A CAPSTAN ATTACHMENT for Small Lathes

A device for the expeditious and accurate quantity production of small turned parts in the home workshop

BY "Ned"

THE differences between the lathes employed in most amateur workshops, and those intended specifically for quantity production on a commercial basis, have already been thoroughly explained to readers of the "M.E.," and it is therefore unnecessary to discuss the reasons why the amateur is unable to compete with the factory in output time and cost, in cases where numbers of identical parts have to be machined. The ordinary centre lathe, no matter how high its quality may be in respect of accuracy and design, is fundamentally intended to deal with work-pieces separately and individually, and its methods of operation do not permit of saving time on repeat operations to any great extent, unless some special equipment is provided for this purpose.

In the ordinary way, amateurs are rarely interested in quantity production, as it is unusual for them to encounter work in which any very considerable quantities of identical parts are called for. At the present time, however, there are many amateur workshops which have been temporarily converted into small factories, and are contributing in a modest way to the national industrial effort. It is thought, therefore, that some particulars of a practical device for facilitating quantity production on an ordinary lathe will be of general interest.

Let it be said at the outset that there is nothing new in the principle or conception of equipping a small lathe with devices for speeding up production. For many years now, equipment such as turret tool-posts and tailstock capstan

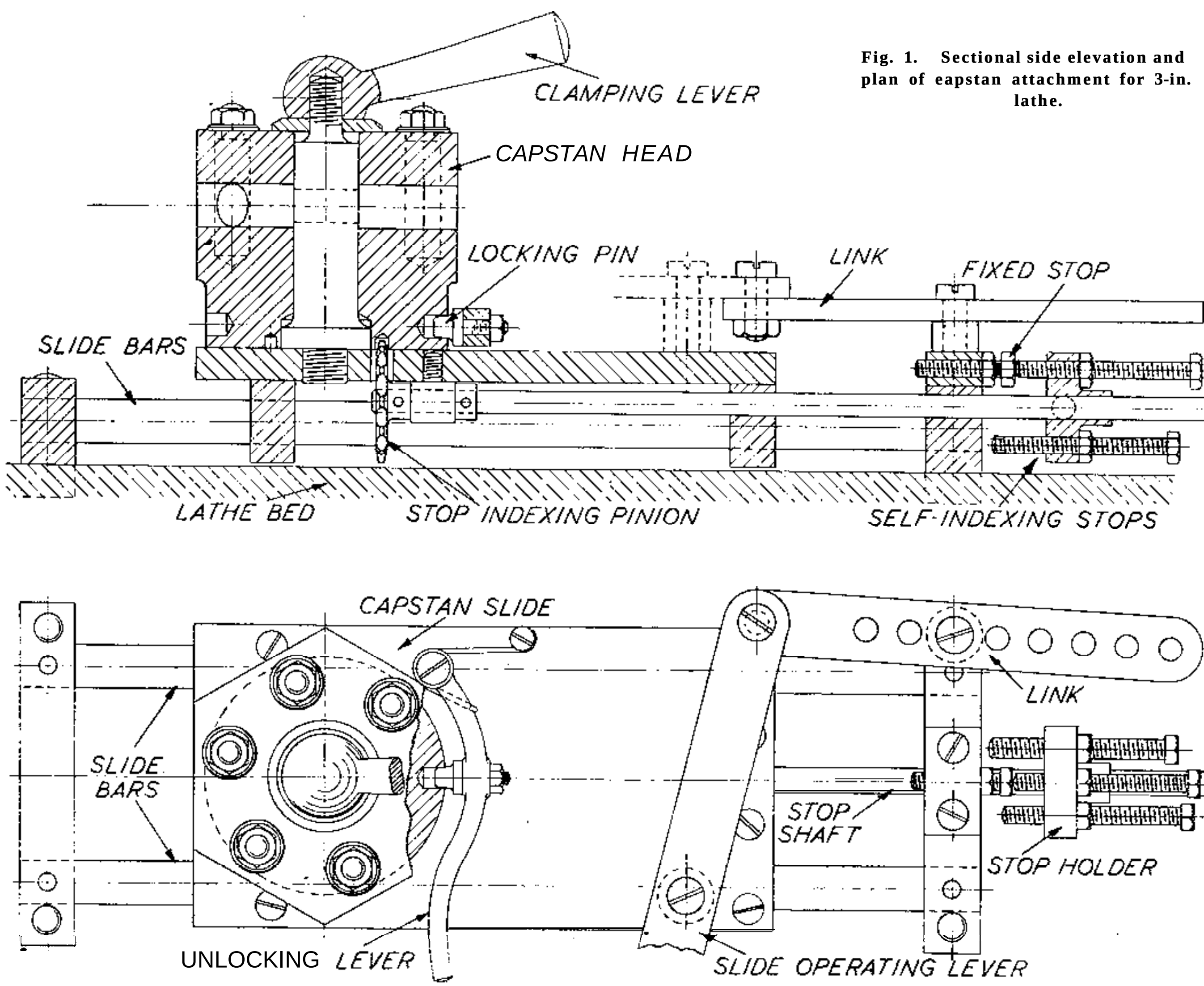

Fig. 1. Sectional side elevation and plan of eapstan attachment for 3-in. lathe.

attachments have been available, and the last few months have seen a revival of many old ideas and the inception of several new ones, all having certain similarities of design and purpose. In practically all cases, the fundamental intention of such devices is to provide a means whereby a number of tools may be kept set up ready for use, and brought into action in very much less time than is normally required to change and re-set tools in the standard form of tool-post. This, of course, is the recognised principle on which the majority of lathes designed specifically for repetition work operate, and the familiar " capstan " or " turret " appears to be the most effective practical method of rapid tool-changing so far known.

Simple and Crude

Like many other fundamentally sound ideas, however, the practical application of such ideas to machines which are not originally designed to use them often falls very far short of what it should be, or might be, and in some cases the devices are very disappointing in use. As the result of a fairly extensive experience with all kinds of extemporised production equipment, dating since the beginning of the last war, the writer ventures to offer a design for a capstan attachment, of a size suited to a 3-in. centre lathe of the type generally used by the amateur, and adaptable to other sizes of lathes by modification of dimensions. It is specially designed so as to be capable of construction in the home workshop, the necessary machining work being carried out on the lathe to which it is to be fitted, and employing materials of such a nature as may be expected to be readily available, Castings or other parts which may be difficult to obtain, or may cause delay in production, and complicated machining operations which might be difficult to carry out in a small workshop, have been carefully avoided. As *a* result, the design is necessarily severely simple, and may even be considered crude ; but to those who are primarily interested in utility, it should be sufficient to assure them that the one and only claim made for it is that it will work efficiently and accurately.

In order to explain in what respects this attachment is claimed to be an improvement on existing devices having a similar purpose, it may be useful to review the various forms of the latter, and to consider their shortcomings and limitations.

Tailstock Capstan Attachments

Most capstan lathes have the capstan slide mounted on the bed axially in line with the headstock centre, and in the location normally, occupied by the tailstock of a centre lathe, as this position is found to be most convenient for dealing effectively with most of the operations carried out in such lathes. It is therefore logical to suppose that this position is also best for an attachment intended for similar purposes on an ordinary lathe. The usual form of capstan attachment, therefore, consists of a "capstan head " or' multi-point rotating tool-holder, mounted on a tapered stalk which fits the tailstock socket. In some cases the head is in the form of a disc which rotates on a horizontal axis, in which case the space available for tools is somewhat restricted, and the idle tools may impede the view of, or access to, the work. This may be remedied by pivoting the head on an oblique axis, thus allowing the tools to be accommodated much more comfortably, and to be rotated over the top of the tailstock barrel.

But the weak point about any form of tailstock capstan head is that the ordinary tailstock barrel is fundamentally unsuited to act as a tool-slide. Its bearing surface is quite inadequate, and the only resistance to torque-which may be very heavy in the case of capstan turning tools-is provided by a key, which in many cases is by no means robust. In addition, the method of mounting the entire attachment on a slender taper shank leaves much to be desired, and apart from the small gripping surface of the shank. its overhang still further reduces the rigidity of the fitting to withstand loads applied by the cutting tools. These deficiencies are entirely beyond remedy while the device remains a *tailstock* attachment, and clearly point to the necessity for mounting it on a more suitable form of slide.

Turret Tool-posts

These devices certainly remove the objection just discussed, by making use of the main sliding saddle of the lathe to carry the rotating tool-holder. So far as steadiness is concerned, they leave little to be desired ; but their principal limitation lies in the fact that if they are used in

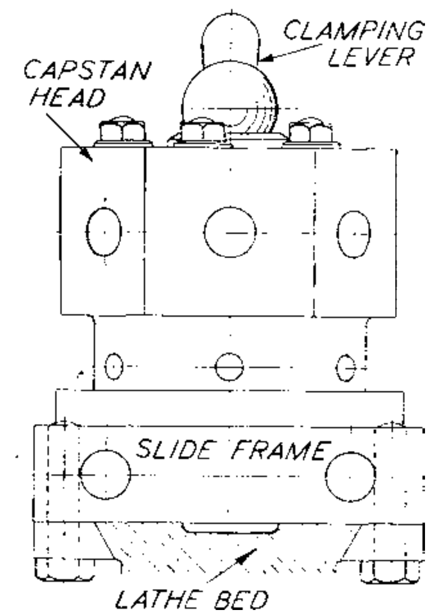

Fig. 2. Front end view of capstan attachment.

conjunction with the tailstock, it is impossible to bring the tools into the most convenient operating position, while, if used as a substitute for the tailstock, they limit the number of operations which can be handled. Capstan lathes are nearly always equipped with a cross slide, in addition to the capstan slide, for the purpose of dealing with forming and parting-off operations, which are a necessity in many kinds of work ; and in adapting an ordinary lathe, it is most desirable that the main slide should be reserved for this function. It is, therefore, clear that any form of tool-holder attached to the main slide should preferably be supplementary to the capstan slide rather than a substitute for it. And this proves the desirability of adding a complete slide, additional to the main slide, for the purpose of carrying the capstan head.

Limit Stops

So far, all the attachments considered have been devised with the sole aim of eliminating or reducing the time normally occupied in changing tools. Admittedly, tool-changing is the principal source of lost time in ordinary lathe operations, but a good deal of time is also occupied in adjusting the tool slides to ensure that the work is machined to correct diameter and length. In a capstan lathe, means are provided for working to pre-determined dimensions without the necessity for continual checking and adjustment. The skilled craftsman is often inclined to despise such expedients as a concession to the incompetent operator, but the fact remains that in addition to reducing the time taken to produce the work, they also make its accuracy practically certain and eliminate the risk of the slips which are occasionally made by the best craftsmen.

The method adopted almost universally in capstan and turret lathes to ensure that the slide always travels the correct distance to produce work of the required length, is to use limit stops attached to the moving part of the slide, and abutting at the end of their travel against a fired part of the slide (adjustment of diameter, it should be noted, is effected by setting the cuttig tool in its holder). It is clear that stops must be provided for each of the tools in use, and they must be brought into action in correct sequence. As it is not generally practicable or convenient to mount the stops directly adjacent to the individual tool-holders, so as to be indexed in position with them, it is usual to mount the stops in a separate indexing fitting, arranged for convenience at the rear end of the slide. This could be made independent of the capstan head, and indexed separately by the onerator each time the head is moved, but this clearly involves the possibility of errors which might have serious consequences, and it is thus usual to gear the stop-holder to the capstan head, to correlate the two positively, and eliminate the risk of them getting out of step. (The mechanism by means of which this is effected is fully described in the handbook, Capstan and Turret Lathes.")

None of the capstan attachments which have come to the notice of the writer so far have been equipped with any form of limit-stop gear, and in this respect the provision of this equipment on the attachment shown here may be regarded as an innovation ; but no particular credit is claimed for it, as it is simply an adaptation of methods which are practically standard practice in capstan lathes. The gear is, however, arranged in the simplest possible manner, and presents no additional difficulties in construction, apart from necessitating a few extra parts.

Repetition Work on Small Lathes

Incidentally, it may be mentioned that the opinion has frequently been expressed, by persons of some considerable experience, that the average small lathe is inherently unsuited to carrying out repetition work, by reason of its light construction and lack of stamina. This is quite true, if one considers the question in terms of the outputs normally attained by small capstan lathes of modern design. The lathes we are considering are incapable of running at the high speeds and taking the heavy cuts for which modern repetition lathes are designed, but that does not mean to say that it is not practicable to do anything at all to increase their rate of output. With the aid of a capstan attachment, and without increasing the speed or rate of actual cutting to anv great extent, it is often found that parts can be produced in anything from one-fifth to one-tenth the time taken in " individual " machining. In many cases, this is quite sufficient to justifv the time and trouble taken in the construction of such an attachment. During the last Great War, when capstan lathes were very scarce, many old lathes of very poor mechanical design were pressed into service and converted into capstan lathes, and despite their limitations, they enabled the production of several factories to be multiplied many times. It may be remarked that the impression that small lathes are not suitable for repetition work may in many cases have been produced by experience with flimsy and inefficient capstan attachments.

Some Notes on the Design

It will be seen that the capstan attachment illustrated in Figs. 1 and 2 consists of a rotating capstan head pivoted on a " post " mounted on a flat soleplate, which moves longitudinally on slide bars in a frame clamped to the lathe bed, in the position normally occupied by the tailstock. The slide is actuated by means of a lever, having an adjustable link, which may be set for convenient operation over the required range of travel. The full range of movement is 3-1/2 in., which will rarely be required in the class of work for which such an attachment is expected to be used. It is hardly practicable to increase the length of travel with the slide frame shown, which is arranged to suit the normal size of 3-m. lathe having a short bed, admitting 12 in. between centres. The long bed lathes would allow of using a longer slide frame, but in this case it would be advisable to use larger diameter slide bars, in order to maintain the same degree of rigidity. If a wide range of travel is desired, it is advisable to arrange the lever for variable throw, by providing a, range of pivot holes in it, like those in the link.

Slide Bars

The use of slide bars may be criticised by some readers, as being inferior to the vee slides usually fitted to machine tools. It is true that a properly-fitted vee slide gives the maximum possible bearing surface and rigidity, but it also involves considerably more work, and presents some almost insuperable machining problems to the amateur with limited equipment. Bar slides are often condemned out of hand, on the strength of the thoroughly bad examples of them which have appeared on some of the " cheap and nasty " machine tools produced in the past. But it is almost certain that their vices were due more to bad workmanship than inherent faults in design, and it is doubtful whether vee slides would have been any better if they had been as badly made. A properly made and fitted bar slide will give quite good results, and it may be observed that they-are used in some of the most modern machine tools, including milling_ machines. in which badly-fitting or flimsy slides cannot be tolerated. The methods which will be described for constructing the slide in this case will ensure correct fit and smooth operation.

Stop Indexing Gear

The capstan head is arranged to index by hand in the usual way, and is locked in position at each tool station by a spring pin attached to a readily accessible lever. It is geared to the stop shaft by a very elementary form of toothed gearing which is neither a bevel or a spur gear, or yet any other classified type of gearing-but it does the job ! The " teeth " in the underside of the capstan head are formed by a number of holes spaced equidistantly on a circle concentric with the axis of the bore, and they mesh with a thin-toothed wheel similar to a chain sprocket, on the stop shaft. This shaft runs in two bearings on the underside of the capstan slide, and passes out through the stationary slide frame crosspiece, beyond which it is fitted nith an adjustable disc, drilled and tapped to take the six stop screws.

Either a round or hexagonal capstan head may be employed, the latter being preferable as it enables tools, steadies or other fittings, to be bolted to the flat faces, in cases where this is better or more convenient than fitting them to the sockets. The number of stations provided in a hexagonal capstan is sufficient for most ordinary purposes, provided that the possibility of using one or more cross-slide tools is also considered.

(To *be continued)*

Clean Hands

Acetone is useful for cleaning the hands after using a paint-brush, as it will remove paint, varnish, shellac, enamel, lacquer and stain.--\\‘. F. COMERFORD.

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THE tool holder drawbolts, shown in Fig. 9, should be made and fitted before the tool holder sockets are drilled in the capstan head ; this will enable the half-round notch to be formed in situ during the latter operation. They may be made from 3/8-in. bright drawn mild steel, turned down and screwed 1/4in. B.S.F. at the end, and the holes which receive them should be reamered, preferably with a D-bit, so that they are a light drive fit. This will ensure that they remain in place while drilling the sockets ; afterwards they may be eased a little with emery-cloth if desired, but this is not strictly necessary, and, in fact, there is no need to remove them at all when once fitted. If they are taken out, it will be advisable to mark them for identification, so that there is no doubt as to which holes they belong.

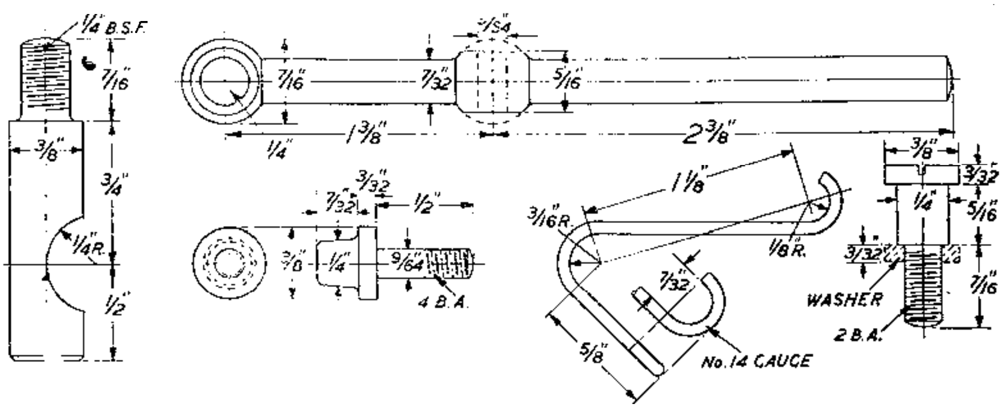


Fig. 9. Details of tool holder drawbolt (six off), unlocking lever, locking pin, spring and pivot screw (1 off each).

Unlocking Lever

There are several ways of making this component, and some readers may prefer a forging operation, but for those who have not the ability or facilities for this kind of work, a round section lever, which can be produced by turning as shown in Fig. 9, and subsequently bent to the required shape (see Fig. I), can be recommended. The spherical portions of the lever should be formed as accurately as possible, so that when cross-drilled and spot-faced on either side, they will present a neat appearance. There will be no difficulty in bending the lever cold ; its exact shape is not highly important so long as the locking pin points directly towards the centre when it is fully engaged. The reason why a bent lever is necessary is to ensure that the pin can engage the holes in the capstan head without any tendency to displace the latter. Some readers may consider that a plunger type of locking pin might have been better here, but while there is no objection to any constructor using his own discretion in the design of any of these details, it will be found that for ease of operation and simple construction, the pivoted lever has much to commend it.

The locking pin should be made either of tool-steel, hardened and tempered at the end, or of mild steel, case-hardened. It is screwed 4 B.A. at the tail, and the collar may be provided with flats to hold it while screwing up the nut. At the engaging end, it is tapered to an included angle of about 10 deg., and of such a size that it will enter about half-way into the holes in the capstan head, the point being carefully rounded off.

The pivot screw of the unlocking lever, which is also shown in Fig. 9. is a straightforward job, which calls for no special instructions, as it can be turned and screwed at one setting and parted off from a piece of 3/8-in. mild steel rod. It will be seen that a special washer is required below the shoulder of this screw in order to pack the lever up to the required height, so that the pin is level with the holes in the capstan head.

A piece of spring-steel wire, 14-gauge or thereabouts (a spoke from an old motorcar wire-wheel is suitable) is bent approximately to the shape and dimensions shown in Fig. 9, to form the unlocking lever spring. It will be seen that the upturned end bears against the side of the lever, the middle bend then passing round the pivot washer and the tail being hooked around a stop screw set near the edge of the capstan slide plate.

Slide Operating Lever

This lever, and its connecting link, are shown in detail in Fig. 10. Both parts are made from rectangular mild steel bar, 3/4 in. wide by 1/4 in. thick, or the nearest available section. It may be mentioned that while the use of plain bars, with no attempt at improving their appearance beyond rounding

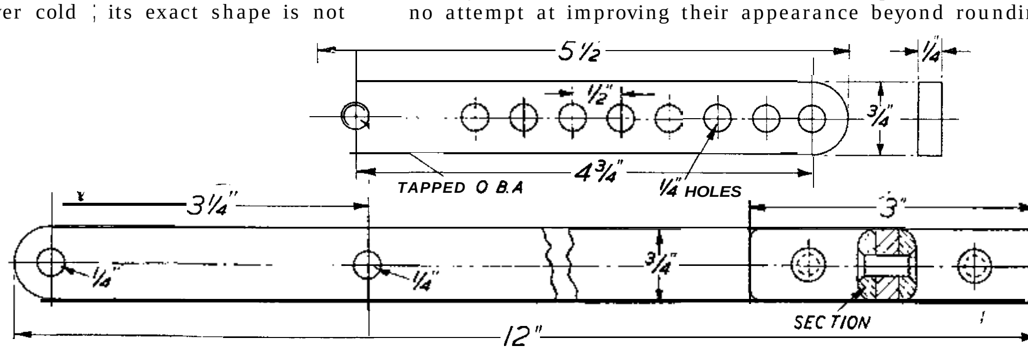


Fig. 10. Slide operating lever and link (1 off each).

* *Continued from page* 338, " *M.E., April 24, 1941.*

off the ends, may be objected to on the grounds of crudity of design, they will effect their intended purpose just as well as elaboratelv designed components, and are thus justified from the utility point of view. The pivot holes in these parts should be carefully reamered out to take the pivots, with the exception of the hole at one end of the link, which is tapped 0 B.A.

Some means of providing a comfortable grip must be furnished at the end of the lever. There are several ways of doing this, but one of the simplest is shown in the drawing, and consists of attaching pads of fibre, ebonite, hardwood. or metal, about 3/16 in. thick, on either side of the lever, and carefully rounding off all corners. The simplest way to attach the pads is by means of a couple of rivets, as shown, but if hardwood or a soft variety of fibre is used, it would be preferable to use special sunk bolts and nuts,

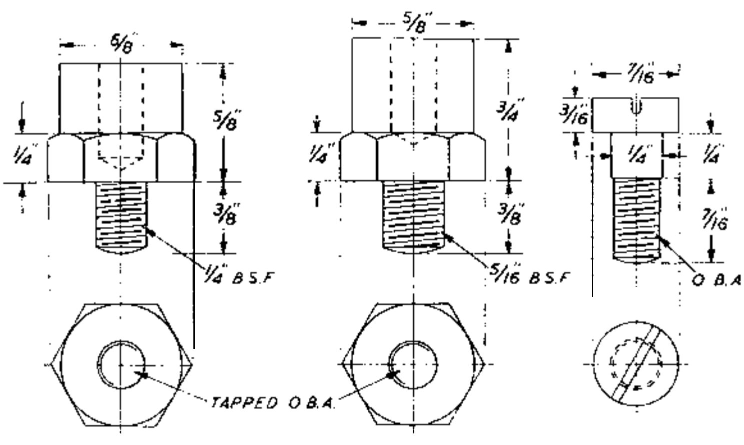


Fig. 11. Lever and link pivot posts (1 off each) and pivot screw (3 off).

similar to those used for securing the wood stock of a hand-saw. This form of grip is very comfortable to handle, but may be further improved in this respect, if desired, by slipping over it a 3-in. length of rubber tube, or a cycle handle-bar grip.

Lever and Link Pivots

The lever and link are pivoted on special screws, the points of attachment on the capstan slide and rear cross-bar respectively being provided by " posts " screwed into the respective parts. Details of these posts and the pivot screws are shown in Fig. 11; the former may be made of any available material, but the diameter should be kept fairly large, in order to present a large bearing face on the surface. It is not entirely essential to make them from hexagonal bar, so long as some provision is made for screwing them home firmly. Although they have to be screwed home against the faces on which they are fitted, it has not been considered desirable to undercut the threads against the shoulder ; a better method, in the present case, is to countcrbore out the last thread or so in the tapped holes. The link pivot post is, of course, fitted to the tapped hole in the rear cross-bar, which also takes the gib clamping screw on the underside; the latter must therefore be shortened so that the two screw points do not foul, but if preferred, the post could be made with a screwed shank sufficiently long to pass through the bar and take a nut, thus dispensing with the need for a set-screw.

The pivot screws, three in number, are all alike, but while two of them are inserted in the tapped holes in the pivot posts, the third screws into the tapped hole in the link and is locked underneath with a nut. These screws should be closely fitted both in respect of diameter and length, so that slop and backlash of the operating gear is avoided.

Locating the Capstan Head

After fitting the lever and link, the slide can be operated " under its own power," so that it is now possible to mount up the capstan for drilling the tool-holder sockets. The slide should be attached to the lathe bed, the capstan head put on its post and lightly clamped with any one of its facets dead square with the lathe axis. In order to check up on this, the lathe faceplate should be mounted and ascertained to be running quite truly. A straightedge, consisting of a parallel bar about the same length as the diameter of the faceplate, is then clamped to the front facet of the capstan head by anv convenient means. The capstan slide is now prevented from moving, by wedging a piece of wood between its rear end and the rear cross-bar (avoid driving this in so tightly as to strain or distort the slide), and the distance between the straightedge and the faceplate checked at the two extremities, by means of inside calipers or some other suitable form of gauge. After adjusting the head so that there is no perceptible parallel error, it should be clamped tightly, care being taken that it is not shifted in doing so.

The unlocking lever is then placed in its working position, with the pin engaging the appropriate hole in the head, and packed up by means of a strip of metal under the face of the end boss, and a thinner piece under the middle boss. Clamp the lever in position by means of a large tool-maker's clamp, or an improvised device of a similar nature, and " spot " the tapping hole for the pivot screw by means of a 1/4-in. drill, which will, of course, have to pass through the packing piece in order to carry out this operation. Remove the lever, drill and tap the hole for the pivot screw, and fit the latter thereto. The unlocking lever, together with its washer and spring, may now be fitted, and if proper precautions have been taken, it will be found that the locking pin lines up perfectly with the hole. Although not shown on the drawings, a stop screw or peg, to prevent the lever being drawn back so far as to strain the spring, would be a useful addition.

In the event of any error having occurred in the location of the pivot hole, however, it is possible to correct it by making use of a longer pivot screw, passing through a slotted hole in the plate and equipped with a nut and washer underneath; or an eccentric pivot screw, passing through a plain hole, with a nut underneath, may be used. Another means of correction would be by completely re-machining the facets of the head, in situ, as will be referred to later. But none of these expedients should be necessary, if the work is carried out in the manner described.

Boring Tool-holder Sockets

The head may now be unclamped and rotated, when it should be found that the locking pin will engage with each of the holes in the head, and locate each facet in turn, exactly square with the lathe axis, the test with the parallel straightedge being repeated in each case. Again, accuracy should be automatic, if the head was indexed for machining the facets in the manner described last week; but in the event of error having crept in, through tackling the job by a different method, or for other reasons, ir would be advisable to mount up the capstan head and slide plate on the cross-slide of the lathe, taking the utmost care in setting, to ensure that the slide ways are in true axial alignment with the bed, and re-facing each facet in its true location,

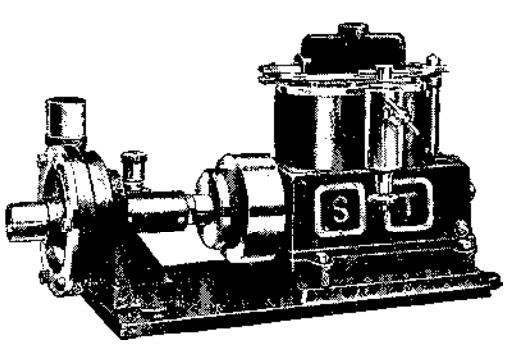
(Continued on next page)

Small POWER PUMPS

IN a recent article on " Improving Fire-Fighting Appliances," our contributor " Artificer " stressed the usefulness of small power pumps as a means of supplying water for replenishinq local reservoirs on roofs or other remote conditions, and suggested that some of the small petrol engines constructed by model engineers are quite powerful enough to drive them. This view is confirmed by Messrs. Stuart Turner, who, as most of our readers are aware, manufacture several types of small petrol engines, and also a complete range of small centrifugal pumps, some of which are intended to be built integrally with fractional h.p. electric motors, and others suited for direct coupling or belt drive from any convenient source of power. In connection with this, they have sent us a table showing the performance of their Nos. 10, 11 and 12 pumps, which we reproduce herewith, and express the opinion that,

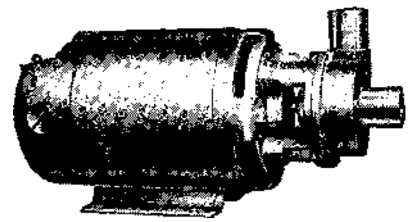
OUTPUT TABLES OF STUART PEDISTAL PUMPS.

	Head, In Feet	G.P.H	R.P.M.
No. 10	5	130	4,000
	10	100	
	5	100	3,500
	10	50	
	5	75	3,000
No. 11	5	50	2,000
	5	180	2,500
	5	200	3,000
	10	300	
	5	350	3,500
	10	200	
	5	350	4,000
	10	300	»
	15	200	"
No. 12	5	200	2,000
	5	350	2,500
	5	500	3,000
	10	250	
	5	600	3,500
	10	500	"
	15	300	
	20	420	4, 100



A Stuart centrifugal pump direct-coupled to a " Sirius " high-speed steam engine.

without the least doubt, any of these pumps could be driven by the Stuart " Lightweight " two-stroke engine of 30 C.C. They also append some useful details of the pumps in question, which incorporate a verv ingenious patented gland, consisting of a carbon disc which is pressed against the sealing face of the rotor casing by means of a bell-



A Stuart motor pump unit, in which the centrifugal pump is built into the endplate of a fractional h.p. electric motor.

shaped rubber washer. Apart from the efficiency of this gland in preventing water leakage, it produces far less friction than the ordinary packed gland, and thus the pump requires far less power to drive, besides which it is immune from the rapid wear and scoring of the shaft frequently encountered with the ordinary types. In addition to their range of pumps which are supplied ready-made, attention is also called to those types which are available in the form of castings. The larger of these (No. 2) will deliver 180 gallons per hour at an included head of ten feet, when driven at a speed of 3,700 r.p.m., and is thus suitable for the purposes referred to.

Capstan Attachment

(Continued from page 348)

as determined by the locking pin in each case. This can be done by means of a face mill held in the chuck, the head being traversed across it by the cross-slide.

It may be remarked that meticulous accuracy of the facets is only of momentous importance when they are to be used for mounting tool-holders ; it has no significance in the case of socket-mounted tools, and should the constructor decide to use a round capstan head, the question does not arise at all. But in a hexagonal capstan, it-would be most slovenly to let the job go through with the facets out of square with the socket-holes, on the grounds of general workmanship. To the good craftsman, " right's right, and there is no such thing as ' near enough ' ! " — a much better policy than the ultra-modern one : '. if you can get away with it, it's O.K. ! "

The capstan head is traversed on its own slide for drilling the socket-holes, which should be started by means of a short stiff drill, such as a centre drill, and every care taken to avoid a tendency for the holes to run out of truth. After deeply centring, the drilling should be done in at least two stages and very cautiously, so as to avoid any snatching, which might tend to shift the drawbolts. Finish the holes with a reamer or D-bit, the latter being preferable, as the slight taper or " lead " on the end of the ordinary reamer will prevent the production of correct parallelism in a blind hole. The drawings show the holes passing right through into the centre bore, but this is not possible when drilling them by this method, neither is it strictly necessary. 4-3/8-in. hole should, however, be put right through the capstan post to form a clearance for abnormally long pieces of work which may have to be turned by the attachment.

(To *be continued)*

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THE precise dimensions of the various components, which will be illustrated in detail, mav have to be varied to suit the size or type of lathe to which the attachment is to be fitted, or the stock material available for constructing it. For instance, although the sections of rectangular bar stock selected for the slide crossbars are believed to be the most suitable for the purpose, there is no objection to the use of sections differing in width and depth if these are not available, so long as the difference is allowed for, and the desired results are achieved. The dimensions in respect of essential heights, widths, etc., of the complete assembly are correct for the 3 in. lathe owned by the writer, which is of a type very popular among model engineers ; but in the event of the sizes being modified to suit other lathes, it is most important that matters should be arranged so that the centre of the capstan head sockets coincides, both vertically and horizontally, with the axis of the lathe centres. The exact alignment of these sockets, assuming that general dimensions are properly adapted, will be ensured by the methods to be described for machining the capstan head.

Slide Frame

This embodies the two cross-bars with their gibs (Fig. 3) and two 11-inch lengths of dead straight (preferably precision-ground) mild steel bar, 1/2 in. diam. The ordinary commercial quality of bright cold-drawn bar may, however, be used, provided that it is ascertained to be perfectly straight, circular, uniform in diameter within 0.001 in., and free from roughness.

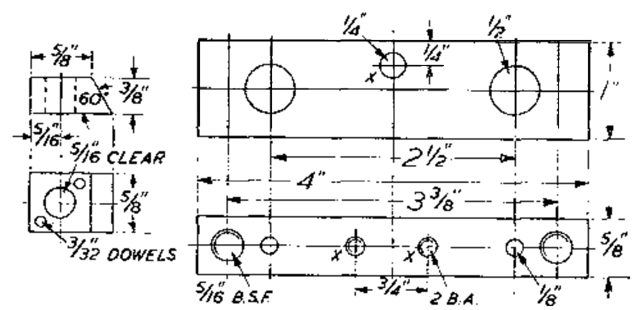

Fig. 3. Slide frame cross-bars (2 off), and clamping gibs (4 off).

The cross-bars should be cut from rectangular bar stock and trued up dead square on the ends, also checked up for general truth on all faces, and if necessary corrected by filing and scraping. As the capstan slide cross-bars have to be dealt with in a very similar way, they may be cut and trued up at the same time. One face and one edge of each bar should be -plainly marked so that no confusion subsequently arises as to which is intended to be front and back, or top and bottom, just in case of any discrepancies, which should not arise, but often do.

The slide frame cross-bars should now be drilled and tdpped to take the clamping gibs, and the latter cut to the dimensions shown in Fig. 3. It will be seen that the latter are drilled to take 3/32 in. dowel pins, a precaution which is strongly recommended in view of the tendency of the gibs to twist round when the single bolt, by which the); are attached, is tightened up. This would result in the gib jamming rather than tightening properly against the vees of the bed, and entail a risk of damaging the latter. The 60-degree edge of the gib should be carefully fitted to provide a good bearing surface, and the position of opposing gibs should be arranged so that they grip the bed firmly when both bolts are fully tightened. A large gap between the gib and the underside of the cross-bar is very undesirable, as it causes the gib to cant and impairs the bearing against the bed, besides tending to bend the bolt. One of the gibs on each cross-bar-preferably that at the front-may be kept permanently tightened up, or even riveted to the cross-bar (when once the frame is completed), the other being tightened or lossened for attaching or detaching the appliance from the bed of the lathe. In some lathes it may be found that there is insufficient clearance between the saddle apron and the bed to allow of using gibs of the thickness shown, or projecting boltheads. In this case, it is permissible to use thinner gibs at the front of the bars, and to attach them by countersunk screws.

The next and most important job on the cross-bars is the drilling of the holes to receive the slide bars. In order to ensure smoothness and accuracy in the working of the slide, it is, above all things, most essential that these holes should be exactly the same distance apart in all four of the cross-bars, also the same distance from the reference face of each bar and square with the sides in both planes. There are several ways in which this job might be tackled, and the

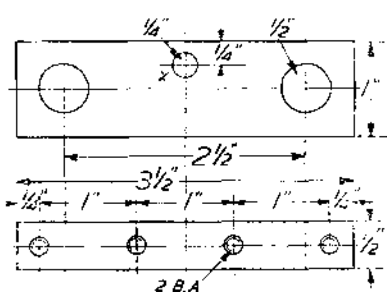

Fig. 4. Capstan slide cross-bars (2 off).

most obvious way seems to be to clamp or sweat all four of the bars together and drill them all at once. But as this method entails drilling through 2-1/4 in. of solid matter, it is quite possible that errors may occur through the drill running to one side, especially if the work is carried out in a drilling machine. Some constructors may prefer to drill the bars in the lathe, by clamping them on the cross slide and running the drill in the chuck. The spacing of the holes could then be ensured by traversing the slide a fixed distance (in this case 2-1/2 in.) without dismounting the bar, This would be quite a workmanlike method if a large lathe were available, and, by fixing up some kind of a traversing stop, it would be possible to deal separately with

* *Continued from page 284, " M.E.," April 10, 1941.*

the bars without risk of error in the spacing. But if only a small lathe is available, it wil! not be possible to traverse the slide the required distance without a risk that its rigidity or parallelism may be dubious at one end or other of the traverse.

After due consideration. a method of carrying out this operation has been decided upon, which enables all the required conditions of accuracy to be obtained without question, and has the further advantage that, as the work is swung on the lathe faceplate, any tendency of the drill to run out of truth is immediately- apparent, and can be corrected by boring if necessary ; also control of the size of the hole may readily be obtained. A rather interesting feature of this mcthod is that although the bars are located by the end faces, it is by no means necessary to make them all the same length to ensure accuracy.

The first step in this process is to make a gauge, of a length corresponding to the required centre distance of the holes. It is not necessary. in the present case, to observe meticulous car-e in measuring the length of the gauge, as slight errors do not matter so long as they are the same for each bar. The gauge may be made by facing and slighty rounding the ends of a piece of mild steel rod.

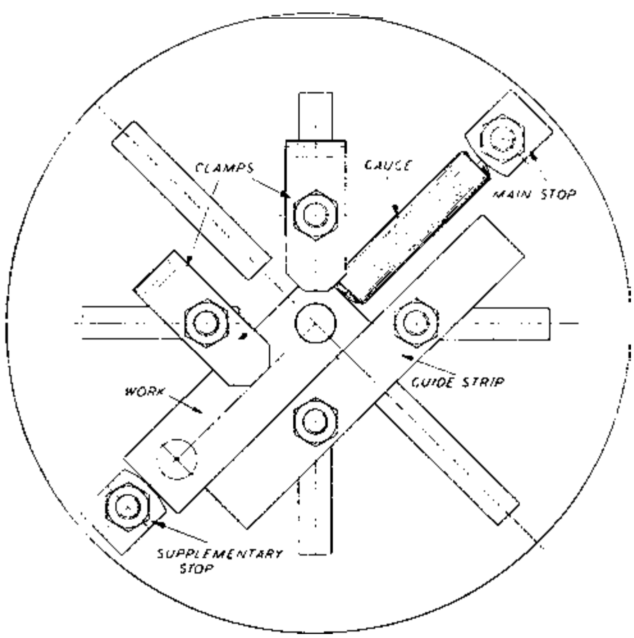

Fig. 5. Method of setting up the cross-bars to drill holes for slide bars.

The w ork is then roughly marked out to show the position of the holes, and set up on the faceplate so that one of the hole centres run truly. A dead straight strip of metal is then clamped to the faceplate in contact with the edge of the work. and an end stop also rigged to make contact with the end of the work furthest from the centre. This stop is not, strictly speaking, a necessity, but is useful because centrifugal force tends to throw the work to the edge of the plate when the lathe is running, and this is definitely prevented by placing a stop at the outer end.

Another end stop is now fitted opposite to the first, and at such a distance that the gauge will just fit between it and the end of the work. It is necessary to adjust the distance very finely, so that the gauge only just drops through with its own weight. The first hole is then drilled, bored and reamered while the work is held in this position, after which the clamps which hold it are released and it is slid along in contact with the guide strip till it abuts against the other stop. It is now in position for drilling the other hole, but just to guard against error, it is advisable to try the gauge in at the other side before carrying out the operation. The necessity for shifting the stops only arises if the length of the work varies, and thus the two pairs of cross-bars can be drilled at two settings of the stops. Fig. 5 shows this method of setting up.

The holes in the slide frame cross bars should be finished to a light driving fit on the slide bars, and those in the capstan slide cross-bars to a push fit. If the available reamer is of such a size that it produces a hole of the required size for the former, it will obviously leave the latter too small, in which case the holes may be lapped out after reamering. Conversely, it may he found undesirable to pass the reamer right through the holes in the former pair of bars.

It mill also be noted that the holes in the capstan slide cross-bars must be slightly below the centre line (this is not shown in the detail drawings), to provide clearance over the lathe bed when they are fitted to the slide bars. This can be allowed for in marking out the centres of the holes, and the guide strip on the faceplate adjusted to suit, when they are set up for drilling. A simpler method, however, is to leave the guide strip in place, and interpose a thin strip of packing (say between 20 and 24 gauge) between the bar and the strip.

The drilling of the other holes in the two sets of cross-bars may be left to a later stage in the construction ; the tapped holes in the capstan slide bars, for instance, may conveniently be spotted through from the holes in the slide plate, and those for the pins or grub screws which secure the slide bars to the slide frame cross-bars may be drilled when the frame is finally assembled. When carrying out this operation, it is most important that the frame should be quite square before drilling holes, and that the two bars should rest truly on the lathe bed, or other flat surface, without any suspicion of twist.

(To *be continued)*

The " Pittler " Lathe

(Continued from page 310)

refer- to the centre of the worm wheel, and are then matched with a worm of 5 t.p.i. on a pitch diameter of 1 5/16 in. and a blank diameter of 1-7/l6 in., 3 " thou." full. The nearest diametral pitch is 16, which would have to have a wheel l/l6 in. less in pitch diameter, but could not have the worm cut more nearly accurately than with an error of 4 thou. per pitch.

In a conclusion of these notes following, the suggested values of the toothed and worm gears of the 3-1/2 in. lathe will be given, unless positive information relating to an actual example comes to hand.

Referring to Fig. 27 it will be noticed that the division plate *D* is adjustably fixed to an extension of the bracket bearing, and an arrangement of the index arm and spring index, with counting sector, will be given in the conclusion, which gear is a duplicate of that on the head dividing spindle.

It only remains here to point out that the cone pulley, in one with its pinion, runs free on an extension of the pivot shaft, to which position it is kept in gear line by a loose collar on the shaft extremity shown dotted. This is about all that can be written for the moment, and it is pointed out that most general dimensions as applied to the 3-1/2in. lathe can be scaled off the illustration by measuring such dimensions with a rule and adding half as much again to the reading. All main dimensions will be given apart from this.

[(To *be concluded)*

*A CAPSTAN ATTACHMENT for Small Lathes

A device for the expeditious and accurate quantity production of small turned parts in the home workshop

By "Ned"

Capstan Slide Plate

THIS is made from a piece of flat steel 6-5/8 in. long by 3-1/2 in. wide and 3/8 in. thick (Fig. 6). A piece of boiler plate will serve the purpose, provided that it is reasonably true, or can be made so. The plate should be made as flat as possible by filing and scraping on both sides, using a surface plate or a thick piece of plate glass for a reference plane. The countersunk holes for the screws which secure it to the slide cross-bars should then be drilled, and the latter clamped to the plate in their correct location, the slide bars also being inserted through the holes, after which the holes can be spotted, drilled and tapped to take the screws.

In order to locate the hole which receives the capstan post, so as to ensure its accurate alignment with the lathe centres, it is advisable to assemble the complete slide frame and attach it to the bed. Then set up a rigid mandrel to run truly in the lathe chuck, and long enough to project over the top of the capstan slide plate; if necessary, take a skim over the mandrel to make sure it runs truly. Now set a square on the plate at right-angles to the lathe axis, and bring the edge of the blade up to make contact with the mandrel. Scribe a mark on the plate where the end of the square-blade comes (or the end of the stock, if the blade does not come right to the corner). Repeat the procedure the other side of the mandrel, and then bisect the distance between the two marks, which will give the true centre-line for the post. In order to check up on any possible errors, the procedure may be repeated at two or three points along the slide plate, or with the latter at various positions on the slide bars. Observe the greatest care in drilling and tapping the hole, so as to ensure that it lies correctly on the centre line, and is perfectly square both ways with the surface of the plate. The complete capstan slide may now be assembled on the slide bars, the cross-bars of the latter driven on and pinned as previously described, and the frame clamped to the lathe bed. If it is found that the capstan slide moves too stiffly on the bars, it may be lapped in by applying metal polish or similar fine abrasive paste to the bars and working it backwards and forwards. When finally fitted it should work quite freely and smoothly, but with no perceptible shake at any point in its travel.

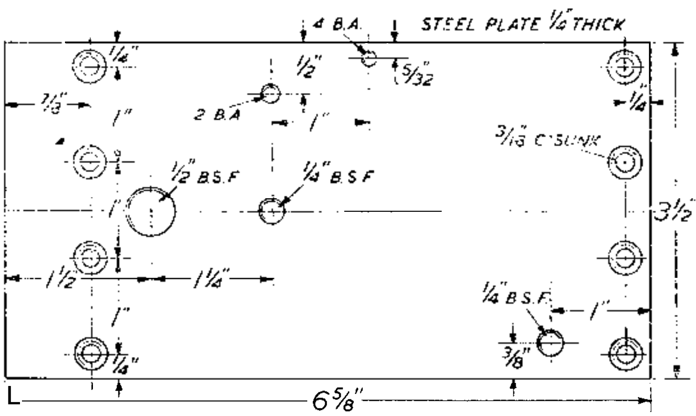

Fig. 6. Capstan slide plate (1 off).

Capstan Post

No special instructions should be necessary for the machining of this component, which is turned between centres from a piece of mild steel bar to the dimensions shown in Fig. 7. The threads on both ends should be screwcut in the lathe, so as to ensure that they are perfectly true with the axis, and that at the lower end should be undercut adjacent to the shoulder and the latter faced off truly so that it will bear firmly against the plate when the post is screwed home. As the post is to be a working fit in the bore of the capstan head, some constructors may prefer to machine the latter first, and fit the post to it.

Clamping Lever

This may be made from the solid without a great deal of difficulty, by first roughing down a piece of 1-in. bar to a little over the maximum diameter of the taper shank (do not taper it at this stage), and if desired, a little extra length may be turned down to a smaller diameter to take a supporting centre. Reverse the work, holding it by the shank to form the spherical boss, and after roughing the latter to approximate shape, finish it by hand tools, using a radius gauge to check up. When a satisfactory appearance has been produced, the job is again reversed, the surface of the boss being protected from marking by the chuck jaws by means of a strip of copper bent round it, and the shank tapered and rounded off at the ends.

The lever is then held crosswise in the 3-in. jaw chuck, gripping it over the boss with the shank inclined backwards towards the chuck face at approximately 15 deg. In this position the boss can be faced, drilled and tapped to fit the top end of the capstan post.

No detail drawing of the washer which is interposed between the lever and the capstan head has been considered necessary, as it presents no special features, but it should be large enough in diameter to provide a good bearing on

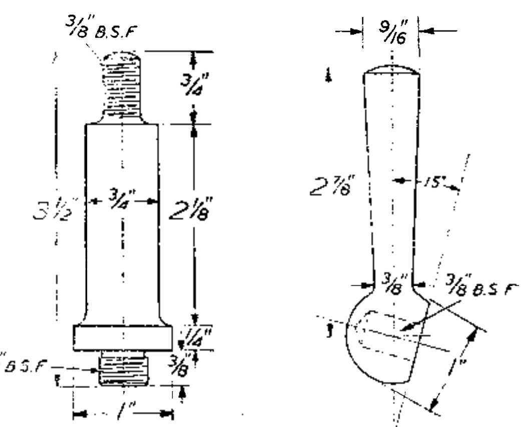

Fig. 7. Capstan post and clamping lever (1 off each).

* Continued from page 312, " M.E.," April 17, 1941.

the face of the head, and thick enough to withstand distortion when the lever is clamped down. The lever should not project forward under these conditions, and it may thus be found necessary to adjust the thickness of the washer, or add a thin shim, so that it comes in a suitable position.

Capstan Head

Either a casting or a solid piece of iron or steel bar may be used for this part, the former being recommended, as entailing less heavy machining. It should first be set up in the chuck, gripping it over the lower spigot, to face the

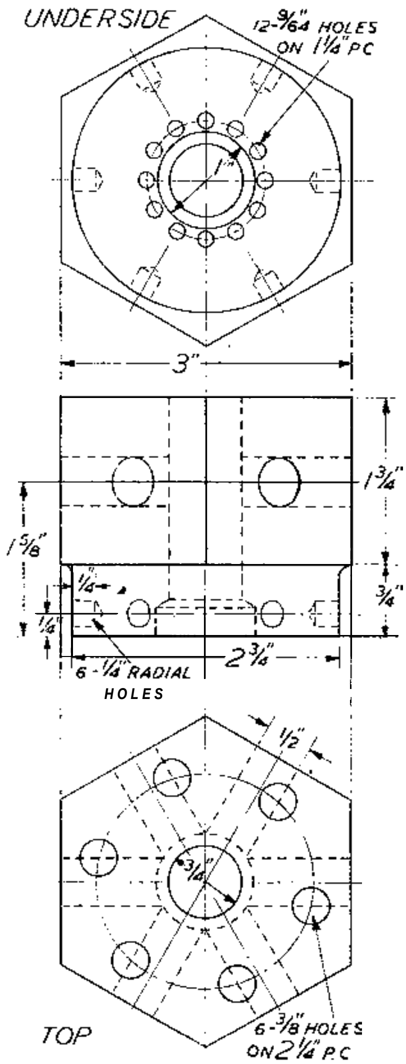

Fig. 8. Capstan head (1 off).

top, after which it is reversed, and bedded firmly against the chuck face, for facing the lower end, turning over the spigot, and boring the centre to fit the post. While thus set up, a line should be marked around the spigot to locate the height of the locking-pin holes, and if any form of indexing device is available, they may also be marked out for angular position, the greatest possible accuracy being observed in this operation. The relation of these holes to the flat facets of the head is also important. It may here be remarked that, even if the lathe head is indexed, simply using the index as a guide to *scribing* the centre lines of the holes is hardly good enough, because with all the care in the world, errors often occur when drilling to a marked line. A very much better method is to spot the holes by means of a drill spindle held in the tool post, on the centre line of the lathe. If such a fitting is not available, a good plan is to mount a centre punch horizontally in a light holder, the end of which can be held in the tool post, so that the punch is on the centre level. When the work is indexed into position, the punch is brought up so as almost to touch it, when a sharp tap on its head with the hammer will spring the holder sufficiently to produce an indentation which will locate the drill point positively.

The same methods may be employed for marking out the twelve 9/64 in. holes in the base of the capstan head, which are pitched on a circle of 1) in. diam.; and these also should be marked out before removing the capstan head from the chuck.

In order to machine the facets of the head, it is desirable to set it up on an angle-plate mounted on the lathe faceplate. A dummy post should be made to fit the bore of the head, and bolted to the angle plate so that the head can be rotated on it without disturbing the general setting. It is also very desirable to rig up some kind of an indexing pin, similar to the locking gear employed on the capstan slide itself, so that the facets can be located in their true relation to the locking holes. Note that as the particular capstan station in use is located by means of the hole on *the opposite side*, the same conditions must be observed when locating the head for machining the facets. All this may seem quite a lot of trouble, but the pains taken to ensure accuracy at this stage of the proceedings will make all the difference between a workmanlike job and a makeshift. In this particular operation, the essential point is the angular setting of the head ; there is no need to take great pains to set up the head so that the facet runs concentrically true. It is not proposed to bore the tool holder sockets at this stage, because, although it might be possible, by meticulous measurement, to ensure that these would be in the correct position to line up with the lathe centres when the head is mounted on the slide, the more certain method is to bore them in *situ*. This operation cannot, however, be carried out just yet, as it will be necessary to rig up the traversing lever, so that the head can be fed up to the drill on its own slide.

The method which has been adopted for securing the tool holders in the sockets is similar to that used in the majority of capstan lathes, and consists of a vertical bolt, located so that it partly intersects the bore of the socket, and cut away so that it does not obstruct the bore. When the bolt is drawn endwise by its nut, the cut away portion exerts a powerful wedging thrust on the shank of the holder, and grips it securely. Some constructors may prefer to fit ordinary set-screws directly over the sockets, but though these may be satisfactory for most purposes, they are more liable to damage the holder shanks. Even if the screw holes are provided with brass or other soft metal pads between the screw-points and the holder shanks, they are not entirely satisfactory for continuous use, as the pads may become upset and jammed immovably in the holes, or on the other hand, they may fall into the sockets when the holders are removed, become forgotten and eventually lost. If the holder shanks are fitted very neatly in the sockets, any scarring caused by the screw points will cause them to seize ; and if fitted with sufficient clearance to avoid this eventuality, they will be forced out of centre when tightened, besides lacking in proper rigidity in the side plane.

(To be continued)

*A CAPSTAN ATTACHMENT for Small Lathes

A device for the expeditious and accurate quantity production of small turned parts in the home workshop

By " Ned "

Stop Indexing Pinion

APOLOGIES have already been made for the design of the gear which rotates the stops ; the only excuse for its existence is that it is capable of performmg its allotted function just as effectively as a properly designed and cut bevel gear. It will readily be appreciated that, apart from low transmission efficiency, quite a considerable backlash in the meshing of the gears can be tolerated, since it is only necessary to turn the individual stops into such a position that they abut against some part of the head of the fixed stop screw. There is, of course, no objection to the use of a proper bevel gear by those who have the facilities for providing one ; the crude but effective substitute is intended for those who have not.

As will be seen in Fig. 12, the pinion resembles a small chain-sprocket wheel, and can be produced by methods which would equally be applicable to such a wheel. In turning the blank, it is advisable to make the disc diameter sufficiently large to enable the tooth spaces to be formed by drilling-say, not less than 1-1/2 in. It may, if desired, be built up by brazing or welding a disc of 1/8-in. sheet metal to a suitable boss in fact, riveting is good enough if it is properly done ; but in this case it may be advisable to leave the boss as large in diameter as possible, to ensure the disc being seated firmly and truly. Note that the permissible diameter of the boss is limited by the clearance under the capstan slide plate. The bore of the pinion, outside of boss, and one face of disc should be machined at one setting, after which it is advisable to mount the blank on a 1/4-in. mandrel to machine the other face. At this stage, both sides of the disc should be left parallel, the tapering off towards the edges being carried out after cutting the teeth.

The latter operation is carried out by first indexing out twelve divisions on a 1 1/4-in, circle, by any means which will ensure reasonable accurac y and drilling small pilot holes, afterwards opening them out with a drill and reamer to 3/16 in. dia. Replace the blank on the mandrel and turn down the edge to 1-7/16 in. dia., which will just break into the holes. It is now necessary to form the edges of the teeth by machining or filing, the latter being quite good enough in the present case, and capable of being carried out easily and accurateIy with the aid of a simple filing jig. This consists of a steel button," 7/16 in. dia. over the flange, and shouldered down to 3/16 in. to lit the holes in the disc. A centre hole is drilled and tapped for a fixing screw, by means of which it ii: clamped to the blank, with a thick washer, also 7/16 in. outside diameter, on the other side. Both the button and the washer should be case-hardened, and the device is used by applying it to each of the holes in turn, and filing the edges of the teeth away until they coincide with the contour of the flanges on either side. Finally, the pinion is again mounted on the mandrel and the outside edges of the teeth thinned down to about 1/16 in. wide at the tip.

It may be mentioned that this method of forming teeth is applicable also to small chain sprockets, and if care is exercised in the indexin g of the holes, will result in quite a sound and accurate job.

Fig. 12 also shows the beariing block for the index shaft, which is made from a piece of 1/2-in. square material, pre-ferablv brass. It will be noted that this must screw into the underside of the slide plate so that its faces arc square with the edges of the latter when it is tightened up ; this may necessitate the use of a thin washer under the shoulder. If more convenient, however, it is permissible to use round material, and drill the cross hole after it is fitted ; the two flat sides may then be formed by mounting the block on a mandrel and-facing them in the lathe. In either case, it is advisable to mark off the position for the cross hole while the block is in position, and by means of a scribing block, produce centre lines, in both planes, on the rear slide cross-bar also so that their alignment with the hole in the block is assured. It will be advisable to remove the rear cross-bars of both the capstan slide and the frame for drilling the holes for the index shaft, After the hole in the former has been drilled to 1/4 in. reamer size to coincide with the marked position, it may be clamped to the other cross-bar, with short 1/2-in, dowels in the slide bar holes, and the latter also drilled, a 1/4-in. reamer being then passed right through both bars. In this way, true alignment of the three holes through which the index shaft passes should he beyond question, at any point of the slide travel.

A detail which was inadvertently omitted from the

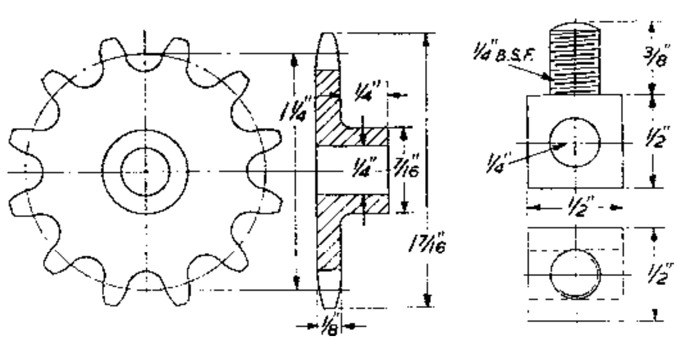

Fig. 12. Stop indexing pinion and bearing block (1 off each).

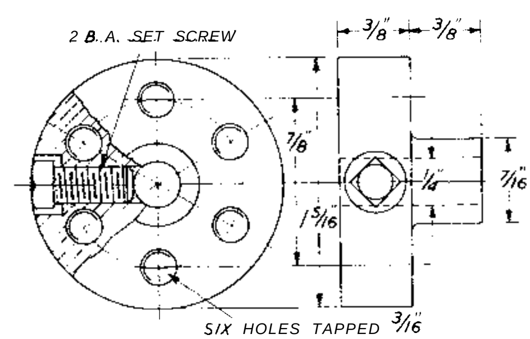

Fig. 13. Rotating stop holder (1 off).

* *Concluded from page 348, "M.E.," May 1, 1941.*

drawing of the capstan slide plate was the slot through which the indexing pinion passes to engage the holes in the underside of the capstan head. The position of this slot will, however, be obvious ; it is 1-1/2 in. long by 3/16 in. wide, and may be formed by drilling a row of holes and filing out the metal between them. Just as easy, and usually more satisfactorv a method, is to clamp the plate to an angle plate on the lathe cross slide and finish the slot, after preliminary drilling of a row of holes, by means of a 3/l6-in. end-mill.

The indexing pinion should be securely pinned to its shaft-grub-screw ing is not good enough, as there is always a possibility of the grub-screw loosening and upsetting the sequence of the stops ; being in a position which is not reaily accessible while the attachment is in use, it would be necessary to dismantle it to put matters right, and thereby valuable time might be wasted. A plain collar (not shown in detail drawings) is also pinned to the shaft behind the bearing block to ensure its endwise location.

Rotating Stop Holder

This consists of a steel or cast-iron collar having six axial holes to take the stop screws, and is shown in detail in Fig. 13. Its machining calls for no special comment, as all

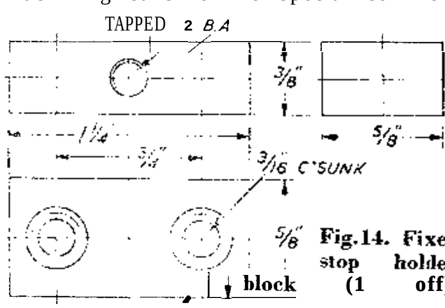

Fig.14. Fixed stop holder block (1 off).

operations are quite simple, and the drilling calls only for normal care. Any available long screws may be used for the stops, and although the general arrangement drawings show hexagon-headed screws, cheese heads are quite permissible, and mav be found easier to manipulate. The lock-nuts must, however, be sufficiently small in diameter to enable them to be operated on by an ordinary spanner, and for this reason it may be found necessary to make special nuts, or to open out some of a smaller original size. The cross hole in the holder is tapped by a screw, by means of which the holder is clamped to the shaft, and it is most important that this screw should be capable of being firmly tightened up. A headless grub-screw is not suitable, and a projecting head would foul the lathe bed so as to prevent rotation of the holder. It will be seen that a square-headed screw, sunk in a counterbore so as to lie flush with the surface of the holder, is specified in the detail drawing, but an alternative which will occur to many readers is an Allen set-screw with an internal square or hexagon ; this may be made 1/4in. dia., but in view of the small amount of room between the axial holes, great care will be necessary to avoid breaking into them when drilling and tapping the cross hole.

The exact length of the stop shaft is immaterial, but it should not be less than about 10 in. long, and may with advantage be made 12 in. long, if the spare length does not get in the way of other workshop equipment. In the writer's case, a rather crowded layout makes it desirable to avoid excessive length. A substantial flat should be filed or machined on the shaft for a length of 4 in. at the tail end to form a seating for the stop holder screw.

The fixed stop holder-block consists of a rectangular block of metal attached to the top of the rear slide frame cross-bar, to hold the fixed stop screw in alignment with the particular indexing stop which happens to be in use. A screw stop is not. strictly speaking a necessity here. but it will be found an added convenience, and is just as easy to fit as any other. In this case, a cheese-headed screw is not suitable, and the head of the screw used should be carefully faced off flat, so as to form a true abutment for the moving stop. The fixed stop must in all circumstances project from the holder block not less than the difference between the longest and shortest stops in the indexing holder. If the work which is being dealt with necessitates greater differences in the position of tools than is normally accommodated by the stops, it is possible to make further adjustment of the tool holders in their sockets : in extreme cases, it may be found advisable to employ extension holders. This expedient should not be adopted unless it is absolutely. necessary, however, because it adversely affects the rigidity of the cutting tools ; but in ordinary practice, the need for it only occurs rarely.

Tool Holders and Cutting Tools

This attachment may be employed in conjunction with ordinary capstan tool holders, so long as these arc furnished with 1/2-in. diameter parallel shanks to fit the sockets, and in other respects adapted to suit the size of the lathe and the work being handled. For those who are unfamiliar with the design of capstan tool holders, it may be mentioned that all the standard types are described and illustrated in the handbook, "Capstan and 'Turret Lathcs," which is obtainable from THE MODEL ENGINEER Publishing Dept., price 2s.2-1/2d., post free. It is, however possible to simplify many of these fittings in adapting them to the requirements of model work, without destroying their general utility, and should this capstan attachment prove to be popular among readers, so that there is a general demand for tools to suit, it is proposed to follow up this article with one dealing with the construction of appropriate holders for cutting tools, also tap and die holders, steadies, and other devices likely to be essential or helpful in carrying out normal production work.

Wrinkles

Rubber and ebonite may be ground on an emery wheel if French chalk is liberally used to stop clogging. Too fine a grade wheel is not satisfactorv.

For turning papier mache, use such tools and speed as that used for cast iron, and not metal turning tools used at wood-turning speed, nor wood turning tools at the latter speed.

Fine metal-cutting saws should be mounted so that they cut on the " pull " stroke-the .' Japanese " fashion-rather than on the " push," or forward stroke. Many broken saws will be thereby saved.

High speed hearings can be satisfactorily lubricated with a mixture of castor oil and sulphur ; in the proportion of 13 of the former to one of the latter This lubricant is satisfactory where no pressure exists on the journal.

For packing superheated steam-pipe joints, thin copper foil is far to be preferred to the usual red or white lead paint, being less likely to he pressed out as the flanges are tightened.

When it is desired to drill into a hard cast iron casting, heat it to redness and place a lump of sulphur on the spot to be drilled ; it will soften locally during cooling off,

To prevent rust deposit when working on bright iron or " tin-plate," wash the hands frequently in soda water, also rub pieces on the work, with a little water.-F.C.