Here's the completed furnace set up ready for use. The burners have separate gas valves to provide precise adjustment of the flame. A single valve controls the air supply from the vacuum cleaner. Although not pictured, the molding flask should be placed near the furnace

Gas-fired smelting furnace

By E. R. HAAN

WITH THIS SMALL FURNACE you can melt down aluminum, brass and copper; preheat small, thick pieces of iron and steel for brazing or forging; caseharden soft steel; make up alloys and bake vitreous enamels on metals. You can use either LP or city gas. The cost runs from $25 up.

The refractory lining: Build the refractory lining inside a sheet-metal can from 11-1/2 to 14in. in diameter, and from 14 to 17 in. high. Drill and ream two 3/4-in. holes diametrically opposite each other as indicated. Then cut 5 pieces of firebrick to the sizes given for the furnace floor. To cut firebrick neatly you score it all around at a marked line by tapping with a sharp cold chisel to form a groove 1/16 to 1/8 in. deep and then break with a heavier blow. The refractory lining consists of ganister and pieces of firebrick. Ganister is a mixture of equal parts of pulverized firebrick and either prepared refractory cement or fire clay. The mixture should have the consistency of rather stiff mortar. If you use prepared cement, you will need two 1-gal. cans. If you use fire clay, you add water sparingly. Pieces of firebrick usually can be had at little or no cost from a brickyard. Pulverize these with a hammer.

Cover the bottom of the can with ganister about 1-1/4 in. deep, and tamp it down to eliminate air pockets. Place the 5 pieces of firebrick in the positions shown, press them down into the ganister so that their top surfaces will be level 1/4 in. below the holes in the sides of the can. Press ganister into the spaces between the pieces of firebrick to come 1 in. from their tops.

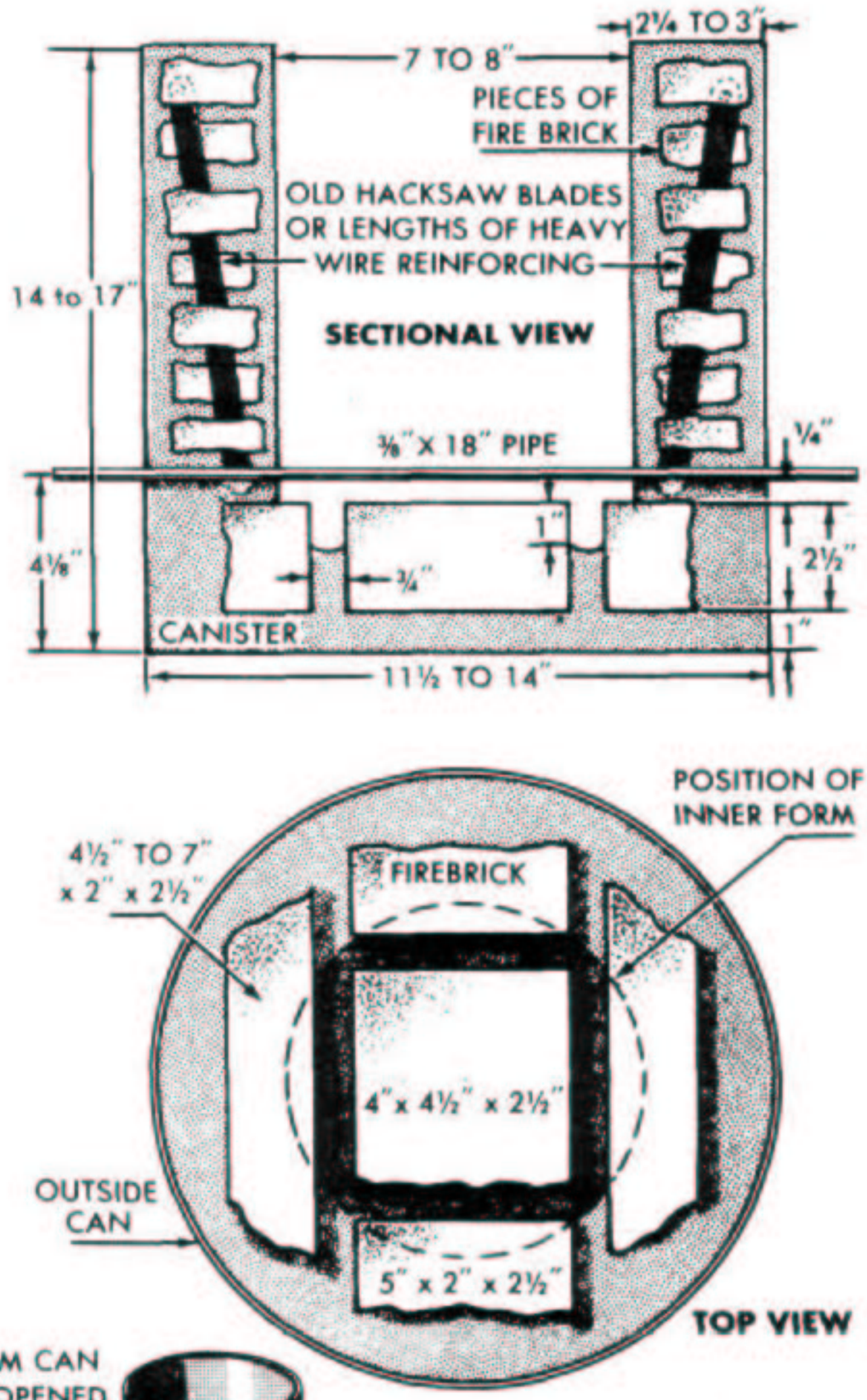
Next, make the cylindrical inner form of sheet metal. This is 7 in. in diameter for a can of 11-1/2 to 12 in. in diameter so the lining will not be less than 2-1/4 in. thick. The inner form is 8 in. in diameter for a 12 to 14-in. can. Hammer the seam moderately tight so that it can be pried open for removal of the form. Drill and ream

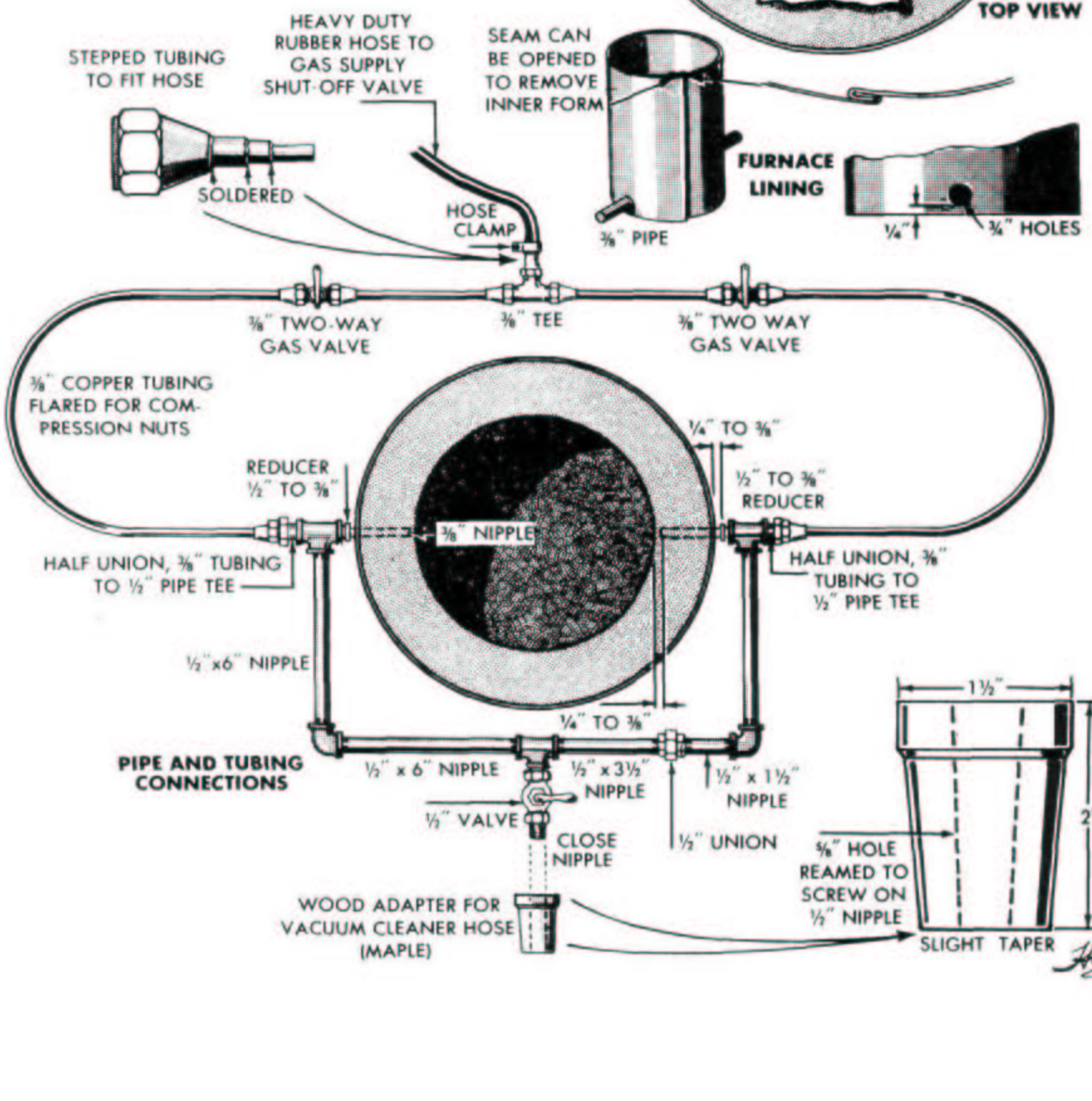
two3/4-in.holes diametrically opposite each other and 1/4 in. above the bottom edge. Place the form centrally on the furnace floor so the holes are in line with those in the can, and push an 18-in. length of3/8-in.pipe through all the holes.

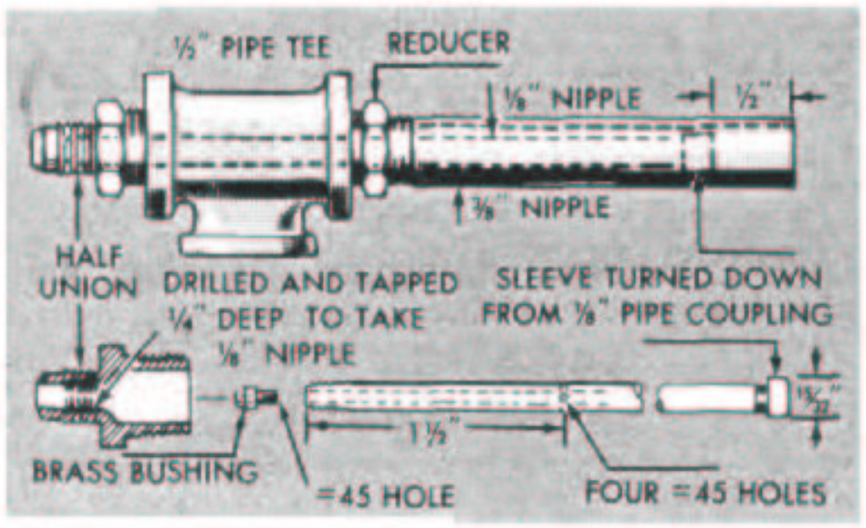
Now you build up the lining. Set 8 to 12 lengths of wire or old hacksaw blades vertically at the center of the lining for reinforcement. Tamp the ganister into all voids and in good contact with the can, inner form and pieces of firebrick. After the lining has dried overnight, turn out the pipe and remove the form. Then let the lining cure for three days.

Burner details: The 3/8-in. nipples of each burner should come 1/4 to 3/8 in. inside the surface of the lining. A similar amount of clearance is allowed between the reducers and the outside of the furnace. The brass half unions fitting the tees are the kind used to attach 3/8-in. copper tubing with compression nuts. Enlarge the inner part of the hole at the beveled end with an 11/32 in. drill to a depth of 1/4 in. To do this you mount the fitting at a true perpendicular in a drill vise and do the drilling on a drill press.

Tap the enlarged portion of the hole with a







Tongs should be designed to grip the crucible firmly when removing it from the furnace. Be especially careful when pouring hot metal into the flask

1/8-in. pipe tap to take a nipple which should extend 1/4 in. inside the end of the burner when it is assembled. The nipple has four No. 45 holes drilled equidistantly through its wall as shown. A steel sleeve fits the burner end of the nipple and a brass bushing, drilled centrally with a No. 45 drill, fits into the other end of the nipple where it screws into the half union.

Pipe and tubing unit: Use 1/2-in. pipe for the air supply line and 3/8-in. copper tubing for the gas supply line. Compression fittings were used on the tubing in the model shown. For these the ends of the tubing must be flared carefully with a flaring tool to produce tight, nonleaking joints. Each burner has a separate gas valve for individual adjustment of each flame but a single air valve serves both burners. Having the air and gas supplies connected midway between the burners equalizes the resistance of pipe and tubing.

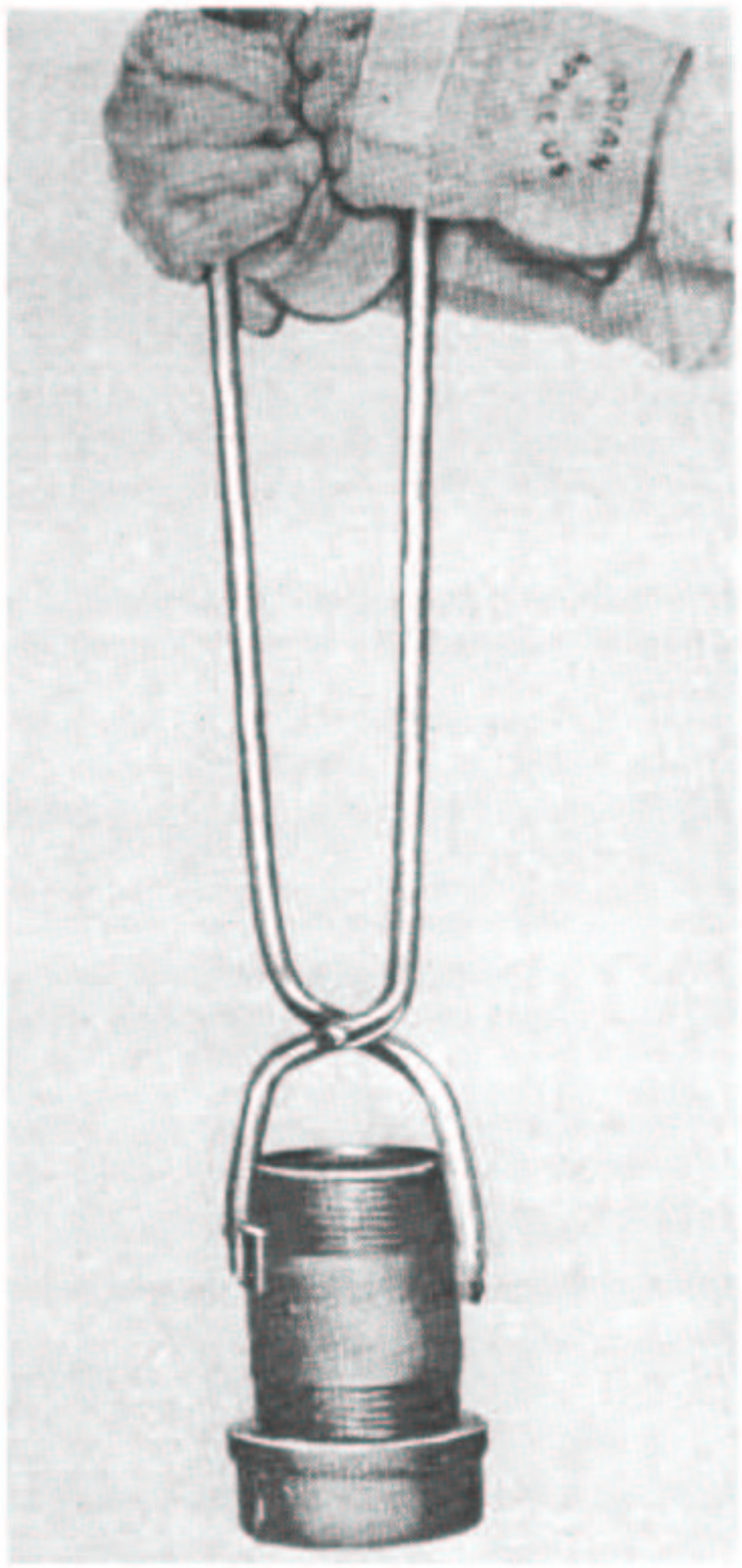
SOME COMMON ALLOYS

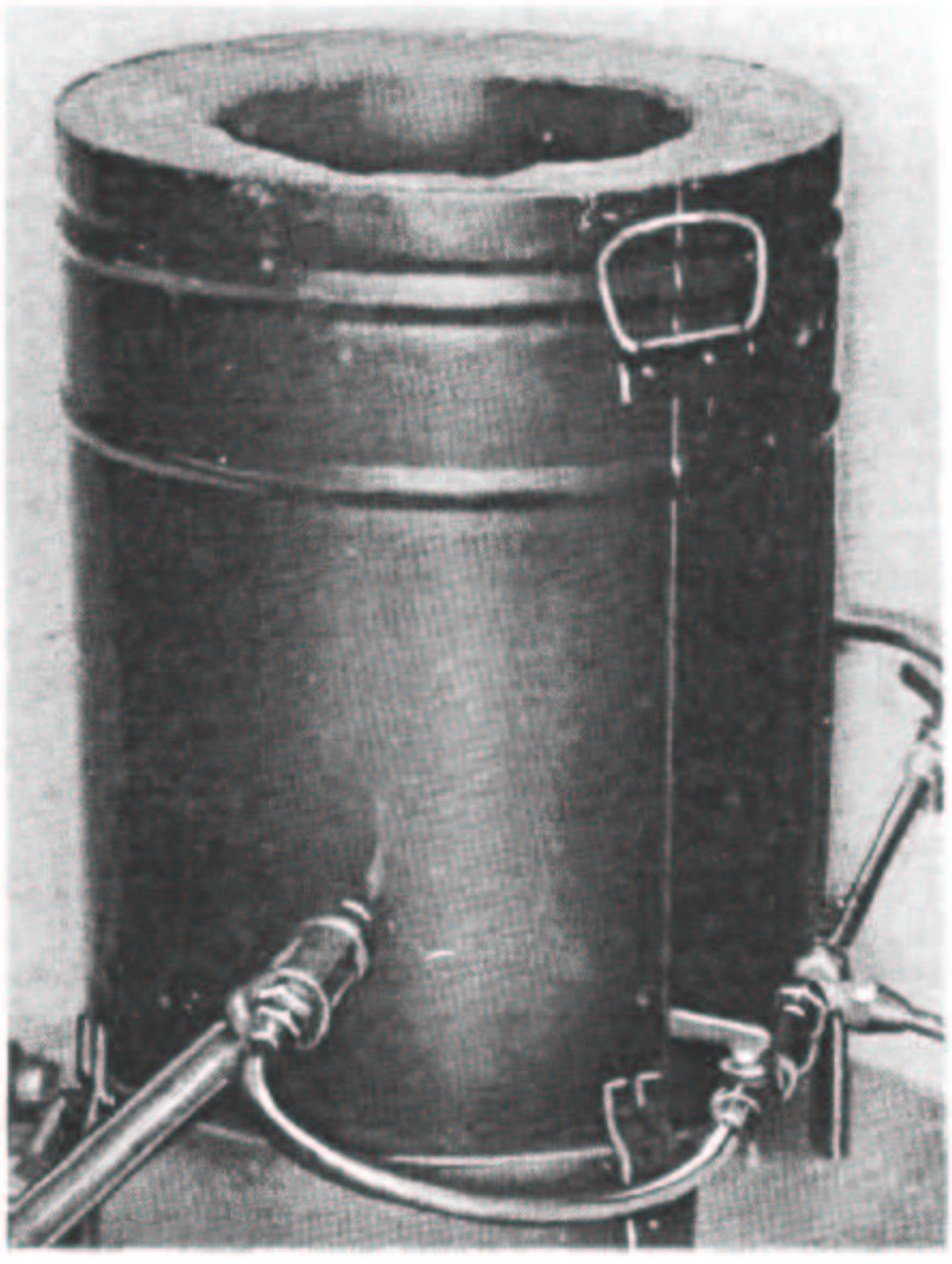
Percentages indicate proportions by weight. Metals are given from left to right in the order of their progressively lesser melting points.

ALUMINUM BRONZE	Copper 90%, Aluminum 10%
BABBIT	Copper 3%, Antimony 7%, Tin 90%
BEARING BRONZE	Copper 82%, Zinc 2%, Tin 16%
BELL METAL	Copper 78%, Tin 22%
BRASS (yellow)	Copper 67%, Zinc 33%
BRASS (red)	Copper 90%, Zinc 10%
BRAZING METAL	Copper 55%, Zinc 45%
BRONZE	Copper 90%, Tin 10%
PEWTER	Copper 6.8%, Antimony 1.7%, Bismuth 6.5%, Tin 85%
SOLDER (tinman's)	Lead 33%, Tin 67%
SOLDER (plumber's)	Lead 67%, Tin 33%
TYPE METAL	Antimony 15%, Lead 82%, Tin 3%
WHITE METAL	Copper 1%, Antimony 19%, Lead 75%, Tin 5%

Melting points of above metals in degrees F.

Aluminum	1220	Copper	1980
Antimony	1160	Zinc	787
Lead	624	Bismuth	520
Tin	449		





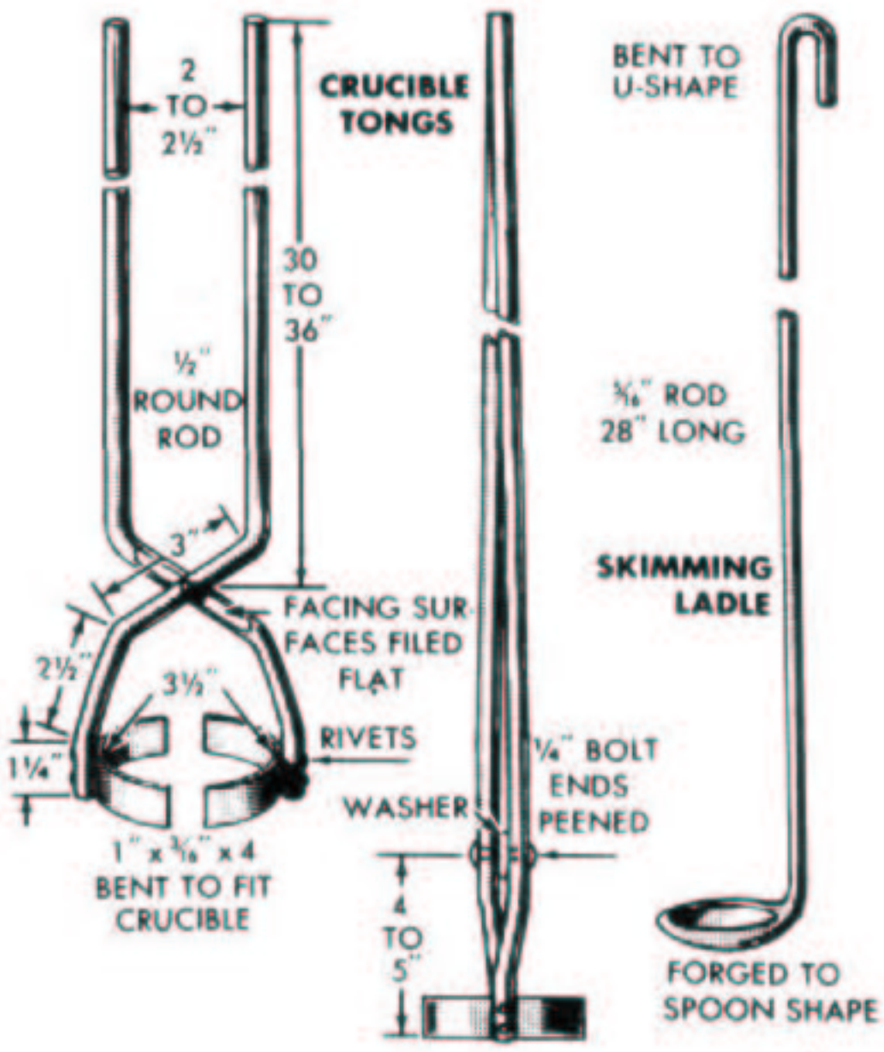
If the rubber hose for the gas line is too small to fit on 3/8-in. tubing, make an adaptor from short lengths of tubing, one fitting inside the other, then sweat-solder together. Also make an adaptor of close-grained hardwood to fit into the end of the vacuum-cleaner hose. Pipe-joint compound is used only at the tees where the half union and reducer screws into the tees, and where the 3/8-in. burner nipples screw into the reducers. All the joints of the gas line should be tested.

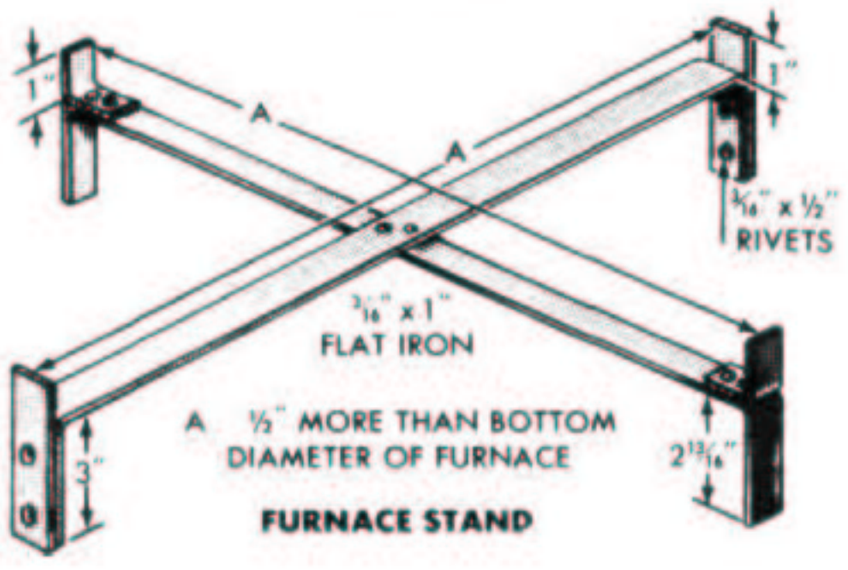
Crucible, tongs: A graphite-clay crucible is best, but for economy you can use one made up from a malleable-iron pipe cap and nipple of suitable size. A 3-1/2-in. pipe cap provided with a 6-in. nipple were used for the model shown. By providing the pipe cap with 4 machine-screw legs turned into tapped blind holes in the bottom to raise the crucible 1/2 to 3/4 in., the flames will meet under it and the heat will be absorbed faster than if the flames contact only the side of the crucible. Curvature of the jaws of the tongs depends on the crucible diameter. The contact should be, uniform and the tongs should be tested for holding before being used.

Curing the lining: After the 3-day drying-out period you ignite the gas and allow small flames to burn without any air blast for about an hour to complete the curing of the lining. To ignite the furnace place a lighted match inside near a burner and turn on the gas supply slowly to produce a small flame. Then turn on the other burner to ignite from the first and turn it down for a small flame.

After an hour's time the air blast is used for about 10 minutes. First open the gas valves farther so that the flames will rise above the furnace top. Then, while the air-supply valve is closed completely, turn on the vacuum cleaner, after which you open the air valve slowly until the flames become light blue. Too much air in proportion to gas will extinguish the flames. Avoid this by turning the gas valve almost fully open, then turn the air valve wide open after which you gradually decrease the gas supply to each burner to reach the point of maximum blast without flame flutter. After 10 minutes close the air valve first and then the gas valves.

When the furnace has cooled you inspect the lining for cracks which are almost certain to develop. Fill the cracks with prepared refractory cement or fire clay and allow this to dry out before the next firing. Crack filling is repeated if more cracks develop. When operating at maximum blast, the furnace can be covered almost





entirely with a piece of asbestos-cement board to retain heat. To inspect the charge you remove the cover with a pair of tongs and observe the contents of the crucible through colored glasses. Use the skimming ladle to drop some borax into the molten metal. Use technical grade borax available at photo-supply houses. Skim off the resulting dross or scum before removing the crucible for pouring.

Safety rules: An LP gas tank should be located outside the building, and the gas piped through a 3/8-in. copper tube provided with one gas valve at the tank and another inside the building.

Locate the furnace on an earth or concrete floor that slopes away from walls or combustible material. The latter should be kept a safe distance from the furnace. A sheet-metal box about 6 in. high and about 3 ft. square, two-thirds full of dry sand, should be located next to the furnace. The molding flask is set on the sand. The crucible is held over the sandbox on its way to the molding flask for pouring.