A COMPARATIVE STUDY OF THE PROCESSES OF LOST WAX CASTING

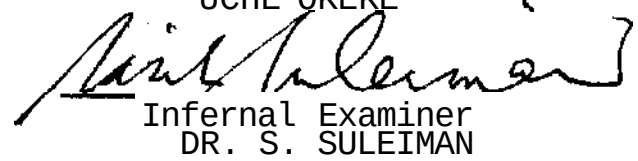
BY

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PREFACE

This thesis is an attempt to record the processes, tools and equipment used by two metalworkers working in Zaria in northern Nigeria. Although both casters use some tools which are European in origin, many of their tools are those used traditionally. Although many articles have been written about the West African "cire perdue" method, none the researcher feels, give a complete working description of the process. One of the aims of this thesis is to enable the sculpture student to undertake successfully this method of casting which is relatively cheap, uses materials locally available and gives good results. The author hopes that some of her suggestions in the final chapter may be helpful to achieve even better results more efficiently.

The author wishes to thank the Department of Fine Art, Ahmadu Bello University and most especially her supervisor, Dr. S. Suleiman for having made this research possible and for offering many helpful suggestions. Thanks must also be given to the casters involved, Ahmadu and Mallam Mohammed Bukini Gurba, for their patience in repeating processes many times for the researcher.

The author has made extensive use of the 35 mm single lens reflex camera and a half frame camera to record the stages of "cire perdue" casting in order that the written material is supplemented visually for a greater understanding of the process. The author is not a professional photographer and conditions under which the craftsmen worked were not always ideal for the taking of photographs. The author would like to thank Linda Ludwin for help in taking many of the photographs and to Trevor Petley for printing them. Where photographs would not have shown a particular process clearly, line drawings have been used.

The writer would also like to express her gratitude to Malcom Redding, Clin Petley, J. D. Knight and Gaye Shortland for their assistance.

Louise P. Baker

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CHAPTER I

INTRODUCTION

Statement of the Problem

The researcher aims to describe the technique of "cire perdue" casting which is as widely used today in the Sahel region as it has ever been in the past.

The two casters cited in this thesis are Mohammed Bukini Gurba, who is a Chadian by birth, and Ahmadu, a Tuarag of the Imaden caste from Niger. Both men left their countries of origin and came to work in Nigeria as a result of the Sahel drought in the 1970's. All too often, either because of lack of information or because the technological aspect does not seem so important, art historians leave out much of the important details of "cire perdue" casting. This might well be because so much ritual is attached to casting amongst some tribal groups that the art historians have not been allowed to see the complete process. One of the reasons for making a study of the processes used by the two casters mentioned was that no ritual or taboos seemed to be attached to the casting of this work. The author feels such ritual and taboos might have caused a barrier in the study of casting as done

at a well known centre of casting such as Benin.

The author became interested in finding out more of the techniques of "cire perdue" casting in relation to her own sculpture and the possibility of using this technique for her own work. Until the process is understood the full potentialities of the method cannot be utilized. The process also needs to be understood to realize the limitations that have to be imposed if the work is to be a success.

"Cire perdue" casting, as practiced in West Africa, has until this century been related to religious cults and has centred around the courts. Now although the courts such as Benin are no longer the sole patrons of casters, and casting is no longer the sole prerogative of certain families the processes are still kept secret to a certain extent. Modern day West African casters have learnt the basic skill involved in making a cast but no longer feel it necessary to aim at perfection in their work. If they can sell a faulty rough casting as an antique to the tourist market why, they feel, should they spend time and lose money ensuring that a casting is perfect. Also many casters are not artists either so the results of their work are crudely conceived and crudely made.

The researcher feels that if modern day artists were to observe closely the traditional methods and use them for their own work there might be a resurgence of well thought out and good quality

casts. The author hopes that this thesis will help in some small way towards this.

Historical Background

Casting is believed to have developed between 3500 - 3000 B. C. with the discovery and the manufacture of tin bronzes. At first open and piece moulds were used but the discovery of the "cire perdue" method quickly followed,[1] (Figure 1). "The earliest form of casting was open mould casting using stone, loam or clay moulds."[2] An open mould is the simplest form of mould and probably developed from a depression in the earth that the smith poured molten metal into to form a rough ingot (Plate 1). Open moulds made from a lump of clay with a rectangular depression would have been used to cast metal bars which could then be hammered into bracelets or daggers. Such moulds were also used for "... small mass products such as votive and ornamental objects and coins."[3] Open stone and clay ingot moulds are still used in West Africa.[4] The ingots produced from them are sold in the markets

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[1]Singer, Holmyard, Hall and Williams. A History of Technology. Oxford University Press, 1956. Chapter 22, p. 607.

[2]Ibid. Chapter 5, p. 133.

[3]Ibid. p. 134

[4]Denis Williams. Icon and Image. Allen Lane, 1974. p. 110 - 111.

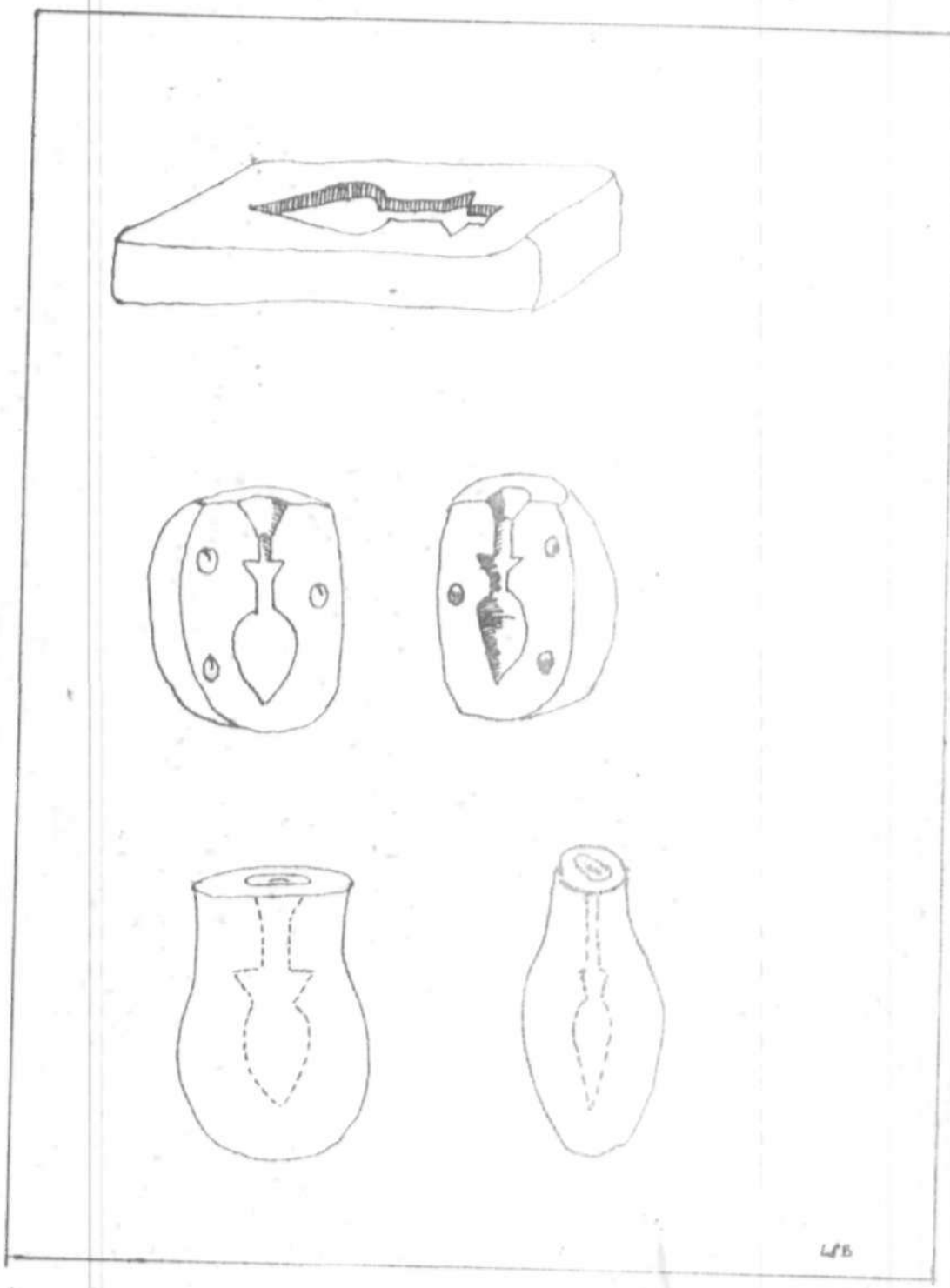


Fig. 1 -- Open, Two Piece and "Cire Perdue" Moulds



PLATE 1. CASTING AN INGOT IN A SAND MOULD

of northern Nigeria and are made into ladles and bracelets by hammering, forging. The disadvantage of open mould casting is that only one side can be shaped in the mould, the other open side will always be nearly flat. It is not difficult to imagine how the two piece mould developed in order that more complex forms could be produced. Herbert Maryon gives the following description of the making of a two piece mould:

> For instance, a craftsman wished to make a bronze knife-blade. He carved a pattern in wood to the exact shape he required. He then rolled out on his bench a slab of clay of suitable proportions and dusted its surface with soot or any other material which would prevent his pattern from sticking to it. He pressed his wooden pattern into the slab till about half the thickness of the model was sunk below the surface. He made the parting line, where the wooden pattern and the exposed surface of the clay met, quite tidy. And, with a rounded pebble or the end of a stick, he made a series of hemispherical hollows, or 'register marks' on the clay surface on each side of his wooden model. He then dusted the exposed clay surface and the model with soot or other powder, as before, and laid a second slab of clay over the first. He pressed it closely on to the model and into the depressions formed by the pebble. Also he trimmed with a knife the outer edges of the slabs, so that they could be replaced at any time exactly one over the other. He lifted the top slab, removed the model and cut a channel to form the pour. He set the mould aside to dry and when ready, he baked it on the hearth ... to a brick-like hardness, ... it was [then], tied together with green withies buried in the ground in front of the hearth and filled with metal before it had had time to cool down.[5]

From the simple two piece mould developed complex moulds of many pieces such as those used by the Chinese for wine vessels

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[5]Herbert Maryon. Metalwork and Enamelling. Dover, 1971, pp. 201-2. (Words in brackets are those of the present author.)

between 2000 - 1000 B.C. The third type of casting used in ancient times was 'cire perdue' casting. "The 'cire perdue' or waste-wax process is a method of casting in metal by means of an external mould in one piece, from which the wax of the model can be removed only by melting."[6] In the simplest terms the method is this, the model is made in wax to which is added a wax rod, the sprue. The model is then covered with a fine clay mixture, the investment, apart from the end of the sprue. The covered model is left to dry. The wax is melted out leaving a hollow mould into which molten metal is poured. The mould is broken off and the cast cleaned. This method was used mainly for casting ornaments and "with slight variations it remains in use to this day."[7]

"The discovery of casting probably belongs to the Ubaid-Urat period of Mesopotamia (c3500 B.C.)."[8] At first this would have meant casting in open moulds but it is believed that the more complex skill or "cire perdue" casting followed soon after. Many of the basic tools used, such as bellows and crucibles, would have developed at the same time or during the earlier discovery of smelting ore. Blast air would have been needed to get the

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[6]Singer, Holmyard, Hall and Williams. A History of Technology. OUP, 1956, p. 634.

[7]Ibid. p. 508.

[8]Ibid. pp. 587 - 588.

metal quickly to melting point. At first this would have been done with a blow pipe. "There is no doubt that the simple means of raising the temperature of glowing charcoal such as the fan and blowpipe belong to the oldest tools of the smith."[9] The use of blowpipes is shown in an Egyptian relief from Saggara, depicting goldsmiths, of about 2400 B.C.[10] From this developed the dish bellows of the Egyptians and the skin bellows of Central Asia. Later the house bellows and smiths bellows of Europe developed from the two earlier types (Figure 2). The clay nozzle or tuyère at the end of these types of bellows can be regarded as a survival of the blowpipe. In addition to blast air the smiths would also have required crucibles in which to melt the metal and these, made of refractory material have remained basically unchanged to this day. From Mesopotamia and Egypt the technique of casting spread along the Mediterrean coast of Africa. "The Phoenicians also taught the Berbers how to use bronze and iron in the manufacture of tools and other objects."[11] How then did this knowledge spread to Africa south of the Sahara where "cire perdue" casting of an extremely high standard was known to have been practised by 900 A.D.,

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[9] Ibid. p. 113.

[10] Ibid. p. 579.

[11] American Heritage Publishing Co. The Horizon History of Africa. 1971. p. 107.

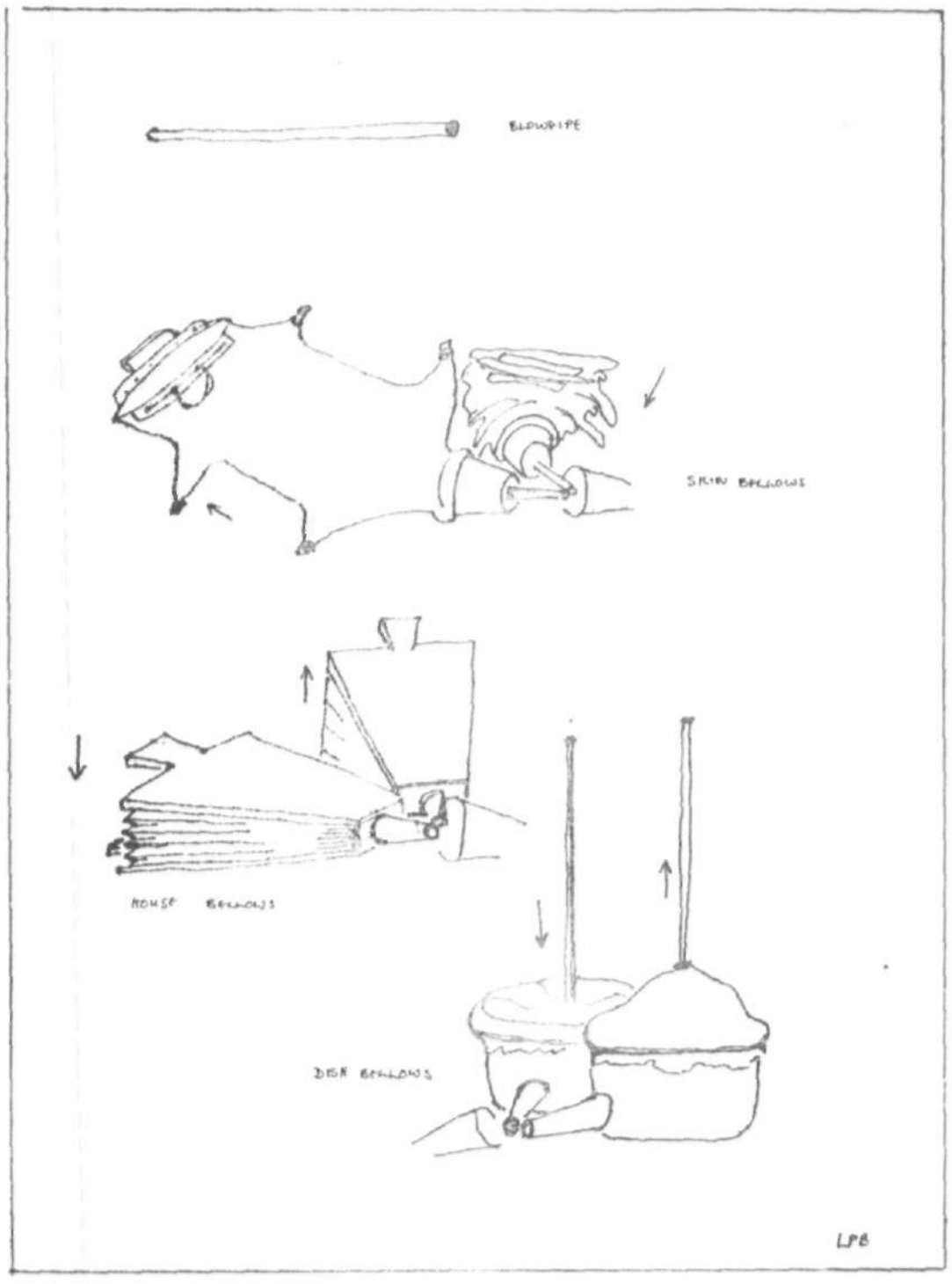


Fig. 2 -- Development of Bellows

at Igbo Ukwu in South Eastern Nigeria,[12] and at Ife by 1200 A.D.[13] From Ife the craft is reputed, by oral tradition, to have spread to Benin.[14] The idea that Benin learnt the art of bronze casting from the Portugese in the 15th Century, as Jack Rich has propounded,[15] is now completely discredited.

Iron smelting is known to have taken place in Nigeria, "at Turuga some 25 miles south-east of Abuja"[16] during the third and fourth centuries B. C. but "in Africa the Iron Age has a special significance. Over most of the continent there was no preceding Age of bronze. In most of Africa iron was the first metal to be worked into tools by man."[17] Walter Cline "maintained that the art of smelting iron was introduced into the western Sudan from across the Sahara by 'camel riding Berbers' from the north."[18] The most likely explanation for the introduction of bronze and bronze

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[12]Thurston Shaw. Discovering Nigeria's Past. OUP, 1975, p. 55.

[13]Elsa Leuzinger. The Art of Black Africa. Studio Vista, 1972, p. 144.

[14]Philip J. D. Dark. An Introduction to Benin Art and Technology. Oxford, 1973, p. 5.

[15]Jack C. Rich. The Materials and Methods of Sculpture. OUP, 1973, p. 147.

[16]Thurston Shaw. Discovering Nigeria's Past. OUP, 1975, p. 43.

[17]Roland Oliver and Brian M. Fagon. Africa in the Iron Age. OUP, 1975, p. 1.

[18]Lloyd Cabot Briggs. Tribes of the Sahara. Harvard University Press, 1960, p. 150.

casting techniques into Nigeria is also "associated with the opening up of Trans-Saharan caravan routes by the Arabs."[19] That the technique of brass casting was introduced from elsewhere and was not an independent invention can be taken as virtually certain, since it is a complicated one."[20]

G. D. Bovill gives the history of the Trans-Saharan caravan routes and their origins,[21] and Denis Williams[22] also deals with this trade. Oliver covers this area and writes:

> Herodotus, writing in the fifth century B. C., reported that the Garamantes, the Libyan Berber pastoralists of the Fezzan, were in the habit of raiding the 'Ethiopians', that is to say the Negroes, in four horse chariots. His report is amply proved by the discovery in recent years of numerous rock drawings of horse drawn vehicles, aligned mainly along two routes both leading towards the great bend of the Niger ...[23]

which "correspond with two of the main caravan routes of historic times."[24] (Figure 3) These trade routes were opened up in the search for gold, primarily, and then later for ivory, kola nuts and slaves. The goods bought by the Berbers to exchange for

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[19]Thurston Shaw. Igbo Ukwu. Faber and Faber, 1970, p. 272.

[20]Ibid.

[21]G. D. Bovill. The Golden Trade of the Moors. OUP, 1958. p.p. 68-9.

[22]Denis Williams. Icon and Image. Allen Lane, 1974, pp. 103 - 113.

[23]Roland Oliver and J. D. Fage. A Short History of Africa. Penguin, 1973, p. 61.

[24]Ibid. p. 61.

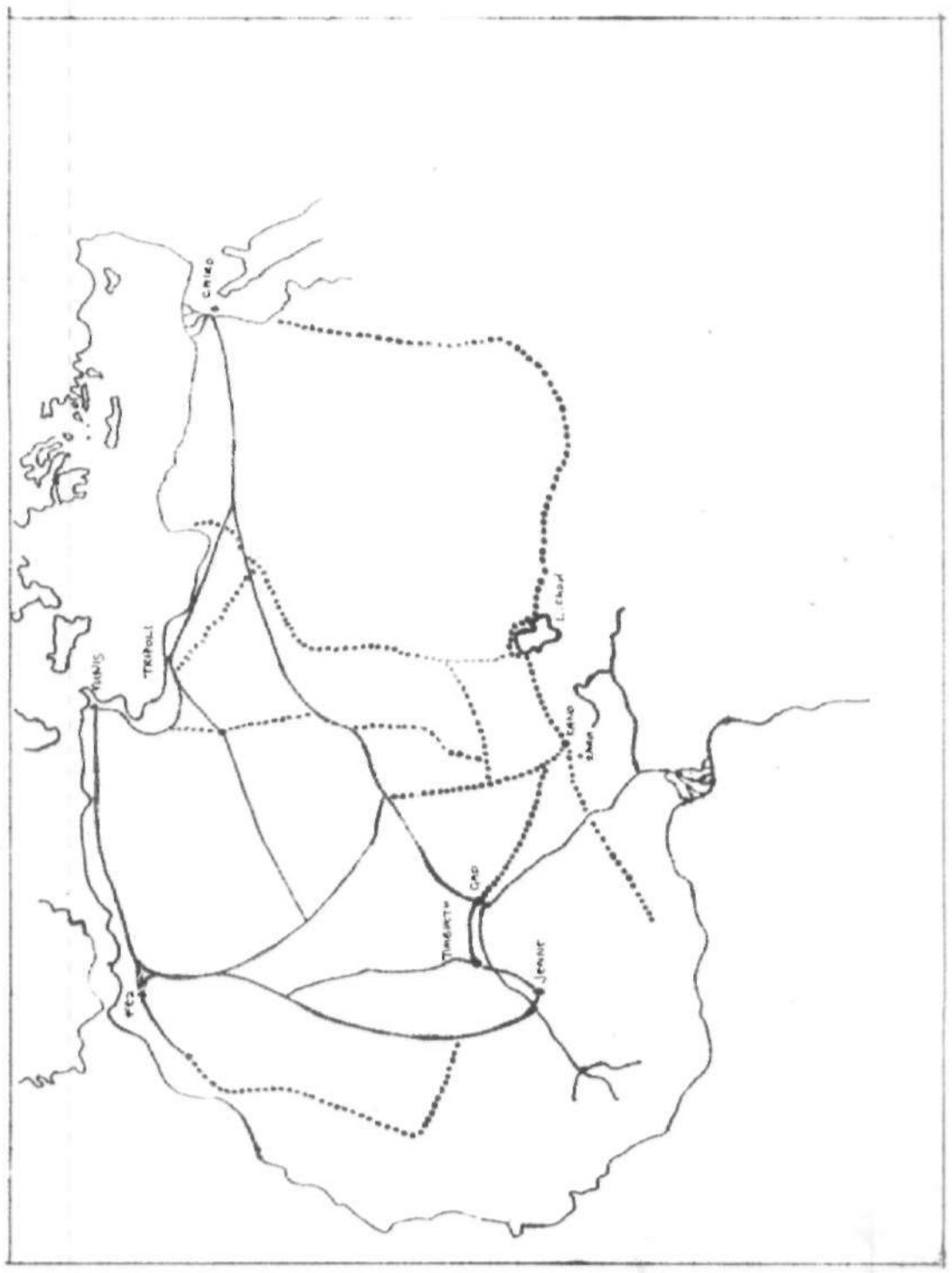


Fig. 3 -- Trade and Migration Routes from North to West Africa

these included, "... salt -- beads, trinkets, and other small items of metalwork such as cutlasses; scarce and therefore valuable base metals such as copper and its alloys; cloth; and cowrie shells."[25] Thurstan Shaw writes, "It seems most likely that the necessary metal for casting was introduced along with the introduction of the 'cire perdue' technique."[26] It is of course more likely that the technique was introduced at more than one place and at different times. There is a tradition at Ife, according to Willet[27] as quoted in "The Horizon History of Africa", that migrant groups arrived there from the east or north-east bringing with them the art of bronze casting. P. Amaury Talbot also hypothesises "That the Yoruba cult was derived from Egypt"[28] and says that from about 3000 - 1000 B.C. "... a wave from Egypt would seem to have reached this region -- perhaps via the east of Lake Chad"[29] maybe along another of the known trading routes. Thurstan Shaw continues this theory,

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[25] Ibid. p. 111.

[26] Thurstan Shaw. Igbo-Ukwu. Faber and Faber, 1970, p. 280.

[27] American Heritage Publishing Co. The Horizon History of Africa. 1971, p. 191.

[28] P. Amaury Talbot. The Peoples of Southern Nigeria. OUP, 1926, Vol. 2, pp. 336-7.

[29] Ibid.

> It is possible that at any rate one route of entry was to the eastern end of the 'cire perdue' belt from Lake Chad area along the line of hills running down Nigeria's eastern border. The 'Sao' bronzes from south of Lake Chad come to mind at once, with casting traditions in Southern Bornu and in Adamawa linking down the Bamando area.[30]

Archaelogical work in Nigeria is still going on and it is to be hoped that at some time evidence may be found to prove or disprove these speculations.

West African Background

Up till now bronzes have been found during excavation of habitation mounds of the Sao at Daima in north-east Nigeria, (Figure 4) south of Lake Chad, amongst which were small button like objects surmounted by very small birds. These were obviously the products of lost wax casting and were probably manufactured around 800 - 900 A.D.[31] Hamelin has attributed the thinness of certain Sao calabash casting to the use of latex as the modelling media.[32]

A far greater group of bronze casting came from the excavation at Igbo Ugwu in southeastern Nigeria conducted by Thurstan Shaw. From radio carbon dates from the finds it would seem that they were

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[30] Thurstan Shaw. Igbo Ukwu. Faber and Faber, 1970, p. 272.

[31] Information from Graham Connah in conversation, Zaria, 1978.

[32] Hamelin, P. Les bronzes du Tchad Tribus. Stuttgart, 1952-53, p. 390.

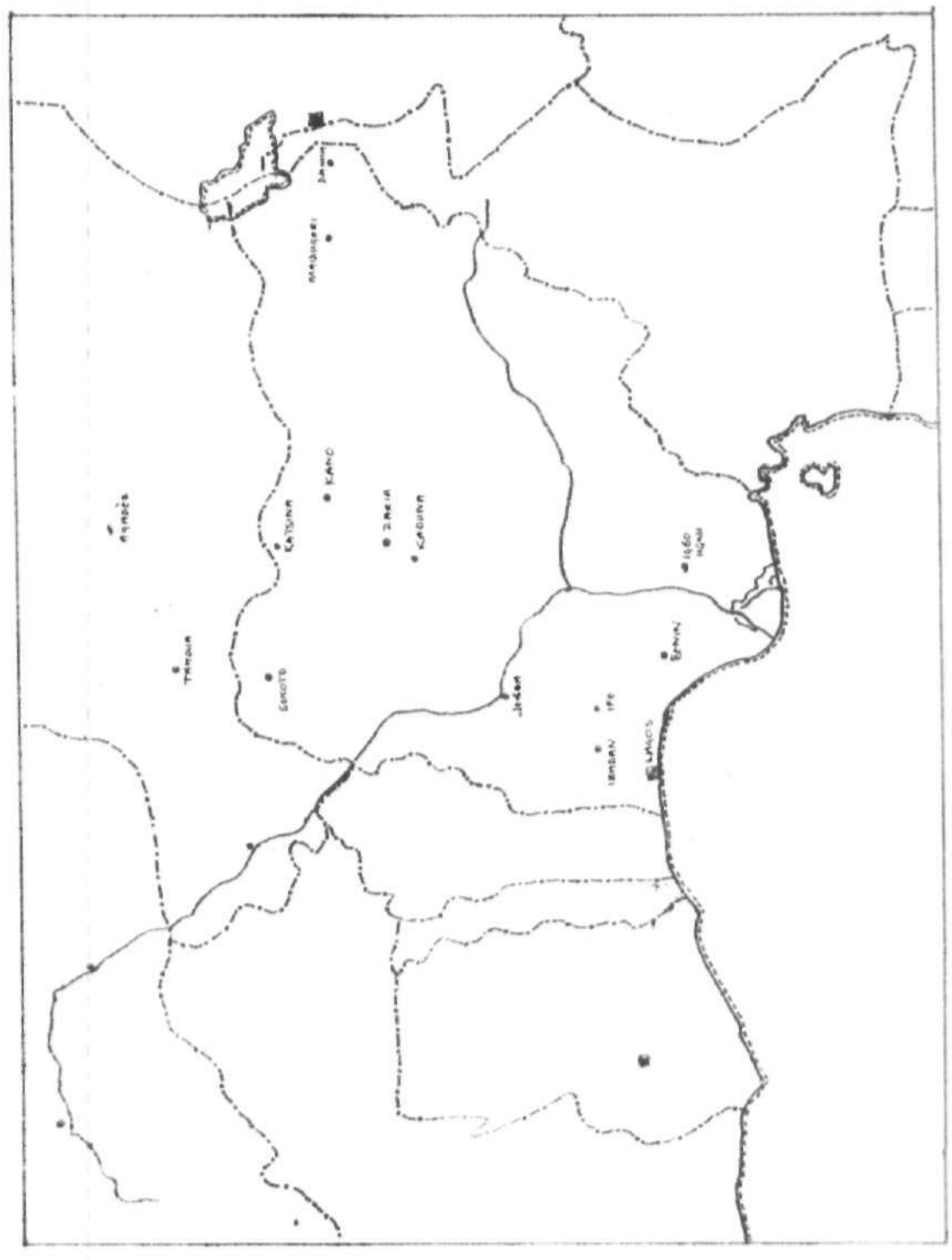


Fig. 4 -- Map of Nigeria

produced around a thousand years ago.[33] No crucibles, mould fragments or traces of the forges of the smiths who made these objects have been found and so there is no indication as to the way that they were manufactured. However from examination of the pieces it can be seen that they are examples of extremely fine lost wax casting but it is impossible to be sure whether the

> Egyptian or the Cinquecento method of casting was employed. The fineness of the casting would suggest the former. ... in the latter method one or more crucibles of molten metal are poured into the mould through an open pouring cup or sprue; in the former sufficient raw material is enclosed within the final investment, beyond the pouring cup, so that when heated to the molten state the metal can be run straight into a hot mould by turning the whole thing over.[34]

It is believed that the models for these casts would have been made from latex, from the Euphorbia succulent, because of the fineness of the detail. Some authorities consider this would be virtually impossible to achieve with beeswax.[35]

The "Igbo Isaiah" is believed to have been a storehouse for regalia and ceremonial objects which included cast pots, pendant heads, staff ornaments, bronze scabbards, belt plaques, bronze shells and bronze alter stands. The second site known as "Igbo Richard" has been reconstructed as a royal burial chamber and this

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[33]Thurstan Shaw. Discovering Nigeria's Past. OUP, Ibadan, 1975, p. 55.

[34]Thurstan Shaw. Igbo Ugwu. Faber and Faber, 1970, p. 273.

[35]Williams, D. Icon and Image. Allen Lane, 1974, p. 212.

contained two cast bronze objects, a bronze leopards skull and a horseman hilt. The last site "Igbo Jonah" is believed to have been a disposal pit and in it were found some bronze cylindrical ornaments and bells.[35]

Chronologically, the next group of bronze castings in Nigeria were those of Ife which are believed to date from 1100 - 1300 A.D. The type of work made is very different from that of Igbo Ugwu in that it is mainly of the human form treated in a very representational way. The portrait heads are only a little smaller than life size. Of the thirty or so extant bronzes there is only one undamaged standing figure. Many of the remaining bronzes are portrait heads believed to have been used in second funeral rites. From examination of these heads Willet has deducted that these were made by lost wax casting using the separate mould and crucible technique. It is known that runners and risers were attached to the wax before investment to ease the flow of the metal and to allow gases to escape. In a few cases where a fault has occurred the cast was mended by "burning in"

> ... the faulty part is made good with wax, to which new runners and risers are attached, and it is reinvested in clay. The great difficulty is to get the fresh metal to

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[35]Thurstan Shaw. Unearthing Igbo-Ukwu. OUP, Ibadan, 1977, Chapters 3, 4, 5, pp. 15 - 67.

> fuse on to the original. In the Ife pieces this was usually done successfully, but some of the Tsoede bronzes ... have repairs which are loose and which rattle.[37]

These Tsoede, or as Williams calls them Jebba-Tada, bronzes are linked stylistically with both Ife and Benin. This group, of ten pieces, found along the Niger River 200 km. north of Ife consists of the largest known bronze castings in Africa.[38] Three of them are over one metre in height. How and when they came to the places where they were found is a matter of speculation and is discussed in detail by Williams[39] and Nadel.[40]

The largest and probably most well known group of Nigerian bronzes came from the city of Benin. This group is also court art and consists of over thirty commemorative heads, a vast quantity of wall plaques depicting events in the history of Benin as well as a number of free-standing figures of musketeers, messengers, dwarfs and animals. Dark in his chronology places the advent of bronze casting in Benin as c 1325.[41] Oral tradition states that the art of lost wax casting was learnt from the Ife casters.[42]

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[37] F. Willet. Ife. Thames and Hudson, 1967, p. 54.

[38] Ibid. p. 172.

[39] D. Williams. Icon and Image. Allen Lane, 1974, Chapters 13 and 20.

[40] Nadel. A Black Byzantium. OUP, pp. 73-75.

[41] P. J. C. Dark. An Introduction to Benin Art and Technology. OUP, Oxford, 1973, p. 7.

[42] D. Williams. Icon and Image. Allen Lane, 1974, p. 179.

It is known that bronze casting was practised before the arrival of the Portugese in 1475. It is believed that far more casting was done after this date due to the increase of constituent metals brought to Benin in trading. Benin casting continued in its traditional forms until the British Punative expedition of 1897. Bronze casting is still practised in Benin and there are several accounts of the technique that is used.[43] [44] Dark describes the process as practised by Chief Ihama:

> The smith usually works on a board on which he places his tools, rolls out and cuts up pieces of wax and lays the form he is modelling. At Benin the tools employed are generally one or two small iron knives for cutting up the wax, one or two modelling tools, perhaps of bone, and some form of flat spatula with which to roll out lengths of wax. ...
>
> The clay core with its layer of modelled wax is covered with clay to form a mould. When the mould is heated and the wax run off, the core will move around inside the mould in the space once occupied by the wax unless it is anchored securely. Thus when the core is being fashioned, metal rods, or chaplets, are stuck into the body of the core and allowed to protrude an inch or two. These chaplets penetrate the wax layer and become firmly embedded in the clay. When the mould is fired the chaplets prevent any movement of the core. In this way the space initially occupied by the wax remains unaltered when the wax is run off and only awaits the molten metal to fill it. ...
>
> At Benin, if a rather large object was to be cast, several of them (runners) would lead from strategic points on the model to a central point above or below the form, and be attached to a wax form, sometimes called a sprue cup or a

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[43] Ibid. pp. 130 - 132.

[44] L. Brinkworth. "Benin: 'City of Blood' -- and Bronze". The Geographical Magazine, XXVII, No. 5, Sept., 1954, pp. 248 - 257.

> pouring cup. ...
>
> The Benin brass smith puts the mould over a small hole in the ground lined with leaves into which the wax runs. ...
>
> In all variations of the lost wax technique, a crucible is used in which to heat the metal... At Benin, ..., this is done over a fire away from the mould and then the crucible is brought to the mould and the metal poured in. ... In Benin a wooden stick is placed at the lip of the crucible when pouring and this acts as a flux ..., attracting or absorbing surface impurities, preventing oxidation at the lip of the crucible and allowing the metal to flow smoothly.[45]

An older description of "Benin" casting is given by Rattray,[46] see Appendix C.

Lost wax casting has been used in other parts of Nigeria for cult figures, see Appendix A, and for the production of body ornaments, Appendix B. Nowadays lost wax casting is used for the production of "art" for the tourist trade but the technique has hardly changed over the years.

Definition of Terms

Alloy	A metal produced from a mixture of other metals e.g. brass.
Anvil	A block of iron against or on which a smith forms metal by hammering or forging.
Beeswax	The comb material secreted by bees. Blocks

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[45] African Arts. Summer, 1973, Vol. VI, No. 4 African Studies Center, University of California, Los Angeles. "Brass Casting in West Africa" by Phillip J. C. Dark. pp. 52-3.

[46] R. S. Rattray. Hausa Folklore, Customs, and Proverbs. OUP, London, 1969 reprint, pp. 234-243.

	for modelling are made by purefying and melting down honey combs. It is used to make models for "cire perdue" casting.
Bellows	A leather bag used for driving air through a pipe into a fire.
Blast Air	Air forced through a pipe under pressure into a fire to raise the temperature.
Blow Pipe	The forerunner of bellows. Air is blown by the smith through a tube to the flame. It is still used by jewellers.
Brass	An alloy of seventy parts of copper to thirty parts of zinc. It has a melting point of 1027°C and has a greater tensile strength than bronze.
Bronze	An alloy of ninety parts of copper to ten parts of tin. It has a melting point of 1027°C.
Burnout	The burning away or melting of wax in a closed mould for "cire perdue" casting.
To Cast	To make an object by pouring molten metal into a mould.
A Casting	An object made by pouring molten metal into a mould.

"Cire Perdue" Lost Wax	A method of casting in which the original model is lost by burning it out of the mould. The model cannot be removed in any other way.
Core	A refractory clay base over which an object is modelled and which remains in the mould thus saving on the quantities of metal required for the cast.
Crucible	A cup or bowl shape made of refractory material in which the metal for casting is melted.
Cupola	Dome shaped furnace for melting metal.
Engraving	To cut lines in metal.
Fin	A thin projection of metal caused by a slight crack in the mould or core.
Flash	A casting fault similar to a fin and caused in the same way.
Flux	An additive that helps the molten metal to flow easily.
Forge	A workshop containing a furnace or hearth and bellows for melting and working metals.
Forging	To shape metal by heating and hammering.
Furnace	A chamber in which metal may be subjected to a continuous intense heat.
Investment	The material used to cover a wax model to form

	the mould for "cire perdue" casting.
Mandrel	A tapering metal rod on which rings are formed.
Mould	The form containing a hollow into which molten metal is poured to produce a casting. There are open moulds, piece moulds and closed moulds.
Nozzle	The metal pipe at the end of the bellows which rest in the tuyere.
Pouring Cup (Gate)	The funnel shape at the open end of a mould through which the metal is poured.
Refractory Material	Substance specially resistant to heat used for making moulds, lining the forge and making crucibles.
Risers	Wax rods added to model to give air channels in the mould when burnt out. Risers allow the escape of gases from the mould and show that the mould is filled when the metal rises in them.
Runners	Channels through which the metal runs into the mould.
Smelting	The processes in which metal is separated from non-metallic materials by heating.
Spatula	Tool of metal, wood or ivory with flattened

or shaped ends used for modelling wax or clay.

Sprue — The principal runner to which the other runners are joined and which leads to the pouring cup.

Tuyère — A funnel shaped hole into the furnace into which the nozzles of the bellows are placed.

Vents — Narrow openings in the mould to allow for the escape of gases. Vents act as risers.

Where it has been possible the indigenous names of tools has been found. Not all the processes or items have names in the indigenous language. For example, one of the casters, Mohammed, told the researcher that he has always used the word "mould" for the outer investment and for the core and there is no Guran term for the investment mixture although clay and sand have Guran equivalents. It should also be noted that the Guran words are spelt as they sounded to the researcher.

English	Hausa	Guran	Tafanik
Anvil	uwar makera	ektil	tahunt
Anvil stake			v-set an tawit
			tende n takaffatin
Hole for Stake			set n tahunt
Beeswax	kakin zuma	sham	dako
Bellows	zugazugai	kotaji	asahad

English	Hausa	Guran	Tafanik
Brass	farin karfi	kopsun	
Clay	yumbo	lowu	
Cold chisel	kurfi	wulang	asayras
File	zarto		tazazzawat
Forge	makera	sukutu	
Mallet	hama takatako		tafadist
Rod		chogoro	
Sand	Yashi	anashi	
Tongs	hantsaki	burra	iyondan
Tin snips		nogus	
Tuyere	dukin makera	afro	
Work table		ekadalie	elku
Dung	kafin jaki		

Sources and Procedures

The researcher used as primary sources two craftsmen working in Zaria. They were both informed of the purpose of the research and asked to make a number of articles using the "cire perdue" process. While these articles were being made the researcher took photographs of the different stages and made notes of the processes. Later, with the help of translators, the casters were questioned about how they learnt their trade and about the methods they used. Secondary sources relating to other casters working in Nigeria

were read and three of these appear as appendices for comparative purposes. It is interesting to note that the method used by the caster in north-eastern Nigeria bears striking resemblances to that used by the caster from Chad. The other two are closer in method to that of the caster from Niger. Other references in magazines to casting in Nigeria were found in "The Art Index". The researcher used the catalogues of the Kashim Ibrahim Library in Zaria and the British Library in London to find background material concerning "cire perdue" casting.

CHAPTER II

MOHAMMED BUKINI GURBA

A Biographical Note

Mohammed Bukini Gurba is a native of Chad and is Guran by tribe. He believes he is about forty years old. He is married and has two children. As a child he was brought up in the capital of Chad, N'Djamena, where his father worked as a blacksmith. He told the researcher that he started work as an apprentice to his father at a very early age, perhaps at five years. A few years later, at about seven, he was working with wax and making casts of his own. During his teens he set up his own workshop where he made jewellery, rings and bracelets as well as the animals that he makes now. He took part in a competition for bronze craftsmen of Chad in which he won the gold medal which was presented by the Head of State.

In 1973 he was employed to work as a demonstrator at the Kaduna museum. He worked there until joining the Fine Art Department of Ahmadu Bello University, Zaria, (Figure 5), in February, 1974. He has worked there since that time except for a short break in 1975 when he returned to Chad for several months.

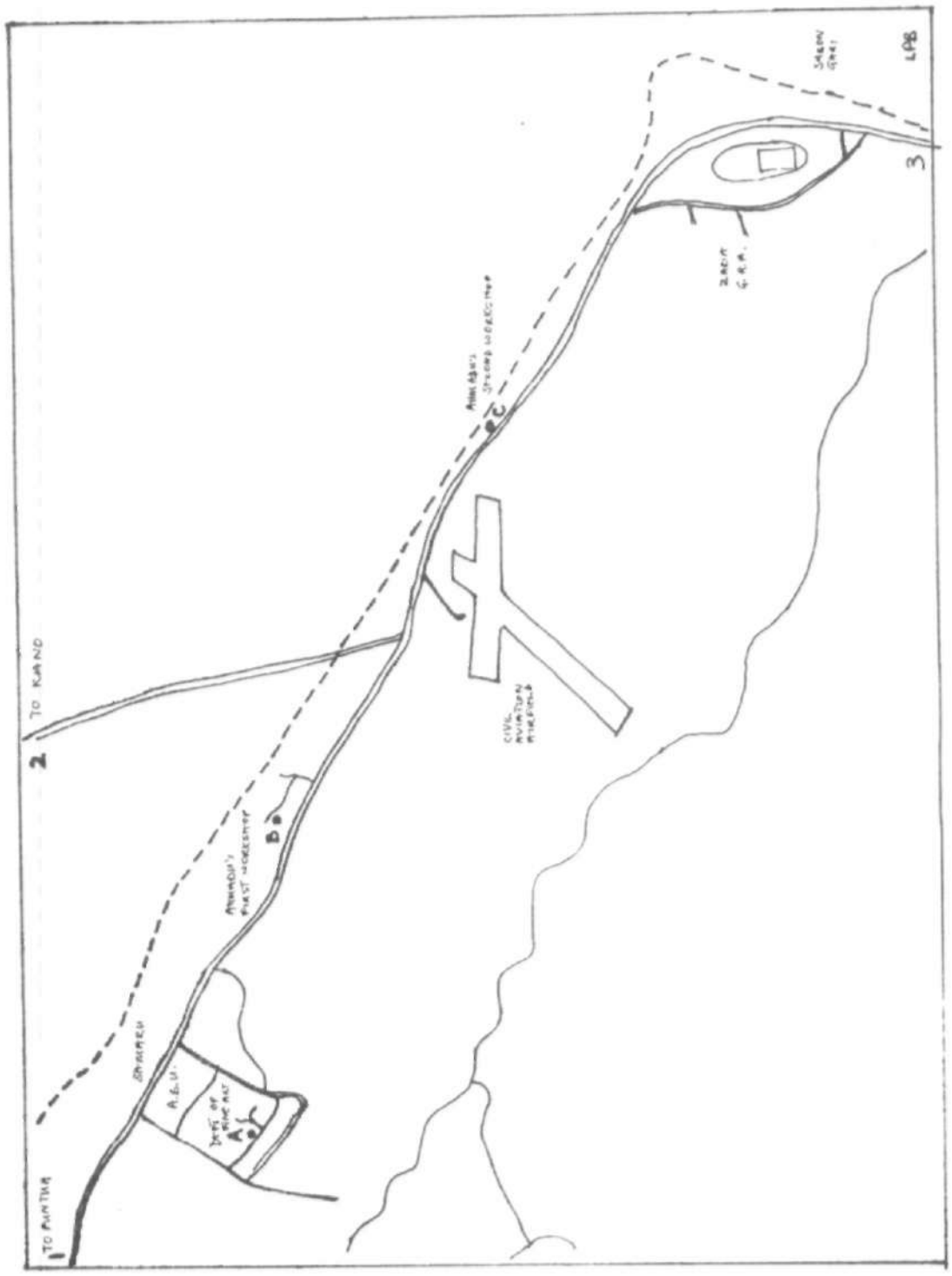


Fig. 5 -- Map of Zaria

The Workshop

When he first came to Zaria, Mohammed brought with him his bellows, his modelling tools, brass and wax and set up his forge where it is still sited. This is between the carpenters workshop and the present first year sculpture studio at the Fine Art Department, ABU. At that time there was no shelter and no fixed forge. When ready for casting he would make a small inverted-cone-shape hole dug out of the sand that he then filled with charcoal. The tuyère was pushed into the ground and the nozzles of the bellows fitted into this. The bellows themselves were weighted down with large stones or concrete blocks.

Since that time the workshop has been covered over with an asbestos roof and two of the open sides have been partially screened off with asbestos roofing sheets. These sides do not go right up to the roof and one side is left open in order that there is cross ventilation. The pit of the forge has been cemented over with refractory material of a similar mixture to the moulds as has the ground around it. The area around the pit forms a slight depression, (Figures 6 and 7). The tuyère itself has been developed from the original clay pipe, to a wall-like structure with a cone shaped hole running through it. The narrow end of the tuyère opens into the charcoal pit and the wider end is outwards. The nozzles of the bellows fit into this. The bellows themselves are

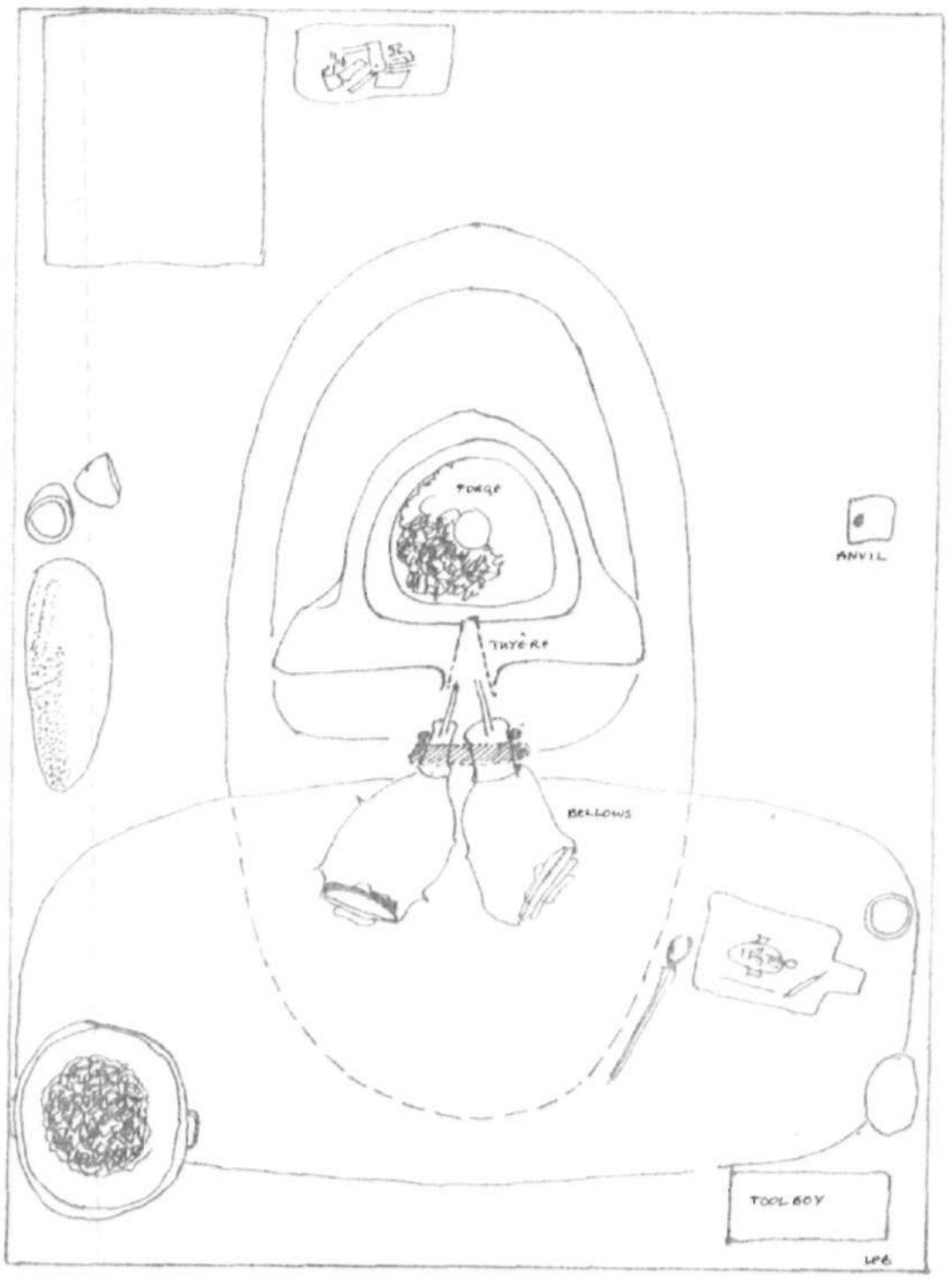


Fig. 6 -- Plan of Workshop of Mohammed Bukini Gurba
From Above

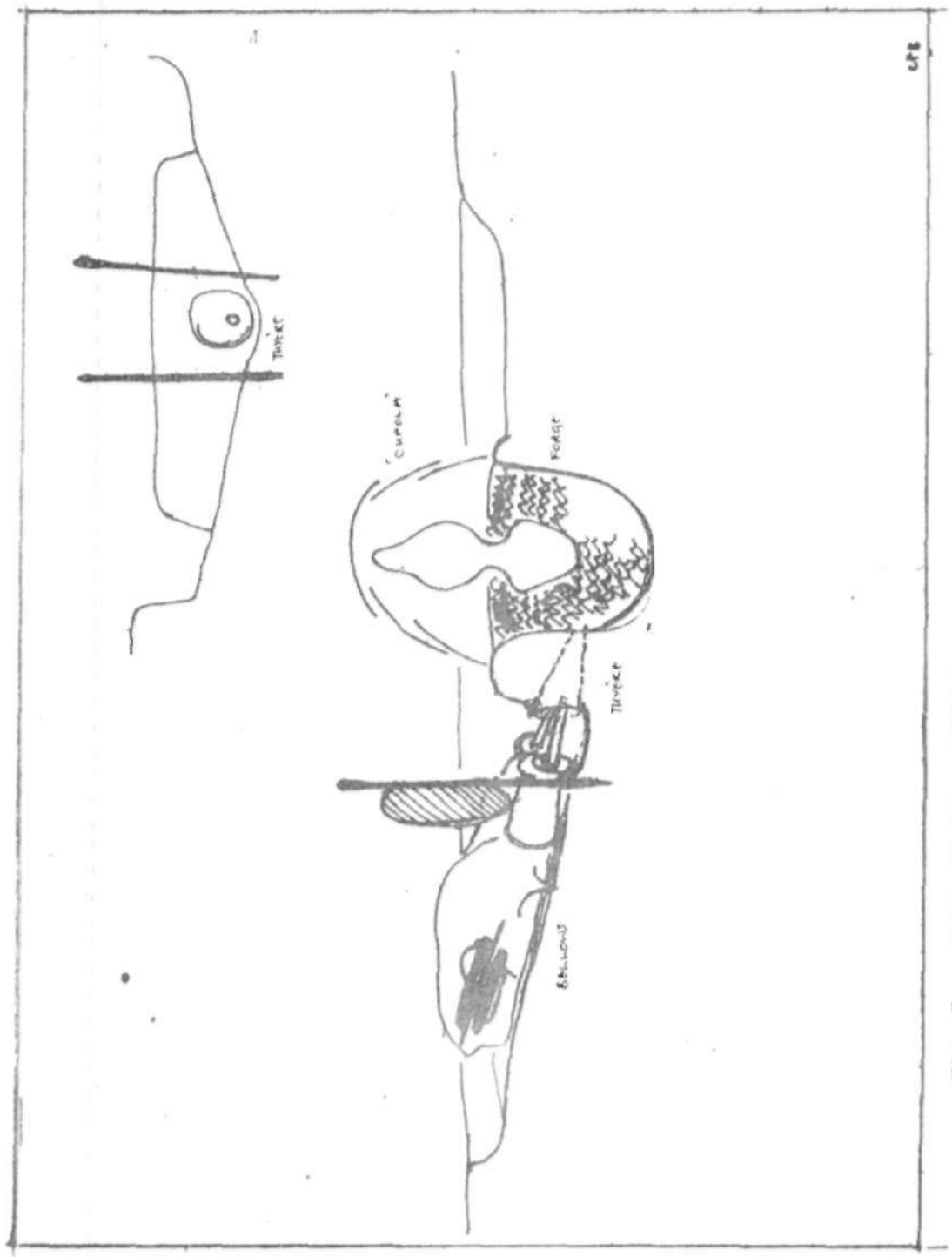


Fig. 7 -- Cross Section of Forge

kept in place by two stakes on either side of the wooden piece that forms the junction between the metal pipe nozzles and the skin bags. The wooden pieces are weighted down with a large stone. The leather bags rest on the mat that Mohammed sits on when he is pumping the bellows. To the right of the pit, and 43 cm. from it, the stake anvil has been fixed into the ground. A larger European type blacksmiths anvil is kept just outside the workshop. To the left of the forge against the asbestos wall is a pile of sand on which the red hot moulds are placed when they come out of the forge. Beside this pile of sand are kept the pieces of enamel bowl used to cover the mould when it is in the forge. When not in use the bellows are hung from a hook just above the pile of sand. Mohammed keeps his other tools, spatulas, files, hammers and pliers in a metal box behind and to the right of the forge. There too he keeps beeswax and any ready-made investment that is left over from a piece of work. The scrap metal, crucible-tongs and a pointed rod are kept at the back of the forge. The charcoal is kept, in sacks, outside the workshop (Plate 2).

Tools

Of the tools needed to undertake casting, bellows are perhaps, the most important as without blast air the forge is unlikely to reach a high enough temperature to melt the metal. Mohammed uses bellows that are of the earliest type known which



PLATE 2. VIEW OF MOHAMMED'S FORGE

are known as skin bellows. The type evolved in western or central Asia and are known, from vase paintings, to have been used by the ancient Greeks. They were "formed by sewing together the skin of an animal (often a goats' skin) attaching the pipe and tuyère to one of the legs and using a slit with two wooden rims as the opening for introducing fresh air into the bag."[1] Theophilus writing in the seventeenth century also gives a description on making bellows which could well be a description of the method by which Mohammed's bellows were made:

> Then make bellows out of ram skins in the following way. When the rams are killed, the skins should not be slit under the belly but opened from the rear and turned inside out so that they can be stripped off whole ... filled with straw and dried out a little. Afterwards they should lie for a day and two nights in a composition of lees and salt. On the third day they should be turned right side out and stretched lengthwise and even more in width. Then they should be greased and stretched again. After this make a wooden head for the bellows to go through the neck and be tied there and then make a hole in the head through which an iron pipe can go. Now, along the width of the bellows and the back, place four pieces of wood, which should be fitted to each other in pairs and tied together in the middle. Each pair should be sewn onto the bellows so that the places where they are joined are at the top and bottom of the middle of the opening in the skin. At these points also two loops of the same skin should be sewn on, a smaller one at the top to hold the thumb and a larger one at the bottom for the four fingers.[2]

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[1]Singer, Holmyard, Hall & Williams. The History of Technology. OUP, 1956, Vol. 1, p. 114.

[2]Presbyter Theophilus. On Divers Arts. Edited and Trans. by Hawthorne and Smith. 1963, Chapter 4, pp. 83 - 84.

The translators in a footnote say "Theophilus does not mention the necessary valve in the head of the bellows to prevent hot gasses being sucked into them during inflation."[3] In fact a valve does not appear to be necessary to this type of bellows. The iron pipe rests in the tuyère not in the fire itself. The air is drawn into the bellows on the upswing of the hand and the likelihood of hot air being sucked in through the pipe seems slight if not impossible. The researcher has never heard of this happening or noticed it when using this type of bellows herself.

The bellows that Mohammed uses are the same type as those used by the blacksmiths in northern Nigeria. The bellows are used in pairs. Mohammed uses only one pair, blacksmiths might use two or more pairs in conjunction. Mohammed works the bellows in the following way: he sits cross-legged on the ground immediately behind the bellows that have their metal pipes resting in the tuyère. He puts his thumbs through two loops on the inner sides of the bellows and his four fingers through the loop on the outer sides of the bellows. He draws the slats together with fingers and thumb and presses the slats down onto the bag. He then starts to lift the slats of the bellows towards himself and as he does so opens out his hand with thumb and fingers as far apart as possible. The bellows are brought up close to the body with the

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[3] Ibid. p. 84.

slats apart thus drawing in the air into the skin bag. The fingers and thumb snap together closing the slats which are then pushed down again onto the bag expelling the air through the iron nozzle through the tuyère into the fire. As one hand is pushing one of the bellows down the other hand is drawing up the second bellows. In this way the working of the bellows is rythmical and a steady flow of blast air into the forge is maintained.

Another essential piece of equipment in casting is the crucible in which the metal is melted. Mohammed does not however keep a stock of these. Each crucible is made at the time the wax is invested. The researcher gives a description of this in Chapter IV. Each crucible is used only once. The size of the crucible varies according to the size of the piece being cast. To lift the crucible and mould in and out of the fire and to arrange the enamel bowl pieces around the mould when it is in the forge Mohammed uses a variety of crucible tongs and jaw tongs made by local blacksmiths (Figure 8). To test the state of the metal during casting Mohammed uses a pointed metal rod which is about 60 cm. long and which is made from 5 mm. wide mild steel (Figure 9). He uses an iron headed mallet or a standard European type ball pein hammer and a cold chisel to break up the brass that is to be put into the crucible for casting. The cold chisel was made from an 8 cm. long bolt, the screw end having been forged and filed into

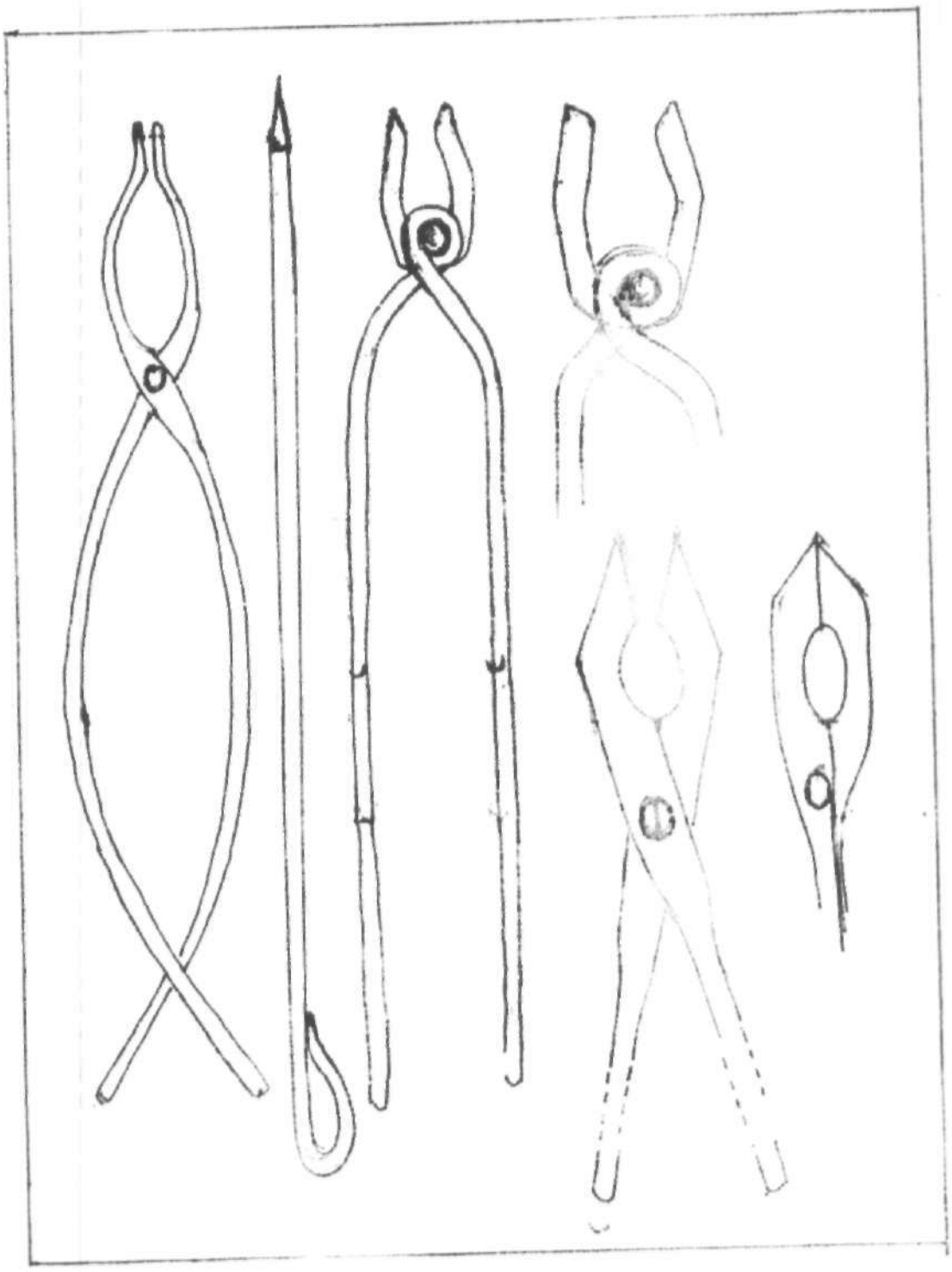


Fig. 8 -- Crucible Tongs and Rod

shape (Figure 9). Much of the flattening and bending of scrap metal is done on his stake anvil. This is about 20 cm. high and has a roughly square head of 10 cm. which is slightly domed from use. This has a hole in one corner through which a stake can be put. Mohammed usually uses a length of scrap mild steel rod for this. The anvil is of steel and is of a pattern used by many metalsmiths in this area.

The modelling tools Mohammed uses are simple knife shapes that he has made himself either from thin mild steel plate or from the strips of metal put around packing cases. Usually they will have one finely pointed end while the other end is "V" shape (Figure 9). They are nearly all about 10 cm. long. They are used for cutting and scraping the wax as he works on the model or are used for pressing wax rods into narrow spaces which his finger will not go into. For nearly all of his modelling he uses only his hands. He does not use "... a flat spatula with which to roll out lengths of wax,"[4] as Dark reports Benin craftsmen as doing but he does use a piece of plywood to roll the wax on. Mohammed rolls out these lengths (Plate 3) often over 40 cm. in length and between 1 - 3 mm. thick which he then cuts, twists together or bends into wavey lengths or spirals before placing on the wax base (Figure 10). He also

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[4] African Arts. Summer, 1973, Vol. VI, No. 4. African Studies Center, Univ. of California, Los Angeles. "Brass Casting in West Africa" by Phillip J. D. Dark. p. 50.

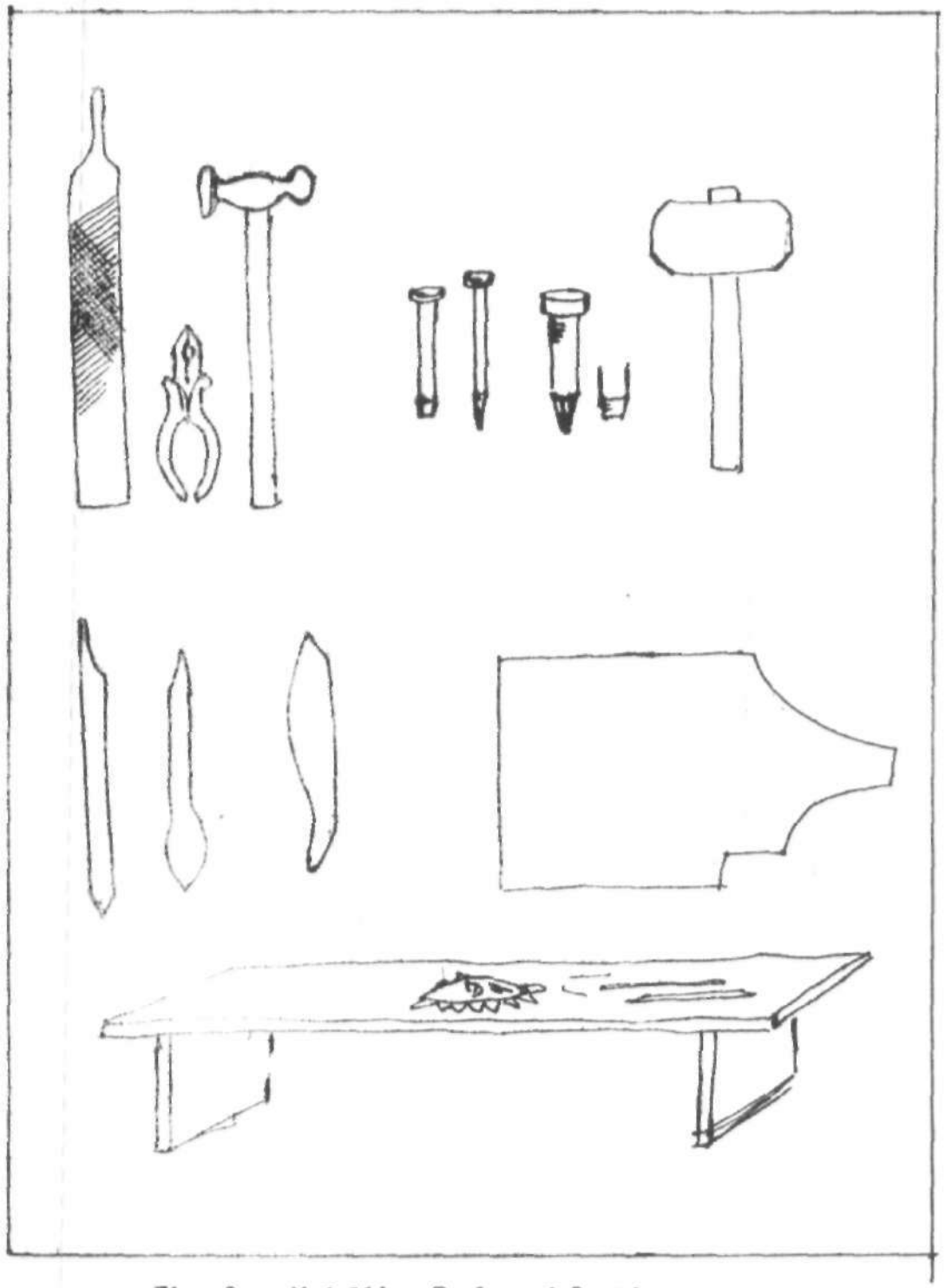


Fig. 9 -- Modelling Tools and Boards



PLATE 3. ROLLING OUT WAX RODS

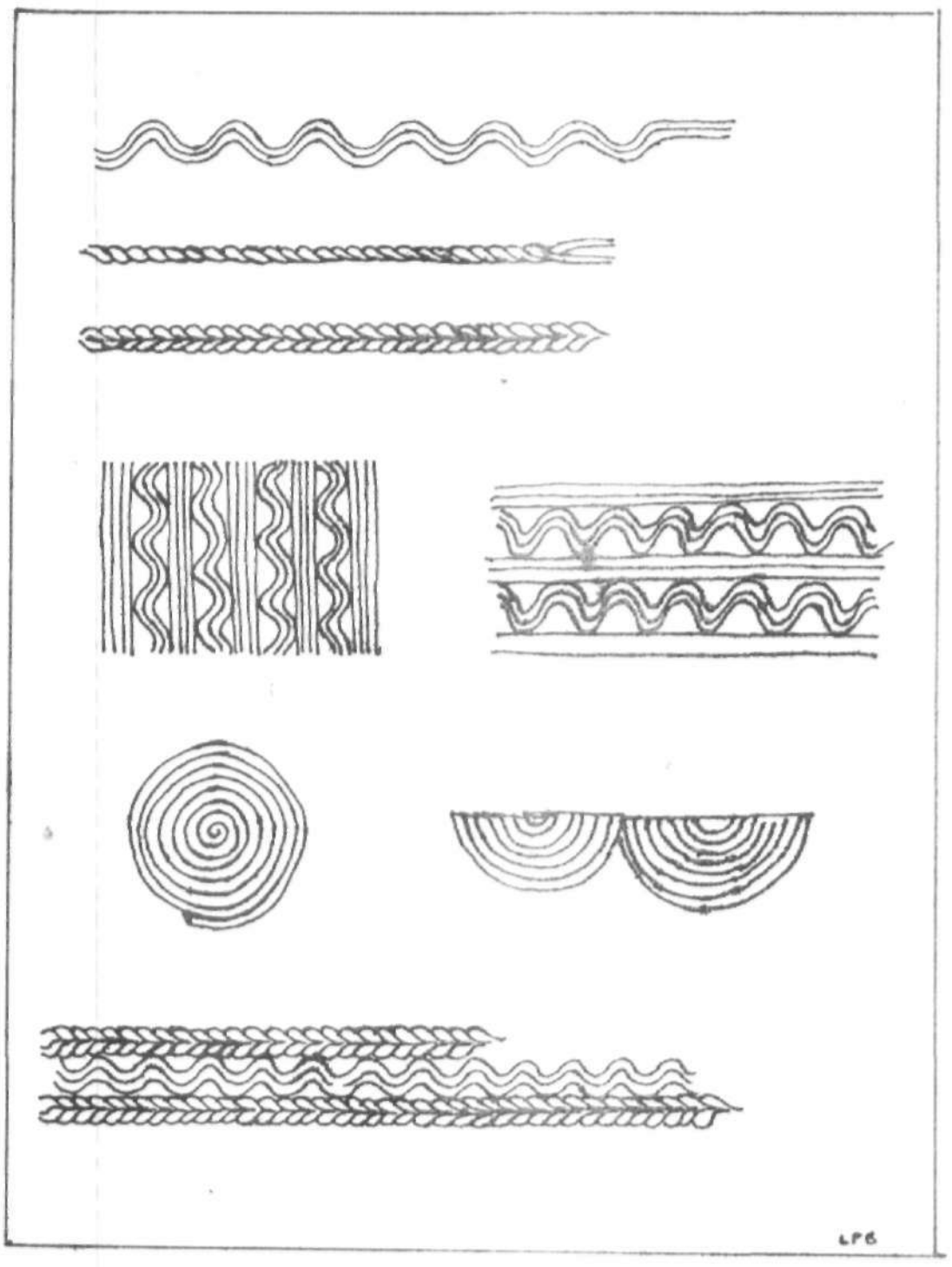


Fig. 10 -- Decorative Features from Wax Rods

forms as a decorative feature "plaits" of wax by placing two twisted lengths side by side but the researcher has never seen him actually braid lengths of wax as one writer, Arline Fisch,[5] suggests was done by West African casters.

Mohammed uses a number of different sized metal files of European manufacture, for filing down the brass cast when it is broken out of the mould.

Sources of Materials

In the processes of making a brass casting Mohammed uses beeswax, clay, sand, brass and aluminum, donkey dung and charcoal. The beeswax which he uses for modelling with is brought from markets around Katsina and Southern Zaria. It is sold in cakes that weigh between 2 - 3 kgms. each. The clay that he uses for the cores and investment is readily available either from the clay pits between Funtua and Dutsin-ma or more locally from the river beds around Zaria. Fine sand is also supplied from the river beds in the area. Donkey dung is collected when needed from around the university campus or neighbourhood. The charcoal is bought from the Sabon Gari market, Zaria, as is most of the scrap metal. The brass comes in the form of old ashtrays, discarded oil lamps,

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[5] Arline M. Fisch. Textile Techniques in Metal. New York, Nostrand Reinhold Company, 1975, p. 15.

water taps and pipes. Two or three small bundles of copper wire from car coils are often included with the brass.

Types of Work Undertaken

Mohammed makes non-functional ornaments, either free standing such as camels, crocodiles, warthogs and gazelles or reliefs such as the masks described in the next chapter. He also casts work from waxes made by students of the department and regularly casts work for the researcher. When working in Kaduna he found a market for his work through the traders of Zaria, Kano and Kaduna but whilst he works at the University his work remains the property of the Department of Fine Art.

CHAPTER III

MOHAMMED BUKINI GURBA

CASTING A BRASS MASK

The author told Mohammed that she was writing a book to describe his method of casting and that she would like him to make two objects. One was to be a mask, a relief form, and the other a camel and rider that would require a core. This he agreed to do and started work on the mask.

He took a lump of beeswax, warmed it by the fire and started to press it into a thin sheet between finger and thumb. This he then worked into a domed form seventeen centimetres long by ten centimetres wide. Two hollows, eye orbits, were formed by pressing the wax forms with the thumbs. This form was set aside while he modelled the features. The nose was made by squeezing a lump of beeswax into shape and the eyebrows by pinching the wax at the top of the nose into two pieces. The brows were then pressed flat. The nostrils were cut out of the wax form of the nose with a knife. The basic face form was warmed by the fire and the nose and eyebrow form was pressed onto it. With a warm knife he then worked on those details, refining them and

paring away any excess wax. Two ovoids were formed for the eyes, and attached to the basic form in the same way. A rod of wax about six centimetres long was worked in the fingers to flatten it slightly and this was pressed around one eye to form the lid. A second rod was flattened and attached around the other eye. Another lump of wax was roughly modelled into a half sphere shape and this was pressed onto the mask for the mouth. When it was in position he used a warmed knife to model it to shape. The lips were formed by cutting a horizontal line across the wax lump. The shape of the lips was modelled by cutting and pressing the wax. A rod of wax five millimetres thick was rolled out on a board with the fingers, it was pressed around the edge of the mask. The entire surface of the mask was worked over with a knife, removing wax where it was not wanted and squeezing the form to the desired shape (Plate 4). The mask was set aside while he started work on the decorative features.

Wax which had been left to warm in the sun was taken and pieces were broken off it and rolled into rods of various thicknesses on a wooden board. Mohammed rolled out four rods which were nearly forty centimetres long and one millimetre thick. Mohammed took two of these lengths, pressed them together side by side and bent them into a wavy strip. He did the same with the other two rods. One of these bands was pressed onto the mask



PLATE 4. SCRAPING EXCESS WAX FROM THE MASK

just above the rod around the edge of the mask. This went from the middle of the left ear, around the chin, to several centimetres above the right ear. The edge was completed with the other band. The wavy band was then bordered with two straight rods each one millimetre thick. The forehead area of the mask was decorated with bands of rods and wavy bands. A wavy band six centimetres long was pressed down the centre of the forehead. On either side of this eight rods were pressed to make up bands one centimetre wide. Wavy bands were attached on either side of these and both sides were bordered with a strip six millimetres wide that was composed of three rods (Figure 11). Mohammed then rolled two rods four millimetres thick and twelve centimetres long. He pressed these together, bent them to form a loop which he attached to the top of the mask (Plate 5).

Finally Mohammed pressed another lump of wax into a flat sheet which was three millimetres thick. This he cut into two stylized ear forms which he attached to the sides of the mask. The overall dimensions of the mask were twenty-two centimetres high by nearly fourteen centimetres wide. The wax form was completed.

He rolled out a further rod, six millimetres wide and three centimetres long that he attached to the base of the chin as the sprue. This stage had taken about seven hours altogether but the

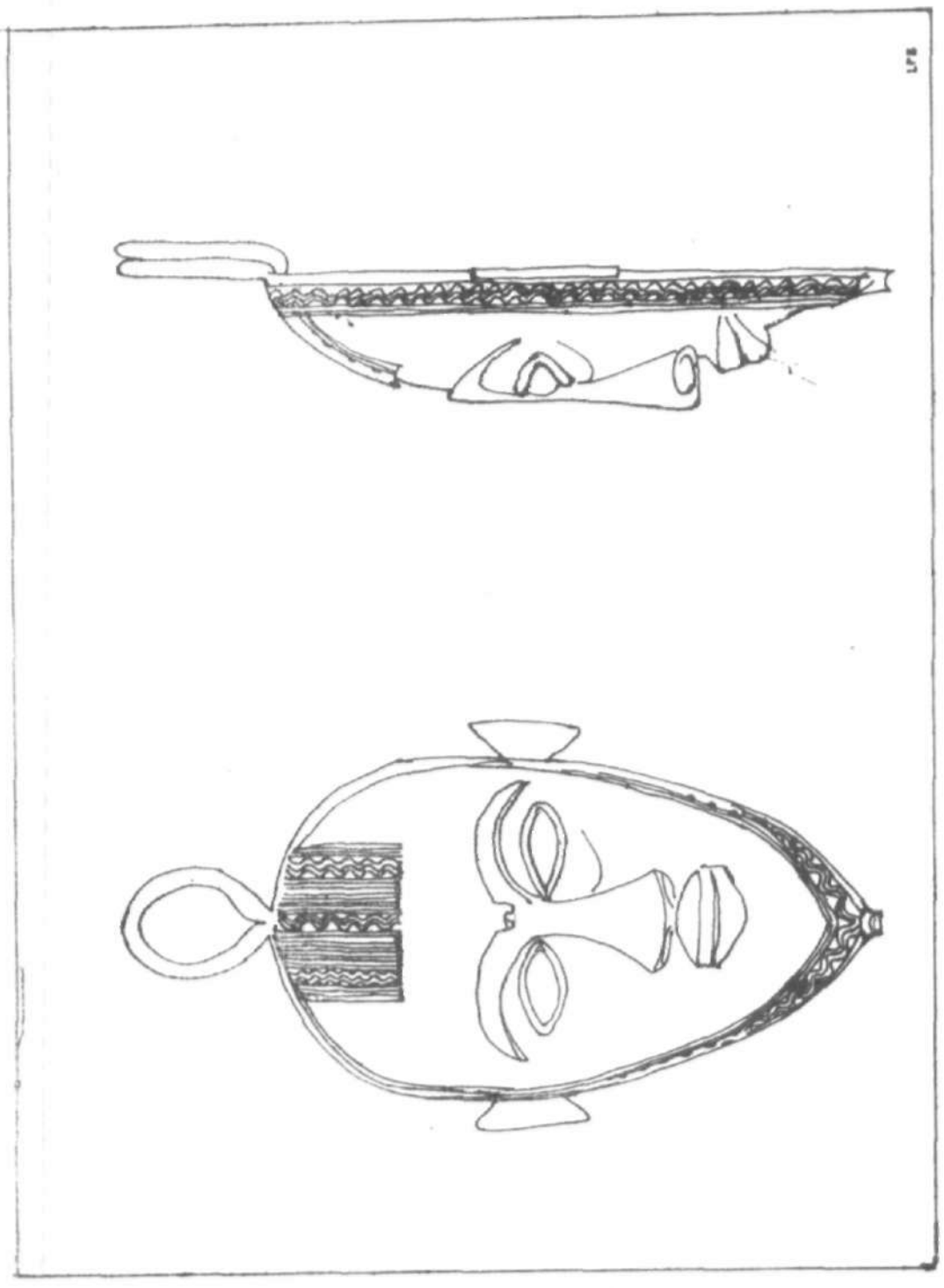


Fig. 11 -- Design with Wax Rods on Mask 1



PLATE 5. LOOP ADDED TO THE MASK

mask was not made in one day. He made the basic form and features on the first day and applied the decorative elements on the second day.

On the third day he made up and applied the first layer of investment material. For this investment he used fine wet potters clay and added to it finely sieved dry sand. He did this by sifting the sand through metal gauze onto a tin lid. He then put the clay on top of this and kneaded the two together for five minutes (Plate 6). Every so often he would pinch the clay and rub it between finger and thumb to feel the consistency. As he worked he dipped his fingers into a bowl of water to keep them wet. He also sprinkled water onto the lump of clay, as he kneaded it, to keep it pliable. When he felt that the sand was evenly distributed and the consistency of the investment was satisfactory he took a piece off the lump and pressed it firmly over a portion of the front of the mask (Plate 7). He smoothed it over ensuring it was pressed into all the depressions in the modelling (Plate 8). When the front was completely covered with an even layer of investment he turned the mask over and covered the back and sides with the investment. The end of the sprue was left uncovered. Mohammed took fifteen minutes to invest the mask which was then set aside to dry until the next day. This layer of investment was about three millimetres thick.

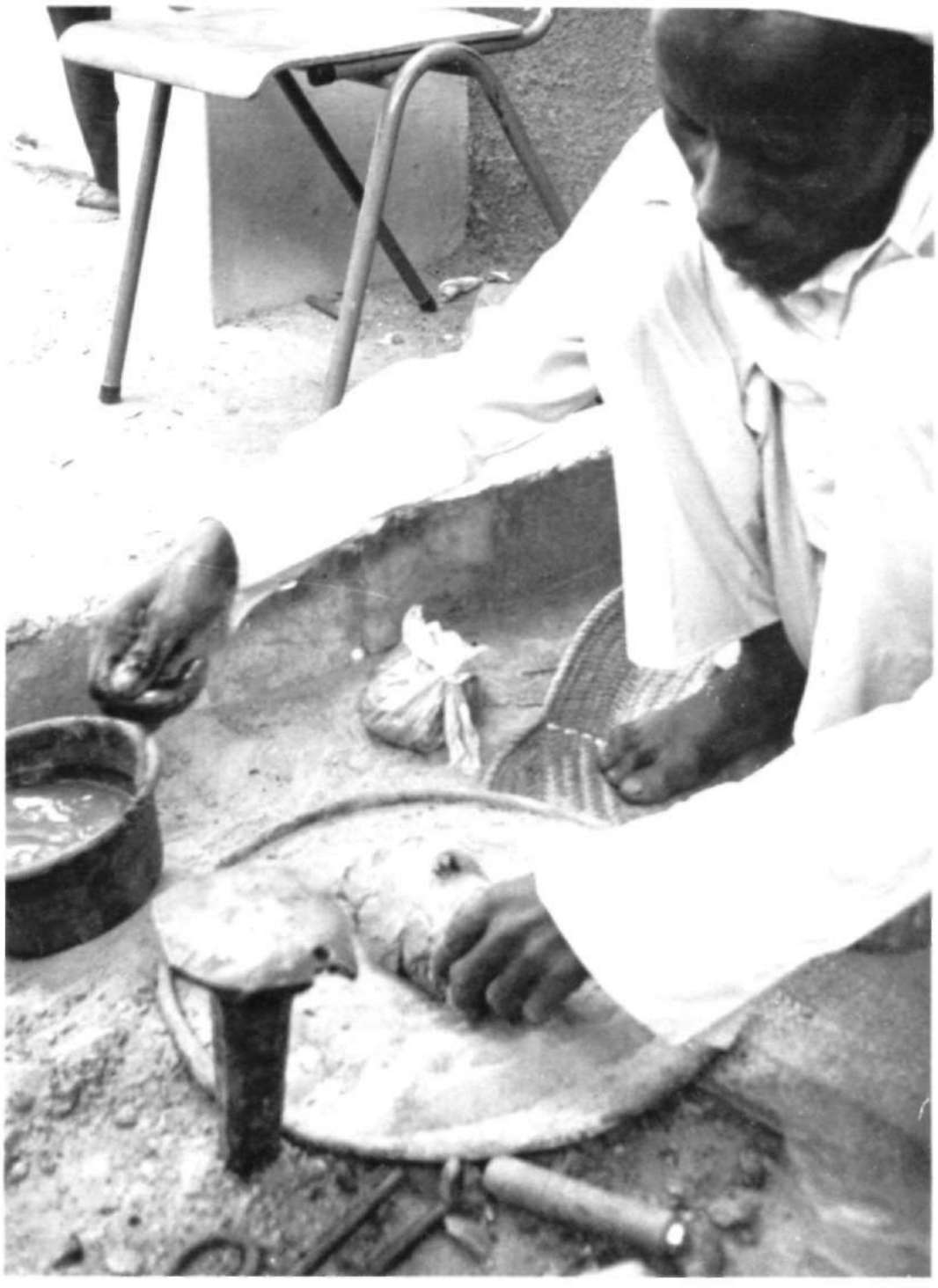


PLATE 6. INVESTMENT BEING MADE



PLATE 7. MASK BEING INVESTED



PLATE 8. INVESTMENT BEING SMOOTHED OVER

The following day the second investment coat was mixed and applied. The composition of this investment differed from the first in that it contained a higher proportion of donkey dung. It took Mohammed fifteen minutes to prepare the second investment. He first of all broke up the dry donkey dung and then crumbled it to a fine powder removing any large straws. When the dung was finely crumbled onto a tin lid fine clay was kneaded over it until the clay and dung were evenly mixed. He tested the mixture between finger and thumb and set the mixture aside while he crumbled some more dung onto the tin lid. He then kneaded the clay lump over this. By this time he had used six handfuls of donkey dung to a lump of clay that weighed about two kilogrammes. The clay/dung mixture was kneaded into sifted fine sand until the sand was evenly mixed throughout it and Mohammed was satisfied that the consistency was suitable.

The mould was dampened and some fine cracks that had formed in the first cast of investment were scraped and smoothed over before the second coating of investment was applied. Once a fine coating of investment had been pressed over both surfaces of the mask a strip of fine wire gauze three centimetres by twelve centimetres was laid over it across the brow area. Mohammed covered this with investment and a second strip of the same size was placed down the middle of the mould from brow to nose. He then covered

this with investment, except for a small piece that overlapped the first strip. A piece of thin mild steel plate of the same size was then bent to fit the contour over the mouth area. This was put into place and covered with investment. Another lump of investment was pressed over the nose and mouth area covering the piece at the brow that had previously been left uncovered. The mould was then set aside. It took Mohammed eighteen minutes to complete this second coating.

Mohammed then took a ball of the second investment material which he rolled into a shape similar to a light bulb. He pressed into the ball side of this with his thumb and worked it into a funnel shape with his forefinger in the hole and his thumb outside (Plate 9). He turned the piece over and pressed into the rod shape to make a hole right through the piece. He worked this side into a tube. This was then placed over the sprue end of the mould to form the pouring cup (Plate 10). He smoothed the investment up the sides of the sprue over the bottom of the mould. Making the pouring cup and attaching it to the mould took five minutes. The mould was set aside by the fire to dry.

With the mould set to dry Mohammed made the crucible by taking a lump of investment pressing into it with a finger and then working around it from the top down. Soon it was beaker shaped and large enough for him to work with it resting over his right hand as he



PLATE 9. POURING CUP BEING FORMED



PLATE 10. POURING CUP BEING ATTACHED TO INVESTED MODEL

smoothed the outer surface with his left hand (Plate 11). The finished crucible was between eleven and eleven and a half centimetres in diameter and seven centimetres deep. The walls of the crucible were about five millimetres thick. When it was made it was set aside in the sand, with the mould, to dry.

The next morning the mould was set sprue end down in the fire. After four minutes of blowing the bellows very gently the mould was removed and a small amount of wax was poured out into a bowl of water. The mould was replaced in the fire sprue uppermost and after two more minutes with the wax bubbling and spitting it was removed from the fire and the wax poured out into the water. The mould was returned once more to the fire, sprue down, for the remaining wax to burn out. The mould was removed and some hairline cracks that had appeared were repaired with wet investment pressed into them.

Brass scraps, tap tops, oil lamps, (Plate 12) and pieces left over from previous castings were broken up with a hammer and placed in the crucible. A few small pieces of aluminum were also added (Plate 13). The researcher was told by the caster that this would decrease the time taken to melt the brass. A length of five millimetre thick mild steel rod was then cut and bent to fit the hollow of the back of the mould. It was put into place and covered with dung investment. The crucible and mould, funnel end



PLATE 11. CRUCIBLE BEING MADE



PLATE 12. BRASS TAPS ARE BROKEN UP ON THE ANVIL



PLATE 13. THE CRUCIBLE IS FILLED WITH BRASS PIECES

down, were fitted together with the edges touching and Mohammed filled the joint with a coil of investment (Figure 12). The investment was smeared down the sides of the crucible and around the pouring cup. This process took Mohammed only three minutes. The mould, with the crucible-end down, was set in sand in the sun to dry for two hours.

When the mould was dry a small depression was made in the charcoal and the crucible pushed into it. More charcoal was piled around to fill the pit and cover the crucible (Plate 14). Parts of old enamel bowls were placed around and over the mould to form a crude cupola, (Plate 15). When these were in place Mohammed started to work the bellows. He told the researcher that one of the bellows was very old, it had been repaired many times and needed replacing so it would take longer than normal for the metal to reach melting point. After twenty minutes the enamel bowls were removed, the caster lifted the mould slightly and more charcoal was added around it. The bowl pieces were replaced and the bellows again pumped. Mohammed repeated this operation after a further thirty minutes and again after another fifteen minutes. After a further ten minutes the enamel bowl bits were again removed. Mohammed took a sharpened mild steel rod and pierced through the crucible wall with it to test the metal. When he removed the rod there was a small amount of brass adhering to

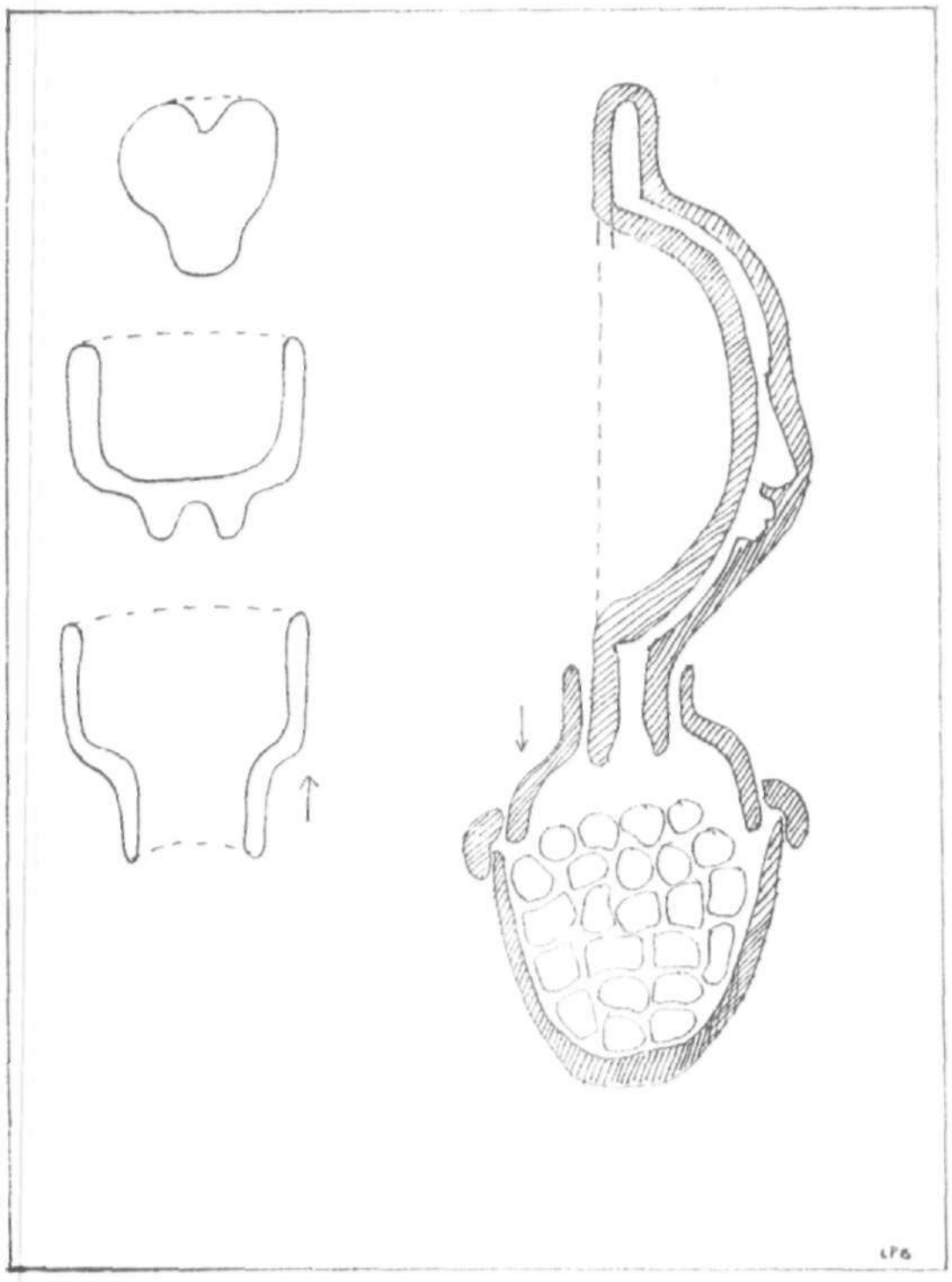


Fig. 12 -- Making and Positioning of Pouring Cup



PLATE 14. THE MOULD AND CRUCIBLE SET IN THE FORGE



PLATE 15. "CUPOLA" IN POSITION FOR MELTING THE BRASS

the tip which showed it was not hot enough to pour although nearly molten. A studio assistant was called to take over the bellows. After a further hour, during which the fire had been topped up twice with charcoal, Mohammed again tested the metal with the rod. This time a lime green flame was observed coming from the hole and the rod came out clean. The metal was ready for pouring. Mohammed lifted the mould and crucible from the fire with a pair of tongs holding it around the neck (Plate 16). He quickly plugged the test hole with wet investment before inverting the mould and crucible which he set to cool in a bed of sand (Plate 17). It took two minutes from the test to the inverting of the mould. After a further two minutes water was splashed over the crucible to cool it. The crucible was broken off from the mould by giving it a sharp blow with a hammer at the joint. The metal in the pouring cup was still molten and so the mould was left for a further eight minutes before being put into a bucket of cold water where it remained for eight minutes (Plate 18). The mould was removed from the water and Mohammed broke off the investment with a hammer (Plate 19).

The surface of the cast was brushed over with a wire brush to remove the remaining particles of investment. The inner investment was burnt black and could be brushed off quite easily. The sprue was removed with a cold chisel and hammer. The surface of the cast

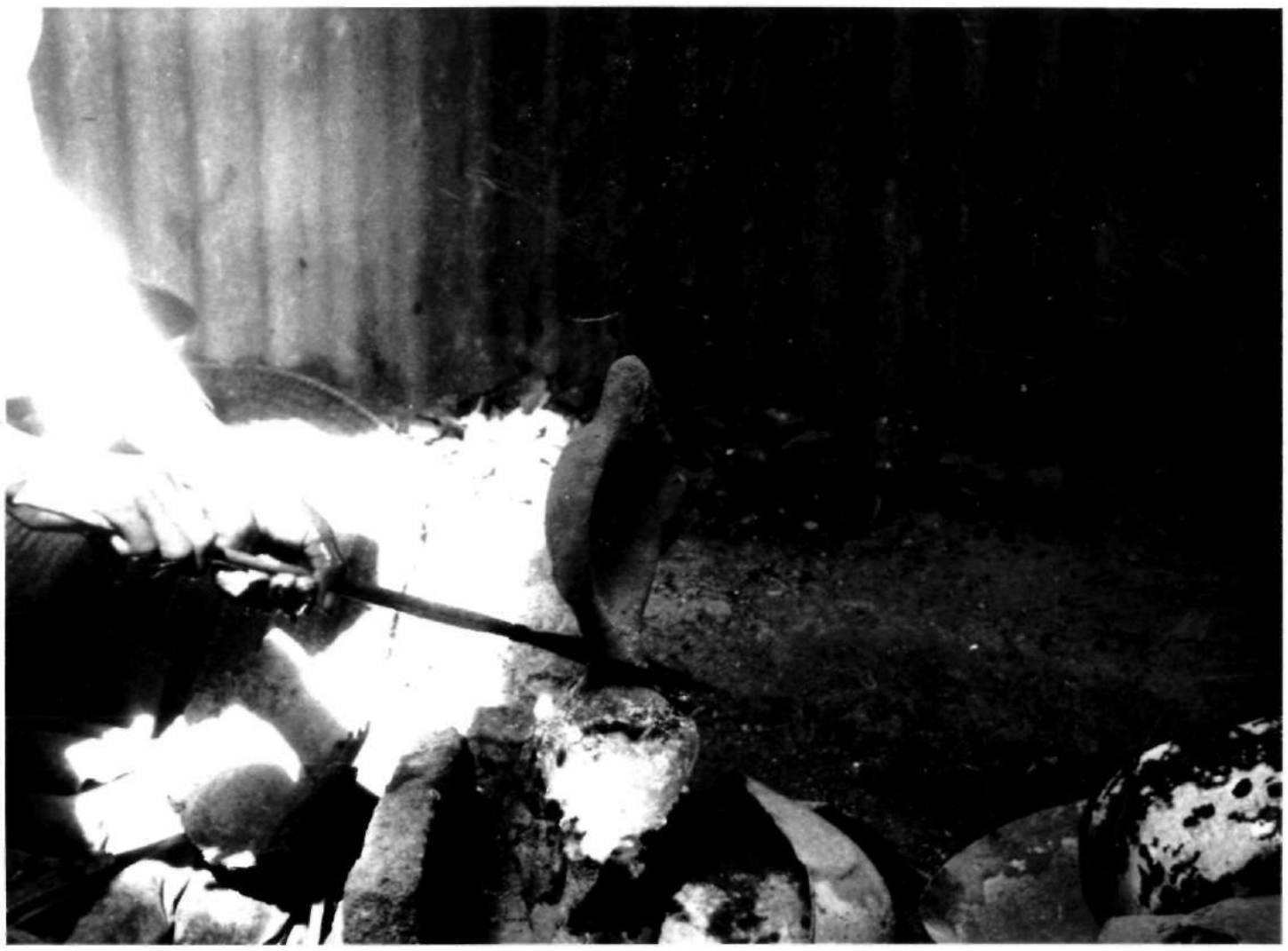


PLATE 16. MOLTEN METAL IN THE CRUCIBLE



PLATE 17. MOULD-CRUCIBLE INVERTED



PLATE 18. CAST COOLED IN WATER



PLATE 19. THE INVESTMENT BROKEN OFF THE CAST

was, in the main, extremely good. It was even possible to see the caster's fingerprints where he had pressed the ears into shape. No further work was deemed necessary on the mask except the removal of a small flash of brass that had formed on the back of the mask during casting. Two other masks were made, during the research, using the same procedure (Figures 13, 14).

Casting a Brass Camel and Rider

The second cast that Mohammed made for the researcher was of a camel and rider. Because of the size of the piece to be made Mohammed decided to make a core for the camel's body in order to decrease the quantity of brass needed in the casting and to prevent stresses occuring when the brass cooled. The core was made with dung investment. A small piece was shaped into a rod approximately 7 cm. long and 2.5 cm. thick, one end was flattened and the other curved (Figure 15). Into one side of the still wet core he stuck a short nail leaving about 1 cm. sticking out of the side. The core was set aside to dry for a day.

When the core was thoroughly dry it was placed in the forge and heated for about fifteen minutes. It was then removed and left to cool. It was a terra cotta colour. When it had cooled Mohammed warmed a lump of wax over the fire which he then pressed into a thin sheet large enough to cover the core. He wrapped the sheet around the core, pressing the nail through it (Plate 20).

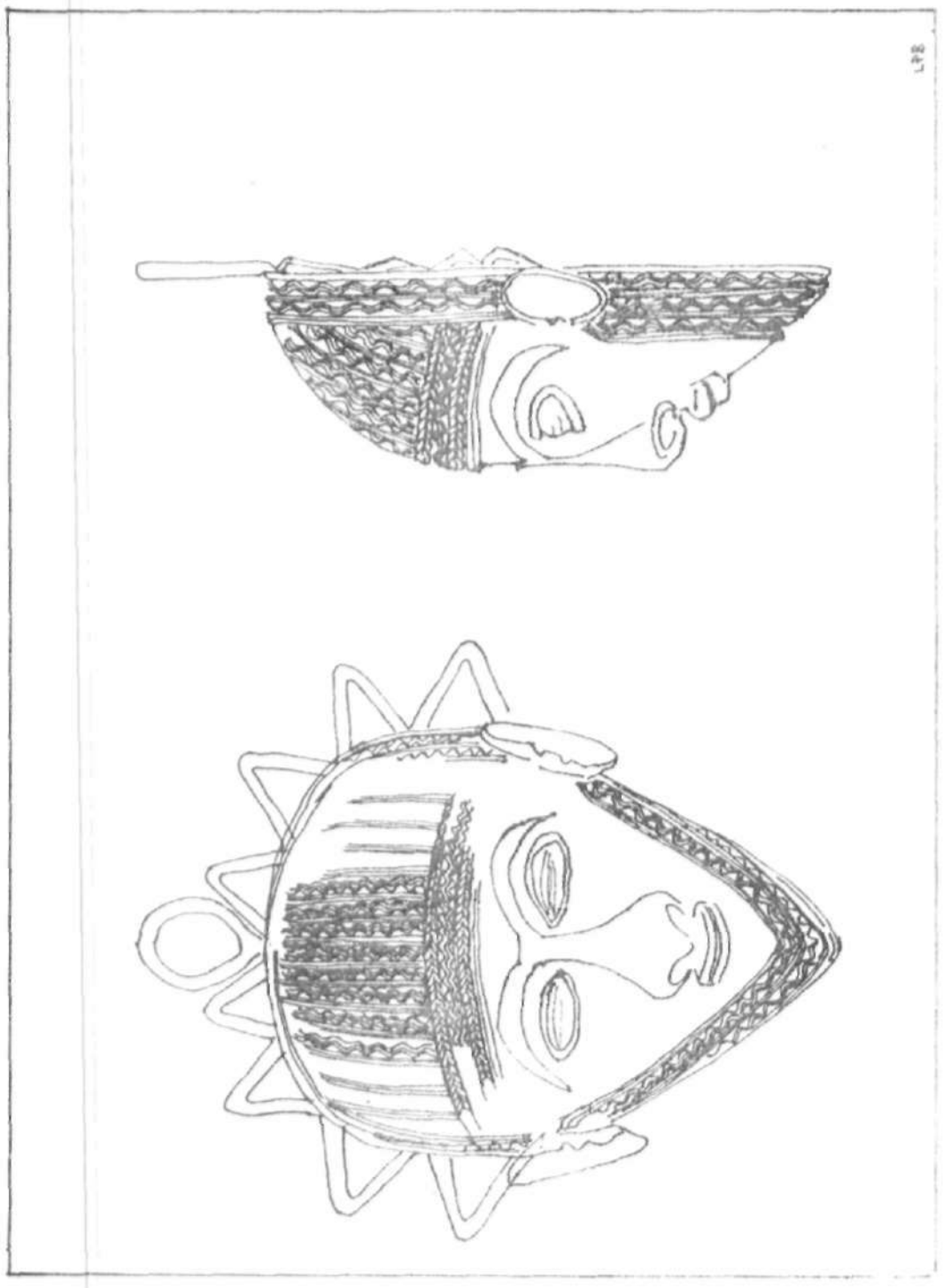


Fig. 13 -- Mask 2

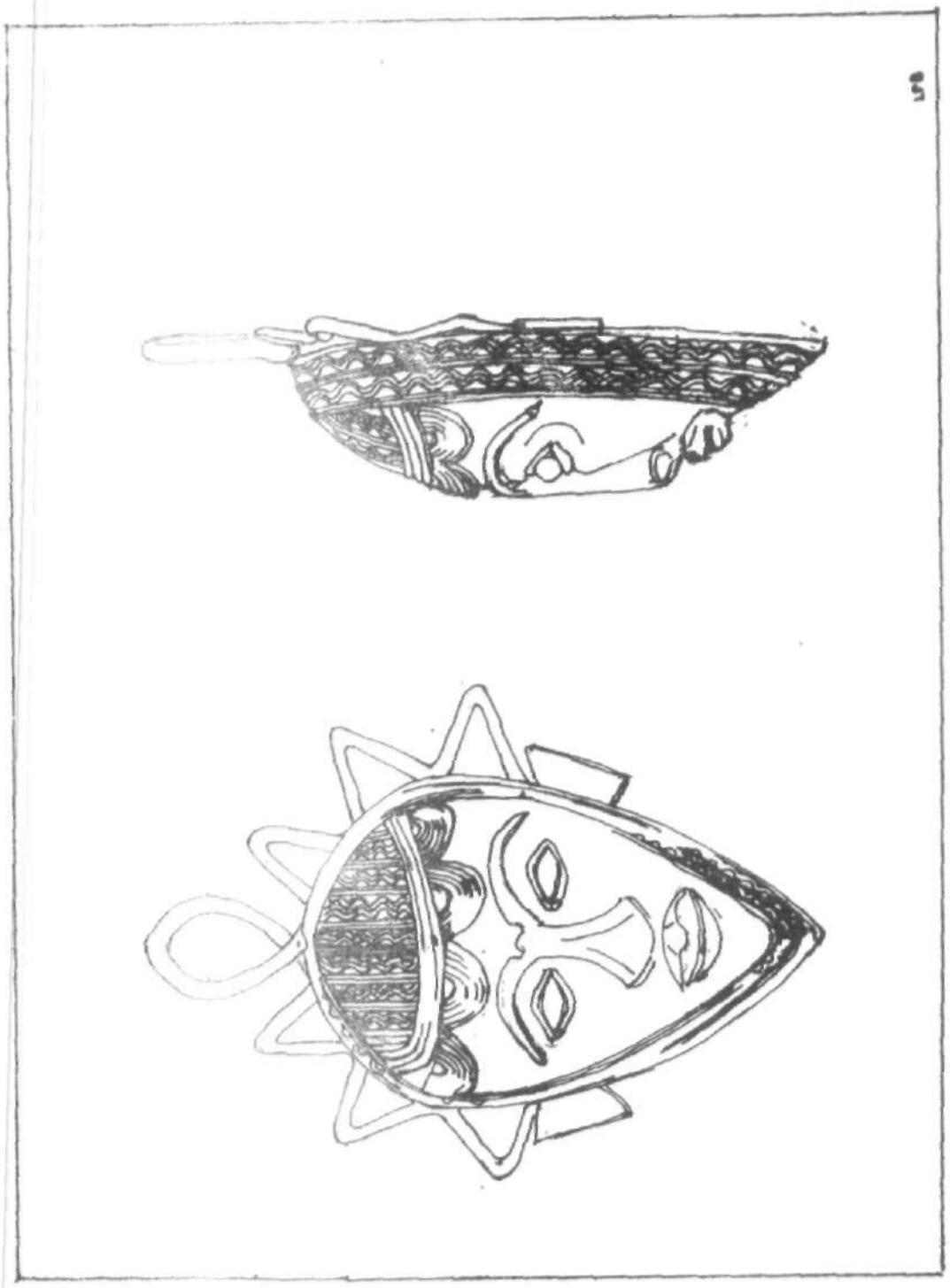


Fig. 14 -- Mask 3

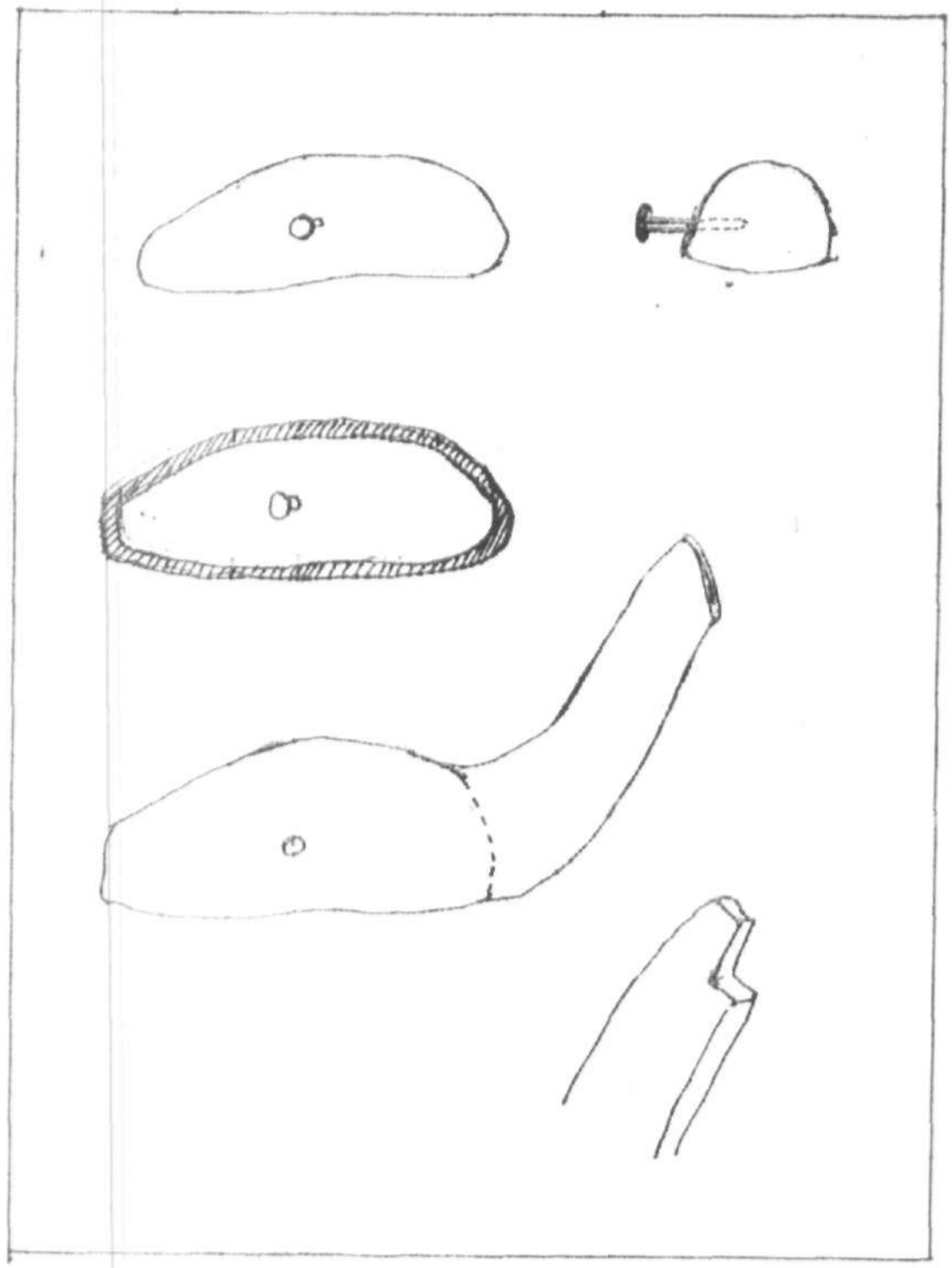


Fig. 15 -- Core and Neck of Camel

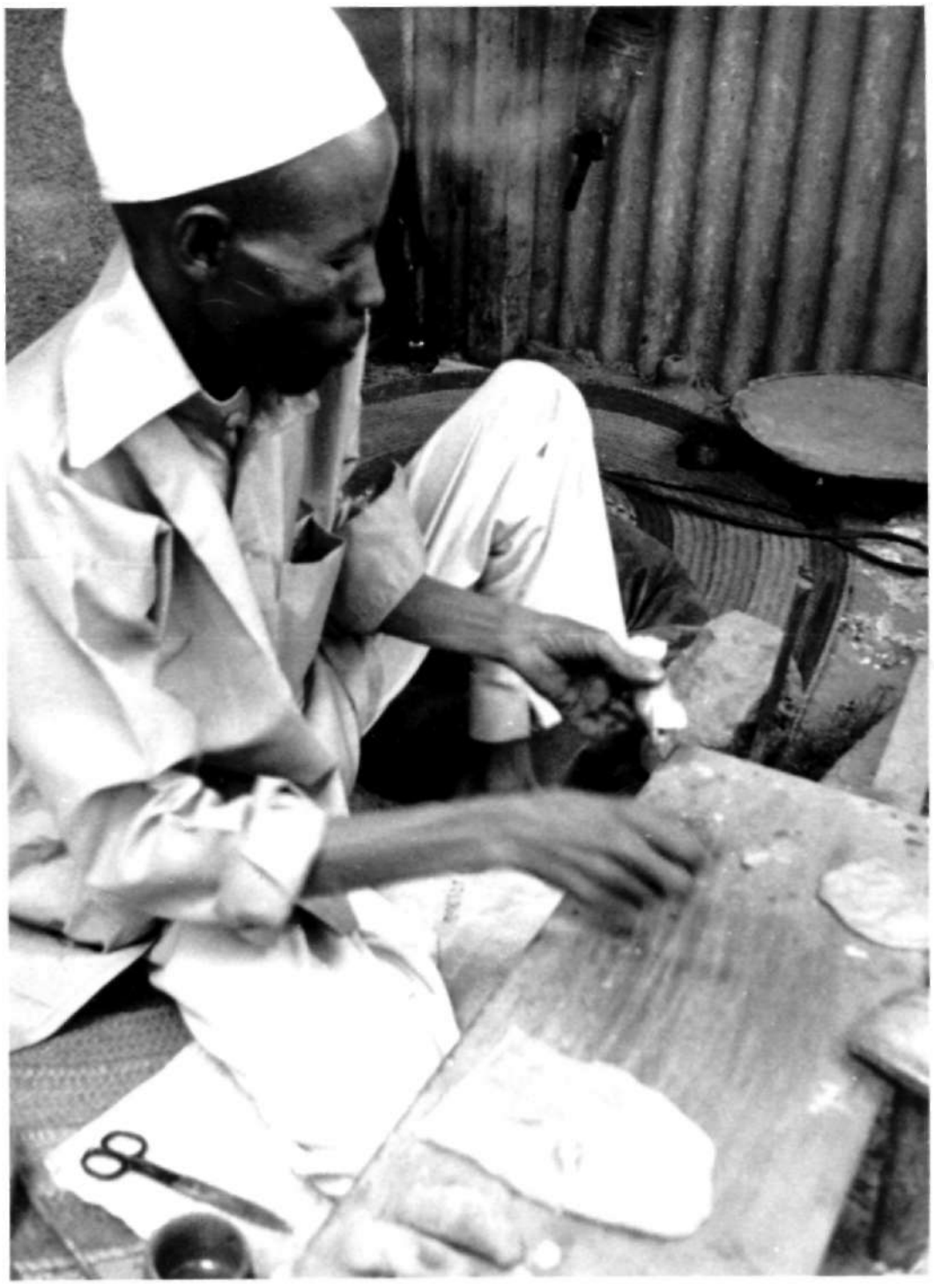


PLATE 20. THE CORE COVERED WITH WAX

The wax around the curved end of the core was pressed and twisted into a rod. A second sheet of wax was prepared and wrapped around the rod and pressed into shape (Plate 21). In these three stages, which had taken fifteen minutes, Mohammed had made the body and neck of the camel. He next rolled out a length of wax, on the modelling table, with the heel of his hand. This rod was approximately 18 cm. long and 5 mm. thick. One end of this he warmed near the fire and then flattened it between finger and thumb (Plate 22). He made a second length in the same way. When one end of each rod had been flattened they were bent to an angle of about 45°. The other end of each rod was pressed and bent at an angle of about 90° to form the feet (Figure 16). The flattened end of the leg was warmed over the fire at the same time as the hip part of the body. These two warmed areas were then pressed together. The same thing was done with the other leg. Around the hip area of each leg a small piece of warmed wax was pressed to reinforce the joint (Plate 23). When the two legs were securely attached the model was put to one side for a few moments for the wax to harden. No wires were used through the legs for support although they were very thin.

Mohammed resumed work on the model by warming the upper neck area of the model and pressing it flatter in sections. A small step was then cut out of the upper end of it. He then



PLATE 21. THE NECK FORMED



PLATE 22. LEGS ARE FORMED

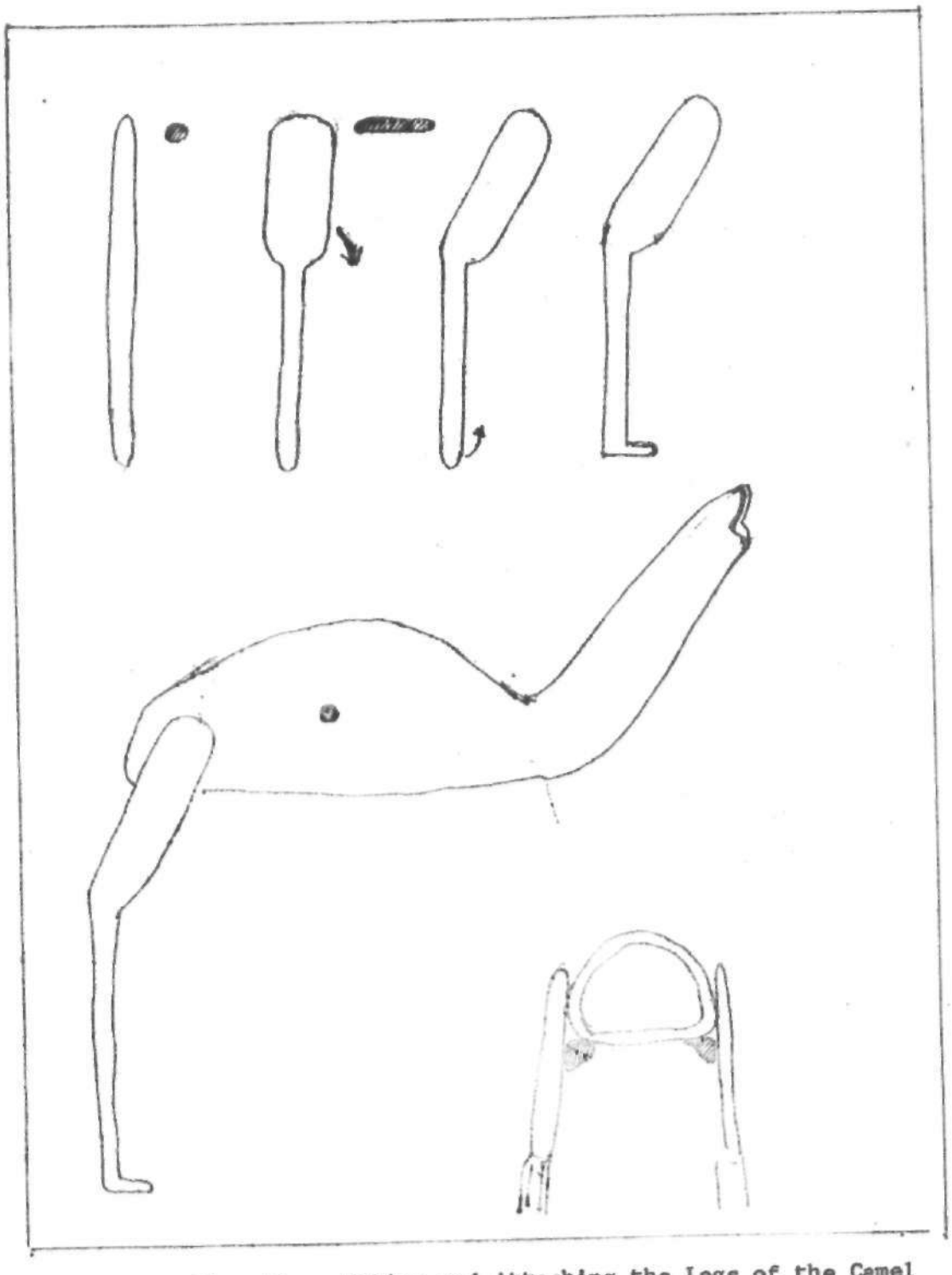


Fig. 16 -- Making and Attaching the Legs of the Camel



PLATE 23. LEGS ATTACHED TO BODY

worked down the length of the neck, shaving off excess wax with his modelling knife. The body was put to one side while he modelled the head of the camel. He took a piece of warmed wax and pressed it into a cup shape (Figure 17). This was dampened and shaped some more with the knife. Into the back of the bowl he cut a "v" shaped notch. He then made a horizontal cut through the handle shaped part to form the mouth of the camel (Plate 24). On the upper part he cut a vertical slit and with the pointed end of the knife cut nostrils either side of this slit. The end of the knife was heated and wiped clean of some wax that had adhered to it before he cut eye shapes into either side of the head. These went through the wax sheet. Mohammed warmed the back of the head and the notched end of the neck over the fire and then pressed the two parts together. The upper end of the neck was pressed over the top of the head to form a slight ridge (Figure 17). The model was set aside while he made the ears by rolling a rod of wax, pressing each end flat, and folding this flattened area slightly. The rod was then cut in half to separate the two ears (Figure 17). Mohammed trimmed the two ears so they were the same length before pressing them onto the head on either side of the ridge (Plate 25).

Mohammed next rolled out a long length of wax slightly fatter in the middle than at the ends. This was cut in two and the thicker

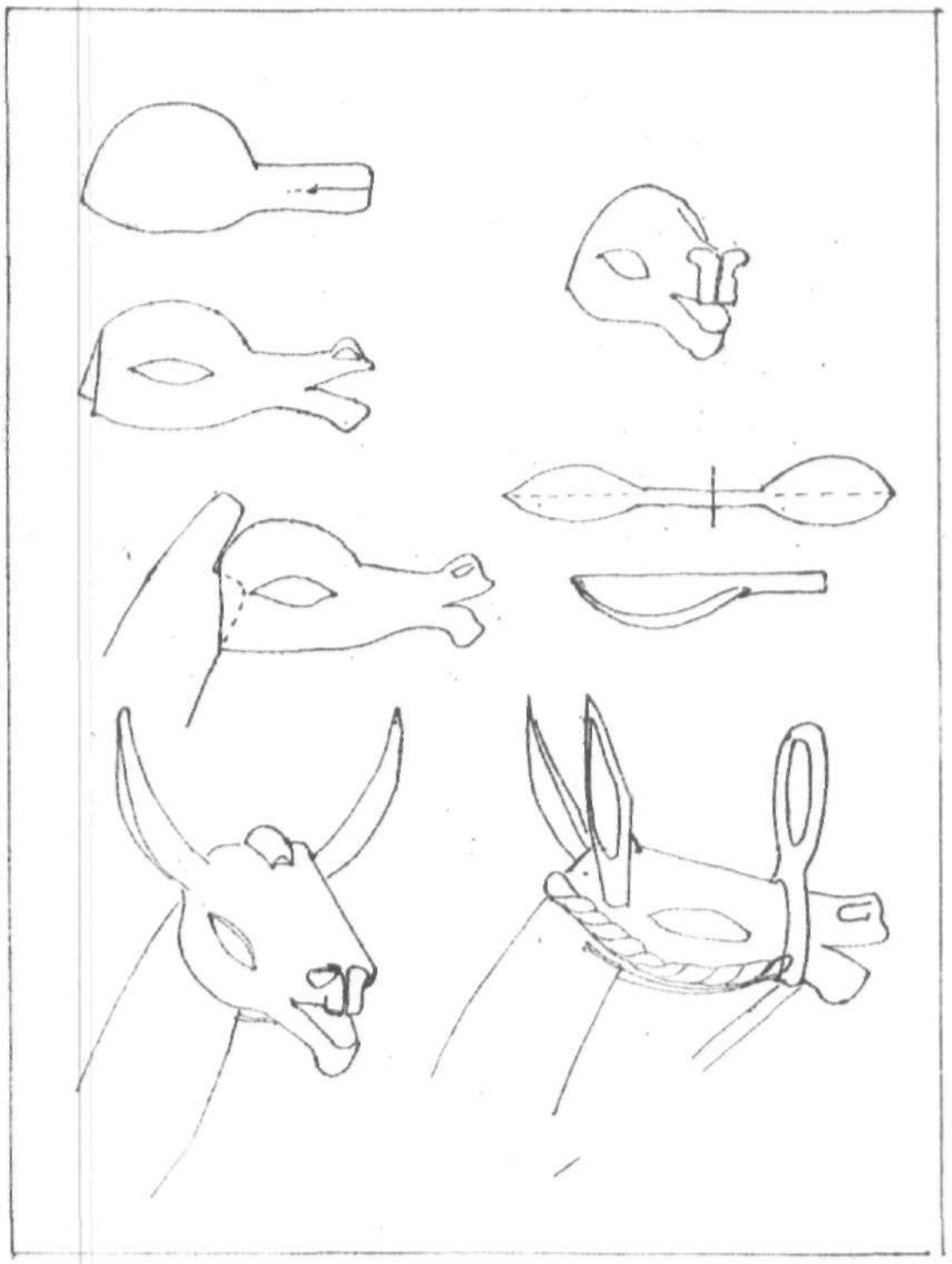


Fig. 17 -- Forming the Head



PLATE 24. HEAD FORMED



PLATE 25. HEAD AND FRONT LEGS OF CAMEL ATTACHED

upper end of each leg flattened. The narrow end of each he bent into shape for the feet. These front legs were then attached in the same way the back legs had been and the joints worked over with a knife. Another length of rod about 30 cm. long was rolled out and from this he cut a 6 cm. long length. This was flattened at one end and cut into a rough diamond shape for the tail which was then attached in the same way as the previous pieces. A second length was cut from the rod and one end was bent at right angles to the other before it was attached to the back of the camel. A third length was cut and joined to the camel 3 cm. in front of the previous piece. The remainder of the rod was rolled out more thinly and then twisted into a loop that was placed around the muzzle. Mohammed rolled out another length of wax very thinly. This he warmed over the fire and bent in half before twisting the lengths together into a rope. He joined this rope to the head of the camel from one side of the loop around the back of the head to the other end of the loop. From the initial making of the head to the stage just described Mohammed took forty-five minutes. The camel was now almost complete.

To make the rider Mohammed took another lump of wax and warmed it over the fire before modelling it into a "t" shape with a lump at one end (Figure 18). The bar of the "t" was cut through its length and the two pieces of wax opened out. A second cut

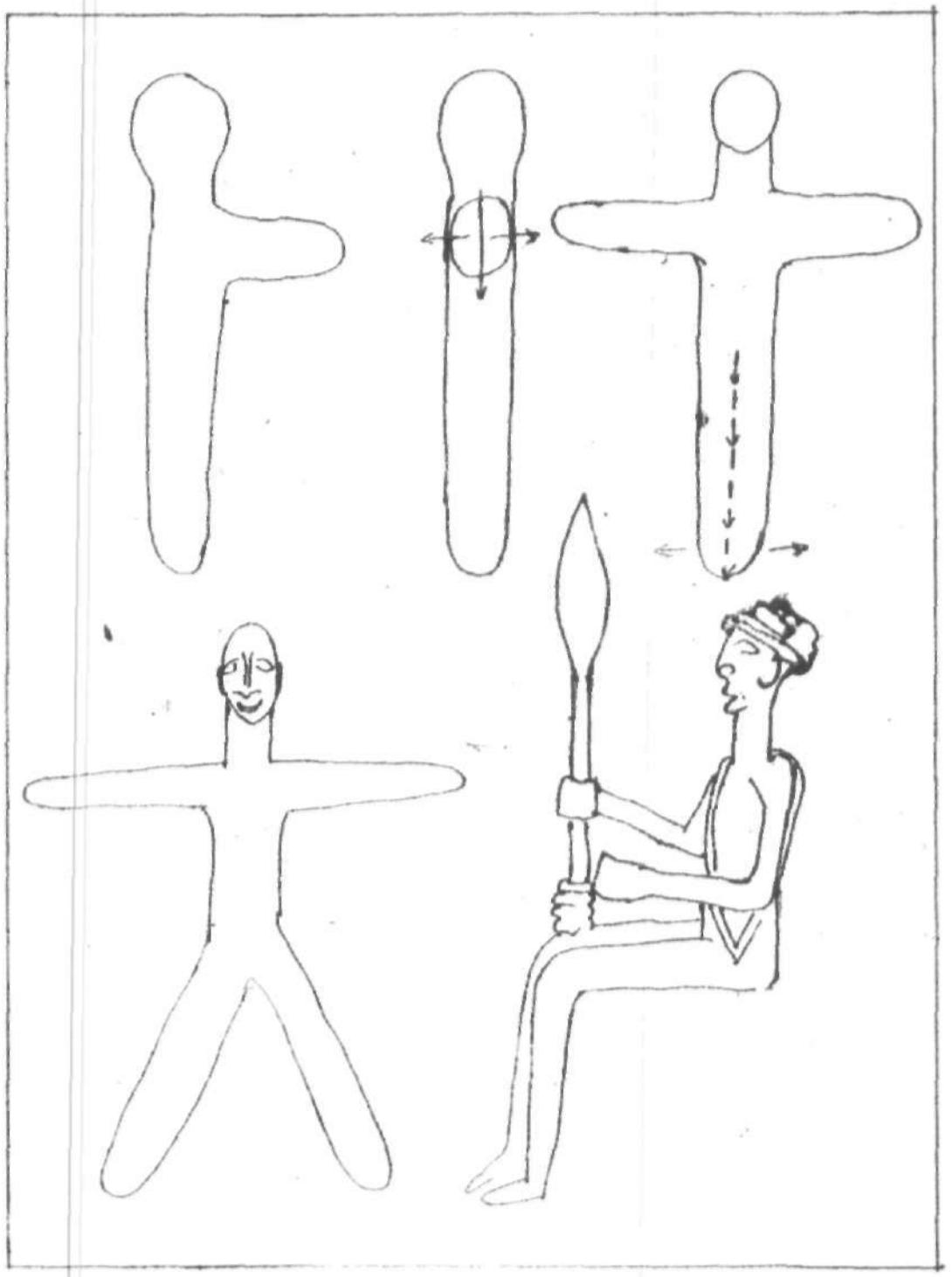


Fig. 18 -- Making the Rider

was made through the stem and the pieces opened out. These limbs were twisted with thumb and finger to lengthen them before they were bent into shape. The lump at the top was modelled into a head and face with the modelling knife (Plate 26). Around the top of the head Mohammed coiled a finely rolled rod to represent a turban. He warmed another piece of wax and pressed it flat. This was trimmed to an oblong shape and two notches were cut at the middle of the two long sides. This formed the saddle that was pressed over the camel's back between the two rods which fitted into the notches that had been cut. A smaller piece of wax was flattened out into an oblong and pressed over this. Mohammed then made a spear by rolling out a rod, flattening one end which was cut to represent the spear head and he coiled a fine rod around the other end. The spear was joined to the rider who was then placed on the saddle (Plate 27) and pressed to join it to the camel. A long thin rod was rolled, doubled over and attached from one side of the camel's head to the rider's left hand. A final rod was rolled and pressed over the rider's right shoulder and under the left arm.

The modelling of the camel and rider completed, Mohammed made the sprue from a thick rod which he bent and attached to the top of the tail and up to the saddleback (Plate 28). The work on the camel and rider took a total of one hour and fifty-five



PLATE 26. RIDER FORMED



PLATE 27. THE RIDER ON THE CAMEL



PLATE 28. SPRUE ATTACHED

minutes.

Immediately he had completed the modelling Mohammed mixed the first investment. This was prepared in the same way as for the mask with finely sieved sand and clay. Mohammed pressed this around the model ensuring that it went into all the undercuts and around the nail sticking out from the body under the saddle. He covered the entire model except for the end of the sprue with the investment which was about 4 mm. thick. It took about twenty minutes to invest the camel and rider which was put aside to dry until the next day.

The following day the second investment was mixed in the same way as for the mask. Before applying this mixture Mohammed went over the first investment dampening it and working over some hairline cracks that had appeared. When he had mended these he proceeded to apply the second investment cast around the saddle area. He then coated the underbelly, the front and back legs and around the sides of the sprue. He cleaned off the free end of the sprue before covering the back, head and shoulders of the rider. A length of investment was then rolled and pressed under the camel's neck. Finally the top and front of the camel's head was covered with investment. The entire process took fourteen minutes to do. The invested model was then put to one side (Plate 29).



PLATE 29. CAMEL BEING INVESTED

Mohammed took a piece of 5 mm. diameter mild steel rod and bent it on the anvil to fit under the neck of the camel (Figure 19). This was put into place and covered with investment. A second metal rod was cut and bent to fit along the back of the rider and the back legs. This was placed in position and covered with investment. The metal was again put to one side while Mohammed made the pouring cup which was fitted in the same way as that for the mask. A crucible was formed from the remaining investment material and put aside to dry. A third reinforcing rod was set onto the model between the feet of the front and back legs. This was made of 5 mm. diameter mild steel rod and was held in place by lumps of investment pressed around the feet (Plate 30). The invested model was put in the sun to dry until the next day.

When the model had partially dried the end of the sprue was cleared of any investment sticking to it before it was placed on some lighted wood scraps in the forge. The invested model was placed sprue end down (Plate 31). After a few minutes it was lifted from the fire and the melted sprue of wax poured out into a bowl of water. The mould was replaced in the fire with the pouring cup up. It was left in the fire until the wax bubbled. The mould was removed from the fire with tongs and more wax poured out (Plate 32). It was replaced in the fire for a little longer and then the wax poured out again. This was repeated until all

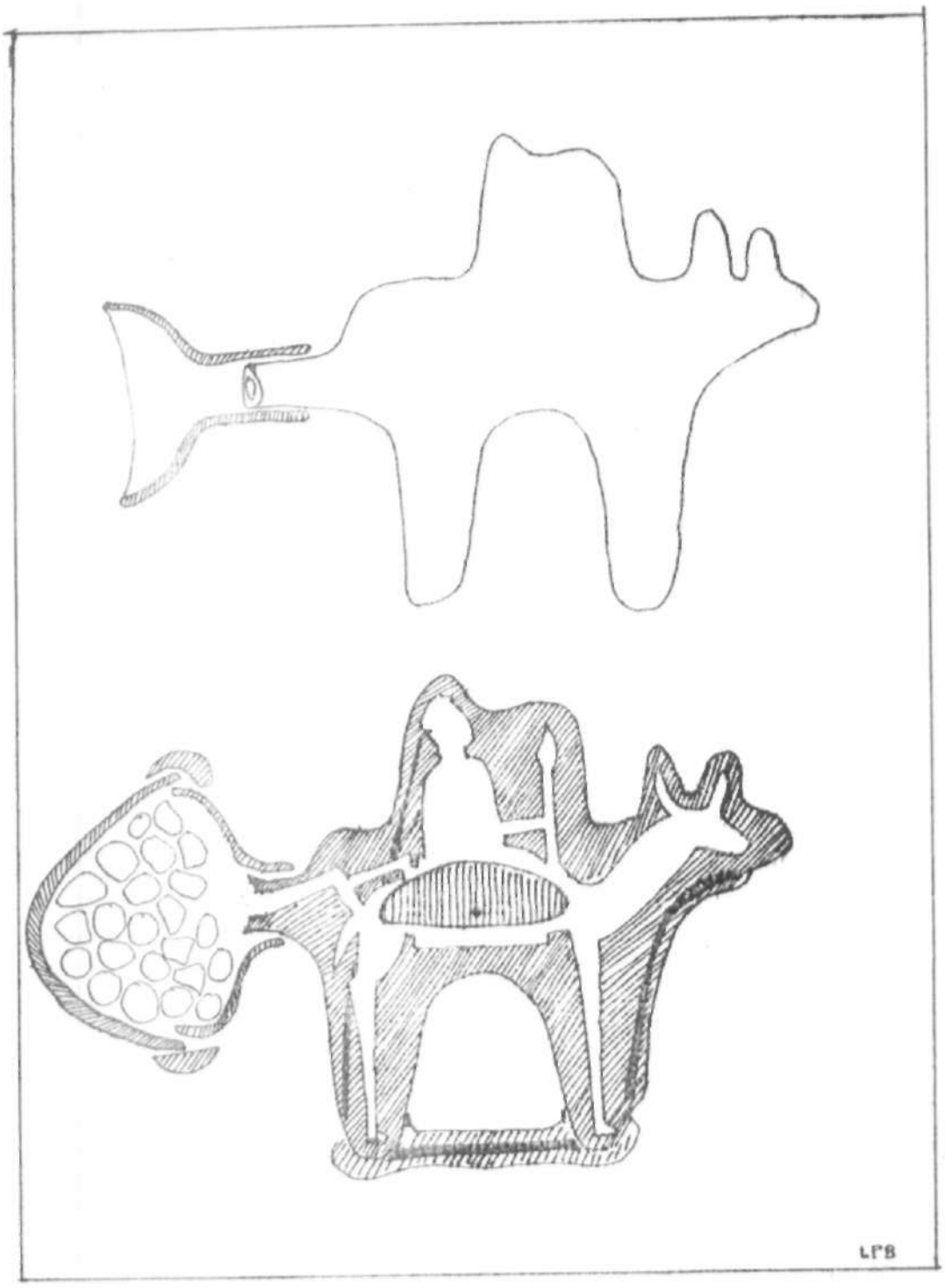


Fig. 19 -- The Camel Invested and Reinforced



PLATE 30. METAL REINFORCEMENT RODS BEING ATTACHED



PLATE 31. BURNOUT OF WAX



PLATE 32. WAX POURED INTO COLD WATER

wax was "lost" and the mould then set aside.

A number of brass taps were put into the fire until they were red hot. They were lifted out and broken up into small pieces with a metal mallet. The pieces were cooled and then heaped into the crucible. Mohammed had prepared some dung investment, he took a lump of this and rolled it into a thick coil (Plate 33). He placed the mould pouring cup end down over the brass filled crucible (Plate 34) and wrapped the coil of investment around the joint (Plate 35). The rest of the crucible was covered with dung investment after which the mould and crucible were set aside to dry, crucible-end down embedded in sand, for two hours.

After the mould had dried, in the sun, for two hours Mohammed placed it, crucible down, on the lighted charcoal in the forge (Plate 36). More charcoal was piled around it. Pieces of enamel bowl were placed around the forge and Mohammed worked the bellows. After twenty minutes he removed some of the bowl pieces and added half a head pan of charcoal to the furnace. He pumped the bellows for a further twelve minutes before again removing the bowls, lifting the mould slightly and adding more charcoal. By this time the charcoal in the furnace was red hot. He replaced the bowl pieces and worked the bellows for a further ten minutes after which he tested the metal by twisting a sharpened rod through the wall at the top of the crucible (Plate 37). He added more



PLATE 33. A SAUSAGE OF INVESTMENT IS MADE



PLATE 34. MOULD HELD OVER CRUCIBLE



PLATE 35. MOULD AND CRUCIBLE LUTED



PLATE 36. MOULDS PLACED IN THE FURNACE



PLATE 37. TESTING THE METAL

charcoal, replaced the bowl pieces and worked the bellows for another thirty minutes. Mohammed removed all the bowl pieces lifted out the mould, (Plate 38), plugged the test hole with wet investment and inverted it (Plate 39). The mould, now with the crucible uppermost was put aside on a pile of sand and broken crucibles and left to cool for fifteen minutes (Plate 40). Mohammed sprinkled cold water over the top of the crucible, knocked the side with pliars and lifted off the detached crucible (Plate 41). The mould was left to cool a little longer before being carried in tongs to a bucket of cold water in which it was immersed (Plate 42). When the water had stopped bubbling, the mould was removed from the water and the investment was broken off the cast with a hammer (Plate 43). Mohammed removed the sprue with a cold chisel (Plate 44) and detached some fins that had formed with pliars. He filed off the back of the canal where the sprue had been. The cast was brushed with a stiff wire brush to remove the residue of investment. The model was finished. Mohammed spent nearly an hour cleaning off the cast after removing the investment. The standard of cast was extremely high and needed very little finishing.



PLATE 38. MOULD REMOVED



PLATE 39. MOULD INVERTED



PLATE 40. SET ASIDE TO COOL



PLATE 41. CRUCIBLE REMOVED

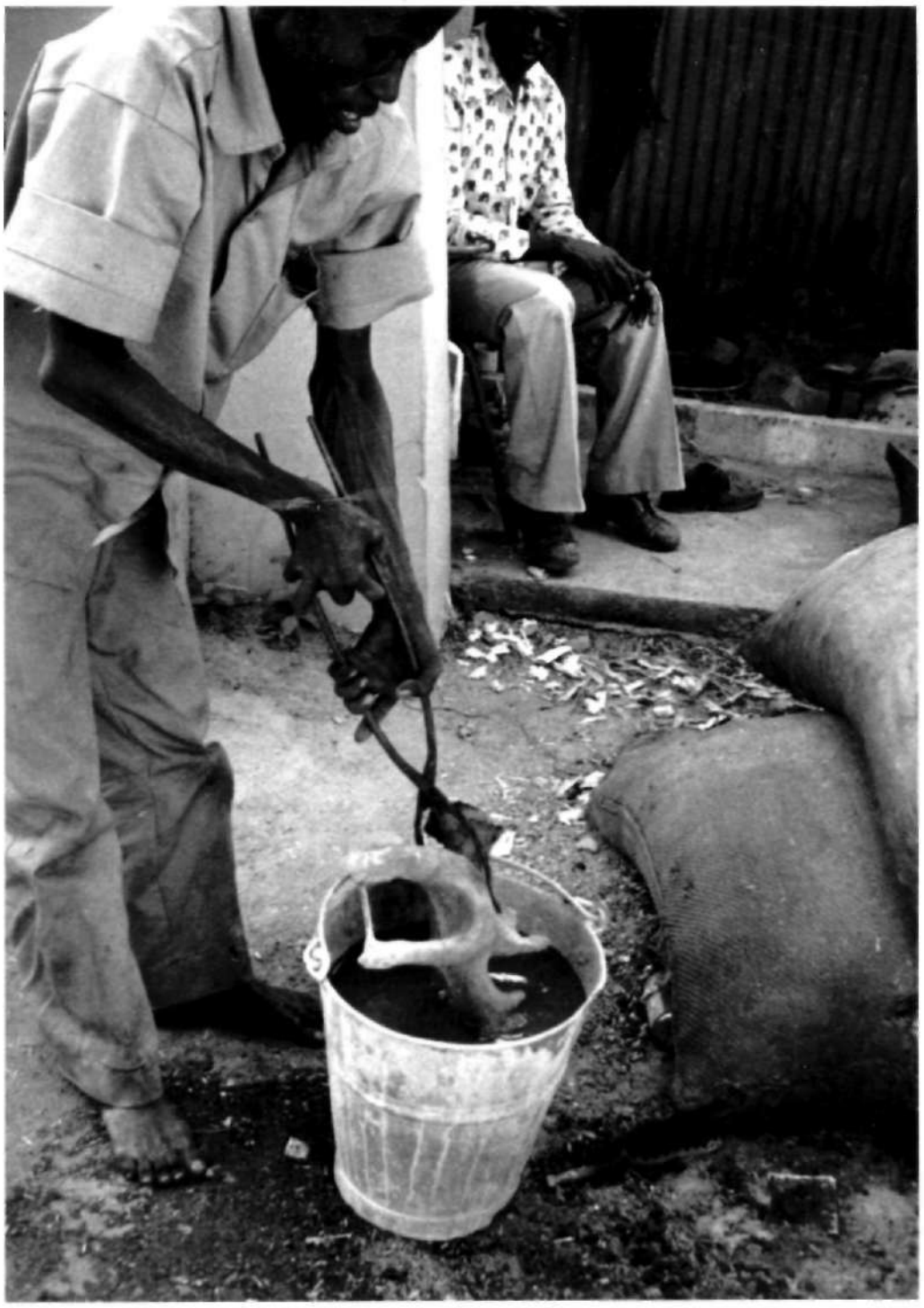


PLATE 42. MOULD COOLED



PLATE 43. THE INVESTMENT IS BROKEN OFF



PLATE 44. REMOVAL OF SPRUE

CHAPTER IV

AHMADU

A Biographical Note

The second caster who the researcher watched at work was Ahmadu, a Bouzo from Tchin Tabaradan north of Tahou in Niger. The Bouzo is the slave caste of the Tuaregs. Ahmadu is one of the Inaden or Enad caste which is a general term for artisans of various types according to Gabus. These are the craftsmen who work in wood, the smiths and the leatherworkers.[1] The men of the "inadane-tivoli" caste make silver jewellry as well as knives, swords, daggers, razors and scissors.[2] Francis Rennel Rodd writing over fifty years ago writes "To-day the smith is only respected for his skill. The position is usually hereditary

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[1] J. Gabus. "Au Sahara" A La Baconnière - Neuchatel, 1958, p. 331. "... et se répartissent en trois groupes de charactère professionnel: les Inadane - talak qui traivaillent le bois, --; ..., les Inadane - tizoli; des forgerons; les Itabaitaibayane ou Taurana, dont la spécialisation est le travail du cuir..."

[2] Ibid. p. 332. "Les hommes faconnet des bijoux en argent et en ciuvre, des fourreaux de poignards, do takouba, des selles de chameau, puis des armes: poignards, dagues - bracelets, takouba, lances et des instruments tels que: rasoirs, ciseaux. Les femmes se réservent le tannage et autre travaux de cuir: sacs, coussins, annulettes, portefeuilles.

and includes the duties of blacksmith, jeweller, carpenter and farrier."[3] Ahmadu comes from a family of smiths but at the time the researcher first watched him cast he was working alone except for occasional aid at the bellows from one of the Tuaregs who met at his workshop. Ahmadu was working as a "maigardi" (watchmen) in Zaria where some new houses were being built but has since been joined by two brothers and moved to another site. Ahmadu who is probably in his late twenties is unmarried but intends to marry a woman of his own caste who is gifted in leatherwork when he can afford the bride price as this is the custom.

The Workshop and Tools

Ahmadu's workshop was a three sided lean-to shack against a building contractor's store shed which formed one of the sides. It was about 3 metres long by 2 metres wide. The short side wall was not completely closed over, a gap was left on the far side for a draught to pass through. Ahmadu set his mat against the store wall and kept his toolbox in the corner formed where the short wall extended from the store. His hearth and anvil were in front of the mat and beside the toolbox was a large log that was sometimes used as a form of anvil (Figure 20). The hearth which was about 20 cm.

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[3]Francis Rennell Rodd. People of the Veil. Macmillan, 1926, p. 229.

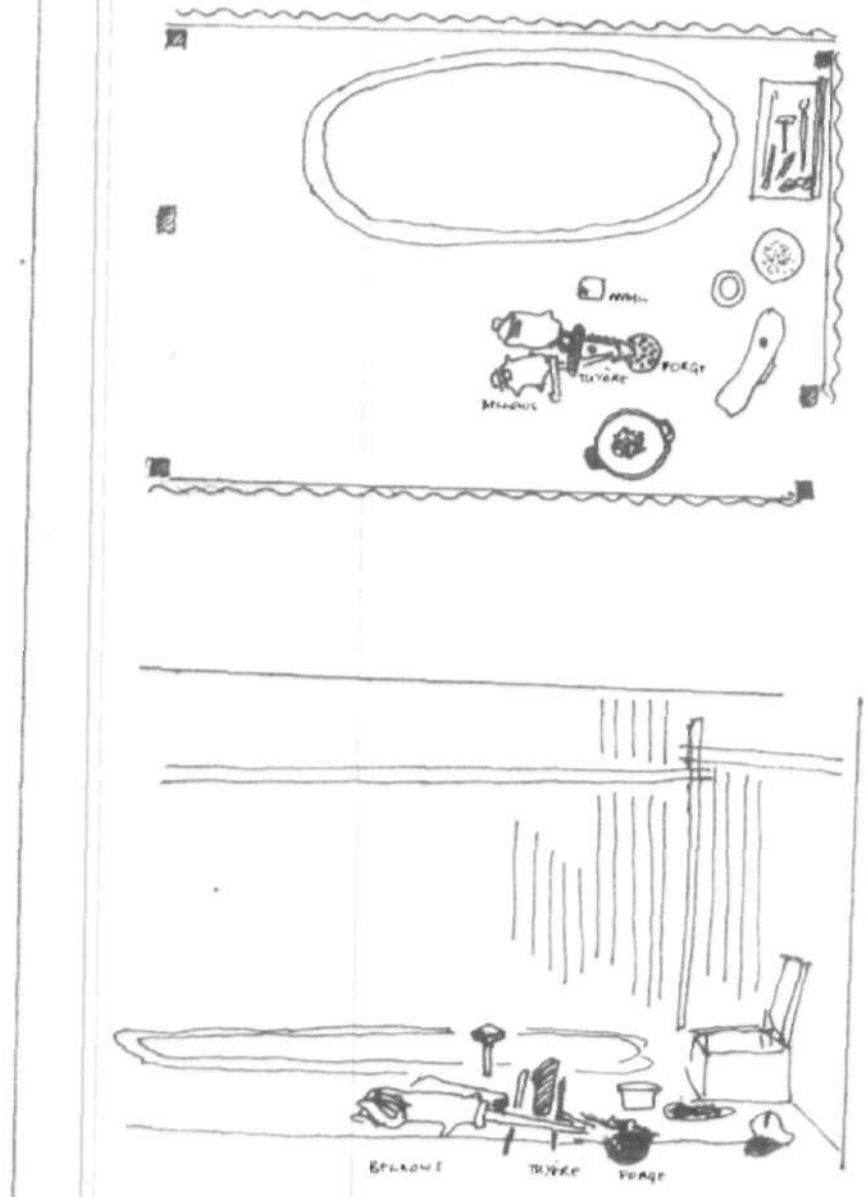


Fig. 20 -- Plan and Cross Section of Ahmadu's Workshop

in diameter was not so sophisticated as that of Mohammed Bukini. It was in fact no more than a depression scooped out of the sand and filled with charcoal. The tuyère which was a cone shape formed from thin metal plate was partially covered by the charcoal. The bellows which were of exactly the same type as those used by Mohammed Bukini were held in place by a large stone lodged over the wooden heads. This was held in place by an old wood rasp stuck upright in the ground between the pipes on the fire side and by two upright steel rods either side of the wooden heads. The anvil beside the hearth was also of the type used by Mohammed Bukini. Rodd describes this type as "like a huge horseshoe nail planted in the ground."[4]

Like Mohammed, Ahmadu had a number of tools of European manufacture. Chief among his imported tools are crucible-tongs and flat metal files. Ahmadu also had a ball pein hammer and a flat faced cross pein hammer with a square neck. The cold chisel that he used for removing the sprue metal was made from a length of metal rod. More specialized tools that Ahmadu used were a ring mandrel, a tapering rod of metal over which he shaped rings, an engraving tool for cutting decorative lines in the ring surface and a wrench that he used for holding the ring on the anvil as he engraved it. He also had a saw that had been handmade from a flat

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[4] Ibid. p. 229.

length of metal. This was used for cutting a groove in the ring prior to inlaying. Ahmadu also had a number of small square and round section files that he used for filing the rings. He had a number of other tools such as nail pincers but he did not use them during the casting process. He had a thin wooden stick that he used to remove impurities from the surface of the molten metal and an enamel bowl for holding water in which the hot cast was cooled. Ahmadu made his crucibles as he required them.

Source of Materials

The expendable materials that Ahmadu used, wax and charcoal, are available in the local market. Other materials such as sand and clay are available from around the area of the workshop. Ahmadu has made a collection of useful scraps, broken plastic from water closet seats, the red reflectors from cars or motorcycles and pieces of metal lock, which he uses for inlays or for the handles of the daggers he makes. Tuareg jewellry is nearly always of silver[5] as gold is disliked and believed to be unlucky.[6] The client usually provides the metal to be used by the smith in the form of

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[5]J. Gabus. Au Sahara, p. 48. "C'est le seul 'metal pur' authorise par le Prophète et il a la vertu d'une benediction. C'est pourquois la plus grande partie des bijoux sahariene sont en argent obtenu par la fonte de pieces anciennes: Napoleon, thalar, douro, écus italiens..."

[6]Ibid. "L'or, ce metal est plutot craint et n'est presque jamais porte chez les Tauaregs ou il a le reputation de,attirer le malheur."

coin silver.[7] Ahmadu will buy Maria Theresa thalers, an Austrian coin still prized in the desert for its purity, for the client. These are usually obtained from Funtua market, (a district town sixty-four kilometres from Zaria), but it is normal for the client to bring the metal.

Types of Work Undertaken

Ahmadu makes a variety of jewellry, by forging as well as casting, such as earrings and rings. These he nearly always copies from a traditional pattern. He also makes daggers and mends swords for other "maigardis".

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[7]Rene Gardi. African Crafts and Craftsmen. Van Nostrand Reinhold Co., 1969. p. 58.

CHAPTER V

AHMADU

Casting a Silver Ring. 1.

Day 1. 9:30 - 10:45

The researcher asked for a silver ring to be made using the lost wax method. As a model a ring worn by a Fargai at Ahmadu's workshop was chosen. A number of rings were tried on by the researcher to find the approximate size.

Ahmadu took a small quantity of beeswax and after warming it for a few seconds, near his fire in order to make it pliable, started to model the ring (Plate 45). This he did by rubbing and squeezing the wax into the right length to go around the finger, bending it round and joining it where the two ends met. The wax ring was then tried on by the researcher. It was too small and so the wax was squeezed some more to make it slightly too large to allow for shrinkage in the casting. When the general shape was made the ring was modelled more precisely. An extra piece of wax was added to what was to be the patterned top surface and the whole was smoothed over with a knife blade warmed in the fire. None of the decorative features had been modelled in the wax,

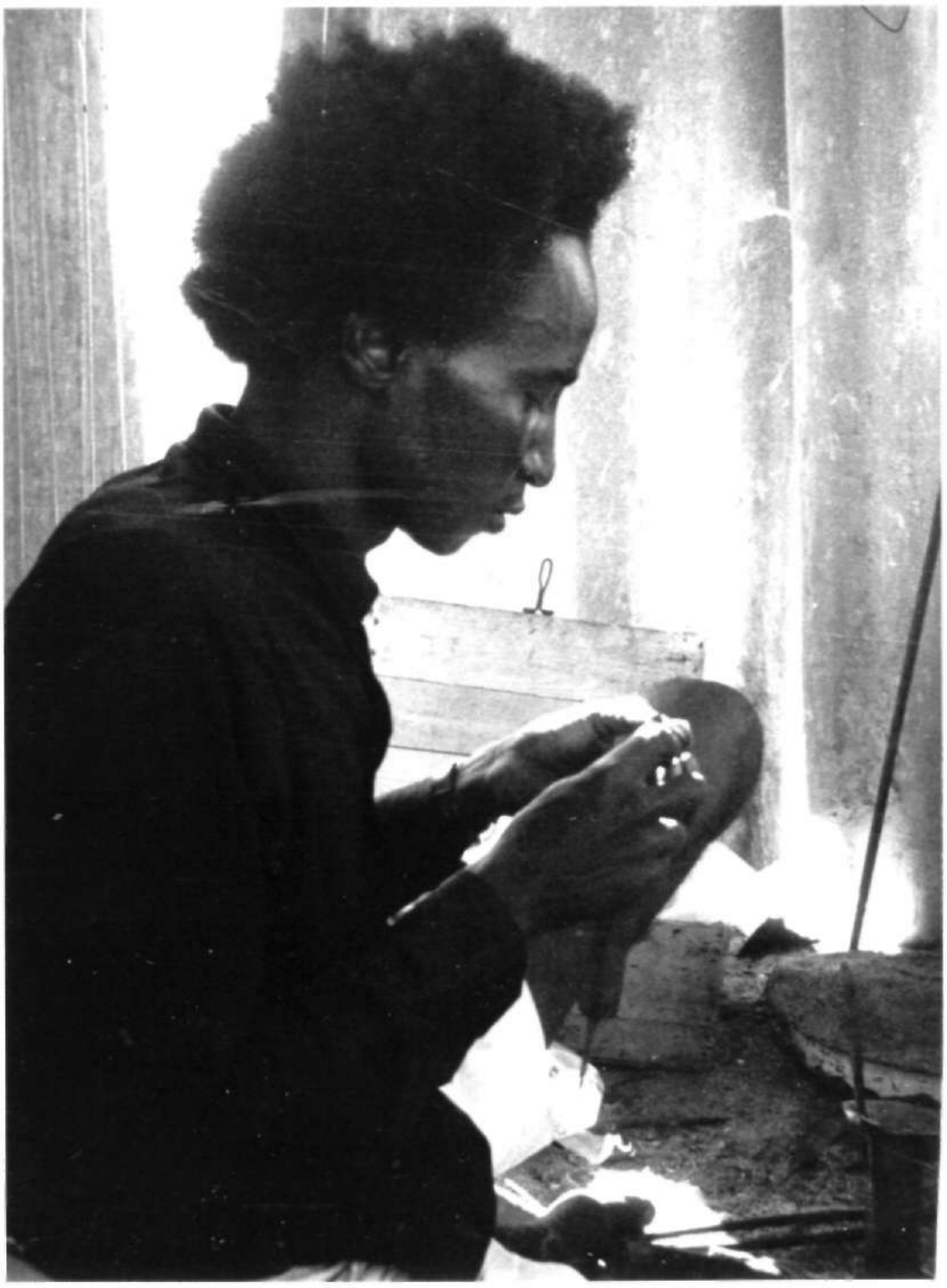


PLATE 45. AHMADU MODELLING THE RING

only the general shape of the ring.

When the ring had been modelled to the caster's satisfaction, the sprue was added (Figure 21). The sprue was a short length of wax joined to the ring at the bottom edge. It was joined by warming that area of the ring and one end of the wax rod and pressing the two warmed areas together. When this had been done the wax ring was put into a bowl of cold water to harden up while the investment was prepared. The preparation of the ring took forty-five minutes.

The investment was made with fine wet clay. The quantity used was about the size of a large chicken's egg and to this was added a piece of charcoal ground to a powder with a hammer. The mixture was thoroughly kneaded on a piece of board to ensure the charcoal powder was evenly dispersed in the clay. When the investment material was ready, the ring was taken out of the water, a piece of the investment was pinched off the lump and pressed over the side of the ring (Plate 46). The ring was turned over and more investment pressed onto the other side, pinching the investment together around the outer edges of the ring. The only area to remain uncovered was the end of the sprue. This part of the investment was modelled into a shallow funnel towards the sprue (Figure 21). The invested ring was then set aside to dry while two crucibles were formed from the remaining investment mixture. The crucibles were formed by pressing the thumbs into the lump of

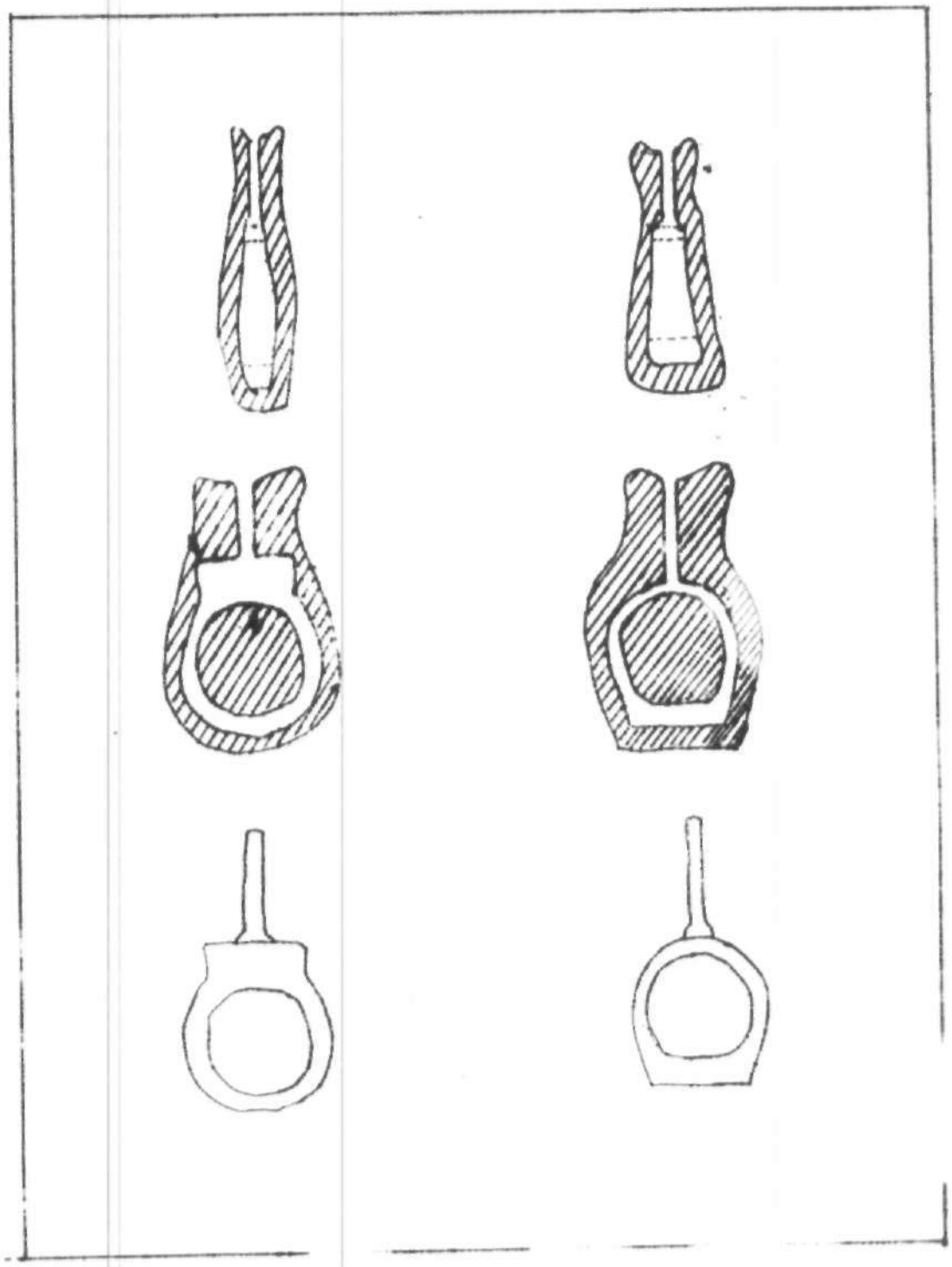


Fig. 21 -- Sprues and Investment of Ring



PLATE 46. THE RING BEING INVESTED

investment and working around with the thumb outside and the fore-finger in the depression first formed by the thumb (Plate 47). Ahead worked from the bottom of the crucibles upwards thinning the walls of the crucibles as he worked. The top edges of the crucibles were then shaped into approximate triangles. These were wider at the back while the two sides converged to form a thinner lip at the front. When the crucibles were completed they were set aside with the invested ring to dry until the next day (Plate 48).

Both the mould and the crucibles were made without the aid of any mechanical device but the mould thickness varied by only a few millimeters throughout except through the hole of the ring. The walls of the crucibles were approximately 9 mm. throughout. These measurements were taken on completion of the casting operation (Figure 22).

Day 2. 8:30 - 11:00

The mould and crucible having dried sufficiently, casting began. The researcher supplied the caster with silver. Silver from an Indian bracelet ingot was used. A piece weighing 19.01 grammes was sawn off the bracelet, hammered and bent to fit the crucible (Plate 49). To this silver, which was very pure, was added a medium sized safety pin.

When the silver was in the crucible the fire was started and the crucible placed on it with the mould that was sprue end



PLATE 47. THE CRUCIBLE BEING MADE



PLATE 48. CRUCIBLES AND RING MOULD

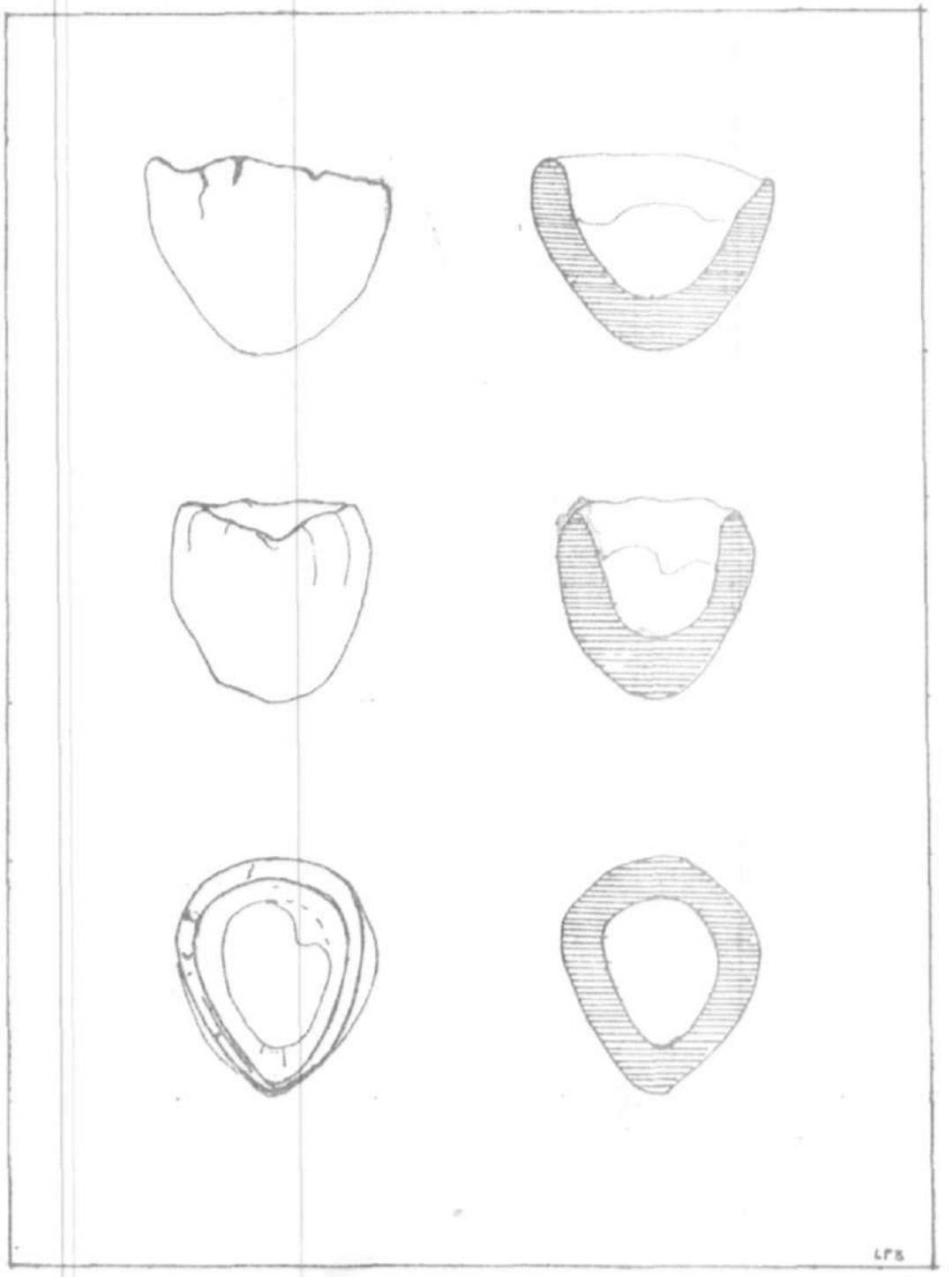


Fig. 22 -- Crucible



PLATE 49. SILVER BEATEN TO FIT CRUCIBLE

uppermost. The fire was started by taking a few live lumps of charcoal from the brazier on which the tea was made, and putting them amongst unlit charcoal in a small sand pit (Figure 20). This was then gently blown into life with the bellows. The bellows were pumped rather more vigorously once the mould and crucible were on the fire. After a couple of minutes the wax in the mould started to bubble. The mould was lifted out of the fire and inverted over a bowl of water to let the wax drain out. The mould was then returned to the fire and remained there until it had stopped smoking (Plate 50). All the traces of wax had by now burned out. At this juncture the mould was lifted out of the fire and embedded in the warm sand about 30 cm. from the fire with the open end of the mould uppermost (Plate 51). The crucible, with the silver, that had been on the top of the fire for three minutes was pushed further into the heart of the fire and covered over with charcoal (Plate 52). After five minutes the charcoal was raked aside with a wooden stick which was then poked into the surface of the molten metal. The crucible was lifted from the fire with a pair of tongs, (Plate 53), and with the stick touching the surface, the metal was poured into the mould (Plate 54). A few small pieces of silver remained in the crucible. Ahmadu eased them out with the stick and placed them in the mouth of the mould (Plate 55), which was then replaced in the fire and the bellows again pumped until the

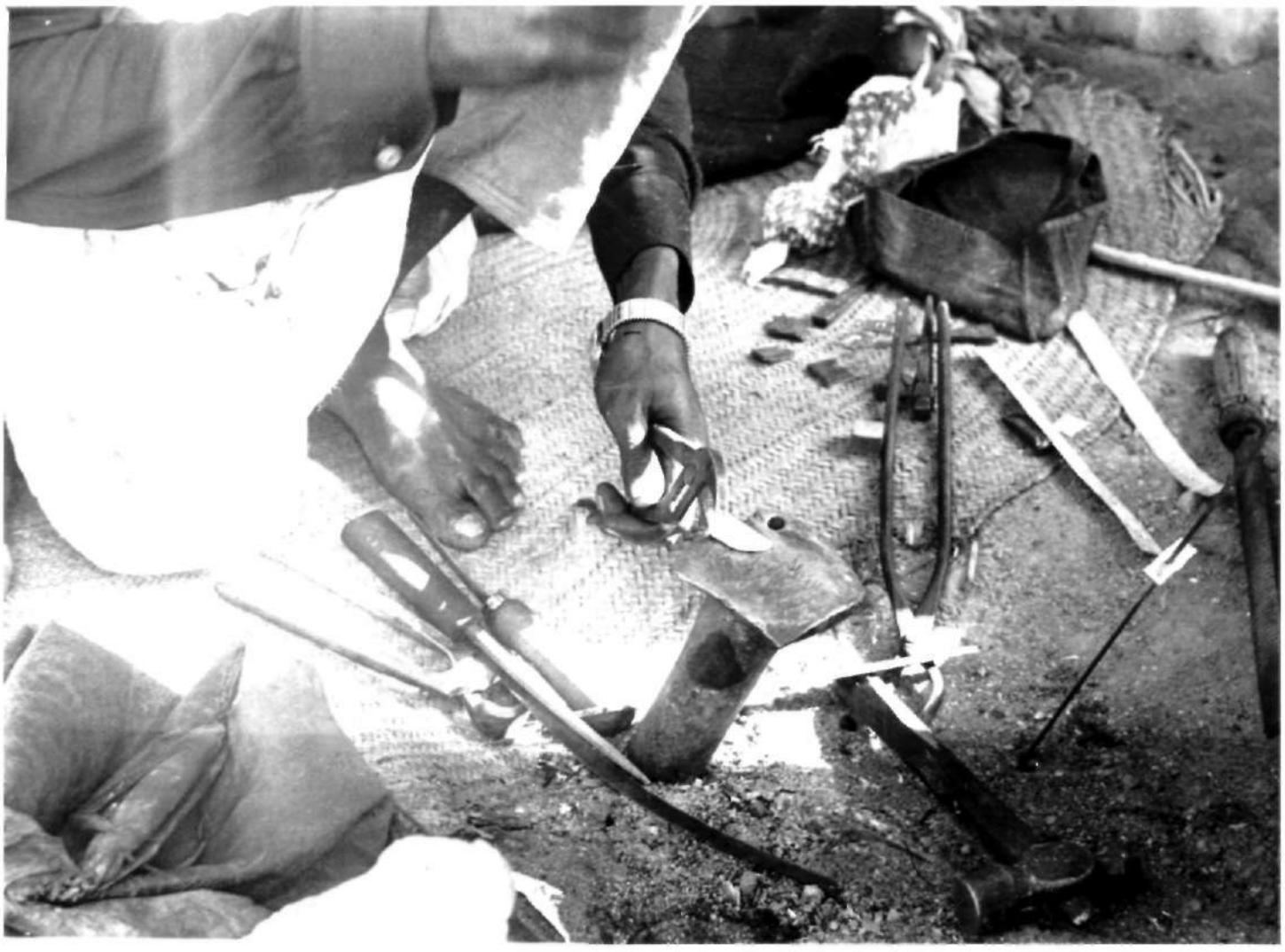


PLATE 49. SILVER BEATEN TO FIT CRUCIBLE



PLATE 50. SILVER BEING HEATED AND BURNOUT OF WAX



PLATE 51. MOULD SET IN SAND



PLATE 52. THE FORGE AND MOULD



PLATE 53. CRUCIBLE TAKEN OUT OF FIRE



PLATE 54. SILVER IS POURED



PLATE 55. SILVER SCRAPED FROM CRUCIBLE

metal was again molten after six minutes (Plate 56). The mould was removed from the fire with a pair of tongs and stood up in the sand to cool for twenty-five minutes after which it was placed into a bowl of cold water. It was taken out almost immediately and the mould hammered off (Plate 57). The ring, which was still hot, was again put to cool in the water before the final processes took place. At this stage the casting of the ring was finished but the decoration and polishing had still to take place.

When the ring was cold it was lifted out of the water onto the anvil and Ahmadu cut off the sprue using a cold chisel and hammer (Plates 58 and 59). The researcher then tried on the ring which was found to be too tight. The ring circle was enlarged by putting it onto the ring mandrel and hammering it after which it was annealed by heating it in the fire then cooling it in the water (Plates 60 and 61). The ring was still a little tight but was found to fit well after the inner surface had been filed smooth. The ring was then decorated by filing, engraving and inlaying (Plate 62). This was done using a handmade file, an engraving tool and a wrench to hold the ring steady on the anvil. Ahmadu first filed the top surface flat and then holding the ring with the wrench on the anvil filed the sides of the ring 1.5 cm. from the top of the ring. He filed a triangle and a groove. Using the handmade saw he then cut two grooves in the top surface of



PLATE 56. MOULD REMOVED FROM THE FORGE



PLATE 57. THE CAST RING



PLATE 58. THE SPRUE IS REMOVED



PLATE 59. REMOVAL OF SPRUE



PLATE 60. THE RING HEATED

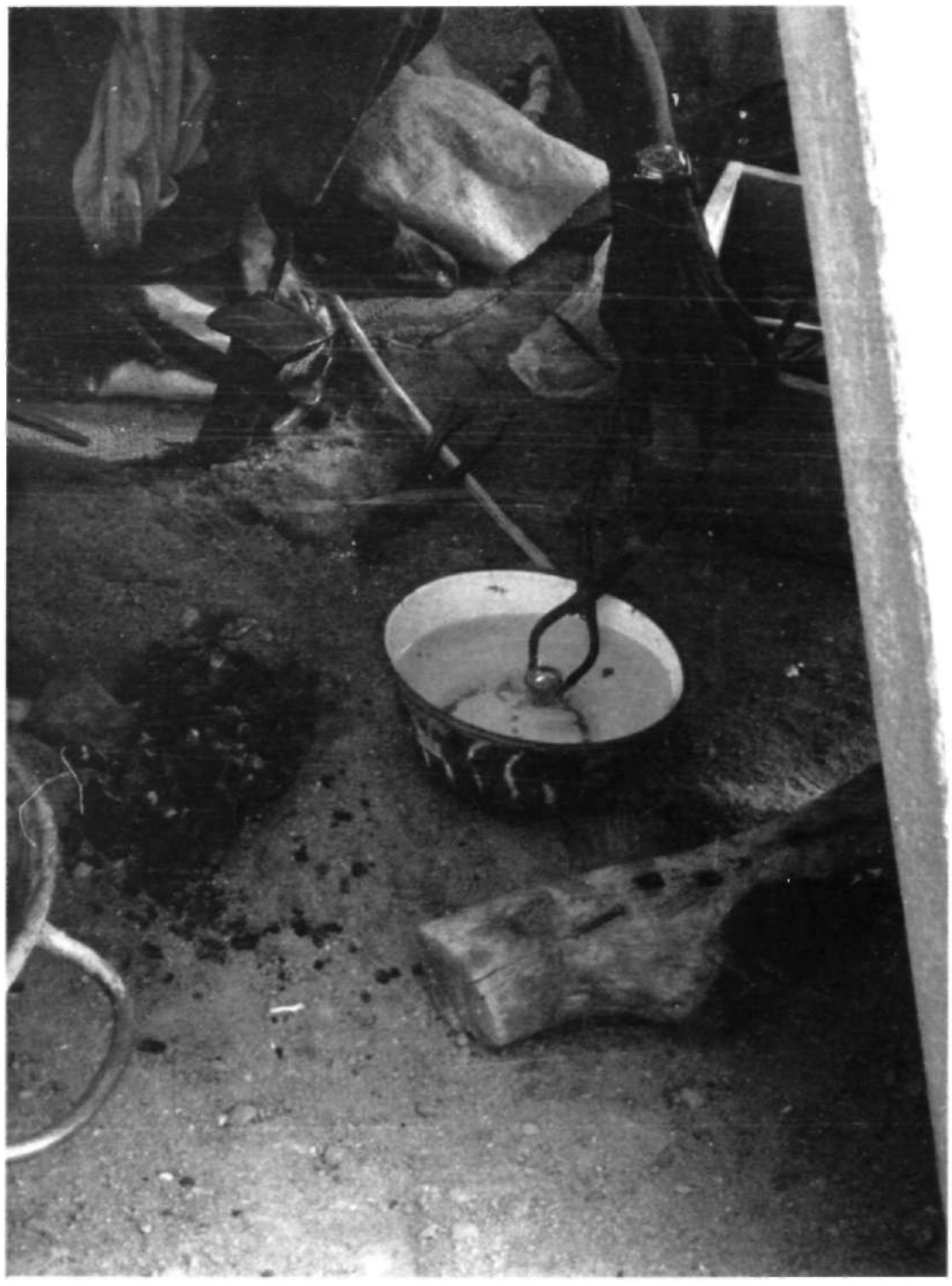


PLATE 61. THE RING COOLED IN WATER



PLATE 62. FILING THE RING

the ring and a groove either side of it (Plate 63). From a piece of black plastic, part of a broken water closet seat, Ahmadu shaved a thin strip. This was laid into the groove and hammered into place (Plate 64). The extra was cut off and the other three grooves cut in the ring were then filled in the same way. All that remained to be done was the engraving. The leather bag of the bellows was wound around the anvil, the ring was placed in a fold of leather and held in place with the wrench while the engraving was done. The engraver was a small V shaped tool held in a wooden handle. Ahmadu gouged the lines by pushing the engraver over the surface of the ring with a very rapid quiver from the wrist. The small triangles cut on the filed triangle on the sides of the ring and on the top surface were a single push of the engraver towards the already engraved straight line. When the ring was finished (Figure 23) it was given a final polish on the leather of the bellows.

Making a Silver Ring. 2

A second ring was commissioned and was made in the same way except for a few details.

On the second ring the sprue was attached to the top face rather than the bottom (Figure 21).

For this ring the researcher supplied silver in the form of



PLATE 63. SAWING THE GROOVES



PLATE 64. INLAYING THE RING

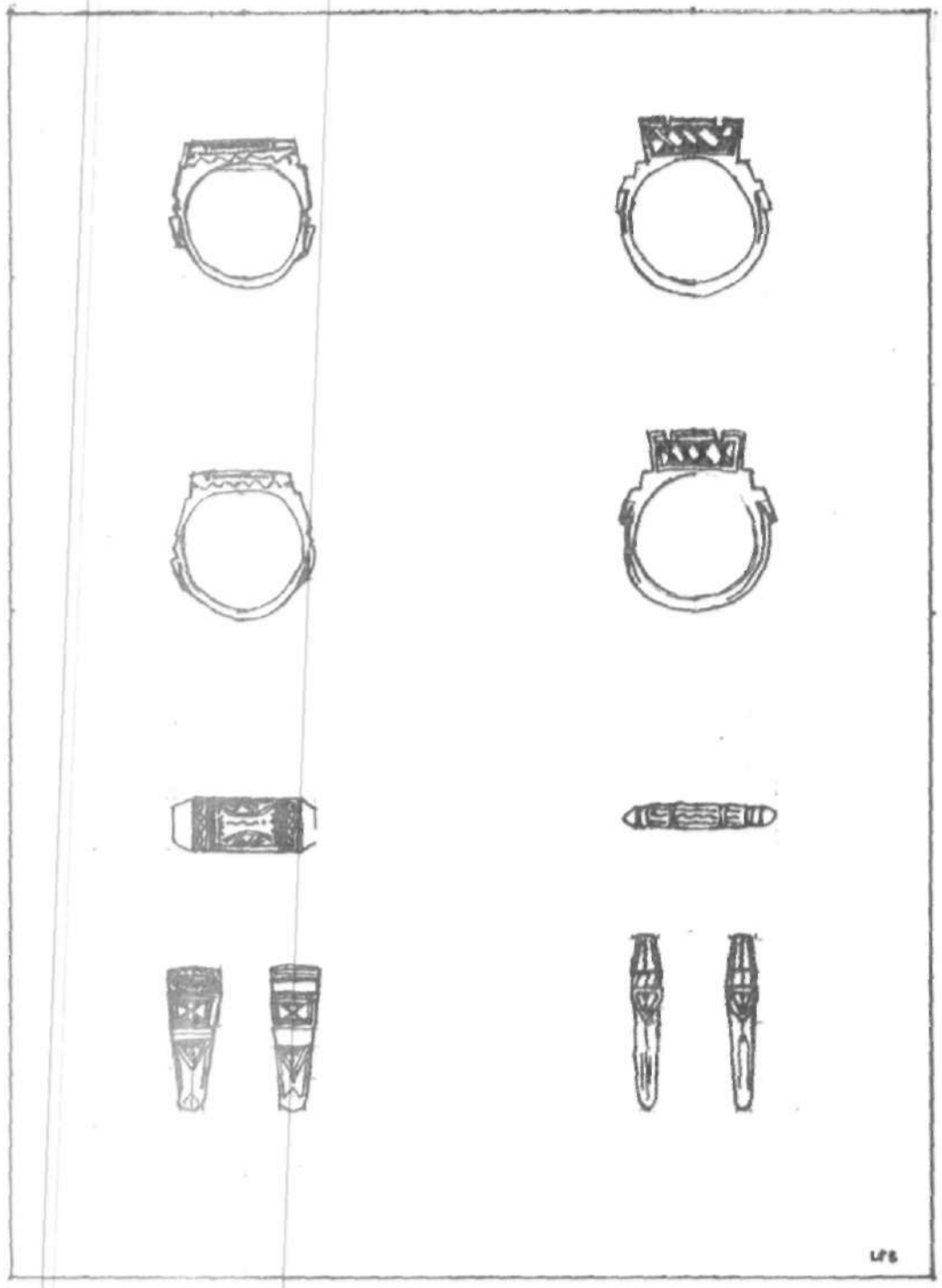


Fig. 23 -- The Rings

a Maria Theresa Thaler (dollar) which weighed 28 grammes. This was beaten thinner and folded to fit into the crucible but no safety pin was added.

After the metal had been poured for the second ring the mould was not replaced in the fire as had been done on the first occasion. It would appear that the caster had not been absolutely confident that the silver had filled the mould before cooling on the first occasion. The ring was finished off by filing and engraving as was the first ring but a different pattern was used (Figure 23).

CHAPTER VI

A COMPARISON OF THE PROCESSES OF THE TWO CASTERS

The two casters discussed in the previous four chapters both use the lost wax system of casting but their use of it differs in many ways. Perhaps some of the variations are the result of the different work produced or occur through the diffusion of the technique to the areas where they learnt it.

Ahmadu produces small pieces of silver jewellry whereas Mohammed is concerned with the production of domestic sculpture in brass. It must however be noted that even when Mohammed produces finger rings he uses the same technique as he uses for his larger scale work except that no core is used.

The forge system and tools that the two casters use are almost identical. Ahmadu's system is the most basic and providing he had bellows he would be able to set up a workshop wherever a shallow pit could be dug, he was able to find the metal scraps to make the tuyere and find a large stone to weight down the bellow pipes. This system whereby a pit is dug, the bellows are set between stakes and weighted down with a stone, is essentially the same as that used by Mohammed when he first started work in

Nigeria. Since he has become more settled he had made a number of modifications to his forge which make it more efficient. The pit has now been lined with refractory material and has the tuyere built into it. It is easy to clean out and there is no danger of the sides falling in. When he wishes to start work all he has to do is fit the bellows into the tuyere and fill the pit with charcoal. He now tends to fire and cast two or three moulds at the same time depending on their size. The bellows that the two casters use are almost identical and are of the skin bellows type made from goat skins and fitted with metal pipes through a wooden block. These bellows are of the same type used by the blacksmiths in the savannah region whereas in southern Nigeria it is more common to find dish bellows or forge bellows of European origin.

Other tools that are used (the crucible tongs, hammers, files and cold chisels) by the two casters, are again almost identical. Ahmadu is more ready to make some of his own equipment such as hammers and files. Modelling tools are manufactured by both casters when they are needed. It is in the casting process itself where the greatest differences are most apparent. The casters both use beeswax for their models but Mohammed models the wax to as close to the finished product as possible by applying sheets of wax to the core and adding the decoration with wax rods and spirals. This could perhaps be a reflection of an earlier system when the whole model

was built up from rods of wax or latex. Ahmadu however makes only the basic shape from a lump of wax and makes no attempt to model the details. He never finds it necessary to make a core as his models are small. The spruing system used by both casters is the same, one wax rod is attached to some inconspicuous area of the model.

The models when sprued are ready for investment and it is at this point that the differences in technique become apparent. Ahmadu uses an investment material made from wet clay and crushed charcoal as do the Ashanti.[1] Mohammed uses a mixture of wet clay, dry donkey dung and fine sand. This makes a more porous investment that allows the gases produced in casting to escape. Both casters coat the model several times with the investment and make the crucible that is to contain the metal at the same time and from the same material. The shape of the crucibles differ because of the method of pouring used. Ahmadu who uses a separate mould and crucible technique makes a crucible shaped with a pouring lip. His crucibles are also much smaller as only a little metal is melted at a time. Mohammed makes his crucibles so they will fit over the pouring cup of the mould and the top of his crucibles are left circular. When the investment is dry the moulds are fired and the molten wax poured out. Ahmadu places his crucibles

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[1]R. S. Rattray. Ashanti. O.U.P. Oxford, 1969, p. 307.

filled with silver into the forge at the same time he dewaxes the mould and is ready to cast as soon as the wax is removed and the metal molten. Mohammed however fills the unfired crucible with metal scraps and lutes it to the dewaxed mould. This is set crucible and down in the fire until the metal is molten at which point the crucible cum mould is inverted so that the metal can flow into the mould. When the metal has cooled both casters chip away the investment. With the minimum of brushing with a wire brush to remove the last clinging pieces of investment and the detachment of the metal sprue Mohammed's cast is finished. In Ahmadu's case however the work has only just begun. The rough casting of the ring is the primary stage. It is with the filing, engraving and inlaying that the ring takes on its finished form and these processes can take longer than the actual casting.

Taking into consideration a number of points, the use of rods and spirals to form the model, the luting of crucible to mould and the fact of his having learnt his trade in Chad it is not unrealistic to suppose that Mohammed's technique derives from the "Egyptian" or "spiral" technique of casting whereas Ahmadu's method is allied more to the "Cinquecento" technique introduced from North Africa. To draw any positive conclusions on the derivation of styles or techniques will require the recording and correlation of a greater sample of casters and their work.

CHAPTER VII

POSSIBLE IMPROVEMENTS TO THE CASTING PROCESS

When considering possible improvements to the lost wax process as practised by Ahmadu and Mohammad the researcher decided that any improvements made should be such that did not require the importation of expensive equipment from overseas. It was decided that as few changes to the basic casting process should be made as possible and that the improvements suggested would be concentrated mostly in the areas of making the wax model and cleaning and finishing the cast. The researcher decided when making her own sculpture to try a number of modifications of Mohammed's processes. These experiments were made mainly in the area of making the wax models and cleaning the finished casts. Mohammed's method of using sheets and rods of wax were not always adequate for the purpose of the researcher and so she decided to experiment with using wax in a more direct way. She also felt that the standard of the finished cast could be improved if more care was taken with the final cleaning and polishing and experimented with these procedures.

The beeswax obtained locally is supplied in flat cakes often over a kilo in weight and inevitably containing impurities. The

researcher has found it more convenient if these cakes are purified and reformed into smaller cakes, sheets and rods ready for working with. This can be done by breaking up the large cake with a cold chisel and hammer and melting the wax in an improvised double boiler. Wax is inflammable and it is therefore safer not to heat it over a direct flame. Such boilers can be made in a number of ways. For a small quantity of wax a clean tin can containing the wax pieces can be supported on a few stones in a larger can that is partially filled with water. This is placed over a heat source until the wax melts. For larger quantities a basin resting on the edge of a saucepan half filled with water would suffice. Where a large quantity of wax is to be melted a boiler can be improvised from two metal buckets and a sheet of metal.[1] A hole is cut in the sheet of metal large enough for a bucket to lodge in. The sheet of metal is placed over the second bucket that is partially filled with water and rests over the heat source, a gas burner or electric hot plate (Figure 24). For very small quantities a dish containing wax can be placed on a tripod made from mild steel rod and be heated by a candle or a spirit lamp made from a screw top jam jar.

If the wax contains a lot of impurities it should, when molten, be poured into cold water. Foreign matter such as sand and stones will sink to the bottom of the water and the wax will float

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[1] John W. Mills. Head and Figure Modelling, Batsford, 1977 p. 36.

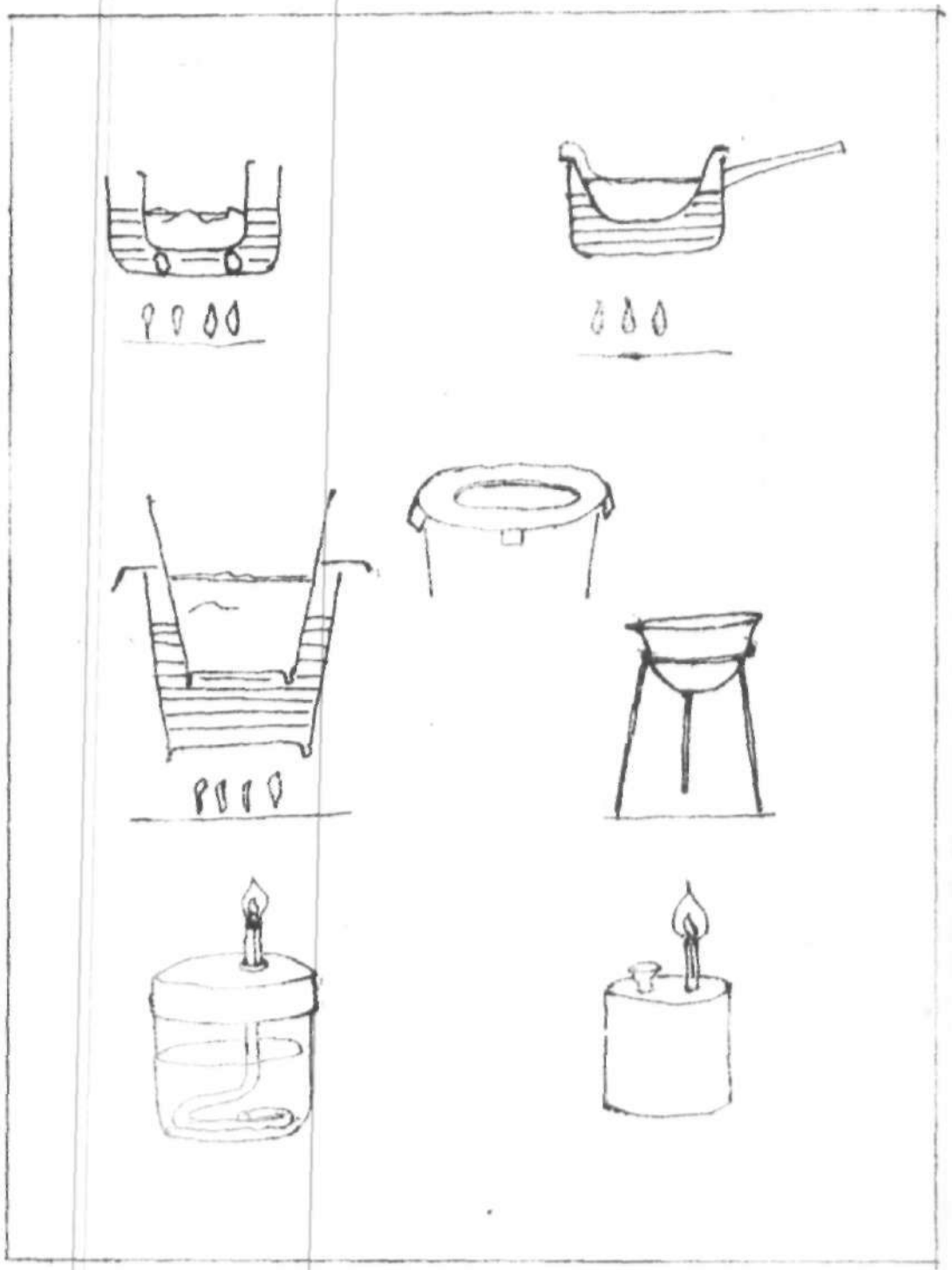


Fig. 24 -- Double Boilers and Kerosene Burners

on the surface. When cool the lump of wax can be taken out of the water and any chaff scraped from the bottom of the wax. The wax can then be remelted and poured into moulds of convenient size and shape for storing until it is required for use. An old bun tin can be used to make small "buns" of wax. The mould should be smeared very thinly with petroleum jelly before the wax is poured in to facilitate removal. Sheets of wax can be prepared by pouring molten wax onto a wet concrete or plaster slab mould. Another method of preparing sheets of wax is to roll warmed wax out on a dampened wooden board with a glass bottle. Rods of varying diameters can be made in a plaster mould which must be well coated in water before pouring in the molten wax. Such a mould can be made by making a bed of clay surrounded by a clay wall.[2] Press into the clay bed petroleum jelly smeared mild steel rods of the thickness required to half their width. Pour the plaster over this. When set turn the plaster and clay over so the clay bed is uppermost and remove it leaving the metal rods in position. Build up the clay wall around the plaster and brush seperator, clay slip or "vaseline", onto the mould surface. More plaster is poured in to form the other half of the mould. When set separate the two halves of the plaster mould remove the metal rods and clean the mould. The two halves of the mould are bound together with wire or thick rubber bands before

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[2] Ibid. p. 65

the wax is poured (Figure 25). Rods can also be produced with a syringe-like press that can be made from galvanised piping metal sheet and rod. Semi-solid wax is put into the cylinder, the piston is pushed down forcing the wax through the perforated wax into a bowl of cold water where the rods will solidify.

Sheets of wax should be stored flat interleaved with oiled paper in a metal or plastic box. Rods and cakes of wax can be stored in the same way. Local wax retains its honey smell for a long time and can be eaten away by various insects if left on open shelves.

It is usual to work over a core when making a model for lost wax casting above a certain size. The material used for this core is a mixture of dried donkey dung, sand, clay and water in the following proportions "41.7% sand, 27.8% clay, 5.5% donkey dung and 25% water by weight."[3] The researcher used this mixture when making cores and investments for casts with very good results. This mixture, because of the donkey dung sounds unpleasant but there is very little odour from it. It would seem foolish to change the mixture when it gives satisfactory results. The use of fine sawdust has been suggested in place of dung but the fibres are not so fine and the mixture does not bind together so well. Another alternative is to use broken down cloth fibre but as this can take over a year to prepare it is not very practicable.

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[3]S. I. Jatau. Improving Investment Casting Methods Used By Nigerian Founders. ABU, Department of Mechanical Engineering, June, 1975.

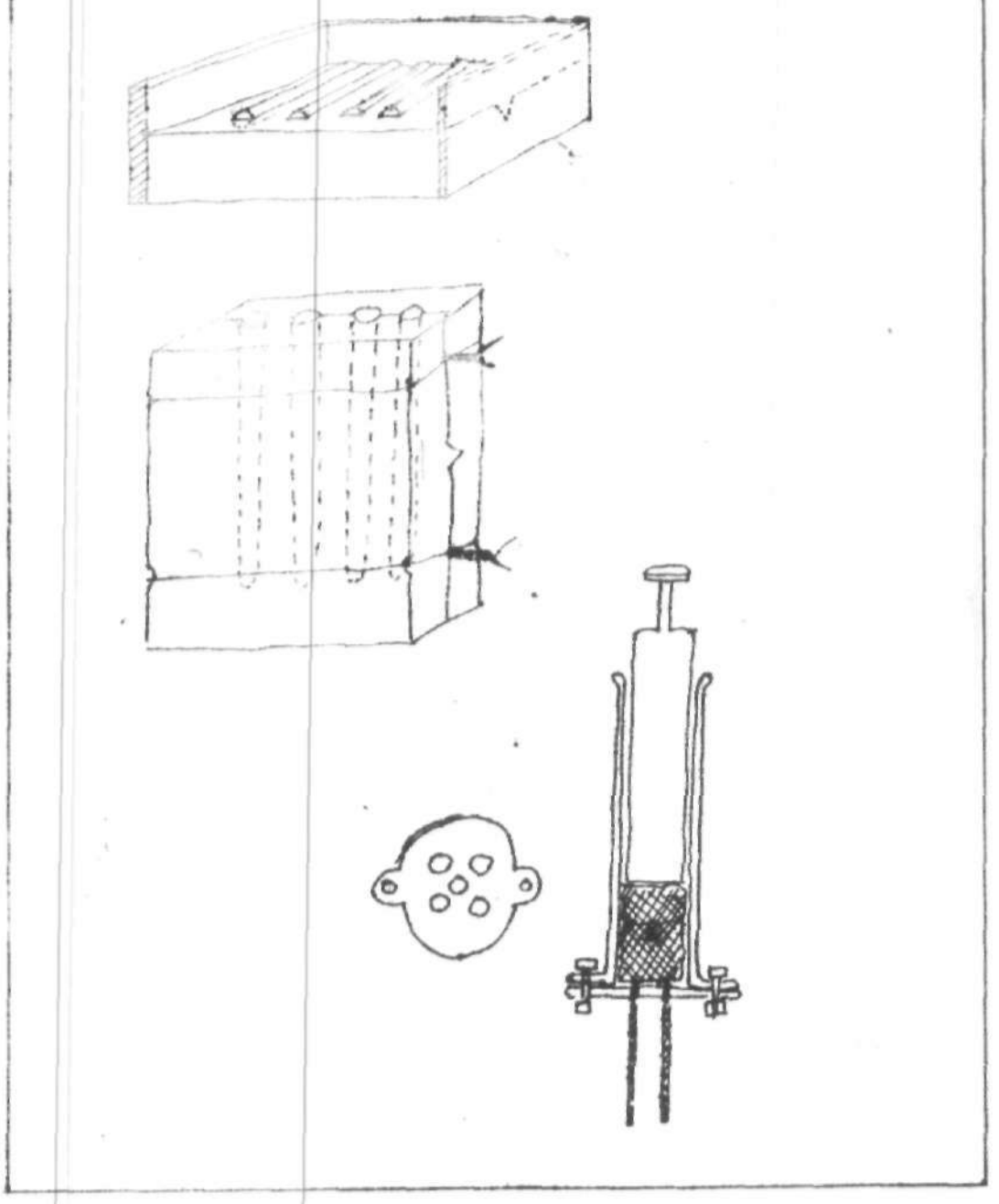


Fig. 25 -- Moulds and Press for Wax

The inclusion of this vegetable matter in the core and investment material is to form minute channels through which gases, generated in the casting, can escape. Without it a complicated system of vents and risers becomes necessary and the mould joined to crucible system cannot be used. Experiments have not been carried out with plaster and grog mixtures which might be found to be a satisfactory alternative although it would mean that risers would have to be attached to the model and these would all have to be filled and cleaned off the finished cast.

The core is modelled taking into consideration the changes that will occur in proportions when the wax coat is added. Metal pins are set into the core before it dries and is fired. Because there is little shrinkage due to the sand and vegetable matter it is possible to include a metal armature in weak areas. When the core is fired the wax can be applied. This ensures good adhesion of the wax to the core it has been found satisfactory to dip the core into molten wax. Alternately a sheet of wax can be pressed onto the core surface or strips of wax can be pressed around it. Rolds of wax can be wound around the form and then smoothed over with a hot knife. Another alternative is to apply semi-solid wax onto the core with a metal spatula. Whichever method or combination of methods is used the aim is to build up an even layer of wax over the core.

Individual sculptors will find that different shapes of knives suit their style of work. Spatulas and knives can be easily made from lengths of mild steel rod by forging and filing. It is unnecessary to temper the tools as they will be constantly in and out of a heat source (Figure 26). When the modelling is complete Rich suggests that the "piece can be polished with a fine sandpaper moistened with either gasoline or turpentine."[4] Alternatively the surface could be burnished with a smooth stone or metal burnisher. The more care that is taken over the surface finish of the wax the easier will be the cleaning of the cast.

Before investment it is advisable to assess the weight of brass to be used in the casting. To do this weigh the core before the wax is applied eg. core weight = 300 gms.; the waxed and sprued core is then weighed = 100 gms.; the wax therefore weighs 200 gms. The specific gravity of wax is just under 1.00 and the specific gravity of brass is 8.10. This means for every 1 gramme of wax, 8.10 gms. of brass will be required. For the example given above this would mean 1620 grammes of brass will be required. It is advisable to add 20% more brass to allow for minor faults such as fins. The total quantity of brass required would be 1944 grammes. Another method suitable for use when there is no core is to partially fill with water a calibrated beaker and note the depth.

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[4]Jack Rich. The Materials and Methods of Sculpture. OUP, 1973, p. 54.

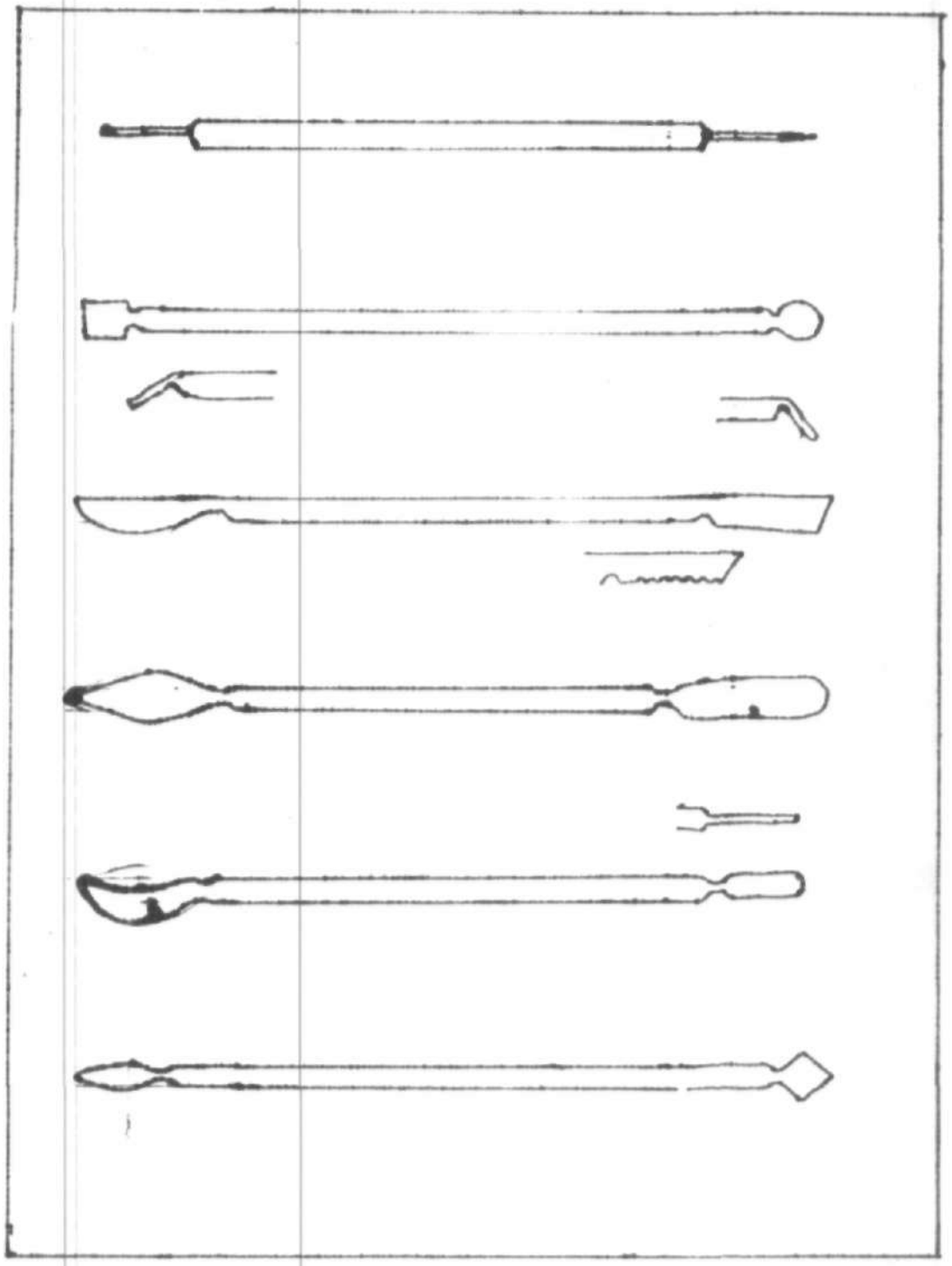


Fig. 26 -- Metal Spatulas

The wax model is then immersed in the water and the new water level noted. The wax model is removed and the brass pieces put in the beaker until the second water level is reached. The brass can then be removed from the water, weighed and have 20% more added to it as before.

For a piece of sculpture up to 30 cm. in height Mohammed's method of casting with the joined mould and crucible works extremely well. For larger pieces of work the researcher feels the following adaptations could be made. The crucible and mould should not be joined. The wax model should be given wax runners and risers before being invested (Figure 27). The wax is lost in the same way as normal whilst the brass is being melted in an open crucible in the charcoal fire. These crucibles should be made with a pouring lip to facilitate pouring. Several crucibles of metal can be melted at the same time. The mould should be kept hot until the metal is molten. Prior to pouring the mould should be embedded in hot sand alongside the furnace with the pouring cup uppermost. When ready for pouring the metal should be skimmed of slag, the crucible lifted with crucible tongs and poured. When metal appears at the top of the risers the mould is full. Any excess metal should be poured into ingot moulds set alongside the main mould. Whichever method of casting is used the hot mould should be left to cool for an hour or more rather than being dropped in cold water

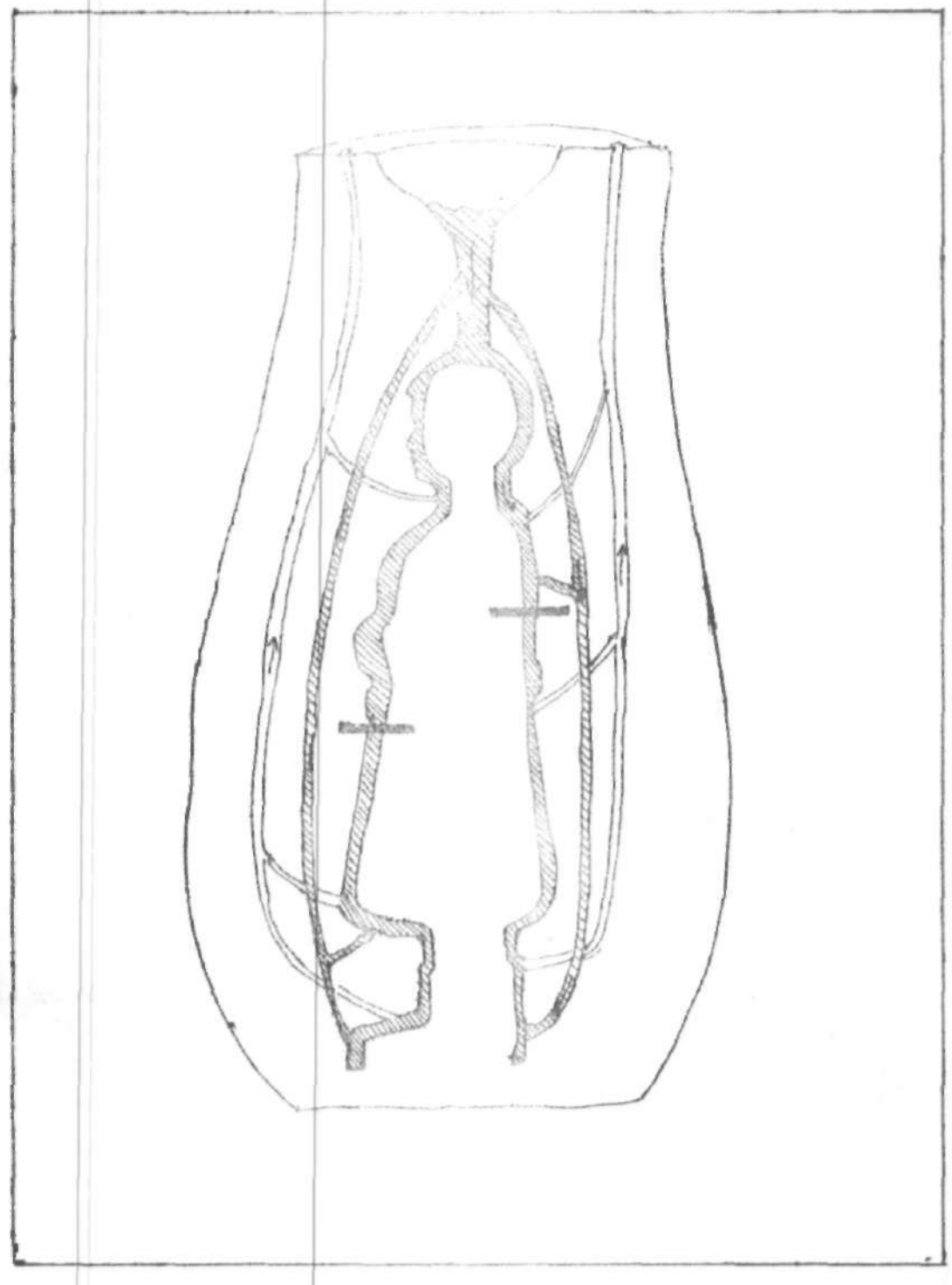


Fig. 27 -- Runners and Risers on Invested Wax

ten minutes after being poured. This would save the setting up of tensions and stresses in the brass that could break the cast. The investment should then be carefully broken off. Where possible the core material could also be scraped out. The now metal filled runners, risers and pouring cup should be detached from the cast either by sawing or with a cold chisel and hammer. Any fins and flashes can also be detached with the cold chisel. Investment that proves difficult to remove should be carefully chipped off in order not to damage the surface of the cast. This should be done in a controlled manner using the cold chisel and hammer in the same manner as a chasing tool that is moving over the surface of the cast rather than hitting at right angles to it. The surface can then be burnished with a steel tool. The cast can finally be polished with a proprietary polish such as "Brasso" applied with a soft cloth and buffed off with a sheepskin buff or chamois leather skin. Very narrow areas can be polished by "thrumming". This is done by threading a polish soaked string through the opening and then pulling the string rapidly back and forth.

The use of coarse files and acids should be avoided as they will spoil the surface of the cast. The researcher has found that it takes as long to clean and polish the cast as it does to make the wax and cast it. She feels that this part of the work is as important as the earlier stages and should not be hurried over.

Castings of an extremely high standard can be obtained using this technique providing that care is taken at each stage from the making of the core to the final polishing. It is a time consuming procedure but the finished cast will be very strong and long lasting.

APPENDIX A

"LOST WAX CASTING IN IBADAN"[1]

Preparation of the Clay Core

Red earth is crushed and sifted to a clean powder and mixed with water. Horse's dung is kneaded into the mix, one part to six, for about 25 minutes. The whole is then placed on a flat stone and beaten with a hammer to ensure an evenly saturated mass. The dung keeps the mass plastic and prevents the core cracking as it dries. The mixture, now smooth and rather wet, is divided into three or four lumps which are laid out in flat cakes on a stone for some minutes to allow excess water to evaporate. From one of these cakes the fashioning of the core commences. When the core is complete, minus limbs, three metal pins -- one through the head, two in the torso -- are stuck through it to hold it in position inside the mould. It is then dried by the fire in readiness for the wax investment.

Second day: The Wax Investment

The wax obtained from Shaki, is rolled into thin sheets (1/8" thick) about 10" by 4". These sheets are then used to clothe the core. It is not coated liquid.

Third day: Sculpting the Wax Figure

The wax is rolled into a cigar-shaped plug about 6" long, tapering at its ends. This is continually heated and kneaded to ensure compactness. A section is cut through the tapering extremity of the wax-plug sufficient for a limb, and from this an arm is modelled and appended to the figure in solid form. Other members are fashioned successively and appended to the figure. During the process the wax is barely warm, stiff and malleable. It is at no point hot and liquid as described for other processes. The sculpturing of the figure is controlled by the finger-tips of the craftsman, who occasionally uses a

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[1]Denis Williams. "Lost Wax Casting in Ibadan." Nigeria LXXV, 1965, pp. 97 - 100

small knife for incising detail, keeping this tool continually wet to prevent it adhering to the wax.

Fourth day: The mould

The original cakes of clay prepared on the first day, now hard, are again crushed to a fine powder. More horse-dung (about one-sixth of the total bulk) is added for greater porosity. This porousness of the clay-mould allows gases formed inside the mould to escape. The mould is then carefully built up around the wax investment in two stages. The first forms a coat about half an inch thick, which is allowed to dry before the next coat is added. The whole is dried in the sun for about three days to get rid of any trace of water. At the base of the mould a runner has been left for pouring the liquid metal.

Fifth day: Preparation for the casting

A horse-shoe shaped metal container, about twenty-two inches by six inches, is packed on the inside with clay, leaving at the centre a combustion area -- a circle of some seven inches diameter. Through the back wall a four inch long tube is fixed for receiving the nozzle of the bellows. The nozzle of the bellows is kept an inch or so from the draught hole to ensure the return draught which reinflates it after each stroke. Two crucibles, four or five inches deep, have been made of clay and stand ready for use in melting the metal. The combustion chamber is now filled with fuel (charcoal prepared from palm-kernels) and set alight by a few live embers. When this is properly alight the mould is placed in the fire, the area around the pouring hole being first inserted. A small amount of the wax investment runs off, the mould then being gradually placed further into the flame. The escaping wax is recovered in a bowl of water. As the mould is gradually inserted towards its middle into the flame, the wax begins to run more freely. The mould is now hot and glowing in places. It is handled with a wet rag kept in water. As the wax boils inside a sizzling sound issues from the mouth of the mould. Finally the mould is placed completely in the fire on end with the pour-hole topmost. Vestigial remains of wax escape only in drops at a time as the mould is further emptied over the bowl of water and replaced in the fire. When the wax ceases to escape altogether the mould is left in the fire for an appreciable time -- about an hour -- during which each area of the mass is brought into contact with the flame long enough to become red hot. The whole mass has thus been thoroughly burnt to make sure that all the wax has been dissipated.

Sixth day: The Casting

The mould is separately roasted in a wood fire prepared in a fragment of a large old pottery vessel. For the casting an extra draught-hole is prepared in the front end of the furnace to

accommodate another bellows. Bits of scrap brass are heated in the flame and beaten into small squares the size of a postage stamp. These are placed in the crucible, and fill it. The whole is covered with charcoal and placed in the fire and the heat built up with the two bellows. When all is aglow a pyramid of fresh fuel is piled on top, entirely concealing the crucible in the mass of flame. After half an hou or so a probe shows the contents of the crucible to be red hot, but covered still with unignited fuel, the metal not yet being molten. At this stage a few metal pieces are thrown in to make good the subsidence resulting from the melting process. With each addition of fuel the crucible is turned about and reseated on the fire. After forty-five minutes flames from the furnace are rising three feet into the air. At the end of an hour the brass is molten. It is thoroughly stirred with a probe (a green stick), which causes it to subside a further inch or so below the rim of the crucible. Again it is topped up with odd scraps of brass, and covered with fresh fuel. Heat continues to be built up by the two bellows.

One hour ten minutes. Another probe is made, and the red hot contents stirred to tip off the residue left floating on the surface by the burnt out cinders. More topping up, following by a fresh piling on of fuel. The bellows continue.

One hour twenty-five minutes. The mould has been resting in a separate fire for about two hours now. A hole is now dug near to the furnace to receive it in a standing position, pour-hole topmost, to receive the metal. Another probe is made into the crucible, cinders are tipped off from the surface of the molten metal. No fuel is added. The bellows continue.

One hour thirty-five minutes. The mould is now securely packed into its hole beside the furnace, with dry earth. The crucible is stirred for a last time and removed from the fire, stirred once more to tip off the last impurities, and the molten metal poured into the mould. A residue of burnt cinders remains at the bottom of the crucible. The mould is left standing for ten minutes or so, after which it is cooled by cold water thrown over it. It is then turned in a bowl of water for a few minutes more, then broken open.

The cast is cleaned and chased with European tools.

APPENDIX B

"BRASS CASTING IN NORTH-EAST NIGERIA"[1]

There was a crafsman who spent several days making the anklets. The first task was to make a form the size and shape of a woman's ankle and lower leg. This is done with dirt and grass leaving a hollow centre. When this is dry the craftsman makes a model of the anklet out of beeswax. The work is begun by putting the beeswax out in the sun to get it pliable; or in case there is no sun, a small fire is built and the beeswax is placed near it. The craftsman works it with his hands until he is satisfied that it is of the right pliability. A small piece is broken off and shaped in the hands to about the size of a lead pencil. It is then rolled on a board similar to a Moslem writing board, only much longer. The craftsman keeps rolling the beeswax back and forth putting pressure on it as he rolls, so that the piece of beeswax keeps getting longer and thinner. When it gets a couple of feet long and is difficult to handle, it is cut in half and rolled again. When it is of the correct diameter it is coiled around the dirt form. This process continues until the beeswax model of the anklet is the desired height. A vertical opening to slip the anklet on is then made by cutting out a strip the length of the model and removing the beeswax from this part. Thicker pieces of rolled beeswax are then used to outline the beeswax already applied to the form. Additional pieces of wax of various sizes and shapes are used for decoration. When the beeswax anklet model is completed, two pieces of beeswax are fastened to the top of the model to form a channel for the molten brass that will be poured into the mould. After four or five hours of work to make one anklet model, water is poured on the beeswax to cool and harden it. The mud form remaining above and below the wax anklet model is also moistened and roughened so that the mud which will be added later to make the completed form will have a rough surface on which to cling.

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[1]Gerald Neher. "Brass Casting in North-East Nigeria." The Nigerian Field. Vol. XXIX, No. 1, Jan., 1964, pp. 20-27.

Red clay and donkey dung are mixed together to make the outside of the mould. The red clay is obtained from termite moulds and pounded into a powder. Donkey dung, which has been outside and has weathered, is gathered and pounded in a mortar. It is then put in a basket or calabash and shaken back and forth until the large pieces come to the top. The large pieces are then removed and the small powdery substance which is left is mixed with the clay and water to form a mud. This is very carefully rubbed over the beeswax making sure that it gets into every crack of the design. A large amount of the mixture is then taken; and a rectangular piece of the mud about a foot long, four inches wide, and a half inch thick is wrapped around the upper half of the model and worked into the thin layer of mud that had just been applied to the wax. A second similar piece is then made to cover the the other half, and the mould is formed to its final shape. A funnel is then made at the top with the same mud, and the mould is put into the house to dry slowly for two or three days to avoid excess cracking.

As soon as the mould is dry a fire is built and the mould is placed near it so that the wax inside will melt. When the wax begins to melt, it seeps through some cracks in the mud. As the cracks become visible a thin mixture of clay and dung is worked into them. When no more cracks appear, the mould is held over the fire with a pair of tongs to get it hotter; and any additional cracks that appear are closed. The mould is then set in the hot coals, and after a short time the mould is inverted and the liquid wax is poured out of the mould into a dish of water. The mould is then replaced in the hot coals for a few minutes until the smoke starts coming out of the funnel. This is a sign that the wax is completely gone and the mould is set aside to cool. After the mould becomes cool, a thin mixture of mud is again rubbed over it to cover up any remaining cracks.

The brass -- which often consists of old shell casings, old bracelets, old stove parts and old bearings -- is then prepared. They are put in the fire to make them more pliable after which they are taken out and beaten into compact pieces.

The brass is put into a small clay pot which has the same diameter as the mouth of the funnel, being about four inches in diameter and about two inches deep. The mould is inverted upon the dish full of brass, and the funnel part of the mould and the dish are completely covered with a layer of mud about half an inch thick; thus, becoming or resembling a large ball on top of the already completed mould.

The furnace used for brass casting is about two feet tall and eighteen inches in diameter. The wall of the furnace is about two and one-half inches thick at the top, but gets thinner towards

the bottom. The bottom of the furnace is rounded, and there is a small hole about two inches in diameter to let the air into the furnace from the bellows outside.

Charcoal is placed in the bottom of the furnace and the fire is started. Some hard wood is then placed around the inside edge of the furnace. The moulds are placed in the centre, and other wood is carefully arranged around them. The top of the furnace is covered with old broken pieces of pots, and the bellows are pumped until the wood catches fire. The furnace is then left with much smoke coming out of it. After twenty or thirty minutes when the smoke dies down, the bellows are again pumped to test the texture of the remaining wood. If the wood makes too much smoke, it is left until the craftsman has the feeling that the right time has come to go ahead. The bellows are then pumped with all the energy that one can afford, to get the furnace as hot as possible. The pieces are inspected occasionally to see how they are; as the entire mould gets red hot from top to bottom. When the craftsman is satisfied that the moulds are hot enough, he removes the broken pieces of pots from the top and lifts out the moulds with tongs, turning them upside down immediately so that the molten brass will run to the cavities. The moulds are then placed against the wall to cool.

All during this time he keeps dipping his hands in a pot of water because of the intense heat which comes out of the furnace. When the moulds are cool, a small hammer is used to knock off the mould and a file is used to sever any brass that might be left on top of the anklet.

The anklets are then ready for use after the proper ceremony has been performed.

No one knows when the first such anklet was cast. Neither do we know when the last one will be cast, but the time may not be far off, as commercial jewellery is fast taking its place among these tribes.

APPENDIX C

"HOW BENIN FIGURES ARE MADE"[1]

'The neighboring Hausa people of northern Nigeria give this oral account of the technique.'

In the name of Allah the Compassionate, the Merciful. This account will show how the [Benin] figures are made. This work is one to cause wonder. Now this kind of work is done with clay, and wax, and red metal [copper] and solder zinc and lead, and fire. The first thing to be done if one of the figures is to be made, is to get clay and work it most thoroughly, and get the little stones which are in it worked out. It is well worked in the hands. Next the shape of the top of the head is constructed [from] the clay, and then the jaws on the same piece as the top of the head. Then the nose is shaped, and the eyes and lips made. Then a certain stick which has been shaped like a knife is put [against] the model and it is smoothed with this ...; then it is set in the sun to dry. Next wax is melted and poured over it -- then it is gone over with the knife. When it has been well done, then a fire is kindled, [and] a knife put in the fire. When it is slightly warm it is taken up and pressed over the wax in order that it may adhere well. ... When he has finished ... he takes up mud [and] covers the whole head with it leaving only a small hole. He puts it in the sun to dry.

... The way the metal is poured in is as [follows]. When the fire has been brought it is poured into the melting furnace, [and] the bellows are set to work [and] the fire blown [and] charcoal poured in. Then the model is lifted [and] placed on the fire. Water is poured into a pot or cup. When the model has become heated then the wax inside melts. 'Then it is taken up, the tongs, or some [take] a stick, are placed across the pot ... and the figure put on top, and the wax keeps dropping out. And it is held so till all the wax has melted and dropped into the water. Then a great quantity of charcoal is poured [into the furnace]. The figure ... is set in the fire. Bars of metal are continually being cut with a hammer; many pieces are broken up in this way,

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[1]R. S. Rattray. Hausa Folklore Customs, and Proverbs. OUP, London, 1913, pp. 234-243.

[and] put in the smelting pot. Then they scrape out a hole in the charcoal and put the smelting pot in, replace the charcoal again, and cover. ... They keep blowing the bellows, and this clay lump is turned till red hot. When the metal has melted, then the figure is taken up, a hole is dug [and] it is placed in it so that it is firmly set. The hole left in the clay is cleared out and the melted metal poured in. If it is filled, that is well; if not, more is added to fill it. If full than [the work] is finished. Next it is set aside to cool, [the outside covering of clay] is broken off. Then you see a beautiful figure. That is it. The work of Ali is completed.

Notes from an article by Prof. Henry Belfour. Journal of the Royal Anthropological Institute, Vol. XI, 1910:[2]

"The core is hollow, with a view no doubt of giving it an equal thickness with that of the outer casting mould so as to admit of a uniform rate of heating and cooling throughout the mass."

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[2] Ibid. p. 312.

BIBLIOGRAPHY

The Art Index

Aitchison, L. A History of Metals. London, Macdonald and Evans, 1960.

American Heritage Publishing Co. The Horizon History of Africa, 1971.

Ashbee, C. R. The Treatise of Benvenuto Cellini on Goldsmithing and Sculpture. Dover, 1967.

Bovill, E. W. The Golden Trade of the Moors. London, OUP, 1968.

Briggs, L. C. Tribes of the Sahara. Harvard, H.U.P., 1960.

Brinkworth, I. "Benin: City of Blood -- and Bronze," The Geographical Magazine, XXVII, No. 5, Sept., 1954.

Connah, G. The Archaelogy of Benin. Oxford, OUP, 1975.

Crawall, T. C. Ironworking in the Sudan. Man., Vol. 33, Article 48, March, 1933.

Dark, P. J. C. "Brass Casting in West Africa," African Arts, Vol. VI, November 4, Summer, 1973.

Dark, P. J. C. An Introduction to Benin Art and Technology. Oxford, OUP, 1973.

Edwards, R. The Technique of Jewellry. London, Batsford, 1977.

Fagg, W. The Living Arts of Nigeria. London, Studio Vista, 1971.

Fisch, A. M. Textile Techniques in Metal. New York, Van Nostrand Reinhold Co., 1975.

Gaskin, L. J. P. A Bibliography of African Art. London International African Institute, 1965.

Gardi, R. African Crafts and Craftsmen. New York, Van Nostrand Reinhold Company, 1969.

Gabus, J. Au Sahara. Vol. II Neuchatel, Editions de la Baconnière, 1958.

Hawthorne, J. G. On Divers Arts. Chicago, U.C.P., 1963. Trans. of Schedula Diversarum Artium by Theophilus Prespyter (Roger of Helmarshausen).

Jatau, S. I. Improving Investment Casting Methods Used by Nigerian Founders. Unpublished Undergraduate thesis, Department of Mechanical Engineering, Ahmadu Bello University, 1975.

Jefferson, L. The Decorative Arts of Africa. London, Collins, 1974.

Kowal and Meilach. Sculpture Casting. London, Allen and Unwin, 1972.

Lester, S. The Craft of 'Cire Perdue'. London, W. A. R., 28, June, 1957.

Leuzinger, F. Africa. The Art of the Negro People. London, Methuen, 1972.

Leuzinger, F. The Art of Black Africa. London, Studio Vista, 1972.

Meek, C. K. The Northern Tribes of Nigeria. London, OUP, 1925.

Mills, J. W. The Techniques of Sculpture. London, Batsford, 1976.

Mills, J. W. Head and Figure Modelling. London, Batsford, 1977.

Nadel, S. F. A Black Byzantium. Oxford, OUP, 1942.

Neher, G. "Brass Casting in North East Nigeria," The Nigerian Field, XXIX, No. 1, Jan., 1964.

Nicholas, F. Tamesna Les loullemmeden de l'est ou Touâreg "kel Dinnîk." Pans imprimerie Nationale, 1950.

Oliver, R. & B. M. Fagon. Africa in the Iron Age, Oxford, OUP, 1975.

Oliver, R. & B. M. Fagon. A Short History of Africa. London, Penquin, 1975.

Parlanti, E. J. Casting a Torso in Bronze by the Cire Perdue Process. London, Tiranti, 1953.

Rattray, R. S. Hausa Folklore, Customs and Proverbs. Oxford, OUP.

Rich, J. The Materials and Methods of Sculpture. New York, OUP, 1947.

Rodd, F. R. The People of the Veil. London, Macmillan, 1926.

Singer, Holmyard, Hall & Williams. A History of Technology. Vols. 1 & 2, Oxford, OUP, 1956.

Shaw, T. Igbo Ukwu. London, Faber and Faber, 1970.

Shaw, T. Discovering Nigeria's Past. Ibadan, OUP, 1975.

Shaw, T. Unearthing Igbo Ukwu. Ibadan, OUP, 1977.

Talbort, S. A. The Peoples of Southern Nigeria. Oxford, OUP, 1926.

Untracht, O. Metal Techniques for Craftsmen. New York, Doubleday, 1968.

Willett, F. Ife. London, Thames & Hudson, 1967.

Willett, F. African Art. London, Thames & Hudson, 1971.

Williams, D. "Lost Wax Brass Casting In Ibadan," Nigeria LXXXV, 1965.

Williams, D. Icon and Image. London, Allen Lane, 1974.