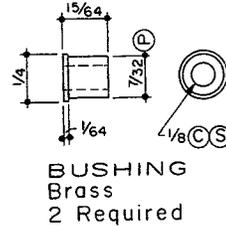
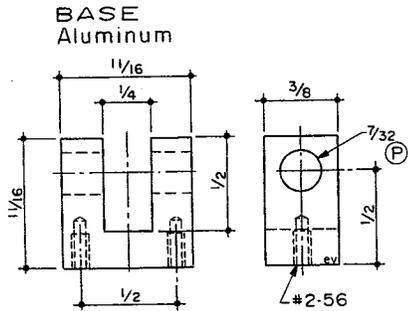


SLIDER

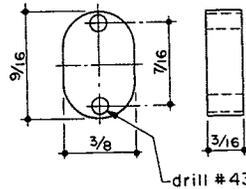


BUSHING
Brass
2 Required

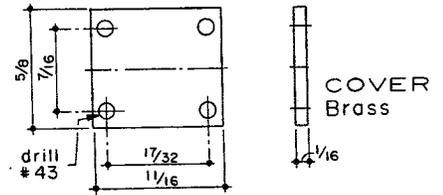


BASE
Aluminum

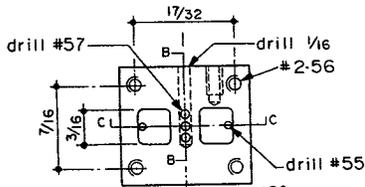
BEARING
Aluminum



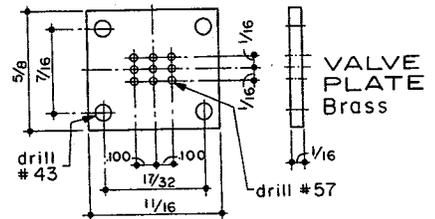
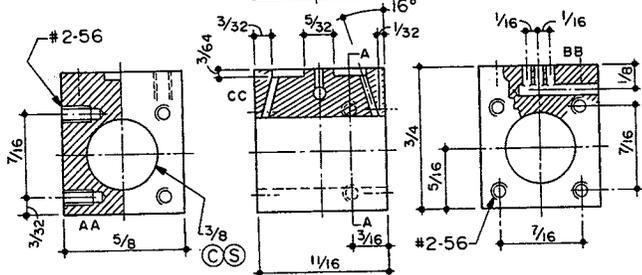
SPACER
Aluminum



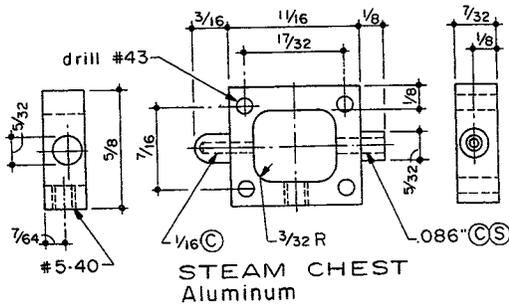
COVER
Brass



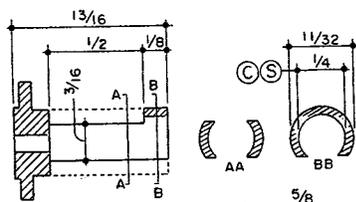
CYLINDER
Hard Aluminum



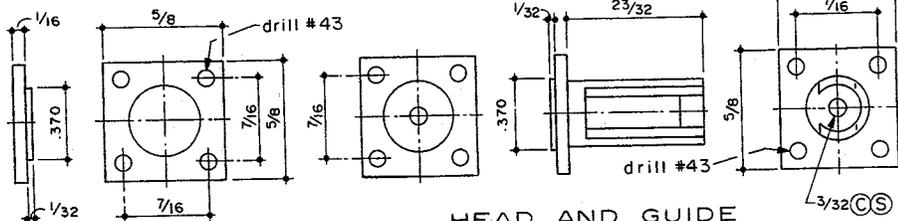
VALVE
PLATE
Brass



STEAM CHEST
Aluminum



HEAD AND GUIDE
Hard Aluminum



HEAD
Aluminum

length permits you to cut away the center hole later. Thread 3-48 up to 23/32" from the shoulder. The O.D. of a #3 screw is .099". This .094" diameter does not seriously affect the thread quality. Mount in the small V-groove in the milling vise and mill the two flats and the 3/32" slot. This can also be done in the 3-jaw mounted on the indexing fixture. Make the 1/16" pin hole squarely across the fork. If the Piston does not run tight on the Rod at the required length, some low-strength Loctite can be used. Cut off the excess Rod projecting through the Piston.

Start the **CONNECTING ROD** with about a 2" length of 1/8" x 1/4"

6

Slider

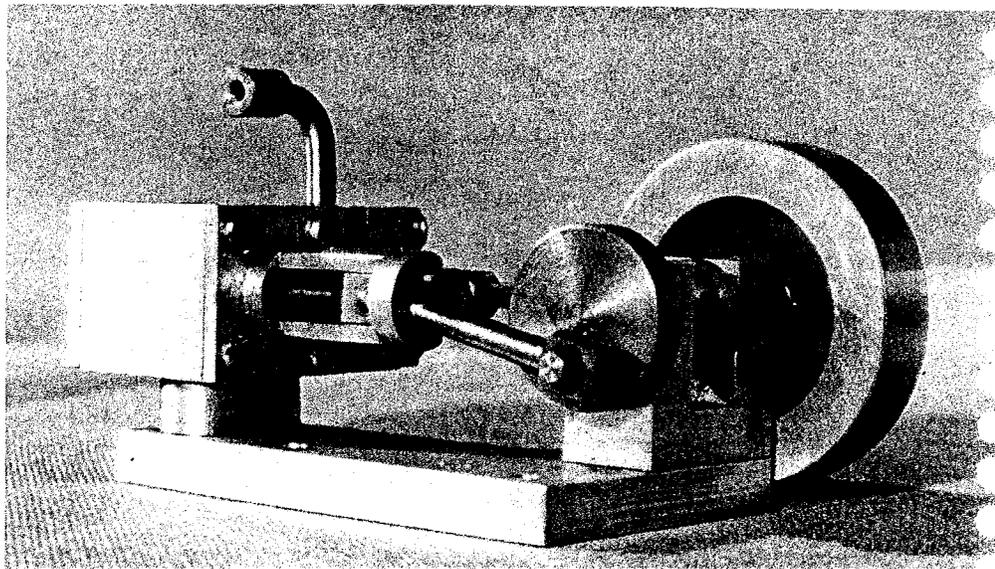
This engine is more complicated than most designs in the Small Engine Series. There are more parts and some are quite small. The proportions are fair when compared with a large engine and the appearance is similar in spite of the bright block-like construction.

The **BASE, BEARING, SPACER** and **BUSHINGS** are plain straight layout and machining jobs and require no comment. The 3/16" steam connection is brass. The Bushings are set in the Bearing with Loctite and oil holes added.

Aluminum was used here for the **CYLINDER**, although any common metal will work. On an accurate and square 5/8" x 3/4" x 11/16" block, lay out the center for the 3/8" bore and center in a 4-jaw using a center test indicator. Bore and ream and break the sharp corners at each end. Next, lay out the two 3/64" recesses on the Valve Face and mill with a 1/16" end mill. Drill the two 1/16" steam passages at about 16 degrees as shown. Lay out and tap the two 2-56 holes that match the spacer. Later, use the cover and heads to locate and complete the drilling and tapping for the Steam Chest and Heads. Lay out and drill the 1/16" exhaust hole that the three #57 holes meet.

Make the two brass plates 1/16" x 5/8" x 11/16" for **COVER** and **VALVE PLATES**. Lay out and drill the Cover for four screws and use as a jig later to spot the Steam Chest, Valve Plate and Cylinder. It would be well to drill the Cover to tap-drill size and, after using as a jig, enlarge to the required size. Lay out and drill the nine #57 holes. This Valve Plate can now be used as a jig for the three center holes in the Cylinder that run into the 1/16" exhaust hole. Flatness and smoothness are important on the Valve side of the Valve Plate. On this model shown, the Cover was replaced by one of clear transparent plastic. It is good only on compressed air, but it adds interest and helps in setting the Valve.

The **STEAM CHEST** was made



out of aluminum on the model shown. Brass would be a bit more durable. Square up a block 7/32" x 5/8" x 1" and lay out the centers for the Valve Rod bosses. Note that they are not in the center of the 7/32" height. Prickpunch and center in the 4-jaw using a center test indicator. Turn the 1/8" projection and make the .086" and 1/16" holes for the Valve Rod. Reverse, center and turn the blind end. Use the Cover as a jig for the four holes. Enlarge them with a #43 drill. Lay out four 3/16" holes for producing the 3/32" radius inside and mill or file to 1/8" wall all around. Then drill and tap the 5-40 steam connection.

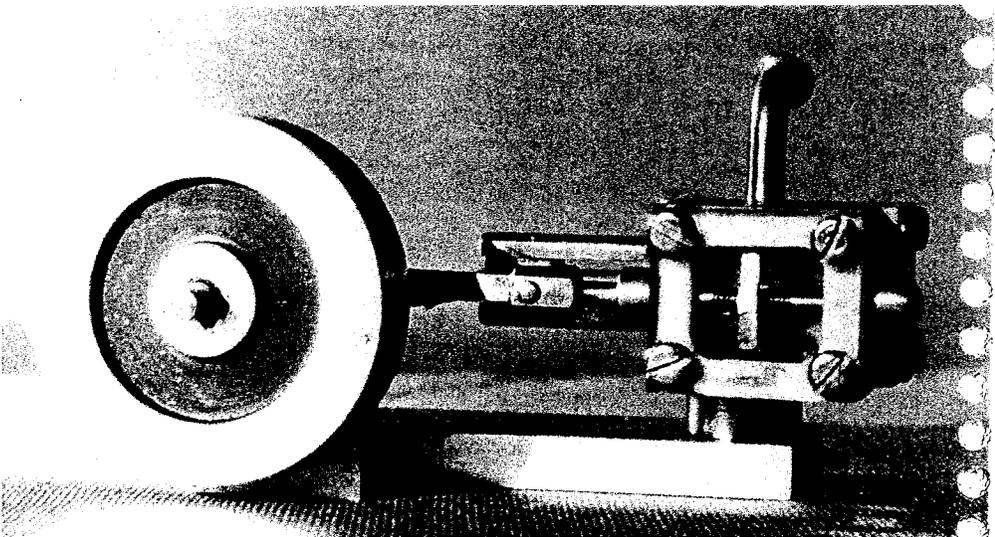
For the **HEADS**, square up the end of a 5/8" x 5/8" bar (aluminum was used on this model) about 2-1/8" long. Center in the 4-jaw with about 1-1/2" projecting from the jaw. Turn to 11/32" diameter back 23/32". Bore 5/8" deep to a flat bottom and ream 1/4". Use a center drill to start the 3/32" Rod hole and finish to a 3/32" close fit for the Piston Rod. Part off at about 27/32". Make the plain Cylinder Head from the piece remaining in

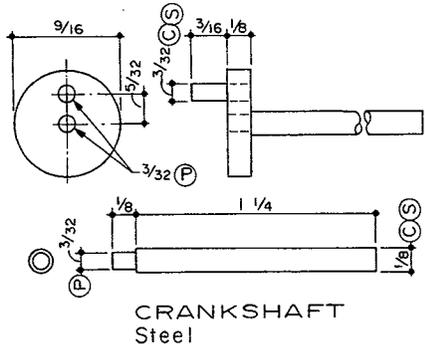
the chuck. Mill or file to the **A** and **B** sections and then drill both Heads for screws. Wrap it in thin sheet copper to protect from jaw marks and chuck in the 4-jaw with enough clearance to use a junior indicator on the 11/32" diameter to center. If you have a 3-jaw accurate to .001", use it or a collet. Now turn to 13/16" long and turn a .370" x 1/32" dowel. This .370" diameter permits moving the Head around to a spot where there is no Piston bind.

Make the **CRANKSHAFT** of steel, using press fit or Loctite at assembly.

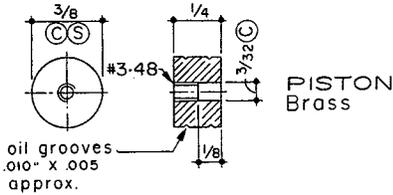
When making the **PISTON**, use the Cylinder as a gauge. Concentricity is important here, so a close-fitting portion is unthreaded to help center the Rod.

For the **ROD**, chuck a 9/32" or 5/16" rod in the 3-jaw with about 1-1/2" projecting from the jaws. Make a tiny center with a 3/64" center drill. Bring the tailstock up for support and turn to 1/4" diameter about 1-3/8" long, using the Head Guide as a gauge. Turn to 3/32" for about 1", again using the Head as a gauge. The extra

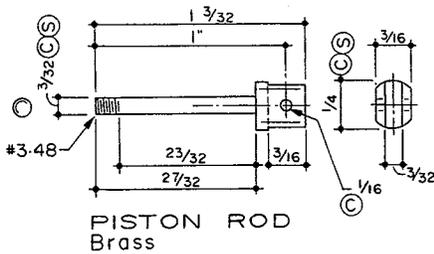




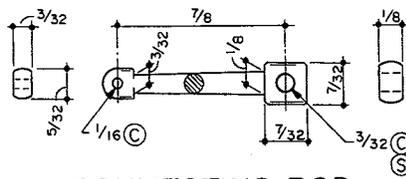
CRANKSHAFT
Steel



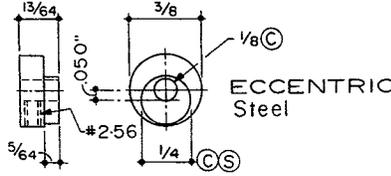
PISTON
Brass



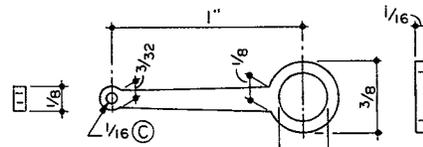
PISTON ROD
Brass



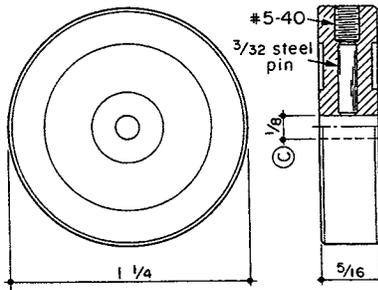
CONNECTING ROD
Brass



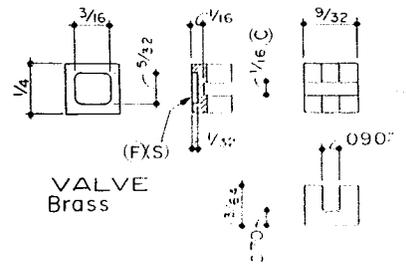
ECCENTRIC
Steel



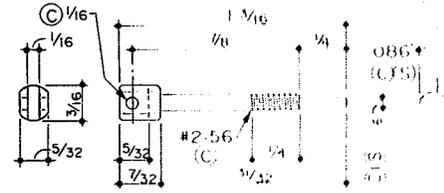
ECCENTRIC
STRAP
Brass



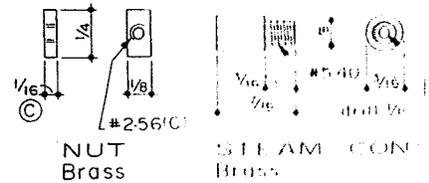
FLYWHEEL
Any Metal



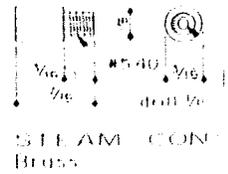
VALVE
Brass



VALVE ROD
Brass



NUT
Brass



STEAM CONE
Brass

brass and scribe the center on one end and prick punch. Chuck it in the 4-jaw with about 1/4" projecting from the jaws. Center it with a center test indicator and make a tiny center with a 3/64" center drill. Loosen two adjacent jaws and project the stock out of the jaws about 1-3/8" against the tailstock center; retighten those two jaws. Then complete it, parting to the finished length. Lay out two holes 7/8" apart and make the 1/16" and 3/32" holes. Last, reduce the small end to 3/32" thick and round the end.

The **VALVE** is simply a 13/64" x 1/4" x 9/32" brass block with a 1/16" slot one way and a .090" slot the other way. A 1/16" end mill is used to make the 5/32" x 3/16" recess. The **ADJUSTING NUT** is a close fit in its slot and on the thread. The ideal condition is to have no shake between the Valve and the Valve Rod, with the Valve sliding just free on the Valve Plate.

The **VALVE ROD** is made of brass similar to the method for the Connecting Rod. Leave enough stock to cut away the tail center hole later. Here, the best bet is to use 3/32" and 1/16" rods that fit the Steam Chest with the right clearance and duplicate their diameters on the Valve

Rod. When all the turning is done, cut the 1/16" end at 31/32" and thread 2-56 using a tailstock die holder. Part at 1-3/16" total length and mill the flats gripping on the .086" diameter in the small V-groove in the milling vise. Mill the slot and make the 1/16" hole squarely across the fork.

Make the **ECCENTRIC STRAP** out of 1/16" brass. It is purely a layout and sawing job with a jeweler's saw and filing to the line. Before sawing, make the 1/4" hole with progressive drill sizes until finally reaming it 1/4". Then make the 1/16" hole for the pin.

The best material for the **ECCENTRIC** is free-machining steel. Chuck a 3/8" diameter rod in the 4-jaw and center it with an indicator. Face the end and drill and ream the Shaft hole. Run the vertical flat end of a tool bit up against the O.D. of the stock. Set the crossfeed collar at zero. Loosen all the jaws slightly and, with

one set of jaws horizontal, back up the rear jaw out 1/16". Force the work back with the front jaw. Run the cross slide in .050". Slowly feed the rear jaw back until the work touches the tool bit. Carefully snug up the other three jaws. Now, when the high spot just kisses the bit and the chuck is then rotated 180 degrees, a .100" diameter bar should just slide between. Turn the 1/4" diameter to a close fit in the Eccentric Strap.

If the holes are all the same size the forks and eyes, the 1/16" cross pins should be just a shade shorter than the thickness across the fork. A very small prick punch mark on each side, at the rim of the hole, will retain the pins. On the model shown, a press fit was used in the eyes. This is no place for Loctite.

At **ASSEMBLY**, the Eccentric must be at 90 degrees from the Crank. With the engine bolted together, but with the Valve Cover removed, the extremes of the Valve travel should expose the Valve holes equally. The Valve Rod is given half-turns until the travel is equal, or very near equal. With the Crank Pin on the vertical center line, the Cylinder should be getting full steam from one set of Valve holes.