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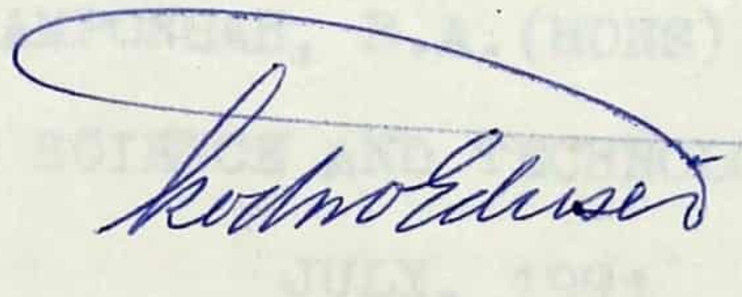

(MR. KODWO EDUSEI)

SUPERVISOR

SELECTED TECHNIQUES FOR FIRING CLAY PRODUCTS IN THE FIRST CYCLE INSTITUTIONS IN GHANA.

A Long Essay Submitted to the Board of Postgraduate Studies, University of Science and Technology, in partial fulfilment of the requirements for the Postgraduate Diploma in Art Education.

BY

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PREFACE

The problems of firing any ceramic work can be overcome as long as the basic principles of clay firing are adhered to. Beginners can be self sufficient in firing provided the existing firing processes are studied and adapted to suit their situation and environment. To achieve self sufficiency, one has to be innovative and resourceful. Therefore, with the methods provided in this study, it is my sincere hope that teachers will experiment with other methods and materials.

This study is devoted to the provision of some selected techniques for firing clay works in the first cycle institutions in the country. It includes fire wood-oven, the Palm kernel shell-oven, Sawdust stove, open pit firing and some simple means of obtaining attractive finishes with the firing processes under investigation. Glost firing is not included nor does it cover the use of electricity, gas or oil.

The study was done with the author's observation and involvement in the processes of firing. Some of the information was sought through interviews and

others through books. The information is presented in as practicable a form as possible, with pictures and illustrations designed to throw more light on the descriptions.

ACKNOWLEDGEMENTS

I am indebeted to Mr. Kodwo Edusei, lecturer at the Art Education Department in the University of Science and Technology, Kumasi, Ghana for his advice and personal assistance and his efforts in reading and correcting, suggestions and teaching, without which this project report would not have been a reality.

I also wish to express my sincere gratitude to individuals who kindly assisted me in various ways in undertaking this project. In particular, Messrs. Ambrose Ankrah at the Computer Science Department, (U.S.T), Naab Kokora, C.K. Nyadi, both at the Ceramic section, College of Art, U.S.T. and Miss Serwaah Frimpong, a coursemate.

Finally, my special appreciation goes to my wife, Jane, for her patience, co-operation and motivation. Infact she has been an unfailing source of encouragement and hope.

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CHAPTER ONE

INTRODUCTION

Of all man's arts, Ceramics deals more directly with earth, water, air and fire. Fire is the key, by its action the soft and formless clay is given hardness and permanence. No one actually knows how or when traditionally firing systems started in this country. One can however start by looking at the Ceramic kiln, one of man's earliest tools the primitive form of which dates back to at least 8,000 B.C. and perhaps earlier.

The method of firing clay objects and vessels to make them hard, durable and impervious to water, was no doubt discovered accidentally. It has been said that, early man in breaking stones, may accidentally have created fire by the sparks which occured due to experience with camp fire. Perhaps men observed that, clay soils beneath the camp fire was hardened by heat or perhaps a reed basket lined with clay for collecting water might accidentally have burnt, leaving the hardened clay in the form of the basket.

From such a discovery, it would only be a small step to a more controlled management of fire,

to gain concentrated heat needed to fire objects fashioned in clay. Such basic technical knowledge has certainly been in the possession of many different societies at varying stages of development, but has only led to a full scale industry when allied with a social need and favourable economic conditions.

The knowledge of pottery making and techniques of firing became wide spread among ancient cultures and was practiced in a similar manner in areas as remote from each other, as Central Asia and South Africa. There were many local variations of open pit firing but the essential procedure involved the digging of a shallow pit. Twigs and branches etc. were placed in the pit as lining, the pots were placed and piled together in a compact with little empty spaces between them as possible. Fuel was stacked in and around the pots. Around and over the setting of raw pots, were placed a layer of broken fragments of fired pottery.

Normally, broken pots from previous firing are used to cover around to retain the heat. The fuel in the pit was set ablaze and allowed to burn rather slowly for an hour or two, to get the pots thoroughly dry. Since the fuel was enclosed in a shallow area, not much air go to it and as such, the fire did not burn intensely. Gradually, with the development of

more embers, the heat is accomulated. More fuel was piled on, as the fire reached a level above the pit. The attainment of red hot pots showed that, the pots were ready and the fire was allowed to die down. The top of the fire might have been covered with wet leaves or ashes to retain the heat and prevent the pots from cooling rapidly.

Evidence of traditional firing with regard to pottery dates back to the 15th Century. Excavations carried out at Dawu (1942), Aseibu in 1963 and Jakpasere (1969), give credit to this. It was discovered that, the method was similar to those found today. The method was similar to those found among ancient cultures. It involved the surrounding of wares with available fuel and the setting of fire to it. This was allowed to blaze just like a bonfire.

As R.G. Hagger says in "Primitive Potters" "the first vessels which they made were sun-hardened" [1] and this is similar to the method practiced by the first cycle institutions in Ghana. This method would not hold liquids or remain intact for any length of time. Many trials must have been made and many failures experienced by

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1. Hagger R.G. Pottery through the Ages
Methuen and Co. Ltd; London
1959, pp.3-4

our far distant ancestors before they learned to harden them by baking. Perhaps they discovered the secret of firing pottery through some domestic tragedy. Very little is known about primitive firing techniques or when the potter first constructed a chamber or oven to bake his ware. Women potters at Pankronu and Apedu in the Ashanti Region in Ghana, heap their unbaked pots in a great mound, cover it with grass and dung and set fire to it, feeding the great bonfire with bundles of dried grass. Perhaps, early Potters baked their vessels in the same way. The Egyptians for example, learned to construct an oven at a very early date; a potter's oven is shown in a tomb at Saggara dating from the fifth Dynasty.

With this background, it has been discovered generally that sometime heat that should have been retained to help fire the works to it permanent hardened state got lost in the process of firing, due to the nature of kilns or oven built and this resulted in reduction in the degree of hardness of the works.

The main aim of this present work is to produce simple techniques for firing pupils' clay works in the first cycle schools. Although most teachers

teach clay work, very few of them are able to preserve the pupil's works. However, some of the works produced by pupils are unique and need to be preserved but surprisingly they are left in the bone dry, fragile state to break. Also pupils show disinterest in clay-work because they see it as valueless and not permanent.

The author, therefore hopes that, the research results would encourage the use of locally produced kilns or ovens, instead of depending on imported ones which our institutions in the first cycle could not afford to order or purchase. This will go a long way in saving the country foreign exchange.

THE PROBLEM AND ITS SETTING

The statement of the problem

Works of pupils in the first cycle schools are normally not fired. This makes the works break quite often, and as such they cannot be preserved. There is therefore the need to device simple techniques to fire these works to make them last.

Objective

1. To introduce simple techniques of firing clay products in the first cycle institutions to

enhance the durability of the clay works produced by pupils.

Delimitations

The study is limited to the use of materials, equipment and fuels which are available locally.

DEFINITION OF TERMS

Bisque : The state of clay when fired but unglazed.

Body : Mixture of clays and other materials to produce a workable material for manufacturing processes.

Chimney : The passage or flue by which the smoke from a fire etc. ascends.

Coil Method: The art of taking a small quantity of kneaded plastic clay and rolling it into sausage shapes with two hands for construction.

Dome shape : A rounded vault forming the roof of an oven.

Fire box : The chamber of an oven in which the fuel is burnt.

Firing : The process of exposing clay and glazes to controll heat within the kiln or oven.

Green Wares	:	Unfired clay wares, awaiting their first firing.
Grog	:	Fired and crushed clay, added to unfired clay to coarsen its texture and decrease its shrinkage.
Leather hard	:	Clay which is too dry to bend yet not too dry to receive attachments - handles, etc. of the same consistency.
Metal grate	:	Chimneys or walls of fire bricks or metal built to protect the ware from flame.
Open firing	:	Firing in which the flames play through the expose.
Pinch Method	:	The art of compressing clay between the tips of finger and thumbs to build.
Rammed	:	Compressing clay or concrete into a mould by repeated hammering.
Sieve	:	Sometimes called a lawn, more correctly a screen for sand, clay or slip.
Slab	:	A flat portable working surface. Rectangular slabs made from wood, metal, asbestors etc.

Wedging : The beating or slamming operation usually employed to expel air or correct in equalities just before clay is used by the potter.

Assumptions

1. Clay works produced by pupils in first cycle institutions are sun baked which get broken easily. This is due to lack of knowledge of firing without conventional kilns.
2. Pupils are not happy with the unfired state of their works and will greatly appreciate their works being fired.

The importance of the study

The study will expose both teachers and pupils to firing techniques that can be adopted to maintain the durability of clay works of pupils.

Data

Information for the project was obtained from books, theses and by interviewing traditional potters at Pankronu, Apeadu and Kumasi Cultural Centre.

Methodology

The descriptive, analytical and experimental methods were used.

Limitation

The continuous rains which made drying and firing of clay works difficult, prevented the author from carrying the experiments further which could have enhanced the data presented.

CHAPTER TWO

LITERATURE REVIEW

This Project/Research is the second research results presented to the Department of Art Education in the College of Art, University of Science and Technology, concerning the simple techniques for firing clay products. The first research was by Adjei-Henne, and it covered firing clay works in Secondary Schools. The work is reviewed here.

Norton (1952), made mentioned of the essential components underlying the principles of kiln design. The kiln, according to him, must have four (4) main components; first, a base on which to set the fire; second, a source of heat; third, a means of transferring the heat from the source to the ware; and fourth, an envelope to confine the heat to the ware.

James Amoah (1965), researched into the Traditional Pottery making at Pankronu, in the Ashanti Region. He touched on the open firing process, which is the main and only method being used at Pankronu. He however emphasized on smoking as a form of finish given to the pots.

Daniel Rhodes (1968), worked on the design,

construction and operation of kilns, and tracing the history of kilns from the open firing to modern electric kilns in use today.

Michael Cardew (1969), also worked on primitive open firing and other types such as terracotta and high temperature firing. He also worked on kiln designing, building, setting, cooling and firing defects.

Kokroko (1970), studied pottery in the various parts of the Volta Region. He discussed the various different methods of firing and smoking (open-firing being the commonest) in the different parts of the region.

Norton (1970), again worked on the building of kilns which covered practical information on planning, construction and operation of kilns. He however made use of foreign materials in the planning and construction.

Daniel Rhodes (1972), worked on drying, oxidation and reduction, quartz inversions and vitrification.

J.N. Okyere, a research officer, in his special report No.11 p.3, sought to design a kiln which is annual in shape for continuous operation. This means that, firing is not stopped after burning a

batch of wares but rather as a batch is being removed from the kiln another batch is fired while dry wares are packed at the other end of the kiln.

Adjei-Henne (1989), sought to analyse and suggest suitable methods of firing that can be effectively adopted in the second cycle schools in Ghana. He therefore suggested certain methods as opening firing, trench firing, sawdust kiln firing and others, for adoption and trial in the second cycle schools in Ghana.

This project report concerns the provision of some selected firing methods for use in the first cycle institutions in Ghana. It includes, firewood oven firing, palm kernel shell oven firing, sawdust stove, open pit firing; which is hoped to achieve its aim at the end of the project.

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CHAPTER THREE

OVENS

1. Fire wood oven:

Tools and Materials

In preparation of the above type of oven, the following tools and materials were used; namely, knife, metal grate, board, slab, grog, clay (Asokwa), sand.

Procedure

50% of Asokwa clay was mixed together with 25% of sand and grog respectively, to form a body. This was to ensure a very strong body to avoid cracking during the drying stage as well as the firing period. For the purpose of avoiding destruction by rain, the oven was constructed on a slab and placed on a wooden board which could be movable.

Step 1

A diameter of about 35 centimetres was drawn on the slab with a piece of chalk to serve as a guide for the construction of the foundation as shown in plate 1.

Plate 1. Marking diameter of kiln on the base

Normally, the oven should be built on the ground. In this case, the diameter of 40 centimetres should be marked with a hoe or cutlass, 4 centimetres deep to ensure a very strong foundation.

Step 2.

A body of clay platform was then erected leatherhard on the slab to prevent direct heat on the slab. See plate 2.

Even if the slab is not a resistance material, the making of the platform would have prevented the slab from being destroyed by the heat.

Plate 2. Building the base

Step 3

With the dimension created on the flat form as a guide, erection of fire compartments was made by the coil and pinch methods after the edges of the platform had been trimmed. See plate 3.
Holes were created on a circular metal to enable heat pass through to the green works, as shown in plate 4.
At certain level of construction, some of the body was cemented both in the inside and outside of the walls and proper care was ensured to follow the diameter. At the height of about 17 centimetres, a groove was made along the circumference and the

Plate 3. Trimming the base to size

Plate 4. Preparation of the metal grate

metal grate was put on it firmly for firm support/ sitting during the parking of the green works.
See plate 5.

Plate 5. Fitting the metal grate in Oven.

Step 4.

After this stage, the main chamber was built on. However, as the height increased, the top part began to narrow up and this reduced the size of the

diameter upwards which eventually closed up the chamber at the height of about 40 centimetres.

Step 5.

The fire box was then measured and cut out with a sharp knife, with the help of water as lubricant at the leatherhard state. At this stage, the whole structure was hard enough to avoid any breakages; as shown in plate 6.

Plate 6. Making the fire box

Another outlet was again created for the parking. A small chimney was also created opposite the fire-box to serve as an outlet for the unwanted gases to escape. The oven was then allowed to dry for about three weeks. See plate 7.

Plate 7. Completed Oven

Firing Process

It took about four (4) hours to get the green works fired completely.

Pre-heating

Initially, pieces of fire wood which was the main source of fuel for this type of firing process was arranged outside the oven and lighted with the aid of kerosene.

Plate 8. Preparation of fire for pre-heating.

Plate 10. Pre-heating

Step 2

More fire wood was added to increase the fire temperature at this stage. As the intensity of the fire reduced, more fire wood was added gradually to rekindle it. This process continued for about another hour. See plate 11.

Plate 11. The firing process

Step 3

At this stage the top outlet was sealed up completely by spreading leatherhard clay around the metal cover used. This was to retain the heat in the oven for an effective firing. See plate 12.

Plate 12. Sealed outlet

The temperature was then increased by adding more fire wood. As the fire wood burned, the gases escaped through the chimney at the back of the oven. The firing continued for about an hour. The fire in the oven was then allowed to die out. After this process, fired bricks were used to cover the fire box to prevent cold air from entering. As show in plates 13 and 14.

Plate 13. Sealing of firebox to retain heat.

Plate 14. Sealed firebox and outlet

Cold air entering the firebox could cause breakages to the fired works. The oven was then allowed to cool gradually after which the bisque works were removed and arranged. See plates 15 and 16.

Plate 15. Arranging fired samples from fire wood oven.

Plate 16. Fired samples from fire wood oven.

Observation

1. The green works should be thoroughly dried before the firing takes place. When worksss are not dried enough and come into contact with the fire, they could crack.
2. To determine - that works in the oven are well fired, the inside of the oven must look as reddish as the flame.
3. Much smoke is not seen through the chimney when works are well fired. Though the works

may turn to black in colour at the initial heating, as the temperature increases, this black colour is turned to buff or red in colour at the end of the firing processes.

Problems and setbacks

Problems and setbacks are inevitable in experiments of this nature. The problems encounted in the course of the experiment were:

1. The oven was constructed during the rainy season and had to take longer time to get it dried. Therefore much time was wasted. It is therefore suggested that future oven is constructed during the dry season to ensure even drying.

2. A major crack developed between the outlet for the packing and the firebox. Time has to be taken to mend this crack but to no avail. This therefore posed problems during the course of the firing. Some parts of the oven began to break off as the temperature increased. Therefore at the end of the firing, it was observed that, part of the oven was broken. However, a very successful firing and result was achieved at the end. Thorough drying of ovens is suggested to prevent further breakages.

2. Palm Kernel Shell-Oven

Tools and Materials

The following tools and materials were used for the execution of the above type of oven: a flat metal tool, a knife, metal grate, clay, sand, a rectangular board and news print.

Step 1

A quantity of sand was seived through 40 mesh seive and 25% quantity was kneaded with 50% of Asokwa clay. This was to ensure fast drying rate then also to prevent the oven from cracking during the drying stage and thirdly to obtain a very strong body.

Step 2

A platform of about 30 centimetres in diameter was constructed on the rectangular board enveloped with newsprint to absorb the physical water in the body. This is also done to prevent unnecessary cracking at the base as the body gets into direct contact with the wooden board.

Step 3

Both coil and pinch methods were employed to build the wall to a height of 10 centimetres. The knife was then used to cut the fire box of about 10

centimetres in diameter. Then a circular metal grate marked into two equal parts was bent a little. It was then fixed about 10 centimetres away from the firebox to serve as fire wall in the chamber.

Step 4

As the construction continued to about the height of 18 centimetres, it was then made to take the dome shape which was finally enclosed at the height of about 25 centimetres. Chimney was then created at the top opposite the firebox for excessive smoke during the firing to pass through. Another outlet was also cut out just at the top part of the firebox to enable clay works to be packed at the back of the firebox. The oven was then allowed to dry completely for four weeks. Refer to plate 17.

Plate 17. Palm Kernel Oven

Firing process

Step 1

Clay works were modelled and allowed to dry completely for seven days. These works were then packed in the chamber through the outlet on top of the firebox.

Step 2

Palm kernel shells which was the main fuel used, were then soaked with dirty oil to ensure continuous burning in the course of firing. Pre-heating firing was initially done for about 40 minutes to get rid of the physical water in the clay works as the edges of the outlet was left open for some of the smoke to find its way out.

Step 3

More of the palm kernel shells were thrown into the firebox to increase the temperature after the edges of the outlet had been sealed with leatherhard clay to retain the heat in the chamber. See plate 18. Much smoke was seen finding its way through the chimney. The degree of heat established in the chamber was maintained for sometime. After two hours, the firebox was sealed with bricks to retain the heat.

Step 4

The oven was allowed to cool till the next day. Works were then packed out and arranged as shown in plate 19.

Plate 18. Process of firing

Plate 19. Arrangement of fired samples from palm kernel oven.

Observation

1. In constructing the palm kernel oven, there should be more space allocated for the palm kernel fuel. This will enable more fuel to be used and also allow sufficient air for efficient burning.

2. It could be fanned or turned to face the direction of wind to allow enough air.

3. The chimney should be big enough to allow greater part of the smoke to escape. This will reduce the amount of soot that glazes the works fired.

CHAPTER FOUR

SAWDUST STOVE

Tools and Materials

In preparation of the above type of stove, the following tools and materials were used; namely, a scrap metal plate, hard-saw blade, a sharp pointed tool, knife, 0.5 centimetre height of nails, a hallow rod, hammer, sawdust, a wooden stick.

It is easy to lay hands on metal cylinder to construct such a stove. Also clay could be used to build. However, if clay is used it should be left to dry completely before firing can take place. Buckets, barrels, etc. could also be used. However, for the purpose of this research, a metal scrap was used.

Procedure

Step 1

A metal scrap of about 0.3 centimetre thickness was cut out with the hard saw-blade to the size of 70 centimetres of length and 56 centimetres of breadth. This was then folded in a cylindrical shape and the joints nailed firmly to avoid opening as shown in fig. 1.

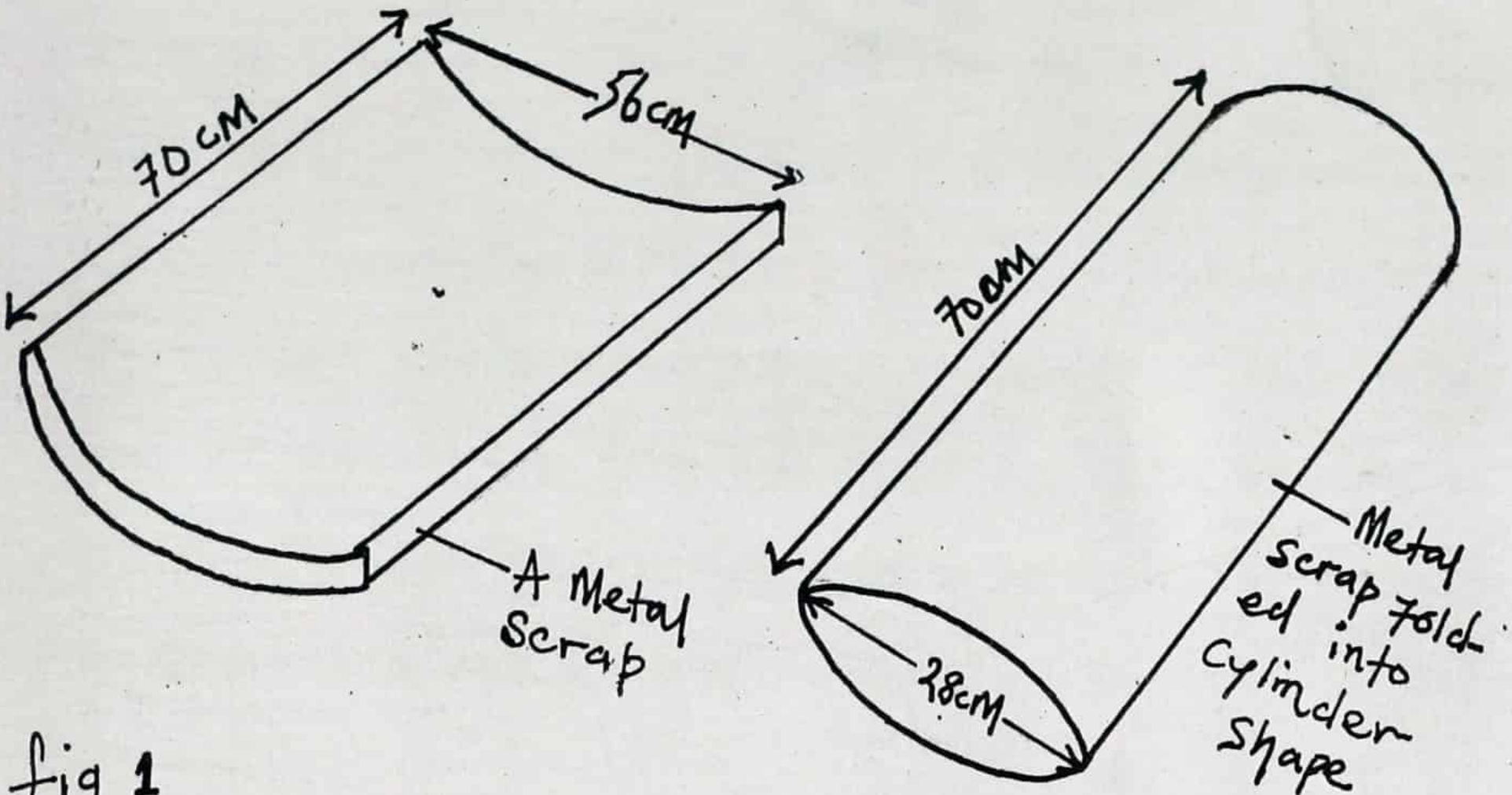

fig 1

The foot was measured, 28 centimetres and cut out to fit the bottom by nailing all round with the help of the hammer, as shown in fig.2.

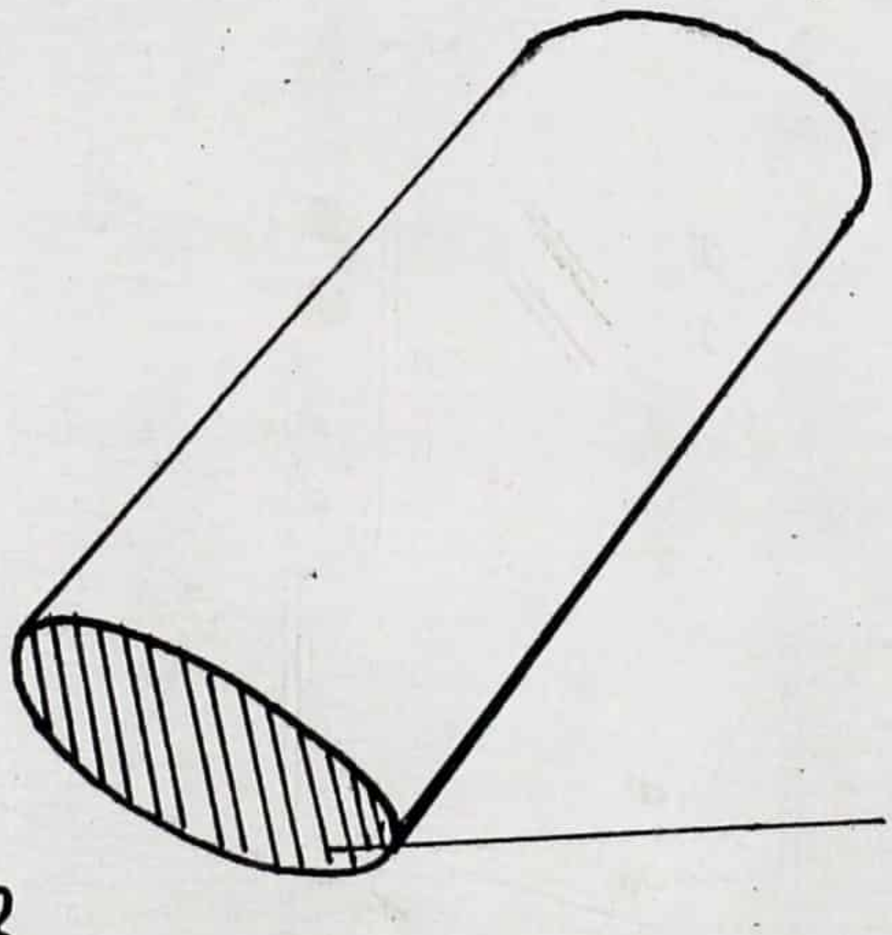

fig 2

Step 2

After this, a measurement of about 26 centimetres was taken to serve as the grate on which the green works could be packed in during the firing process. To ensure its removal and replacement within the cylinder, a groove was created about 45 centimeters from the soot. Holes of different sizes were later created in the metal by use of the sharp pointed tool as this was to allow heat to reach the green works packed before the sawdust was set ablaze. See fig.3.

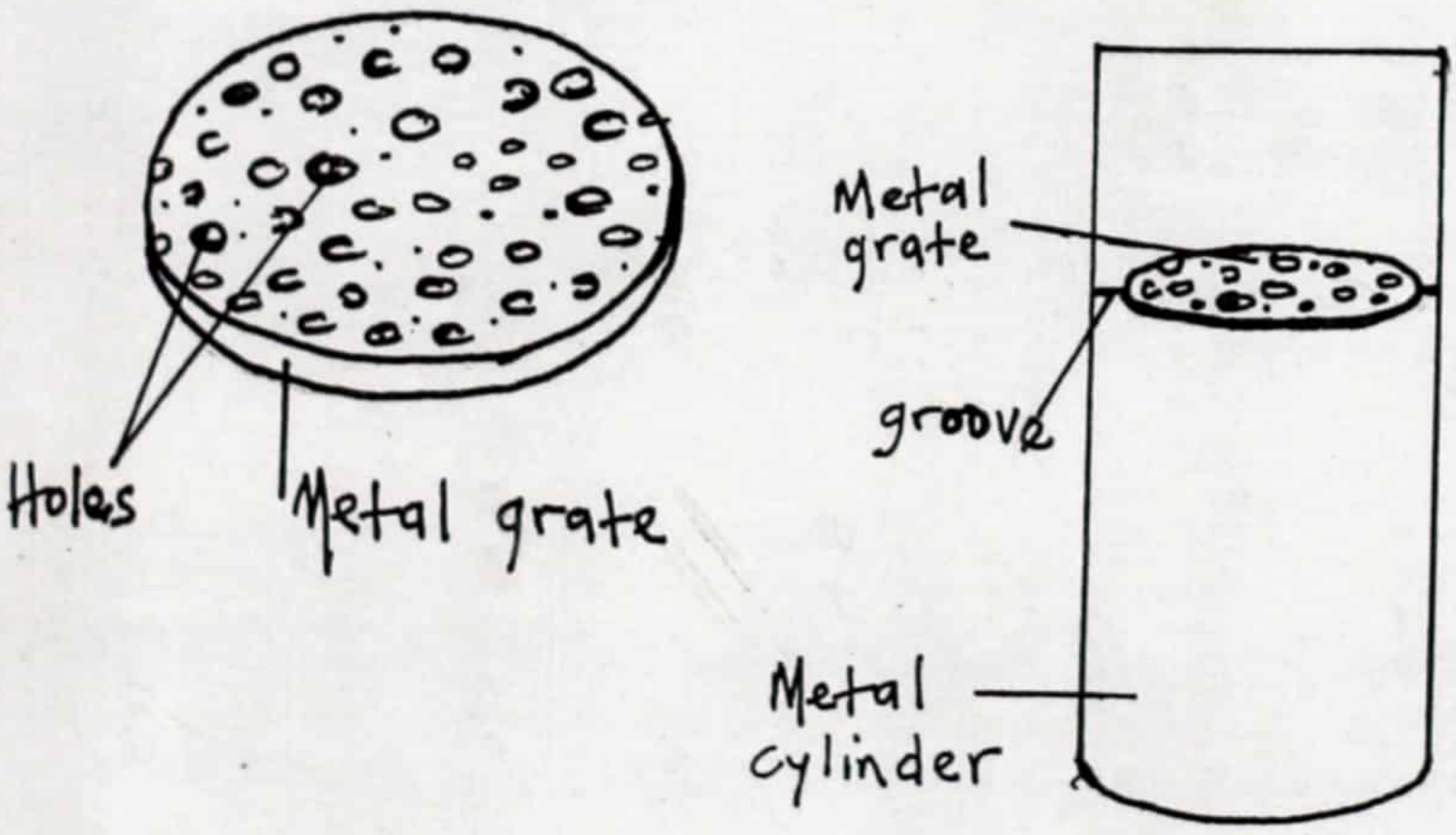

fig 3

Step 3

The next stage saw another groove created at the mouth of the cylinder to enable the lid rest on. This was achieved by welding a strip of metal within the top level of the cylinder. The lid was then spread like a funnel. However, a small outlet was left at the top of it for gases to escape during firing; as shown in fig.4

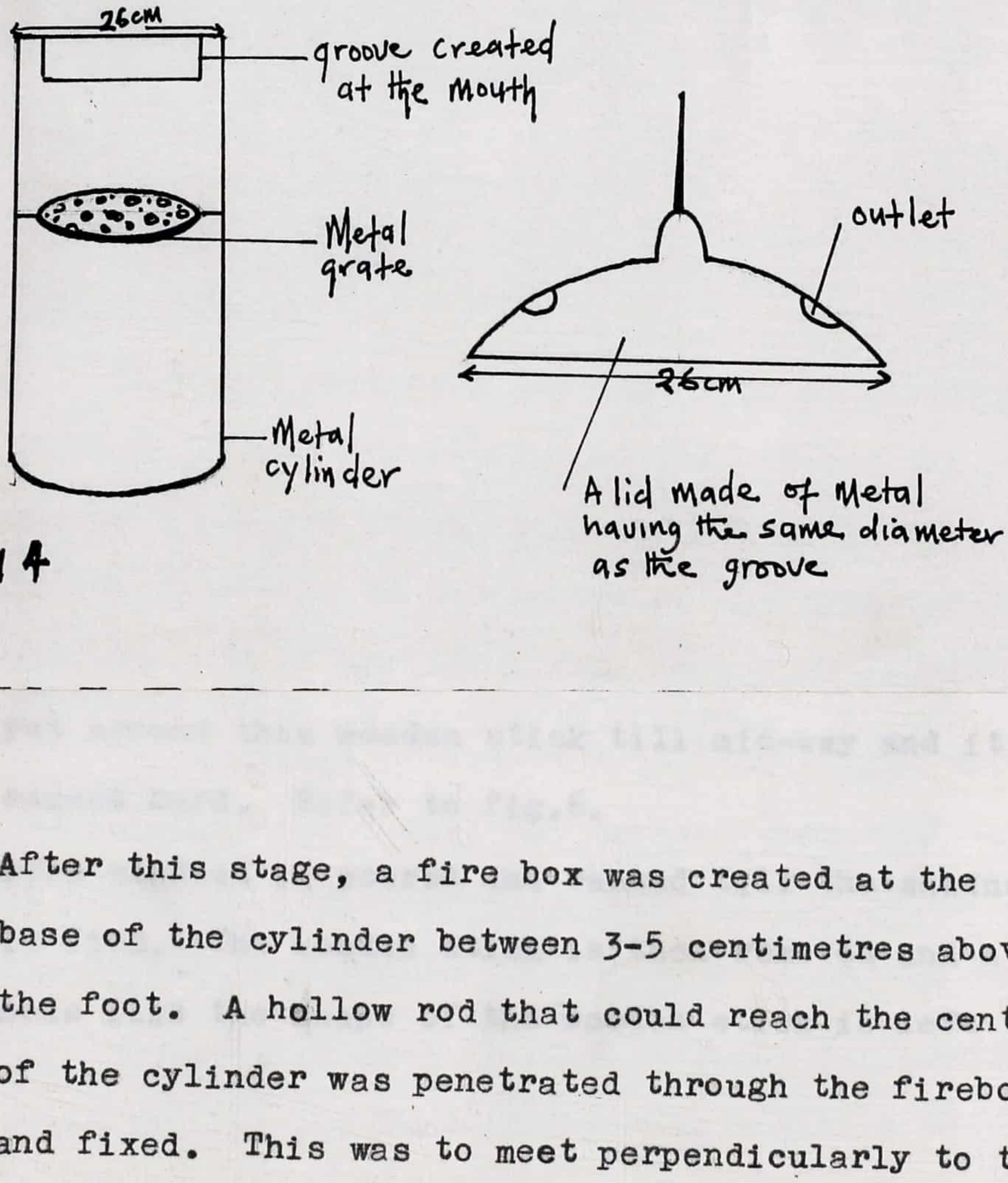

fig 4

After this stage, a fire box was created at the base of the cylinder between 3-5 centimetres above the foot. A hollow rod that could reach the centre of the cylinder was penetrated through the firebox and fixed. This was to meet perpendicularly to the

piece of wood which is to create a hole as the saw-dust is put into the chamber, and rammed, as shown in Fig.5.

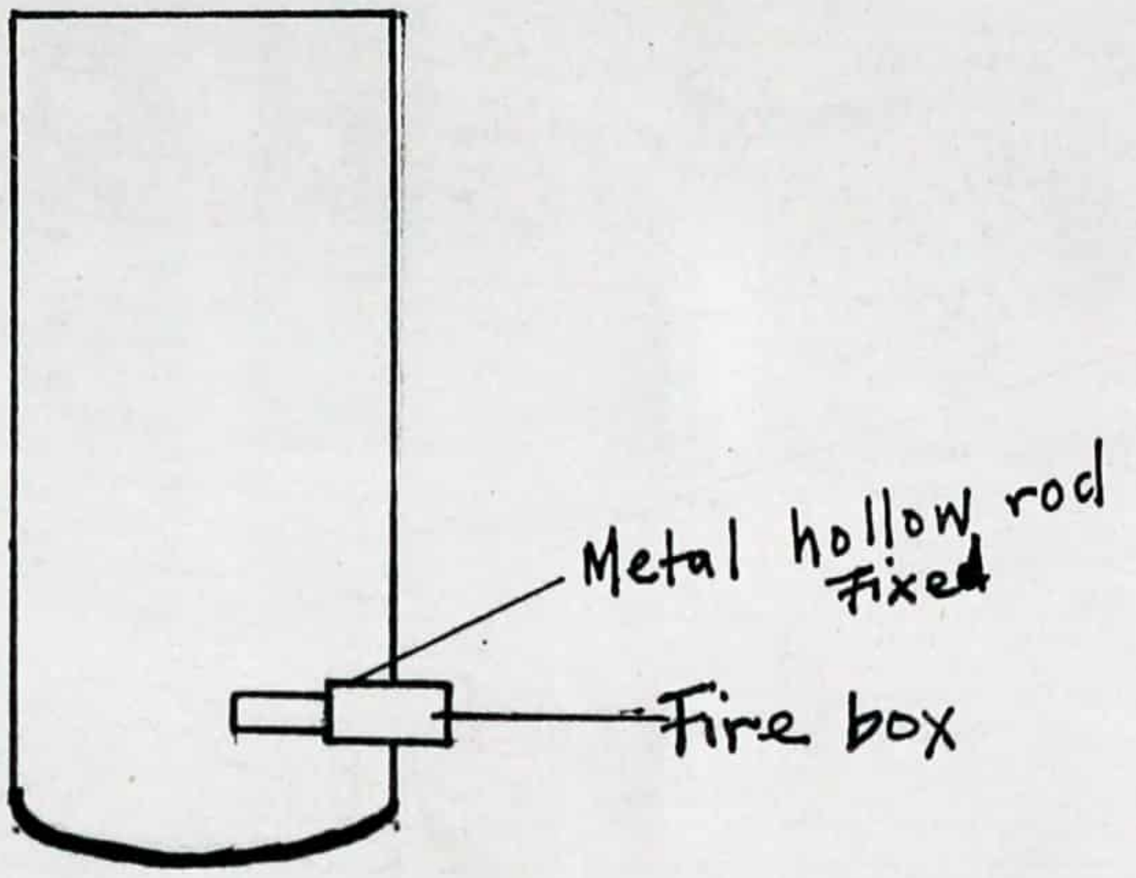

fig 5

Firing process

The main fuel used for this type of firing is sawdust. After the removal of the lid and the metal grate, a rounded wooden stick of about 70 centimetres length is placed at the centre of the cylinder to meet the end of the rod fixed. A lot of sawdust is put around this wooden stick till mid-way and it is rammed hard. Refer to fig.6.

More sawdust is poured and rammed till the sawdust is firm. The wooden stick is then removed and a hole like the shape of the wooden stick is left to

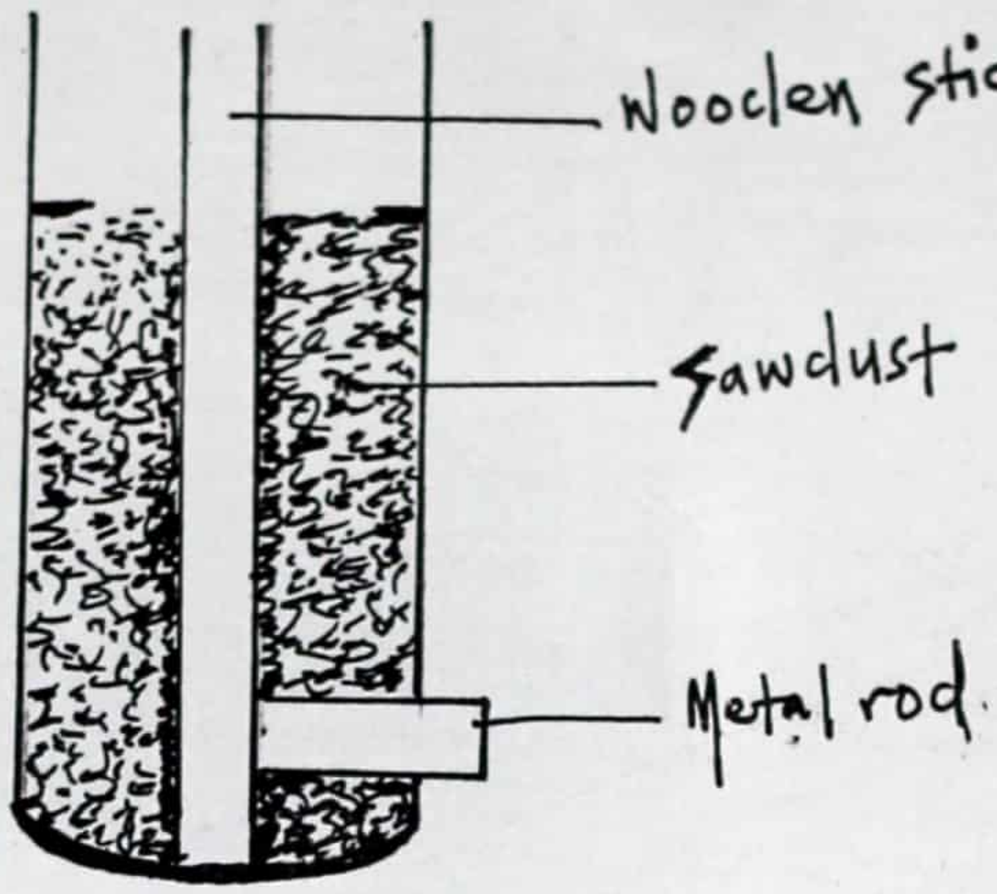

Fig 6

serve as a channel for the air.

The metal grate is then placed at its position. Some unwashed clay which was kneaded and wedged, and moulded into various forms and allowed to dry, were later used for the firing.

Packing

It is always advicable that, the bigger works are packed first before the smaller ones. If this is not done, the works will break in the course of the firing as a result of the weight from the top.

Kerosene is used as fuel to light the sawdust after the lid has been laid at its position and

leather-hard clay applied around the lid to ensure that heat is retained in the chamber.

Preheating is necessary at the beginning of the firing. See plate 20.

Plate 20. Preheating

This will ensure the physical water in the green works being dried out. Smoke initially passed through the outlet as shown in plate 21, but

Plate 21. Firing Process

after sometime, between twenty to thirty minutes, the burning of the sawdust intensified as the air passed through the channel below and this resulted in increase in temperature as the metal cylinder became hotter and hotter. Looking through the firebox, it was realised that, the whole chamber has turned to

bluish flame. This reduced the amount of smoke coming through the outlet.

After an hour later, no smoke was seen at all through the outlet, but the sawdust continued to burn out until only ashes could be seen. This took about two hours to burn out. The metal container was then left to cool as works were later packed out. See plates 22 and 23.

Plate 22. Arranging fired samples from sawdust stove.

Plate 23. Fired samples from sawdust stove.

Observation

It was observed that, the clay works which had closer contact with the fire, fired buff in colour. However, those above these works were black in colour due to the narrowness of the chimney which trapped some of the escaping smoke. Therefore, there is the need to widen the chimney to allow the smoke easy acces to escape.

Two hours duration was used to fire and this was due to the compactness of the sawdust which as a result, generated more heat for the green works.

It is therefore suggested that, more sawdust is rammed up to ensure a very high temperature.

Another cause of the discoloration was the pressence of iron in the clay used, which was Mfensi clay.

CHAPTER FIVE

OPEN PIT FIRING

This can be done by first preparing the ground to make provision for the digging of a shallow pit of about 40 centimetres deep and several square feet in area, depending on the volume of wares to be fired. See plate 24.

Plate 24. Preparing the ground for digging.

Twigs branches or reeds are used to line the sides and bottom of the pit. On this lining, the wares,

are packed with fuel stacked in and around them. Potshards are then placed over and around the setting. If these are not available, either broad tree back or dried cow dung can be used.

The fuel is then set alight and allowed to burn rather slowly for an hour or two to bring about thorough drying of the works. Since the fuel is in a shallow enclosure little air gets to it so the fire is not likely to burn intensely at the start. As heat begins to intensify, more fuel should be piled on the wares to make it burn more fiercely. As more and more fuel is burned, a bed of red hot embers surround the wares and raise the temperature in the pit.

As the entire pit and its contents become red-hot, the fire is allowed to die down. The fire is then covered with wet leaves, dried dung or ashes to help retain the heat in the pit, since the hot wares coming into direct contact with the cold air may develop some cracks. The unpacking ought to be done when the fire has completely died down.

Fuel - Sawdust

This is done by first lining a prepared floor with sawdust to a thickness of about 8cm. as shown in plate 25.

Plate 25. Lining a prepared floor with Sawdust.

The pieces to be fired are packed on top of this lining. See plate 26.

Plate 26. Arranging green wares.

More sawdust is poured onto them until they are buried in it. The inside of the works must be filled with sawdust so that heat work can be accomplished there.

A wall of loosely packed blocks or bricks could be built around the setting to help check the sawdust from blowing off. The height of the wall rises with the packed arrangement of the wares to be fired.

When the final set of pieces are in place, a heap of sawdust is poured over them. Firing can then be started at this stage by pouring kerosene at vantage points of the heap and setting fire to it. The fire should be allowed to burn until the sawdust turns into ashes as shown in plate 27.

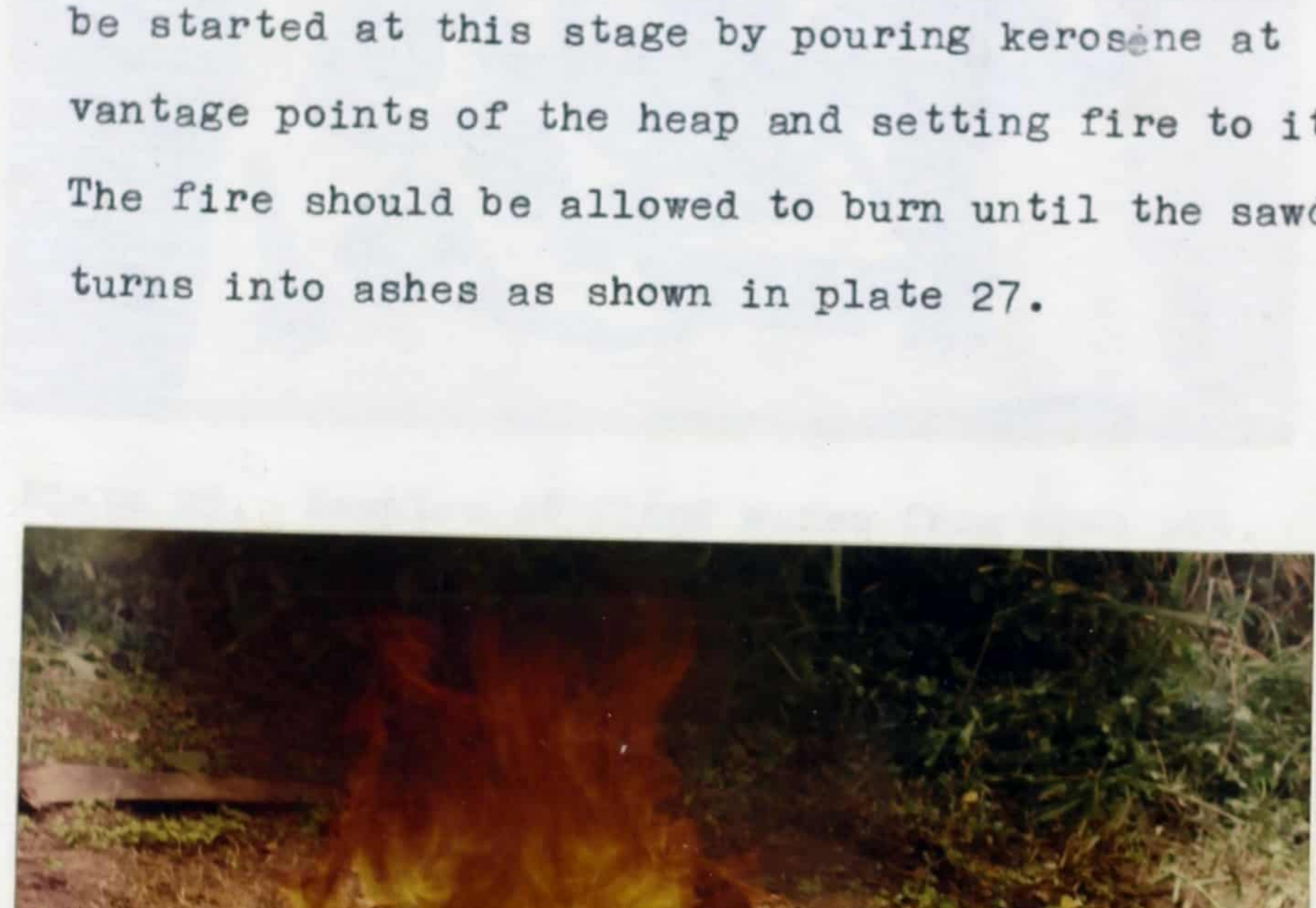

Plate 27. Firing in progress

The unpacking should be done when everything has cooled down. Refer to plate 28.

Plate 28. Samples of fired wares from open pit.

Observation

Some heat was lost because the fuel was not properly encased or covered to retain heat as in the case of ovens. Therefore more fuel should be added to obtain the requisite temperature.

CHAPTER SIX

DISCUSSION OF RESULTS AND CONCLUSION

The various methods of firing described in the project report, produced varied results, but were still closely related. All the methods tried produced smoke which blackened the surfaces of the wares, producing an effect similar to traditional glazing (decoration). There was also no means of knowing or reading the temperature at which the wares were fired. Thus, the products could either be over-or under-fired. However the wares look strong with all the methods of firing used.

The various methods produced the following results:

1. <u>Oven Firing</u>

   (i) Firewood:- It took about four hours to complete the firing. The preheating took about one and half hours and was well controlled. The wares are strong and well fired with no casualties.

   (ii) Palm kernel shells:- This method could not produce a very satisfactory result. This

is probably due to the fact that enough air could not enter the oven and through the kernels to produce enough heat to fire the wares.

2. Sawdust Stove

This also produced strong and well fired wares. This was due to the ramming (pressing) of the sawdust in the metal container. This was able to produce enough heat because air could enter the inlet created. However, it took a long time to fire. It also used much sawdust. Eventhough this method produced good results, the problem of getting sawdust at certain places will crop up.

3. Open pit firing

Sawdust:- This method also produced strong wares. However, due to the direct contact of wares with sawdust, the wares became very black in colour. This also produced more shiny surfaces as compared with the others.

Conclusion

Firing of clay products is a very important aspect in Ceramics. Without firing, ceramic items for that matter clay wares become fragile and do

not last long. Firing gives durability to clay products.

When the wares are not properly fired, there could develop various forms of damages, especially cracking, over firing and under firing. It is therefore important that clay products are fired.

Successful firing however depends on certain factors. These include proper production process so as to avoid any unwanted air pockets; even thickness; proper weight of item and most especially, well dried ware.

The above factors were taken care of and so there were not much casualties. The few casualties were caused by over firing. All the methods described in the project were successfully, undertaken. It was the sawdust stove method which produced the best result, and is recommended for use in the first cycle institutions. If however sawdust becomes difficult to come by, the oven firing using firewood is recommended. Firewood is easy to come by anywhere anytime. The open pit firing using sawdust also proved successful and is also recommended. Fire wood can also be used to replace the sawdust in the open pit firing.

The result of the oven firing using palm kernel was not very good. This could be improved if enough air can enter. Thus Bellow could be used to blow enough air into the system if available, or provision

should be made to ensure that enough air enters into the system. This should be done at the fire box.

The main problem encountered was the inability to provide means of knowing the temperature at which each type of firing could go, so as to increase or decrease it when and where necessary. However, since this project seeks to suggest ways of firing clay products in the first cycle institutions, it does not become so much of a necessity to read and know the required fired temperature. The main aim is to make the wares permanent and durable, which was achieved from the various methods employed. Developing a local means of firing ceramic wares has also been the major aim of the project. This is in line with the government's call for educational institutions to use their knowledge acquired to research into local materials and means for economic growth. The call makes this project important since acquiring various types of kilns like electric, gas, oil, etc. is highly impossible for all first cycle institutions. Developing an easier means of firing therefore becomes a necessity; since materials and tools can be obtained easily in the environment.

It is in line with the above factors and reasons that this project could be said to have been successful after going through all the types of firing methods discussed.

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