

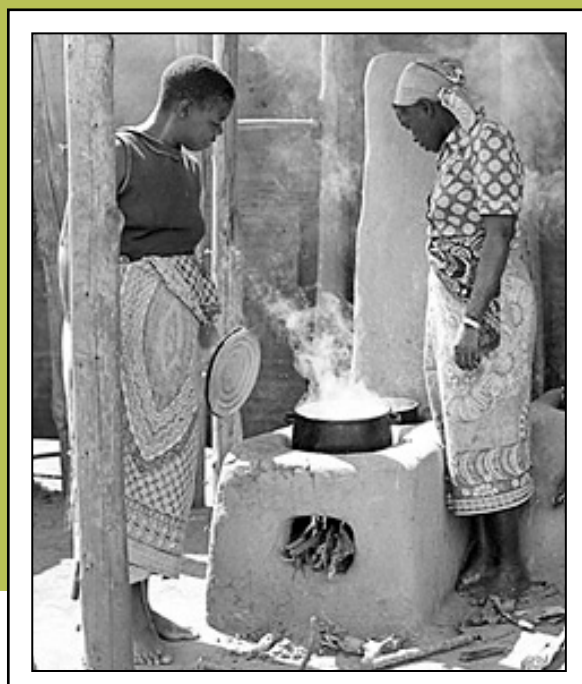
THE EXPERIMENTALIST

Encyclopedia of Science and Technology for Young People

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Technology: Rocket Stoves

Construction: Village-made Improved stoves

Community: Weaving on the Inkle loom.

The Boy who Harnessed the Wind

World Technology: Modern Wind Turbines

Editorial

This edition of *The Experimentalist* contains the story of William Kamkwamba of Malawi, a boy from a poor family who built a windmill to generate electricity. As we have shown several times in this magazine, many young people from sub-Saharan Africa are inventive. They are capable of doing things which many of their fellow countrymen do not believe can be done by poor rural people.

You young people who read this magazine must believe this. With the help of this magazine and from your lessons in school, you should seriously consider learning practical science and technology. It is a career open to all boys and girls.

You can do it. As William said: "Trust in yourself and never give up."

How to make a Rocket Stove

The Rocket stove is a variety of wood-burning stove. It is easy to construct using low-cost materials and is designed to burn small pieces of wood very efficiently. Cooking is done on top of a short insulated chimney. This article shows you first how to make a simple version of this stove using regular sized food tins (as seen in Figure 1) that can be easily procured. Then other materials will be shown to make a stronger or larger stove.

The principal of the stove

The idea is to use the smallest possible amount of wood to give the maximum heat possible by giving the stove the dimensions and form shown in the diagram:

A = Lower part of the Burn-tube.

B = The top part of the Burn-tube.

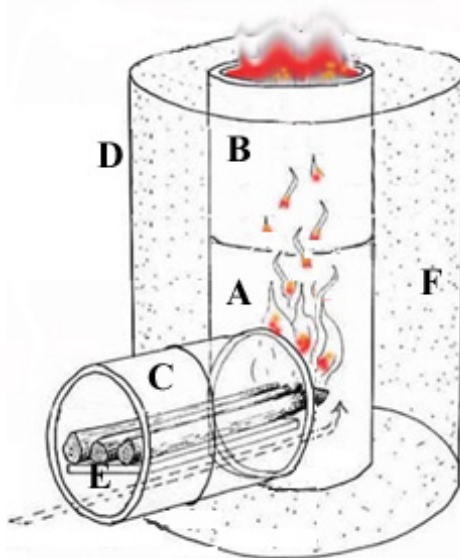
C = The Fire-box

D = The outer wall of the stove.

E = Tin shelf for the wood to rest on.

F = Insulation

L = Tin lid



The burn-tube should be about 40cm tall and is insulated, thus creating a strong draft. Smoke is drawn through the flame and burns completely. This eliminates noxious kitchen smoke.

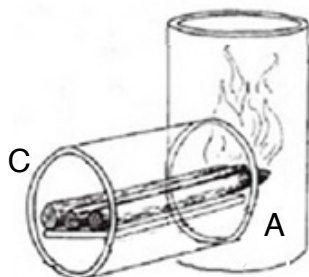
Only small amounts of wood can enter the fire-box. The wood limits the air flow, making the air/fuel mixture ideal. Air enters beneath the wood.

You will need 1 large tin of approx. 40cm high x 25cm. and 4 smaller tins of 15x10cm. The sizes do not need to be exact and they could be rectangular instead of round. You also need a flat piece of tin to serve as a lid for the large tin.

Figure 1



Tin A, the lower end of the burn-tube, (which has a closed base and an open top) also has a hole cut in it so that tin C, the fire-box, can fit into it exactly. Tin C is open at both ends.



Tin D is the outer casing and has a hole cut into it for the fire-box and lower burn-tube to fit in exactly.

Here you can see how tins A and C fit into the large tin D.

The upper part of the burn-tube B is open ended and has slit in it so that the sides will overlap and fit inside the lower burn-tube.

Insulation

Now fill the the entire empty space around and under the burn-tube and the fire box with sand or ashes for insulation.

Vermiculite (from an Agricultural store) could also be used if it can be obtained. It provides better insulation.



Fit the tin lid on top of the insulation.

Now we need to make the shelf E for the wood to rest on from the last tin. Open out the tin and cut it to the shape shown in the photo so that it wedges into the firebox. >>



The finished stove

<< Note the sides that have been cut and folded down to provide pot rests and hold the lid in place.

Using stronger materials

The disadvantage of the stove made with thin food tins is that it won't last long - six months at the most. However the stoves can be made larger and sturdier, but the same proportions should be kept.



The stove will be more efficient and lose less heat if a kind of metal "skirt" is placed around the pot on top of the stove so that the heat passes the sides of the saucepan. Or the outer tin can be tall enough to allow space for the pan to sit into the stove. Note the iron rod pot-rests in the photo.

See the film "Build a Rocket Stove, Step-By-step" at the following web site:

<http://www.youtube.com/watch?v=P6ValmUnjz4>

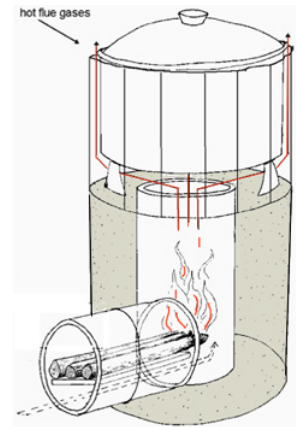
Also: "Best Rocket stove design ever": <http://www.youtube.com/watch?feature=fvwp&NR=1&v=yRLR07GRgvQ>

And: <http://youtu.be/Flo4sn7TASU>

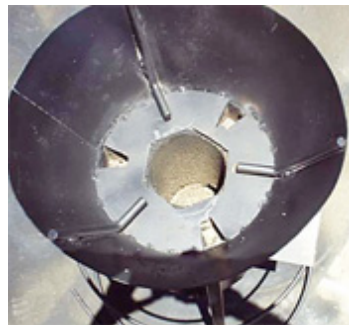
And: <http://youtu.be/wRbr3KsEjeE>



M = Metal skirt around the pan



Paint tins, water tins or oil tins could be used as the outer wall of the stove. But food tins are really too thin for the burn-tube and the fire-box. It would be better to make cylinders of stronger metal. For example you could beat flat a piece of corrugated roofing sheet and make up the required size cylinders either by getting it welded or using rivets.



View inside the institution stove

Rocket stoves can also be used for institutional cooking where food is cooked in large pans. They can be scaled up to be slightly taller and wider. A metal construction can be made to support the large pan as you can see in the picture of a stove produced in Malawi. >>



A rocket stove made with bricks

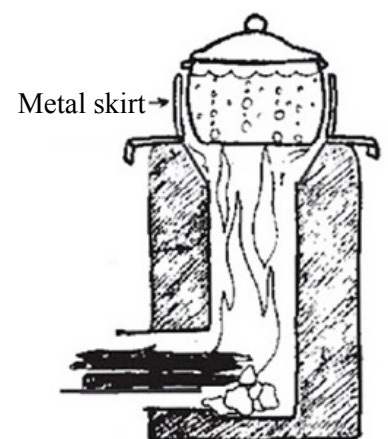
Fire bricks can be used to build the fire-box and the burn-tube inside a tin. You can make your own fire-bricks using common clay if you mix sawdust or vermiculite into them so they are very light after firing. (in the proportion of about 1-1)

They can be placed inside a tin the same way as the metal tube and the space around and under them filled with cement mixed with vermiculite for insulation and to secure the bricks. The fire-box diameter should not be more than 12 or 13cm.

To see more details watch the film on the following web site:

http://www.youtube.com/watch?v=YIMi0DvDvqw&feature=player_embedded#!

How to build a small rocket stove



Place the bricks in the form of a chimney with an opening for the firebox into a 20 litre water or paint tin. There should be a layer of insulation in the bottom to form a base. (a round brick or a layer of the cement and vermiculite.)

Fill the space around and under the bricks with the cement and vermiculite mixture and make the top smooth and neat. Note the iron rods being put in as pot rests.



First, make a small stove to learn how to do it. Then make a bigger, stronger one.

Vermiculite is a product used in certain types of compost to lighten heavy soils and should be available in most large towns. Experiment with ashes if you cannot get it although the bricks will not insulate so well. They should be light enough to float in water.

Build a rocket stove! Save yourself money and help conserve the forests.



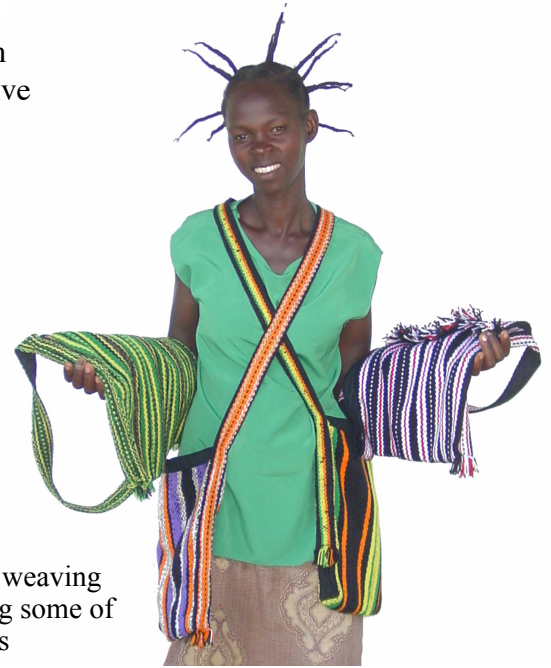
In this magazine we have not written about biology, but we will in the future. Meanwhile, here is an amazing photograph to introduce the subject. This giant crocodile was killed in Angola on the border with Namibia. The question is: how did they capture and kill it?

Weaving with a Simple Inkle Loom

In this article we will learn how to make strips of fabric. They can be sewn together to make bags, cushion covers and other decorative household items.



Sra Amália weaving and showing some of her products



The following shows how to make and use a loom known as an **Inkle** loom.

Materials Needed:

A strip of wood 90 x 5 x 5 cms;
Three wood pieces of 30 x 5 x 3cms; (The wood strip B fits into the place A to stabilise the loom.)
Six round bars 20 x 3 cm; (can be made of a broomstick) Wood glue.

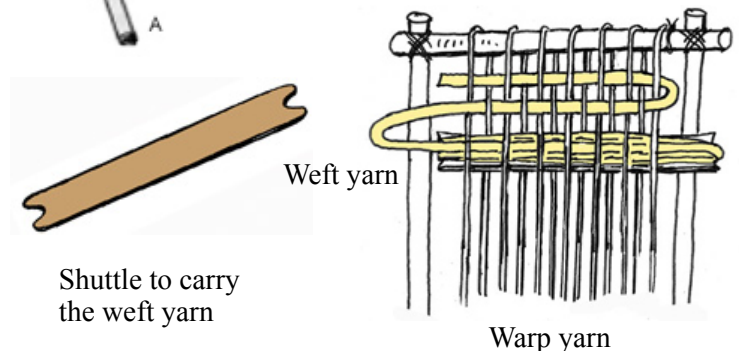
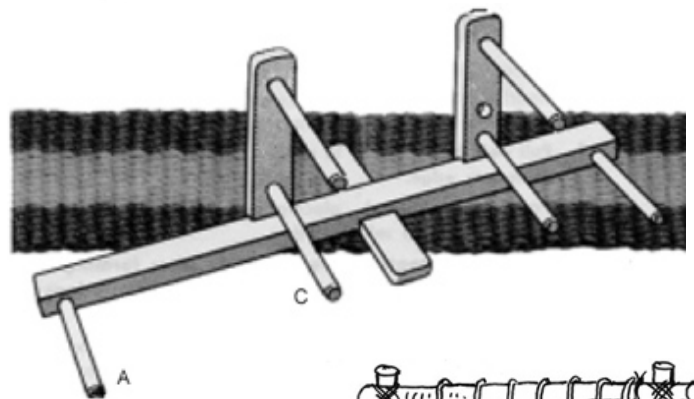
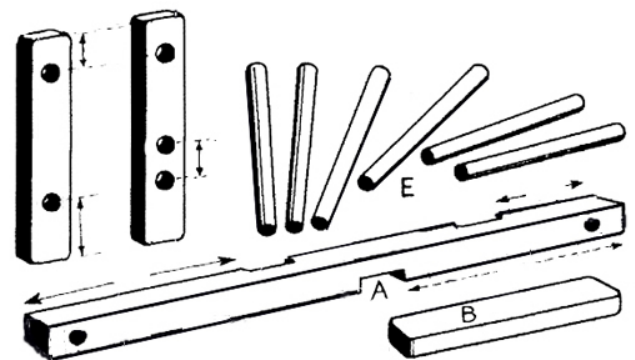
It would be best to ask a carpenter to do the construction. It must be well-made, very strong, to withstand the tension of the yarn without breaking the horizontal bars.

We have made the loom, now we need to know how to mount the yarn. The colour arrangement we use now will decide the final design. For example, you could mount an array of six black threads, 4 white, 6 blue, 4 white, and 6 more black threads, using knitting wool. 26 threads in all, which will give a woven strip of about 5/6 cm width. Then, we can weave using only black yarn to make a design with stripes.

What is Weaving?

The cloth is woven as the weft thread passes through threads of the warp (the vertical threads already mounted on the loom), weaving it over and under alternate threads, as can be seen in Figure 1.

The weft yarn can be wound on a shuttle or in a ball.



The work goes better when there is a method of lifting alternate threads all together instead of one by one manually. This is done using string loops called heddles.

How to make and assemble the heddle loops.

We will have 26 warp threads, so we need 13 heddle loops. they should be tied and mounted on bar C as shown in Figure 2. They should all be of equal size.

How to mount the warp threads

Tie the first warp thread on the bar A near the inside end. The thread should go to the bar D and down to bar E. Then, to bar F and back to the bar A, as shown in Figure 3. The thread should be tied to itself now not to the bar. It must be free of the bar. >

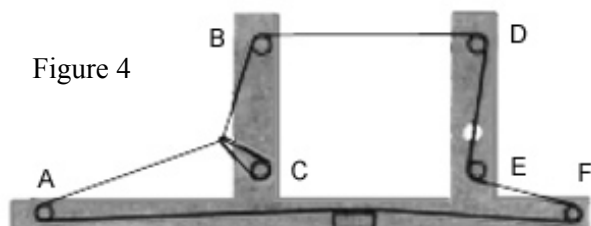


Figure 4

Figure 5 shows two mounted warp threads. This makes a pair of threads. The third thread will go via bar D and the fourth thread will pass through a heddle loop, making another pair of warp threads. >

Keep going until you have 26 warp threads in the color of your choice. (You can of course have more or fewer warp threads if you wish.)

How to weave

Before you start weaving with the weft thread, press the threads A - D down all together to create a space and put in a strong piece of cardboard strip to start the work. (Fig. 6)

Then lift up the same threads. This opens up yet another space. Place another piece of cardboard strip in this space. (Fig. 7)

Now you can start weaving with the weft thread. You must take care to keep the edges of the weaving even and straight.

Figure 2

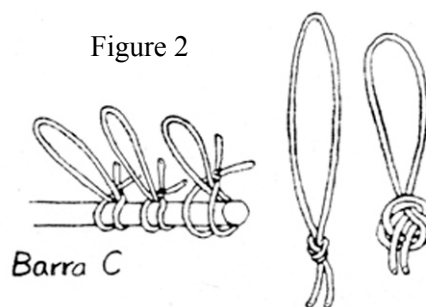
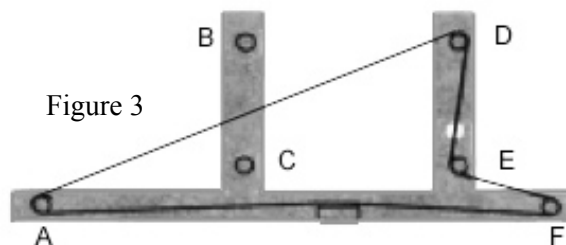


Figure 3



< The second warp thread must pass through the first heddle loop on the bar C and up to the bar B. Then it goes D, E, F and back to A as shown in Figure 4.

Figure 5

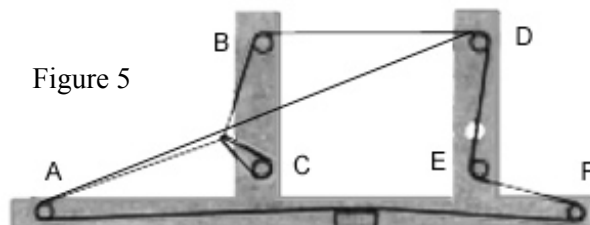
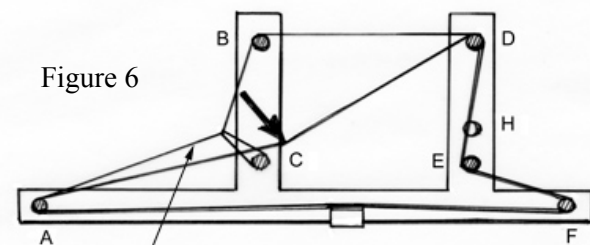
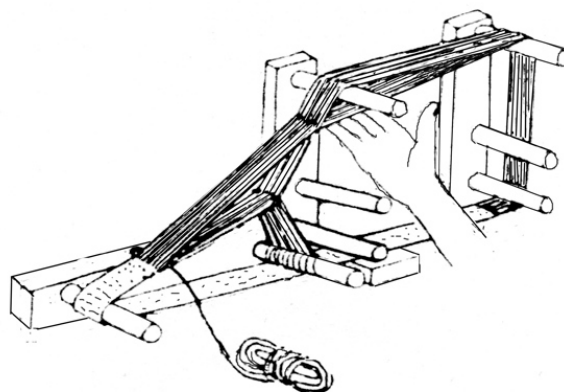
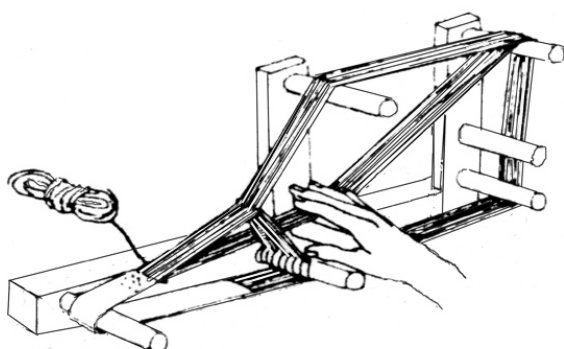
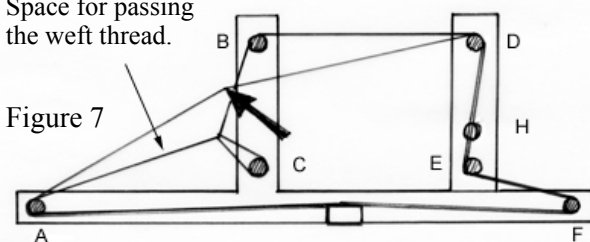


Figure 6



Space for passing the weft thread.

Figure 7



You should now make use of a comb, beating the threads to fit close together. Be careful not to pull the weft thread too tight or your work will be very narrow. Put in the threads loosely pressing down with the comb, as can be seen in Figure 8.

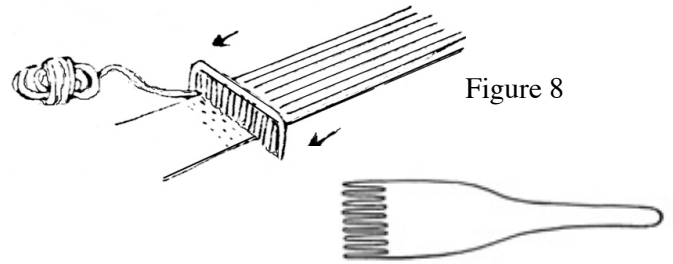


Figure 8

Continue weaving until you reach the area of the heddles.

The advantage of this loom is that when the warp threads are not tied to the bar, all the threads can move freely on the loom. You can take hold of them and pull them down to the bottom and start weaving again.

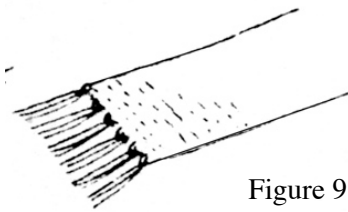


Figure 9

When you reach the end of the work without the possibility to weave more, you can cut the threads of the warp leaving enough yarn to tie the warp pairs together as shown in Figure 9.



The looms in these images have more horizontal bars to allow the possibility of making longer woven strips.

Once you understand how to make the strips you can experiment with many arrangements and yarn colors to make different patterns. 4 ply yarn or double knitting synthetic yarns or cotton yarns are suitable for this work. Experiment with yarns that are available in your area.

Girls of the Children's Community Centre in Chamissava, Katembe, Mozambique working on their looms.

The Boy Who Harnessed the Wind

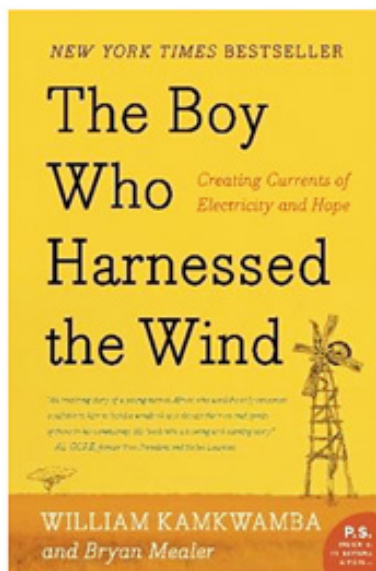
William Kamkwamba was born in Malawi. His family survived on the corn they grew on their small farm in Wimbe. In 2001, a drought drastically reduced the crop yield, and famine grew so severe that his family lived on just one or two mouthfuls of food per day.



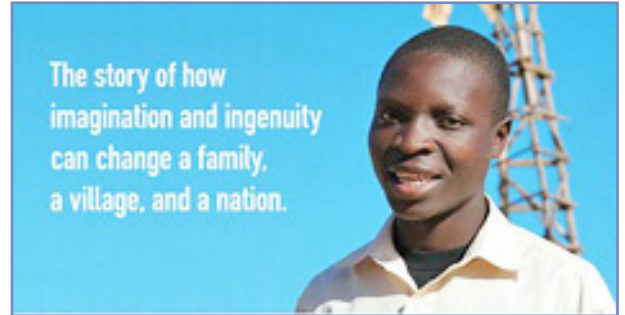
So Mr Kamkwamba scoured a local scrapyard and found the necessary components: the fan from the engine of a tractor, the generator, a shock absorber, pvc pipes, the frame of a bicycle etc.

He then built windmills to generate electricity. In the midst of so many challenges and lack of resources, William's house now has power in a region where less than 2 percent of people have electricity.

When William's first windmill was up and running, people were constantly stopping by to charge their mobile phones. In his rural village where most lived without electricity or running water, some of them had mobile phones but no means to charge them.



William is now 22 and is applying to universities in the US; He will no doubt accomplish many more amazing things in his lifetime. 'Many people, including my mother, thought I was crazy. But I said to myself: "Trust in yourself and never give up."' He has now written a book, 'The Boy Who Harnessed the Wind'.



Because money was so tight and his family couldn't afford the fees, William had to leave school during his first year of high school, aged 14. Not wanting to fall behind his classmates, William went to a small library nearby and studied textbooks to try to keep up. Without knowing much English, he taught himself physics by studying the diagrams and translating phrases associated with the diagrams.

One science book taught him that windmills could be used to generate electricity. 'I decided to build one myself, but I didn't have the materials'.



Improved stoves made from local resources

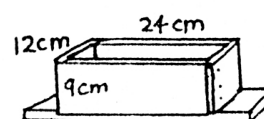
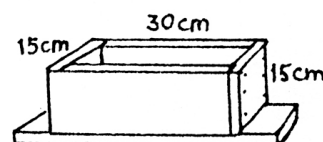
Why build such a stove?

It is increasingly difficult to find or buy firewood for cooking. Many families still cook using wood and three stones, which is not an efficient use of wood. Most of the heat is spread out into the air instead of focusing on the pan. As an alternative to the Rocket stove which you may not manage to make, why not try an 'improved stove', of the type described here. It is made of clay, earth and sand.

What are the advantages of such an improved stove?

- It uses half the wood that is used when cooking in the open with the pot on top of three stones.
- You can use other fuels, such as maize cobs, nut shells and thin wood (or even rubbish).
- It uses all the heat instead of losing heat to the air.
- It heats up more than one pot at a time. Stoves can be made with 1, 2 or 3 cooking mouths.
- The smoke comes out through the kitchen chimney. It does not contaminate the lungs.
- There is no danger of children being burned in the fire.
- The fire-box also serves as an oven to bake cassava, potato or to cook bread after taking out the ashes.

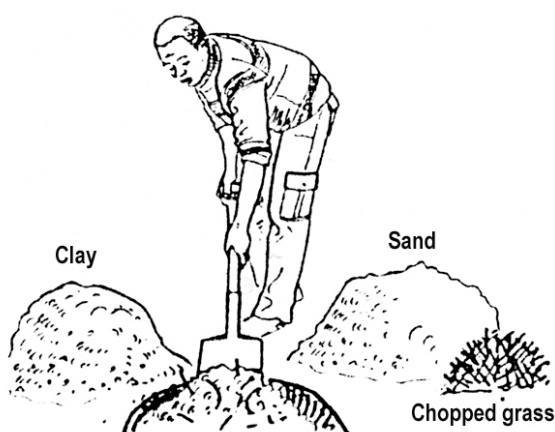
The stove is built with bricks from a mixture of clay, sand and grass and can be made by yourself.



The construction of the stove

The mould

Make a wooden mould to form the bricks. For the chimney bricks you will also need a smaller mould.



Put the mould on a flat dry area.

Put the mixture into the mould and remove excess clay. Invert the mould, and the brick will drop out ready to leave to dry. To build the stove the bricks should be firm but not completely dry.

Make 50 bricks for the stove and 60 smaller bricks for the chimney.

How to prepare the clay mixture

The clay can be dug out of swampy or low-lying areas. Termite hills are good. It should be soft and sticky. Do not let it dry.

Cut grass into small pieces with a machete.

Mix the clay, sand and grass in the following quantities: 4 buckets of sticky clay, 6 buckets of sand, a bucket of cut grass, and enough water to make a cement-like mixture.



How to build the stove

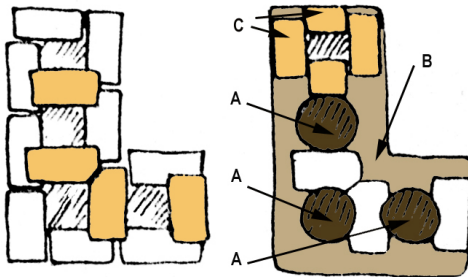
Layer 1 is the base on the ground

Layer 2 is the bricks to form the sides of the combustion channel.

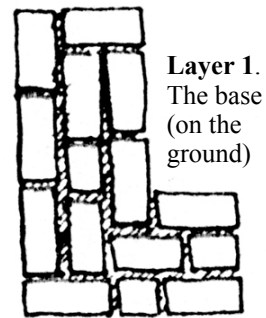
Join the bricks with the clay mixture.

Layer 3

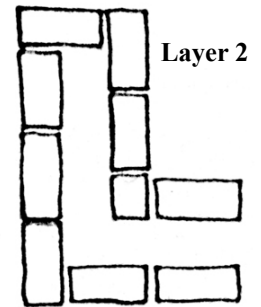
Layer 4



Plan views (seen from above)



Layer 1.
The base
(on the
ground)



Layer 2

Layer 3 is the next layer (4 bricks).

Layer 4. Bricks C are the base of the chimney.

B is a thick wall of clay which forms the top surface of the stove.

Cut wide circular holes (**A**) in this clay (with a machete) so that the cooking pots fit well inside. The flames must reach the pots as shown in Figure 5.

The pot should be well inside the mouth to reach the flames. Layer 4 shows the top view of the finished stove ready to build the chimney.

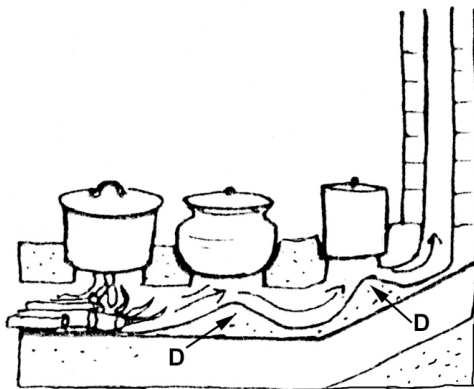


Figure 5

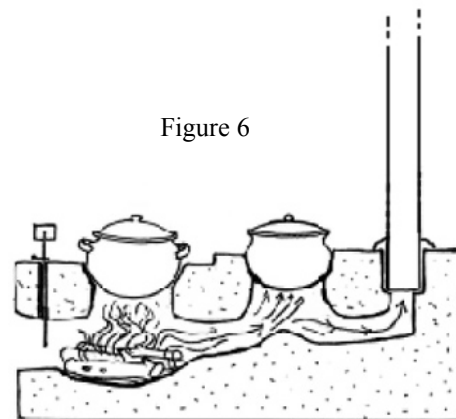


Figure 6

Now make bumps (**D** and **D**) (using the clay mixture) beneath the pots to direct the flames up, as you can see in Figures 5 and 6 which show stoves with three mouths and two mouths.

How to make the chimney

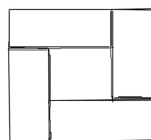
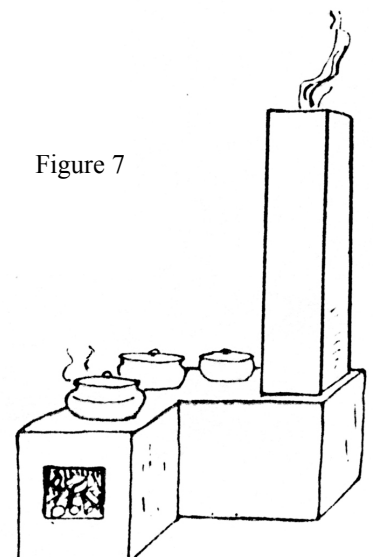


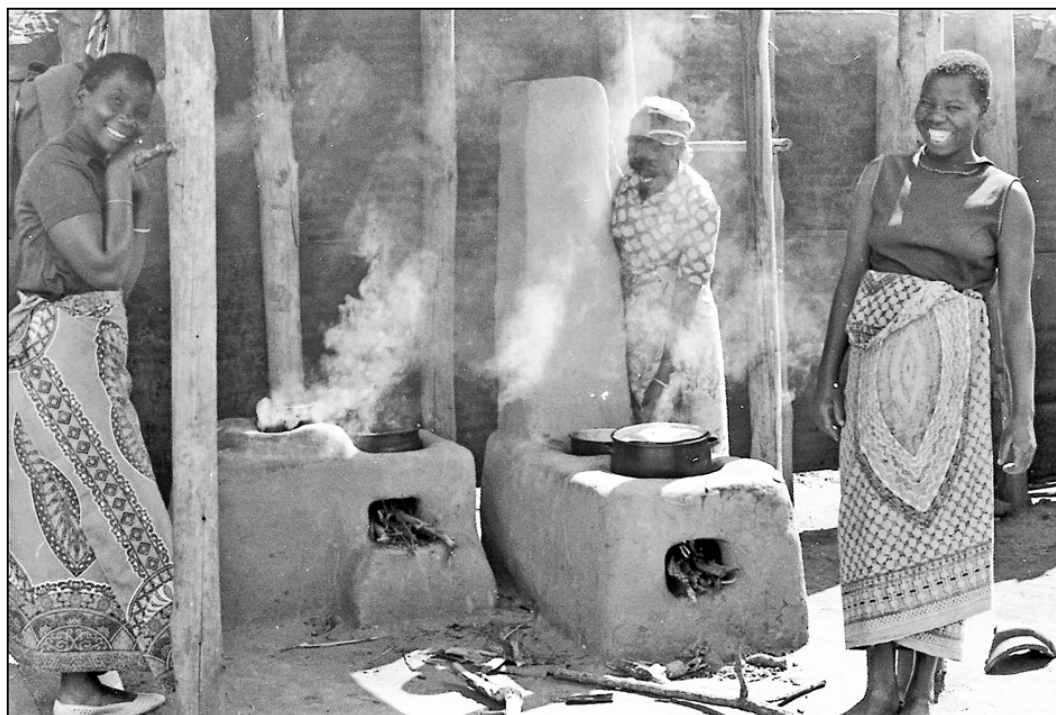
Figure 7

It is easier to use a metal or lusalite (cement) tube that can be fitted inside the stove and fixed with the clay mixture, as seen in the two-burner stove (Figure 6).

If you can not get a metal tube, build the chimney using the smaller bricks, leaving a channel for the smoke to exit as shown in Figure 7.

Finally plaster the exterior of the stove using a mixture of clay and sand. Do it 2 or 3 times to fill any cracks that appear as it dries.



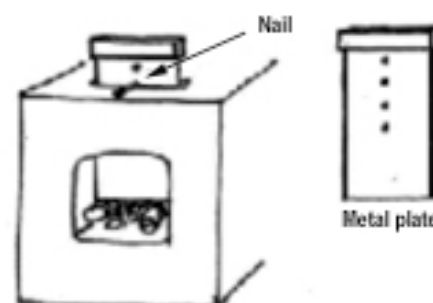


Senhora Alice and friends cooking on the stoves made by them in Lichinga.

The combustion regulator

If you want better control of the fire, you can insert a metal plate through a slit cut in the front of the stove, as shown in Figure 8. This moves up and down to control the entry of the air stream. The more air that comes in, the stronger will be the flames. The plate must be drilled to allow the placing of a large nail to keep it in position.

After cooking, you can take out the ashes and cook bread, closing the iron plate to keep in the heat.

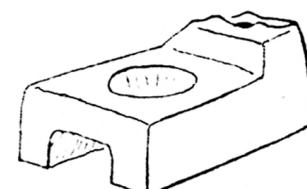
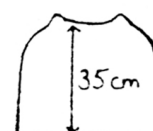
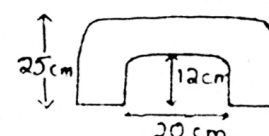
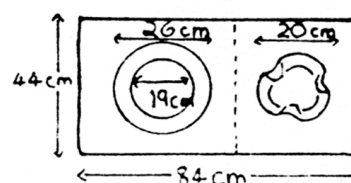
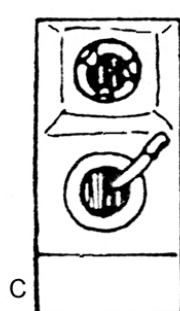
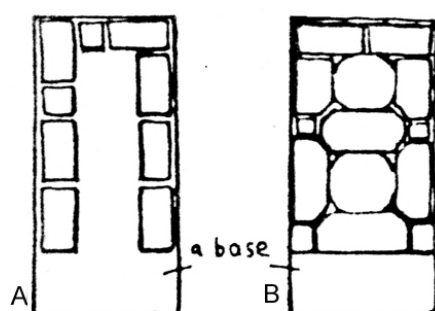
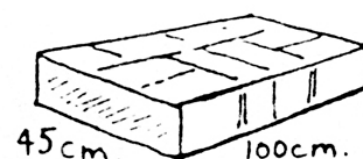


A simple stove without a chimney

First make the base from measurements given in the figure and make a base and build the first layer of bricks as shown in Figure A.

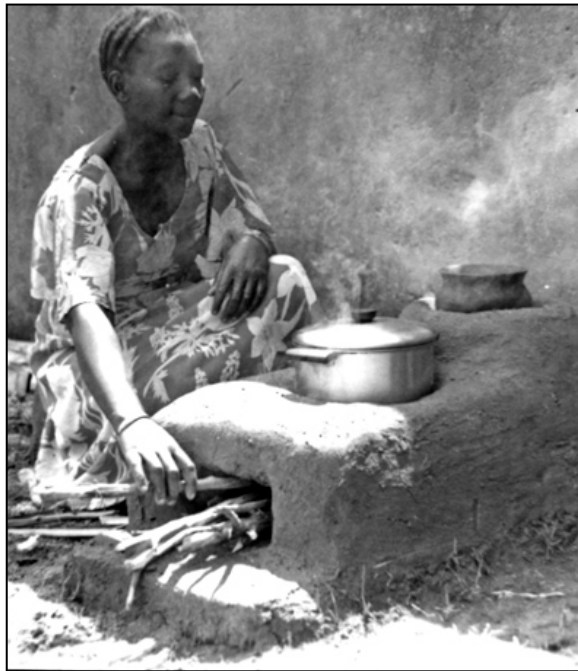
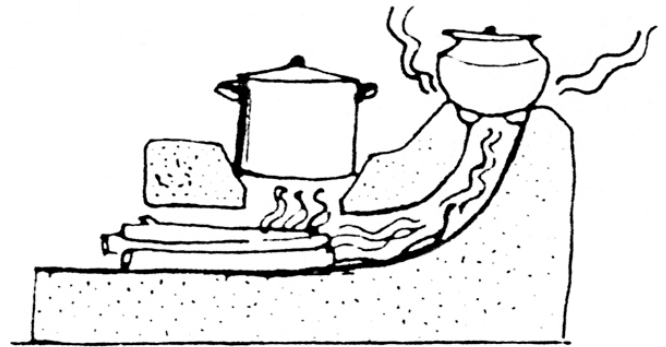
In the second layer of bricks put in the cross-brick to form the two cooking mouths. (Fig. B) Form the first mouth by using your cooking pot as a guide so that it sits securely inside.

The second mouth is at a higher level. Place another layer of bricks and shape the mouth with three mounds for the pot to sit on top of, allowing spaces for the smoke to exit. (Fig. C)

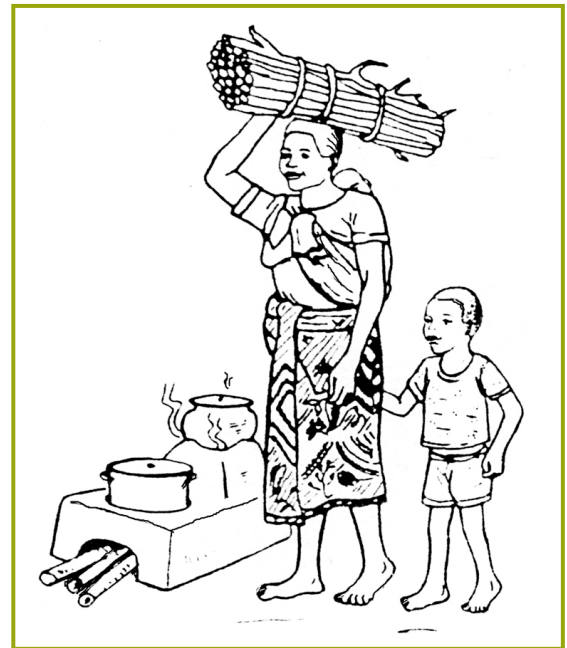


The flames must rise to the second mouth. So we have to fill in with clay to make a hill on the inside of this mouth leaving only a narrow channel as shown in Figure D.

Then you must plaster the stove with new layers of clay and sand for 3 or 4 days to fill small cracks that will appear during the drying. Finally, you can paint it with sand or lime.



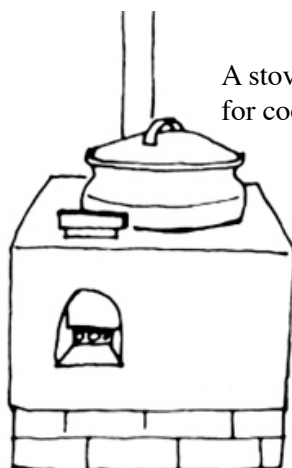
Alice cooking on her stove on the veranda of her house.



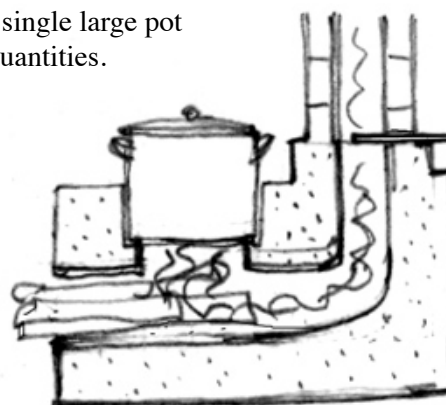
Caution!

When you build a stove in the kitchen you should think about where the hot smoke will come out the chimney. The chimney must pass out of the kitchen so as not to burn the grass roof.

A roof is needed to protect against the rain, but one made of zinc sheets would be better.



A stove that takes a single large pot for cooking larger quantities.



< Alternative Combustion regulator

Modern Wind Turbines

14

Modern commercial wind turbines are installed in many countries.

Some are small, to supply a house with about one or two kiloWatts.

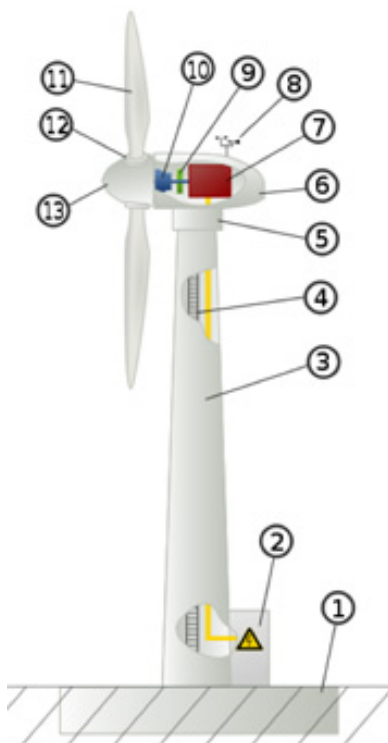


Some are very large, 100 metres high, with blades 50 metres long. They produce one or two megaWatts, sufficient to supply the energy needs of 1,000 modern homes. A modern house uses about 2 kW.



A large wind turbine is generally connected to the national network of electricity supplies

A large 'wind farm' may consist of several hundred individual wind turbines. A wind farm may also be located offshore. Wind power is an alternative to generators which use oil or coal as fuel.



Wind power is plentiful, renewable, widely distributed, clean, produces no 'greenhouse gas' emissions during operation, and occupies little land. In operation, the overall cost per unit of energy produced is similar to the cost for new coal and natural gas installations.

On 8 August President, Armando Guebuza of Mozambique inaugurated at Rocha Beach, Inhambane province, the country's first modern large wind turbine.

The project will cost \$2.5 million. It will generate 300 kW of electricity to supply the local tourism industry and 1,200 consumers.

The parts of a modern large wind turbine

1-Foundation, 2-Connection to the electric grid, 3-Tower, 4-Access ladder inside, 5-Wind orientation control, 6-Nacelle, 7-Generator, 8-Anemometer, 9-Electric or Mechanical Brake, 10-Gearbox, 11-Rotor blade, 12-Blade pitch control, 13-Rotor hub.