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Metal-Turning Lathe, Built from Stock Parts  
Popular Mechanics No. X387

by: Frank Beatty

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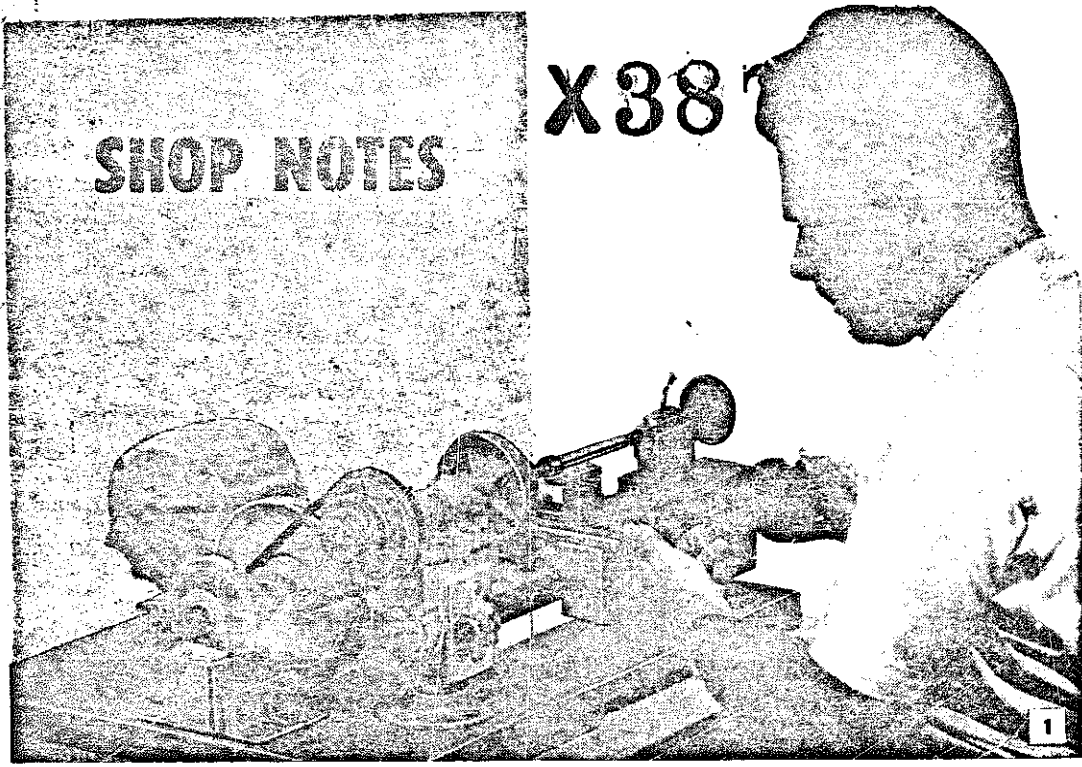
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SHOP NOTES

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# METAL-TURNING LATHE

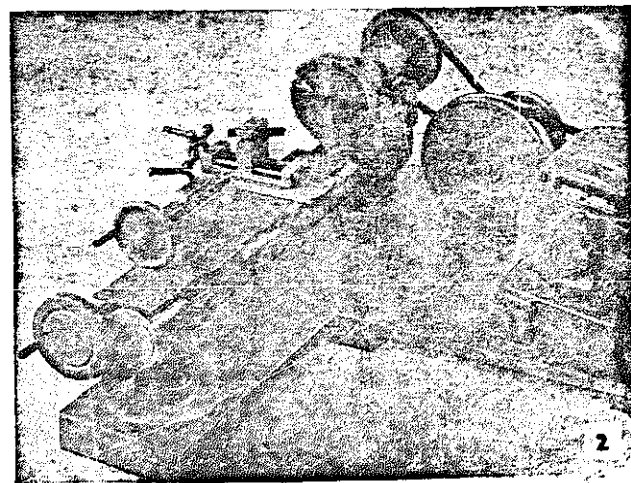
## Built From Stock Parts

By Frank Beatty

USING STANDARD PARTS and stock materials that are available almost anywhere, you can build this metal-working lathe with only a few tools. Because of simplification of the assembly in order to make the unit easy for anyone to build, the lathe as pictured and detailed cannot be rated as a precision tool. It is simply designed to do practical work within reasonable limits. As detailed, the lathe swings  $4\frac{1}{4}$  in. over the bed and takes 10 in. between centers. Standard pipe and fittings are used to form a frame on which the headstock, tailstock and bed are fitted.

The first step is to assemble the pipe and fittings. Do this before any other parts are made or stock cut to dimension. The reason for this first step is that in the manufacture of standard pipe there are allowable variations and some changes in dimensions of lathe parts may be necessary because of these variations. The pipe assembly consists of one 14-in. length of  $1\frac{1}{2}$ -in. pipe, two close nipples, two

tees, two floor flanges and one pipe plug (optional) for closing the tee at the headstock end of the assembly. Screw the parts tightly together and then mount on a hardwood base as in Fig. 5. Later when the countershaft, motor and motor mount are added to the assembly, a second piece is attached to the first, making an L-shaped base as pictured in Figs. 1 and 2.



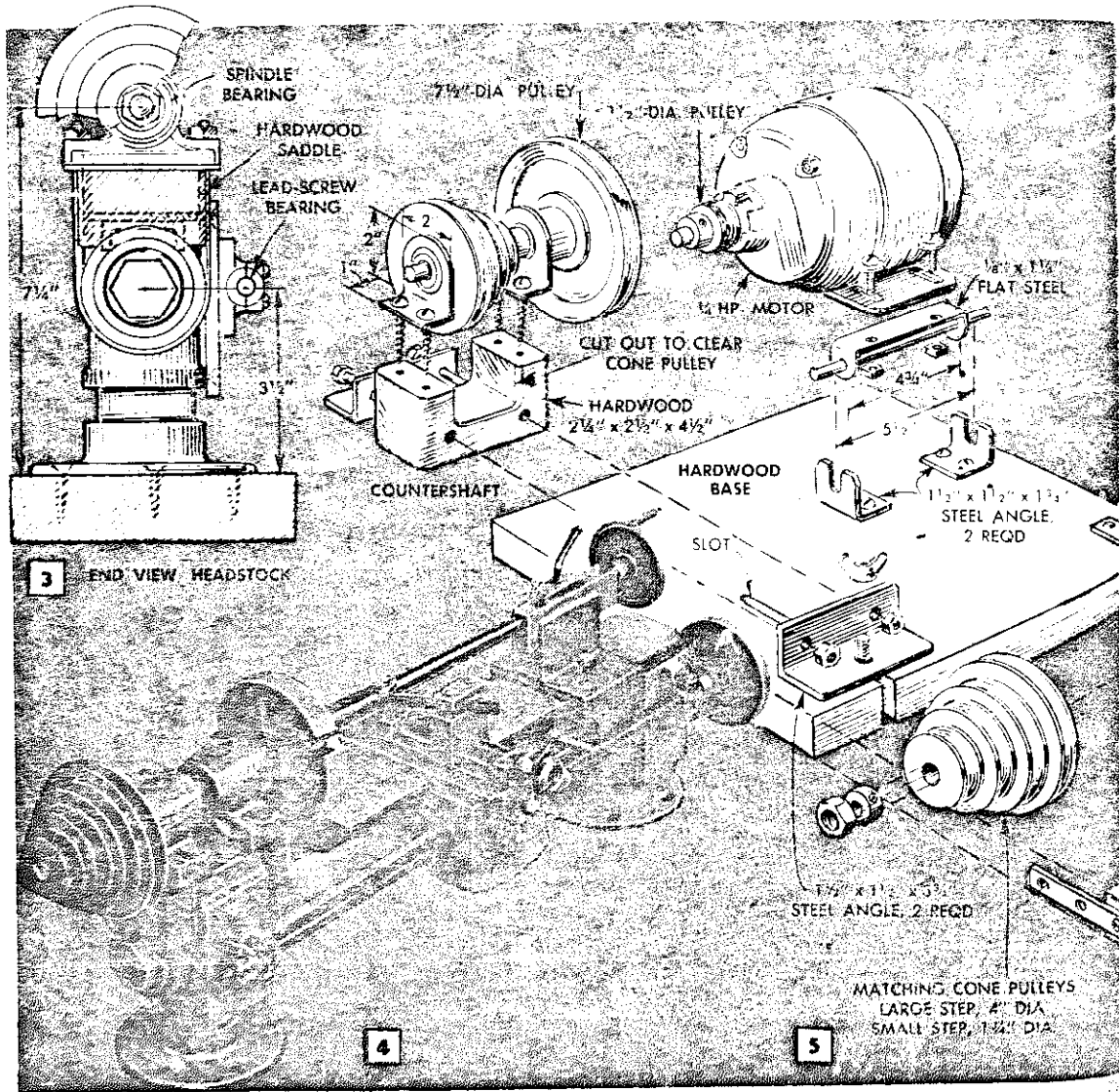
Also at the outset it should be noted that the spindle-thread characteristics are not given. The reason for this is that chucks are available to fit spindles threaded  $\frac{1}{2}$ -24,  $\frac{1}{2}$ -20 and  $\frac{3}{4}$ -16. You can use a  $\frac{1}{2}$  or  $\frac{3}{4}$ -in. spindle and have it threaded to take any one of these chucks. The original lathe spindle was threaded  $\frac{1}{2}$ -20 and is suitable only for light work. A solid spindle is, of course, much simpler and less expensive to make or have made than is a hollow spindle with a No. 0 or No. 1 Morse taper. For turning work between centers the solid spindle requires a special 60-deg. center with a driving pin, Fig. 5. This center and the spindle can be made in a machine shop at a very nominal cost.

The headstock-spindle bearings, Fig. 5, are held on the pipe tee by means of U-bolts and a saddle block of hardwood. One face of the saddle is shaped to the contour of

the tee; the other is faced with a  $\frac{1}{8}$ -in. steel plate on which the pads of the pillow blocks rest. The purpose of the steel plate is to make it easier to align the bearing sleeves when the assembly is bolted in place. Cut the saddle about  $\frac{1}{8}$  in. thicker (about  $2\frac{1}{4}$  in.) than indicated. Then assemble the parts temporarily.

Next, build up the tailstock, assembling from parts as indicated in Fig. 5. Then assemble the bed on the pipe frame. Slide the tailstock onto the bed and check the alignment of the centers, both vertically and horizontally. Any misalignment can be corrected by reducing the height of the saddle and by tapping the bed lightly to shift it on the frame. Once the centers are aligned, tighten the parts permanently in place.

The tool post, tool-post slide and the actuating screw are shown in an exploded



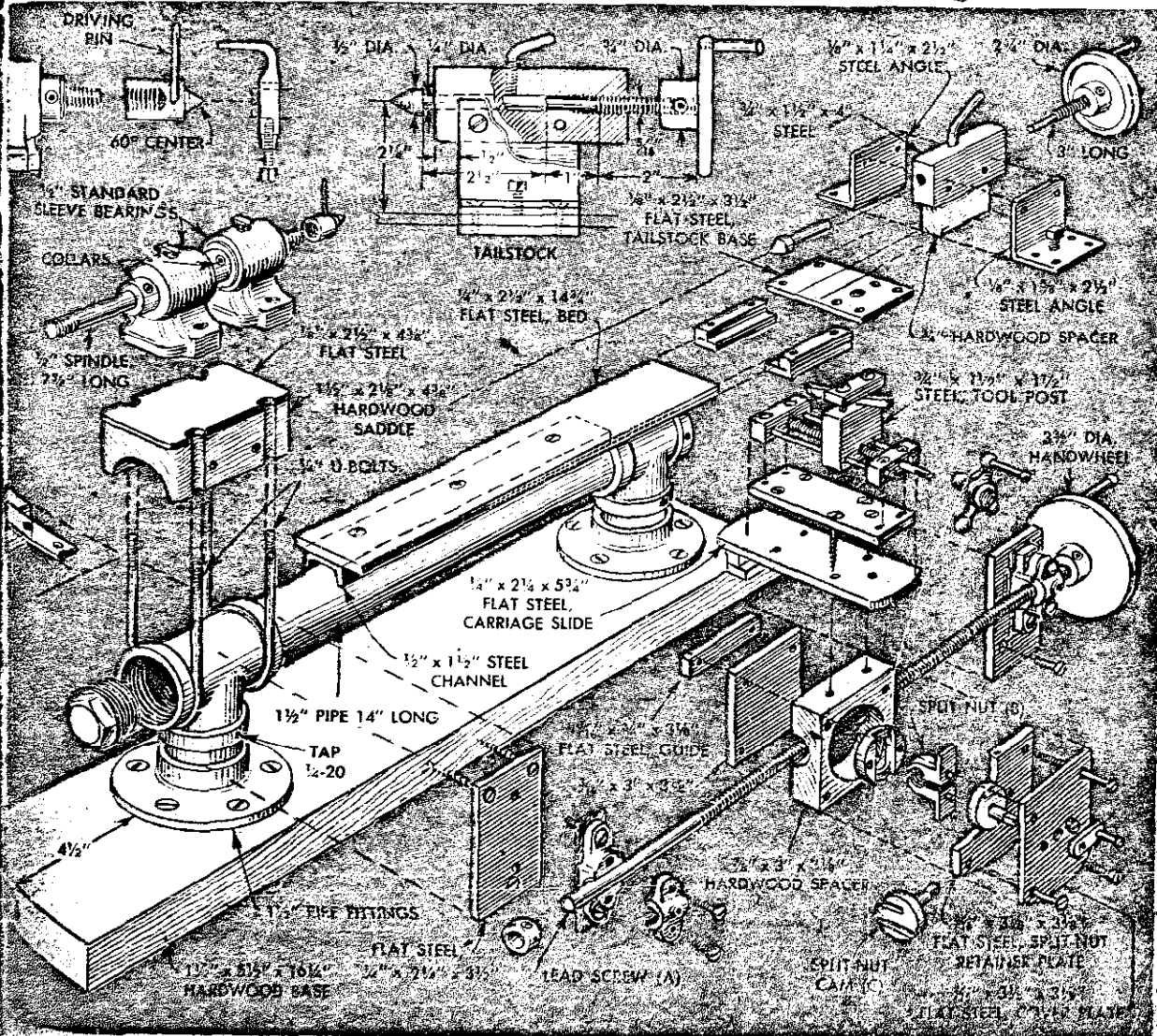
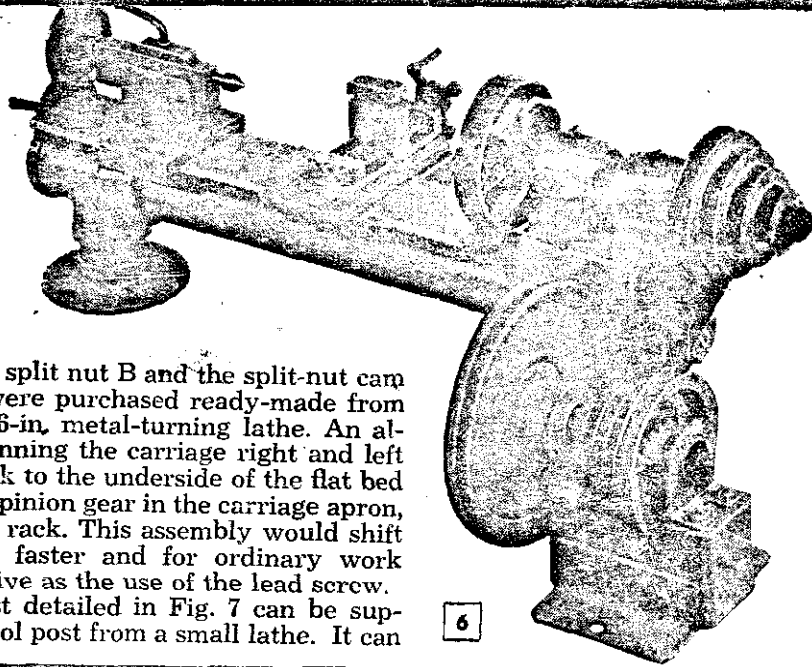
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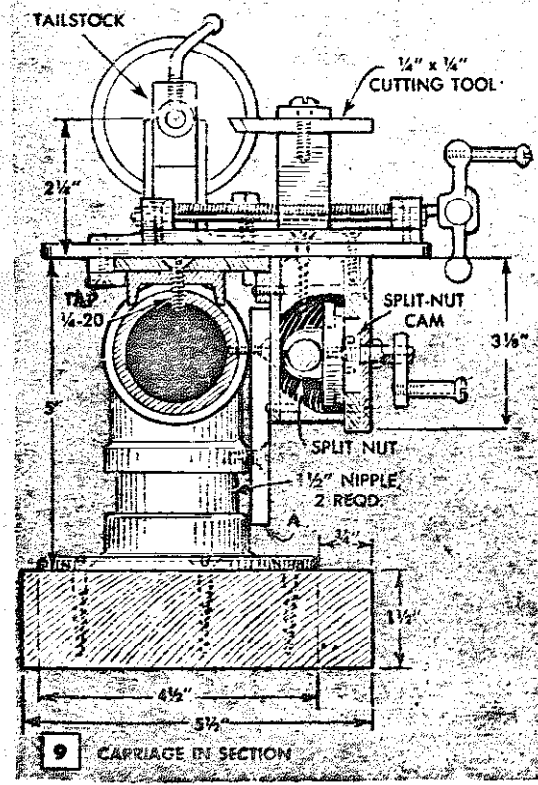
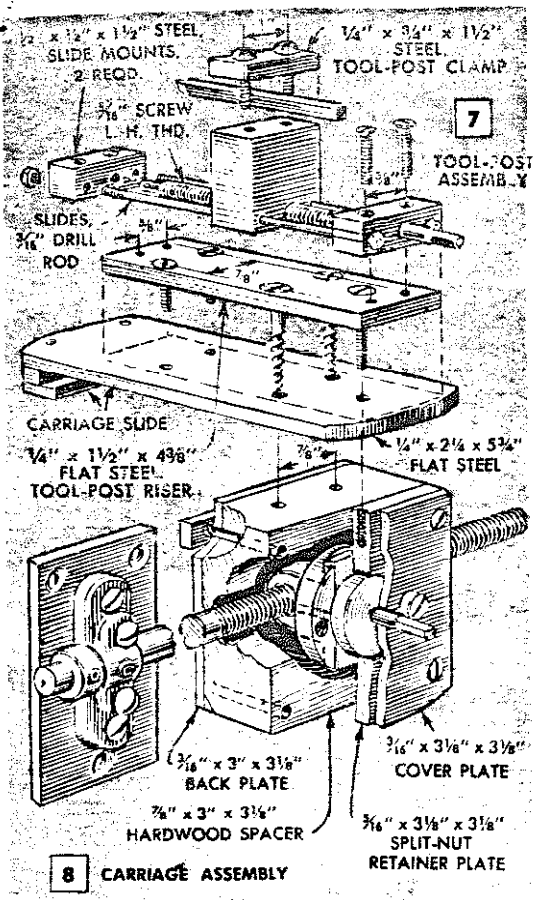
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view at the lower right in Fig. 5 and are shown in more complete detail in Figs. 7, 8 and 9. In this assembly the tool is moved in either direction by turning the handwheel at the end of the lathe bed. The actuating screw consists of the lead screw A, the split nut B and the split-nut cam C, Fig. 5. These parts were purchased ready-made from the manufacturer of a 6-in. metal-turning lathe. An alternate assembly for running the carriage right and left would be to attach a rack to the underside of the flat bed and fit a handwheel and pinion gear in the carriage apron, the pinion engaging the rack. This assembly would shift the carriage somewhat faster and for ordinary work would be quite as effective as the use of the lead screw. Likewise the tool post detailed in Fig. 7 can be supplanted by a standard tool post from a small lathe. It can





be mounted by having a small block of tool steel T-slotted at a local machine shop and drilled and tapped for the guide rods and the screw. This assembly would, of course, allow more latitude in adjustment of the cutting tool.

In the original lathe the carriage consists of two steel plates stacked, and an apron built up from three steel plates and a hardwood spacer, the latter also serving as a housing for the split-nut assembly. Figs. 5, 7, 8 and 9 show quite clearly how the parts are assembled. Fig. 9, the sectional view, shows the relationship of the parts when the carriage is fully assembled. Note in Fig. 5 that the lead-screw-bearing plates are attached to the pipe tees with screws, the latter being turned into holes drilled and tapped into the pipe-tee flanges. These holes should not be drilled and tapped until the carriage is fully assembled with the lead screw in position. Only then can the bearing plates be accurately located.

Care must be taken to fit the carriage to the flat bed so that it moves along the full length of the bed without side play at any point. It is best temporarily to fit the parts tightly, then free them by polishing the edges and top of the bed with fine abrasive or with an oilstone. The same procedure should be carried out when fitting the parts of the tool-post assembly, Fig. 7, and the tailstock, Fig. 5. Hand fitting and hand stoning of the sliding parts give a smooth slow motion essential to the performance of the lathe and to accurate work. It is especially important that the tool post move throughout its entire travel without any tendency to rock on the supporting plate. It should move on the slides (rods) with a slight amount of friction and should seat firmly on the supporting plate.

The countershaft, Figs. 1, 2 and 6, is detailed in Fig. 5. It can be built from any parts at hand, or available, that will serve the purpose. Although the original countershaft was mounted in ball-bearing hangers, sleeve-bearing hangers will do quite as well. Standard shaft hangers having a range of adjustment sufficient to give clearance for the countershaft and drive pulley will eliminate the necessity of blocking up the hangers as detailed. Adjustable hangers can be bolted directly to the base. Construction time also can be saved by purchasing the cradle motor mount rather than making it up as detailed. Or, if desired, you can simply bolt the motor directly to the hardwood base and rely on the slotted motor base to provide adjustment for tensioning the belt. Pulleys of the diameters given will give ample speed range for turning nearly all metals. Use a motor of 1750 r.p.m. ★ ★ ★

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Smelting Furnace

Popular Mechanics No. X297

by: E.R. Haan

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X297

# SMELTING FURNACE



**ADJUSTING FLAME.** Burners have separate gas valves for delicate flame adjustment. Single valve controls air supply. Sheet-metal box containing dry sand on which the molding flask is set, is placed near furnace

**Twin-burner, gas-fired furnace, fed by air blast of vacuum cleaner, smelts up to 10-lb. charges of metals having melting points below 2000 deg. F.**

**By E. R. Haan**

**W**ITH THIS SMALL FURNACE you can smelt aluminum, brass and copper; pre-heat 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 is about \$25. **The refractory lining:** Build the refractory lining inside a sheet-metal can from 11½ to 14 in. in diameter, and from 14 to 17 in. high. Drill and ream two ¾-in. holes diametrically opposite each other as indicated. Then cut five 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 a sharp cold chisel to form a groove ¼ to ⅜ in. deep, and then sever 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. Broken pieces of firebrick usually can be had at little or no cost from a brickyard. Pulverize these with a hammer on a concrete floor.

Cover the bottom of the can with ganister about 1¼ in. deep, and tamp it down to eliminate air pockets. Place the five pieces of firebrick in the positions shown, press them down into the ganister so that their top surfaces will be level ¼ in. below the holes in the side of the can. Press ganister into the spaces between the pieces of firebrick to come 1 in. from their tops.

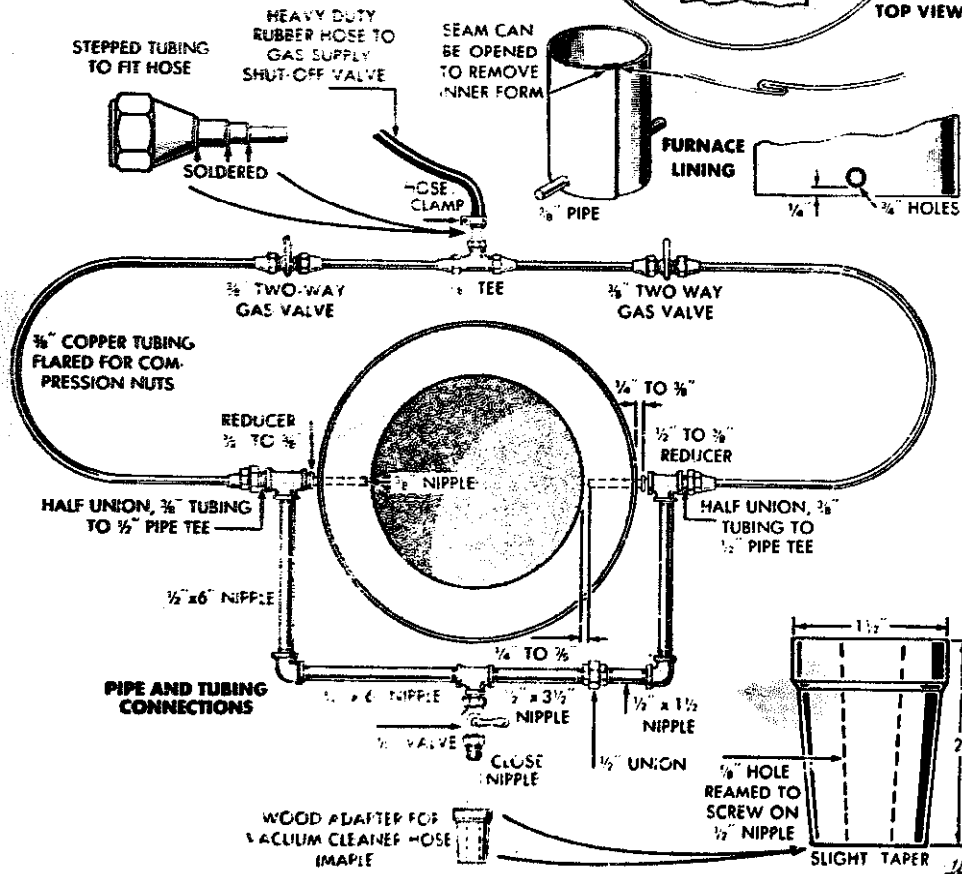
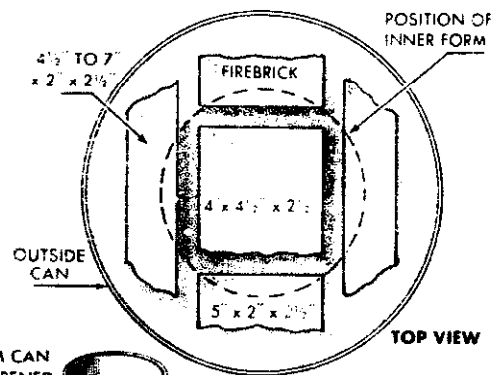
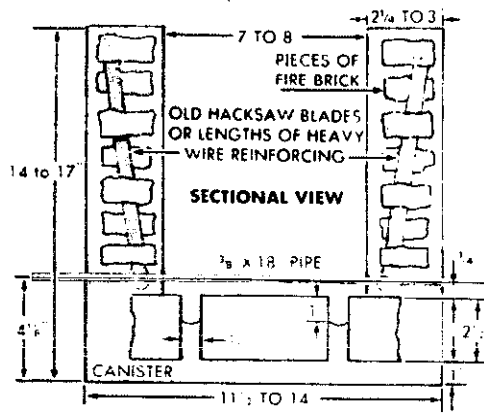
Next, make the cylindrical inner form of sheet metal. This is 7 in. in diameter for a can of 11½ to 12 in. in diameter so the lining will not be less than 2¼ in. thick. The inner form is 8 in. in diameter

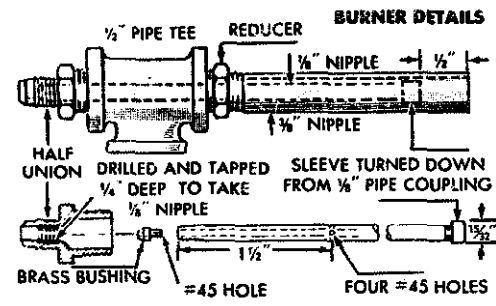
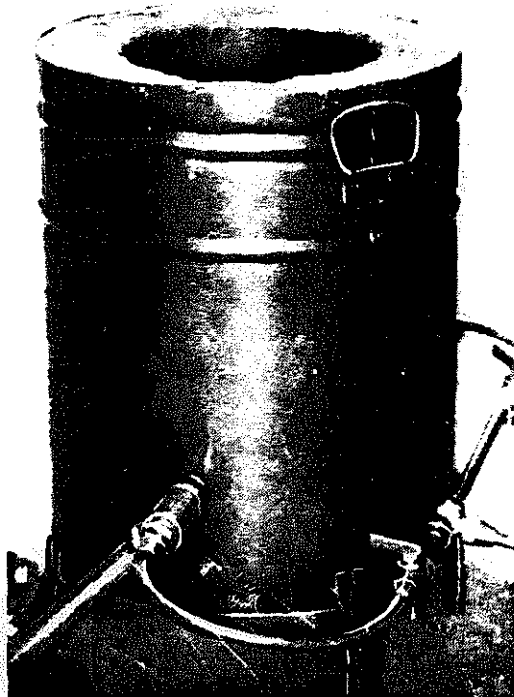
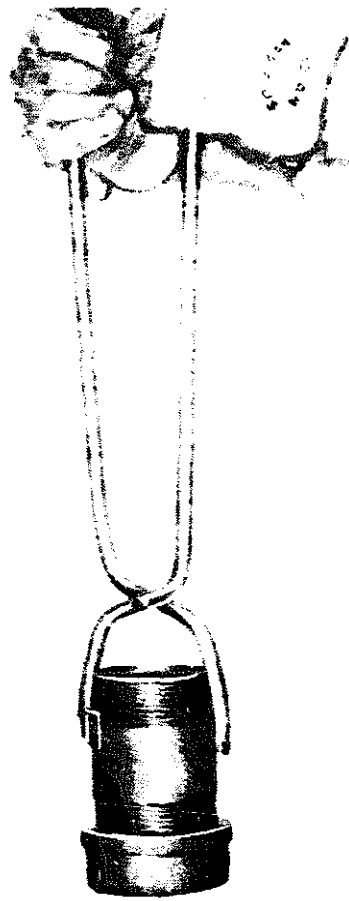


for a 12 to 14-in. can. Hammer the seam moderately tight so that it can be pried open for removal of the form. Drill and ream two  $\frac{3}{4}$ -in. holes diametrically opposite each other and  $\frac{1}{4}$  in. above the bottom edge. Place the form centrally on the furnace floor so the holes are in line with those of the can, and push an 18-in. length of  $\frac{3}{8}$ -in. pipe through all the holes.

Now proceed to 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 dry out for three days. During this time you can make the burners, assemble the pipe and tubing.

**Burner details:** The  $\frac{3}{8}$ -in. nipples of each burner should come  $\frac{1}{4}$  to  $\frac{3}{8}$  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  $\frac{3}{8}$ -in. copper tubing with compression nuts. Enlarge the inner part of the hole at the beveled end





**TONGS GRIP** crucible securely when removing it from furnace for pouring molten metal in molding flask

with a  $\frac{1}{16}$ -in. drill to a depth of  $\frac{1}{4}$  in. To do this you mount the fitting at a true perpendicular in a drill vise and do the drilling on a drillpress. This assures getting the inner pipe nipple located centrally.

Tap the enlarged portion of the hole with a  $\frac{1}{8}$ -in. pipe tap to take a nipple which should extend to  $\frac{1}{4}$  in. inside of the end of the burner when it is assembled. The nipple has four No. 45 holes drilled equidistantly through its wall as above. 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. In the absence of a metal-turning lathe, you can dress the sleeve and bushing to size on a drillpress, using a file. **Pipe and tubing unit:** Use  $\frac{1}{2}$ -in. pipe for the air supply line and  $\frac{3}{8}$ -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

**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

flaring tool to produce tight, non-leaking 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.

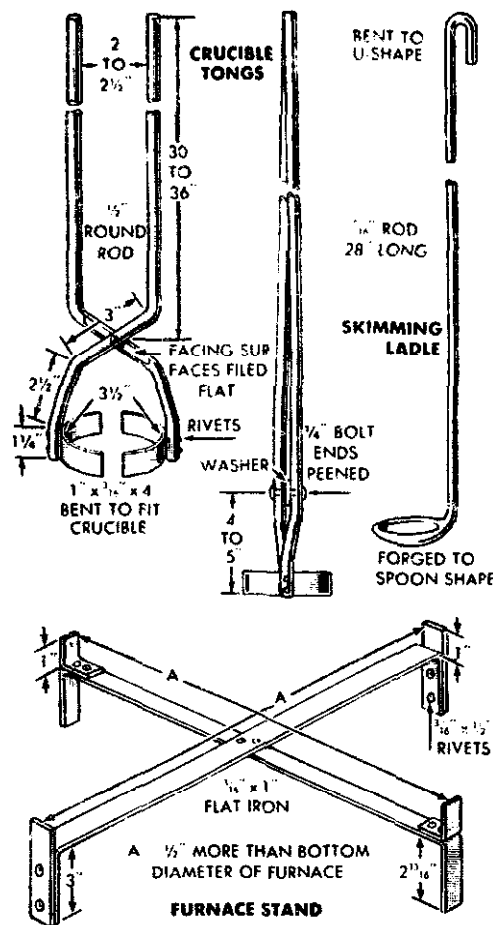
If the rubber hose for the gas line is too small to fit on  $\frac{3}{8}$ -in. tubing, make an adaptor from short lengths of tubing, one fitting inside the other, then sweat-solder together. Also make an adaptor of close-grained hardwood to fit into the end of the vacuum-cleaner hose. Pipe-joint compound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

**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  $3\frac{1}{2}$ -in. pipe cap provided with a 6-in. nipple were used for the model shown. By providing the pipe cap with four machine-screw legs turned into tapped blind holes in the bottom to raise the crucible  $\frac{1}{2}$  to  $\frac{3}{4}$  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 power before being used.

**Drying out 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 drying out 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 further 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 to avoid a possible pop-back.

When the furnace has cooled you inspect

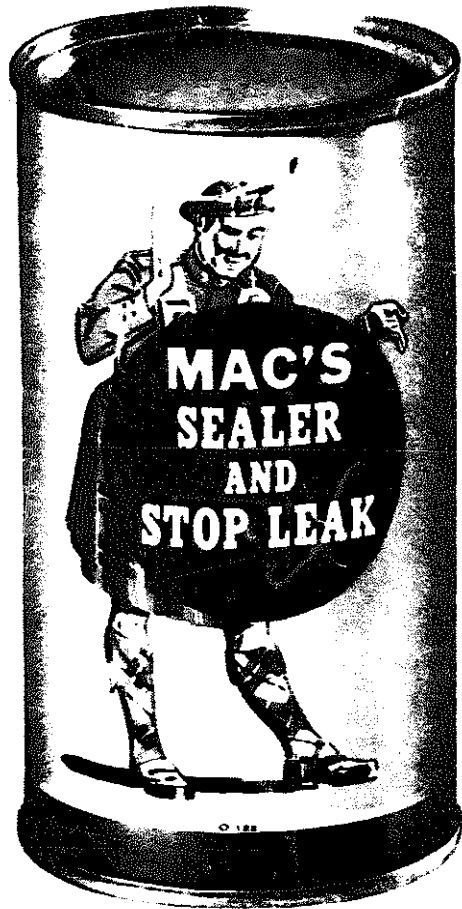


the lining for cracks which are almost certain to develop. Fill the cracks with prepared refractory cement or fire clay and allow this to dry out before the next firing. Crack filling is repeated if more cracks develop. When operating at maximum blast, the furnace can be covered almost entirely with 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  $\frac{3}{8}$ -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

Please turn to page 190.



## Dam It!

Leaky radiator owners swear by it. And Mac's guarantees it. It stops high pressure leaks up to 20 pounds. It stops all leaks fast. Mac's Sealer and Stop Leak mixes with any anti-freeze, too. If somebody tries to sell you something less, tell him to go to . . .



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Los Angeles 42, Calif., Cincinnati 26, Ohio

## Home Fire Escape

(Continued from page 145)

Of course, the real value of any alarm system depends on how efficiently you've trained your family to use those precious extra minutes the warning gives you. You should all know a few basics about emergency procedures. Wherever practical, you should sleep with upstairs bedroom doors shut. By the very nature of a two-story home's construction, its stairway is a chimney for heat and smoke. The door provides a barrier that can save your life.

If you awaken to the alarm and find the door hot to the touch—*don't open it!* You may be felled by the rush of searing gases that have built up behind it. It's always wise to have provided an alternate escape route out the window of principal upstairs bedrooms. You can buy a rope ladder or make one of the several types detailed in *PM's* June, 1962 issue. But these require some special treatment if you want to conceal that ever-ready coil you must store inside the escape window. The advantage of the folding ladder shown on page 145 is that it's ready for instant use, yet remains out-of-the-way on the outside of the house. Assemble it on the ground, using 4-in. strap hinges to attach the 2x4 sides to opposite faces of 10-in.-long 1x4s. Secure the low-folding side to the house wall with lag screws, and provide a screw-eye to which the raised side can be tied. Then, should that warning bell ever sound, break the tie-cord for a fast exit. ★★★

## Smelting Furnace

(Continued from page 167)

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 flash is set on the sand. The crucible is held over the sand box on its way to the molding flask for pouring. With this arrangement any spilled metal will be confined safely. Surplus molten metal can be poured into a depression in the sand; it should not be left in crucible.

Wear asbestos gloves when handling the crucible tongs. It's a good idea to have an asbestos apron and to protect the face and eyes with an appropriate mask against possible splattering of molten metal. When adjusting the flame keep your face a safe distance from the furnace.

**Casehardening:** Place pieces of soft steel in a crucible, burying them in fine-powdered bone charcoal or potassium carbonate. Under high heat, steel absorbs carbon. Then you brush off scale, reheat cherry red and plunge in cold water. ★★★