

SIMPLE PLANS FOR THE APROVECHO DOUBLE BURNER ROCKET STOVE



This chimneyless, very low smoke stove is designed to be used outside or in well ventilated areas. It can cook 2 pots at the same time and can also bake bread when used in conjunction with an enclosed skirt/oven (see photo left) . Anecdotal reports from around the world have shown a 40-75 % reduction of fuel wood consumption when compared to a traditional 3– Stone fire.

This stove was designed through the coordinated efforts of Aprovecho Research Center, GTZ, ProBEC and the people of Southern Africa. If you have questions about these plans please contact your local ProBEC representative at _____ or contact Aprovecho at apro@efn.org .

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BEFORE GETTING STARTED

Tools

- Tin snips (offset if possible)
- Electric steel grinder and cutter
- Arc welder
- Vice grips and/or pliers
- Steel friction cutter for cutting 45° angles
- Square
- Metal chisel
- Scribe

Optional

- Hydraulic box and brake (for bending)
- MIG welder

Materials

- 1/2 of 200L used steel drum
- Combustion chamber: ceramic, 3CR12, or mild steel
- 3 mm by 25 mm steel flat bar
- 6 m by 12 mm steel round bar
- 1 sheet of 1.2 mm 3CR12 or 2-3 mm mild steel
- 10 kg of vermiculite
- 25 mm by 2 mm square tube

Before selling the stove, you should ask the potential buyer a number of questions:

What type of fuel are they using for the majority of their cooking?

Wood?

The Rocket stove is suitable.

Fossil fuel (paraffin or LPG)?

Be cautious about introducing a wood stove to women who are using other types of fuels as it can lead to an increase in overall wood consumption. Consider promoting a Wonder box instead.

Does the buyer want to cook inside or outside of their house?

Outside?

The Rocket stove is suitable.

Inside?

Ask if the house is well ventilated.

Is it a well ventilated building ?

The Rocket stove is suitable.

It is *not* well-ventilated?

consider using a Rocket stove with an external chimney like the Ecostove (if funds permit).

What size pots are they using?

Are they round bottomed or flat bottomed or a combination of both?

Make the two pot supports and skirts based on the cooks needs (see pages 11, 12, 13).

What is the thickness of the pieces of the wood that they are using?

Twigs and pieces less than 50 mm?

the 100 mm diameter rocket should be used.

Pieces larger than 50 mm?

the 125 mm diameter round rocket elbow should be used.

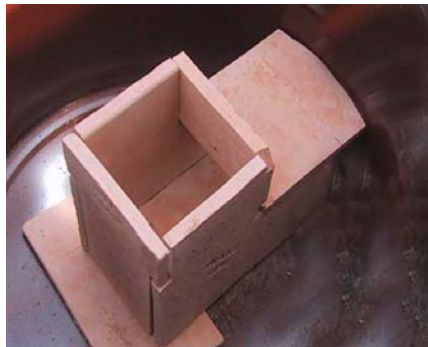
Note: This is only a partial list of the questions that should be asked. Try to find out as much about the cooking habits of each customer before selling a stove

ROCKET ELBOW OPTIONS

The Double Burner Rocket Stove can be made with different types of materials. The type of elbow/combustion chamber should be chosen before building the stove body as each elbow requires a different stove body configuration. Options are listed in order of preference.

Option 1: Ceramic Tiles

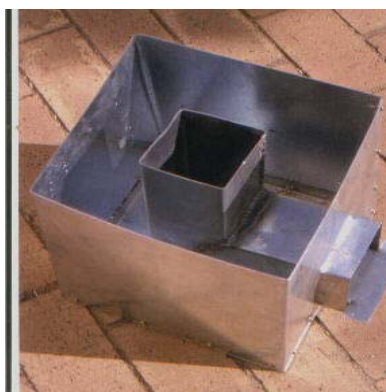
Price (in Central America): is approx 10 Rand per elbow



Option 2: 3CR12

1.2 mm flat sheet 3CR12 can be bent into a 100 mm rectangular box which can then be cut to form an elbow.

Price (in South Africa): is approx. 30 Rand per combustion chamber. (The 3CR12 elbow shown here is the Single Pot Rocket version*).



Option 3: 100 mm by 3 mm mild steel square tube

Price in South Africa: is approx 20 Rand per combustion chamber.

125 mm by 3 mm mild steel round tube can also be used .

Price: in South Africa is 22 Rand per elbow.



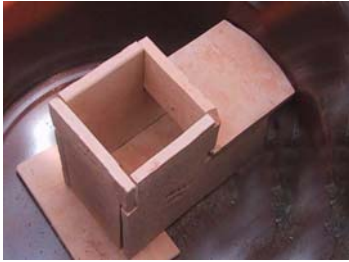
Cast iron, refractory cement and various types of insulative ceramic (such as pumice/ vermiculite and clay blends) can also be used. See Rocket Design Guide for more information about the benefits and challenges of these materials. Aprovecho is currently developing a new insulative ceramic elbow. Contact us for more details.

*Plans are also available for the single pot model.

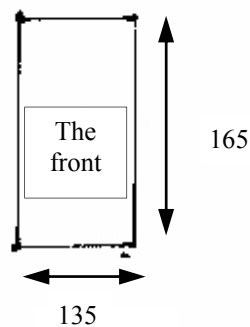
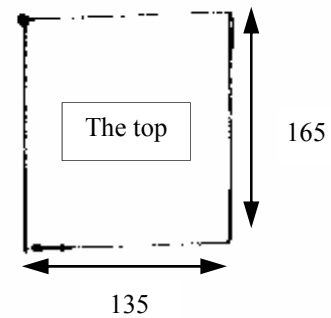
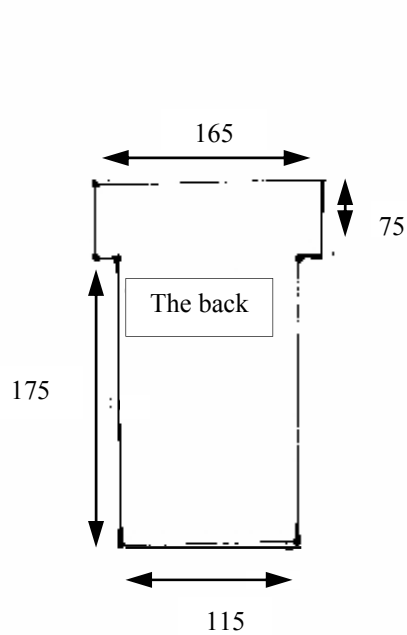
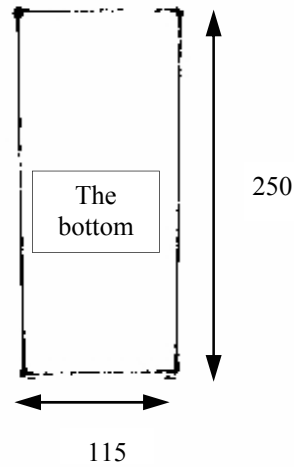
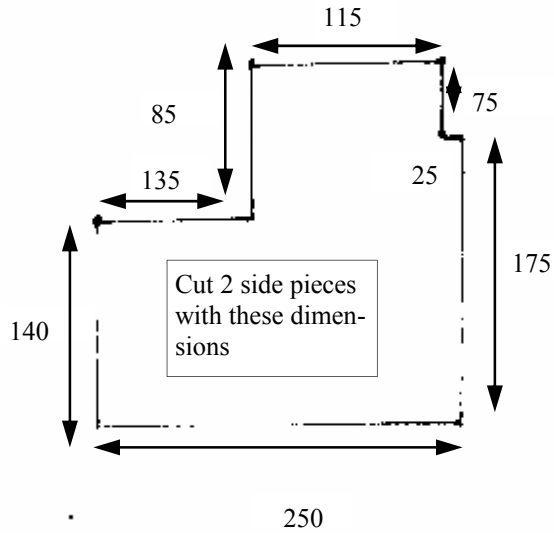
From the following 5 pages choose one of the 3 elbow options: ceramic tiles, 1,2 mm 3CR12 or 3 mm mild steel.

Follow the appropriate directions in the other parts of the guide which are specific to the elbow that you have chosen. For example if using the 100 mm elbow be sure to follow the directions for the corresponding 100 mm shelf.

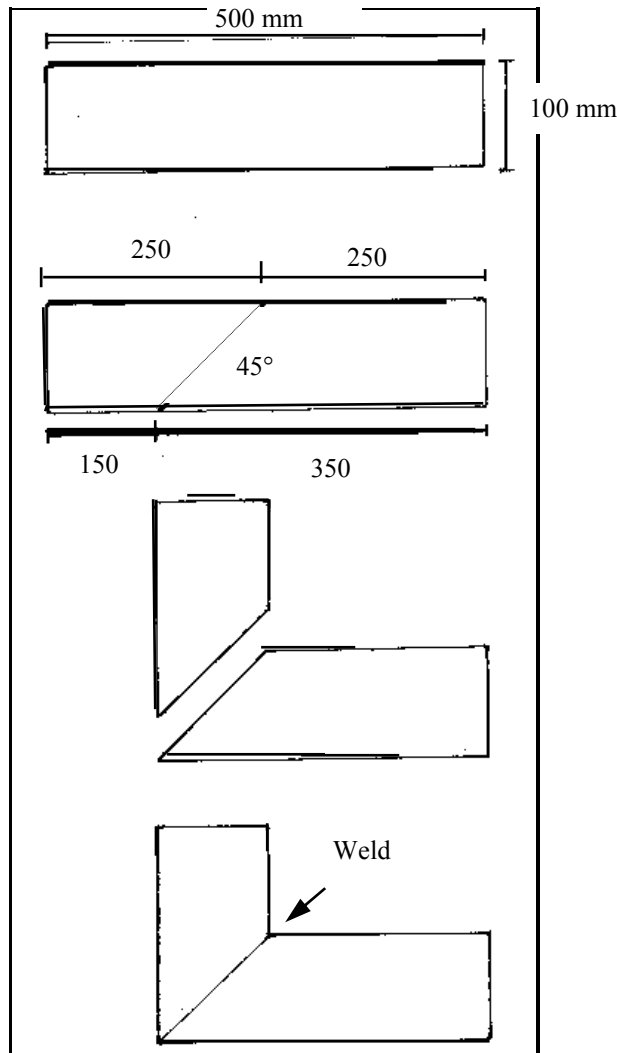
ROCKET ELBOW WITH CERAMIC TILES



Use the following measurements to form a combustion chamber with ceramic bricks. Some experimentation will be necessary to create the ideal ceramic brick. The ideal bricks are not hard pressed or compacted like modern brick. They use a lot of water and are set up 'sloppy'. This will result in a porous brick that is friable. When placed in water, it should 'fizz' due to the large number of pores in the brick. The tiles should not feel dense or heavy but crumbly and soft. The ideal thickness is 25 mm. See Rocket design guide for more info.



CONSTRUCTING THE 100 MM SQUARE TUBE ROCKET ELBOW



Take one piece of 100 mm by 6 metre square tube and cut a 500 mm section.

Cut a 45 degree angle as shown.

Lift the smaller piece 90 degrees vertical and rotate 180 degrees.

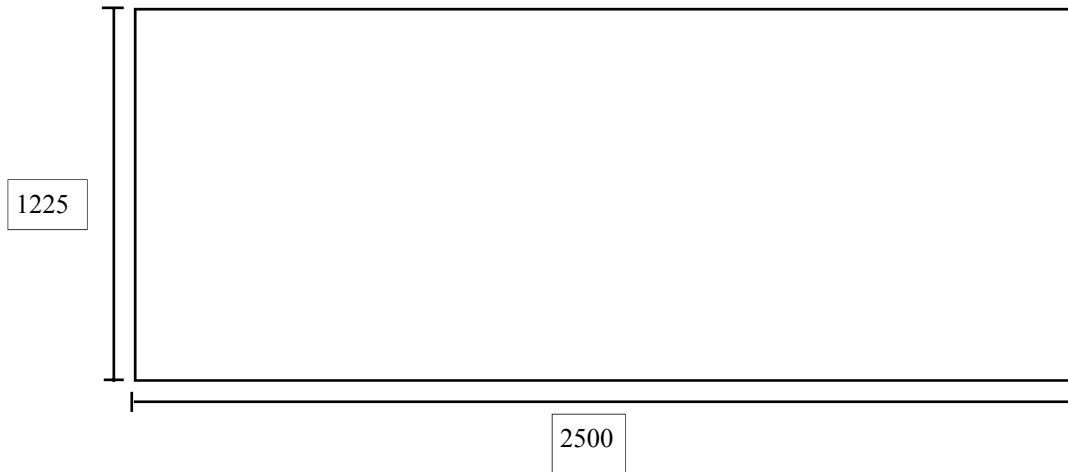
Connect the two pieces and **tack** weld along the seam. Be sure to fill in any gaps between the pieces that might allow insulation to pass through.

Before welding the two pieces together, grind the insides of the joints until smooth. If sharp pieces are left exposed on the inside of the tube, the cook could cut their hands when they reach in to clean out the wood ash.

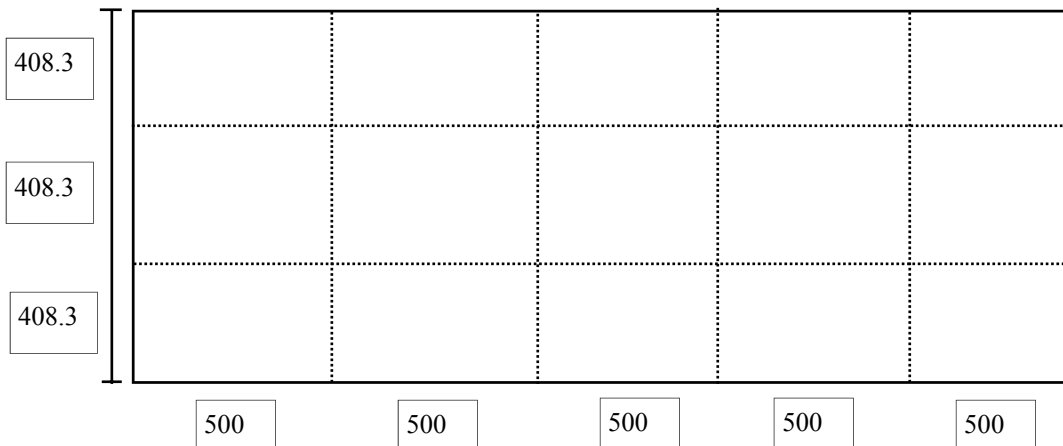
Build two complete combustion chambers as shown.

BUILDING THE COMBUSTION CHAMBER WITH 1.2 MM 3CR12

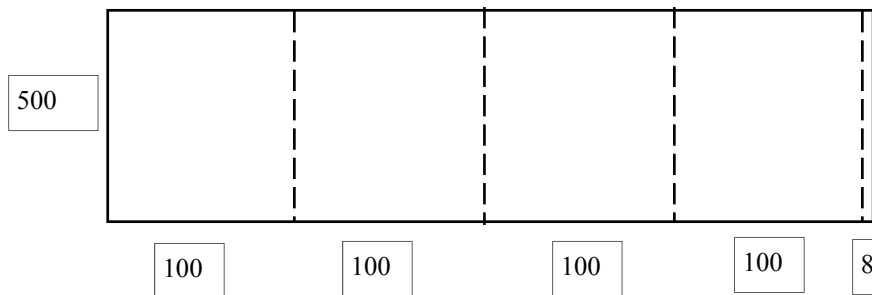
Take one piece of 1225 mm by 2500 mm by 1.2 mm 3CR12



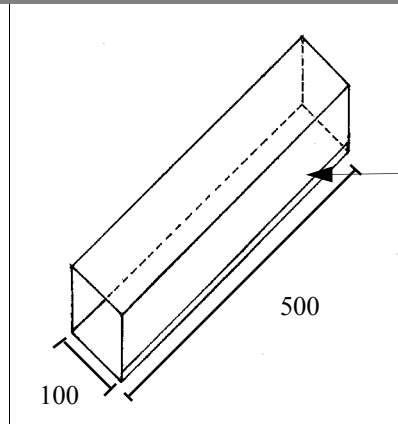
Scribe and cut the 1225 mm by 2500 mm piece as shown below to yield 15 pieces



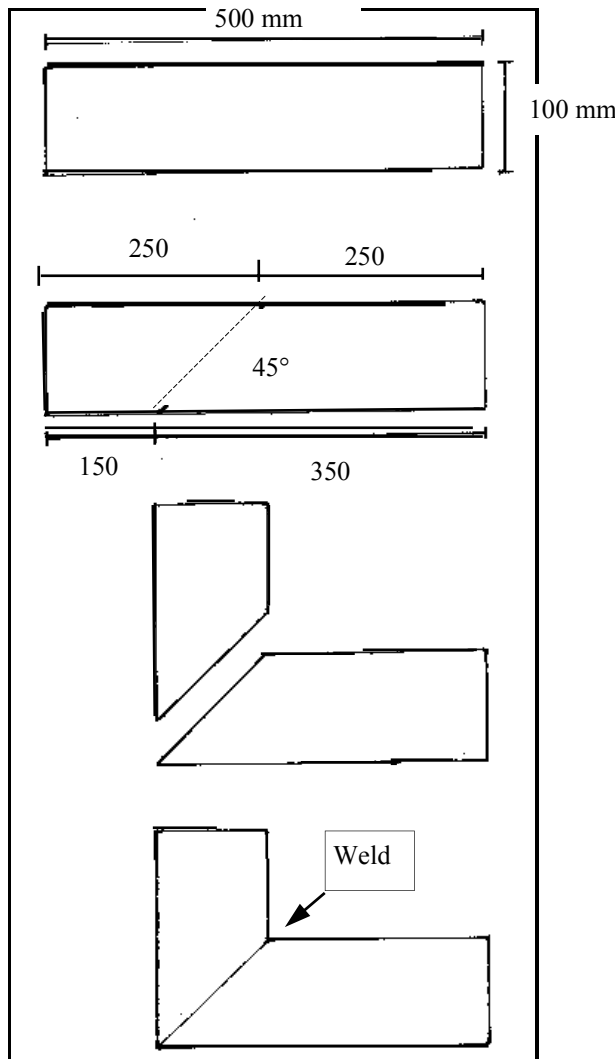
Take each of the sections and scribe the lines as shown but do **not** cut. Bend the 4 scribed lines to form a 4-sided box with an 8 mm lip. See following page for a sketch of how the box



COMPLETING THE 100 MM 3CR12 COMBUSTION CHAMBER



The 3CR12 rectangular box from the previous page should look like this.



Take the 500 mm by 100 mm section.

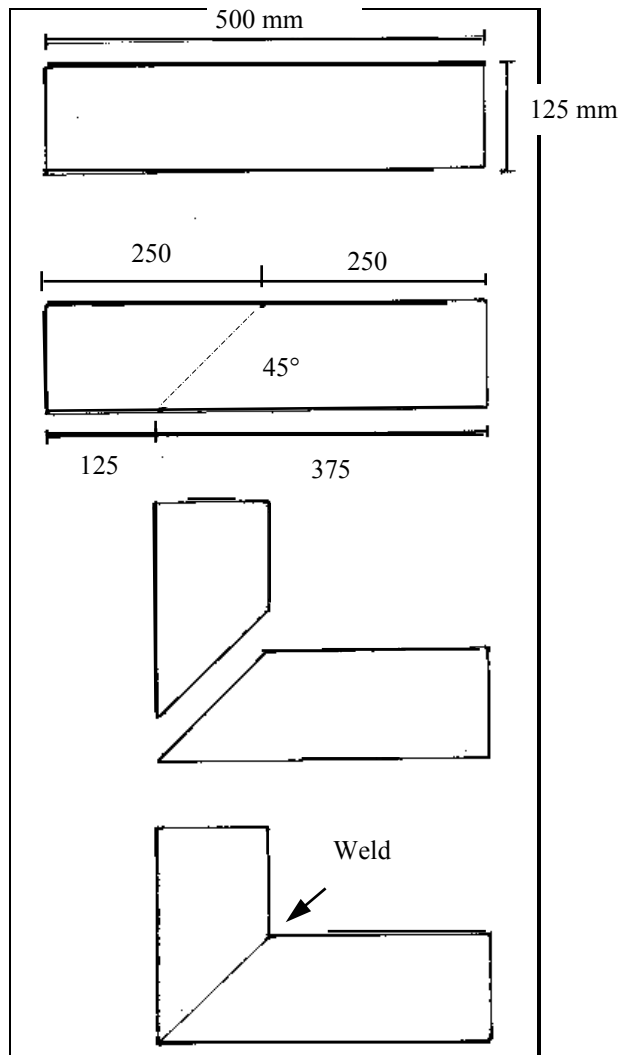
Cut a 45 degree angle as shown.

Lift the smaller piece 90 degrees on the vertical and rotate 180 degrees.

Connect the two pieces and **tack** weld along the seam. Make sure there are **no** gaps along the seam that could allow insulation to fall through.

Before welding the two pieces together, grind the insides of the joints smooth. If sharp pieces are left exposed then the stove users could cut their hands when they reach in to the combustion chamber to clean out the wood ash. Build two complete combustion chambers as shown.

BUILDING THE 125 MM BY 3MM ROUND TUBE ROCKET ELBOW



Take one piece of 125 mm by 6m square tube and cut one 500 mm section.

Cut a 45 degree angle as shown.

Lift the smaller section 90 degrees (on the vertical axis) and rotate 180 degrees.

Connect the two pieces and **tack** weld along the seam. Be sure to fill in any gaps that might allow insulation to pass through.

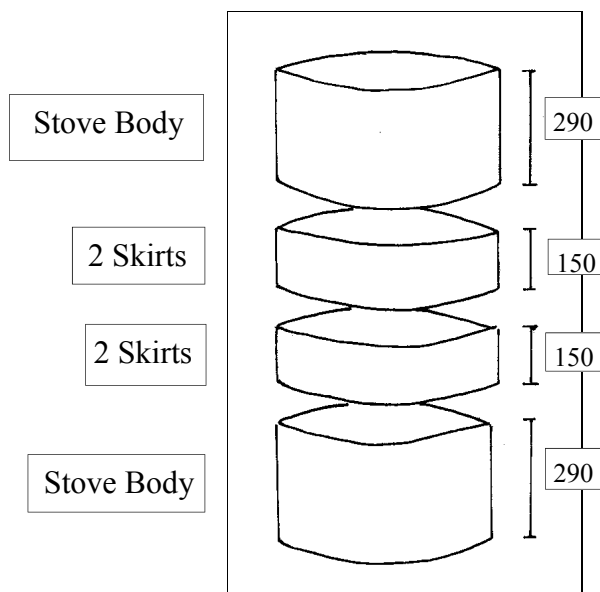
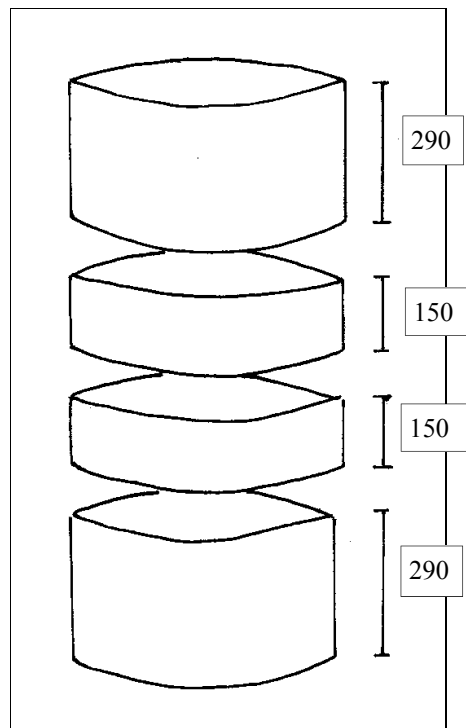
Before welding the two pieces together, grind the insides of the joints smooth. If sharp pieces are left exposed the cook could cut their hands when they reach in to clean out the wood ash.

Build two complete combustion chambers as shown.

BUILDING THE STOVE BODY WITH USED 200L STEEL DRUMS

The body of the stove can also be built with other materials such as .8 mm galvanized sheet steel, brick, adobe, cement or pumicrete. The type of stove body will not significantly effect the efficiency of the stove.

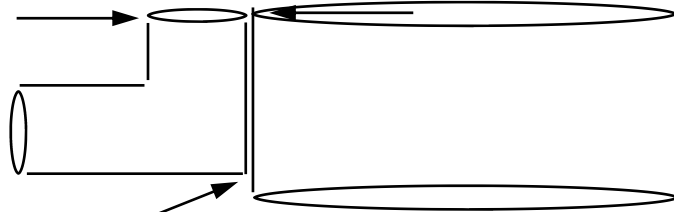
Cut the drum into 4 pieces as shown: two 150 mm sections and two 290 mm sections. The 290 mm section will be the body of the stove and the 150 mm section will be cut to form 2 pot skirts. Use an electric grinder to smooth out any sharp edges.



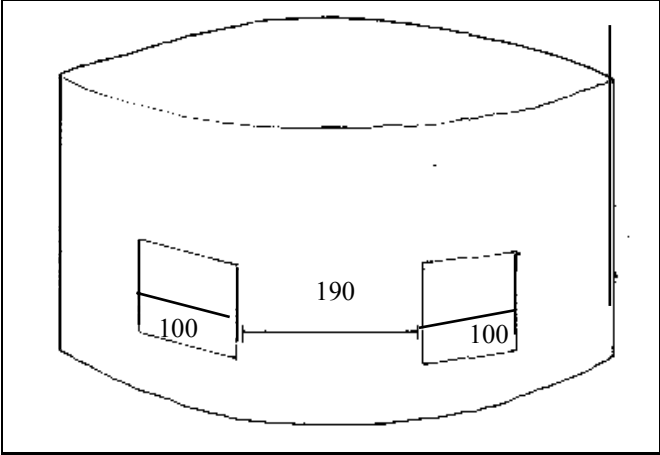
Note: If using 100 mm square tube, follow the directions given below . If using ceramic tiles or the 125 mm round tube then adjust the opening accordingly.

CUTTING THE OPENING FOR THE ROCKET ELBOW

1 Place the elbow against the drum so that the top of the chamber is level with the top edge of the drum.

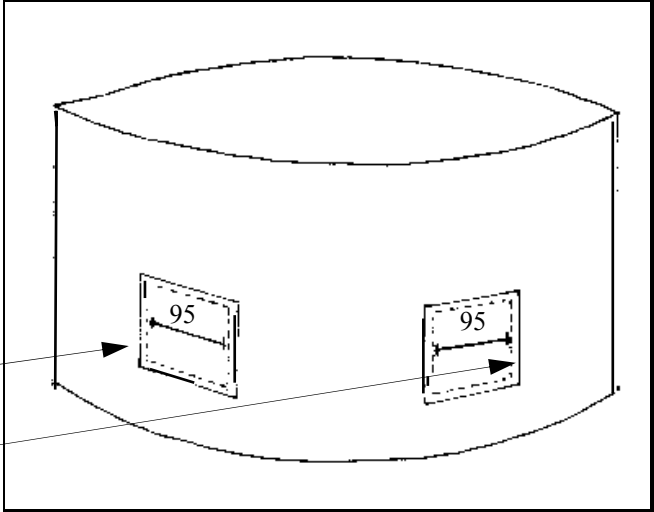


2 Scribe a 150 mm horizontal line on the drum where it meets the bottom of the elbow. There should be a 40 mm (approx.) gap between the *bottom* of the elbow and the *bottom* of the drum. Repeat steps 1 and 2 for both entrances.



3 Scribe two 100 mm squares spaced 190 mm apart (using the 150 mm horizontal lines drawn in step 2 as a starting point. You can trace the perimeter of the elbow to create the 100 mm squares. Do **not** cut these lines.

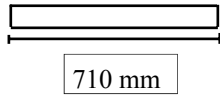
4 Scribe a 95 mm square on the inside of the 100 mm scribed line. Cut and remove the 95 mm square with tin snips or a electric grinder. Bend the remaining 5 mm flange to the inside of the stove body.



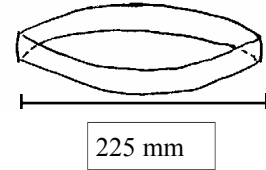
5 The outer side flanges will have to be bent severely to allow the elbow to enter on the correct angle. Once in place, the two elbows should be parallel to each other.

CONSTRUCTING THE POT SUPPORT FOR #2 AND #3 ROUND BOTTOM 3-LEGGED POTS*

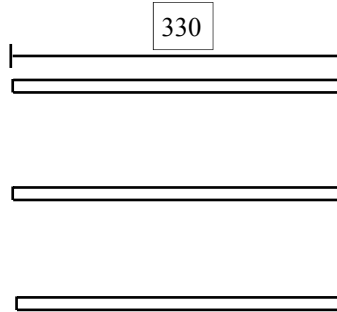
1 Take a strip of 3 mm by 25 mm by 6 metre flat bar and cut one 710 mm section .



2 Form the 710 mm flat bar into a 225 mm diameter circle and weld the ends together.



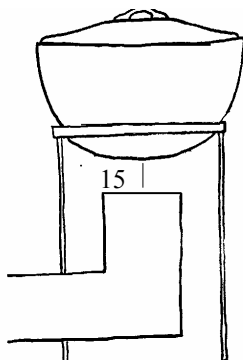
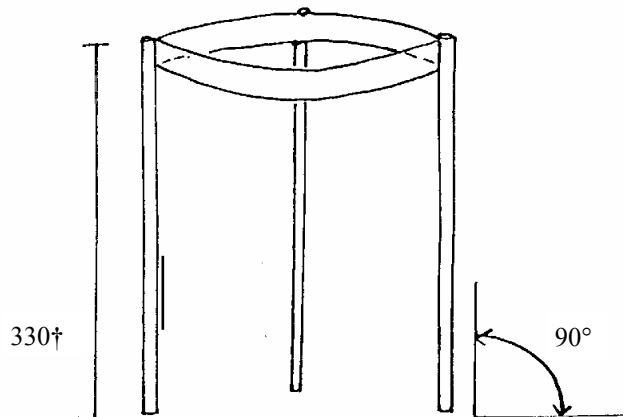
3 Take a strip of 12 mm steel round bar and cut three 330 mm sections.



4 Connect the round bar sections to the flat bar circle. Make sure the round bar is 90 degrees to the flat bar and the welding table.

Construction tip

A small square can be temporarily welded to the welding table to maintain the correct angle.

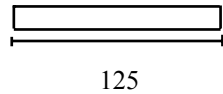


- *Pot supports should be custom made to suit the pots most often used by the customer. Most women in South Africa tend to use only 2-4 pots so the pot supports can be adapted for each women's cooking needs . A selection of common size pot supports should be produced in small quantities to have for display and sale.
- † 330 mm is the standard height of the pot stands but may need to be altered to form the ideal gap between the pot and the top of the combustion chamber. The *bottom of the pot* should be **20 mm** from the *top* of the Rocket elbow. Depending on the shape of the bottom of the steel drum, the pot stands may need to be raised or lowered to achieve this ideal gap.

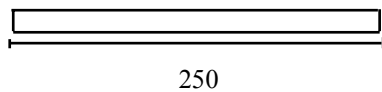
BUILDING THE POT SUPPORT FOR FLAT BOTTOMED POTS

Suitable for a wide variety of pot sizes.

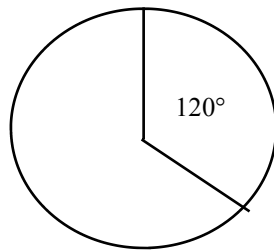
1 Take one piece of 3 mm by 25 mm flat bar and cut a 125 mm section.



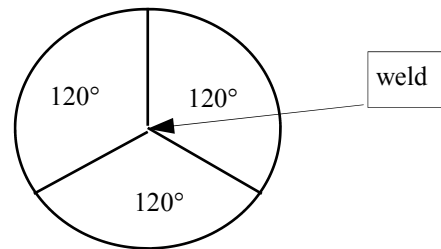
2 Take one piece of 3 mm by 25 mm flat bar and cut a 250 mm section.



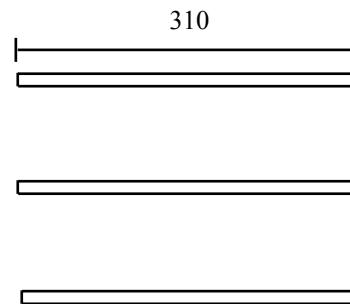
3 Bend the 250 mm section of flat bar 120°.



4 Weld the 125 mm section to the 250 mm section to form two more 120° angles.

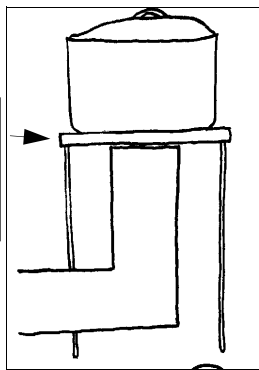


5 Take a piece of 12 mm round bar and cut three 310 mm sections.†



† 310 mm is the standard height of the flat bottomed pot stands but may need to be altered to form the ideal **25 mm** gap (the thickness of the flat bar). Depending on the shape of the bottom of the steel drum, the pot stands might need to be raised or lowered to achieve the ideal gap. Note: the the bottom of the flat bar should touch or rest a few mm above the combustion combustion.

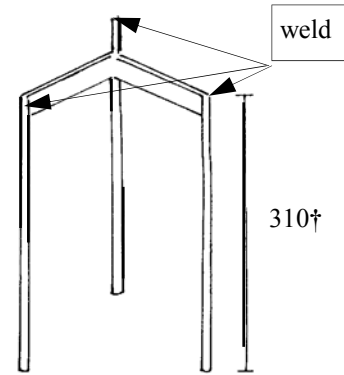
25 mm gap formed by the flat bar.



6 Weld the round bar sections to the y-shaped flat bar. Make sure the round bar is 90 degrees to the flat bar and the welding table.

Construction tip

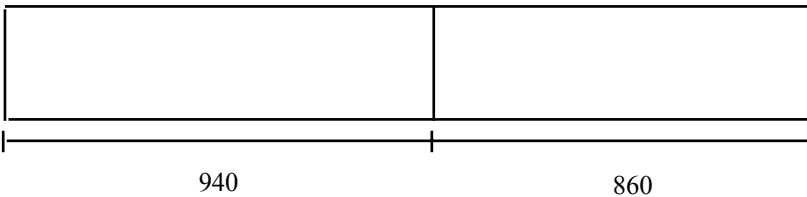
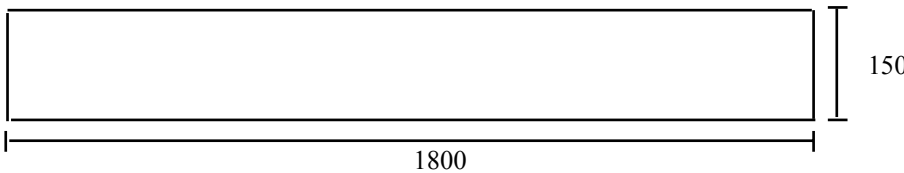
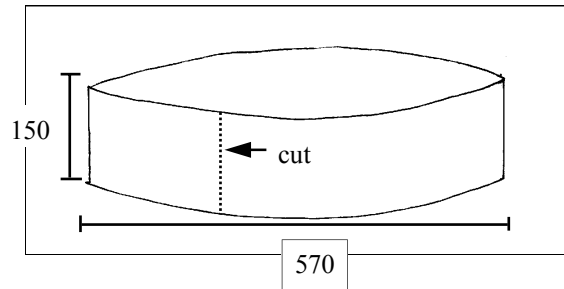
A small square can be temporarily welded to the welding table to maintain the correct angle while connecting the round bar to the flat bar.



BUILDING THE POT SKIRTS FOR #2 AND #3 ROUND BOT-TOM 3-LEGGED POT.

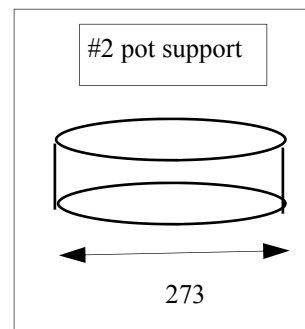
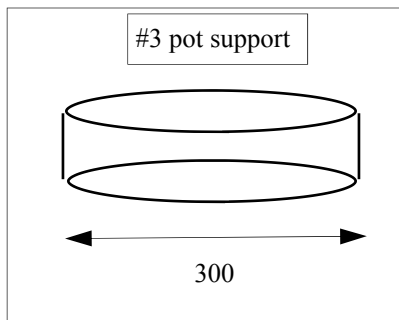
These dimensions will have to be modified if building skirts for other sizes of pots. Different size skirts might require extra material - use 1 mm untreated sheet steel or 3CR12

1 Make a vertical cut anywhere on the steel drum section and hammer in to a 1800 mm by 150 mm flat section (shown below).



2 Cut the 1800 mm section into one 940 and one 860 mm section.

Roll the sections into 2 separate cylindrical forms and join by brazing along the edges. Do **not** fold a seam to join. When the pots are put in place, there should be a 10 mm gap between the pot and the skirt. If the gap appears to be too small, then the skirt needs to be expanded to allow sufficient air flow between the pot and the skirt



The gap between the pot and the skirt

Maintaining the gap between the **skirt** and the **pot** is just as important as maintaining the gap between the **pot** and the **combustion chamber**. If the gap is too small, then the heat will not flow through the system. If it is too big (>20 mm) then the heat will not be forced to rub against the pot. A good rule of thumb for the gap between the pot and the skirt is 10 mm for big pots size 2 and larger and 20 mm for smaller pots.

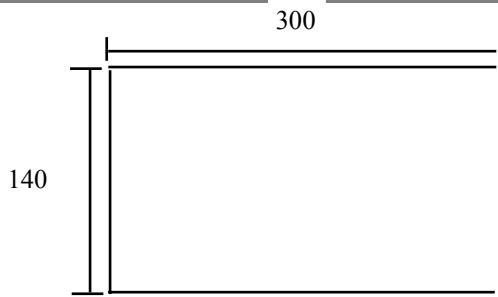
If you want to find out the exact gap for each pot and combustion chamber combination you can use this simple equation (in cm)

$$\frac{2.5 \cdot \text{diameter of combustion chamber}}{\text{diameter of pot}} = \text{gap between pot and skirt}$$

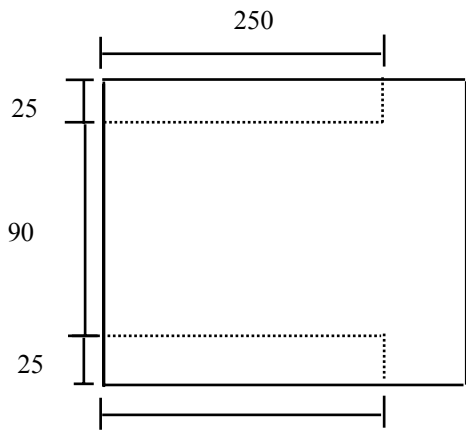
Remember this is the ideal gap and might need to be widened to make the skirt more user-friendly.

BUILDING THE SHELF FOR THE 100 MM COMBUSTION CHAMBER

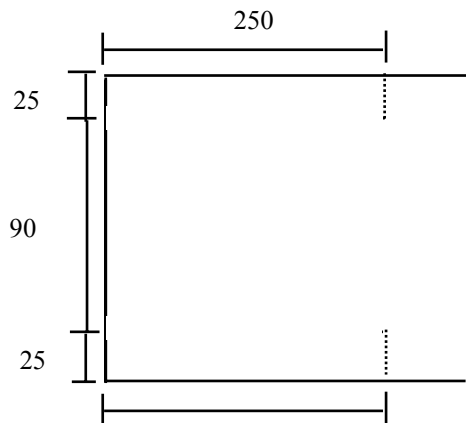
(Use 2-3 mm mild steel or 1.2 mm 3CR12)



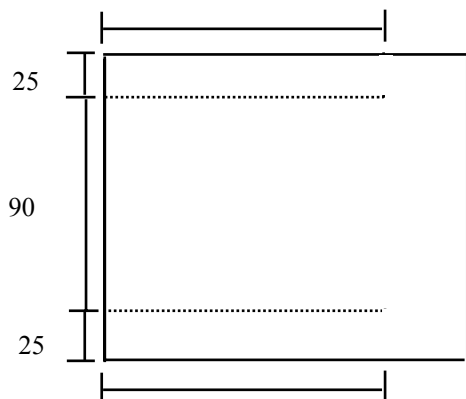
Cut one piece of mild steel or 3CR12 into a 300 mm by 140 mm section.



Scribe but do **not** cut the dotted lines as shown.



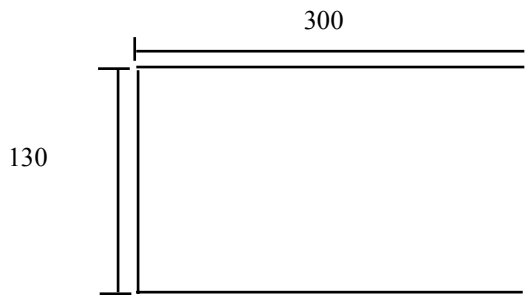
Cut the two 25 mm dotted lines.



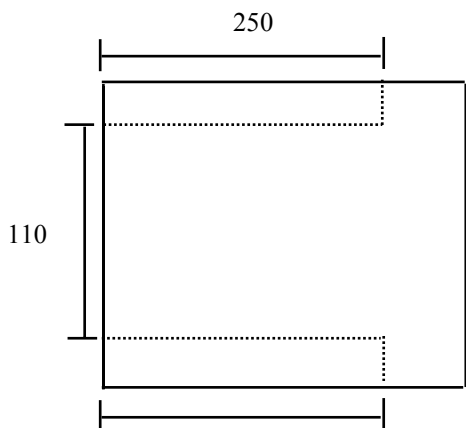
Fold upward along the two dotted lines to form the 25 mm shelf supports.

BUILDING THE SHELF FOR THE 125 MM ROUND TUBE ROCKET ELBOW

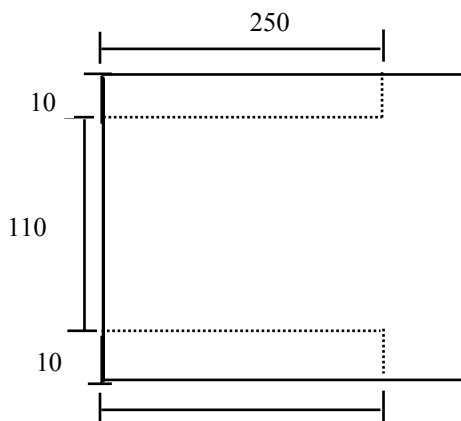
(3 mm mild steel or 1.2 mm 3CR12)



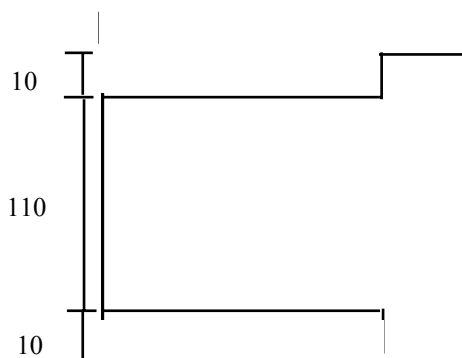
Cut one piece of 300 mm by 130 mm 3 mm mild steel or 1.2 mm 3CR12.



Scribe but do **not** cut the dotted lines as shown.



Cut along the dotted lines and remove the two 10 mm by 250 mm sections.



The shelf should be T-shape upon completion.

BUILDING THE OVEN/ENCLOSED SKIRT FOR BAKING

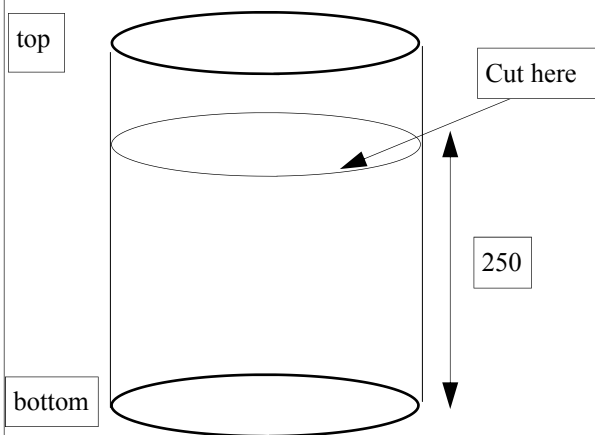


This skirt is made from a 20 or 25L used drum and is designed to be used only with a #2 cast iron pot (or equivalent). Smaller pots can also be used but will be less efficient due to the larger gap between the pot and the skirt/oven. Try to keep the bread away from the sides of the pot by placing a grill or an inverted aluminum pie plate between the bread and the pot bottom.

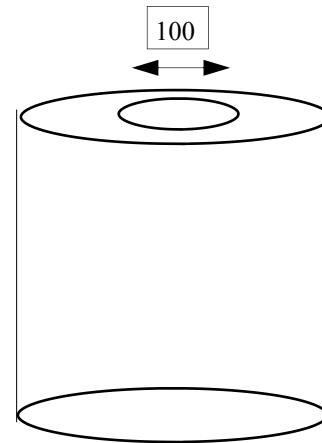
How to use the oven skirt

After the pap and relish has been cooked, the leftover coals can be used to cook the bread. A few twigs can be added to the combustion chamber to maintain a small fire. Do not allow flames to touch the bottom of the pot as it will burn the bread. Baking takes about 30 minutes.

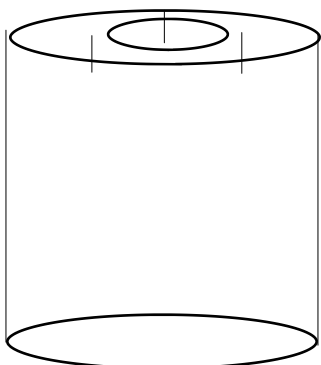
1 Take one 20 or 25L used clean drum and cut a 250 mm section (measuring from the bottom of the drum). Be sure to cut the **top** of the drum off, not the bottom.



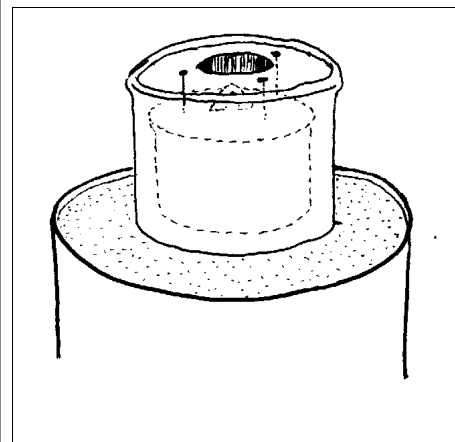
2 Invert the drum and cut a 100 mm circle in the middle of the bottom of the drum. Be sure to grind the edges smooth to prevent cuts.



3 Take three 20 mm screws and drill them into the drum body spaced 120° apart. This will maintain the ideal gap between the pot and the oven skirt for optimum air flow.



4 If possible paint the oven skirt with a high temperature paint and use as shown below

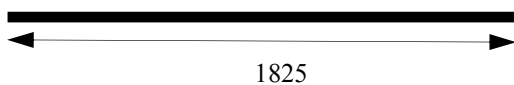


BUILDING THE STOVE BODY STAND

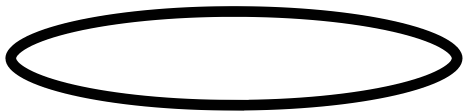
The stove can be built with or without a stand depending on the needs of the customer. The height can also be modified to suit the individual.



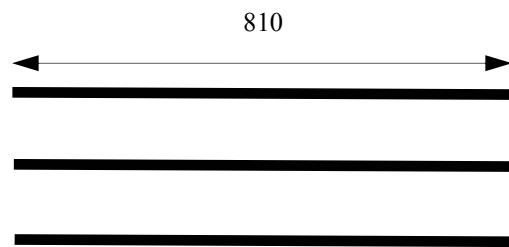
1 Take one piece of 12 mm steel round bar and cut a section 1825 mm long.



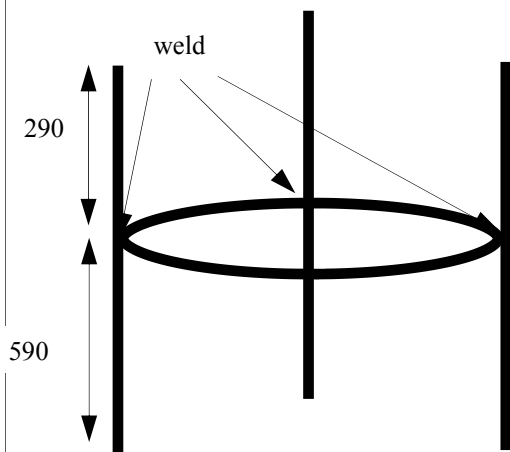
2 Bend into a circle and weld.



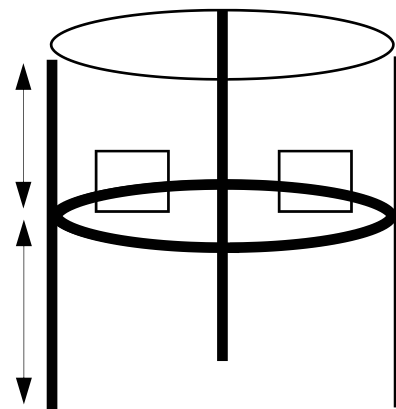
3 Take one piece of 25 mm by 2 mm square tube and cut three 810 mm section.



4 Weld the square tube to the round bar as shown.



5 The drum/stove body can be fixed to the pot stand with screws or rivets or it can be left unattached.



COMPLETING THE DOUBLE BURNER STOVE

- When the stove is complete it should look similar to the schematic shown below. The final appearance will depend on which pot supports and pot skirts are used. If women are using both flat bottomed and round bottom pots, be sure to include both types of supports with the stove.
- Each stove requires one 10 kg. bag of vermiculite (cost in South Africa is 25 Rand per bag plus 5 Rand for delivery). I recommend that the vermiculite not be placed in the stove until it is delivered to the owner's house. . Medium grade is the ideal size although any grade will work. In South Africa vermiculite can be purchased from DJ Mining (tel. # 011 762 5366). In areas where vermiculite is not available dry wood ash can be used instead.
- Be sure to include the user guide with each stove .

