Notes on LATHE DESIGN

By " **G.E.S.**"

ALTHOUGH many articles have been written about small lathes and many ideas suggested for model engineers' lathes, there is little information available as to those principles and proportions which make for success in lathe design. Out of a long experience and much research the following data have been obtained. These, wisely used, will produce a sound design for any ordinary sliding and surfacing lathe whether of 1-1/2 in. centres or of 9 in. centres-the same proportions will answer in all cases. It would be a fascinating exercise to make a 1-5/8in. or 1-3/4in. centre lathe fot tiny jobs.

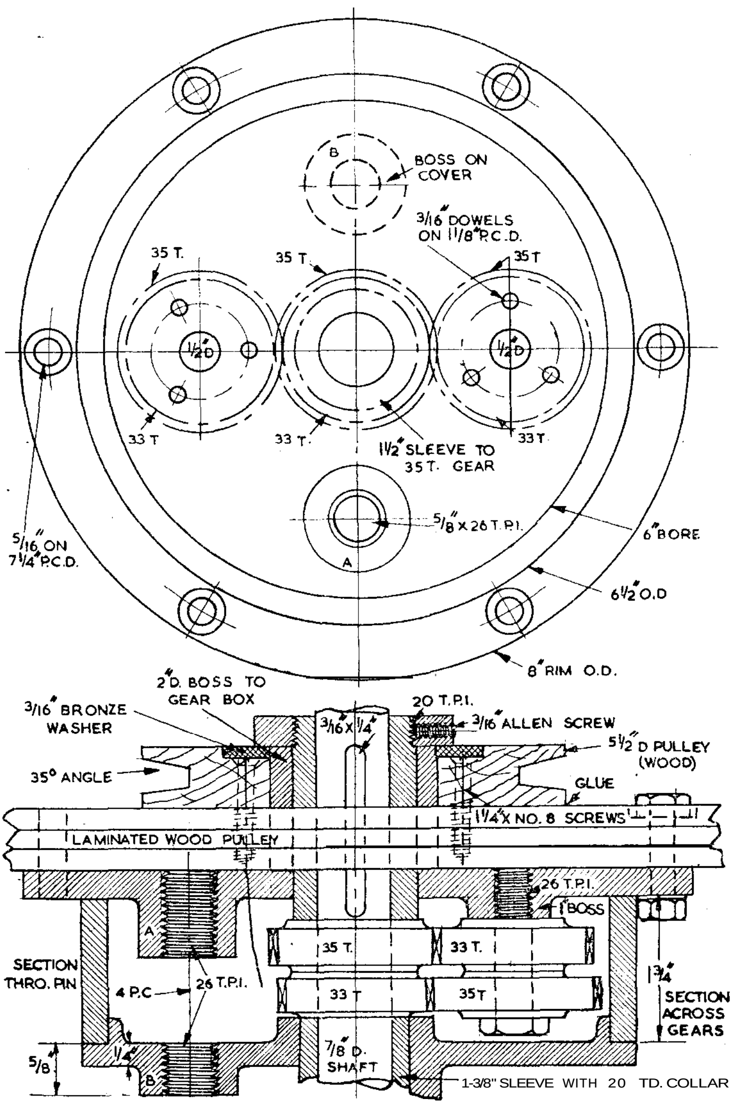
The proportions are worked from the centre height, thus allowing for a design of any centre height. Where akward fractional figures are obtained, these may be brought up to the nearest standard fraction above. C.H. equals centre height.

(I) Bed sizes: Width, minimum, 1-1/2 x C.H. If possible, the distance from the centre line to the front edge should be equal to the centre height, if not 2/3 of the width should be in front of centre line. Height, minimum, 1-1/4 x C.H. with feet extra or flat base and feet bolted on. ***Shear thickness,*** at least 1/8 x C.H. or 3/16 x C.H. for small lathes The front shear should be of rectangular section and narrow in width. The back shear should be from one third to three eighths of the total width, and is best with two 60 deg. (or 55 deg.) edges. The centre line of the lathe can be the front line of this shear, on which the tailstock is wholly carried. The drawing illustrates one idea embodying this.

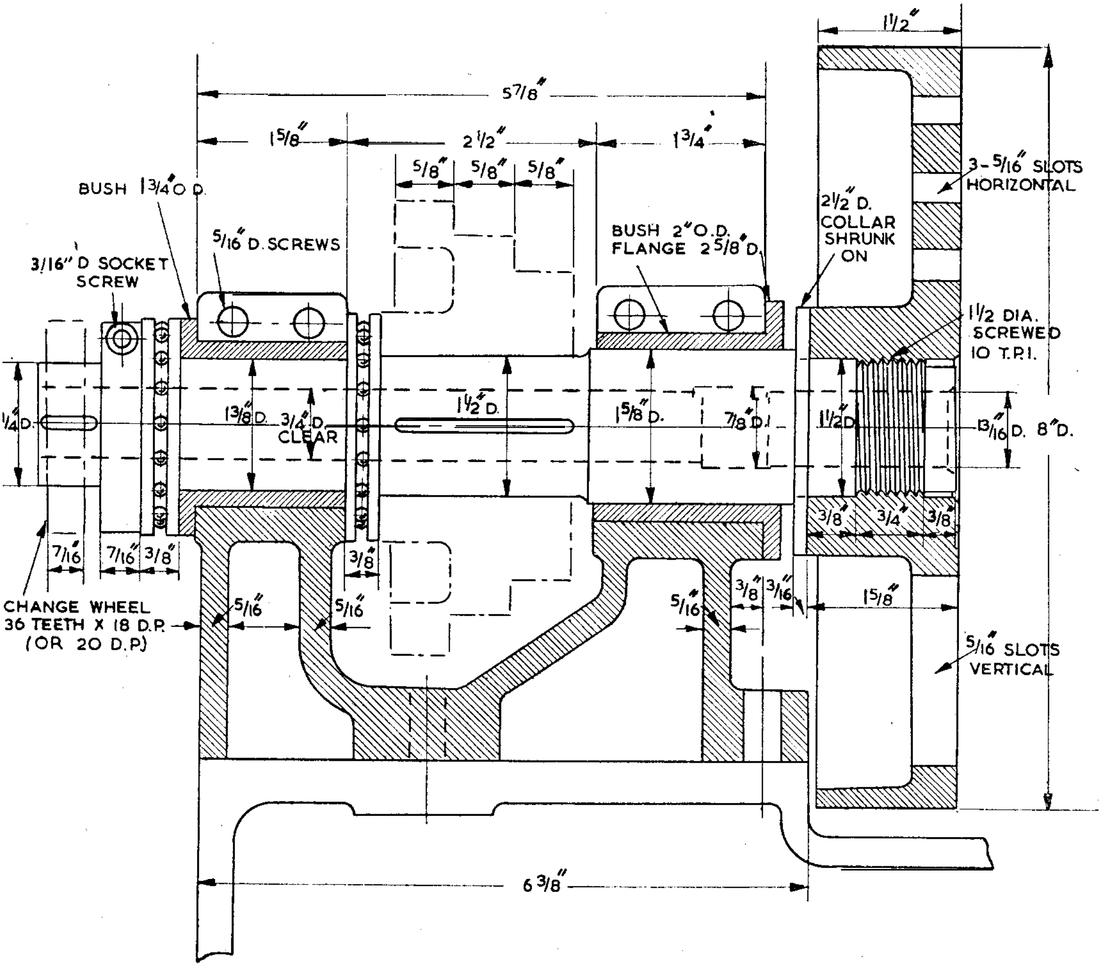
The bed casting should be of box section, as this can be designed with no loose strips, and only one draw-off core piece. A bed of 150 pounds weight was successfully cast in this way. Quite thin metal can be used, if great care is taken to avoid sudden. changes of section (see drawing)..

(2) The headstock. This is a simple one-piece half box casting. The bearings are high duty cast-iron, finished to a high degree with " Widia " or " Wimet " tools, and hand lapped to fit. Proportions: Front bearing, 4/10 of C.H. and half the centre height in length; tail bearing, 5/8 of C.H. and with length, 1/2 to 5/8 of C.H. The pulley bearing is some standard size in between these sizes, and the nose of the mandrel is equal to main bearing, or larger, according to collets fitted. The mandrel should be of at least 30-ton tensile steel. Finish to the mandrel can be either fine turned and lapped; or turned and ground, but in the latter case some slight lapping must be allowed for, to give the necessary precision fit.

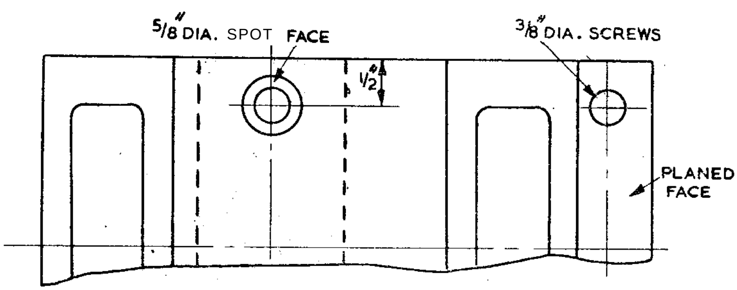
Tailstock. This is a simple casting, which may be any one of several shapes. As drawn, it is an easy matter to cast and machine, without



Back Gear (Epicyclic type)



Sectional elevation of lathe headstock based on data contained in the article



Part plan of headstock base

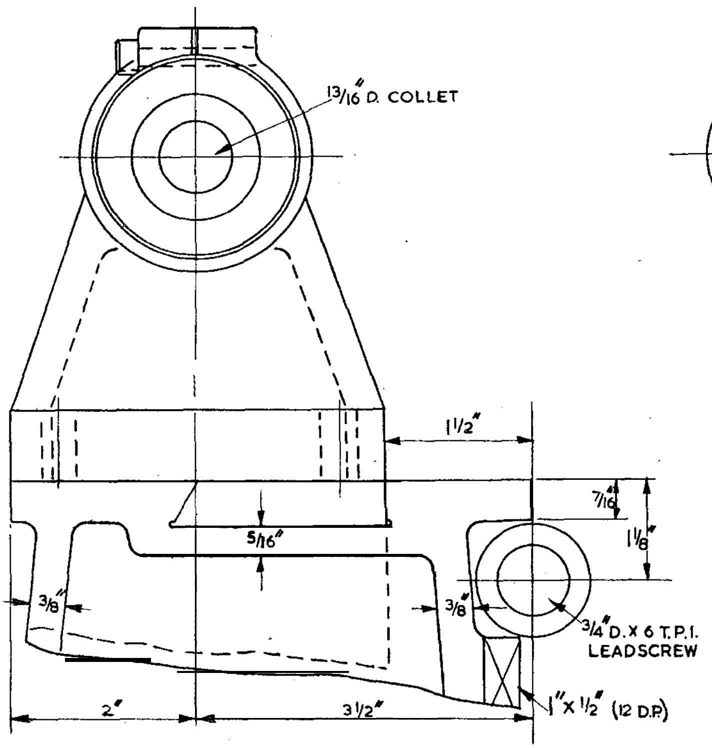
elaborate patterns or complicated machining operations. The barrel is fully floating, as the nut' and screw are inside the barrel. Proportions-the barrel should be at least 1-1/2 x the diameter of the centre fitted and have a travel equal to the normal length of a standard 3/8in. drill (4-1/2in.) in sizes up to 4-1/2 in. lathe, and equal to the normal length of a 5/8in. drill (5-1/2in.) in sizes above. The loose base makes for ease of fitting, and gives a desirable accessory, even if not used frequently.

ment, with simple parallel gibs fitted to the vees. These, though a little more difficult to machine are easier to fit, also definitely easier to measure for parallelism, and alignment to the mandrel.

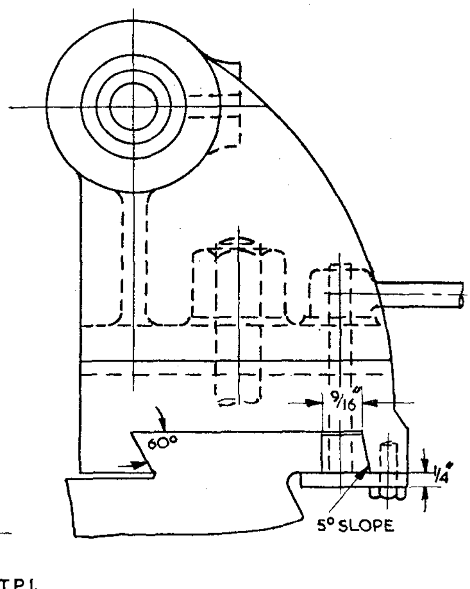
Whether an apron is fitted depends on the desires of the users. In practice, it is vital that if one is fitted, there should be a separate leadscrew and tail shaft; not, as so often done, a combined tall shaft and leadscrew. Where no screw-cutting is contemplated, a simple apron with cross and sliding traverses later on. All that is required as a basis for calculation is the highest speed and the lowest speed required (worked from the largest diameter to be worked and the smallest ditto). There are standards available in table form, but in cases of special nature, the formula is:

$$R = \sqrt[n-1]{\frac{b}{a}}$$

R = Ratio required.
n = The number of speeds required.
a = Lowest speed.
b = Highest speed.



HEACSTOCK



TAILSTOCK

Saddle. This should be well proportioned, the main dimension is the length of the front guide strip, which should be 1-1/2 times the bed width. The various sections of the saddle should be carefully worked out so that no sudden changes occur. The basic design of the saddle depends on the work to be done, but for small engineering, where a table is desired, a cross length should be allowed for, sufficient to give cross travel of twice the centre height. The width of cross' shears = 2-1/2in. to 3-1/2in. according to centre height. In the design of both cross-slide and top-slide, square shears should take the thrust, and vee shears act as adjust-

is practical, with a 3/8 in. vee-belt drive in lieu of gears-an obvious saving.

The speeds of a small lathe are of vital importance, and for model engineering, 12 speeds are really desirable. These should not be a matter of compromise nor of convenience, as is so often the case, but should follow a standard law as in larger machines. This law is a matter of simple mathematics-each speed after the first (starting from the highest speed) should be equal to not more than 75 per cent. the previous speed, i.e.: 1,000 r.p.m. first speed; second speed, 750 r.p.m. and so on. This will be demonstrated in an actual set of speeds

This formula can be written and worked as follows :

$$\text{Log } R = \frac{\text{Log } b - \text{Log } a}{n - 1}$$

In actual practice, the figure given would involve too many changes for the range desired in small engineering, so up to 66 per cent. is used to give few changes. The drive to give these can be an all vee-belt drive in small sizes of lathes, and a vee-belt drive with epicyclic gear for lower speeds in larger lathes. This gear is housed in the shaft pulley, out of the way, but handy to throw into gear if wanted, (see drawing).

(To *be continued)*