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FIELD PERFORMANCE OF ASTRA-OLE IN UTTARA KANNADA DISTRICT

By

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ABSTRACT

Domestic cook stove developed by ASTRA group of Indian Institute of Science has been field tested in several villages of Uttara Kannada district. A simplified method of construction has been evolved. Fuel efficiencies and the acceptability of the stoves have been evaluated. Efficiencies of presently used domestic cook stoves have been measured for comparison. Modification of the new stove to suit to different types of vessels have been carried out. The results show that in the new stove, only 158 gms of wood is sufficient to cook 1 kg of cooked food whereas in the presently prevalent stoves, 420 gms of wood is required saving of over 60 % of the fuel is demonstrated.

Two training camps have been held to train over 30 local people to construct ASTRAOLE. Presently the trained persons are propagating the new stove. Over 500 ASTRA stoves are working in Uttara Kannada.

INTRODUCTION

Uttara Kannada is one of the Western Ghat districts of Karnataka. Once forest was plenty in this area. Due to extensive exploitation of forest, even here, availability of domestic fuel has decreased drastically. A survey of fuel needs of a typical village, Unchagi in Kumta taluk showed that 1.29 kg of fuel per person per day is needed for cooking and 0.96 kg for bath water heating. Taking together other fuel needs such as grain drying, perboiling, jaggery making, a total of 400 tonnes of fuel is needed for a population of 363 in 63 families. It was interesting to note that no family used kerosene, or electricity for cooking. Only one family had a biogass plant. Thus, people are using only the biomass as fuel. Here too it is only 35 % in the form of the cut wood, 15 % in the form of the farm residues such as coconut husk, palm, arecanut husk / and the rest are twigs, leaves etc. Only about 15 years ago 100 hectares of minor forest area around this village was essentially under production forest cover and now most of this area is essentially barren. This is a typical scenario of most of the western ghat villages.

As part of the ecosystem development of western ghat region by the Centre for Ecological Sciences of Indian Institute of Science, a programme of conservation of

biomass has been taken up. It is believed that while increasing vegetation in a scientific way, conservation of fuel should help ease the pressure on minor forests. Under this programme, fuel efficient cook stove developed in the Institute[1-2], is taken up for extensive field trails.

A systematic study of efficiencies of existing cook stoves in Uttara Kannada has been carried out.

2. MATERIALS AND METHODS

2.1. Efficiency of cook stove

Fuel efficiencies of the stoves studied here have been measured by (a) water boiling test (b) specific fuel consumption.

(a) Water boiling test:

In this method, standard sundried wood (eg. Matti) is used. Known weight of water is boiled on a stove by burning a weighed quantity of wood. Percentage heat efficiency was obtained as follows:

Heat gained = (Wt. of water in kg) x Δ T
+ (Wt. of water evaporated in kg) x 540 ..(1)

Heat supplied = (Wt. of wood in kg x 3800)
-(Wt. of residual charcoal in kg) x6000 ..(2)

Percent heat utilization or efficiency $= \frac{\text{Heat gained}}{\text{Heat supplied}} \times 100$ ..(3)

Here ΔT is the rise in temperature from room temperature to boiling point.

Calorific value of the sun dried wood is taken equal to 3800 KCals/kg and that of charcoal equal to 6000 KCal/kg.

(b) Specific fuel consumption

This is defined as follows:

Specific fuel consumption $= \frac{\text{Wt. of wood burnt}}{\text{Wt. of cooked food}}$ ..(4)

This method gives a figure of merit of the stove directly by comparing with the conventional stoves. Lower the value of SFC, better is the stove.

To take standared dry wood from village to village was too difficult. It was not possible to ensure that the wood used was dry and it was not possible to confirm the calorific value of the wood used. Therefore reliability of boiling water test was not good in the conditions the experiments were carried out. Villagers were not cooperative to BPT measurements since their wood was burnt without any use for them. Therefore to carryout large number of BPT test was not

feasible under field conditions.

In the second method, however, all one had to do was to give a weighed quantity of wood while house wife was cooking the food and at end, just weigh the cooked food. The data obtained were thus realistic for comparison between different types of stoves. Therefore, we in this study have carried out SFC tests.

2.2. Materials for Construction of new stove

a) Latterite stones (15) 25cm x 30 cm x 30 cm

b) Cast iron grate (1) 15cms x 15cms

c) Asbestos cement pipe(1) 10cm dia. x 2.5 to 3 meter Wt.

d) G.I. Sheet (1) 30 cms x 50 cms area; 20 gauge

Other than this, locally available tile pieces, sand, mud, rice husk are required.

3. RESULTS

3.1. Variety and efficiency of existing cook stoves

Before undertaking the field trials of the ASTRA stove, a study of conventional stoves was undertaken in 3 focal villages of Uttara Kannada, namely, Unchagi(Kumta), Bengle and Bhairumbe(Sirsi). Schematic diagrams of different types of stoves prevalent in these typical villages are

shown in fig.1 and photographs of some of these stoves are given in fig.2 Percentage occurrence of types of wood stoves, biogas and electricity usage for cooking are given in table 1. From table 1, we can see that in over 95 % of the houses, wood is used for cooking in Unchagi and Bengle. Only in Bhairumbe which is a more progressive village, 10 % of the houses have biogas and 8 % do use electricity for cooking. Less efficient 3 stone type stoves are found in labour class families . Otherwise, slightly improved types of single and two pot stoves are prevelent in these villages. Occurrence of 3 pot stoves are rare. Isolatedly, stoves burning charcoal are also observed and on enquiry we find that they are used less frequently.

SFC measurements carried out in the conventional stoves are given in Table 2. As single pot B type stoves show high SFC with mean value of 476 gms and standard deviation 175 gms, whereas the C and D type stoves show a mean value of 370 gmswith a standard deviation 110 gms for standard food (rice,sambhar and sabji). Thus variation is quite large in both the type of stoves. The possible reasons for such large variation in SFC are:

(a) There is no standard method of construction; particularly distances between the ground and the pot bottom vary from house to house in making stoves.

(b) Each family has its own skill of making stove and way of cooking.

On the whole, the results show that the conventional stoves require 430 ± 125 gms of fuel for cooking 1 kg of food.

From the fuel conservation point of view, these stoves are not good for burning arecanut husk, coconut husk and fuel of small size such as twigs and shrubs. Firstly the burning rate is as high as 4 to 5 kg. per hour as has been observed in our study. Due to this, large amount of ash gets collected. When the ash and unburnt charcoal collects, smoke production is high. Due to this, excessive organic volatiles are given out, there fuel are not preferred for cooking the food inside the house. Burning incidences are high since flame is seen outside.

It should also be mentioned here that there are a few conveniences of these stoves such as vessels of most sizes can be kept on the stoves (not with same efficiency); the stoves are part of their life in terms of its construction as well as maintanence.

3.2. Construction of ASTRAOLE

A manual as to how to construct the ASTRA OLE (in Kannada) is published by the Karnataka Rajya Vidnyan Parishad, Bangalore. The method of construction has further evolved since the first such stove was built in Unchagi. A few-steps in the construction are given in Appendix

The original design of ASTRA stove was for round bottom vessels figure 3(a). In Uttara Kannada, people use flat bottom vessels. Therefore the stove was modified to suit the local needs to cook in flat bottom vessels. A systematic study was undertaken in achieving high efficiency (low SFC) by changing the distances between the vessel bottom and the stove. The bridge between the vessels were of 3 to 4 cms thickness and 4 - 6 cm width. Because of this, it was difficult to maintain only 4 cm gap between the second pot bottom and the stove when the flat bottom vessel is used in ASTRA OLE. Instead, the inside of the stove was shaped such that the flame and flue gas rises to the second and third vessel and finally flue gas passes through chimney.

The modified stove for flat vessel is shown in Fig. 3(b). Efficiency of this modified stove was 38 % compared to 45 % in ASTRA stove. SFC was 110 gms/kg of

wood in this stove compared to 85 gms in ASTRA OLE. However in this experiment the stove was constructed entirely with bricks and mud as against the iron sheet covered ASTRA OLE . Therefore the efficiency and SFC of the stove modified to flat bottom vessels were considered reasonable and suited to local needs.

3.3. Performance of ASTRA stoves in Uttara Kannada Villages:

SFC measurements carried out on the new stoves are given in Table 3. The SFC values compared to the ones obtained in conventional stoves in Table 2 are quite encouraging. The mean SFC is 158 gms with a standard deviation of 20 gms. Taking the mean values of SFC in conventional stoves and the new one, the saving in wood is over 60 %.

The stoves mentioned here are only the randomly chosen ones out of over 100 stoves constructed under this programme. Since the variation in SFC is not large, we can be reasonably sure that the stoves can be propagated with this kind of saving in fuel. SFC data shows that the stoves can be built which can give SFC between 150-170 gms with 95 % confidence limit.

One important point to be noted here is that there were no restrictions in the type of vessel to be used in these stoves. Vessels which they have been using in the old stove were used in the new one. Also there was no differentiation between aluminium, mud, brass, copper or stainless steel, in which they cooked. It is possible that if only round bottom vessels are used, one could reduce the SFC values further. This however puts a serious limitation on the propagation of the stove. When flat bottom vessels are used in stoves constructed for round bottom vessels, efficiency falls drastically. (See fig 3a) Therefore a stove primarily meant for a flat bottom vessels which of course can be used with round bottom vessels of slightly higher dimensions is more suitable in this region.

Yet another factor for this choice was for making the stove more universal for cooking different kinds of food other than rice, ragi, sambhar. In Uttara Kannada, morning breakfast with 'Dosa' or 'Idli' is a common practice. As is well known, dosa making pan as well as idli vessels are flat bottom ones . It was found that the stove constructed for round bottom was not convenient for Dosa preparation. High heating rate required for this purpose was not achieved. Considering all such local requirements, a stove based on Fig.3(b) is found more suitable in this region. Typical ASTRA Stoves constructed/shown are Figure.4.

3.4. Propagation of ASTRA OLE

A simple description and demonstration of the new stoves in 5 villages was not sufficient for easy propagation. Since there are certain critical parameters in construction, only a trained person could build it to reproduce it with good efficiency. Therefore training of local people was found absolutely essential for propagation.

Hence training camps were held in the villages, Yadahalli, Unchagi, and Bengle.

The mode of training was as follows:

a) A simple lecture cum demonstration of the new stove (a stove was built 15 days before the training and tested).

b) Select a group of 10 trainees (to be selected by local organisations such as Yuvaka and Mahila Mandalis, Schools and Cooperative societies.)

c) Select 5 houses for each pair of trainees.

d) Demonstration of different stages of fabrication at the training centre by a trained person.

e) Fabrication of at least 5 stoves in the kitchen of the selected houses by the trainees.

f) SFC measurements in conventional stoves and the new stove by the trainer for making the trainees realize the fuel saving in the new stove and the added conveniences.

g) SFC measurements by the trainees in the stoves they have built.

During the first training cum demonstration camp at Yadahalli, there were 4 to 5 people in a group and only one stove per group was built. Follow-up of these trainees showed that such a short course was insufficient. The second camp was held at Unchagi with 8 groups consisting of two each and 8 trainers. Each group fabricated 5 stoves with a total 40 stoves during the training programme. By the time the trainee completed 5th stove, he was confident and the stove performance was very good. Therefore 5 stoves per group was fixed for a training programme.

The third training programme was held at Bengle in Sirsi by the trained people of Unchagi and one of us (CMS) The performances of the stoves were very good in terms of SFC (see table 3) and hence the confidence in the training procedure laid down here.

The first training programme was held under the Ecodevelopment programme of CES, IISc., Bangalore. Financial assistance for the other two training programme

came from Dept. of Science and Technology, Govt. of Karnataka and District Rural Development Society, Karwar. The training programme was found feasible for easy propagation of ASTRA OLE. Following this, DST, Karnataka Govt. has launched a series of training programmes in every district of Karnataka through the assistance of KSCST and ASTRA Centre IISc. This way, experiences gained first in the training programme in Uttara Kannada could become useful for propagating the stoves on other parts of Karnataka.

4. CONCLUDING REMARKS

A much more detailed investigation of SFC values would be desirable since cooking is essentially a skill of individuals and it would be worth finding the variation for only round bottom vessels, flat bottom vessels, only brass or aluminium vessels and so on. There could be variation in SFC values for cooking only 'Dosa', 'Idli' 'Rice' and 'Ragi' or any particular type of food. However taking similar type of food cooked in old and new stoves, the SFC values quoted above are reliable and an overall saving of 60 % of fuel is realised expected. Since fuel saving is a major criterion in this stove the achievement was considered good . Another factor in favour of this stove is that agricultural

residues especially areca husk, coconut husk and palms could be efficiently burnt. Therefore not only saving in wood is achieved, but husks otherwise not much used as fuel or for any agricultural purpose has now found useful for cooking. Over 50 % of the stoves fabricated in Uttara Kannada were from house owner's expenditure and the rest from funds of the forest department. This shows that the stove is accepted by people and they are ready to invest on it. Thus, this technology is truely being transfered to the villages of Uttara Kannada.

References

1. R. Kumar, M.S. Hegde, S.S. Lokras and K.S. Jagadish, Annual report of KSCST, Indian Institute of Science, Bangalore 1982-83, p 31.

2. S.S. Lokras, S. Babu, Swati Bhogle, K.S. Jagadish and R. Kumar, Proceedings of ASTRA Seminar, Indian Institute of Science, 1983, p 13.

TABLE - 1

Types of stoves[+] and fuel for domestic cooking in 3 villages

Village	No. of houses	Type of stove	percentage occurrence	SFC mean value
Unchagi (Kumta) 363 people	63	A	50 %	445 gms/kg
		B	20 %	440 gms/kg
		C	28 %	350 gms/kg
		Biogass	2 %	-
		Electricity	nil	-
Bhairumbe (Sirsi) 430 people	62	A	2 %	450 gms/kg
		B	42 %	430 gms/kg
		C	38 %	358 gms/kg
		Biogass	10 %	-
		Electricity	8 %	-
Bengle (Sirsi) 874 people	153	A	nil	-
		B	49 %	432 gms/kg
		C	47 %	363 gms/kg
		Biogass	4 %	-
		Electricity	nil	-

[+] This data above is before construction of ASTRA OLE . Till July 1984 50 % in Unchagi, 11 % in Bhairumbe and 21 % in Bengle houses has ASTRA OLE.

TABLE - 2

SFC Values in different types of conventional stoves

Sl No.	Name	Place	Type of stove	SFC in gms of wood/kg of food
1	2	3	4	5
1.	K.S.Hegde	Sirsimakki	A	450
2.	Masti Hulia	Bhairumbe	C	313
3.	K.G.Hegde	Bhairumbe	B	380
4.	A.M.Hegde	Bengle	C	314
5.	D.G.Hegde	Bengle	C	701
6.	Y.S.Hegde	Onikeri	C	534
7.	Holelinga	Bengle	B	561
8.	Manjunath	Sirsi	C	361
9.	Mahadev Yallapa	Sirsi	B	431
10.	Gulya Tai Bangari	Bengle	C	351
11.	G.Ramappa	Sirsi	C	463
12.	T.R.Shastri	Terkanalli	B	295
13.	Shire Gouda	Bhairumbe	C	327
14.	G.C.Hegde	Onikeri	C	322
15.	V.G.Hegde	Onikeri	C	336
16.	K.R.Hegde	Onikeri	C	271
17.	Kenya Thakur	Bengle	B	736
18.	Abdul Khadar Abubkai Shetty	Sirsi	C	314

Table - 2 (contd.)

1	2	3	4	5
19.	Venkatesh C.Siddapur	Sirsi	C	348
20.	Venkappa Lansappkenade	Sirsi	B	309
21.	Somya Tai	Bengle	B	864
22.	V.G.Hegde	Kallabe	B	380
23.	Narasimha	Kallabbe	B	408
24.	Hanumanna Naik	Bidrahalli	C	415
25.	Timma Naik	Bidrahalli	B	426
26.	Narayan Manj	Bidrahalli	B	397
27.	Ishwar Naik	Bidrahalli	A	438

TABLE - 3

Sl. No.	Name	Village	SFC in gms of wood/kg of food
1.	R.S.Hegde	Bellekeri	144
2.	I.S.Hegde	Kallabbe	175
3.	R.A. Hegde	Sankal	181
4.	S.S. Hegde	Kallabbe	144
5.	U.S.Hegde	Kotegudde	161
6.	G.S.Bhat	Kotegudde	202
7.	S.G. Achari	Unchagi	171
8.	S.S.Gouda	Unchagi	181
9.	B.Tai Bangari	Bengle	165
10.	Kempa Chennashetty	Bengle	161
11.	Rajanna viradashetty	Bengle	177
12.	Linga Tunde Beerg	Bengle	189
13.	Keriya Tandechedya	Bengle	172
14.	Somya Tai Bangari	Bengle	158
15.	Keriya Thakur	Bengle	150
16.	Bangarya Tarde iddappa	Bengle	133
17.	Gulya Tai Bangari	Bengle	132
18.	S.P.Hegde	Bhairumbe	160
19.	M.V.Shastri	Unchagi	150

Table - 3 (Contd.)

Sl. No.	Name	Village	SFC in gms of wood/kg of food
20.	S.S.Hegde	Bhairumbe	126
21.	M.V.Hegde	Onikeri	160
22.	G.G.Hegde	Onikeri	134
23.	S.R.Hegde	Unchagi	160
24.	P.V.Shanbhage	Unchagi	111
25.	S.V.Bhat	Unchagi	150

APPENDIX

Construction of ASTRA OLE

An instruction mannual on the construction of 'ASTRA OLE' has been published in Kannada by Karnataka Rajya Vijnana Parishat, IISc., Bangalore. In this appendix some of the important steps of construction is given here from the Kannada booklet

(a) Materials for construction:

Materials for construction has been given in the text. Some details are given here.

(i) Window for inlet made of G.I. sheet required is shown in Fig.5(a). Two hooks are welded to the window which can be embedded in the wall of the stove.

(ii) Fuel box cover can be of simple design as shown in figure 5(b) . The length and breadth can be varied depending upon the length of the wood pieces. Generally 50 cm x 30 cm cover is sufficient.

(iii) Bridges between the first and the second hearth of the stove can be simply a 4 cm x 25 cm Mangalore tile pieces. Iron rods rolled into thin wire mesh can be used. Iron bars of 4 cm x 25 cm can be used. These are shown in Figure 1(c).

(iv) To keep smaller vessels, a lid with hole in the centre serves the purpose (see fig. 5d) . The lid can be of mud or tin sheet.

(b) Choice of place:

In the kitchen, an area of 175 cm x 40 cm is sufficient to construct 3 pot ASTRA OLE. The direction of the stove be fixed so that the convenience to push the fuel in right hand is possible and facing east while cooking. Secondly, stove be constructed such that chimmeny comes towards low roof end of the kitchen so that chimmeny goes out of the roof for smoke to be left outside the kitchen. This way mark the area.

(c) Choice of vessels:

Choose 3 vessels which are most commonly used for cooking such as rice, sambhar, dal or subji, ragi etc. If the vessels are round bottom it is better from the point of efficiency of the stove. Flat vessels can also be used. Measure the highest diameter of the vessle as shown in Figure 5(e).

(d) Construction of the stove:

(1) Mark the area 175 cm x 40 cm. Mark the direction of the chimmney position and the fuel box at the other end as

shown in figure 6(a). Keep the 3 vessels chosen in succession leaving about 75 cm for fuel box and 4-5 cm between the vessels. Mark the position for the first vessel.

(2) Construct a wall along the wall of the kitchen either with bricks or laterite stone. Height of the wall be about 2 brick height (20-22 cm) and leave about 60 cm for fuel box and keep two half cut bricks as shown in fig.6(b) to keep the grate. The distance between the brick support for grate be 12-13 cm when 15 cm x 15 cm grate is used. Keep the grate such that wood when placed on the grate will be perpendicular to the channel of the grate

(3) Now construct the second wall as shown in the figure 6(c) 6(d). The inside distance between the walls should be equal to the highest diameter of the vessel used

(4) Keep now a stone above the bricks supporting grate and notice that an air inlet and the ash removing place below the grate gets formed. Now complete the construction of the wall for fuel box till the height is only 20-22 cms as shown in fig.7(a,b)Also fit up the air inlet window at the ash removing place.

(5) Keep the first vessel now above the grate such that centre of the grate is about 2 cms towards chimmney side with respect to the centre of the vessel. Even if the grate is exactly below the first vessel no harm is done. Now keep two bridges at each side of the vessel across the channel as shown in figure 7 (b).

(6) Measure the distance between the bottom of the vessel and the top of grate. Put the mud on the walls and keep the bridges such that the distance is 11 cms exactly. This is most crucial. Now give tile pieces and other packages after keeping vessel towards the corners and put rice husk - sand - mud mixture. Shape the top part round by turning the vessel on the wet mud. Leave it at that. (see page 8 a,b)

(7) Keep a bridge now to keep the second vessel and shape the top as is done for the first vessel.

(8) Similarly, make the third hearth by keeping the third vessel.

(9) Keep good support for chimmney and mount the chimmney on the channel. Chimmney bottom is not to be blocked.

(10) Now take rice husk - mud - sand (1:1:1) mixture and shape the inside of the stove. Firstly, cover the wood box bottom level to the grate level

with mud. Then only the grate part is kept uncovered but it should be fixed with mud. See that air can come only through the grate and all other gaps should be closed. Put mud mixture below the second and third pots. If round vessels are used, shape the inside exactly as that of the vessel bottom and see that distance between top layer of the mud mixture and the bottom of the second vessel is only 4 cm. The distance between the first pot bottom and the grate is already adjusted to 11 cms.

(11) Similarly pack with mud below third pot and shape it so that top layer of the third herewith is only 2.5 cm to the bottom of the pot. Below the bridges between the first and second pot, keep large gap for flame to be seen by the second pot. Also keep sufficient gap below the chimmney for the fluee gas to escape.

(12) Keep 1 cm diameter hole in the wall above the air inlet gap. The position of the hole should be just about at the bottom level of the first vessel. This is called secondary air inlet which helps burn combustible gases. (see fig.8c)

(13) Plaster the fuel box as well as outside of the stove so that the top level is same throughout . Now again take care that 11 cm , 4 cm and $2\frac{1}{2}$ cm gaps are

maintained below first, second and third pots. Distance between the vessels can be 4 cm to 5 cm.

(14) Now put the lid for the fuel box . See that there is no gap and it is properly closed.

(15) Smoothening of the stove can be done now and finally the stove can be covered with cowdung and cleaned. Fine cracks get closed due to the fine fibres in the dung. On continuous curing the stove becomes hard. Make sure that every time the curing is done, vessels be placed on the stove and there should be no gap between the stove and the vessel.

(16) After about 10 days, stove is dry and is ready for firing cross estimated view for found and flat bottom vessel stoves are given in fig 3a and 3b).

(d) Lighting Method:

Put small quantity of easily combustible plam on the grate and light it, wait for a minute. Now cover the fuel box. Put the first vessel on the stove. Wait for a minute. Then keep the second vessel and third vessel

Keep some more wood and close the fuel box. Now the smoke escapes through the chimmney. Sometimes smoke comes through fuel box because the stove is still wet. Continue to burn the fuel. In about 15 minutes,

stove starts cooking well. Push the fuel once in 8-10 minutes. In case it is not burning, fan through the air inlet hole, instantly fuel gets lighted.

ACKNOWLEDGEMENTS

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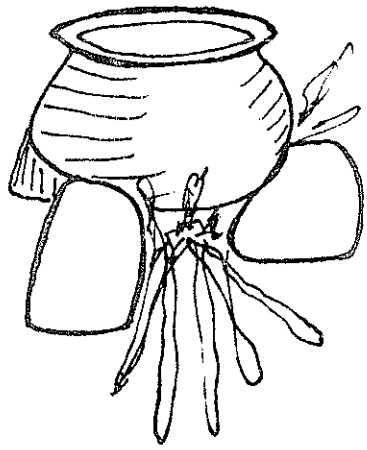
A



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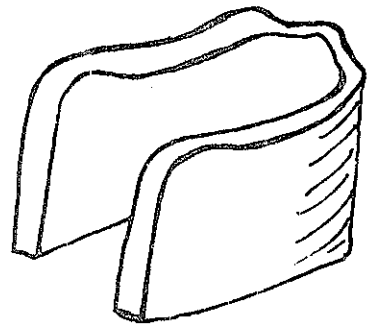

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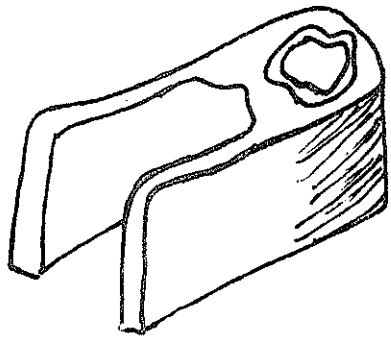

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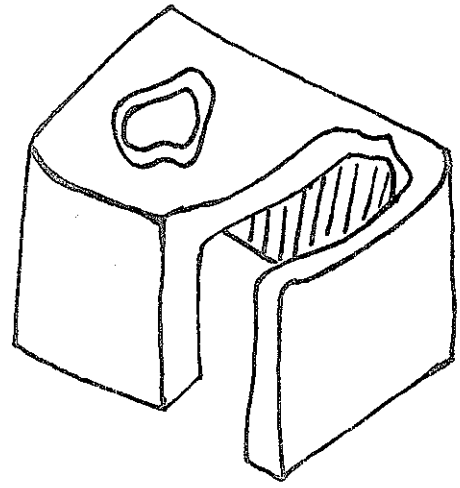

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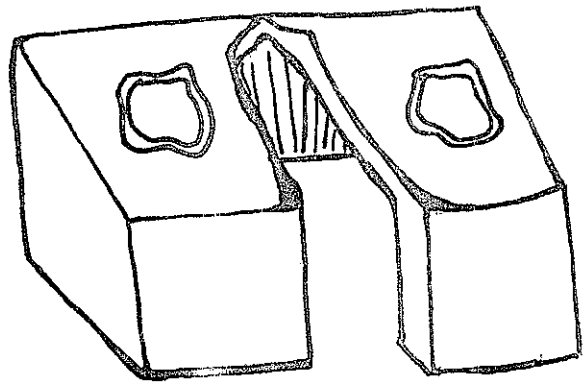


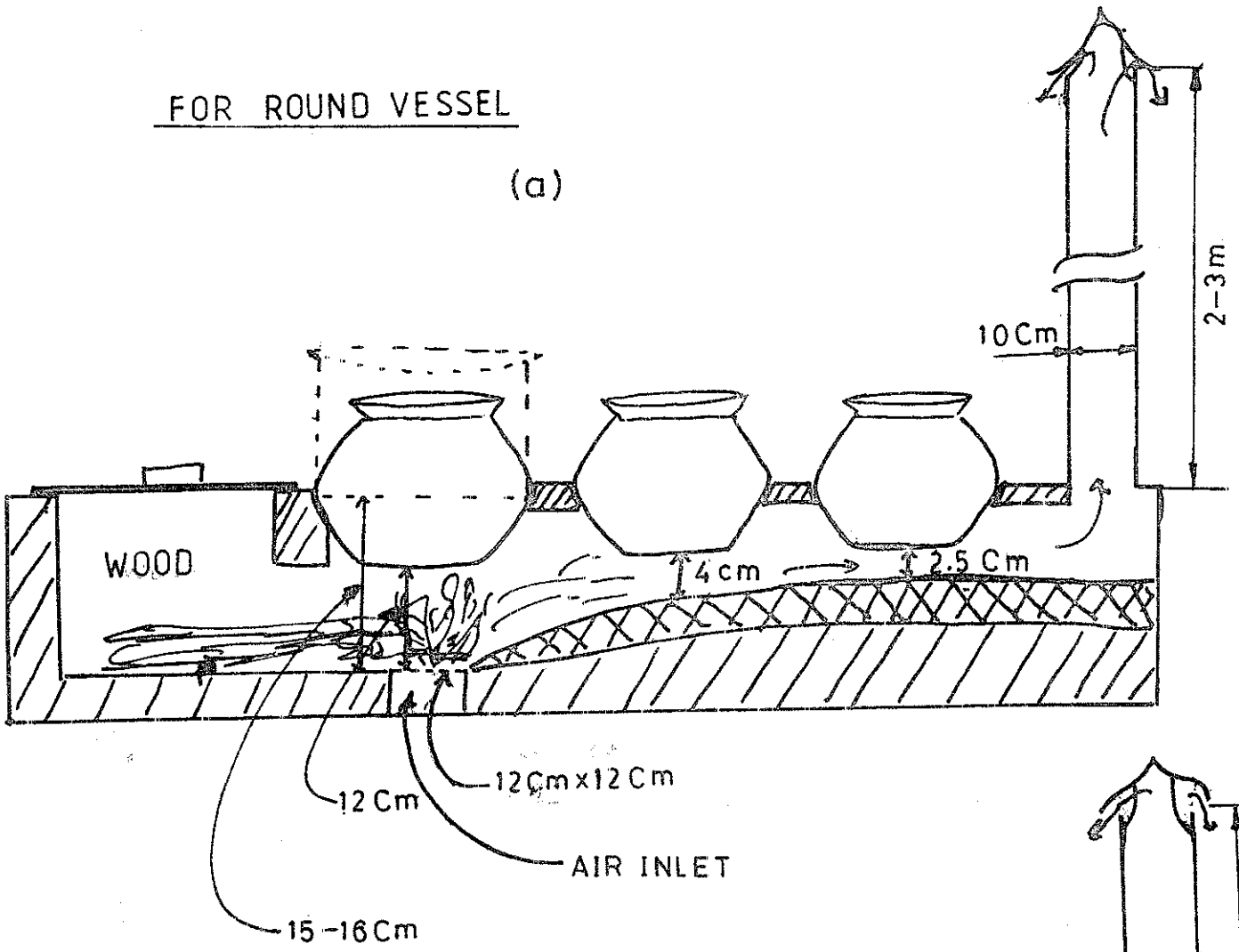
Fig 1

Traditional Wood Stove

Fig 2

FOR ROUND VESSEL

(a)



(b)

FOR FLAT VESSEL

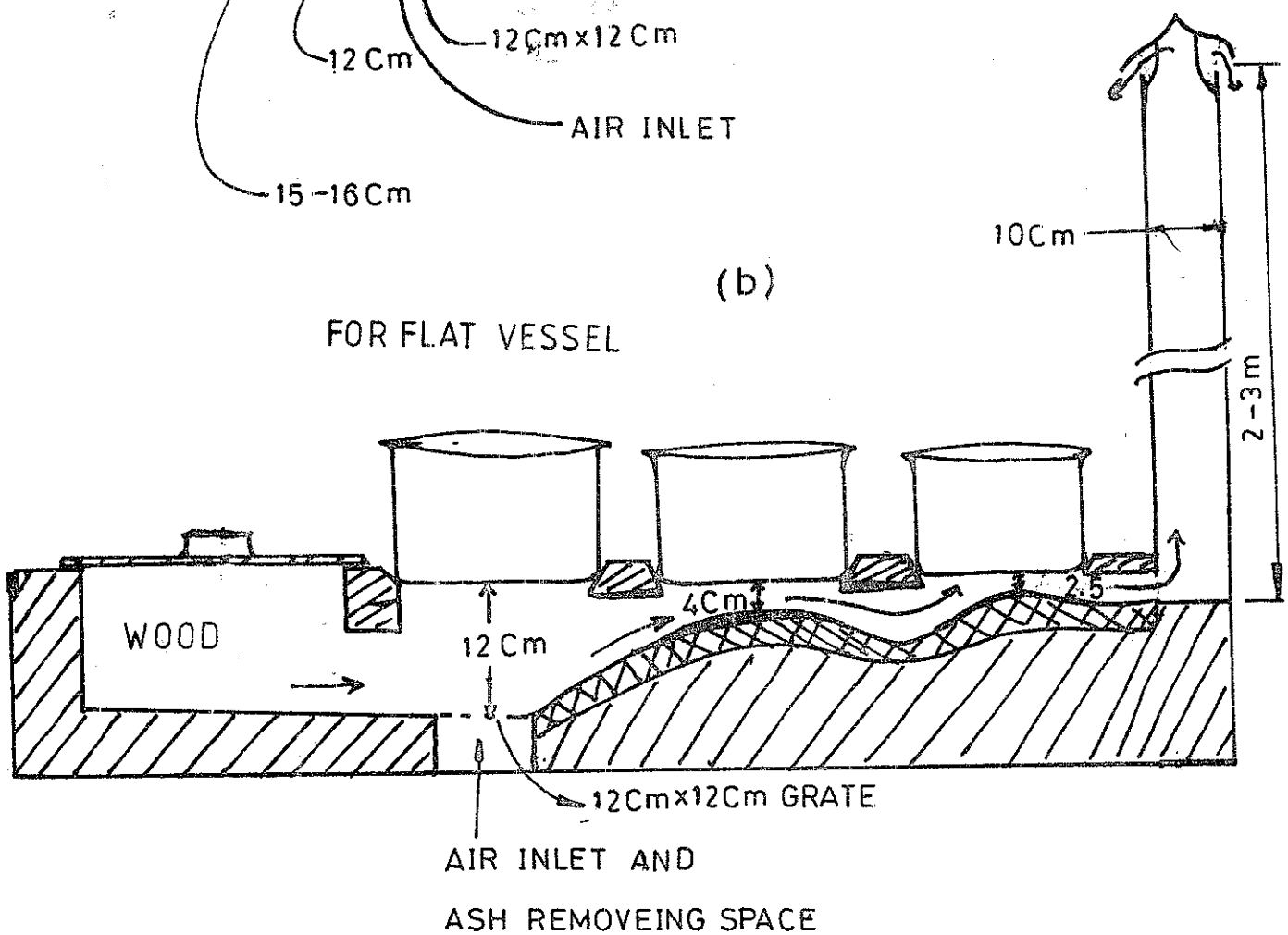
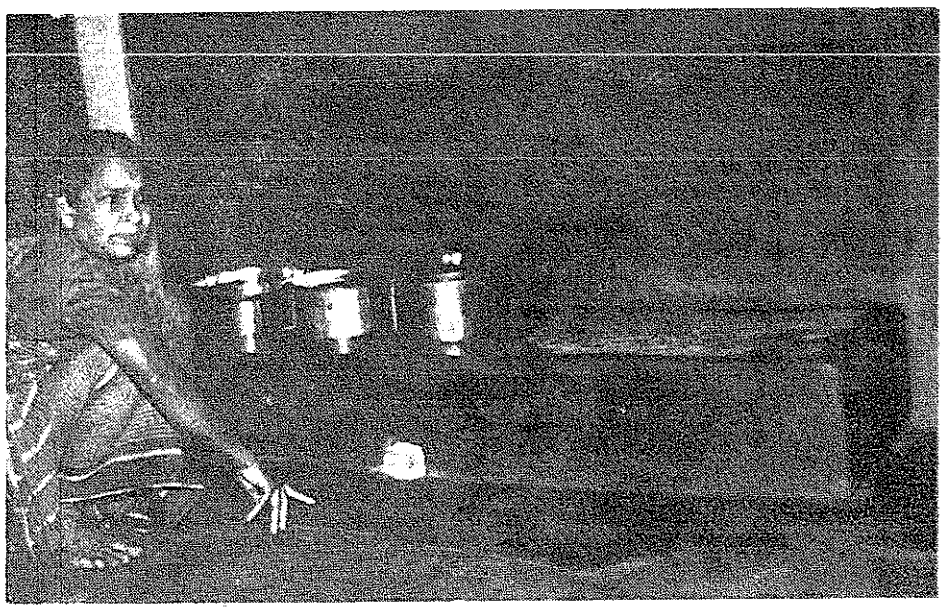


Fig (3b)



Astra ole at Bangle

Fig 4

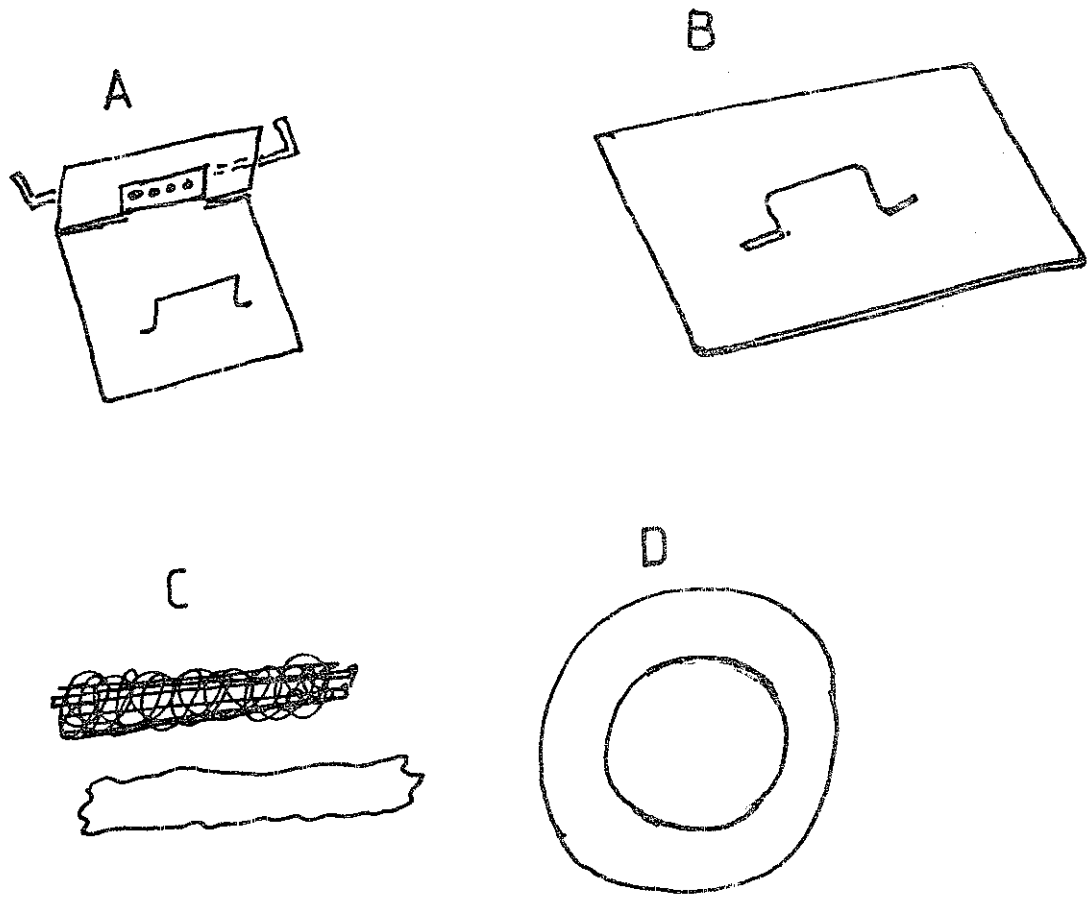
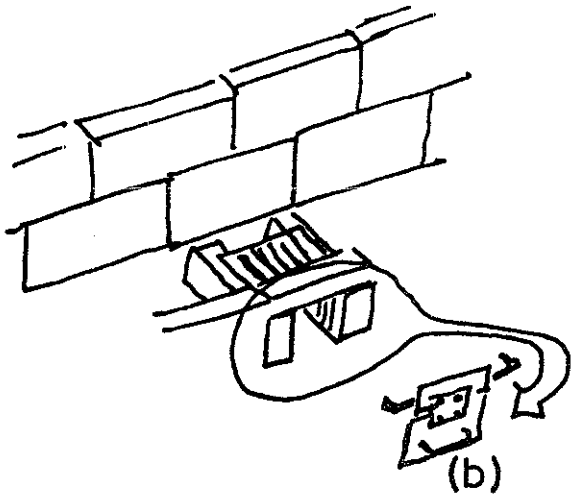
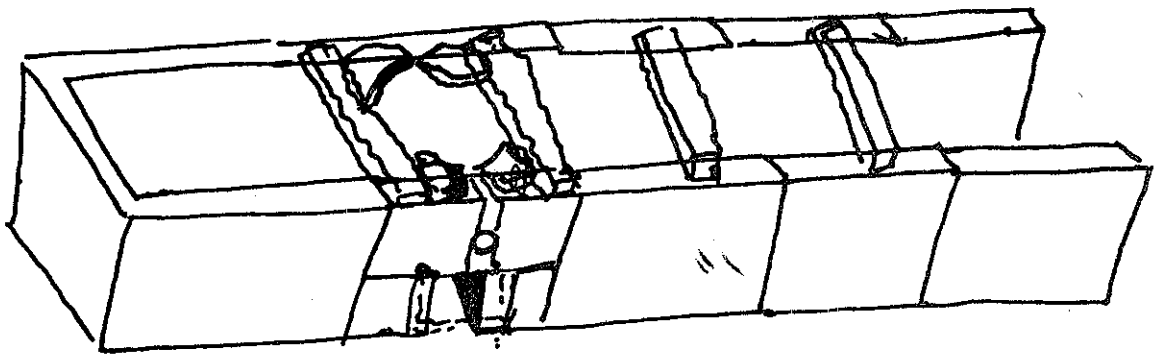


Fig. 5

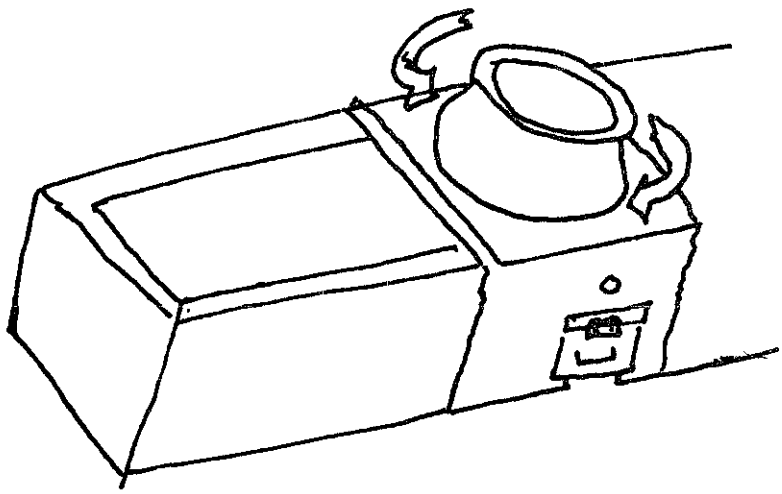
(a)

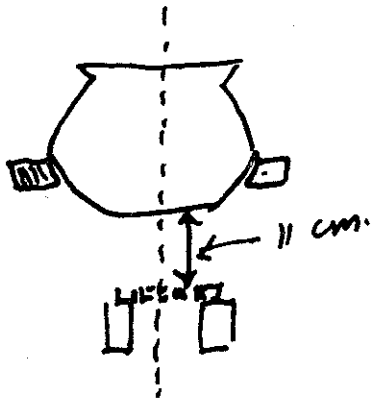


(b)



(c)

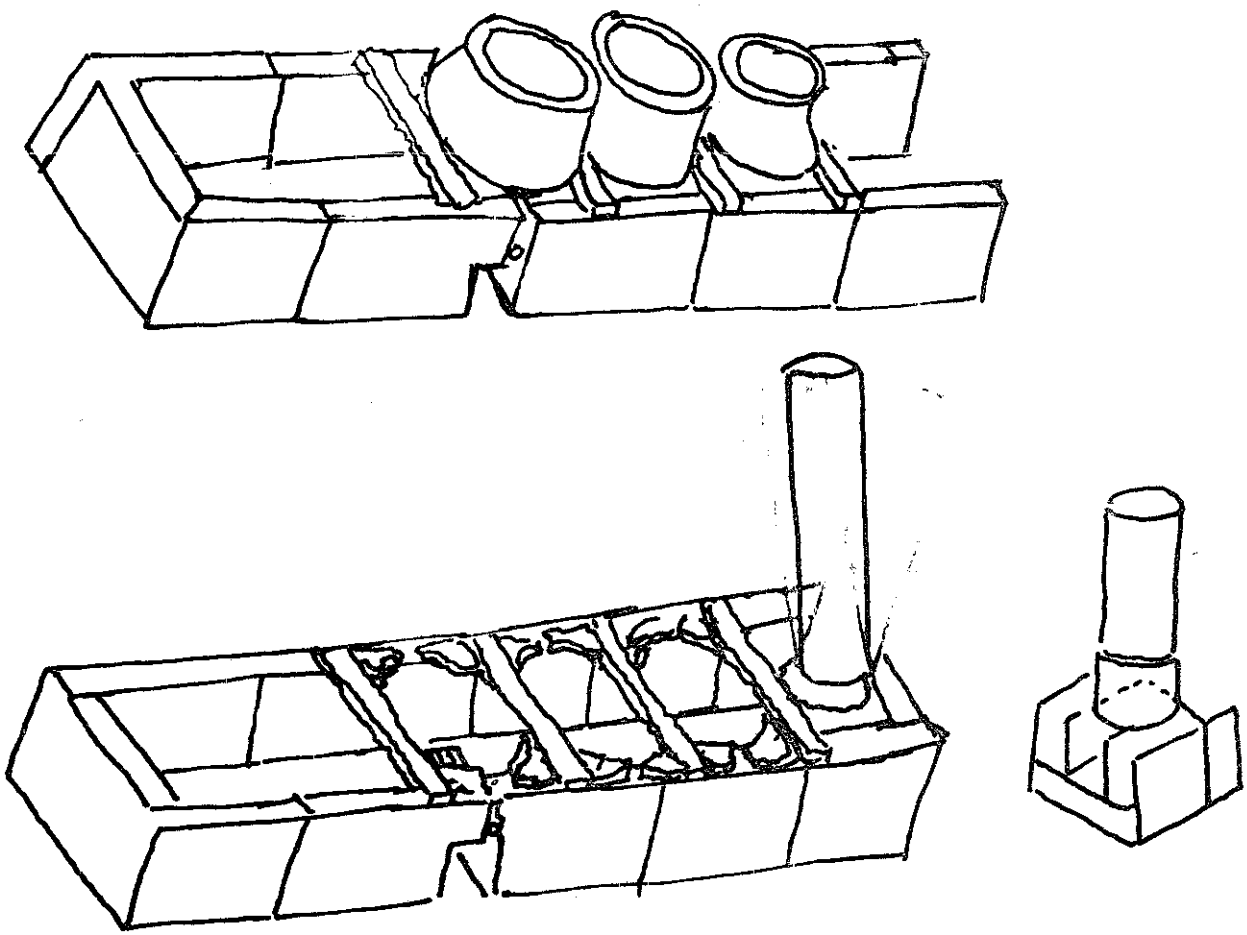




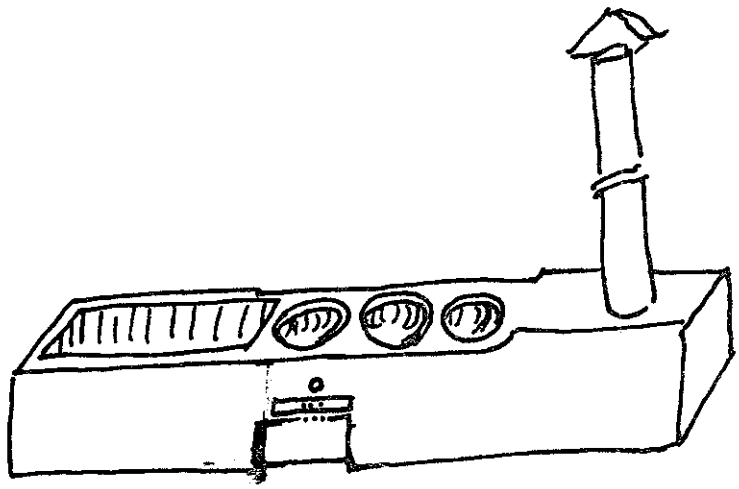
(d)

Fig 7

(a)



(b)



(c)

Fig 8