A MINIATURE TUBE BENDER

stock chuck and feed the saddle slowly against it. This should start a hole correctly without a centre punch mark. The latter should not be made; it will be almost impossible to ensure that it is set exactly opposite the drill and if it is not, the drill will follow it, start on the slant, and run still farther out of truth.

Any circumferential marks left by the drill are an advantage, as they help to grip the work endways—the direction of pull on it. Do not finish the hole with a reamer.

Next feed the saddle across to a position for drilling a hole to form the radius in corner of the cutaway, and proceed with drilling as before. Make two sawcuts to meet the hole and trim the space with a file, also filing flush with the edge of the base—the 1/64 in. projecting part of the jaw, now reduced to $\frac{1}{16}$ in. thickness.

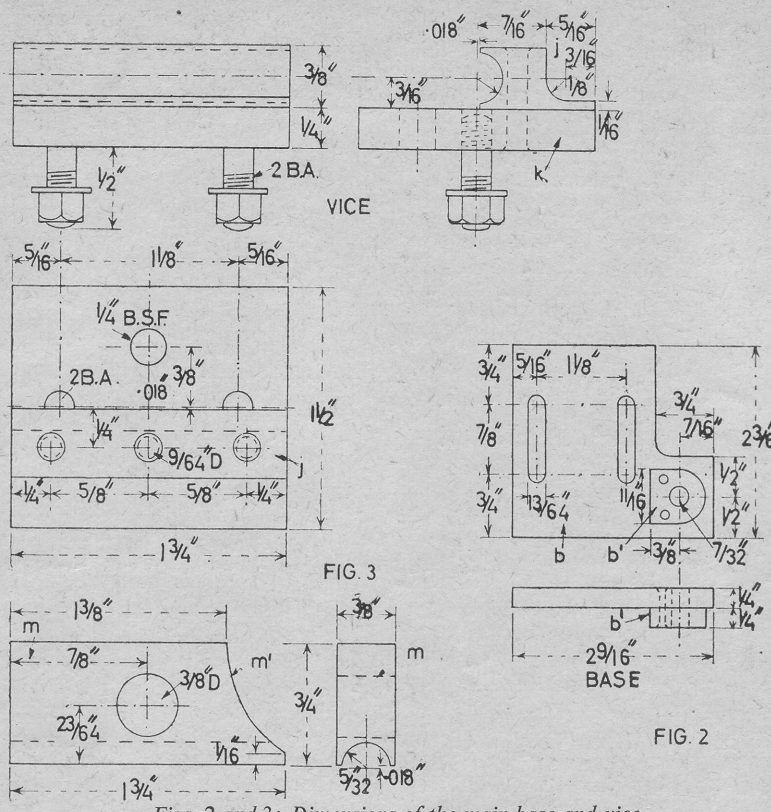
Cam and handle

The hole in the moving jaw, *M*, for the cam, *N*, is preferably finished with a reamer to leave the smoothest working surface, because the cam, *N*, must be a tight working fit, just moveable by the handle, otherwise, the jaw might have a tendency to slip loose. The cam pivot is turned out of a $\frac{5}{16}$ in. or $\frac{3}{8}$ in. bolt so as to have a head large enough to cover the end of the handle.

The screwed end is filed flush with underside of the base, *K*. The handle is of $\frac{3}{4}$ in. × $\frac{1}{8}$ in. stock, and the attitudes of the square hole in this and the square on the cam are such that the handle will be outwards parallel with the lever in the position of Fig. 1 when the vice jaws are closed up.

The tight position on the work should be a little before this. The eccentricity is so small in order to give sufficient closing force that there is a very small margin of movement to compensate for errors in workmanship, hence some experiment may be necessary and this is best applied to the positioning of the tapped hole in the vice base to receive the cam pin.

The bending roller lever, *D*, is shown in Fig. 4. The fork end is built up from $\frac{3}{4}$ in. × $\frac{1}{8}$ in. flats riveted to a piece of $\frac{3}{4}$ in. × $\frac{3}{8}$ in. stock. First drill and tap the holes in the latter for the $\frac{5}{16}$ in. round handle extension. Drill the holes for the roller pivot and, with a piece of rod through these for alignment, clamp the flats to the central block with the aligning rod square both ways. Drill and counter-



Figs. 2 and 3: Dimensions of the main base and vice

sink for rivets as before, then after riveting up, drill a hole for the pin, *G*, finally rounding the fork ends. The pin, *G*, should be a close working fit in the hole.

Locking the links to the pin

One of the two links, *E*, of $\frac{1}{4}$ in. × $\frac{1}{2}$ in. stock, is shown in Fig. 5, with its accessory screwed parts. The links are locked to the pin, *F*, by taper-pointed screws and the radius adjusting screws are locked by brass set-screws to avoid damaging the thread. It is intended that the adjusting screws should be made from 3 B.A. studding, but if they have to be screwed, rod can be used since a head is not necessary and would only waste time turning down.

On the other hand, long cheese-head screws can be used if available, but their heads must be reduced in diameter to the thickness of the links or less, or they will foul the lever, *D*. The same applies to the heads of the other screws. One of the links (left-hand link in the end view at right of Fig. 1) has a milled recess to receive the tip of the roller pivot and this acts as the aforementioned stop to hold the lever, *D*, against further movement after being brought into line with the links at the position shown in Fig. 1.

As has been explained, adjustment for different radii of bend, and for bringing the roller, *C*, firmly against the block *A*, is provided by mounting the pin, *G*, in the slots, *H*, in the links, *E*. Bearing blocks, *H*1, sliding in the slots are provided and, as the thrust is only in one direction, they need be only on one side of the pin, *G*, otherwise a wider and much longer slot would be necessary to accommodate them.

They are shown in the group of details (Fig. 6) and can both be made together out of $\frac{1}{4}$ in. sq. stock, drilled through for the pin, and afterwards filed on both sides to fit the slots—they are then separated. The tips of the adjusting screws should bear on the bottoms of the recesses, in which they should be a slack fit.

A spacing bush, *G*1, is required between the lever, *D*, and the right-hand link, E, in Fig. 1, having a clearance hole for the pin, *G*. The length over the shoulders of the pin, *G*, also shown in Fig. 6, should be such that, with links, lever, and spacing bush threaded on the pin and the washers clamped tight against the shoulders, the lever, *D*, is just free to turn without shake.

As the bearing blocks, *H*1, fit the spaces between the washers and lever, there is no possibility of their falling