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## Mini Technology

by: B. R. Saubolle, S. J. and A. Bachmann

Published by:  
Sahayogi Prakashan  
Tripureshwar  
Kathmandu  
Nepal

Paper copies are \$ 3.00

Available from:  
Sahayogi Prakashan  
Tripureshwar  
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# **MINI TECHNOLOGY**

Vol. I

**B. R. Saubolle, S. J.**

and

**A. Bachmann**

**SAHAYOGI PRAKASHAN**

Tripureshwar, Kathmandu

Published by  
**SAHAYOGI PRAKASHAN**  
Tripureshwar, Kathmandu, Nepal.  
Phone : 11489

First printing Nov. 1978

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Rs. 25.00 in Nepal.  
US \$ 6.00 (Airmail postage paid)

Text by B. R. Saubolle, S. J.  
Technical drawings by A. Bachmann  
Cover design and illustrations by L. S. Bangdel

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Printed in Nepal  
at Sahayogi Press, Tripureshwar, Kathmandu.

## P R E F A C E

This booklet was born from my private file, where I jotted down odd scraps of information on how people provided simple solutions to the problems of daily living. Then, when someone would ask "What am I to do about this ?" or "How does one tackle such a situation ?" I would produce a copy of my notes on the subject. As appeals for information began to multiply, I was repeatedly urged by friends to edit the whole file and publish it. I have done so.

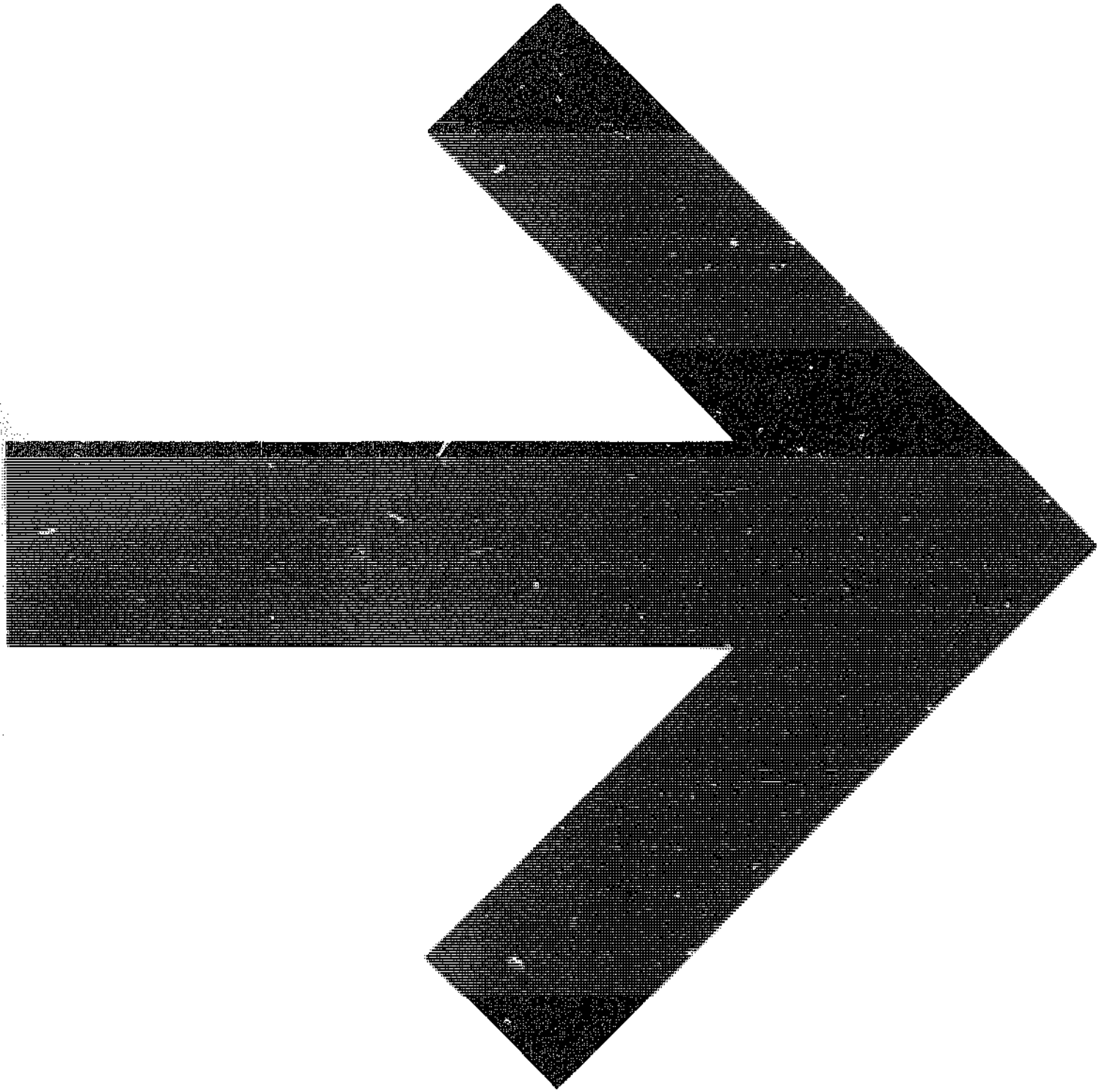
One who read the manuscript remarked "In an age when people build rockets and supersonic jet planes, you come along and teach them how to make a wheel-barrow ! What's the big idea ?" There's no big idea. I always think small. Since far more people would be interested in making a wheel barrow than in making a jet plane, why not tell them how ? As a matter of fact there is nothing on wheel-barrowes in these pages. It's a lacuna to be remedied in a later edition.

Technology strides ahead in seven-league boots; but all the jet planes and rockets and other sophisticated means of transportation will never push off the face of the earth the humble bullock cart, the bicycle and the barrow. There's room for the old as well as the new. Human beings have similar needs and problems no matter where or when they live, and it helps to know how other people have handled a situation one faces oneself. We are often quite content to adopt the age old answer rather than indulge in the expensive, flashy, modern solution.

This booklet is based very largely on the experiences of the writer, who was born and bred in India. It gives mostly Indian solutions to problems encountered in an earlier age before the onrush of modernity. It tells how to cool a house without air-conditioning, how to chill beer without a refrigerator, how to produce gas for cooking and lighting where there is no town supply, a way to make crows trap themselves, several ways of getting hot water at no expense, and so on and so forth. If the suggestions made herein are helpful to you in any way, and you enjoy browsing through the booklet, the authors will be delighted. But if you find them crude, simplistic and out of date, then pass on, Friend, to richer pastures elsewhere. This booklet is not for you.

A feature that enhances greatly the usefulness of these pages is the excellent diagrams. It is really they that make the book : the text only explains them. They are all the work of my friend and collaborator, Mr. Andreas Bachmann, of the Swiss Association for Technical Assistance. I am deeply indebted to him. I wish also to thank Mr. L. S. Bangdel, Vice Chancellor, Royal Nepal Academy for graciously providing the, illustrations and the cover design.

B. R. SAUBOLLE, S. J.



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## KEEPING COOL WITH KHAS KHAS

There grows in India a grass with the botanical name of *Vetiver zizanoides* or *Andropogon muricatus* or again *A. squarrosus*. North Indians call it *khas-khas*. Its roots give off a pleasant aromatic scent that is also insect repellent. These roots are loosely woven into mats which, in the hot weather, are hung in a doorway or between the pillars of a verandah. They are sprayed or sprinkled liberally with water. As the dry, hot wind blows through them, the water evaporates and cools the wind entering the room, thus lowering the room temperature a few degrees. The hotter and drier the scorching wind, the more thorough the evaporation, and the cooler the room.

Instead of having to spray the mats frequently the whole day through, it is possible to keep them wet by arranging a pipe above them with tiny holes that allow a constant gentle trickle of water, drop by drop, through the mat from top to bottom. With proper flow control the water can evaporate before it reaches the very bottom. So there need be no messy pool of water on the floor. Or the mat could be hung outside a window to let any accidental excess flow of water be absorbed by the soil.

Khas-khas mats are not the only material that can be used for cooling. Sackcloth will do, once the smell has been eliminated by repeated washings. Excelsior (wood-straw) held between two chicken wire screens will also serve, or any material that can absorb water and is woven or held together loosely enough to let the breeze blow through.



To be independent of the breeze, which may die down, it is more efficient to erect a box-like structure of mats outside a window or hole in the wall in which an exhaust fan is installed to draw the air through the mats and blow it into the room. I saw this arrangement as late as 1978 in a hotel in New Delhi. I know that it was also used in a printing press in Patna, Bihar, where the temperature not infrequently rises to 46°C and even more. In this press the gentle humidity in the cooled air prevented static electricity from playing tricks with the printing paper.

The window-box and fan is perhaps the most efficient way of cooling a house, short of air-conditioning. The cool air can pass from room to room and cool the whole house before being vented on the opposite side. It must be vented, otherwise pressure will build up so much that a sheet of paper pressed against a wall will adhere to it, and the occupants of the room will feel dull and head-achey, and have trouble breathing.

While electric fans merely swirl the dry, scorching air round and round the room, the khas-khas mat arrangement adds a slight freshening humidity and a pleasant fragrance, in addition to a remarkable and delightful coolness.

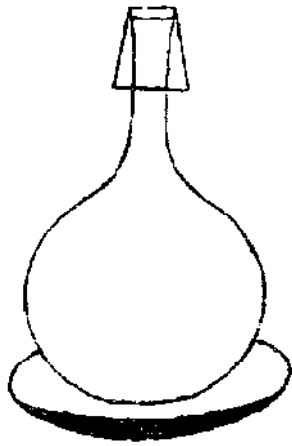
### THE COOLING CUPBOARD

A *duli* or *dooley* is a pantry cupboard for keeping butter, jam, fresh fruit and other odds and ends that you would put in your fridge if you had one. The framework and shelves are of wood; the four sides are covered with fly screening. The legs are often stood in water to keep ants out of the food.

In the summer, if sackcloth is draped round the sides in such a way that the bottom ends dip into a shallow tray of water, it sucks the water up by capillarity, and the dry hot air in the room causes evaporation, which cools the contents of the cupboard, cool enough anyway to prevent butter from melting.

## THE MAGIC GOBLET

It cools down in the heat.



When a man perspires, if he sits in a dry breeze, no matter how hot, he will feel cool. The magic goblet does just the same. It is made of a special kind of sandy clay that allows a constant but infinitesimal seepage. As soon as the moisture comes to the outer surface, it evaporates in the bone-dry heat of our summers, thereby cooling the water in the goblet. The hotter and drier the day, the cooler the water.

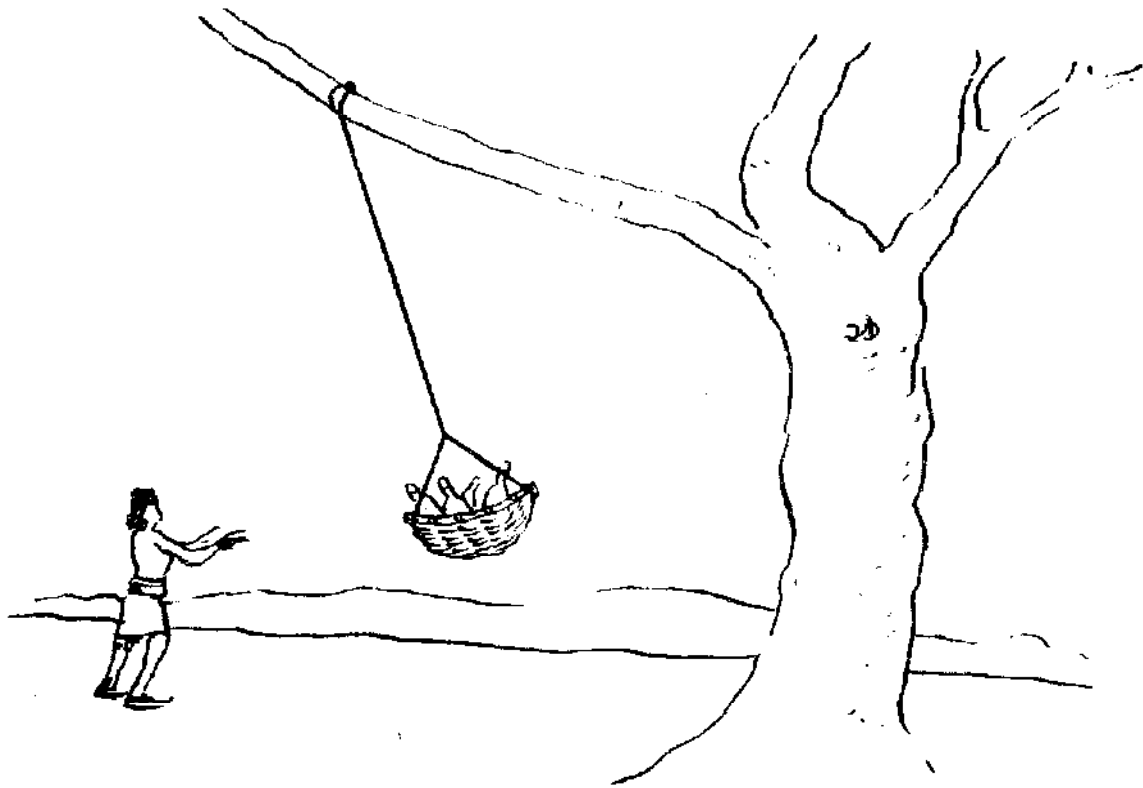
The same effect may be obtained with goblets of any material whatsoever, even glass. Just wrap them in cloth and stand them in a soup plate of water where the dry wind can blow upon them. Remember to disinfect the goblet from time to time.

## THE STRAW BASKET

cold drinks without ice

At the turn of the century, the very dawn of history for me, there were no such things as refrigerators in private homes. Ice was made in big factories in Calcutta, Bombay, Delhi, Madras, and delivered to hotels and restaurants in huge blocks or slabs perhaps four feet long and six inches thick. They were also sent by train all over the country packed in crates of sawdust. Local dealers in the smaller towns along the line would pick them up at the railway stations and retail the ice to clubs and institutions and private individuals. However, if one lived on the fringe of civilization far from the main lines, ice was unavailable, and one had to think up some other means of cooling drinking water, beer and soda, which were not too refreshing drunk lukewarm.

The most common means employed was the straw basket. Any basket will do, preferably a shallow one of large diameter and open mesh. It is filled with straw. The bottles and cans are



laid horizontally in the straw and kept covered with more straw. The basket is tied to a long rope, the longer the better, and hung from the branch of a tree or a high beam near which servants frequently pass. The straw is thoroughly wetted. Everyone passing by gives the basket a push. As it swings, the water evaporates and cools the contents. Keep the straw wet, and keep the basket swinging. It is quite efficient.

## A WOOD-BURNING STOVE

for room heating

This stove is made from an empty 20-litre paint drum.

Cut a hole of diameter 8cm in the top for the chimney as near as possible to the circumference.

Cut out the rest of the top, leaving a 1 cm ledge. Make a flap cover and hinge it at the dotted line. It must rest on the ledge. This allows for loading the stove with kindling and wood.

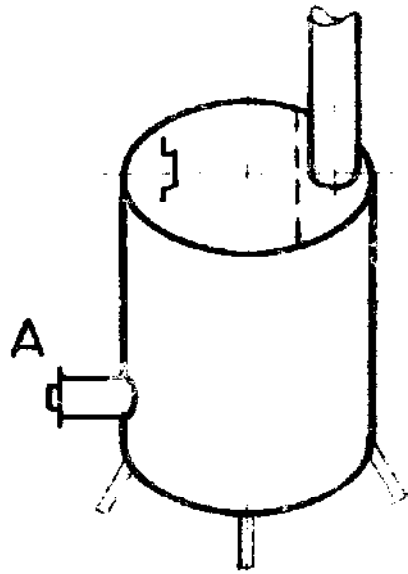
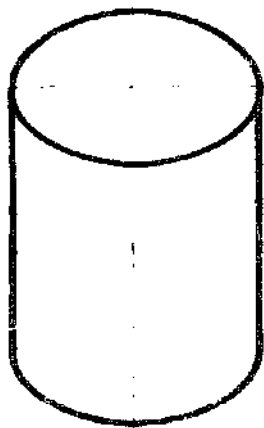
2.5 cm above the bottom make a 7cm hole. Fix to it an 8cm long metal tube open at both ends. Make a second metal tube of slightly smaller diameter to slide smoothly into the first. The second (inner) tube is closed at one end and given a handle. Along the length of this inner tube make about six slits 6cm x 1 cm. This inner tube serves as draft control. Give the stove three legs. Fill the bottom of the stove with 2.5cm of clay. This is a safety measure : it acts as insulation in case the stove is used on a wooden floor. It also prevents the bottom of the stove from getting red hot and wearing out before its time.

These stoves will work satisfactorily through five or six winters before having to be replaced.

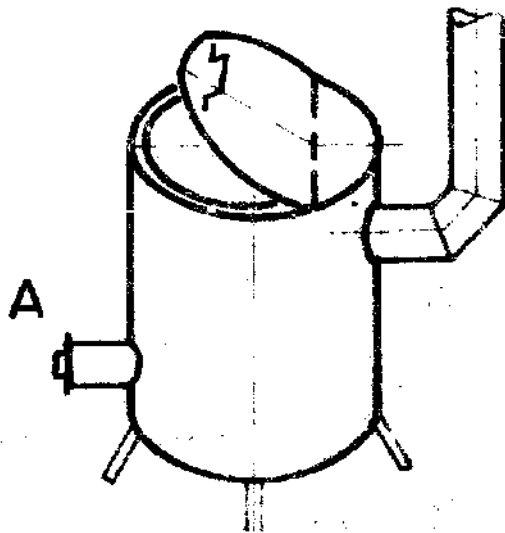
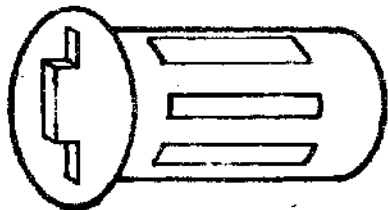
Alternative to putting the chimney on the top of the stove, it could conveniently be placed high up on the vertical side of the stove opposite the draft control. The chimney diameter should be somewhat greater than that of the draft control. A side chimney leaves space on top for a pot.

If the chimney is nice and long, (4 m) the draft is excellent, and the stove lights with one match. There is no need to blow or fan. Start the fire with much kindling and little wood. Once it is burning well you can fill it up with more wood.

# A WOOD-BURNING STOVE



## detail A



## A SAWDUST STOVE

One of the simplest fuels for cooking, and for heating the house in winter is sawdust, a waste product which is usually thrown away and is therefore available free or at nominal cost. True, not everybody lives conveniently near a sawmill or lumberyard; but the same objection applies to many other alternative sources of power. Not everyone has a stream running through his property to generate electricity, or keeps cattle to supply manure for methane. We must make use of whatever resources are available to us.

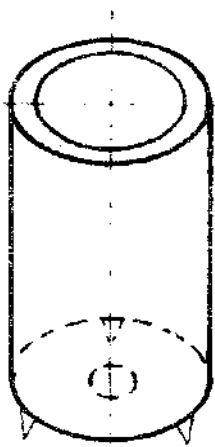
Sawdust will burn properly only in a specially constructed stove, which is very simple to make and costs practically nothing. The fuel in such a unit always lights with only one match, and keeps burning for long periods – six, eight or even twelve hours if desired – with absolutely no smoke, except at the moment of lighting, no blowing or fanning and no refuelling. Once lighted, such a stove burns until all the fuel is consumed. It can then be re-charged and lighted again. Such a device is ideal where steady heat is required for hours on end with no attention, as for instance, to provide day-long hot water, or to keep a sick room cosy and warm through a chill winter's night.

To make a sawdust stove, take an empty paint drum of say twenty litre capacity. Cut out the top and make a 5 cm hole in the middle of the bottom. Set the container up on three legs, and the stove is ready. The only "tool" you need to make the burner work is a smooth round stick or length of water pipe the diameter of the hole in the bottom, and long enough, when resting on the ground, to protrude 10 or 12 cm above the can top.

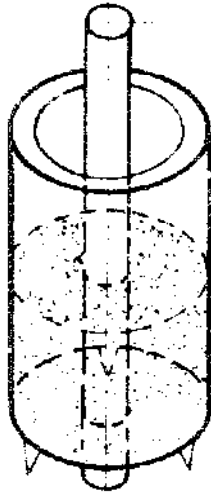
It is absolutely essential that the fuel for this stove be *bone dry*. If it is slightly damp, it will smoke; and if it is very damp it won't light at all. Dry sawdust burns wonderfully well – some times even with a blue flame – and is entirely smokeless. It does give off some fumes, however, and so the room where the stove

# A SAWDUST STOVE

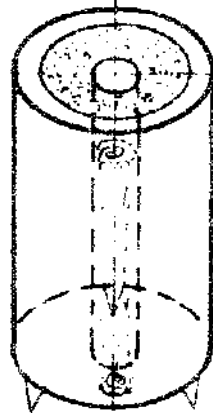
drum with  
legs + hole



drum partly  
filled



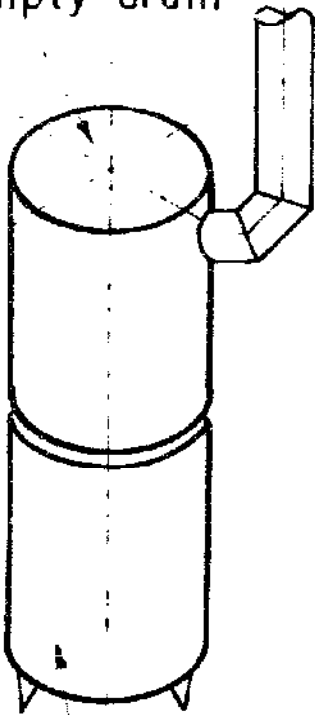
stick removed  
ashes over fuel



paper in chimney  
ready to light

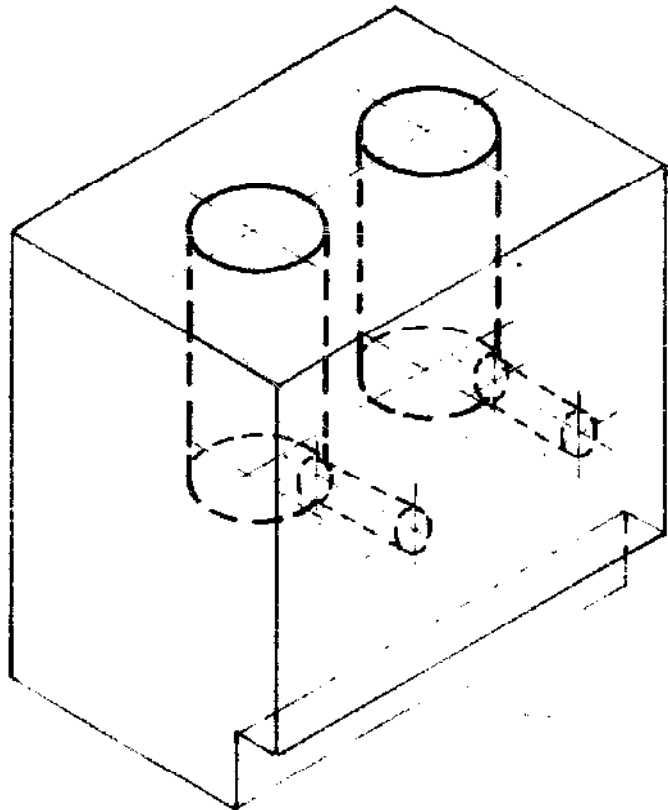
## space heater

overturned  
empty drum



stove

## cooking range



is being used must be well ventilated.

To load the burner, insert the stick or pipe through the hole in the bottom, and hold it upright while you pour sawdust around it. Every now and then, as you fill the container, press the fuel down firmly to make it tight and compact. When the drum is full, completely cover the top of the sawdust with a thin even layer of sand or ashes to prevent the flame from creeping over the top and causing smoke. Then twist the pipe as you carefully pull it out of the packed fuel. You will now have a neat hole, which will act as a chimney, right through the mass.

The sawdust stove is easy to light. Just crumple a sheet of newspaper accordion fashion and push it gently down the chimney until it protrudes at the bottom. Put a match to the lower end and the home made heating unit will require no further attention whatever until the fuel is completely consumed.

The sawdust burns from the centre outwards, the hole gradually increasing in diameter until there is no sawdust left and the flame dies out. The rate of consumption is approximately 5 cm per hour (the figure varies slightly with the quality of the fuel and how tightly it is packed). A stove 30cm in diameter will burn about six hours, and one 20cm across will operate long enough to cook a meal and produce some hot water to wash the pots and pans.

The amount of heat produced is dependent on the depth of the container: the longer the "chimney", the hotter the flame. A tall, narrow stove will become very hot for a relatively short time; a broad, squat model will give gentler heat for a longer period; a tall, wide drum will burn both long and hot. Calculate the dimensions to suit your requirements.

The basic design described above can be adapted to special purposes. For instance, a good sawdust-fired kitchen range can be constructed in either of two ways : (1) Two or more legless



drum stoves can be bricked in with a small opening below each to admit air and remove ashes; (2) the range can be built of brickwork alone, without drums, but with one or more spaces the shape and size of a drum to hold the sawdust. Each of these spaces should have a 5cm hole through the brick work into the bottom of the space. This second model is loaded with the help of two sticks or pipes. One is first pushed through the front opening at least as far as the centre of the stove, and the other is held upright resting on the horizontal pipe. Then the unit is packed with sawdust and both pipes or sticks are drawn out. To light this stove, the paper is shoved in horizontally.

The sawdust drum stove may be modified into a space heater to dry laundry on a rainy day, or warm a living room on a cold night. To adapt a drum stove for this purpose, a second drum, with its top removed, is turned upside down and fitted snugly on the upper rim of the heater. This radiates warmth into the room. If desired, a hole with a removable cover could be cut in the top to make an open burner for heating a kettle.

### **ROOM HEATING WITH SAWDUST\***

The previous article described a small two-drum sawdust room heater. A much bigger and more efficient heater, also made with two drums, has one inside the other. The outer drum can be a 225-litre one. It should have a securely closing but removable cover with two handles of 1/2" rod. The smaller drum should be some 10cm less in diameter, and 16 shorter in height.

A false bottom, cut to a close fit, is placed inside the larger drum 8.5cm above its true bottom. It is supported by two 1/2" iron rods running from front to back through holes in the drum and welded or brazed to it. The false bottom should have a 6cm hole in the very centre.

The outer drum is given a chimney take-off hole of 12.5cm diameter just above the false bottom. Opposite this hole, and between the two bottoms, comes a metal drawer which acts as ash pan and draft control. It has a curved front to fit the drum, and is given a handle. The drum should be given three legs.

The inner drum for holding the sawdust needs no cover. It should have a 6cm hole in the bottom centre.

The centre stick used in packing the stove with sawdust (cf previous article) is better made slightly tapering to facilitate extraction. It should be as long as the inner drum is deep, and should have a handle. Remember to put ashes or sand over the top surface of the sawdust to prevent smoking. To light, put crumpled paper down the hole in the sawdust; cover the stove; put burning paper into the drawer just under the centre hole.

The stove cover should have a secure, close fit to prevent the possibility of carbon monoxide fumes escaping into the room instead of going up the chimney. Adequate room ventilation should be provided with this stove as, in fact, with all stoves. Avoid opening the stove while it is burning.

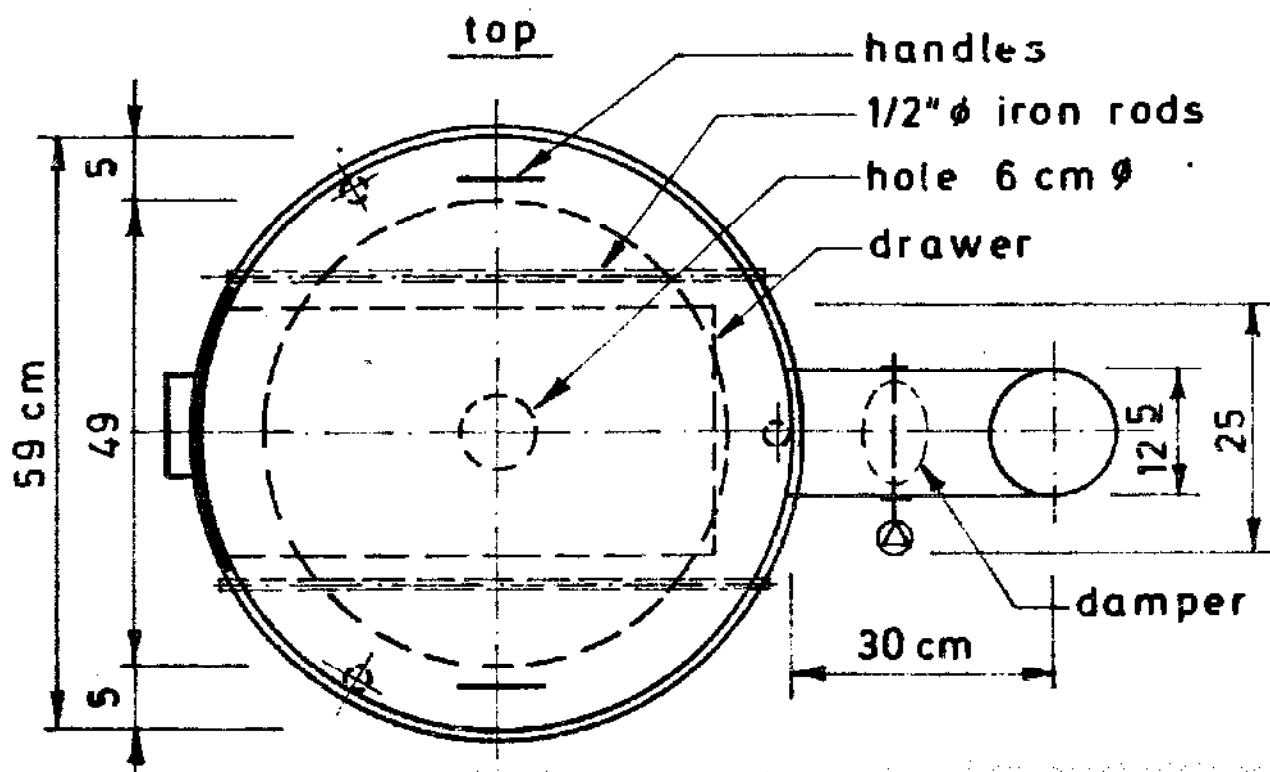
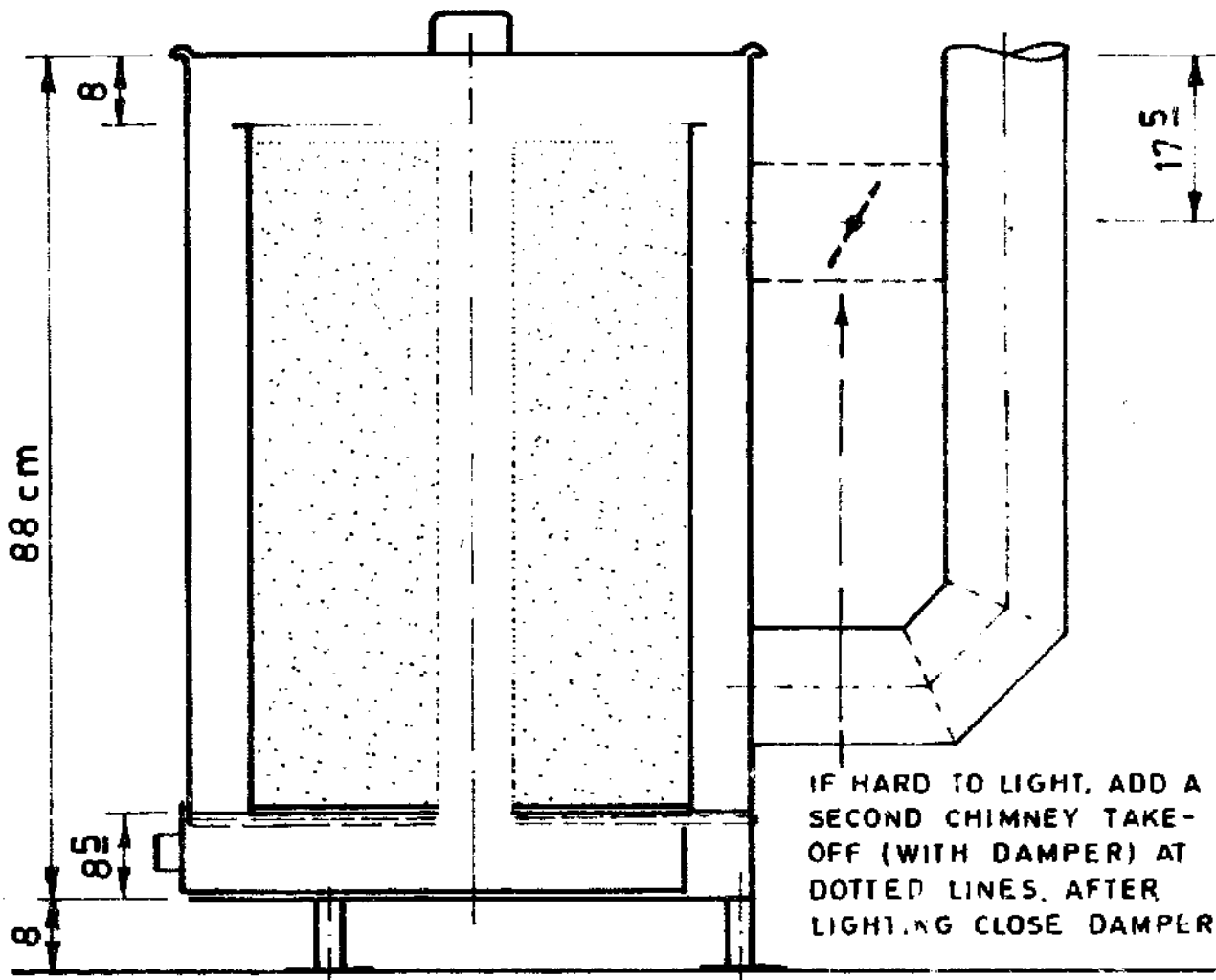
The stove gives greatest heat with dry sawdust. If the sawdust is slightly damp (60% or less) it will burn, but will smoke. Damp sawdust burns longer, but less hot, because much of the heat generated is spent in drying the fuel instead of being available for heating the room.

A stove of this kind can keep a room 8m x 5m at approximately 25°C for eight or ten hours when the outside temperature is below freezing.

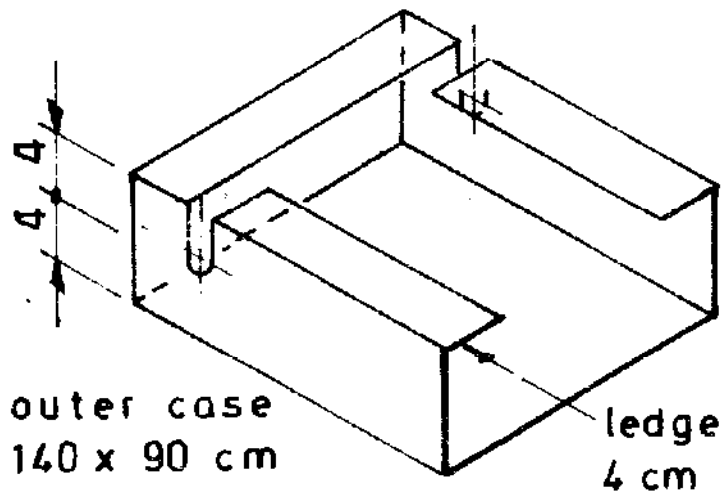
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\*For the general idea of this stove, and for much of the information given here, we are indebted to the Northeastern Forest Experiment Stn., Upper Darby, PA. 19082, U.S.A.

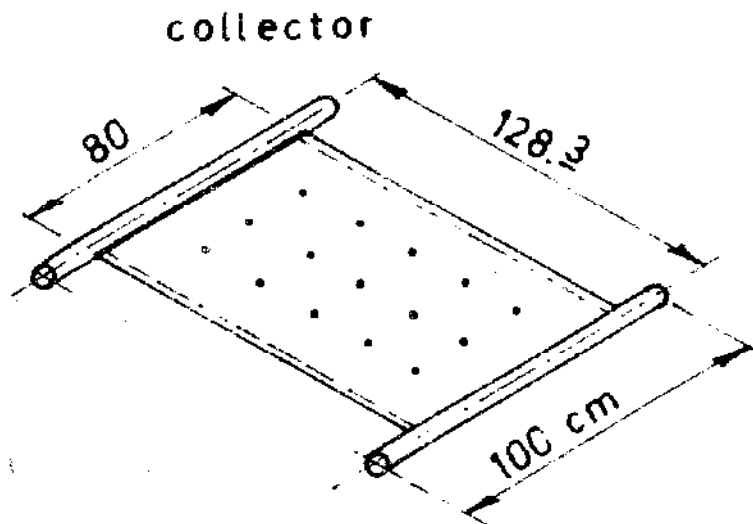
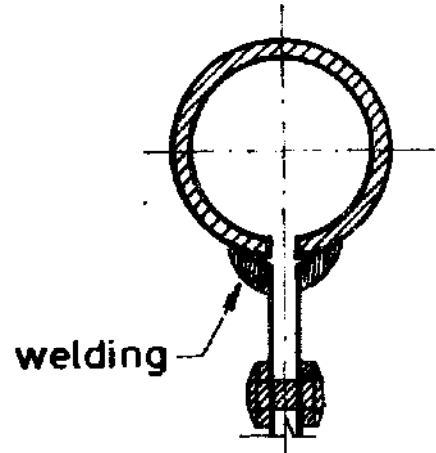
# ROOM HEATING WITH SAWDUST



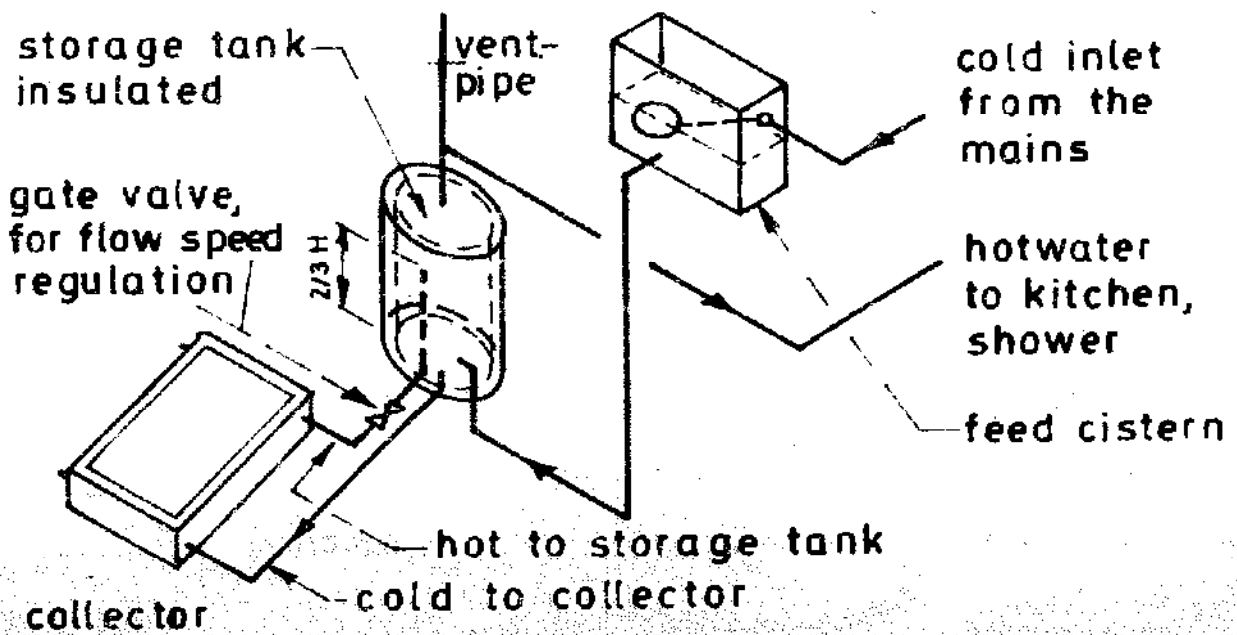
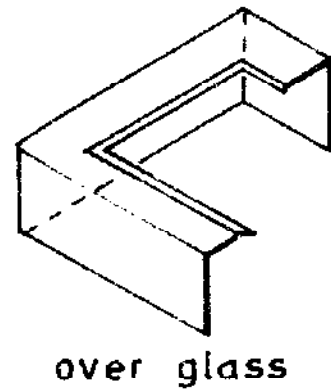
# SOLAR WATER HEATER (TWO PIECE WITH STORAGE TANK)



header pipe, welded to absorber plate (G.I. 1"φ)



detail cover frame



## SOLAR WATER HEATER

(two piece : with storage tank)

Using solar energy to provide hot water for domestic purposes is now common practice around the world. The initial cost is the only expense; once installed, the running cost is nil.

The heater comprises two sections : the *absorber* or *collector*, which collects the sun's heat and passes it on to the water, and the *reservoir* or *storage tank* which holds the heated water. These are connected by pipes through which the water circulates automatically by convection current, and gets hotter and hotter every time it passes through the absorber. The size of the collector is determined by the volume of water to be heated. It is usual to allow 45 litres (10 imp. galls.) per person for showers, laundry and kitchen, and to give the collector an area of  $1\text{ m}^2$  for every 70-75 litres of water to be heated. With a 225-litre (50 gall.) oil drum serving as tank for a family of five, the absorber should have an area of at least  $3\text{ m}^2$ . As this size is too big and unwieldy, it is better to use two of  $1.5\text{ m}^2$  each, joined together. The surface area is important; the shape is immaterial. A larger surface will heat the same amount of water hotter faster.

We give below detailed instructions for making a small collector to heat 75 litres of water, enough for four or five showers a day, or for a couple of showers with some hot water left over for kitchen use.

**The Collector** - This can be made of thin metal sheet of approximately SWG 18 (1.22 mm). Copper is the best, but the most costly. Steelsheeting, or galvanized-iron sheeting, is the easiest to work with and weld or braze, and gives perfect satisfaction. Before joining the sheets together, paint the inner surfaces with rustproof paint. Make both sheets the same length, but make one 2.5cm broader than the other. Place the narrower sheet on the broader. Fold the edges over and weld them down. Next drill holes 20cm (8") apart through both sheets over the entire surface, and placing metal washers above and below, rivet the sheets together. Weld or braze or solder each rivet, or seal it with silicone sealant.

Now take two 1" pipes 20cm longer than the breadth of the collector plate. Thread the four ends. Make in each pipe a straight cut 6mm wide, equidistant from the ends and almost as long as the collector is broad. Flare the open ends of the collector plate to form two "lips" and braze these to the pipes over the cuts. These pipes form the inlet and outlet for the water. When this is done test the collector under pressure for leaks. If no leaks appear, paint both sides with anti-rust paint, and re-paint one side dull black (*not* shiny enamel).

**The Outer Case** – The absorber has to be put into an outer case together with insulation. Make the case of metal, 10cm longer and 10cm broader than the collector plate, and 8cm deep with a 4cm inward right-angle bend at the top all round to support the glass cover. Centre the plate on the case, and under the pipes cut slots 4cm deep and just wide enough to take the pipes. Put insulating material into the case, on the bottom and all round the sides to a thickness of 5 cm. In the very centre, place a block of wood 5cm high to support the collector and prevent it from crushing the insulation. Put the plate in, black side up, over the insulation, and fix it firmly in position with locknuts on the pipes. The fixture must be leak-proof against rain water. In case some water does seep in, make two 4mm holes in the very bottom angle of the case to let it trickle out again.

The case is covered with a sheet of glass protected with rubber channelling all round; and over the glass, to hold it in position, is placed a metal frame duly painted with rust-proof paint. With that the absorber unit is completely finished.

**The Storage Tank** – A metal tank 36cm in diameter by 74cm high will just hold 75 litres. Make three holes in the bottom: one to take a 1/2" inlet from the cold mains; one to take a 1" hot inlet from the collector top. This pipe must stand two-thirds the height of the tank, i.e. 50cm high, inside the tank. The third hole is for a 1" outlet to the bottom of the collector. At the very top of the tank fix a 1/2" outlet to the showers or kitchen, and from the same outlet, through a tee, have a vent pipe

as high as the top of the cold water supply tank, which, if the mains pressure is very high, could be a small float tank right near the heater and a foot (30cm) higher than the storage tank.

Insulate the tank with a 5cm or 7.5cm thickness of insulation all round and above and below, using glass fibre, coir, sawdust, or other suitable material. If the tank is to stand out in the open, it should be weatherproofed. Both pipes between collector and tank should have 2.5cm of insulation, which also should be weatherproofed.

**Installation** - Place the collector unit in a spot free from shadows of trees or buildings. In the northern hemisphere face it south; in the southern, north, sloping it at an angle from the horizontal equal to the local latitude plus  $15^{\circ}$ . During installation, and as long as there is no water in the unit, keep the glass covered with paper or sackcloth, otherwise the unit will get so hot as to crack the glass and melt paint and plastic insulation.

The tank should be mounted close to the collector, with the bottom of the tank at least 30cm higher than the top of the collector. This minimizes reverse flow at night.

**Efficiency** - The efficiency of the heater depends, among other factors, on the design, the materials employed, the insulation, the angle and relative size of the absorber. Under normal conditions, a heater such as described here will deliver water a about  $55^{\circ}\text{C}$  on a bright, sunny day. Just for comparison, a shower over  $40^{\circ}$  is uncomfortably hot.

On cloudy days, if the sun shines for even only two or three hours, the heater will operate satisfactorily. However, under extraordinary circumstances, like a week of no sun, it may fail to function. To cope with such an emergency, an electric water heater element could be incorporated into the tank at hot inlet level and be controlled with a thermostat and/or an external switch. This would also serve as a booster in case of an occasional unusually great demand for hot water.

## A ONE PIECE SOLAR HEATER

### The Flat Tank

A solar heater normally consists of two parts: an absorber, or heating element, and a storage tank. Both are connected by pipes, and both, together with the connecting pipes, must be heavily insulated. In the One Piece Heater there is only one part, the absorber, which is both heating element and storage tank combined. It is half as costly as any comparable heater.

The flat tank heater is extremely simple. It consists of a shallow metal tank placed inside a somewhat larger metal case with a glass top. On one of the longer sides of the tank there are two pipes, one to admit cold water, the other to deliver hot water. Between the tank and the outer case there is a 5cm thickness of any suitable insulating material round the four sides and on the bottom. Between the top face of the tank and the glass there should be an air space of 2.5 to 3cm.

From the table of tank capacities below select the size that suits your requirements. Allow 15 litres per person for a shower. This may seem little, but the water gets so hot that much cold water must be added to make it bearable.

#### Tank Capacities

Length	Breadth	Depth	Volume	Showers
cm	cm	cm	ltr	
100	60	10	60	4
125	80	10	100	7
150	100	10	150	10
180	125	10	225	15
125	80	6	60	4
150	100	6	90	6
180	125	6	135	9



Where hot water is drawn chiefly in the afternoon or evening, the 10cm depth is more than adequate; but where there are frequent demands for small quantities throughout the day, the 6cm depth is preferable: it heats up faster and hotter. If greater quantities of water are required than shown in the table, two or three heaters could be installed independently or in tandem.

Make the tank of galvanized-iron sheeting or black metal sheeting of SWG 18 (1.22mm). Two pieces of 1/2" or 1" pipe 8cm long are welded to one of the long sides of the tank in such a way that when the heater is inclined with its upper surface facing the sun, the upper pipe is in the angle towards the glass (the topmost angle), and the lower pipe is in the diagonally opposite angle (the lowest) away from the glass (cf diagram). The outer ends of these pipes should be threaded at least 4cm.

It is recommended to strengthen the tank against stress, especially if the water pressure is high, by welding short strips of 1/2" pipe or 1/4" rod to the top and bottom on the *inside*. It is done this way. Weld them 20cm apart in every direction to the sheet which will be the *inside* top of the tank. The bottom sheet has holes cut to fit the struts snugly. Then these strut ends, which should protrude 5mm, are welded to the sheet from the *outside*. Bracing the tank thus prevents it from bulging out under pressure.

Paint the inside of the tank with rustproof paint by pouring it into the tank and swirling it round in every direction. The outside too should be painted, the top face being a dull black stove paint or boiler paint or even blackboard paint, but not a shiny black enamel.

Make the outer case too of metal sheeting. Wood ultimately warps and rots and falls apart. The case has only sides and bottom. The top edge is given a 4cm inward bend to form a ledge for the glass to rest on and to give rigidity to the case. If the heater is to be hung on a wall, weld to the case two rings to catch on two hooks embedded in the wall. The case too should be rustproof painted inside and outside.

One more part has to be made: an iron frame to hold the glass down. Make this of metal strips 8cm wide. Bend each strip lengthwise to a right angle with one arm 5cm and the other 3cm wide. Cut the shorter pieces to fit the breadth of the case. Make the longer pieces 1cm longer than the case. Mitre the ends of the 3cm arms and weld the four pieces together.

When putting the tank into the case, first put in a couple of wooden blocks as deep as the insulation to support the tank and prevent it from compressing the insulation. Put two shorter blocks on the shorter side that will be the lowest side of the heater when installed. Put a locknut on each of the pipes. Pass the pipes through the holes in the outer case; centre the tank properly; then with a second locknut on the outside secure the pipes and tank firmly in position. Make the locknut moisture proof against rain water. Fill the space between the case and the tank, including the bottom, with insulation (glass fibre, foam plastic, coir, kapok, pine needles, cotton...).

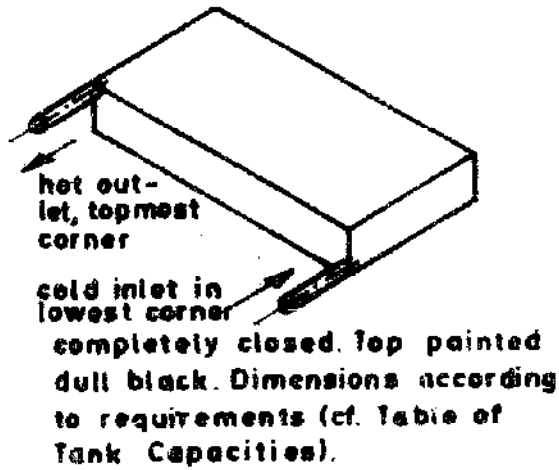
Put rubber channelling on the left, top and right edges of the glass and on the bottom edge of the case to allow rain water to flow off without creeping up and entering the case. For the same purpose the glass should be a trifle shorter than the frame length. Lay the glass on the case and place the frame over it.

Install the heater where shadows of trees or buildings will not fall upon it. Face it towards the Equator, and give it an angle from the horizontal equal to the local latitude plus 15°. While installing the heater, cover the glass. An empty tank gets so hot as to crack the glass and melt paint and plastic insulation. Connect the cold water to the lower pipe on the tank, and the showers to the upper.

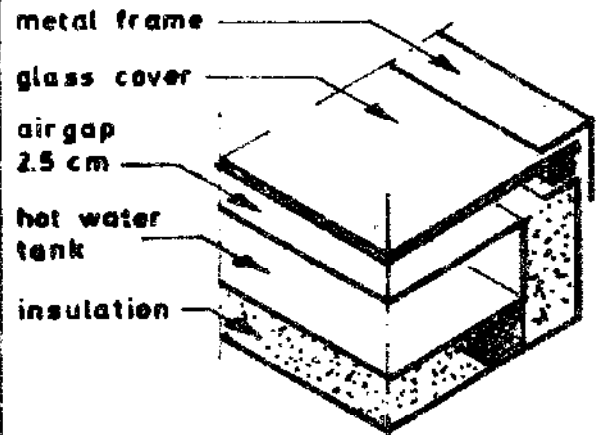
The heater must never be allowed to empty completely. If there is any likelihood of the water supply running dry and the heater being drained, or if the mains pressure is too high (over 10 mtr.), then don't connect the tank direct to the mains, but to

# A ONE-PIECE SOLAR WATER HEATER

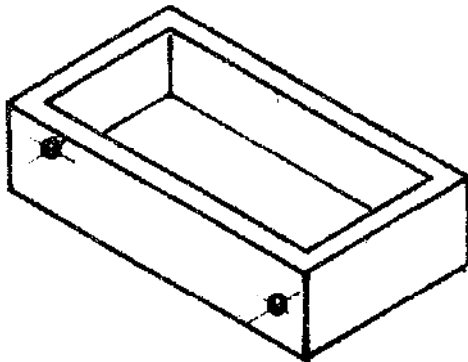
## Hot water tank



## cross/assembled unit

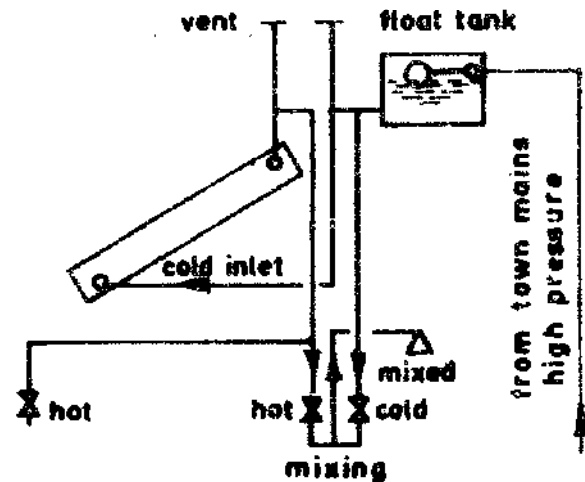


## Outer case

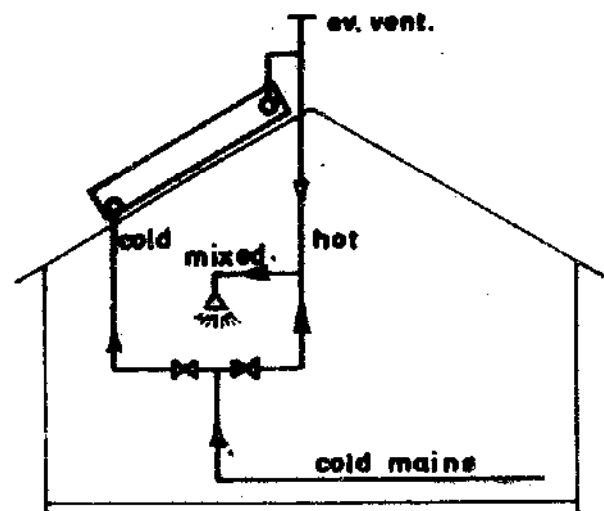


The flat tank is put into this with 5cm insulation on sides and bottom.

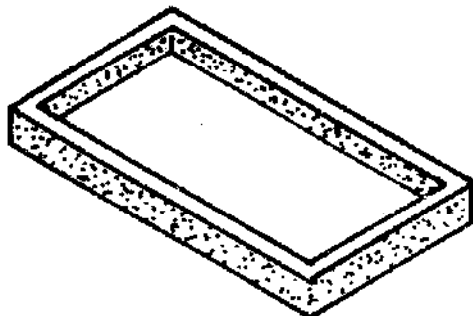
## Installation for several h-w taps



## Installation for single shower



## Metal frame



to fit outer case and hold glass cover in position.

a float tank slightly higher than the heater, and from the outlet right near the heater have a pipe rising to the top level of the float tank. In case of need, this automatically breaks the syphon and prevents the tank from draining.

**What you may expect the heater to do** – On a bright sunny day at an altitude of 1600 metres in the Himalayas in winter, beginning with cold water in the morning, the heater raises the temperature by 9 a. m. to 38°C, a comfortable heat for a warm shower, By 11 o'clock cold water has to be added to make the shower bearable. By mid afternoon it reaches 55° – 60°C. After sunset it gradually loses heat, but remains warm enough for a pleasant shower till almost midnight, then continues cooling till, by 6 a. m. it is less than tepid. How hot it remains, and for how long, depends very much on how good the insulation is.

Even if, say for sixty-five days of bad weather in the year, you may have to heat your water by conventional means, for the other three hundred days of every year for ever, your hot water costs you nothing.

## **A SOLAR WATER HEATER FOR VILLAGE USE**

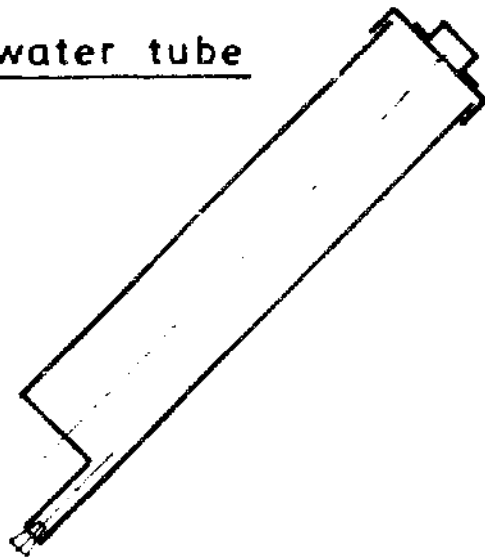
no water mains needed

**The Water Tube** – First make a sheet-iron tube of 12cm diameter x 100cm long, bottom end closed, top end open. In the bottom end make a 2cm hole near the circumference and weld to it a small tube 2cm diam. x 4cm. This is the outlet. Close it with a cork. Give the top end a removable cover. Paint inside of tube first with red oxide, then with white enamel. Paint outside dull black (stove paint or blackboard paint).

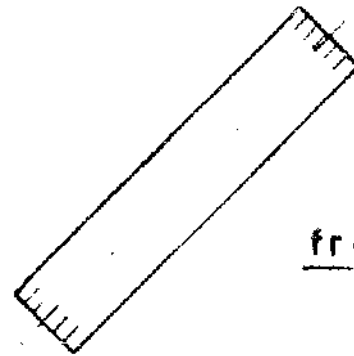
**The Flow Guide** – Make a second tube (which does not have to be water tight) 10cm diam. x 90cm long. At both ends of

# A SOLAR WATER HEATER FOR VILLAGE USE

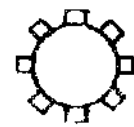
water tube



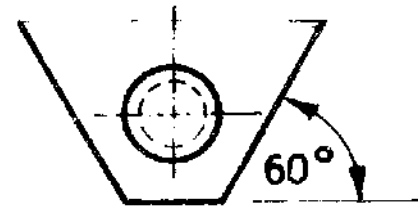
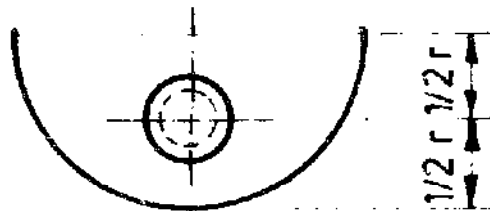
flow guide



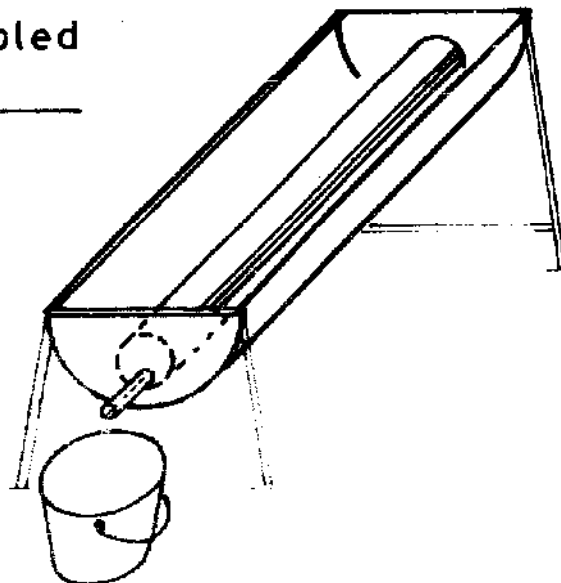
front/end



reflector - types



assembled unit



this tube make a number of cuts 1cm deep x 1cm broad, thus making a number of small strips. Bend every alternate strip outward to a right angle. The others are left straight. Now slip the flow guide right down to the bottom of the water tube. If correctly made, it will be exactly 1cm away from the latter all round. Its purpose: the 1cm depth of water between the tube and the guide will heat up very rapidly and flow upward by convection current, while cold water from the centre will flow down and pass to the circumference between the open strips at the bottom. The flow guide thus helps rapid heating and circulation.

**The Reflector** - Take a sheet of metal (aluminium, mild steel or galvanized iron) 100cm x 78.5cm and bend it into a perfect semi circle of 50cm diameter. Give it two end pieces. In one of these first cut a 10cm hole having its centre at exactly the mid point between the circumference and the centre of the reflector diameter, i.e. at 12.5cm from each. This is the focal point of the reflector. The water tube should fit snugly into this hole.

In the other end piece cut a small hole at the right spot to take the outlet tube. The water tube is correctly in position if it is half way between the reflector diameter and its circumference.

If the metal used is aluminium, polish it. Any other metal may be painted with shiny white enamel. Cover with window glass 3mm thick in an overlapping cover frame. Install heater in full sun facing south, and high enough to set a bucket below the outlet. Tilt at an angle from the horizontal equal to local latitude plus 15°. To get most advantage from the heater, keep it always quite full. In good sun it delivers 10 litres water at 60°C every two or three hours.

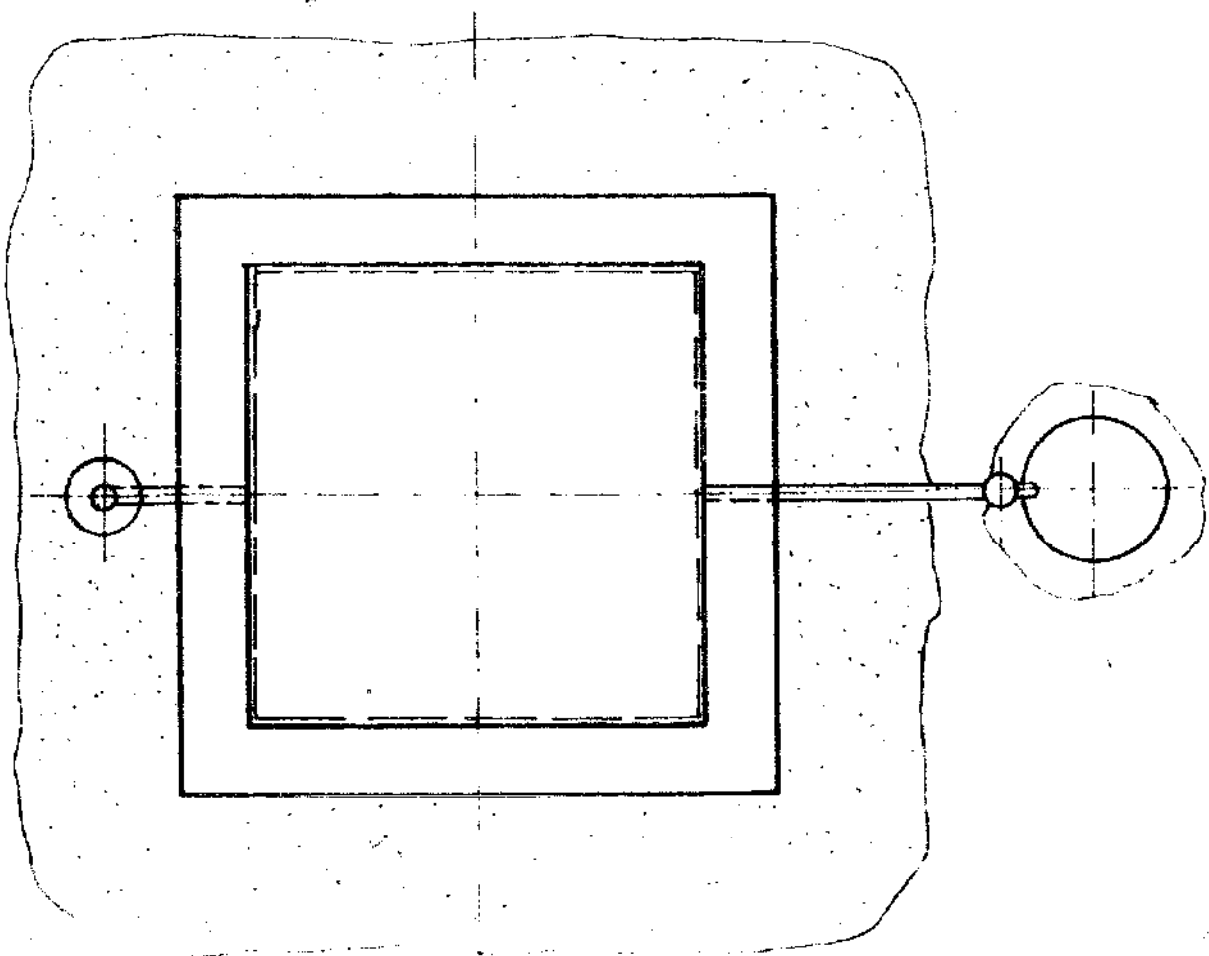
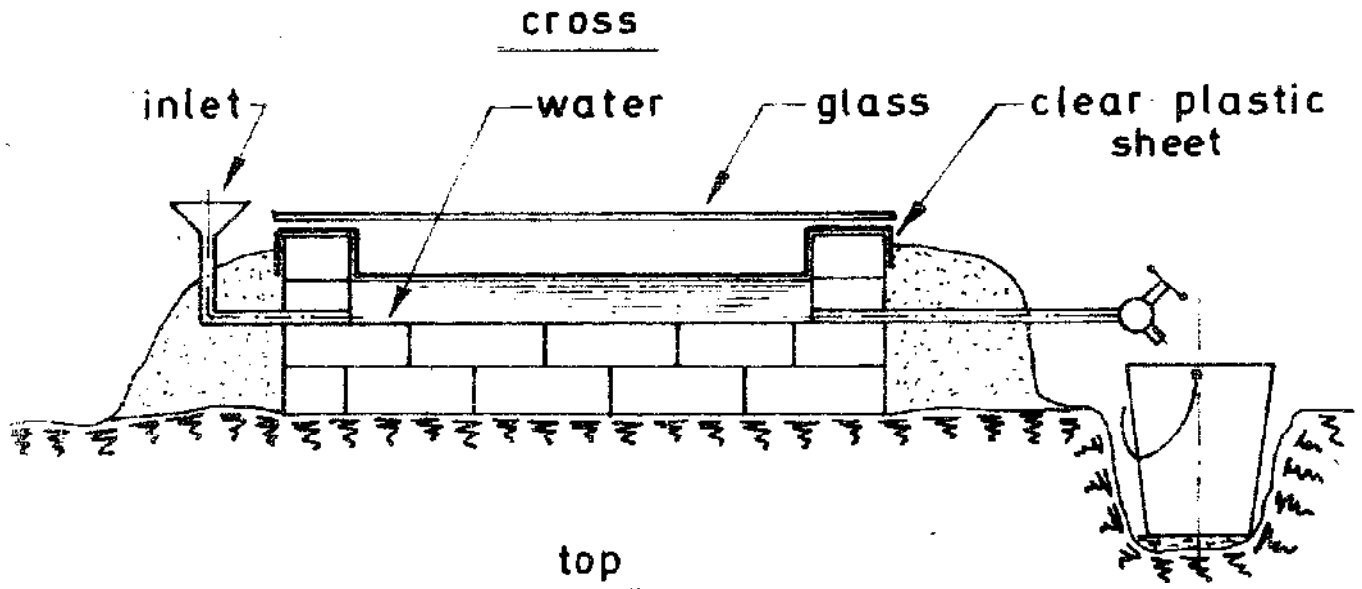
## A MINI SOLAR POND

People in far out places, who would appreciate a little hot water, say enough for a daily shower or bucket bath with some to spare, but find it not worth the expense of transporting and erecting a flat plate solar heater, can easily make themselves an efficient Mini Solar Pond at very little cost. The only things needed are about 175 bricks (depending on local brick dimensions), a little cement, a sheet of glass 120cm x 120cm, a sheet of clear plastic 1.5 M x 1.5M, a piece of 1/2" pipe 60cm long for the outlet and two pieces of 15 cm joined with an elbow for the inlet, a little black waterproof cement, or failing that, any dull black paint.

In an open sunny spot of your property where no shadows fall (a flat roof-top away from trees and tall buildings is good), lay down two layers of bricks 120cm square. On these build up the sides of the pond 10cm thick to a depth of two bricks, not forgetting to put in the inlet and outlet pipes at the bottom. Plaster the inside with black waterproof cement or paint dull black. Bank mud at least 30cm thick on all four sides to provide insulation. Fill the pond with water to the level of one brick (5cm). Lay the sheet of plastic on the surface of the water and let the ends hang over the sides. It prevents evaporation. Place the glass on top, giving it a slight slope for rain run-off. Your solar pond is now ready to function.

Just how efficient is such a pond ? For demonstration purposes a French scientist made one at Wardha in India. Here are the performance records:

# A MINI SOLAR POND





With plastic film alone

Jan. 23	Ambient Temp.	Water Temp.
11 a.m.	22°C	35°C
2 p.m.	30°C	56°C
4 p.m.	29°C	49°C
6 p.m.	19°C	32°C

Jan. 24	With plastic film and glass cover	
12 noon	23°C	42°C
1 p.m.	29°C	65°C
2 p.m.	28°C	66°C

From the above figures it is clear that these mini solar ponds are remarkably efficient. The small one described above will provide 50 litres of hot water. Each centimetre of depth holds 10 litres. If desired, the pond may be filled up to 8cm (80 lit.), but a minimum air space of 2.5cm must be left between the plastic sheet and the glass cover. If a single pane of the required size is hard to obtain, two smaller overlapping panes may be used.

## A SOLAR DRIER

Here is a simple, yet efficient, solar drier.

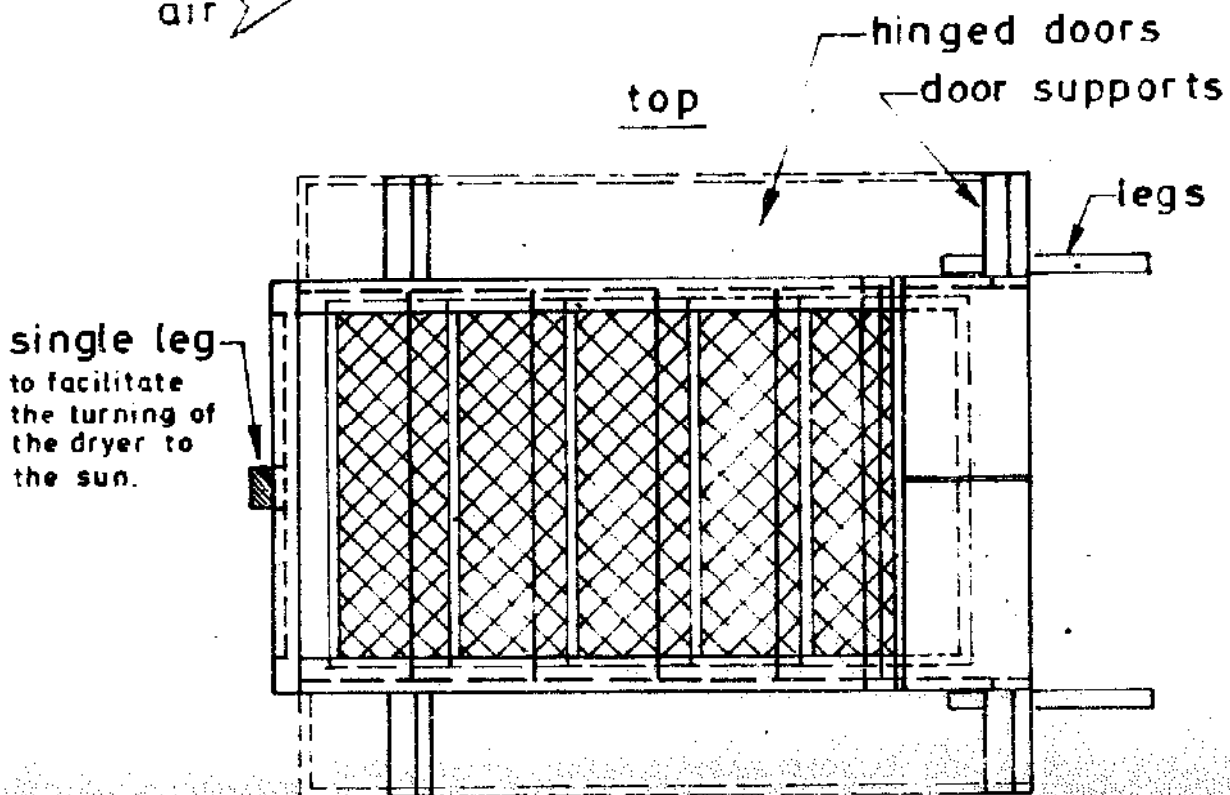
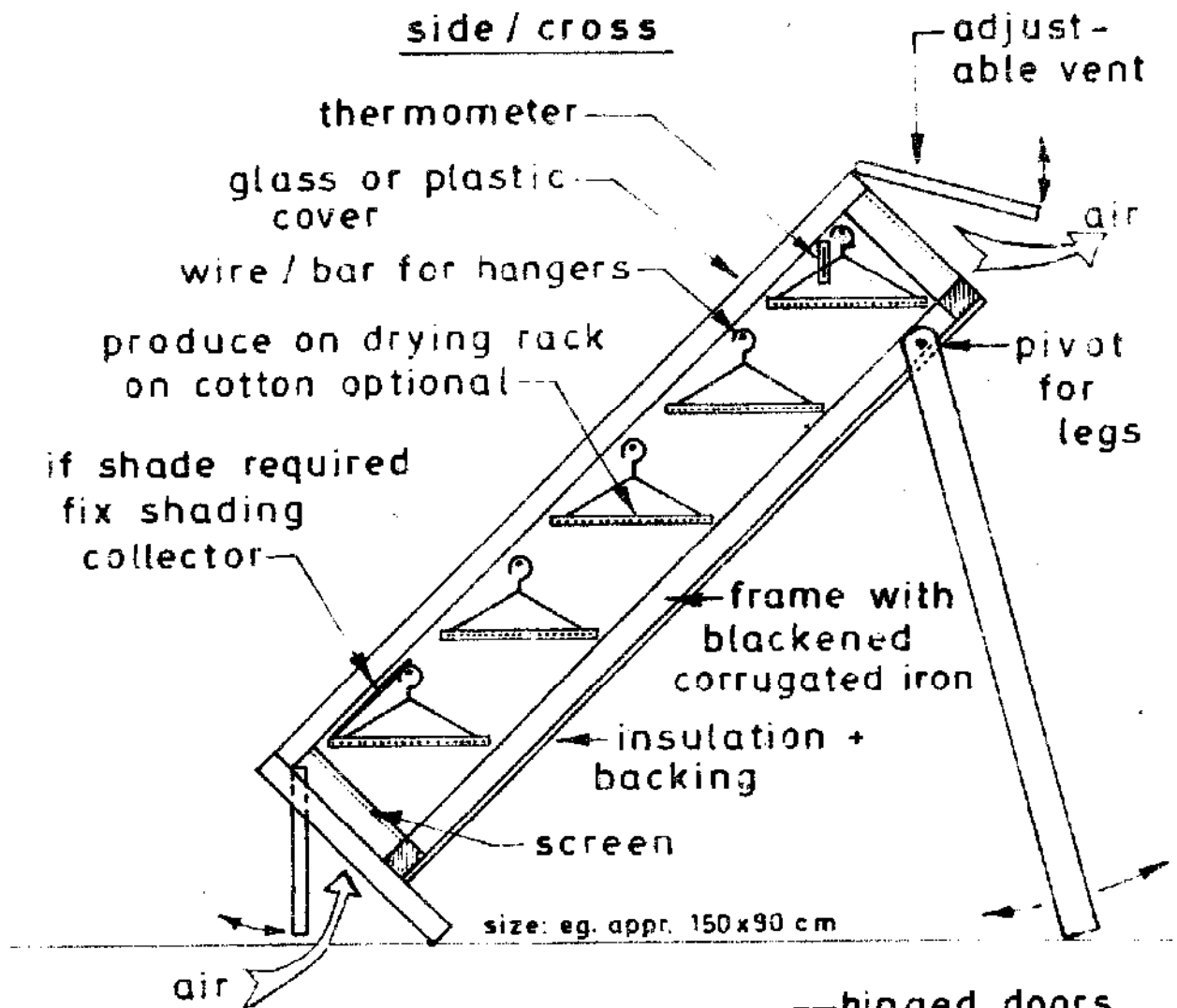
Make a wooden framework the length and breadth of a sheet of corrugated iron, and about 30cm deep. Give it a wooden bottom, on which is placed about 2.5cm of insulation (glass fibre is best). Over this comes the corrugated sheet painted dull black. Fix a door with hinges to each of the long sides. The two short sides have smaller doors or flaps to allow air to enter and leave the drier. Each of these flaps has a wire screen behind it for protection against rodents, insects, & c. Both long sides of the wooden frame have hooks on top conveniently placed, from which are hung coat hangers, or loops of wire or string. These coat hangers support open-mesh bamboo trays, or light wooden frames with one-inch wire screen, on which is placed the material to be dried. The whole drier is covered with glass or plastic.

The back legs of the drier should be long enough to tilt it at an angle equal to the local latitude. If they are slightly longer, they can make the angle 10 or 15° bigger to adjust the drier to the lower winter sun. To allow for this movement they are pivoted to the frame.

Produce that should be dried in shade, rather than in direct sunlight, can be protected from the sun's rays by a "shading collector", i.e. a thin, light, metal sheet as long as the drying tray and painted black on the outside to help collect heat. It can be attached to the same hooks as the coat hangers.

If the hot air leaving the solar drier can be directed into a greenhouse or a living room, it acts as a space heater and warms the room.

# A SIMPLE SOLAR DRIER



## THE IC-MIC COOKER

About the time that the 19th century became the 20th a little before or a little after, I do not know exactly, a Bengali invention came on the market by the name of The Ic-Mic Cooker. It was so successful and so much in demand that two or three other manufacturers copied it. They copied not only the appliance itself, but slavishly copied even the instruction booklet, misprints grammatical errors and all !

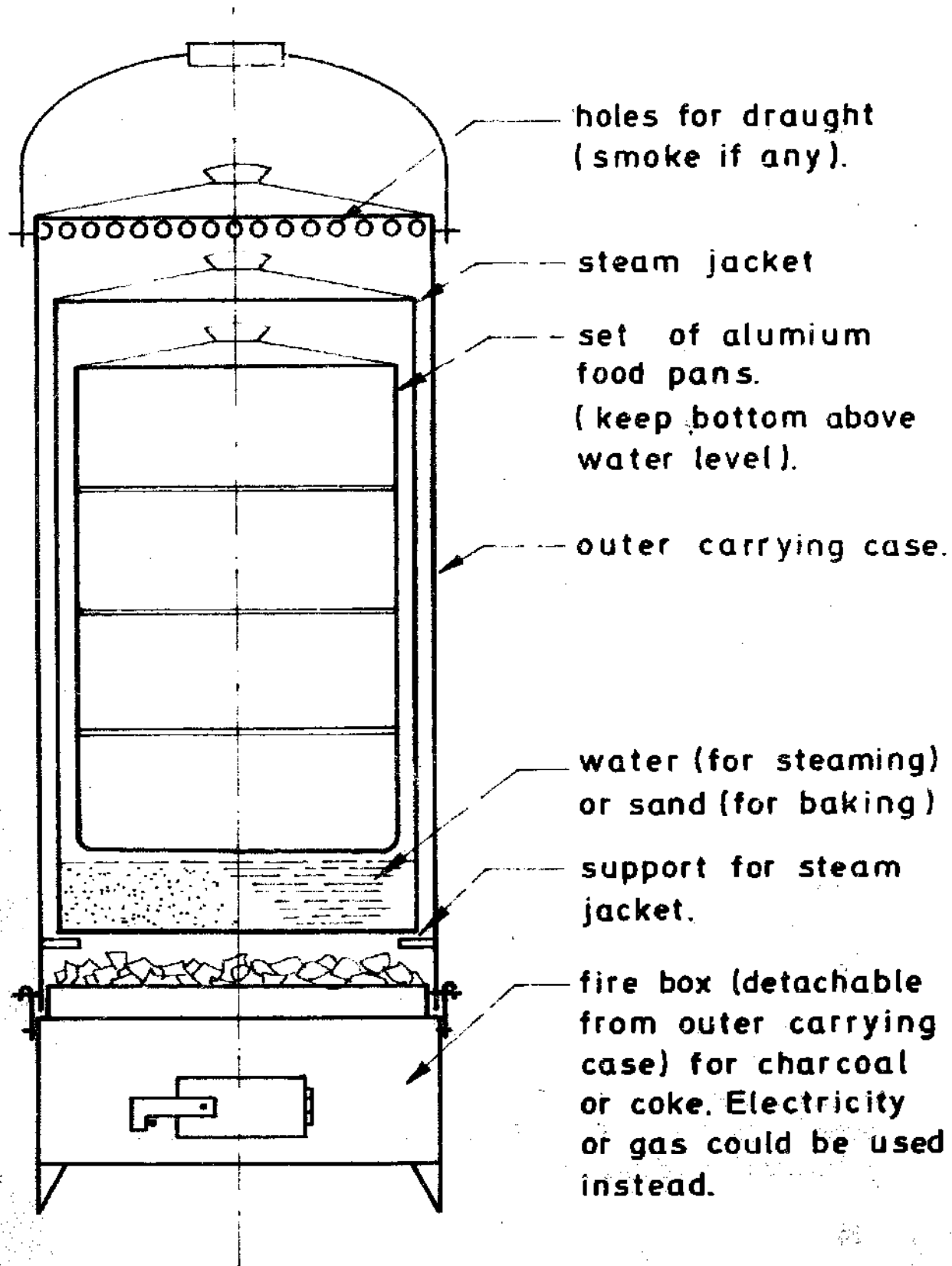
The Ic-Mic is a pressureless steam cooker extremely economical on fuel. It will thoroughly cook for 100 gms of food on approximately one litre of coke, charcoal or walnut-size balls of charcoal dust bound with a thin slurry of cowdung. Gas or electricity may also be used.

Once the raw materials have been put into the pans with all necessary seasonings, and the cooker closed and lighted, no attention whatever is needed. The food is well cooked, very tasty and nourishing, and even after the fire is burnt out, the cooker keeps the food warm for up to six hours. This is ideal for campers, travellers and picnickers : they set up the cooker, go about their business and return when they please to a hot well-cooked meal.

For steaming the food, the steam jacket holds 2.5 cm of water below the pans, but not touching them. For baking, the water is replaced by sand. Obviously baking and steaming cannot be done together. All frying, e.g. of onions or spices for curry, must be done separately before setting up the food in the cooker. There may be some limitations to what the Ic-Mic will do, but the advantages are enormous.

It is quite normal to cook meat in one pan, vegetables in another, desert in a third and soup in a fourth, all at the same time, without the aroma or flavour of one dish interfering with that of another, without any dish being over-cooked, and without

# THE IC - MIC STEAM COOKER



your having to fan or blow or rake up or replenish the fire once it has been lighted.

Recipe books for use with the Ic-Mic are available in India, but any resourceful housewife will soon learn to manage the cooker successfully. Rice cooked on the Ic-Mic is delicious. Put one measure rice into 1 1/2 measures water. When cooked, all the water will have been absorbed into the rice; so no nourishing elements are thrown away. The rice is clean. The grains fall separate, and don't stick in one clammy lump.

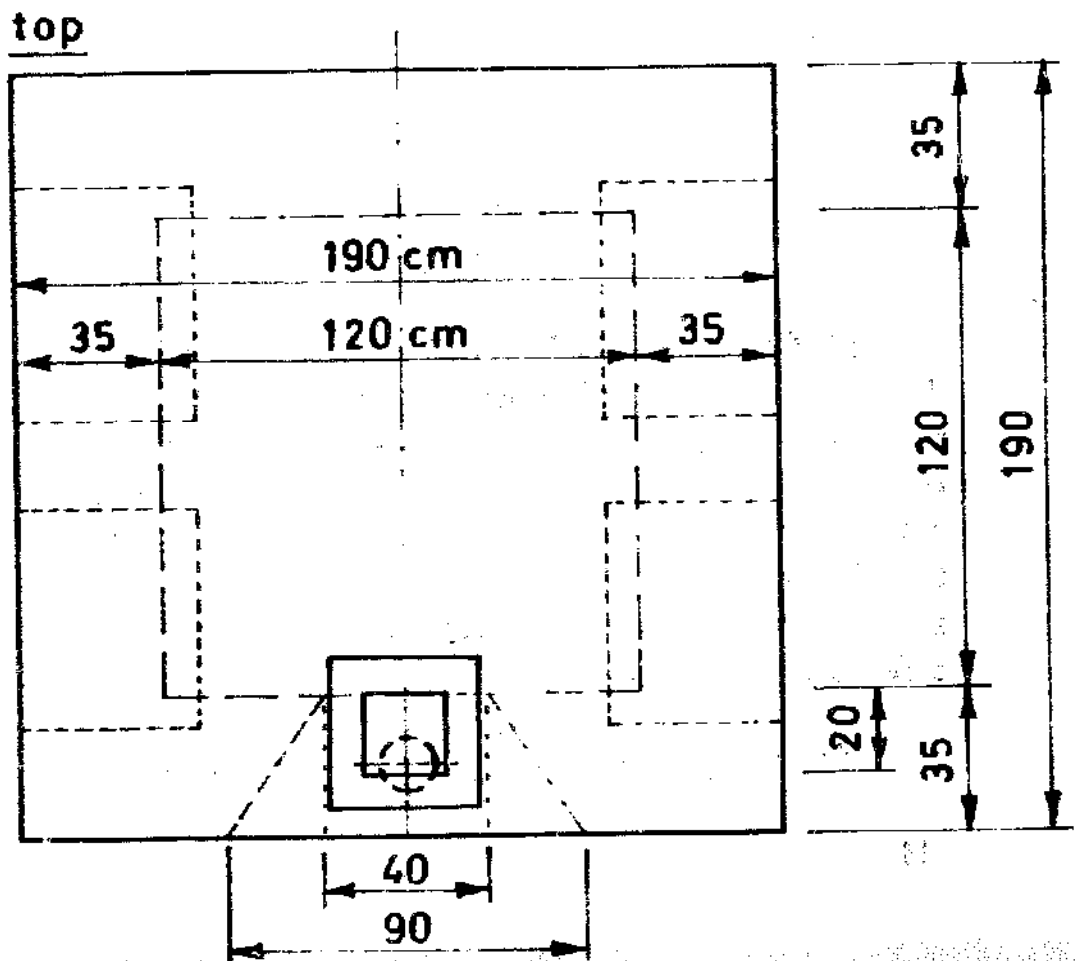
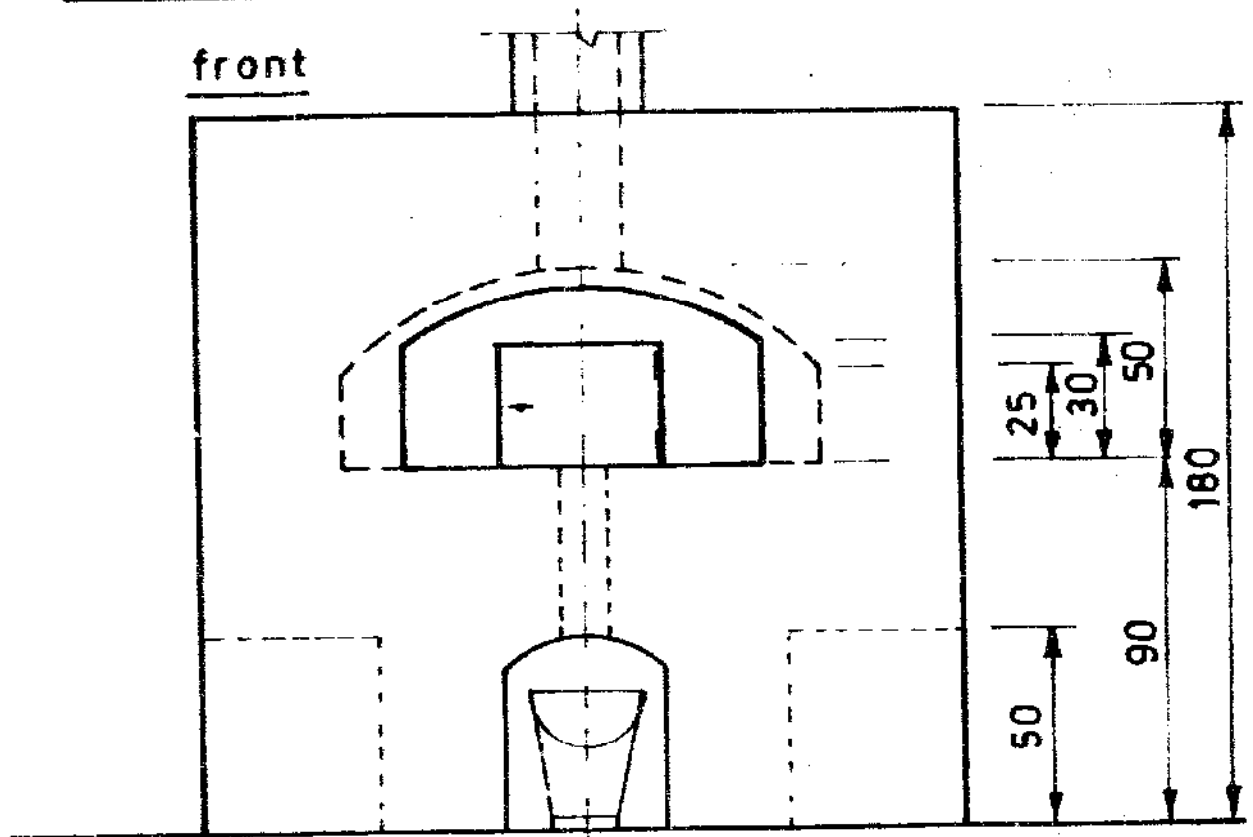
### **A LARGE WOOD BURNING OVEN**

We built one of these ovens for a school of about 150 boarders. It has worked excellently for the past twenty years. Loaded to capacity, it can hold 3 doz. 2-lb loaves (pans 28cm x 11.5 x 7.5), or nearly 6 doz. 1-lb loaves (pans 19cm x 9 x 6). After baking bread, it can bake a lot of biscuits, which, being thin, require less heat and bake quicker.

The oven is a cube of brick-and-mortar construction with a side of 180cm. At 80cm from the floor comes the oven proper, a square of 120cm with an arched top. The side walls of the baking space are built up to 25cm on the right and left, and from there comes the arch. The measurement from the oven floor to the centre of the arch is 50 cm. The walls all round are 30 cm thick. The brickwork above the arch centre is 40cm.

The front wall of the oven has an opening in the middle 90cm wide, narrowing down to the oven door which is 40cm broad and 30cm high. This latter is made of iron sheeting hinged to an angle-iron frame to protect the brickwork around the door. If firebricks are available, line the baking space with them: otherwise use the hardest bricks you can find, at least for the floor, which in the course of time suffers a lot of wear and tear with the pushing in and pulling out of bread pans and the scraping out of embers. The ledge in front of the oven door is covered with a protective sheet of thin metal.

# A LARGE WOOD-BURNING OVEN



Fire is lighted in the oven. The smoke comes out at the door and rises straight up the chimney, which begins immediately in front. Make the chimney hole as large as possible, at least 20cm, and the smoke will give no trouble whatever. In the twenty years that our oven has been used, the front face has remained clean without the least trace of blackening. When the fire dies down, rake out the embers and put in the bread.

That is the basic design of the oven. A few helpful improvements are recommended. The thin metal sheet covering the ledge could be replaced by an iron plate, say 2mm thick, of the same shape, hinged along the front edge so that it can be flipped up to expose a hole in the ledge through which the embers can drop straight into a bucket recessed into the oven wall. This is neater and cleaner than letting the hot embers and ashes fall on the floor.

Another suggestion is to have a couple of arched storage spaces under the baking space. They should be not more than 50cm high, so as to leave 40cm of brickwork under the bread.

The school oven mentioned above has no back wall of its own. It abuts against the wall separating the bakery from an adjacent store room, which it keeps warm and dry.

### **A CAMP OVEN**

My father did an awful lot of camping. He baked his bread daily in the simplest of ovens: an ordinary cooking pot. The pot was set on a very gentle fire. Inside was an overturned saucer or small pot cover to keep the bread pan off the bottom. The pot was closed with a larger cover holding two or three centimetres of glowing embers. And that was all! The baking was always successful. Sometimes he would bake himself a small cake or a few scrumptious scones.

If you have never used a pot oven, it may take a couple of



attempts before you can judge rightly just how strong to make the fire. It's so simple that it's well worth the try.

## HOME MADE FUEL GAS

Gas for cooking and lighting can be very easily obtained from cowdung by letting it ferment anaerobically (without air) in a well-like pit. Thousands upon thousands of these gas plants are in use in India. They are easy to operate, very efficient and virtually trouble free. A slurry of dung and water in equal proportions is poured into the pit every day when the cowshed is cleaned. The slurry is always up to overflow level in the pit, and in it floats an inverted drum which collects and stores the gas for piping to the kitchen. The daily overflow of spent slurry is an excellent manure and soil conditioner for field or garden.

What size plant do you need? To calculate pit volume allow 1 m<sup>3</sup> per person. This is a safe rule for the smaller, family-size pits. Build the pit as shown in the diagram. Give it a strong foundation. Make the wall 35 cm thick of baked brick and mortar. As the wall rises pack mud tightly on the outside little by little this gives the wall good support against pressure from the inside, and prevents fine cracks from forming in the brickwork and later developing into troublesome leaks.

The dividing wall needs no strength: it can be as thin as convenient. It rises from the bottom to just below the ledge, which provides a rest for the drum when empty. The ledge is 90 cm (or the depth of the drum) from the pit top, which itself is 60 cm above ground level, thus bringing the main gas valve and the moisture release within arm's reach.

Built into the ledge are the cross supports for holding the guide pipe firmly in dead centre. As the gas drum fills and empties, it slides up and down on this guide pipe, which doubles as

gas delivery pipe from the pit. The drum has a centre pipe of slightly larger diameter than the guide pipe, since it must slide freely on it. This pipe protrudes through the drum top and is welded to it. Just inside the drum top, a number of 1 cm holes are drilled into the pipe to allow the gas from the drum to pass through the slide pipe into the guide pipe, and out to the kitchen. Obviously, the top of the slide pipe has to be closed.

To break up a troublesome scum that forms on the slurry surface and may even prevent the gas from rising out, weld four metal strips or fins, say 10cm wide, to the tie-rods at the bottom of the drum, one to each tie-rod, and to the slide pipe, as high as possible, just below the holes. Stagger the positioning of the fins, so that when the drum is rotated slightly, clockwise or anti-clockwise, the fins break a path through the scum in four places.

The moisture release tap must be at the lowest point of the whole gas line from pit to kitchen. If, as may sometimes happen in winter, the cold ambient temperature causes the moisture in the warm gas to condense inside the pipe, this condensed moisture must flow down to where it can conveniently be released, otherwise it may fill the pipe and prevent the passage of gas.

Insert a flame trap inside the gas pipe, either near the pit or near the kitchen. This is a fine-mesh copper screen. In the event of an accidental back-fire, the flame will be arrested at the screen and will not pass into the drum and explode it.

When the pit is ready, fill it to overflow level with equal volumes of fresh dung and water well mixed. Pour the slurry equally on both sides of the dividing wall, or the pressure on one side may break the wall. It helps rapid formation of gas if, the first time, a good proportion of the water is septic tank effluent, which is rich in the required bacteria. Where this is not available, the gas will form by itself, but it may take about a month.

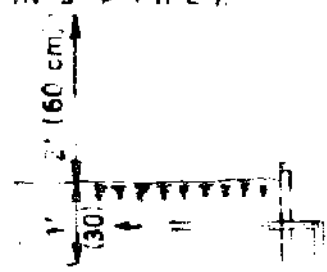
# FUEL GAS FROM COWDUNG / GOBAR GAS PLANT

**TYPE W/T** FOR PLACES WITH HIGH WATER TABLE = REQUIRED PIT DEPTH, BIGGER DIAMETER, RED DRUM HEIGHT = 5 FT

SIZE	DAILY GAS- PRODUCTION	PIT DIAMETER		PIT DEPTH		DRUM DIAMETER		CLEANING 30 DAY CYCLE
		cm	" - "	cm	" - "	cm	" - "	
1	65 cft	140	4'-8"	245	8'-2"	130	4'-4"	125 LITERS
2	100 cft	170	5'-8"	265	8'-10"	160	5'-4"	200 LITERS
3	150 cft	200	6'-8"	287	9'-7"	190	6'-4"	300 LITERS
4	200 cft	230	7'-8"	290	9'-8"	220	7'-4"	400 LITERS

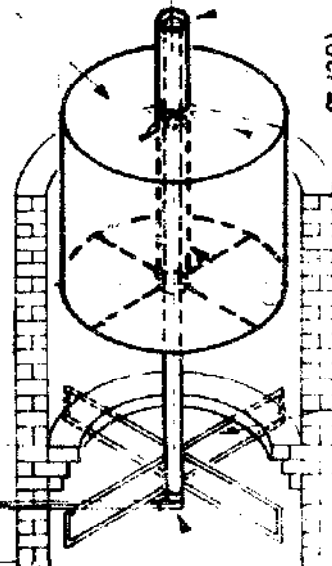
PIT (upper part only) cross-section A-A

DRUM OF 16 SWG  
1.6 OR 2.0 mm  
MILD STEEL  
HOLES FOR GAS EXIT  
(ON TOP, INSIDE DRUM  
IN 3"  $\phi$  PIPE).



moisture tap  
main gas valve

DRUM DIAMETER



TOP OF PIPE 2" (50  
70 cm) ABOVE  
OVERFLOW-LEVEL

TOP OF DRUM HAS  
A CONICAL COVER

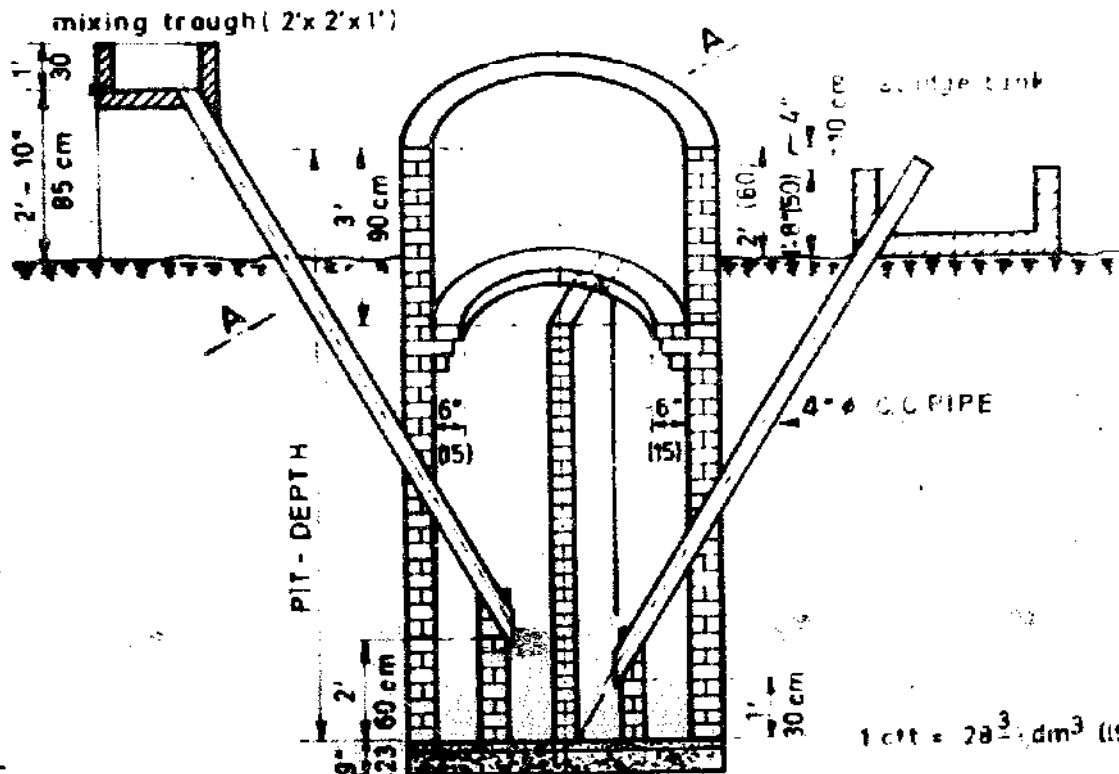
3"  $\phi$  PIPE, TOTAL  
LENGTH 5' (150 cm)

CROSS-SUPPORTS

CENTRAL GUIDELINE =  
GAS PIPE IN 2"  $\phi$   
LENGTH = 6' (180 cm)

FIX RED ELBOW 2" x 1"  $\phi$   
TO THE BOTTOM

PIT cross section (full depth)



1 cft = 28.3 dm<sup>3</sup> (ltr)

design: B. Sauballe  
802 2/78

PIT-DIAMETER

With the pit full of slurry, place the drum in position with the gas outlet valve open, so that the drum can sink down to the ledge and push almost all the air out. Close the valve. When the drum rises and fills, it will contain gas and air. If this mixture is between 5% and 14% it is explosive. So void the whole first drumful into the atmosphere and let the drum fill again. It will now be safe for use.

### USEFUL INFORMATION

Pit volume : roughly 1 m<sup>3</sup>/person; more precisely 0.7m<sup>3</sup>/person.  
Daily slurry (half dung, half water) : minimum 1/40 pit volume;  
maximum 1/30 p.v.

Optimum temperature of fermenting slurry; 30° – 35°C.

Optimum pH of fermenting slurry : around 8.

Under opt. conditions 1 ltr fresh dung/day gives 40 ltr gas/day.

Standard working pressure of gas : 7–10 cm water head.

Daily gas requirement : 425 ltr/person for Indian villagers.

The gas is non-toxic and virtually odourless.

Chicken dung is richest in gas; next pig dung; third cattle dung.

A cowdung-gas plant can serve as septic tank (but avoid disinfectants in toilet).

For fuller information on cowdung gas see the author's booklet  
Fuel Gas From Cowdung, Sahayogi Press, Tripureshwar, Kathmandu, Nepal.

## FUEL GAS FROM HUMAN WASTE

### A few facts and figures to help in Planning and Building a Night-Soil Gas Production Plant

It is a fact that gas from a septic tank, if produced under the proper conditions (temperature, pH, & c.) will burn. In a hospital in S-E Asia it is piped to the nurses' day room to sterilize injection needles, prepare hot water bottles, & c. At a Buddhist monastery in Kathmandu in 1977, a boy playing with matches near the monastery septic tank caused an explosion which blew the septic tank and the ferroconcrete toilet to pieces. So proper precautions have to be taken.

Because the input is so little, the gas produced is not much. A private home with its own small septic tank will never get enough gas to do useful work, but institutions like hospitals, jails, boarding schools, village communities, can supply part of their fuel requirements.

The gas produced from human waste alone, under optimum conditions, amounts to about 30 litres per day per person. But if chopped straw is mixed in at the rate of 500 grams per person per day, the gas is increased seven fold and then becomes really worthwhile. Additional space must be allowed in the pit to accommodate the straw.

The daily addition of a little dung from chickens, pigs<sup>1</sup> or cattle greatly helps the formation of methane.

The optimum temperature is around 35°C. Gas production at this temperature is abundant. At 18°C it is almost half as much.

The optimum pH of the slurry in a pit fermenting animal dung alone is from 8 to 8.5. In the fermentation of sewage it is from 7 to 7.5.

If the slurry becomes too acid, much carbon dioxide is produced and the gas will not burn. Urine is rich in ammonia,

which makes the slurry acid. In gas production toilets, it is recommended to drain off the urine separately and dispose of it elsewhere than in the fermenting pit. Very small amounts of urine however, would not make an appreciable difference.

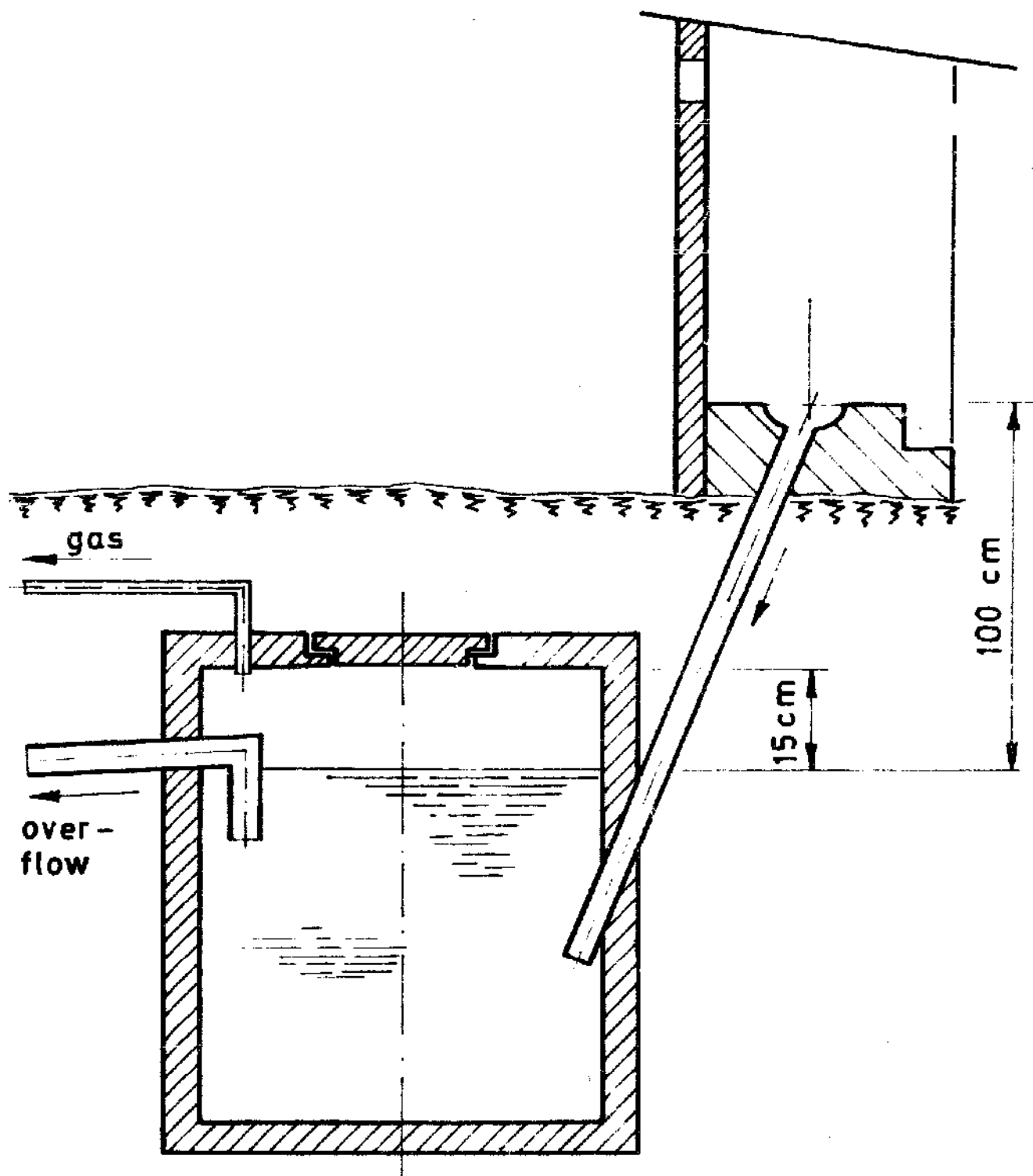
Where the urine cannot be separated and the slurry becomes too acid, the acidity can be counteracted by the addition of a little powdered lime. How much should be added must be determined by trial, checking the results with the pH obtained.

The tank should not be overloaded with too much solid matter, nor flooded with too much flush water. In the Orient the common practice is for people to clean themselves with water rather than with toilet paper (though paper is a help to gas production). The quantity of water normally needed is about one litre, but for toilets designed for gas production in the East, calculations for pit size are based on a two litre input per use, including faeces, with a 60-ltr volume per person. This allows a 30-day retention.

The toilet seats should be about one metre above pit overflow level. Since not much flush water is being used, the pipes from seats to pit should be as straight and as vertical as possible, and should end 30 cm below the slurry surface. If the pipes go down to the bottom, solid matter tends to pile up in them. The mouth of the overflow pipe should be a trifle higher than the input pipe, say 20 cm below water level, so that if excess pressure builds up, the gas may be vented through the overflow and not through the toilets.

No. of users	Diam. cm	Depth cm	Pit Vol. litres	Gas ltr	Burners 5 cm	Hours
10	90	100	600	280	1	1
25	120	135	1500	700	1	2.5
50	150	170	3000	1400	1	5
100	190	212	6000	2800	2	5.5
1000	400	478	60000	28000	10	10

# FUEL GAS FROM HUMAN WASTE.



The figures for the depth show the distance from the bottom to the overflow level. Some 15 cm could be left above the water level for froth and scum.

The pit is closed over with concrete with a manhole for cleaning. The gas is collected in a separate floating tank, especially if cut straw is added and the output is seven times greater than indicated in the table above.

To make the tank gas-leak-proof the Chinese insist on four plasterings : 1st : with fine concrete and 10% lime. 2nd : with 3 parts fine sand and 7 parts lime. 3rd : cement lime and fine sand 1:2:1. 4th : lime- sand 1:1. The Indians replace the plasterings with a coat of enamel paint. Make the man-hole gas-leak proof.

### KRISHNA'S CONTRIBUTION TO CULTURE

Krishna lived in his ancestral home on a one-acre plot on the outskirts of a big village. Over the years the village had developed and grown in his direction, and his home was now in a back alley surrounded by neighbours who used the edges of the pathway as their toilet. The approaches to his home were filthy, and this greatly distressed Krishna, who was a man of some culture.

So he did a very sensible thing. He built a small two-cubicle latrine near his fence along the pathway, and told a friendly neighbour he was welcome to use it if he wished. Then another friend asked to share the privilege, and soon almost everyone on the back alley was using Krishna's facility.

This was just what Krishna wanted. As septic tank he had a pit with a floating drum, and into this pit he put every day the dung of his single cow and the droppings of his dozen chickens. The gas generated by all this organic matter he piped to his little kitchen and found it was quite enough to cook all the meals for



his family. He buys no more firewood.

The pathway is now clean and fresh; the neighbours are all happy; and Krishna is delighted.

At a girls' hostel in Gujarat, India, the toilets are at the edge of the property. Five separate cubicles, just on the outside, are open to the public. The input of the septic tank is augmented daily with the dung of a couple of cows. The gas produced is sufficient to cook all the meals for the seventy-five girls in the hostel.

## A LIGHT FROM THE EAST

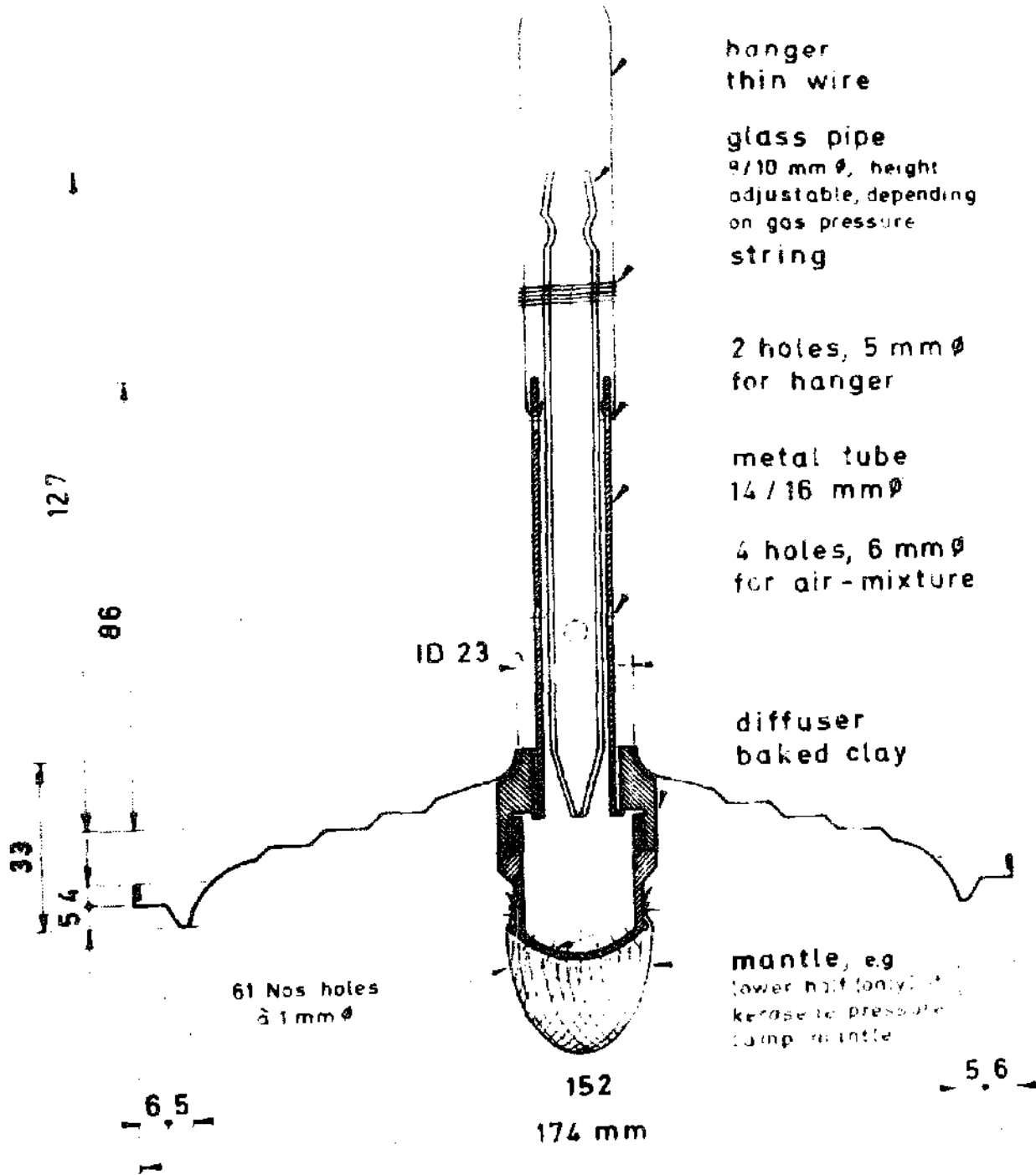
### The Brighter Side of Cowdung Gas

Take your hat off to the Chinese, and bow low from the waist. With the artistry characteristic of their race, they have produced a real gem of a lamp for use with bio gas. It is light-weight, slender, extremely simple in construction, gives a soft, bright light, and – a most attractive feature – it is inexpensive.

Of the many different models available in China, I describe here only one that for me has the charm of a rose bud. It consists of only six parts : an aluminium or galvanized-iron tube, a gas diffuser (the Chinese call it "the rootstock of lotus") to which the mantle is attached, a flattish disc reflector with glass globe, and a slim glass tube that acts as gas jet or nozzle.

The aluminium tube is 86mm long and 15mm in diameter. A little below the top are two small holes for a wire hanger. About 40mm from the bottom are four air holes of 4mm. The glass jet is 127mm in length, and looks like a very small pipette. The jet hole is less than 1mm. Such a small orifice is all right in China where the gas pressure is generally very high, but in plants with a pressure of only 10cm water head, the jet diameter may

# A LIGHT FROM THE EAST



have to be doubled. This glass tube slips into the aluminium tube where its position is adjustable : higher up for high pressure, lower down for low. Its top end is connected through a rubber or plastic pipe to the gas mains. The top of the aluminium tube is open. Its bottom end holds the diffuser, which is very similar to the Indian diffusers in material (baked clay), shape and size. The reflector fits snugly at the bottom of the aluminium tube just above the diffuser. And that is all ! Sometimes the Chinese use a glass globe and sometimes they don't.

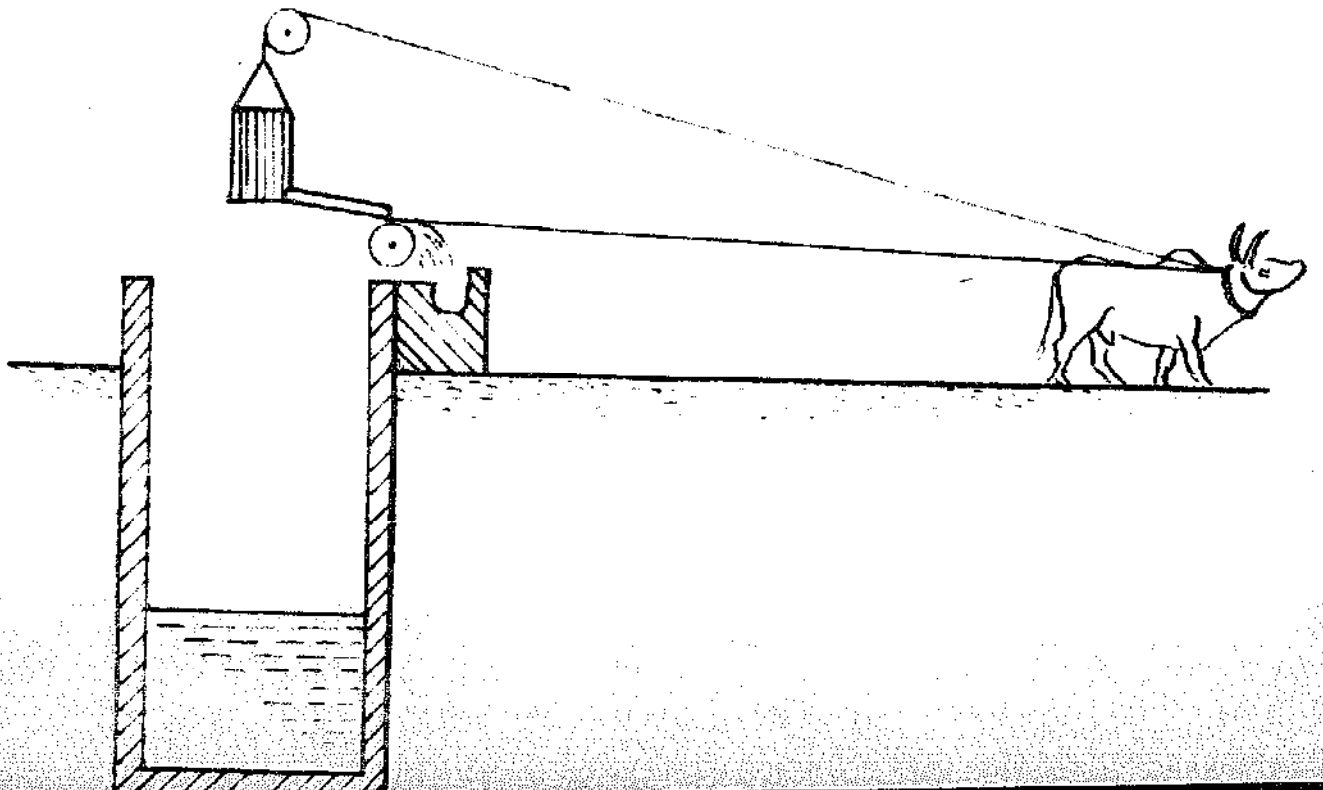
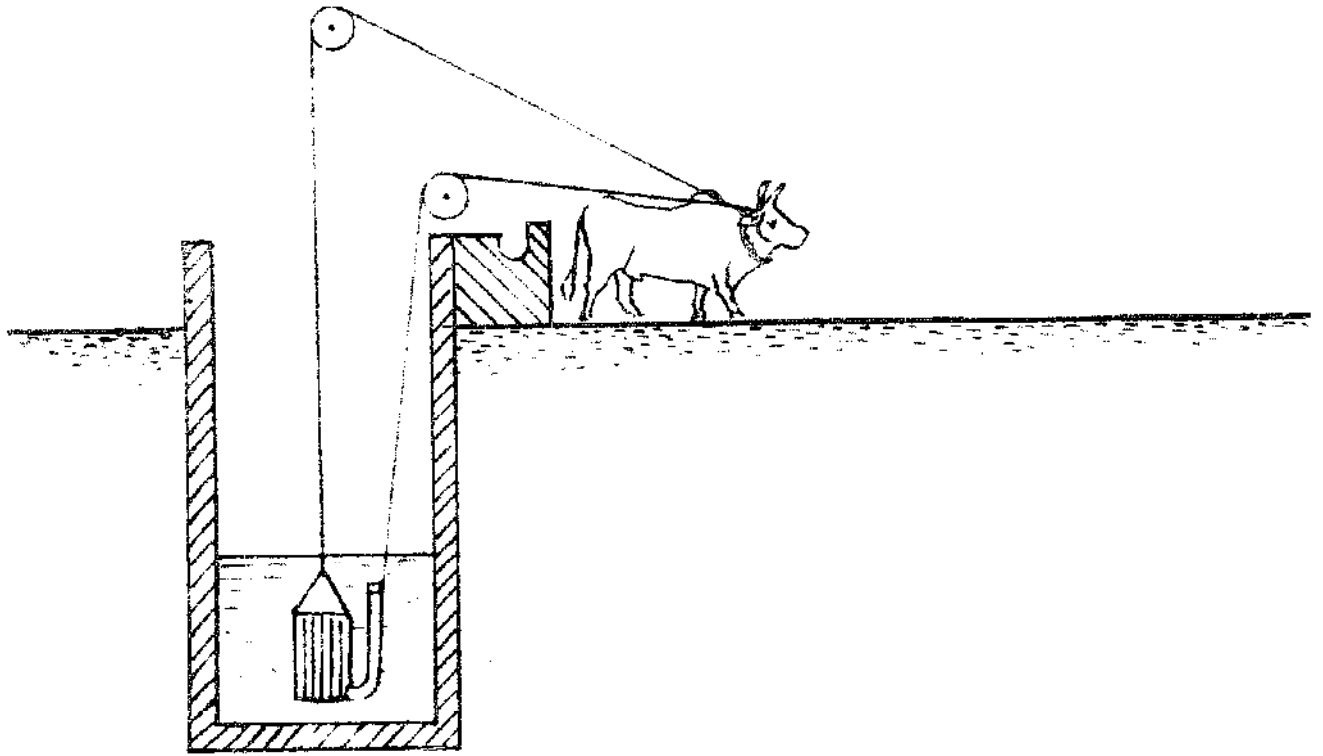
An added feature in some lamps is a wheel-and-flint lighter. A wire arm attached to the wheel is pulled down with a string. When the string is released, a spring or rubber band pulls the arm back sharply, activating the wheel against the flint to produce a spark that lights the lamp. No running around looking for matches, no standing on a stool to light the lamp. It takes just a second or two to manipulate. It is as fast and efficient as pressing an electric switch. These lamps work perfectly and give entire satisfaction.

### **AN INDIAN ANIMAL DRAWN WATER LIFT**

To lift water from wells for irrigation purposes, India has for centuries used a buffalo-drawn or bullock-drawn water lift, which may prove helpful to other developing countries of the world. In essence it is a bucket holding 100 litres or more with a flexible spout at the bottom. In India both bucket and spout are made of buffalo skins; but these could of course be replaced by a steel drum with a plastic or rubber hose. Drum and hose are attached to separate ropes running over pulleys and drawn by one or two animals. The spout is longer than the height of the drum, so that when the drum is pulled, up, the spout top is higher than the drum top, thus preventing water from falling back into the well. The drum pulley is high enough above the spout pulley to allow the water to flow out when the drum is at the height of

# AN INDIAN ANIMAL-DRAWN WATER LIFT

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its run. The drum rope is longer than the spout rope, and both must be long enough to reach the bottom of the well when the animal begins its pulling. As the animal walk away from the well it pulls the drum up, and then walks back to the well *backwards* to let the drum down again. In the beginning it may object to walking backwards, but after having been made to do so a couple of dozen times, it finally gets the idea and meekly co-operates.

Just outside the well is a sump to catch the water as it flows out from the drum, and from this it is led away to the fields. The animal can draw on level ground, but generally the ground slopes downward from the well. This makes it easier for the animal, since it walks down when pulling up, but whether the slope is intentional or just forms by dint of the animal's constant trudging back and forth for years and years, I cannot say.

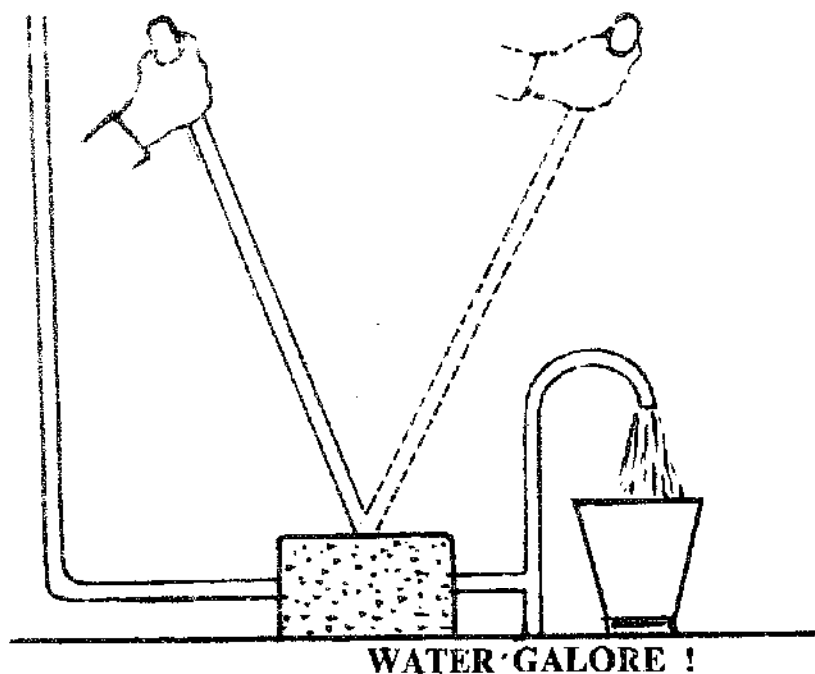
## THE BRAIN WAVE

### A Short Story in three Chapters

**Chapter 1** – A missionary in North India had a well in his compound fitted with a hand pump to draw water for his vegetables and flowers. A second pump was installed to pump water into a roof tank for the house supply, and a young man was employed to work it for an hour morning and evening to fill the tank.

**Chapter 2** – People of a near-by village, whose only source of water had till then been a far way stream, opened big eyes at the garden pump and the ease with which it delivered instant and endless quantities of crystal clear water. It was not long before they began trooping into the garden and filling their buckets and pots from the well, without so much as a “May I?” or a “By your leave”.

**Chapter 3** - Then one day a gleam of intelligence lightened up the missionary's mind. He went off to Calcutta and invested in a double-action pump, which he connected to both the garden hydrant and the roof tank. He removed the other two pumps and dismissed the young man. Thereafter every villager who came for water pumped with one stroke into his bucket, and with the next into the roof tank. And all lived happily ever after.



In some Pacific islands, and doubtless in many other parts of the world too, there's a superabundance of water during the monsoon and little or none the rest of the year. Open air ponds help for a while, but eventually dry up, and there's just no water anywhere.

An old, old idea, born many years B. C. like the Redwoods of California, yet as modern as today, is to channel the rain

water from the roof of one's house through a sand box filter into a cement tank, either out in the open or under the house verandah.

A house with a floor space of 20m x 30m and an annual rainfall of 100cm receives on its roof 600m<sup>3</sup> of water. This can be filtered into the reservoir through a sand box, chlorinated and kept in reserve for use only when other sources of supply are exhausted. If the monsoon lasts for four months, and other sources (ponds, wells, streams) last another two, then the 600m<sup>3</sup> of roof water in your private reservoir can still give you 100m<sup>3</sup> a month till the next rains, That works out to (according to my calculator) 3333.3333 liters every day of the month, more than enough to drown the whole family !

Leaving facetious figures aside, a shack 6m x 3m getting 100 cm rain a year can store 18m<sup>3</sup> of water in a reservoir 4.5m x 2m x 2m. 18000 litres a year gives, for the six dry months, 3000 lt/month, or 100 lt/day, which is more than ample for drinking and cooking. Think about it.

### **WATER HOT AND COLD**

Arthur, Sam and Harry lived together. They noticed that the water in the small galvanized-iron tank on their roof grew tepid in the sun. In the winter they wished it would grow hot; but it didn't. Harry got an idea: he painted the tank black. Next day Sam took a shower, and found the water so delightfully warm that the began to whistle and to sing. Then suddenly it grew quite chill and he yelled, and the next moment it was unbearably hot. Obviously something was wrong.

Arthur figured it out. The water nearest the metal got very hot while that in the middle of the tank was still cold. The solu-

tion he proposed was to paint one white stripe 3 or 4 inches broad right across the tank. By doing this, he caused a convection current within the tank which thoroughly mixed all the water and gave it a uniform bearable temperature.

In the high temperatures of the tropics a water tank, even unpainted, gets scalding hot, and the only time one can take a shower is in the early morning or late evening. Try this: when the weather begins to warm up, paint your roof tank white; and as winter approaches, paint it black. This will give you comfortable showers the year through for the price of two small cans of paint.

## INSTANT HOT WATER

from yesterday's news

In a boarding school in Darjeeling in the Himalayas at an altitude of about 1600 M, the tiny tots aged six to eight needed hot water in the cold months for their morning ablutions. At one time this was provided instantly by a most ingenious device : a conical boiler.

It was a double cone of galvanized-iron sheeting, one inside the other, with a gap of two or three millimeters between them. Water entered at the bottom and came out at the top. The cone was mounted on a fire box in which old newspapers were crumpled up and set ablaze. Within a few seconds the outflowing water was hot. Once the fire is lighted, the water should be allowed to flow, or steam pressure may build up and burst the cone.



## SELF CLOSING HYDRANT

The World Health Organization has published a design for an excellent, simple, self-closing hydrant. In essence it is a tube large enough to hold an average bucketful of water, or enough to fill a normal village waterpot. Inside the tube is a "piston" with a stump of 1/2" pipe protruding through the centre. The main water supply enters at the bottom of the tube. The outlet pipe is near the top. As the water enters, it pushes the piston up, thus forcing the water which is above it to flow out through the tap. When the piston reaches the top of the tube, the short pipe in its centre presses against a rubber pad or cushion and at the same time the side of the piston blocks the outlet pipe. Thus the flow of water is completely shut off.

As long as the tap is open, the pressure of the water mains keeps the piston blocking the flow. In order to draw water again, the tap has first to be closed. The pressure is thus cut off, and the piston drops to the bottom. The water that was below the piston flows through the short central pipe and comes above, ready to be pushed out next time the tap is opened and the piston rises.

The idea is brilliant. When the hydrant is made by professionals it surely works to perfection, but when made at home by a more or less skillful mechanic, it is not quite successful. Unless the mechanic has the necessary tools to make the inside of the tube perfectly smooth, and to give the piston a very close yet free running fit, the hydrant will leak. This has been our experience.

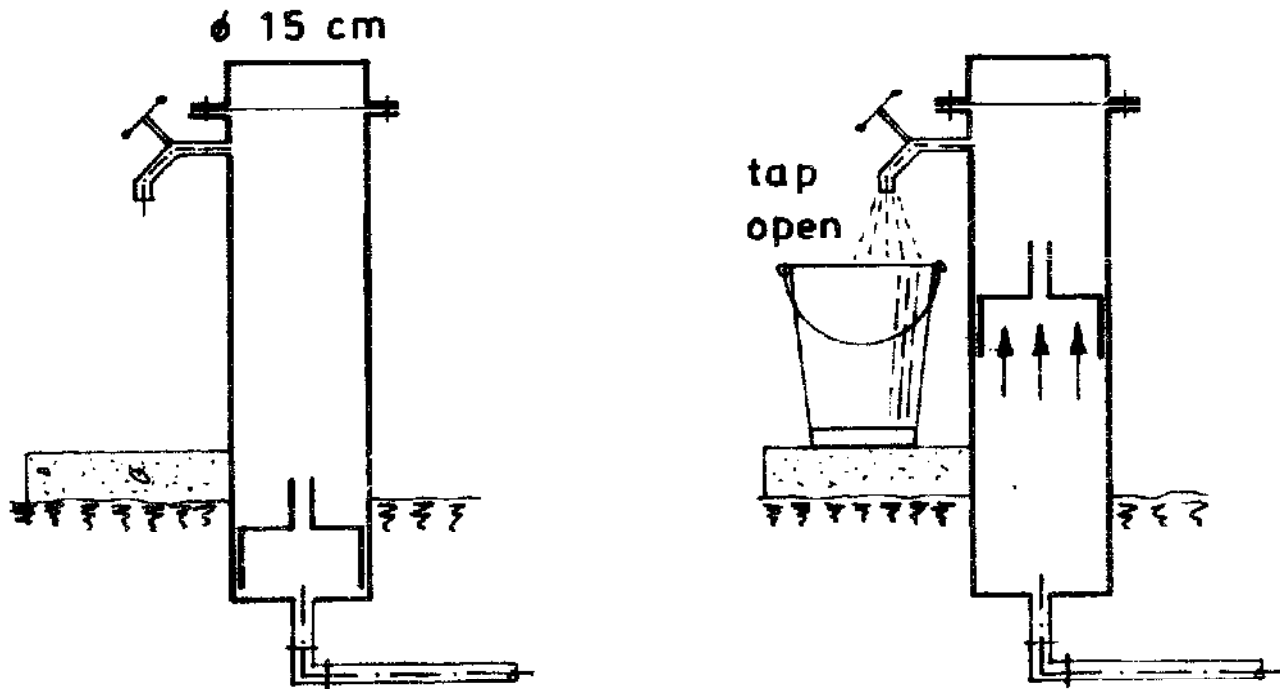
I would suggest a slight change. Instead of having the outlet pipe at the side of the tube to be blocked by the piston, put it in the centre at the top of the tube. This way the very outlet is plugged, and even if some water does leak past between piston and tube it merely goes above the piston, but simply cannot flow out.

Another useful suggestion : eliminate the tap. Taps manufactured in the Orient are a perpetual source of trouble. Four

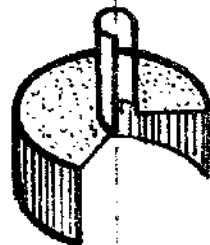
# SELF - CLOSING STANDPIPE

1. piston at bottom of standpipe, before drawoff commences.

2. piston rising as water is drawn.



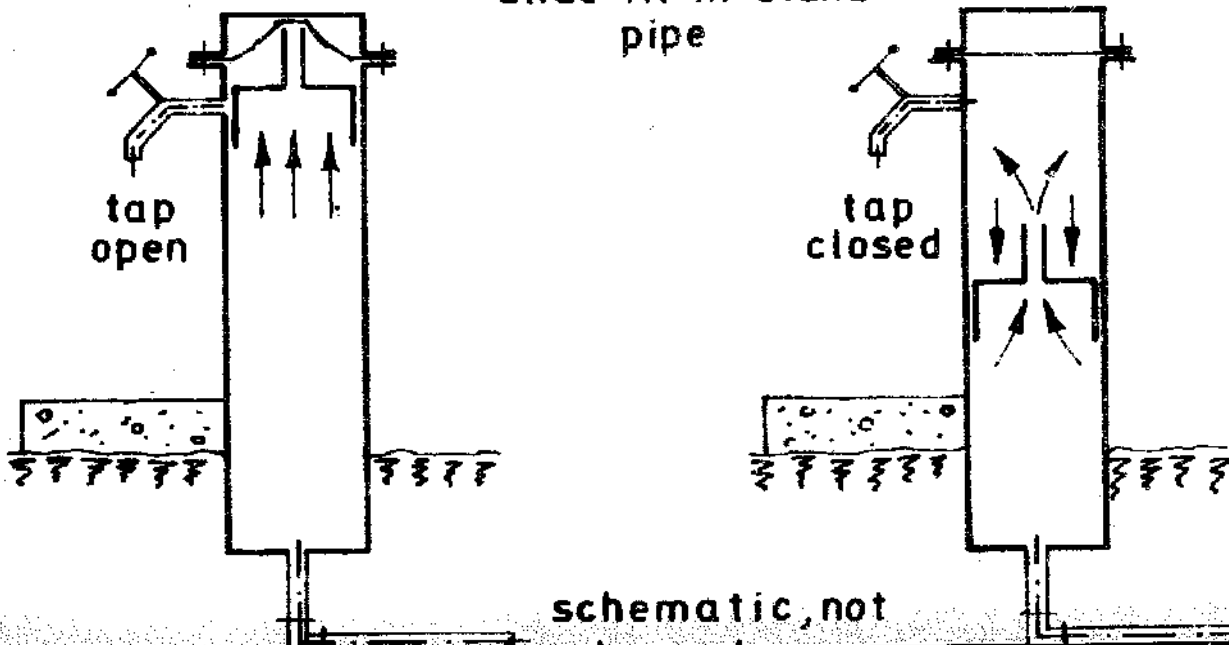
piston detail



3. outlet sealed after water in standpipe has been drawn off.

4. piston sinking by its own weight when tap closed.

slide fit in standpipe



schematic, not

of our taps that worked well were stolen, one after the other. The open end of the outlet pipe can quite easily be blocked by the user's hand till the piston drops.

### THE FOUR POT FILTER

One thing that used to be very common all over the country in the good old days was the four-pot filter. It was present in every railway station, dak bungalow (Government rest house) and country club; but it is rare now. It was superceded first by the British Berkefeld type filter with candles of porous stone, natural or artificial, and later, as villages and hamlets grew into towns, by municipal supplies of filtered and chlorinated drinking water.

On a wooden stand, generally triangular so as to fit into a corner, there are three shelves supporting three mud pots of capacity six or eight litres each. Each pot has a 4mm hole in the bottom plugged with a twist of clean cloth. The fourth pot, the lowest, has no hole. Water from a well or stream is poured into the top pot. It should drip through the cloth at about two or three drops per second.

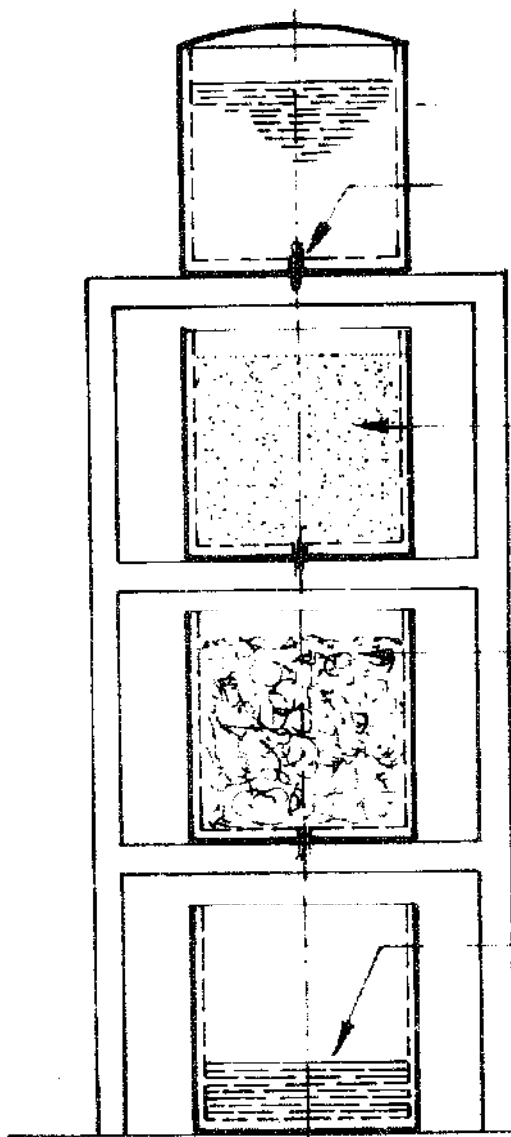
These drops fall into the second pot which is filled with fine, clean sand. The sand should first be washed in several waters, and then sterilized by either boiling or baking.

From here the water drips into the third pot containing charcoal, crushed but not powdered. This too should be properly cleaned and sterilized before use.

The fourth and last pot, resting on the ground, contains the clean, filtered drinking water. Many would pour this water straight into cooling goblets for use at table; some would boil it first before drinking.

It is advisable to throw out the first pot of filtered water.

# THE FOUR-POT FILTER



4 nos mud pots

— water from stream or well

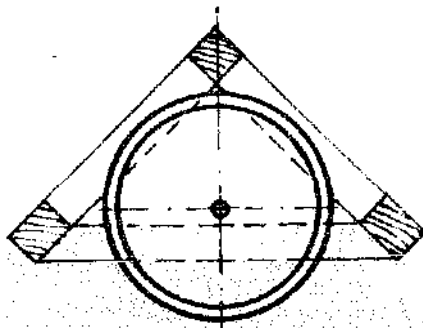
— 4 mm hole, plugged with a twist of clean cloth.

— fine, clean sand

— cleaned charcoal crushed, but not powdered

— filtered, clean water

top



triangular wooden stand,  
so as to fit in a corner.

It is also advisable to re-clean and sterilize the sand and charcoal periodically, how often depends on how dirty the unfiltered water is. All filters of whatever kind need regular cleaning and sterilization.

Our diagram shows cylindrical pots. The spherical village mud pots were more commonly used.

### THE ONE-MAN DESK FAN

In the days of long ago, before current came to the little lost towns at the back of beyond, there were no electric fans. We all got by with the *punkha*. Unfortunately you cannot find one nowadays, not even in a museum.

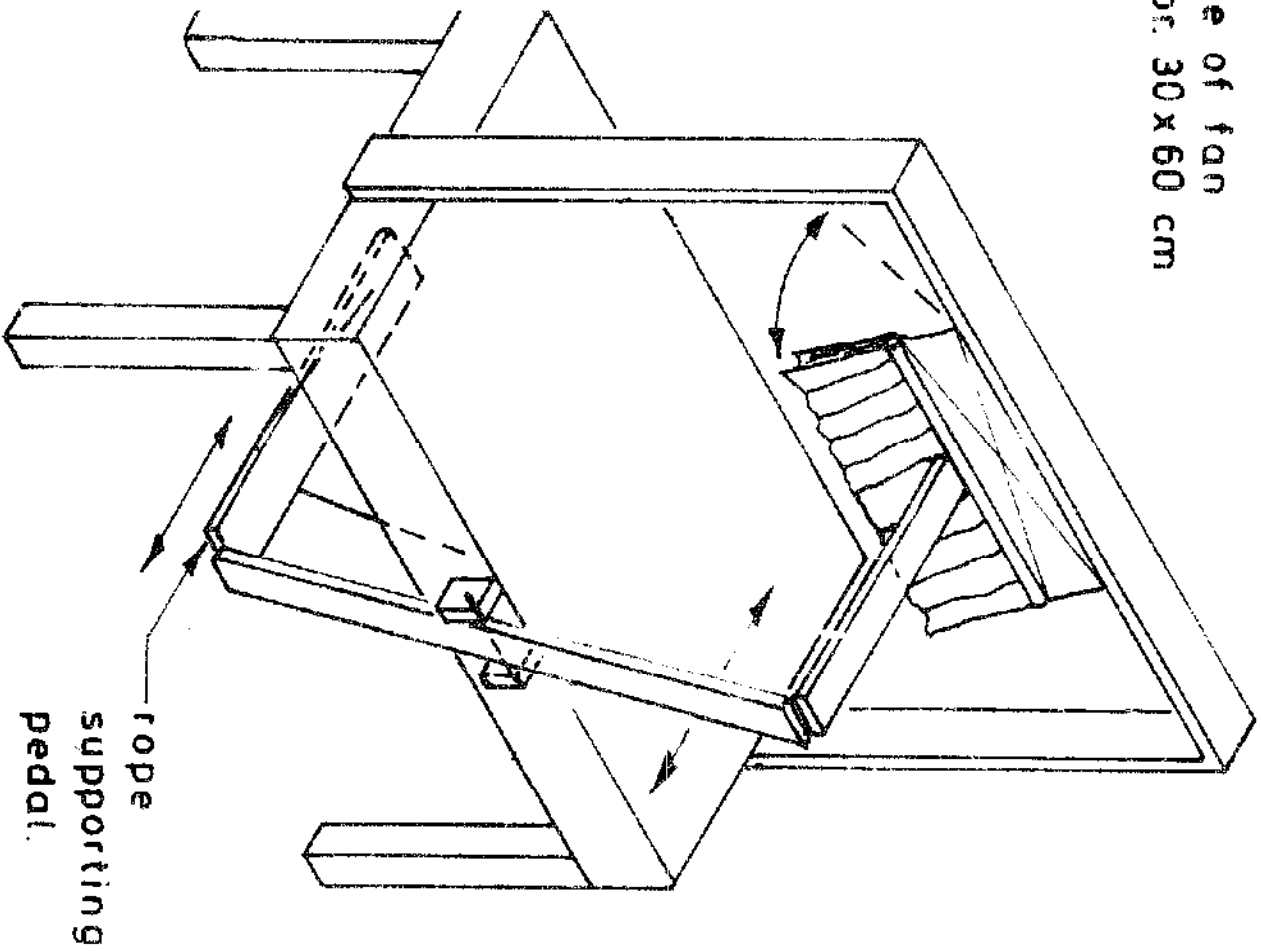
The *punkha* was a wooden pole with a frilly skirt-like appendage, yards and yards of white cloth done up in many gatherings along the pole with a stiff canvas strip in the middle. The whole contraption was hung from the ceiling and made to swing to and fro by being pulled with a rope, generally by a sweating *punkha-coolie* sitting outside the room and enjoying none of the breeze his efforts created for his master. It was quite efficient.

But we are interested here not in the room *punkha*, which may have been eight or ten feet long, but in the diminutive, "pocket-size", one-man *punkha* rigged up over a desk and worked by the user pushing a pedal back and forth with his foot, as he sat at his desk reading or writing. This too was quite efficient, and much appreciated, especially on sweltering hot days.

To the right and left sides of the desk were fitted uprights with a cross piece, much like a goal post. The *punkha* was hung from this. For working the fan, the pedal was slung with ropes at a convenient height below the desk. It was about 6" broad and 3' long. At the back of the desk was an upright 2"x3/4" pivoted at desk level and hinged to the pedal below and the push-rod above activating the fan. It was all very simple and silent and satisfying.

# A DESK FAN

size of fan  
appr. 30 x 60 cm

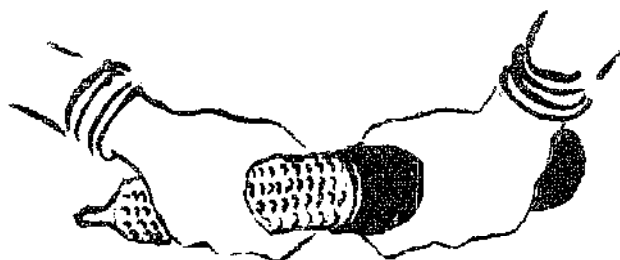


## A HAND HELD CORN SHELLER

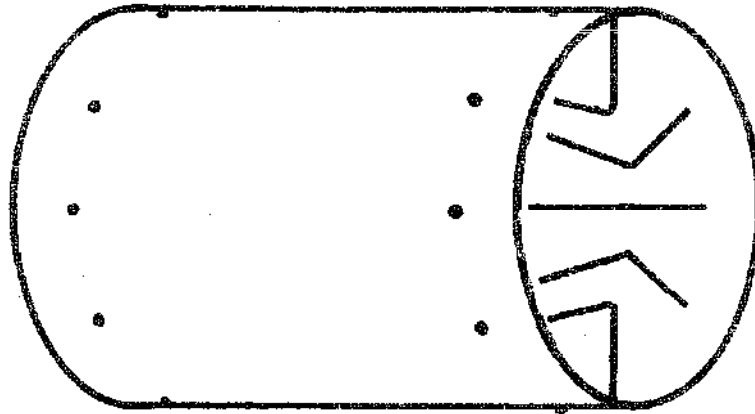
This hand-held corn sheller is made from a 6cm length of galvanized-iron pipe of 5cm. diameter.

It has eight fins or ribs of g-i wire of 3mm diameter. These are bent as shown in the diagram, passed through holes drilled in the pipe and welded in position from the outside.

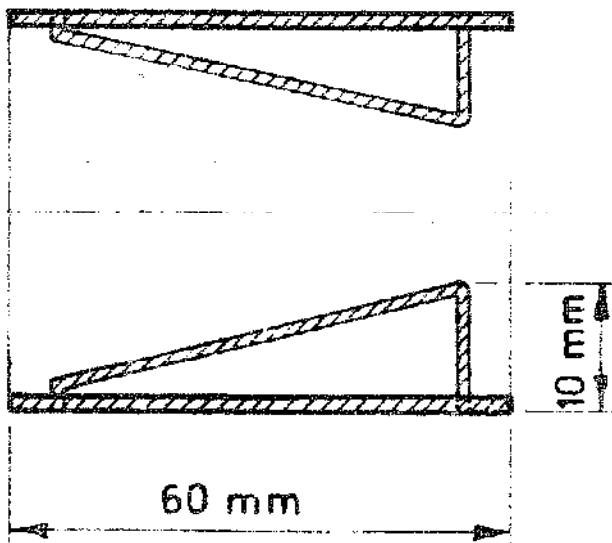
The corn is pushed in at the broad end and twisted while pressing against the fins. In two or three seconds all the grains fall off in a golden stream.



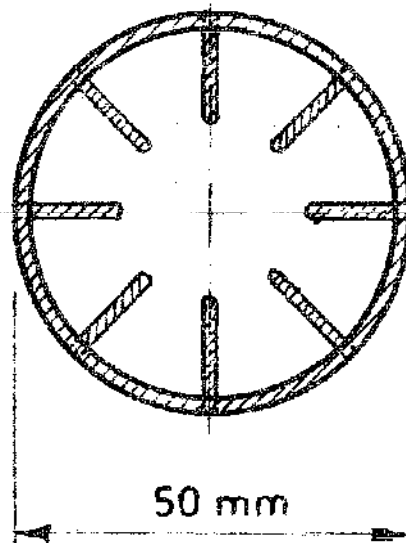
# THE HAND-HELD CORN SHELLER



side/cross view



end view





## A FLY TRAP

An efficient fly trap is made with a square cage of wire screening fixed to a wooden base on four legs. In the middle is a cone of glass, or of wire screen. A fly trap of this kind was seen in use in Shanghai. It is not a new invention. It has been around for half a century at least.

Any bait that attracts flies is placed in a receptacle underneath. After eating their fill, they fly up through the cone into the outer cage, where they remain vainly attempting to escape through the screen. Somehow they never seem to think of flying back through the cone.

The trapped flies can be singed over a flame and removed through a hole in the bottom board blocked with a cork.

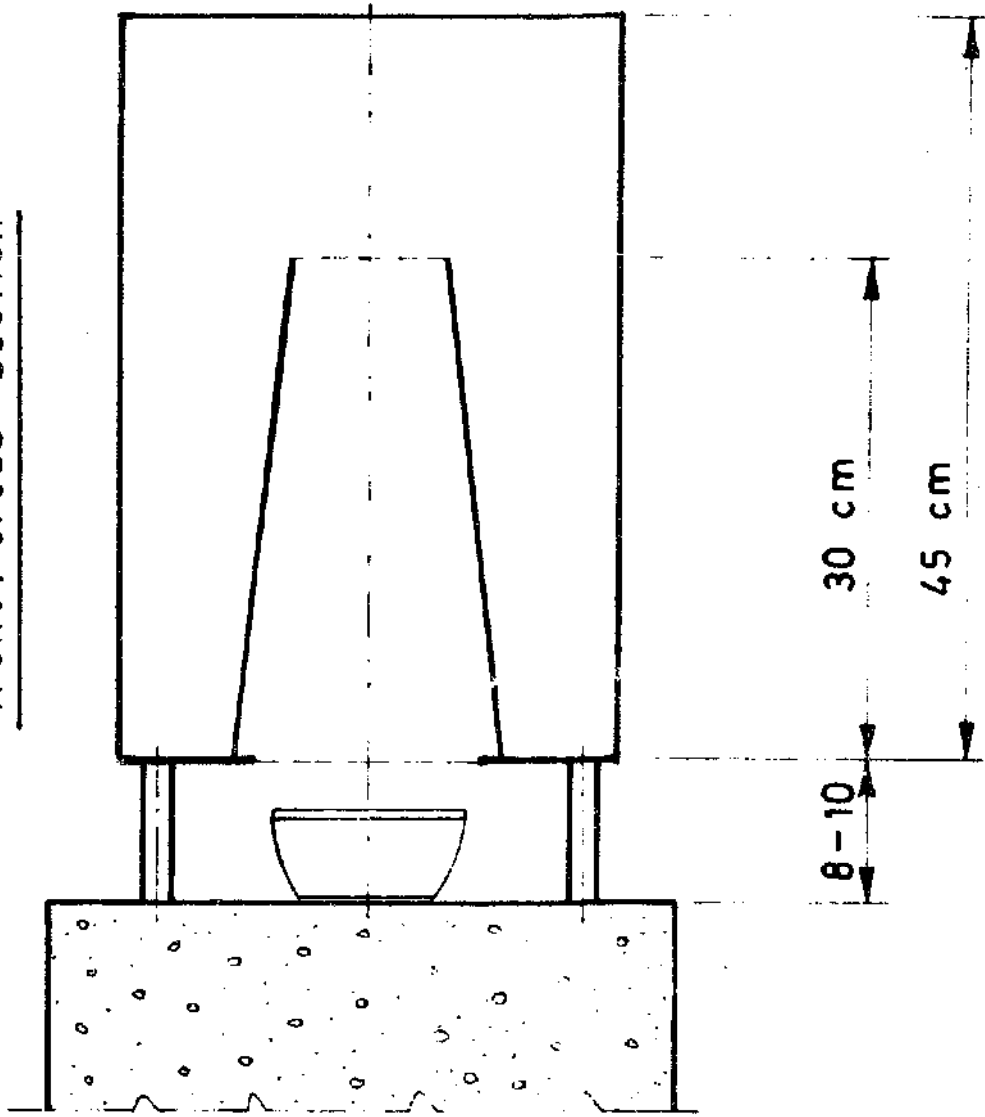
The measurements are not critical. The model shown in the accompanying diagram is rather large. A smaller size works just as efficiently.

## THE CLEVER COBBLER

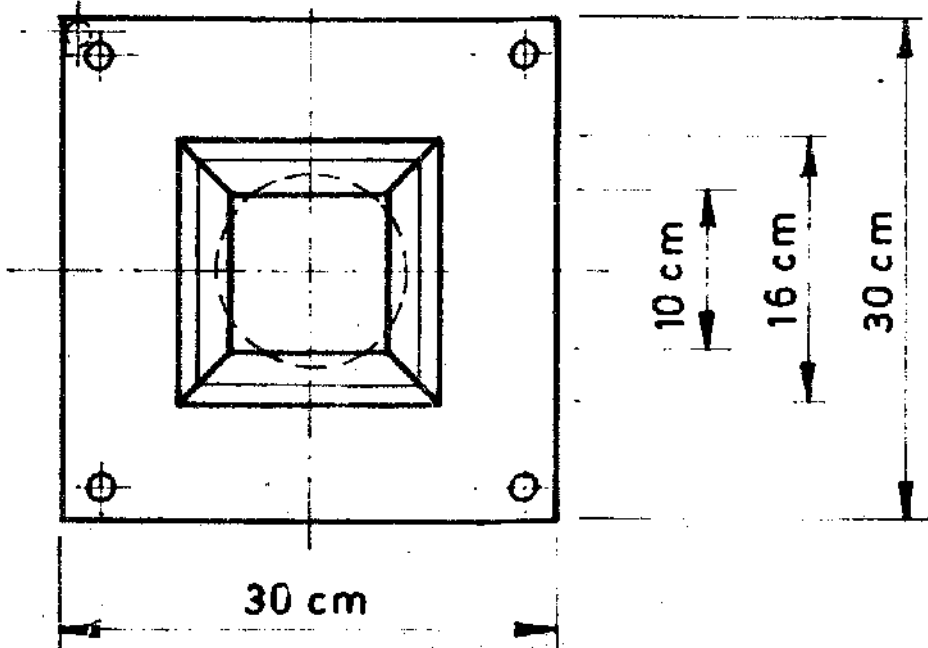
Many many years ago, there lived in Europe a clever cobbler. He worked all day, from morning till night, plying his trade with much industry, though not with much profit; for winter days are short in the northern latitudes, and shorter still when the sun sets early behind a nearby hill. He couldn't work at night, because all the illumination he had came from a simple tallow candle, and cobbling needs close attention. In those days there was no electricity in his remote village. In fact, there was no electricity anywhere.

# THE FLY-TRAP

front / cross - section



top view



The clever cobbler had three little goldfish in a big glass bowl that was almost a perfect sphere. One night he sat down to read, and no sooner had he lighted his candle than, oh, wonder of wonders! he noticed to his amazement and intense delight, that all the rays falling on his fishbowl came together on the opposite side into one, small, brilliant patch of light ! This phenomenon must surely have been noticed in other places by other people too, but the cobbler, being clever, promptly put it to use. He laid aside his book, brought out his awl and his leather and his thread, and forthwith set to work on a pair of new shoes in the bright magnified beam from his candle.

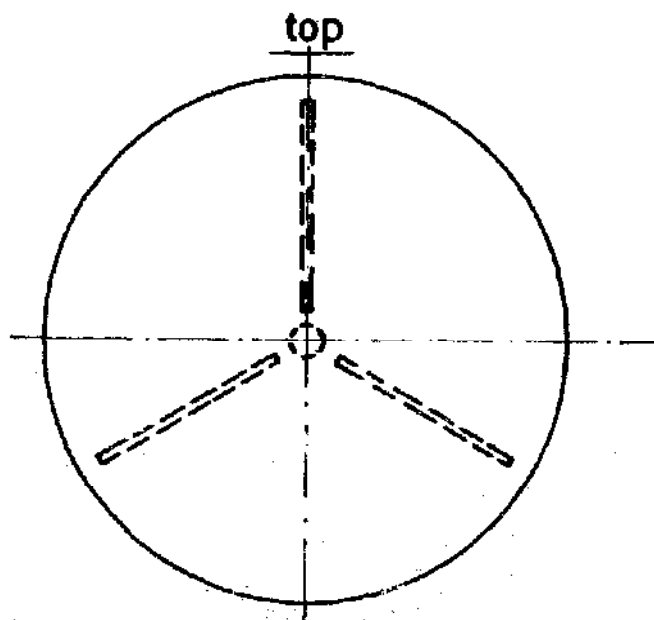
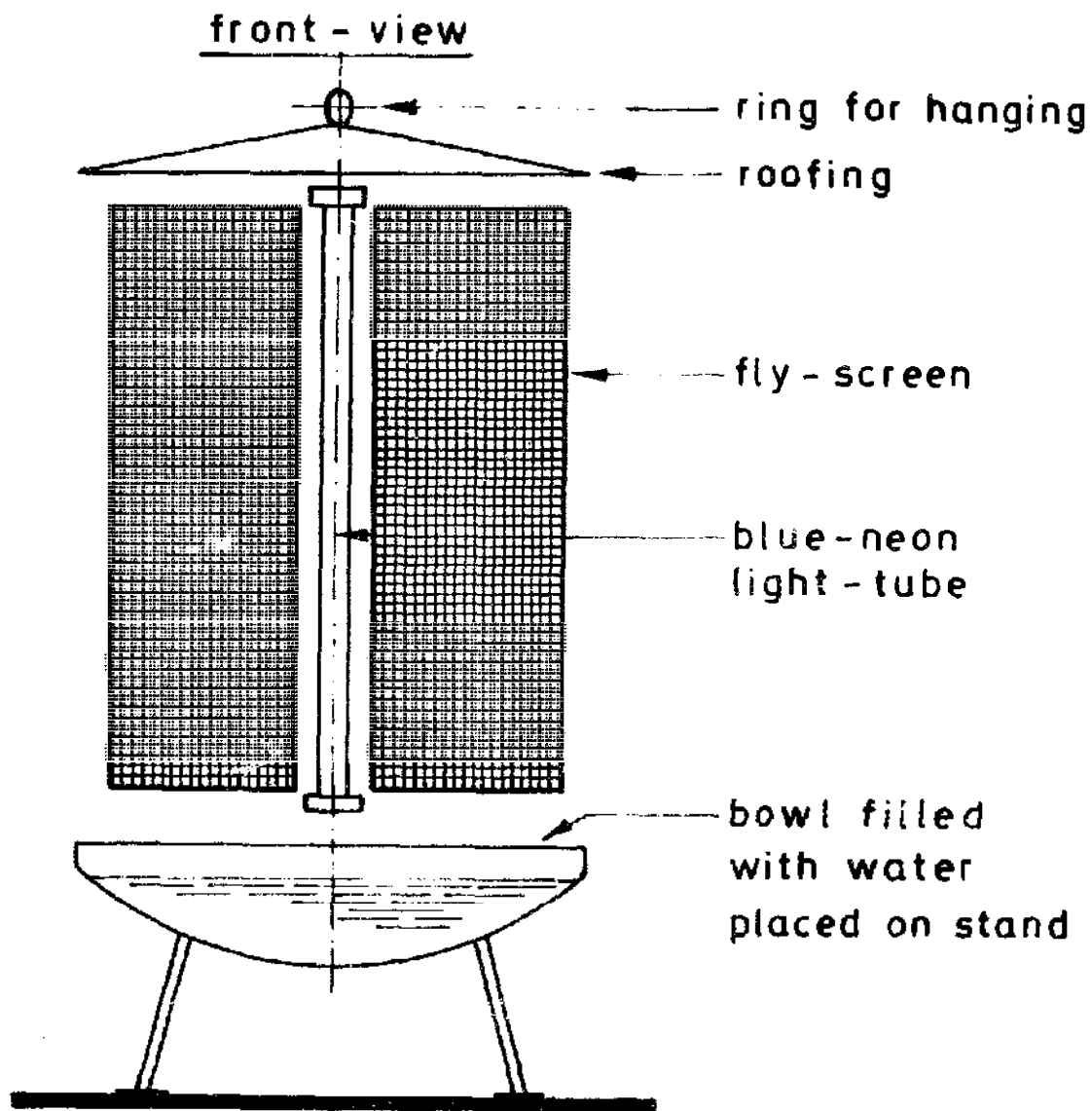
His discovery was hailed with glee by all the other cobblers in the village, and by the tailors too, and they all blessed God for making the clever cobbler so very very clever.

### **THE NEON INSECT TRAP**

A lamp, as everyone knows, attracts insects. Here is a diagram of a Chinese insect trap using a fluorescent lamp and three wire screens to destroy the insects that attack the growing paddy. The lamps are hung from posts about 150 metres apart all over the cultivated area.

As the insects try to fly round the lamp, they bump into the screens and fall into the bowl of water below. It helps to put a thin film of oil on the water to clog the wings of all insects falling in; otherwise some may manage to crawl out and fly off.

# THE NEON INSECT TRAP



## THE AFRICAN TOP BAR HIVE\*

A modern rectangular box hive, with its individual frames and other parts made to very exact specifications, may be too costly for villagers, or too difficult for untrained and inexperienced carpenters in remote villages to construct. The Africans have come up with a much simpler design that any carpenter can make. This hive is far simpler to manage, less costly than the modern box hive, and yet very productive.

If bees are given a rectangular frame, they hang comb from the top bar and fix it firmly also to the side supports and the bottom. The Africans have found that if there are no frames in a hive, but only top bars, and the hive is not rectangular but slopes downward at an angle of from 60° to 70°, the bees do not fix the combs to the box; they merely hang them from the top bars. The result is that each comb can be easily lifted out for inspection or extraction, and since no frames are required, the hive is simpler and cheaper to make.

The African hive is oblong and may be made of wood or matting or brick. A full-size hive has thirty top bars, of which the middle half are reserved for the bees and their brood, while the remainder at either end are filled with honey. There are no supers. After the honeyflow, the beekeeper inspects the combs one by one, beginning with the outermost. Those that contain only honey are removed for extraction; those with grubs are replaced intact. The combs are cut from the bars leaving a finger's breadth on top, so that the bees can build new comb along the bars and not across several bars making removal impossible. The hive may be slung like a hammock on strong wire to keep it out of reach of rodents and other animals like pine martens, honey badgers and bears, or it may be given legs.

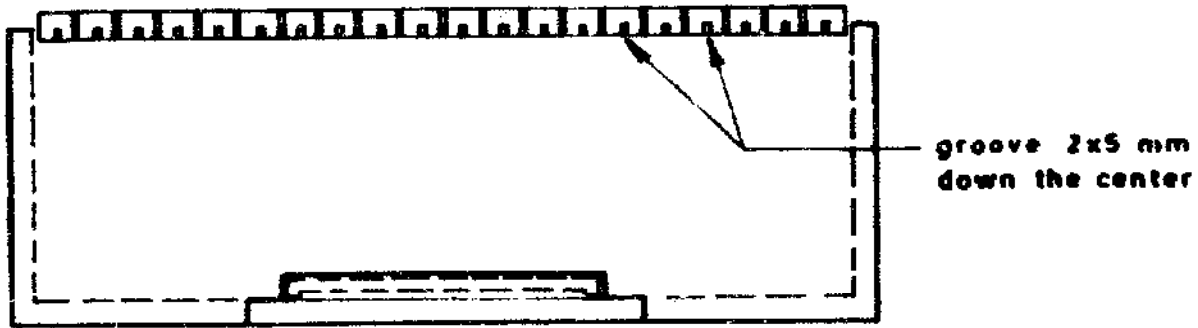
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\* Taken from the author's book *Beekeeping*

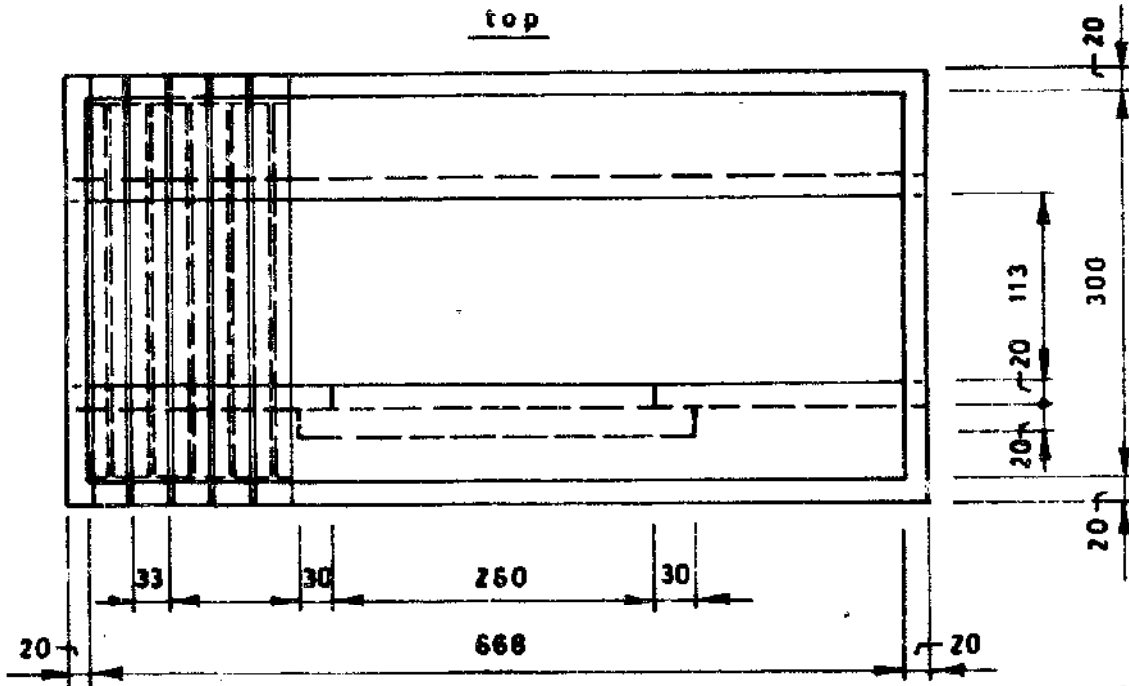
# AFRICAN HIVE

## 2/3 SIZE FOR 20 FRAMES

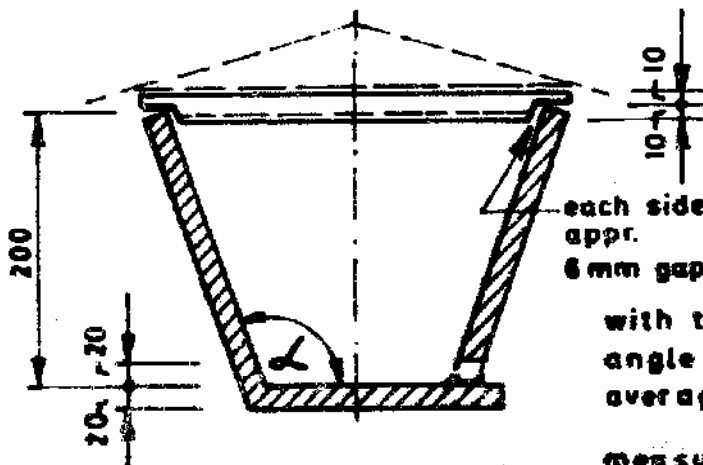
front / cross



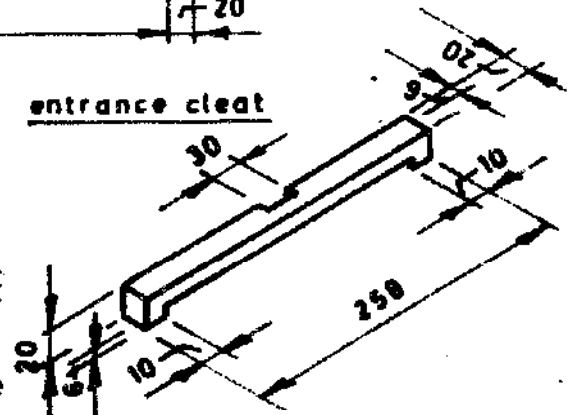
top



side/cross



entrance cleat



each side  
appr.  
6 mm gap

with the indicated measurements the angle  $\angle$  will be  $115^\circ$ , which is the average of the required  $110^\circ$  upto  $120^\circ$  measurements in mm.

It is foolish to be greedy and want every single drop of honey in the hive. Only the extra honey in the end combs should be taken. Every comb of brood has two or three centimetres of honey on top. This is absolutely necessary for the brood. Removing this is like drawing all the milk from a cow and leaving nothing for the calf.

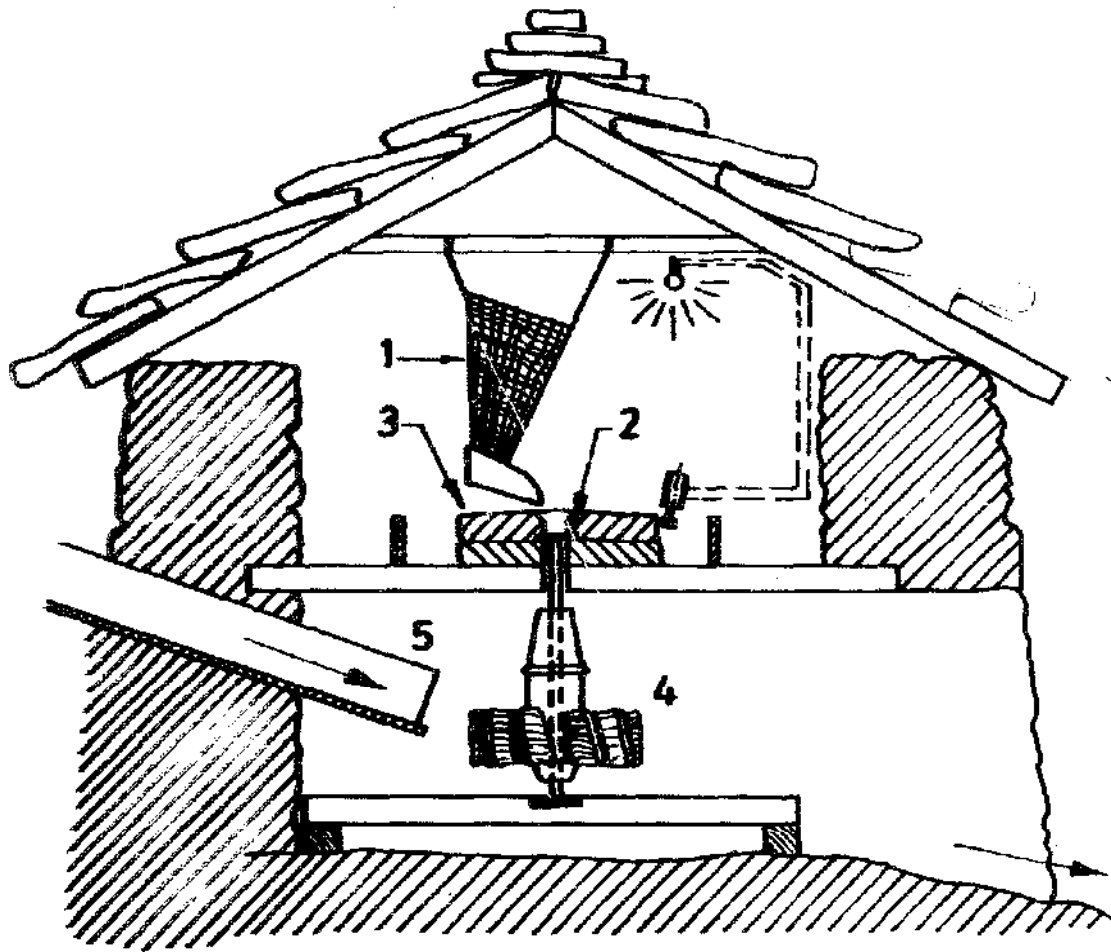
The diagram of the African Hive given here was drawn for the *Apis indica*, common in all countries of South-East Asia. The bee space for the Indian bee is 6mm, while for the larger European races it is 8mm. So if the hive is built to house European or African bees, the entrance cleat should have a passage of 8mm instead of only 6mm.

### LIGHT FOR THE MILLER

A water mill in the Himalayas is a little shack some 3m x 5m. In that much space the miller works and cooks and sleeps. He sleeps early, with the birds, because he has no lamp.

He could provide himself with electric light easily and cheaply. All he has to do is to rig up a small bicycle generator, which he can push against his mill-wheel in the evening. This will give him enough current to light a 6-volt head lamp—more than ample illumination for his diminutive dwelling.

## LIGHT FOR THE MILLER



### The horizontal water wheel.

- 1 basket**
- 2 rynd**
- 3 stones**
- 4 wheel or tirl, with obliquely-set paddles on thick shaft**
- 5 chute delivering the water to the side of the wheel behind the shaft.**



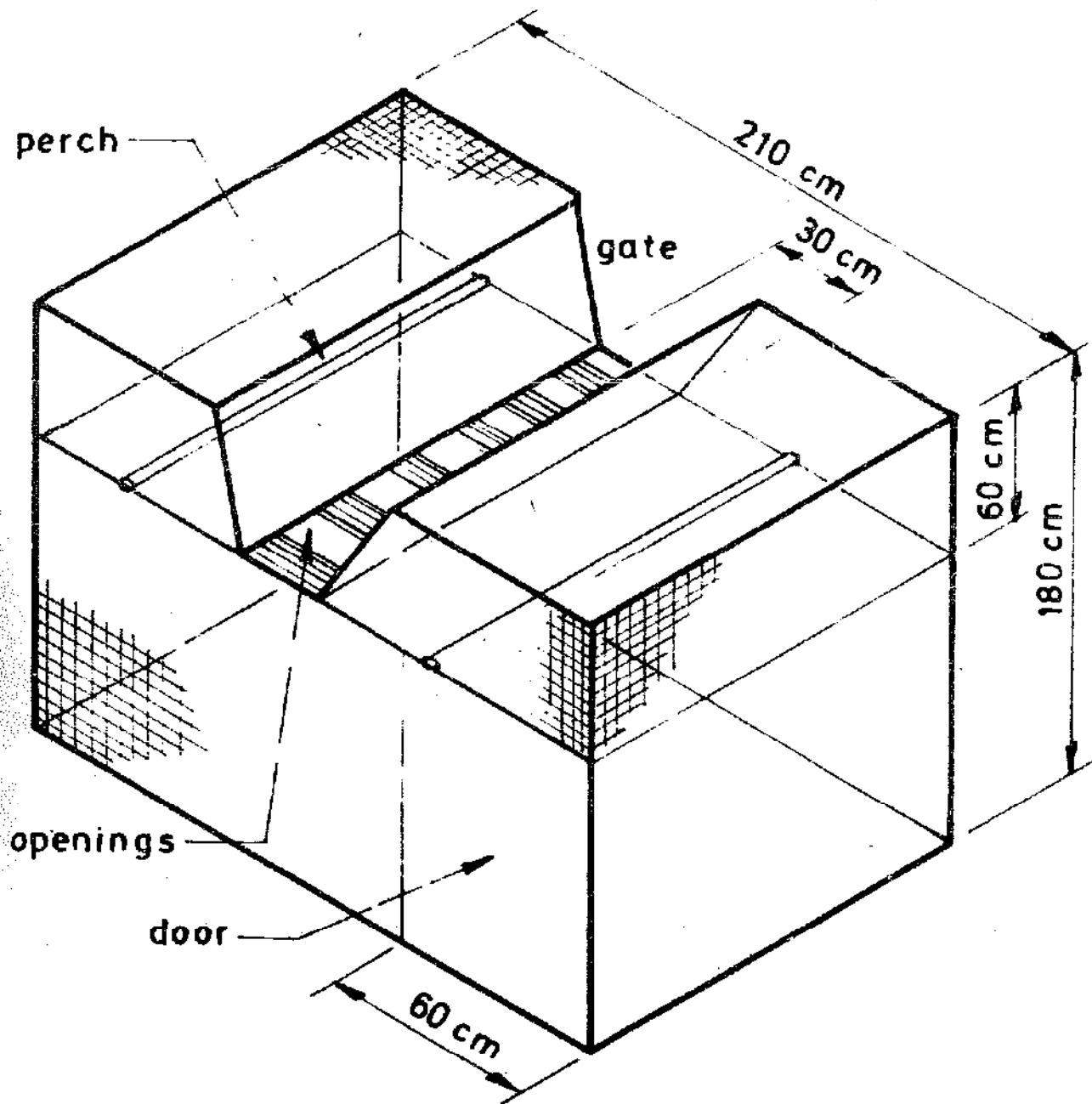
## THE INDIAN CROW TRAP

"A *crow* trap?" you say "You must be kidding! Crows are about the smartest beings alive. I just can't imagine a crow being trapped." No kidding, Brother. The Indian crow trap traps, beyond the least shadow of doubt. At a farm in Hazaribagh, India, a crow trap caught just over 2000 crows in one year. I call it the Indian crow trap, because it was in India that I was introduced to it, though who invented it or where it was originally made, I cannot say. It is a big chicken-wire cage. Apart from one or two features that must be incorporated, it need not conform to any specific dimensions. A small one I once made measured 8ft x 6ft x 6ft. I give a design of this below.

The first crow is the hardest to catch. He'll fly near the trap, but not onto it. He'll fly round it suspiciously, then perch on a nearby tree. He'll turn his head sideways and scrutinize the trap, first with one eye and then with the other, always cautious, always hesitant. But when he spots the bait inside, a dead rat, or chicken entrails, or some other equally appetizing morsel, he is irresistably drawn to danger. He flies down to the cage and hops about the top till he comes to the "gate", which is a row of rectangular openings through which he can slip quite easily from a perching position with his wings folded. He finally takes the plunge and glides down to the bait, temptingly spread out just below, and begins his meal. In his delight he caws and caws, and soon there are four or five inside all sharing the tit-bit.

After a while they want to fly off. They look up and see the perch on one side of the gate, so up they go. But this doesn't get them out. They spot the other perch and fly round to it, only to be disappointed once again. Thereafter they spend the day flying from one perch to the other and back again in the vain hope of somehow being able to escape. Neighbourhood crows are attracted by all the cawing and flapping taking place within the cage, so they too drop in to intestigate, especially if the bait has not all been consumed. They cannot fly out straight through the

# THE INDIAN CROW TRAP



framework is covered with chicken wire.

gate has six or more openings, 30 x 15 cm or 30 x 10 cm.

gate because since they approach it with extended wings, the rectangles are too narrow to let them through. I have been told that very, very rarely a crow does somehow manage to get out, but personally I have never known this to happen.

Now what does one do with a dozen crows at sundown ? Normally someone enters the cage when the crows are asleep, catches them one by one and wrings their necks (a very gratifying operation when the brutes have been eating your corn). One or two crows should be left alive in the cage to entice more crows in the next day, or you have to begin all over again catching a first crow. The dead crows could be buried, perhaps profitably at the roots of a fruit tree. I know one man who wraps them in banana leaves or cabbage leaves, ties the bundle with string and throws it into his fishpond where it sinks and in a few days' time produces maggots that feed the fish. I know another who cleans and boils the crows, then feeds them to his pigs, that devour them with grunts of relish.

Rather than wringing their necks, I think the birds could more easily be electrocuted, though I have never tried this method of killing them. Run two bare wires 15mm apart along the top of one of the perches, then press the switch when the birds are asleep and making good contact. But make sure that one or two birds are on the un-wired perch; and also be quite sure your children don't enter the cage and electrocute themselves.

A less gruesome yet quite effective method of ridding oneself of crows is to scare them away by shooting one and hanging it, or only its wings, where the crows come. They will keep away for many days.

## **HOW TO CLARIFY SALT**

### **In small Quantities for Home Use**

Kitchen salt bought in the Orient is very often as coarse as gravel and about as dirty. It can easily be clarified.

Dissolve it in boiling water to make a more or less saturated solution (1 cup salt to 3 cups water). Let it stand overnight in a bottle or jug. The dirt will drop as sediment and the water will be quite clear. Without disturbing the sediment, syphon the water off. Then evaporate it over a slow fire. When the salt crystals begin to appear stir constantly to prevent burning. Remove from fire when the salt begins to "spit". Spread out thinly on a tray or a sheet of newspaper in a dry room and leave till thoroughly dry. Then pass it through a flour sieve or a tea strainer. The salt comes delightfully snow white, free flowing and eminently fit for table use.

Larger quantities could be evaporated in a solar still, or simply in shallow trays or pans placed in the sun in a dust free atmosphere.

## **TO CLARIFY MUDDY WATER**

When out camping, if you have no filter and the only water available is muddy, rub a piece of alum in it with your fingers, stir thoroughly and let stand. Within a few minutes the mud will fall to the bottom leaving the water clear.

## POSTSCRIPT

We have offered you, Gentle Reader, the fruit of our labours, in the hope that one or other of the articles presented will be of use to you in making life more livable. But if nothing at all here is found to be instructive or useful in any way, we hope that at least you have derived from these pages a modicum of entertainment.

Should you encounter any problems in following our instructions, if the explanations are not clear enough, or in parts are imprecise, please feel free to tell us so. We shall welcome your criticisms, and give you all the help we can to bring you to final success.

If you can offer us any suggestions, either to improve our presentation, or to give us new ideas of your own for simple, practical projects, we shall be glad to consider including them in a later edition or in a second volume. The credit, of course, will be given to you.

Sail forth, Little Book, on the crowded sea of publications. Plough proudly through wind and wave, carrying your modest cargo to the ends of the earth. May you successfully fulfil the purpose of your launching !

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Printed in Nepal  
at Sahayogi Press, Tripureshwar, Kathmandu, Nepal. Phone: 11489