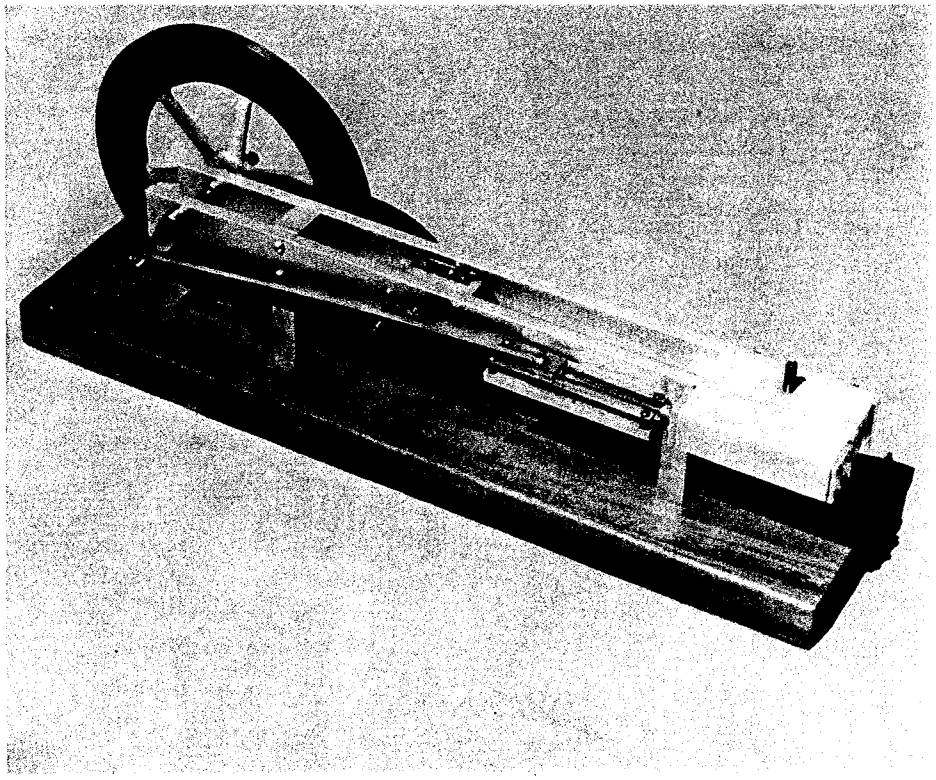
CHAPTER

50

Educational Model



An effort has been made on the past engine designs to show different ways of rotating a shaft with air or steam pressure. Among these engines such terms as wobbler, vertical, horizontal, slide valve, piston valve, oscillating valve, poppet valves, cams, eccentrics, single action, double action, reverse linkage, Scotch yoke and more are mentioned.

This engine is still another, showing the long stroke, slow speed principle of a riverboat engine. The framing is a very simple form to get across the idea, expecially the Cam which was used on these engines. The data for the Cam was supplied by Bob Maynard who detailed the *Omar* riverboat for us in **MODELTEC** Magazine.

The full stroke Cam is fascinating and a bit more complicated. It holds the Valve open for a longer time and provides steam pressure for most of the length of the Piston stroke, quickly reversing the Valve at each end of the stroke. The engine in Bob's *Omar* uses a drive for the Cam which is interesting to watch. It is taken off the Connecting Rod instead of the Crankshaft. It reduces the length of the Valve Rod and is mounted away from the splash of the paddlewheel. It is used on this model.

There is no attempt made to control the exhaust. There are no stuffing boxes. Close fits and a bit of oil make a fair seal. It is a showoff and conversation piece or a classroom demonstration model run on low pressure air. It should be run as slowly as possible.

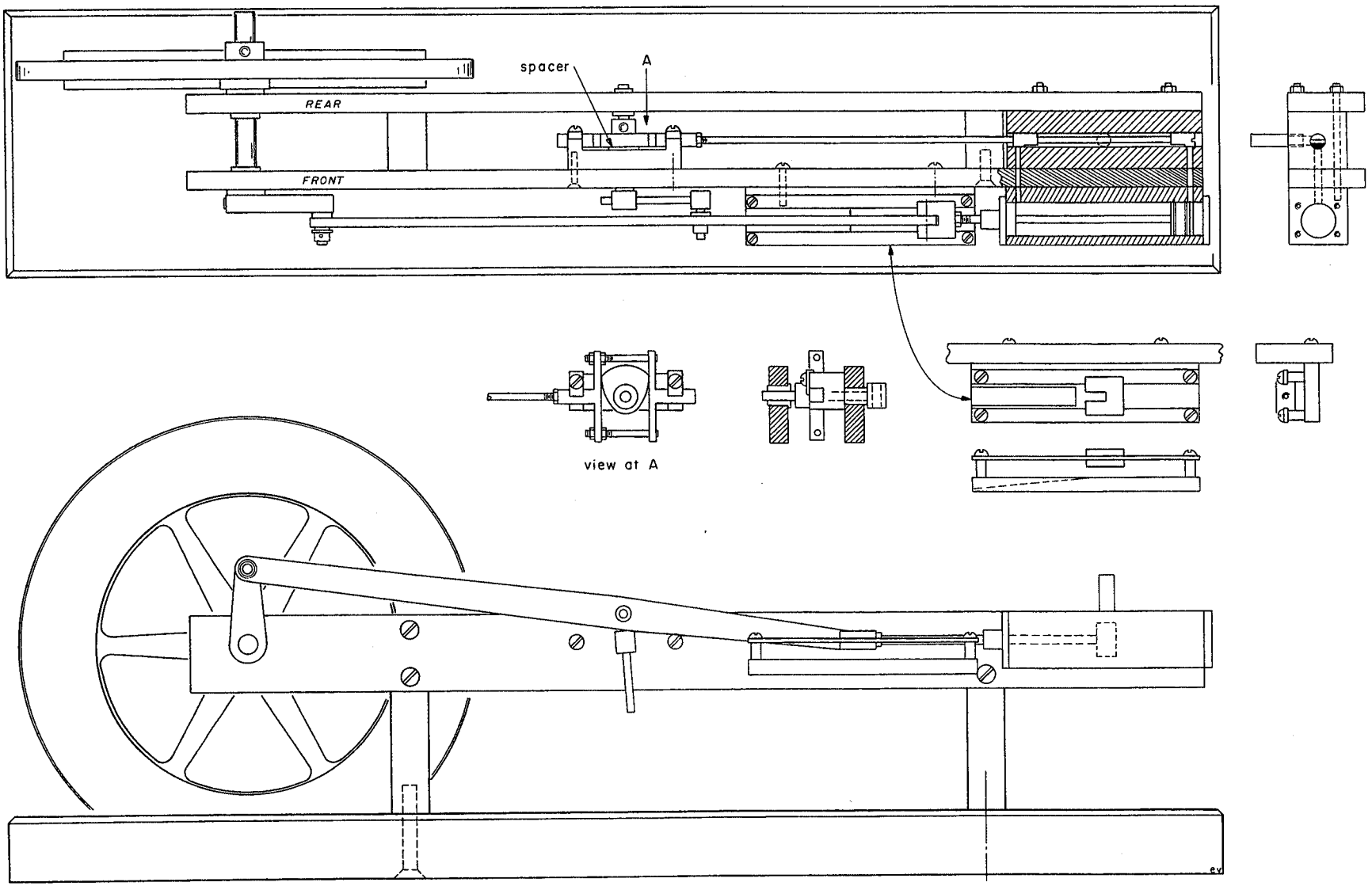
The **BASE** and **LEGS** are simple. Use any piece of wood that you like and give it a fine varnish finish.

The **RAILS** were made of the 1/4" x 11" aluminum found in many hardware stores. Lay out all the centers on the **FRONT RAIL** and clamp the Front and Rear Rails together. Drill through BOTH pieces for all the holes called out on the **REAR RAIL**. On the Front Rail, drill two holes for the steam passages and two for the Shelf, and two holes for the Cam Frame Guide. Some holes are shown countersunk. You can use round or hex screws if you wish.

Two identical blocks are made into the steam **CYLINDER** and the **VALVE BLOCK**. Lay out and bore the Cylinder 7/16". Use the Heads to SPOT the Head capscrew holes. The word "spot" used here means making only a dimple to guide the tap drill. Very carefully, lay out and tap ONE 3-48 hole in the Cylinder. A 3/32" stud is inserted through the Front Rail and into this hole, and clamped together well aligned and square. Use the Front Rail as a jig and spot the remaining stud holes and two steam ports. Remove the clamp and tap drill and tap 3-48. Complete drilling the steam passages.

Again using the Front Rail, do the same for the **VALVE BLOCK** after reaming the 3/16" Valve bore. This time the #41 drilling can go completely through the block. One close-fitting pin is inserted before aligning and clamping.

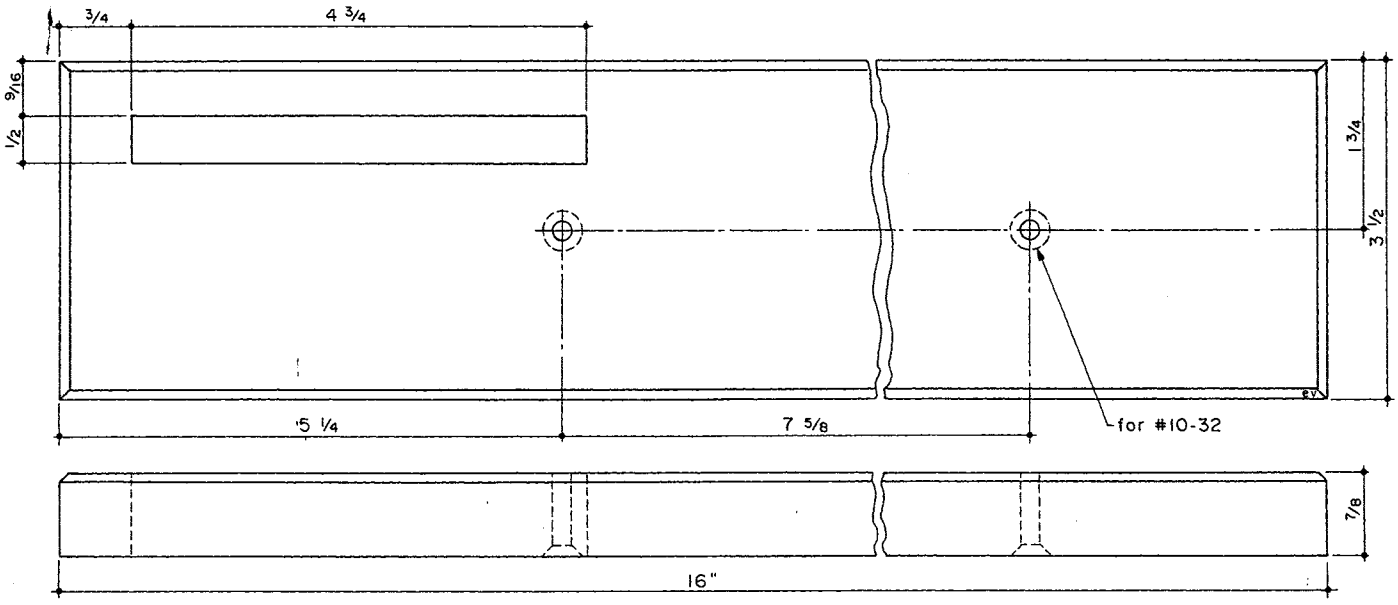
On both **HEADS**, lay out the centers and all bolt holes while both are



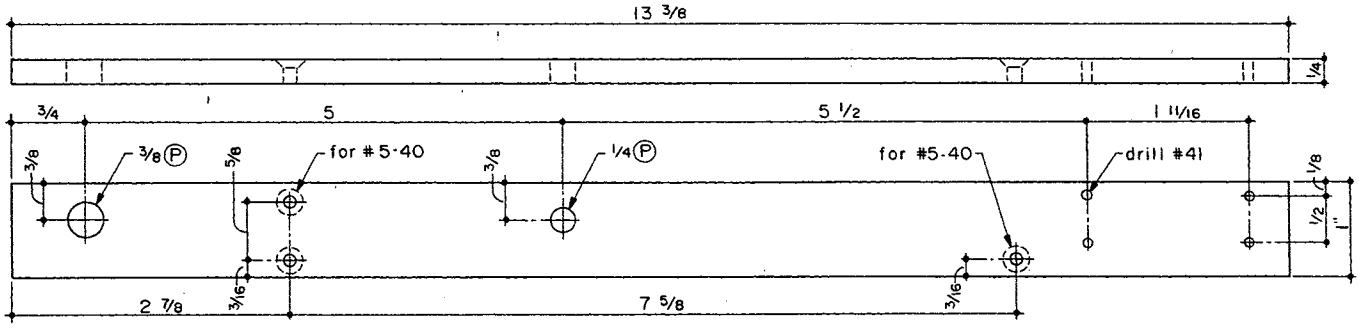
EDUCATIONAL MODEL

SIMILAR TO A

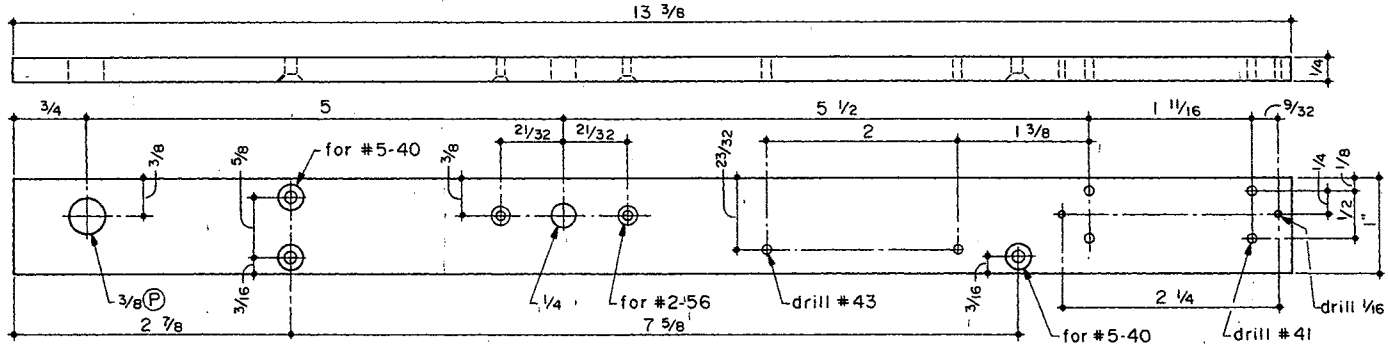
RIVER BOAT ENGINE WITH FULL STROKE CAM
DRIVEN OFF THE CONNECTING ROD



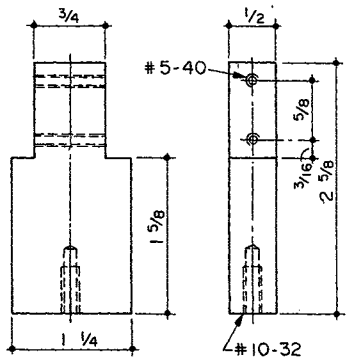
BASE
Wood



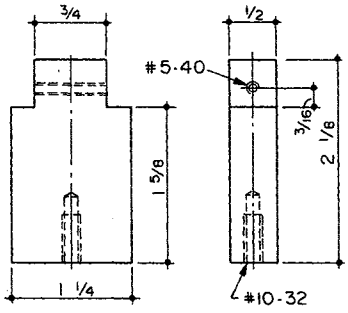
REAR RAIL
Aluminum



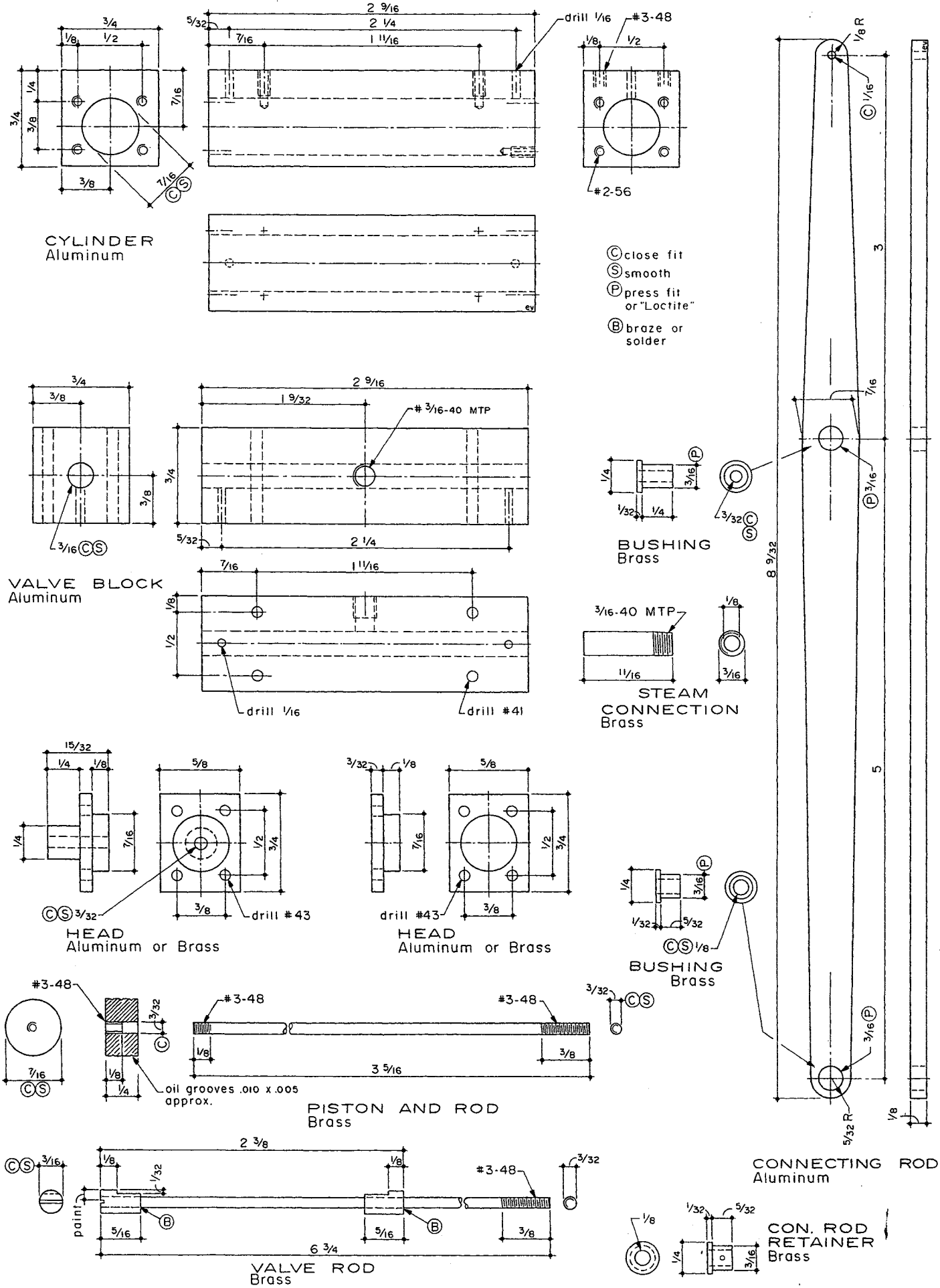
FRONT RAIL
Aluminum

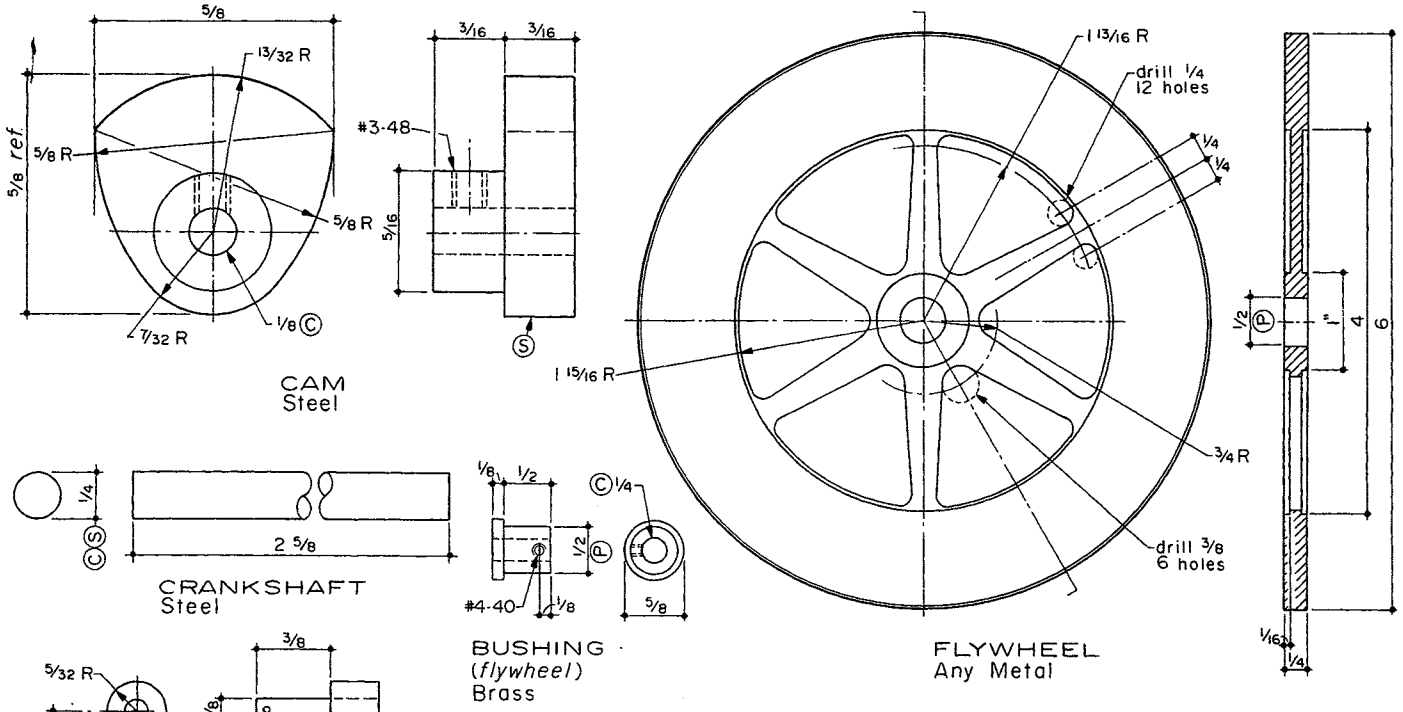


LEG
Aluminum



LEG
Aluminum


CYLINDER
Aluminum
drill 1/16
#3-48
#2-56
Ⓒ close fit
Ⓢ smooth
Ⓟ press fit or "Loctite"
Ⓑ braze or solder
VALVE BLOCK
Aluminum
3/16-40 MTP
drill 1/16
drill #41
BUSHING
Brass
STEAM CONNECTION
Brass
3/16-40 MTP
HEAD
Aluminum or Brass
drill #43
HEAD
Aluminum or Brass
BUSHING
Brass
#3-48
oil grooves .010 x .005 approx.
PISTON AND ROD
Brass
CONNECTING ROD
Aluminum
paint
VALVE ROD
Brass
CON. ROD RETAINER
Brass



rectangular blocks. Drill through the blocks for the bolt holes. On the Inboard Head, chuck the block, centering for the 1/4" hub using a center test indicator. Turn the hub projection and reverse in the 3-jaw chuck for turning the dowel and 3/32" bore.

The **PISTON** and **ROD** are simple machining. About the only mention here is good concentricity.

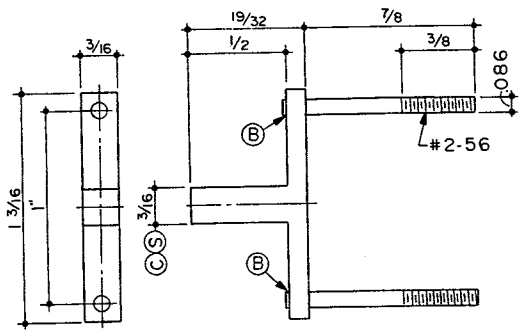
The **VALVE ROD** is a soldering job. Carefully solder the two 5/16" x 3/16" pieces to the Rod at 2-3/8" spacing. Set up in the cross slide mill and mill the flats, holding the 1/8" dimensions. On the same milling setup, change to a thin slitting cutter to make the screwdriver slot PARALLEL to the flats. This slot helps to align the flats squarely facing the ports. Painting the half on the side of the flats with layout dye will tell you which side has the flats. The Valve can be adjusted 1/48" per revolution; that is, one turn of the Rod moves the Valve .021". At final assembly and tuning, the Valve will be close to flush with the ends of the Valve Block at each end of the Valve travel.

The **CRANKSHAFT**, **CRANK** and **RETAINER** are simple machining. Spot the Retainer about .010" from the Connecting Rod Bushing and drill for a 1/32" cotter pin through the Crank Pin.

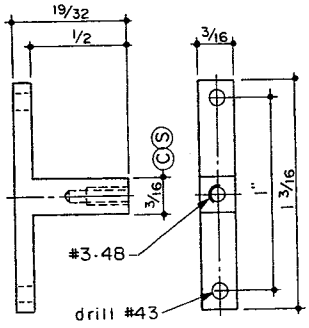
The **FLYWHEEL** on the model shown was made from some salvage 1/4" cast aluminum plates so the surface is rough. Rolled stock will make a better-looking wheel. The 18 holes are laid out and drilled on a rough 6-1/8" disk. Using a center test indicator, center the disk in the 4-jaw and turn the recess on one face. By careful chucking in the 3-jaw on the 1/16" x 4" recess, the second side and outside diameter are turned and center-bored 1/2". Lines are drawn connecting the holes and the spokes sawed and filed to shape.

The **CONNECTING ROD** on the model shown is 1/8" blue anodized aluminum with Bushings set with Loctite. The light weight of the aluminum is desireable for this Rod.

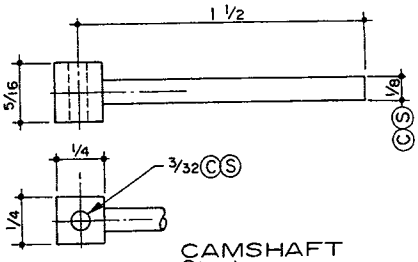
The **FULL STROKE CAM** is made of steel. First lay out the Cam on some 1/32" brass. From one straight edge of the brass, scribe at 90° two lines 5/8" apart. Scribe a centerline midway between these two lines. About 1/4" from the edge, scribe a centerline parallel to the edge. Prick punch at the crossing of the two lines. Scribe a 13/32" radius intersecting the two 5/8" lines. At the intersections, scribe two 5/8" radii. They should meet a 7/32" radius struck from the center. Scribe a 5/16" circle for the hub. Very carefully, bore the 5/16" hole and then cut and file down to the Cam outline. Set a slide caliper to 5/8" and try the Cam. It should rotate between the blades with only a few thousandths freedom. True up the end of a 1-1/2" piece of 3/4" diameter free-cutting steel and prick punch a center for the Cam about 1/4" from the O.D. Center in the 4-jaw, using a center test indicator, and turn the hub until it will just enter the brass template you just made. Next, bore the 1/8" Shaft hole. Turn a smooth 13/32" radius until it just matches the radius on the template. Using a parting tool, cut off at a bit over 3/8" overall and rechuck on the hub to finish to 3/16" thick. Coat the Cam blank with layout dye, insert the Cam in the template and scribe around the template. Make small overlapping mill cuts almost to the outline and then file to the line. A filing machine is almost a must for this. Polish the



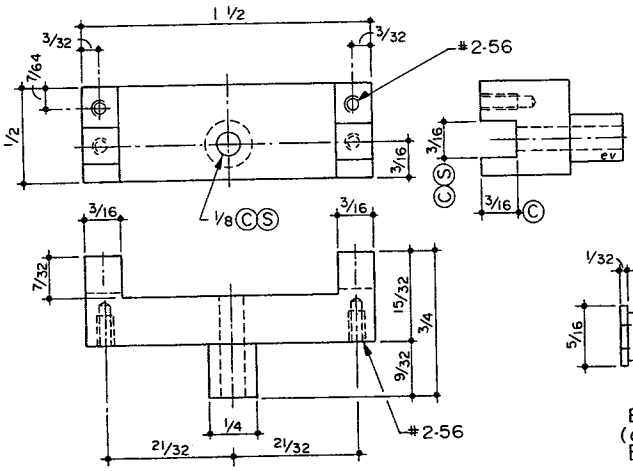
CAM FRAME A
Brass



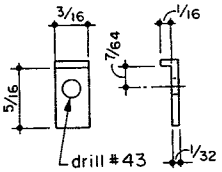
CAM FRAME B
Brass



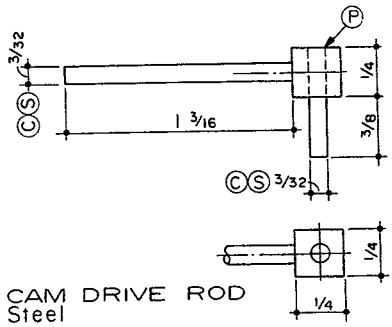
CAMSHAFT
Steel



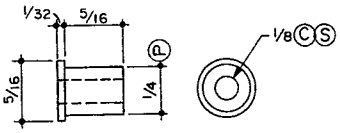
CAM FRAME GUIDE
Brass or Hard Aluminum



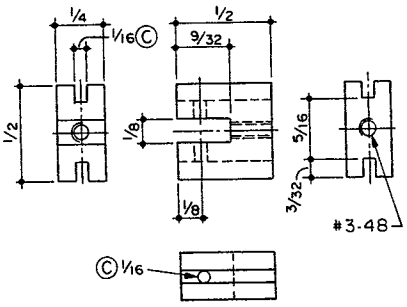
RETAINER
Brass
2 Required



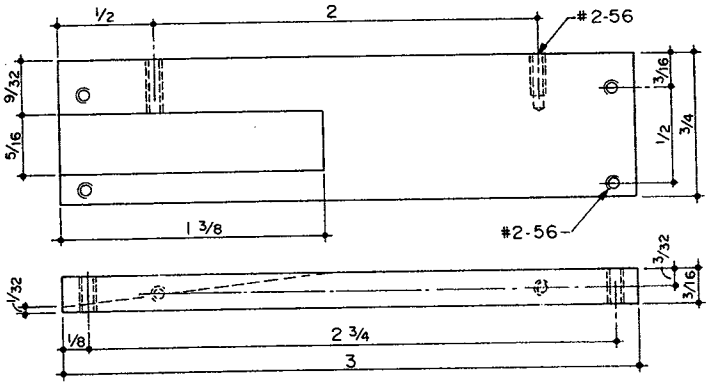
CAM DRIVE ROD
Steel



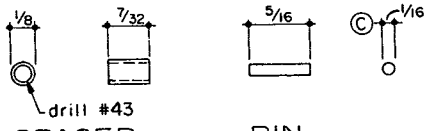
BEARING
(camshaft)
Brass



CROSSHEAD
Brass

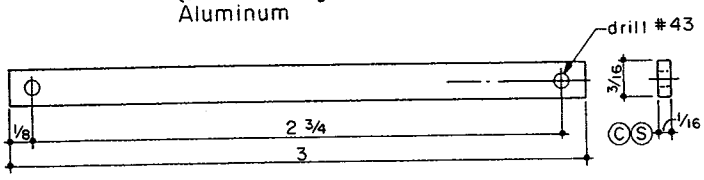


SHELF
(crosshead guide)
Aluminum

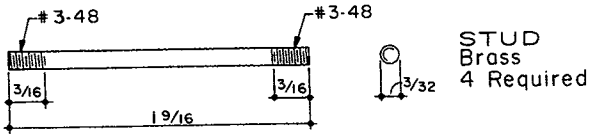


SPACER
Any Metal
4 Required

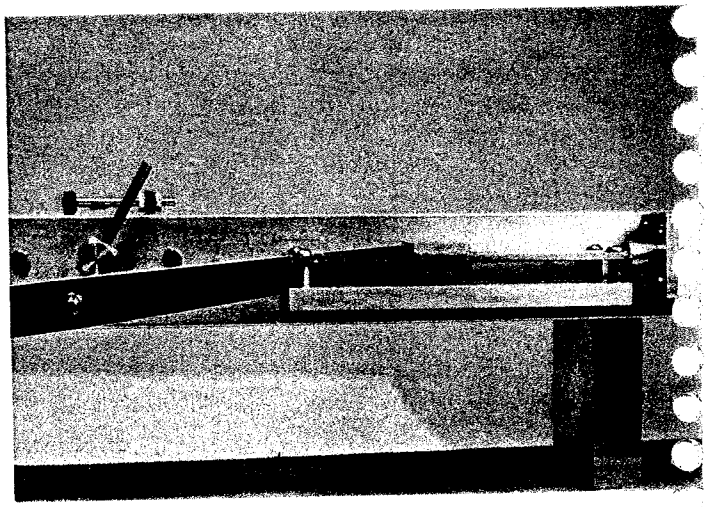
PIN
(crosshead)
Brass



CROSSHEAD GUIDE
Steel
2 Required



STUD
Brass
4 Required



Cam surface on a surface plate, using fine emery cloth. Again, try the Cam with the calipers set at 5/8".

The **CAM FRAME** is built up from 3/16" brass stock. The two main pieces are alike except that **A** has the two studs squarely soldered in, while **B** slides on the studs, and a hole is tapped for the Valve Rod. At assembly, the two pieces of the Frame are adjusted so the Cam just easily rotates between them with minimum slop. Take care when soldering that the 3/16" x 3/16" bars are in line and slide freely in the Frame Guide.

The **FRAME GUIDE** starts out as a 3/4" x 1/2" x 1-1/2" piece of brass. Lay out all outlines and centers on this bar except the two at 21/32" which are spotted from the Front Rail. Drill and tap the two holes for the retainers. Chuck in the 4-jaw and turn the 1/4" diameter projection. Squarely clamp the Guide into the Front Rail and spot, drill and tap the two 2-56 holes. Mount in the cross slide mill and mill the 7/32" x 1-1/8" area. On the same setup, you can mill the two 3/16" x 3/16" slots for the Cam Frame. These two slots must be parallel with the face and top edge of the Front Rail and must be a nice, close, free fit on the Cam Frame.

The **CAM SHAFT** and **CAM DRIVE ROD** are simple and about the only mention is squareness and a close, free fit. Make the rubbing surfaces smooth for long life. When the engine is running, these parts are really active.

The **CROSSHEAD GUIDE SHELF** is laid out completely and the four holes on the face drilled and tapped. One mounting hole is carefully laid out and tapped. Mount the Shelf on the Front Rail with one screw; align, clamp and spot for the second mounting screw. Mill the 5/16" clearance for the Connecting Rod.

The **CROSSHEAD GUIDE** consists of two smooth steel bars mounted on the Shelf, using the **SPACERS** to bring it in line with the Cylinder bore. At assembly, the Crosshead should be just a nice free-running fit between these bars.

For the **CROSSHEAD**, square up the end of a 1/2" x 1/2" x 1-1/2" brass bar. Lay out all the lines and centers at the end of this bar on all faces. Make the 1/16" hole for the Connecting Rod Pin. Drill and tap 3-48 for the Piston Rod. Mount squarely in the cross slide mill with the end toward the head stock in such a way that you can make a 1/16" cut up one side and down the other, thus keeping them in the same plane. Note that the 1/16" hole and these 1/16" cuts must coincide. On the same setup, cut the block to the 1/4" thickness, using a slitting cutter. With another setup in the mill, make the 1/8" x 9/32" cut.

At assembly, mount each part so it runs free. Add light grease or a light coat of STP or equivalent to all Slides and Cam. Squirt oil into the steam connection to lube the Valve and Piston. A drop of oil on the Shafts at the Bearing will work in for light-duty running. If you wish, oil holes can be drilled. This engine will run on very low air pressure. Adjust the Valve until the engine runs smooth.

Photos below show the function of the Cam.