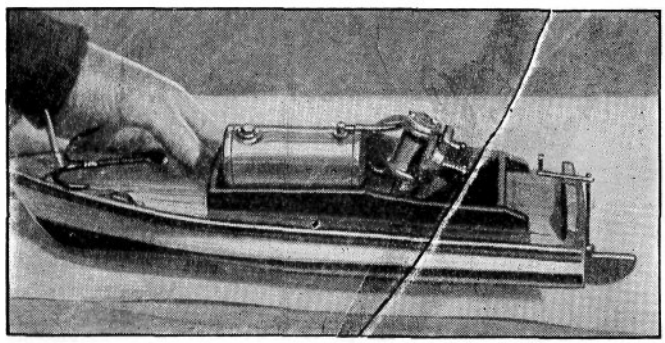
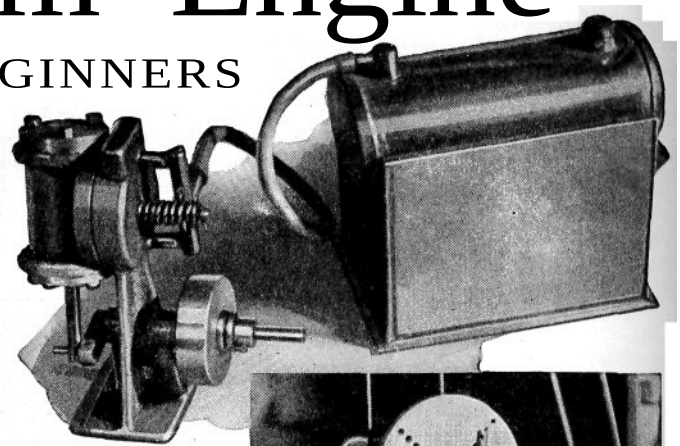
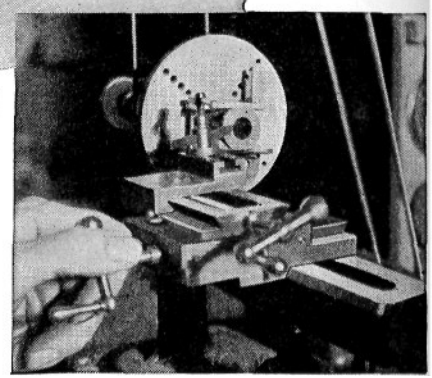
Model Steam Engine

SIMPLIFIED FOR BEGINNERS

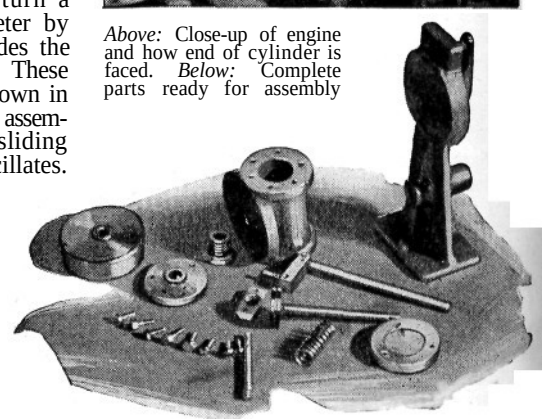


The finished engine and a small boiler installed in a model boat 18 in. long. The engine itself is only a trifle over 3 in. high





Above: Close-up of engine and how end of cylinder is faced. *Below:* Complete parts ready for assembly



Can be built without a lathe if necessary, and without castings if you have brazing equipment

THIS model steam engine has been designed as a miniature power unit that can be built with the facilities of an ordinary home workshop. As built originally, it calls for a lathe and castings, but as explained later, it can be built up from stock materials, and with nothing more elaborate than ordinary hand tools.

The engine stands a little over 3 in. high, has a base of 1 by 1½ in., a bore of ½ in., and a stroke of ¾ in. It will operate satisfactorily on either a pot or a flash boiler and has sufficient power to drive a fair-sized model boat.

The base and cylinder are brass or bronze castings, which any brass foundry should supply from your patterns at a very moderate cost. White pine or mahogany may be used in making the patterns, with fillets of wax. Allow 1/16 in. for machining on surfaces that are to be finished.

To make the cylinder pattern, turn the cylinder from solid stock. Then turn a disk of wood 1 5/16 in. in diameter by ¼ in. thick. (This thickness includes the 1/16-in. allowance for machining.) These two pieces are fitted together as shown in the drawing of the finished cylinder assembly. The 1 5/16-in. disk forms the sliding surface on which the cylinder oscillates.

The pattern for the engine base and frame can be built up of several pieces and filleted with wax.

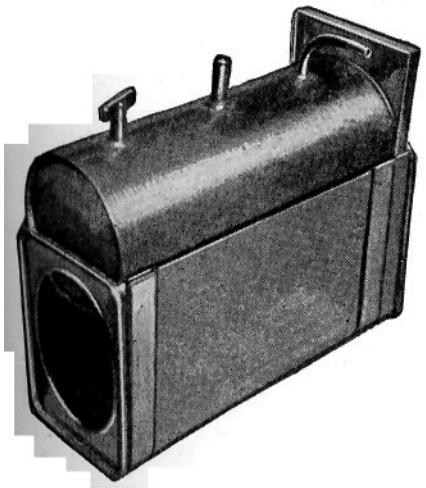
The cylinder may be cast solid and drilled out to 3/8 in. on a power drill press, then bored to finished size on the lathe, or core prints may be put on the pattern and the casting made with a 3/8-

in. core. Having obtained your castings, proceed as follows:

Cylinder. Mount in four-jaw chuck or on angle plate bolted to faceplate as shown so that center line of cylinder bore is in line with lathe centers. Face off one end of cylinder. The casting may then be turned end for end. If the finished end is butted against face of chuck, the opposite end will be parallel and can be faced off.

To finish surface of disk that forms back of cylinder assembly, the casting may be mounted in the four-jaw chuck or on an angle plate fastened to the faceplate. The second method is preferable. If the angle plate is used, placing one finished end of cylinder on it will insure that cylinder is at right angles to lathe bed. It is then necessary only to adjust the casting until surface of disk to be finished is at right angles to a line between lathe centers. This can be done by mounting a scriber in tool post.

After surface of disk has been finished flat, take a 1/32-in. cut across the center, leaving a 3/16-in. rim at edge to reduce bearing.



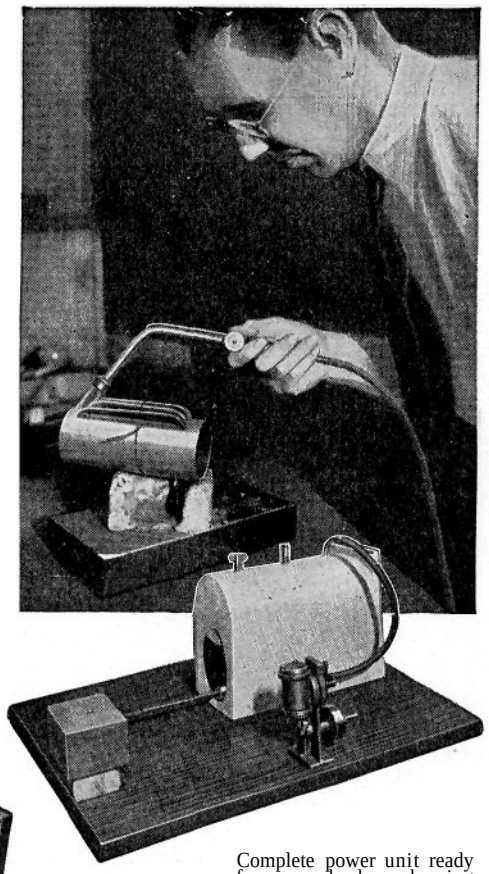
The boiler and cocoa-can housing assembled preparatory to covering them with asbestos

To bore cylinder, mount it on an angle plate with one finished end flat against the surface of faceplate. Adjust until a line between lathe centers coincides with center line of cylinder bore. With boring tool, bore cylinder to finished size. The last cut should be fine, with a slow feed. The cylinder will be lapped in after piston has been made.

Drill steam ports as shown. Holes for cylinder-head bolts may be drilled and tapped to suit your convenience. Use 0-80 hexagon-head machine screws if you can get them. Cylinder heads may be of 1/8-in. sheet brass.

For the stuffing box, thread a piece of brass rod ¼ in. in diameter. Turn it into a threaded hole in center of lower cylinder head and cut off to required length. Then drill a 1/8-in. hole through center for piston rod. This hole should be drilled a trifle undersize and finished with a 1/8-in. straight reamer. The stuffing-box cap can be made from a piece of ½-in. round brass stock.

Base and Frame. File bottom of base flat. Mount on faceplate. Block up until



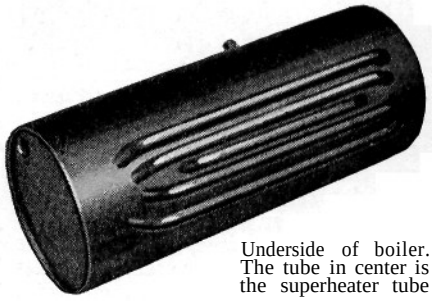
Complete power unit ready for use and, above, brazing the tubes with silver solder

circular portion at top, against which cylinder oscillates, is at right angles to lathe bed with its center coinciding with a line between lathe centers. Turn this face flat, then recess the center portion like disk at back of cylinder. While casting is still in position, drill a 1/8-in. hole through center of this circular portion for bearing bolt that supports cylinder.

By turning lathe at slow speed and taking light cuts, the front end of shaft bearing can be faced off at this time. Change position of casting so that shaft bearing is in line with the lathe centers. Using a surface gage resting on lathe bed, adjust so that the disk surface just finished is at right angles to line between lathe centers. Using chuck in tailstock, drill and ream shaft bearing with a 1/8-in. hole. Reverse casting and square off other end of shaft bearing. Drill steam ports with hand drill or drill press. (The photos show a rectangular piece at top originally intended for attaching an exhaust stack, but found unnecessary and therefore omitted from the drawings.)

Piston. Turn from steel rod. The shaft is 1/8-in. drill rod or cold-rolled steel, threaded at one end and screwed into a hole tapped in center of piston. If cylinder is carefully bored and piston is lapped in, no piston ring is necessary. The groove in piston will hold oil and prevent undue leakage. If desired, however, a split ring can be made.

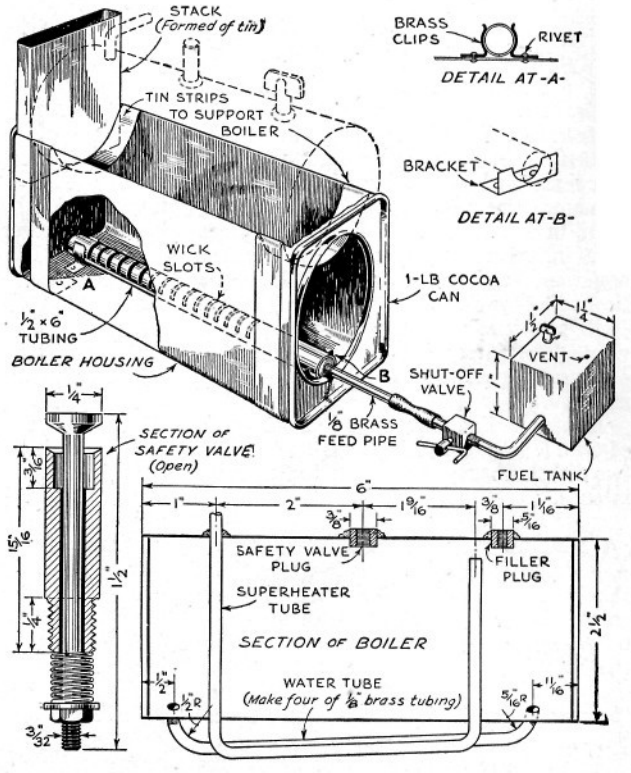
Crankshaft. Build up from 1/8-in. cold-rolled steel.



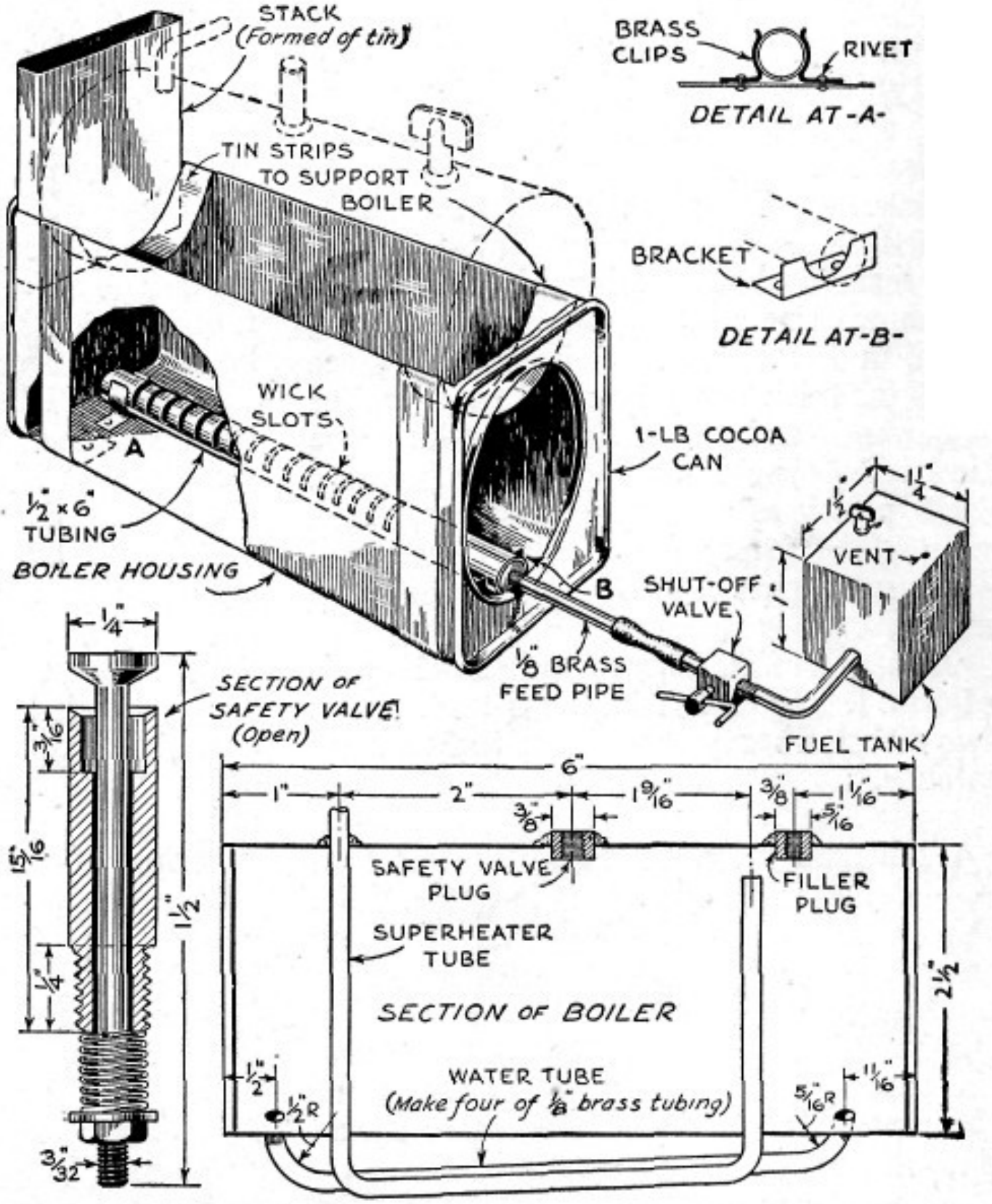
Underside of boiler. The tube in center is the superheater tube

Assembly. The cylinder is held against engine frame by a 1/8-in. bearing stud, screwed into a hole tapped in rear of cylinder. A coil spring holds cylinder against frame. The tension should insure a close fit, but should not interfere with free oscillation of the cylinder. Cylinder and engine-frame surfaces should be lapped together with fine valve-grinding compound. The piston should also be carefully lapped into the cylinder. The flywheel is turned from brass and keyed to shaft, or may be a driving fit.

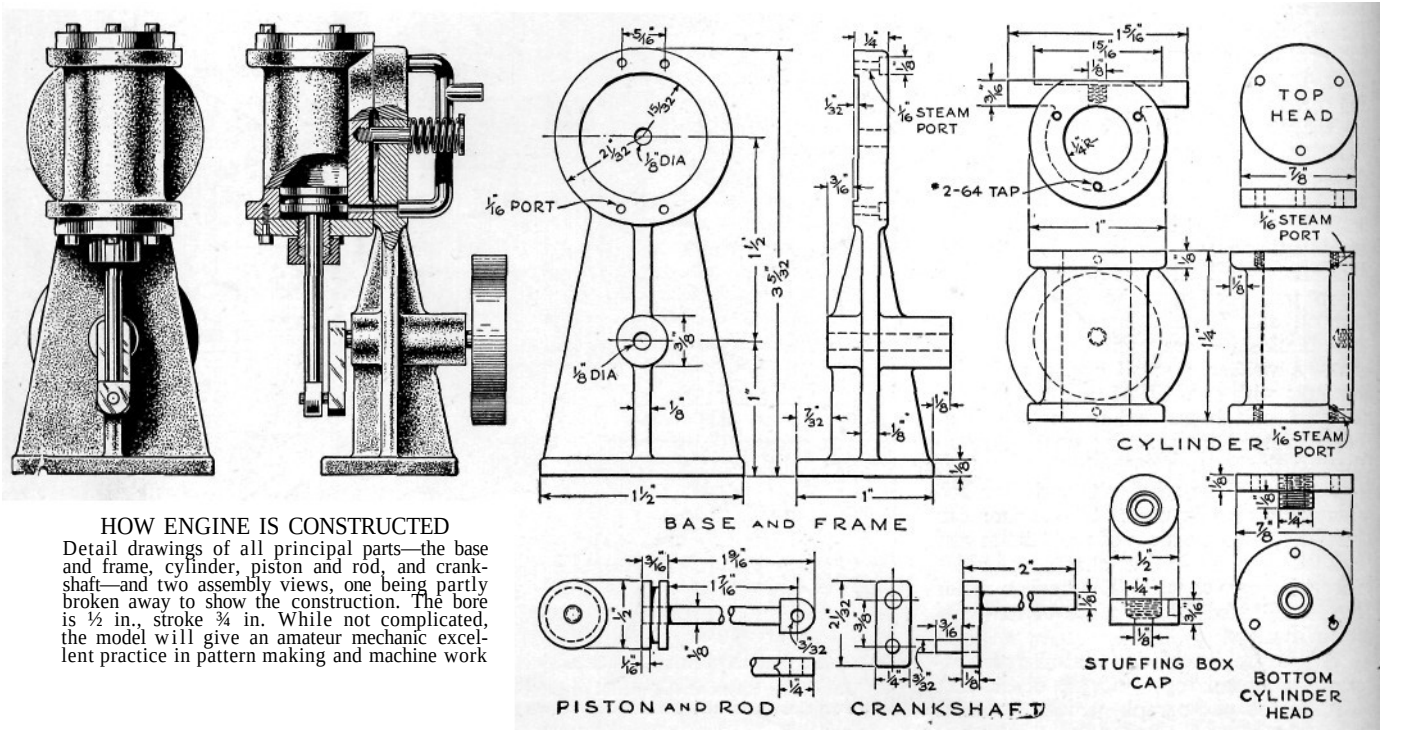
Alternative Construction. By making a few changes in design, it is possible to construct an engine of this type without a lathe. The cylinder may be made from a piece of heavy brass tubing or from a brass bushing of suitable size and bore. A disk of heavy brass can be sweated to one side and filed flat. Then the surface should be



The general set-up, sectional drawing of boiler, and the safety valve

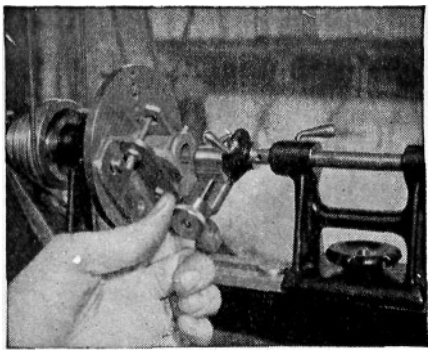


The general set-up, sectional drawing of boiler, and the safety valve.



HOW ENGINE IS CONSTRUCTED

Detail drawings of all principal parts—the base and frame, cylinder, piston and rod, and crankshaft—and two assembly views, one being partly broken away to show the construction. The bore is ½ in., stroke ¾ in. While not complicated, the model will give an amateur mechanic excellent practice in pattern making and machine work



Boring cylinder with small boring attachment

scraped down so that only a small area around the steam ports is in contact with the bearing surface of the engine frame. Other surfaces can be filed smooth. In finishing the engine frame, file the surface against which the cylinder oscillates as flat as possible; then scrape down all but a small area around the steam ports.

IF brazing equipment is available, no castings need be made. The engine frame can be of heavy sheet brass sweated together.

Action. Steam is led to engine through brass tubing which enters both inlet ports, one at top, the other at bottom. Check ports so that connection is made with proper holes. When piston is at top, the port in cylinder should be in line with inlet port in engine frame. The lower inlet port in frame will then be covered by the cylinder, while the hole in lower end of cylinder will be in line with lower exhaust port in frame. When piston is driven downward, steam is driven out of lower exhaust port.

The boiler, although designed especially for this engine, is suitable for use with any small steam power plant. It is particularly suitable for installation in model steamboats of the slower type where a high-pressure flash steam system is not required. Among its advantages are simplicity of construction, low cost of materials, a unique and efficient heating unit, and safety.

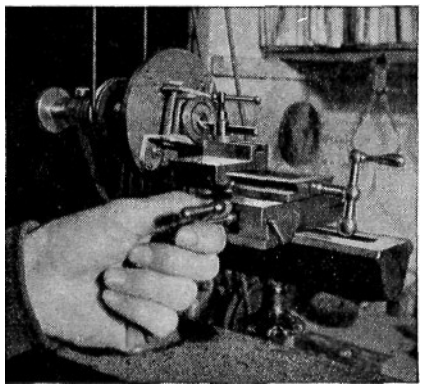
Materials. One piece seamless brass tubing 2½ in. in diameter by 6 in. long. Six feet seamless brass tubing of 1/8-in. inside diameter. One piece copper or brass tubing ½ in. in diameter by 6 in. long. One piece 1/32 in. thick sheet brass, 6 by 8 in. for boiler ends and fuel tank. One 1-lb. cocoa tin of the type shown for boiler housing, ¼ lb. plastic asbestos, and a little asbestos wool. The safety valve, filler plug, and other small parts can be made from scrap material.

Making Boiler. Square and smooth ends of 6-in. length of 2½-in. brass tubing. Cut two disks of heavy sheet brass to fit snugly in ends.

ANNEAL 1/8-in. tubing by heating to a dull red and quenching in water. Take the entire length of tubing and, leaving enough stock to hold onto with a pair of pliers, make the first bend. Then, using the hands only to hold the tubing, make the second bend the proper distance from the first to form one of the water tubes. Saw off and trim to exact length.

As shown in cross section of boiler, the super-heater tube has its open end inside boiler about ¼ in. from the top. The tube then passes down through bottom of boiler and along underside between the water tubes, enters boiler again at opposite end, and passes up through top.

After all tubes have been formed and ends filed square and smooth, spot the ten holes on bottom of boiler into which the tubes are to be soldered. Drill holes a trifle undersize and file ends of tubes to a snug fit. Ends of water tubes should project into boiler about 1/32 in. Put tubes in place and bind securely with iron wire. If you have access to a brazing torch, the soldering should be done with silver solder. However, since the boiler operates at low



Turning recess in disk at rear of cylinder

pressure, a careful job of soft soldering will serve.

NEXT solder in the end plates, which should fit closely. First spot-solder them at three or four points around the edge, placing them about Ms in. in from ends of boiler. Using light hammer blows while rotating the boiler on an anvil or iron block, carefully turn ends of boiler in over end plates.

Filler Plug and Safety Valve. The filler plug is simply a screw plug, seated in a short length of drilled and tapped brass rod soldered in top of boiler. If you do not care to buy a safety valve, a simple one can be made of scrap brass as shown. By varying tension of spring, the valve can be adjusted to pop at the desired pressure. The adjustment can be made at any filling station having an air pump that can be set to deliver air at different pressures.

Housing. The 1-lb. cocoa can is exactly the right size, but light gauge sheet iron can be used if desired. Carefully cut out one entire side of the cocoa tin. Then, with ¾-in. strips of tin or light brass, form straps to support boiler so that it drops half way into can. It will be found that the can is ½ in. longer than the boiler. This space is left at the rear and serves as an opening for the stack, which is formed of tin. The stack should run from bottom of boiler to any desired height.

Strips of brass or tin may then be fastened to bottom of boiler housing for mounting purposes. Next rivet in place the clips or supports for burner as shown.

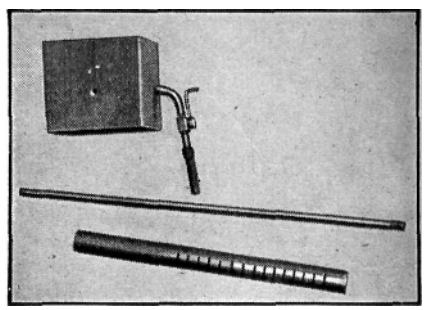
After assembling boiler, stack, and housing, bind boiler firmly in place with copper wire. Then cover entire assembly with a ¼-in. layer of plastic asbestos.

Burner. Take a piece of ½-in. brass or copper tubing and with a hack saw make, eighteen cuts ¼ in. apart, each halfway through the tube. Close one end of tube with a plug. Cut a plug to fit other end and drill a hole through plug to receive a piece of 1/8-in. brass tubing. Take a piece of 1/8-in. tubing about 10 in. long and, starting at one end, drill sixteen or eighteen holes ¼ in. apart with a No. 60 drill. Insert this fuel supply tube in burner tube as far as it will go; then pack unit with asbestos wool. Slip plug over protruding end of fuel supply tube, slide it into place, and crimp burner tube over plug. With a pin, pull a portion of the asbestos wool out through each of the slits in burner tube to form wicks. These wicks should be about Mi in. long. The burner tube is held in position by the bracket and clip shown.

The fuel tank is simply a small sheet brass tank or a can of suitable size. Insert a small shut-off cock between fuel tank and burner.

Operation. Open shut-off valve, allowing the fuel, which is alcohol, to run down into the burner. The size of the flame may be regulated by the valve.

If used in a boat, the fuel tank may be located in any convenient place so long as it is higher than the burner. Boiler and engine should be so placed as to make the distance from the boiler steam outlet to the engine as short as possible. A small globe steam valve should be inserted in steam line between boiler and engine. The photo of the entire power unit shows the engine connected to the boiler by a length



The ½-in. burner tube with wick slots, the 1/8-in. feed tube, and tank for holding fuel

of rubber tubing. At 25-lb. pressure this is entirely satisfactory where flexibility is desired in making tests and adjustments and in experimenting with the unit. Thick-walled rubber tubing of the type used on auto windshield cleaners is satisfactory.

This type of boiler can be altered slightly for high-pressure use in a speed boat on short runs by adding a water gauge and substituting a gasoline burner of the blow-torch type. By a few experiments with the throttle wide open, it can be determined just how much fuel can be used at one filling without exhausting the water supply.