**Drive Piston**

This is machined from $\frac{5}{8}$-in. cold-rolled steel rod. To get a good fit (without resorting to a small hole gauge) requires slow, careful machining; toward the end, take the diameter down half a thousandth at a time. That's half the space between adjacent marks on the numbered crossfeed thimble. For top performance, the final fit should be so tight that the piston must be lapped into the bore.

Shape and slot the bottom as with the valve piston, then trim to the length shown in the detail and face the cut surface.

**Connecting Rods**

Lay out the drive-piston rod and the flat section of the valve-piston rod on $\frac{3}{8}$-in.-wide strips of 16-ga. sheet metal. Rough-shape with a coarse file, then do final shaping with an ignition-point file chucked in a jigsaw. Smooth with emery followed by crocus cloth, and polish on a buffing wheel.

The brass eccentric ring for the valve rod is formed by hollowing out $\frac{1}{2}$-in. brass rod, then cutting off a $\frac{3}{16}$-in. width.

**Crankshaft Assembly**

To make the eccentric, machine the end of $\frac{1}{2}$-in. drill rod, remove from the lathe and drill to accept the reduced end of the shaft. Then return to the lathe and cut the eccentric to width. It must be a smooth, sliding fit inside the valve rod's brass ring.

The crankplate is turned to a 1-in. dia. from the same bronze stock as the engine block, and cut off $\frac{1}{4}$ in. thick. Cut off a second disk, trim off a segment for the coun-
You needn't be a skilled machinist to make this perky little one-lunger from the detailed plans on the following pages. Part II will cover the blowtorch-fired boiler.
IF YOU HAVE ACCESS to a six-inch model-maker’s lathe, a drill press and a jigsaw, you can have a lot of fun making this midget powerhouse. It’s a single-acting, piston-valve-type reciprocating steam engine with a ½-inch bore and ½-inch stroke. Machining has been kept to minimum—and the boiler (detailed next month) is literally a “pipe” to assemble: it’s made of standard plumbing fittings. Fired with a blowtorch, it generates enough steam in two minutes to set the pistons whirring.

**Engine Block**

The trickiest machining is boring the two holes—for cylinder and steam chest—in a piece of bronze bearing stock. After cutting the rod to approximate length, face both ends and scribe a diameter across what will be the lower end. Prick-punch centers for the two bores. Bore the cylinder as shown on the opposite page, drilling 1½ in. deep with a ½-in. drill; then enlarge to that depth with successively-larger drills.

**HOW STEAM DRIVES THE ENGINE**

EXAGGERATED SEE-THROUGH sketches show two extreme positions of pistons. At far left, drive piston has just begun power stroke, forced down by steam rushing through steam chest, above retracted valve piston. Revolving eccentric is about to raise valve to cut off steam flow. Expanding steam in cylinder continues to push drive piston to bottom of stroke. In second sketch, engine is viewed from opposite side to show how energy stored in flywheel thrusts drive piston upward. Valve piston, now at top of its stroke, presents exhaust passage to port between steam chest and cylinder. Rising drive piston forces steam down valve’s hollow core and out base of bore.

CRANKSHAFT ASSEMBLY, detached from engine block, shows how connecting rods link pistons to crankplate. Both plate and eccentric are soldered to flywheel shaft.
IGNITION-POINT FILE is chucked in jig saw to finish off connecting rod. For easy handling, piece is worked while still attached to parent strip of sheet metal. After filing, cut rod free. Use same setup to file connecting-rod slots in pistons. Bearing block details are shown at right.

Switching to a boring tool for a finish diameter of ½ in. Exact diameter isn’t critical; the piston will be machined to fit.

Remount the block so the steam-chest punch is centered, and drill 1½ in. deep with a ¼-in. drill. Transfer the work to the drillpress vise and with a No. 41 drill, bore into the side, passing through the steam chest and into the cylinder. Switch to a ¼-in drill and enlarge the hole into the steam chest only, to provide a seat for the steam-inlet nipple. Machine this nipple from a ¾-in. length of brass rod and insert it until it butts the far wall of the steam chest. Anchor it with 20-80 solder.

This solder is 20 percent tin and 80 percent lead, and melts at a temperature of 532 deg. F. Don’t use ordinary 50-50 solder as it has a much lower melting point that can’t withstand the heat of the engine block. You can’t get 20-80 solder commercially, so make your own by melting together 1 oz. of 50-50 bar solder and 1½ ozs. of lead (fishing sinkers are fine). Stir the molten mixture and pour it into a simple mold, such as a blind saw kerf in the face of a board. Later, when you sweat the steam line to the nipple, buy 40-60 solder to avoid the risk of melting.

Now, with a ½×⅛-in. drill, drill out the steam-chest bore, right through the soldered-in nipple, to the full 1¼-in. depth. Since a drilled-out bore is far from perfect, you must finish it to size. A better method than reaming is to lap the bore. First, machine from 3⁄8-in. drill rod a 1½-in. long cylinder that just fits—without looseness—to the full depth of the bore. Using the drill press setup shown on the first page of this article, smear the rod with oil and dental pumice (available at drug stores) and run it up and down in the bore with the drill press set for 600-800 r.p.m. After a couple of minutes, replace this first rod with one machined a few thousandths larger—big enough to stick when you try to insert it in the bore. Apply oil and pumice as before, but lap only until the rod can be run down the full depth of the bore. Back off immediately and flush out the bore with kerosene or paint thinner. This final lapping rod is then made into the valve piston.

**Valve Piston**

Cut the rod to length and mount it in a three-jaw lathe chuck. Face the cut end and center-drill to within ¾ in. of the opposite end, to provide an exhaust passage. Machine the bottom to shape and hacksaw the connecting-rod slot. File this slot to an easy slip fit, then drill for the wrist pin, which can be a 3-penny finishing nail. Note that the slot aligns with the exhaust passage, forming its mouth.

With the rod in a drill press vise, drill into the side (at right angles to the slot) to connect with the center hole. This provides the port which will mate with the cylinder exhaust port when the valve piston is at the top of its stroke. Since the valve continues to rise slightly during this exhaust operation, you must elongate its exhaust port by drilling a second hole overlapping the first, but not deep enough to meet the core hole. Grind out metal between these holes to form the stepped recess shown at right.
weights, and rivet this to the crankplate, filing the rivets flush with the rear surface.

Thread the brass crankpin tightly into the socket tapped near the opposite edge of the crankplate. This, too, should be filed flush at the back—after punching several points around the edge of the socket to prevent unscrewing. To provide for an additional counterweight, drill and tap the counter-weighted edge for a 6-32 screw.

Assemble the connecting rods to their respective pistons by cutting off the point of a 3-penny finishing nail and driving it through piston and rod; cut off the nail head close to the piston, and peen both ends. The rod should swing freely.

The main bearing can be made from oillite bearing stock, or can be purchased as a stock-size bearing. In either case, lap the shaft into an easy-turning fit.

Once the crankshaft assembly is complete, insert the two pistons into the engine block, and the shaft through its bearing. With the columns attached only to the underside of the engine block, position the feet on the base plate by trial, holding them down while turning the shaft to check piston function. Then tap for screws.

The engine at this initial-assembly stage is shown in the inset on the opening page. There is still an additional counterweight to add. For satisfactory operation, the counterweight on the crankplate of a vertical engine must balance the weight of the drive piston and connecting rod. The bronze segment so far added does little more than balance the weight of the crankpin. If possible, weigh the drive-piston assembly on a gram scale; the lead to be added can weigh a gram or two less. Use sheet lead, or melt a fishing sinker and mold it in a saw kerf. Drill the lead strip at the center and attach it to the counter-weight side of the crankplate with a single screw. Wrap it around, trim both ends slightly beyond the counterweight and clinch these ends around the bronze.

**Engine Adjustment**

To keep the piston connecting rod riding straight on the crankpin, its lower end has a projecting sleeve. The nominal length of this is given (in the Engine Assembly drawing) as ¼ in.—which does to start with. In the final assembly, file the free end of the sleeve to give the piston a smooth fit in its bore, without binding.

Use 50-50 solder to join the eccentric to the shaft; then grip the shaft vertically in a vise and push the crankplate on, adjusting the pin position to the 15 deg. offset shown in the front elevation. Apply a drop of 50-50 solder to sweat the plate to the shaft.

If any further adjustment of the valve and piston relationship is needed, it can best be determined by operating the engine. To adjust at this stage, you must melt the solder joint between shaft and crankplate, using the tiniest possible blowtorch flame, and shift the crankplate as required. (That's why high-temperature solder is used on the rod sleeve—to keep it from coming loose when the crankplate is heated.) Keep the eccentric straight up, so the valve is at the top of its stroke, while you tap the crankpin with a small screwdriver.

*(Concluded next month)*