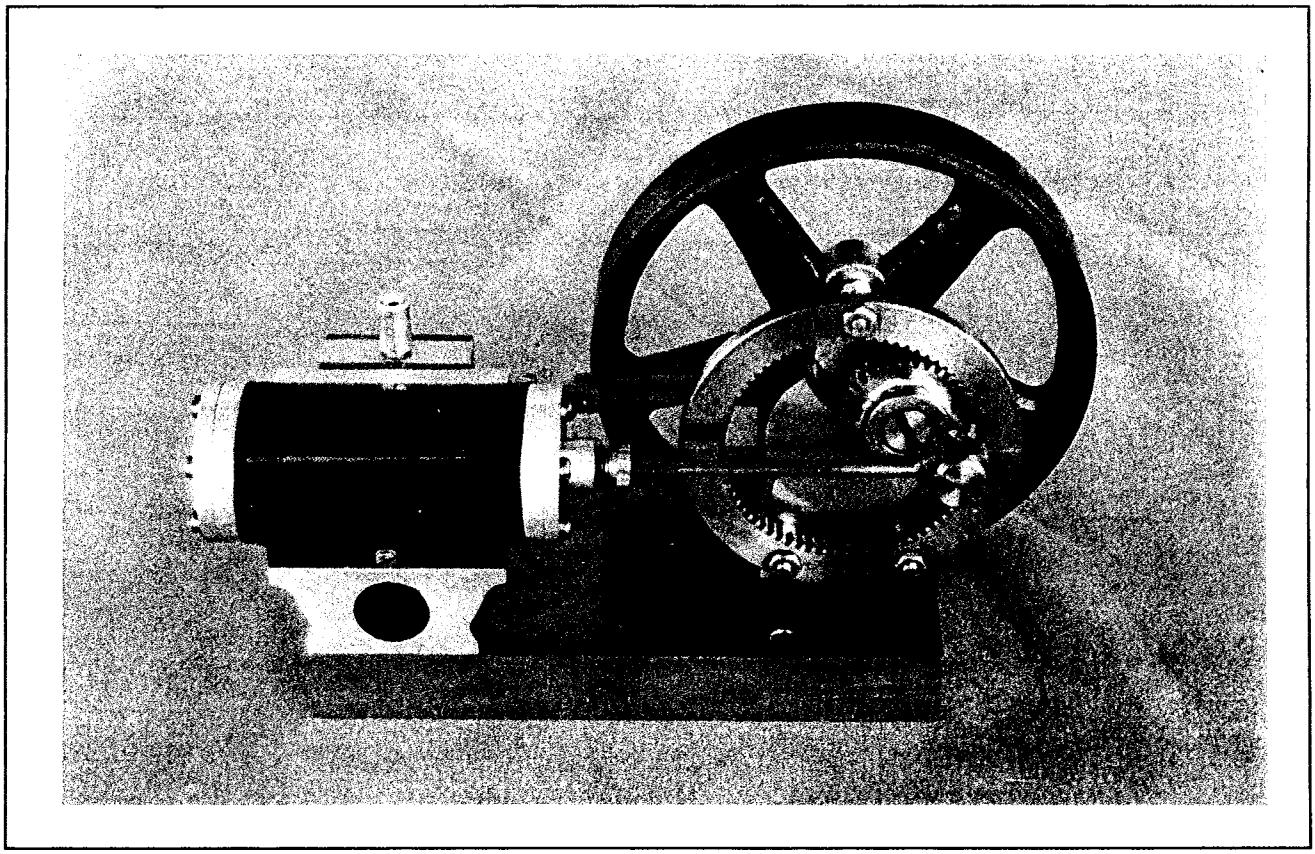
CHAPTER

5 Geared Steam Engine



This is an engine with an internal gear producing straight line motion to the piston rod. It required careful machining to prevent binding and is a bit more challenging than a simple crank engine.

First, the gears shown were purchased from Boston Gear and cost $38.00, which may discourage some builders. It is a fascinating engine to watch when running at slow speed and will not be found in many exhibits.

If you strike out on your own there are a few rules that must be followed:

1. The two gears must have the same pitch and pressure angle. Twenty degree pressure angle teeth will not mesh with 14-1/2 degree PA teeth.
2. On this engine the pitch diameter of the internal gear must be two times the PD of the orbiting gear and will have two times as many teeth. The PD of the internal gear is the piston stroke of the engine. Pitch diameters are the imaginary circles, or outside diameters of two wheels, one driving the other by friction. To make the drive positive, "teeth" are laced across these pitch circles.
3. The mounting of the internal gear must be with centerlines passing THROUGH THE TEETH CENTERS, and the piston rod screw CENTERED BETWEEN TWO TEETH as shown or you will get binding and not straight line motion.

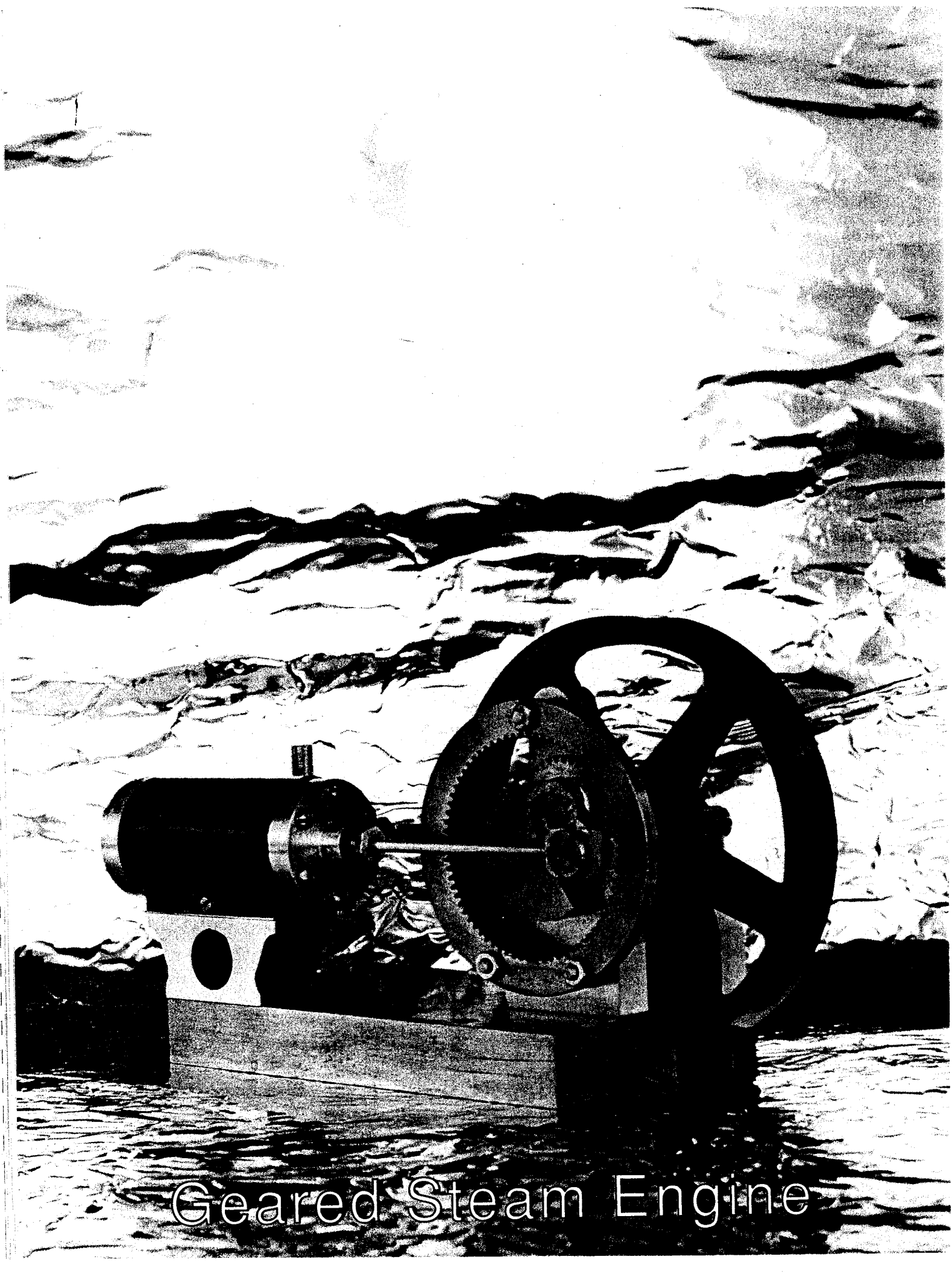
The critical dimension is the .375" dimension on the crank. Also try to hold the .375" dimension on the gear arm. A few thousandths full on the crank will cause binding. It is better to aim for a couple thousandths under on these two dimensions. Remember the tooth working depth for 48 pitch teeth is only .041" and you do not have much leeway.

The **BASE** calls for aluminum though the model shown has a steel base. The weight makes it more stable if not anchored down.

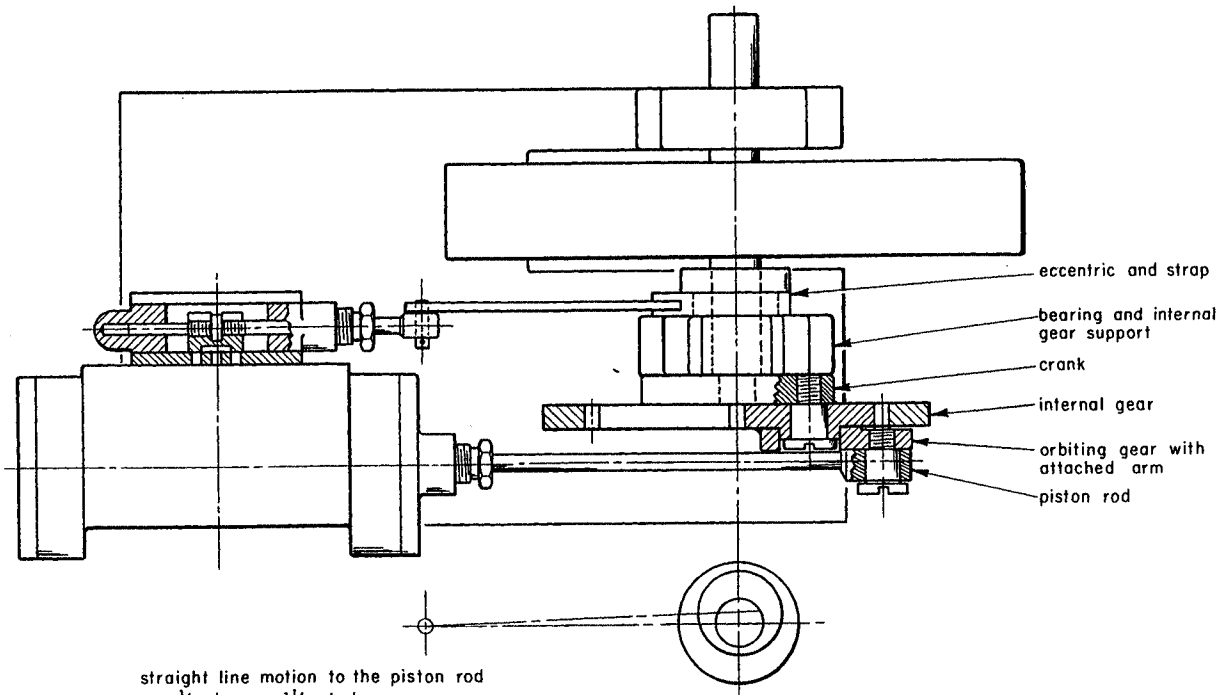
The **BEARINGS** are simple machinging except the tall Bearing should be laid out completely, the three gear mounting holes drilled and the #5-40 holes tapped. Locate these three holes very carefully for sake of gear alignment. Mount the two Bearings on the Base and hold this assembly squarely in the cross-slided milling attachment. Pick up the bearing center with a wiggler and drill in easy stages and line-ream to size for the crank shaft. Bushings are optional.

On the **PISTON ROD**, solder the 3/16" thick block in place and then mill to 9/64".

The **VALVE ROD** is 3/16" stock turned with tailstock support. Mount in the cross-slide milling attachment and mill the flats. It is well that the #2-56 thread fit the nut closely to

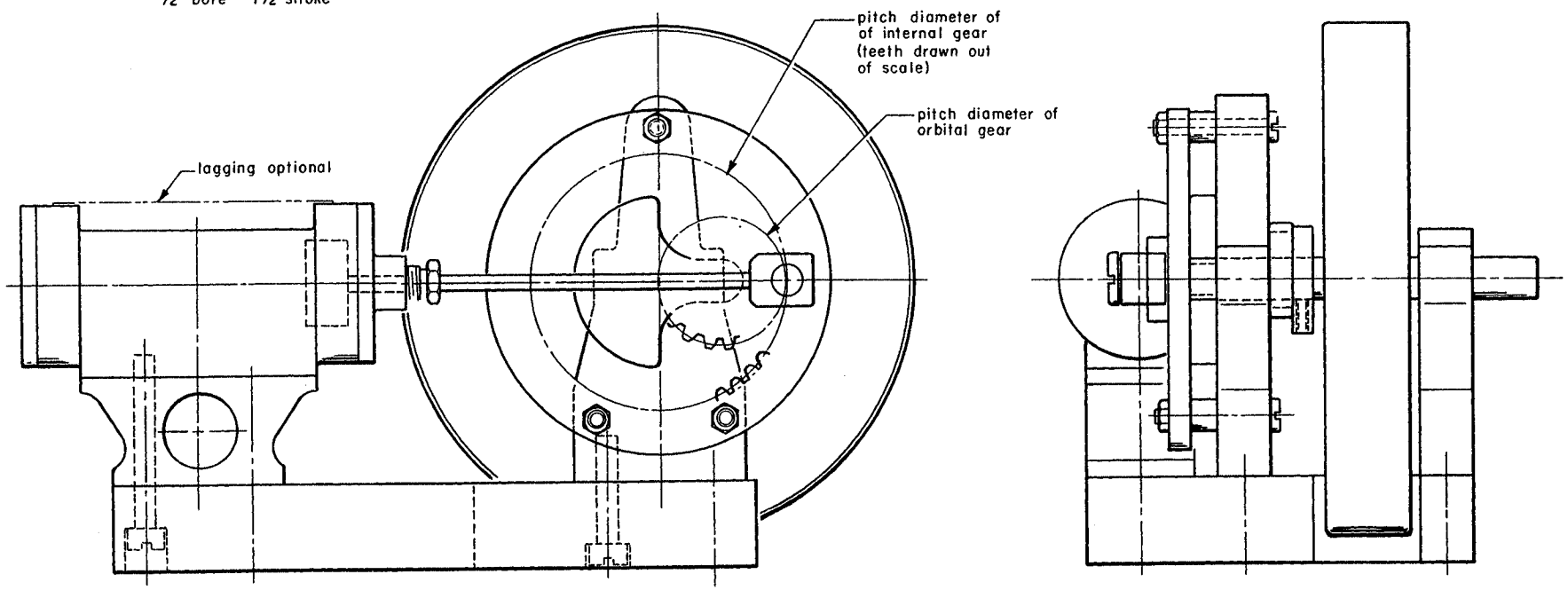


Geared Steam Engine

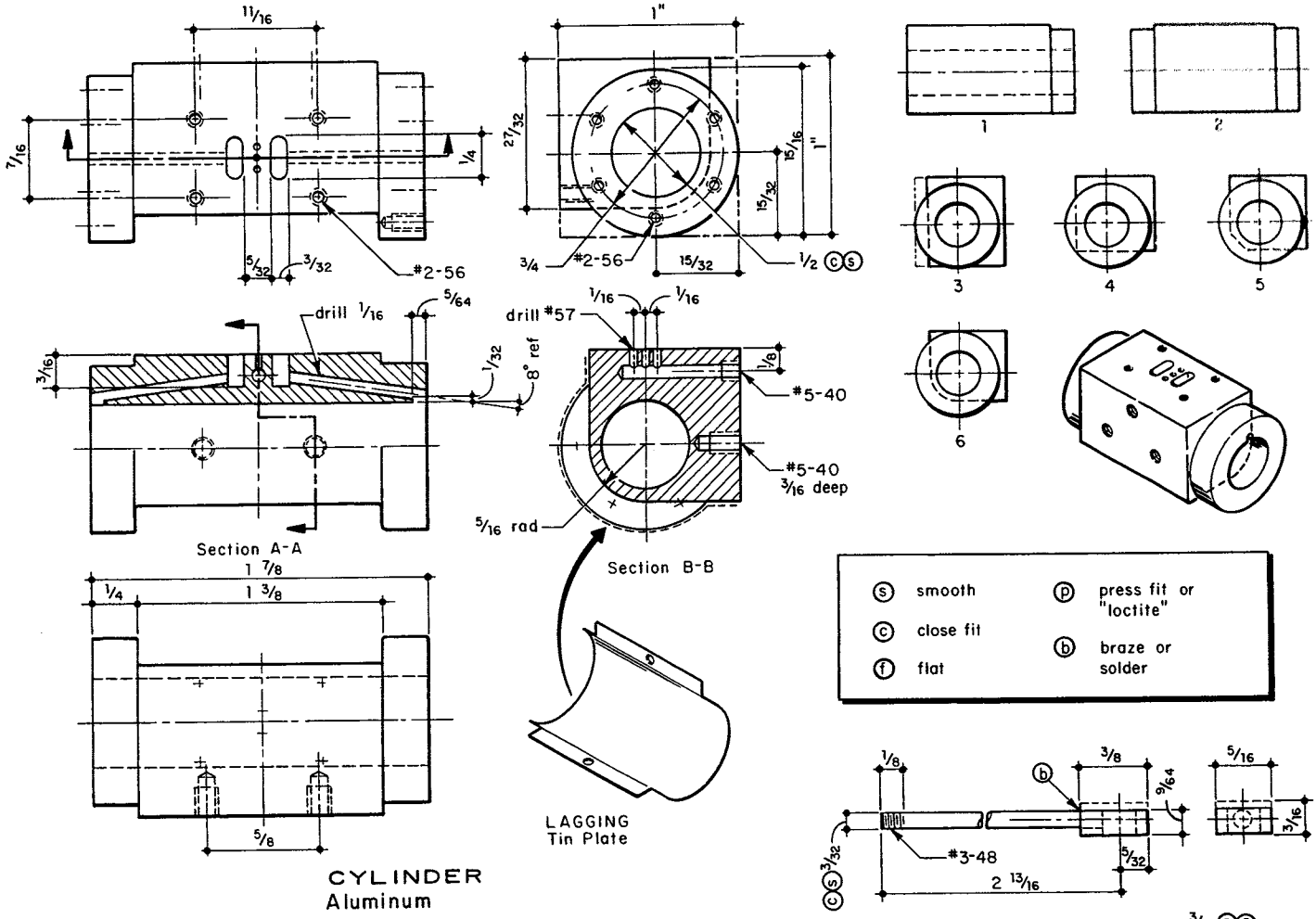


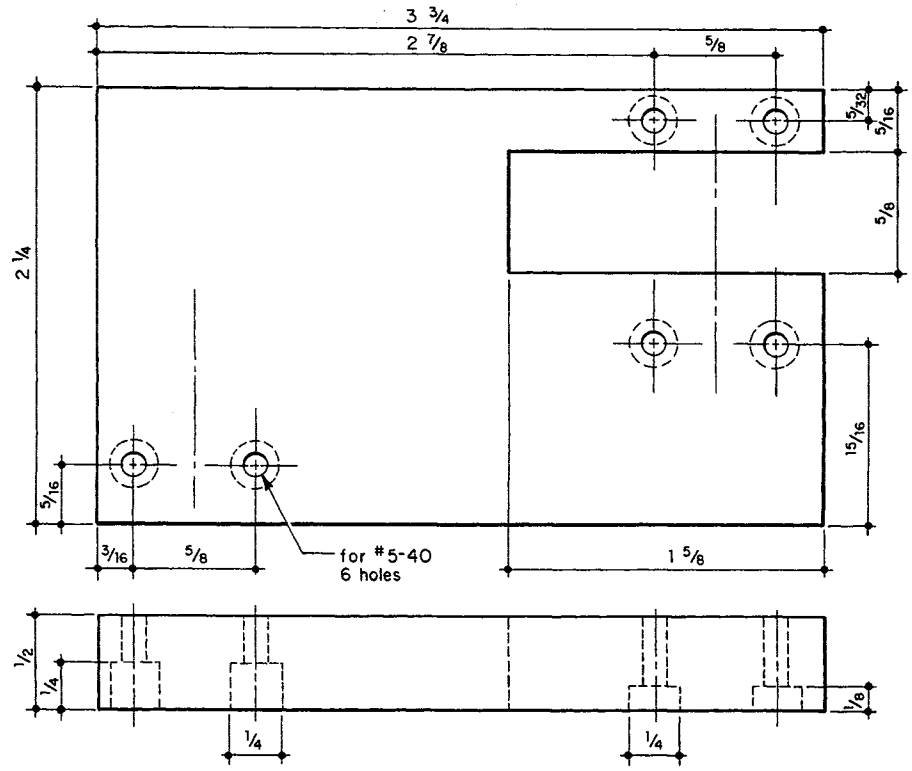
straight line motion to the piston rod
½ bore 1½ stroke

BOSTON GEAR		
TYPE	SPUR GEAR	INTERNAL GEAR
catalog number	Y4836	Y14872
pressure angle	20°	20°
pitch	48	48
number of teeth	36	72
pitch diameter	.750	1.500
outside diameter	—	2
face	1/8	1/8
hole	3/16	—
hub diameter	1/2	—
hub projection	1/4	

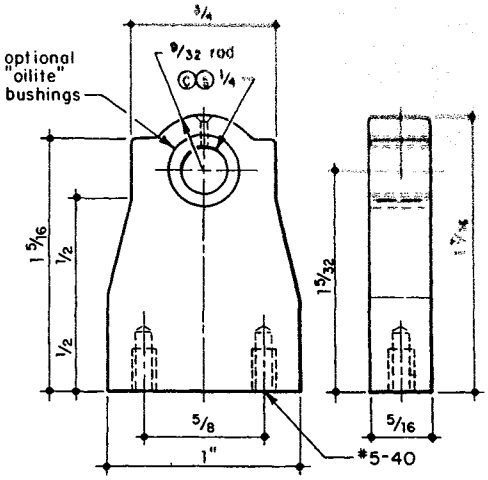


ENGINE WITH GEAR MECHANISM

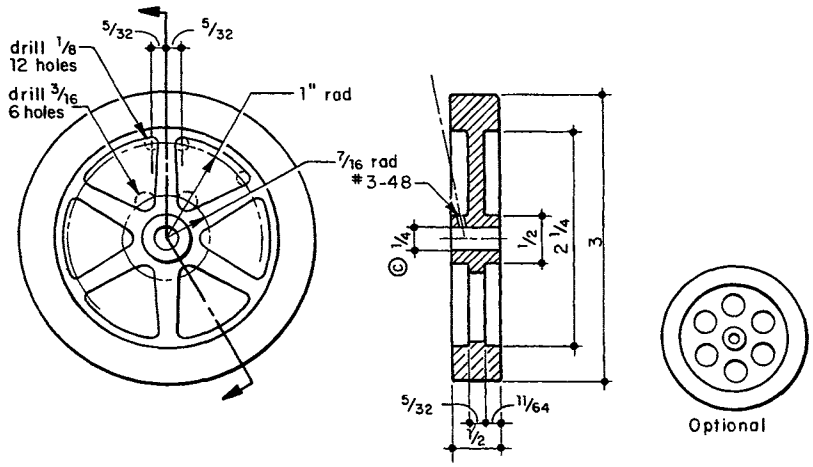

11/16
7/16
1/4
5/32
3/32
#2-56
1"
27/32
15/16
1"
15/32
3/4
#2-56
15/32
1/2 (c)(s)
1
2
3
4
5
6
drill 1/16
5/64
3/16
1/32
8° ref
Section A-A
drill #57
1/16
1/16
1/8
#5-40
#5-40
3/16 deep
5/16 rad
Section B-B
1 7/8
1 3/8
1/4
5/8
CYLINDER
Aluminum
LAGGING
Tin Plate
(s) smooth
(c) close fit
(f) flat
(p) press fit or "loctite"
(b) braze or solder
1/8
3/8
(b)
9/64
5/16
3/16
#3-48
5/32
2 13/16
(c)(s) 3/32
3/16 (s)(c)
PISTON ROD
Brass
3/32
1/32
15/16
drill #43
1/2
3/4
OUTBOARD HEAD
Aluminum
15/16
drill #43
3/4
3/32
1/32
3/16
drill #41
drill #21, depth 1/4
tap 3/16-40
1/2
5/16
INBOARD HEAD
Aluminum
#3-48
(c)(s) 1/2
1/4
1/8
oil grooves
approximately
.010 wide x
.005 deep
(c)
3/32
PISTON
Brass
1/16
11/16
5/8
7/16
drill #43
COVER
Brass
3/16
7/8
3/16
11/16
#5-40
1/4
5/8
7/16
11/32
3/16
drill #43
17/32
drill #41
drill #21, 1/4 deep
tap 3/16-40
1/16 dia (c)
STEAM CHEST
Aluminum
11/16
drill #43
drill #57
9 holes
(s)(f)
5/8
7/16
1/16
1/16
.100
.100
7/
VALVE PLATE
Brass



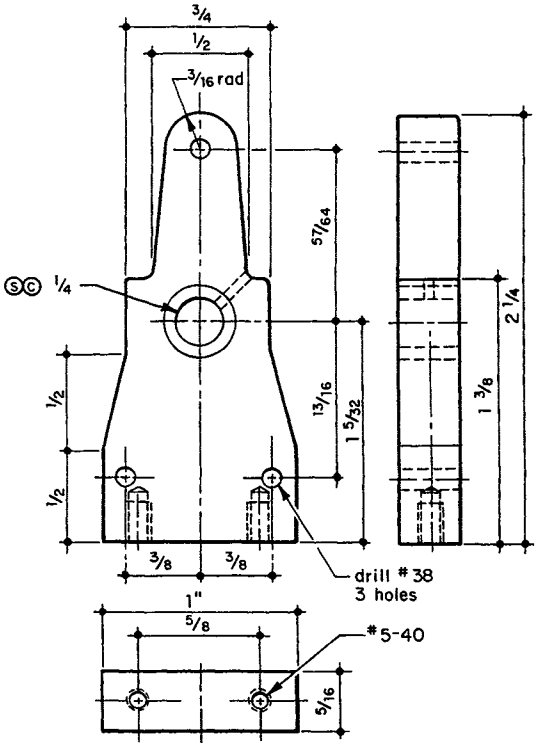
BASE
Aluminum



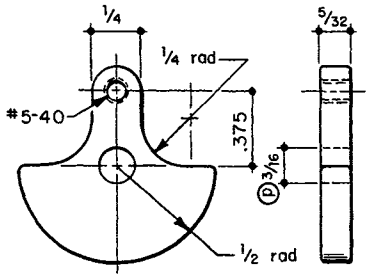
REAR BEARING
Aluminum



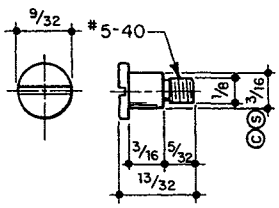
FLYWHEEL
Aluminum



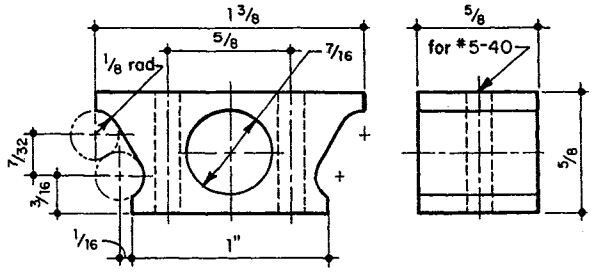
FRONT BEARING
Aluminum



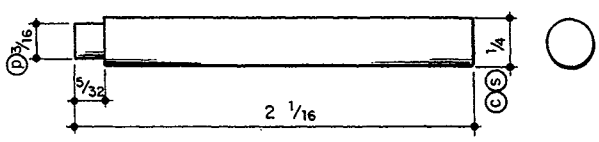
CRANK
Steel



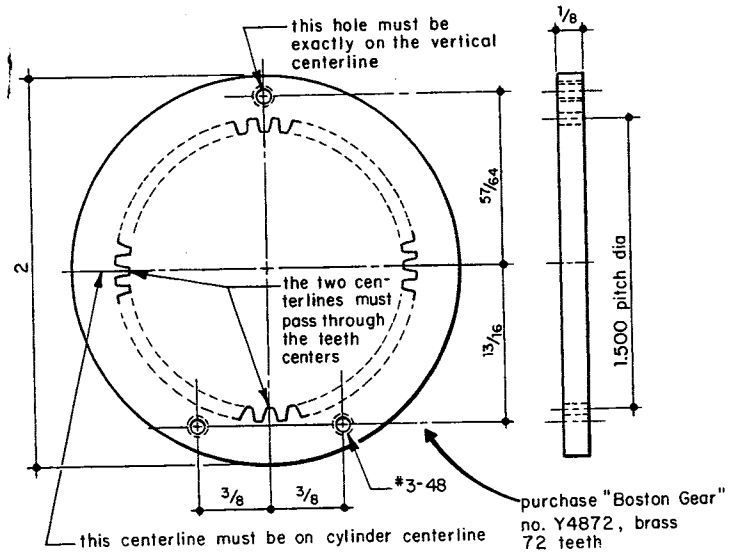
CRANK SCREW
Steel



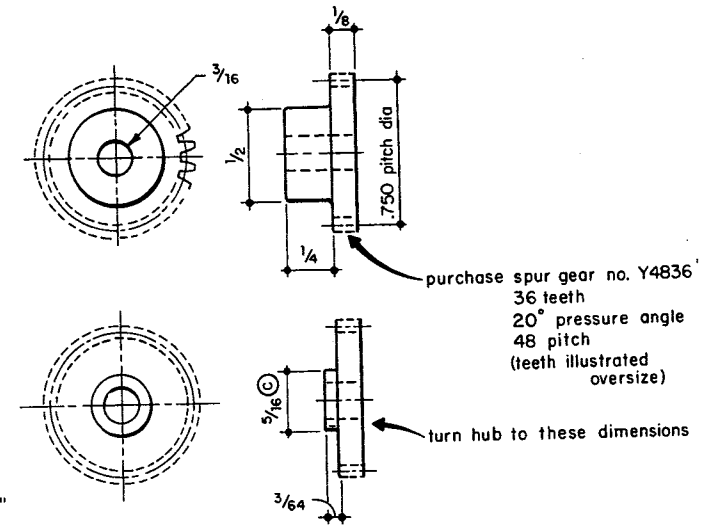
FOOT
Aluminum



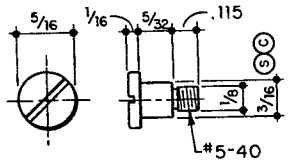
SHAFT
Steel



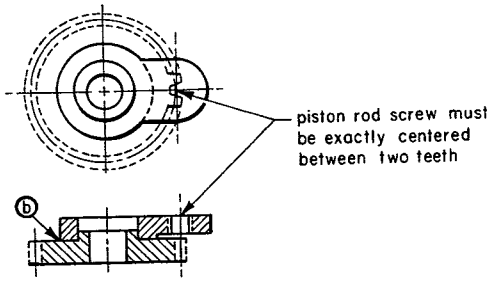
INTERNAL GEAR
Brass

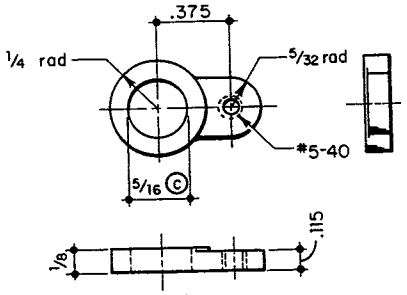


ORBITING GEAR
Brass

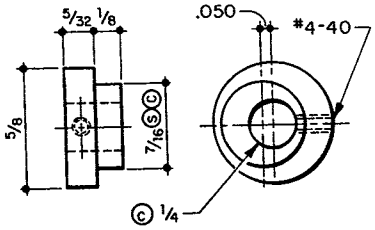


PISTON ROD SCREW
Steel

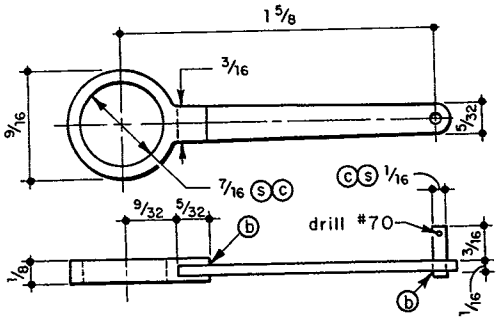




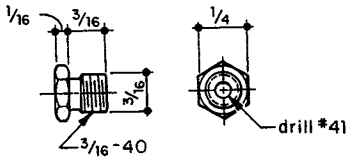
GEAR ARM
Brass



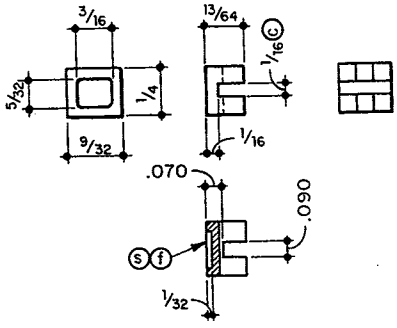
ECCENTRIC
Steel



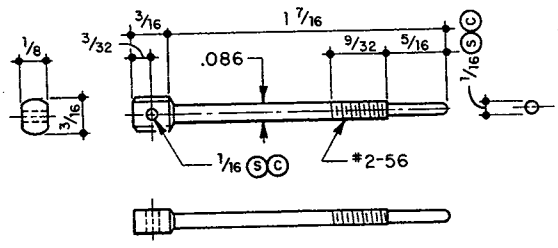
ECCENTRIC STRAP
Brass



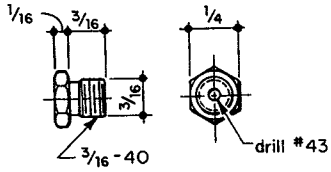
CYLINDER PACKNUT
Brass or Aluminum



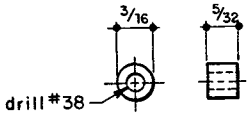
VALVE
Brass



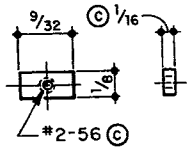
VALVE ROD
Brass



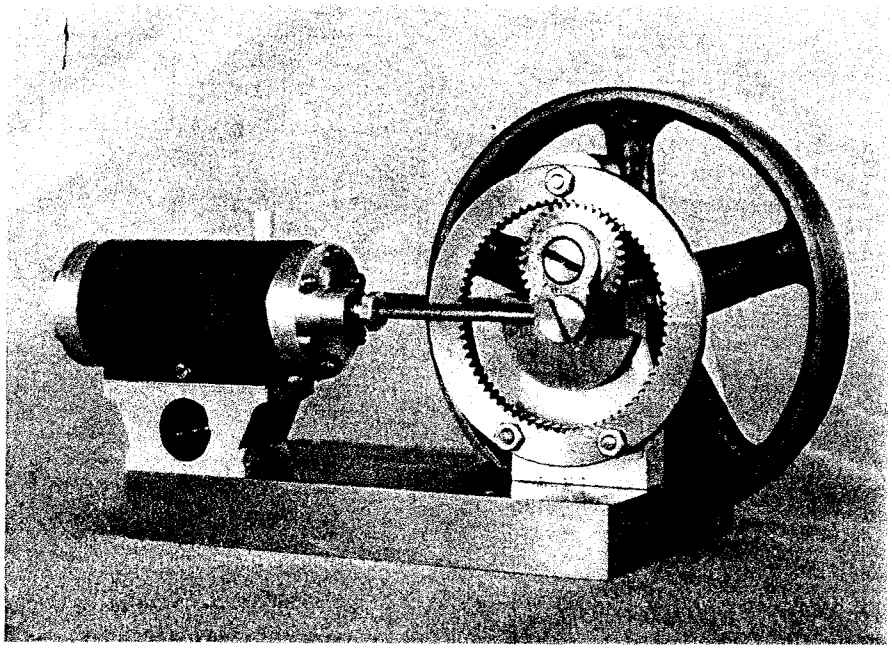
STEAM CHEST PACKNUT
Brass or Aluminum

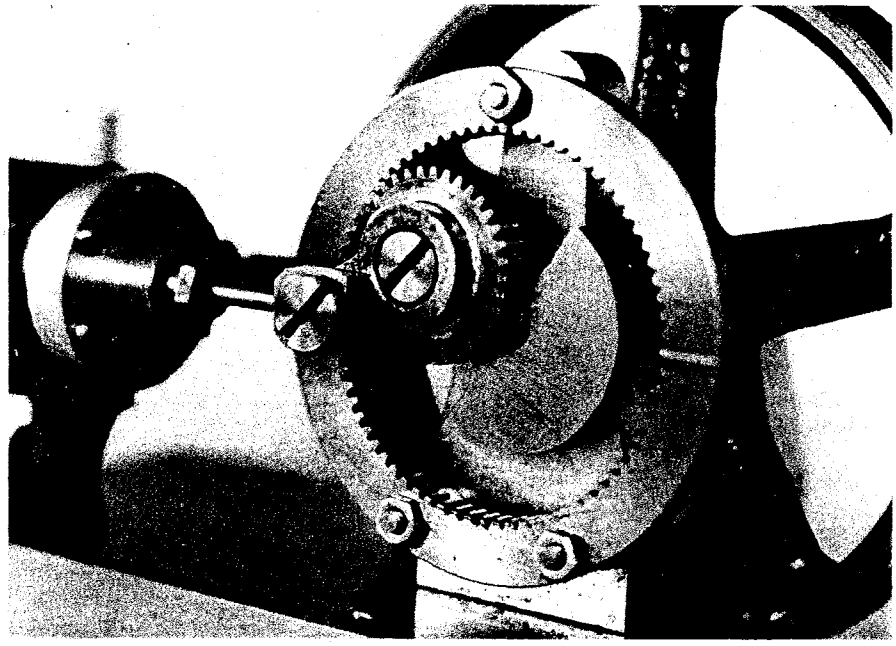


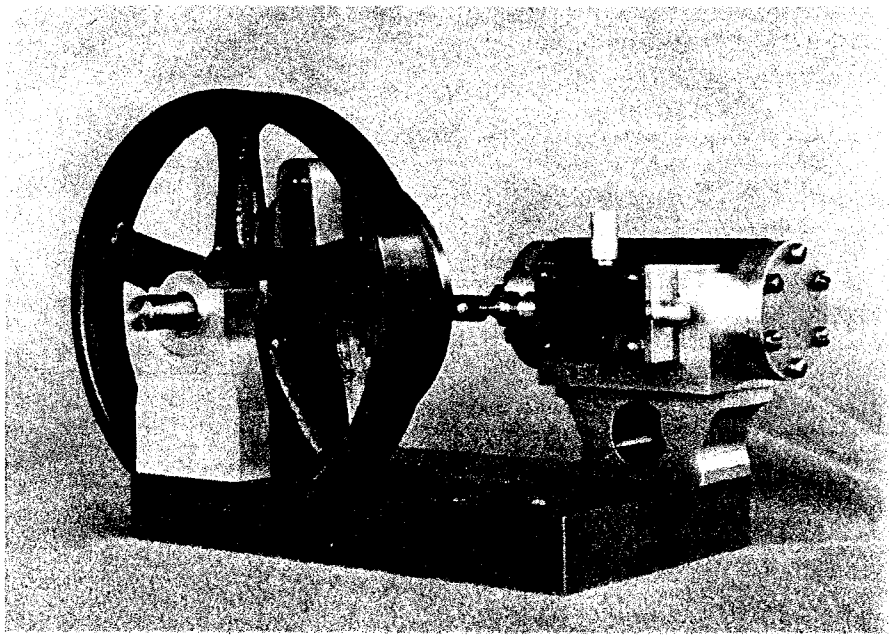
SPACERS
Brass or Aluminum
3 required



NUT
Brass







reduce pounding at the Valve.

The **ECCENTRIC STRAP** is a machined bearing end soldered to flat stock. Solder a close-fitting pin in the other end.

The **PACKING** is 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.

Chuck 5/8" diameter stock in the 4-jaw for the **ECCENTRIC**. Brighten up the O.D. and bore 1/4" for the shaft. Offset .050" and turn the 7/16" diameter. One method is to 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 the bar, 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.

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

The **LAGGING** shape is transferred from a heavy paper pattern made by the cut-and-try method.

The mounting holes in the **INTERNAL GEAR** are critical and must match the bracket holes. Misalignment here can cause binding. count the teeth very carefully so the two center lines can be accurately established. A small vise, square on all faces, a surface plate and height gauge are a big help here. The three holes may be enlarged slightly if needed to line up.

At the **FINAL ASSEMBLY**, turn the Crank to one dead-center position and tighten the Eccentric with its 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.

Oil all Bearings and sliding surfaces and load the gear teeth with light grease.

At first glance, it is a mystery why the rod travels in a straight line, making this engine fun to show off.