

HOW TO BUILD A MODEL

Air-Cooled Hot-Air Engine



By Harry Walton

JUST 15 seconds after you light up, this little engine chugs into action. It will keep going as long as it has fuel—at a lively 1,000 r.p.m. running light, or plugging away hard under any load short of stalling it.

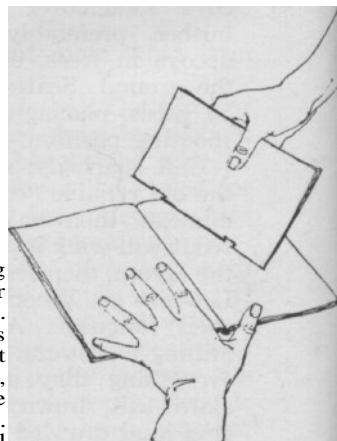
You'll fire it up to mystify friends or just to see it go. Its rocker-arm action is fascinating to watch.

Dating back to 1816, the hot-air engine is also one of the latest subjects of research. It could be fueled by nuclear heat, and a highly sophisticated design, to be powered by solar heat, is proposed for generating electricity aboard space satellites.

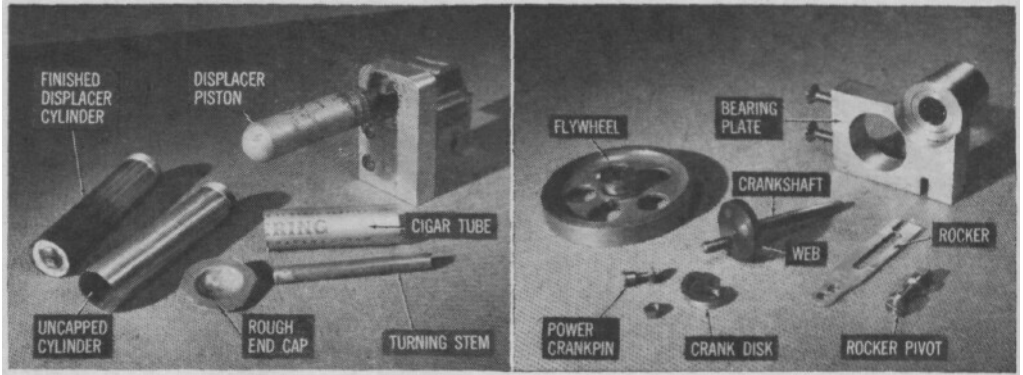
This simple one, fueled by alcohol, will drive small models, pump water, spin a display turntable, or turn a fan. It requires no castings, and involves some interesting but not difficult lathe work. Fun to build and operate, it's a conversation piece for your den or workshop, or a safe but exciting gift for any youngster who can be trusted with matches.

A FREE PS Save-It Blueprint

Save the following four pages for your personal project file. Pinch the blue sheets together, gently lift from the magazine, and tear them loose from the two staples. The blueprint will then lie flat for use.



Steps in machining the parts for the air-cooled hot-air engine



ALTHOUGH not hard to build, this engine won't forgive bad workmanship. Mechanical freedom and airtightness are essential. It should both turn easily and bounce back against compression. Metallic auto-body putty, thinned with lacquer thinner, should be used on all joints to seal against pinhole leaks.

The frame. This is two pieces of 1/2" dural bolted together. Lay out the cylinder standard first. Transfer the center of the upper (displacer) recess to the opposite face by drilling it through No. 60.

In the four-jaw chuck, first center the lower (power-cylinder) recess. Bore it 1/4" deep and .044" smaller than the outside cylinder diameter; then thread it 40 threads per inch. Reverse the work with the displacer recess centered. Bore this also undersize by double the thread depth, and 5/16" deep. It will overlap and break through the other recess, the hole forming the transfer port.

If your lathe doesn't cut threads, both recesses may be smooth-bored, the cylinders turned to push fits, and seated with auto-body putty.

With the standard still chucked, drill and countersink for the 1/4"-20 brass bolt that forms the gland. Insert the bolt with a smear of sealer under its head, and tighten a nut on the other side. Do not remove the piece from the chuck to do this; unscrew the chuck from the lathe if necessary.

Remount it to centerdrill the bolt head. Run a No. 43 drill through. Follow with a new No. 42 or a 3/32" reamer to make

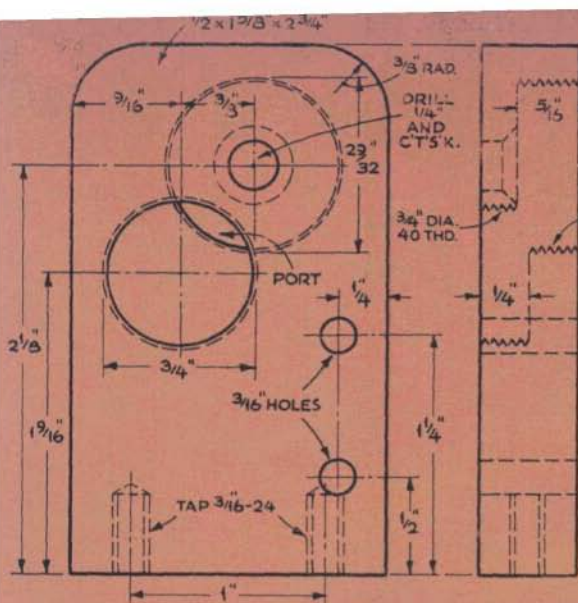
a free-sliding, absolutely shakeless fit for the displacer-piston rod. A reamer can be made from a piece of the rod stock by filing a long flat taper on it and stoning the flat smooth.

Bearing plate and housing. Clamp the plate to the standard with bottom and side flush. Spot holes to be tapped by running a drill through those in the standard. In the lathe, turn out the 3/16" deep step or shoulder; then bore through to 3/4" diameter. The 1" hole is for appearance only, and optional. Saw and file the top radius to shape and the slot in line with the bearing center.

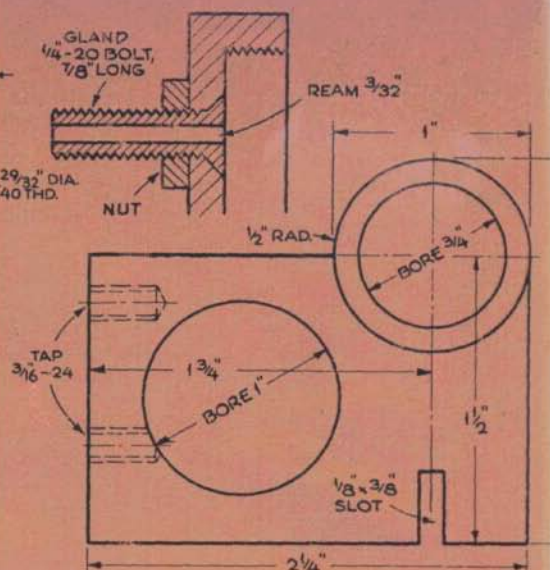
For the bearing housing, chuck 1" aluminum and turn the shoulder to a press fit in the plate. Drill the through hole; then bore for the inboard ball bearing. Reverse the piece, centering it carefully, and bore the seat for the outboard bearing. If you prefer a plain brass or bronze sleeve bearing, drill an oil hole after pressing it in. Press the housing carefully into the bearing plate so that the shoulder seats squarely. Do not push in the ball bearings as yet.

Displacer cylinder and piston. As air must be alternately heated and cooled in the cylinder at every revolution, it must be thin-walled. Twist 1" steel conduit onto a tight-fitting arbor centerdrilled for tailstock support. Turn the outside to leave a wall about .010" thick up to 1/4" of one end. Thread this end to fit the recess and cut to 3 1/2" length.

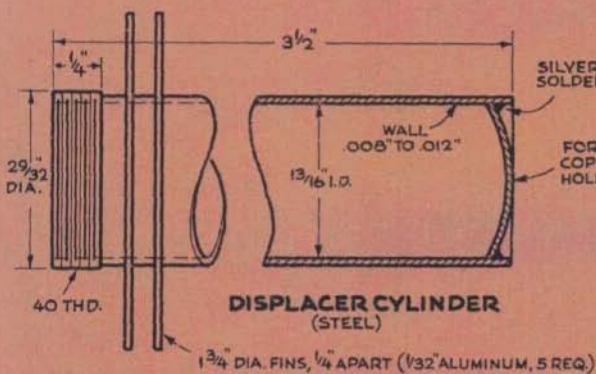
Silver-solder or braze a domed copper cap into the unthreaded end. Test for air



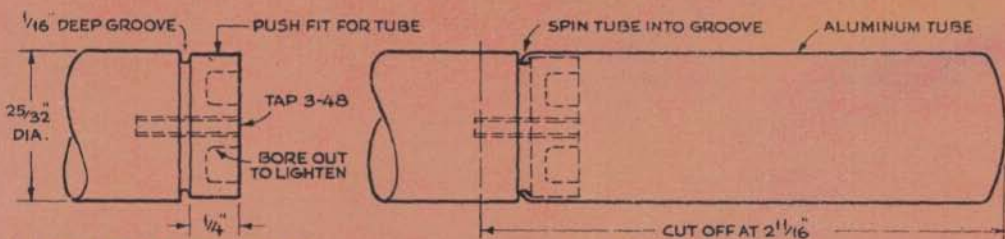
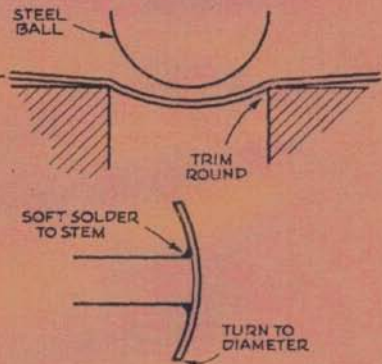
CYLINDER STANDARD ($\frac{1}{2}$ DURAL)



BEARING PLATE
($\frac{1}{2}$ DURAL)

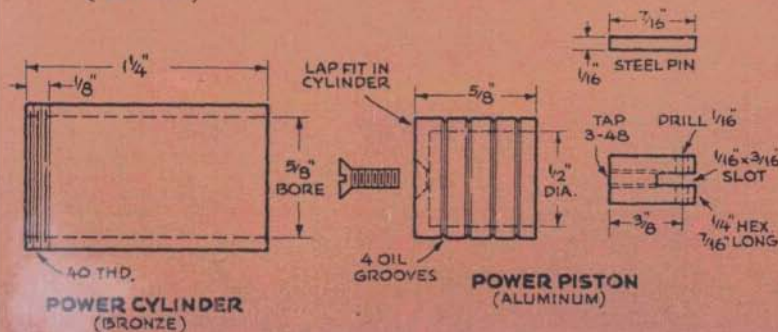


DISPLACER CYLINDER
(STEEL)



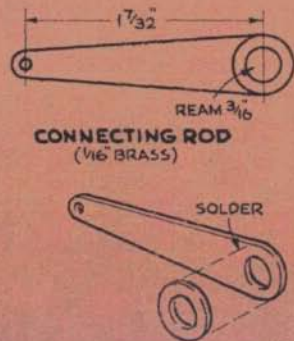
DISPLACER-PISTON HEAD
(ALUMINUM)

DISPLACER PISTON

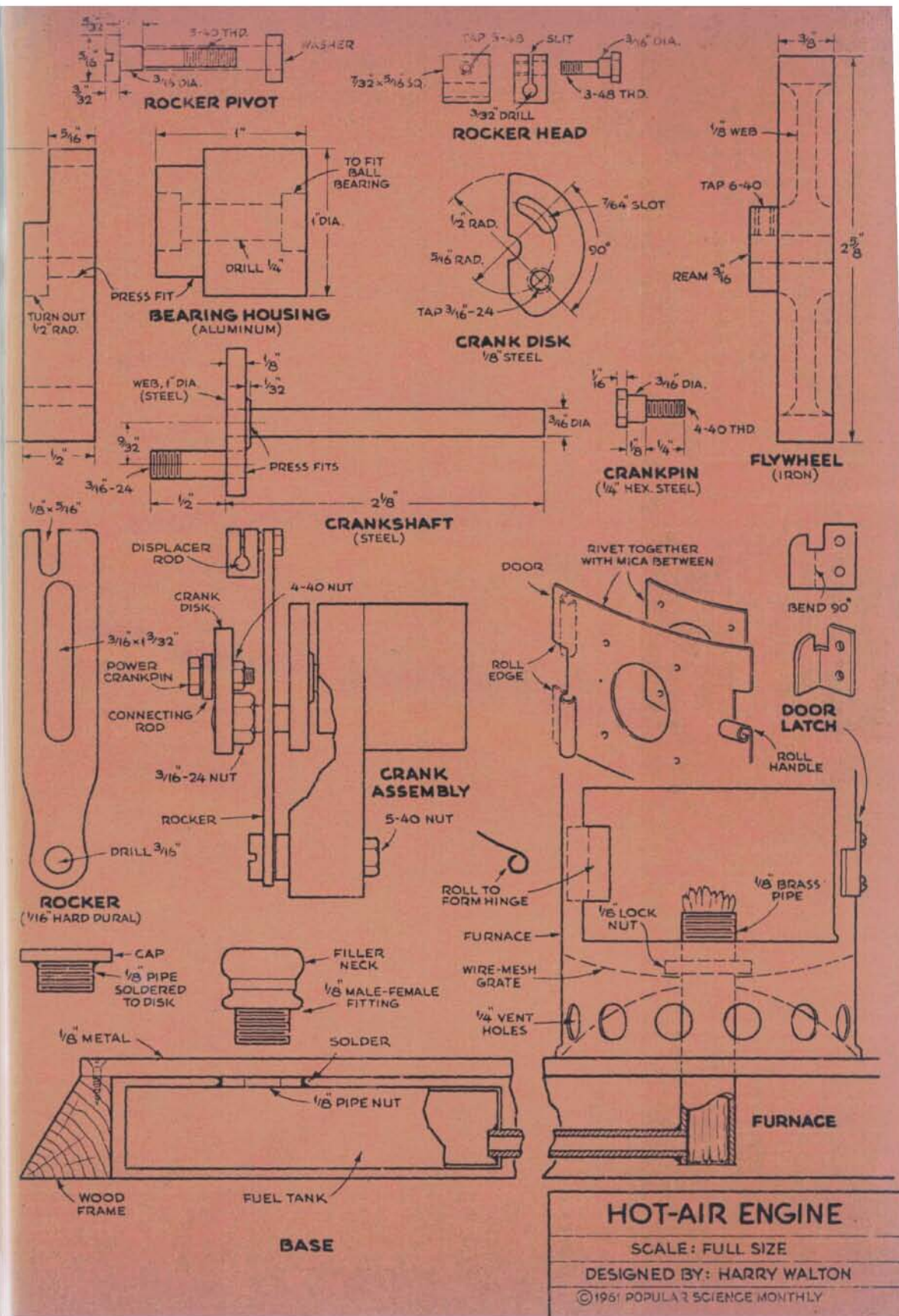


POWER CYLINDER
(BRONZE)

POWER PISTON
(ALUMINUM)



CONNECTING ROD
($\frac{1}{16}$ BRASS)



HOT-AIR ENGINE

SCALE: FULL SIZE

DESIGNED BY: HARRY WALTON

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leaks by blowing into the other end with the joint under water.

The displacer piston must be light, airtight, and a loose fit to let air flow around it. An aluminum cigar tube is the right size and has a domed end.

Chuck a piece of aluminum bar; turn to 25/32", centerdrill, and tap for the rod. Recess the end to lighten it; then turn a 1/4" length to a close push fit for the tube with a shallow groove at the end of it. Push the tube on to run true. Feed a round-nose tool, mounted upside down, against the groove to spin the edge of the tubing in. Apply a coat of sealer around the spun joint.

Thread the displacer rod in the lathe to insure getting the threads square (a die held against a tailstock pad will do). Smear a little sealer on the threads before screwing the rod in.

Power cylinder and piston. A bronze bearing bushing makes a good cylinder. Lap the inside smooth, if necessary, with fine abrasive cloth in a slotted dowel. Thread one end to fit the recess, and chamfer the bore at the other for insertion of the piston.

Bore out the inside of the power piston, then twist onto an arbor. Turn the outside to a virtually airtight fit in the cylinder. Final fitting may be done by honing with a fine stone, abrasive cloth on a metal block, or a split lap. Lightly oiled, the piston should strongly resist being pulled out of the cylinder when the other end is held shut. Pushed in, the piston should act as if there is a spring behind it, rebounding vigorously against compression, and hold this air cushion for several seconds.

Insert the displacer rod and mount both cylinders. The displacer must slide full length without rubbing. Submerge the assembly in water past the gland. Pushing in the power piston will cause bubbles to reveal any air leaks. Only one or two slow bubbles from around the displacer rod are permissible.

Crankshaft and crank assembly. Turn a narrow thrust shoulder on the web and drill to a press fit on the shaft. Make sure the main crankpin is absolutely parallel to the shaft. Drive the inboard ball bearing on the shaft, insert it in the housing, and press the outer bearing into place.

Always apply driving pressure to the race being seated, not through the balls.

Now you're ready for the crank assembly. Adjust displacer stroke by moving the rocker pivot up or down in the slot; fix the rocker head to move the displacer full length without hitting at either end. Screw on the crank disk, locking it, by the jam nut, concentric with the crank web. The engine shown runs clockwise as seen from the crank end; to reverse rotation, turn the crank disk over. Push the power crankpin through the con rod and tighten its nut at the center of the slot.

Cooling fins. These are necessary for steady running. They can be cut from sheet aluminum with a fly cutter, then chucked and bored to an interference fit on the cylinder. Lay them on a plate heated by a torch or stove burner (not too high, or the aluminum will melt). Pick up a hot fin with pliers, quickly slide it into position, and let it cool.

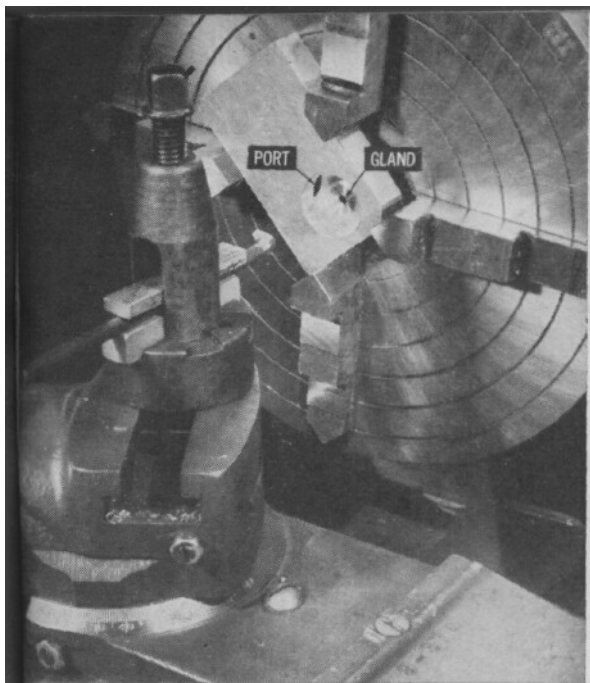
Base and lamp. Frame a metal plate with 3/4"-high strips of wood or metal channel. Mount the engine with two 3/16" bolts screwed into the standard. A shallow fuel tank may be soldered up of tin-plate. A tube carries alcohol to the burner, a piece of 1/8" pipe (3/8" o.d.) with wicking. Add a wire-screen grate for burning matchsticks or charcoal.

Furnace. A taper-necked beverage can makes a good one. Punch a hole in the domed bottom for the wick tube. Cut an opening for the displacer cylinder and a firedoor as shown. Drill air holes around the bottom.

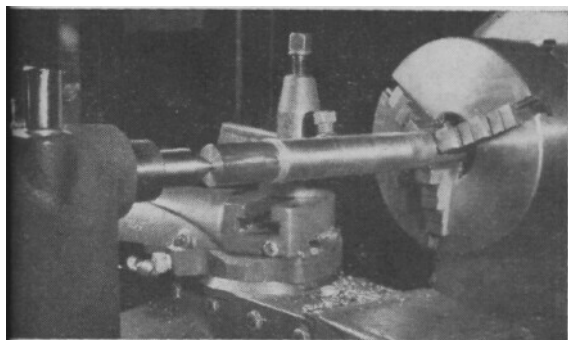
Flywheel. This should be of moderate weight and of a size to clear the base, but is otherwise not critical. It may have a pulley for a spring belt.

Timing. The crankpin slot permits shifting the power stroke slightly to both sides of its normal 90-degree position behind the displacer stroke. To check timing, run the engine and then blow out the flame. Running should continue with an even beat on both in and out strokes, right down to a tick-over.

If the engine doesn't run, check for binding and air leaks. Sometimes a leaky displacer piston is at fault. Remove it from the engine and plunge it into very hot water. Bubbles will show leaks.



BORE CYLINDER STANDARD from both sides, the power-cylinder recess first. The recess for the displacer cylinder breaks through as above, leaving an open port between the cylinders. Be sure to drill and ream the displacer-rod gland (arrow) at the same chucking.



TURN STEEL CONDUIT on an arbor to make the thin-walled displacer cylinder. A short end section (left of toolpost) is left thick and threaded to screw into the cylinder standard.

HINGED FIREDOOR has a mica window. Alcohol is the best fuel, but a fly-screen grate makes it possible to burn wood. Engine starts cold, runs half a minute on three paper matches.

