Simple tube manipulation . .

Build this simple machine under the directions of G. S. BATES and avoid many of the pit-falls of tube bending

THE BENDING OF TUBE is performed in various ways and of these the four methods most likely to interest the model engineer are compression, roll, press and draw bending.

Compression offers a quick method of bending, since there is no mandrel on which to slip the tube, and as the stationary end is merely held against a vee block no time is lost in clamping. Bending may be effected by a formed roller or a flat " slipper " carrying the tube form interposed between a plain roller and the tube.

The approach of roller or slipper to the tube is by screw adjustment. Tubes of substantial wall thickness are best suited to this method. Light-gauge tubes bent to a small radius exhibit this defect (see Fig. *5)* which is objectionable on decorative work.

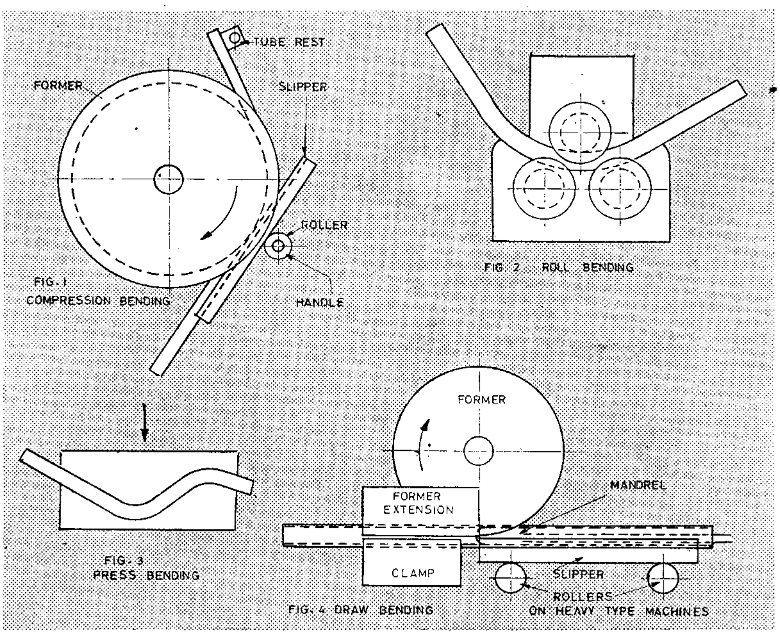
Roll bending is usually performed by three rollers as shown. Mention of it is made because some model engineers have their own rolls and may adapt them for tube bending.

The home workshop is unlikely to contain a press bending machine but it may be noted that repetition bending of small tubes could be undertaken by a pair of wooden die-blocks carrying the tube form gouged in them and held in the bench vice.

In draw bending, the tube is clamped to a rotating former, and a sliding and adjustable slipper carrying the tube form withstands the pressure of bending. When using thin-walled tube, a mandrel being used to give support to the tube on the inside. It will be seen that the former for draw-bending has an extension, *A*, which is welded to it, the tube form being continued along the top of the extension. The tube is clamped to this extension by the fork arrangement, *B*.

In producing a bend the tube is slipped over the mandrel, *C*, and the fork, *B*, is secured to the former extension by the withdrawable pin, *D*, which passes through both fork and extension. The clamping is effected by block, *E*, which also carries the tube form in its face. This action of clamping may be performed by a screw, as at *F*, or by arranging an eccentric to operate block, *E*.

Figs. 1-4: Four neth d. f tı e bending described th c o t press and draw. The diagrams illustrate types of machine used and direction of thrust



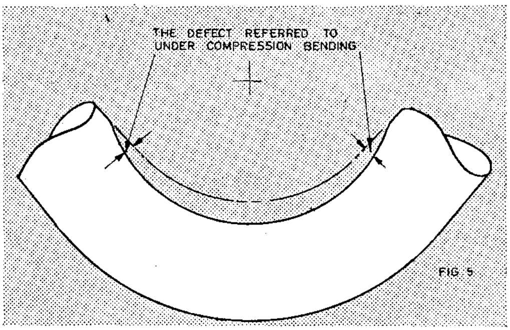
Using the slipper

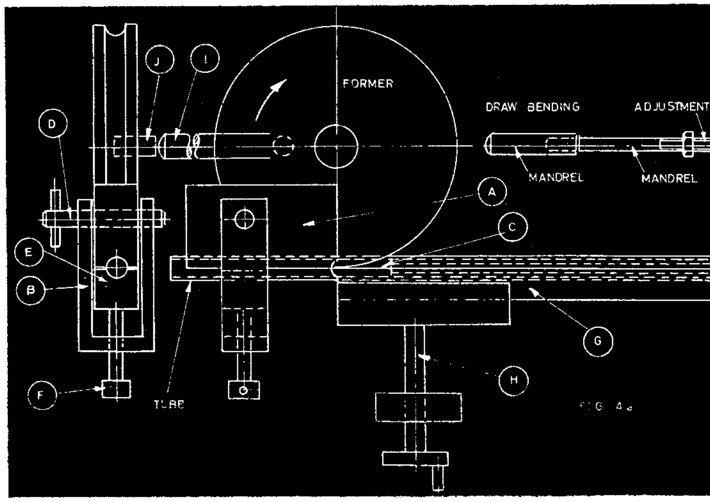
The slipper, *G*, is advanced to the tube by means of screw, *H*, to bear lightly but firmly against it, thus affording necessary support outside the tube while the bend is produced. The tube may now be bent by turning the handle, *I*, through the desired angle. The clamp screw is now slackened, enabling the pin to be withdrawn, the fork lifted away and the workpiece removed from the machine.

On the under side of the former is a stop-pin, *J*, the function of which is to arrest the rotation of the former at the desired angle by causing it to strike a suitably positioned block on the bed of the machine. The most convenient way of obtaining an adjustable stop block is to mount it in an arcuate slot cut in the baseplate concentric with the former mounting stud.

An adjustable back-stop is used to align the bending mark on the tube with the former centre. When bends

SIMPLE TUBE MANIPULATION





are required in different planes in more than one plane, a jig must be provided so that the bend about to be produced may be set at the correct angle with the preceeding bend. This arrangement is shown in Fig. *6*.

The writer had occasion to execute a few hundred bends in each of three workpieces. The first of these was a bend of 1 1/8 in. inside radius in 1/2in. dia. mild-steel tube of **24** s.w.g.; the *other two were of 1 in. and 1-13/16in.* inside radii in **3/8**in. dia. x 18 s.w.g. copper tube. It was found that a mandrel gave a better quality bend in the first workpiece, which was to be afterwards chronium plated, while the two copper tubes were bent unloaded. **As** all these examples were **90** deg. bends, no arcuate slot was cut in the baseplate, the tooling being kept as simple as possible. **A** fixed block was used to arrest the former.

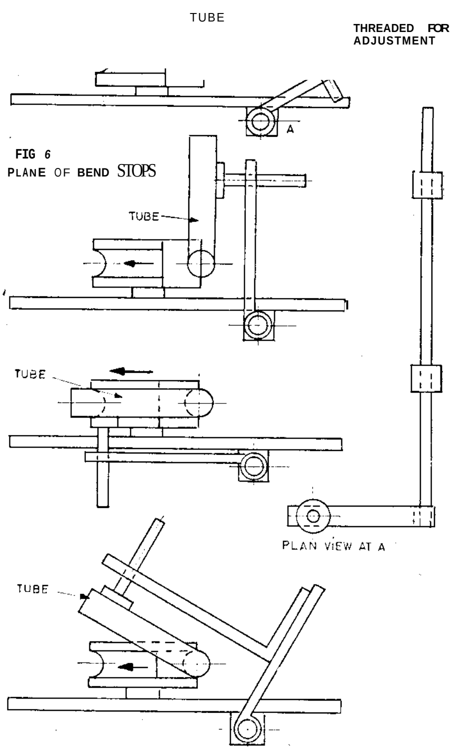
The sketches in Fig. **7** show the arrangement of this simple machine, which the writer thinks may be a little longer than that required by the average model engineer, but its capacity is lower than the requirements of Mr. Twiss, outlined in his

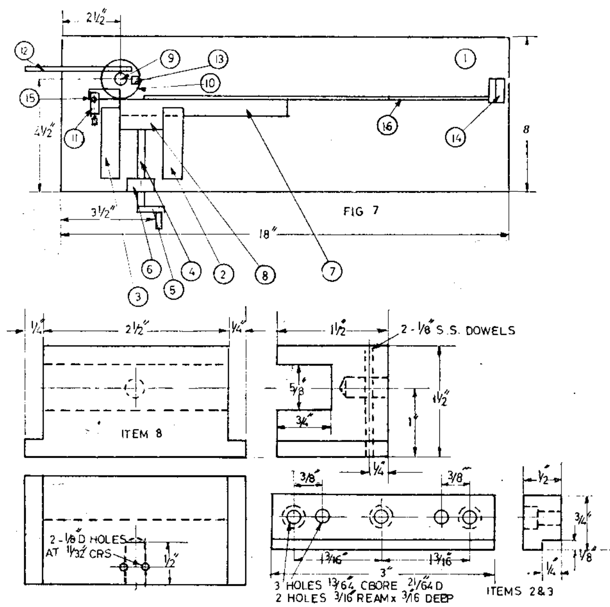
Top left, Fig. 5: Kind of defect which arises with compression bending

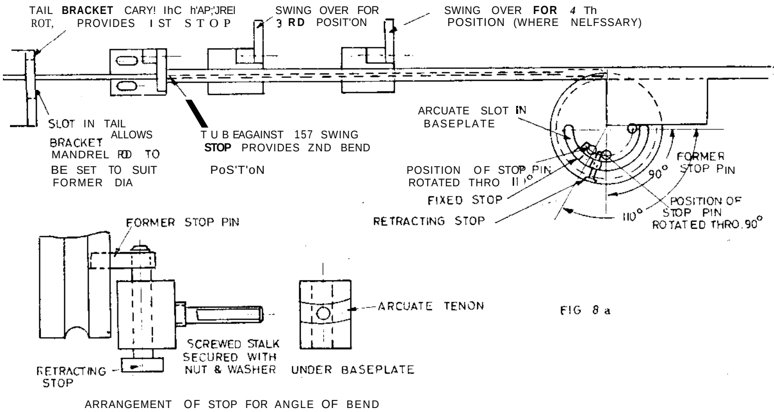
Above right, Fig. 4a: Method of applying mandrel to tube to be bent

Lower left, Fig. **6**: *When bending tube in more than one plane some form of jig, such as that specified in this illustration,* ***is a*** *vital necessity*

Lower right, Fig. **7**: *The-arrangement of a simple tube-bending machine*





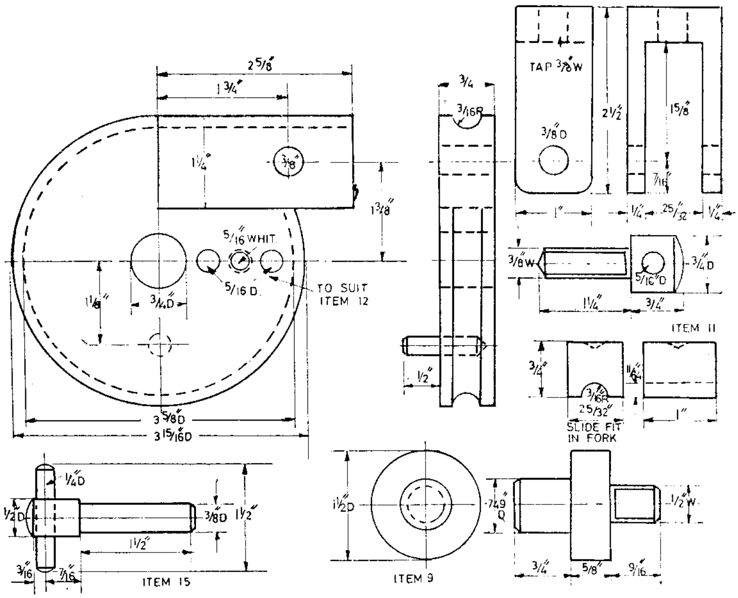


Above, Fig. 8a: Details for positioning the stop to suit the angle of bend

Right: Further details of the tube bender. Refer to table on page 606

Below centre: Constructional details of the bender. Refer to table on page 606

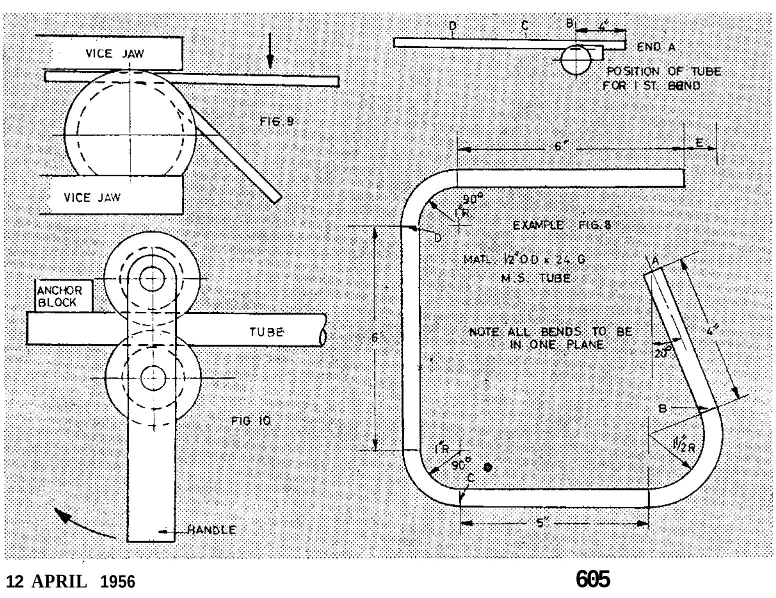
Below, Figs. 8-10: *A bench-vice tool for bending; roller-operated bender; and the type of work that can be done*



letter (MODEL ENGINEER, 12 January, 1956). **A** lever of 3 ft. 6 in. length would be required to bend 1 in. x 18 s.w.g. mild-steel tube to an inside radius of say **3** in. **A** bender of the type shown in the sketches is easy to construct, and the dimensions could be increased or decreased and refinements incorporated to suit individual requirements.

As an example, suppose the workpiece in Fig. 8 is required and it is also assumed that the resultant bending **is** to be of high quality, making necessary the use of a mandrel. The design for the workpiece is accurately drawn out on a sheet of paper, or alternatively on a piece of sheet metal covered with marking fluid such as Spectra colour blue.

A mandrel is now turned and polished to a slide fit inside the tube, the clearance allowed for this not being excessive or it will result in the loss of support. The mandrel is adjusted so that the point where its full diameter commences is in line with the centre line of the former (see Fig. 4a).



Marking the work

Working from the end, *A,* scribe a line 4in. from the end **of** the tube, which should be slightly longer than the workpiece requires. The former of 1-1/2in. radius **is** set on the stud. The tube is now slipped over the mandrel and the scribed line set to the centre line of the former. The fork and pin are placed in position, and the tube clamped, and the slipper adjusted to bear against the tube, as previously described.

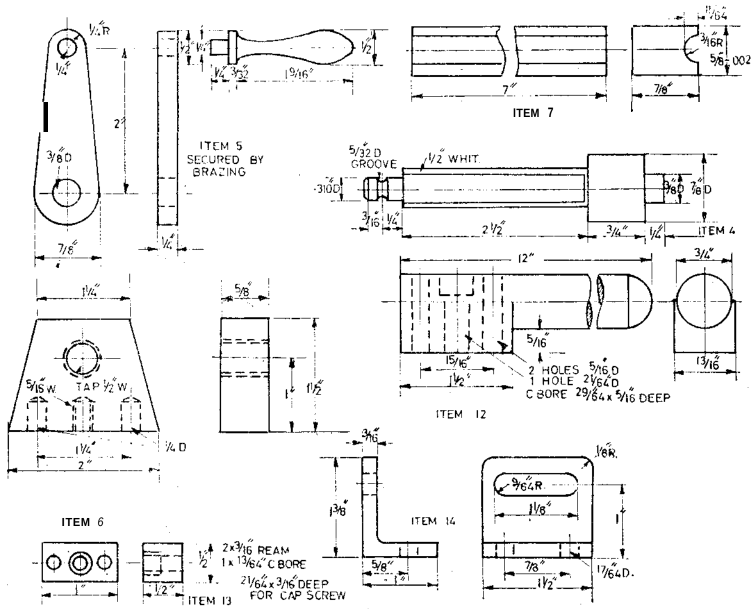
SIMPLE TUBE MANIPULATION

The former is now rotated through 110 deg., the tube withdrawn and checked against the drawing, and on being found correct the second bending mark, ***C,*** is transferred from the drawing to the workpiece. Before offering the workpiece to the machine again, the 1-1/2in. former is removed and the 1 in. substituted for it. Proceed to bend as before and obtain bending mark, ***D,*** from the drawing and complete the workpiece.

In same plane

The surplus, ***E,*** may now be cut from the end, and on deducting this from the previously noted sample length the correct cutting length of the workpiece is obtained. It is obvious, of course, that when producing the second and third bends the tube is clamped to the former in a manner that will ensure their being in the same plane as the first bend.

Assuming that this tube was required in quantity, three back stops would be provided to give the position of the bending marks in relation to the former centre line, and the two nearer the former would be required to hinge over until used in connection with their respective bends. As the rotation of the former involves two angles **(90** deg. and 110 deg.) two stops in the arcuate slot are necessary. The one controlling the angle of 90 deg. would contain a retracting pin to allow the former stop pin to pass it when producing the first bend of 110 deg. (see Fig. 8a).



Further specifications** of the machine. **See table below

Key to diagram at top of page and on page 6Q5

Item No.	Description
1	Base Plate ¼" thick
2	Slipper Adjustment Guide
3	„
4	„ „ Screw
5	„ „ Handle
6	„ „ Nut
7	
8	„ Housing
9	Centre Stud
10	Former
11	Fork Assy
12	Handle
13	Fixed Stop Block
14	Tail Bracket
15	Withdrawable Pin
16	Mandrel Rod, length to suit

Fillings

A support to ensure that the bends were all in one plane would also be in evidence and would be part of the equipment used to produce bends in any desired plane. These "Plane of Bend Stops are shown in Fig. 6, and mentioned previously.

Fillings are often used to afford support inside the tube while bending takes place, and take the form of rosin, sand, lead, or Hoyt tube-bending metal, a commercial product which flows freely at a low melting point. Rosin is low in cost, but if the workshop is in the house its attendent smell will certainly be objectionable to the womenfolk therein and one foresees that it may invoke the inviolable. decision (on their part) of never again.

On occasions the writer has used lead for filling; it has, of course, a much higher melting point, and the fact that it contracts on cooling lessens the support inside the tube. However, the results were satisfactory, and model engineers will, no doubt, have in their possession a quantity of scrap lead which could be used. In all these forgoing cases one end of the tube has a metal plug driven in while being filled. Fine dry sand also gives support, and is added in small amounts, each quantity being firmly rammed. Wooden plugs or corks seal both ends.

Bench-vice tool

Two further small devices for bending tubes are worthy of note. The little tool depicted in Fig. 9 **is** often used when piping air and hydraulic systems and is used in the bench vice. Since the tube in consideration **is** of substantial gauge, good work is produced. In the second tool, a roller wipes the tube round the former, as shown in Fig. **10.**

Personal requirements will determine the size of machine necessary, and if the work pieces are of the one off variety, as indeed they may well be, they can be produced as in the aforementioned example without the aid of setting stops.

The material being worked must be physically suitable for bending, i.e., sufficiently ductile, indeed if this is not the case, good work will not be produced with mandrel or fillers. ☐