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**Ministry of Forestry**
**Forest Department**


# Operation of a Portable Kiln and Use for the Investigation of Quality of Charcoal Produced from Some Fuelwood Species in Delta Area.

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1986

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# မြစ်ဝကျွန်းပေါ်ဒေသတွင် အပေါက်များသော ထင်းအဖြစ်ထုတ်ယူခွင့်ပြုသည့် သစ်မျိုး အချို့အား မီးသွေးဖုတ်စမ်းသပ်ခြင်း နှင့် အရည်အသွေးခွဲခြားခြင်း

ဦးစိုးမြင့်သိမ်း၊ Diplom Forstingenieur [ T. U. Dresden],
အကြီးတန်းသုတေသနမှူး
သစ်တောသုတေသနဌာနရေဆင်း။

## စာတမ်းအကျဉ်းချုပ်

မြစ်ဝကျွန်းပေါ်ဒေတွင် ထင်းအဖြစ်ထုတ်ယူခွင့် ပြုထားသည့် သစ်(၅) မျိုးဖြစ်သော မြင်းဂ၊ သမဲ့၊ ကမွလာ၊ ပြူးခြေထောက် နှင့် ခရာသစ်မျိုးတို့အား ရွှေပြောင်း သယ်ယူနိုင်သည့် သံမဏိမီးသွေးဖိုဖြင့် ဘိုကလေးမြို့နယ် စက်ဆန်းဒေသတွင် မီးသွေးဖုတ် စမ်းသပ်ခဲ့ပါသည်။ သစ်တစ်မျိုးစီမှ ၏ရှိသော မီးသွေး ထွက်နှုန်းများကို နှိုင်းယှဉ်ပြထားသည့်အပြင် မီးသွေးများ၏ အတန်းအစားနှင့် အရည်အသွေး ခွဲခြားသိနိုင်ရန် လိုအပ်သော စမ်းသပ်ချက်များကို တင်ပြထားပါသည်။

# Operation of a Portable Kiln and Use for the Investigation of Quality of Charcoal Produced From Some Fuelwood Species in Delta Area.

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Senior Research Officer, Forest Research Institute, Yezin.

## Abstracts

The performance of five fuelwood species in the Delta Area, namely Myinga (*Cynometra minosoides* Wall; syn. *C. ramiflora Linn*.), Thame (*Avicenia officinalis* Linn.), Kambala (*Sonneratia apetala* Ham.), Byu-chedauk (*Rhizophora candelaria* D. C; syn. R. *conjugata* Kurz non Linn.) and Khaya (*Argemone mexicana* Linn.) in the carbonization process was conducted at Set San area in Bogale Township, using a portable metallic kiln.The yields and quality of charcoal of the five species were compared.

## Contents

# 1. Introduction

Charcoal in the Socialist Republic of the Union of Burma is mainly used as domestic fuel for cooking and heating, etc. Raw materials for charcoal making is produced from the reserved and public forests. Charcoal burning is not generally allowed in the reserves, except in the Delta area. The mangrove forests produce large quantities of wood for charcoal and supply the densely populated Irrawaddy Delta and the capital city of Rangoon. Generally the population in Towns and Cities are the main users of charcoal, which is in short supply and the price is continually rising. (For. Dept. 1985)

To augment the shortage of fuelwood and charcoal supply, the Forest Department has planned to increase the local supply plantation areas. Charcoal producing in Burma sued a variety of kilns, mostly made of earth and constructed at the site.

Previous investigations revealed that better quantity and quality of charcoal could be produced more efficiently with a portable metallic kiln.( S. M. Thein-84)

This study consisted of two parts. First it was an examination on the construction and operation of portable metallic kilns in sufficient detail to instruct the operation.

Second this kiln was used test the suitability of five species for quantity and quality charcoal production. These five species were selected from the many other species permitted in the area for the manufacture of charcoal.

# 2. Metallic Transportable Steel Kiln

Interlocking steel kilns, introduced by the British and French foresters in Africa, have spread to other regions. The best-known types hold about 6.5 $m^3$ stacked wood. The cylindrical parts of the kiln can be easily rolled in flat terrain. This model was later modified, notably by the Tropical Products Institute (T.P.I) (Whitehead 1980).

Interlocking steel kilns commonly consist of the following parts. (Figure I)

- 1 bottom ring (1)
- 1 upper ring (2)
- 1 cover (3)
- 8 air inlet/smoke outlets (4)
- 4 pipes (5)

If assembled, the 2 rings and the cover are interlocking (6)

The 8 air inlet/smoke outlets support the kiln with the base open.

The four pipes fit on the smoke outlets.

The interlocking steel kiln requires an investment of more than 10,000 KS and has a service life of only about three years. Thus, it is important that it be used efficiently by well-instructed charcoal markers in carefully-organized operations. Otherwise, it will become uneconomical in comparison with traditional methods.

Its advantage over alternative methods of carbonizing being used, is in the case of its control, the speed of the process due to fast cooling, and the higher output of charcoal per $m^3$ of stacked wood. Therefore, it should be particularly attractive to small-scale contractors. Furthermore it is widely used for practical training as the techniques of carbonization can be demonstrated clearly and easily.

Metallic transportable steel kiln

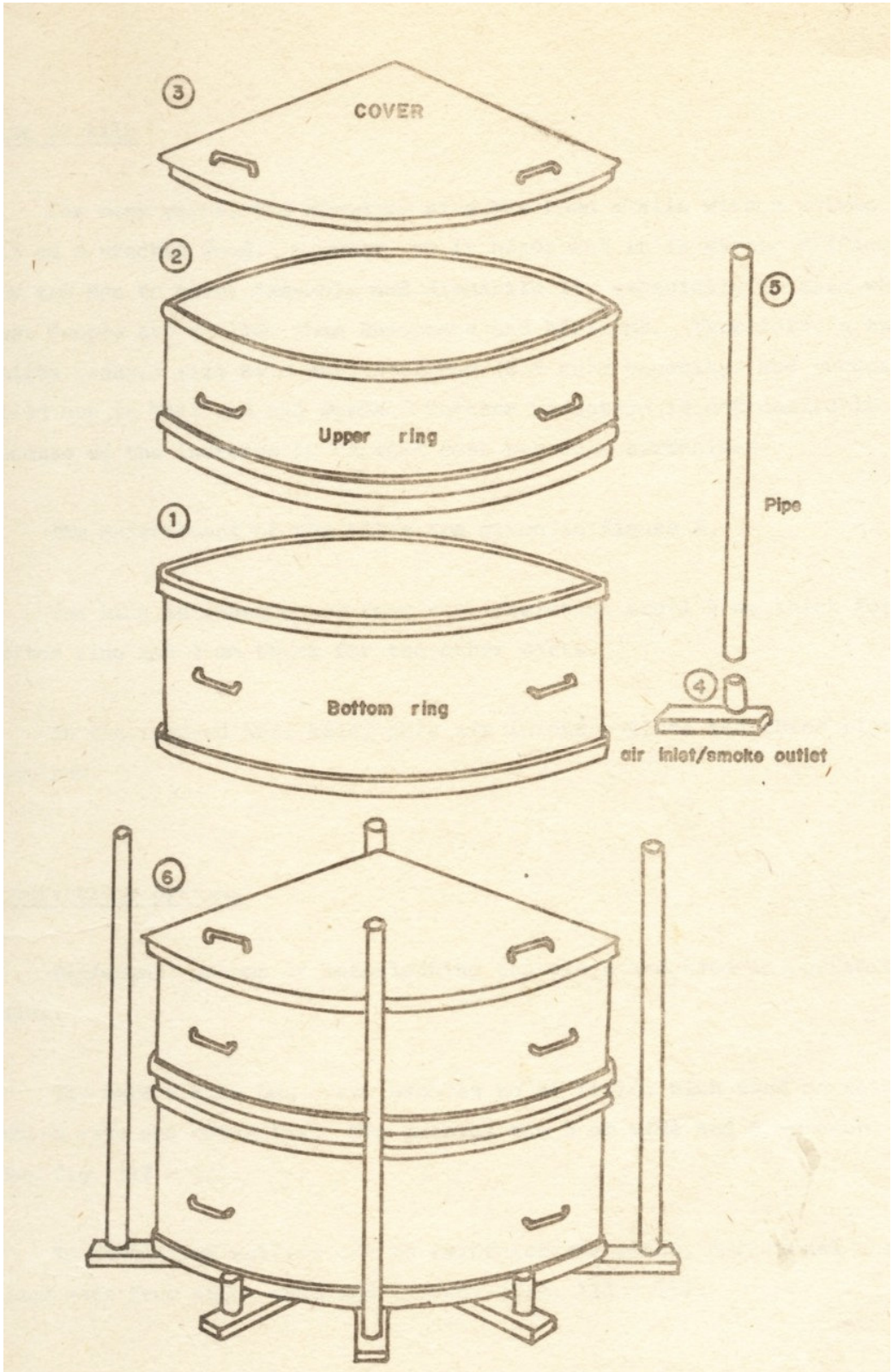



Fig. I. Assembeled transportable steel kiln.

## 2.1 Size of Kiln

For many years, the standard size has been a kiln with a volume of 6.5 cu m stacked wood. However, it is heavy and it is rather difficult for two men to move, assemble and dismantle it, especially in Asia where most people are smaller then Europeans and Africans. Therefore, a two-thirds reduced size kiln was developed (6.5 cu m capacity) and successfully tried out in Thailand and Burma. Further reduction is not desirable because of the increase in capital cost per cu. m carbonized.

The measurement of the kilns are given in figure 2.

The kiln is constructed from rust-resistant steel 3 mm thick for the bottom ring and 2 mm thick for other parts.

In the reduced size kiln, only six inlets/outlets and three pipes are required.

## 2.2 Interlocking Systems

Different systems of interlocking the rings are used in portable steel kilns.

The mark V kiln has outer groves to be filled with sand on which the second ring and cover fit. The grooves are 5 cm wide and 5 cm deep.

To facilitate rolling and to reinforce the rings, additional stiffening rings made from angle iron and welded. (fig. III-1b).

The FTP kiln interlocks by means of inner steel angles on which the upper parts rest (fig. III - 2a). In this case, sanding is applied after assembling the kiln. Assembling is easier than with grooves especially if the rings and a lid lose shape.

However, heavy rains may the sand from the deal of the cover. Where this is a problem a groove may run the ring. (fig. II-b)

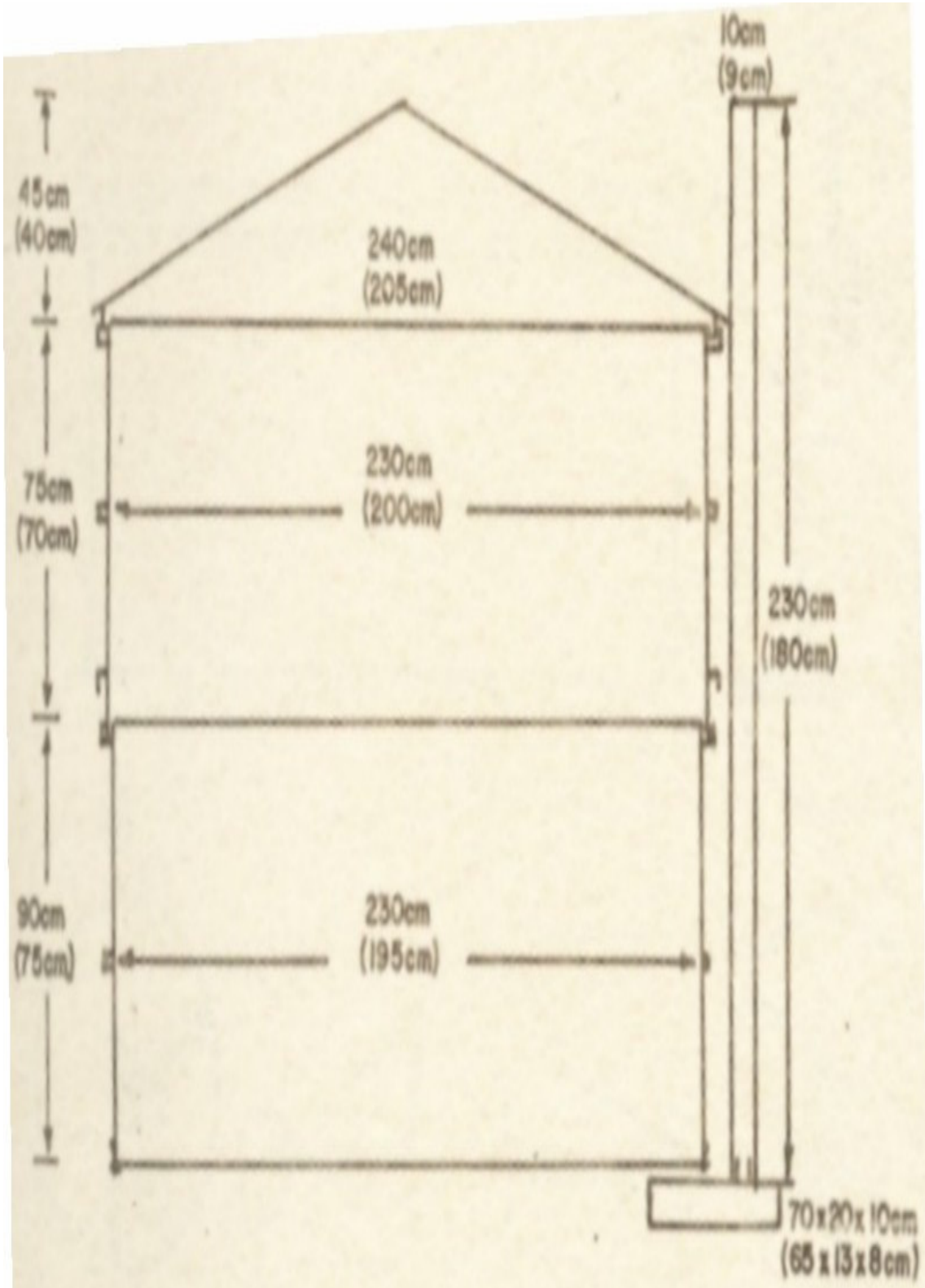



Fig.II. Size of interlocking steel kiln.

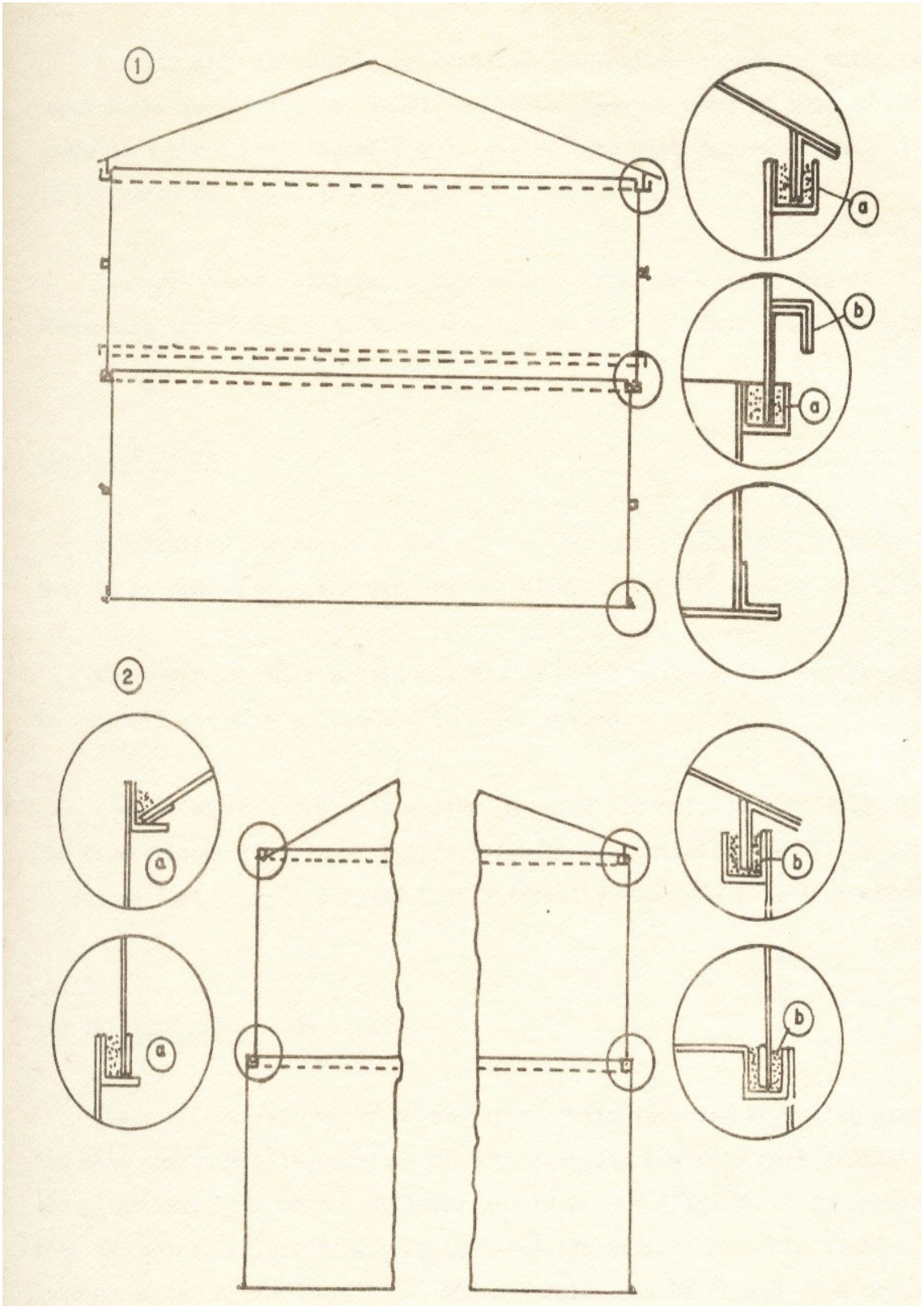



Fig. III. Mark V kiln.

## 2.3 Covers of Kilns

Originally, the cover of the mark V kiln was fitted with a central hole to be closed when the fire in the kiln was well under way (fig. IV-1).

The cover of the FTP kiln has four smaller holes which are intended to requlate air flow during the ignition period. (fig. IV)

A cover without holes is easier to build and more durable (fig. IV-3). The experienced operator will find it quite convenient to use if it can be sealed to the upper ring without difficult once the fire is started.

## 2.4 Air Inlets and Smoke Outlets

There are variations as to the type of air inlet/smoke outlet used. The main part normally consists of a rectangular box with mark indicating the place where the bottom cylinder should be put (fig. V-1a) to ensure that the air is released wide enough into the kiln in order to avoid overheating of the bottom cylinder. The air inlet can be closed by a movable flap (fig- V-1b) a rectangular lid (fig. V-2b) or just by a stone (fig. V-3b). The smoke outlet can be closed by a round lid fitting outside (fig. V-1c) or inside (fig. V-2c) or by a metal plate held by three pieces of wire (fig. V-3c), to be covered with earth once lowered into the opening.

Flaps tend to break and lids tends to get lost in the course of time. Preference should therefore, be given to the most simple solution such as a box suggested by FTP which is open on the underside and is thus easy to keep clean, especially from liquors running down the pipe and which can be closed with stones, pieces of wood and earth, (fig. V-4)

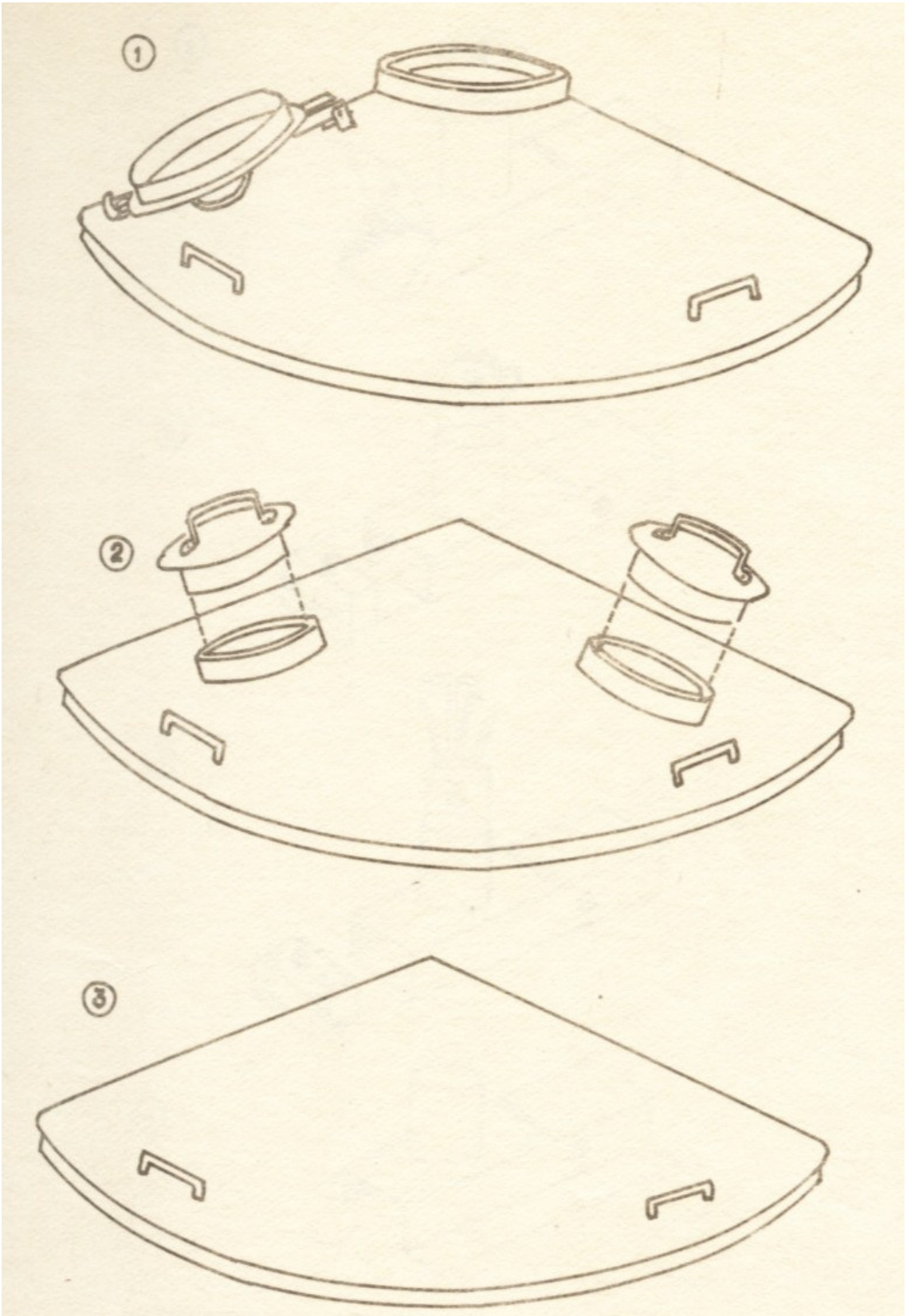
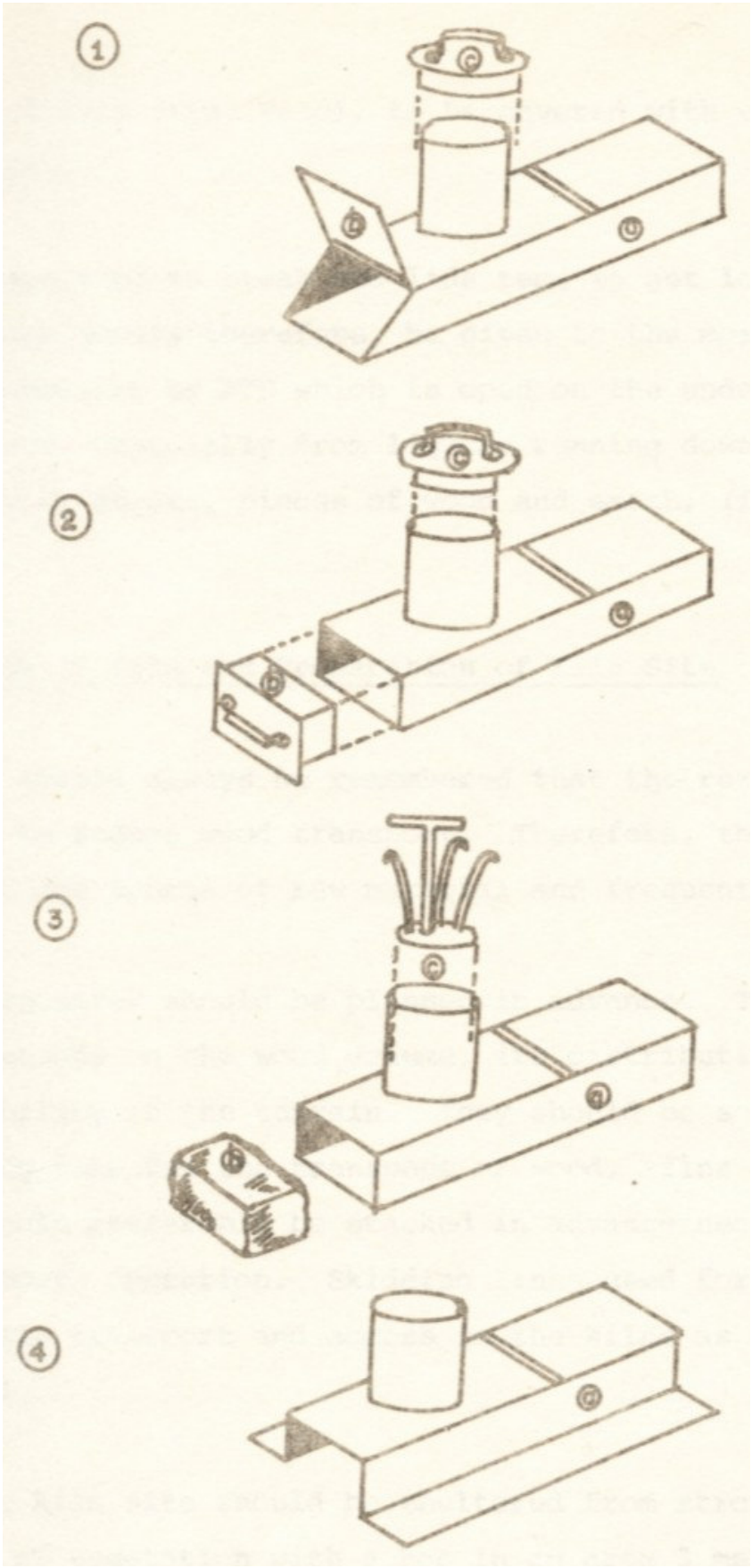



Fig. IV. Covers of interlocking steel kilns.


1
2
3
4

## 2.5 Operation of Kiln and Preparation of Kiln Site

It should always be remembered that the reason for using a portable kiln is to reduce wood transport. Therefore, the kiln should be used close to the source of raw material and frequently moved.

Kiln sites should be planned in advance. Their distance from each other depends on the wood volume, its distribution in the area and on the accessibility of the terrain. They should be so located that total operating time for the transport of wood, kilns and charcoal is minimised. Wood should preferably be stacked in advance near the place selected to allow smooth operation. Skidding lines used for log extraction may facilitate transport and access to the kilns as well as for transport of charcoal.

The kiln site should be sheltered from strong winds. It must be cleared of vegetation with a hole in an area 3 meters in diameter and leveled. With a central stick and string, the surface to be cleared is easily marked. There should be sufficient sand or earth available to seal the kiln as needed, nearby water supply can be advantage.

## 2.6 Loading of Kiln

The kiln is operated by two workers. To load the kiln, they first place the bottom ring on the kiln site. One worker lifts the ring with the pole as a lever while the other inserts the 8 air inlets/smoke outlets (fig. VI-1a) at equal distances. They must reach at least 25 cm into the kiln.

Medium-sized places of wood, about 15 cm thick and 1 m long, are then placed inside the kiln paralled to the air inlets (fig. VI-1b) to keep air channels open (fig. VI-1c).

In the center, a small heap of easily inflammable material is placed (fig. VI-2a) connected to four sides of the kiln by more inflammable material to serve as a use (fig. VI-2b). This is followed by putting one layer of wood pieces crosswise on the first layer (fig. VI-2c) taking care that the inflammable material is not too compacted and that the air channels to the center of the kiln are kept open.

## 2.7 Filling the Bottom Ring

The bottom section of the kiln is now filled up as densely as possible with pieces of wood not exceeding 1 m in length and in 20 cm in diameter. This requires careful piling to make full use of the space in the kiln.

Subsequently, the groove of bottom ring is filled with fine sand, or a mixture of fine sand and mineral earth. Care must be taken to exclude small stone which make seating difficult. Coarse sand may also seal insufficiently.

The upper ring is now placed on to the bottom ring and more sealing material is added if necessary.

Care must be taken during transport and also when opening the kiln after carbonization that the interlocking parts are not bent or damaged. If this is the case, it can be quite difficult to settle the upper ring and the lid in the grooves.

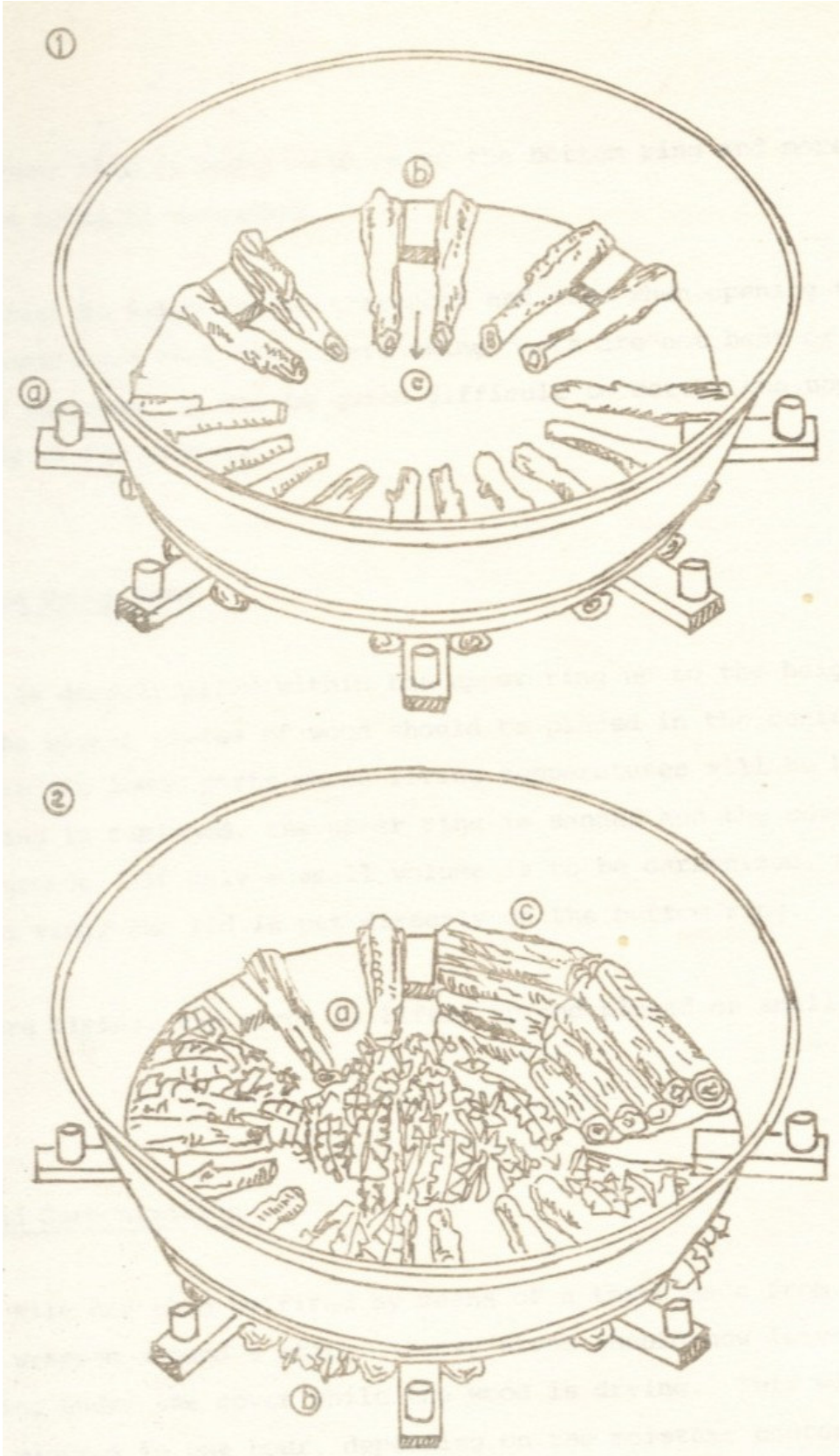



Fig. VI. Loading of steel kiln.

## 2.8 Filling the Upper Ring

Wood is densely piled within the upper ring up to the height of the cover. The bigger pieces of wood should be placed in the center of the kiln and in the lower parts where firing temperature will be highest. When loading is finished, the upper ring is sanded and the cover fitted into the groove. If only a small volume is to be carbonized, not exceeding the bottom ring, the lid is put directly on the bottom ring. Before firing, the cover is lifted up and placed on small pieces of wood.

## 2.9 Firing and Carbonization

The kiln can then be fired by means of a torch made from dry leaves or paper wrapped around a stick. Heavy steam should now leave the kiln from the opening under the cover while the wood is drying. This will take from about 15 minutes to one hour, depending on the moisture content of the wood. For air dry wood with a moisture content of 30 % the drying period will take about 30 minutes. When the first is well under way, the gaps between the air inlets/ smokes outlets are covered with earth.

## 2.10 Reversing of the Draught and Controlling Carbonization

When the moisture has been driven off after about half an hour, the supports under the cover are removed and the cover is sealed. The pipes are fitted on four alternate smoke outlet and the inlet are closed with stones or wood and earth (fig. VII-1a). The other four inlets/smoke outlets are left open (fig. VII-1b). Air now enters only through these four openings, circulates through the kiln and smoke leaves the kiln through the pipe. This system is called reverse draught. It results in burning a larger part of the inflammable gases escaping from the wood if the kiln is sufficiently hot.

At intervals of bout 8 hours the air inlets/smoke outlets are changed by shifting the pipes on former air inlets which are now closed (fig. VII-2b) and by opening the former smoke outlets which now become air inlets. Carbonization proceeds well if thick white smoke is coming from all the four pipes.

Sometimes wind, rain, or wet wood may cool the kiln on one side or near one chimney which may emit only little smoke or cease to emit any smoke. In such cases, the earth is removed from the bottom of the kiln near the inactive pipe, In addition, it may be necessary to reduce the air inlets on the opposite side of the kiln. Fire will thus spreads to the cooler side of the kiln and warn it up. Once the pipe is again emitting whit smoke, the bottom of the kiln is closed and operation continues in the normal way.

The opposite may happen if the smoke on one pipe turns bluish indicating that the fire is too strong. In this case, the pipe is removed and the smoke outlet closed for about 15 minutes to lower the temperature.

When changing the pipes, care must be taken to ensure that air can freely enter and smoke freely leave. Sometimes the air inlets/smoke outlets are block by tar. A long stick is inserted deeply into the kiln to remove any obstruction. When looking through the air inlet/smoke outlet, one should be able to see the red-hot fire.

The whole carbonization process takes about 16-24 hours from the time of firing. For wet wood, carbonization Lasts considerably longer and may go on for to 48 hours.

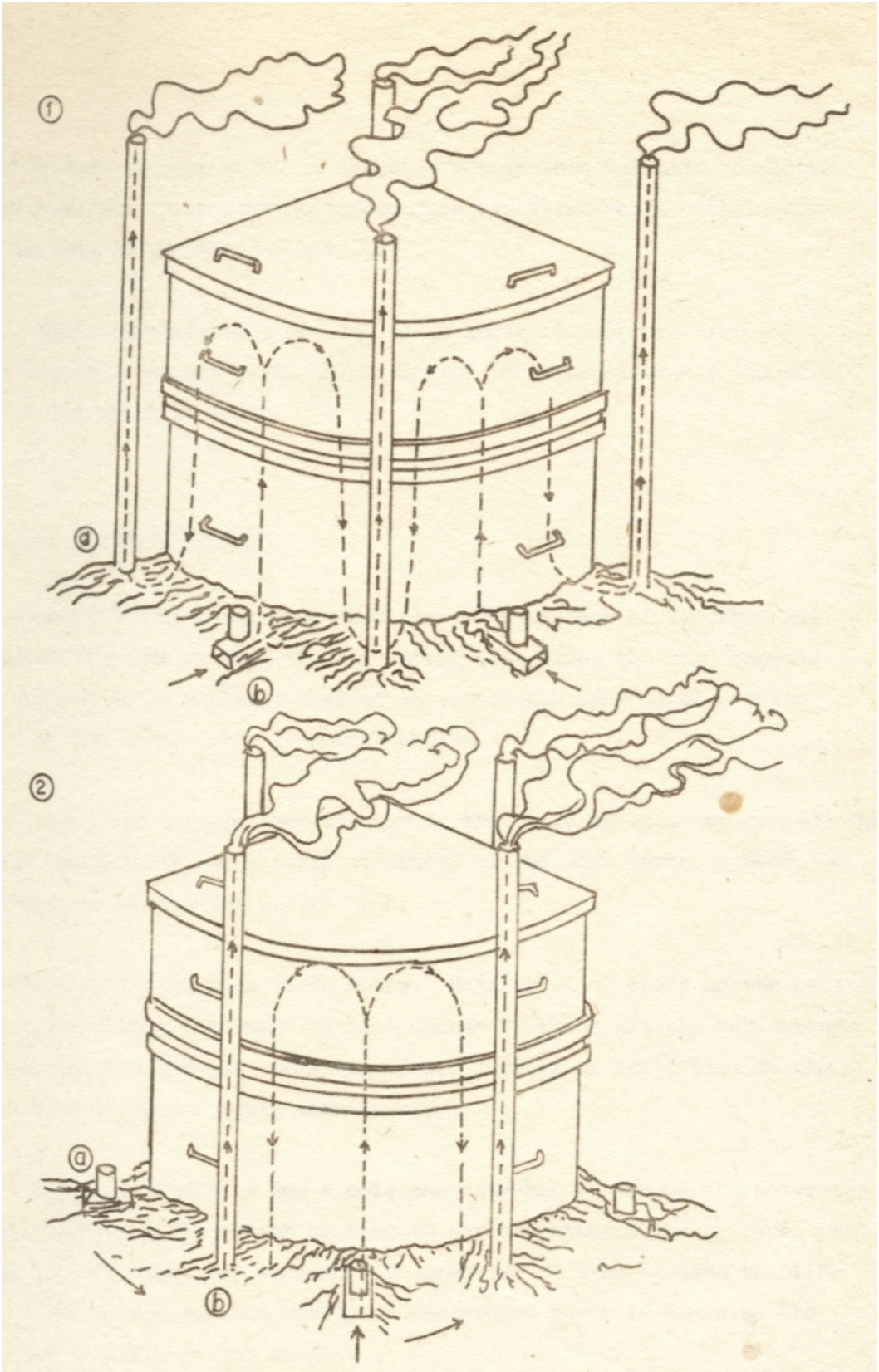



Fig. VII

### 2.11 Cooling and Opening the Kiln

Carbonization is terminated when the smoke becomes bluish thin and transparent from one or more pipes. At the same time, the kiln becomes rather hot and water splashed against it evaporates immediately. When knocking on the upper ring, it sounds hollow.

The pipes are removed successively as they release thin and transparent smoke and the base of the kiln is carefully closed with earth, preventing any further air from entering the kiln.

Cooling will take from 12-24 hours. Rain or wind speeds up the cooling process. The bottom ring must be cool enough to tough all the way around before the kiln is opened. If after opening, there is still fire in the kiln, it must be closed again immediately.

It may be necessary to use a pole and crow-bar to remove the cover and the upper ring from the bottom section if tar has entered the grooves. The crow-bar is also handy for cleaning the grooves. A pole is used to side the cover and bottom section gently to the ground to avoid damaging the grooves and the make the job easier.

After opening, the bottom ring should be full of charcoal, indicating normal carbonization and a good yield. If the fire has been too hot on one side, there will be less charcoal. The something happens if the kiln is closed too late. On the other hand closing it too early will result in brands of uncarbonized wood particularly on the outer sides and near pipes which had not been fully active. Once the kiln has been opened the charcoal must be taken out immediately to avoid loss through self-ignition.

For air-dry wood, the whole operation take about 48 hours per kiln. Within one week, there burns per kiln are possible. If the kiln is ready for firing in the early afternoon, it requires little attention during night-time and can be closed at about the same time on the following day and be emptied on the second day. With two kilns in operation for efficient used of time, two charcoal-makers can produce about 10-12 tons of charcoal per month loaded into sacks ready for transport (Wood preparation not included).

## 3. Production from Species Tests in the Present Investigation

In this paper five wood-species are investigated for their suitability of charcoal production. They are; Myinga *(Cynometera minosoides* Wall.), Thame *(Avicenia officinalis* Linn.), Byu-chidauk (*Rhizophora cabdeloria* D.C.), Khaya (*Argemone mexicane* Linn.), and Kambla ( *Sonneratia apetala* Ham.). The yield from the different species were compared and the quality assessed.

As far as known, no recorded investigation on charcoal quality has been made in Burma using these species.

## 4. Materials and Methods

### 4.1 The Woods

The woods for charcoal burning were brought from Pyindaye Reserve, Bogale Township, and were transported to the Set San test site in the township.

The size and age of the wood varied, the average age of the species tested being 15 years old. The average girth of the wood was 18 to 30 inches.

The wood was cut and split into the sizes appropriate for carbonization and then it was measured for volume and stacked in the open air. In the Delta area and in rainy season, the humidity was high so the moisture content of the wood decreased slowly. When the moisture content of the wood was 40 to 45 percent, or partially seasoned, it was considered ready for carbonization.

Among the five species studied Kambala, Gyu-chi-dauk, Thame and Myinga can be classified as good commercial charcoal producing species, while Khaya has the quality close to the required standard.

The charcoal was tested in living laboratory by allowing actual household consumers to use it and state their preference according to various factors.

Selected users in the Bogale were requested to use the charcoal and report their estimate of quality of the listed factors. Their opinions are shown in Table 2.

A comparison was made between the results from carbonization in local-type beehive kiln and the portable kiln by the author (Thein, 1984).

It was obvious that a much shorter time was required per change.

Approximately 6.5 $m^3$ of each species was piled in 5 batches and carbonized in the kiln. The charcoal produced from the test totaled over 1700 pounds (in average 19 pounds each).

## 5. Results and Observation

Charcoal quality can be specificed and measured in various ways, usually derived from the various and used requirements such as the following factors.

a. Amount of heat transferred

b. Burning characteristics

Smoke
Sparking
Odor
Completeness of burn

c. Hardness and weightsSample from the five species were sent to the Central Research Organization, Rangoon, for testing. The results are shown in Table 1.

According to the standard of quality adopted by the FAO, good charcoal of commercial quality have a calorific value of 13,000 B.T.U. per pound of even dry material (FAO, 1983).

## 6. Discussion and Conclusion

### 6.1 Portable Kiln

The portable kiln described appears to have a great potential for improving the production of charcoal per cubic meter of wood both in quality and quantity.

The shorter cycle permits greater total production per year in a more efficient operation.

Further investigation of charcoaling of authorized species should evaluate the various types of kiln in yield and quality and make an economic analyses of the profitability. It can be speculated that, even with the high cost of steel for portable kiln, the greater efficiency and production may resulted in a greater profit to the charcoal operator.

In addition, more useable charcoal was recovered per charge and the quality was better due to less brands and fines.

## 6.2 Charcoaling of Authorized Species

In carbonization processes, no technological difficult was encountered with any of the species.

According to the results of the present investigation, Kambala is the most suitable species of all followed by Byu-chidauk, Thame, Mainga and Khaya in that order. However, charcoal obtained from any of the five species tested can be acceptable for domestic consumption. The user survey indicated that all were acceptable and that Kambala seemed to be the most favoured.

# Appendix

The following wood species are used for carbonization in Bogale Township, delta area of the Irrawaddy River at the present time.

1. Myinga = *Cynometra mimosoides* Wall
2. Byu = *Dillenia aurea* Smith,
3. Kyetyo = *Vitex pubscens* Vahl.
4. Te = *Diospyros burmanica* Kurz.
5. Pantama = *Melia burmanica* Kurz.
6. Nyaung-byu = *Ficus rumphii* BL.
7. Migyaung-new = *Millettia pachycarpa* Benth.
8. Pinle-On = *Xylocarpus granatum* Koenig
9. Than-That = *Albizzia lucida* Benth
10. Lamu = *Sonneratia caseolaris* Linn.
11. Byu-U-talon = *Brugiera conjungata* Me.

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Table 1. Results of Test Made at the Central Research Organization, Rangoon, are given below.

| Sample | Moisture Content (%) | Ash % | Volatile Matter m. c. % | Fixed Carbon (%) | Colorific Value B.T.U./ lb Ovendry basis |
|---|---|---|---|---|---|
| Khaya | 5.03 | 4.80 | 37.20 | 52.61 | 12857.70 |
| Myinga | 7.03 | 4.05 | 22.30 | 66.82 | 13134.30 |
| Thame | 8.55 | 3.55 | 24.33 | 63.62 | 13352.60 |
| Byu-chidauk | 8.80 | 4.03 | 22.36 | 64.81 | 13389.20 |
| Kambala | 11.83 | 5.05 | 22.93 | 60.99 | 13587.40 |

(Tested by CRO: Reference: CRO - 1645 / 12-149 / 85-86)

Table 2. Householders Rating on Quality of Charcoal.

| Charcoal (Wood Special) | Smoky | Fire Cracking | Odour (Smell of burning charcoal) | Hardness and Weight | Cleanly Burning |
|---|---|---|---|---|---|
| Kambala | none | none | none | moderate | good |
| Byu-chidauk | none | none | none | moderate | fair |
| Thame | none | none | none | Light | fair |
| Myinga | none | none | none | moderate | fair |
| Khaya | none | none | none | Light | fair |