Here's simplicity—no castings needed:

**Rotary-Valve Steam Engine**

Few sounds are as thrilling as the chugging of a steam engine at full throttle—especially an engine you've built yourself. If you have access to a lathe, this two-cylinder vertical marine model is an easy week-end project.

A modified Corliss-type rotary valve is the secret of the engine's simplicity. The steam passages can be filed by hand to control the intake and exhaust cycles of both cylinders. There are no valve eccentrics or guides, or tricky timing, to cope with. And you don't have to make or buy any castings. All parts are machined from raw metal.

The engine is single-acting. Its stroke is 7/16" in a 9/16" bore. At 30 pounds of steam (or air) pressure, the flywheel will turn up 2,000 r.p.m.

**Turn the crankshaft** from a 4" length of 1"-diameter cold-rolled steel rod. Face the ends of the rod, clamp the rod in a V block on a flat surface, and scribe centerlines at 90 degrees on both ends. Punch the main centerline where the scribed lines intersect, and punch matching center marks 5/16" out from the center for turning the crankpins. Center-drill all punch marks carefully.

Mount the rod in the lathe on one pair of offset centers and begin turning the first crankpin. Take light cuts, and when the pin is half completed reverse the rod in the lathe on the opposite pair of offset centers and begin turning the second crankpin. Repeat this operation to bring both pins down to finished diameter together. If you complete one pin before starting the other, the shaft will be springy and hard to machine.

After completing the throws, file two small blocks to fit snugly in the spaces opposite the crankpins. These blocks will stiffen the shaft and eliminate chatter when you machine the remaining diameters on the main center.

**Base and cylinder-block support.** Make the base from 1/4" aluminum or...
cold-rolled steel and the cylinder-block support from 1/8" brass. Both are the same size—2" by 27/8".

Shape the main bearings from 5/16" brass or bronze. Fit the cap studs to the bearing body and fasten the caps in place with a paper shim beneath them before drilling and reaming the 1/4" holes for the crankshaft ends. The preshimmmed bearing can then be adjusted to take up wear. Fasten the bearings to the base and install the crankshaft, using a thin collar at each end of the throws to center them between the bearings. Machine the flywheel and fasten it to the rear of the crankshaft (behind the No. 2 piston).

Cylinder block and pistons are next in order of construction. If possible, use a bronze block milled to size. This will save you much filing and assure you a square block. Lay out the cylinders and mount the block in the four-jaw chuck for boring in the lathe.

No matter how carefully you bore the cylinders, they'll differ slightly in diameter, so make the pistons fit the individual cylinders and mark them. Turn the pistons from 3/4" steel rod, and bore them hollow as shown. Drill through the walls for the 1/8" wrist pins.

Turn the connecting rods from 3/16" square steel bar. Shoulder the lower end of each rod and thread it ±2-56 to join it to its bronze end bearing. Assemble the con-rod bearings before drilling and reaming them to fit the crankshaft throws. Then mount each bearing in the four-jaw chuck and turn a round neck to the diameter of the connecting rod. Drill and tap ±2-56 to receive the threaded rod end.

Cylinder head. Fit a block of 5/8"-thick aluminum to the top of the cylinder block. Fasten it in place with six ±6-32 head bolts turned from 11/4" lengths of 1/4" steel hexagon rod. Drill and ream a 5/16" hole through the longitudinal center line of the head and press a length of 5/16" o.d. brass tubing into it to line the hole. Ream the inside of the sleeve 1/4". Press a length of 1/4" dowel in the sleeve to keep the drill bit from deflecting, and drill the holes for the inlet and exhaust ports. Note that the vertical inlet ports are drilled off center to minimize the degree of valve rotation required to admit and exhaust steam.

Valve linkage must be installed before
MAIN-ROD ASSEMBLIES, with pistons installed, can be fitted to crankpins before cylinder block is added. If too free, shim bearing end caps with thinner paper. Check, too, for binding.

How the rotary valve works

WHEN LINKAGE is at top dead center, No. 1 inlet port is open, piston is on way down. No. 2 piston, halfway up, forces steam out.

AT BOTTOM DEAD CENTER, No. 1 piston is halfway up and exhaust port is open. No. 2 inlet port is open, admitting steam to piston.
filing the port passages in the valve rod. Make the valve crank from a short piece of \(\frac{5}{8}\)" steel rod. Turn the hub and mount it 5/32" off center in the four-jaw chuck. Turn a \(\frac{1}{8}\)" crankpin on the face, leaving a flange about 1/16" thick. The lower linkage rod can be cut from 3/16" brass, then chucked and turned round. The center hole used to support the small end while turning the rod will later be used as an oil hole. Drill and ream the large end \(\frac{1}{8}\)" to fit the pin on the valve crank.

An idler arm between the linkage rods more than doubles the short throw of the valve crank. Turn the arm from 3/16" square steel rod. Drill and ream a \(\frac{1}{8}\)" hole on one end to pivot on a brass bushing and file a clevis on the other end. A steel block bolted to the end of the cylinder base supports it.

The upper rod can be turned from \(\frac{1}{4}\)" brass rod. File its bottom end flat and drill a 1/16" hole for the idler-arm clevis pin. File a clevis in the rod's top end to receive the short pin that connects it to the valve rod. Drill a \(\frac{1}{8}\)" hole \(\frac{1}{4}\)" in from the end of the valve rod for the end of the connecting pin, and install an Allen setscrew in the rod end to lock it and permit slight adjustment. Turn two \(\frac{1}{8}\)" collars to fit on both ends of the valve rod and hold the rod in position.

**Port passages** in the rotary valve must be shaped by the file-and-try method. Lay out the passages at top and bottom dead center as illustrated; then file the passages in the valve, trying it frequently until it uncovers correctly at top and bottom dead center.

Machine the parts for the inlet manifold and join them with hard solder. Simple flanged tubes are used to exhaust steam. In a model, rubber tubing can be slipped on the exhaust tubes to carry the condensing steam overboard or to the stack on the boiler. Drill and tap \(\pm 2-56\) holes in the cylinder head to match the clearance holes drilled in the flanges of the exhaust tubes and fasten the manifold and tubes in position. Cut kraft-paper gaskets to fit under the head and manifold, and fasten them on.

Pour some diluted silver polish or toothpaste into the cylinders and rotate the crankshaft by hand to lap the pistons to a smooth fit. Wash out the polish and oil all the parts. Then hook the engine to the boiler for the test run.

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**INLET MANIFOLD** is fastened to top of cylinder head with \(\pm 2-56\) machine screws. Gasket cut from oiled brown paper seals flanges against leaking. Simple flanged tube on each side of the cylinder head covers the exhaust ports.

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**ROTARY VALVE** reciprocates in an arc of less than 45 degrees to pass steam in and out of the cylinders through notches filed in line with inlet and exhaust ports. Collars locked on ends of the valve hold it in alignment.

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**TO LAY OUT PASSAGES** in rotary valve, insert scriber in No. 1 inlet port and No. 2 exhaust port with valve crank set at top dead center. Rotate crank to bottom dead center and mark valve through No. 1 exhaust port and No. 2 inlet port. File notches to shape indicated by dotted line, and try the valve frequently until the ports uncover, as illustrated here.