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Charcoal Production Using a Transportable Metal Kiln

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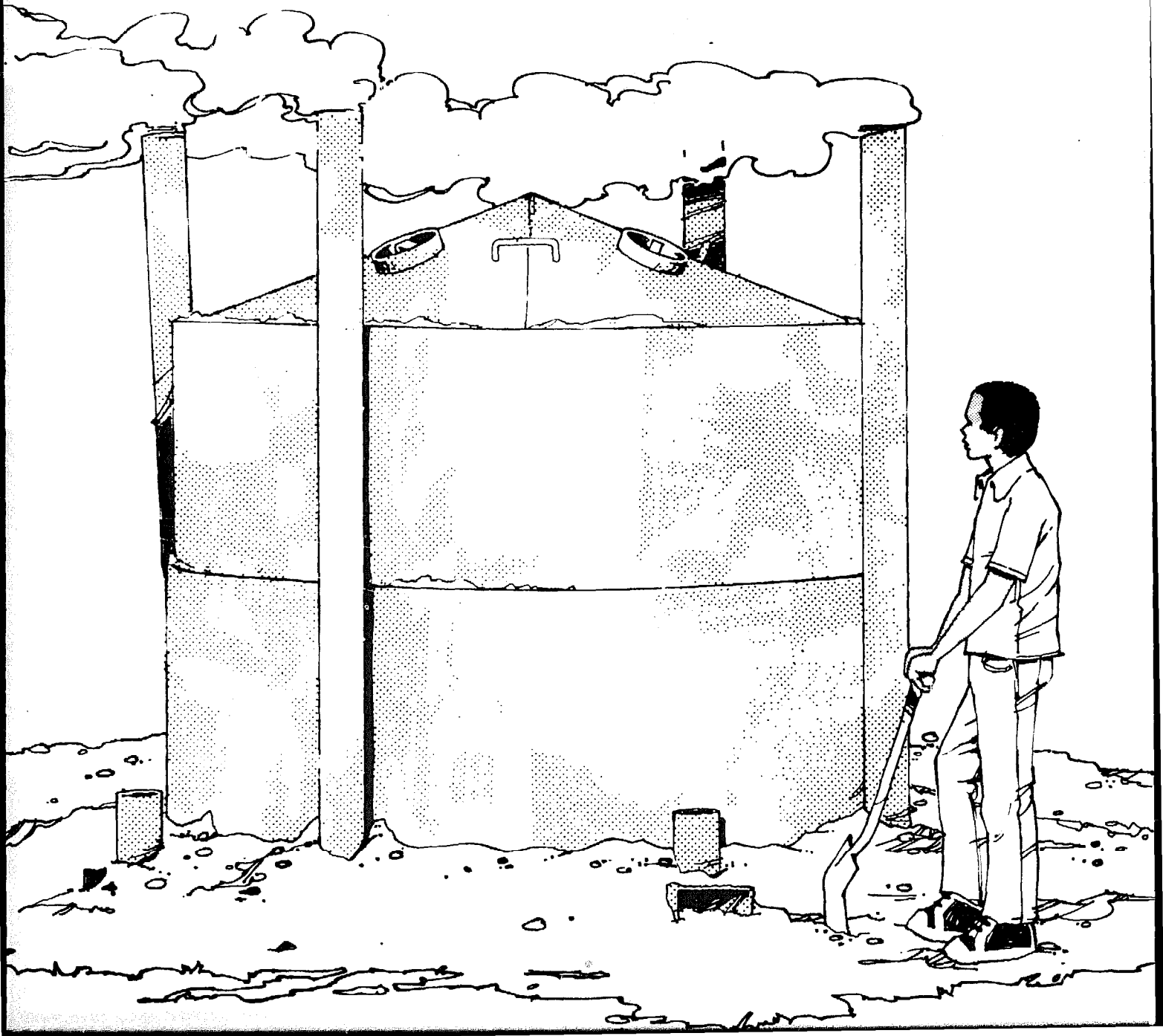
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# Charcoal production using a transportable metal kiln



Rural Technology Guide 12 1980

# **Charcoal production using a transportable metal kiln**

**A R Paddon and A P Harker**

The Tropical Products Institute recommends that charcoal production be carried out under the guidance of a Forestry Department or similar government body, to prevent the uncontrolled exploitation of woodlands for financial gain.

The use of transportable metal kilns in charcoal production is particularly suited for local authority reforestation and land reclamation schemes.

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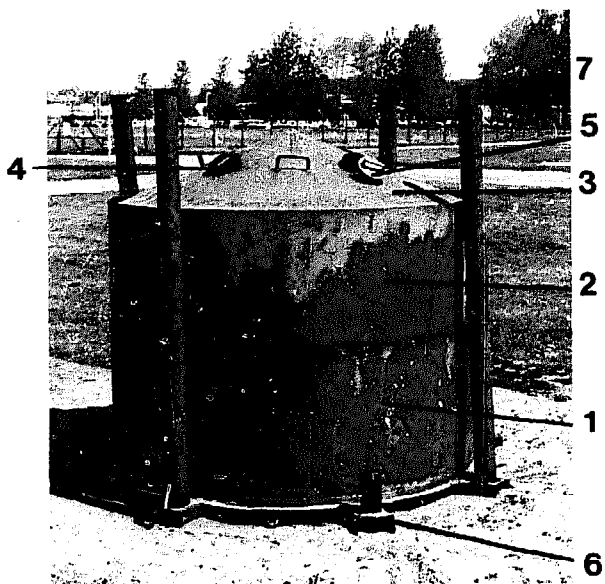
# Introduction

This guide describes how to operate a transportable charcoal kiln which will produce charcoal more quickly and efficiently than the traditional pit and earth clamp method.

The kiln is made from sheet metal and can be built by local craftsmen in a workshop which has basic welding, rolling, drilling and cutting facilities.

## Description of the kiln

The kiln consists of two interlocking cylindrical sections (1, 2) and a conical cover (3). The cover is provided with four equally spaced steam release ports (4) which may be closed off with plugs (5) as required. The kiln is supported on eight air inlet/outlet channels (6), arranged radially around the base. During charring, four smoke stacks (7) are fitted onto alternate air channels. The construction details of the kiln are given in Rural Technology Guide 13 to be published shortly.



# Tools required for two-man operation

Chain saw or cross-cut saw

Wooden pole or plank

Shovels or spades (2)

Sieve-chute

Sacks

Matchet

Needle and string

Axe

Wedges (2)

Industrial gloves

Sledge hammer

# Preparation of the raw material

Fell the wood, cut up and stack it at least 3 weeks before kilning. This period allows the wood to dry out, thereby reducing the charring time and increasing the yield of charcoal.

The size of wood most suitable for the process is between 450 – 600 mm long and up to 200 mm in diameter. Wood with a diameter greater than this should be split before use.

Approximately 7 cubic metres of wood are required to fill the kiln.



# Selecting the site

Choose a well drained and roughly levelled area 3 metres x 3 metres for the site of the kiln. Roll the bottom cylindrical section on to the site and position it upright after the area corresponding to the floor of the kiln has been made firm by stamping down.

Loose earth or sand should be available close to the site for sealing off the air supply to the kiln as required during the operation.





# Assembly and loading of the kiln

1. Using a wooden pole as a lever, arrange the eight air inlet/outlet channels radially underneath the bottom section of the kiln.

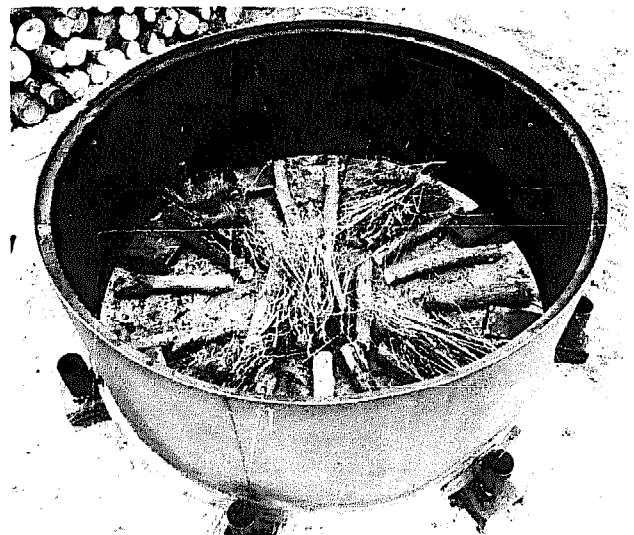
A minimum of 250 mm of air channel must protrude into the kiln to prevent overheating of the kiln wall.



2. Make sure that the inlet/outlet air channels and the spaces between them are not blocked when the bottom of the kiln is loaded with wood. To do this, support the charge on "stringers" which are medium diameter (150 mm) pieces of cordwood arranged radially like the spokes of a wheel.



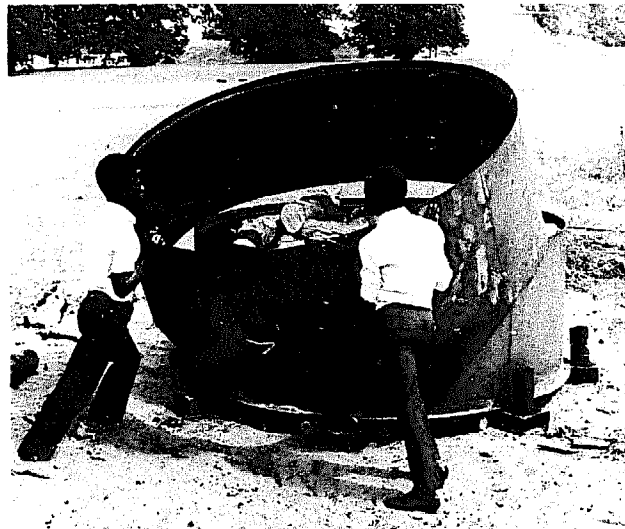
3. Place dry kindling wood together with any inflammable waste (paper, sump oil etc.) between the stringers from a point 50 mm from the edge of the bottom of the kiln to the centre so as to provide four lighting points.



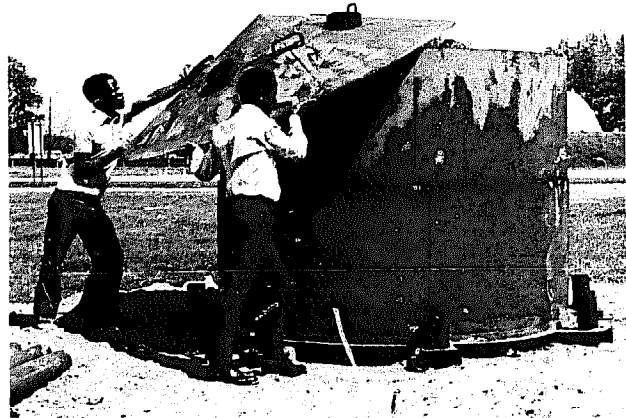
4. Next place a layer of wood and "brands" (incompletely charred wood from the previous firing) across the stringers and air channels to form air ducts which will make it easier to light the charge.



5. Load the bottom section of the kiln with successive layers of wood, filling in as many voids as possible and placing the larger diameter timber towards the centre of the kiln. When the bottom section has been filled roll the top cylindrical section alongside the kiln and push it up on to the supporting rim.

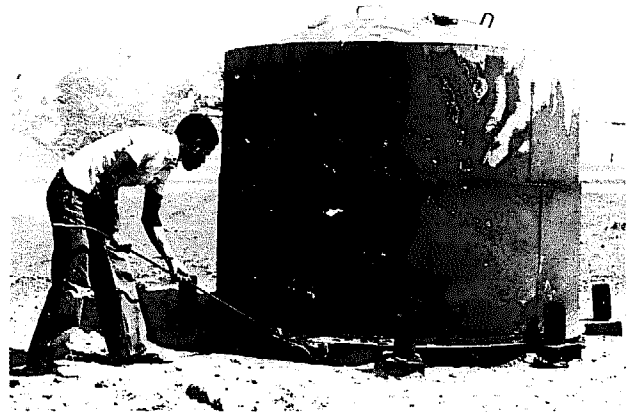


6. Continue loading until the wood forms a conical shape above the rim of the top section which will allow the cover to be located into the rim without hindrance. Then roll the cover alongside the kiln and push it up on to the supporting rim.



With two experienced men, the kiln takes about 2 hours to load.

7. Make sure that all four steam release ports in the cover have been removed, then apply a flame to the prepared lighting points. Some areas of the kiln may burn more quickly especially on the windward side. Because of this, do not ignite the lighting point facing the wind until the lee side of the kiln is well alight.



8. Allow the kiln to heat up for 30 to 60 minutes until the bottom section is so hot that it is unpleasant to stand close to the kiln. During this period fill the joints between the main sections of the kiln with sand and place the smoke stacks in position over the support collars of alternate air channels.



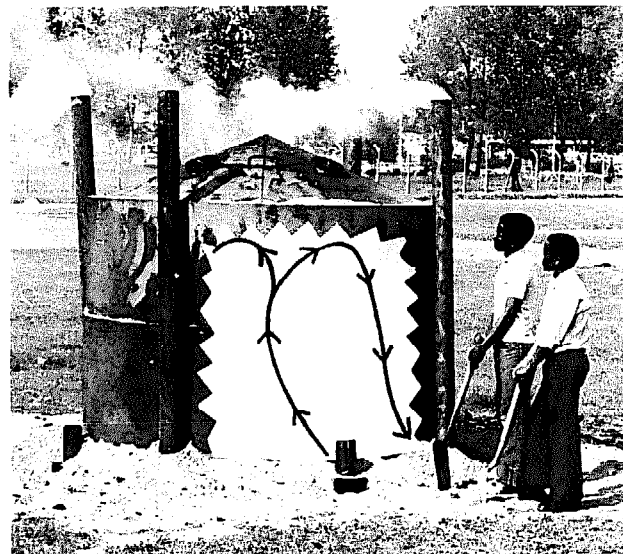
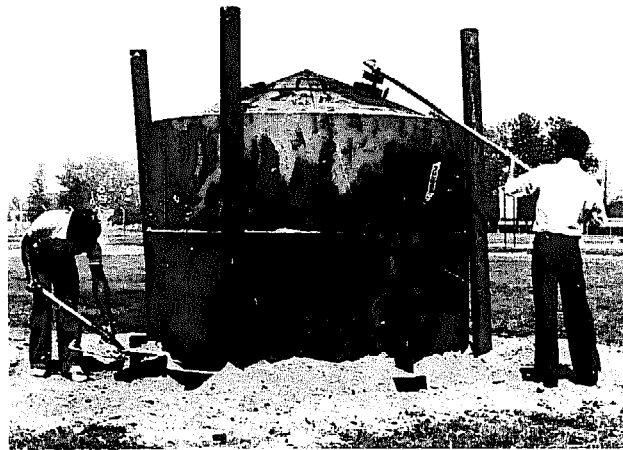
# Reducing the draught

As each sector of the kiln reaches the required temperature, cover the spaces between the air channels with sand or soil.

When all the spaces between the channels have been covered, seal the ends of the channels supporting the smoke stacks.

Then replace the steam release ports so that the smoke is drawn out of the base of the kiln by the four smoke stacks.

When the draught has been reduced air enters the kiln only through the inlet channels from where it flows up through the centre of the charge. The combustion gases are drawn down the outer edge of the kiln and are exhausted through the smoke stacks. As the air and exhaust gases flow in opposite directions, this condition is known as the Reverse Draught.



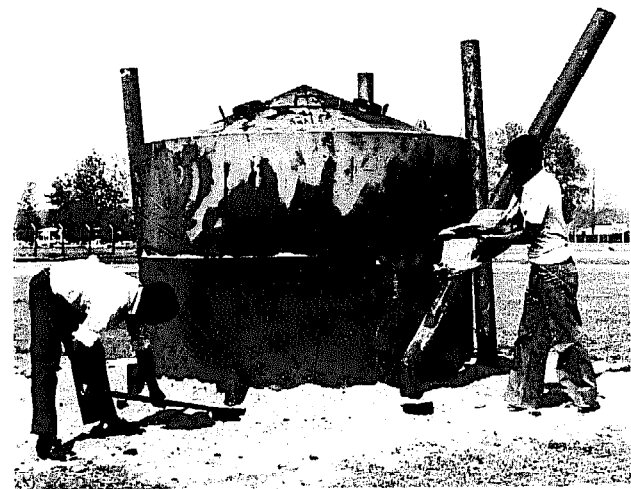
# Control of charring

1. After 15 – 30 minutes each stack should emit a column of thick white smoke.

If there is a slowing down of smoke production, remove the sand or soil temporarily from the lighting points next to the affected smoke stack to allow more air into the kiln at this point. When a satisfactory emission of smoke has again been achieved, close the lighting point.

2. During charring a certain amount of tar is deposited in the outlet channels and smoke stacks. This tar restricts the exhaust gas flow from the kiln and should be removed when there is a noticeable reduction in the quantity of smoke issuing from any of the stacks. Take off and clean the stack and remove any tar which has collected inside the outlet channel. At the same time, a long stick should be inserted through the channel into the centre of the kiln to make sure that there is no internal restriction to the exhaust gas flow.

After 8 – 10 hours move the smoke stacks on to the adjacent air channels to convert air inlets to air outlets and vice versa. This creates a more even burn and reduces the formation of ash at the air inlets. Use a sack or industrial gloves to remove the stacks which will by this time be very hot.



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# Cooling of the kiln

Charring is complete when the colour of the smoke from all chimneys takes on a bluish tinge and becomes almost transparent. This normally occurs 16–24 hours after lighting. The whole surface of the kiln should now be very hot (150–200°C) so that a spot of water applied to the side wall will evaporate immediately with a spitting noise. At this stage close the kiln completely by removing the smoke stacks and completely blocking all the air channels with soil or sand. Apply more soil or sand to ensure that the angle iron rims supporting the top section and cover and the steam release ports are fully sealed so that no air may enter the kiln.

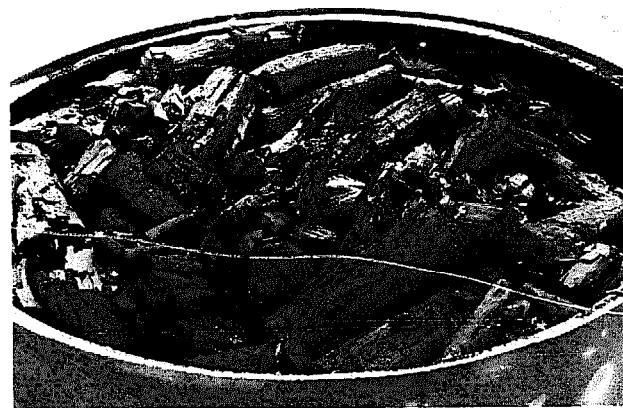
Allow kiln to cool for between 16 and 24 hours before opening and unloading.

# Unloading the kiln

1. The kiln must not be opened before the outside surface is cool. Once the kiln is opened, make certain that it is emptied immediately to prevent any localised fires igniting the charcoal; otherwise the result could be serious damage to the kiln.

When the kiln is opened, if part of the charcoal is seen to be still alight, the kiln must be re-sealed for a further cooling period before it is unloaded.

During charring, the volume of wood will have been reduced, and it will therefore be easy to remove the cover and top section once the kiln has cooled.



2. To remove the bottom section, remove the inlet/outlet channels from one side of the kiln using a lever, and tip the section on to its side, leaving the charcoal free to be loaded into sacks. A bucket of water or a quantity of sand or soil should be on hand while unloading the kiln in order to quench any small fires that may break out.



# Sack filling with charcoal

A sieve chute is used to separate the large charcoal pieces from the fines and to make sack filling easier. The construction details of the sieve chute are shown in the Appendix.

Unloading the kiln and filling the sacks with charcoal takes about 1 hour with 2 men.

The kiln will produce between  $\frac{1}{2}$  and  $\frac{3}{4}$  tonnes of charcoal per batch depending on the density of the wood.





# Commercial operation

Two experienced men can operate two portable metal kilns producing 2–3 tonnes of charcoal per week. A suggested 5-day work plan is outlined below:

|               |               |                         |  |
|---------------|---------------|-------------------------|--|
| MONDAY        | 08.00 – 10.00 | Kiln 1 and Kiln 2       | Unload both kilns  |
|               | 10.00 – 12.00 | Kiln 1                  | Load kiln with wood  |
|               | 12.00 – 13.00 | Kiln 1                  | Light kiln and reduce draught  |
|               | 13.00 – 17.00 | Kiln 1                  | Control charring. Change and clean stacks at 16.30.                            |
|               |               | Kiln 2                  | Load kiln with wood  |
| TUESDAY       | 08.00 – 08.30 | Kiln 1                  | Change and clean stacks  |
|               | 08.30 – 11.00 |                         | Prepare wood for next burn   |
|               | 11.00 – 12.00 | Kiln 2                  | Light kiln and reduce draught  |
|               | 12.00 – 17.00 | Kiln 2                  | Control charring. Change and clean stacks at 16.30.                            |
|               | Kiln 1        |                         | Shut down kiln when charring complete. Continue to prepare wood for next burn. |
| WEDNESDAY     | 08.00 – 08.30 |                         | Kiln 2 Change and clean stacks   |
|               | 08.30 – 14.00 |                         | Continue to prepare wood for next burn.  |
|               | 14.00 – 15.00 | Kiln 1                  | Unload charcoal from kiln.   |
|               | 15.00 – 17.00 | Kiln 1                  | Start loading kiln with wood   |
|               |               | Kiln 2                  | Shut down kiln when charring complete.   |
| THURSDAY      | 08.00 – 10.00 | Kiln 1                  | Finish loading kiln with wood  |
|               | 10.00 – 11.00 | Kiln 1                  | Light kiln and reduce draught  |
|               | 11.00 – 13.00 |                         | Kiln 2 Unload charcoal from kiln   |
|               |               | Kiln 1                  | Control charring   |
|               | 13.00 – 15.00 |                         | Kiln 2 Load kiln with wood   |
|               |               | Kiln 1                  | Control charring   |
|               | 15.00 – 16.00 |                         | Kiln 2 Light kiln and reduce draught   |
| 16.00 – 17.00 | Kiln 1        | Change and clean stacks |  |
|               |               | Kiln 2                  | Control charring   |
| FRIDAY        | 08.00 – 09.00 | Kiln 1 and Kiln 2       | Change and clean stacks  |
|               | 09.00 – 13.00 | Kiln 1                  | Shut down kiln when charring complete  |
|               |               |                         | Kiln 2 Prepare wood for next burn  |
|               | 13.00 – 17.00 |                         | Kiln 2 Change and clean stacks at 12.30  |
|               |               | Kiln 2                  | Continue to prepare wood for next burn   |
|               |               | Kiln 2                  | Close down kiln when charring complete   |

# Alternative method of operation: Lighting from the top

This method of operation is particularly suitable for the carbonisation of small wood or coconut shells where extra care is needed to ensure a sufficient gas flow through the charge.

## *Loading*

Load the kiln as previously described, except that no kindling should be used between the stringers at the base. Instead, build a fire in a 250 mm deep depression on top of the charge which is then covered with a final layer of wood.

When carbonising coconut shells, the use of 'stringers' is not required. Make sure, however, that the shell material does not block the ends of the inlet/outlet channels inside the kiln. To do this, rest a flat piece of wood (for example a piece of rib from a dead palm frond) on the top of the end of each channel before covering it with shells.

## *Lighting*

Light the fire at the top of the charge through one of the four steam release ports and allow the kiln to burn with a completely free access of air into the kiln base. The smoke will escape through the four ports in the cover. Allow this stage to continue for about 2 hours until the whole of the top section of the kiln is too hot to touch with the bare hands.

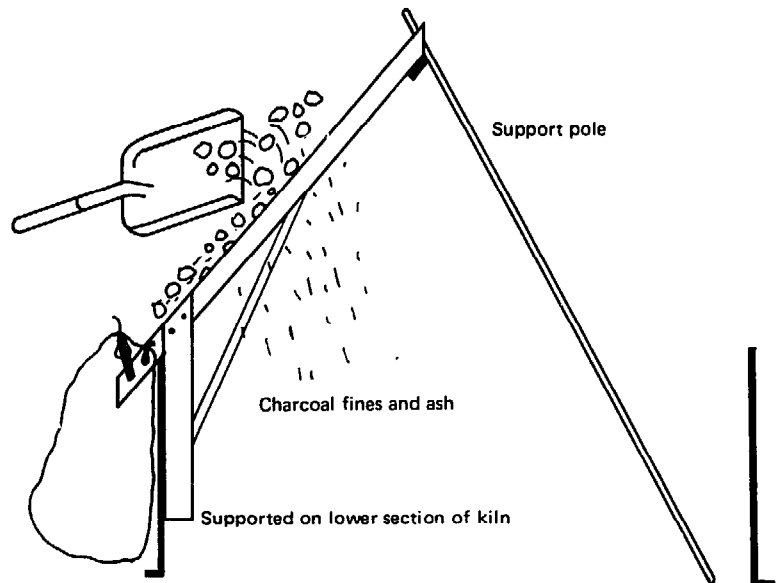
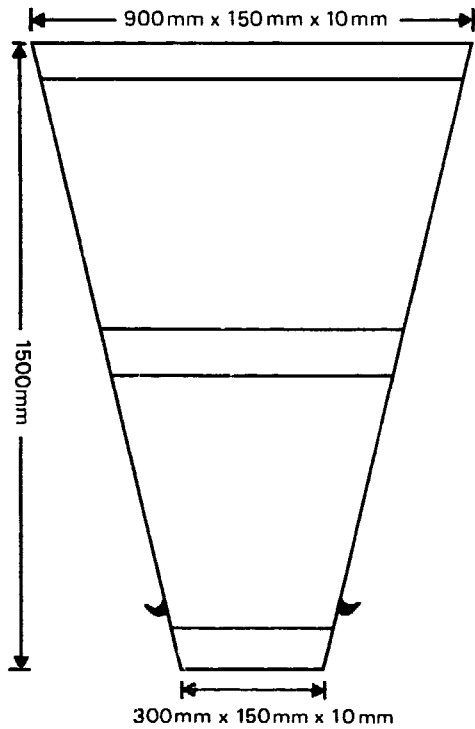
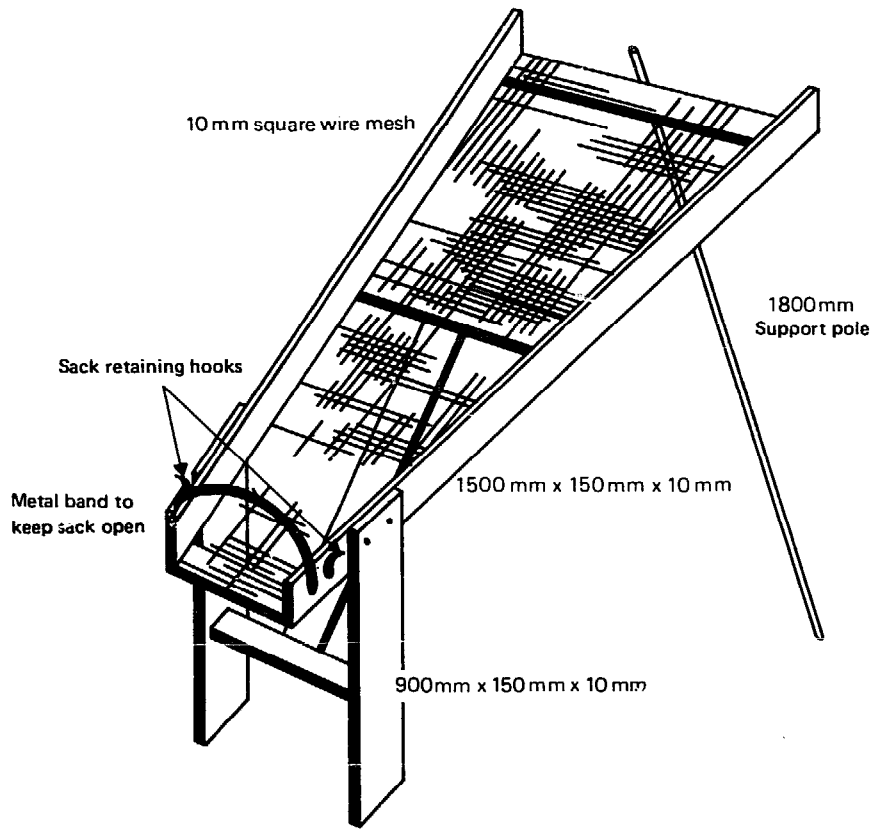
## *Reducing the draught*

When the top section is sufficiently hot cover the spaces between the channels with sand or soil and control the supply of air to the kiln as in the normal method of operation.

From this stage the kiln is operated in the normal way as already described.

# APPENDIX

## SIEVE-CHUTE FOR UNLOADING KILN



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