter is thus enabled to travel farther back before the thrust collar of the screw runs home against the slide way of the saddle. To take full advantage of this alteration, it would be necessary to make a longer feed screw as well ; but even without this, it is well worth while, not only for adapting the lathe to production work, but also on the grounds of general adaptability.

The two tool posts shown in the photograph were produced by Mr. Ian Bradley, whose articles on workshop topics are well known to readers. Although he is not specially concerned with the adaptation of the lathe to production work pure and simple, he has a keen appreciation of the utility of these fittings in general lathe work. The use of the front tool post is recommended, on account of its excellent rigidity, for all purposes except those which call for the swivelling motion of the top slide, i.e. taper or bevel turning. The rear tool post

*(Continued on next page)*

# Brazing and Hard-Soldering Aluminium

IT is frequently asked by model engineers why, if aluminium cannot readily and effectively be soft-soldered, it cannot be brazed. Aluminium is without doubt one of the most difficult metals to braze effectively . This is largely due to the difference in the fusibility of aluminium oxide (3,000 deg. C.) and aluminium metal. 658 deg. C. From a mechanical point of view, to attempt to braze aluminium is a mistake ; the metal is far more likely to fuse than many of the brazing alloys employed.

The coefficient of expansion of aluminium is considerable and a model component may be rendered worthiess owing to the deformation it has received during the brazing process. The essentials of a brazed joint are the contact of absolutely clean surfaces free from oxide and dirt, and the bugbear to successfu1 brazing is the difficulty in eliminating the oxide layer that is so refractory at brazing temperatures, and effectively prevents the essential intimate connection between the brazing metal and the surfaces to be joined.

A number of experiments were made by the writer some months ago with the brazing of various sheet aluminium model components. Several types of joints, brazing alloys and fluxes were employed. The results were unsatisfactory in that fusing of the aluminium took effect before a perfect joint was obtained. Obviously the brazing of aluminium, strictly speaking, is at present far from being a satisfactory commercial proposition ; yet aluminium is one of the most readily weldable of all metals, and the metal can be successfully hard-soldered.

The solder used in hard-soldering aluminium is an alloy of aluminium having a melting point of approximately 550 deg. C. Many such alloys exist, but the silicon alloy containing 10 to 13 per cent. of silicon is best. The oxide film is removed by means of an alkaline halide flux. At the temperature which the soldering is effected the flux is melted and rapidly attacks the oxide layer, permitting the liquid solder to come into contact with clean aluminium and to alloy with the metal. An atmospheric gas blowpipe flame is used, but, apart from this and the higher temperature employed, the process does not differ from the ordinary soldering of brass or copper. The flux is applied on the end of the solder strip or bar, which is melted up and flows readily. soldering the parts together. Silicon alloy solder may be obtained in the form of a tube with the flux contained inside. The art of hard-soldering can be recommended for ease of application, giving permanent joints and strength. Unlike soft-soldering, a hard-soldered joint can withstand the action of boiling water or steam. As evidence of the simplicity of the process it may be mentioned that one large manufacturer of aluminium hollow-ware has employed girls for soldering spouts to kettle and teapot bodies.-A. J. T. EYLES.

## Small Capstan Lathe Tools

*(Continued from previous page)*

is less constantly in use, but all turners will realise the advantage of being able to keep a parting tool ready for action when turning small parts from bar stock-even though they may be dead against " mass production " in-the home workshop !

It will be seen that in this case both tool posts are substantially alike, but in the rear tool post, clearance for the tool has been increased by machining a concave groove across the front of the tool slot. These components are well on the massive side for the duty they have to perform,. but it is a good fault, and the use of two substantial set screws in each post undoubtedly ensures that the tools will never alter their setting under any normal stress.

Smaller tool posts would, however, be quite satisfactory for most light capstan lathe work, and the use of a single set screw would also suffice, so long as the tool is bedded home against the side of its slot. The bearing surface of the bottom of the post should, however, be kept fairly large, and thus there is much to be said for the use of tapered (" bottle-jack " or " lighthouse ") types of tool posts. An adaptation of the familiar " American " type of tool post is also well worth consideration ; the special advantages which this type offers in respect of tool height adjustment will appeal to many readers, but the central tool slot may restrict the section of tool which can be accommodated, and may also limit the ability of working close up to the chuck with a tool of normal shape.

*(To be continued)*

# *Small Capstan Lathe Tools

**Notes on ‘( tooling up T for repetition work, with special applica- . tion to the " M.E." small capstan attachment .**

**By "NED"**

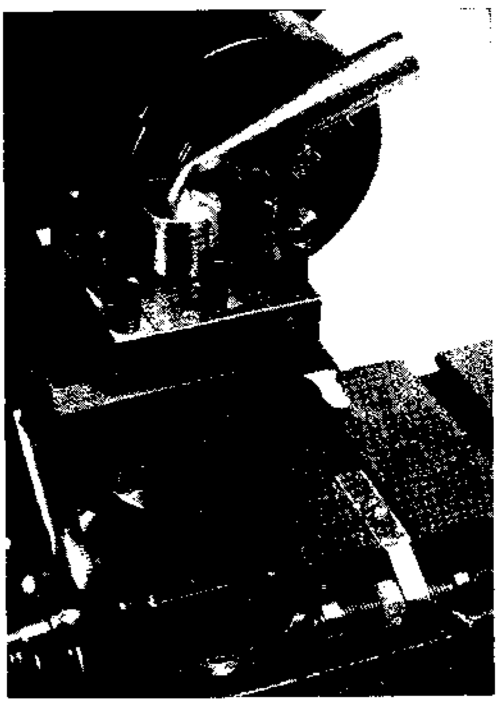
ANOTHER form of tool post which is extensively used on the cross slide of the lathe for production work is that which is equipped with means of bringing a number of tools successively into operation. There have been many forms. of such tool posts developed, either for use on particular types of lathes or for universal fitting. Perhaps the commonest of all is the four-way rotating turret tool post, an example of which is shown in the photograph. This particular device was on the market previous to the war, and is understood to be still obtainable ; it is intended for top slide fitting, but on the smaller sizes of lathes it is rather difficult to apply in this position because. of the limited height available from the top surface of the slide to the level of the centres. For this reason, it would only be possible to use tools of small section, or specially made " dropped " tools. If, however, the turret is adapted to direct attachment to the cross slide, by the use of a suitable packing block and a tee bolt, it can be used to take much heavier section tools, ‘and will also. hold them much more rigidly than when used on the top slide.

The rotating turret is arranged to index in eight positions, at 45 degrees apart, and this enables each or any one of the four tools to be used for a double purpose, provided its shape is suitable. For instance a round-nosed tool could be set square-on to the lathe axis and used in this position for front roughing or grooving, and then turned 45 degrees to the left and used for end facing.

The tool stations are located by means of a peg or dowel in the stationary baseplate, which engages eight equidistant holes in the underside of the turret ; in this way the tools are always brought to exactly the same position when indexed. To shift the turret it is necessary to unclamp the central hand lever nut sufficiently to allow it to be lifted clear of the peg. A spring is often fitted to lift the turret automatically when unclamped, but its advantage is somewhat questionable, as it makes it rather more difficult to find the position of the next hole when clamping down again.

Some forms of turret tool posts have other methods of indexing, such as a spring plunger or latch, working horizontally, and engaging holes or slots in the side of the turret. This constitutes an improvement over the method above described, as it is only necessary to slacken the clamping nut about a quarter of a turn to release the turret, and after the locking plunger has been withdrawn, it will find the next hole automatically. The few seconds saved in this way will make a great difference in the time taken in producing a large number of components. Another objection to the lifting of the turret is that it offers a possibility of swarf getting between the underside of the latter and "the baseplate, thereby not only affecting the accuracy of the tool setting, but also entailing risk of damaging the appliance.

The multi point tool post may be used either as auxiliary or ancillary to the employment of a rear tool post but as the turret itself takes up more room on the cross slide than a plain tool post, the situation is liable to be even more crowded than usual when both are used together.



**Four-way turret tool post set up on cross slide.**

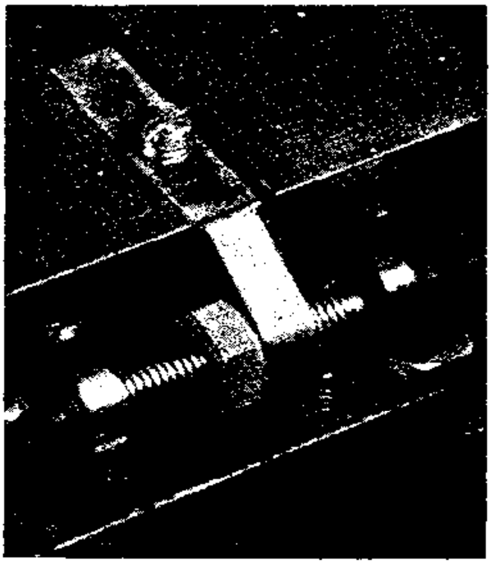
*Continued *from page* 185, " M.E.," Aug. 20, 1942.

It is thus advisable to dispense with the rear tool post, if possible, when the turret tool post is fitted. Many operators believe that there is some special merit in applying the parting tool from the rear, and in an inverted position ; but this is not the case unless the cross slide is specially designed for the purpose, with provision for taking the upward thrust which is thus caused.

Although the general utility of the turret tool post in repetition work is beyond question, it should not be brought into operation unless the complication of the component renders it necessary. If it is possible to carry out all operations, with the exception of a simple forming operation *and* parting off, by the use of the capstan head tools, this course should always be adopted.

The reason for this is because of the comparative diff i-culty of arranging the cross slide turret tools to work automatically to a fixed limit, unless a complicated arrangement of end stops are provided. on the cross slide. Often, too, longitudinal movement of the saddle may be called for, in order to use these tools effectively, and thus stops would have to. be arranged to limit the saddle movement also. In large capstan and turret lathes, it is nsual to provide an indexing stop bar to the saddle slide, so that traversing movement of each of the cross slide turret tools may be limited ; but a single cross slide stop usually suffices, as the tools themselves can be set in the tool post or holder so that they complete their cut at the correct depth.

In the smaller and simpler capstan lathes, however, the advantages of being able to dispense with complexity in tlne manipulation of cross slide tools will be obvious, and it may be remarked that, in practice, very few of the components likely to be dealt with in these lathes involve the necessity for it. A very important part of the production planning department's job, in any engineering works, consists of simplifying small components so that complicated tooling of capstan lathes becomes unnecessary, and considerable time is thereby saved in production.



**A close-up of the adjustable cross slide stop.**

**Other Cross Slide Equipment**

The lack of room on the cross slide of a small lathe practically precludes the fitting of yet more gear on it, so that only a passing reference to the many additional items of cross slide equipment which are occasionally encountered should be necessary here. Steadies of various types are sometimes used for dealing with slender or unsuitable jobs, but unless they are ingeniously devised so as to be capable of being rapidly set and unmounted, they are liable to slow up production very considerably, or to impede the operation of other tools. Swinging work - stops, applicable in cases where all the capstan stations are fully occupied, have already been referred to ; and knurling gear can also be brought into action by means of a swinging arm.

The use of chasing heads is uncommon on modern production lathes, but occasionally it happens that they are indispensable to some special production problem, and at least one example of this device applied to a small lathe has recently come to the writer's attention.

It is possible to apply extra tools in a vertical position, either above or below the work ; the latter position is most common, as it enables the tool to be more rigidly mounted. The feed is applied tangentially, by the normal cross slide motion. and is verv suitable for forming operations, especially if the tool is set obliquely, so that only a part of its width is employed at anv given time. It is most important that the-slide should be run back so that the tool is behind the work, before starting to machine each component.

**A Simple Cross Slide Stop**

Many requests have been received for advice on how to limit the travel of the cross slide for forming operations and similar purposes. Much, of course, depends on the type of slide rest fitted to a particular lathe, and in some cases it is possible to attach a cross bar to the rear end of the slide way by clamping it over the latter or bolting to the end face, and simply fitting a stop screw to the cross bar. This course, however, is not so convenient in the case of the lathes possessed by most model engineers, in which the cross slide usually over-runs the, slide way at the inner end of its travel and never allows much room for the fitting of a cross bar of this nature. It is equally inconvenient, and sometimes almost impossible, to fit a stop screw at the front of the cross slide, as the only practical location for it would be in the keep plate, and a screw projecting from the latter would almost inevitably foul the handle of the feed screw.

The appliance consists of two elements, one of which is attached to the cross slide and the other to the saddle. In the former case, it is designed to be anchored in one of the cross slide tee slots, being fixed in place by means of a single grub screw, so that it is not necessary to drill holes in the slide for its attachment. Previous to devising the tee slot fitting, however, the writer had used a holder for the stop screw which was screwed into one of two holes tapped in the side of the cross slide between the, tee slots (these tapped holes can be seen in the photograph). The arrangement shown, however, is much handier, and more quickly applied. If desired, the grub screw which clamps the fitting in place may be sunk

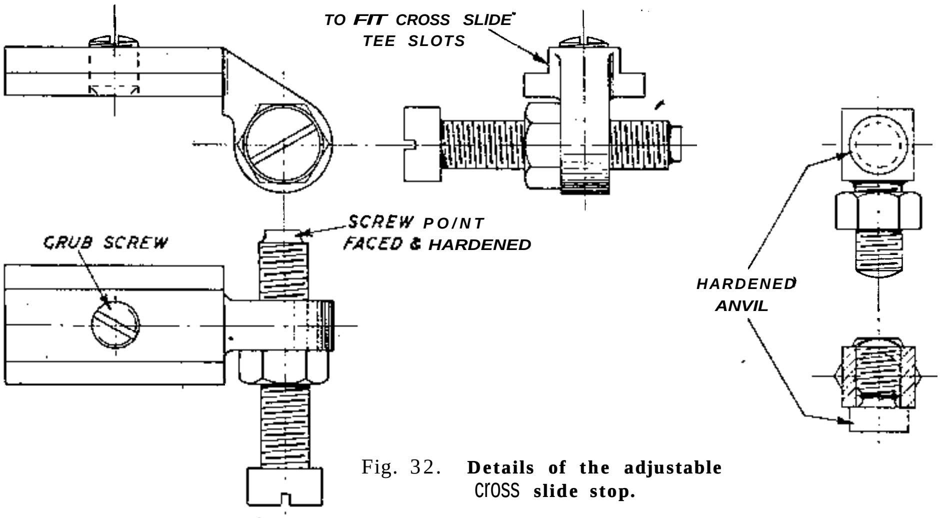



Fig. 32. **Details of the adjustable cross slide stop.**

Some readers have therefore reasoned that it is almost impossible to equip this form of cross slide with an end stop without a great deal of trouble, involving some restriction of its motion, and possibly encumbering the motion of other working parts. Considerable thought has been given to this problem, as a result of which the adjustable stop shown in Fig. 32, and also in the accompanying photograph, has been evolved, and has proved entirely satisfactory 'in the course of two or three months' practical test.

An interesting and useful feature of this stop is that it can be mounted on or detached from the cross slide in few seconds, and a when fitted, it is entirely out of the way, so that it does not restrict any of the slide movements or take up room which can ill be spared. It would be quite feasible to develop it into a double stop for limiting the feed motion in both directions, if this should be necessary ; but the single-way stop is sufficient for most small capstan lathe operations.

flush with the surface of the tongue, so that there are no projections above the cross slide surface when it is in use.

The fitting was built up by pinning and brazing together two pieces of mild steel forming the tongue and the tapped lug, respectively, but it could have been machined from the solid fairly easily, or made from a casting. An ordinary machine screw, 1-1/4 in. long by 1/4 in. B.S.F., was used for the stop screw, the end being very carefully faced dead flat and turned down below the core diameter of the thread, then case-hardened.

It is necessary to drill and tap one or more holes in the top surface of the saddle to accommodate the fixed stop, which is made from a piece of 3/8-in. x 5/16-in. rectangular steel bar, the end of which is turned down and screwed 1/4 in. B.S.F. A cross hole is then drilled through the upper part and screwed 1/4 in. x 40 t.p.i. to take the hardened anvil.

The exact dimensions of these components will, of course, depend on the lathe to which they are fitted ; there are differences of detail, even in lathes of a given make, according to their date of manufacture. It is necessary to position the tapped hole in the lug of the screw holder, and the hole or holes in the saddle for the reception of the fixed stop, in such a relation to each other that the stop screw abuts squarely in the centre of the anvil, when brought into contact with it by the motion of the slide. The tongue should be a close fit in the tee slot, so that it does not tend to slew round under pressure ; but in order to contend with any slight shifting, the slide should always be fed hard up on the stop when first fitted, to eliminate the risk of adjustment being subsequently upset through this cause.

It is possible either to simplify or elaborate this device to suit individual taste, but in the form shown it will be found quite satisfactory for all practical purposes and reasonably accessible for adjustment. Some readers have asked for a *micrometer* end stop ; this term is a somewhat indefinite one, but presumably is intended to mean one having a marked graduated screw reading in thousandths of an inch. The modification of the screw holder necessary to incorporate this refinement is a fairly straightforward matter, and the screw may be cut 40 t.p.i. and equipped with a graduated thimble if desired. Its success will depend mainly on the workmanship and material put into it ; but it may be remarked that an ordinary micrometer screw is not really robust enough for the heavy duty and rough usage it is likely to get when applied in this way. The use of an ordinarv lock nut is not advisable, as it may damage the very fine thread when repeatedly tightened.

In most cases, when micrometer stop screws are fitted on machine tools, they are made much larger than the standard 1/4 in. x 40 screw, and special provision is necessary to protect them from wear, especially when they are likely to be buried in chips or swarf most of the time. Few capstan lathes are equipped with micrometer stops ; in fact, the arrangements for adjusting the tools are sometimes very coarse and primitive, and there are many professional tool setters who would be very satisfied with a 26 t.p.i. adjusting screw as specified in the present case.

### Automatic Collet Chucks

Some time ago. I mentioned that I was investigating the possibility of equipping small lathes with chucks of the " automatic " type, which can be operated without stopping the mandrel. Readers may be interested to learn that a successful chuck of this type, quite simple in construction and applicable to any lathe, has been evolved, and when sufficient evidence has been obtained, by practical test, of its satisfactory operation, it is hoped to furnish a description of this device. There is more than a bare nossibilitv that the chuck, or a modified version of it, may be put into production by a well-known firm of lathe manufacturers, in which case it will be possible in due course, to obtain one ready-made.

Automatic chucks are almost universally fitted to production lathes designed for bar work, as they save a great deal of time between operations, especially when the lathes work at high speed. Hitherto, however, it has only been possible to fit them to lathes having the mandrel soeciallv designed to incorporate the chuck as an integral feature.

It should be noted that, in order to use a chuck of this type effectively, it is also necessary to provide some means of feeding the bar forward when the chuck is released, but this is a relatively simple matter, and does not necessarily involve any elaboration of the lathe itself.

(To *be continued)*

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## Don'ts for the Model Engineering Beginner

AS one who is a constant and appreciative reader of THE MODEL ENGINEER, I think that there must be many in the elementary stage of model engineering who would derive some benefit from the following list of " Don'ts " which I have compiled from experience. It is surprising how often such simple matters are neglected.

Don't make hammer marks on your models.

Don't use the tail end of your vice for an anvil.

Don't screw bolts and nuts hard enough to strip their threads.

Don't use your vice more than a month without oiling it.

Don't try to drill a piece of metal unless it is properly supported.-

Don't attempt to drill a hole unless vou know that the drill is properly ground.

Don't drill or ream out holes in aluminium model parts (or its light alloys) without using a suitable lubricant ; kerosene, or a mixture of equal parts of paraffin and lard oil, are about the best.

Don't tap a hole and put a bolt in it without clearing out the chips.

Don't try to take a bruise or indentation from a flat surface with a scraper or the tip of a file.-A. J. T. EYLES.