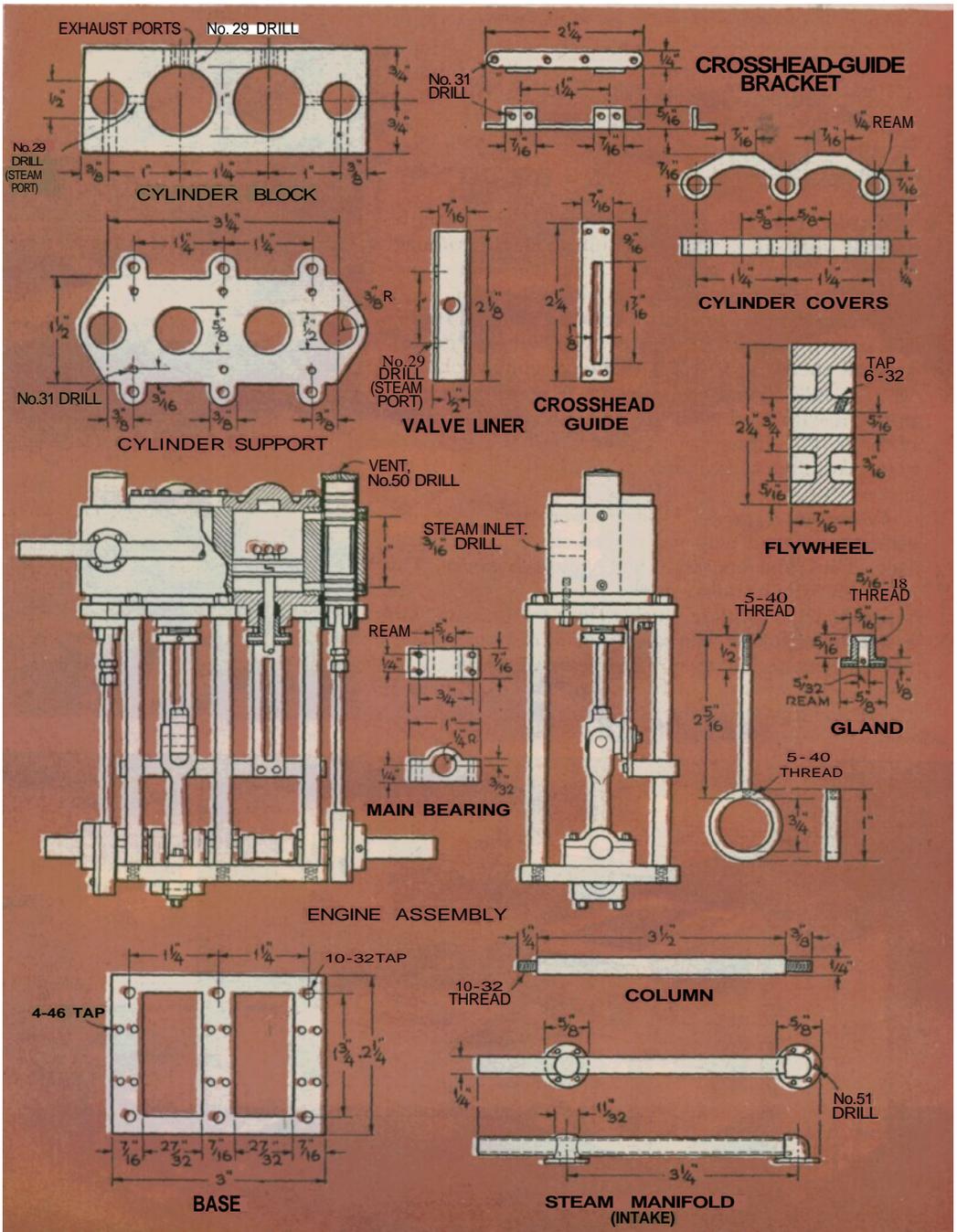
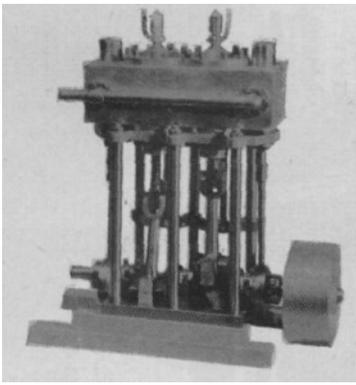


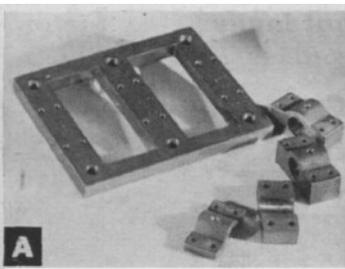
Model Marine Engine

Requires No Castings

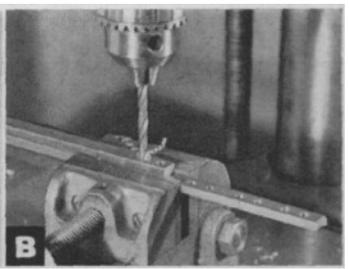




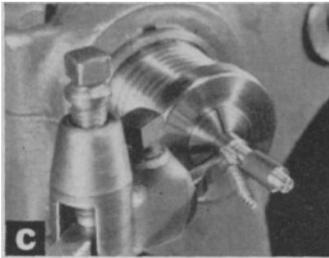
Here are the 26 steps in the construction of the engine.



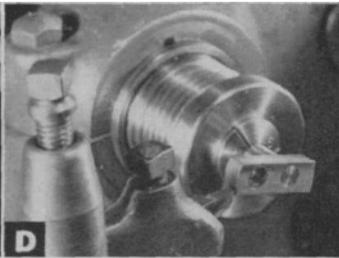
Base and main bearings. Brass base plate, $\frac{1}{4}$ " thick, is cut out for two crankcase wells. Large holes, tapped 10-32, are for supporting columns; small holes, tapped 4-48, are for bearings. Main bearings are two pieces of $\frac{1}{4}$ " brass soldered together for machining, then unsoldered to form upper and lower sections.



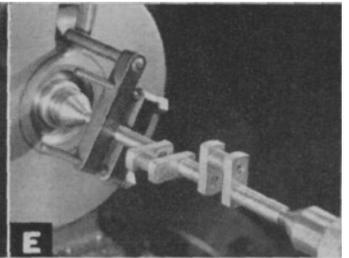
Crankshaft webs are cut from steel bar stock, .188 by .375. Shaft holes are drilled .437 apart, using jig to assure uniform spacing. After drilling, the webs are cut off, stacked in a drill-press vise and reamed to make absolutely certain holes are spaced right. Ends of webs are machined later in the lathe.



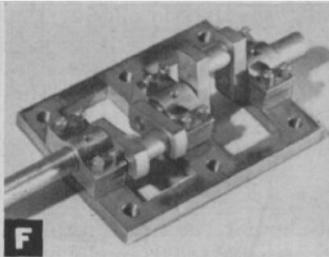
Crankpins and crankshaft ends are made from .312 drill rod. Turn both ends of the pins and the inner end of the shaft sections .002" oversize for a force fit in the .188 reamed holes in the webs. As no truing cut is made on the crankpin surfaces, the drill rod should be held in a collet or indicated true.



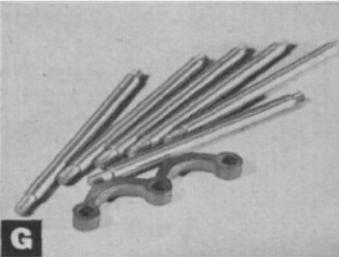
Web ends are finished and brought to dimension in the lathe. As each web is forced onto a shaft or crankpin section, it is chucked and turned to an .687 radius from the center of the far hole. It is not necessary to pin the force-fitted webs to the shaft, but driving pins in undersize holes is extra insurance.



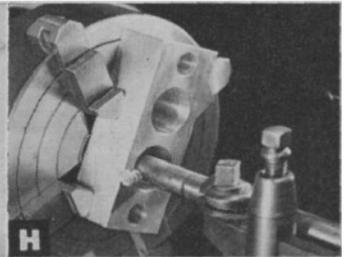
Completed crankshaft is set up between centers and tested for accurate alignment. Crankpins are set at 90° , giving shaft a smooth-running quality with four evenly spaced impulses to each revolution. This allows it to run without a flywheel, although performance is improved if one is used. Chances of stalling are also lessened.



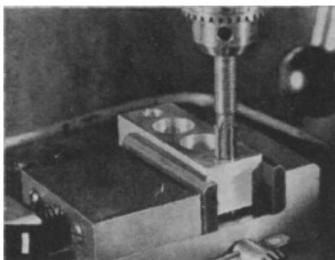
All set up. Prior to installing crankshaft, main bearings are aligned by slipping them on a straight piece of .312 drill rod and clamping in position. Holes are thru drilled in base for mounting screws. All hex-head screws are turned from .125" steel hexagon rod and threaded 4-48. Corners of hex heads are rounded and polished.



Crosshead-guide support, shown with columns, is cut from $\frac{1}{4}$ " brass plate. Three holes are drilled first, using the base as a spacing jig, and then layout of shape is made, using holes as reference points. Columns are $\frac{1}{4}$ " drill rod cut to length, shouldered for $\frac{1}{4}$ " at bottom, .375" at top and threaded 10-32 at both ends.



Cylinder block is solid chunk of brass or bronze. Lay out centers for cylinders and valve-insert holes and bore out 1"-dia. cylinders in lathe. Make final pass with a honed, round-nose boring bit fed slowly for maximum smoothness. Cylinder is lapped with Noxon silver polish after assembly, then washed and oiled.



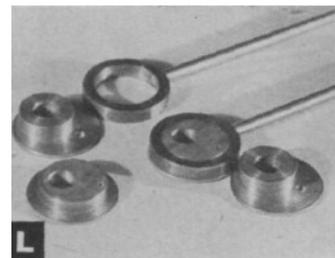
Valve-insert holes are reamed $\frac{1}{2}$ ". Intake and exhaust ports are drilled. Valve liners— $\frac{1}{2}$ " brass tubing—are drilled in one wall. Liners are then turned 180° to line up holes with ports and locked with setscrews in block end. Steam-inlet holes are drilled through block and one wall of liner from front of block.



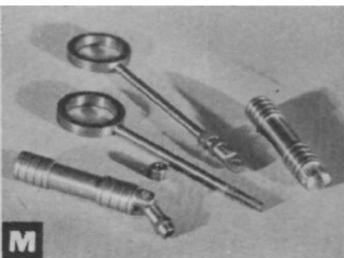
Cylinder covers are turned from $1\frac{1}{2}$ " brass rod. Inside face of upper and lower covers are turned to a snap fit in cylinder bore, using cylinder as gauge. Then they are cut off, reversed in the chuck and finished. Piston-rod packing-gland hole should be drilled and tapped in lower cover before cutting off.



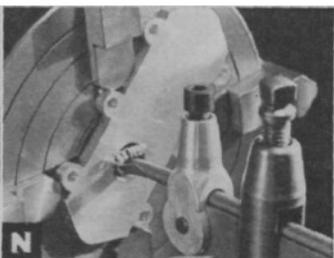
Packing glands (at right in photo above), are turned from .625 brass rod and threaded to fit lower cylinder cover. Gland is drilled and reamed .156 for piston rod and upper end of hole is counterbored for packing. Four .063 holes in flange are for adjusting pin to tighten flange on graphite packing.



Valve eccentrics are made in two parts and joined by a single setscrew. The body or bearing was turned in the three-jaw chuck; the cover plate with off-center collar, in four-jaw chuck. The collar is drilled in the lathe, then used as a jig to locate the hole in the body. Straps are thick-wall tubing of proper inside diameter.



Piston valves, turned from mild steel, should be perfect fit in valve liners. Oil grooves are cut with V-shaped cutter bit. Lower ends are slotted and drilled for adjusting eyes, which are threaded onto eccentric rod and held in proper adjustment by lock nuts. Rods are threaded into eccentric straps.



Cylinder-block support is cut from .188 brass plate. Holes for supporting columns must match those in base. Support is chucked in lathe and bored to receive the .375 collars of the lower cylinder covers. Six No. 38 holes for the screws that join plate to underside of block are then drilled according to the layout.

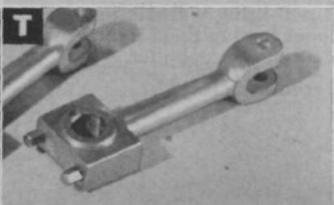
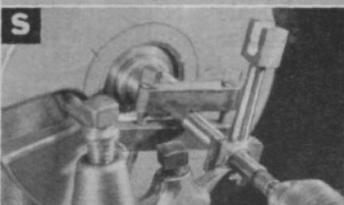
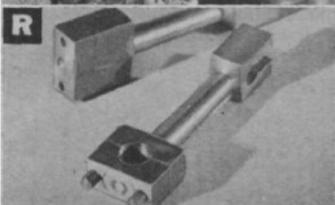
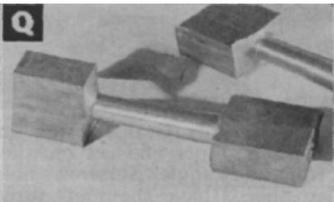
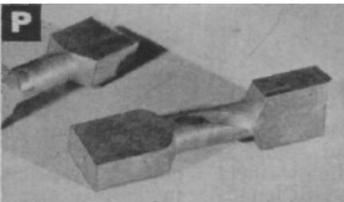
Connecting rods, developed from lengths of steel bar stock, are made in successive stages:

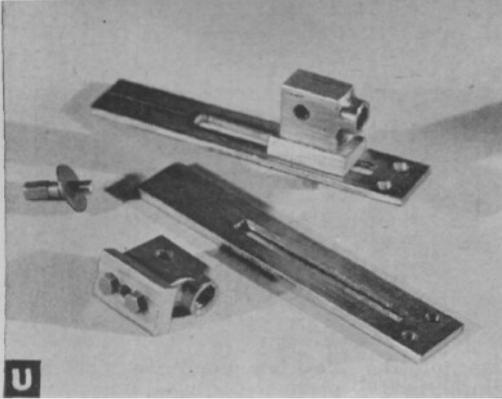
(O) The steel bar is centered in the four-jaw chuck, centerdrilled at the free end, and supported by the tailstock center while the middle section is rough-turned. (P) The big end is then clamped in a vise, the rod heated almost white hot and the small end bent at right angles to the big end. (Q) When cool, it is set up in the lathe again and turned to finished size. (R) The little end is then cut out and filed to shape and the big

end drilled for the two bearing-cap screws. The bearing cap is cut off the big end, the meeting surfaces smoothed, and then joined with the two cap screws.

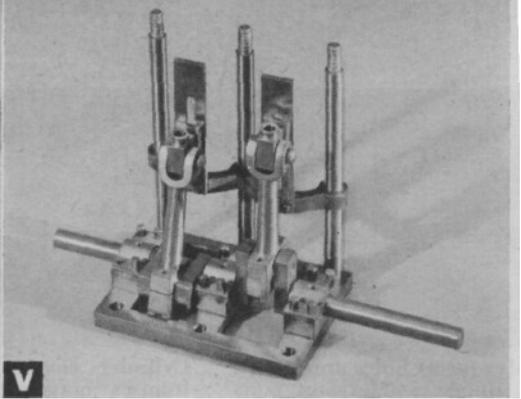
The crankpin hole is then drilled and reamed .312. (S) The big end is clamped on a mandrel and turned to shape, and the little end is drilled for a .125 rivet that links it to the crosshead. (T) The finished con rod looks like this after machining.

Turn the page for the six final steps.

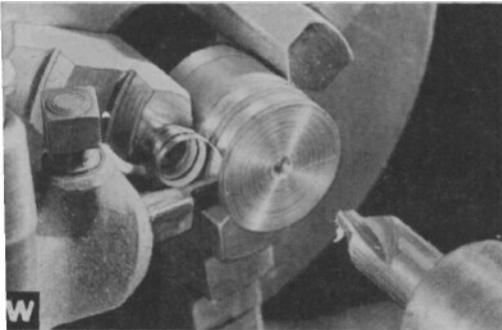




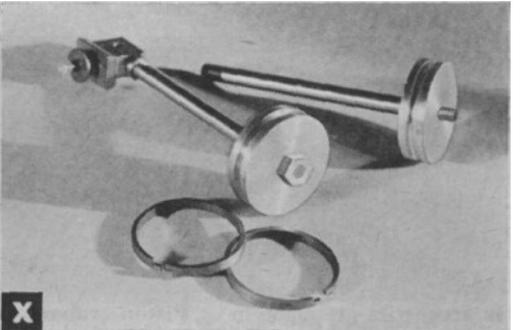
U **Crossheads** are shaped from 1/4" brass and a slipper of .063" brass is soldered on foot. Any error in the crosshead-guide support can be made up by altering the thickness of the slipper plate. The heads of two hex-head screws ride in slotted crosshead guide; setscrew and washer hold assembly together.



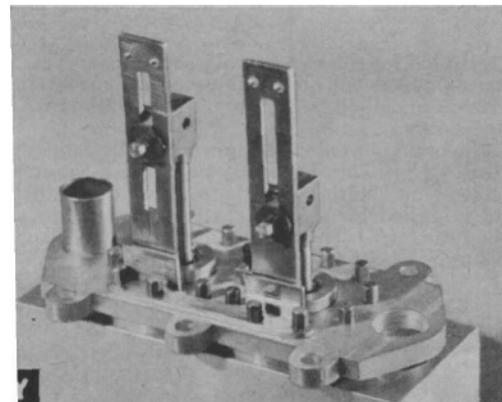
V **Trial setup.** Smooth action of moving parts is checked by setting up lower half of engine and rotating crankshaft by hand. Crosshead-guide support should be placed in proper position on columns to check crosshead travel in slot. Upper ends of guides are later supported by bracket on upper assembly.



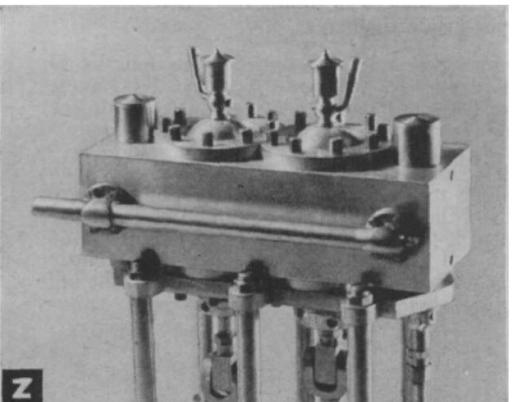
W **Pistons** are turned from brass or dural rod to an easy fit in the cylinders. Parting tool is used to cut groove for piston ring. Center of piston is drilled and tapped for 6-32 thread on upper end of piston rod. Piston is then faced, cut off and reversed in the chuck for facing opposite end and bringing to dimension.



X **Cast-iron piston rings**, of standard 1" size, are purchased commercially and fitted to pistons. Lower end of piston rod is threaded 6-32 to fit in crosshead. Lock nut is tightened against top side of piston after upper end of rod is threaded into center hole to prevent piston from working loose on piston-rod threads.



Z **Upper assembly is tested** for smooth action, bracket for upper ends of crosshead guides is cut from brass angle. Setscrews holding washers to crossheads have shoulders turned to length that will bring washers up against slotted guide without forcing them tight. Setscrews join cylinder support to cylinder.



Z **Petcocks** on cylinder covers are dummies but could be drilled and used as gravity-feed oil cups. A displacement oiler should be fitted for model-boat use. Caps for valve liners are drilled No. 50 to vent space above valves; they are turned to a snap fit. Intake manifold is 1/4" tubing soldered into turned fittings. **END**