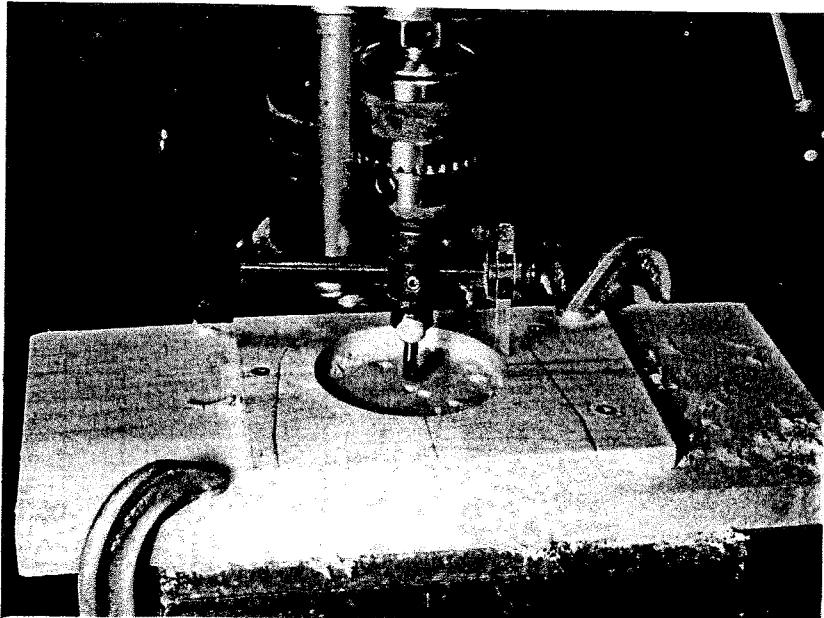


Securely fasten the thinner piece to a backing block, line up its center hole with the pilot drill, and clamp the work to the drill-press table, where it must remain undisturbed until both cuts are completed.

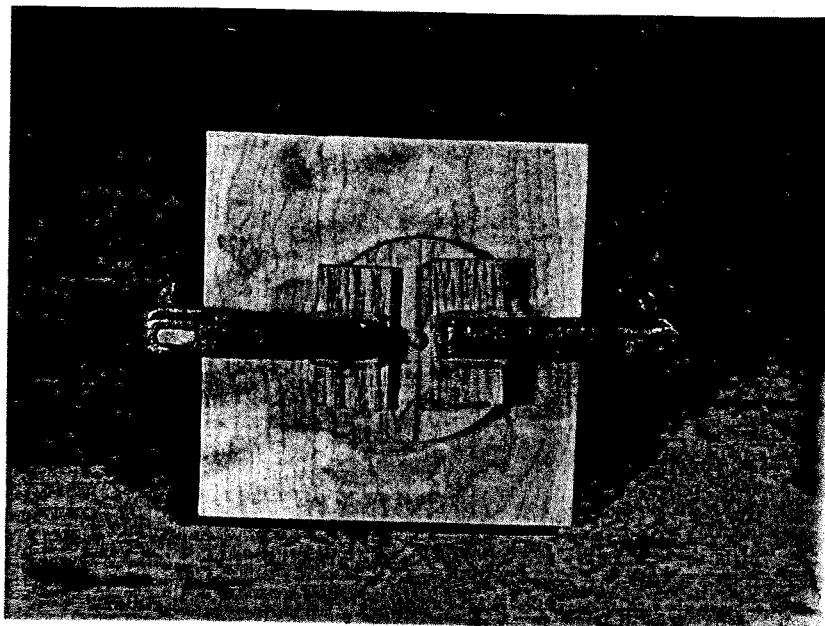
Put a disk-cutting bit in the circle cutter, and adjust it to the inner radius of the groove. Make sure that if the cut isn't precise that the radius is oversize rather than undersize.

Some extra center distance won't affect the gears, but too close a distance will require you to rework all the teeth. Make the cut using a slow, steady feed rate. Your disk should require only fine-sanding to be ready for use. (See Illus. 6-9.)

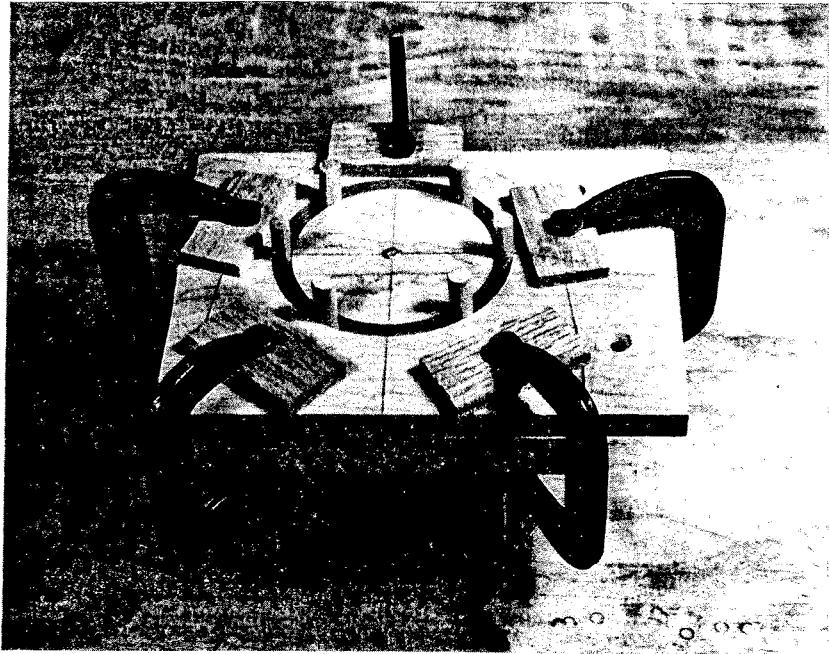
Change to the hole-cutting bit and adjust it to the outer-groove radius; again, any errors should be on the "plus" side. Make the cut



Illus. 6-11. Boring the large hole to size.



Illus. 6-12. Gluing the disk in place.



Illus. 6-13. Gluing together the backplate assembly, using spacers.

and remove the work from the drill press. (See Illus. 6-11.)

Using a piece of dowel as an alignment pin, glue the disk onto the rear member. Align the grain in its original direction. (See Illus. 6-12.) Remove the dowel before the glue sets or you may have to drill it out.

When the glue is dry, cut six spacers of a size that will fit snugly in the groove between the parts. As dowel stock is rarely round, I plane a flat on a length of $\frac{5}{16}$ -inch dowel which I then cut into six pieces. This way I can control the geometry of the spacers.

Apply glue to the parts, keeping it well away from the groove, and assemble the unit with the six dowels equally spaced. (See Illus. 6-13.) Use several clamps to keep the thin plate flat. When it is dry, cut the part to shape, sand it smooth, and round the corners. Drill the one dowel hole in the base and open the shaft hole to its finished size.

Remaining Parts

The remaining parts are similar to those in preceding designs and don't need much ex-

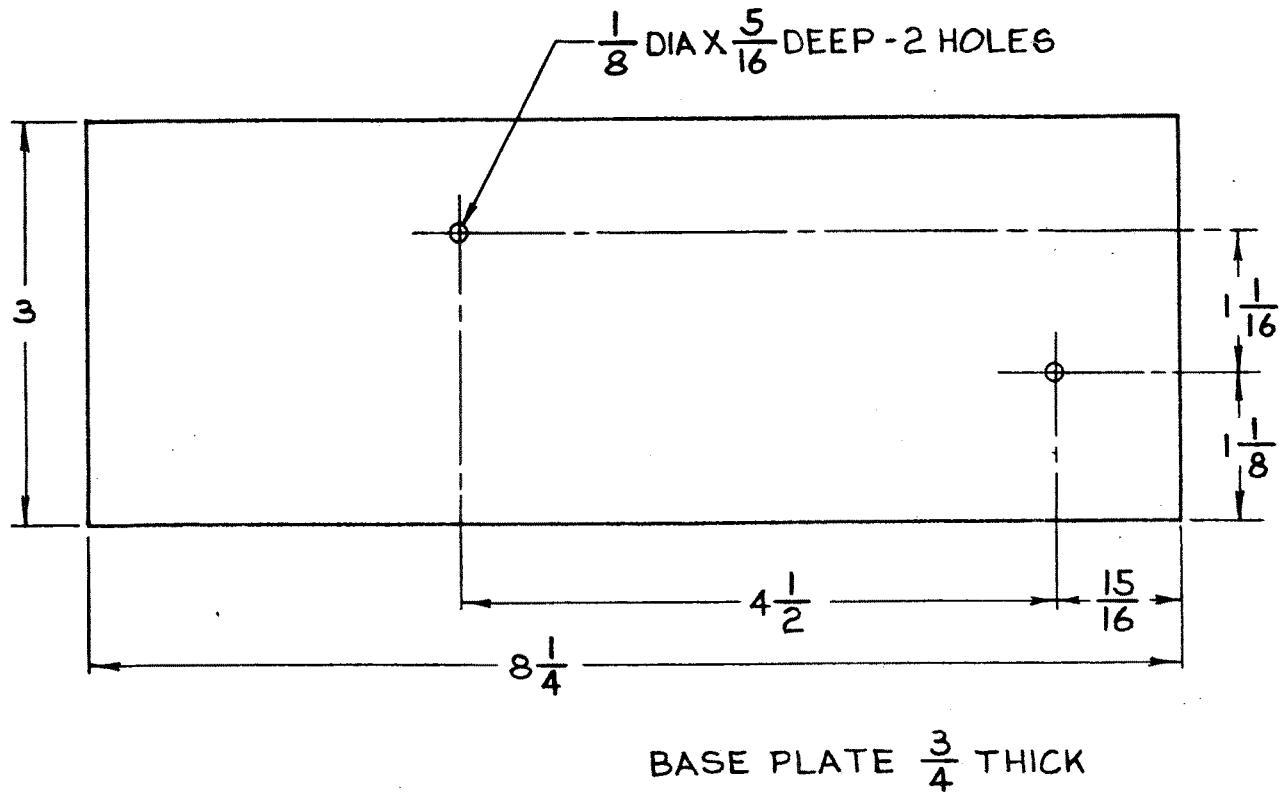
planation here. Just remember the overall rule for small parts: Plan your work so that as many operations as possible can be performed with the piece still attached to a larger blank.

You may notice that the rocker bearing, the connecting rod, and the slots in the rocker are all the same thickness, which would give zero clearance. There should be very little lateral shake in this assembly, so just sand the completed parts so that they fit freely. Details for slotting the rocker are covered in the instructions for the Slide, in Chapter Four. (See Illus. 6-3.)

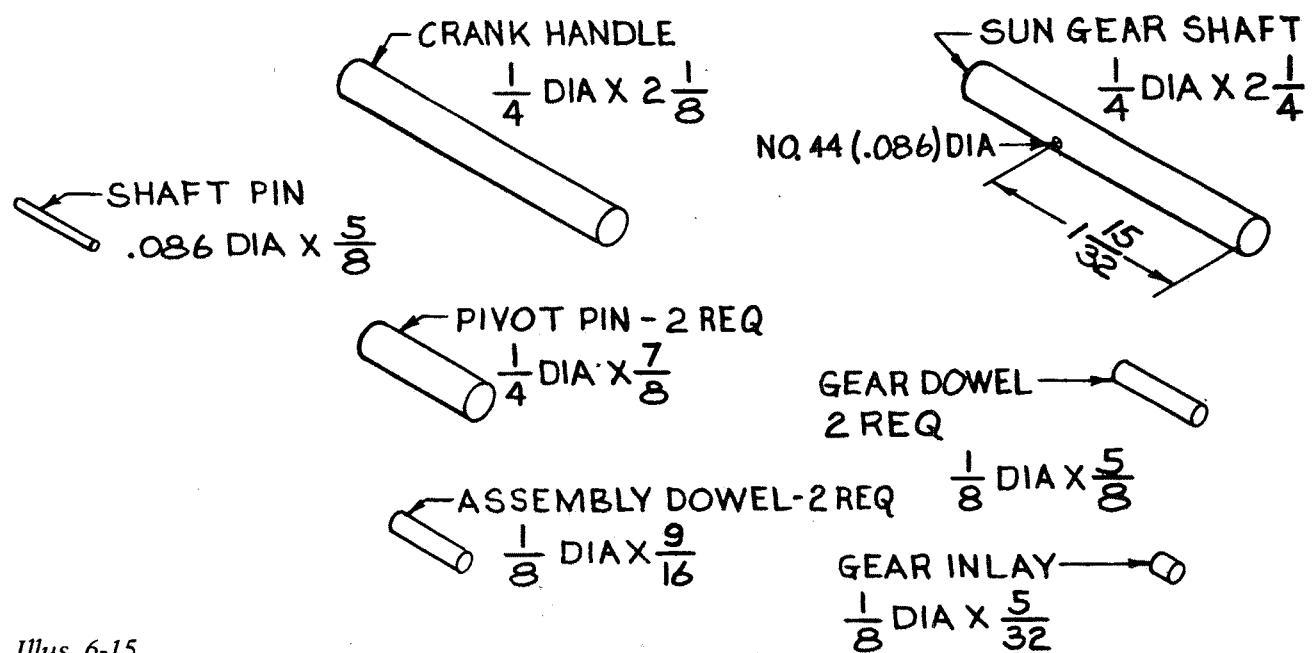
ASSEMBLING THE MECHANISM

When all parts have been fitted and finish-sanded, dry-assemble the backplate to the base, using the one locating dowel. Align the part carefully and clamp a scrap block against it to provide a reference surface for final assembly. Remove the backplate, apply glue, and clamp the assembly.

After a minute or two to make certain that none of the parts will move, remove the

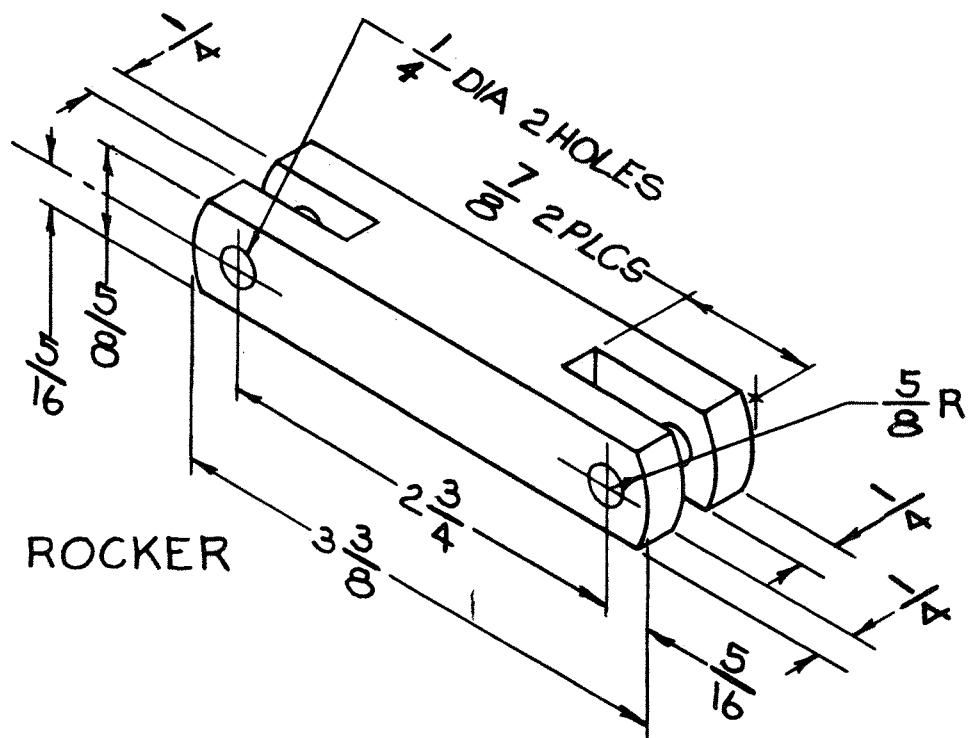
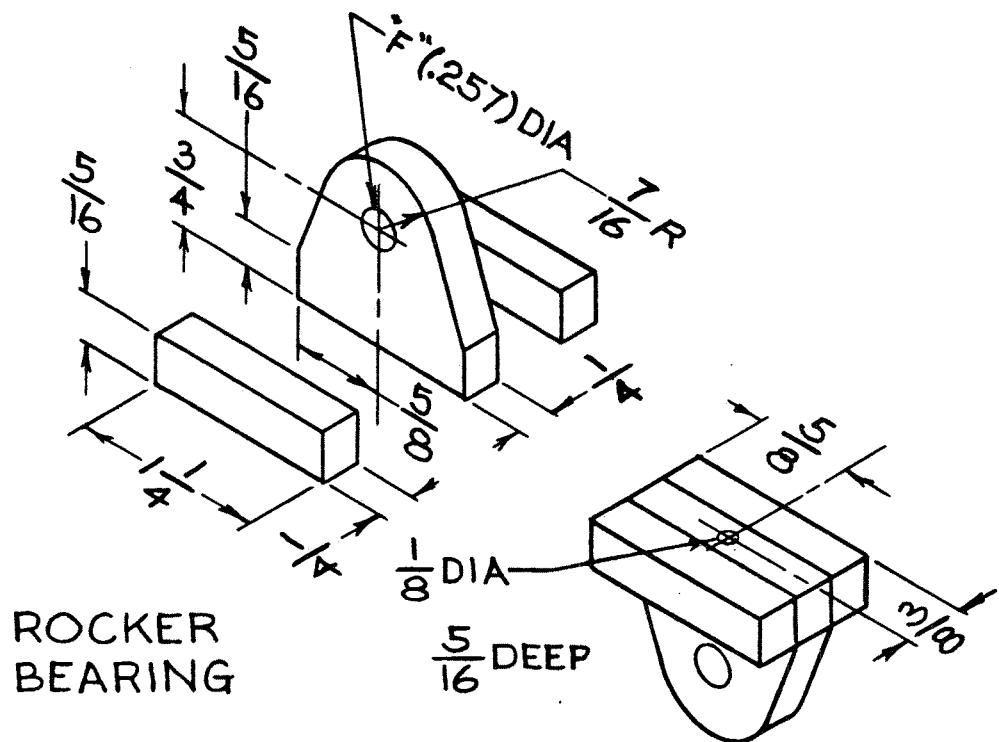


Illus. 6-14.

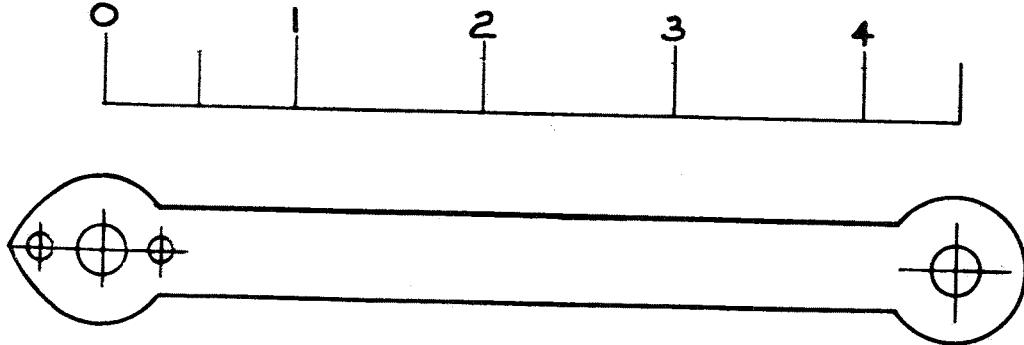


Illus. 6-15.

Illus. 6-16.



Illus. 6-17.



PATTERN FOR CONNECTING ROD

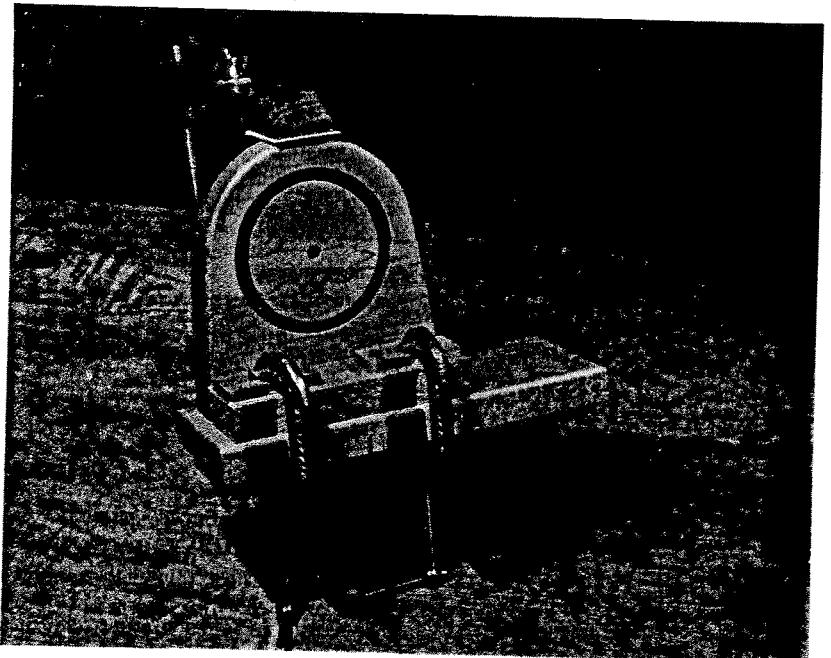
GLUE PHOTOCOPY TO $\frac{1}{4}$ INCH STOCK

USE INCH GRADUATIONS TO CHECK COPY SIZE

LARGE HOLES "F" DRILL (.257)

SMALL HOLES $\frac{1}{8}$ DIA

Illus. 6-18. Gluing the back to the base, using an aligning block.



alignment block. (See Illus. 6-18.) Repeat this operation for the rocker bearing. Your base assembly is now complete.

Glue a contrasting colored pin into the sun gear and sand it flush. This makes it easy to count revolutions when demonstrating the

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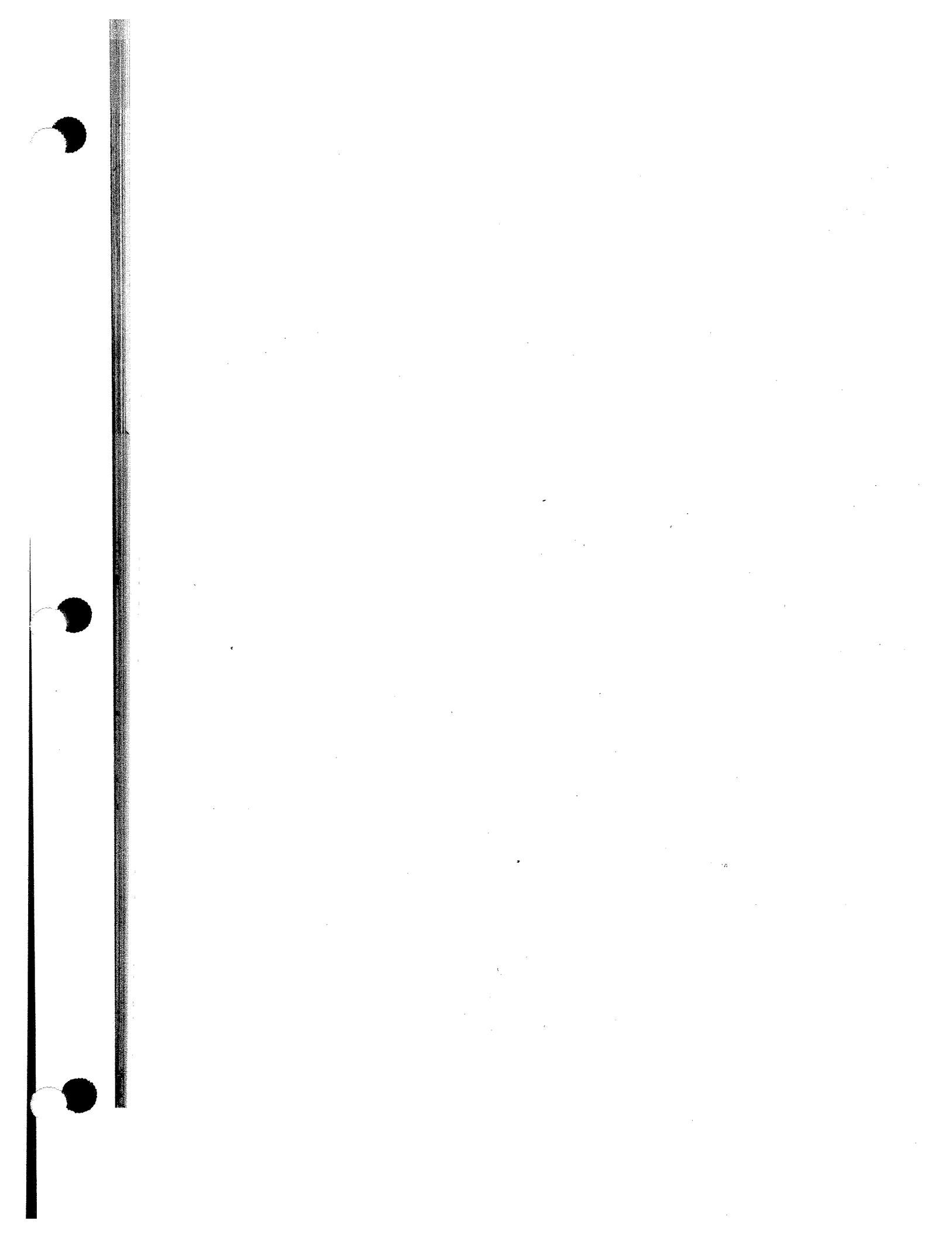
device. Fit the crank handle into the planet gear so that it can be tapped in with a small mallet; glue will be too messy here. The handle should project $1\frac{1}{32}$ inch from the back of the gear.

Put the connecting rod on the handle, and

line up the two dowel holes on the centerline of the rod. Drill through the dowel holes to provide a snug fit for two dowels, and tap them in. The absence of glue in this unit permits disassembly if necessary.

Pin the rocker to the connecting rod with one of the pivot pins. Set the projecting part of the crank handle into the groove, swing the

rocker onto its bearing, and insert the remaining pivot pin. Try the assembly. If the gears are tight at any position, mark them and remove a little material to ease the action. When everything works smoothly, you will have an interesting and unusual model to demonstrate.



CHAPTER 7

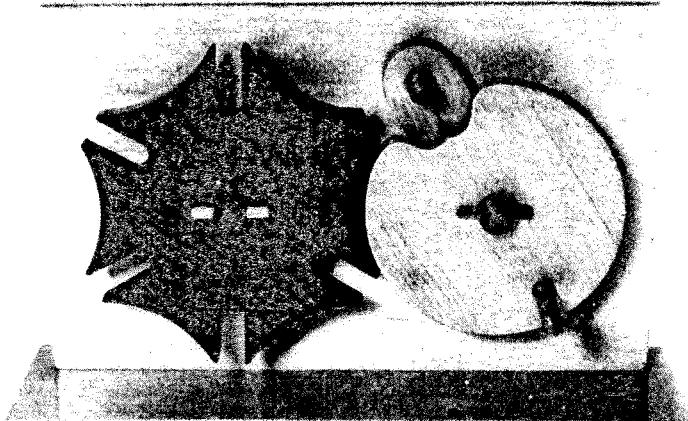
The Geneva Wheel

This device converts continuous rotary input motion into intermittent output motion, the driven member being prevented from moving except when actually driven. You can find this movement in better-quality spring-wound watches, where it is used to prevent over-winding of the mainspring. In this application, one of the slots is left uncut, and the device is known as the Geneva Stop. At the other extreme, we once built a pair of these units, about 30 inches in diameter, for a glass-bottle sealing machine.

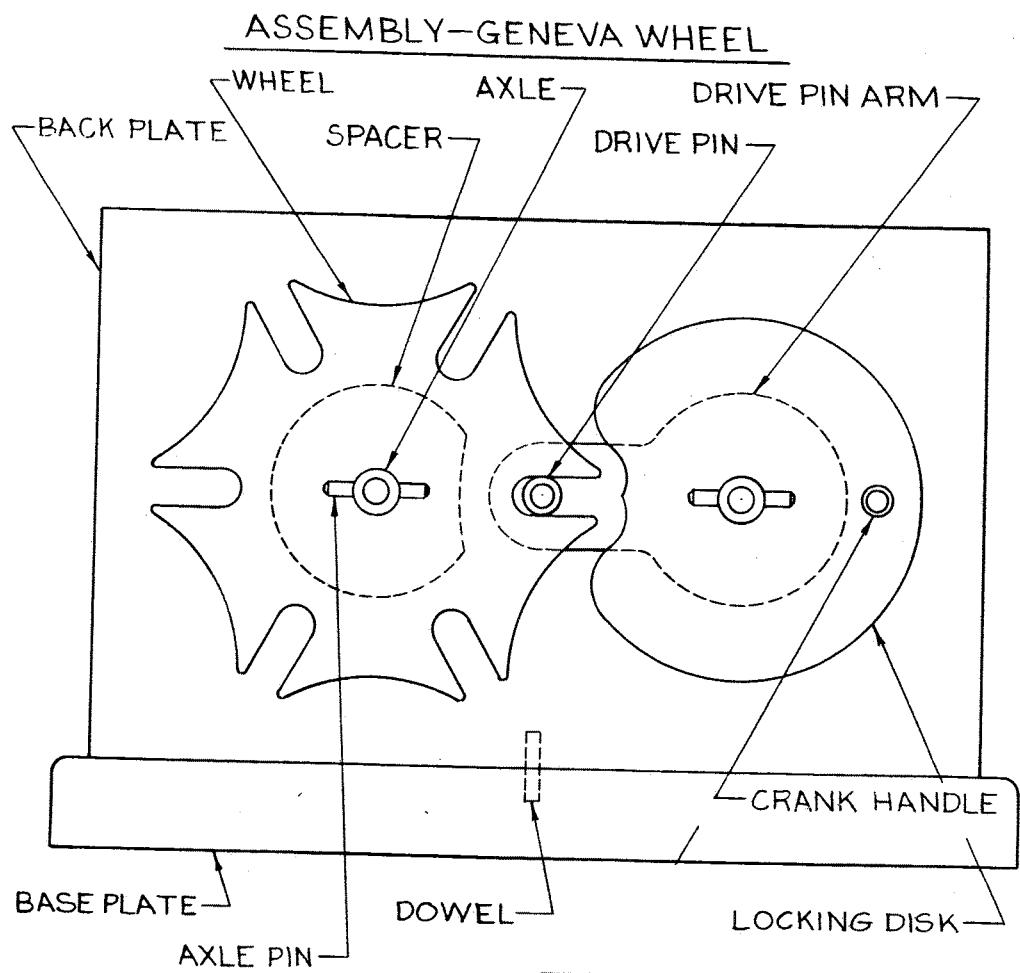
Illus. 7-1. The Geneva Wheel assembled.

HOW THE MECHANISM WORKS

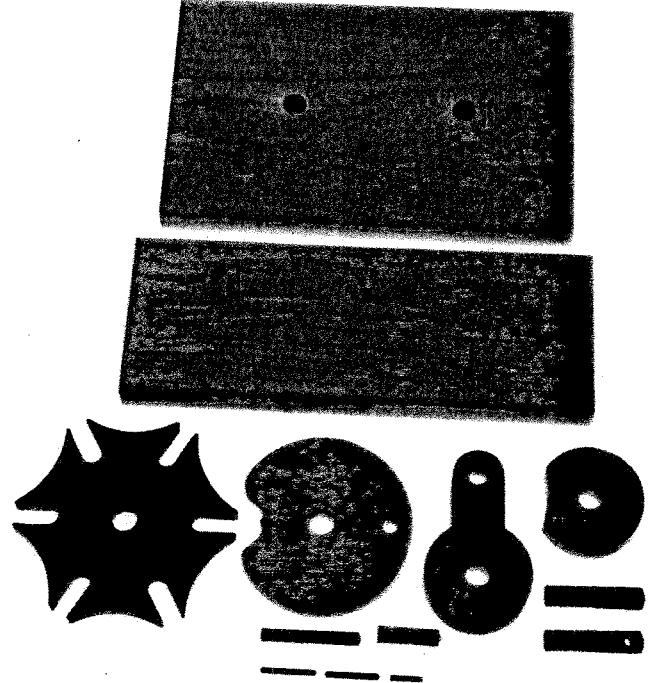
During most of the operating cycle, the circular part of the locking disk turns in one of the semicircular cuts on the wheel, thereby preventing the wheel from moving. As the driving pin enters a slot in the wheel, the corner of the wheel is opposite a clearance cut in the locking disk, allowing the wheel to turn. Just before the pin exits the slot, the wheel is once again locked by the disk.



Illus. 7-2.



Illus. 7-3. All the parts for the Geneva Wheel.



MAKING THE PARTS

The back- and baseplates, shown in Illus. 7-4 and 7-5, are similar to those of earlier models, and don't require further explanation, except to state that the hole-center distance is fairly critical, and determines the smoothness of operation of the model.

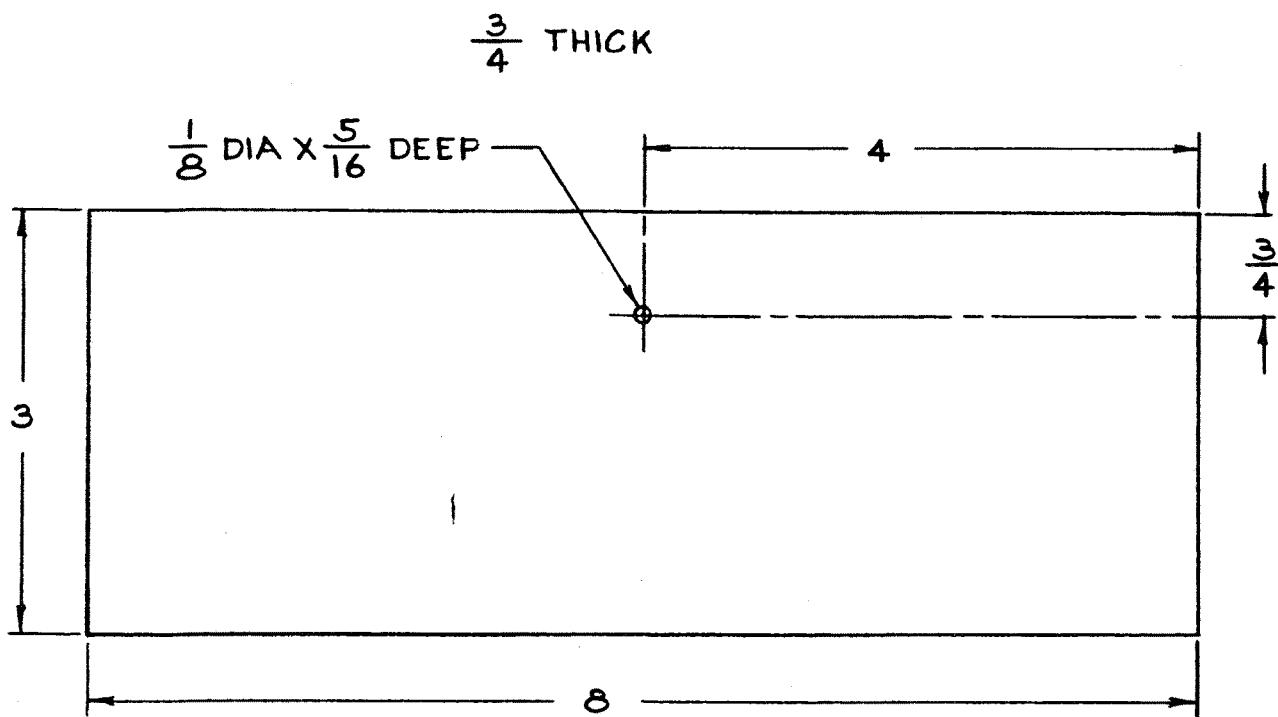
Glue the photocopied patterns to the parts (Illus. 7-6-7-8), drill all the holes, and cut out the profiles. (See Illus. 7-10.) There is a preferred sequence for making the wheel. First, drill all the holes and cut to the outline on a band saw, but don't cut the slots. Use a sanding drum in the drill press (a drum two inches in diameter is ideal) and sand the semicircular locking radii, finishing with the finest available grit of sandpaper. Sand to just remove the lines. Put the part aside until you have made the locking disk. (See Illus. 7-11.) Drill the center hole in the disk $\frac{3}{8}$ inch

in diameter; it will be enlarged after assembly. Sand the disk to size. The best way to do this is to rotate it on a moveable pin clamped to the belt sander. Fine-sand by hand in the direction of rotation. The contours of the clearance cut can be smoothed with a sandpaper-wrapped dowel rotated at high speed in the drill press.

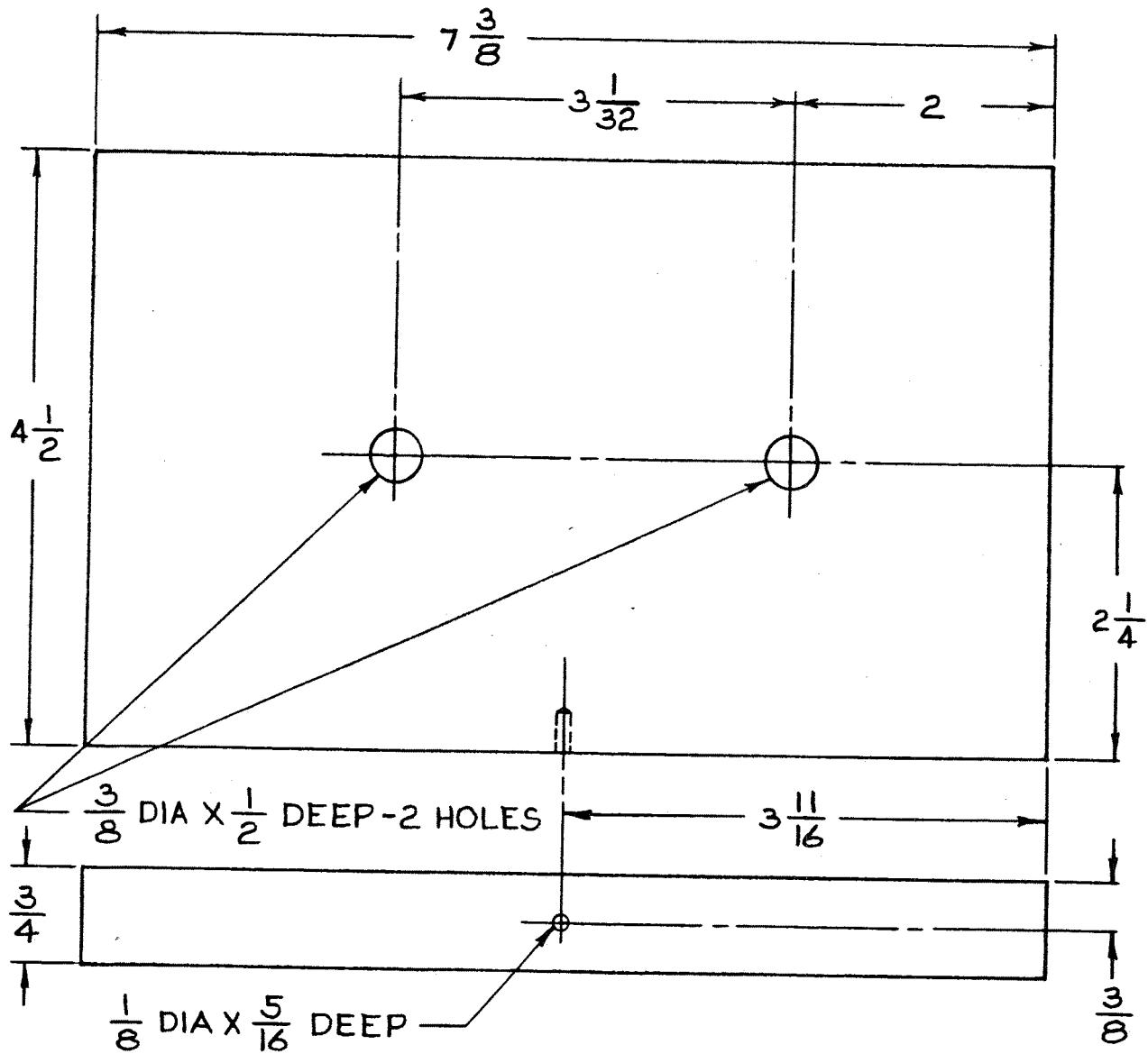
Drill the two axle holes in the backplate and insert pieces of dowel to serve as temporary axles. Put the locking disk on one axle, with its circular profile facing the other axle, and clamp the disk to the backplate. Now, try the wheel in all six possible positions, sanding where required so that all the locking cut-outs have equal clearance. Unless you keep this model in an environment with a very uniform humidity, you should allow a minimum of $\frac{1}{64}$ -inch clearance at each position. When you are satisfied with the fits of the locking cuts, cut the six driving slots,

Illus. 7-4.

BASE PLATE

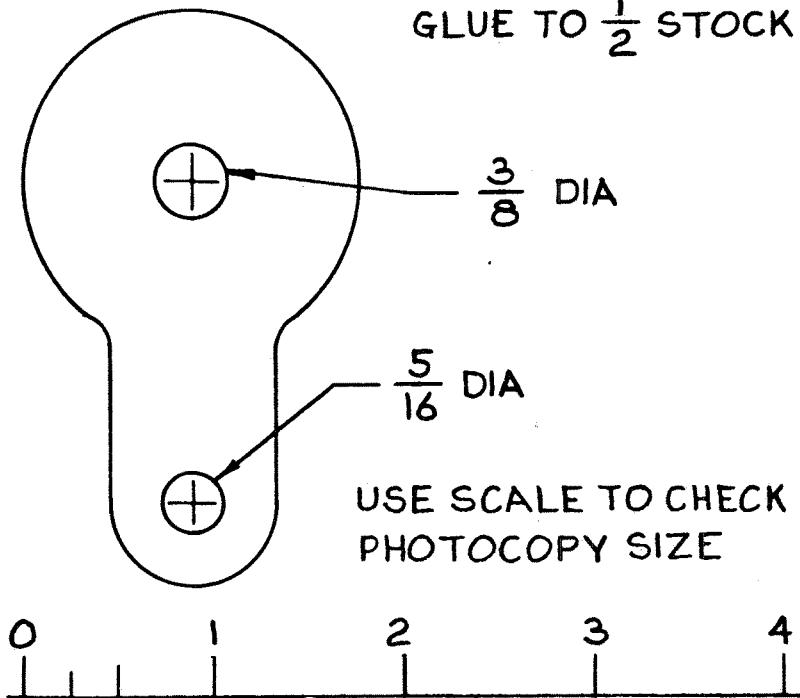


BACK PLATE



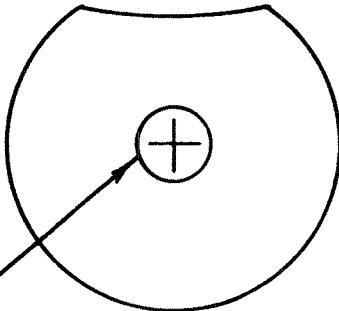
Illus. 7-5.

PATTERN FOR
DRIVE PIN ARM
GLUE TO $\frac{1}{2}$ STOCK



PATTERN FOR
SPACER
GLUE TO $\frac{1}{2}$ STOCK

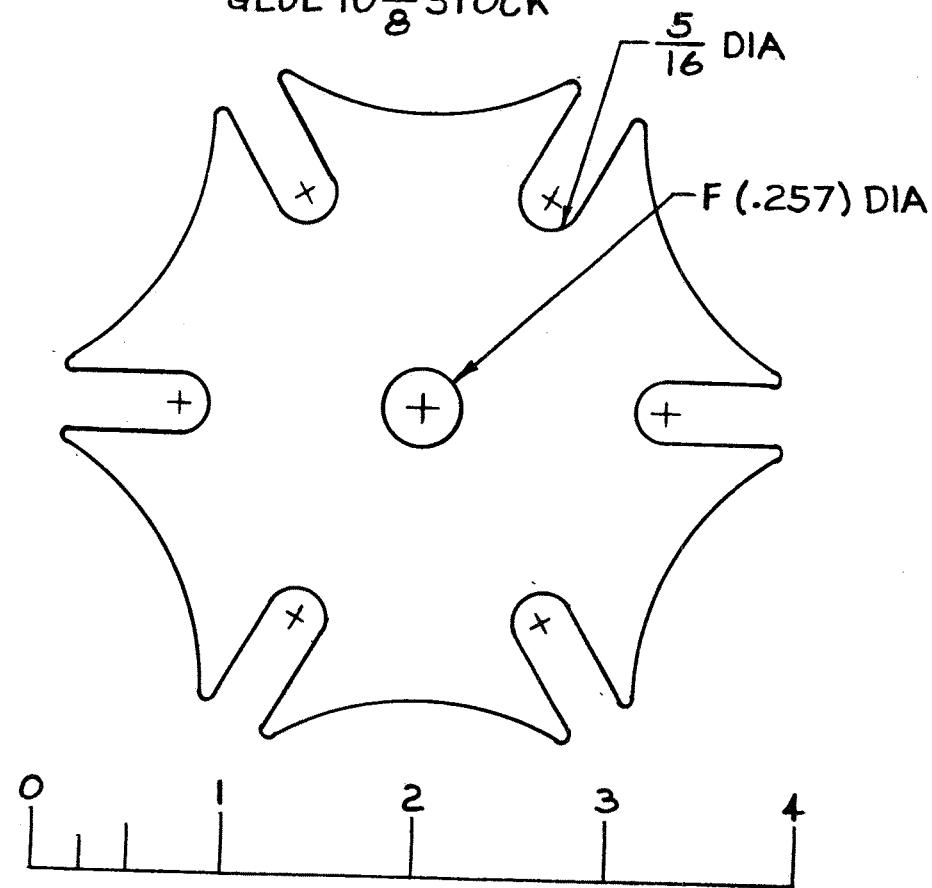
$\frac{25}{64}$ DIA



Illus. 7-7.

PATTERN FOR
GENEVA WHEEL

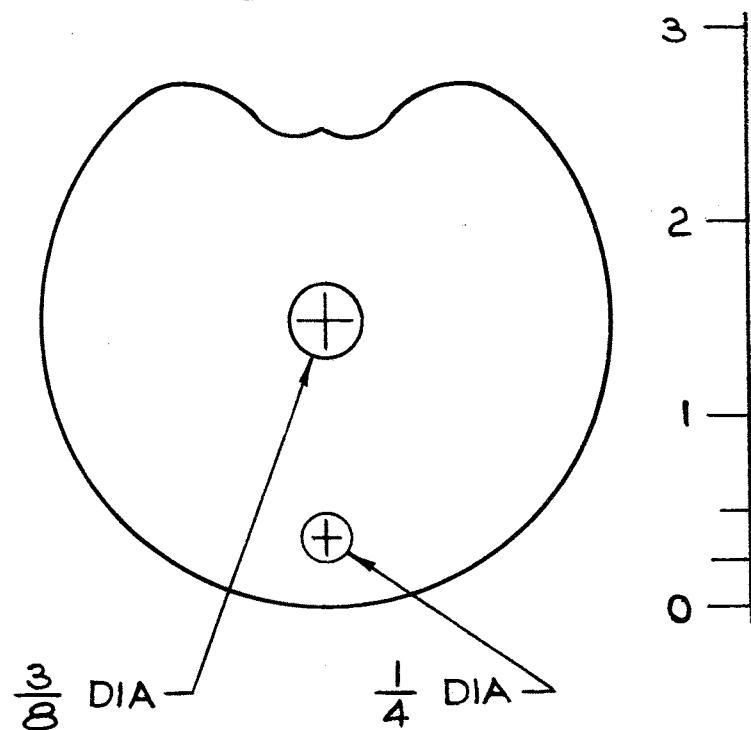
GLUE TO $\frac{3}{8}$ STOCK



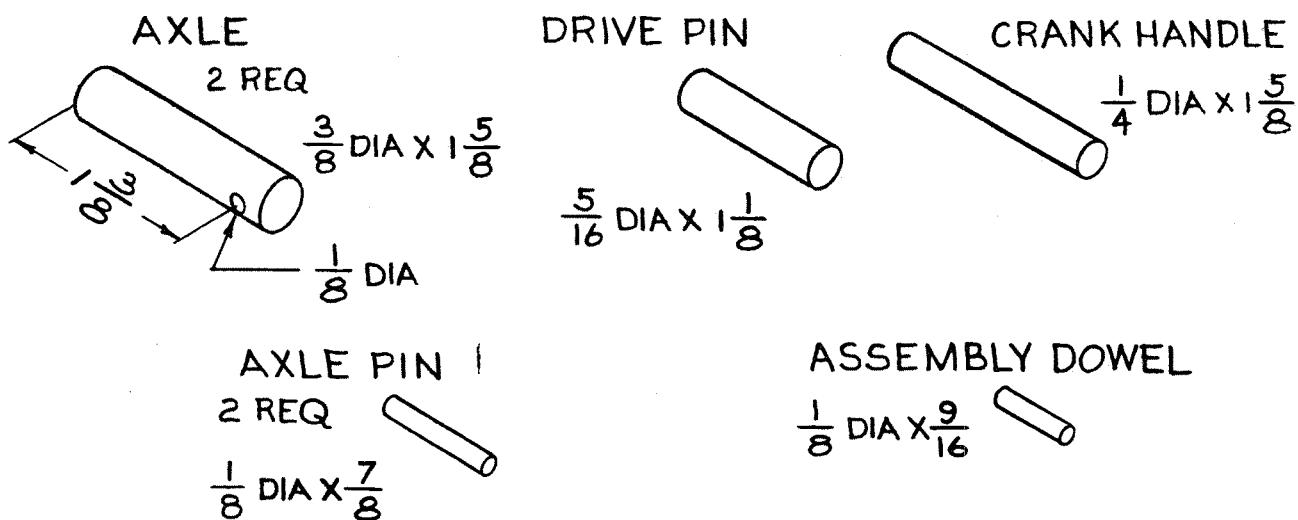
INCH SCALE TO CHECK PHOTOCOPY SIZE

PATTERN FOR
LOCKING DISK
GLUE TO $\frac{3}{8}$ INCH STOCK

Illus. 7-8.

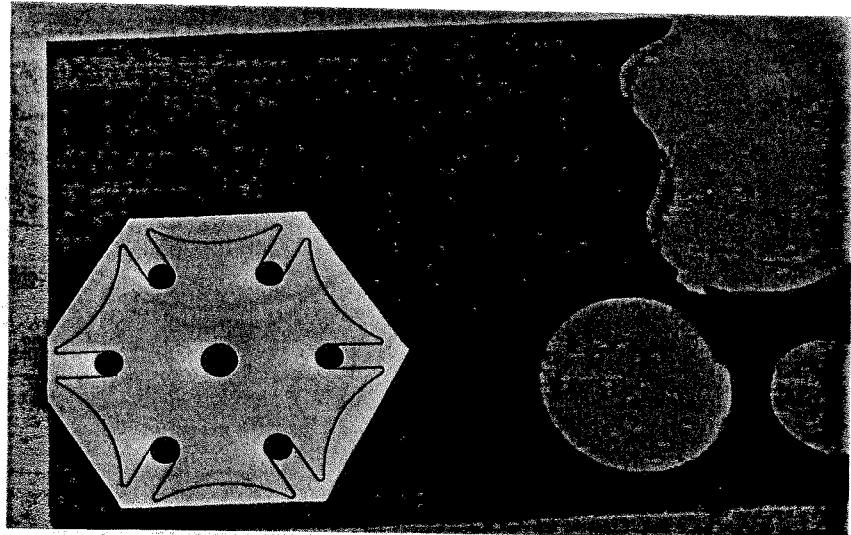


USE 3 INCH SCALE TO CHECK PHOTOCOPY SIZE

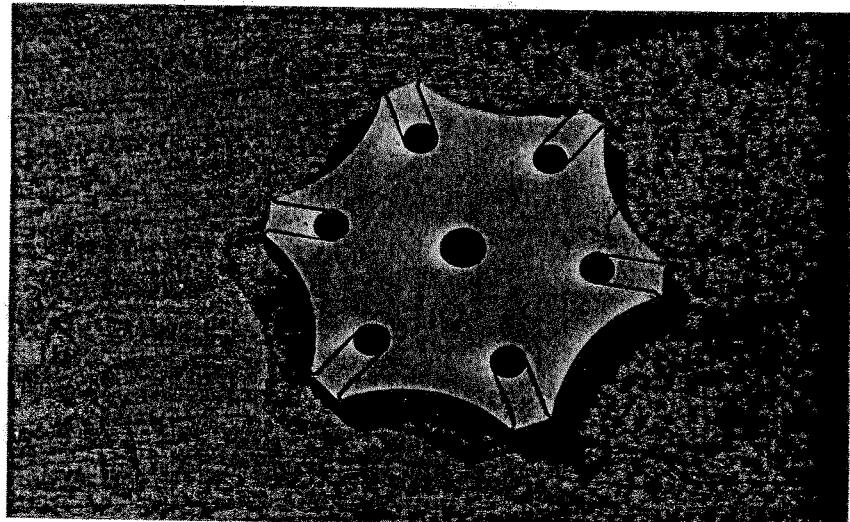


Illus. 7-9.

Illus. 7-10. The wheel pattern glued to the wood, with its holes drilled.



Illus. 7-11. The wheel cut out, and its outer contour completed.



file them to size and checking each with a piece of dowel to ensure uniform clearance. The small radii at the entrance to each slot are important, since they compensate for looseness in the assembly, and allow the drive pin to enter the slots. Fine-sand the wheel all over. (See Illus. 7-12)

Use the patterns shown in Illus. 7-6 to make the drive-pin arm and the wheel spacer. When the drive-pin arm is completed, glue it to the locking disk, using an easy-fitting, waxed dowel for an alignment tool. Center the arm in the clearance cut by eye. When the

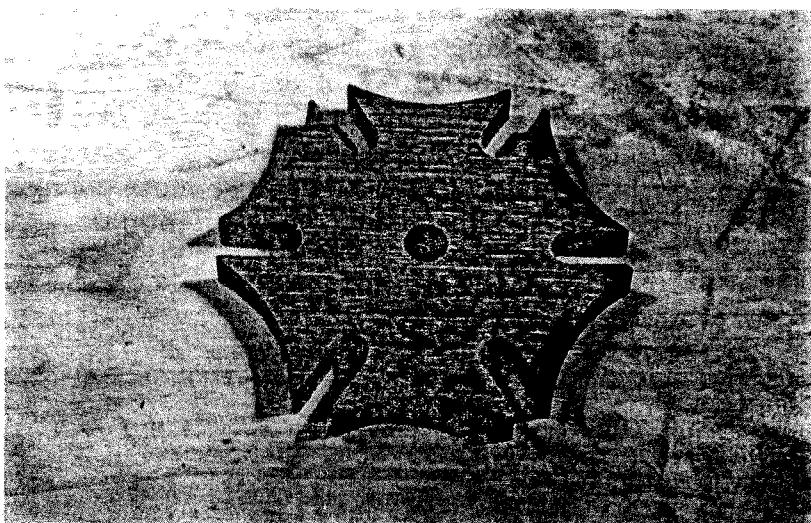
parts are dry, run a $25/64$ -inch-diameter drill through them. (See Illus. 7-13.)

Make the back- and baseplates with the same techniques used for the other models. The small parts also require no additional instructions. (See Illus. 7-3.)

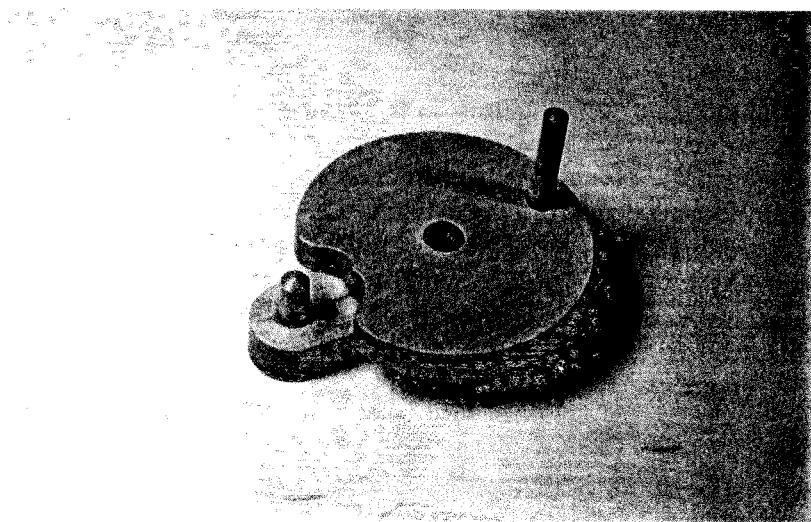
ASSEMBLING THE MECHANISM

Glue the back-to-base subassembly, using an aligning block as described for other projects. Glue the spacer to the backplate, with the

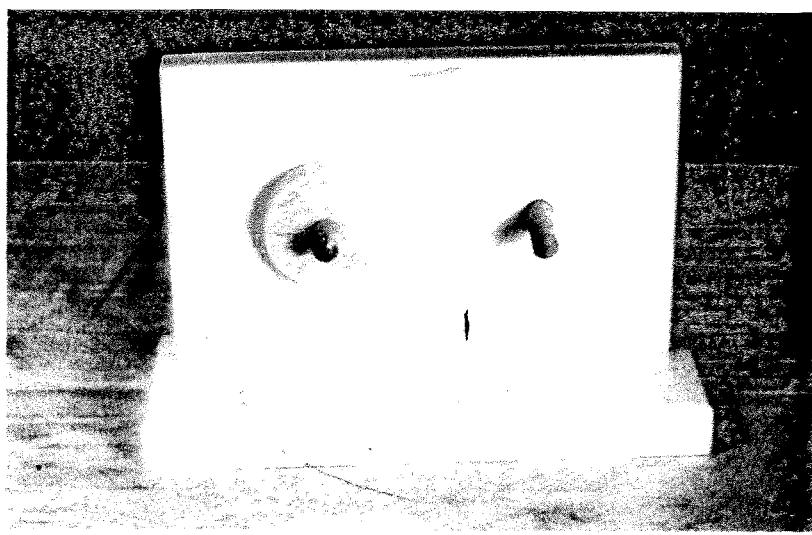
Illus. 7-12. The completed Geneva Wheel.



Illus. 7-13. The locking disk and the drive-arm subassembly.



Illus. 7-14. The back and base subassembly.



clearance cut facing the locking disk; use a dowel for alignment of the parts. (See Illus. 7-14.) Glue the drive pin and the handle into the locking disk assembly. Now, dry-assemble the parts to try their operation. If any of the parts fit too tightly, sand them carefully to ease the action.

Clean up all parts and apply a finish. I tap slightly tapered dowels into the axle holes to keep the finish out of them, wiggling them out before rubbing down the coats of finish. Wax all the working surfaces and assemble the model. This is one of our more popular designs and always attracts attention.

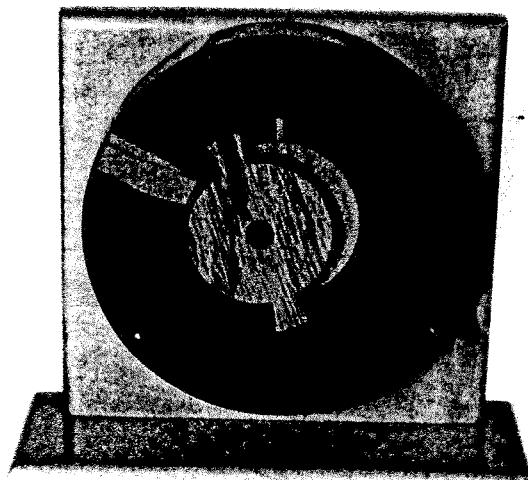
CHAPTER 8

An Intermittent Drive

Various mechanisms are used to convert continuous rotary motion into intermittent rotary motion, but few are as simple as this one. This unit will drive for half a revolution, pause for an equal length of time, and then drive another half revolution, providing a useful action for display turntables, rotary valves, and similar applications.

HOW THE MECHANISM WORKS

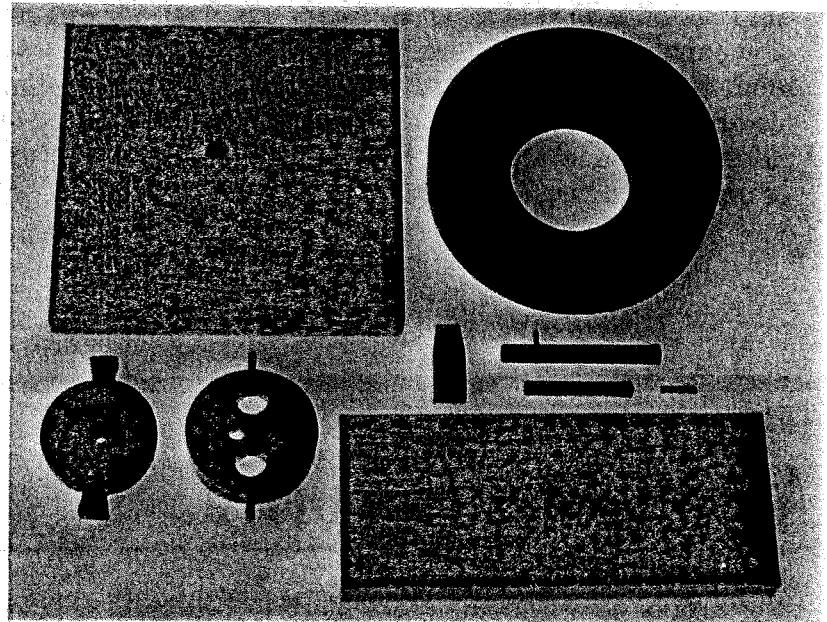
The drive member and the driven member



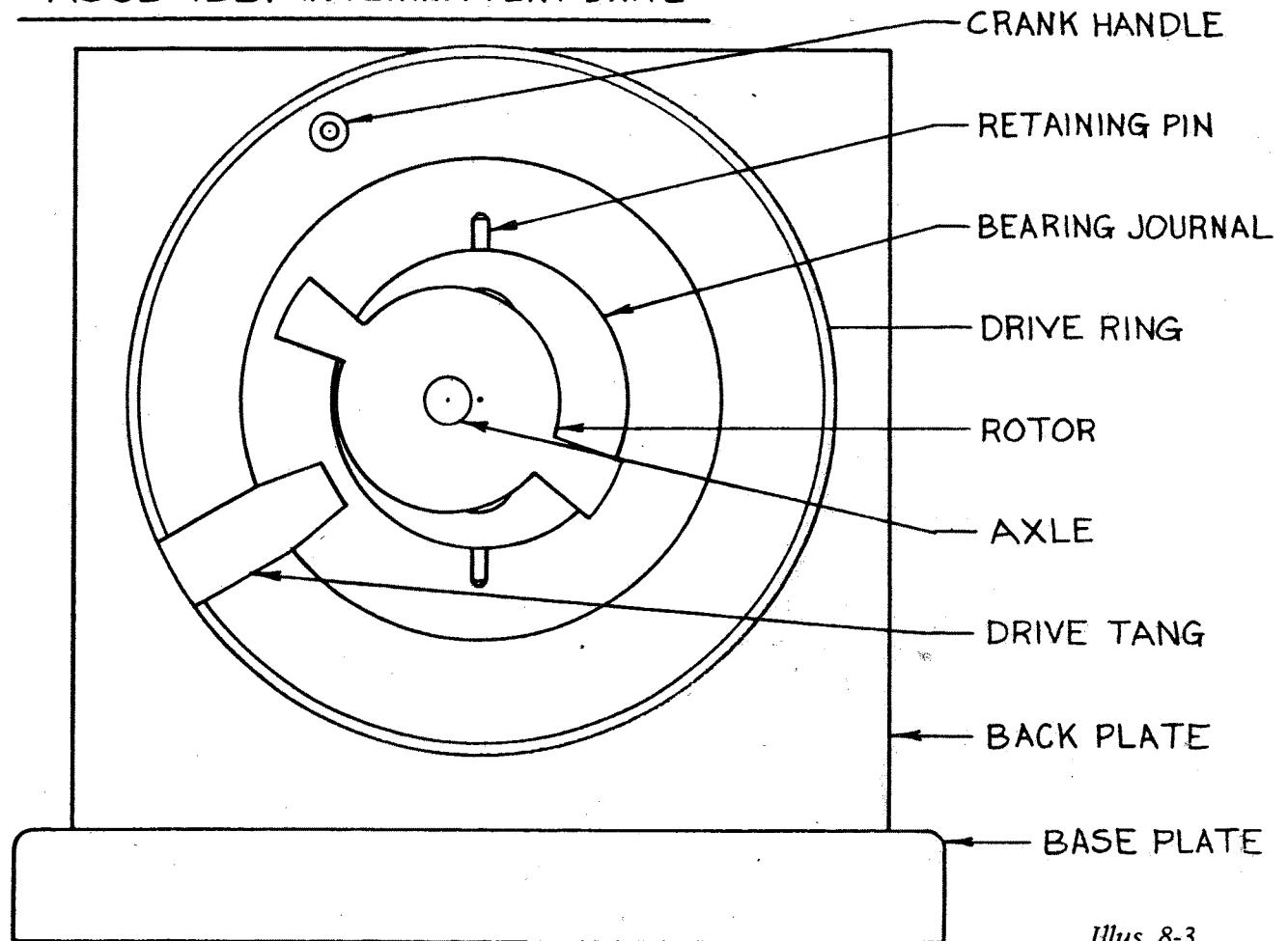
have their centers offset from one another, so the part diameters are eccentric. A tang projecting from the driver engages a lug on the rotor at the close point of eccentricity, and releases it half a revolution later. The unit can be designed so that either the inner or the outer member is the driver, and works best for frictional loads that don't tend to drift or coast.

Illus. 8-1. The Intermittent Drive.

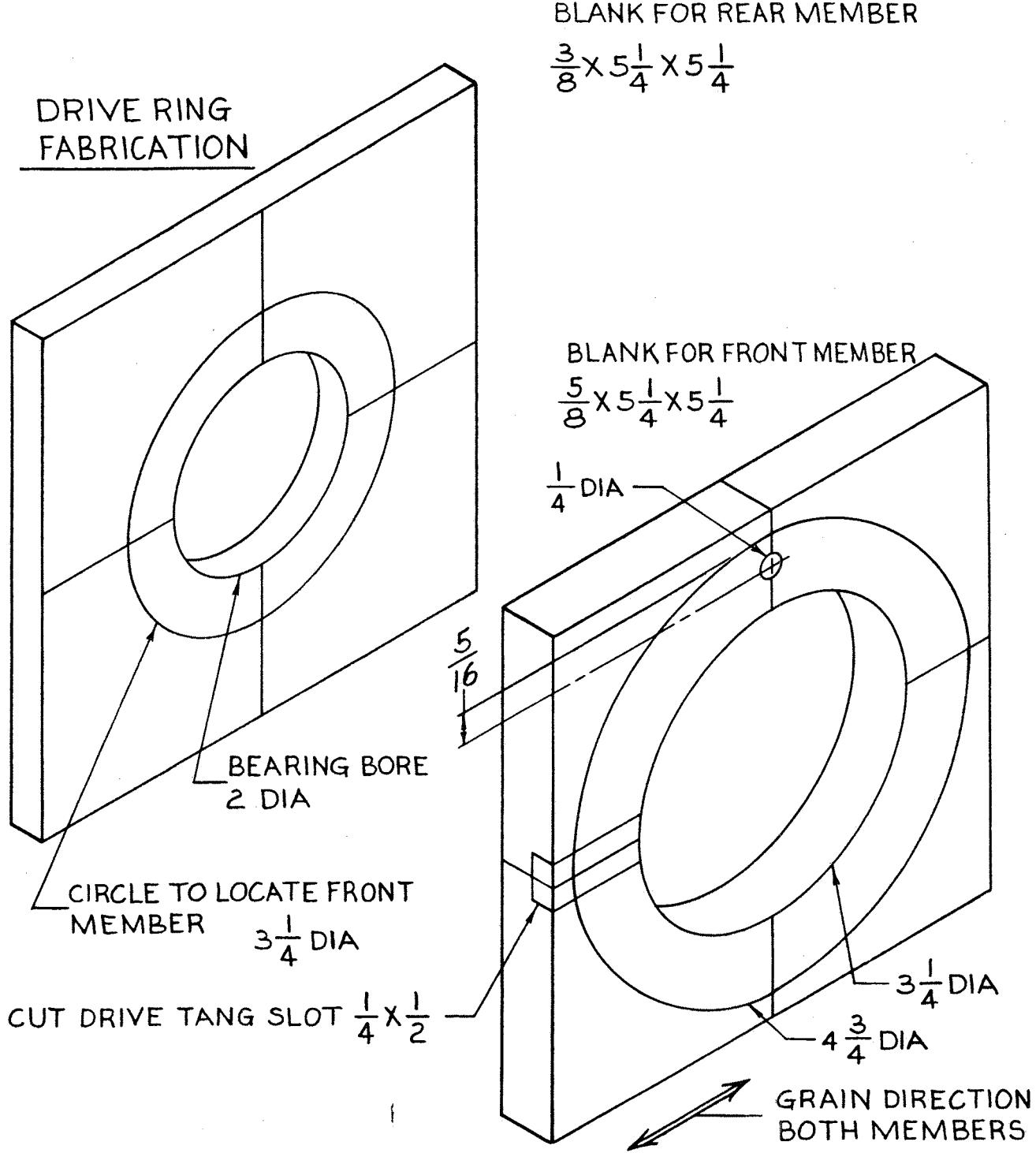
Illus. 8-2. All the parts for the Intermittent Drive.



ASSEMBLY-INTERMITTENT DRIVE



Illus. 8-3.



Illus. 8-4. Drive ring fabrication.

MAKING THE PARTS

Drive Ring

The two-piece drive ring requires a sharp circle cutter for its two large holes. Plane the two thicknesses of stock and lay out the circles as shown in Illus. 8-4. Fasten each piece to a backing block and cut the two inside diameters. Sand the holes smooth, as they will be difficult to sand after gluing the assembly.

Lay out the slot for the drive tang so that it is parallel to one smooth edge of the blank and aligned with the grain. Cut the slot on a router table or a table saw. Lay out and drill the hole for the crank handle.

Apply glue to both pieces, keeping it well away from the inner edge of the large hole. Align the front member with the circle drawn on the rear member, checking constantly while clamping to see that nothing shifts. If any glue squeezes inside the hole, remove it immediately with a wet cloth, so the alignment circle is not obscured. (See Illus. 8-5.)

Allow the joint a day or two to dry and then saw and sand the outer diameter. The

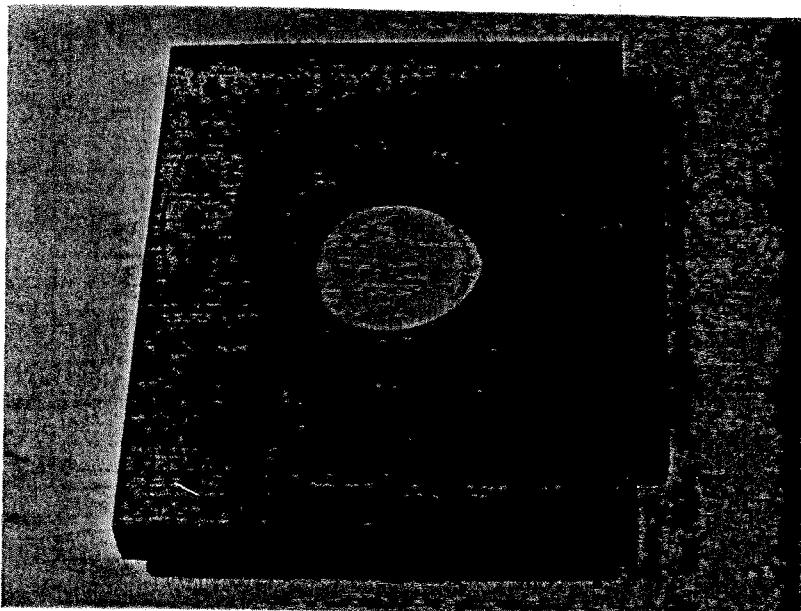
corner chamfers enhance the part's appearance, and can be easily cut on a router table. To avoid chipping the corners, plug the slot with a tight-fitting piece of scrap wood, as shown in Illus. 8-7. Clamp a stop block to the router table, square to the fence and placed so as to center the disk on a chamfering bit. Rotate the part into the revolving cutter. This is a quick, safe way to cut the chamfers.

Bearing Journal (Illus. 8-6)

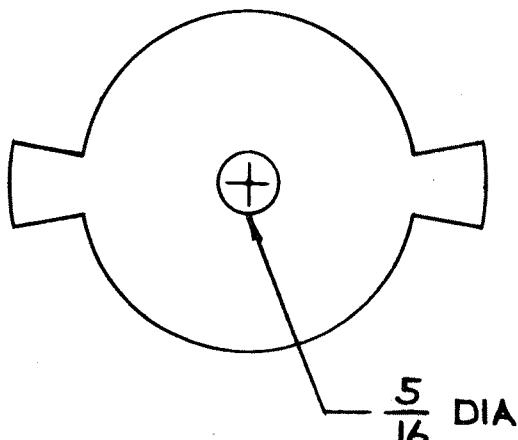
With the driver ring completed, you can make the bearing journal so that it fits the center hole. Allow at least $\frac{1}{64}$ -inch clearance for seasonal changes. Drill the three holes in the face, and the two pin holes in the edge. Before drilling the pin holes, check the thickness of the rear member of the driver assembly. If this varies much from $\frac{3}{8}$ inch, adjust the pin-hole locations to provide a small amount of operating clearance when the parts are assembled. (See Illus. 8-8.)

Remaining Parts (Illus. 8-9)

The rest of the pieces are similar to others in earlier projects and should present no problems. Fit the two retaining pins so that, when



Illus. 8-5. The drive-ring parts glued together.



PATTERN FOR -
ROTOR

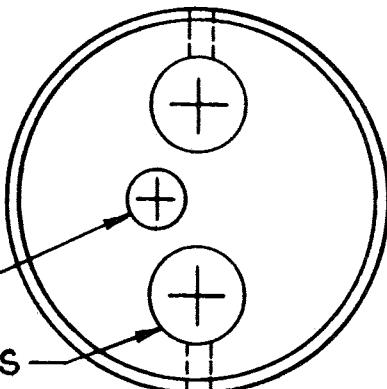
GLUE TO $\frac{1}{2}$ INCH STOCK



INCH SCALE - USE TO CHECK PHOTOCOPY SIZE

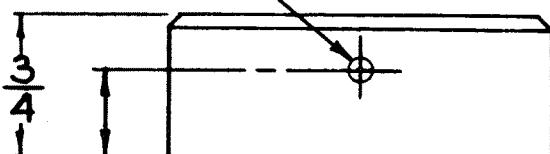
PATTERN FOR -
BEARING JOURNAL
FIT TO DRIVE RING

$\frac{5}{16}$ DIA THRU



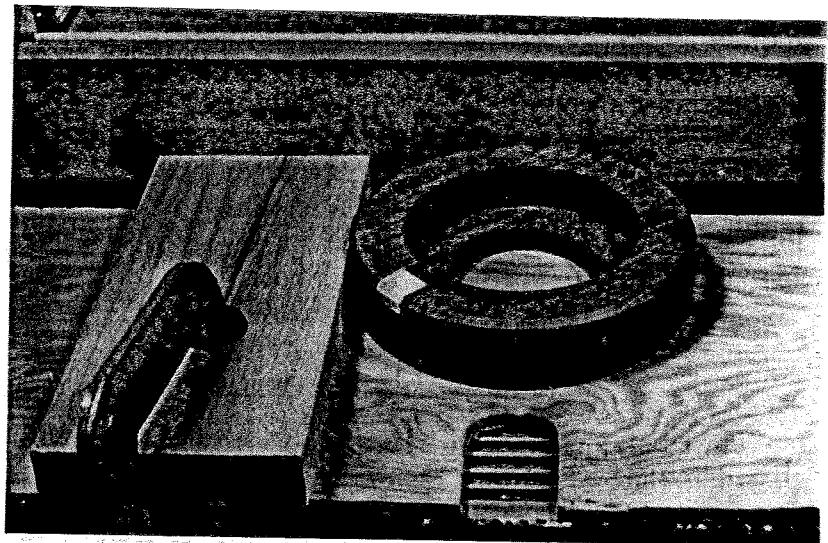
$\frac{1}{2}$ DIA THRU - 2 HOLES

$\frac{1}{8}$ DIA - 2 HOLES

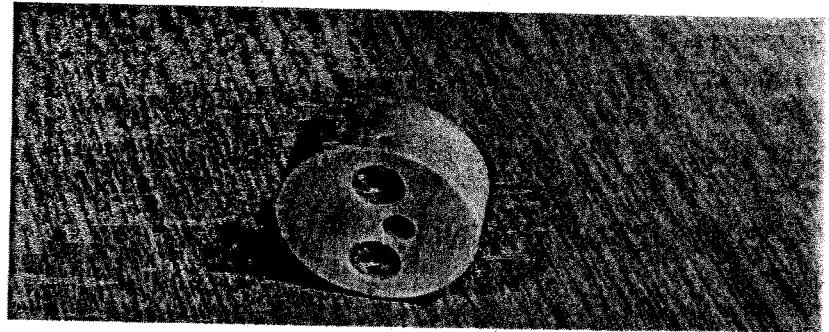


$\frac{29}{64}$ - REFER TO TEXT

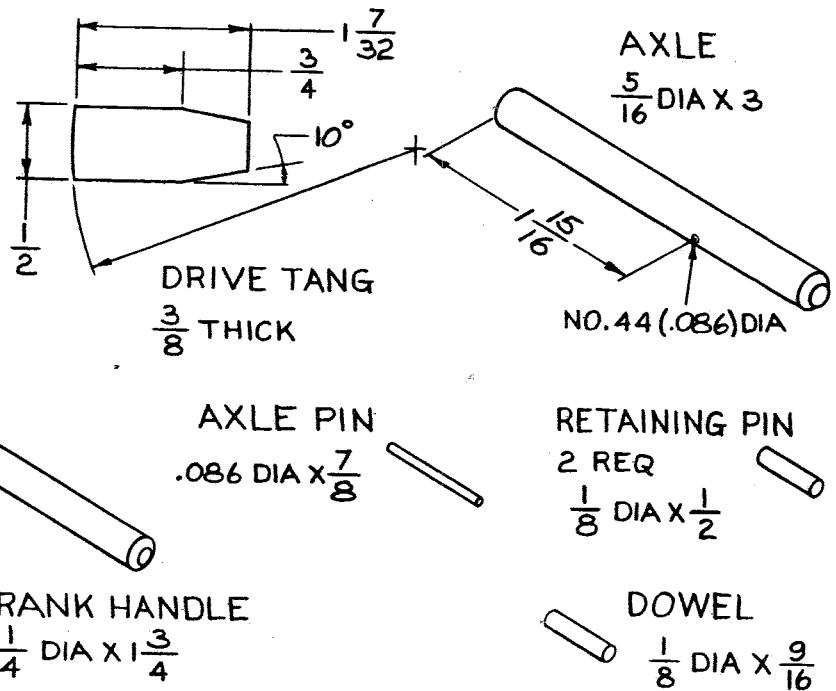
Illus. 8-7. The setup for cutting a chamfer on the drive ring.



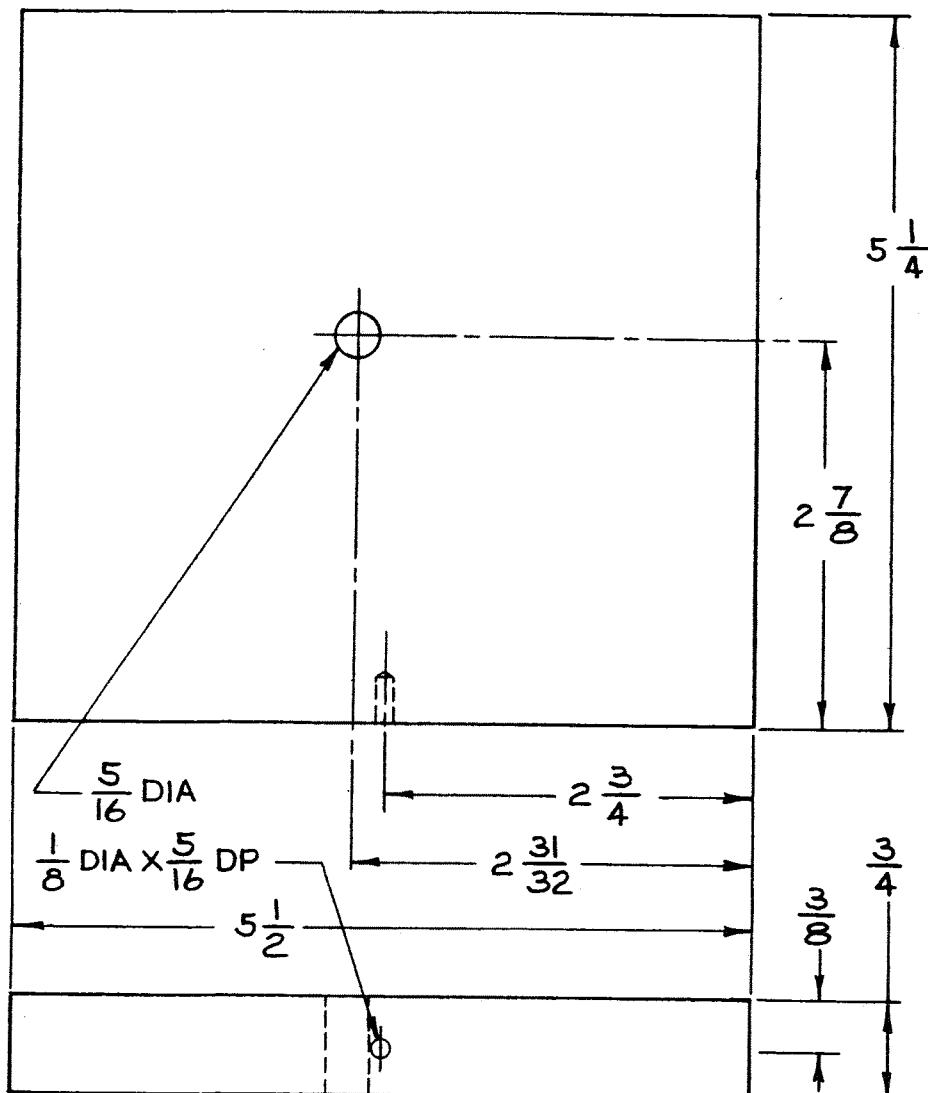
Illus. 8-8. The bearing journal.



Illus. 8-9.



BACK PLATE



Illus. 8-10.

finished and waxed, they can be pushed in and out of engagement without a lot of effort. Make the drive tang a snug fit in its slot and use the pattern in Illus. 8-6 to make the rotor. (See Illus. 8-2.)

Assembling the Unit

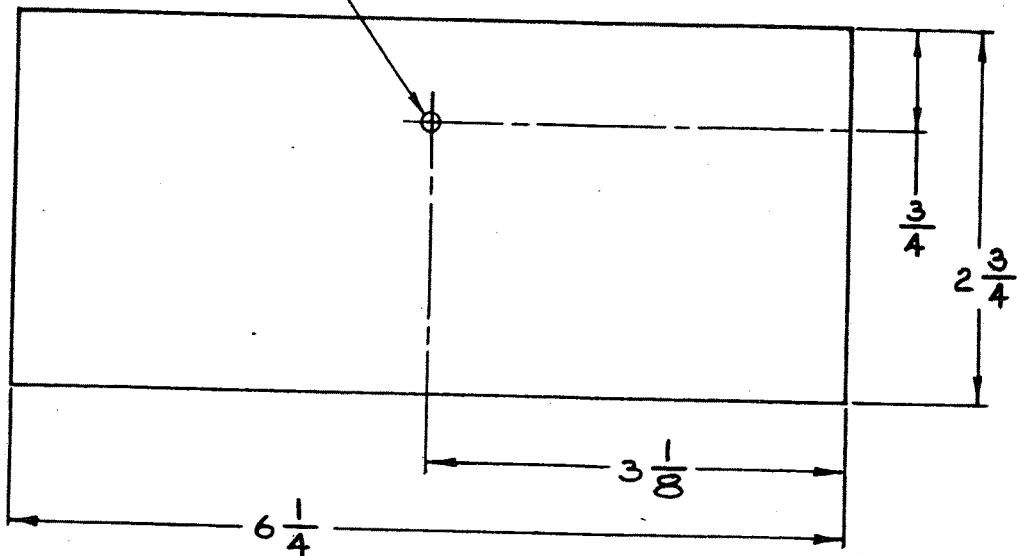
Glue the back to the base, and glue the journal to the backplate, using a waxed dowel

for alignment. When the parts are dry, drill the shaft hole to a $2\frac{1}{64}$ -inch diameter.

Glue the tang into the driver and sand it flush if necessary to match the outer radius. Glue the axle into the rotor so that the axle pin clears the backplate when assembled, and sand the end flush with the front face. Glue the crank handle into the driver. Clean up and apply a finish to all the parts.

Push the two retaining pins flush with the

Illus. 8-11.

BASE PLATE $\frac{3}{4}$ THICK $\frac{1}{8}$ DIA X $\frac{5}{16}$ DEEP

diameter of the bearing journal. Wax all the rubbing surfaces, set the driver in place, and push the two pins outward to retain it. The driver should turn freely, with a minimum of shake. Assemble the rotor and its pin, completing the assembly.

For each full turn of the crank handle, the rotor will make half a revolution, a useful action for a variety of toy and display designs.

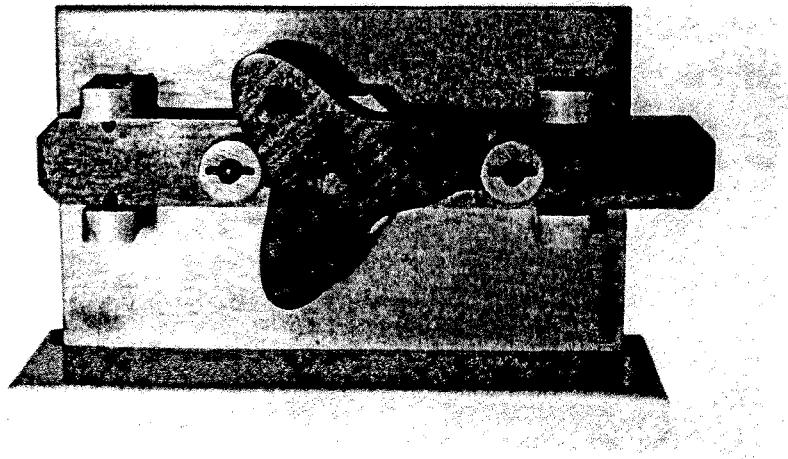
CHAPTER 9

Positive-Action Cam

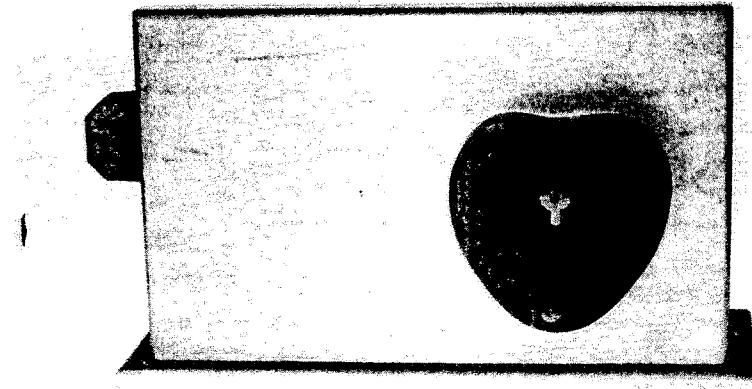
This is another form of self-conjugate cam. Unlike the one in Chapter 2, which was intended for a particular application, this type of cam permits greater flexibility in its design, and is more often used in industrial machinery.

In this model, I include two interchangeable cam profiles; you can also use cams of your own design.

Illus. 9-1. A front view of the Positive-Action Cam.



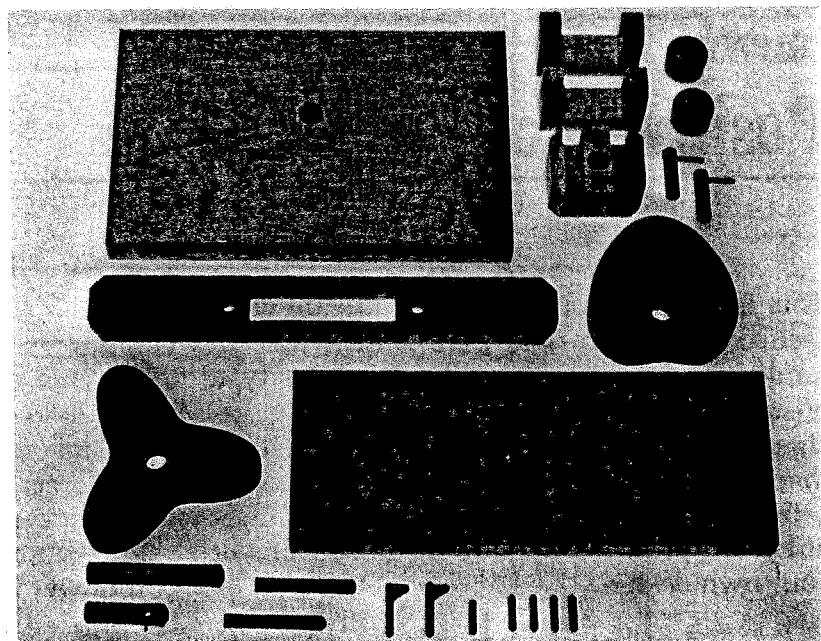
Illus. 9-2. A rear view of the Positive-Action Cam.



HOW THE MECHANISM WORKS

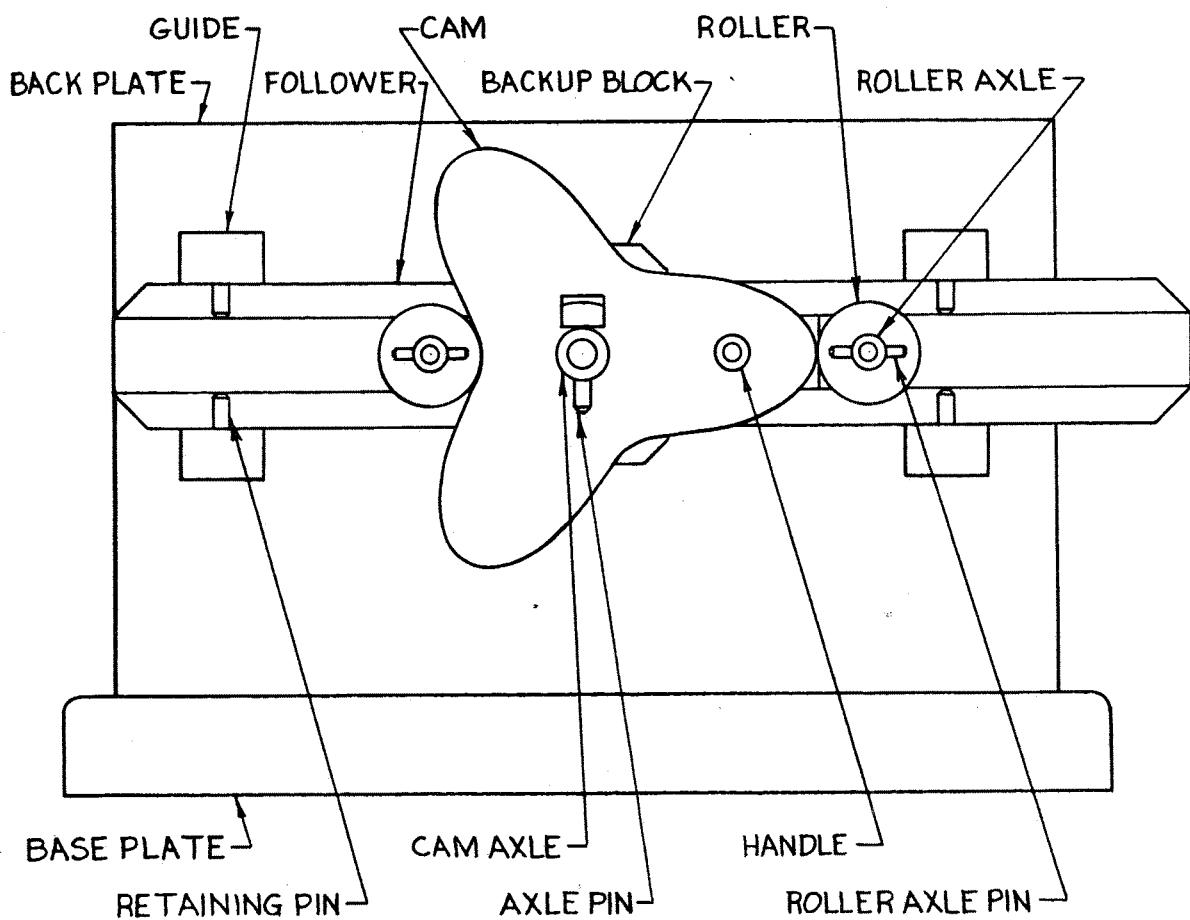
The cam operates between rollers mounted on a follower slide and contacts both rollers throughout its rotation. Therefore, no external force is required to keep the follower against the cam, so this mechanism will function in any position and is not subject to "follower float" at high operating speeds.

Illus. 9-3. All the parts for the Positive-Action Cam.



Illus. 9-4.

ASSEMBLY-POSITIVE ACTION CAM



MAKING THE PARTS

Back- and Baseplates

Make the back- and baseplates as shown in Illus. 9-5 and 9-7. The hole on the rear of the backplate is for a parking axle to hold the second cam, and may be omitted if you only intend to make one cam.

Follower Slide (Illus. 9-6)

Cut the four pieces of this part a little longer than finished size and glue them together, leaving the correct length of opening in the center. (See Illus. 9-8.) When they are dry, trim the part to size and shape and drill the two roller axle holes, locating them as accurately as you can.

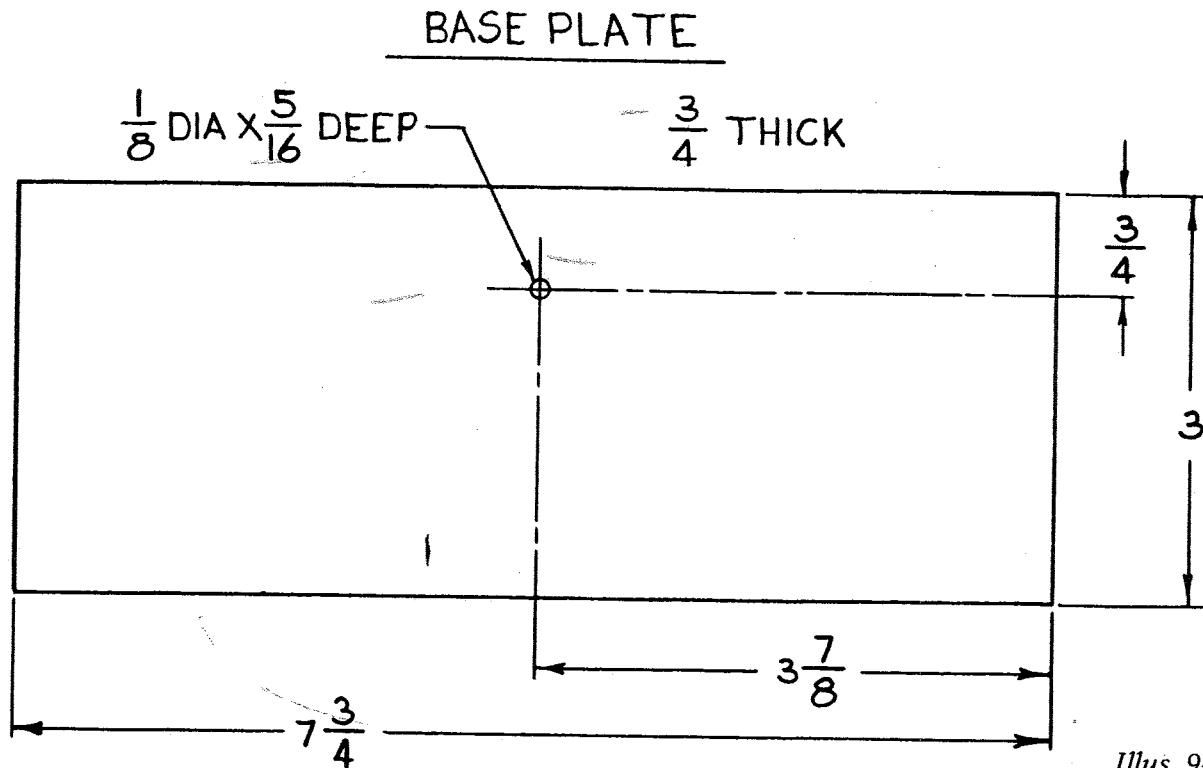
Follower Guides (Illus. 9-6)

Cut material long enough to make several parts, and glue it together as shown in Illus. 9-9. The center block should be slightly larger than the follower, to allow this part to slide easily.

Slice off the two guides and sand them clean. Lay out and drill the pin holes, locating them so as to allow slight clearance for the thickness of the slide.

Cam Backup Block (Illus 9-6)

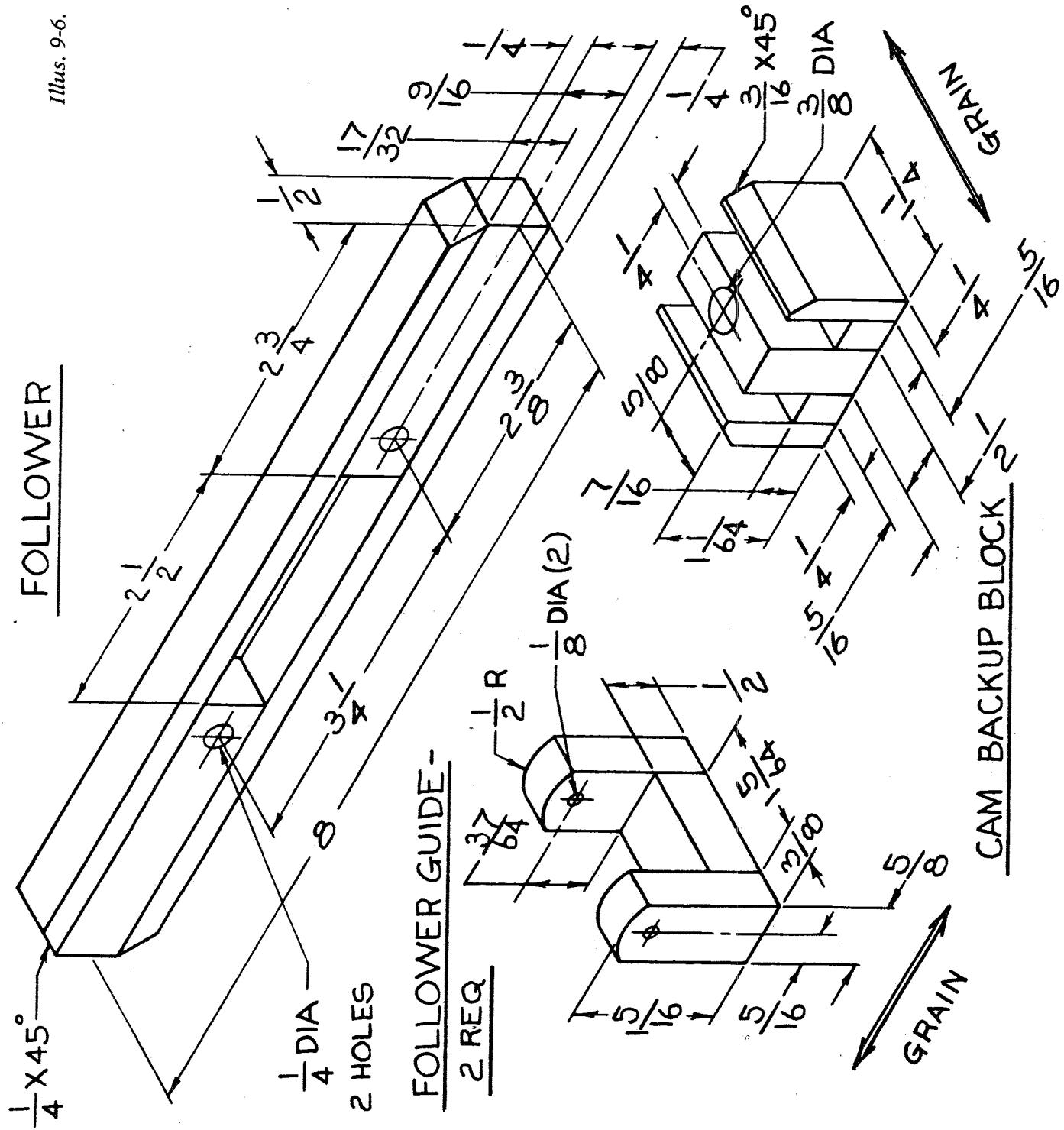
This part is also built up from pieces. Drill the axle hole in the center member before gluing the assembly, to avoid losing the whole block if the drill wanders. Glue the pieces and trim them to size when they are dry. The height of the block should position the cam just above the slide to prevent these

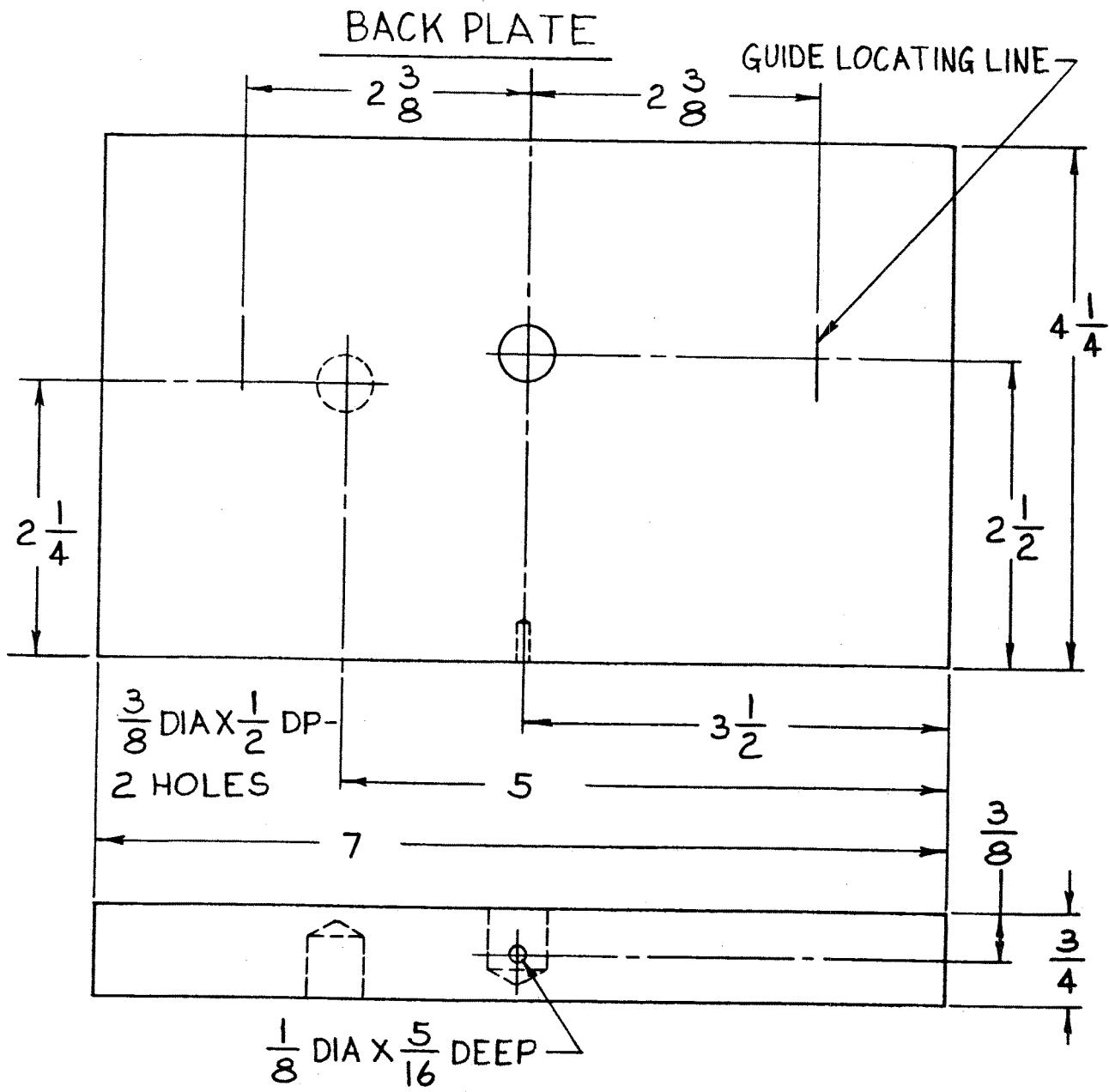


Illus. 9-5.

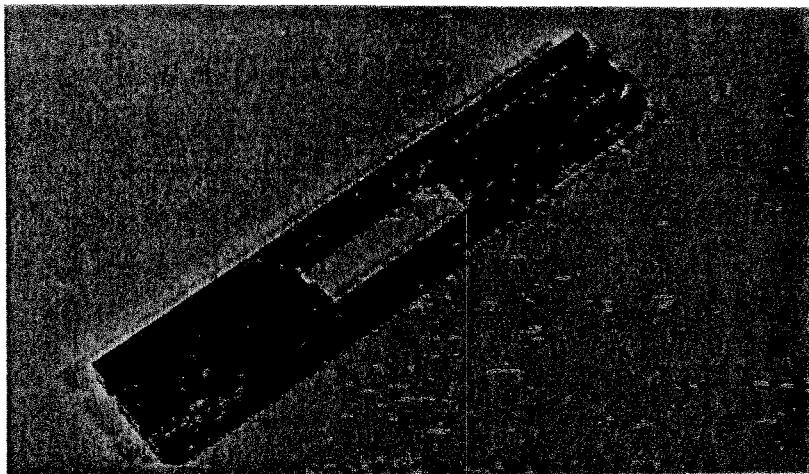
FOLLOWER

Illus. 9-6.

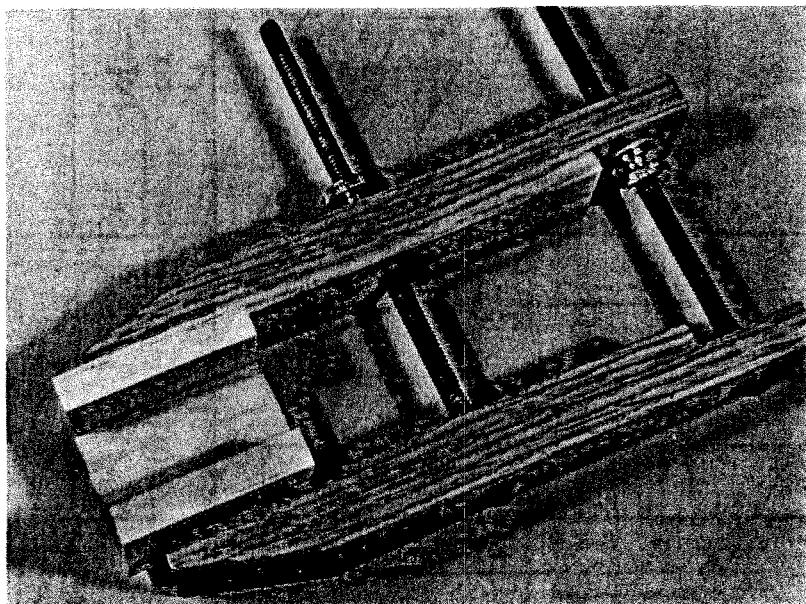




Illus. 9-7.



Illus. 9-8. The follower parts ready for gluing.



Illus. 9-9. Gluing together a blank for the follower guides.

parts from rubbing, so check the assembly of your completed parts before trimming the block to its final height.

Cam (Illus 9-10 and 9-11)

Check the size of your photocopy and glue the pattern to the stock. (See Illus. 9-12.) Drill the holes and saw and sand to the outline, but don't finish-sand until you have tried the cam in the assembled model.

Remaining Parts (Illus. 9-13 and 9-14)

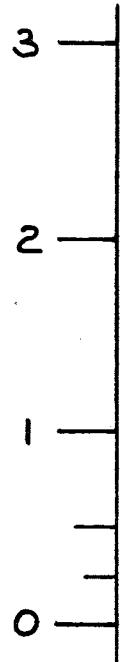
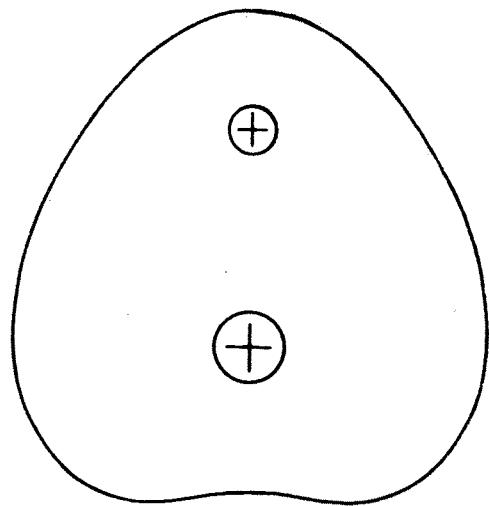
The two rollers are best made with a circle cutter, but if your cutter can't cut pieces this small, saw them out and sand them on a fixed pin, as explained in previous chapters.

All other parts are similar to those in earlier projects. If you cut both cams, you may want to make the handled retaining pin, shown as an alternate design in Illus. 9-14. Fit this so that it wiggles in and out easily, and orient

1 LOBE CAM PATTERN

Illus. 9-10.

GLUE TO $\frac{1}{2}$ INCH THICK STOCK

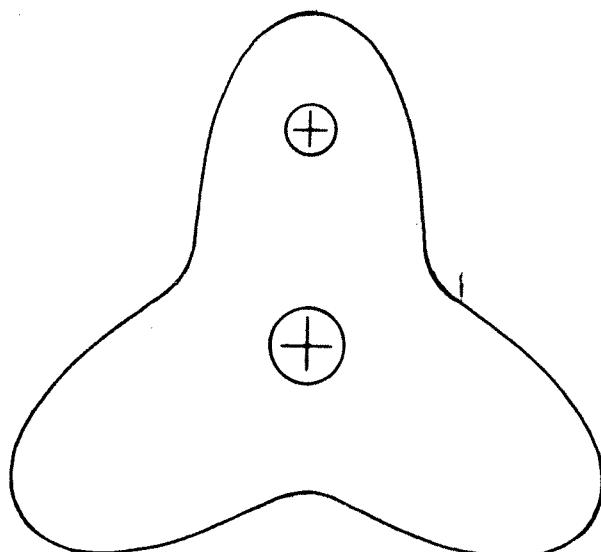


CENTER HOLE $\frac{25}{64}$ DIA THRU

HANDLE HOLE $\frac{1}{4}$ DIA X $\frac{3}{8}$ DEEP

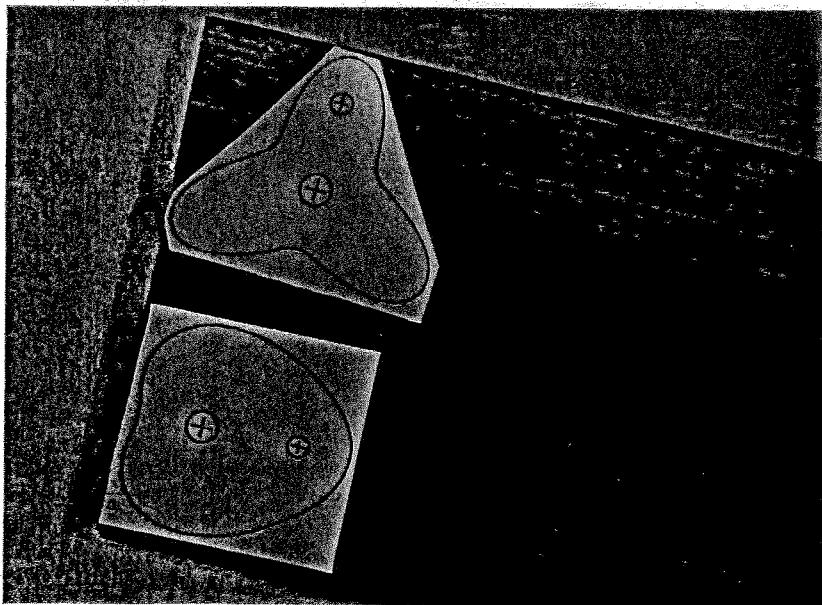
3 LOBE CAM PATTERN

Illus. 9-11.

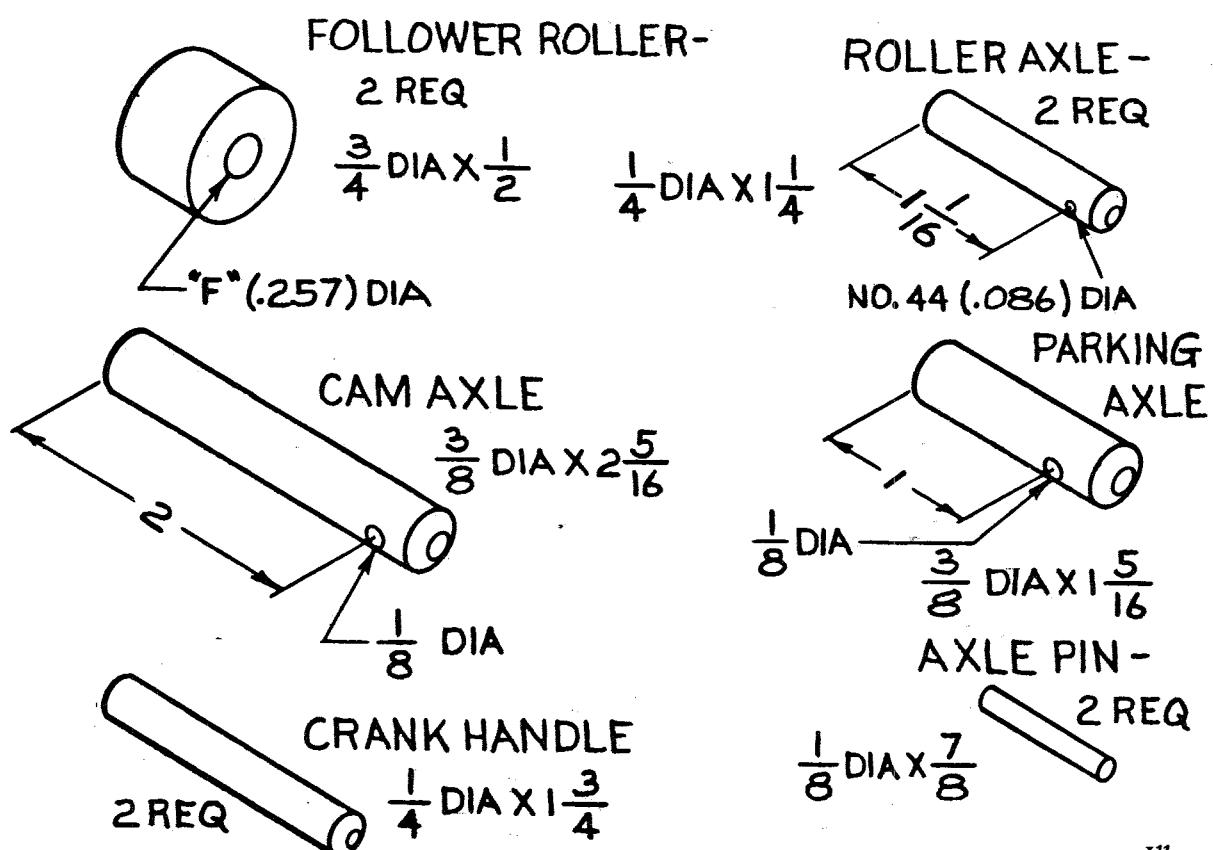


CENTER HOLE $\frac{25}{64}$ DIA
THRU

HANDLE HOLE $\frac{1}{4}$ DIA X $\frac{3}{8}$
DEEP



Illus. 9-12. The cam patterns glued to the wood.



Illus. 9-13.

RETAINING PIN-
4 REQ
 $\frac{1}{8}$ DIA X $\frac{5}{8}$
ROLLER AXLE PIN - 2 REQ
 $.086$ DIA X $\frac{9}{16}$

PIN LIFTING HANDLE
2 REQ - GLUE PIN IN PLACE
BEFORE CUTTING PART FROM
LONG BLANK

the axle pin hole vertically, when using this design.

Fit the four slide-retaining pins so that they can be pushed in or out of engagement without a lot of force. (See Illus. 9-3.)

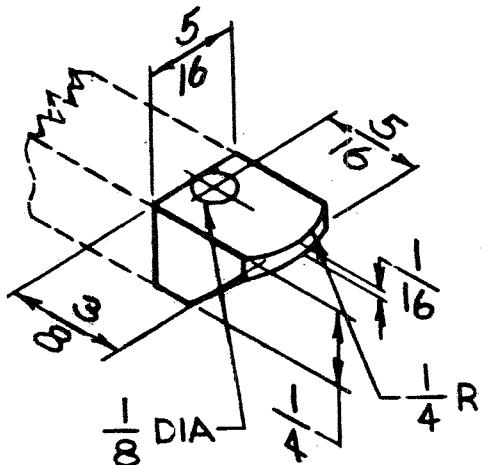
ASSEMBLING THE MECHANISM

Shim the follower in the cam backup block, using equal amounts of cardboard and paper on each side, so that the part is centered in the block. Do the same for the two follower guides, although these shouldn't require much more than a piece of paper on each side to take up all clearance. Sand a piece of $\frac{3}{8}$ -inch dowel about 5 inches long so that it fits easily in the backup block and the backplate. Push this through the two holes to dry-assemble the parts.

Measure from the baseplate to the follower at two widely separated points to establish the dimension for the levelling blocks. Select parallel blocks of scrap wood to fill the space so that the follower is levelled. Now remove

DOWEL

$\frac{1}{8}$ DIA X $\frac{9}{16}$

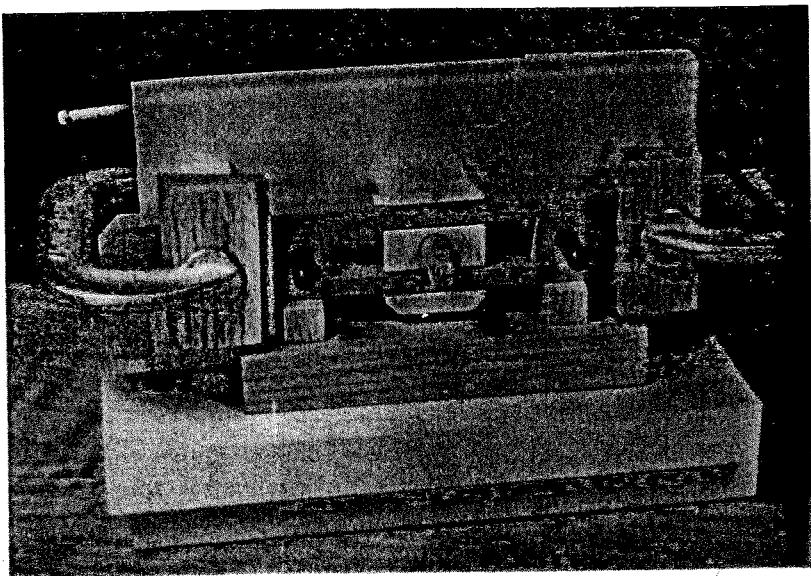


the two guides and glue the backup block to the backplate, keeping the follower shimmed in place and levelled by the spacer blocks. Use the dowel for alignment, removing it before the glue sets up.

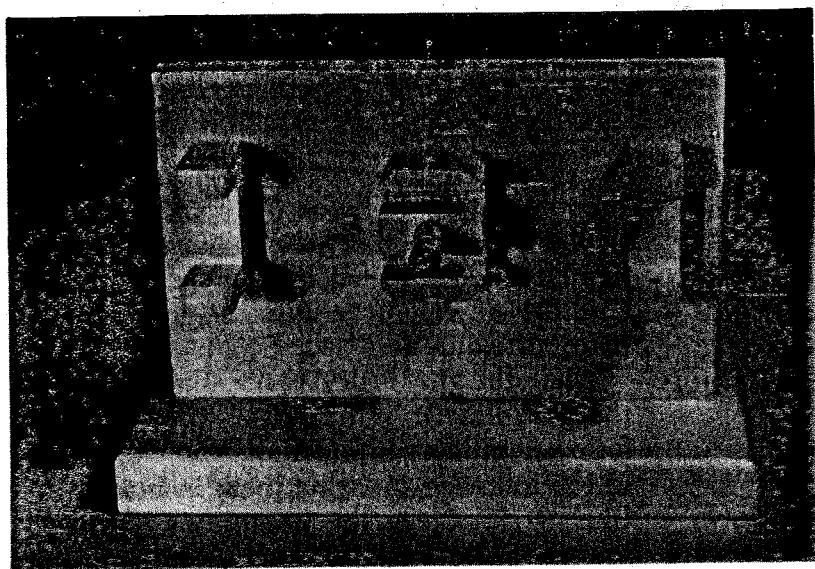
When the glue is dry, make small marks on the backplate to indicate the location of the follower guides. Shim these follower guides to the follower and glue them in place. (See Illus. 9-15.) Clean the assembly and glue in the cam axles, front and back, keeping the pin holes a little above the faces of the cams.

Glue the two roller axles into the follower slide. Now, set the follower in place, assemble the rollers, and try the cams for fit. They should have a little clearance at all points of rotation; so sand wherever there is not enough clearance. When the cams are satisfactory, fine-sand them and glue in their handles.

Clean all the parts and apply a finish. Wax all the bearing surfaces and assemble the components, checking each individually for smoothness of operation. This model is now ready to display. The three-lobed cam gives an especially lively action.



Illus. 9-15. Gluing the follower guides to the backplate, using levelling blocks.



Illus. 9-16. The base and back subassembly.

CHAPTER 10

Roller-Gearing Mechanism

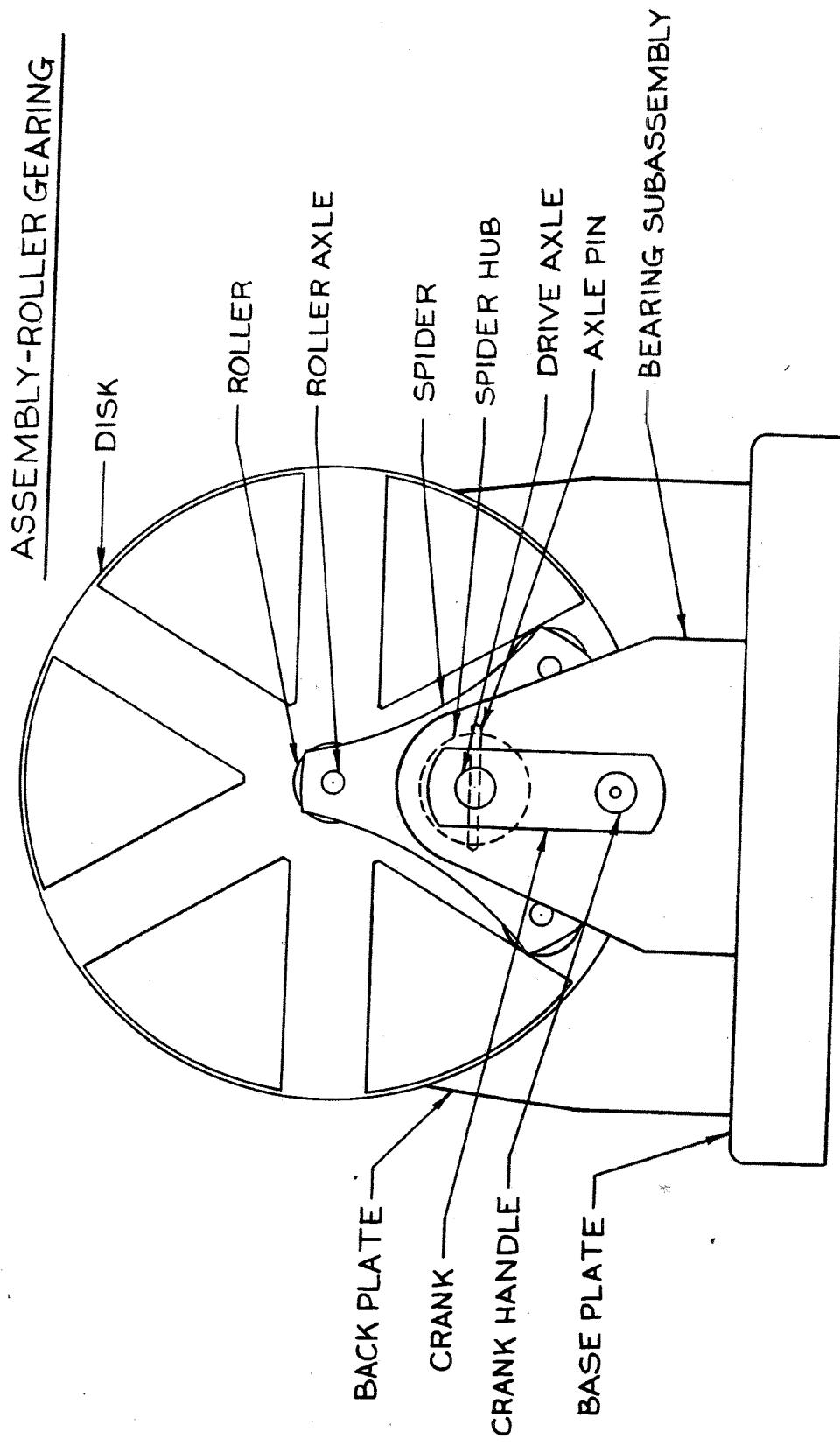
This is an economical, low-friction alternative to conventional toothed gearing. It has been used to drive machine tables and heavy fixturing, as it is compact, requires less lubrication than ordinary gears, and can be built as strong as required for a given application. Its only drawback is that it is limited to a 1 to 2 speed ratio.

HOW THE MECHANISM WORKS

The rule of hypocycloids tells us that if a small circle is rolled around the inside of a circle exactly twice as large in diameter, any point on the small circle will trace a straight line, which will be a radius line of the large

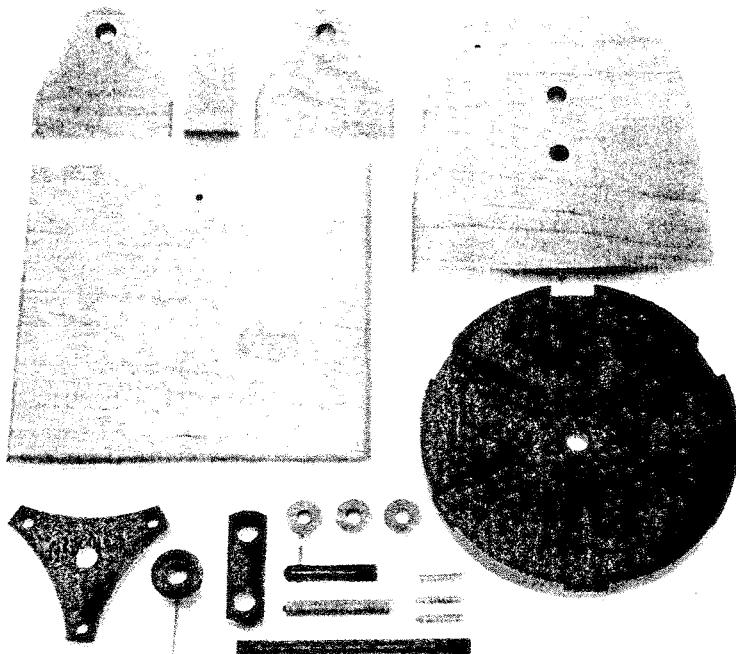
Illus. 10-1. The Roller-Gearing mechanism.





Illus. 10-2.

Illus. 10-3. All the parts for the Roller-Gearing mechanism.



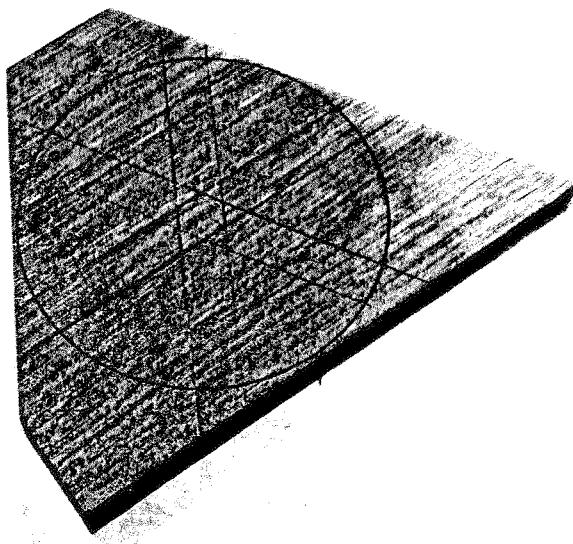
circle. If, then, you make two disks, one of which has rollers located on the circumference of the small circle, each of which is centered in a radial slot in the large disk, the two disks will operate together at uniform velocity, with a ratio of 1 to 2 for any of the possible combinations of rollers and slots.

MAKING THE PARTS

The Disk (Illus. 10-5)

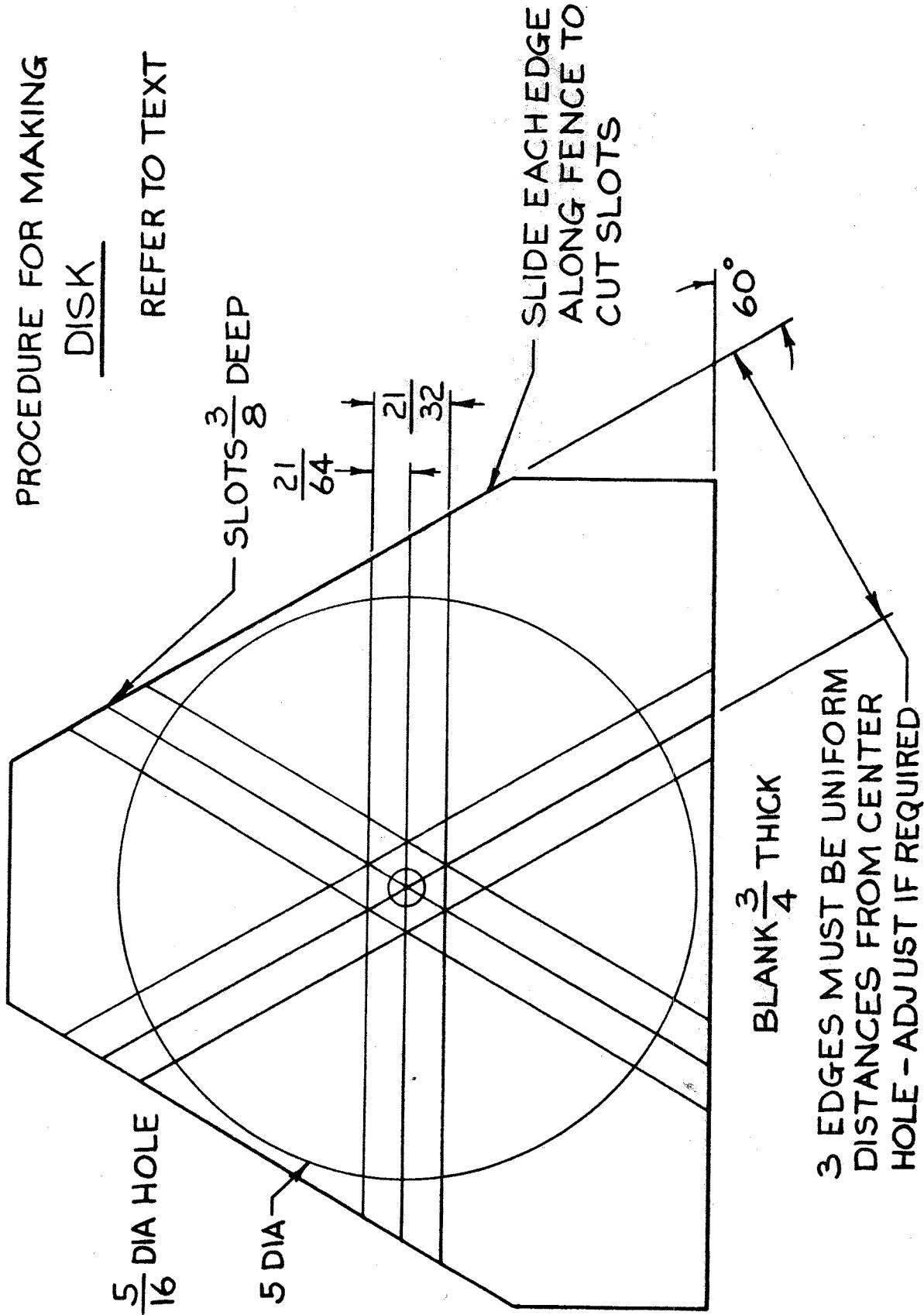
Draw a five-inch-diameter circle on the material, keeping it slightly away from the

Illus. 10-4. The triangular blank laid out.



PROCEDURE FOR MAKING
DISK

REFER TO TEXT



edges. Lay out two 60-degree angles to form an equilateral triangle, equally spaced from the circle. Extra flats on the corners won't matter as long as they aren't too large. Cut out the triangle and check the angles with a good protractor, correcting any errors with a small plane. It is important that the triangle is an accurate 60 degrees on each side. (See Illus. 10-4.)

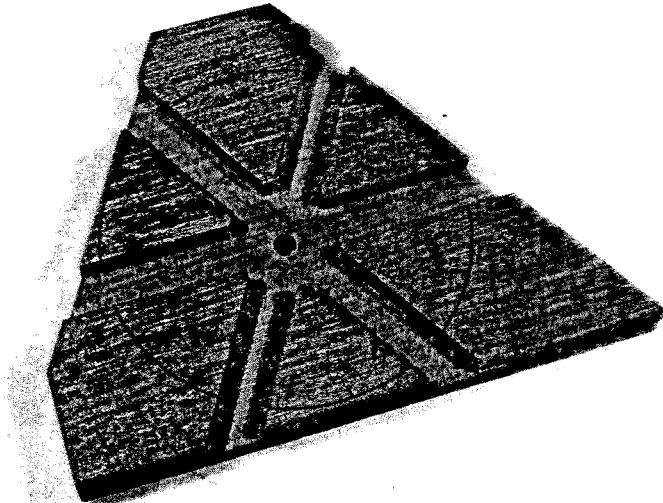
Set a marking gauge to the centerline dimension and draw a short line parallel to each of the three sides. These lines will probably intersect to form a tiny triangle. Drill a $\frac{5}{16}$ -inch-diameter hole as accurately centered in this triangle as possible. Put the drill shank or other rod in the hole and measure from it to each side of the triangle. If there is a noticeable difference in the measurements, correct it before proceeding.

Set a marking gauge to the location of one side of a slot and draw lines that are parallel to each side of the triangle. Repeat this for the other side of the slot. Carefully mark one set of the lines around the corners onto the edges of the blank, to aid in setting up the slotting operation.

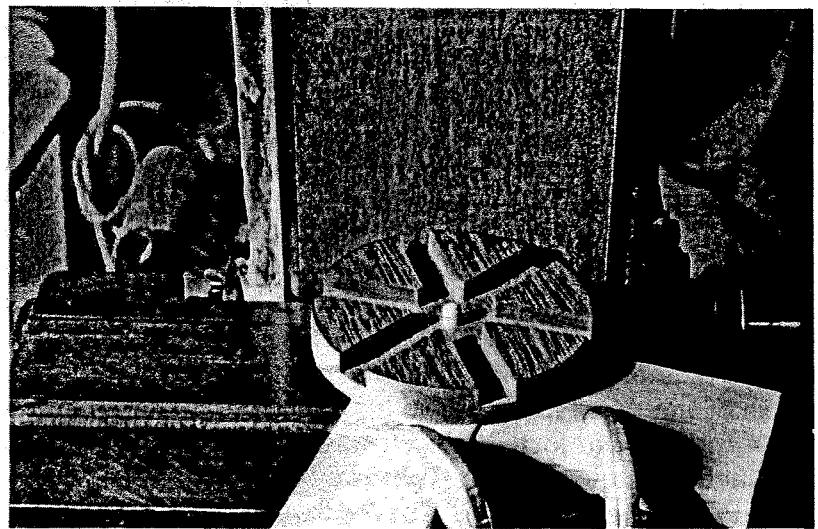
Now, cut the slots with a table saw, or on a router table. You can use either a sharp circular saw blade or sharp router bit. A circular saw blade will not chip the blank as much, but a router bit makes the smoothest, most accurate cut. However you cut the slots, work up to a finished depth and width in easy stages. You will undoubtedly experience some chipping of the sharp points at the inner ends of the slots. This will not noticeably affect operation, so just trim them neatly to a uniform dimension, using a sharp chisel. (See Illus. 10-6.)

Saw the outside diameter, and belt- or disk-sand it to size on a fixed pin. (See Illus. 10-7.) Chamfer the back of the disk on the router table as described for the Intermittent Drive in Chapter Eight. The front face has too many corners to risk a machining operation, so use a sharp block plane and/or a sanding block to form a uniform chamfer. Sand everything smooth, and lightly round the sharp corners of the slots.

Illus. 10-6. The slots cut on the blank.

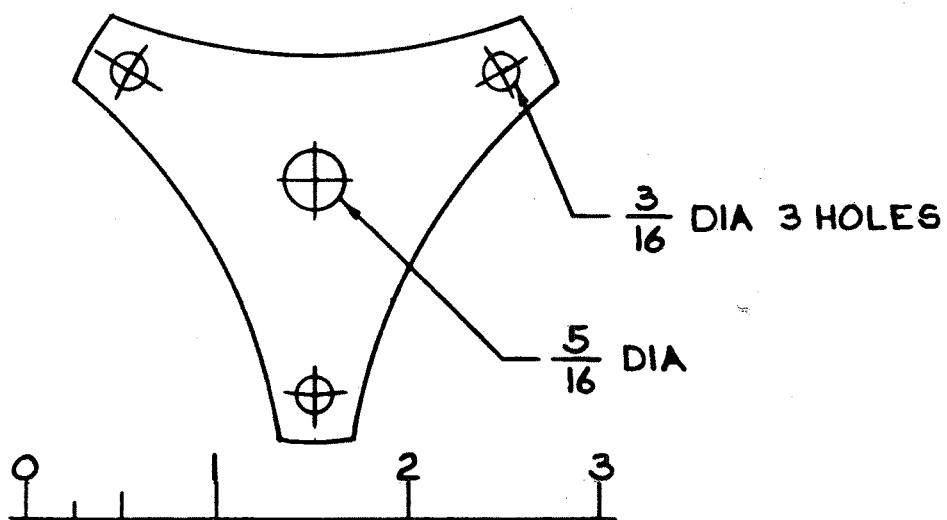


Illus. 10-7. Belt-sanding the outside diameter of the disk.



PATTERN FOR
SPIDER

GLUE TO $\frac{3}{8}$ STOCK



Illus. 10-8.

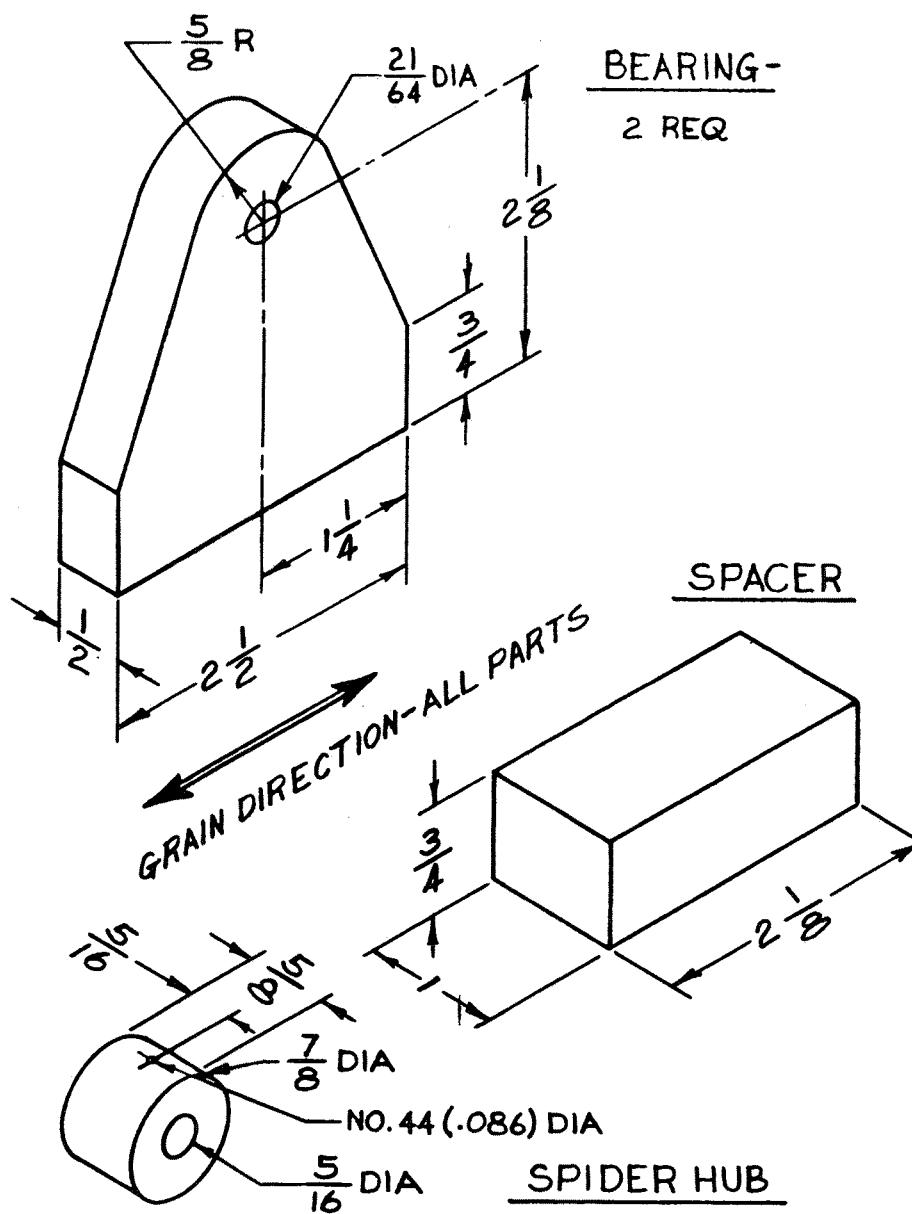
INCH SCALE TO CHECK PHOTOCOPY

Spider

Use the pattern in Illus. 10-8 to make this part, checking the size of the photocopy. The hub is easily made with a circle cutter, but if yours cannot cut a piece this small, just saw the part and sand it smooth.

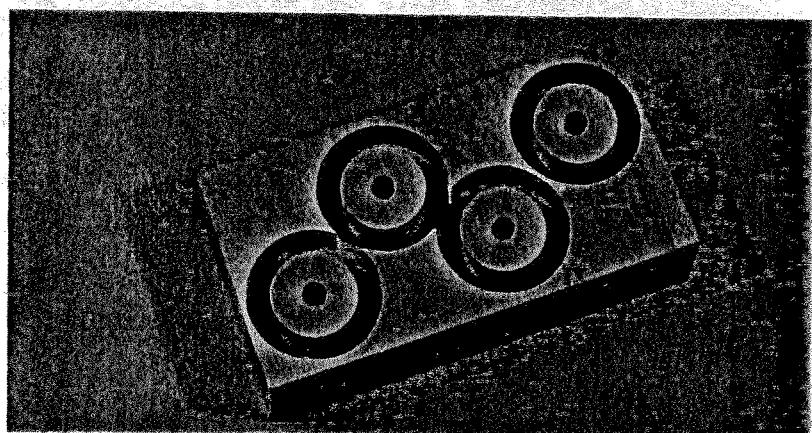
Rollers (Illus 10-11)

I make the rollers with a circle cutter that will cut down to a $\frac{7}{16}$ inch diameter. If you don't have such a tool, drill the parts, saw them to their outlines, and sand them to size on a fixed pin. It is important that these little parts are concentric, so make sure that you make them as accurately as possible. (See Illus. 10-10.)

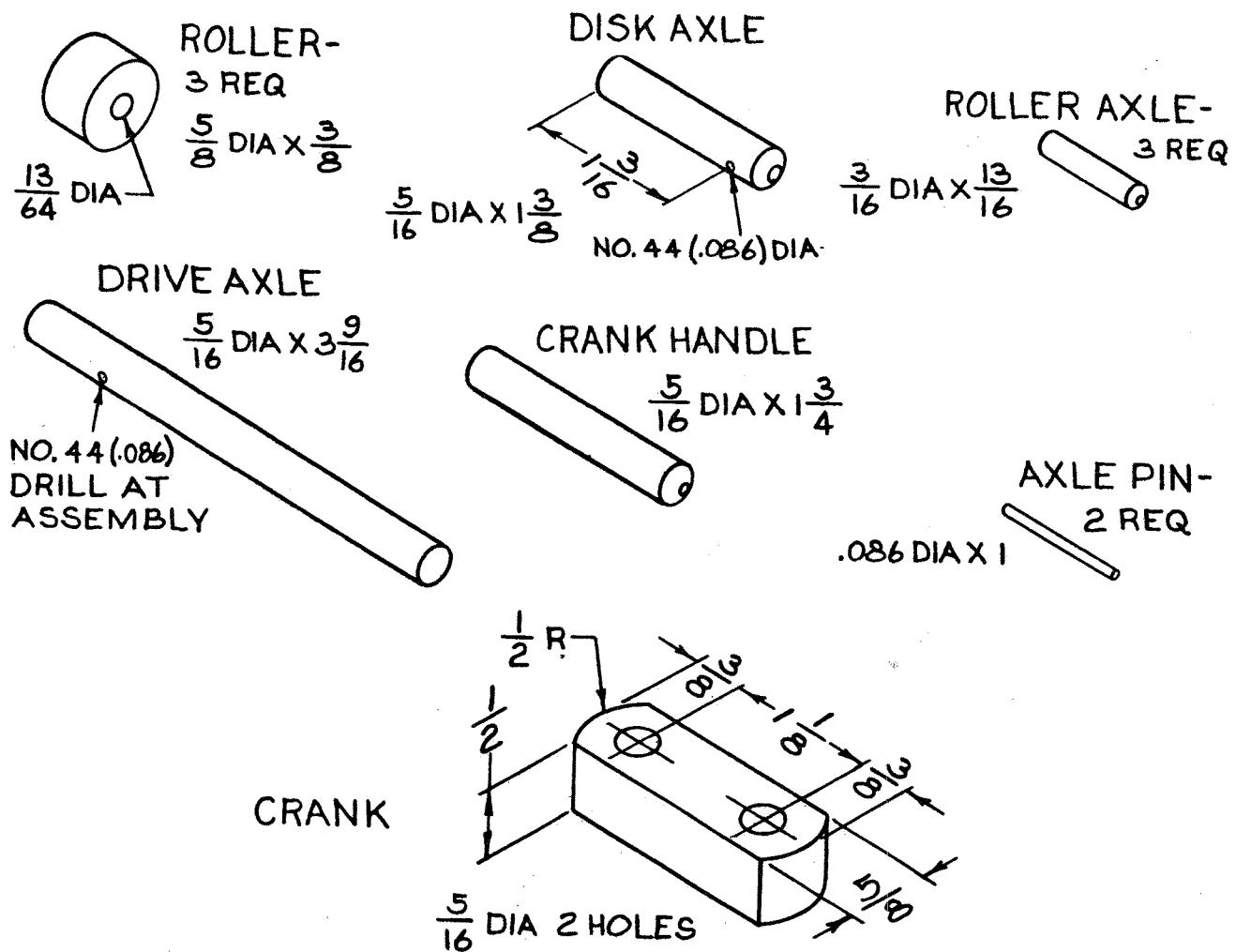


Illus. 10-9.

Illus. 10-10. The small rollers on the blank.



Illus. 10-11.

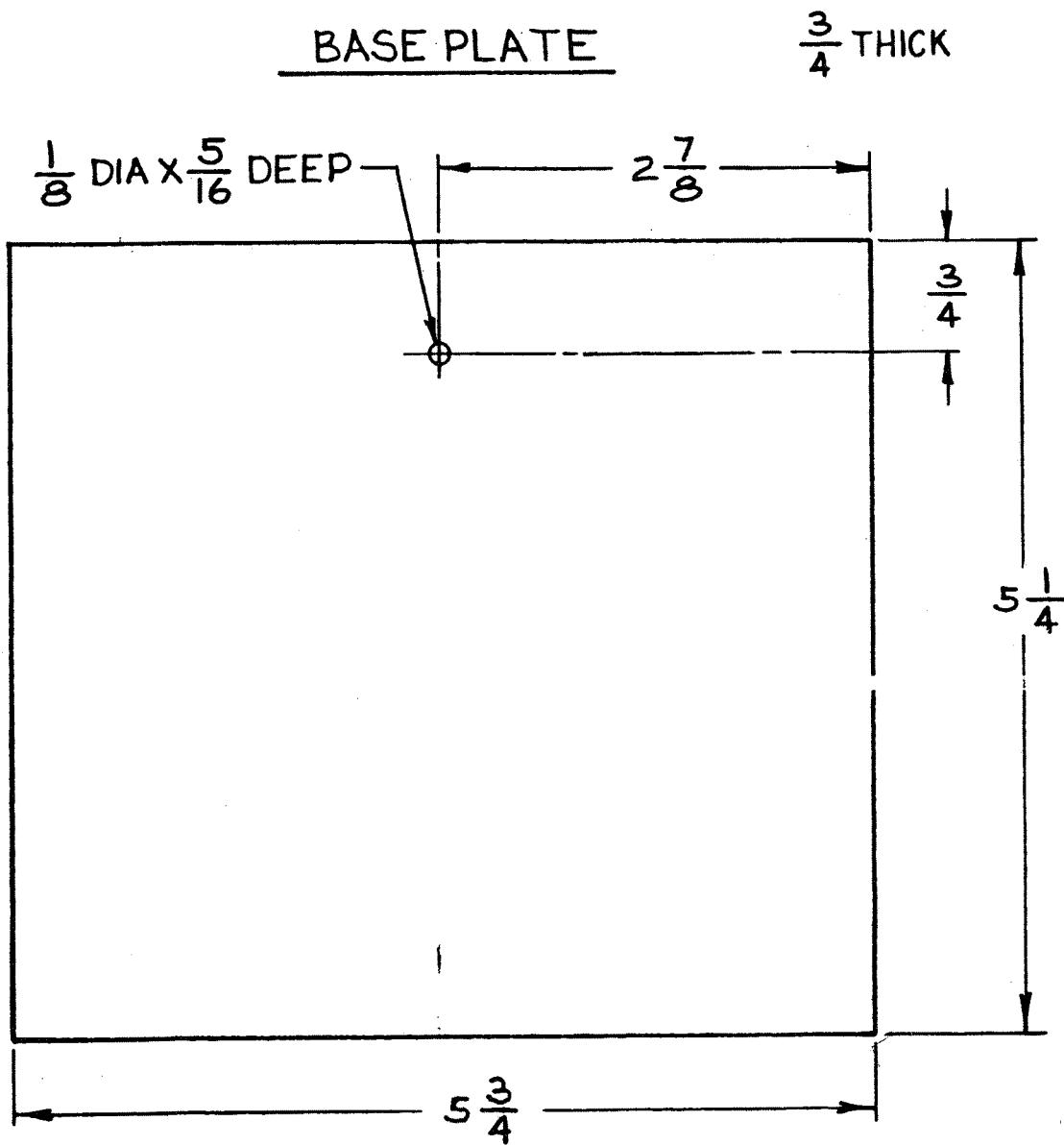


Remaining Parts (Illus. 10-11-10-13)

Size the roller axles to fit easily into their holes in the spider, to prevent this slender part from splitting.

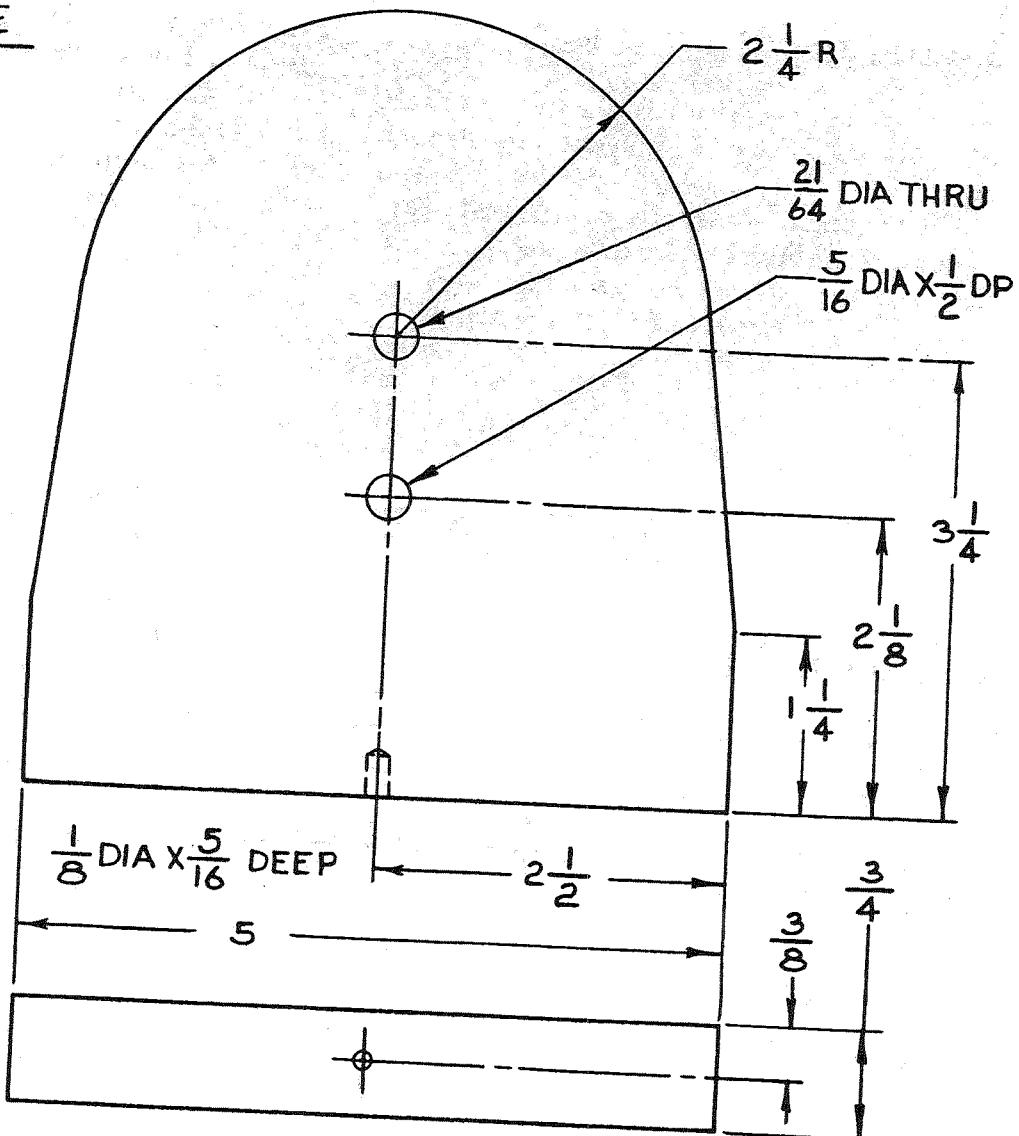
The backplate, baseplate, crank, and bearing blocks are straightforward, except for one detail: the lower of the two holes in the backplate is used to align the bearings at

assembly. When you have drilled the parts, assemble the two bearings and the backplate on a dowel, orienting the grain on all three parts so that they can be planed in the same direction. Clamp the parts together and level their lower edges with a sharp plane so that the axle holes will be a uniform height from the baseplate.



Illus. 10-12.

BACK PLATE



Illus. 10-13.

Assembling the Mechanism

Put a dowel through the two bearings and glue them onto the spacer block. When it is dry, scrape or file the bottom of this subassembly to a flat surface. (See Illus. 10-14.) Glue the hub to the spider, aligning the grain and using a waxed dowel to center the parts. Glue in the roller axles so that they extend $\frac{3}{8}$ inch from the face of the spider.

Clean out the hole with a drill, if necessary, and slide in the drive axle so that it is flush with the face of the spider. Mark both parts for future assembly, and drill the pin hole.

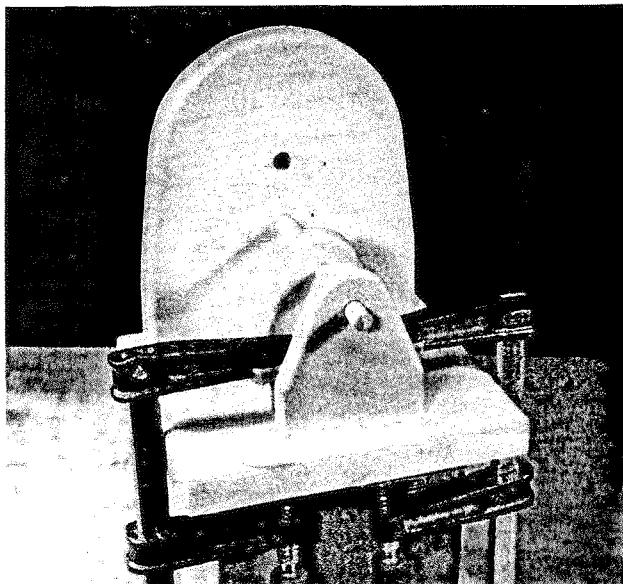
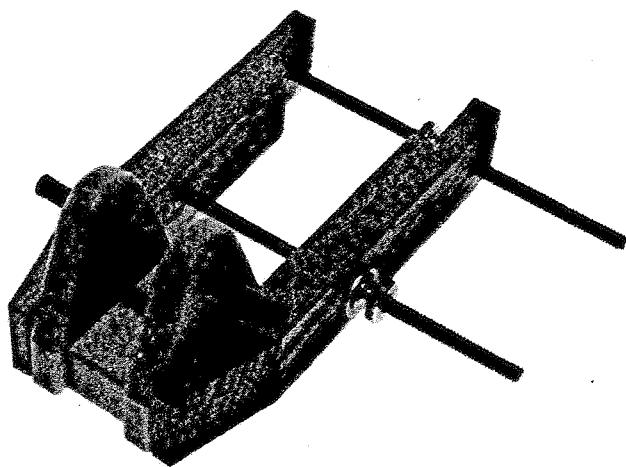
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through the axle. Push in the pin, assemble the axle into the bearings, and glue the crank onto its other end, allowing a little operating clearance. When dry, drive out the pin, remove the axle, and sand the end flush with the crank. Glue in the crank handle.

Glue the backplate to the base. Attach the disk axle to the disk, so that the pin hole is just clear of the backplate, and sand it flush with the bottom of the slot when it is dry.

Cut a piece of scrap to $1\frac{25}{32}$ inches to use as a spacer. A word of caution: if the disk is thicker than $\frac{3}{4}$ inch or the axle projects more than 1 inch from the disk, you will have to

Illus. 10-14. Gluing the bearing subassembly.



Illus. 10-15. Gluing the bearing to the base.

increase the size of the assembly spacer to compensate for this.

Put a piece of dowel through both bearing holes, apply glue to the lower surface of the bearings, set the assembly spacer in place, and then carefully lower the bearings into position, sliding the dowel into the hole in the backplate. Clamp the parts, removing the spacer when you are certain that nothing will move. (See Illus. 10-15.)

Apply a finish and wax all the moving parts. Assemble the disk to the backplate. Put the rollers on their axles, set them in the slots, and turn the disk to bring the spider in line with its driving axle. Slide the axle into the spider, checking the alignment marks, and push in the axle pin. The unit should operate smoothly. This model gets a great deal of attention from visitors.