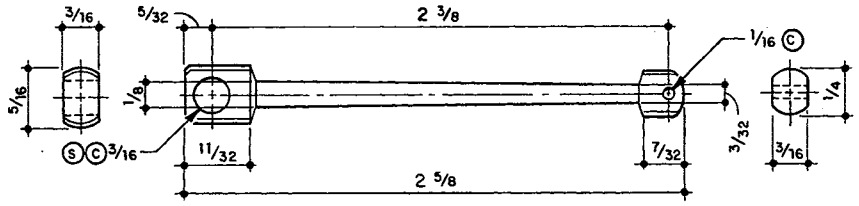
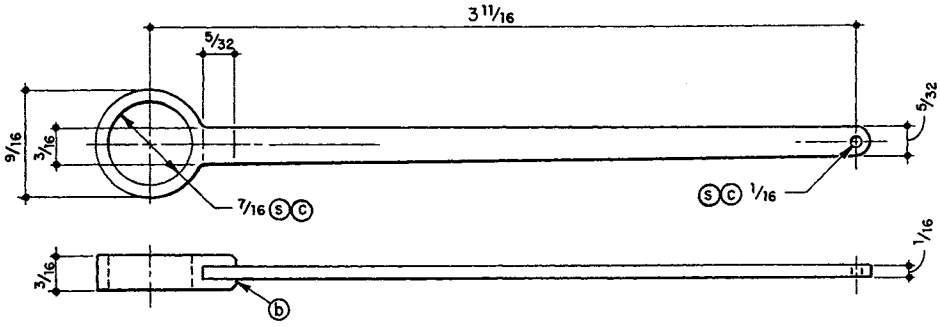
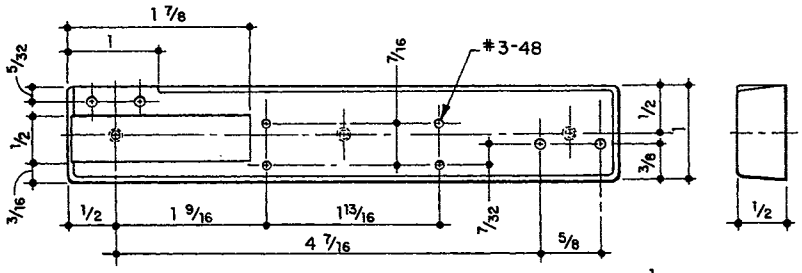
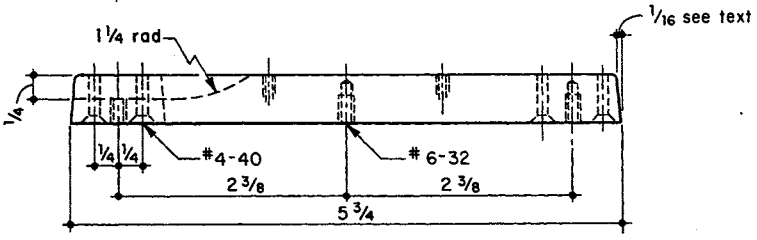


CONNECTING ROD

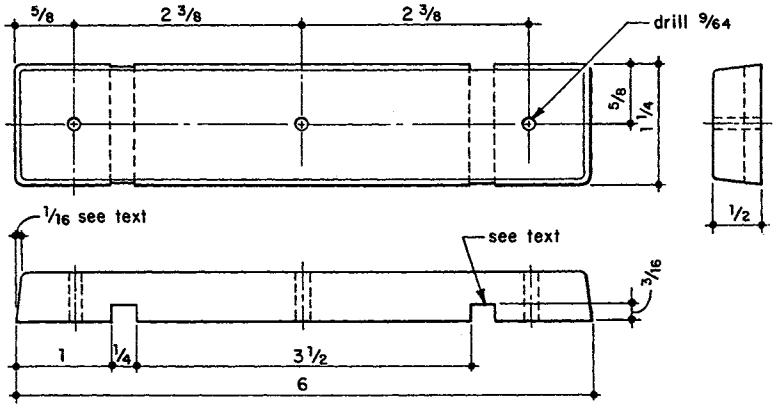


ECCENTRIC STRAP

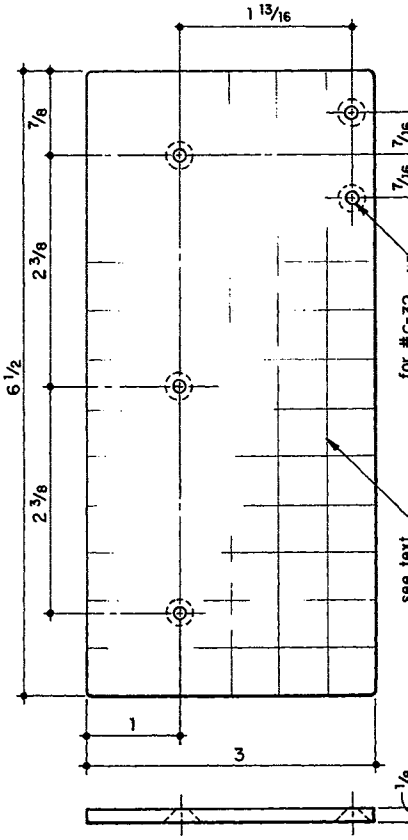




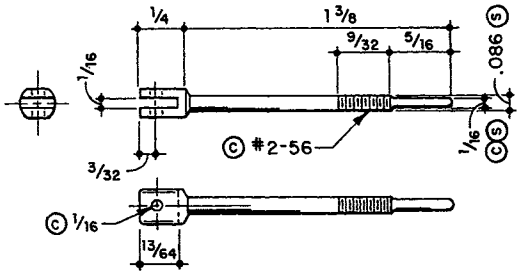
BASE



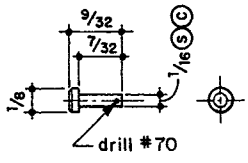
SUB BASE



FLOOR



VALVE ROD



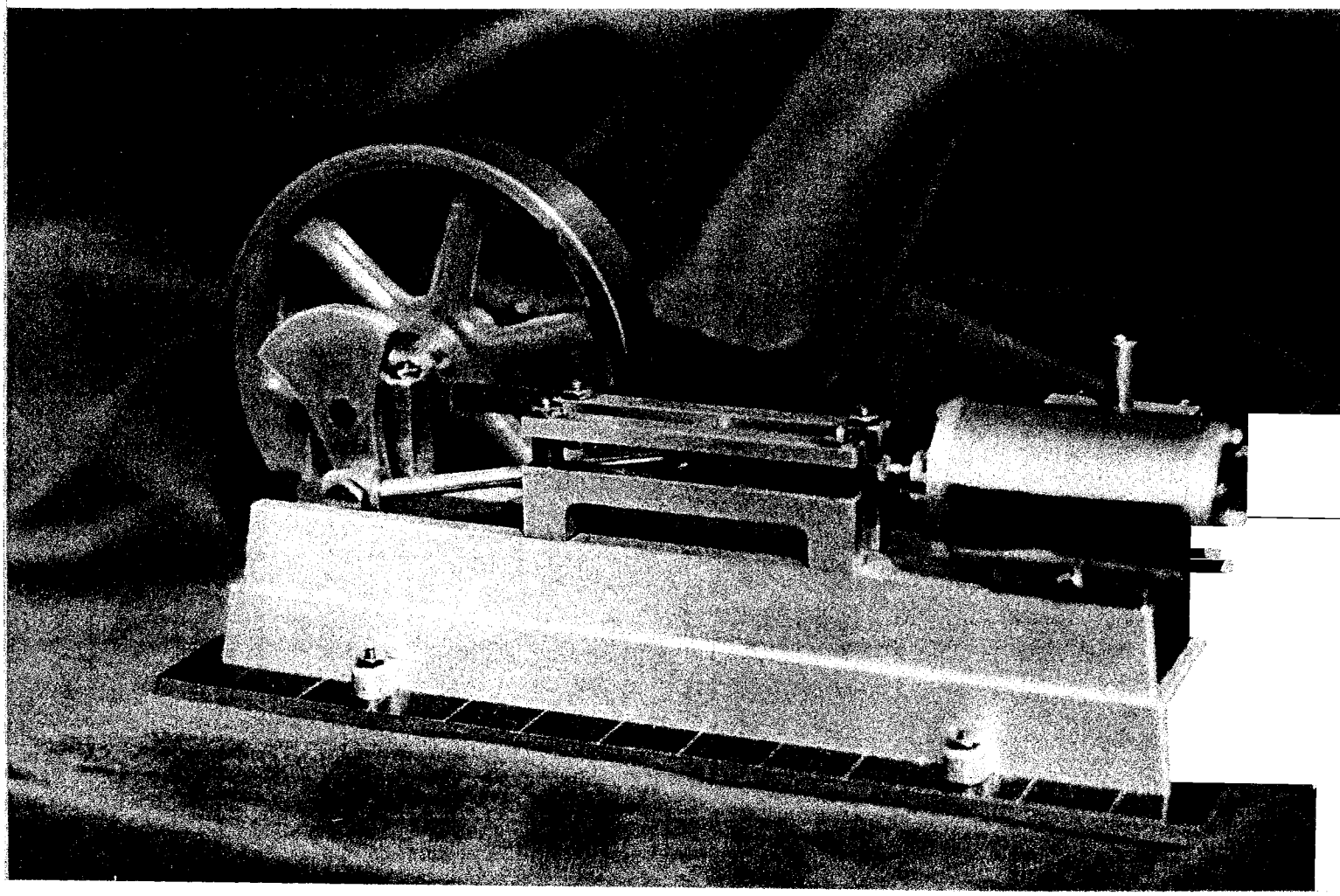
VALVE ROD PIN

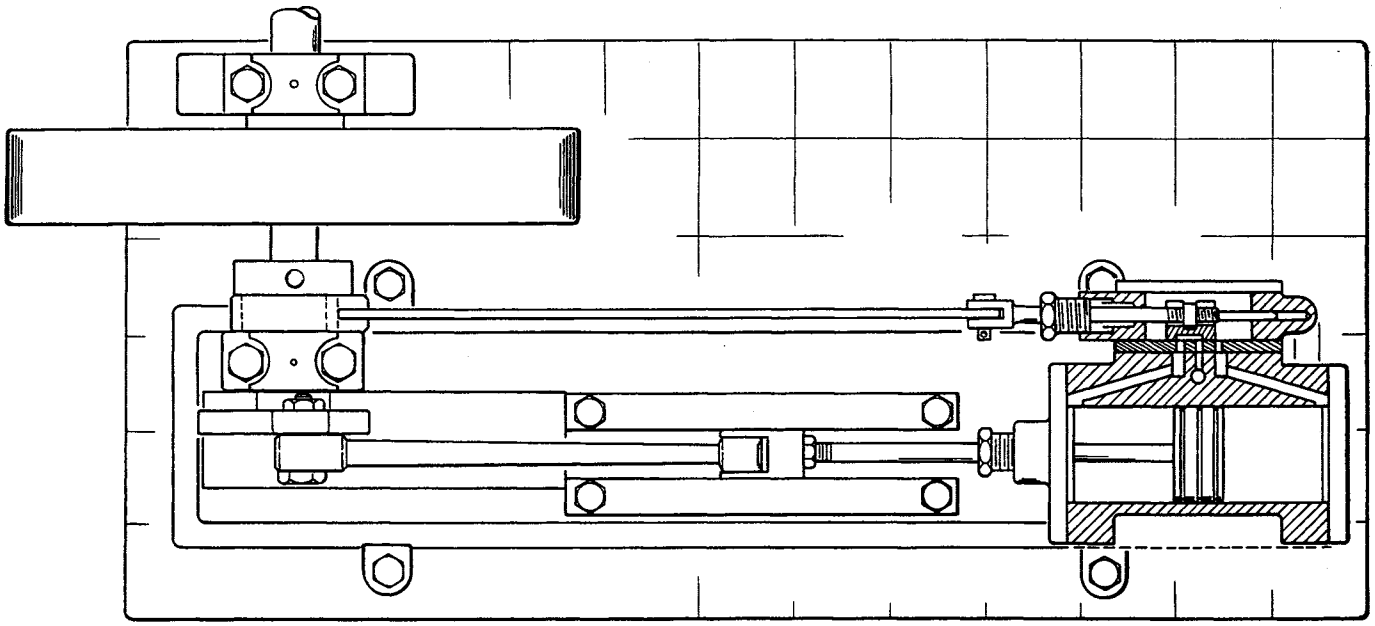
CHAPTER

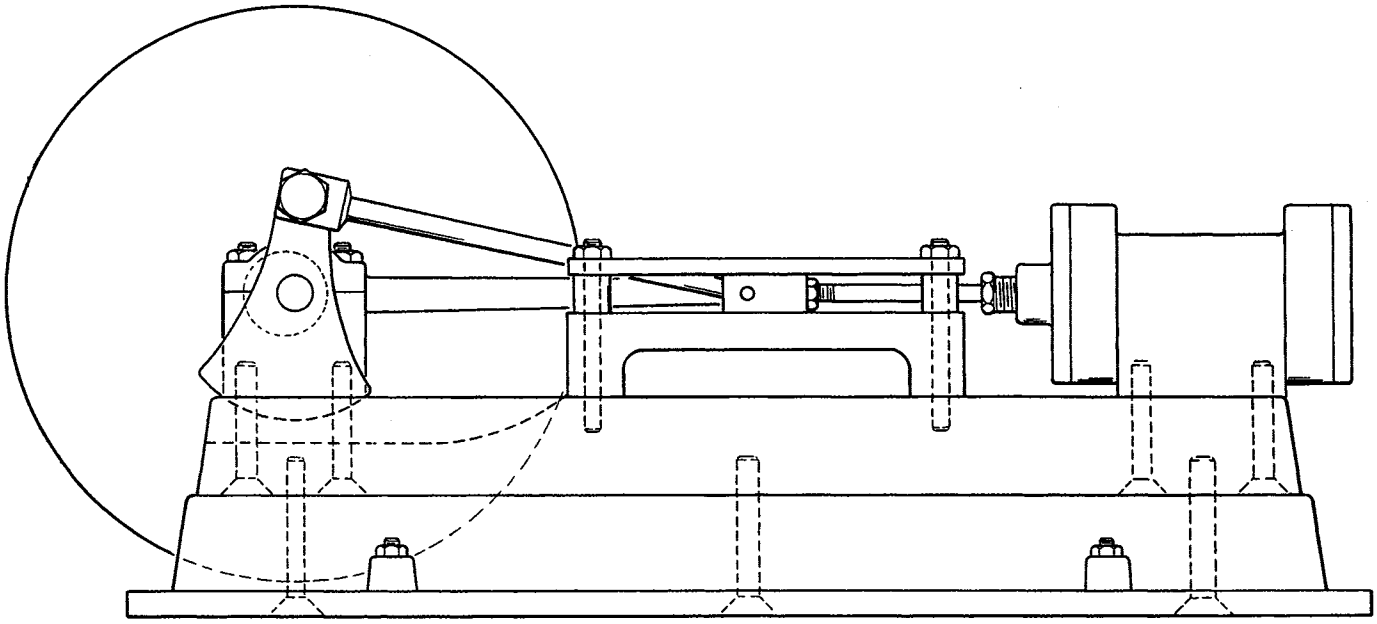
33 Mill Engine

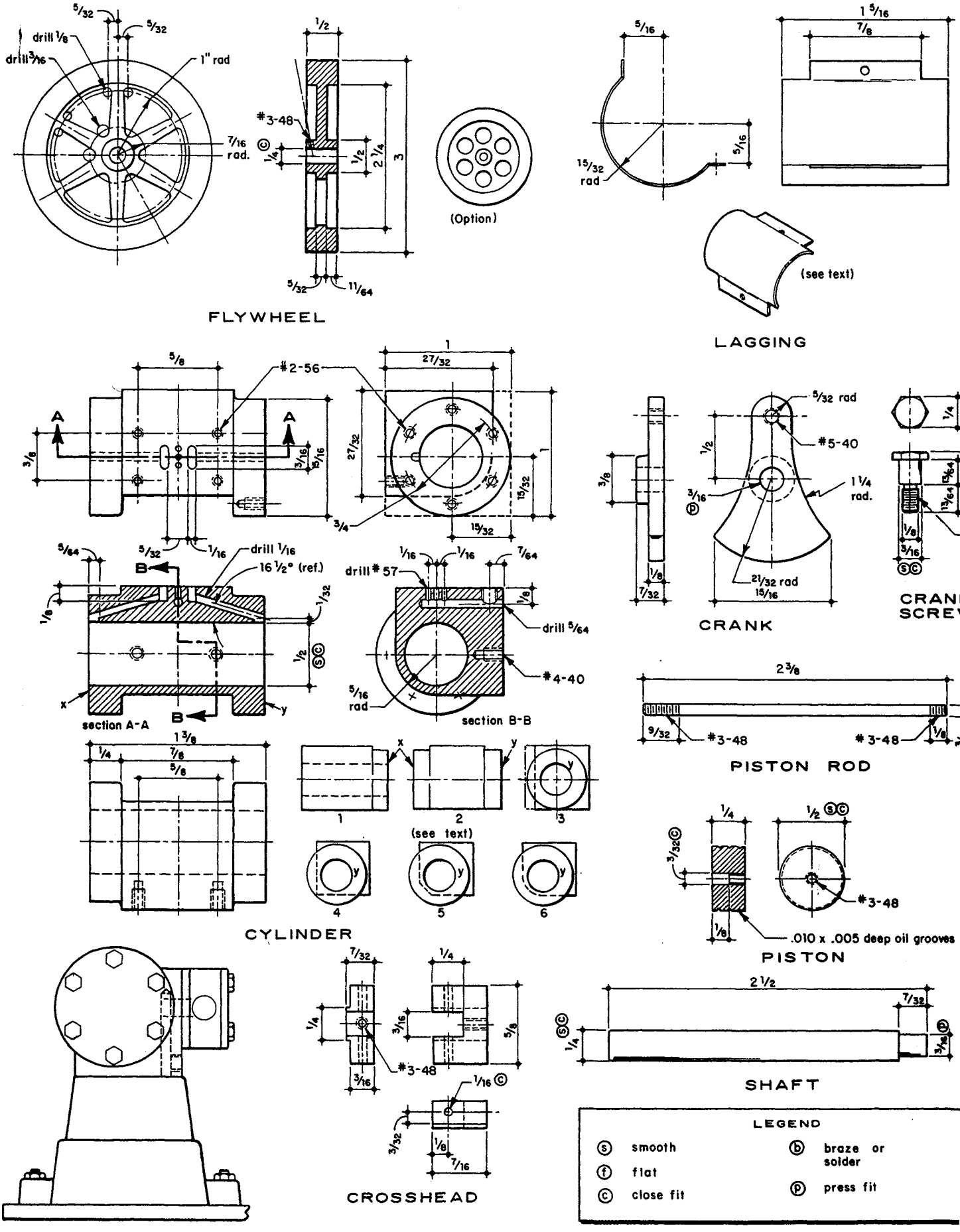
This is a small Mill Engine with 1/2" bore and 1" stroke. The proportions are fairly good and , using hexagon screws, it appears quite authentic. It runs good on as little as 5 psi air. No castings are required and most of the material can come from your scrap bin. On the model shown, most of the parts are made of a fairly hard jig-and-fixture grade of aluminum. The Piston is Teflon, although brass or bronze would be suitable. The Flywheel shown is a 3" Stuart Turner borrowed from a model 10H engine, but the drawings show a Flywheel made from 1/2" flat stock. Packnuts, Eccentric Strap, Valve Plate, Crosshead, Spacers, Steam Chest Cover, Valve, Valve Nut, Valve Rod, Piston Rod and the Valve Rod Pin are all brass. The Eccentric, Crank Screw and Crank Shaft are of steel. You can use any material you may have available and the use of steel and/or bronze instead of aluminum will make a more durable engine if it is to be run on live steam. Most of the parts need no special comments and follow customary machine shop procedures.

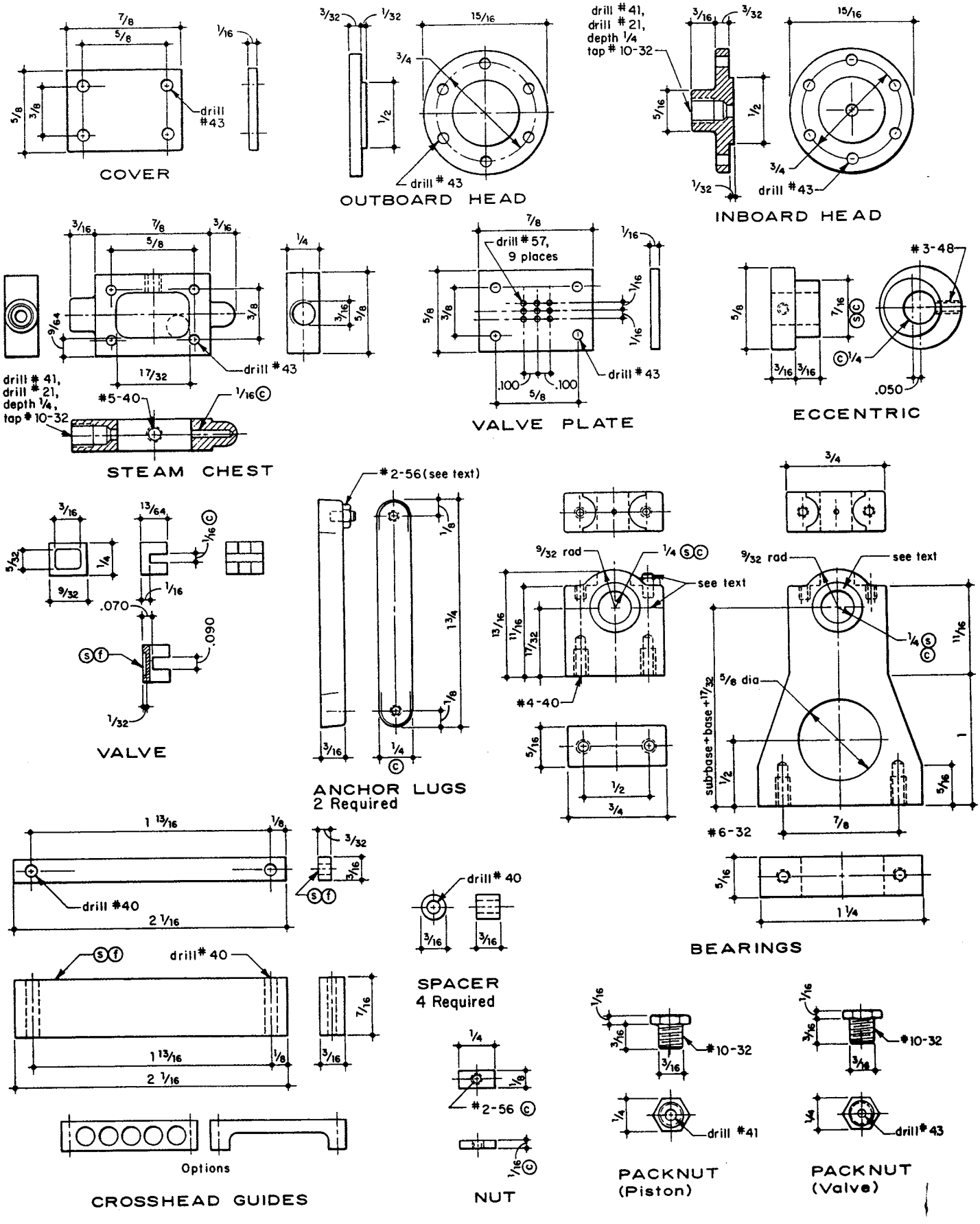
For the **BEARINGS**, start out with accurate 5/16" x 3/4" x 13/16" and 5/16" x 1-1/4" x 1-13/16" blocks. Scribe the outlines on the faces of each Bearing. Lay out and tap the Bearing mounting holes. Lay out the center for the shaft hole on the **TALL BEARING** and mill to outline. Assemble the Bearings to the Floor, Sub-Base and Base, all snug and well aligned. On the model shown, the assembly was mounted in the cross-slide milling attachment. The Shaft center was picked up with a wiggler and the Bearing holes line-drilled in easy stages to avoid strain on the setup. The last few thousandths were taken out with a reamer; in this case 3/8", since "Oilite" bushings were to be used. If you do not choose to use bushings, work up to a 1/4" reamer. A 1" long flathead bolt with a thick nut was used as a jack between the Tall Bearing and the Base to take some of the drill thrust. This operation might be done in a drill press, using an angle plate or a deep-jawed drill press vise. Mark each Bearing so it can be returned to its own position where it was machined. If you wish, you can actually make Split Bearings, but you must plan for this at the start. On this model, a deep scored line was








FLYWHEEL
(Option)
LAGGING
(see text)
CRANK
CRANK SCREW
PISTON ROD
CYLINDER
section A-A
section B-B
PISTON
.010 x .005 deep oil grooves
SHAFT
CROSSHEAD
LEGEND
s smooth
f flat
c close fit
b braze or solder
p press fit


COVER
drill #43
OUTBOARD HEAD
drill # 43
INBOARD HEAD
drill # 41, drill # 21, depth 1/4 tap # 10-32
drill # 43
STEAM CHEST
drill # 41, drill # 21, depth 1/4, tap # 10-32
#5-40
drill # 43
VALVE PLATE
drill # 57, 9 places
drill # 43
ECCENTRIC
#3-48
.050
VALVE
.070
.090
ANCHOR LUGS
2 Required
#2-56 (see text)
BEARINGS
9/32 rad
see text
#4-40
5/8 dia
subbase + base + 17/32
#6-32
SPACER
4 Required
drill # 40
CROSSHEAD GUIDES
drill # 40
Options
NUT
#2-56
PACKNUT
(Piston)
#10-32
drill #41
PACKNUT
(Valve)
#10-32
drill # 43

scribed to represent a Split Bearing and fake studs and nuts added in spot-faced holes. The 5/8" hole is optional.

The **CYLINDER** starts out as an accurate 1" x 1" x 1-25/64" block. Lay out all the centers and lines on all the faces. Complete all drilling and tapping. Note that the bore centerline is 15/32" from the faces at one corner. The Head bolt holes can be made by using a Head as a jig. Looking at the **Y** end in **Step 3**, note that the circle is at the lower left hand corner. The opposite end is **X**. Turn **X** end first so the 1/64" turned off the end makes it square with the bore for sake of the inboard Head. Make a milling setup and do **Step 3**, **4** and **5**. Rounding at **Step 6** is optional as Lagging will cover it.

The **CONNECTING ROD** is a piece of 5/16" x 3/16" stock, drilled, reamed and turned. Add extra length for a center hole for tailstock support when turning.

Try for good concentricity on the **PISTON** and **ROD** to avoid binding at the inboard Head.

The **STEAM CHEST** is laid out completely on an accurate 1/4" x 5/8" x 1-1/4" block. Center in the 4-jaw to turn each end and bore. Use drilled holes to form the radius in the center hole.

Make the **VALVE** of brass. Try for freedom on this part so it will float on the seat as steam pressure holds it down. At the same time, avoid sloppiness at the **VALVE NUT** and **VALVE ROD** thread.

The **VALVE ROD** is 3/16" stock, turned with tailstock support. Mount in the cross-slide mill attachment and mill the flats and the slot. It is well that the **NUT** fit the 2-56 thread closely to reduce pounding at the Valve.

The **ECCENTRIC STRAP** is a machined Bearing end, soldered to a flat bar.

The **FLOOR** on the model shown is salvaged blue-colored anodized aluminum and the 1/2" squares were easily scribed to represent tile. The scribing is optional but adds considerably to the appearance of the finished engine. However, the metal can be left bright or painted to suit your fancy... and don't overlook the possibility of scribing deep lines which can be filled with paint and the surface wiped clean to leave some color in the lines. There are some dyes on the market for coloring metal and they should make a background for the lines.

When making the **BASE** and **SUB-BASE**, make the beveling (which is optional) the last operation. You will have more accurate edges and corners for layout and holding. Mount the Guides, Brackets and Cylinder on the Base before beveling so you can see which areas can be beveled and which corners can be rounded. The fake **LUGS** are set in the Sub-Base with Loctite. Short trimmings from 2-56 screws plus hex nuts complete the fake anchor bolts.

The lower **CROSSHEAD GUIDE** can be simple solid pieces or drilled out or arched as shown. The Piston Rod hole in the **CROSSHEAD** should match the Piston centerline height in the Cylinder. Use a 1/16" x 5/8" Pin in the Crosshead.

The **PACKING** is made from 1/16" strands unraveled from braided asbestos graphite packing. Do not snug up the Packing Nuts too tight, but turn them lightly with the fingers.

Next, chuck 5/8" diameter stock in the 4-jaw for the **ECCENTRIC**. Brighten the O.D. and bore 1/4". Offset .050" and turn the 7/16" diameter. Mount a square-ended bar in the tool post and bring it up against the stock. "Zero" the cross-slide collar. Turn the chuck so two jaws are horizontal. Ease off the vertical jaws slightly and back up the rear jaw about 1/16". Push the stock back to the rear jaw, using the front jaw. Advance the cross slide .050" and ease the stock back against it, using the rear jaw. Snug up all jaws. Now, when the high spot just kisses the bar and then the chuck is rotated 180 degrees, a .100" diameter rod should just pass between the bar and the stock in the chuck.

A **FLYWHEEL** can be made from 1/2" flat stock. Lay out and drill twelve 1/8" holes and six 3/16" holes as shown. Chuck in a 4-jaw, gripping about 1/8" of the stock thickness. Center and turn the O.D., the 11/64" x 2-1/4" recess and Shaft bore. Reverse and mount in a 3-jaw, gripping on the rim I.D., then finish the O.D. and the second 11/64" x 2-1/4" recess. Remove from the chuck and apply layout dye to one entire web face. Scribe lines tangent to the holes as shown, then saw and file spokes to shape.

The **LAGGING** is tin can stock. First, make a heavy paper pattern and transfer to the metal. The pattern is a cut-and-try job. Spot two tiny screws to hold the lagging in place.

At the **FINAL ASSEMBLY**, turn the Crank to one dead center position and tighten the Eccentric with it axis 90° from the centerline through the Crank. Temporarily hold the Steam Chest in place while adjusting the Valve to equally expose the Valve holes at each end of the stroke. Spot a few drops of oil on bearing and wearing surfaces and give it a trial run on air. This is the point at which all your efforts bear fruit and the enjoyment of watching the engine run will continue for years and years!