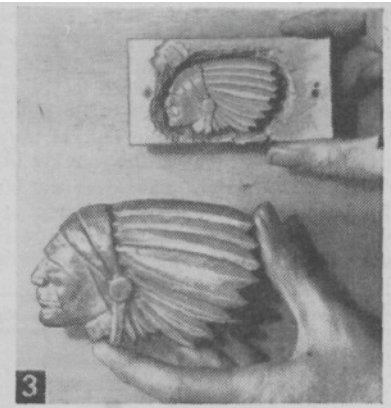
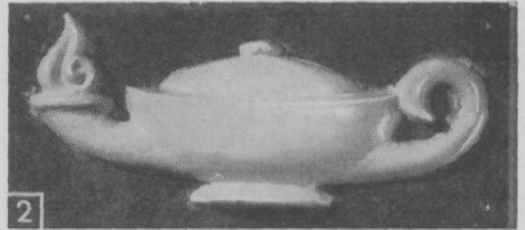


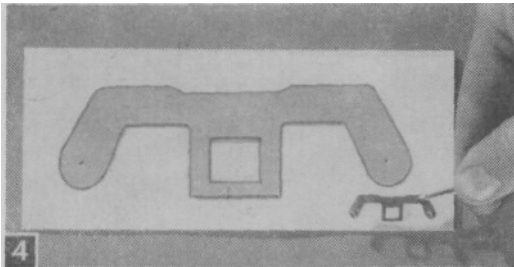
Left, pantograph being used to carve head from master pattern to one-half actual size. Right below, Aladdin's lamp master pattern, and above it, 1/4-size ebony wood brooch and 1/2-size wood carving made by the pantograph from the master carving.



Above, comparison of Indian head master and finished birch carving.



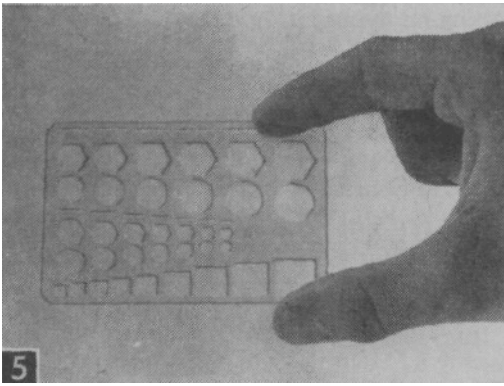
Making and Using a Carving Pantograph



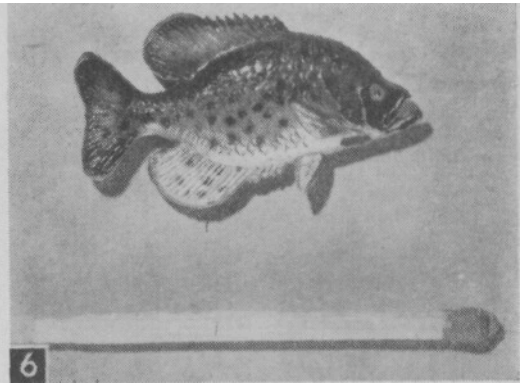
Small electrical part for model railroad made with pantograph from 4 to 1 cardboard pasteup. Making parts this way frequently saves industry the cost of expensive dies until final designs are approved.

YOU can make fine reduction carvings from almost any three-dimensional object within the moving limits of the comparatively simple carving pantograph seen in Fig. 1.

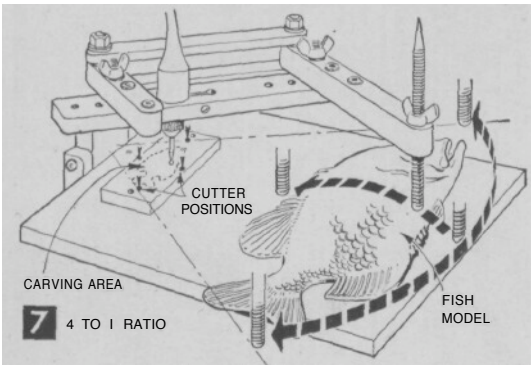
This inexpensive unit can be built from scratch or assembled from pre-cut, finished parts furnished in a \$12.95 kit (see construction details on page 154). You can make templates, brass molds for plastic injection molding, name plates, and form dies for small ornamental metal parts. Jewelers can engrave tiny lettering and signatures. HO-gage model railroaders can make detailed models four times gage size, then accurately pantograph-carve them down to size as in Fig. 4.



5 Draftman's template reduced to $\frac{1}{2}$ the original size for minute work.



6 Mold for this tiny fish is part of a series made by Wildlife Miniatures of Chicago, from large plaster casting of original model. The plastic miniatures are hand painted in full color.

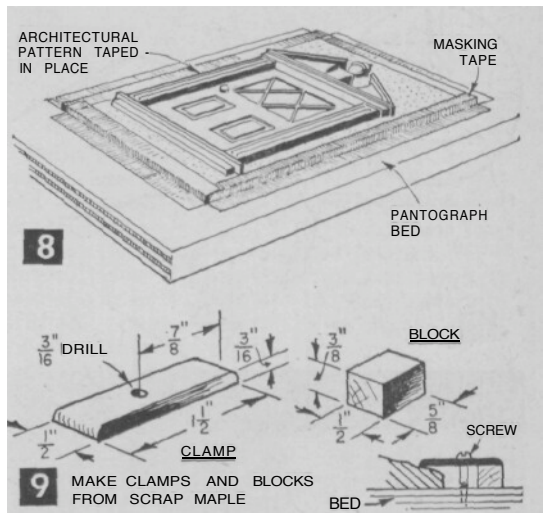


7 Place the work on the bed. Then, with the stylus, test to be sure entire project will fit on material. Fasten it in place with screws, screw clamps or tape.

This tool is ideal for linoleum block carving, for block printing plates, or for carving miniatures of animals and flower plaques for jewelry. For example, you can easily carve in a small bit of rare wood a beautiful brooch, one-third the size of the original model. Then, using the finished carving as a pattern without resetting the pantograph, you can reduce the same carving to one-sixth the original—or just the right size for matching earrings. Ordinary shop tools (Fig. 17) make ideal models for men's tie-clips and cuff links.

How to Use a Pantograph. When setting up your work for carving, allow about a half-inch of extra material on all sides to be cut away as scrap. First locate the pattern on the bed as indicated in Fig. 7, then temporarily spot the material to be carved in position. Move the stylus to the outside edges of the pattern, checking to be sure the material will be large enough to cover these points.

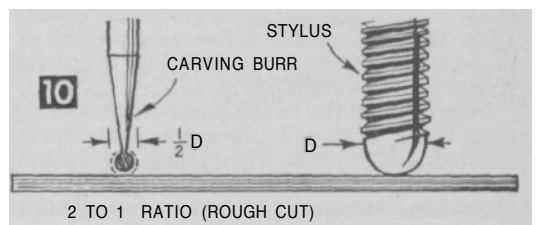
The patterns may be taped, clamped or screwed directly to the pantograph bed. For simple flat work, ordinary masking tape usually works well (Fig. 8). For irregular objects, make simple clamp blocks as in Figs. 1

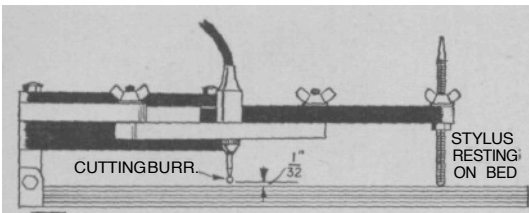


8 Two methods of holding work and patterns in place. A third way is to screw through a scrap portion of the unit to the bed.

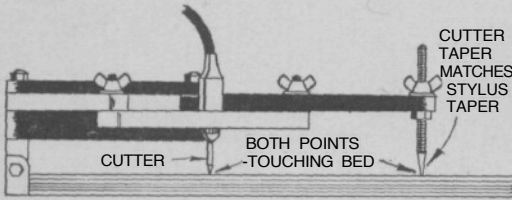
and 9. If your pattern has plenty of scrap area, it may be easier to screw directly through the pattern into the bed. Fasten the material to be carved to the bed similarly, making sure that none of the tape, screws or clamps will be in the immediate vicinity of the carving head.

If you are carving with a round-headed burr, choose a burr that is $\frac{1}{2}$, $\frac{1}{3}$ or $\frac{1}{4}$ the size of the round end of the stylus. For rough

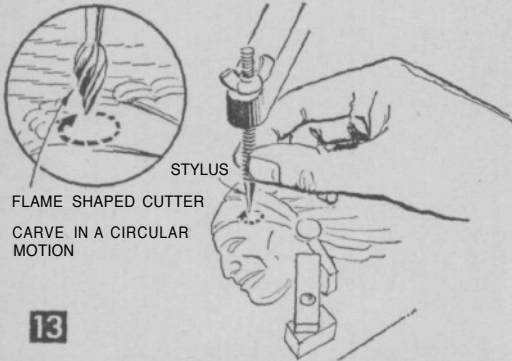




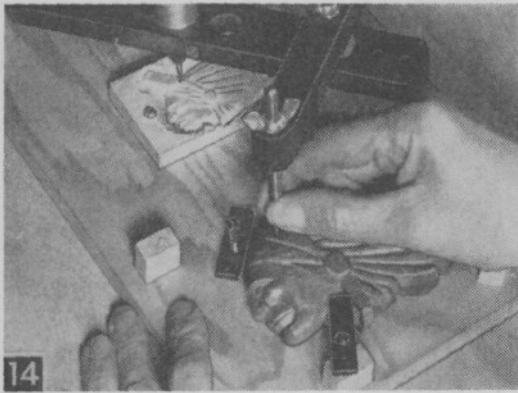
11 SETUP FOR ROUGH CUT



12 SETUP FOR FINAL CARVING



13



14 Loosen one clamp at a time and carve away excess material in that area. Then reclamp, loosen the next clamp and repeat the procedure.

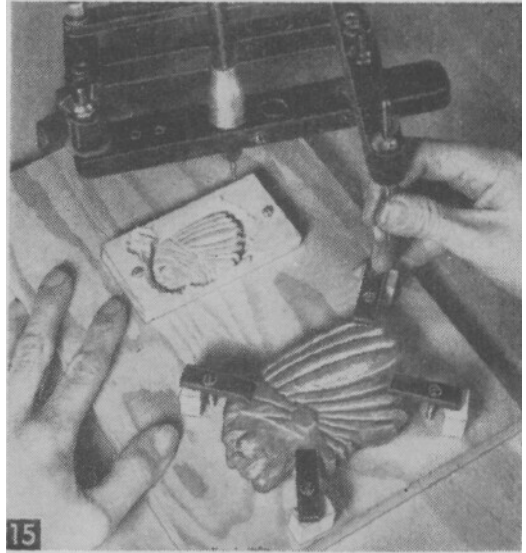
cuts the burr should be even smaller than the exact ratio of the reduction you plan to make (Fig. 10). If you use a flame-shaped or tapered cutting tool, then you'll need a tapered stylus point to match (Fig. 13).

Insert the stylus in the pantograph and set to a depth that will allow the arms to be approximately level. Then insert the cutting burr and set it so that it will be about .032 in. above the pantograph bed while the stylus is

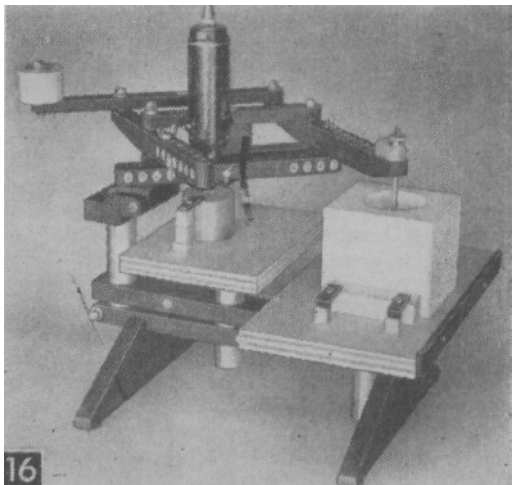
resting on the bed (Fig. 11).

You are now ready to make the first rough cut in the material from the pattern. With the pattern and material securely clamped to the bed, start carving on the high points and work in a rotary cutting motion with the stylus over the pattern. This will allow the cutter to clear away any shavings after each bite (Fig. 13). Work over the entire pattern, including areas around but not under the clamps, which are not removed when making the rough cuts.

For the Finish Cut, put in your sharpest cutting tool and reset the depth so that the cutting tool will just touch the bed while the

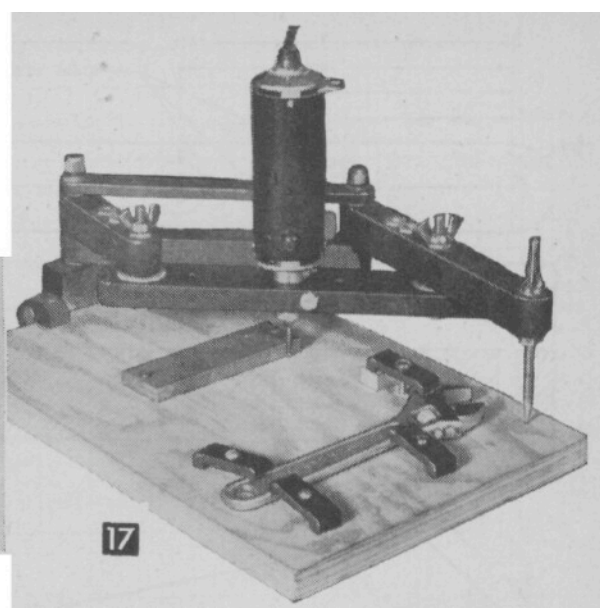
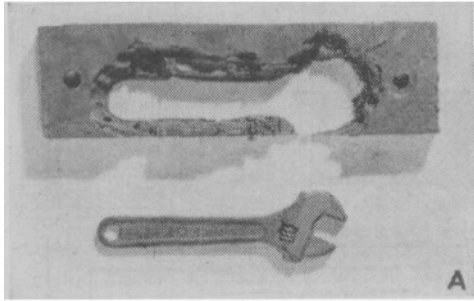


15 Finished Indian head carving ready for light touch-up sanding and finishing.



16 Mold of the outside tall bottle cap made on a professional-size Bench Craft pantograph from a deep plaster pattern. Note the two adjustable beds.

Pantograph set up to carve out a wrench pattern one-third size of wrench clamped on the bed. Inset shows smooth-finished piece cut out of small hardwood block by portable electric grinder held in the motor arm.



stylus is resting on the bed (Fig. 12). Again carefully go over the original pattern with the stylus in a circular motion, being sure to carve away every bit of scrap. Then remove one clamp at a time and carve away the material in that area (Fig. 14). Replace the clamp and move to the next one, and so on. Finally carve around the edge to free the finished reproduction. When you are through, you will have an accurate reproduction of the original pattern ready for slight sanding and painting (Fig. 15).

For larger projects that are too thick for a single flat bed, you may need to build a two-level bed similar to the Bench-Craft professional model shown in Fig. 16. The two-level beds will allow you to obtain at least double the height with much less distortion due to the tool pivoting about the hinge-blocks.

Construction Details. To build this carving pantograph accurately from scratch, you will need to have access to a good circular saw and drill press, a sharp letter D-size drill, a left-hand $\frac{1}{4}$ -in. spiral reamer, a .469-in. counterbore with $\frac{1}{4}$ -in. pilot, and a circle cutter with a $\frac{1}{4}$ -in. pilot drill.

If you do not have this power equipment and special tools, you can dispense with the need for them in this project by ordering the parts pre-cut and finished in kit form from Bench-Craft, 3011 Starling Lane, Rolling Meadows, Ill. (\$14.95 postpaid).

The kit includes fully-machined rock maple arms protected with a warp-resistant ebony finish, all hardware washers, the stylus and assembly sheet, and notes on processing the bearing. All bearings are ready for lubrication and assembly.

Not included, of course, are the plywood bed (which you can make from scrap), the powered hand grinder and flexible shaft.

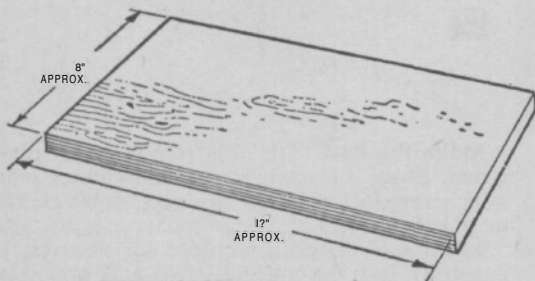
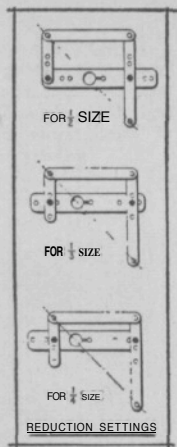
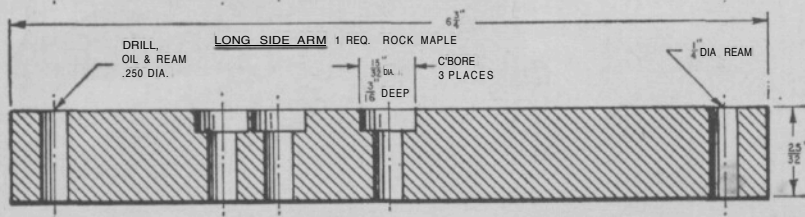
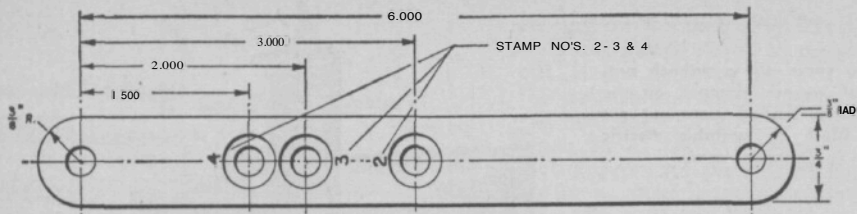
Make the Bed (Fig. 18) from $\frac{3}{4}$ -in. fir plywood. Since it is a work surface to which you will screw-fasten many projects, don't finish or polish it.

From rock maple (required for accuracy) carefully saw the various arms and brackets to shape as in Figs. 18 and 19. Then carefully drill and counterbore the holes shown, starting with the pivot block.

Drilling the arms requires the utmost accuracy. For best results, lay out a template on a piece of .125 x $\frac{3}{4}$ -in. steel or aluminum bar stock for the locations of the various holes in individual arms. Clamp the template in place on one arm, drill the end hole with the letter D drill, and insert a $\frac{1}{4}$ -20 bolt. Drill the hole in the opposite end and insert another $\frac{1}{4}$ -20 bolt. Then drill the rest of the holes in that arm. Drill the various holes in the other arms similarly, using the template for accuracy.

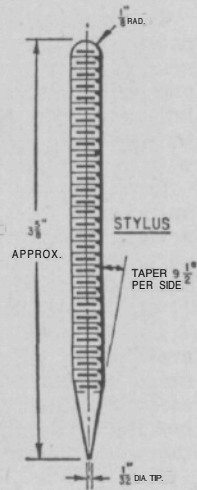
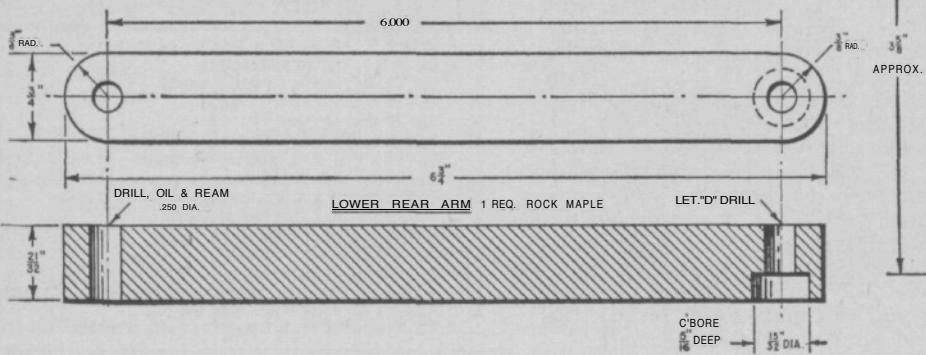
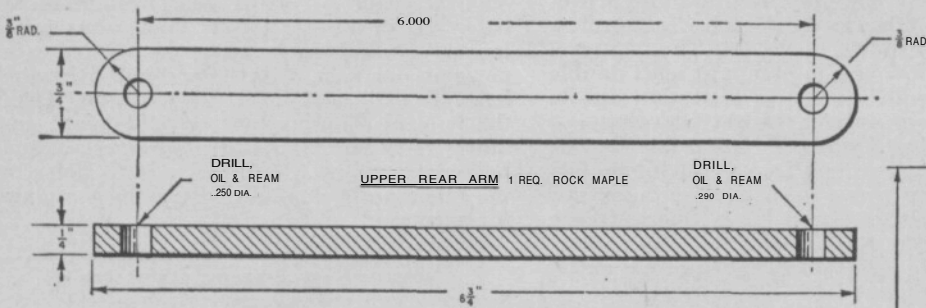
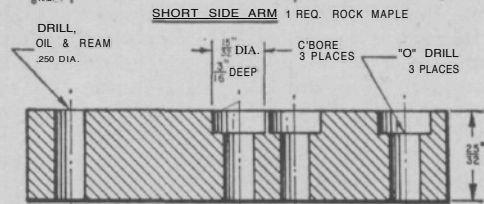
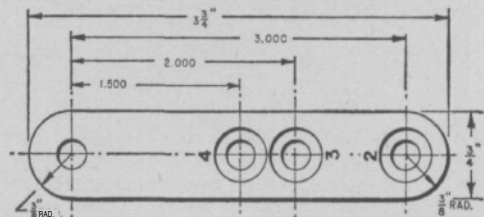
MATERIALS LIST—CARVING PANTOGRAPH •

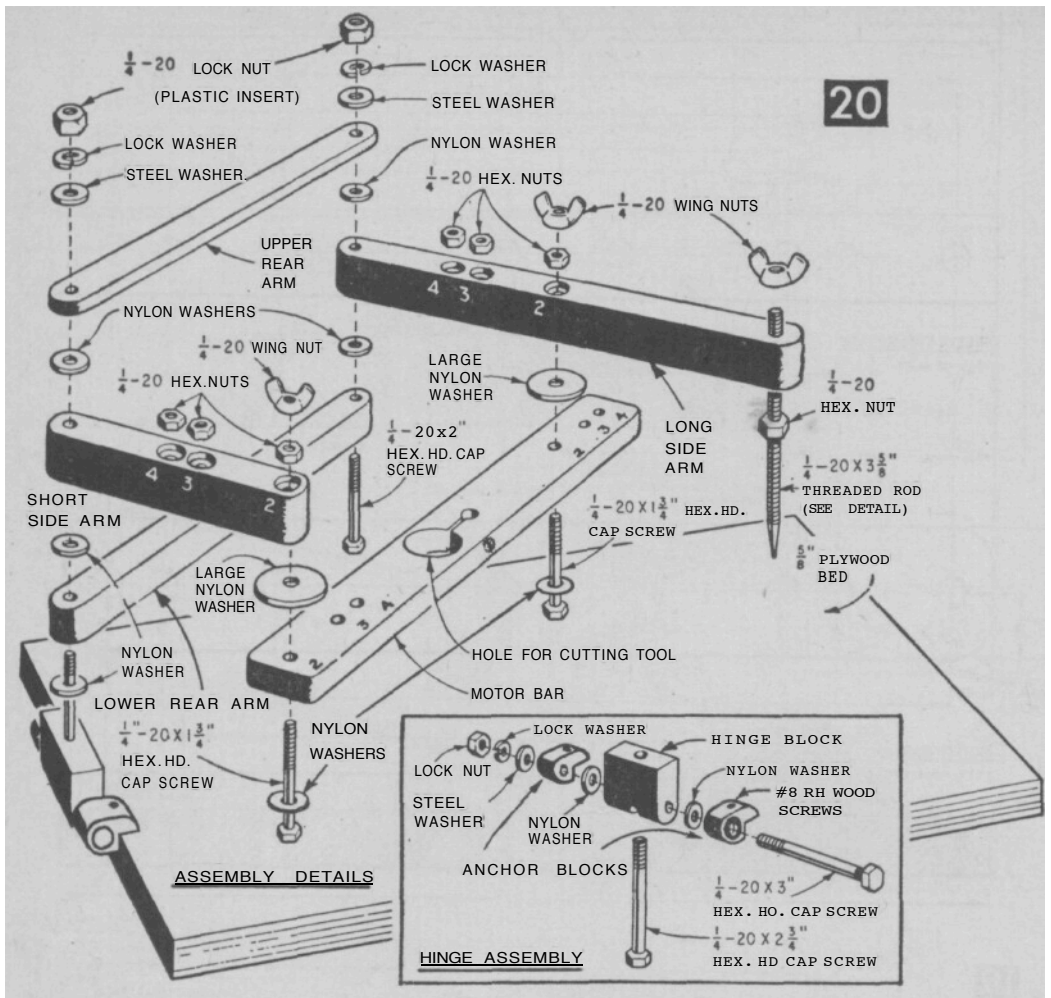
No.	Req'd	Size and Description
2	1.125	O.D. x .266 I.D. x .060 thick 1" dia. nylon washer
10	.563	O.D. x .266 I.D. x .060 thick nylon washer
2	9/16	O.D. x 9/32 I.D. x 3/64 thick steel washer
3	$\frac{1}{4}$ "	A.S.A. medium lock washer
3	$\frac{1}{4}$ "	20 N.C. lock nut (plastic insert)
7	$\frac{1}{4}$ "	20 N.C. standard hex nut
3	$\frac{1}{4}$ "	20 N.C. standard wing nut
1	8-32	N.C. standard hex nut
2	$\frac{1}{4}$ "	20 x $1\frac{3}{4}$ " N.C. hex head cap screw
1	$\frac{1}{4}$ "	20 x 2" N.C. hex head cap screw
1	$\frac{1}{4}$ "	20 x $2\frac{3}{4}$ " N.C. hex head cap screw
1	$\frac{1}{4}$ "	20 x 3" N.C. hex head cap screw
1	8-32	x $1\frac{1}{4}$ " rh machine screw
2	#8	x $1\frac{1}{4}$ " rh wood screw
1	$\frac{1}{4}$ "-20	x 4" threaded rod
1	1	x 6 x $1\frac{1}{4}$ " clear rock maple—planed two sides to $\frac{3}{8}$ " thick
1	.625	x 8 x 12" fir plywood—good one side
		Cut clamps and blocks from scrap maple as needed



PANTOGRAPH BED
1/4 PLYWOOD

18





This pantograph can be adapted to almost any flexible shaft such as Foredom or small portable electric hand grinder with a straight shank such as Dremel, with an rpm ranging between 7,500 and 27,000. Just adjust the large hole in the tool-holding motor bar for a snug fit on the tool you plan to use. By cutting a slot to a smaller hole in the motor bar as in Fig. 19 and using a nut and bolt, the carving tool can be clamped securely in this bar.

Swab the bearing holes in the arms with SAE 20 oil, then ream all bearing holes with the left-hand, 1/4-in. spiral reamer. Re-oil the reamed holes and allow to stand for two days. Repeat this process three times. This will saturate each bearing with oil and give satisfactory bearings for accurate carving.

Insert all of the 1/4-in. bolts and nuts that must be press-fitted into the arms. To seat the parts, tap lightly with a small hammer. Re-swab holes heavily with oil and complete assembly except for the motor bar. Add a

drop of oil on each nylon washer at assembly.

Adjusting the Arms. Starting with the hinge, adjust bolt so hinge will work snugly without sticking. Carefully adjust bolts in each arm individually so that the arms work snugly without binding. If arms are too tight, they will not move; if too loose, they will cause sloppy work.

After the arms are adjusted they should not require readjustment for various reduction settings. Now you can attach the motor bar and make final adjustments at this bar only.

Make the Stylus from 1/4-20 threaded rod, tapering one end for a fine point cutter and rounding the other end for ball-shaped cutters.

If nylon washers and lock nuts are not available, you can obtain a complete set of 11 washers, three nuts and a tracing stylus by sending \$2 to Bench-Craft, 3011 Starling Lane, Rolling Meadows, Ill..

Add the flexible shaft and stylus, and you are ready to go to work.