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DEVELOPMENT OF SMALL AND MEDIUM-SCALE ENTERPRISE - PHASE II

DP/LIR/87/007

LIBERIA

Technical report: Upgrading of blacksmiths activities\*

Prepared for the Government of Liberia  
by the United Nations Industrial Development Organization,  
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. Joseph B. Stokes,  
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\* This document has not been edited.

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## I. INTRODUCTION

Liberia is a relatively small nation well endowed with natural resources with a population of a little over 2.0 million. Over decades the government of Liberia has been providing liberal incentives and concessions for economic development of the country. In spite of that, it is only around 1.6% of the employment that is provided by the manufacturing sector. The concessions have not much promoted backward linkages which could have caused development through adoption of better and better technology by the traditional skilled workers converting their cottage type enterprises to workshops, workshops to small-scale establishments and such enterprises over a period of time graduating into modern medium scale product oriented units. This could have bridged technological gap between the Liberian owned and operated large scale concessions. The result is that now when many of such foreign establishments are scaling down their activities or closing those down, the government is not able to squarely meet the problems as compatriots are not in a position to provide alternate sources of employment.

The metal based industries form the core of industrial sector. These are basics for other industrial activities as well as for development in other sectors of the economy. Greater Monrovia which represents the vast majority of industrial establishments has about 1% of the enterprises engaged in metal

working industries. An extensive survey of the SMEs (small and medium scale enterprises) was conducted in 1979. It covered 1300 enterprises and vast majority among them was of tailors, restaurants, carpentry, garages, etc. Competition is intense and product quality is poor mainly due to low level of skill. Fixed assets are mostly lower than \$1,000, utilities availability is highly inadequate, working conditions are not conducive and bank financing is not available. The management of the enterprises is illiterate and deficient. Even desire to upgrade the enterprise and to look for prosperity is not there.

With the highest priority allocated to the development of the agriculture sector and the shifting method of cultivation being largely in vogue, the demand for simple agro-tools is increasing. Most of these can be locally fabricated using the steel scrap. Blacksmithing is the basic skill required for the purpose. One hardly comes across any blacksmith in the greater Monrovia. However in each county there are some blacksmiths. They are thinly spread over the countryside. One seldom comes across any concentrations of blacksmiths. At places like Voinjama, Gbarnga, Seclepea and Sanniquellie one can observe around ten blacksmiths working as two or three groups. None of them had any formal training. With the problems of foreign exchange becoming more and more acute, higher emphasis on agriculture is being placed and imported tools and implements being too expensive, the government has become quite keen to review the support needs of those artisans.

When one looks at the hearth, the blower, the anvil and the blacksmithing and fire management tools, he or she can not help to comment that Liberia in this trade is at least ten of decades backward. The working posture is easily tiring and leads to inaccuracies in performing the labour intensive and hard operations. <sup>The</sup> blacksmith is a tool maker. Why does he buy tools. He should purchase just scrap and convert that to valuable products for himself and the community. Blower functioning is inefficient. Fire temperature hardly reaches 1000 degrees which with the same fuel can be easily raised to 1400 degrees to 1500 degrees and thus less number of fire stays necessary and workability of hot metal becomes easier. Use of certain tools helps to give accurate shape to hot metal and more quickly. As such the current mission feel it necessary to concentrate on those aspects and demonstrate to the blacksmiths how they can help themselves. Development by stages will be effective, acceptable to artisans and be absorbed. This motto was kept in view all through.

## II. EXPLANATORY NOTES

2.1 It is important that readers of this report have a clear mental picture of blacksmithing, it's minimum requirements, skills used and the potential of the draft. To this end the writer includes this general outline of blacksmithing which will also make clear some of the more unusual terminology used.

2.2 The blacksmith is a worker in hot ferrous metals, (metals based on iron). For efficient working a smith must be able to heat metals rapidly with the minimum of oxidation, (combining with O<sub>2</sub>), through the temperature range from ambient to about 1450 degrees. To achieve this, a hearth of good design to hold a fire, good quality fuel and an efficient air blast are essential.

2.3 Heated metal is worked on a steel block called an anvil. Work is carried out by hammer blows applied directly onto the metal or through tools held in position and then hammered. The weight of an anvil should be at least eight to ten times that of the heaviest blow applied. Light weight, poorly designed anvils waste time, physical effort and fuel. Well designed anvils facilitate all forging operation and have provision for holding various forming tools.

2.4 Basic hand tools required are:

- a) Hand hammer, 750gm to 1500gms
- b) Sledge hammer, for two handed use, 3.5 to 5kgs
- c) Tongs to hold hot metal.
- d) Swages and fullers, forming tools for various shaping operations.
- e) Set hammer, indirect forging tools for setting down shoulder such as tenons.
- f) Flatter, indirect forging tool for finishing flat surfaces.
- g) Various punches and drifts for making, sizing and shaping holes.

- h) Setts, like chisels with handles, for cutting both hot and cold metal.
- i) An assortment of mandrels and bending tools etc.

2.5 Smithing operations carried out on the anvil are:

- a) Drawing down - making metal longer and thinner
- b) Upsetting - making metal shorter and thicker
- c) Bending - all kinds of bends and angles
- d) Cutting - carried out on hot or cold metal
- e) Punching - making holes of many sizes and shapes
- f) Welding - joining metal by heating to near melting point then hammer together
- g) Changing Section - square to round, round to hexagonal etc.
- h) Hardening and tempering - heat treating to give metal the desired degree of hardness.

All work carried out by a smith includes some or all of these operations carried out in a pre-planned sequence according to the complexity of the work in hand.

2.6 Examples of smiths work would include:

- a) Making spikes, nails and staples
- b) Making "S" links, split links, and welded chain links.
- c) Making own tools; tongs, swages, setts, chisels, fullers, hammers etc, etc.



- d) Making carpenters tools, chisels, flame iron, draw knives, rasp, etc, etc.
- e) Making tools and rings for many purposes.
- f) Making door and gate hinges and other fittings.
- g) Making and/or refurbishing agricultural hand tools, axes, hoes, slashers, rakes, spades, forks, and shovels etc.
- h) Making or repairing parts for agricultural implements, ploughs, harrows, seeders etc.
- i) Making or repairing iron work for ox-carts
- j) Making bolts of many kinds.
- k) Making mechanics pliers, spanners etc.

The above is only a sample of work which can be achieved with quite simple tools and equipment.

### III. BACKGROUND

3.1 Forgework is one of the primary forming processes mostly carried out by machines in industrialized countries. In developing countries hand forge work is uniquely placed to utilize otherwise scrap materials. Shapes, sizes, and sections can be changed by forging operation leading to local production of many necessary items becoming a reality. Smithing is related to nearly all metalworking processes. Forged products can be machined or welded to form more complex wholes. Smithing is a

very viable basis for the development of other engineering activities.

3.2 Blacksmithing in Liberia is hindered to a large extent by:

- a) Very poor equipment of primitive design, lack of hand tools, limited skills and technical knowledge.
- b) Difficulties in obtaining workable materials. This is mostly a logistic and personal contact problem. Scrap materials and some new steels are available but the cost to transport is a disincentive and time is consumed in locating supplies.
- c) Largely due to ancient design of hearth and fire, work is generally carried out in the sitting position causing great stress on back muscles, reduced effectiveness of hammer blows and reduced flexibility of movement.
- d) Although prices obtained for smiths products seem to be fair, much profitability is lost due to labourious techniques, working metal at relatively low temperatures and excessive number of working heats being taken.

3.3 The objectives of the consultancy mission were, as outlined <sup>in</sup> the consultants term of reference:

- a) To assist the blacksmiths in upgrading their forging skills for the production of agricultural hand operated tools and implements with other rural needs for forged products being considered.
- b) Assist blacksmiths in modifying their charcoal fired hearths to improve the quality of forged products without any sizeable increase in investment.
- c) Train the blacksmith how to select the proper steel for specific forging job from available scrap materials.

3.4 It is clear that there is much scope for modernization of blacksmiths production units, to enhance production and to

widen the range of products. Initially, priority must be give to:

- a) Equipment and tools.
- b) Skill training
- c) Workshop environment and working position

#### IV. ACTIVITIES UNDERTAKEN

4.1 Time proved to be quite a limiting factor due to it being necessary to locate and purchase some basic hand tools, locate and purchase materials and to travel quite extensively to get quality cutting and welding carried out. The project's CTA, Mr. Khosla helped in every way possible and eased many of the difficulties. Having to work in unshaded and unsheltered conditions slowed practical work quite a lot.

The assistance of UNV Mr. Hoque and his counterpart Mr. Snorton was invaluable. Mr. Hoque made available the results of a survey carried out by him regarding blacksmiths, their technical level, tools and equipment used and their main products. He also made available ground space at his residence for the mission activities. He assisted in every possible way. Mr. Snorton worked very hard throughout, weekends and holidays without pay. Much of the work was strange to him and physically demanding. Any success achieved by the mission is largely due to these two individuals.

4.2 A survey was carried out by the consultant amongst smiths and smithing enterprises in the areas of; Gbarnga, Sanniquellie, and Seclepea. The evaluation of priorities was drawn up and the most pressing needs were found to be:

- a) Improved hearths, fires and blowers.
- b) Improved anvil,
- c) Improved and additional tools.
- d) Skill training

The scope for activity remained largely as the consultants term of reference. However, as skill training cannot be carried out in the absence of adequate tools and equipment, priority were changed to the above order of a), b), c) and d).

4.4 A simple hearth, water cooled tuyere (blast pipe) and blower fan were designed and made using only hand tools. Only locally available materials and components were used. See Annex I, II and III. The fan is quite large diameter and driven by a cheap (\$17) bench grinder readily available in Liberia. The large fan diameter means that adequate air can be delivered to the hearth and fire at low turning speeds. This in turn reduces wear and tear and means that only little physical effort is required for it's operation. Only basic fitting and welding skills are needed in the construction meaning that the equipment can be reproduced locally. After using the hearth for about two days the fire bed settles down, that is, dries out and consolidates. It was found that temperatures in the region of

1400 degrees were reached using local charcoal as fuel. At temperature approaching 1350 degrees steels can be welded together by hammering on the anvil enabling some items to be made by joining steel. This reduces the need for heavy and prolonged hammering in many cases. The ability to quickly reach higher temperature enables more work to be carried out before reheating is necessary saving time and, to some extent, fuel.

A second similar hearth with water cooled tuyere was also constructed and fitted with a heavy duty, commercially made American blower fan. During training comparisons of the two were made. There was no obvious difference in the performance of either the locally made or American blower. Both performed well. However, being made locally, the blower produced during the mission is easy to maintain or repair. The imported model would require parts which would need to be imported. See photograph I, II, III, IV, and V.

4.5 With only local materials being considered an anvil was designed and made as in Annex IV. It served its purpose well. See photographs VI and VII. The anvil enables all standard forging operations to be carried out while the flat, spring steel face enables good surface finishes to be attained. The tool hole allows bottom shaping and forming tools to be used to facilitate more efficient working. Currently smiths use as many as six or seven odd pieces of metal as anvils during otherwise simple operations. Photograph No. IV illustrates this. Old motor crank shafts to the left are used as well as the 'Anvil'

being worked on. The newly introduced anvil allow the upright stance to be adopted for working, allowing work to be carried out more easily and quickly.

4.6 A range of fire tools and standard forging tools were designed and made from scrap motor spring steel and mild steel rod. They comprised:

- a) Tongs of various sizes, for holding hot metal.
- b) Fullers, three sizes, for grooving, rapid by drawing down and spreading hot metal.
- c) Setts, (like large chisels with handles). One for cutting cold metal, one for cutting hot metal.
- d) Sett hammer: used for setting in shoulders such as tenons etc.
- e) Flatter; used for attaining flat, smooth surface finish. Often used after fullering.
- f) Fire tools. Essential for constant fire control. See Annex V and photograph No. VI.

4.7 From 20th March to 4th April inclusive, it was possible to run short, two day, introductory and training courses for interested smiths. Smiths from the Gbarnga, Sanniquellie and Seclepea areas took part. Topics covered by discussion, explanation, demonstration and practice were:

- a) Equipment, hearth, fire, blower and anvil
- b) Fire management
- c) Hand facing low carbon steel with cast iron,
- d) Case hardening low carbon steels using the open fire method.
- e) Introduction to forging tools, their uses and application.

f) Forging techniques:

- 1) Upsetting
- 2) Drawing down
- 3) Bending
- 4) Punching holes
- 5) Changing Section
- 6) Riveting
- 7) Simple forge welding
- 8) Heat treatment, annealing, normalizing, hardening and tempering.

g) Tool making demonstrations and practice included:

- 1) Making files for use on metal
- 2) Making chisels
- 3) Making hot and cold setts
- 4) Making fullers
- 5) Making sett hammer
- 6) Making flatter
- 7) Making tongs.

All smiths practiced the upright working stance and worked double handed, smith and helper. They all adapted to this as well as the strange tools and techniques very quickly. All made at least some tools of their own choice for use in their workshops. eg. Tongs, setts for cutting and flatters.

The only criticism voiced was that training sessions were too short for them to enjoy enough supervised practise. Most would like more and longer training periods along similar lines. However, it was considered that what was introduced was such a radical change to current practices that had more been attempted, saturation point would have been reached beyond which assimilation would have been negligible. As it was, all smiths seemed to be keen to acquire hearths, blower and anvils as well as making more of their own tools.

4.8 Training sessions could not effectively continue after 4th April due to the need to repair and replace some tools. It must be realised that forging tools, particularly in the hands of inexperienced persons, are subjected to much distortion and damage. Tools and equipment were left in workable condition. An additional consideration was, of course, the time and facilities needed for this report. Few if any facilities exist at Gbarnga.

4.9 The upright working stance was introduced to reduce the strain on back muscles, to improve mobility and flexibility which is essential for working hot metal. The upright stance also allows double handed working on the heavier sections of steel. A smith and helper can use heavier hammers and a wider range of tools resulting in much higher production rates with less physical strain. Some of the reasons for introducing forging tools are:

- 1) When struck with a flat hammer face metal tends to stretch or move in all directions. The use of a fuller helps to move metal in the direction required while, at the same time concentrating the force of the hammer blow over a smaller area thus moving metal more quickly.
- 2) Metal cutting is carried out by smiths using chisels held in the hand or tongs and hammered. With heavy cutting damage to hands often results or, chisel can be forced out of tongs with great velocity resulting in danger to other workers. Hot and cold setts were introduced and are essentially heavy chisels fitted with handles. These are more accurate and much safer in use.



- 3) Neat, clean shoulders are difficult to produce using only hammers due to minor inaccuracies of successive blows. The set hammer was introduced. This is held on the work then struck by hammer blows resulting in neat accurate shoulders being formed.
- 4) Clean flat surfaces as required for some products are difficult to produce with hammer blows alone. The use of a flatter as a finishing tool saves much time and gives a much improved finish.
- 5) Tongs which properly fit the metal being worked speed up operations and are much safer in use than weakly made, badly fitting tongs and other devices currently in use.

As an example. Most smiths entertained during training take about one hour or more to produce one heavy weight axe of traditional design. Using the tools and equipment made during the mission and an inexperienced helper, the consultant demonstrated two similar axes being made in a little over thirty minutes.

## V. CONCLUSIONS

5.1 A longer training component to the mission would have been desirable. However, as training cannot be carried out in the absence of tools and equipment, these had to be developed and made. In addition, there is a limit to what can be assimilated as already mentioned in 4.7. The methods, tools and equipment introduced seem to have opened up the minds of smiths to the wider possibilities of their craft. Correct heat treatment procedures plus case hardening were greatly appreciated and should yield some better results. There is keenness to adopt tools, equipment and methods if these are skillfully demonstrated and are proved to have immediate advantages. Older smiths are, of course, more difficult to influence than younger men. This should be considered and taken into account.

5.2 Short missions such as this one can only have a limited effect on relatively few blacksmiths over a small area of the country. Much greater efforts are needed. However, in the short term, and after no more than about three months additional follow-up training sessions are needed to build on what has been introduced. By this time smiths should have been able to make use of and evaluate what they have experienced. If this is done it is necessary to have adequate tools, equipment, materials and working site available and prepared in advance. Arrangements for transportation and the accommodation of course participants need to be considered.

5.3 With better tools and equipment such as described herein plus skill training, the productivity of smiths can be increased at least threefold. The Governments aims to produce agricultural hand tools and implements within the country can be achieved. Some financial assistance might be needed to enable smiths to acquire tools and equipment and possibly alter their workshops. At present most workshops have very low roofs which are not conducive to the upright working stance being adopted. Most are open sided structures without security for tools, equipment and materials. Present project staff both national and international could assess the amount of financial help needed in individual cases.

5.4 If more tools and equipment for training purposes or for sale to smiths are to be made locally, this would be best carried out in a small workshop capable of basic bench fitting, oxy/acetylene cutting and quality electric arc welding. Tools already with the UNIDO project plus:

- a) Oxy/acetylene cutting plant,
- b) Electric arc welding plant-about 200 amps output.
- c) Facilities for drilling holes.

would suffice. Alternatively a local enterprise could be developed to carry out such work on a carefully costed basis. Enterprises currently doing similar work charge excessive prices and the quality of welding carried out is very poor.

5.5 As all the objectives of the mission were achieved, with some additional work carried out, the mission would appear to have been successful. It would be disappointing if, after having made a start and created interest, no useful, practical follow-up was carried out. Practical follow-up should include:

- a) Revision or repetition of training carried out.
- b) Development of additional skill in the basic forging operations listed in 2.5
- c) Application of operations to current products, axes, hoes, slashers, shovels, etc.
- d) Development of additional, simple forming tools for the making of shovels and hoes with eyes forged from the solid in the case of hoes.
- e) Revise on heat treatment and include the two heat method of hardening and tempering.
- f) If possible introduce some additional products such as carpenters tools, chisels, plane irons etc.

One hearth, anvil and set of tools are needed for each pair of course participants.

Four trainees	=	2 sets tools and equipment
Six trainees	=	3 sets tools and equipment
Eight trainees	=	4 sets tools and equipment

Courses need to be of about five days duration and, preferably consist of not more than six participants, eight is an absolute maximum.

Shaded and secure working conditions are essential such as a small workshop capable of holding tools and equipment in safe storage.

Summary of prerequisites for any followup:

- 1) Job description based on a) to e) above.
- 2) Suitable shaded and secure work area.
- 3) Sufficient tools and equipment; one set per pair of trainees.
- 4) Sufficient fuel supplies, about two bags of charcoal per day per forge unit.
- 5) Supplies of scrap materials, ie, flat motor spring leaf from 4m/m to 12m/m thickness. Round section spring steel, odd bits of angle iron, channel and flat bar etc.
- 6) New materials; mild steel flat bar 25m/m x 10m/m (or near) 2 metres per trainee. 8, 9 or 10m/m mild steel round section rod, 4 metres per trainee.
- 7) Borax powder, about 250gm per trainee (minimum).
- 8) Case hardening compound, KASENIT or similar about 250gm per trainee.
- 9) Assessment of the numbers of smiths been to partake and a planned programme for transportation of smiths area by area.
- 10) Reliable and unrestricted transport facilities for consultant, and day to day running of the mission.

5.6 Accurate costing of training was not possible due to heavy work load and the number of activities taking place at the same time. Costs of fuel varied and, with hindsight, more was often paid for materials and services than should have been the case. Costs for materials alone can be estimated at about \$6 per day per trainee.

## VI. R E C O M M E N D A T I O N S

6.1 To ensure that the Liberian Government aims to meet the widespread needs for agricultural hand tools and implements by production within the country, using mainly the services of blacksmiths are achieved, modernization of smiths working methods is needed. Steps should be taken to formulate, finance and implement a joint UNIDO/Government project aimed at, as a minimum:

- a) Providing a very high standard of skill training.
- b) Making available, at affordable prices, minimum equipment such as:
  - 1) Anvils
  - 2) Robust hand powered blowers
  - 3) Heavy duty vices
- c) To train a core of national instructors/extension workers. Say, about six initially.
- d) Develop staff and facilities to enable such activities to expand to all agricultural areas within the country.

6.2 As an interim measure and as a follow-up to the current mission, smiths be helped to make or have made:

- 1) Anvils similar to that developed during mission activities.
- 2) Hearths and blowers similar to those developed and used during this mission.

At this time, UNV Mr. Hoque and his national counterpart, Mr. Snorton are well able to advise and assist in this. It would be of advantage if the management of the national railways were approached with reference to the supply of used

railway line at low cost. This should be done by a senior person, perhaps Mr. Khosla, CTA of Project DP/LIR/87/007 would be prepared to carry out negotiations. Good cutting and welding facilities are needed which could be satisfied by either:

- 1) Making gas cutting and electric arc welding equipment available to Mr. Hoque and Mr. Snorton.
- 2) Possibly obtaining the co-operation of vocational training establishments.
- 3) Developing a local enterprise to do the work with costings supervised.

The work carried out locally is charged at a very high rate and standards are low.

6.3 When, and if the foregoing is achieved, additional follow-up is needed to encourage smiths to make and use at least the basic forging tools. This requires the services of a highly skilled smith with better working conditions than those available during this mission. A shaded area is essential with shelter from wind and rain. Security for tools and equipment is necessary.

6.4 Training of some national instructors should commence as soon as possible. This might be carried out on a fellowship basis outside of Liberia. Courses need to cover all smithing operations with a strong bias towards African conditions regarding fuel, tools, materials and equipment. Such courses are of ten to twelve weeks duration.

Many establishments offering training in the field of blacksmithing do not, or are unable to cover all skills adequately in spite of claims to do so. The consultant does not know of every such establishment but has seen many examples of time and money being wasted on such exercises. At the present time the consultant can only recommend one organization with confidence. Contact should be made with:

I.T.D.G. (INTERNATIONAL TECHNOLOGY  
DEVELOPMENT GROUP)  
Myson House. Railway Terrace  
Rugby. CV21 3HT  
England

Their training advisor is: Mr. Rodney King.

6.5 If 6.2 and 6.3 are achieved some locally made, special tools of simple design should be developed to help in the more efficient production of currently made products. Tools would include, special swages, special fullers, mandrels and bending aids.

6.6 Some help should be organized with reference to material supplies. Smiths acting individually have difficulty in locating supplies and find the cost of transport high. Approaches could be made to mining companies and others who dispose of quite large quantities of good, usable scrap materials. Transport could be arranged on behalf of smiths at a lower cost than that borne by individuals.



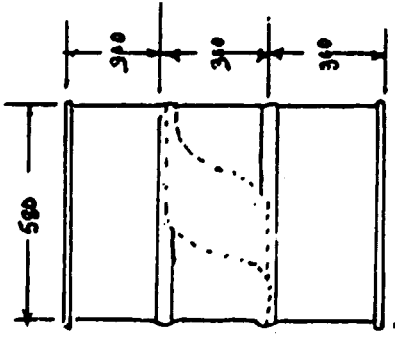
6.7 Continued advice and assistance is needed in the marketing of products and simple accounting.

6.8 The use of BORAX powder and CASE HARDENING compounds were introduced during the mission. There is a need to locate supplies of both and advise blacksmiths of its cost and availability. BORAX should be available as laundry products are made here. CASE HARDENING compounds might already be imported by some of the larger companies.

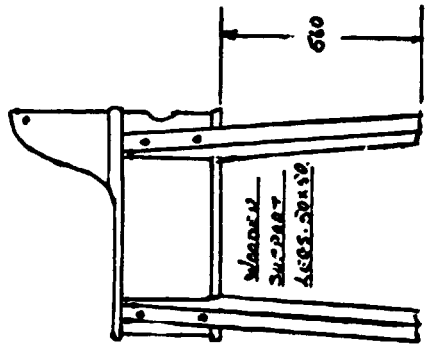
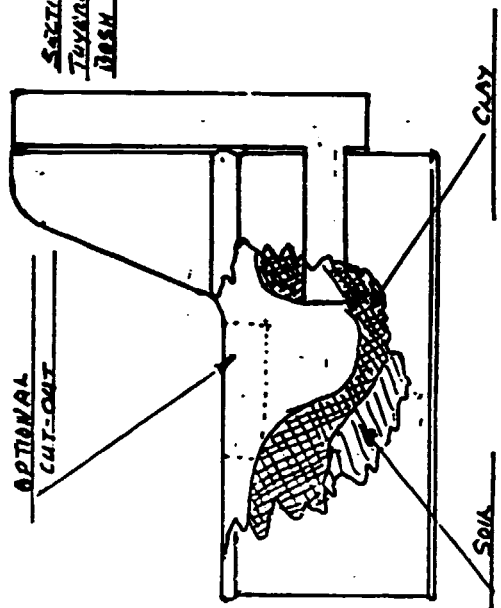
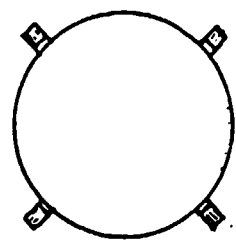
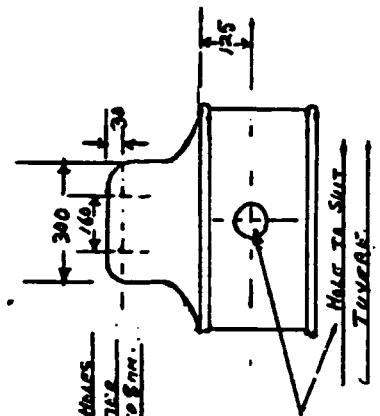
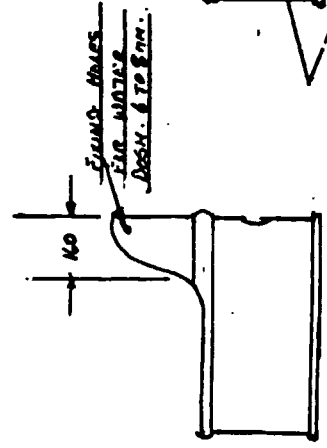
NOTE: BORAX is used as a fluxing agent to dissolve oxides during some forging operation.

CASE HARDENING compounds enable low carbon steels to be surface hardened easily in an open smiths fire.

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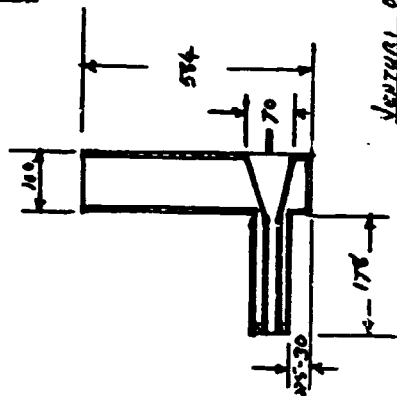


USED ON DRAIN  
SHAPING CUTTING  
LINES

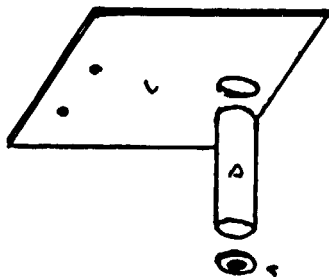
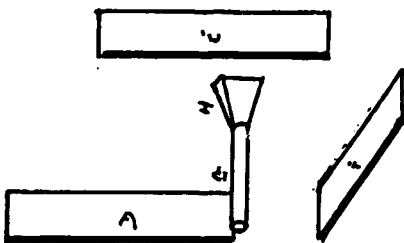
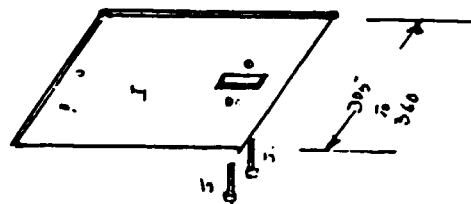


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 MATERIALS SPECIFICATIONS: BEECH.  
 COST: \$400.00, AMOUNT \$18.50  
 DATE: MARCH 1957.

ANNEX II



WATER BUSH AND COOPER TUBE.  
ALL WELDED CONSTRUCTION.  
COST ABOUT \$30 DEPENDING ON COST OF WELDING.

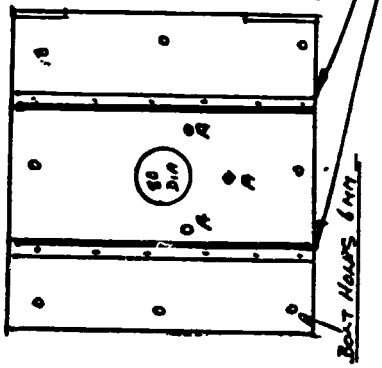


- A) ALUMINUM AND IRON PIPE ENDS
- B) 2" (50mm) WATER PIPE.
- C) 1/2" (12.5mm) IRON PIPE.
- D) 2 TO 3mm MILD STEEL.
- E) 2 TO 3mm MILD STEEL.
- F) 1" (25mm) WATER PIPE.
- G) FABRICATED VENTURI.
- H) 2 TO 3mm MILD STEEL.
- I) 6mm HEX BOLTS TO FIX BLOWER.

WATER BUSH AND TUBE.  
DESIGNED BY: J.O. STOKES.  
DRAWN BY: J.O. STOKES.  
MADE AT: SERRANA, LIBERIA.  
USED AT: SERRANA, LIBERIA.  
DATE: MARCH 1959

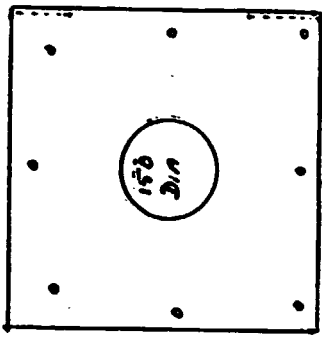
ANNEX III  
SHEET 1 of A.

SIDE PLATE. REMOTE.  
DRAWING SIDE.  
HOLES A, A, A TO  
SUIT BENCH GRINDER

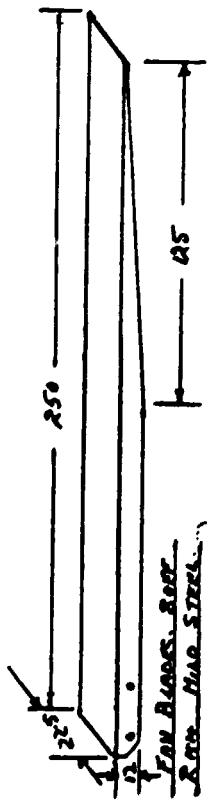
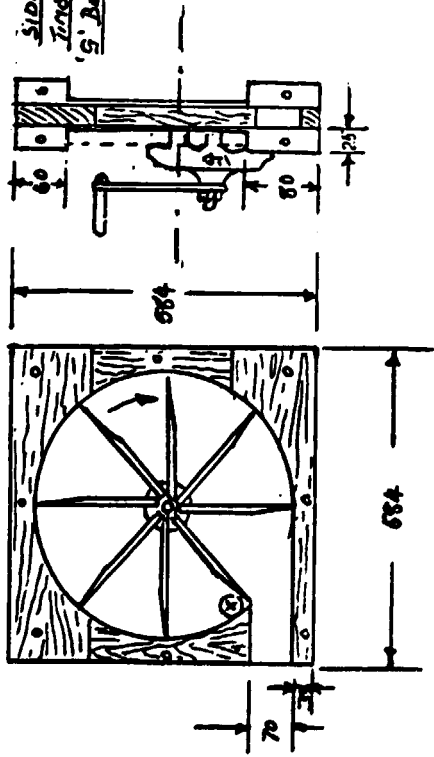


HYPOEUTECTIC  
STEEL OR  
LINED WITH  
SUNK  
RIVETS.

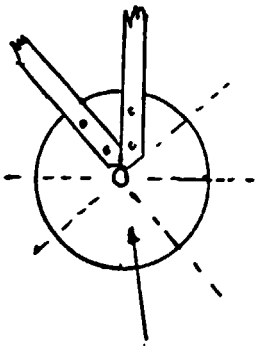
SIDE PLATE. REMOTE.  
DRAWING SIDE.  
BOLT HEADS TO MATCH  
DRAWING SIDE PLATE  
AND TO PASS THROUGH  
TIMBER.



SIDE PLATES 2mm M.S.  
TIMBER 2 1/2" TO 3" DIA THICK.  
'S' BENCH GRINDER - MODIFIED.



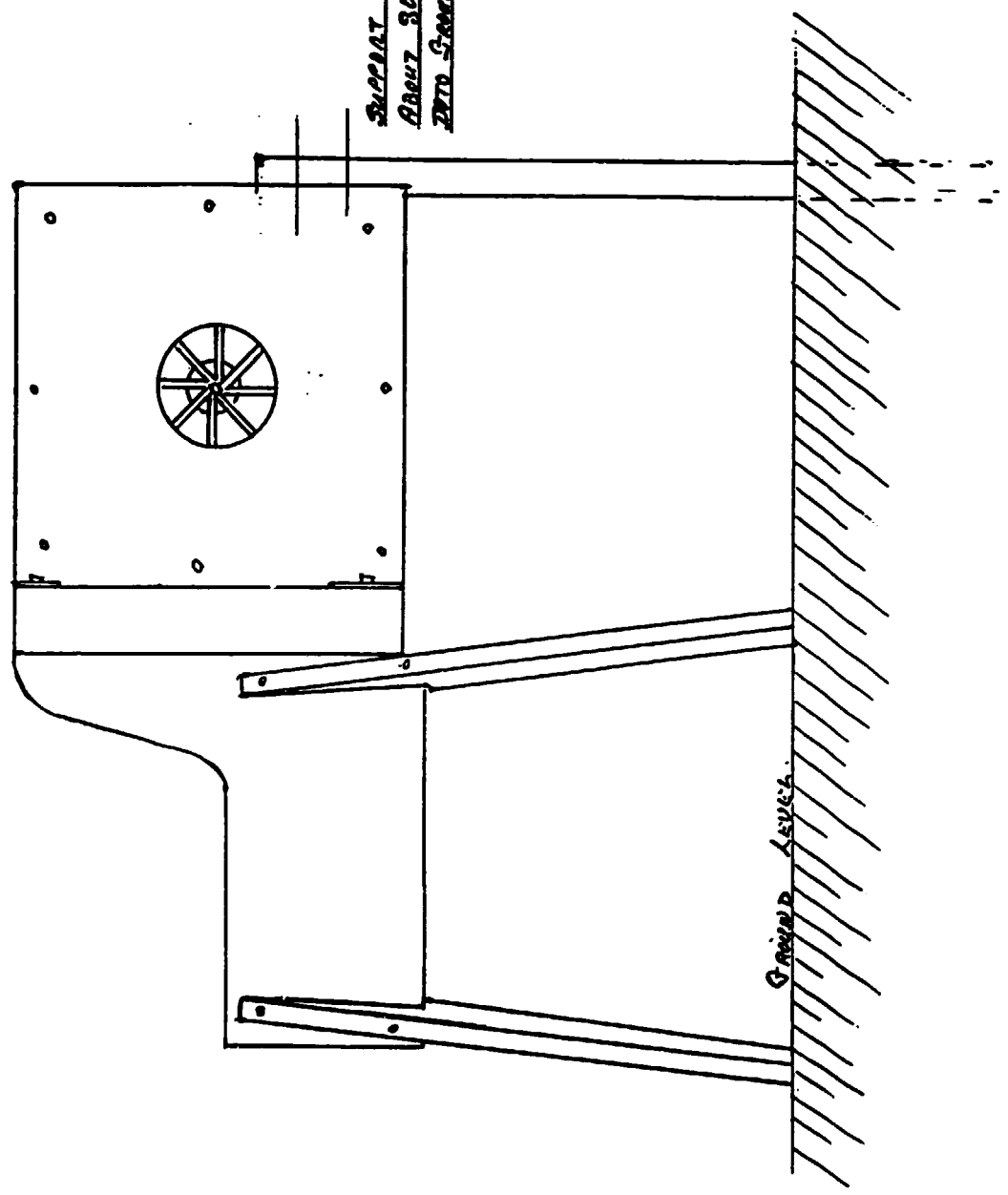
BLADE CLEARANCE TO BE  
MINIMAL AT (B) ABOVE.



BLADE FOR FOR RESINUS MERRY  
DESIGNED BY: J.B. STOKES  
DRAWN BY: J.B. STOKES  
MADE AT: SERRANA, GUERNA  
USED AT: SERRANA, GUERNA  
COST: ABOUT £42  
DATE: MARCH 1979.

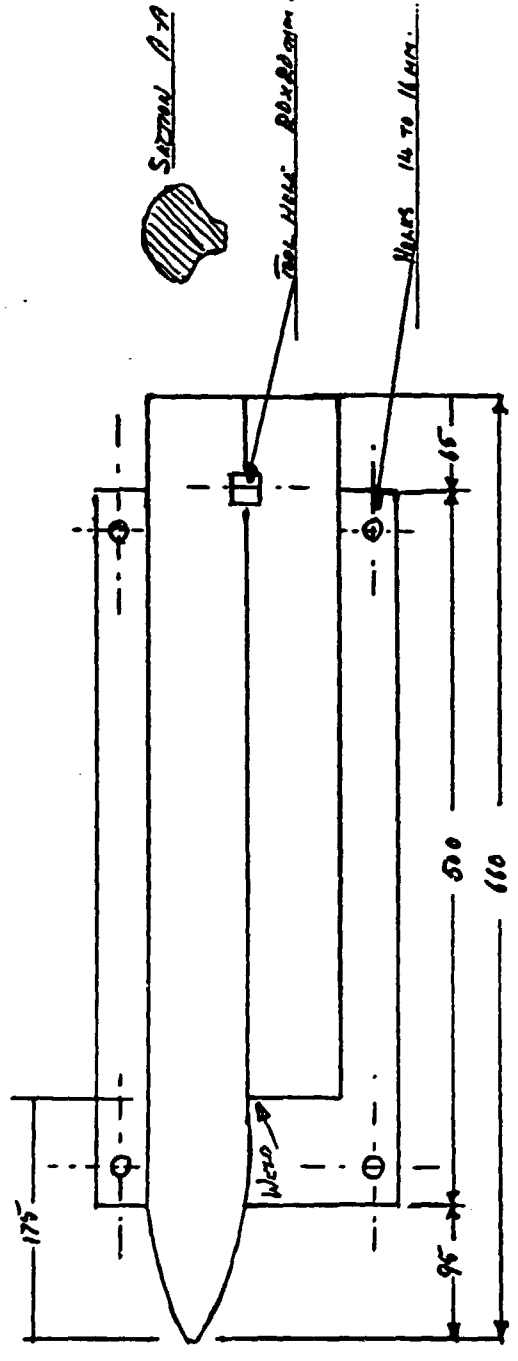
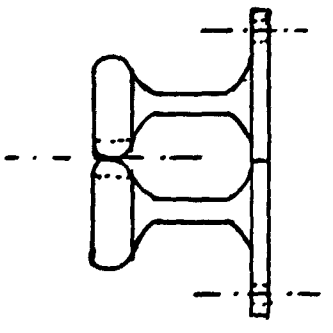
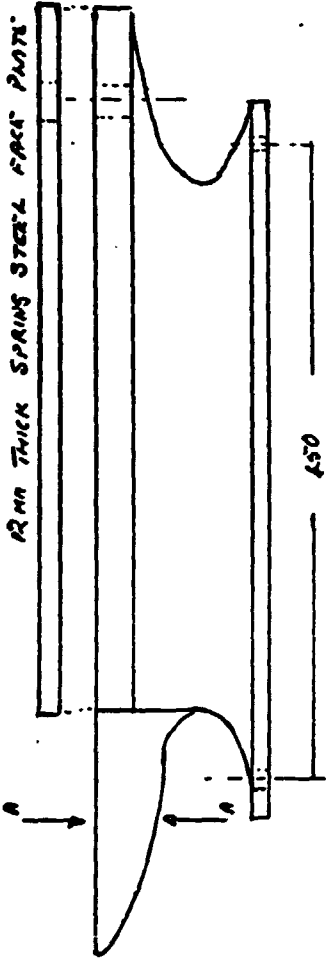
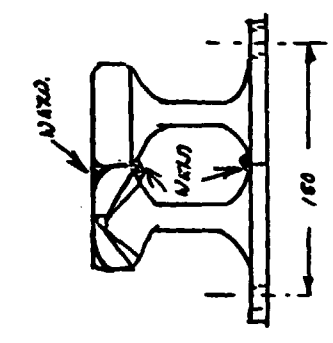
ANNEX III  
SHEET 2 OF 2.

SCHEMATIC LAYOUT OF  
HEALTH TUBE, BUSH AND  
DRAIN.  
BY V. J. B. STOKES. MARCH 59



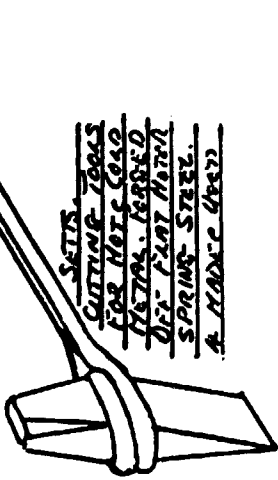
SUPPORT POST. WOOD.  
ABOUT 300 - 350 MM  
DIA. GALVANIZED.

APPENDIX IV

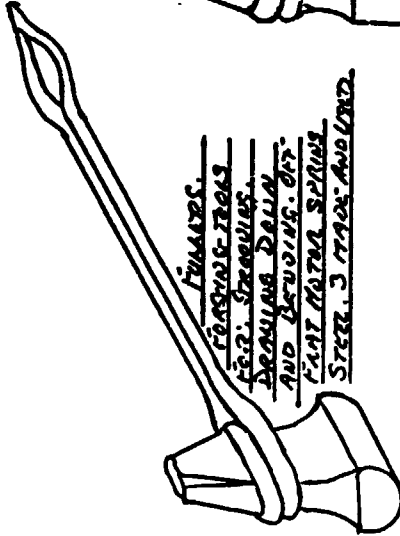


AWAL DARI LOCAL MATERIALS.  
 DESIGNED BY : J.D.S. STAKES.  
 DRAWN BY : J.R.S. STAKES.  
 MADE AT : SURABAYA, INDONESIA.  
 DESIGNED AT : SURABAYA, INDONESIA.  
 DATE : MARCH 1987.  
 EST. : PT. SUTERA PERKAWA  
 IN NEERLANDSE COLONIAL-GEBOUWEN.

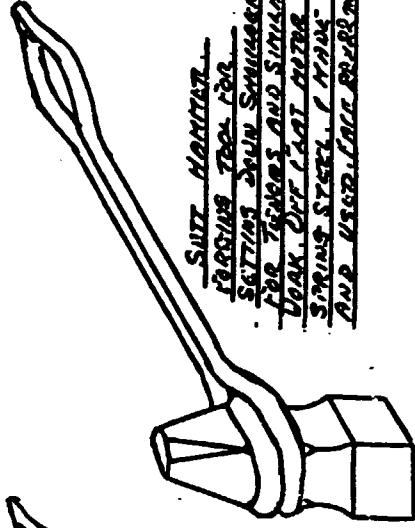
ANNEX No. V



SETS  
CUTTING TOOLS  
FOR HOTS COLO  
METAL. HARD  
OFF FLAT METAL  
SPRING STEEL.  
A MAX. C. 45027

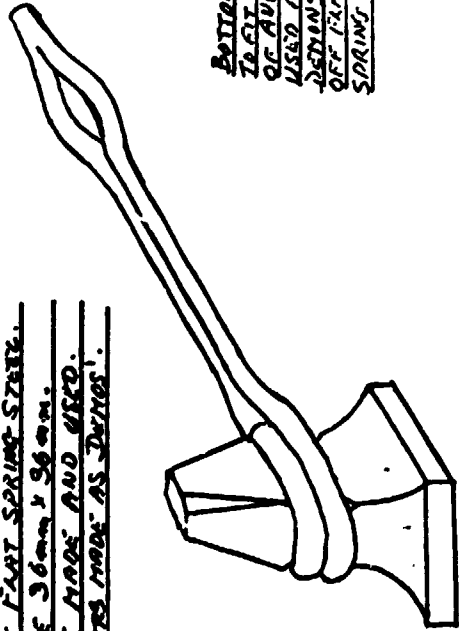


FUSERS.  
FOR STRINGS  
AND BEARING DRUM  
AND BEARING DRUM  
FLAT MOTOR SPRING  
STEEL. 3 TRACKS AND LARD.

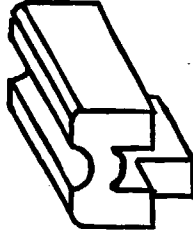


SUIT HANGER  
FORGING TOOL FOR  
SETTING DOWN SHIMMERS  
FOR TURNS AND SIMILAR  
WORK. OFF FLAT MOTOR  
SPRING STEEL. 1 1/2 INCH  
AND USED. FACE 20027MM

FLATTER FINISHING TOOL  
FOR FLAT SURFACES.  
OFF FLAT SPRING STEEL.  
CASE 36mm x 96mm.  
ONE MADE AND USED.  
GRATES MORE AS DURING.

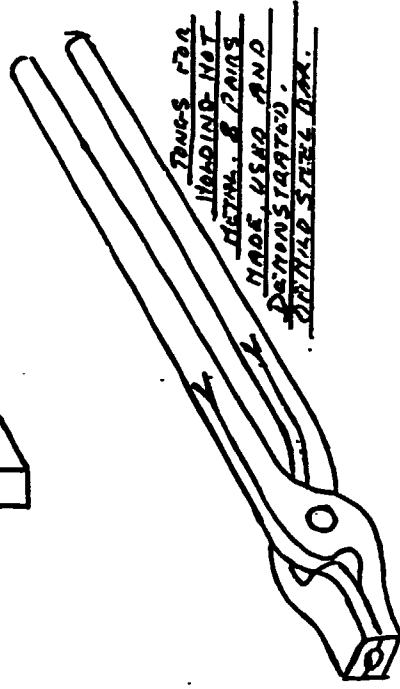
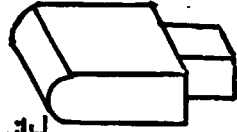


'HARDEN' CUTTING TOOL  
TO FIT TOOL HOLE  
OF ANVIL.  
OFF FLAT  
FLATER SPRING  
STEEL. MADE  
AND USED



BETTER SWAGE. TO FIT  
TOOL HOLES OF ANVIL.  
GRADE AND DEMONSTRATED  
OFF FLAT MOTOR SPRING  
STEEL.

BETTER FUSERS  
TO FIT TOOL HOLE  
OF ANVIL. MADE,  
USED AND  
DEMONSTRATED  
OFF FLAT MOTOR  
SPRING STEEL.



TOOLS FOR  
HOLDING HOT  
METALS. 8 PAIRS  
MADE, USED AND  
DEMONSTRATED.  
OFF FLAT MOTOR SPRING  
STEEL.

DESIGNS OF SOME TOOLS MADE, USED  
AND DEMONSTRATED.  
DRAWN BY: J. B. STOKES  
MADE BY: J. B. STOKES  
DATE: MARCH 1989

ANNEX VI

COURSE PARTICIPANTS 20TH MARCH TO 4TH APRIL 1989

	<u>Name</u>	<u>Location</u>	<u>Special Interests</u>	<u>Remarks</u>
<u>Group 1</u>	Mr. Mohammed Kerta	Gbarnga	Blower. Anvil. Tools	Little Interest in Techniques
	Mr. Sekou Konneh	Gbarnga	Blower. Anvil. Tools	Little Interest in Techniques
	Mr. Dawudu A. Bility	Gbarnga	Blower. Anvil. Tools	Little Interest in Techniques
<u>Group 2</u>	Mr. Solomadi Kromah	Sanniqueellie	Equipment, tools, techniques	Overall, keenly interested
	Mr. Johnson Diallor	Sanniqueellie	Equipment, tools, techniques	Overall, keenly interested
	Mr. Mamadee Konneh	Sanniqueellie	Equipment, tools, techniques	Overall, keenly interested
	Mr. Molyu Dumuyah	Sanniqueellie	Equipment, tools, techniques	Overall, keenly interested
	Mr. Morris Fafana	Sanniqueellie	Equipment, tools, techniques	Overall, keenly interested
<u>Group 3</u>	Mr. Morris Barclay	Gbartala	Equipment, Tools, techniques	Overall, keenly interested
	Mr. Amara Konneh	Seclepea	Equipment, Tools, techniques	Overall, keenly interested
	Mr. Mamadee Kromah	Seclepea	Equipment, Tools, techniques	Overall, keenly interested
	Mr. Sekou Kromah	Seclepea	Equipment, Tools, techniques	Overall, keenly interested



	<u>Name</u>	<u>Location</u>	<u>Special Interests</u>	<u>Remarks</u>
<u>Group 4</u>	Mr. Musa Keita	Seclepea	Equipment, tools, techniques	Overall, keenly interested
	Mr. Lamine, Jebba Konneh	Seclepea	Equipment, tools, techniques	Overall, keenly interested
	Mr. Morris Konneh	Seclepea	Equipment, tools, techniques	Overall, keenly interested (Teacher and Supervisor of smiths, Nimba Co.)
<u>Group 5</u>	Mr. Joseph Kromah	Gbarnga Area	Equipment, tools, techniques	Overall, keenly interested
	Mr. Joseph Kamara	Gbarnga Area	Equipment, tools, techniques	Overall, keenly interested
	Mr. Abdulahi Bamba	Gbarnga Area	Equipment, tools, techniques	Overall, keenly interested

A N N E X VII

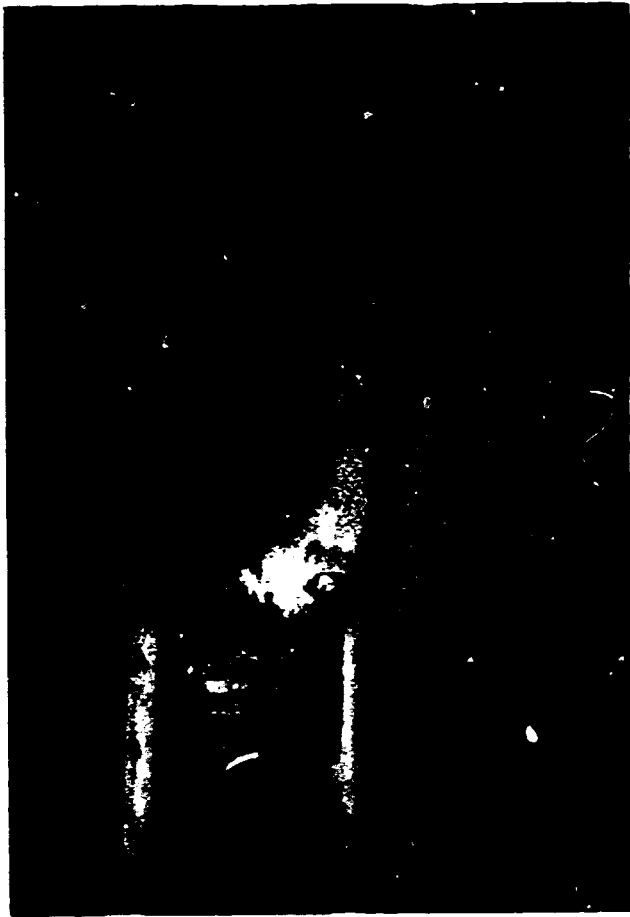
The consultant met and had discussions with:

UNDP - UNIDO

Mr. Francis R. Blain	UNDP Resident Representative
Mr. Khrishan D. Khosla	CTA. LIR/87/007 UNDP/UNIDO Project
Mr. T. Nakano	Associate Expert LIR/87/007 UNDP/UNIDO Project
Mr. Kazi Enamul Hoque	Metalwork Specialist LIR/87/007 UNDP/UNIDO Project

GOVERNMENT OF LIBERIA

Mr. George A. Bolo	Chairman of NIC, Monrovia
Mr. Pete E. Norman	Director Small/Medium Enterprises Department/National Investment Commission
Mrs. Mary Roberts	Regional Supervisor NIC/Gbarnga Branch Office
Mr. Moses Jackson	Industrial Engineer SME Department National Investment Commission
Mr. Irwin Snorton	Metalwork Technician NIC/Gbarnga Branch Office/Counterpart
Mr. Dennis Williams	Senior Industrial Planning Officer
Hon. Minister Toweh	Minister of Agriculture Ministry of Agriculture
Mr. Roland S. Toweh	Assistant Minister of Extension Services Ministry of Agriculture
Mr. J. Hillary	Assistant Minister of Technical Affairs Ministry of Agriculture



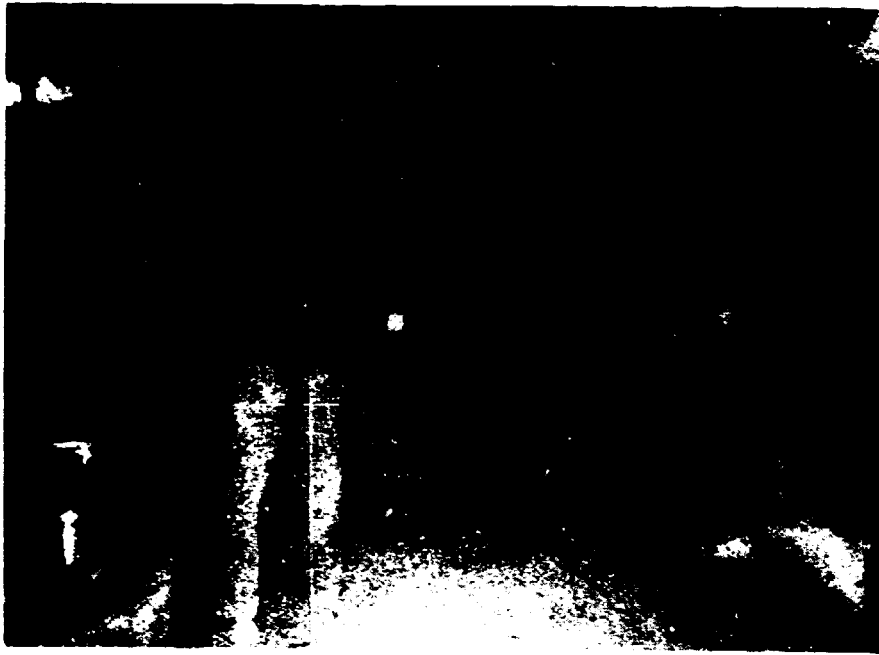
PICTURE NO. I

Liberian blacksmith using a newly introduced hearth at Gbarnga. View from the side of blower fan.



PICTURE NO. II

Operating side of a blower showing locally purchased and modified hand grinder in position. Cooling water system can be seen.



PICTURE NO. III Heavy section motor spring steel being worked. Note high temperature and upright stance adopted by smiths.



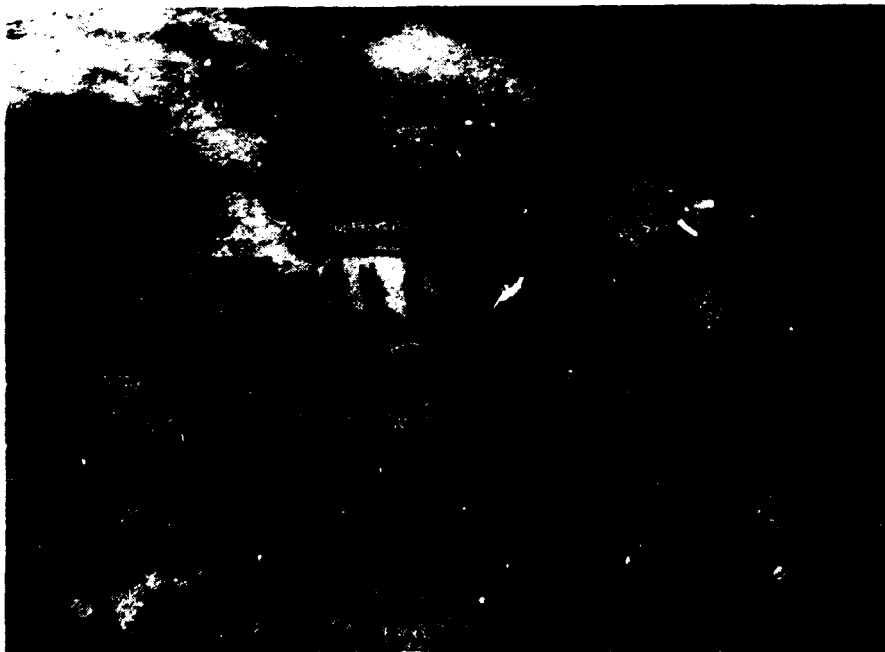
PICTURE NO IV

Typical smith in traditional working position. Note a scrap metal used as anvil.



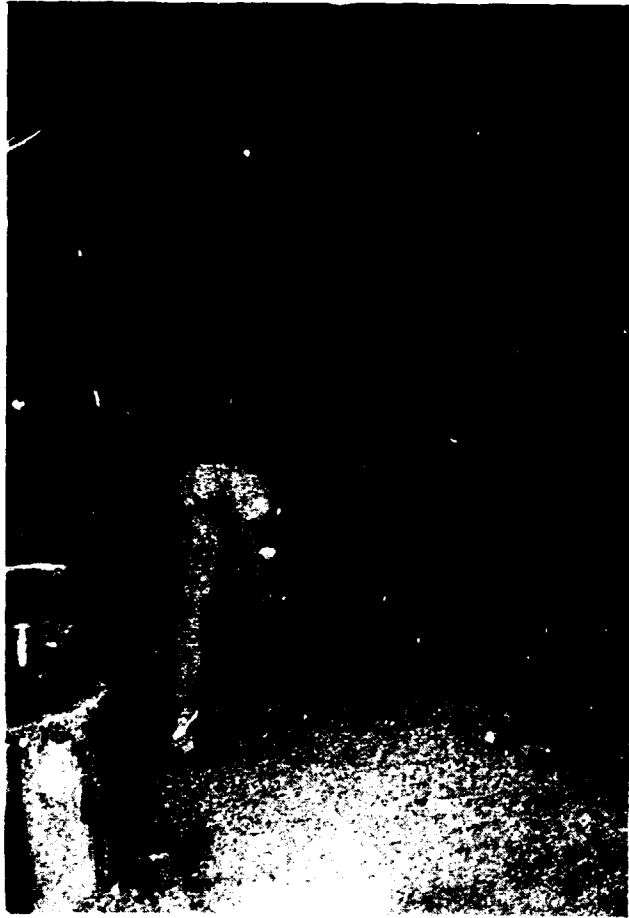
PICTURE NO V

A general view of introduced hearth  
and blower.



PICTURE NO. VI

Anvil with some of tools produced. Tools (right to left) poker, rake and slice (fire tools)  
Hot sett, cold sett, three sizes of fuller, assorted punches, chisels and bolster plate.  
Upper picture: six pairs of tongs of various sizes.



PICTURE NO. VII      The locally produced anvil at use.