Instructions for Building a VITA Stove

By Samuel F. Baldwin, "Biomass Stoves: Engineering Design, Development, and Dissemination", 1987

TEMPLATE DESIGN: CYLINDRICAL STOVES

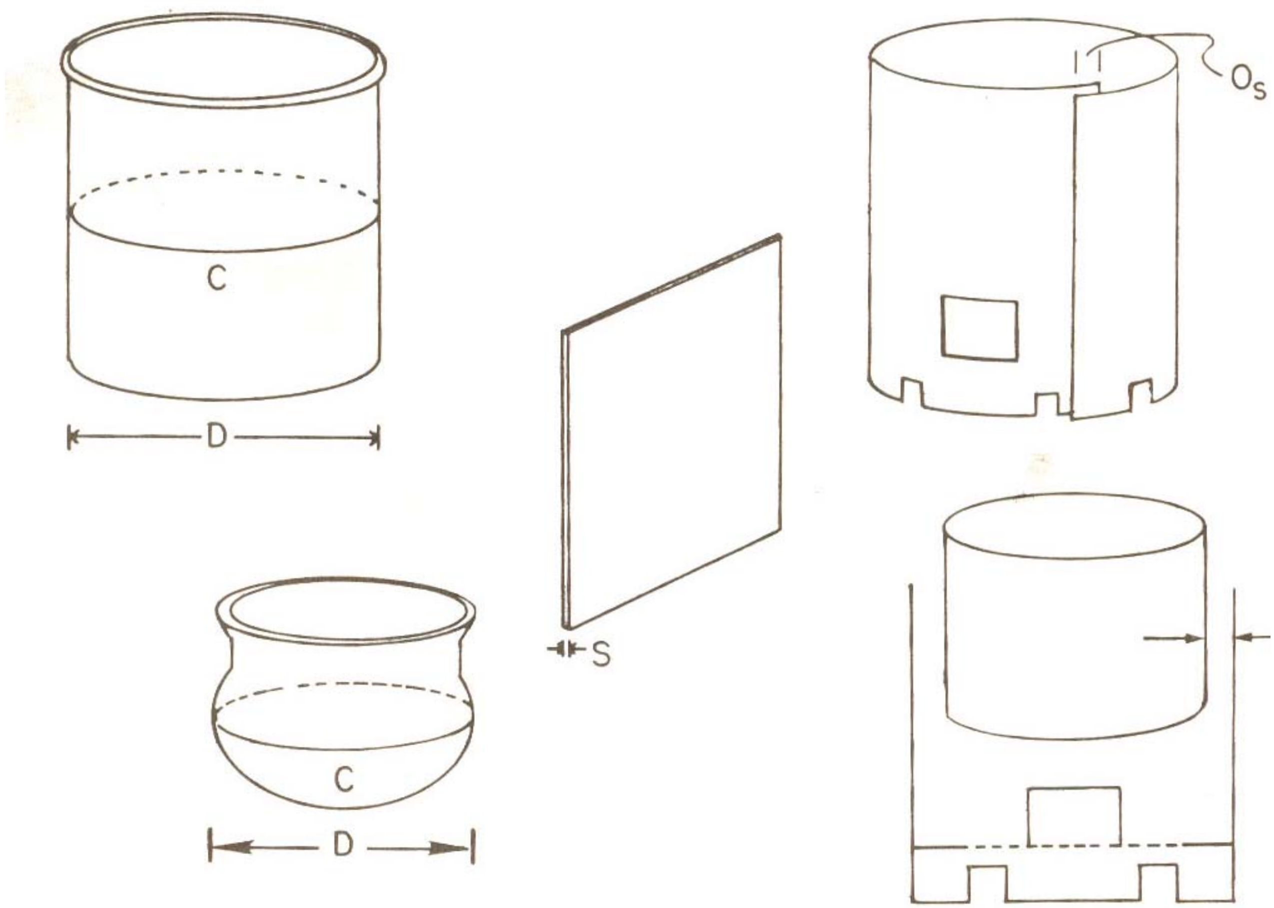
Template design for a cylindrical, open firebox, channel type metal stove is straightforward. Such stoves are best used with cylindrical pots, but have also been used with spherical pots with good results. Dimensions listed below are nominal and need to be optimized through laboratory testing. Laboratory and controlled cooking test data for this type of stove are given in Tables V-1 and V-2.

1. The width of the cylindrical stove template is given by

$$W = C + 2\pi G + O_s + \pi S$$

where C is the measurement of the pot around its widest circumference. G is the desired pot-to-wall channel gap. For a gap of 4 mm, $2\pi G = 2.5$ cm; for 6 mm, $2\pi G = 3.8$ cm; for 8 mm, $2\pi G = 5.0$ cm, and so on. O_s is determined by the amount of overlap in the seam. It is preferable to weld the stove together end to end (thus $O_s = 0$) to prevent the creation of a small vertical channel by which the heat can bypass the pot. If the seam is crosswelded or folded, typical values for O_s will be 1 cm. S is the thickness of the metal used. One typically uses 1 mm ($\pi S = 0.3$ cm) or 1.5 mm ($\pi S = 0.47$ cm) thick metal. Thus, for a 90-cm-circumference pot, a 6-mm-channel gap, an end to end welded seam, and 1-mm-thick metal:

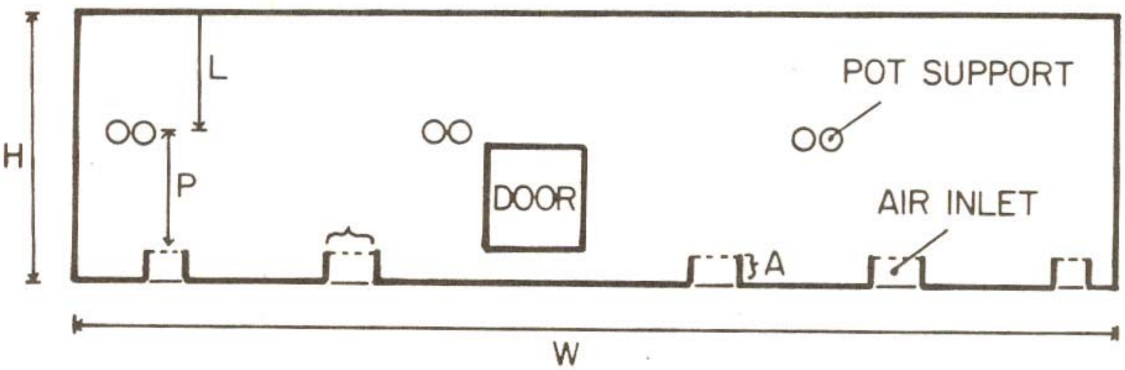
$$W = 90 + 2\pi(0.6) + \pi(0.1) = 90 + 3.8 + 0.3 = 94.1 \text{ cm}$$



Baldwin's Suggested Gap Sizes

Wood Burned per Hour (kg)	**Skirt Gap (mm)**	**Length of Gap (cm)**	**Thermal Efficiency of Stove (%)**	**Firepower (kW)**
0.50	8	20	40	2.8
0.75	10	20	35	4.1
1.00	11	20	30	5.5
1.25	12	20	28	6.9
1.50	13	20	26	8.3
1.75	14	20	25	9.6

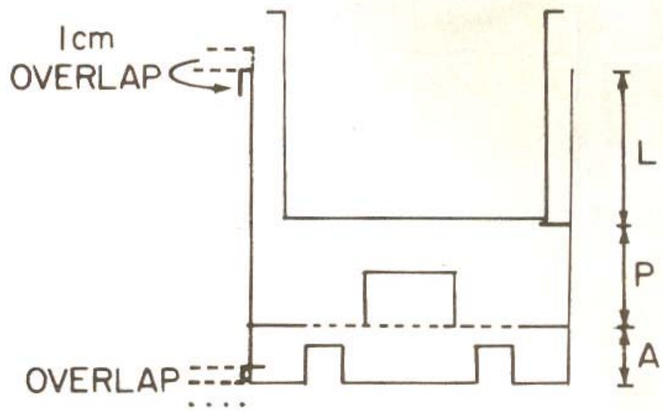
For a family-sized VITA stove, a 12 mm Skirt Gap is recommended.



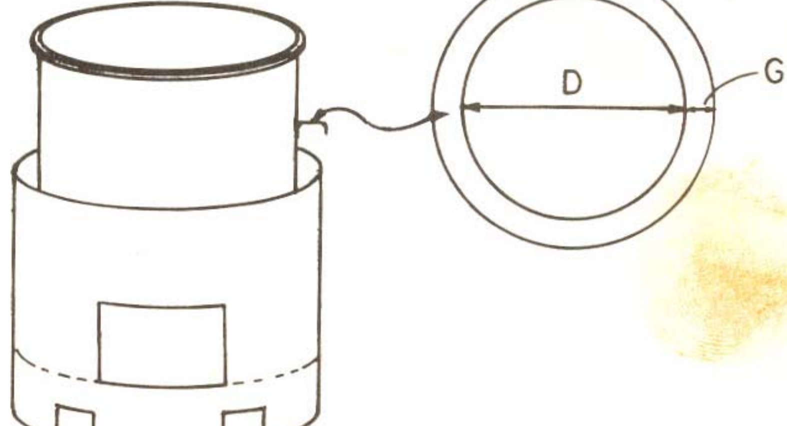
2. The template height **H** is determined by the sum of the airhole height **A**, the grate-to-pot height **P** (measured from the top of the grate), and the channel length **L** or, for spherical pots, the amount necessary to extend a few centimeters above the pot's maximum circumference. For cylindrical pots, **L** is determined by the desired channel length (chapter III)

$$H = A + P + L$$

Typical values for **A** are 3 to 5 cm and for **P**, 0.4 of the pot diameter. For small cylindrical pots the height L is typically 5 to 10 cm. Larger institutional or industrial stoves may have channel lengths **L** of 50 cm and more. The best height **L** is determined more precisely by comparing the increased efficiency and reduced fuel use caused by the additional height versus the increased cost of the extra metal. Additional height can also be provided at the top and bottom of the template, typically 1 cm each, to allow the edge to be folded over to protect against cuts on the sharp edges and to increase the stove's rigidity and strength.



3. Stoves should have a total air inlet of at least half the area of the pot to wall channel gap. For the above stove 94 cm in circumference and with a gap of 6 mm this is 56 cm^2. A convenient size, then, is to have four airholes, about 3 cm by 4 cm each (**A**=3 cm) or 48 cm^2 in area, spaced symmetrically around the stove, but far enough away from the door and the seams to avoid weakening the wall. The airholes are cut



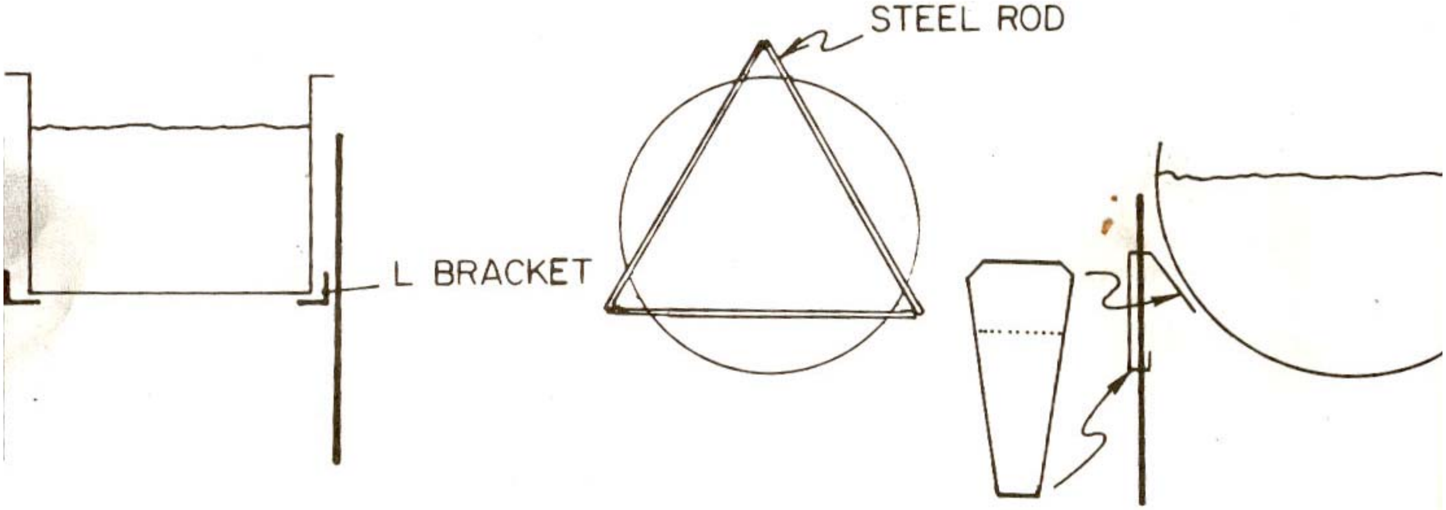
on two sides only so that when bent upward and inward they can act as supports for the grate. Larger airholes may be necessary if large pots are used or if the stove is used on soft soil where the stove will sink into the ground and block the airholes. Alternatively, for soft soil conditions a ring-shaped platform can be cut and attached to the stove.

A fifth airhole (tab) can be cut opposite the door and bent to be above the grate. This will prevent the grate from tipping upwards when wood is pressing down too heavily at the doorway.

4. Pot supports are similarly spaced evenly around the stove, but offset from the door and edges so as not to weaken the wall. The height P for the pot supports above the top of the airholes (where the grate will rest) is given roughly by

$$P = 0.4C/\pi = 0.4D$$

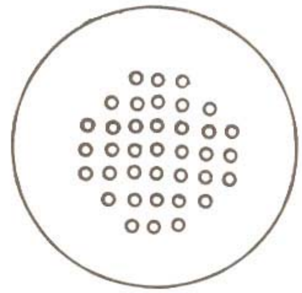
where D is the pot diameter. The best distance will vary somewhat with the size of wood used locally, its moisture content, and other factors.



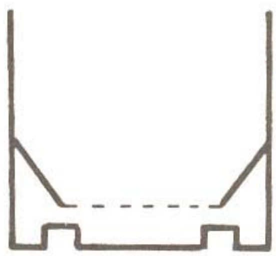
Pot supports should support the pot stably, yet be small in area so as not to shield the pot from the hot gases -- reducing heat transfer. Pot supports should not cause the stove wall to bend when heavily loaded as this can change the effective channel width and reduce performance.

5. The size of the door is somewhat arbitrary and is determined in part by the locally available wood size. Typical door sizes for use with a 90-cm-circumference pot are 12 cm wide by 9 cm high. The bottom of the door is placed at the grate position -- the top of the airholes. The top of the door is made several centimeters below the bottom of the pot so that the hot gases are guided up around the pot rather than out the door. If necessary, the door height can be decreased to ensure that it is below the bottom of the pot.

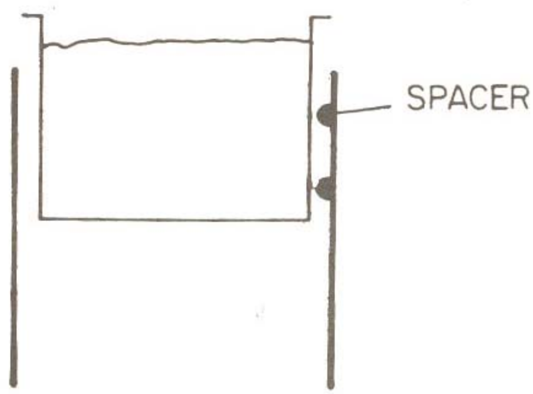
6. The grate is a circle of sheet metal cut to fit snugly into the finished cylinder. Recuperated scrap metal is often used. The center half diameter is punched with a 30% hole density of 1 cm holes. Grates should not have any holes much larger than 1 cm in diameter, since large holes in the grate will allow the charcoal to fall through and burn below the stove, reducing efficiency. Holes of too small a diameter will easily clog and reduce air flow into the charcoal bed.



In some cases it may be useful to form a conical grate. This will both better localize the fuel to improve combustion and provide an insulating dead air space along the stove wall.



7. Spacers, used to center the pot evenly, are also often needed.

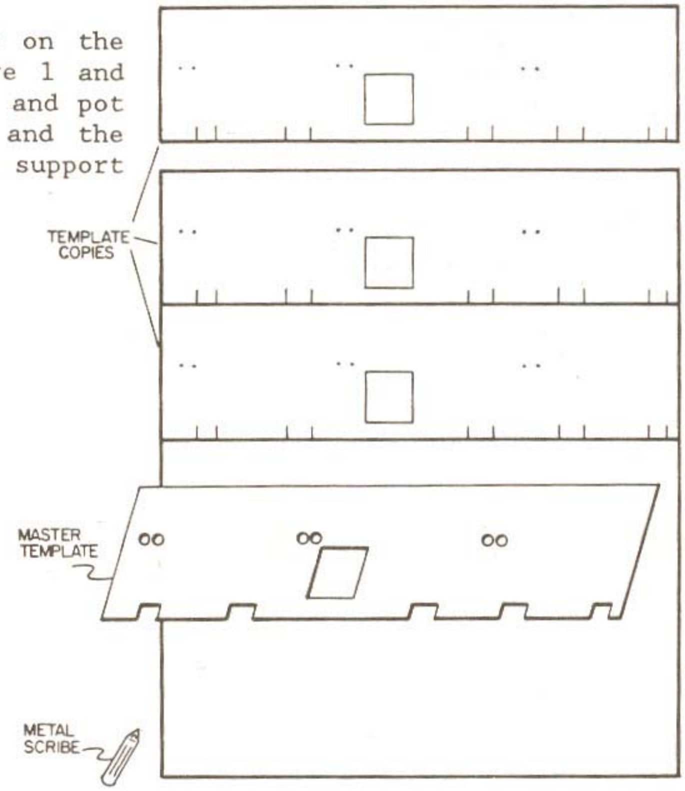


Templates for tapered pots can be developed geometrically from conic sections. Dimensions are developed in the same manner as above. Other features such as double walls, insulation, chimneys, or others can be included as desired. Attachments might include handles for carrying the stove or clamps for holding the pot firmly in place while stirring thick porridges.

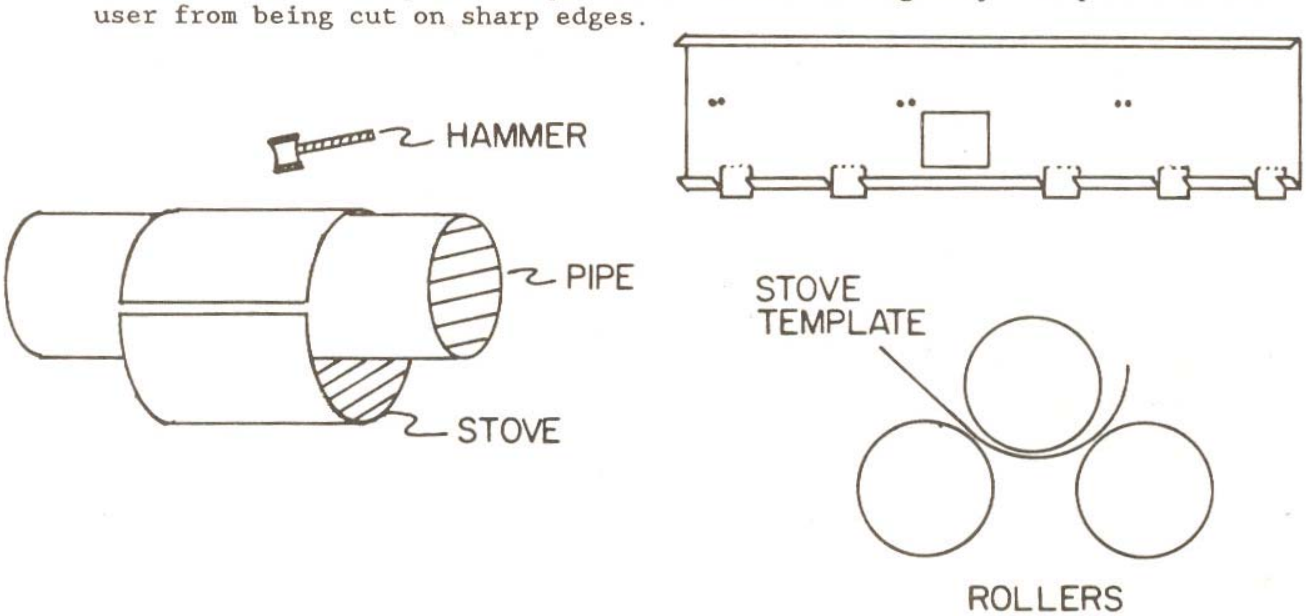
METAL STOVE PRODUCTION

Production test data for this type of stove, including production rates and costs, are given in Tables V-3 and V-4. The general procedure used is the following, with specific tasks divided among different workers.

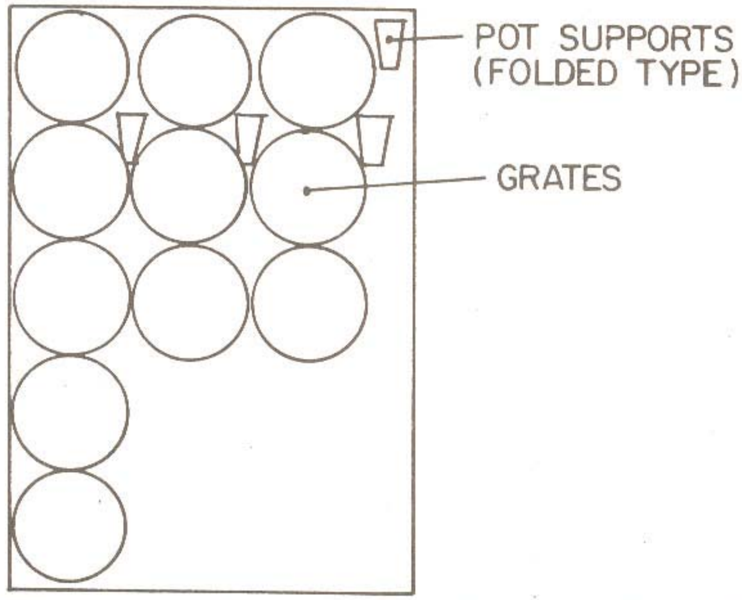
1. The template is traced out on the metal sheet as shown in Figure 1 and cut out in outline. The door and pot support holes are cut out, and the strips for the airholes and to support the grate are cut.



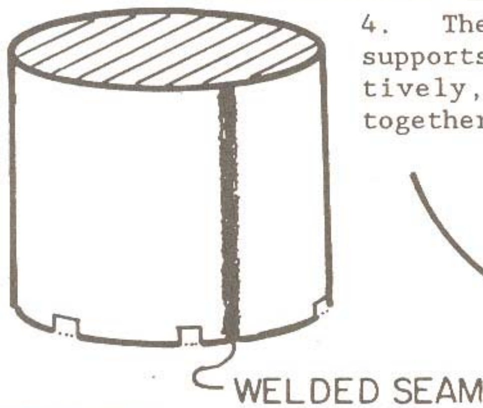
2. The metal is rolled into a cylinder -- it should be as smooth, round, and straight as possible. If a sheet metal roller is used, the top and bottom can be folded over before rolling. If bent by hand, they can be folded after rolling. This provides additional rigidity and prevents the user from being cut on sharp edges.

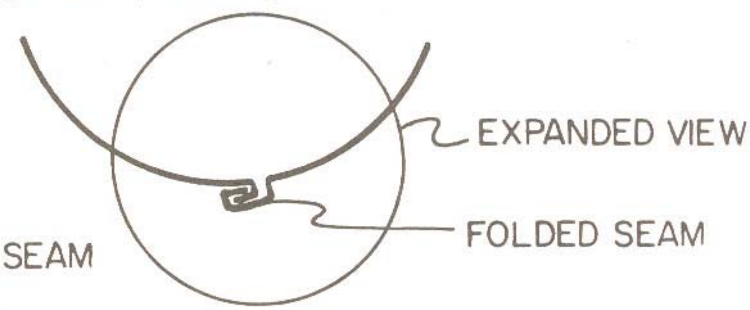


3. Other components such as the pot supports and the grate are cut out and the holes punched in the grate.

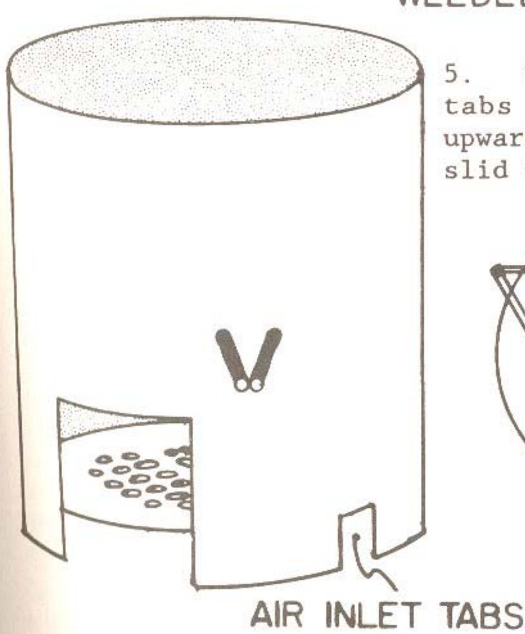


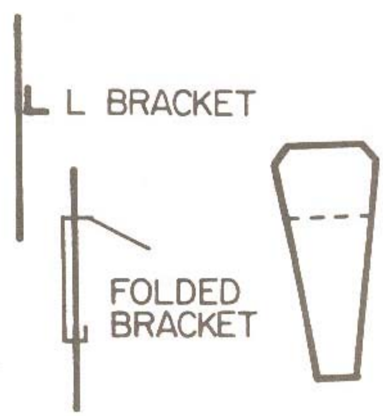
4. The stove is welded together and pot supports are welded into place. Alternatively, the stove walls can be locked together by folding.





5. The grate is placed in the stove, and the tabs for the airholes are bent inward and upward to support the grate. Pot supports are slid and folded or welded into place.





6. The stove is given the desired surface finish (electroplating, painting with heat resistant paint, etc.) to improve its rust resistance and market appeal, and to reduce its heat loss by lowering its emissivity.