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4.- DESIGN AND DEVELOPMENT OF A THRESHING MACHINE IN TANZANIA.

5.- A SIMPLE LOW-COST RICE BRAN STABILIZER

6.- BOTSWANA

7.- THE STERILIZATION AND DRYING BY STEAM PROCESSING (ETUVAGE), THE CONCEPTION OF AN ARTISAN OVEN

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PORTABLE GRAIN CLEANER p. 1

## Introduction

Clean grain can be dried more efficientiy, stored with less chance of damage and processed into higher quality food products

The portable grain cleaner (fig.1) was developed to fill the need for a faster and more efficient method of grain cleaning.

The machine is easy to operate and convenient to service and maintain.

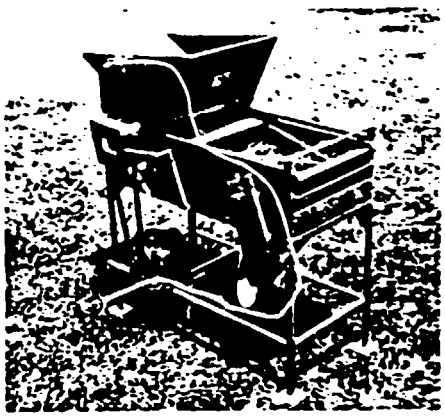


fig 1 Portable Grain cleaner

## Technology description

The portable grain cleaner consists of a frame, body, engine or electric motor, grain hopper, oscillating dual screen assembly and a centrifugal blower.

The body and grain hopper are made from plywood and angle iron is used for the frame and legs.

The eccentric and support linkages of the screen assembly cause it to oscillate, which moves the grain over the horizontal screen.

## Process to apply the technology

During operation, grain is loaded into the hopper and fed into the oscillating screen through the bottom opening and regulated by the slide gate (fig.2).

The top screen separates the impurities that are bigger than the grain and the bottom screen separates those that are smaller.

As the grain drops from the lower screen onto the wind board, the air blast separates materials lighter than the grain.

Clean grain is then collected at the grain chute.

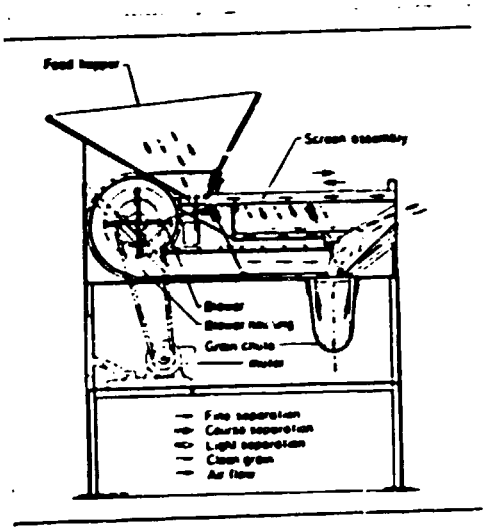



fig 2 Cross sectional view of cleaner

PORTABLE GRAIN CLEANER p. 2

Materials required

COMPONENTS PARTS LIST AND MATERIALS

| part num | qty rqd | description or part name | material required |
|---|---|---|---|
| 1 | 1 | blower housing assembly | steel |
| 2 | 1 | blower assembly | steel |
| 3 | 1 | electric motor 1/2 Hp | motor |
| 4 | 1 | V-pulley,section B,3"O.D.,1/2"bore | pulley |
| 5 | 1 | belt guard | steel |
| 6 | 2 | 1/8"diam.,spring wire lock | spring |
| 7 | 2 | ball bearing 6304-2rs deep groove | ball bearing |
| 8 | 2 | eccentric bearing clamp assembly | steel |
| 9 | 1 | V-pulley, section B, 7"O.D.,1"bore | pulley |
| 10 | 2 | pillow block 1" NP-16 | bearing |
| 11 | 1 | eccentric shaft | steel shaft |
| 12 | 1 | engine base assembly | steel |
| 13 | 4 | vibrating plate pivot assembly | bronze |
| 14 | 4 | vibrating wood plate | wood |
| 15 | 2 | eccentric pivot assembly | bronze |
| 16 | 2 | eccentric wooden linkage | wood |
| 17 | 12 | bracket clamp | steel |
| 18 | 2 | screen shaft | steel shaft |
| 19 | 2 | lifting bar | steel bar |
| 20 | 1 | grain screen assembly | steel wire |
| 21 | 1 | screen frame assembly | steel |
| 22 | 1 | dust spout extension assembly | steel |
| 23 | 1 | windboard | wood |
| 24 | 1 | sliding gate assembly | wood |
| 25 | 2 | hinge | steel |
| 26 | 1 | grill assembly | steel bars |
| 27 | 2 | screen side fastener | steel |

Recommended top screen sizes

| crop | screen hole size |
|---|---|
| rice | 8-9 mm (#20-22) |
| sorghum | 6-7 mm (#14-16) |
| soybean | 7-8 mm (#18-20) |
| wheat | |
| mungbean | 5-6 mm (#13-14) |
| maize | 10-12 mm (#26-30 |

The cleaner is small, light and can be accommodated in jeeps, vans or trailers for long transport; two handle bars can be inserted through loops on the frame, so that two men can carry the cleaner to the cleaning site

Machine characteristics:

- High capacity - up to one ton of paddy per hour
- Lower power requirement - 0.50 Hp electric motor or 1.0 Hp gasoline engine.
- Low labour requirement - one to two men to feed and bag the grain
- Ease of operation - minimum adjustments reduce operation and maintenance problems.
- Multicrop capability - two screens with interchangeable top screen.
- Simple design - integral shaft for horizontal oscillating screen drive and fan.
- Highly mobile - can be carried by two men

Specifications:

| | |
|---|---|
| - Power | 0.5 Hp electric motor or 1.0 Hp gasoline engine |
| - weight(with electric motor) | 72 kg |
| - length | 123 cm |
| - width | 67 cm |
| - heigth | 126 cm |
| - capacity | up to 1000 kg/hr (rough rice) |
| - grain purity | up to 98 % |
| - construction | wood and steel |
| - component speeds: | |
| - screens | 730 rpm |
| - fan | 730 rpm |
| - labour requirement | 1 - 2 men |
| - fuel consumption(approx) | 0.5 lts/hr |

Main recommendations

When operating the machine in open areas, determine the wind direction and position the machine as shown (fig. 3) to prevent dust and impurities from flying back to the operators and cleaned grain.

Place the machine on firm, level ground. If the machine has to be located on soft ground, place the legs on boards, stones or hard materials to prevent the legs from sinking during operation

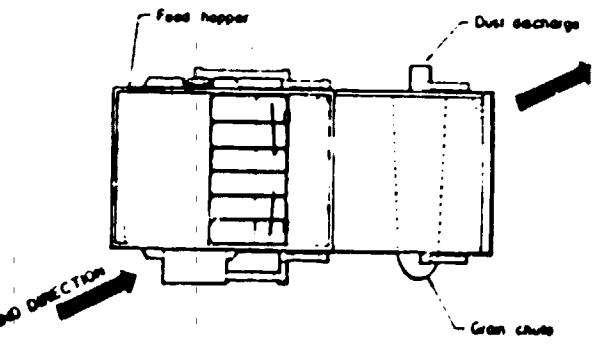



fig 3 cleaner position with respect to the wind

Always level the machine before operating

Inspect the machine for loose bolts, nuts and screws and tighten or replace them.

Select the proper size of screen for the grain

Place a canvas on the ground to collect the spillage and a suitable container for collecting the clean grain at the chute and transferring it to the bagging station or other storage facilities

Before starting the engine check the crankcase oil level, air cleaner condition and service as recommended in the engine operator's manual

Move the belt tightener lever to the disengaged position and start the engine or electric motor. Engage the belt tightener level to check and observe the operation of the machine for possible malfunctions and correct as necessary.

Maintenance

Lubricate the two pillow block bearings every 24 hours of operation.

Periodically apply a few drops of oil in the holes of the pivot assemblies of the oscillating screen assembly.

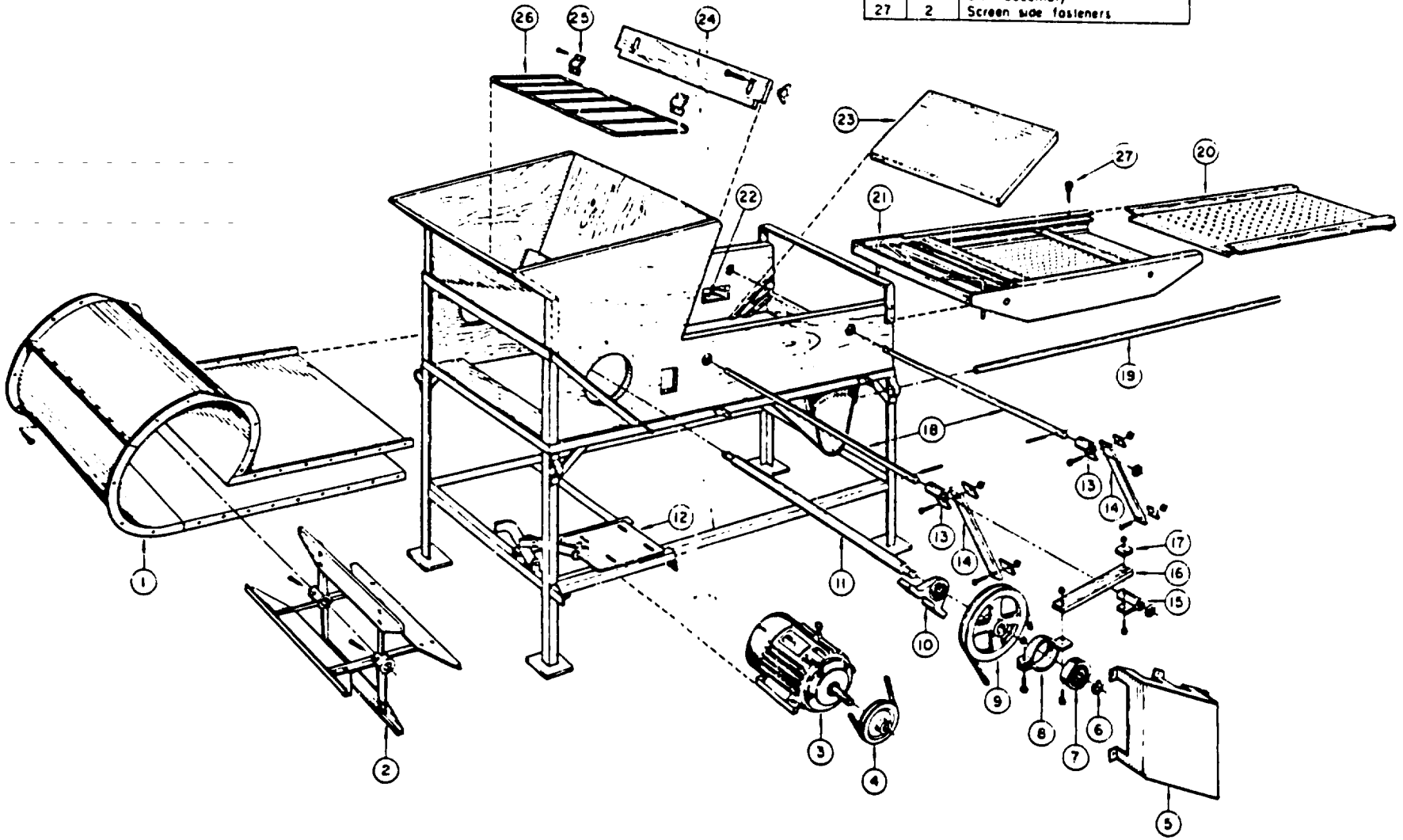
Always release the belt tension after each use, disengaging the belt tightener lever to extend belt life.

for further information refer to:

IRRI
Agricultural Engineering Department
International Rice Research Institute
Rice Found.
P.O.Box 933
Manila, Philippines

# COMPONENT PARTS LIST

| REF | REQ'D | DESCRIPTION |
|---|---|---|
| 1 | 1 | Blower housing assembly |
| 2 | 1 | Blower assembly |
| 3 | 1 | Electric motor, 1/2 hp |
| 4 | 1 | V-pulley, section 'B', 3" OD 1/2" bore |
| 5 | 1 | Belt guard |
| 6 | 2 | 1/8" dia spring wire lock |
| 7 | 2 | Ball brg ,6304-2rs deep groove |
| 8 | 2 | Eccentric bearing clamp assy |
| 9 | 1 | V-pulley, section 'B', 7" OD 1" bore |
| 10 | 2 | Pillow block 1" NP-16 |
| 11 | 1 | Eccentric shaft |
| 12 | 1 | Engine base assembly |
| 13 | 4 | Vibrating plate pivot assembly |
| 14 | 4 | Vibrating wood plate |
| 15 | 2 | Eccentric pivot assembly |
| 16 | 2 | Eccentric wooden linkage |
| 17 | 12 | Bracket clamp |
| 18 | 2 | Screen shaft |
| 19 | 2 | Lifting bar |
| 20 | 1 | Grain screen assembly |
| 21 | 1 | Screen frame assembly |
| 22 | 1 | Dust spout extension assembly |
| 23 | 1 | Windboard |
| 24 | 1 | Sliding gate assembly |
| 25 | 2 | Hinge |
| 26 | 1 | Grill assembly |
| 27 | 2 | Screen side fasteners |




Exploded view of portable grain cleaner

MOLTIPURPOSE TOOLBAR p. 1

Description: Multi-purpose agricultural machine (MANGONATSOTLHE).

Technical and economical details:

To the ox-driven tool bar almost any type of cultivation tool can be attached and it can also be used for carting or transporting drums of water. By removing some of the components from the tool bar a walking model can be created which allows inter-row cultivation when crops are taller. With this machine a new appropriate tillage system may be realized. At the same time the toolbar can also be fitted with a mouldboard plough and also as a two-row planter so that it can be used with conventional methods too.

The multi-purpose machine consists of an iron frame on two wheels and several implements. The full range are carried on traverse subframes which clamp onto the edge of the angle iron frame. Since subframes can be positioned anywhere along the width of the frame, either one or two planter units may be used at row widths varying from 75 cm to 100 cm. Other tools can likewise be positioned as desired for prevailing circumstances. All of the bolts used in assembly and adjustment of the components are the same size, 12 mm., so that only one size spanner is required.

The frame of the tool bar can be raised and lowered according to the working depth required. A planter unit incorporates the seed metering drum, the seed press wheel, the chain drag and the open drag. The fertilizer applicator consists of a metering device and subsoiler shank with a tube extending down the back to deliver deep into the soil. The unit is designed so that it can be used in combination with the planter. The disc hillers may be used both for throwing away the soil from the plants and the ridge building. Full sweeps may be fitted for stubble mulching. With the tool frame in full down position, it is a very convenient height for carrying water drums or other goods. By fitting floor boards and sides the toolbar becomes a scotch cart capable of carrying 500 kg. A walking implement can be assembled, which can be used for inter-row cultivation.

As well as being extremely versatile, the toolbar incorporates a number of additional features that aid crop productivity and quality. The toolbar will:-

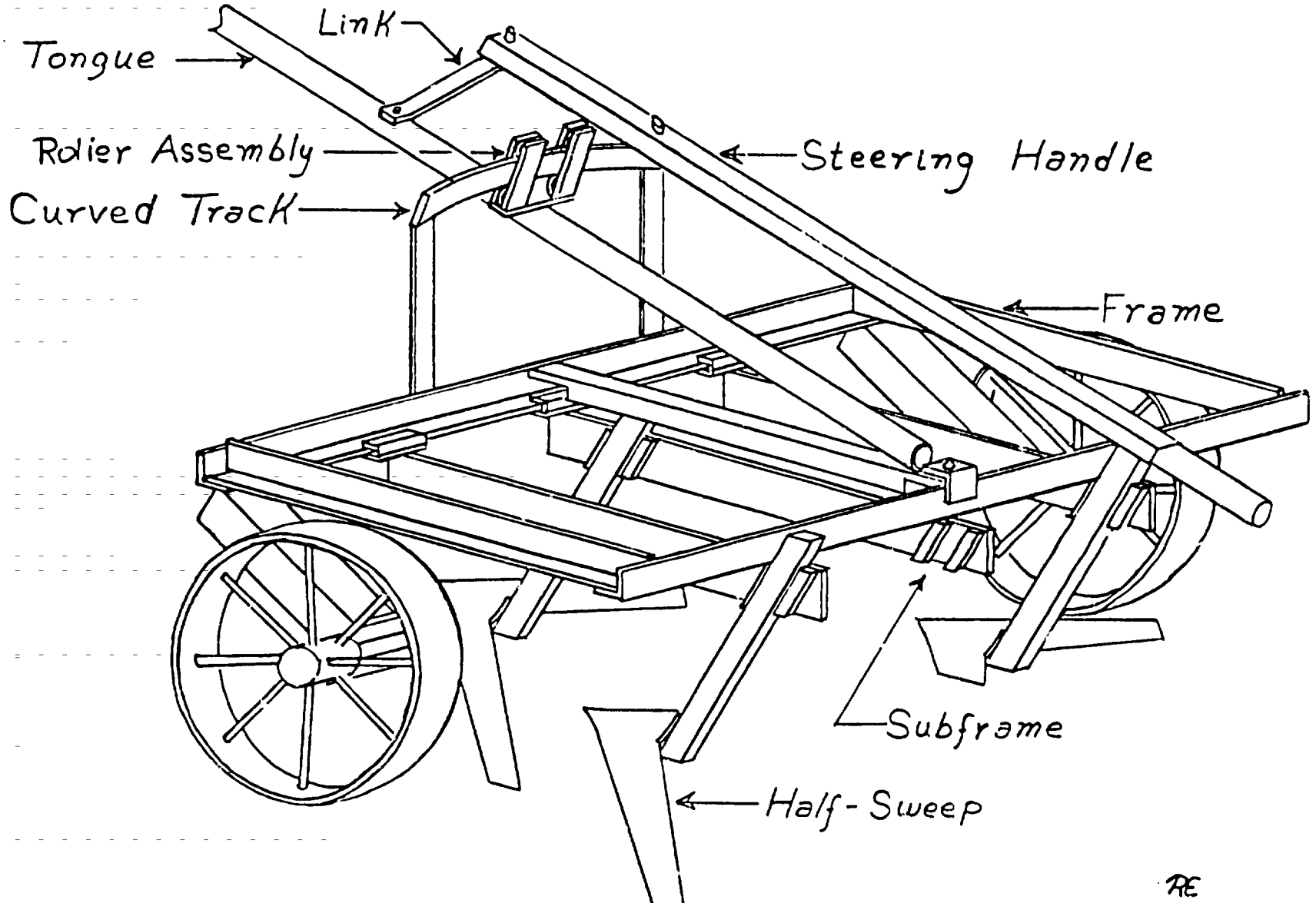
- reduce soil erosion through maintaining the crop residues as surface mulch,
- conserve moisture also by leaving the surface mulch and tilling only the top ten milimeters of soil,
- control weeds with the use of Texas style sweeps in combination with disc hillers,
- increase germination and reduce seedling mortality. (A lister share ahead of the planter, will allow the seed to be placed in the moist oil.),
- imbed the seed firmly in moist soil before covering with the seed press wheel,
- make better use of fertilizer through applying the fertilizer below the seed when planting.

A report and complete set of drawings are available.

Status of Commercialization: The tool bar is used in Botswana since 1973.

Contact Address:

Mochudi Farmers Brigade
Box 200
Mochudi
Republic of Botswana


Link
Tongue
Rolier Assembly
Curved Track
Steering Handle
Frame
Subframe
Half-Sweep



RE

SOLAR ENERGY POWERED CROP SPRAYER p. 1

Description: The sprayer involves the use of minute quantities of herbicides or insecticide and the energy for spraying is provided by the sun, using silicone photovoltaic cells and a battery of Ni-Cad cells.

Technical and economical details:

The photo-voltaic generator comprises a panel, about 33 cm2, equipped with 38 semi-circular silicone cells, 7.5 cm in diameter, connected in series, to deliver about 6 watts at 12 to 14 volts. Cells are rated at a conservative 100 mW/cm2 light intensity to deliver, each, 500 mA at 0,45 V. The panel is protected by a blocking diode. It also serves as a sunshade for the operator and only weights 1.2 kg. Eight Ni-Cad cells in the handle of the sprayer are series connected and at full charge deliver 1.2 V each (total 9.6 V) with a capacity of 4.0 Ah. They function both as a voltage stabilizer, maintaining a constant 7000 rpm and also to store the considerable excess power generated by the panel during periods of medium to bright sunlight (3 to 6 Watts) over the requirements of the sprayer (0.8 to 2 Watts). In continuous operation for eight hours a day, seven days a week, the batteries were found to be as full of charge as on the first day.

The advantages of this technology lies in the very light equipment, the reduced quantity of chemical solution necessary (15 litres per hectare instead of some 500 litres), and in the fact that no labour for pumping the sprayer is required.

Status of commercialization : No details provided

Contact Address :

Dr. Ray Wijewardene
International Institute of Tropical Agriculture (IITA)
Ibadan
NIGERIA

Harvesting is done by uprooting the entire plant when the pods have fully ripened and dried. The harvested plant are heaped and bundled ready to be moved to homesteads, if they are located near the fields but where homesteads are far away threshing is done in the fields.

Winnowing of the threshed beans is done entirely depending on natural wind speed. This is accomplished by pouring the materials in a winnowing vessel from slightly above ones head onto the ground. For more effective cleaning the vessel is shaken while the material is being poured. However, effective cleaning depends mainly on wind speed which cannot be controlled. The material poured on the ground is likely to be contaminated.

2.1- Design and construction aspects of the thresher.

A rubberized cylinder and concave type of thresher was designed and constructed. The set up of the threshing machine is shown in fig. 1.

The drum was constructed from a kapok log which was machined in a lathe machine to 300 mm diameter and 300 mm wide. The log was then fixed on to a 20 mm mild steel shaft. The shaft was supported by two wooden bearings, one on each side. The bearings were fixed onto a 50 mm x 50 mm x 5 mm angle iron frame.

Six strips of used tyres were bolted onto the surface of the log. The strips were machined to uniform thickness. Half of the strips were 6 mm thick and the rest were 3 mm thick. The different sizes were then fixed alternately.

The concave was made from a 16 gauge sheet metal. The sheet was then curved to follow the curvature of the drum, but with the clearance gradually decreasing from top to bottom. The lower part of the concave was connected to moveable plates screwed onto the frame so as to enable adjustment of the clearance. Three used tyre strips were also fixed to the concave to serve as rasp bars. The strips were 60 mm wide and 5 mm thick and were placed 50 mm and 20 mm apart at the lower part of the concave.

The drum was then connected to a power drive shaft through a bicycle chain. The drive shaft was also supported by wooden bearings which were then fixed onto the frame.

Winnower mechanism was designed and constructed using a 16 gauge mild steel sheet. A fan was constructed from a 20 mm steel shaft and four 360 mm x 210 mm curved metal sheets to form fan blades. The blades were arranged radially on the shaft. The blades were then slightly curved forward. The shaft was similarly supported by wooden bearing. Fan housing was made from the sheet metal and fixed in such a way that the clearance between it and the

blades is 50 mm. The fan was then fixed diagonally below the threshing mechanism. An air duct from the fan was inclined at 20 degrees. Above the duct a screen with 16 mm x 20 mm holes was placed. Below the screen a collector inclined at 30 degrees was placed. The screen was 280 mm below the drumm. The fan was driven by the same power drive shaft as that of the drum through a bicycle chain. The arrangement is such that one person could operate the thresher.

2.2- Performance of the thresher.

Performance test was carried out at the Sokoine University farm. Two varieties of beans i.e. Canadian wonder and Maasi red were threshed at moisture content (wet basis) of 13 % and 16.7 % respectively. During the test the power drive was not connected to the fan. Handfull size samples were randomley picked and weighed at an accuracy of 0.1 g. These samples were threshed and the time taken to thresh each sample was measured using a stop watch. The seed completely separated from the pods were collected and weigned. Unopened pods were thumb opened and then collected seeds were weigned separately. The ratio of the opened seeds to the total seeds in the sample was calculated to give threshing effectiveness. A handfull of seeds from the threshed lot was randomly picked and weighed. Seeds with visible cracks or peeled coats were sorted out and weighed. The ratio of the damaged seeds to the total seeds in the sample was calculated to give percentage seed damage. The procedure was repeated ten times for each variety.

Performance of thresher was compared to traditional threshing method i.e. hand beating. Threshing was done by twenty men and women with an average age of 30 years. Each individual was given 10 to 12 kg of harvested crop to thresh. Performance of the winnowing mechanism was tested on Canadian wonder and Mascai red at moisture content (wet basis) of 25 %. The test was made using a 0.75 hp electric motor with variable pulley diameters so that the fan speed could be varied. Fan speed was measured using a tachometer and the air velocity using a hot wire anemometer.

A 1 kg mixture of hand threshed seeds and chaff were let to fall from the threshing mechanism while the fan is rotated. After the operation material in the seed collector was weighed. Chaff in the container was separated by hand and weighed. Likewise blown off material was collected on a canvas and weighed. Seeds contained in the chaff was sorted and weighed. The effectiveness of separation was then calculated as winnowing from the relationship

$$I = (a/(a+c))(d/(b+d))$$

where

a = Seeds in the seed collector
b = Chaff in the seed collector
c = Seed blown off with chaff
d = Chaff blown off

2.3- Results.

The results obtained gave a threshing effectiveness of 28.2 % and 85.8 % for Canadian wonder and Maasi red respectively. Seed damage was found to be very low at 2.7 % for both varieties. The threshing capacity was 15 kg/hr and 14 kg/hr for Canadian wonder and Maasi red respectively. As far as winnowing is concerned, optimal effectiveness of separation was found to be 94 % at 380 rpm fan speed. The winnower throughput capacity was observed to be 240 kg/hr of cleaned seed. The thresher was found to be very effective in both threshing and winnowing. However, its capacity has to be increased substantially in order for it to be a good substitute for traditional hand threshing.

3.0- Sorghum thresher.

Sorghum is a common cereal in semi-arid areas of Tanzania. It is used for food and for making local beer. traditionally, threshing is done by hand beating using sticks or trampling by foot and sometimes tractor wheels where available. figure 2 shows a p.t.o. driven sorghum thresher which has been developed to ease the drudgery of threshing sorghum. Design and construction has just been comlleted at the Centre for Agricultural Mechanization and Rural Technology (CAMARTEC) in Arusha, Tanzania. Performance test as for the bean thresher is to be done next harvesting season i.e. mid July to end of September.

3.1- Design and construction aspects of the thresher.

3.1.1 Materials.

1. feed trough - wood 21 mm thick
2. threshing drum - sheet metal 2 mm, mild steel
3. threshing fingers - steel rods12mmØ,mild steel
4. threshing drum shaft - 38 mm Ømild steel
5. upper concave and spiral deflectors - sheet metal 3.0 mm thick, mild steel
6. straw thrower paddles and straw outlet - sheet metal 1.5 mm thick, mild steel
7. blower housing - sheet metal 3 mm thick, mild steel
8. blower shaft - 31 mm Ø, mild steel
9. blower blades - wood, 15 mm thick
10. Screen, perforated sheet metal, 1.5 mm thick, mild steel
11. collecting trough and grain outlet, sheet metal, 1.5 mm sheet metal
12. frame of the machine - angle iron 65 mm x 65 mm x 6 mm mild steel

3.1.2 theoretical working speeds.

If the threshing drum is directly coupled to the tractor's p.t.o. shaft, following speeds can be obtained:

| | |
|---|---|
| speed for threshing drum | 540 rpm |
| speed of blower | 1091 rpm |
| speed of pulley for sieving mechanism | 160 rpm |

The minimum and maximum reciprocating velocities of the sieve are 1 m/s and 1.38 m/s respectively. Modification of the drive system with the tractor p.t.o. is necessary to attain a higher working speed.

3.2 Sorghum threshing

Sorghum heads are piled on the feed trough and then using a stick they are pushed through the inlet to the threshing chamber. The sorghum heads are threshed by a high speed rotating threshing drum which is equipped with steel fingers. The upper concave is fixed with spiral deflectors which axially convey the mass being threshed forward. The far end of the threshing drum has straw thrower paddles which catch the threshed straw and throws them out. The threshed grains and chaff fall through an air stream from the blower where the chaff and other lighter material are blown out and the grains fall on the reciprocating screen. The screen sieves out the clean grain which fall on the collecting tray leaving behind remnants of small pieces of straw which are cascaded away. The grain is collected through the grain outlet and bagged.

4.0 The double operated paddy thresher

Rice is a common staple grain in Tanzania which is increasingly becoming important. As for sorghum, threshing of paddy is done by hand beating or trampling. Fig. 3 is a double operation manual thresher designed by TEMDO in Arusha.

4.1 The design aims at simplicity of construction, ease of operation and low cost, combined with rapid and thorough threshing.

4.1.1 Materials

- the threshing drum is made of wood and 4 mm mild steel wire loops
- the hopper and cover is made of 0.8 sheet metal, mild steel
- the threshing drum shaft is Ø 16 mm. mild steel
- bicycle chain and sprocket drive
- the frame of the machine is made of wood
- the grain outlet is made of 0.8 mm sheet metal, mild steel

4.1.2 Working speed and daily output

The minimum manual speed of the machine is 500 rpm but the machine can be hand driven to the speed of 1,000 rpm. The maximum output of the thresher is 1,500 kg of dry paddy for a 7 hour day.

4.2 Paddy threshing

Harvested paddy with its straw is piled on a hopper. The machine is hand driven until it reaches a speed of 1,000 rpm and then the paddy is fed onto the threshing drum. The term "double operation" is derived by the fact that during the process, the threshed paddy is passed through a sieve on the bottom of the threshing drum while the straw is thrown out by wire loops through the straw outlets.

The crop being threshed must be dry enough i.e. 15 - 17 % moisture content wet basis to achieve complete separation of paddy from the straw.

5.0 Problems of adoption

The adoption of the above and other simple food processing technologies has been very slow due to the following:

a) The cost of raw material is ever high especially for steel. This makes it difficult for small scale farmers to buy the technologies developed. The potential manufacturers also become reluctant to take up developed technologies from Research and Development (R&D) institutions to manufacture them in large scale.

b) Lack of coordination among R & D institutions. This results in duplication of efforts and uneven use of the scarcely available resources.

c) Inadequate R & D engineers to take up the challenge of the ever rising demand for food processing equipment. This limits design and development in this area.

d) Social and cultural barrier e.g. threshing and winnowing has in many areas been considered a woman job hence, limiting the use of developed technologies. In some cases, activities like threshing and winnowing has been taken as a social event where women meet for gossiping and exchanging social jokes while working.

6.0 Conclusion.

With the succesful development of threshing machines for beans, sorghum and paddy the elemnet of drudgery may be solved. In view of the growing importance of such crops not only as food crops but also as a source of income for the farmers, there is a need to tackle the problems of adoption to improve the threshing operation and reduce drudgery.

Design for other food processing machines should be explored and this calls for coordination and collaboration among the national and the international Research and Development Institutions.

FIGURE 1. HAND OPERATED BEAN THRESHER

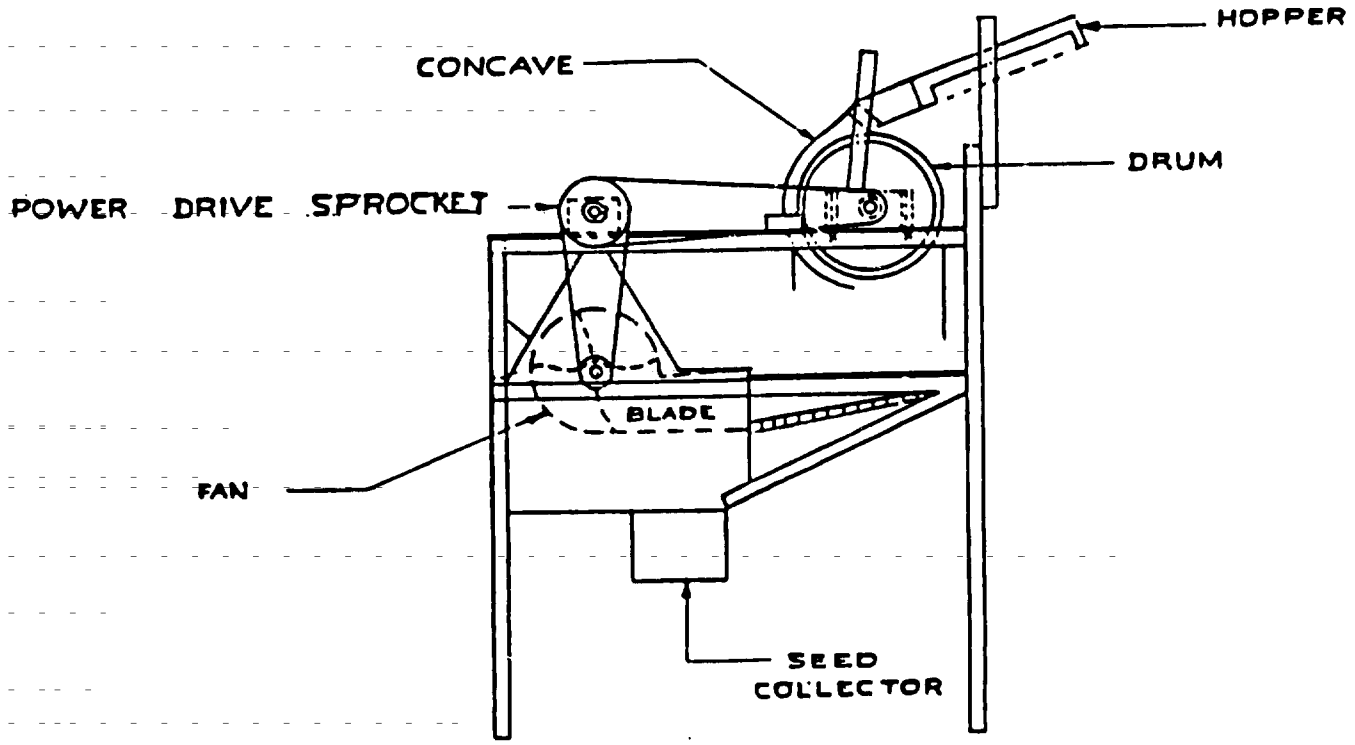
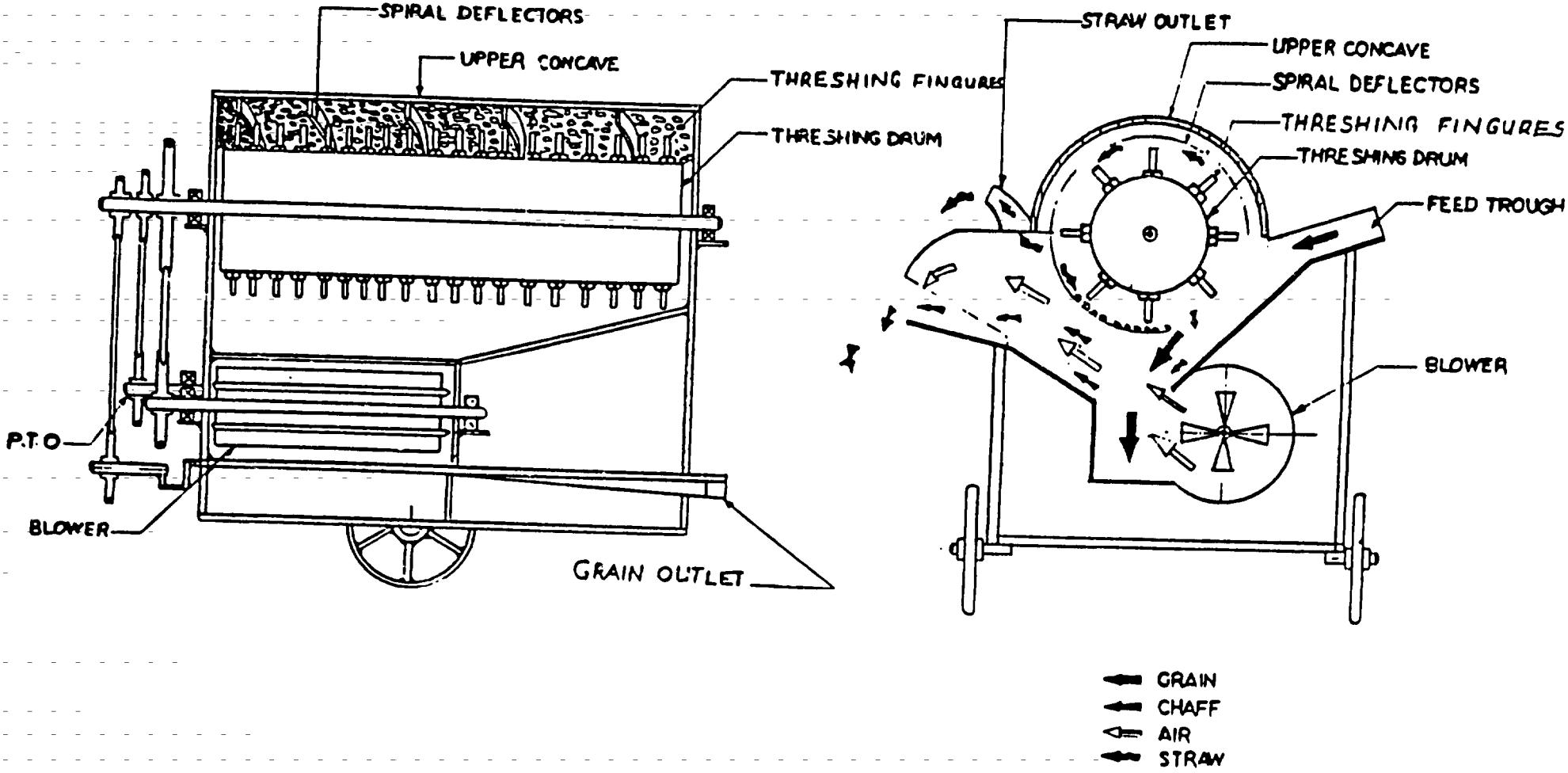
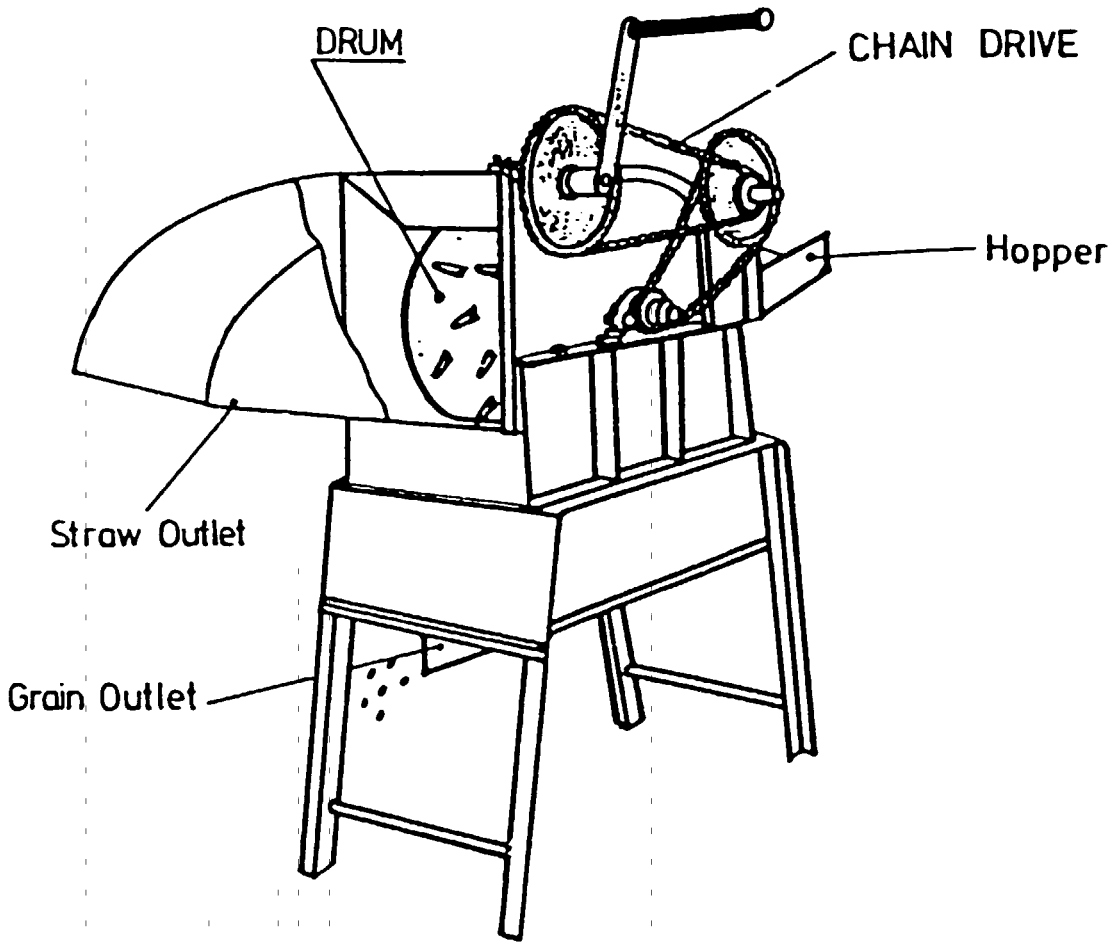


FIGURE 2 ÷


SPIRAL DEFLECTORS
UPPER CONCAVE
THRESHING FINGURES
THRESHING DRUM
P.T.O
BLOWER
GRAIN OUTLET
STRAW OUTLET
UPPER CONCAVE
SPIRAL DEFLECTORS
THRESHING FINGURES
THRESHING DRUM
FEED TROUGH
BLOWER
GRAIN
CHAFF
AIR
STRAW

# DOUBLE OPERATION MANUAL THRESHER

FIGURE 3



A SIMPLE LOW COST RICE BRAN 

## Introduction.

The development of rice bran stabilizing equipment involves at least two technologies:

Food technology to determine that the process developed effectively stabilizes the bran without destroying the nutriment contents the oil, vitamins, etc.

Engineering to design and develop machinery to effciently and economically achieve the required stabilization

There are a number of processes which can can be used to stabilize rice bran including:

(A) Dry heat treatment
(B) Moist heat treatment
(C) Chemical treatment
(D) Insert atmosphere
(E) Gamma irradiation

this paper will consider solutions to the problems by processes (A) and (B)

## Brief description of rice bran and the processes of stabilization

Rice bran, with a protein content of about 10 - 15 % and vegetable oil content of 18 - 20 %, is an important raw material for the extraction of rice bran edible oil for human consumption as well as for the production of rice bran meal, a valuable component of protein animal feed.

Some 8 mill. tons of rice bran remain unused in the rural areas of developing countries, because of rapid deterioration during storage and transportation - operation, caused by a biological encymatic process, splitting the oil contained in the bran into free-fatty acids and glycerin, thereby not only destroying the neutral oil but quickly turning the bran into a valueless waste product. In order to maintain its value as a raw material for the production of edible oil and protein feed meal and to make optimun use of it, the rice bran needs to be stabilized by a special heat treatment combined with a certain dehydration effect.

The use of Rice Mill by-products, (Husks) as a fuel

To comply with the UNIDO suggestion that the rice mill by-product and (husks) are used as fuel. Only this method of heat generation is considered in this paper. This fuel has the advantage of being readily available at the required place and is not a finite energy source, also provided the combustion is complete does not create excessive atmosphere pollution when burning.

The availability of heat from rice husks.

From each 100 kg of paddy approx. 20 kg of rice husk are obtained when it is milled the free volume is approx. 6 cu. ft. but can be compressed to approx. 2 cu. ft. When burnt this liberates 220,000 to 264,000 Btu. (Assuming complete and efficient combustion)

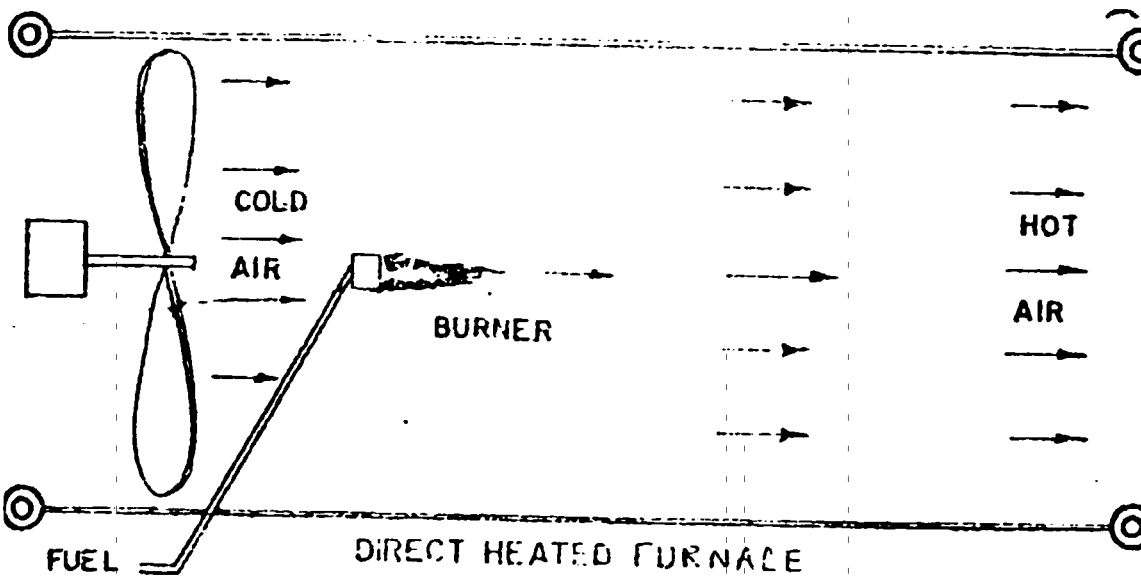
The designs of simple furnaces for burning rice husks,

Provided rice husks are burnt with complete and efficient combustion the flue gases are clear and do not contain noxious fumes. Tests when using these flue gases to dry paddy have not indicated that the colour and odor of the milled rice changes appreciably after drying. To obtain complete and efficient combustion the best method appears to be to start with a hot fire and then add the new fuel in small and regular quantities, this way minimum smoke is generated. The appearance of the ash indicates the efficiency of combustion. completely burnt husks will be white, if not completely burned they will be black.

Some designs of furnace.

Furnaces can be of two main types:

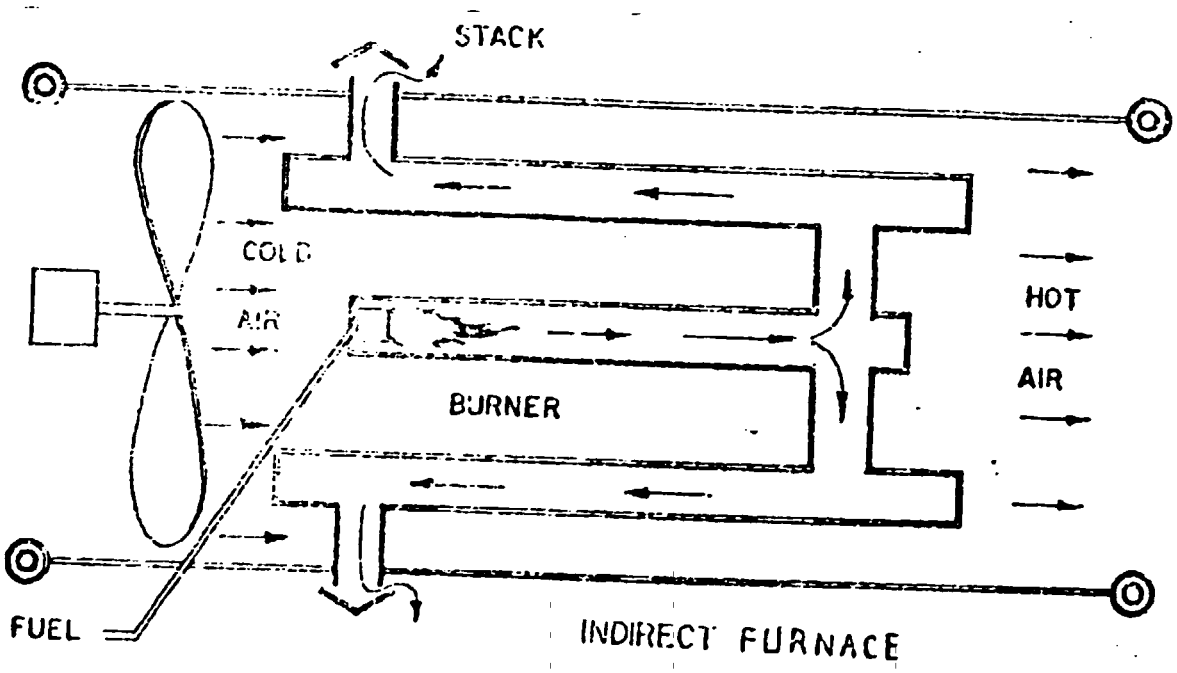
(a) Direct heated in which the flue gases are used for heating




Schematic drawing of a direct fired heater
(note: liquid fuel not shown)

and

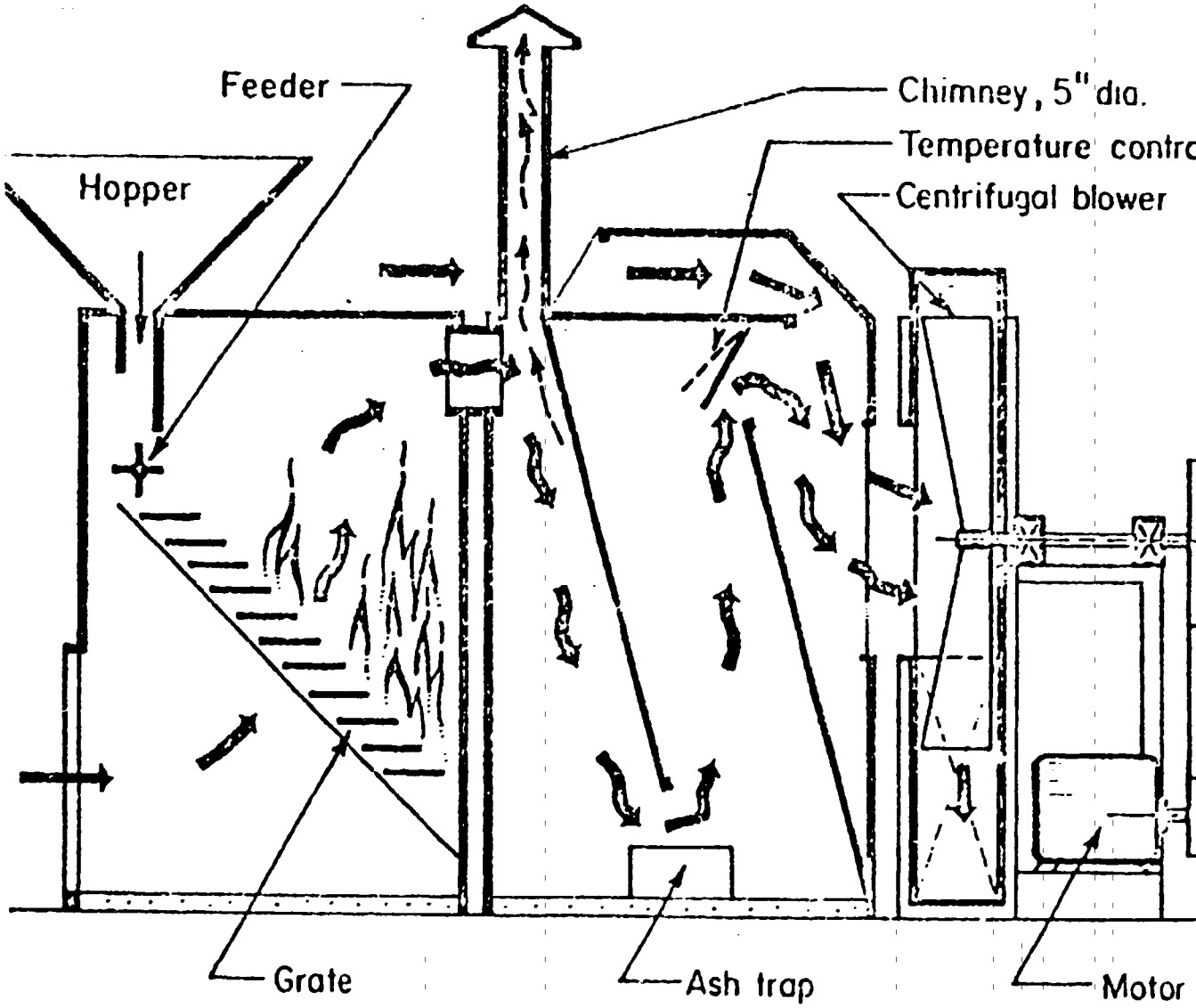
(b) Indirect heating, in which some form of heat exchanger is used.




Schematic drawing of an indirect fired heater
(note: liquid fuel shown)

The direct heating is the most efficient and simplest but there is the possibility of contaminations by the flue gases. The indirect heating is less efficient and more complicated but there is no possibility of cantamination by the flue gases.

Design of Rice hull furnaces

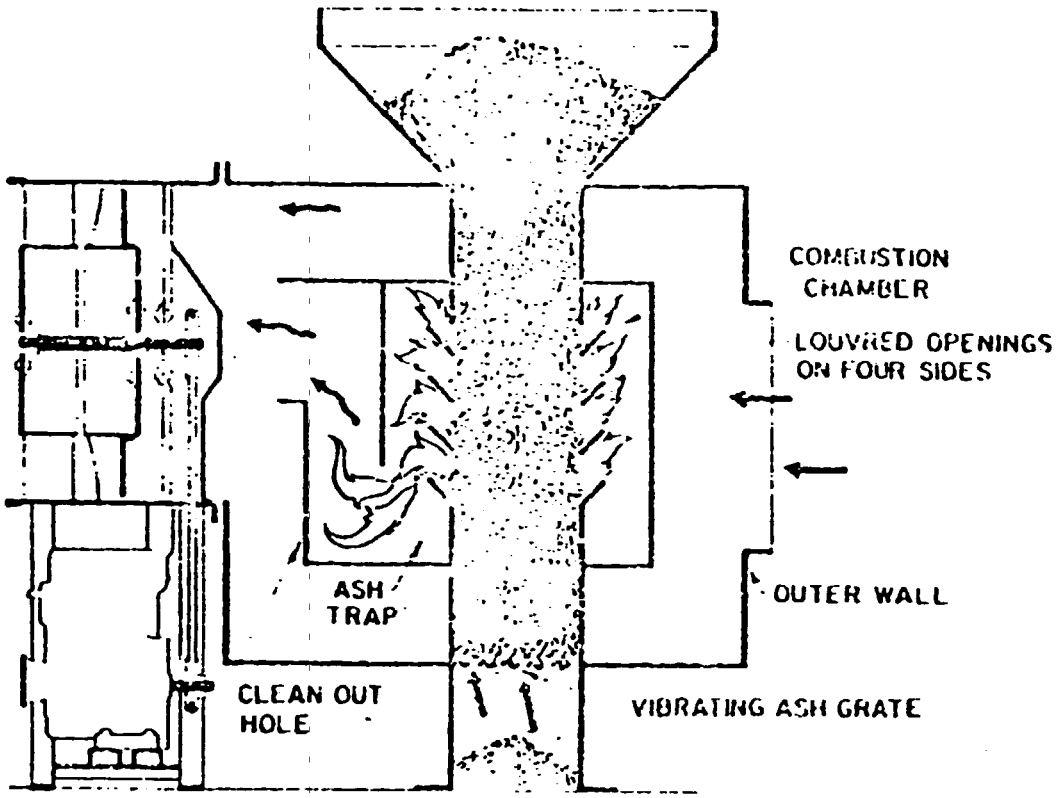



Rice hull furnace

Made by joining two old 44 gallon oil drums toghether

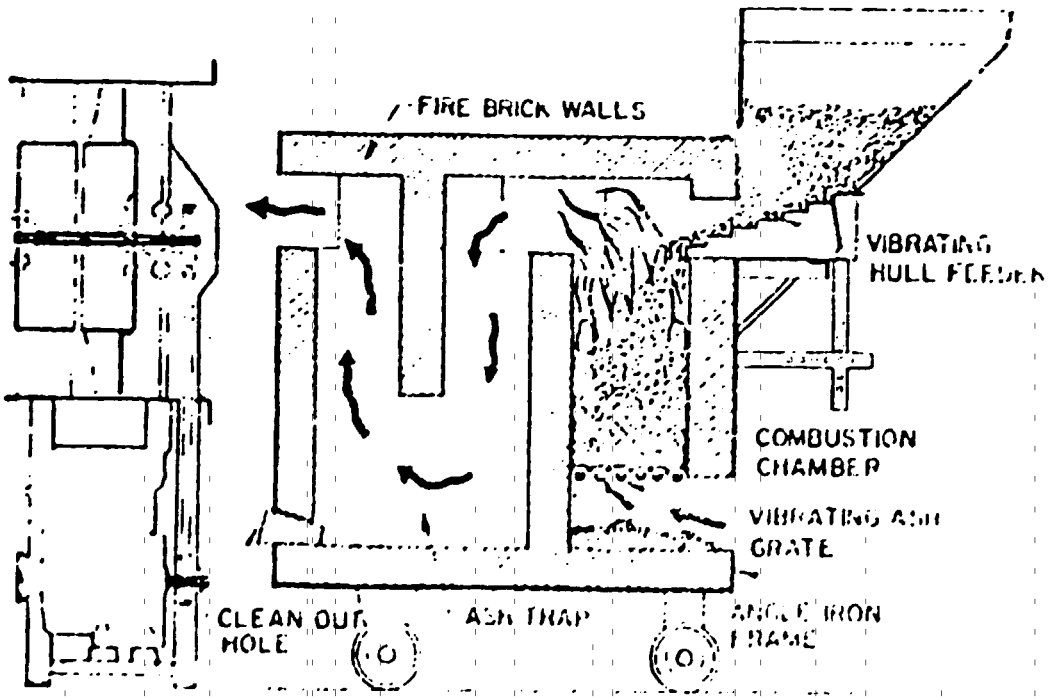
A SIMPLE LOW COST RICE BRAN





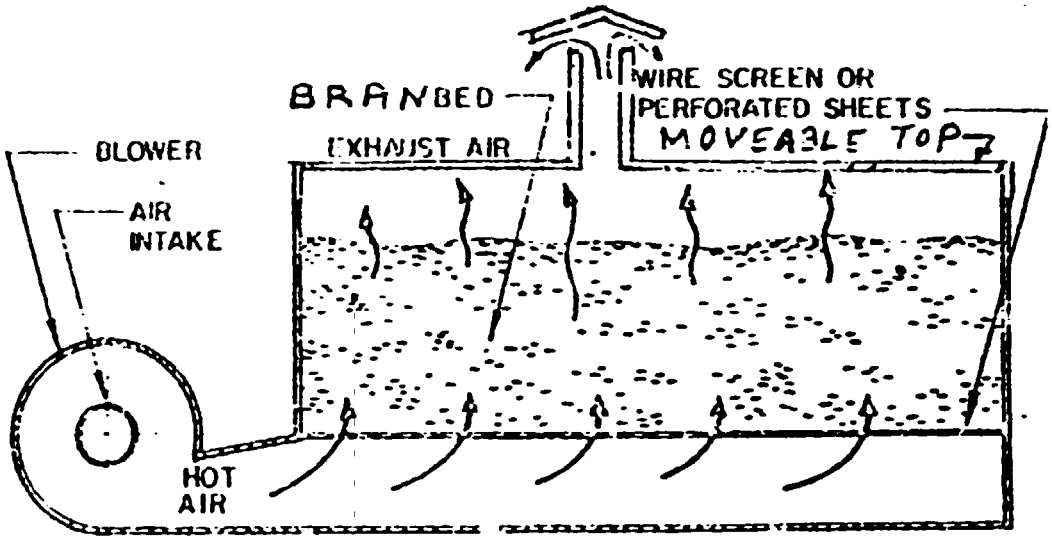

## RICE HULL FURNACE

Louvered rice hull furnace.



Possible design of equipment for stabilizing bran

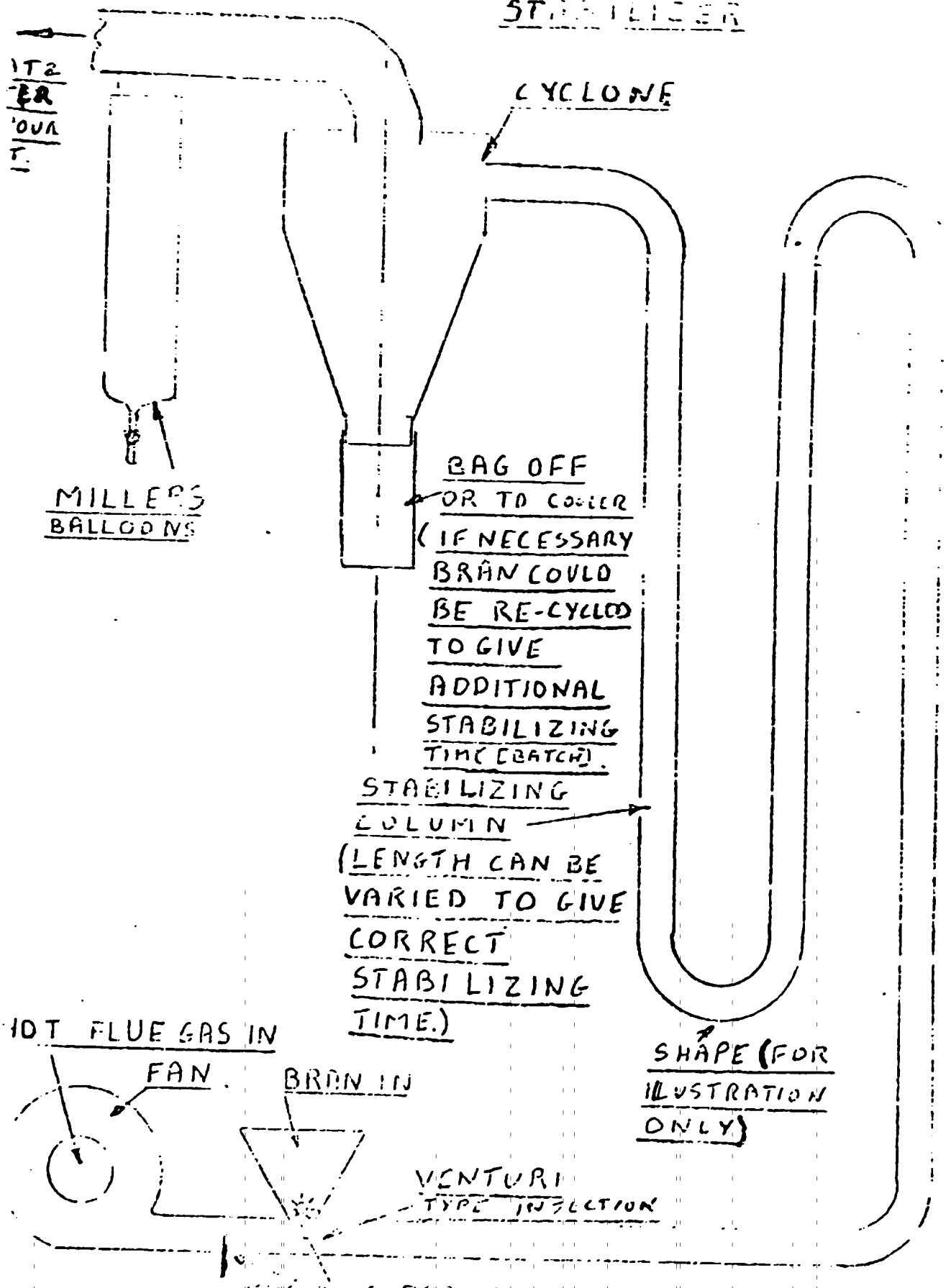
(a) Dry heat process




Flat Bed Stabilizer

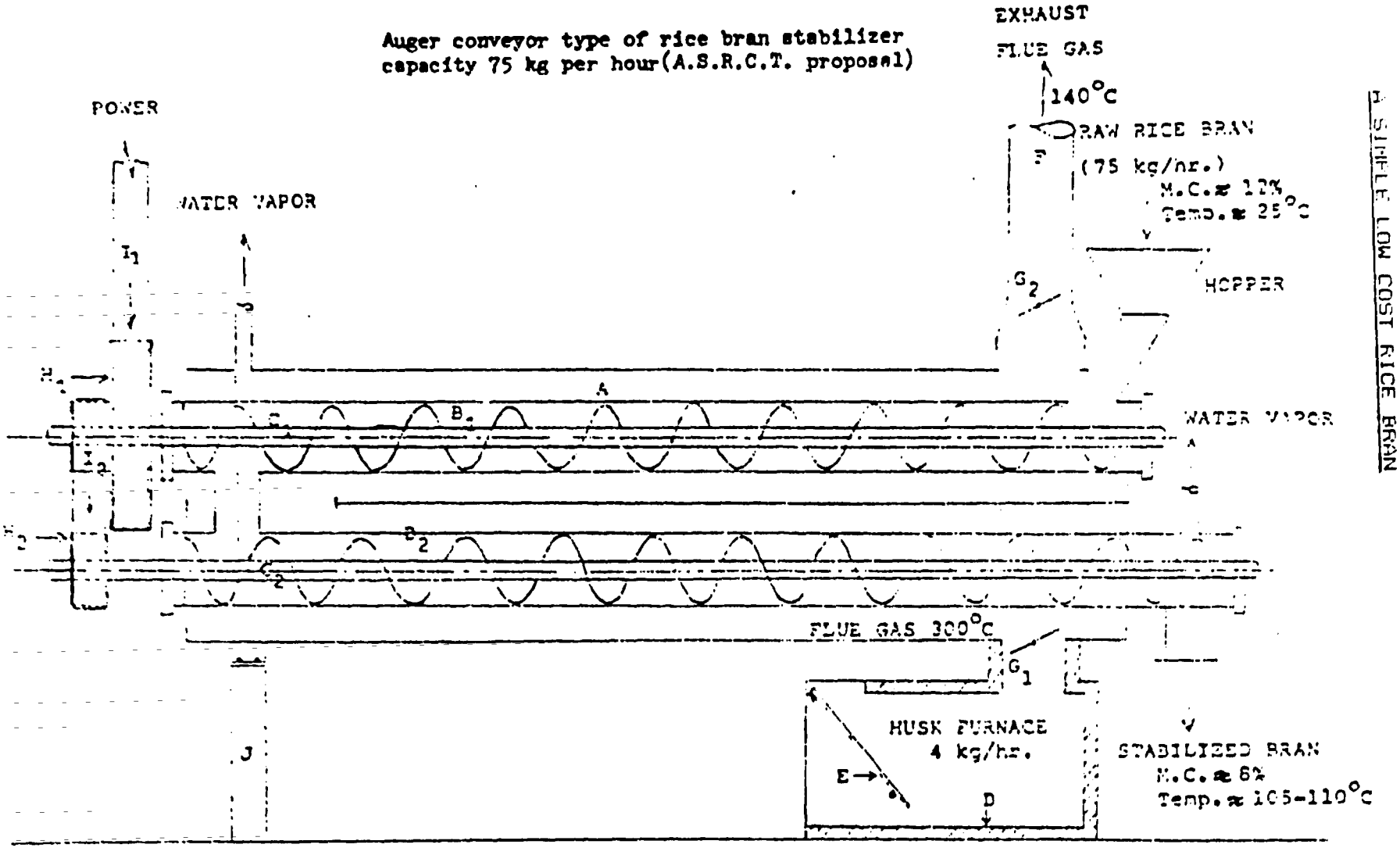
Some hand-driven stirrers could be added

# COLUMN OF BLOWN HOT FLUE GASES TYPE STABILIZER




REVISION 1 7-12

**Auger conveyor type of rice bran stabilizer capacity 75 kg per hour(A.S.R.C.T. proposal)**



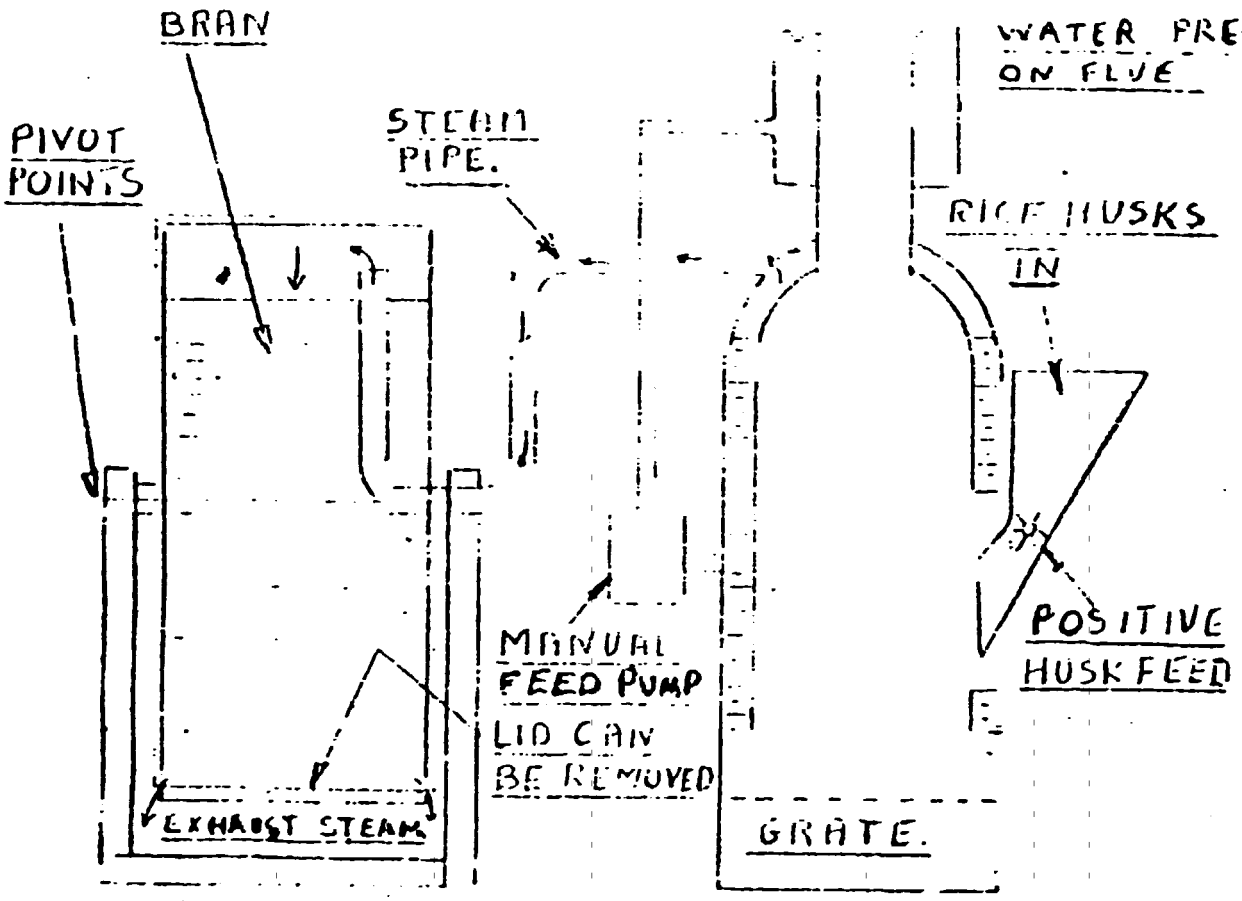

A = flue channel; $B_1$, $B_2$ = pipes; $C_1$, $C_2$ = shafts with conveyor blades;

D = fire brick; E = grade; F = chimney; $G_1$, $G_2$ = Dampers;

$H_1$, $H_2$ = driving pulleys; $I_1$, $I_2$ = belts; J = supporter

# (B) MOIST HEAT TREATMENT.

Stabilising pans and rice husk-fired boiler




PAN CAN BE ROTATED ABOUT THE PIVOT POINTS SO THAT LID IS AT TOP FOR EMPTYING & FILLING

Food Processing and related activities

The report registered under UNIDO Doc. Number ID/WG.480/1 describes some of the activities and the way that Botswana is trying to solve the problem of the need for industrialization faced by the country.

It highlights that the country has full concious that many products original from their country, especially indigeneous plants, with medicinal or other applications, are being exported for processing and sale outside the country.

It also indicates that the most benefited from this situation, are not precisely the peasants or small farmers that produce those plants but the traders that acting as middle-men obtain the largest share of the profits.

The country has recognized the need for designing and testing appropriate processing methods and equipment for small and medium size scale commercial production, to process their native produces into products for domestic consumption and for export, they also recognize the need for providing training to small industrial entrepreneurs in the utilization of such methods and equipment production.

The country in their efforts of finding solutions to this situation has given way to nongovernment organizations that have become involved in Botswana in developing such kind of appropriate technology for food and plant processing.

Examples of these institutions are The Botswana Technology Centre's for Food Technology Research Service dedicated to design and development of appropriate processing methods and equipment - an example of their activities is the Bilton Project, see appendix I - and the Rural Industries Innovation Centre that concentrates on renewable energy and food processing - examples are the sorghum dehuller and the Kgoletso oven, see appendix II. Another institution is the Thusano Lefatsheng dedicated to see aspects related with agricultural production and processing of medicinal plants, industrial plants, fruits and nut trees and other potential commercial value.

## APPENDIX I

## BILTONG MEAT DRIER DIAGRAM

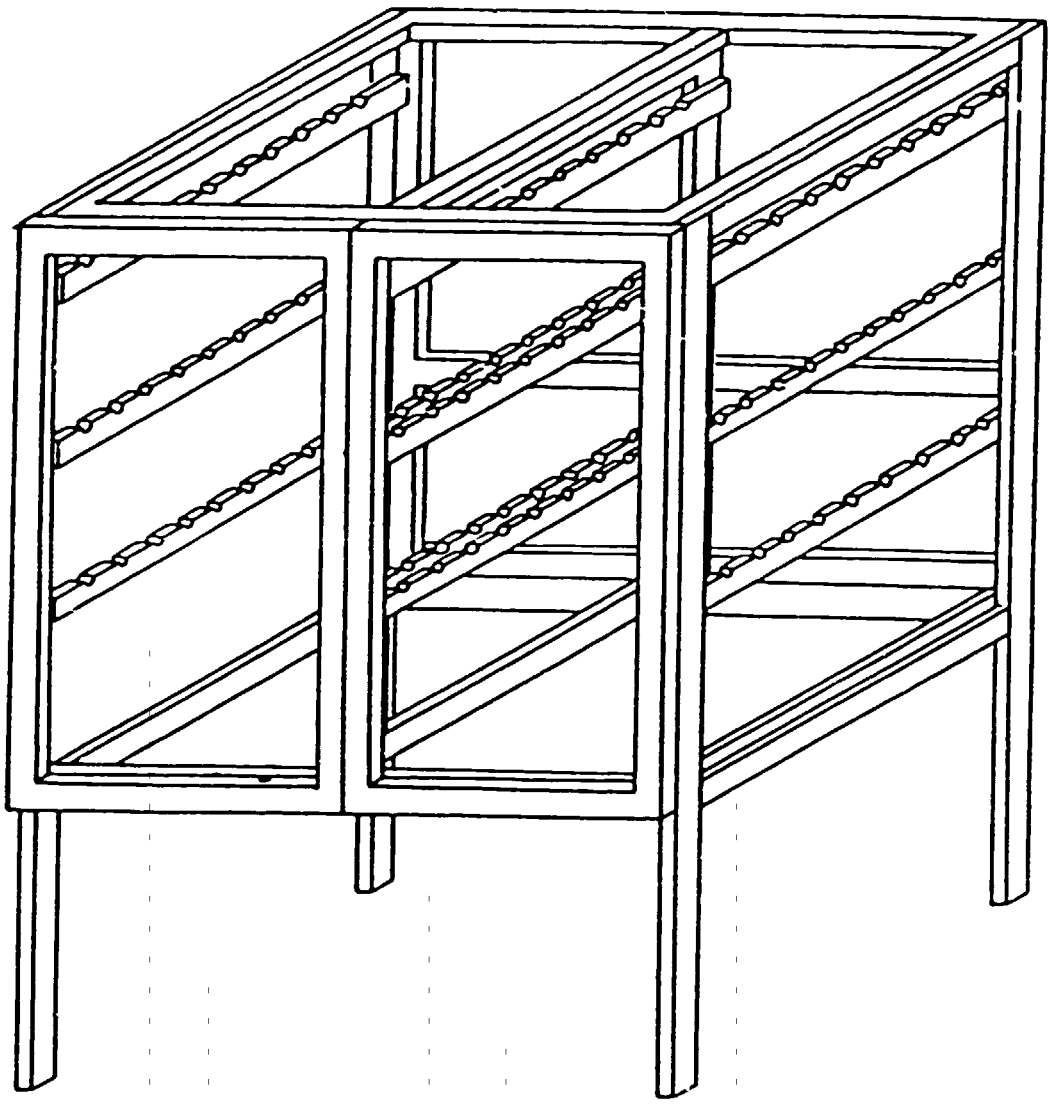
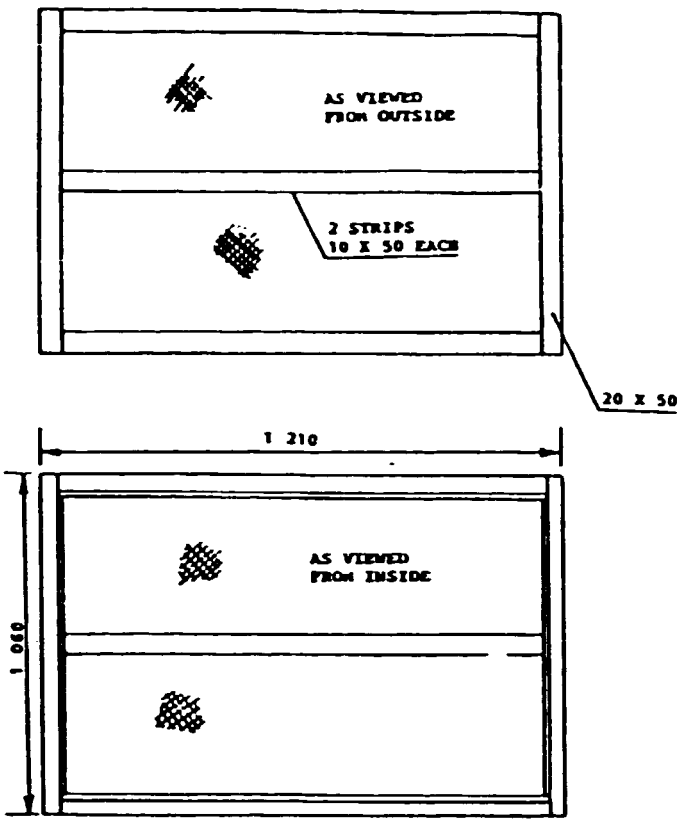


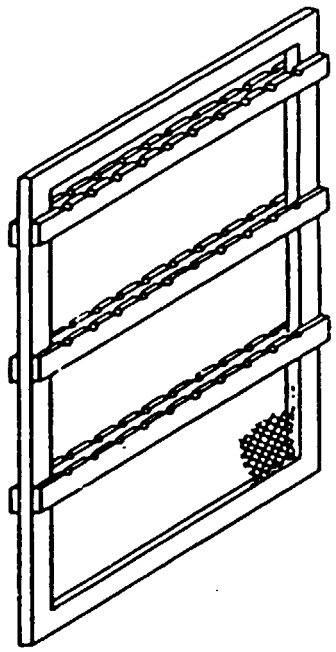
Figure 1

# APPENDIX I




BACK PIECE

1 off



MIDDLE PIECE
WITH DOWEL SUPPORTS

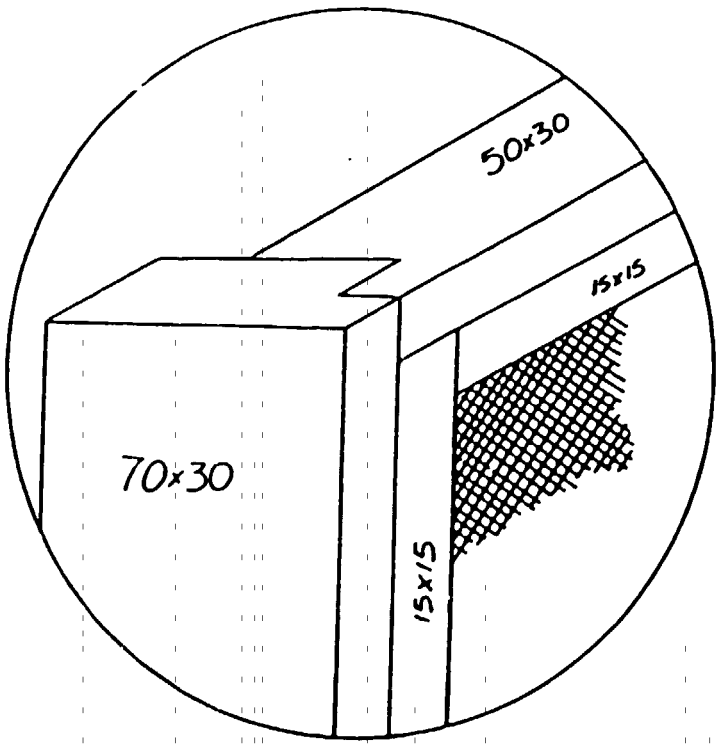
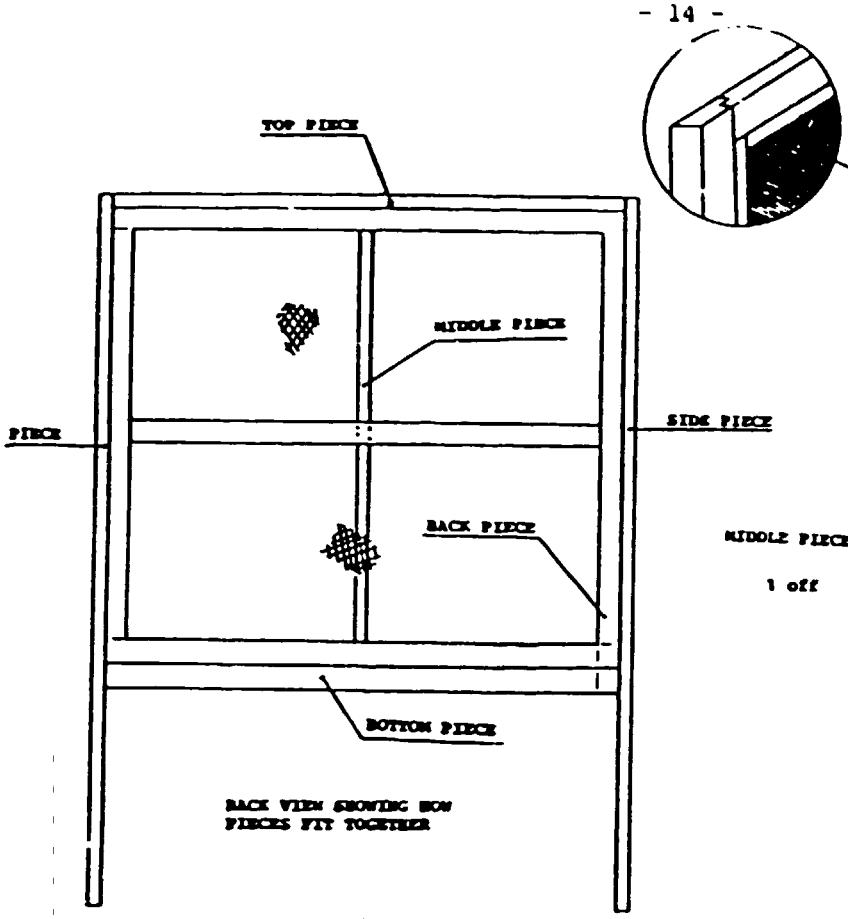
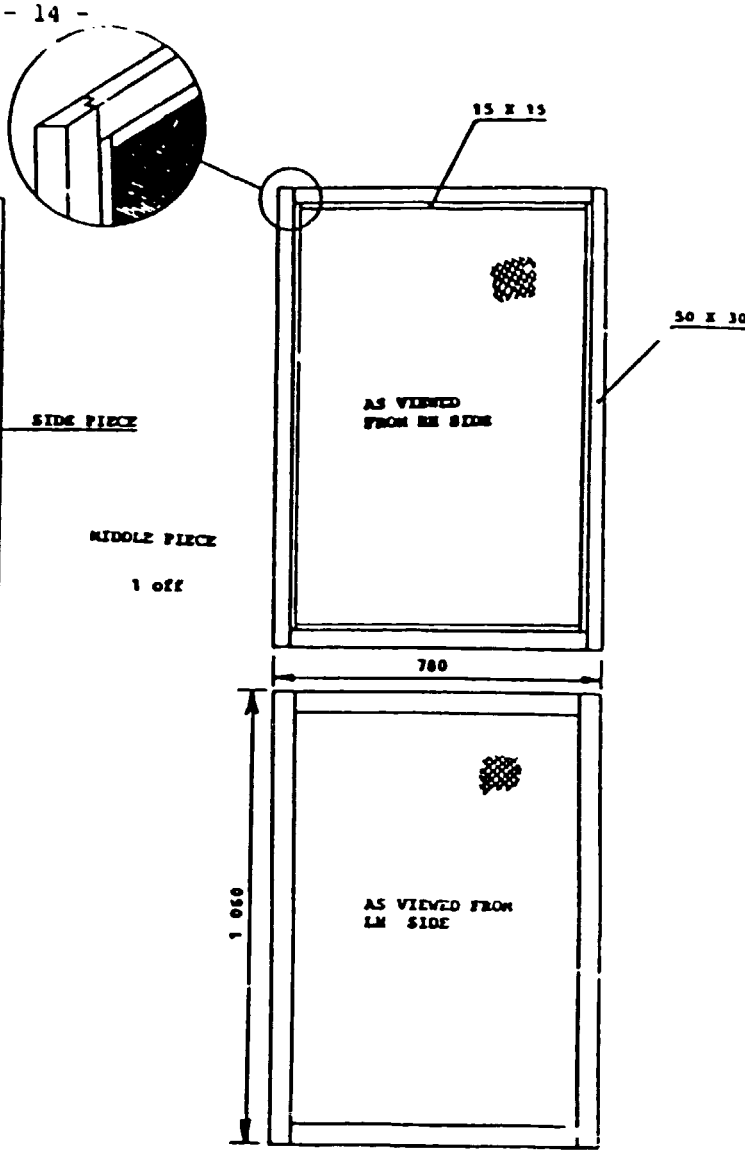


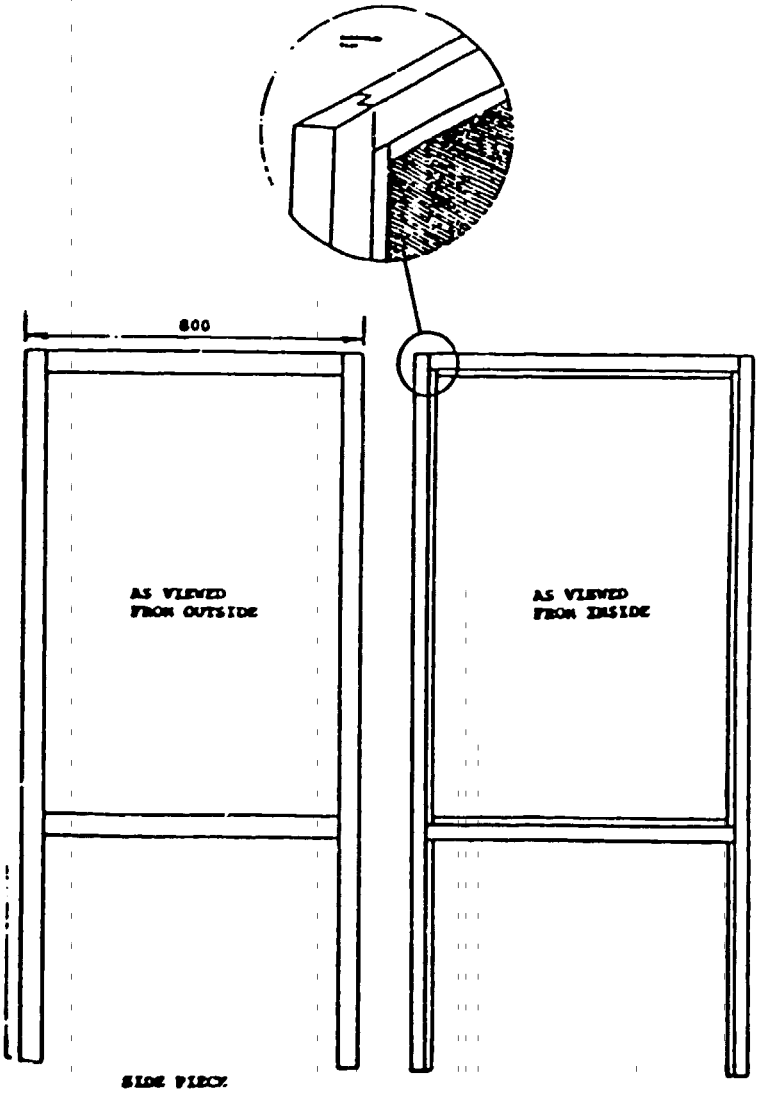

Figure 2



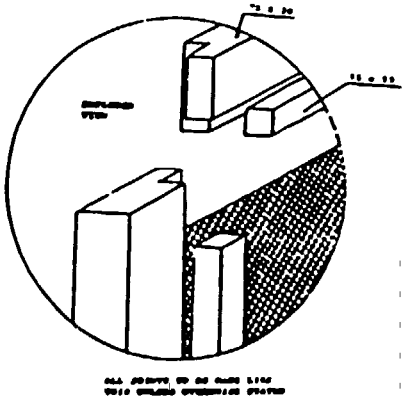




MIDDLE PIECE

1 off




SIDE PIECE

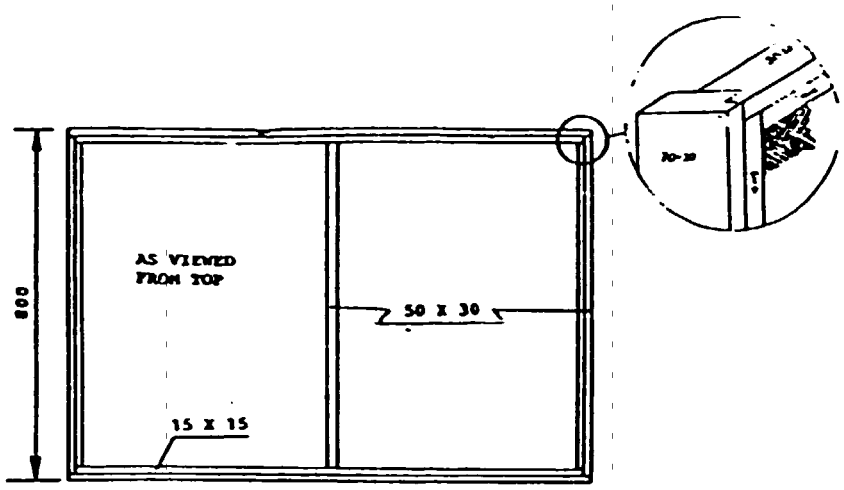


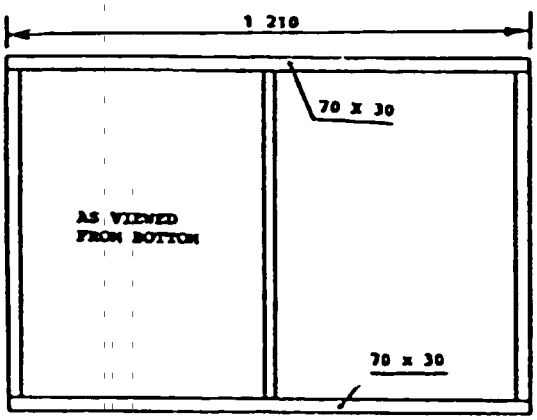
APPENDIX I

Figure 3.

APPENDIX I

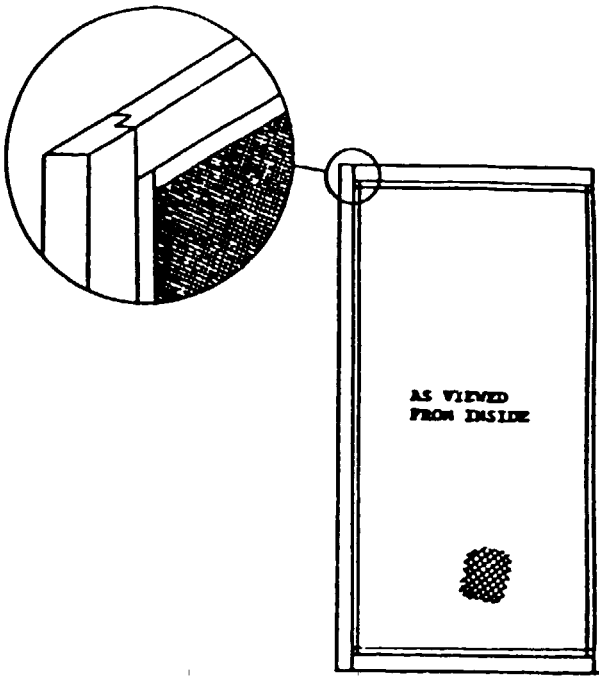
Figure 4

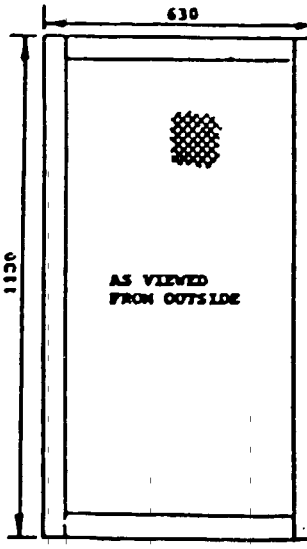



BOTTOM PIECE

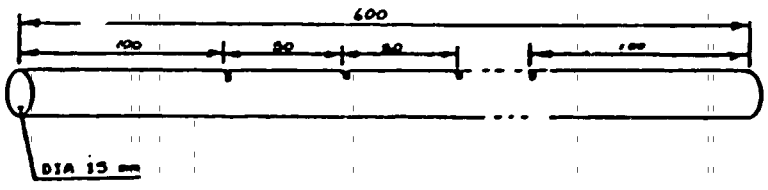
1 off




DOORS

2 off




DOWELS

600 OFF

APPENDIX II

Figure 1

TSHILO DEHULLER MK II

(The compact versatile, high performance machine that removes husks and grinds cereals.)

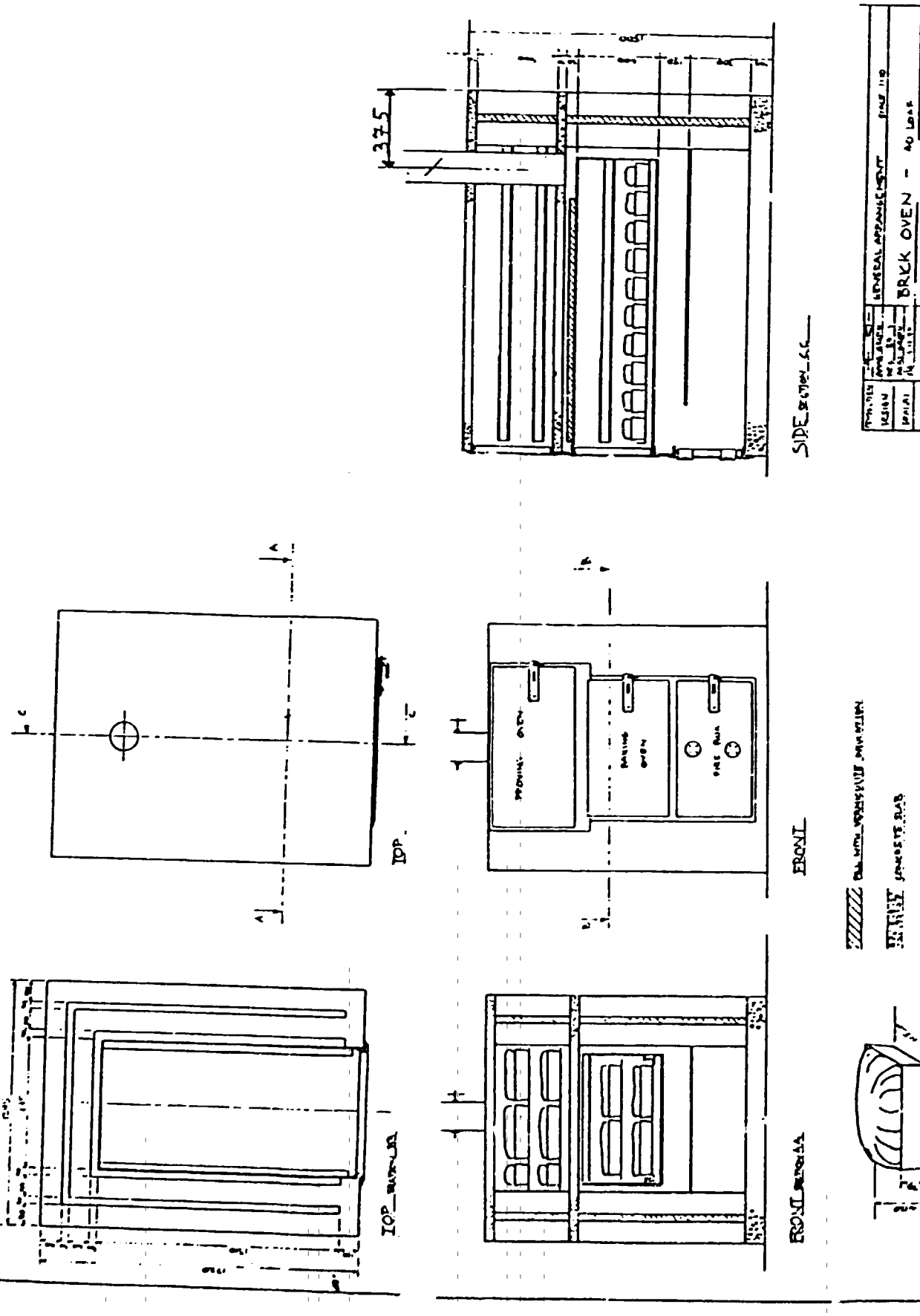
TECHNICAL DATA

| | | |
|---|---|---|
| Power requirement | : | 5.5 Kw. 3 phase electric motor or a 10 HP engine |
| Main shaft rpm | : | 2000 |
| Fan shaft rpm | : | 2000 |
| Throughput speed | : | 10 Kg/min. |
| Approximate net weight | : | 200 Kg. |
| Hopper capacity | : | 25 Kg of grain |
| Barrel capacity | : | 20 Kg of grain |
| Fan capacity | : | max. velocity 2000m/min. |
| Grinding stones | : | carborandum vitrified bonding wheels with K face size 250 x 20 x 38 |

Tshilo dehuller, a product of the Rural Industrial Innovation Centre in Kanye has been designed to blend in harmony into its African environment. About 50 sorghum dehulling machines are in operation in Botswana. Some of these machines are being exported to 10 other African countries.

APPENDIX II

Figure 2



THE STERILIZATION AND DRYING BY STEAM PROCESSING (ETUVAGE), THE CONCEPTION OF AN ARTISANAL OVEN 

## Introduction.

Rice cultivation has become very important in Burundi. Rice is becoming a national staple food. So far, treatments on this crop have only produced whitened rice (cargo). This white rice has lost its vitamin (especially vitamin B12) and mineral-salt contents. Husking and pounding in the factory causes breakage, which affects rice production.

The governemnt, toghether with the FAO project in the Ministry of Rural Development, has recently introduced the technology of drying rice to provide its population with quality food products. The purpose of this technology is to modify the physical and chemical properties of rice, to make it more nutritious and economical.

## General principle for sterilizing and drying rice.

- Position in transformation
- Rice - beating - paddy - sterilization and drying - husking - whitened rice.

The production of treated rice is based on a general principle, which uses the two main elements - water and heat. After the rice has been soaked in water and heated with vapour, it is dried and stored.

## Soaking.

With the help of a valve, the paddy is cleared and put in a barrel full of water (see figure B), which can contain 25 kg. It is then heated on a fire supported by three large stones. Drenching was formerly accomplished by using small clay jugs.

The present system offers more advantages. Inside the barrel vapour is produced for drying and sterilization. The size of the barrel is designed to save energy; its space can take a much larger quantity during the operation.

During this phase the grain must absorb at least 30 % of the humidity to allow a homogenized redistribution of soluble substances in the grain and a homogeneous transfer

of heat from the surface of the grain to the centre of the endosperm during the drying process - a gelatinization of the starch. The soaking process lasts only 4.5 hours in hot water instead of 12 to 48 hours at ambient temperature.

## Drying and Sterilization process.

The drenched rice is put in an oven, which was designed and manufactured by the FAO (see figure A). The oven is perforated with small holes from which the vapour escapes. This vapour is produced by a one-hour heating process that occurs in the first half of the barrel, which served for the soaking procedure. The operation concludes once the heavy vapour pushes through the edges of the cover.

Afterwards, the rice is dried and consequently is ready for further processing. In this phase the starch gelatinizes and the biological processes, such as germination and mushroom spores, are suppressed.

Vapour treatment yields economic advantages - production output, storage and alimentary improvements, namely firmness, enriched vitamin and mineral salt contents.

## Design and manufacture of drying kilns

In countries such as India, traditional ovens are made in large, metallic containers. They are placed on a heated furnace during the drying process. The rice, approaching the final desired stage, is heated more than the other rice, hence, carbonization results. Sometimes the wet rice must be stirred continuously. Water must be occasionally added to compensate for the vaporization. As the steam is not evenly distributed in this process, the drying process is incomplete; therefore, the desired result is not achieved.

To overcome these problems, the project has designed and adapted ovens made from locally available materials. A 200 liter-capacity barrel (figure 1a), which is cut in the middle, form the oven. One half (B) serves to soak the rice and to retain water to produce vapour needed for sterilization and drying. The second half (A), which is the actual oven, has a base perforated with many holes (figure 1f), four tubes are vertically joined to the base, which is also perforated with many holes (figures Ad, Ae and Ag).

During the operation the oven is set on the first barrel as a couscous pan. The vapour travelling from the barrel B, passes through the perforations and spreads homogeneously in the oven. (figure 1h).

The first experiments focussed on the drying and sterilization of a new product variety of rice: its name is "IRON". Iron was introduced in 1987 by the Regional Society for the Development of Imbo (SRDI), which promotes rice production in the plain. This variety yields up to 10 tons per hectare. Unfortunately, the husking process produces a large amount of breakage, affecting the output. Depending upon on the method used, the output varies from 50 to 60 percent. The table below compares the output from husking with a pounder to the output from husking with and Engleberg machine.

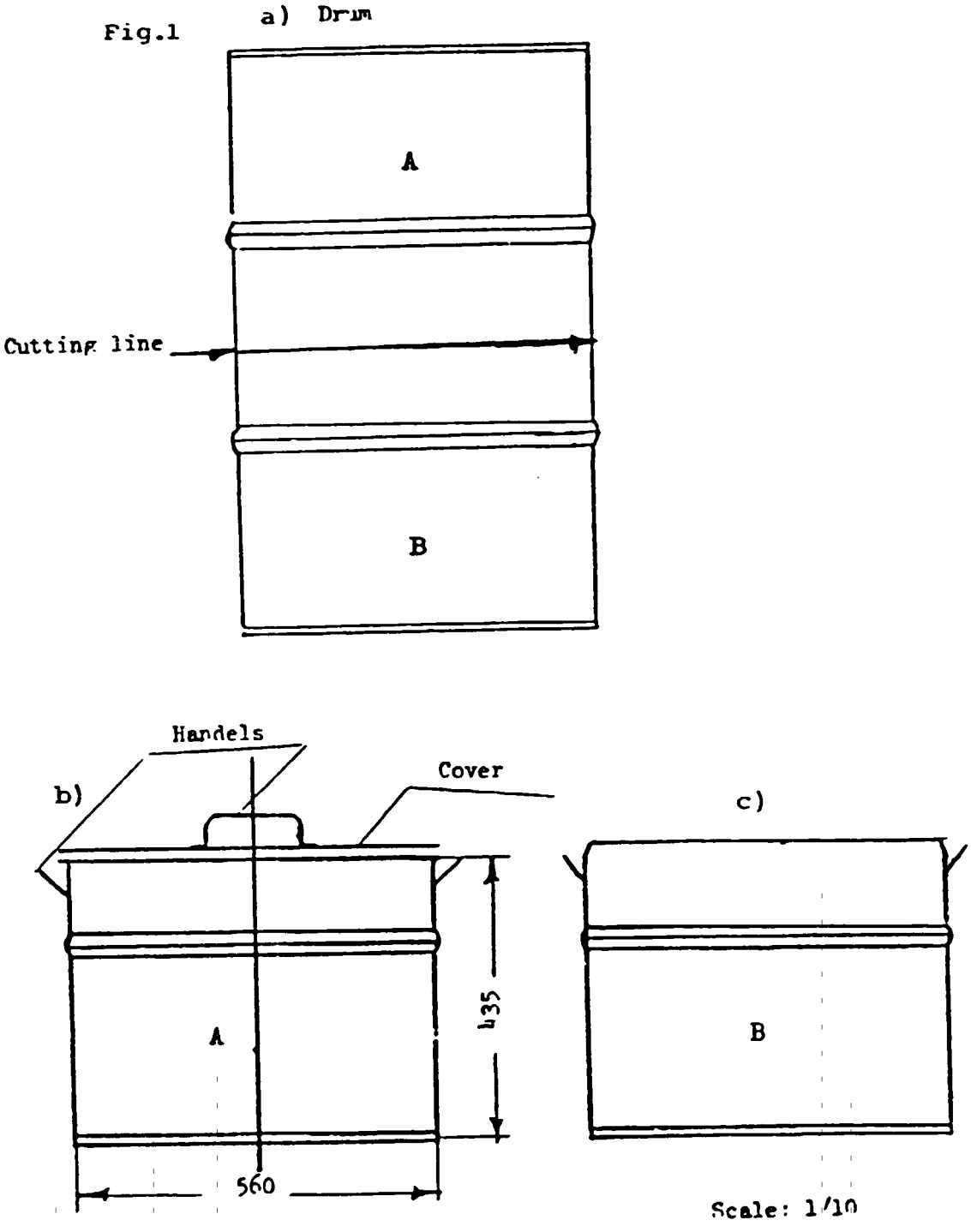
| | Husking with a pounder | | Husking with an Engleberg machine | |
|---|---|---|---|---|
| rice | output in weight | Breaks | output in weight | Breaks |
| untreated | 55 - 60 % | 75 % | 50 - 55 % | 83.6 % |
| treated | 70 - 75 % | 5.4 % | 70 - 73 % | 35 % |

## Conclusion

Taking into account the socio-economic conditions of Burundi, drying and sterilization process using vapour, presents a particular interest at the domestic or artisanal level, because of its practical advantages:

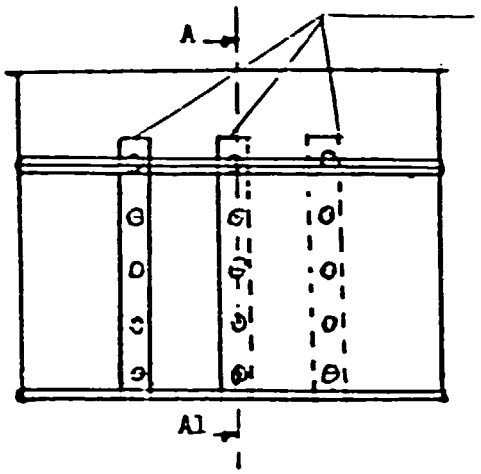
(a) the pounding process becomes easier;
(b) the period for conservation is longer;
(c) the output in grinding is improved (less grain is broken)
(d) the taste and consistency of the product are more pleasant.

Fig.1

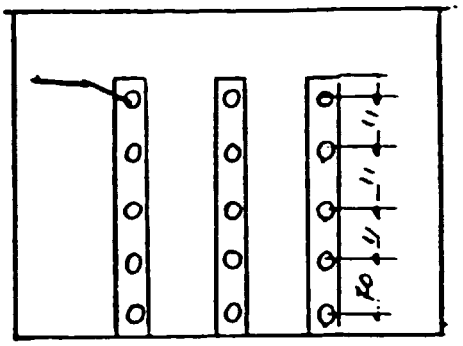


Fimure: 1A.

THE STERILIZATION AND DRYING BY STEAM PROCESSING
d) (VADE) THE CONSTRUCTION OF AN ARTISANAL OVEN p. 5

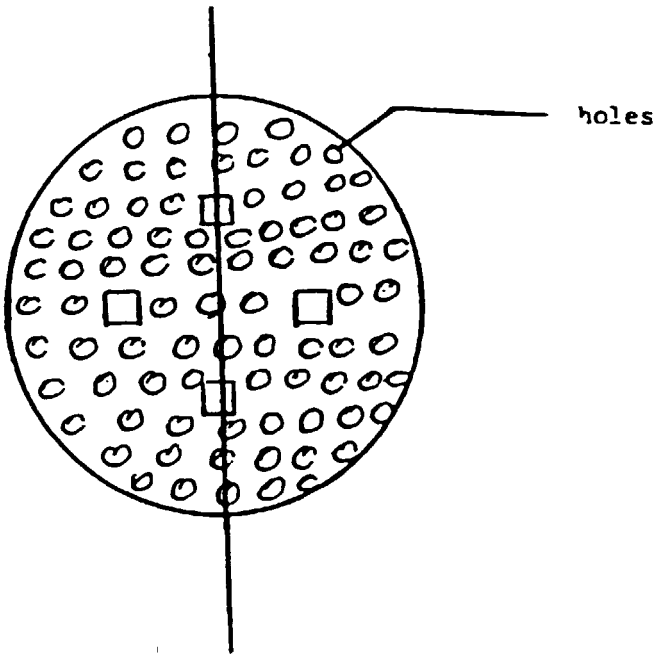



e)

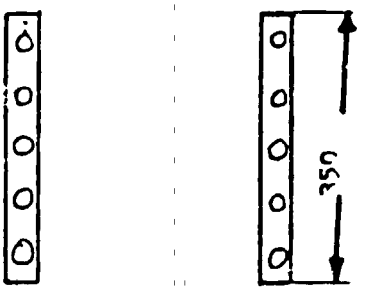


Segment AA'

f)




g) square tube

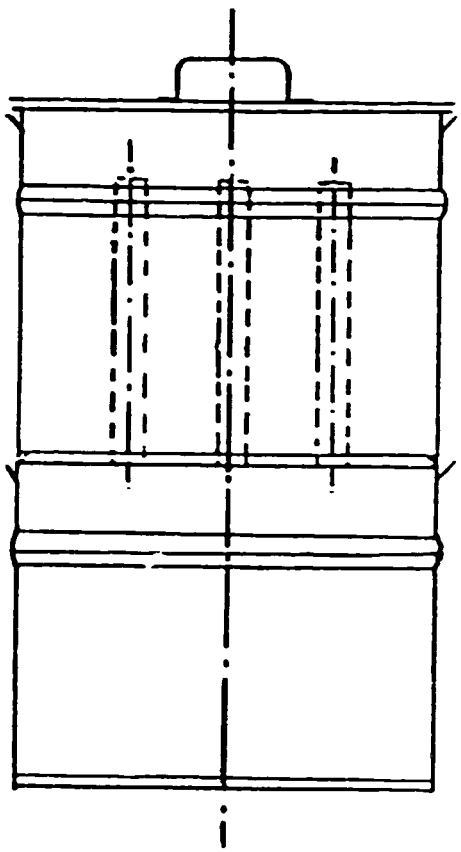


THE STERILIZATION AND DRYING BY STEAM PROCESSING (ETUVAGE), THE CONCEPTION OF AN ARTISANAL OVEN p. 6

Figure: I[6]:

A READY-TO-USE DRYING AND STERILIZATION EQUIPMENT

h)



## Introduction.

The artisanal process of cassava is still a family affair in Burundi. The applied treatments, the manipulation and processing aim at the elimination of the hydrocyanic acid in the tubers.

The major processes used in Burundi are based on dry or water retting. Such technologies yield a weak output and a low quality final product whose conservation is for no longer period than one week. To overcome these problems, the farmers store their produce in the ground. Cassava is harvested depending on the need, thus sometimes it is kept in the ground too long. Not only thus this prevent the soil from being used for another crop, but, this also diminishes the root quality and increases the fiber rate.

Distribution is an additional problem: some regions have excess crops, while others have hardly any. Therefore, it is essential to create an interregional flow to improve storage systems and processing of food crops, particularly of tubers. Thus, programmes geared mainly to the processing of cassava have been initiated.

## Processing of cassava and gari using appropriate equipment

Gari is a fermented final product of cassava, which has been gelatinized and dried. It is the staple food found in Benin, Togo and Ghana. Nowadays, it is also found in other african countries.

The processing technique used to produce gari has been introduced because of the following advantages:

(a) it is a product that has a storage capability of more than one year, which is contrary to the cassava flour, that cannot be kept for longer than one week;

(b) it can be produced at any season, since it does not require drying;

(c) it is a product cooked in advance for ready consumption or preparation in association with other flours.

Process of Gari fabrication.

The sequence of the operation is: peeling, washing, rasping, fermentation in bags, pressing in bags, garification, granulation and shifting.

Finally, many operations are identical to those used to manufacture traditional cassava flour; the purpose is to eliminate the hydrocyanic acid. The details of these operations are not discussed in this paper.

Indeed, the production of Gari has two phases: pressing and torrefaction. These phases are the main constrains and vary among countries. For this purpose the project has attempted to adapt artisanal types of: a press, the type of screw press and torrefaction device.

## Design and manufacture of a press equipment to extract water from the fermented pulp

Traditionally, this operation was performed simultaneously with fermentation. The pulp is put into bags made of strong materials. With a piece of wood, the top of the bag is twisted so that the water can be partially eliminated. Big stone are then put in the bags and all is kept stationary for three to six days. In this case, fermentation and draining are combined into one operation.

Local differences in this operation exist. Sometimes one type of traditional fermentation is constituted of a system of cords and boards between which bags of pulp are tied. Other times the pulp is kept in cloth-covered baskets upon which heavy objects are placed to apply addtitional pressure. All these operations serve the same purpose: that is, to reduce the quantity of water in the pulp to facilitate the drying and garification processes.

However, this operation is long in time and less efficient. The pressure exerted by such a practice is indufficient to decrease the humidity to a reasonable level. The cost of energy for drying or garification remains high.

The use of a screw press is a possible small scale solution. The produced pressure reduces the humidity rate from 45-50 %. This economizes energy during the garification operation. The press element is composed of:

(a) a press screw;
(b) a press lever;
(c) four metallic supports;
(d) a recovery container;
(e) a compressor disc;
(f) a perforated plate containing a pressed pulp (fig. 2).

The pressing operation consists of putting about 15 kg of grated cassava in a polyethylene bag into the press by turning the press bars. This allows the compressor disc to move down to the cassava masses. During the process the juice or water from the cassava is extracted and removed by the drainig channel on the lower part of the equipment. The longer the pressing time, the easier it is to grill the cassava. The press equipment has a capacity of 140-150 kg.

## Design and manufacture of a stationary roasting device

According to traditional operation, garification took place in a big metallic stove, often in a ceramic vessel of 60 cm in diameter, over a ground fire. Gari should be continuously stirred with a triangular calabash pallet to mix it and to prevent it from burning. The gari is then put in the sun to reduce roasting costs. A low quality gari is obtained: it has a very low swelling capacity. Garification is an unpleasant operation because the equipment is unconfortable to handle and the worker is constantly exposed to smoke.

These traditional methods cause a low production of gari. The quality is unsatisfactory and the energy consumption of grilling is high. To overcome these problems, the project improved the roasting device to economize energy, improve the quality and increase the production capacity.

The first attemps took place in Rushubi, in the Bujumbura province. It has presently spread to Rugombo, in the province of Cibiroke, which daily produces 70-80 kg of gari, consists of the following items:

(a) an oven made of bricks in a rectangular form;
(b) an oven to insert wood or charcoal;
(c) a tray (the roasting device itself) with elevated edges, which is put in the oven;
(d) a chimney outlet for the smoke.

The fermented and pressed pulp is pulverized on the roasting device heated by the oven. The flour is slowly roasted until all the moisture is drained; the remaining cyanide substance also dissapeared. Two women with wooden spatulas supervise the operation to avoid carbonization. The heat should be continuously controlled. Garification occurs when the flour obtained becomes slightly yellow and the cassava pieces shrink and become dry.

## Grinding process

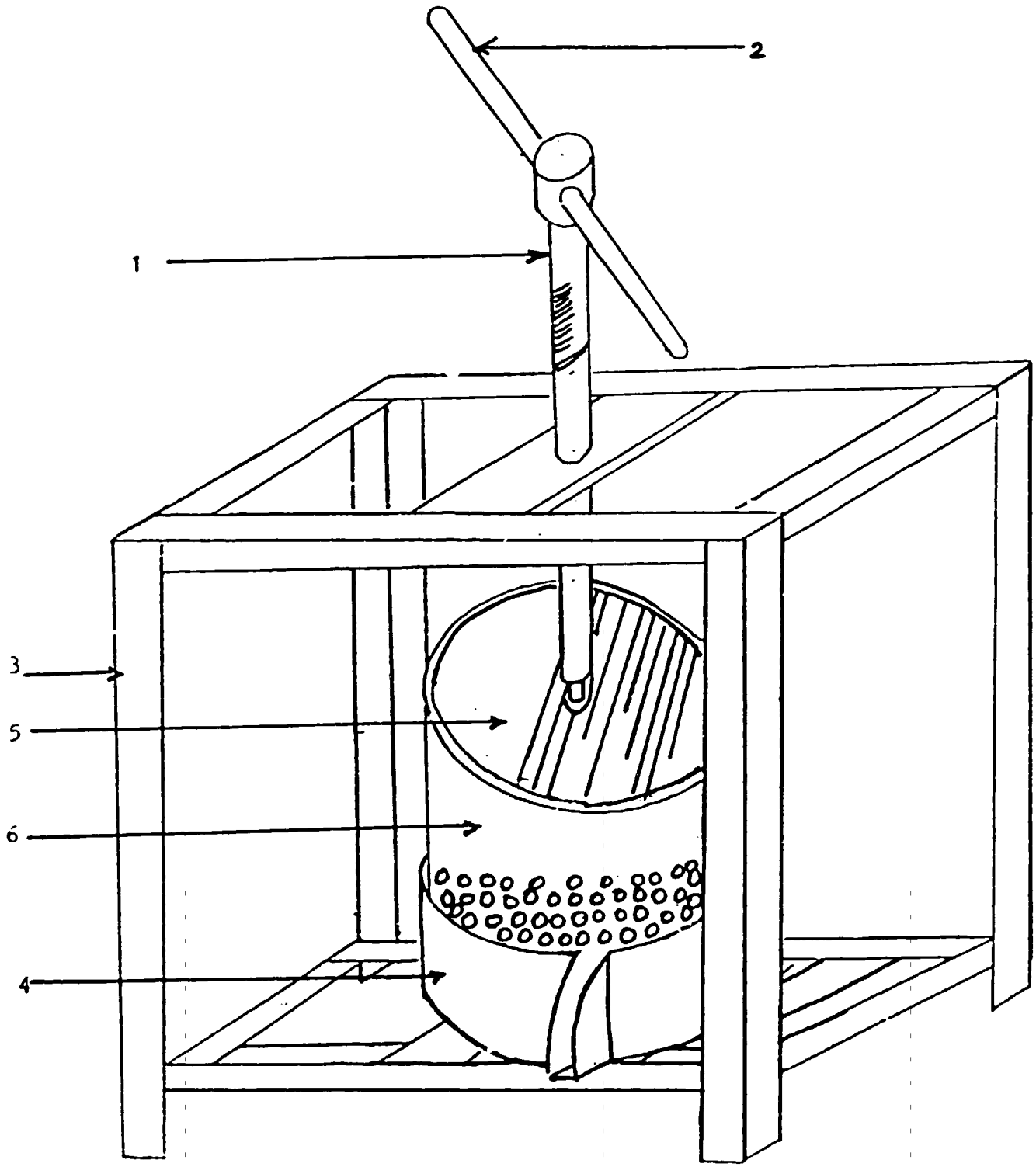
Dry flour can be ground with the help of a mill. There have been previous attemps to manufacture a mill in the experimental area. At the time of writting this report a hammer mill is under construction and the drawing plans have not yet been concluded, therefore they are not reproduced here. The hammer mill can replace the rasping device.

## Conclusions

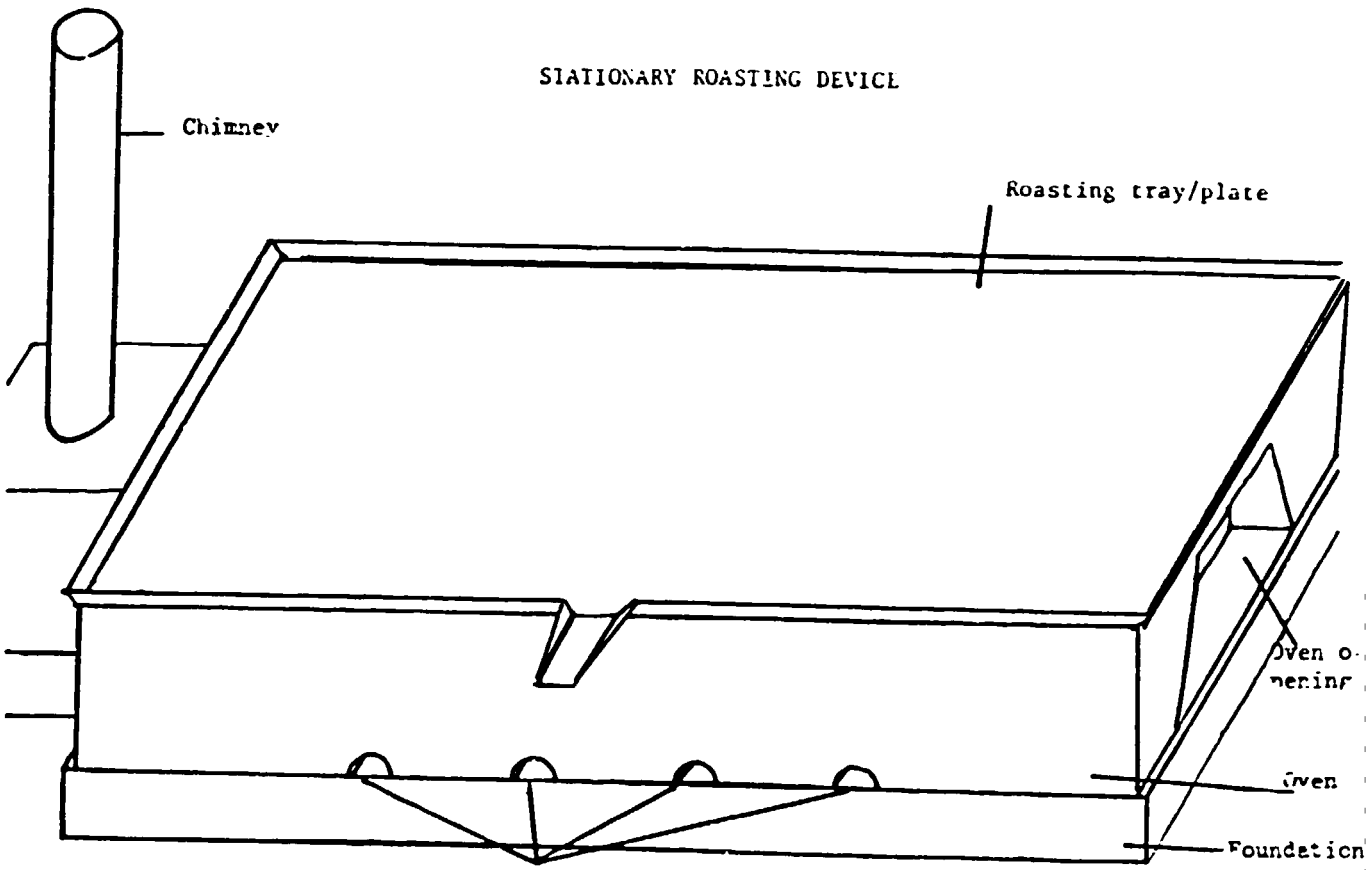
In Burundi, the transformation of food crops is meaningless at the national level, despite the efforts made to reduce the post-crop loss. Programmes initiated by international bodies, sometimes present shortcomings: for some interesting projects designed for the rural area failed because there are no clear guidelines to carry out the programme. Therefore they try to introduce and adapt an improved technology. The technology is valuable if it answers a specific need of the population. This, in fact, requires a good knowledge of the milieu.

Finally, analisis of the local technologies of food processing and conservation should become the basis to solve the problems and define the priorities. It is also indispensable to strengthen the contact among national, regional and international researchers to allow the exchange of information on existing work performed in Africa and elsewhere, as well as on improved materials.

- SCREW PRESS -



SIATIONARY ROASTING DEVICE




8 smoke outlets

DESIGN, DEVELOPMENT MANUFACTURE
OF SIMPLE FOOD EQUIPMENT 

## Introduction.

Lesotho is an agriculturally based economy, eroded to the point that natural fauna is near depletion. There are only few natural woods for preservation and processing. The country suffers of severe winters and special steps have to be taken to produce more crops and to preserve food. During spring and summer a considerable amount of food crops grow (maize, beans, vegetables, fruits). In winter time grow vegetables, winter wheat, fodder and peas. Therefore it is necessary to develop food preservation techniques to help solving the problems related to seasonal production of crops. Food has to be prepared in such a way that it will be edible after certain period of storage and acceptable to taste.

Technological devices have been developed for food processing and food preservation. These are classified in traditional, modern and in appropriate technologies.

SIMPLE FOOD PROCESSING TECHNIQUES :

i) Grinding stone:
Granite stone is used with a small stone for grinding grain against the larger stone. The surfaces of both stones are roughened up. The texture of flour is varied depending on whether flour will be used to make soft/hard porridge or weaning foods for the babies. All grains are processed by this technique.

ii) The hammer mills and dehuller for sorghum.

iii) Soaking and grinding on the stone-grinder.

iv) Cooking in clay pots. This is obsolete and three-legged pots are utilized.

v) Source of energy is wood, cow dung or plant remains after harvest.

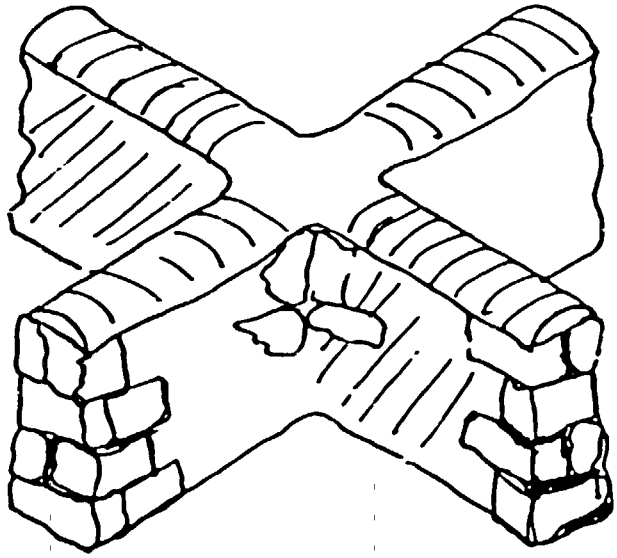
## B. APPROPRIATE TECHNOLOGY FOR FOOD PROCESSING :

In the ministry of Interior, Chieftains Affairs and Rural Development, there is an Appropriate Technology Section (ATS), whose main objective is the development of new technologies, trials, publicity and dissemination of information and sale of developed appropriate technologies which are usefull to Basotho, especially in the Rural areas. The following devices have been developed and tested:

1) Wind Protection Fireplace (Leifo):

This device is used to protect fire from wind effects. Mud and stone is used to build four walls attached to each other at 90 degree angles. The height and length of the device depends on choice of the user (see figure 1)

LEIFO - WIND PROTECTION FIREPLACE Figure 1



ii) Mud-Stoves/Earthern Stoves :

Materials needed are: Water, sand, clay, wooden planks, two pots, meshed wire, chimney, corrugated iron sheet, ash pan, stones or bricks. Dimensions depend on the size of stove to be built.

Method :
Start by placing two pots by side on the ground where the device is to be constructed. Leave space about a palm's length between pots and the edge of the stove. The distance between the last pot and the chimney is also as broad as the palm. Draw a line around the pots and chimney. Remove the pots and build a rectangular

wall around the line. The wall constructed should be about the length of a fish-oil tin and half the fish-oil tin (one and half fish-oil tin). (5 litres).

The inside of the wall should be filled with a mixture made in the following manner.
- three buckets (liemere) of rough sand
- one bucket of clay
- water.

mix the ingredients to make a good moist mixture of requisite consistency. Fill the wall structure with the mixture and make holes for the pots and the chimney, the ash tray, device to control the heat/flame and provide space for the grate.

Cover the stone structure with mud and smooth the smeared walls so that the device appear clean.

figure 2

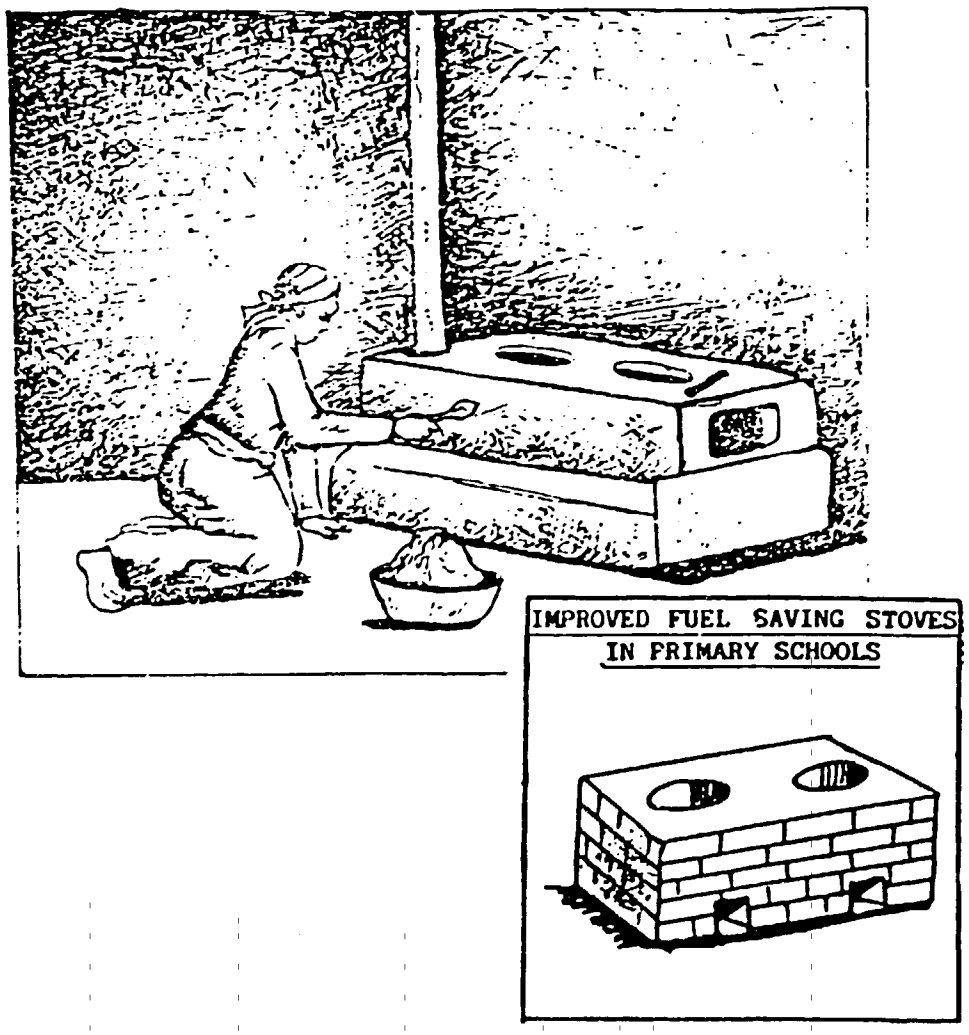
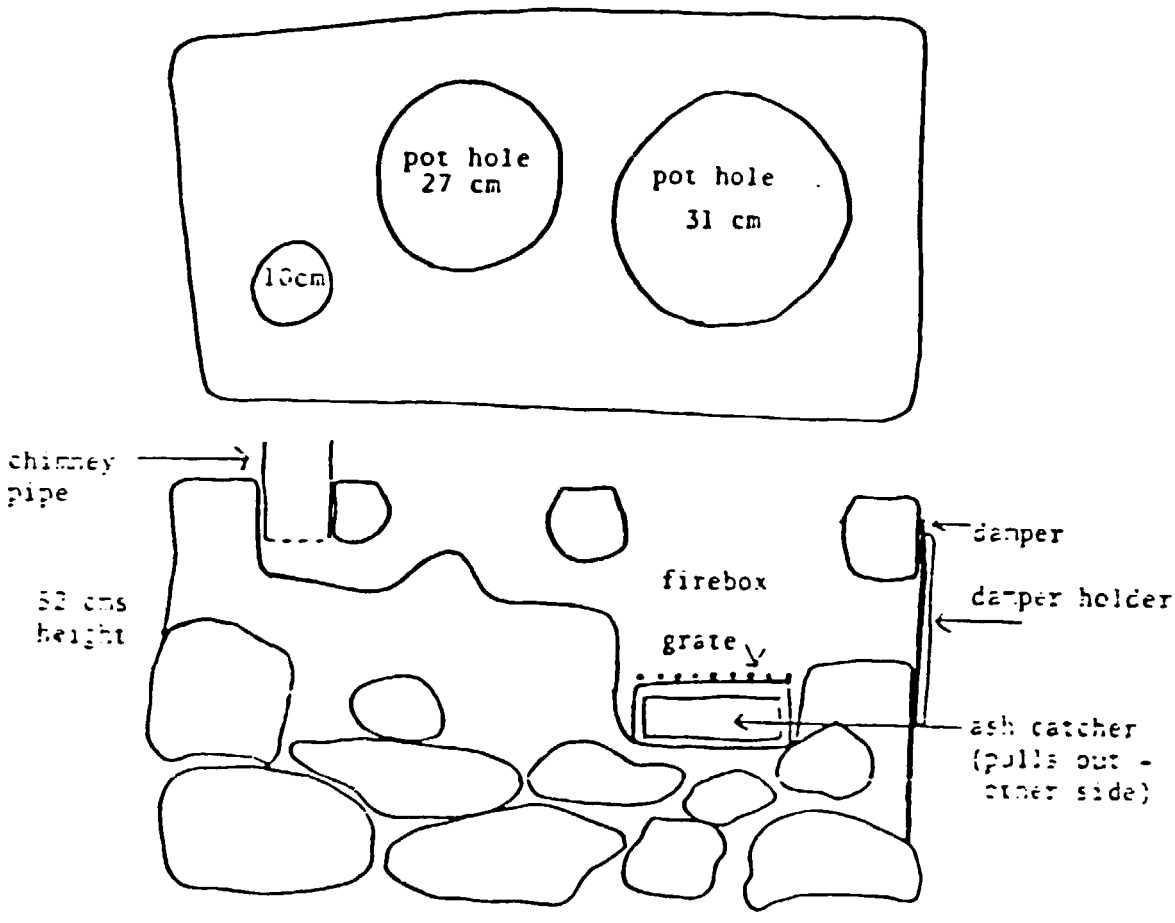


figure 2: RET Earthern Stove Model 3 (Scale 1:10 cm)




A Rock Base Mud Stove with Grate and Ash Catcher

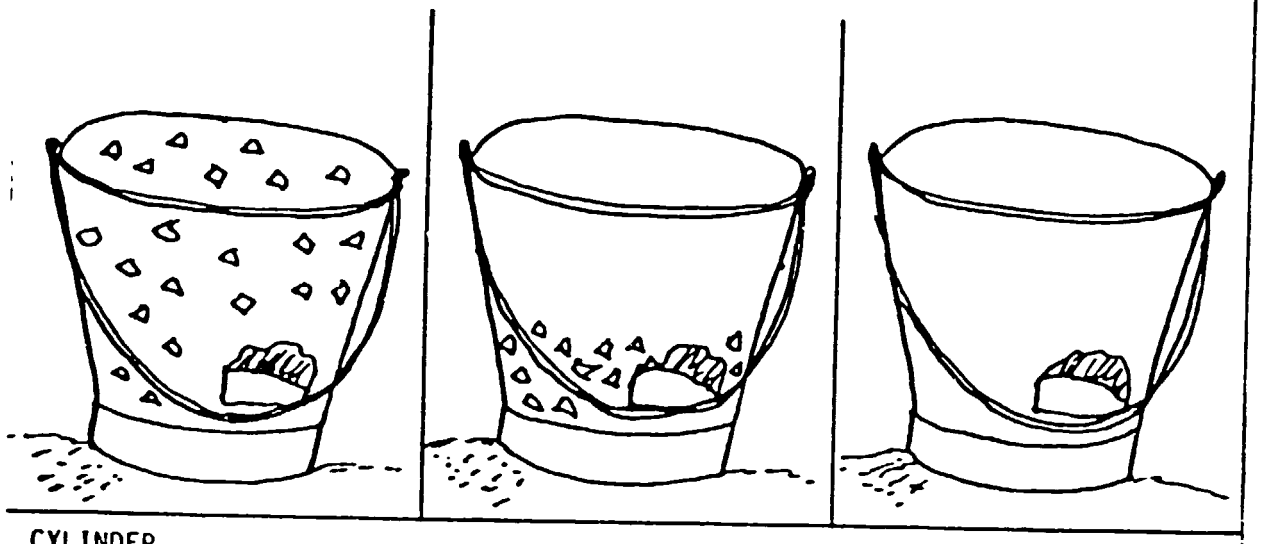
iii) Paolas :

Traditional paolas can be constructed from buckets, by making holes all over the surface of the bucket or one hole on one side of the bucket. The device is good for cooking outside, but dangerous to leave overnight in a closed room.

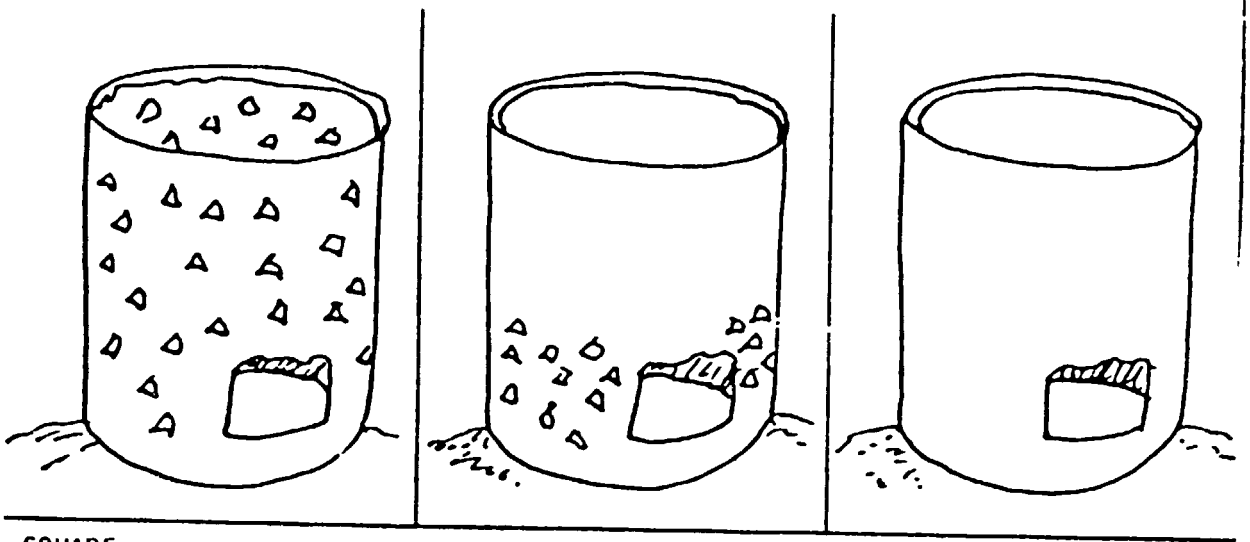
DESIGN, DEVELOPMENT MANUFACTURE
OF SIMPLE FOOD EQUIPMENT



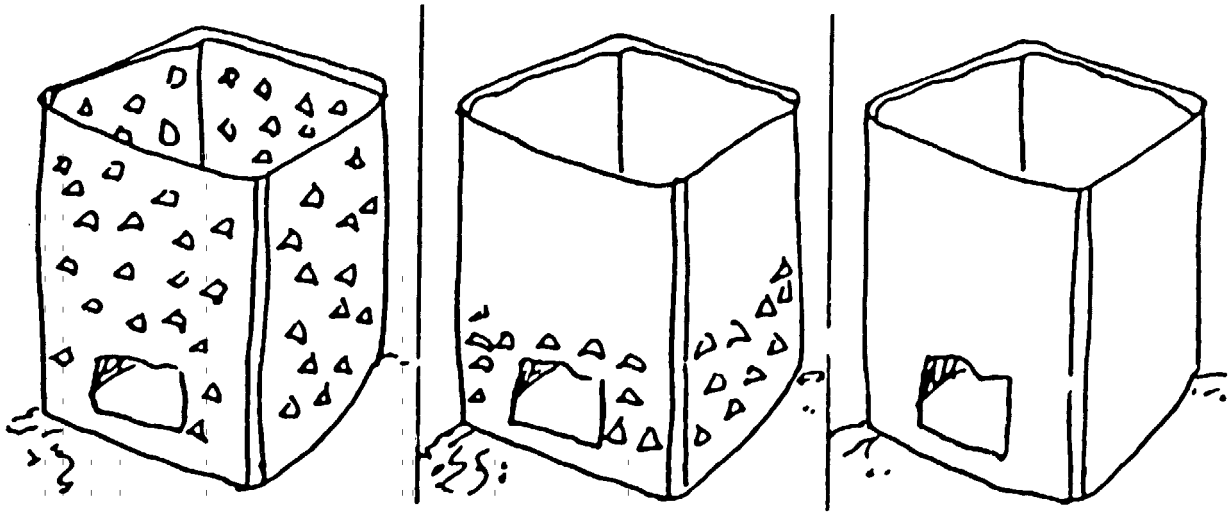
**BUCKET**



**CYLINDER**



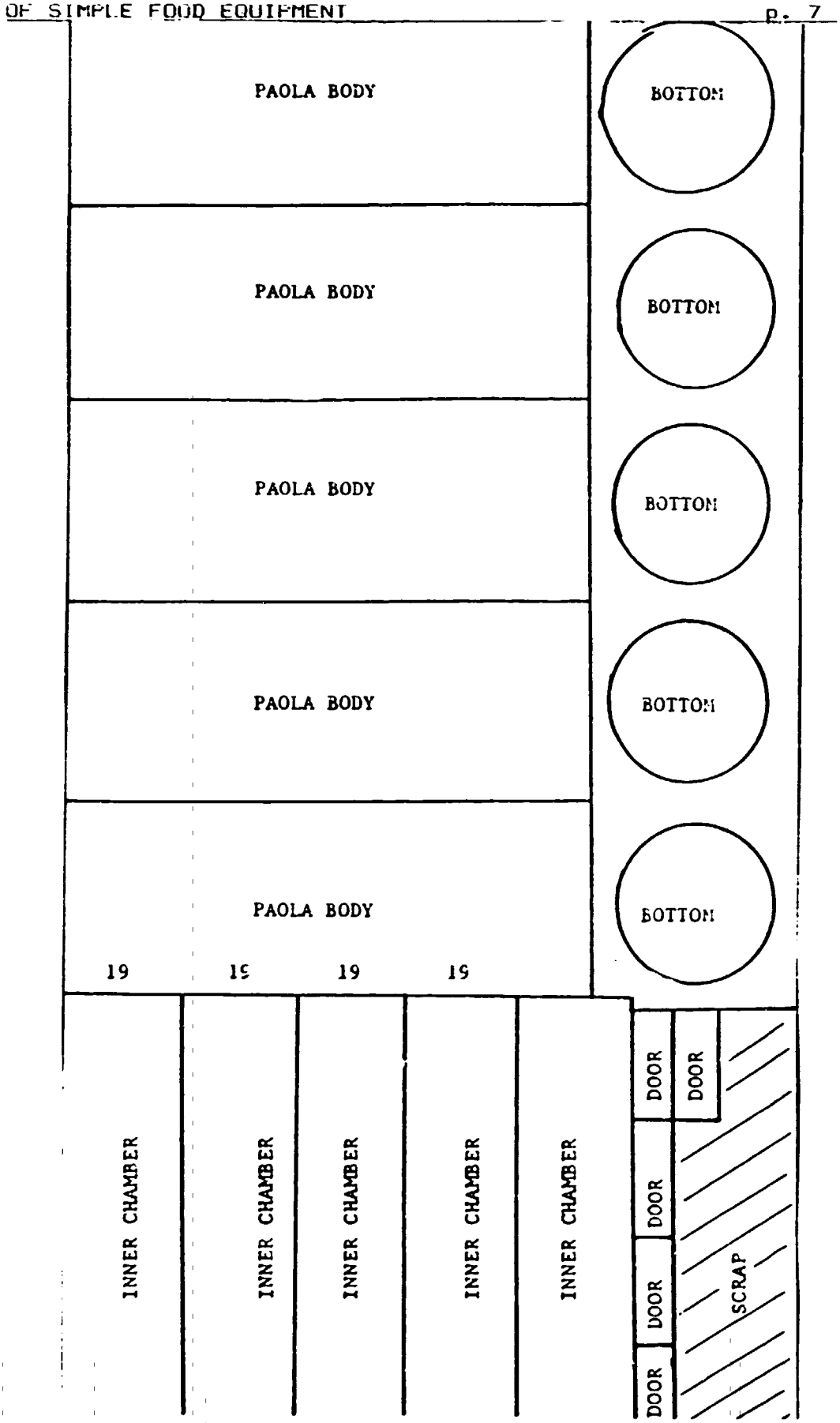
**SQUARE**

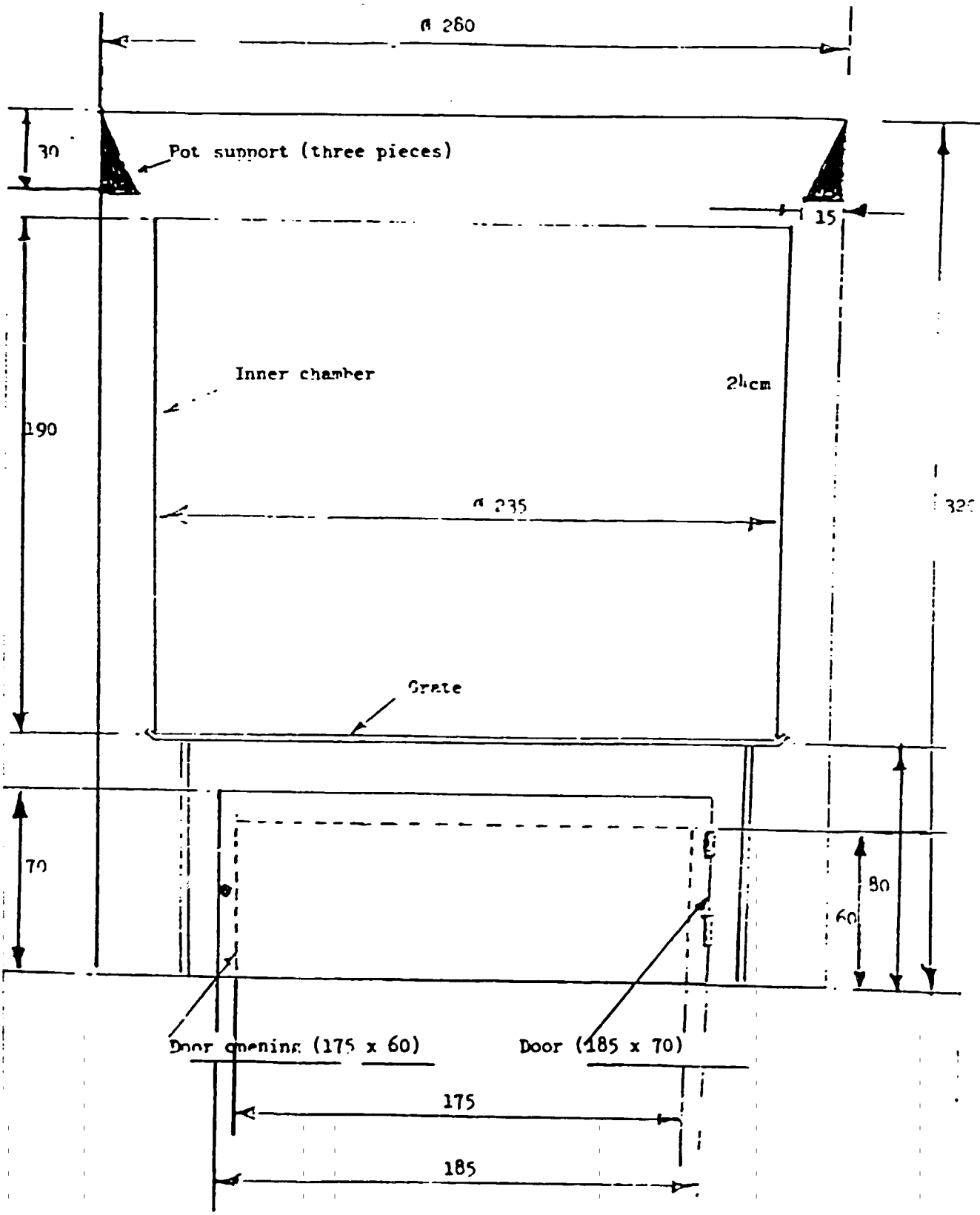


The improved Paola

DESIGN, DEVELOPMENT MANUFACTURE
OF SIMPLE FOOD EQUIPMENT



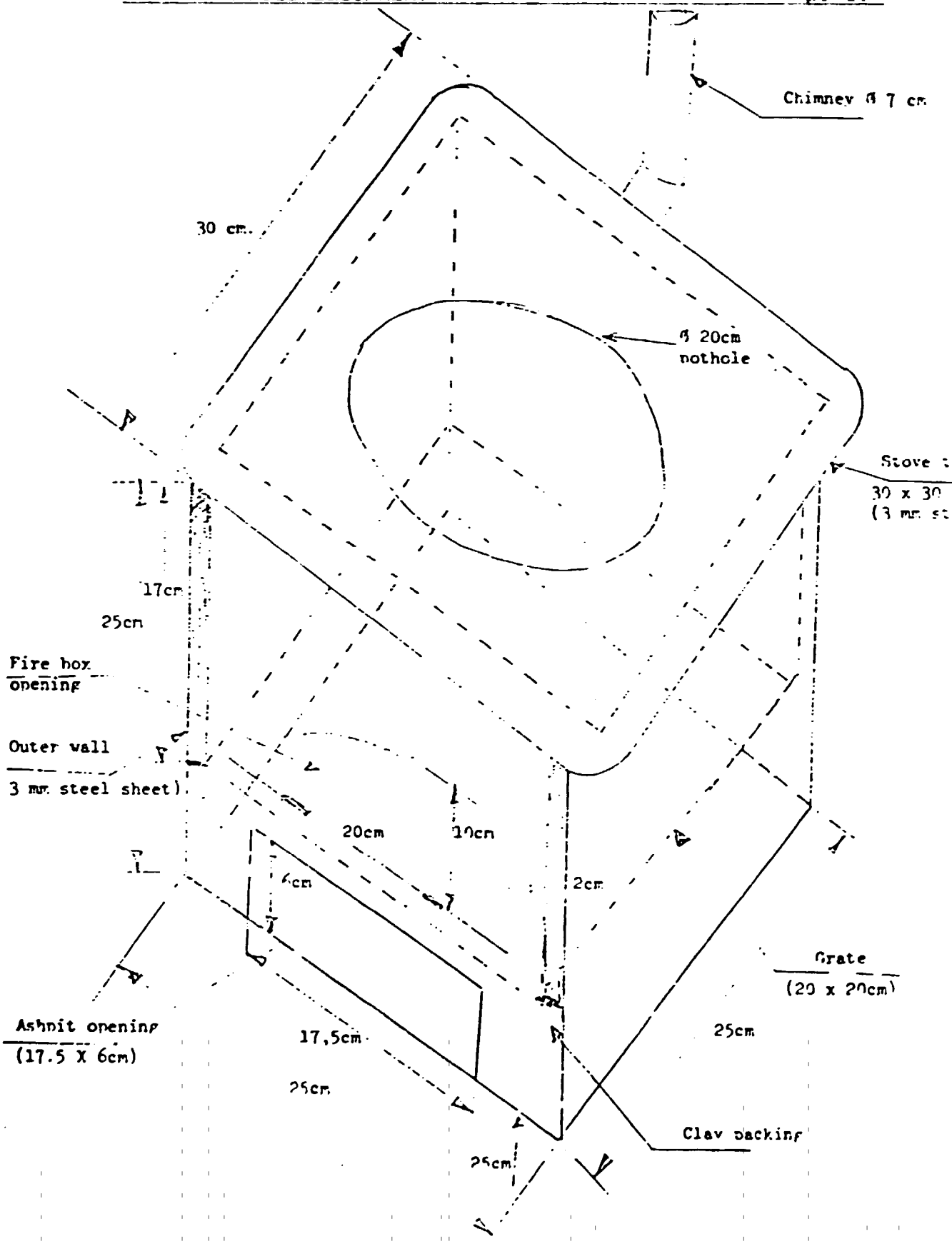



ø 260
30
Pot support (three pieces)
15
Inner chamber
24cm
190
ø 235
Grate
70
80
60
Door opening (175 x 60)
Door (185 x 70)
175
185

iv) The single pot stove :

The structure can be used indoors in winter and outside in summer. The device is made of cooking surface, consisting of a double wall of corrugated iron packed with trwo (2 cm.) centimeters clay in between the walls. The bottom of the cooking surface is a grate made from pieces of corrugated iron sheet or iron bars.

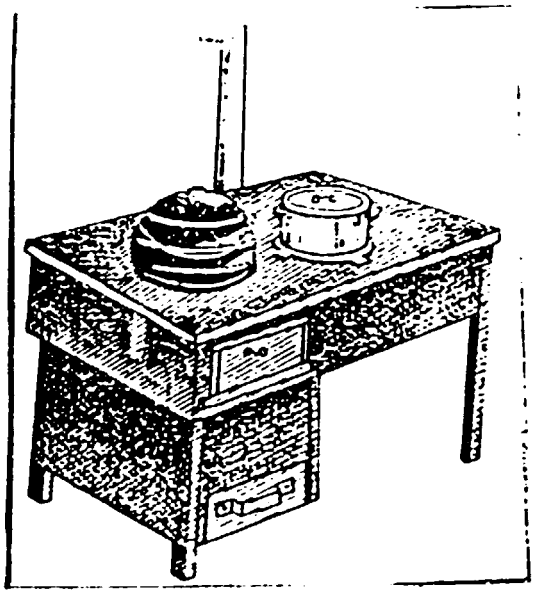
The stove has a chimney, fire bos opening and an ash tray.


Chimney Ø 7 cm
30 cm.
Ø 20cm
pothole
Stove to
30 x 30 c
(3 mm ste
17cm
25cm
Fire box
opening
Outer wall
3 mm steel sheet)
20cm
10cm
6cm
2cm
Grate
(20 x 20cm)
Ashpit opening
(17.5 X 6cm)
17,5cm
25cm
25cm
25cm
Clay packing

v) "Mabotle" stove :

This is a very popular device (instructions as detailed).

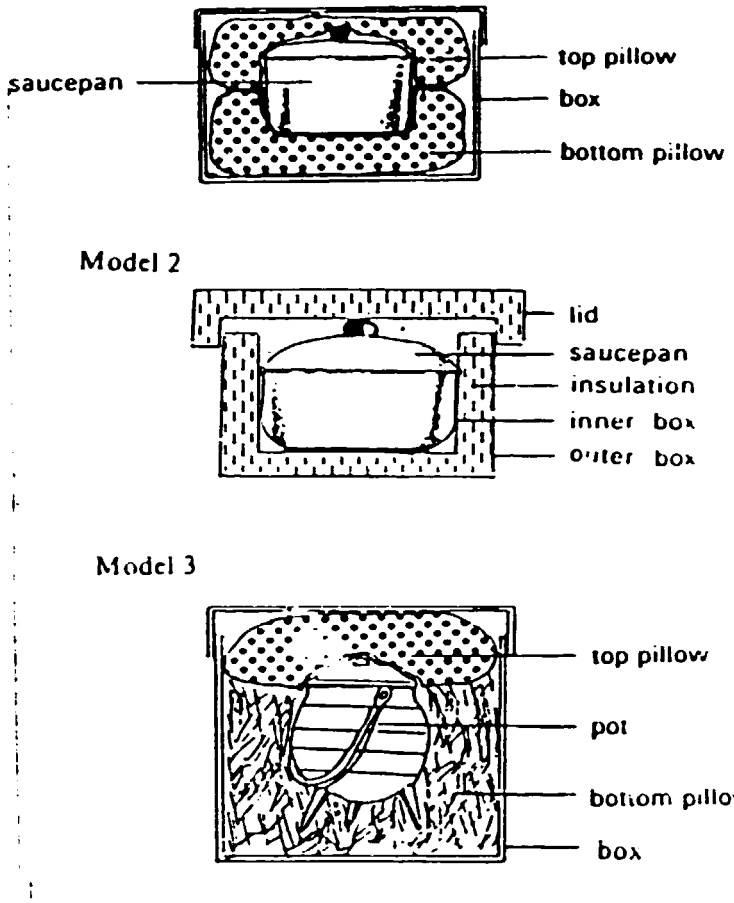
Figure 5 :



vi) Retained heat cookers :

These are becoming popular devices in Lesotho. The retained heat cooker is a cooking structure which is used to finish cooking food that has already been boiled. The cooker consists of a box (bottom and top containers) and insulating materials (pillows).

Figure 6 :




How to make the retained heat cooker :

Most of materials of the Retained Heat Cooker, can probably be found somewhere in your own home.
All you do is find and assemble the parts. The type which is easy to make and very efficient consists of a cardboard box with a lid, two cushions for the bottom and the top of the containers. The cushions provide most of the insulation and the box is a convenient portable container. The cushions should be made so as to fill the box completely when used.

How to make the two pillows :

To make the two pillows, cut two rectangles, the width and length of the inside of your cooker.
Fold each in half and sew up two sides. Turn the two cases so that the stitching is on the inside and the staff loosely with your insulating materials. Close the opening with the hem-stitching or a zipper.

Another simple model is made of two boxes, one inside the other, with the space between them filled with insulation. An insulated lid or cushion goes over the top.

Another simple model is made of box layered out with grass/chaff or sawdust at the bottom and covered with the top pillow stuffed with insulation.

A temporary retained heat cooker can be improvised by wrapping the container in blankets, sleeping bags. The possibilities are endless.

Important points to consider in making the retained Heat Cooker :

There are a few principles to bear in mind when making any type of the retained heat cooker :

- make sure there is enough insulation on all sides of the container.
- the pot should fit as ssnugly as possible into the cushions or lining of the box.
- the lid of the box should fit closely to be as nearly air-tight as possible. This minimizes heat loss by convection.

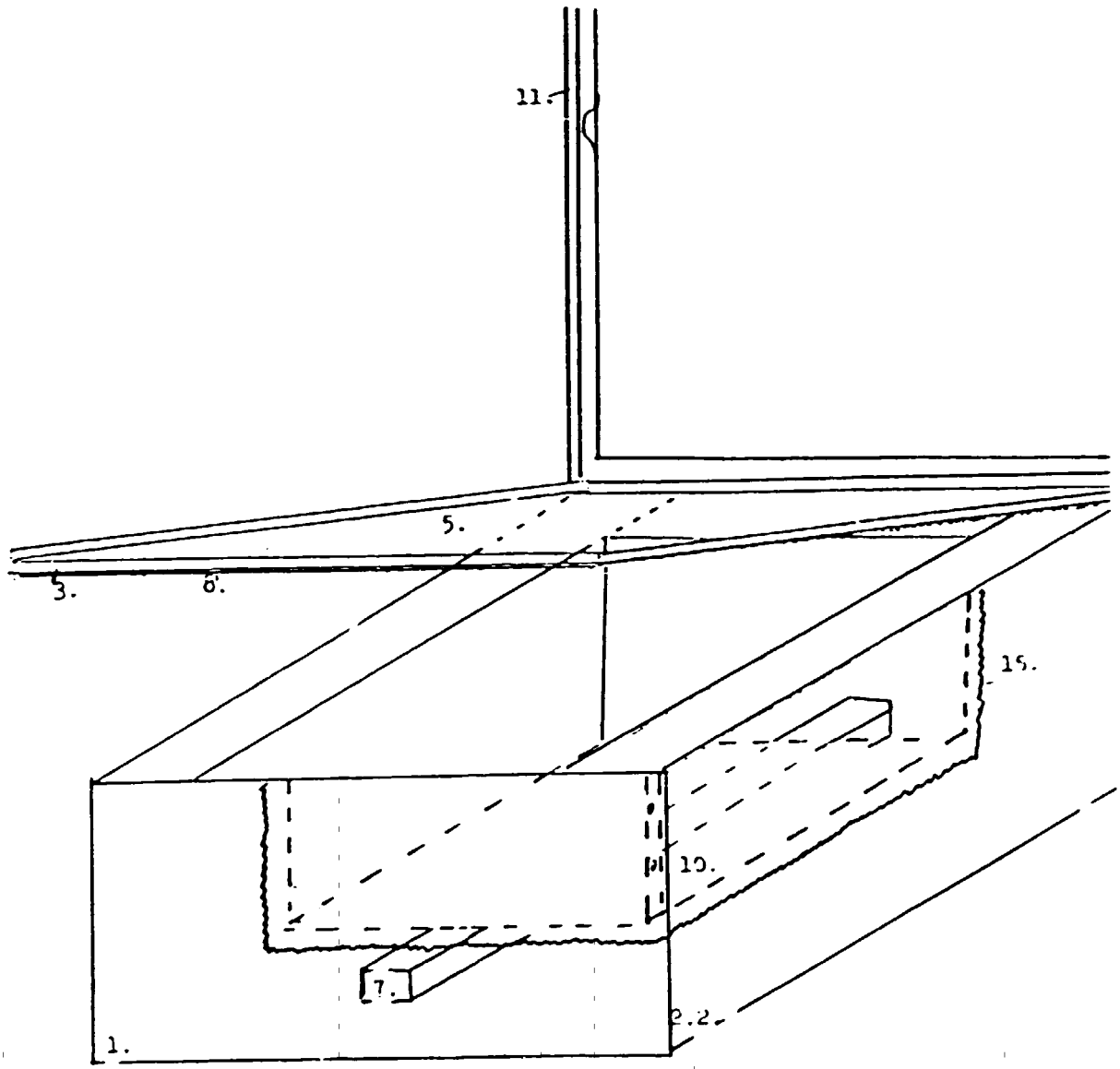
Insulating materials :

A wide variety of commonly available matrials can be used for insulation. Any material which consists largely of small or less isolated air pockets will insulate well. The trapped air acts as barrier to heat loss by convection and conduction. Examples of insulation materials are hay, straw, chaff, sawdust, shredded cloth, crumpled newspaper, feathers, wool, sponge, fur, fibreglass and styrofoan beads.

The solar cooker and the solar oven :

Solar cooker and solar ovens trap sun's energy to cook food or bake bread or cakes. The devices consists of two boxes of different sizes which fit into one another so that there is an inner box and an outer box; space between the boxes insulated. The inner box is painted with black paint. The boxes have a glass lid mounted on wooden frames. The rays of the sun are reflected into the inner box by two mirrors supported by wooden frame in such a manner that the mirrors can

be tilted to direct the reflected rays so that the focal point lies in the centre of the inner box. The boxes are made of corrugated iron sheets. The frames are supported by wooden frames. The solar oven is constructed from corrugated iron sheets (boxes - outer and inner as with the cooker). Reflective surfaces are made from corrugated iron flaps - petal - like which are lined with tin foil. When the petal like flaps are opened the rays of the sun are concentrated towards the inner box which is covered with a glass lid. Both cookers are provided with locking deveces and can be securely left to cook outside while the cook is attending to other duties at home or in the field.


11.
5.
3.
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15.
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1.

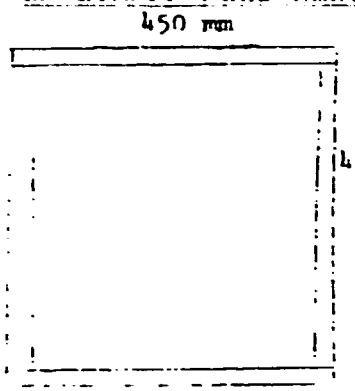
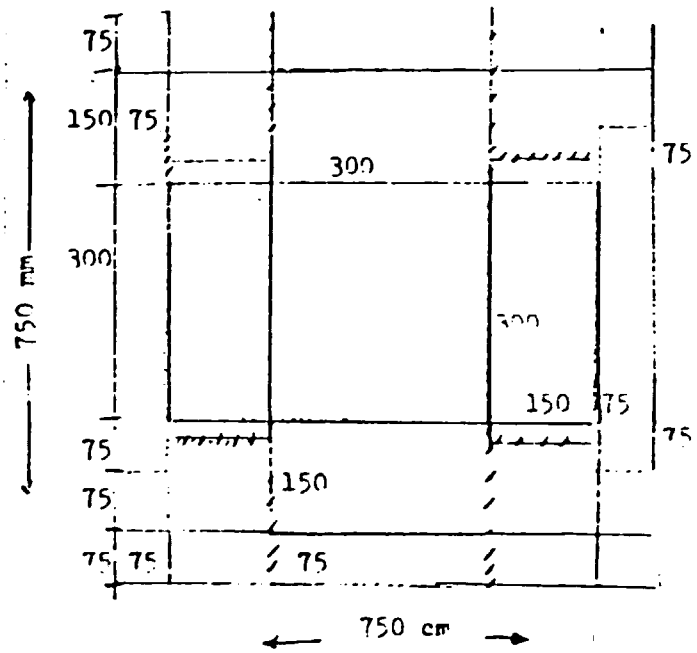



Figure 7a.

flat iron - inner box




① overlap

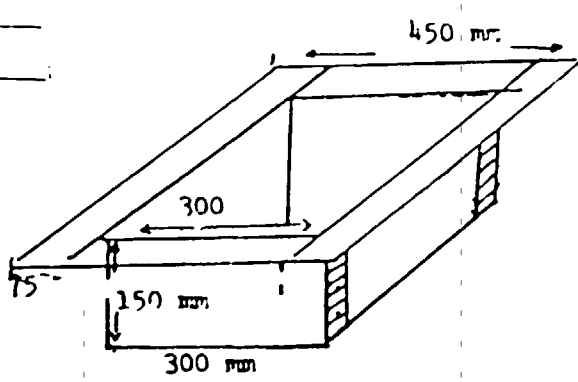
— where to cut

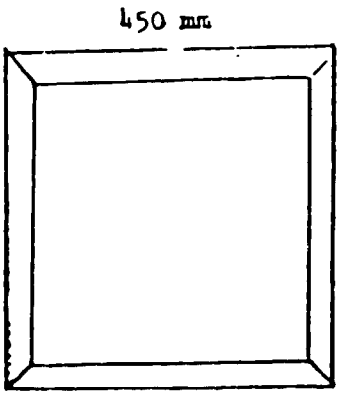
▭ what you must have after cutting

— where to bend

▭ overlap

• • pop rivets




x 3

1x lid
2x mirror frame

FOOD PRESERVATION TECHNIQUES :

a.- Food drying :

This method was used to preserve vegetables, fruits meats. The material were dryed in the sun. Meat was salted before drying.

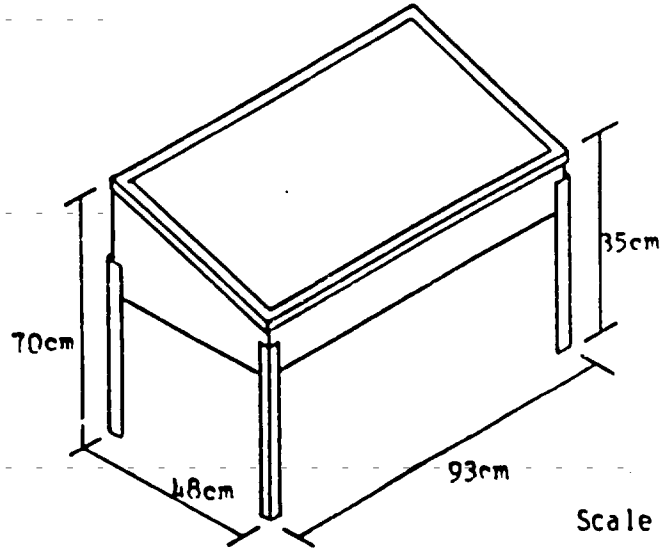
b.- Bottling :

This is the most popular food preservation method used by Lesotho women. Vegetables and fruits are usually preserved. Items can be kept in bottles for more than five years.

c.- Solar dryer :

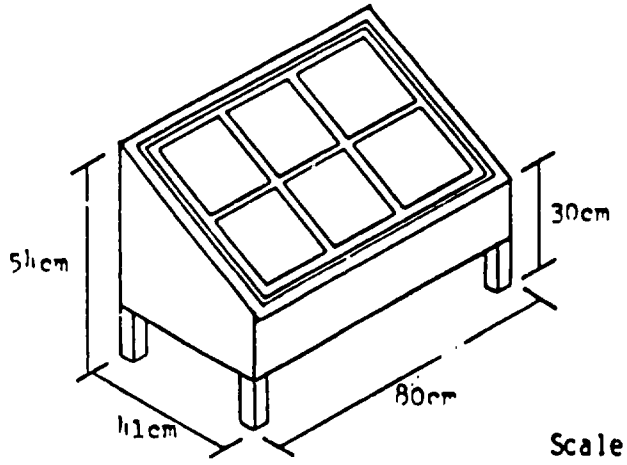
These devices have been developed by the Appropriate Technology Section (ATS).

1: Metal Fiberglass Dryer



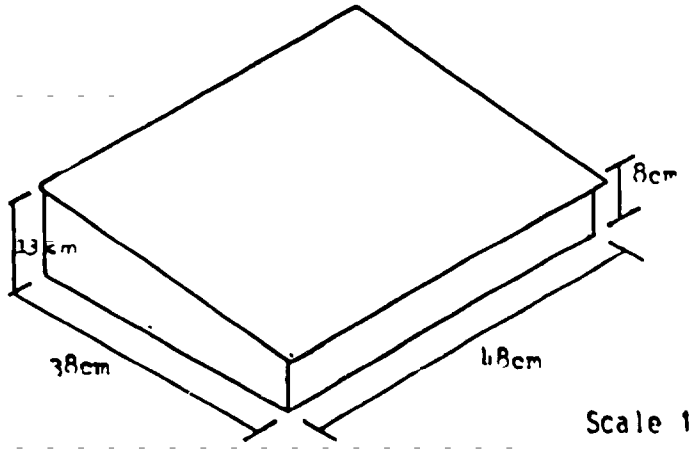

Scale 1:20

Figure 2: Window Dryer



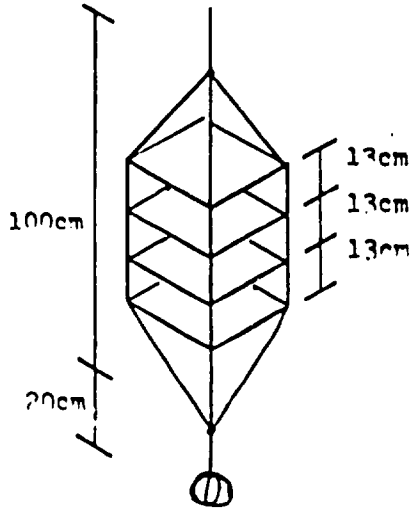

Scale 1:20

: Cardboard Box Dryer



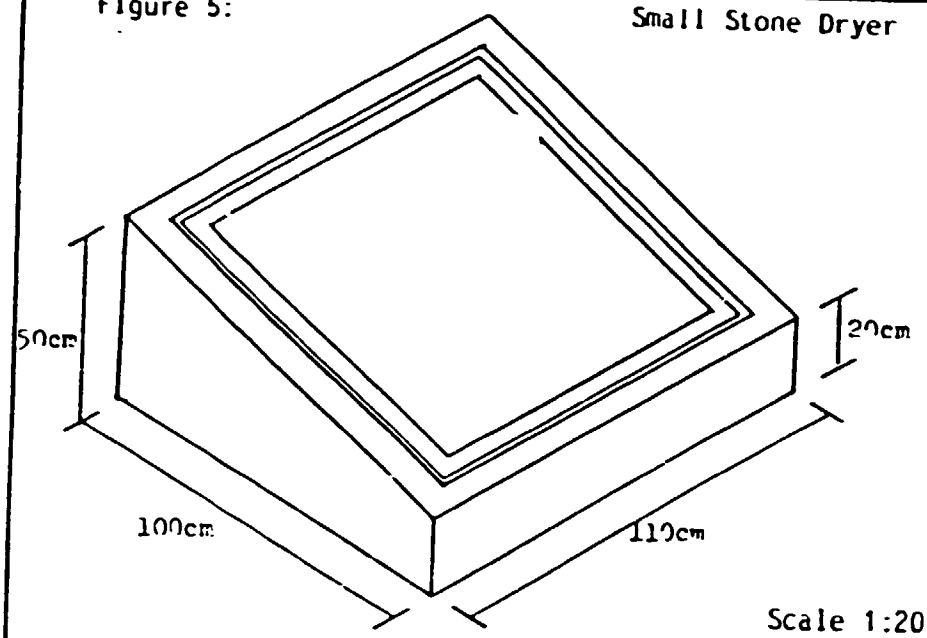

Scale 1:10

Figure 4: Cabbage Bag Dryer



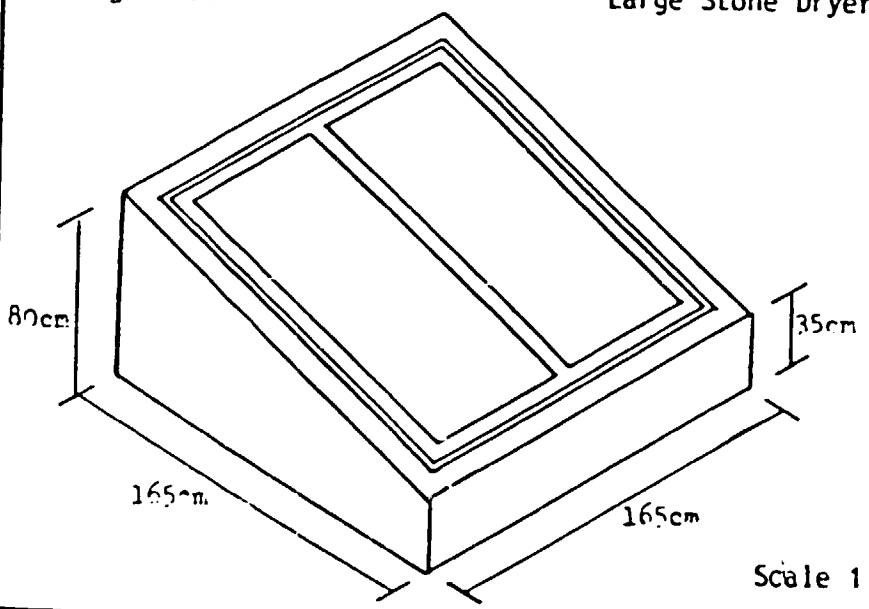

Scale 1:20

Figure 5: Small Stone Dryer



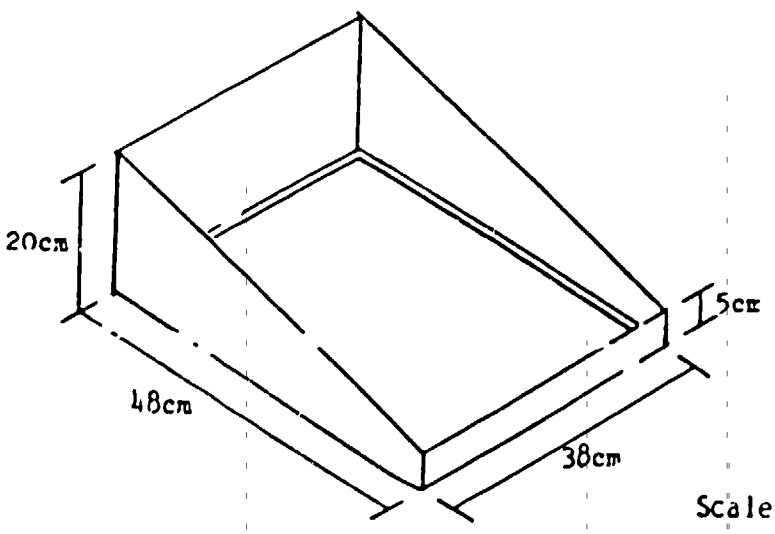

Scale 1:20

Figure 6: Large Stone Dryer




Scale 1:33 1/3

Figure 7: Traditional Dryer




Scale 1:20

## SOLAR DRYER

Figure: 8B

### MATERIALS REQUIRED FOR THE FRAMEWORK

a). Top Frames

970 mm x 32 mm x 32 mm (4 pieces)
555 mm x 32 mm x 32 mm (4 pieces)

b). Legs

660 mm x 32 mm x 32 mm (2 pieces)
390 mm x 32 mm x 32 mm (2 pieces)

c). Bottom Frames

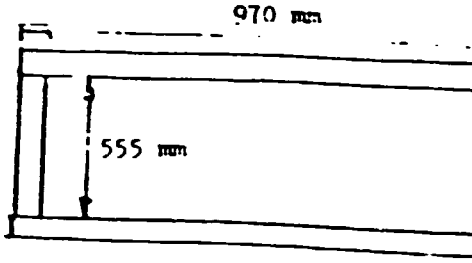
800 mm x 32 mm x 32 mm (2 pieces)
500 mm x 32 mm x 32 mm (3 pieces)

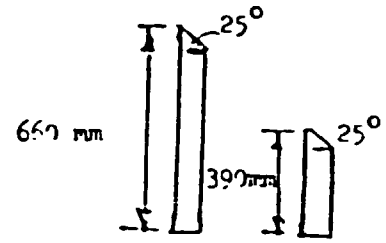
d). Tray

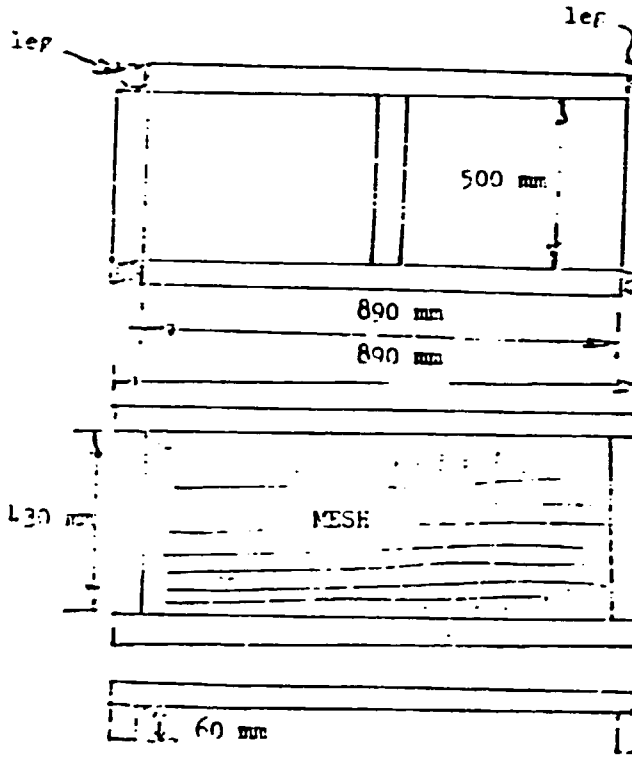
890 mm x 32 mm x 32 mm (2 pieces)
430 mm x 32 mm x 32 mm (2 pieces)
60 mm x 32 mm x 32 mm (4 pieces)

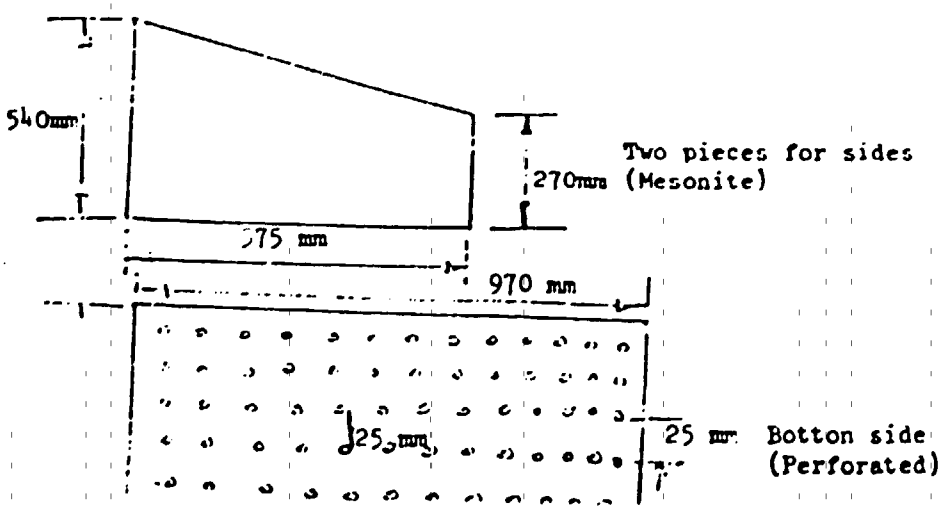
e). Materials for body

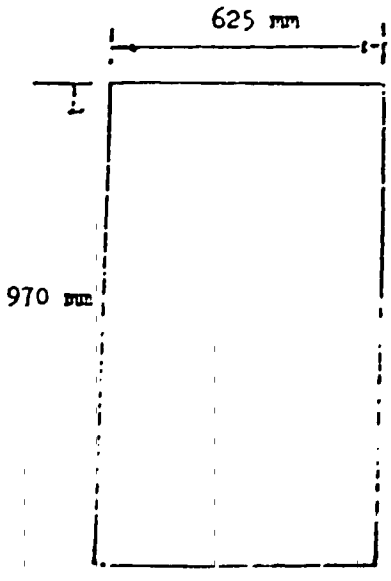
970 mm x 500 mm Mesonite for Rear
970 mm x 230 mm Mesonite for Front

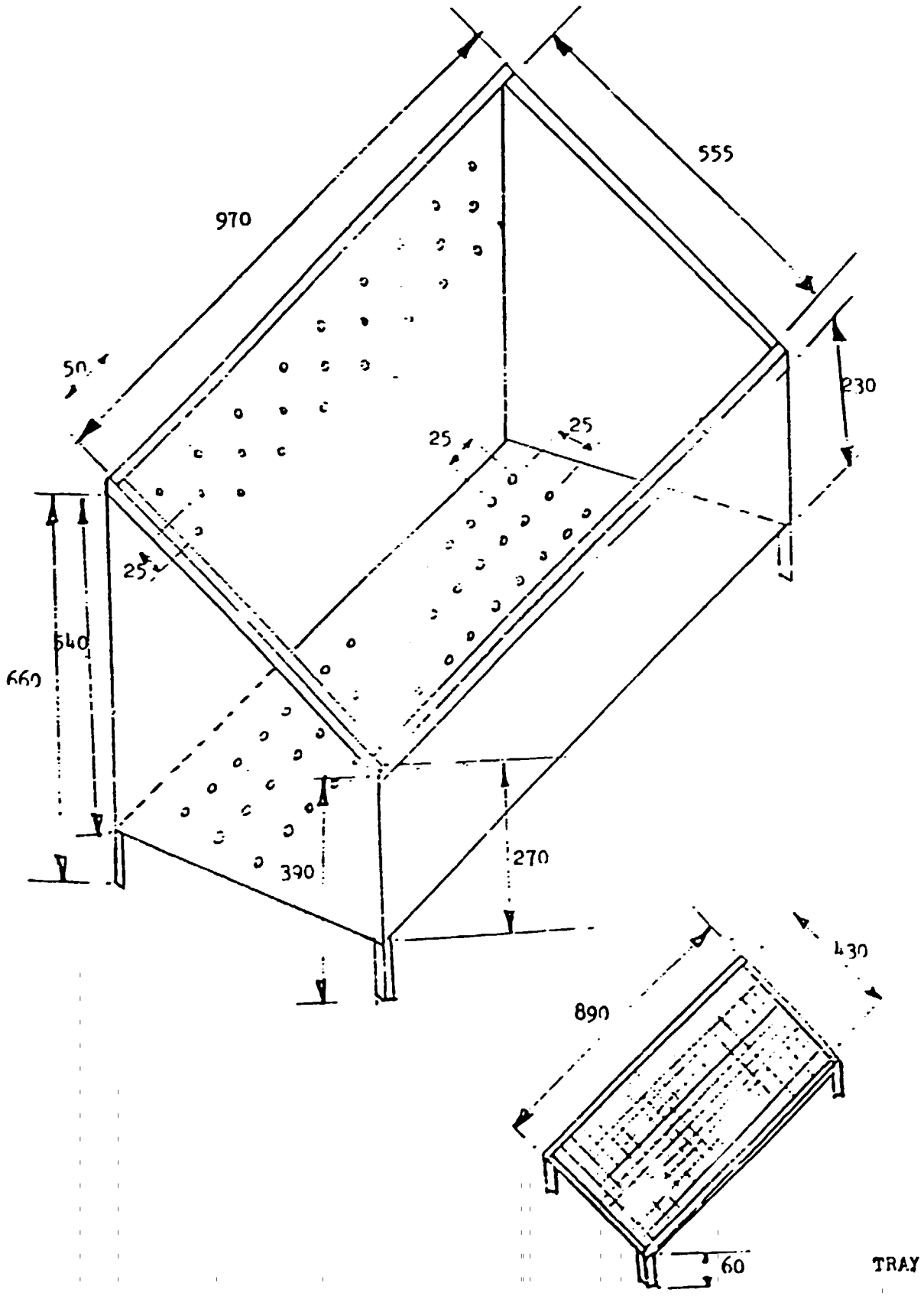



970
555
50
230
25
25
25
540
660
390
270
430
890
60
TRAY

d. Storing Grains:

The brick silo/stone silo:

This is a structure constructed of brick or stone.

Figure 9: Brick Silo

Brick Silo

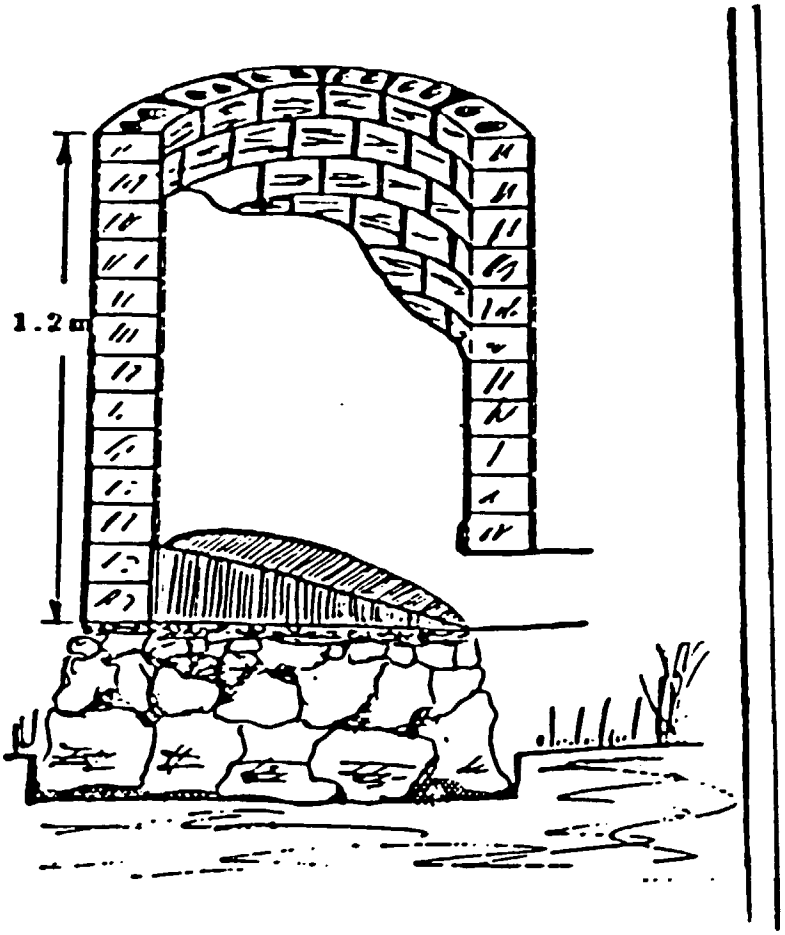



Figure: 9A

BIOGAS GENERATION PLANTS :

Biogas is used as fuel for food processing. In Lesotho the technique is gradually gaining popularity. There is about twenty six (26) plants in the whole country, with every district having at least trwo plants. Maseru district has six (6) and Mohale's Hoek four (4) plants.

The biogas plants consist of basically three parts i.e.:

- Top dome where gas is accumulated.
- The cylynder where cow dung is kept for fermentation
- Bottom-dome - keeps dung before fermentation.
- Inlet - letting in cow dung.
- outlet - letting out slurry after fermentation.
- sherry chamber

OTHER FOOD PROCESSING TECHNOLOGIES :

1. Soy bean processing project in Outhing (Plenty Lesotho)

Technology used here involves traditional and modern methods. The major activities are extraction of milk from the beans and grinding the roasted beans into popular powder (lipabi) and fat cakes. Technical devices used in the Soy-bean dairy for extraction of milk/tofu/soy yoghurt include the following:

- traditional grinding stone (Leloala la Lesotho)
- casseroles
- buckets for soaking beans overnight
- cloths for sieveing
- press for amking soy-cheese/tofu
- vinegar/lemmon juice
- refrigerator for storing food
- clock for timing the operations involved
- solar dryer

Extraction of milk ffrom soy-bean involves soaking beans overnight in a bucket. This procedure is followed by grinding the beans finely in the grinding stone, boiling the ground matter mixed with water for twenty minutes. The mixture is then sieved and the liquid is ready for drinking. Residue can be used to mix with wheat, flour or maize flour to improve the nutritional status of maize and wheat meal.

- keep food covered
- wash dishes before placing food in the dish
- Do not eat discoloured food or smelling food
- Soy milk and Soy yoghurt should be kept for a day during cold weather. After a day boil them for 15 minutes. They will turn into cheese which should not be kept for too long.
- Tofu should be kept in cold water. Tofu can be kept for a day or further if the weather is cool.

The milk can be mixed with vinegar or lemmon to curdle the milk. The curd can be passed through the pressto turn it into cheese.

Soy bean flour (from ground beans) is mixed with wheat/ maize/ sorghum meal to improve the nutritional status of the grains.

The most common practice at Plenty, Lesotho is the use of Soy bean powder to make fat cakes (makoenya) which are very popular. The beans are soaked overnight, ground finely, then the powder added to brown wheat flour and kneaded into dough which is fried as fat cakes.

Another popular item is powderr from roasted beans. The beans are soaked overnight, then ground roughly, dried in a solar dryer for 6 hours, then roasted in oil and ground into fine powder. Powder is mixed with fine salt and sugar to good taste, packaged and sold as "lipabi".

Another delicacy is roasted beans. Beans are soaked overnight, then roasted in oil.

Proper storage for soy bean products :

- keep food for short time if it is hot
- keep food in shady, cool place (refrigerator) or in a hole in the ground

EXTRACTION OF OIL FROM SUNFLOWER :

The Catholic Relief Services has introduced sunflower production programmes around the clinics. The major aim is income generation for participants. Technology used include:

- Power husker "LU"
- Hand grain winnower "B"
- "Cecoco" Oil Expeller
- "Cecoco" Filter Press

Brick Silo

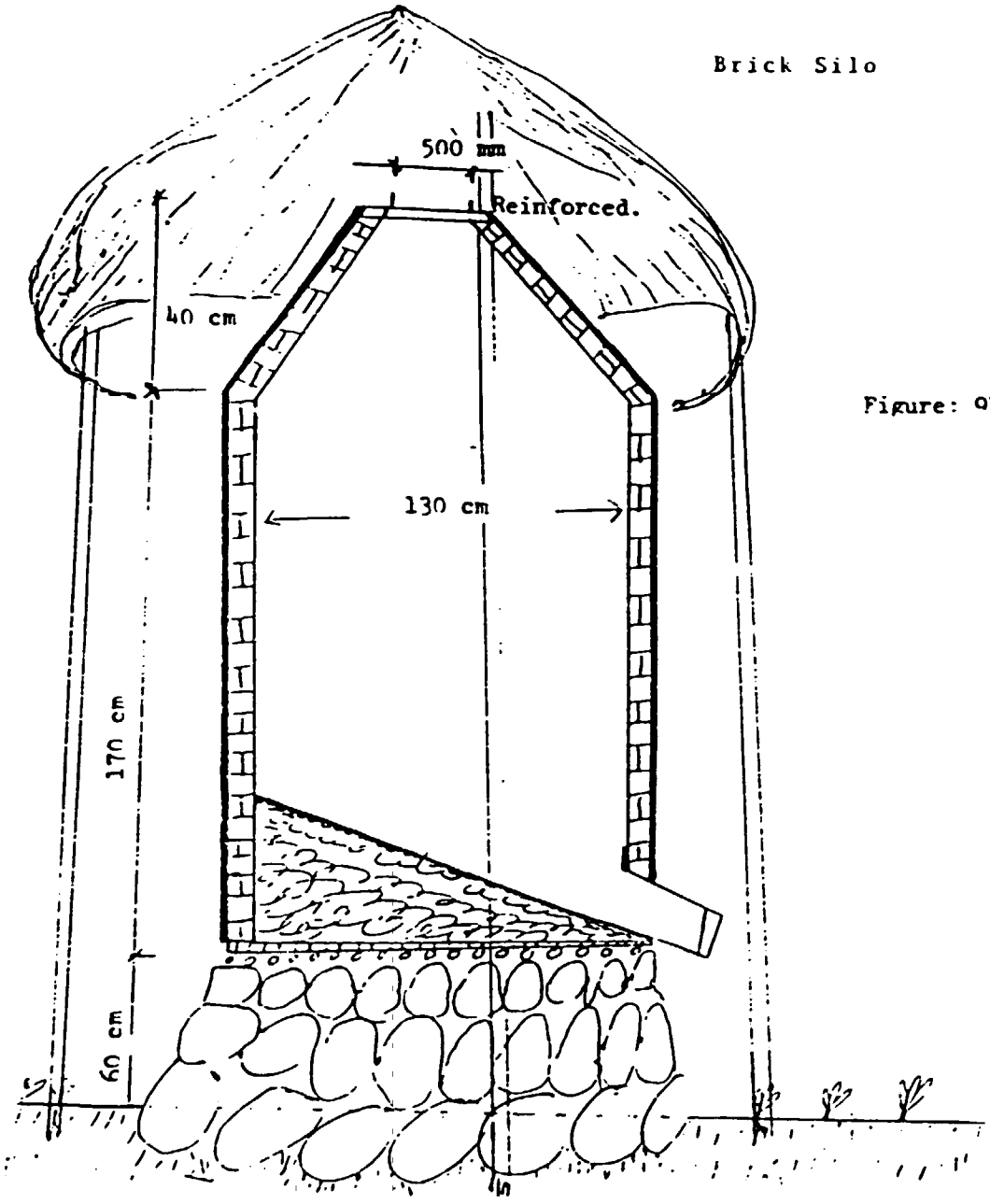



Figure: 08

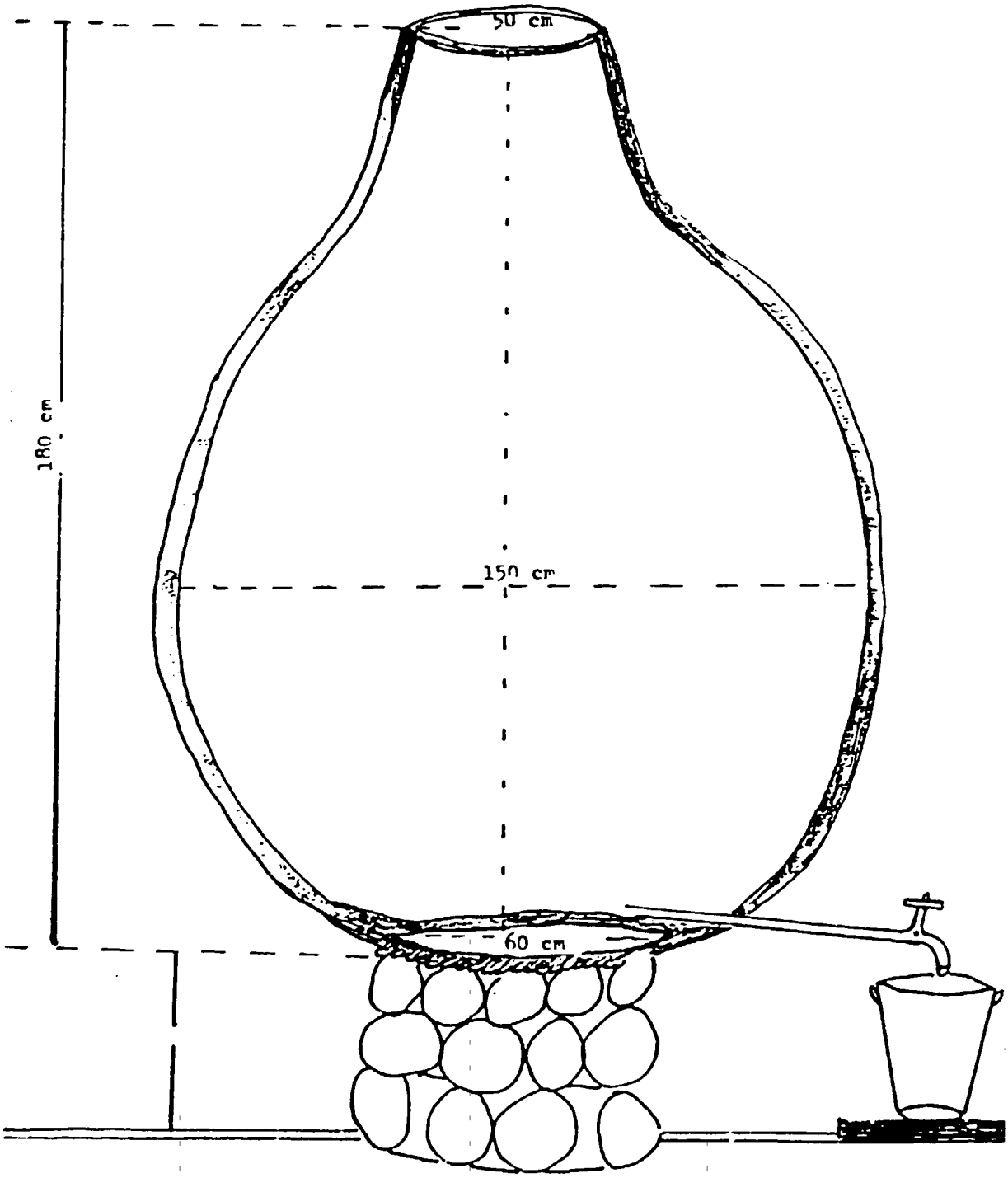
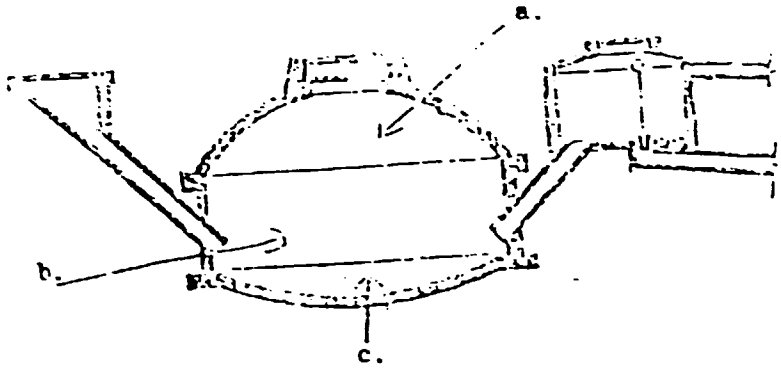
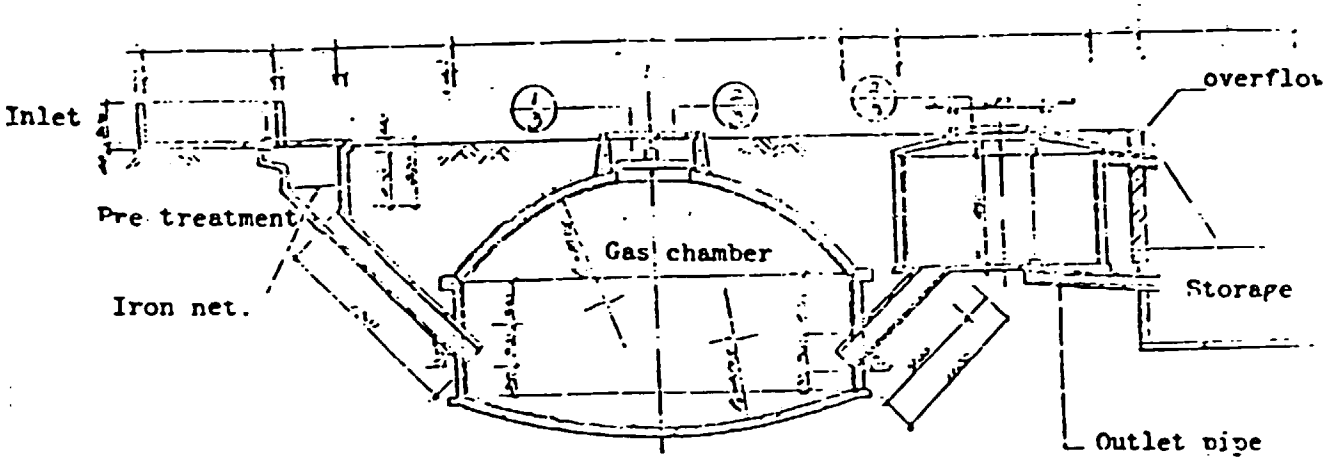

50 cm
180 cm
150 cm
60 cm

Figure 11




Section 1 1

THE DESIGN AND MANUFACTURE OF MAIZE HULLERS 

## 1.0 Introduction.

The design, development and manufacture of machinery in Malawi have advanced parallel to the agricultural activities and the level of consumption of the food production in the local market.

In the early years of independence, most of the machines were imported as the accelerated agricultural output required immediate industrial support. When the situation had stabilized, the design of local equipment began to take place, particular for the processing of maize and rice products.

This paper focuses on one of the locally manufactured equipment substantially used in the rural areas of production of dehulled maize, a stage prior to making meal flour. The equipment is commonly known as maize huller.

## 2.0 The maize huller.

The maize huller has been developed to mechanize the removal of the husk and the germ from the maize in readiness for further disintegration into flour. In traditional technology this process is accomplished by pounding the raw maize in a mortar and a pestle. This operation is tiresome and less efficient as the rate of production is in the range of 7-10 kg/hr.

The huller is manufactured through die casting, the material of which is extracted from cast iron and brass scraps. These scraps are locally found and smelt in a coal-fired furnace.

Scrap material is used as it is the only source of crude metal.

2.1 The design of the huller is non-traditional as in the indigenous practice, removal of the maize hull is achieved by the hammer effect. In fact the technology is adapted from an earlier foreign design, which vanished from the market due to purchase and maintenance costs.

2.2 The change of local design over the past years has seen hardly any progress. While there have been many failures, there has been no effort to improve or modify the design because of the following handicaps:

- lack of adequate and appropriate skills on the part of the designers.
- unfavourable costs of new design and manufacturing methods.
- minimal competition available in product development.
- unavailability of accepted design standards.
- lack of adequate research facilities to support new innovations

3.0 The design facilities and technology for the huller has neglected the conventional practices. As previously mentioned, the technology has been fully adopted from foreign products and no further development in design has yet occured.

The design has remained closed from criticism and improvement as it has always been left to one person - the designer.

4.0 The drawings attached demonstrate the basic engineering geometry employed in the design. Sometimes, though the designs have been acceptable, further development has been hampered by a poor manufacturing base. For instance, a worm spindle may not come ut clearly during manufacturing.

The following discussion raises a few aspects in the design of the huller that would definitely need to be developed further to optimize the huller productivity.

4.1 Hulling worm and chamber geometry.

The hulling effect is achieved by rubbing the surface of the maize between the spindle and the chamber. The stripping of this skin is supported by the moisture amount in the maize. In reality the dehusked maize should be immediately extracted from the system through a screw movement of the spindle. However owing to manufacture problems this movement is not distinctly affected. A similar movement could easily be achieved through tapering or offsetting the spindle; but the problem lies either in the under or overhusking of the maize.

4.2 The discharge mechanism also need to be further developed. The present design extracts the husks through a crudely made sieve. The sieve is manufactured from a perforated iron sheet and is made into a semi-cylinder inserted below the chamber. The system's pressure forces out the husks. The discharged maize still contains a fraction of the waste owing to some inefficiency in the above stage. A blower is provided at the product outlet to suck out the excess husks. Despite efforts, the end product still contains husk rudiments, which are manually removed.

4.3 The dehusking mechanism must incorporate some particle-size control. During dehusking some of the maize grains are crushed in the local huller. The crushed material may amount to 50 percent of the finish product. In the worst situations, an invariable power drive makes the control extremely difficult.

5.0 The above captioned discussions convey some of the solutions or further developments required in the present huller in this paper.

5.1 The rate of progress or further development of the huller design in this respect may partly be attributed to the source of technology and to some extent to the cost sensitivity of any design and manufacturing changes. As this is an adopted technology, the level of innovation by the local design is low. As long as there is some performance achieved, the designer will tend to be complacent.

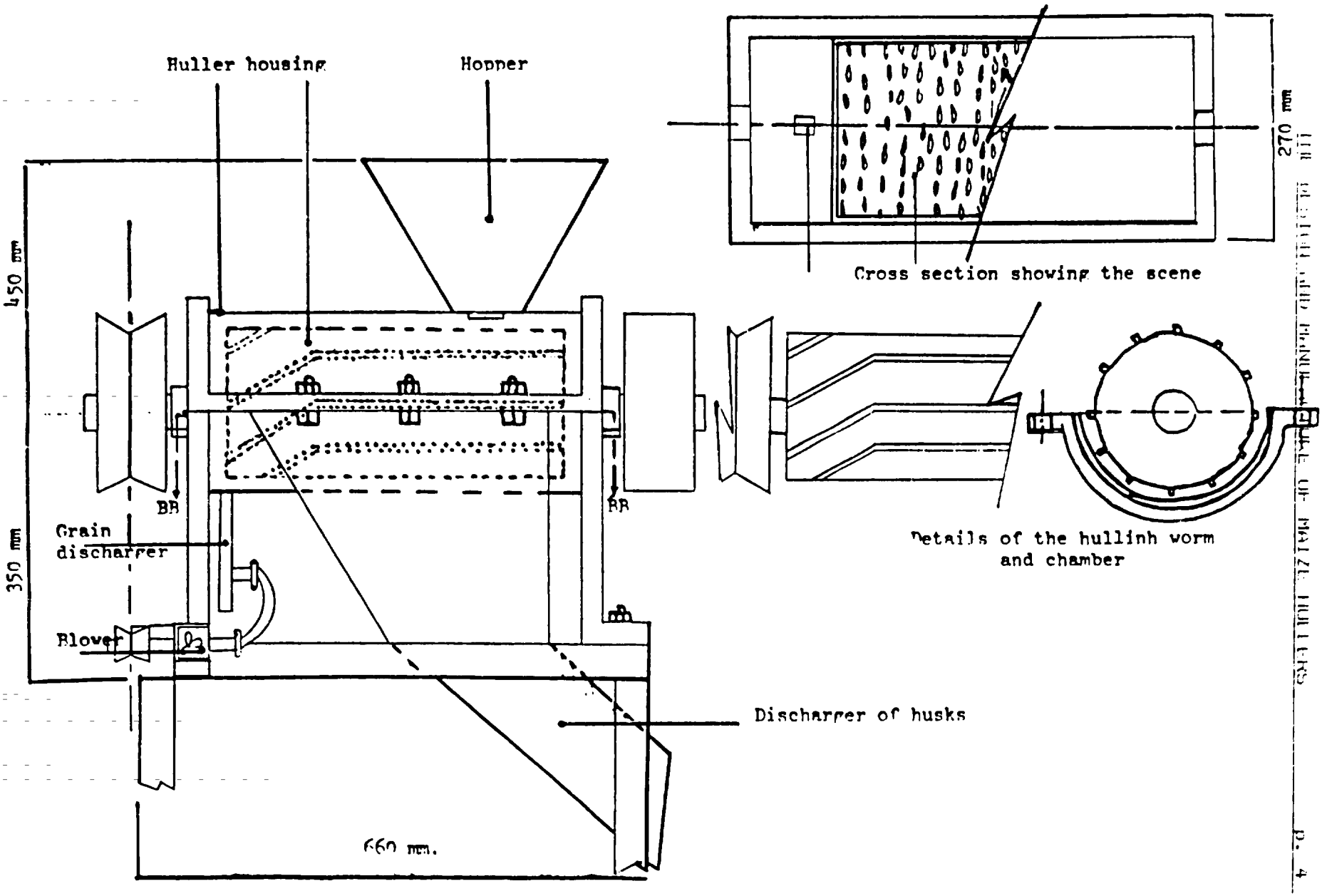
Probably the recommended approach to designing food processing equipment is to employ the indigenuous technology which are normally simpler and dependent on local raw materials. In this case, one could still look at the traditional pounding of maize as a hint to some design innovation.

5.2 The huller should incorporate some systems to control the rate of discharge and consistency of the grain size. The control could also assist in decreasing the rate of waste discharge.

5.3 The huller cannot be easily maintained at the village level, where such equipment is in great demand. Maintenance is restricted by the manufacturing principle employed: 80 percent of the componentry is iron casting.

6.0 To summarize the discussion, the present huller has undergone no further development because of the poor approach to design, development and manufacturing. An extra effort could easily elevate the design so that a higher production yields a finished product. The promotion of design and manufacturing must be institutionalized so that there are skill-training and research facilities within the reach of the innovators and designers.

THE MAIZE HULLER



Introduction.

Molasses is the by-product of processing sucrose in cane refineries. It is the final effluent and residual syrup from which no crystalline sucrose can be obtained by simple means. The final molasses from the centrifugal plant is a very heavy and viscous syrup with a composition, shown on table 1, that varies with soil and climatic conditions. The estimated quantity of molasses produced in Sudan in 1985-1986 was approximately 2.0 million tons. Very little of this quantity was utilized and the rest was discharged into the rivers.

Usually molasses can be diversely utilized. For example, it can be used as fertilizer, animal feed, and indirectly for the production of spirits, alcohol, vinegars, acetic acid and baker yeast.

The Finsugar and Zuzucker processes are two such well known methods of chemically and physically recovering sugar from molasses. It seems, however, that these processes for desugarization of molasses are more expensive than the ususal methods for refining sugar cane and beet juice. At present, sugar is a rare commodity in Sudan. Although Sudan produces and imports sugar, the supply is still short of demand. Sugar on the black market sells for prices ten times that of the usual price. Therefore in places like Sudan, it is worthwhile to tackle the molasses to increase the availability of sugar.

The objective of this research is to investigate ways to utilize molasses to obtain a syrup fit for human consumption.

Desugarization of molasses.

To render the raw molasses fit for human consumption some of its constituents must be removed. These unwanted constituents are mainly inorganich ashes. Table 1 shows the nature and quantities of these metallic ions.

Although the sugar can be removed chemically from molasses by precipitation methods, these methods are not yet recommended in industry because, they need further removal treatments of chemicals unpermissible for human consumption, like $Ba^{2+}$

This process utilizes chromatography as a physical method for the purification of sugar in the molasses. The process utilizes ions-exchange chromatography for separation.

Description of the preparative apparatus

In this research the apparatus used for desugarization of sudanese molasses was a simple glass column of the dimensions 750 mm x 50.8 mm Ø. The column was packed with a cation-exchange resin charged in Ca2+ form as shown in figure 1. A molasses solution of 5 % w/v was prepared.

A suitable amount of active carbon was added to decolorize the molasses solution. The solution was then filtered and fed to the top of the column. Afterwards the molasses was followed by an eluent (water). Both penetrated downward through the resin bed under gravity. The resultant solution was collected and then analized for the presence and quantities of metallic ions. The theory behind the separations process is that the chromatographic column with an ion-exchange resin acts as an ion-exchanger, an ion-exclusion and a gel-permeation to selectively separate metallic ions and colloids from the molasses.

Results and discussions

The analysis of sudanese molasses before and after elution through the column was performed by Flame Emission Spectrophotometry (AAS). FES was used for the determination for K+, Na+ Ca2+, while AAS was used for Mg2+, Fe3+, Hg2+ and Pb2+. The result is tabulated in table 2. From the figures shown, it is clear that a notable and sometimes complete elimination for monovalent ions like K+ and for the ions like Ca2+ and Mg2+ took place. Less deionization resulted in the case of trivalent ions like Fe3+.

Scaling up of the processing

Figure (2) shows a suggested sketch of a process that is designed to desugarize molasses based on the findings of the column chromatography used in this work. The dimensions of the units of the suggested process depend on the amount of molasses produced by the refinery.

Conclusion

The process proposes to solve a present sugar crisis in the Sudan. The product of the process can serve as a thick sugar syrup in beverages and confectioneries, thus saving the crystalline sugar for other needs.

**TABLE 1**

**CAN MOLASSES COMPOSITION**

| Constituent | Per cent |
|---|---|
| Water | 20 |
| Sugar | 62 |
| Organic ashes (nitrogenous) | 10 |
| Inorganic substances | |
| $SiO_2$ | 0.5 |
| $K_2O$ | 3.5 |
| CaO | 1.5 |
| MgO | 0.1 |
| $P_2O_5$ | 0.24 |
| $Na_2O$ | --- |
| $Fe_2O_3$ | --- |
| Silica | 1.6 |
| Chlorides | 0.4 |
| | 100.00 |

TABLE 2

AMOUNT OF METALLIC IONS IN SUDANESE MOLASSES BEFORE AND AFTER ELUTION

| Ions | Amount before elution (PPM) | Amount after elution (PPM) |
|---|---|---|
| $Na^{+}$ | 708 | 7.0 |
| $K^{+}$ | 550 | 0.0 |
| $Ca^{2+}$ | 495 | 29.0 |
| $Mg^{2+}$ | 445 | 1.6 |
| $Pb^{2+}$ | 2.6 | 1.4 |
| $Hg^{2+}$ | 6.27 | 5.67 |
| $Fe^{2+}/Fe^{3+}$ | 37.0 | 2.59 |

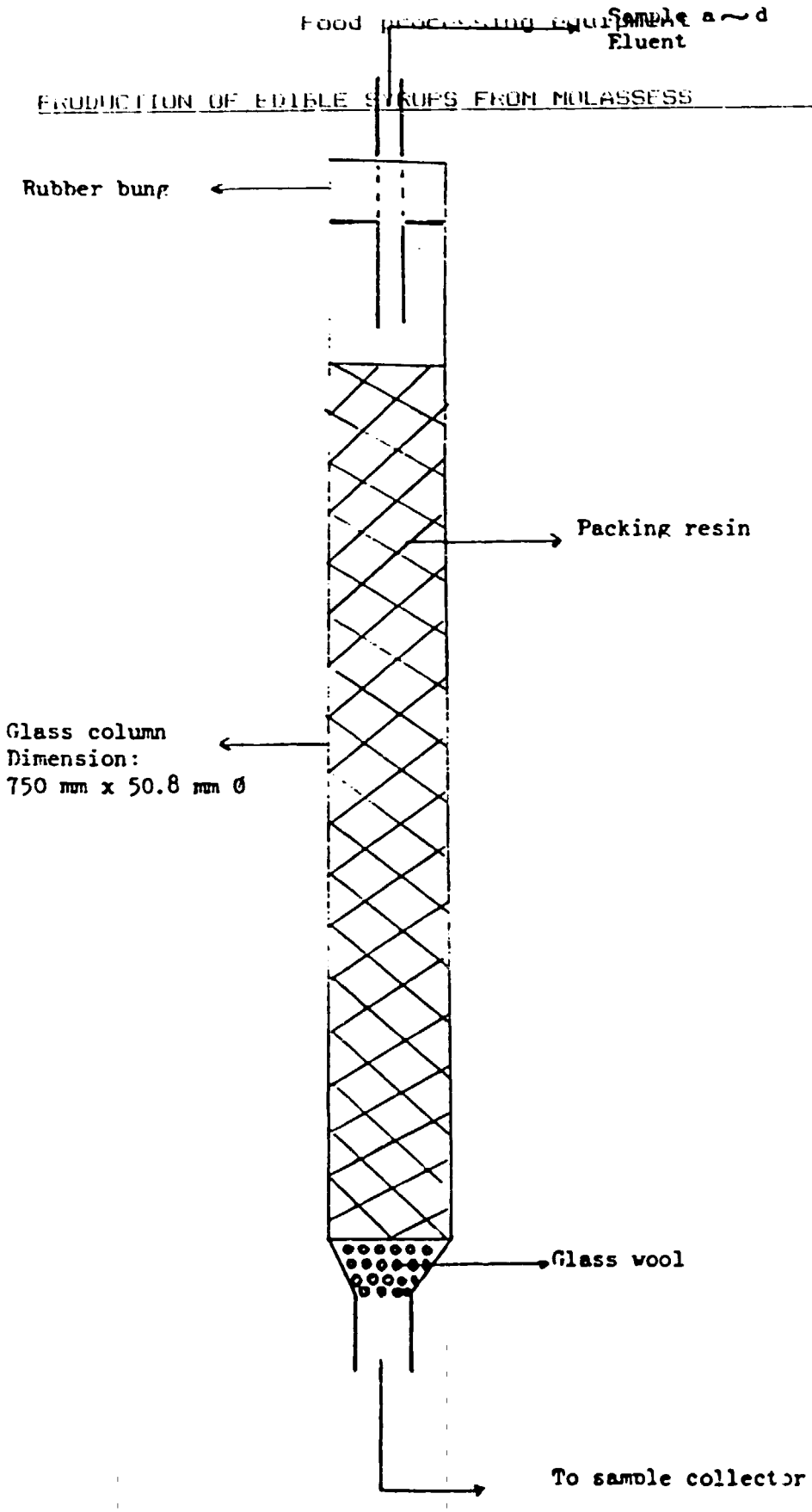
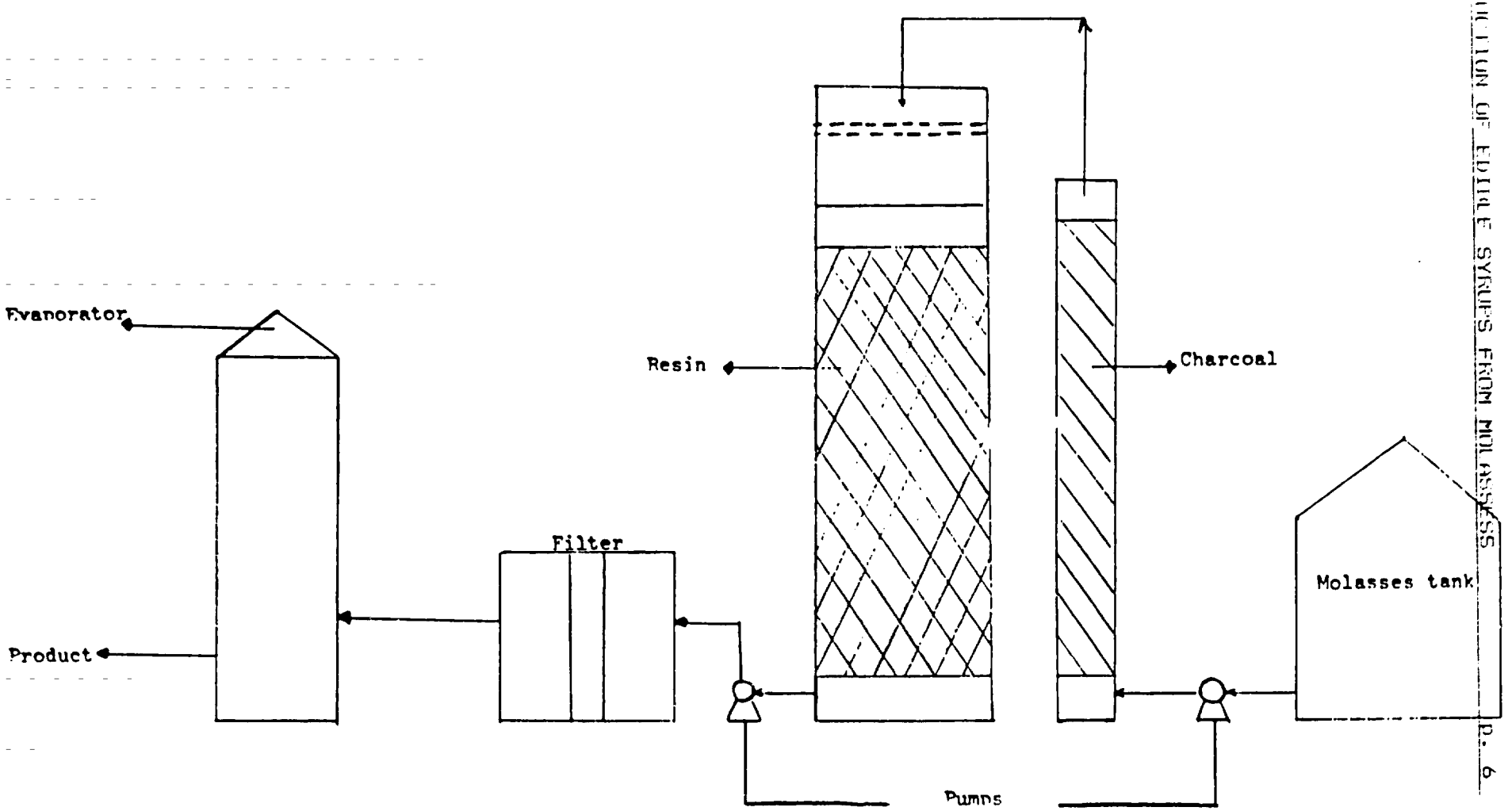



Figure 1: CHROMATOGRAPHIC ION-EXCHANGE COLUMN

Figure 2: A BLOCK DIAGRAM OF A SUGGESTED DESUGARIZATION UNIT






Food processing equipment

FEASIBILITY OF EDIBLE SYRUPS FROM MOLASSES

A LOCALLY MADE STONE MILL p. 1

## Introduction.

The processing of food grain plays an important economic role in Sudan for two reasons. Firstly, processed grain food is a very important element in the diet of a low income groups, especially in urban areas where there is no equipment to perform the basic processing of agricultural and animal products. Secondly, the use of appropriate technologies to process the grain may further achieve socio-economic objectives, such as employment generation and the saving of scarce foreign exchange.

The stone mill is an example of locally manufactured equipment in Sudan. It has been constructed in a private machine shop. To have locally manufactured equipment, there must be skilled manpower and good know-how, available raw materials and well equipped machine shops.

### 1. Skilled manpower and know-how

The beginnig of this century has witnessed the erection of the first machine shop in Sudan. The purpose of that machine shop was to produce essential spare parts and machine elements for Sudan Railways. Accordingly, a technical school was opened to provide skilled, trained manpower to the machine shop. This machine shop influenced industrial development in the Sudan. There are now more than 100 secondary technical schools and 25 high-technical Institutes. Four engineering Colleges have been established, as a result of this development, skilled manpower has exceeded the local demand.

### 2. Availability of raw material

Cast iron, brass and mild steel are not the most common materials required in machines and in the equipment manufacture. Recently several foundries heve developed to meet the demand of local industry. Electric furnaces have gradually replaced the diesel ones; overhead cranes have replaced the manual operation of materials. These developments in foundries have eliminated the problems of cast iron and brass. Only mild steel is imported.

## 3. Machines and equipment

The government organized well-equipped machine shops to cover the needs of big governmental enterprises, such as, Sudan Railways, Sugar Plant and El Gazira Board. These shops do not include the manufacture of food processing equipment. Fully stocked machine shops handling such equipment are found in the private sector.

## Design of food processing equipment

Many food processing operations frequently require the breakdown of solids through the application of mechanical forces. One such mechanical force is cereals milling.

The size reduction of solids generally involves three types of forces. Those predominating forces in commonly used mills in the food industry are summarized below:

| Force | Principle | Machine |
|---|---|---|
| Compressive | Compression (nut cracker) | Crushing rolls |
| Impact | Impact (hammer) | Hammer mill |
| Shear(attrition) | Attrition (grindstone) | Stone mill |

The third type of force is extensively used in machines for the comminution of softer nonabrasive materials of smaller sizes, i.e. fine grinding.

## Milling techniques used in Sudan

The three distinct milling techniques used in Sudan are:

1. the motor-and-pestle technique used in the household.
2. the engine-powered hammer mills and stone mills, equipped with diesel or electric motors, used by custom mills and merchants mills to produce whole meal; and
3. the roller mills ( this paper discusses the grain stone mill).

## Description of stone mills

In a typical stone mill, a conical or pyramid-shape holds the whole grain, which enters the milling chamber through a feed valve. In some models, a shaking device and a screen prevent large impurities from entering the milling chamber. The shearing action of the flat surfaces of two identical millstones performs the milling of the grain. One stone is fixed to the milling chamber while the other stone is mounted on a rotating drive shaft, connected to an external energy source (e.g. an electric motos, diesel or tractor engine). figure 1 illustrates the basic design of a stone mill.

The grain from the hopper is fed through the central hole in the rotating stone and then into the gap between the two stones. As the rotating stone moves against the stationary stone, the grain is ground as it travels from the centre to the periphery of the stones. The two millstones may be set vertically with a horizontal rotating shaft or horizontally with a vertical rotating shaft. The diameter of the millstones varies according to the type and size of the model. Generally, because of the weight of the stones and the relative difficulty in supporting them in an upright position, vertical millstones are smaller in diameter (20-56cm) than the horizontal millstones (61-71cm)

The capacities of electric motors used in stone mills vary between 0.4-1.5 kw, according to mill capacity and the diameter of the millstone. The motor capacity governs the rotation speed of the millstones with a maximum speed of 600-800 rpm.

The amount of ground material depends upon the motor capacity, the rotation speed, the millstone diameter, the grain variety and the desired fineness of the ground material. The average output of a vertical stone mill is 80 kg per hour. Thus, the average output of stone mills varies between 33-1,600 kg/h, depending on the motor capacity, the position (vertical or horizontal) and diameter of the millstone, the type of grain and the required fineness of the ground material.

Millstones are made out of one of the following materials:

1. natural stones;
2. small pieces of natural stones embeded in a matrix of cement or other suitable material, such as emery;
3. artificial stones made of emery, carborundums or a mixture of these two materials embedded in a matrix of magnesium oxychloride cement; or
4. additionally heat-treated or vitrified carborundum for increased durability.

A supporting and protecting metal band encloses all stone types. They are grooved to allow the shearing of the grain, as well as to assist the movement of the grain to the stone periphery.

The casing of most stone mills is made out of cast iron.

Description and specifications of the Sudanese mill

An electric motor runs the mill through three V-belts. It has a vertical spine, which rotates the lower stone. The hand wheel of the spring tensioner raises or lowers the lower stone to control the fineness of the flour. The upper

stone is fixed and has a larger diameter than the lower stone. The Trading and Contracting Company locally manufactures the stones; the raw material (emery and carborundum) required is imported from Denmark. The mill has a stand with three legs made from mild steel iron angles, which are joined to the body of the machine by riveting and post welding. There are two outlets for flour. A feed control is there for the seeds supply, which has a vibrating butterfly flap.

Specifications

| | |
|---|---|
| capacity | 500 kg/hr |
| electric motor | three-phase, 10 hp, 1,500 rpm |
| pulley | 420 rpm |
| upperstone | 71 cm |
| lower stone | 61 cm |
| hopper | 58 x 68 cm. made from a 1.2 mm mild steel sheet |
| lower case | 74 cm diameter x 32.5 cm height made from a 1.2 mm mild steel sheet |
| stand | 6.5 cm mild steel angle and 4 x 8 cm. iron U-section. |

Note

Cast iron parts, such as a main spindle hub, roller bearing guide and top bearing case, are produced in local foundries.

Figure 1 (vertical stone mill) and 2 (horizontal stone mill) show the parts of the locally made stone mills.

Evaluation

The evaluation study of locally manufactured stone mills was performed by a team from the Industrial Research Consultancy Service (IRCC).

A comparison of the operation, the efficiency and the price of the locally manufactured stone mill with that of an imported one having the same specifications, from Denmark shows:

1. The price of the locally manufactured stone mill was LS 8,000. The price of the imported mill was LS 9,600;
2. The degree of fineness of the product was the same;
3. The locally manufactured mill was more stable (less vibration) during operation; and
4. The locally casted thrust bearing had a longer lifespan than that of the imported mill.

Conclusion

The proper running of custom mills depend on an efficient, organized production and an available, adequate infrastructure.

1. Skill requirements

The running of milling equipment requires skills, which may be quickly learned, for example, on the job training. The mill operators need only know how to adjust the mill for grain processing. On the other hand, the repair and maintenance of the equipment require mechanical skills and in some cases, a minimal knowledge of electricity.

2. Infrastructure requirements

Generally, infrastructure requirements depend on the type and capacity of the mill as well as on the need to store the raw materials and/or output. Depending on the adopted engine, mills may require an electric supply line or a petrol/diesel storage area.

The installation buildings for milling equipment and the storage areas should be well ventilated since the milling process generates a large amount of dust. There should be adequate roofs to protect the grain or flour from rain. The buildings should have cement floors to minimize flour contamination by sand or dirt and to facilitate the cleaning of the floor.

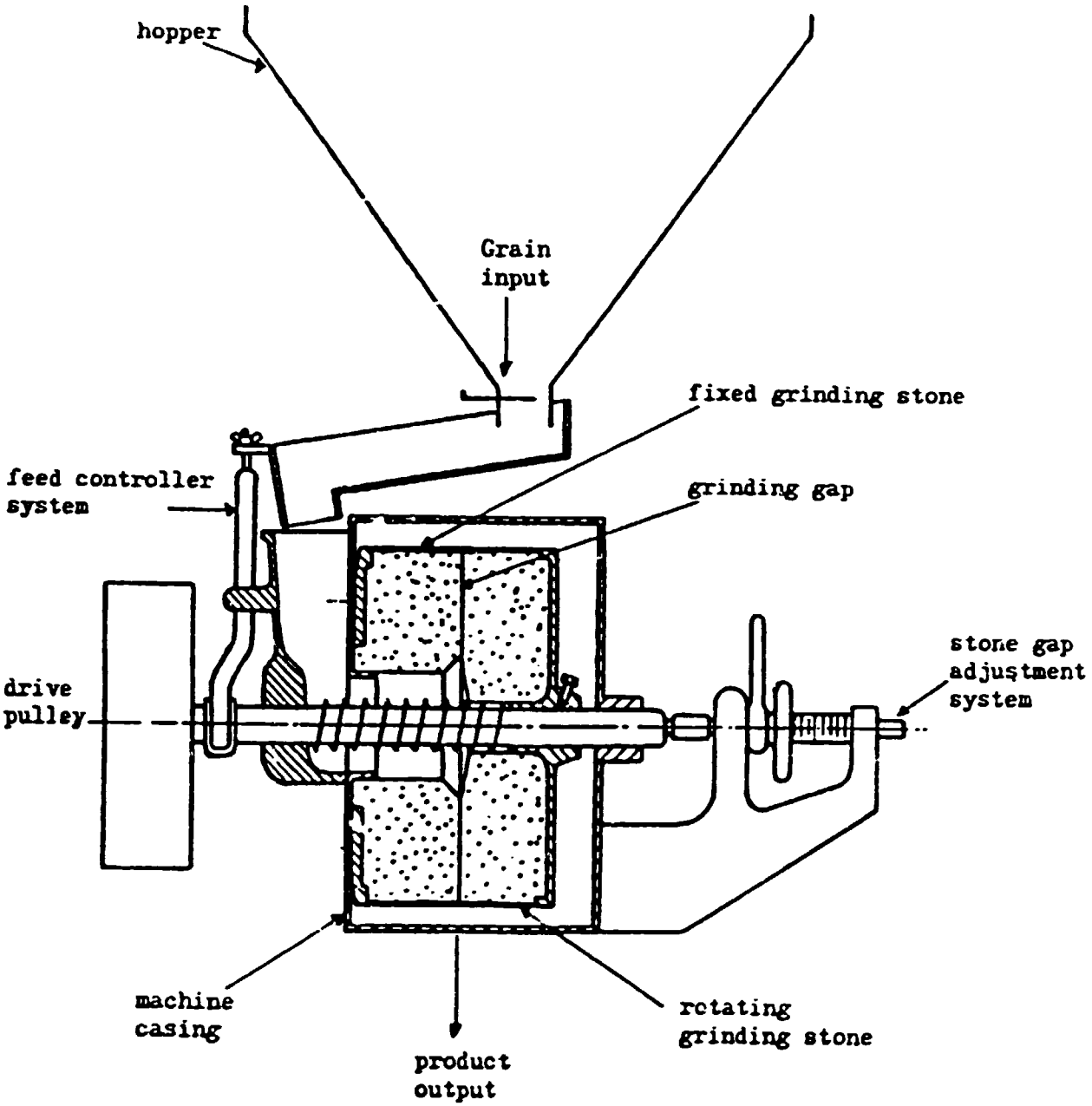



Figure 1

Diagrammatic representation of a mechanical stone mill with vertical grinding stones

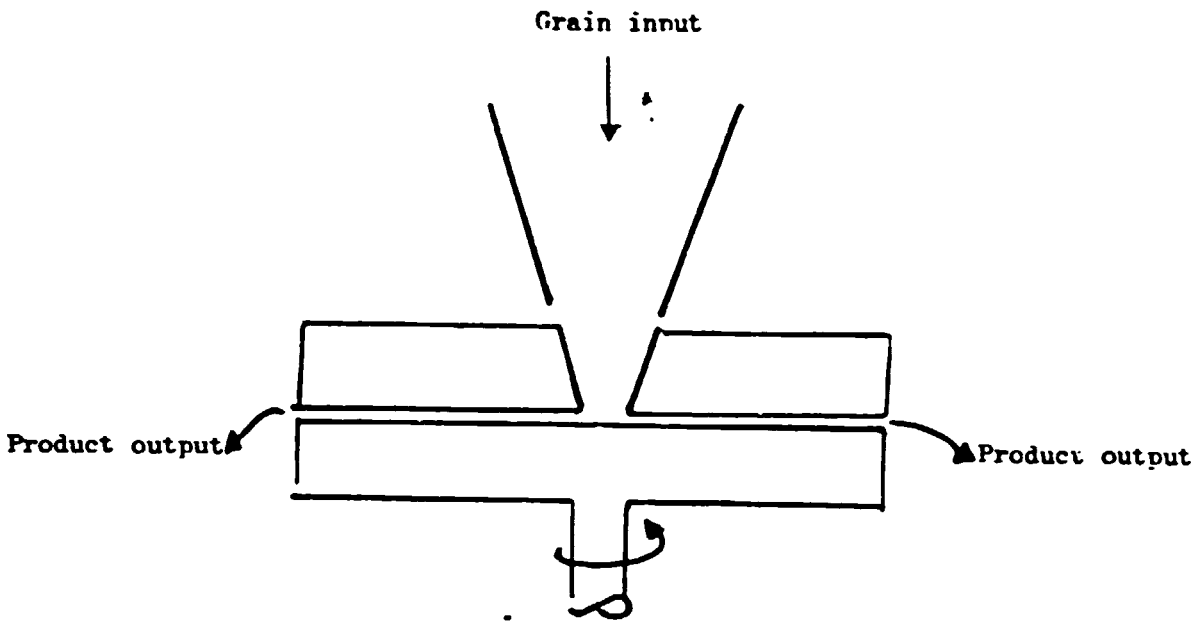



Figure 2.1 Stone mill diagram

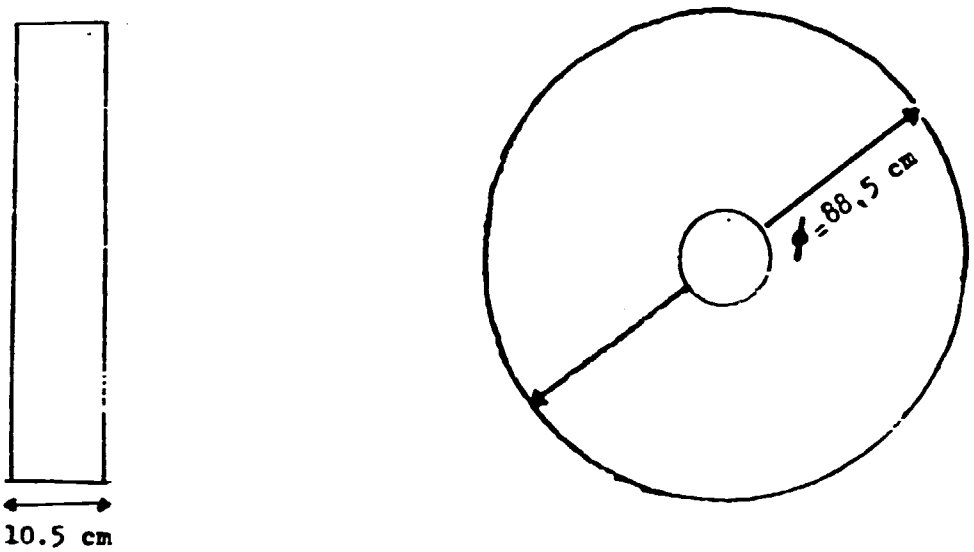



Figure 2.2

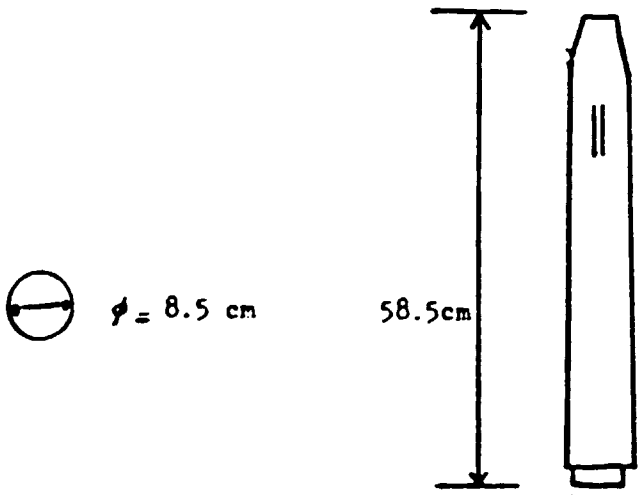
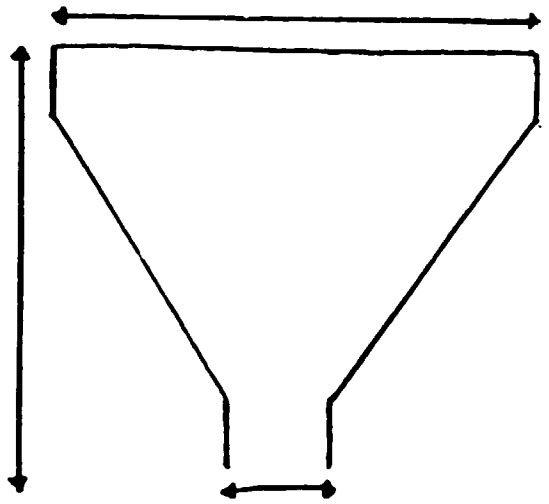
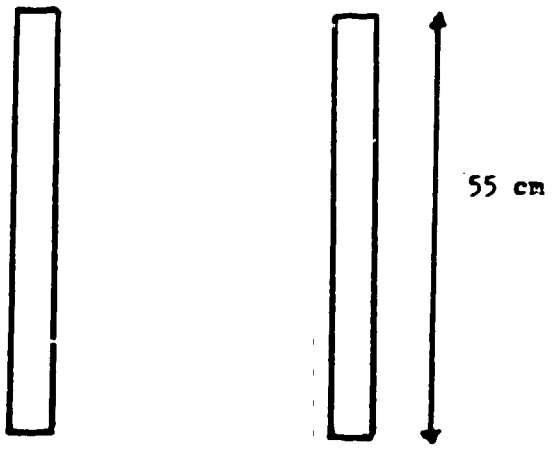



Figure 2.3 Shaft

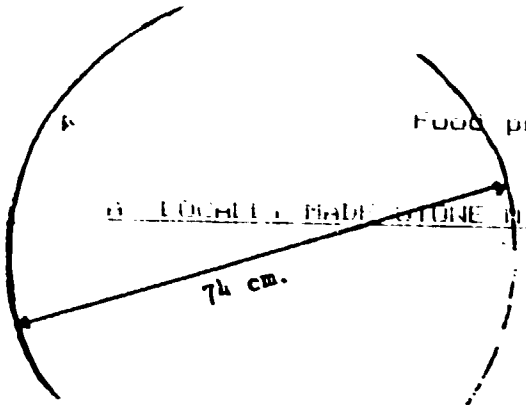


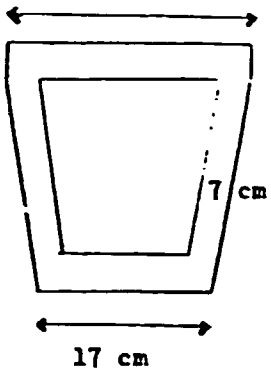
Hopper




Hopper holding plates

Figure 2.4 Hopper



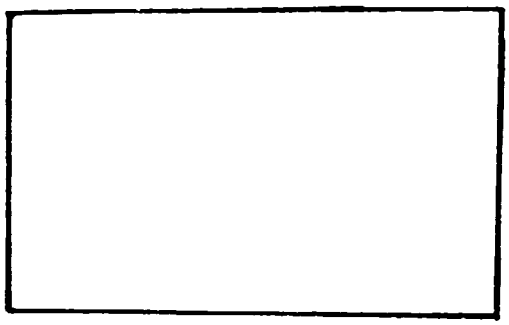



Figure 2.5 Seen from botton
(Lover facing)

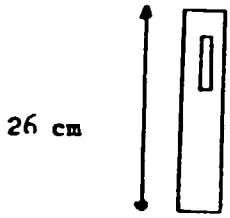
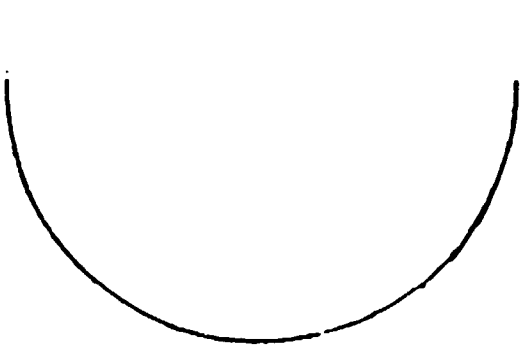
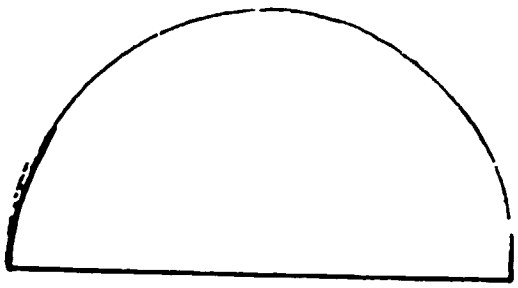
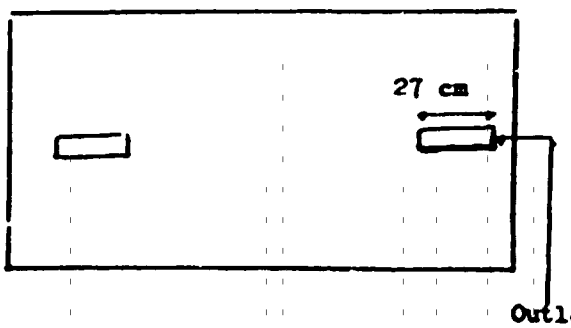



Figure 2.6 Flour outlet







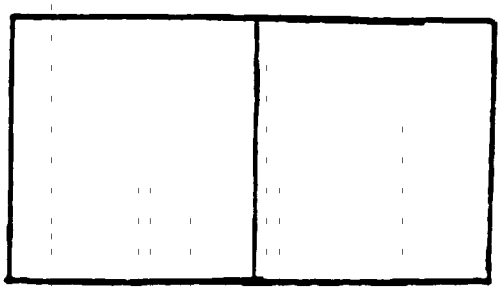



Figure 2.7 Flour outlets

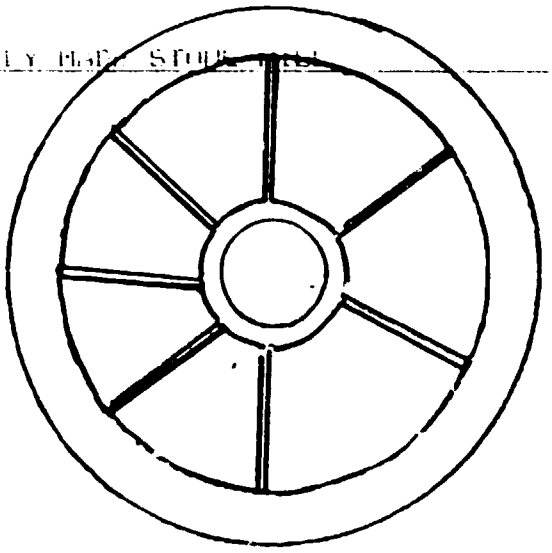


Figure 2.8 Stone wheel

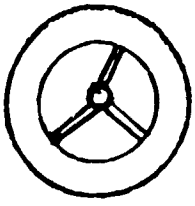


Figure 2.9 Tensioner and spring

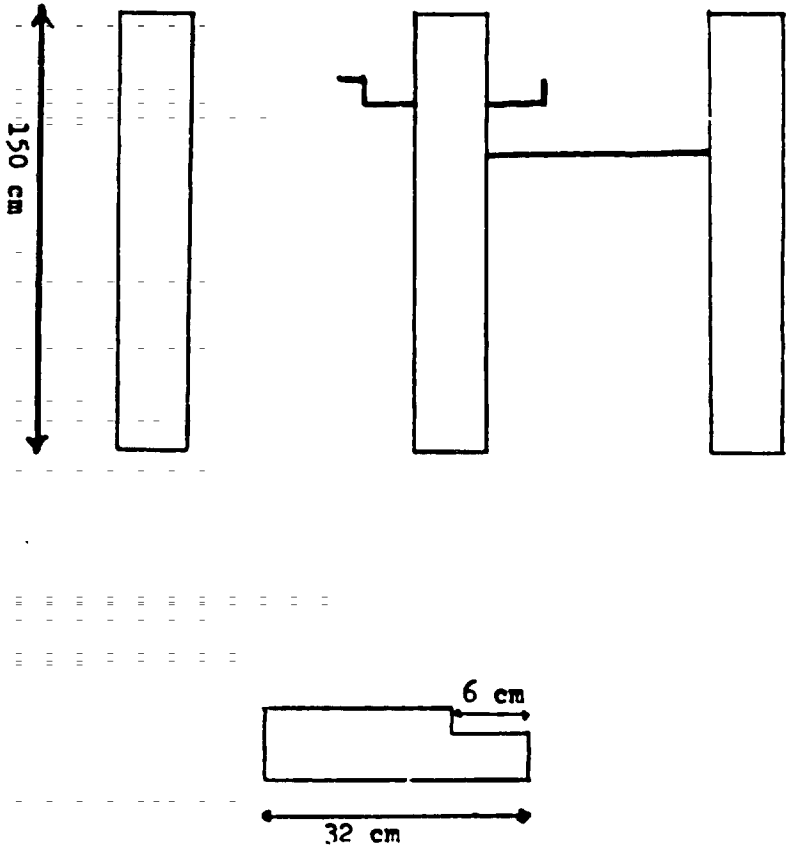



Figure 2.10 Supporting stand

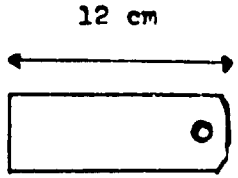



Figure 2.11 Stone fixing plate

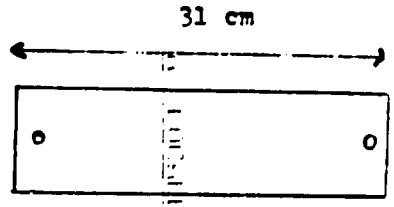



Figure 2.12 Guide

1. Introduction:

Uganda recognizes the need for developing their own industry to produce food processing equipment, to satisfy their local needs, the government is making efforts in this direction, promoting the development of small scale industries.

Several pieces of agricultural equipment has so far been developed, as declared by their promoters, being especially abundant in the country the food processing equipment, however, very few developments have been accomplished for food preservation.

This report deals about some of those designs developed and produced in Uganda: a Hammer Mill and a Ground Nut Sheller.

HAMMER MILL.

(for maize, millet, cassava, etc.) see appendices 1.1, 1.2, 1.3, 1.4 and 1.5

This hammer mill is designed to suit any type of grain milling, The main body is essentially fabricated from galvanized heavy duty (3 mm thick) mild steel plates, with a central rotor hammer fitted on 2" Ø, self centering bearings. The average hammer mill can be connected to an electric or diesel motor of 11-15 kw (15-20 hp). Power transmission is supplied by a 3'B' section vee belt (or more depending on size) and the recommended speed is 3,000rpm. It has an output of 700-150 kg/hr, depending on the screen size and the moisture content of the grain in question. With a maize grain of 16 percent moisture content, 1,520 kg/hr of maize flour can be produced on a " m screen while a 1.5 mm screen will yield 780 kg/hr.

The hammers are made of a low-carbon steel, which is hardened and reversible, giving them four lines. Depending on the capacity of the mill, a different number of swinging hammers are fitted onto the rotor:

for 16 hp.....16 hammers;
for 26 hp.....32 hammers;
for 40 hp.....48 hammers.

Similarly the efficiency of the fan is improved by additional blades:

for 16 hp.....2 blades
for 26 hp.....4 blades
for 40 hp.....6 blades

Grain is fed by bulk or bag into the feed hopper. Pneumatic feed in the grinding chamber is controlled by a regulating duct. This duct controls smooth feeding simultaneously, allowing the operator to inspect the milled stuff for any impurities which may occur, i.e. stones, nuts and bolts.

## 2. GROUNDNUT SHELLER (see appendix 2.1)

This machine is designed to remove groundnut shells from the nuts themselves. For a long time farmers have removed by hand the nut meat from the shells. To lessen this laborious task, this machine has been desigred to increase production.

This is basically a manual operation. Dry nut shells are fed into the machine until it is 75 percent full. With a back and forth movement of the handle, the machine crushes the nut shells and in doing so, the resultant nuts and the shell fragments pass through the perforated grill base of the machine. The resultant mass is collected for easy separation by hand picking.

### Construction.

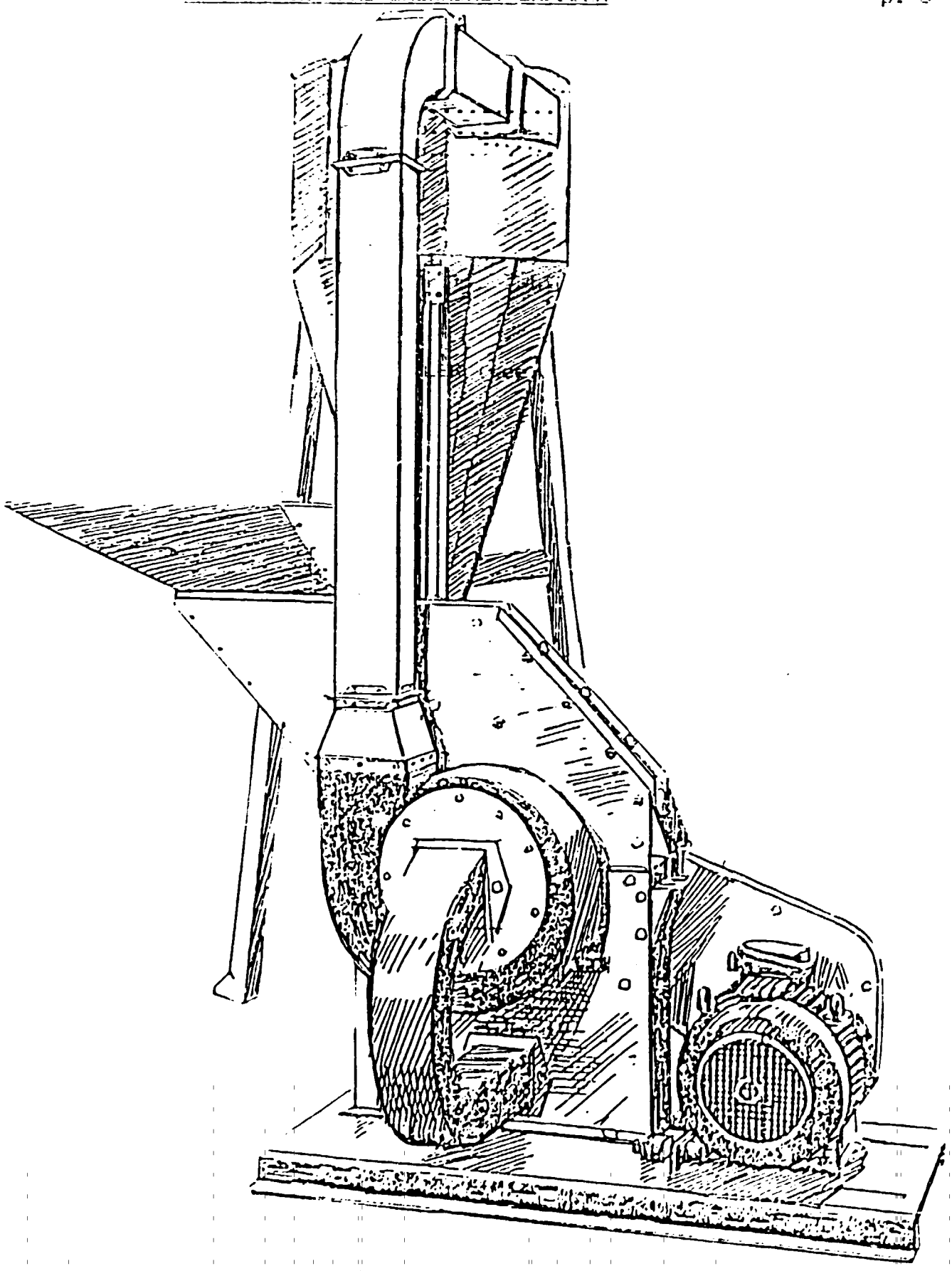
The body of the machine consists of a heavy, mild steel plate, 3 mm thick, while the bottom is made of mild steel flats of 1.5". The crusher is made of surface hardened steel rods of 8 mm diameter. The clearance between the crusher and bottom grill is 4-6 mm.

### Output.

For an eight hour working shift, one can crush an average of five to six bags of dried groundnut shells.

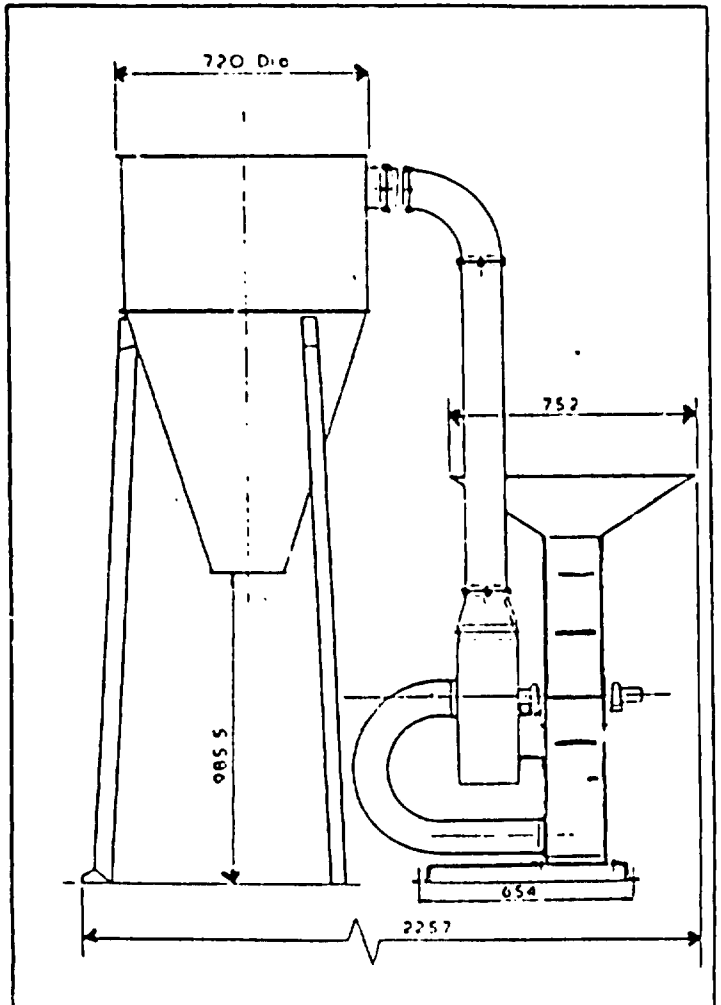
HAMMER MILL AND GROUNDNUT SHELLER



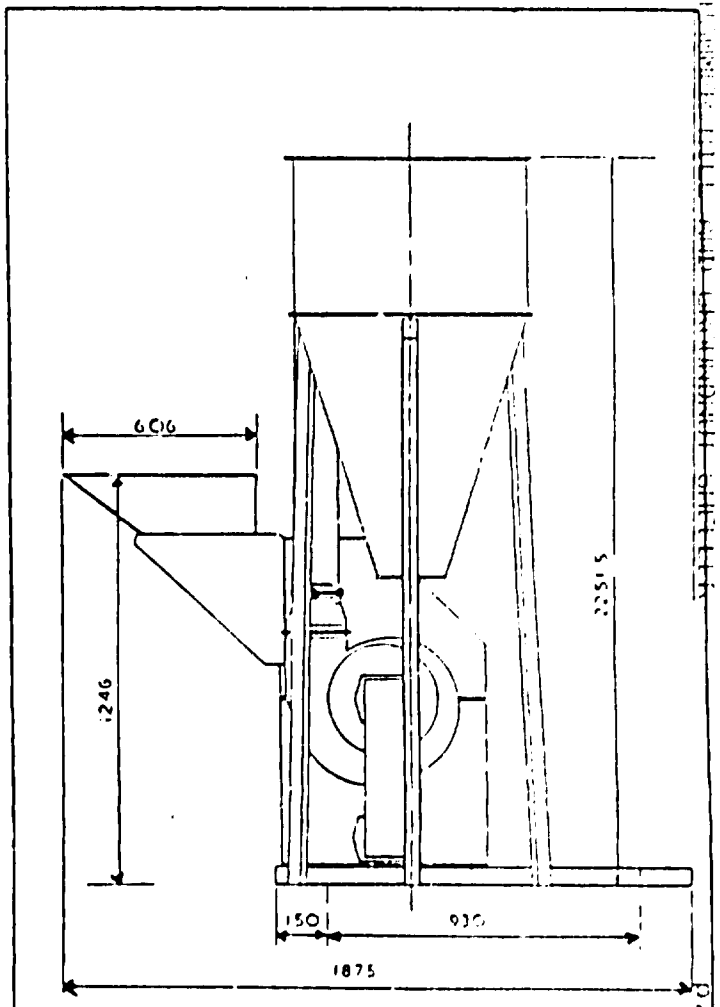


The mill should be firmly bolted to a flat solid base.

END ELEVATION



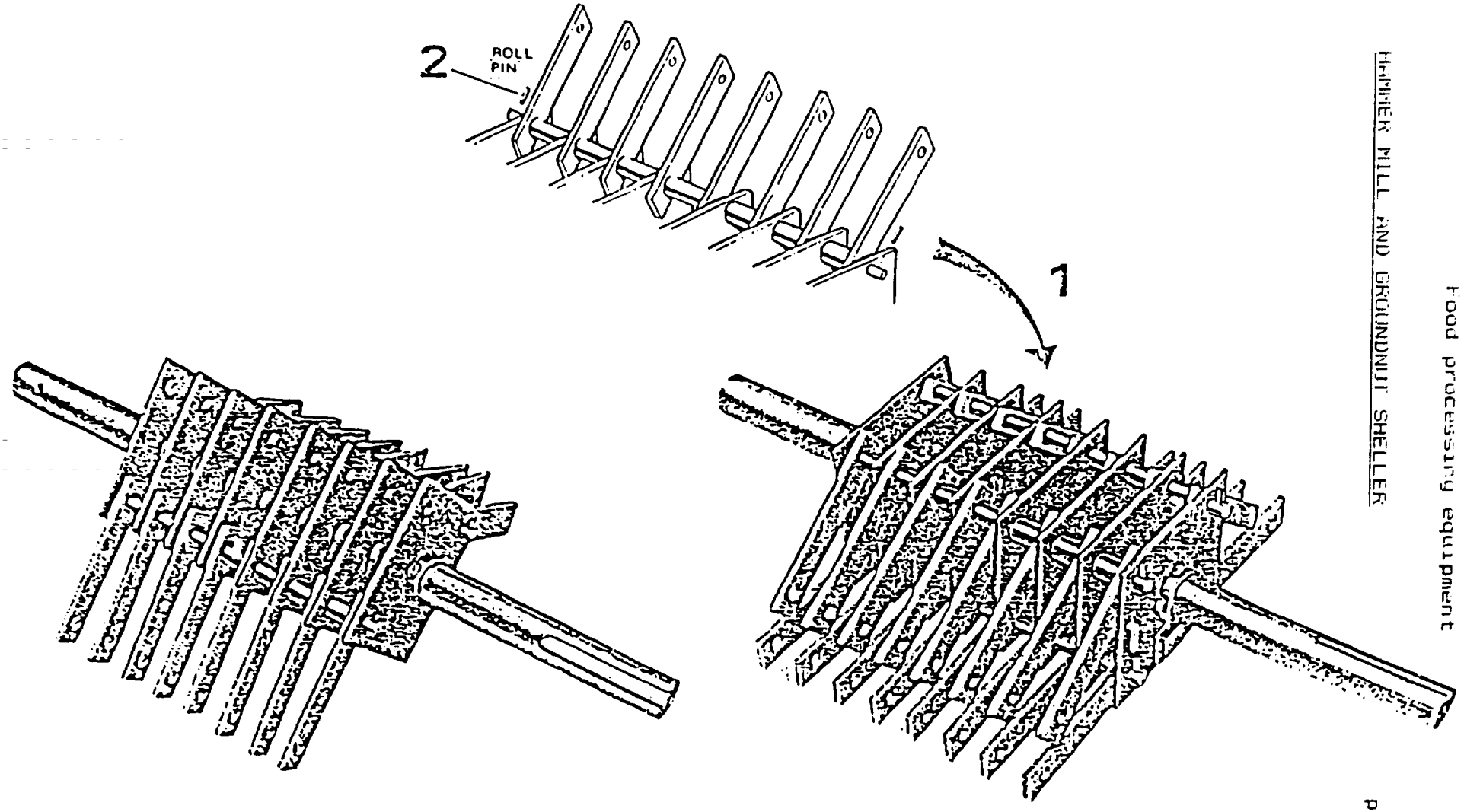

SIDE ELEVATION



# Rotor

APPENDIX 1.3





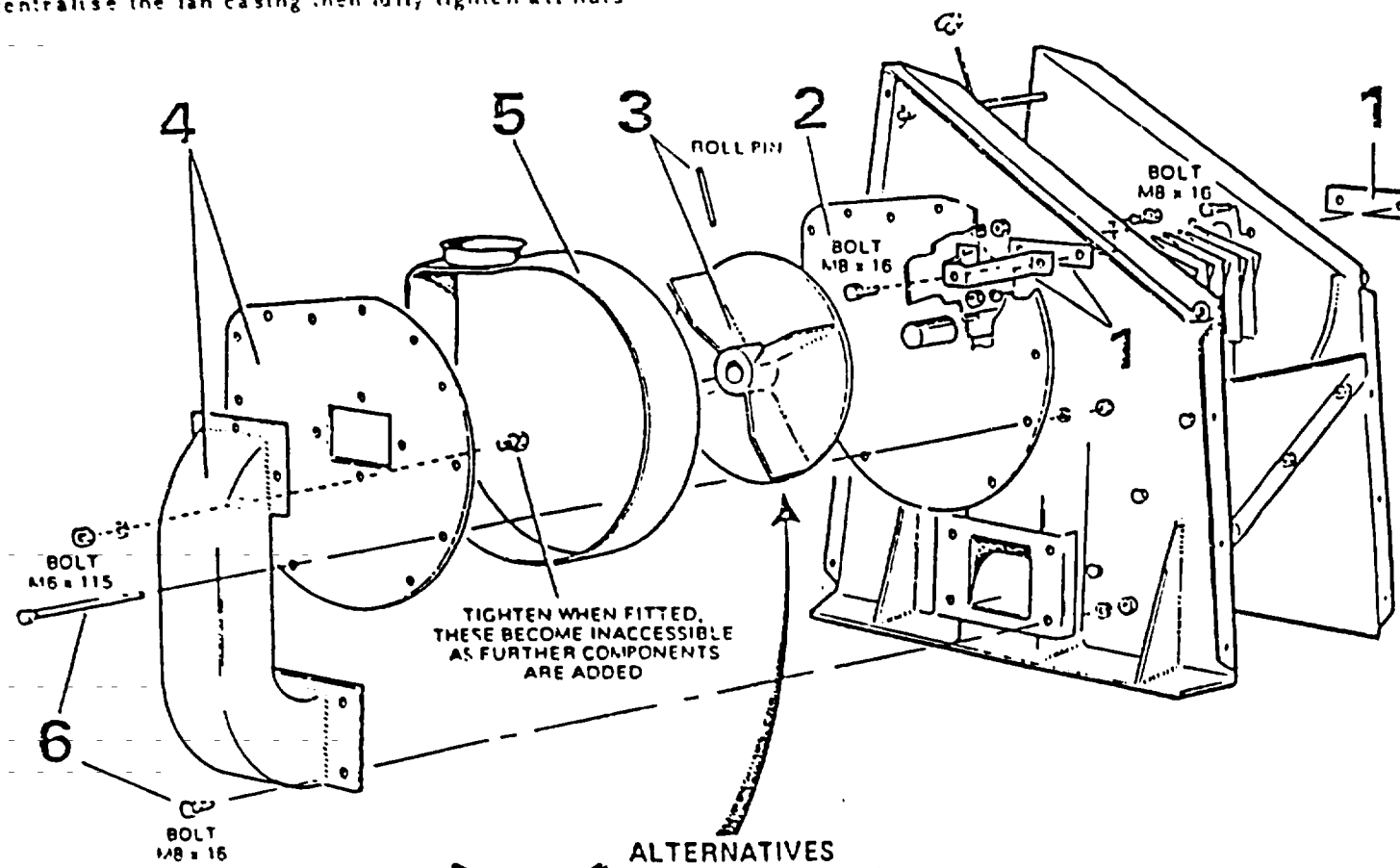

Rotor for 16 h.p. Mill

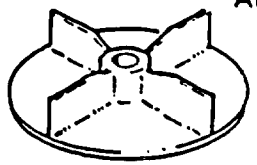
Rotor for 26 h.p. Mill

# Fan

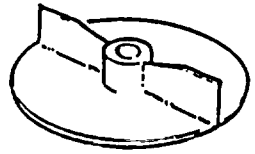
Assemble the fan and fan casing. During assembly the nuts at the end of the long bolts surrounding the fan casing should be left [illegible] tight. After all components are in place, centralise the fan casing then fully tighten all nuts

APPENDIX 1.h

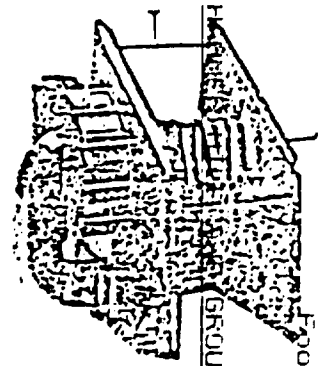


FAN FOR 2.6 HP MILL



FAN FOR 16 HP MILL

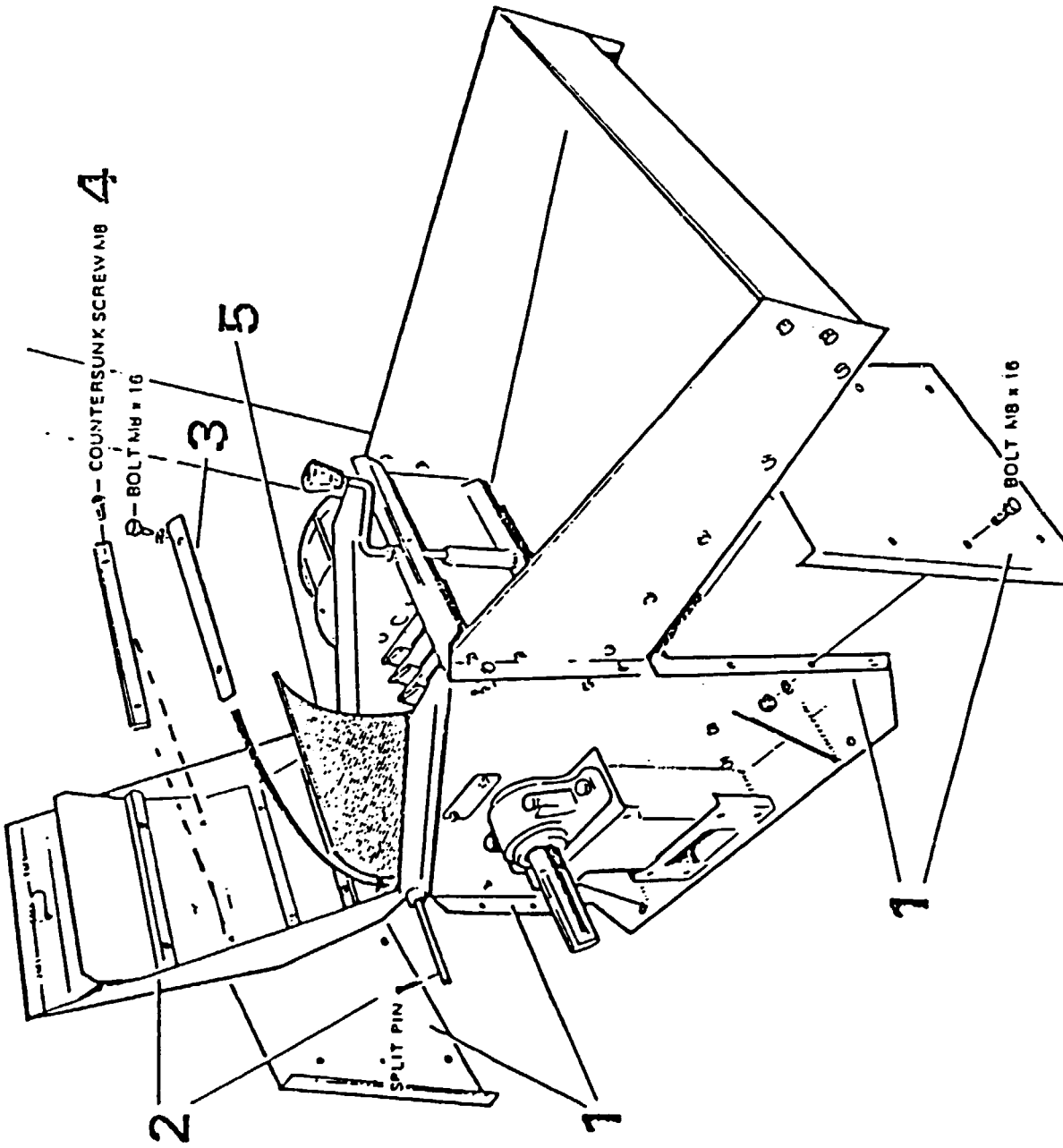


HARVESTING GROUNDNUT SHELLER

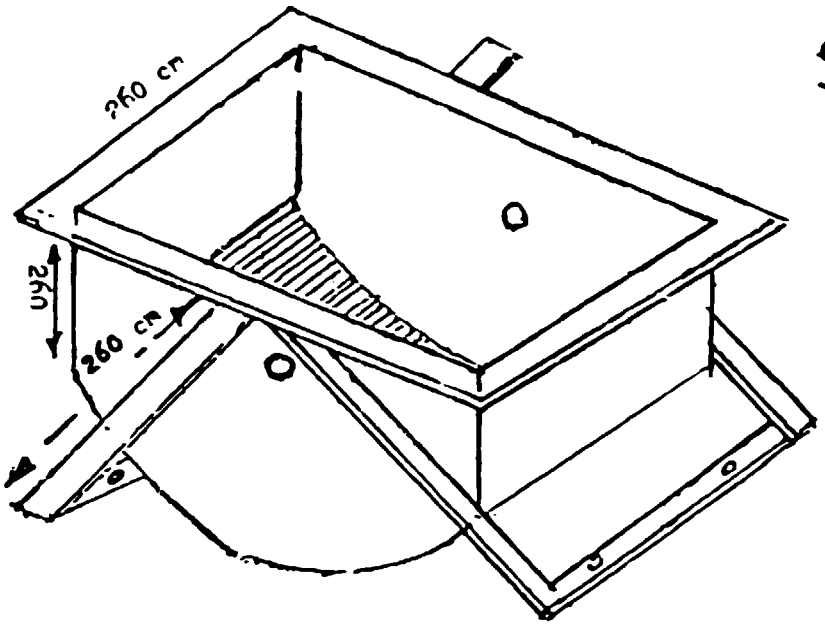
Food processing equipment

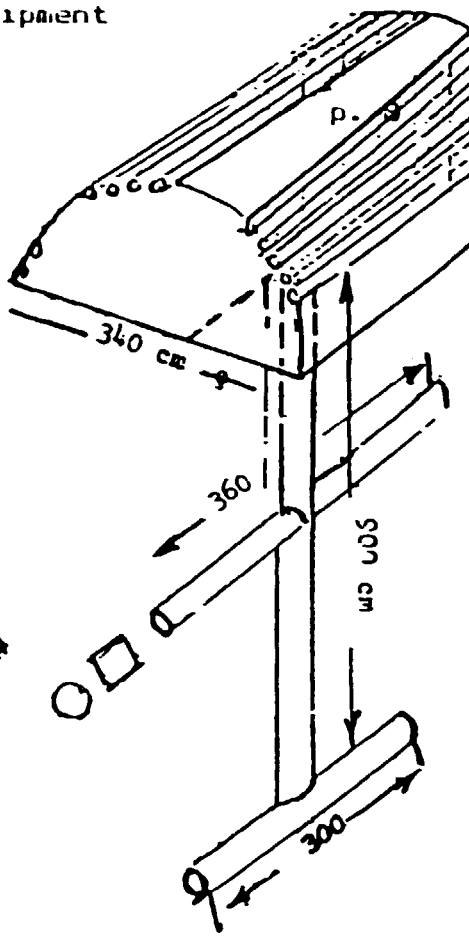
APPENDIX 1.5

## Cover, Panels and Screen



HAMMER MILL AND GROUNDNUT SHELLER




APPENDIX 2.1

A HYDRAULIC JUICE PRESS 

## 1. Introduction:

Studies conducted in Zambia at the National Council for Scientific Research (NCSR) have indicated that storage conditions of processed foods play a major role in either enhancing or retarding of nutrient degradation. Vitamin C (Ascorbic acid) in carbonated guava juice degraded from 35.1mg/100g to 2.8mg/100 g, i.e. 90 percent in 72 days, when stored at room temperature (20-25 deg.C): (i) results in a similar product by other scientists; (ii) indicatethat there would be only 5 percent degradation of the acid if the juice is stored at 0 to -5.deg.C. Sofisticated equipment such as freeze driers have led to an even greater improvement in retarding degradation of nutrients. Pulp from guava was freeze dried at NCSR laboratories. It was found that vitamin C had dropped from 225.28 to 222.64 mg/100g, (i.e. one percent degradation) in a one-week period, as compared to 152.4 mg/100g (32 percent) for the pulp stored under room temperature.

## 2. Choosing construction materials for equipment development.

In Zambia, development of food processing equipment has been hampered mainly by the lack of suitable local construction materials. The most readily available materials are wood (planks), mild steel and cast iron. Unfortunately, termites tend to attack wood unless it is treated. This, however, increases the cost of the materials and consequently of the equipment. Wood cannot withstand the high pressure involved in most food processes. In addition, it tends to soak water from juices thereby making it fragile. The expensive way to prevent this is to paint the wood so that it becomes water resistant.

Cast iron or mild steel are not recommended for most processing equipment since these materials are readily susceptible to rust and incapable of withstanding heavy loads. Stainless steel, which is not easy to find in Zambia, is recommended for fabricating food processing equipment.

Due to lack of stainless steel, wood was selected for fabrication of the juice press.

3. Effect of processing on nutrients in food.

In most cases food processing results in losses in food nutrients. Results from experiments at the Food Technological Research Unit (FTRU) of the NCSR, indicated a substantial loss in vitamin C in guavas (Psidium Guajava) after processing them through a hammer mill. The result showed a greater loss of the vitamin in the flesh than in the peels. The loss was more pronounced in the processed flesh and peels than in the unprocessed parts after a 14 day period in the cold room at 0 to -5.C.

TABLE ONE

Deterioration of vitamin C in processed and unprocessed guavas

| part of fruit | Vitamin C(mg/100g) | | | |
|---|---|---|---|---|
| | before processing | after processing | processed* parts | unprocessed* parts |
| peels | 275.6 | 270.2 | 188.3 | 243.1 |
| flesh | 189.0 | 171.4 | 10.5 | 36.7 |

* after 14 days of storage

JUSTIFICATION

The justification for fabricating a juice press include:

a. low cost of fabrication
Materials used are locally available and do not need foreign exchange. The metals used (channels) were picked from the scrap yard at the manufacturer's workshop.

b. Easy to operate
The equipment does not require specialized training to operate or even to maintain it. Its light weight makes transportation easier.

c. Cheaper than current methods of extraction
The current method of juice extraction from local fruits involves costs of clarifying agents, of filter aid and of electricity to run the filter press. See the process diagrams for the two different modes of juice extraction (diagrmas 1 and 2).

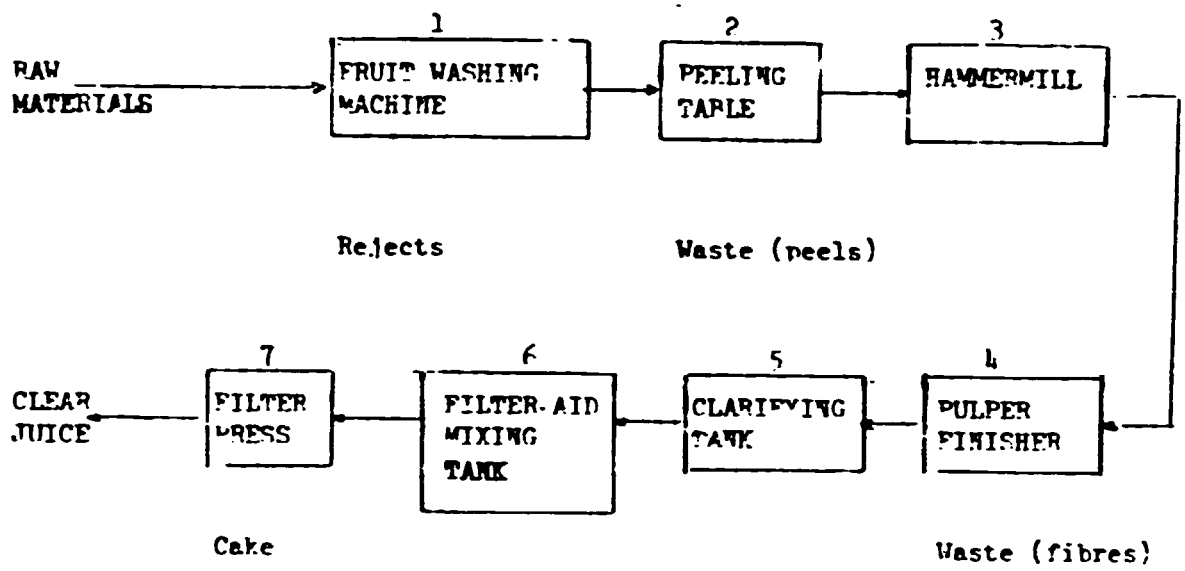



DIAGRAMME 1: CURRENT (EXISTING) PROCESSING STAGES

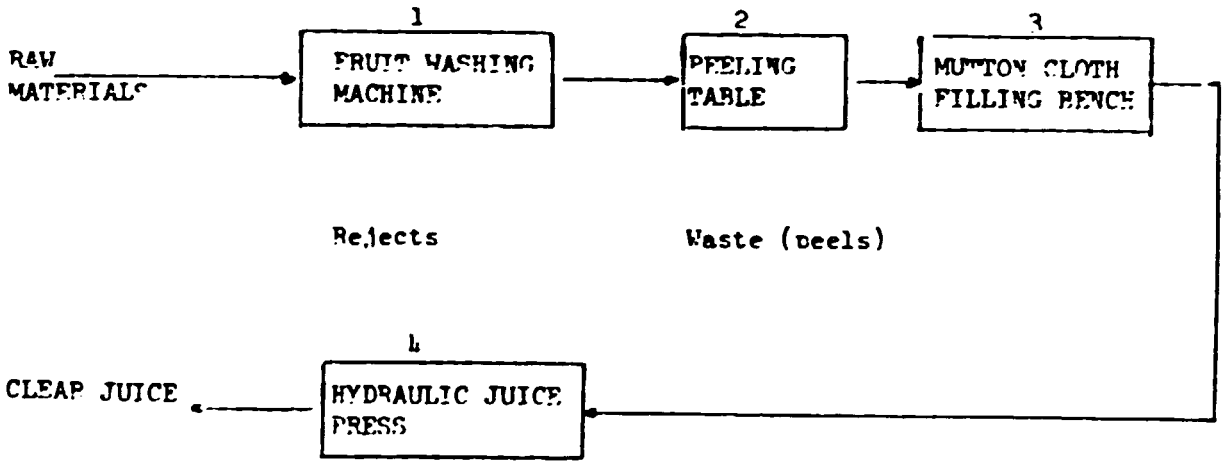



DIAGRAMME 2: MODIFIED (USING JUICE PRESS) PROCESSING STAGES

## FABRICATION OF THE EQUIPMENT

From the design drawings, the hydraulic juice press ( see drawing no. 1-A pictorial view of the press) was constructed. Timber bought from Zambia Forestry and Forest Industries Corporation (ZAFFICO) was used in making vertical and base supports, racks and the J-form. The cutting of the planks into required dimensions was done mostly at the manufacturer's Unit and partly by EW Tarry Zambia Limited. The dimensions of the used materials are found below:

| Material | Thickness | Width | Diameter | Length |
|---|---|---|---|---|
| Vertical supports | 5.1 | 10.2 | - | 91.6 |
| channels | 5.1 | 10.2 | - | 45.7 |
| Receiver | 7.6 | 35.6 | - | 35.6 |
| Receiver Pipe | - | - | 1.5 | 5.1 |
| Racks | - | 36.0 | - | 36.0 |
| J-form | - | 36.0 | - | 36.0 |
| guides | 2.5 | 10.2 | - | 45.7 |

Two channels of mild steel were collected from the scrapyard. These were cut to the required dimensions and used as press top and press base. Bolts (M12 x 200 mm) secured the channels to the vertical supports.

Racks were made from planks (36 cm long and 3.8 cm wide). To allow the juice to flow down, the planks were placed 1.5 cm apart. The receiver was made from stainless steel. A 5 cm long and 1.5 cm diameter stainless steel pipe was inserted into the hole made in the middle of the receiver.

The components were painted before assembling. The channels were painted with iron oxide primer to prevent rusting. Planks were painted with a white undercoat, then a pink primer and finally with a glossy white paint. The gloss white is widely used in food processing industries because it is non-toxic, acid resistant and impermeable to water.

## TESTING OF EQUIPMENT

Fifteen pineapples bought at the Soweto market were divided into three batches. The fruits were peeled, sliced into small pieces and then covered in mutton cloth. The covered pieces were placed between the J-forms and by using the hydraulic press, clear juice was extracted and collected from the receiver. The following results were obtained from the tests.

A HYDRAULIC JUICE PRESS

| Whole fruit (kg) | Peeled fruit (kg) | Juice (kg) | Percent juice extracted (kg) per whole fruit | per peeled fruit |
|---|---|---|---|---|
| 4.96 | 2.25 | 1.25 | 25.2 | 55.6 |
| 4.56 | 2.95 | 1.56 | 34.2 | 52.8 |
| 4.56 | 2.85 | 1.60 | 34.4 | 56.1 |

The average yield is 31.3 per cent juice per whole fruit or 54.8 per peeled fruit. The conventional methods used at NCSR (where clarifying agents have to be used) yield 44.6 per cent peeld fruit or 21.3 per cent per whole fruit.

OPTIMIZATION OF EQUIPMENT

Several parameters would be considered in optimizing the equipment to have the highest yield. One parameter considered was the particle size of the pineapple and its relation to the juice yield. The following results of the test conducted on different sizes of the pineapple pieces are shown below.

| Particle size | Juice yield |
|---|---|
| 4 x 4 x 4 cm | 58.4 |
| * 3 x 3 x 3 cm | 57.1 |
| 2 x 2 x 2 cm | 61.7 |

* most of the juice lost during the processing due to improper use of the equipment

CONCLUSION

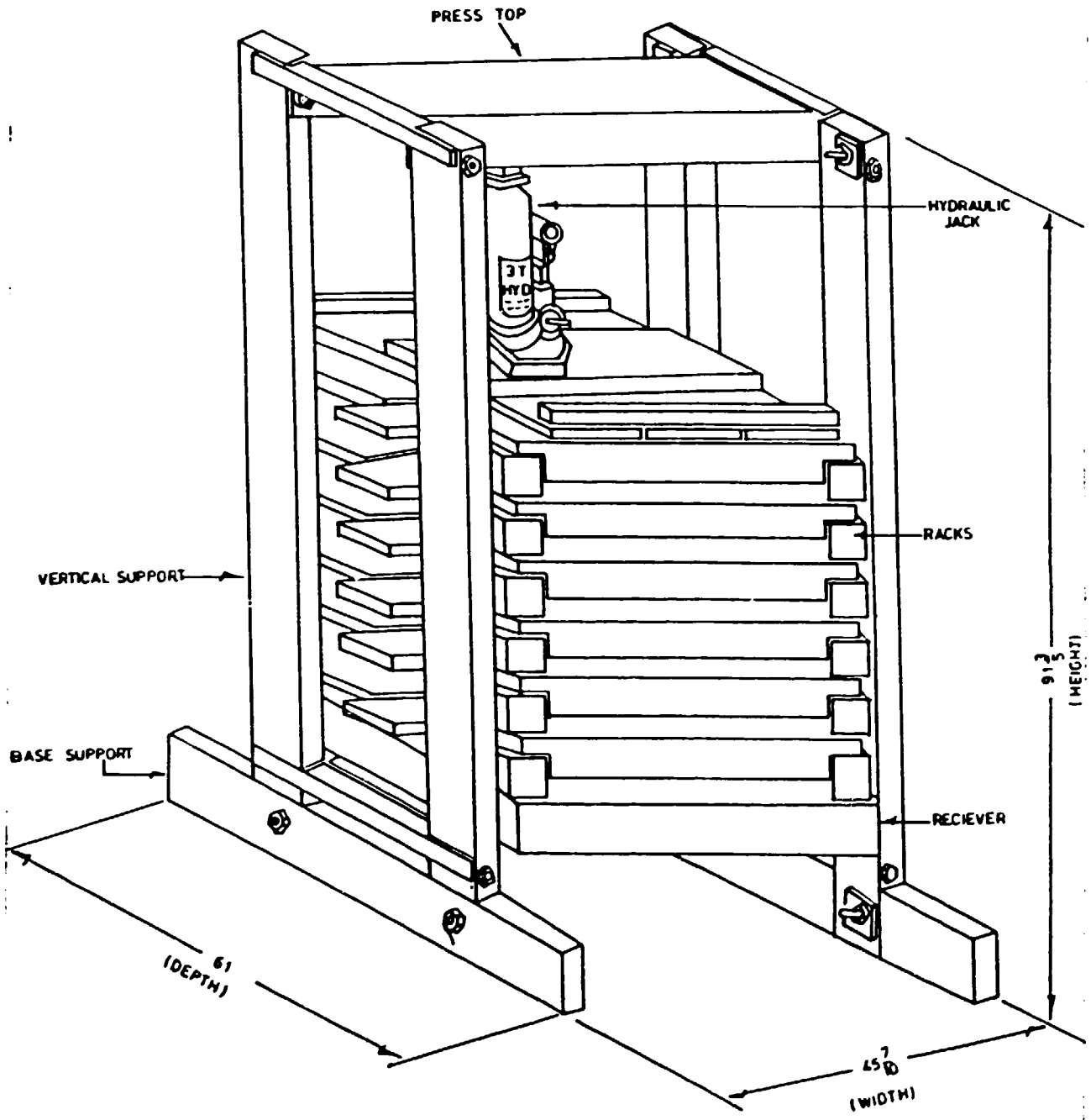
The equipment performed better than the conventional methods of juice extraction. The hydraulic juice press yielded 54.8 per cent in comparison to 44.6 per cent for the conventional method.

In the optimization test, the results showed that the smaller the size, the more juice one expected to extract. This is no surprise since the surface area of extraction, i.e. cell wall on the piece, increases with the decrease in the piece size. However, there is a limit to which one can decrease the size after which it becomes inpractical to handle. Thus, the size 2 x 2 x 2 cm was easy to handle. It yielded the most juice and is, therefore, the recommended size.

Improvements are needed to decrease spoilage losses and increase the amount of fruits to be processed. More juice would be extracted if metals (stainless steel) were used to replace planks.

A HYDRAULIC JUICE PRESS






PICTORIAL VIEW OF A HYDRAULIC JUICE PRESS

DRAWING NO. 1

## APPENDIX

| | Materials | Cost (*Kwacha) |
|---|---|---|
| 1. | 3-ton hydraulic jack | 1559-48 |
| 2. | Planks | |
| 3. | Paints (undercoat, gloss white, pink primer and iron oxide primer) | 1117-75 |
| 4. | Bolts (mild steel) | 540-00 |
| 5. | Channels (scrap metal) | 850-00 |
| 6. | Stainless steel sheet (for receiver) | 379-00 |
| 7. | Cutting of planks | 3-72 |
| | TOTAL | K4449-95 |
| | LABOUR | 1500-00 |
| | GRAND TOTAL | K5949-95 |

* One US dollar = 10 Zambian Kwacha

## I. Introduction:

The United Nations Industrial Development Organization (UNIDO) in August 1986 mandated the Federal Institute of Industrial Research, of Oshodi, Nigeria (FIIRO) "to develop a small-scale gari plant that is marketable, efficient, low cost and will improve efficiency of gari production in rural areas", here is a technological summary of the report submitted in November 1989.

1. The gari processing plant which was built for UNIDO is based on upgraded and modified existing basic designs of the component unit machines which are readily available and which were identified from a national survey of major gari producers. The gari-plant is made up of seven component machines that facilitate the operations of more than 10 different steps in gari processing from the cassava root.

2. The most critical machines are:
   i. the grater - used for particle size reduction from peeled cassava tuber and dewatered (pressed) cassava cake;
   ii. screw press - for water removal from fermented cassava pulp;
   iii. garifier/dryer - this is a cylindrical cooker/dryer that first gelatinizes (cookes) the pulp followed by water removal (drying), yielding ready - to-eat dry gari product; and
   iv. a sifter/shaker - for gari grading.

3. The layout of the plant is arranged in such a way that there is only one prime mover - a 6 hp diesel engine - which drives all the movable machines (i.e. the grater, the sifter and the garifier/dryer). Performance tests on the gari plant showed that it is versatile in that equally dryes gari, cassava flour, lafun and starch, unlike other existing gari plants which produce only gari. The plant is therefore expected to be also suitable for use in various other countries that have preference for cassava flour.

4. The design of the plant took into consideration the manufacturing facilities limitations in african countries, avoiding undue sofistications that might defeat the objective, that is to produce a low technology/low cost gari processing plant. The dryer can burn charcoal, coal, firewood, sawdust or gas, whichever is available, thus making the plant suitable for rural areas. The present output is 120-160 kg/8hr, but this could be considerably increased by changing the present prototype from a batch to a continuous process.

Technology - Generalities

Gari is a gritty gelatinized starch food processed from fermented cassava (Manihot esculenta, Crantz) and used as staple food in some countries of West Africa and Central Africa. Other products of cassava processing are cassava flour, starch, tapioca, "fufu" and "latun".

Basically gari processing involves the peeling of the cassava tubers, the grating of the peeled tubers, the fermentation and dewatering stages, and the frying and packing stages.

There are three recognized levels of gari processing in the country - depending on the extent of mechanization involved.

The first and basic level is the traditional system where each unit operation is essentially manual, time consuming and tedious. The frying is carried out in a semispherical iron pot fired with wood.

The second level incorporates some mechanization or improvements, generally in the areas of: Grating, where a motorized grater is used to replace the hand grating; Dewatering where a screw press or hydraulic jack are used to replace the heavy stone, used in the traditional process; and the friers where a semi-cylindrical metal pot paddled manually or mechanical replaces the semi-spherical pot.

The third level are the almost entirely mechanized used by commercial plants, the FIIRO design, presented here, would fall into this category.

Visits made to several places in the country showed that the extent of mechanization varies from place to place, in some places only the grating is mechanized, in others two or more unit operations have been mechanized. In all cases the peeling of the tuber is still manual. In all places where mechanization has been introduced, the equipment for each unit operation are similar and conventional as discussed below:

Grating

The grater consists of an inverted perforated light gauge sheet wrapped around a wooden roller. This roller is connected to a motor which may be petrol; diesel or electrically operated. The machine is also being used as cassava cake granulator.

Dewatering process

The equipment used for this process consists of either a screw press or a hydraulic jack. The mash packed in synthetic sacks, is stacked in layers and dewatered through the operation of the screw press or jack.

Sifting

This is the removal of fibres from the granulated gari mash. This is generally done manually but some processor have mechanized this operation. The sieve is however made from vegetable fibres instead of having a metal mesh.

Frying trays

These consist of either rectangular or semi - cylindrical metal sheets fired either with wood, diesel or gas. The number of frying trays varies from place to place, depending on capacity.In all cases the gari is manually paddled or turned round with wooden spatulas - usually two people standing by a tray of about 1 x 2.5 m and 10 cm deep.

Disc mill

Only one of the places visited had a disc mill which is needed to mill the coarse gari particles to even sizes.

Sifter/Grader

The grader is a manual sifter or a mechanized one.

The conclusion of the tour to a large number of places in Nigeria revealed that a silent revolution has been going on at the grass roots level to mechanize gari production to the extent they can afford - assisted by local engineering companies.

FINAL SPECIFICATIONS OF THE MAIN EQUIPMENT.

Grater.

| | | |
|---|---|---|
| overall dimensions | : | 714mm (L) x 618mm (B) x 965mm (H) |
| designed capacity | : | 300 to 350 kg/hr |
| actual capacity | : | 300 kg/hr |
| power required | : | 2 hp, if driven by electric motor |
| actual arrangement | : | belt and pulley drives coupled to a diesel engine |

| Materials: | | |
|---|---|---|
| i. | - main frame | - mild steel |
| ii. | - shaft | - mild steel |
| iii. | - main rotors | - cast aluminun |
| iv. | - abrasive covers | - galvanized steel |
| v. | - pulleys | - grey cast iron |
| vi. | - belt | - size B 930 |
| vii. | - bearing | - MP 25 basic bearing size 1030 |

## SCREW PRESS

overall dimensions : (L) 980 mm x (B) 700 mm x (H) 1690 mm
designed capacity : 80 kg per batch
final capacity : 240 kg per batch
max.compressive load: 3 tonnes

materials:
- i. - frame - mild steel sections and plates
- ii. - screw shaft - mild steel rod
- iii. - nut - brass
- iv. - Rams (top and bottom) - cast iron or cast aluminum or seasoned wood, depending on availablity

thread type - square with pitch 12 mm
installation - Bolt down on concrete base with drainage facility.

## GARIFIER FRYER

overall dimensions : 1420 mm (L) x 1100 mm (B) x 1660 mm (H)
charge capacity designed : 150 kg/batch
operating capacity : 50 kg of fiber free, fermented granulated cassava per hour
power requirement : 1.5 hp

material:
- i. - cooking drum - mild steel
- ii. - drum cover - aluminum
- iii. - support frame - mild steel
- iv. - fire place - brick or mud (to be built in situ around frame or fiber insulating jacket or mild steel plate)
- v. - paddles - seasoned wood on stainless steel pipe arms)
- vi. - main shaft - mild steel rod bushed by stainless steel pipe.
- vii. - firing fuel - wood, material waste, cooking gas, charcoal, mineral coal, palm kernel shell. When the fuel is other than cooking gas a fuel oil firing tray of mild steel trolley can be used.

## SIEVE (SHAKER)

| | | |
|---|---|---|
| overall dimensions | : | 1160 mm (L) x 500 mm (B) x 1025 mm (H) |
| designed capacity | : | 70 kg per batch |
| operating capacity | : | |
| i.- | | 700 kg per hour for granulated cake |
| ii.- | | 500 kg per hour for crude gari |
| iii.- | | 650 kg per hour for milled gari |
| power requirement | : | 1.5 hp |

| | | | |
|---|---|---|---|
| materials: | i. | - main frame | - mild steel |
| | ii. | - Tray | - mild steel and wood |
| | iii. | - screen | - wood and metal welded mesh or drilled mild steel plate |
| | iv. | - bearing | - pillow block NF.30 |
| | v. | - shaft | - mild steel EN8A |
| | vi. | - cam | - mild steel EN8 (case hardened) |

## WEIGHING SCALE

This is a dial type having a maximum capacity of 200 kg weight. It is hung on a structural steel frame of I-beam during weighing.

## MILLING MACHINE

| | | |
|---|---|---|
| operating capacity | : | 45 kg of coarse gari particles per hour ( dry milling) |
| overall dimension | : | 500 mm (L) x 500 mm (B) x 1300 mm (H) |
| power required | : | 1.5 hp |

| | | | |
|---|---|---|---|
| materials | i. | - grinding disc | - grey cast iron |
| | ii. | - grinding housing | - grey cast iron or cast aluminum |
| | iii. | - grinder base | - grey cast iron or cast aluminum |
| | iv. | - grinder stand | - structural mild steel angle iron |

| | | |
|---|---|---|
| maximum speed | : | 725 rpm |
| disc arrangement | : | one rotating the other stationary |
| installation | : | bolting down on concrete base |

## DRIVE SYSTEM

i. FOR THE GRATER

| | |
|---|---|
| drive ratio | - 1.67 : 1 (1500/900 rpm) |
| belt size | - B 930 |
| pulley on grater | - 280 mm Ø |
| pulley prime mover | - 170 mm Ø |
| power required | - 2 hp |

ii. FOR REDUCTION GEAR BOX

| | |
|---|---|
| speed reduction ratio | - 60 : 1 (725 rpm : 12 rpm) |
| belt(gear box to engine | - A 930 |
| pulley | - 315 pcd |

iii. FOR THE DRYER

| | |
|---|---|
| chain drive(dryer/gear box) | - pith 3/4" |
| driver sprocket | - 23 teeth on 150 mm pcd |
| driver sprocket | - 57 teeth on 300 mm pcd |
| type of sprocket/chain | - double link |
| power required | - 1.5 hp |
| speed reduction ratio | - 2 : 1 (12 rpm : 6 rpm) |

iv. FOR THE SIEVE

| | |
|---|---|
| power required | - 1.5 hp |
| drive ratio | - 2 : 1 (725 rpm : 363 rpm) |
| belt size | - B 930 |
| pulley on sieve | - 280 mm Ø |

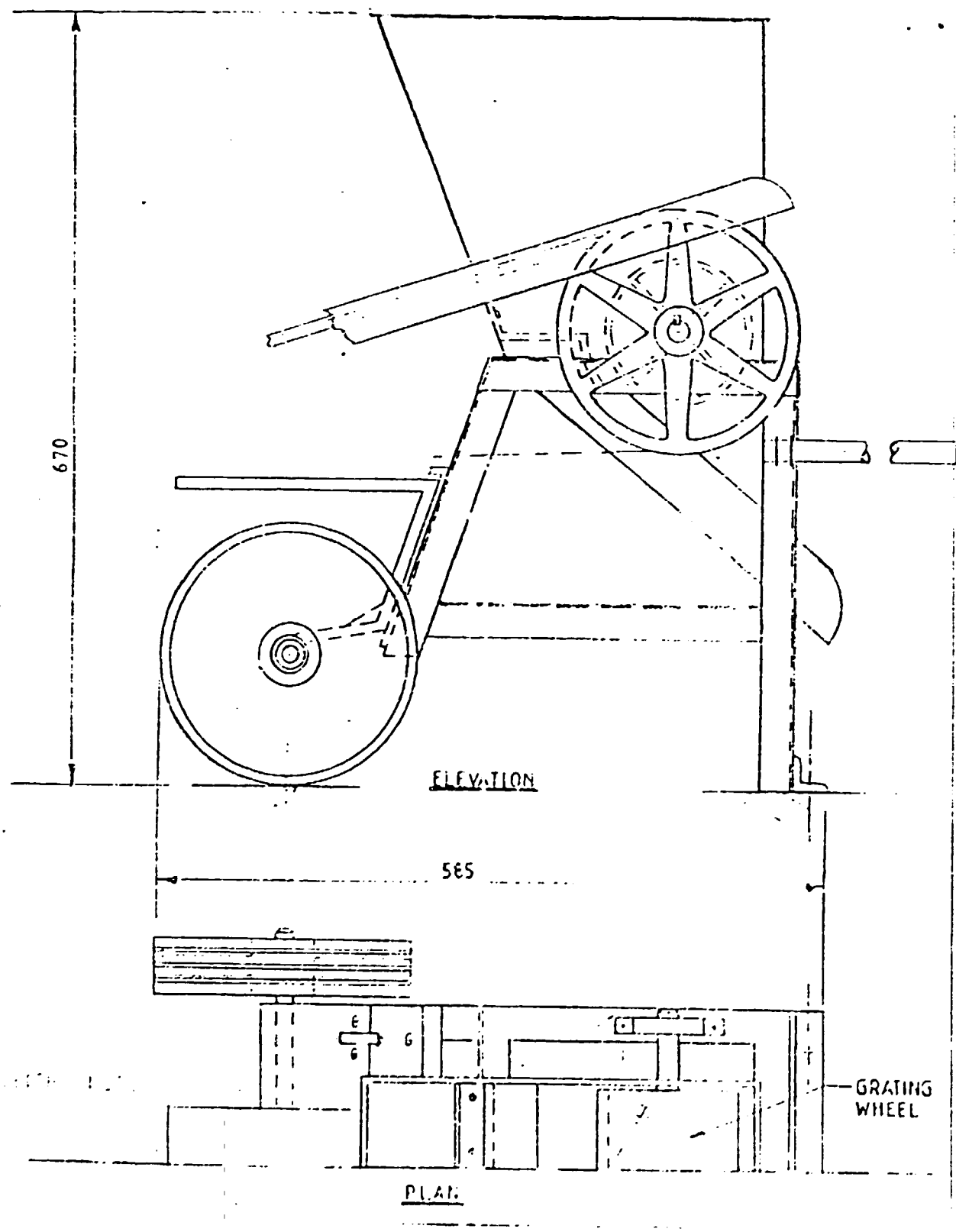
v. FOR THE MILL

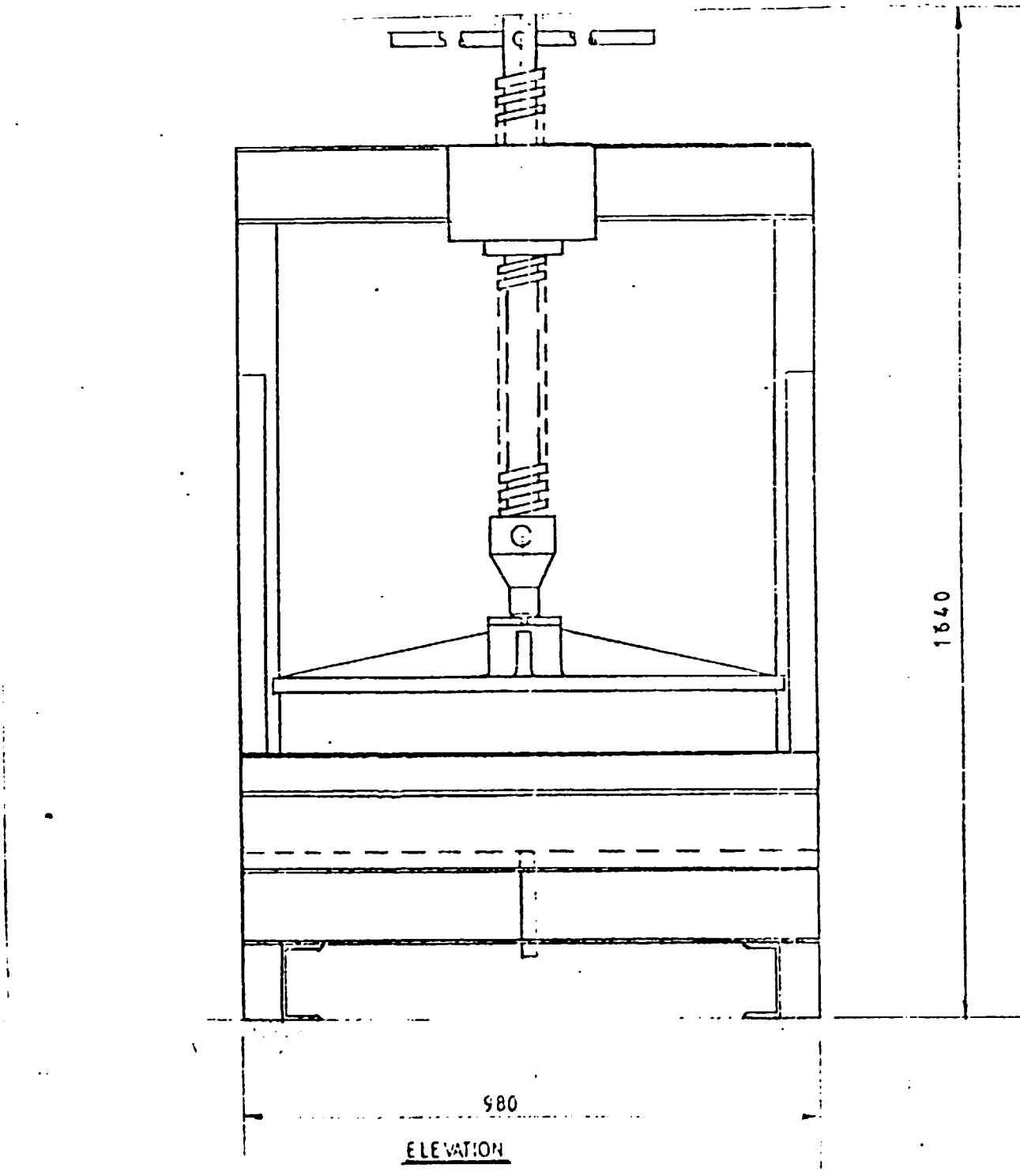
| | |
|---|---|
| power required | - 1.5 hp |
| speed reduction | - 1 : 2 (363 rpm : 725 rpm) |
| belt size | - A 85 |
| pulley size on mill | - 200 mm Ø |

## DETAILED DRAWINGS OF THE GARI PLANT

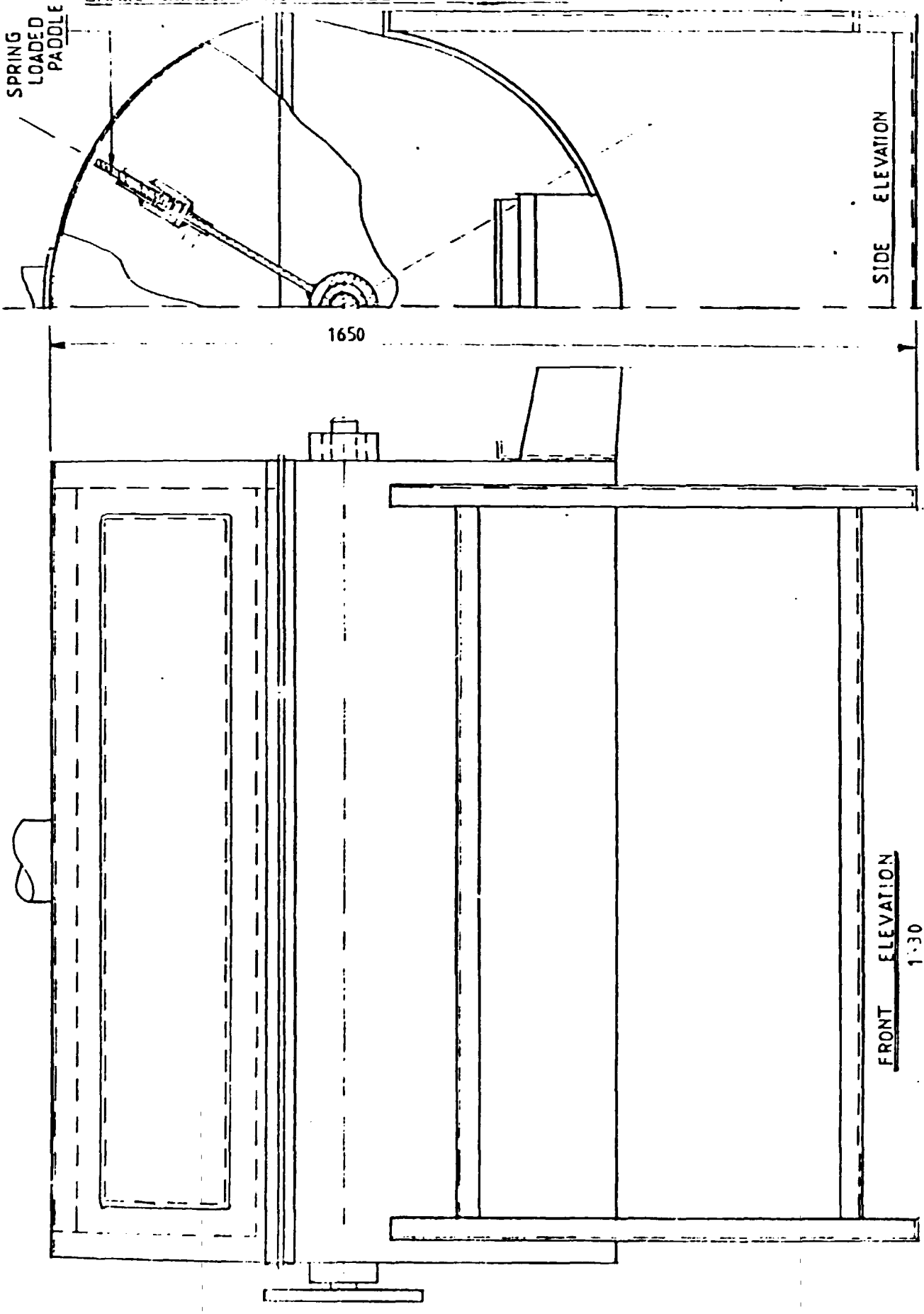
Detailed drawings of the grater, sieving machine, screw press and garifyer/dryer are available as shown in the annex. The garifyer has as much as 20 component drawings as shown below

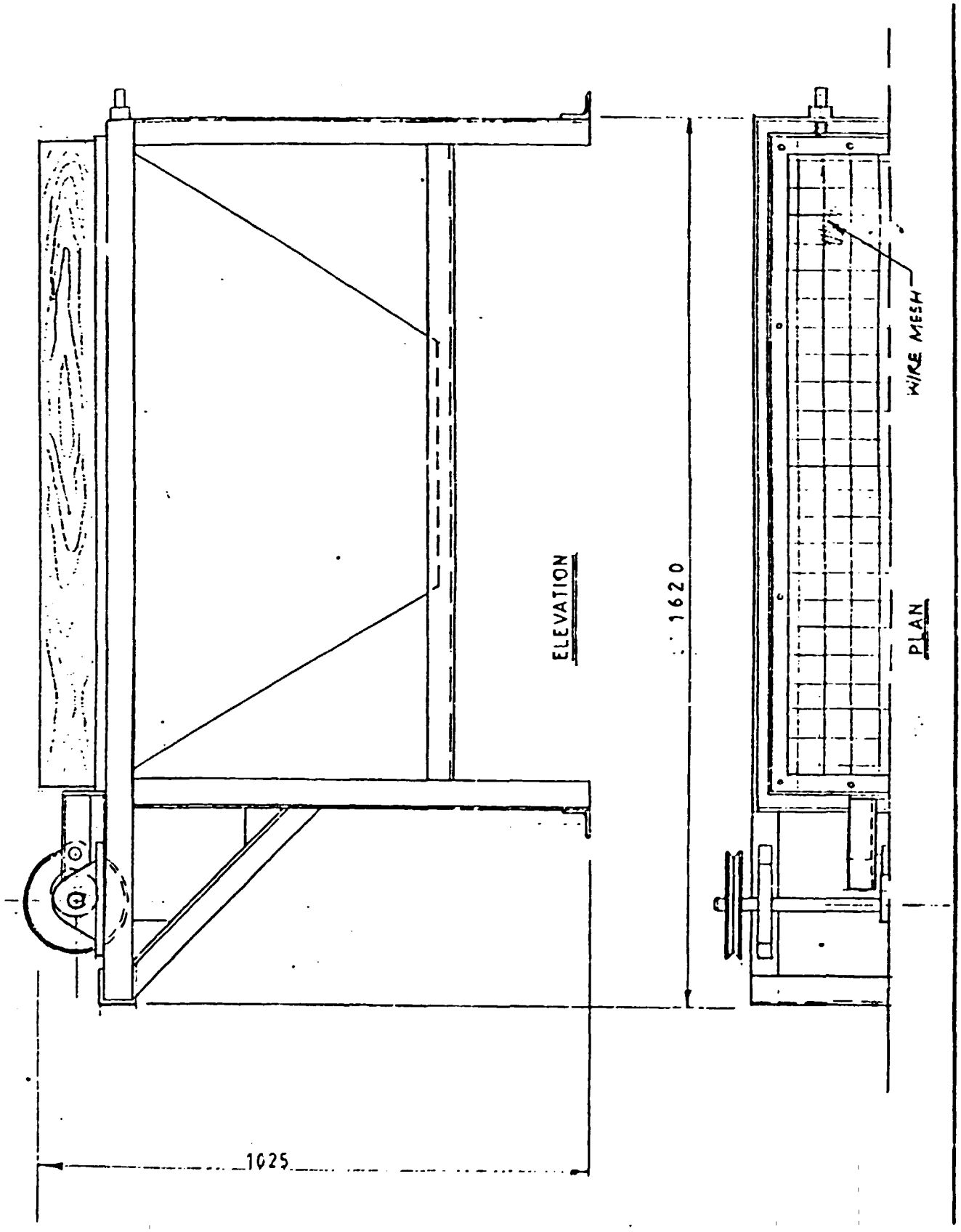
| ITEM NO. | DESCRIPTION | QUANTITY |
|---|---|---|
| 1 | Cassava grater | 7 |
| 2 | Sieving machine | 9 |
| 3 | Screw press | 7 |
| 4 | Garifyer/dryer | 20 |

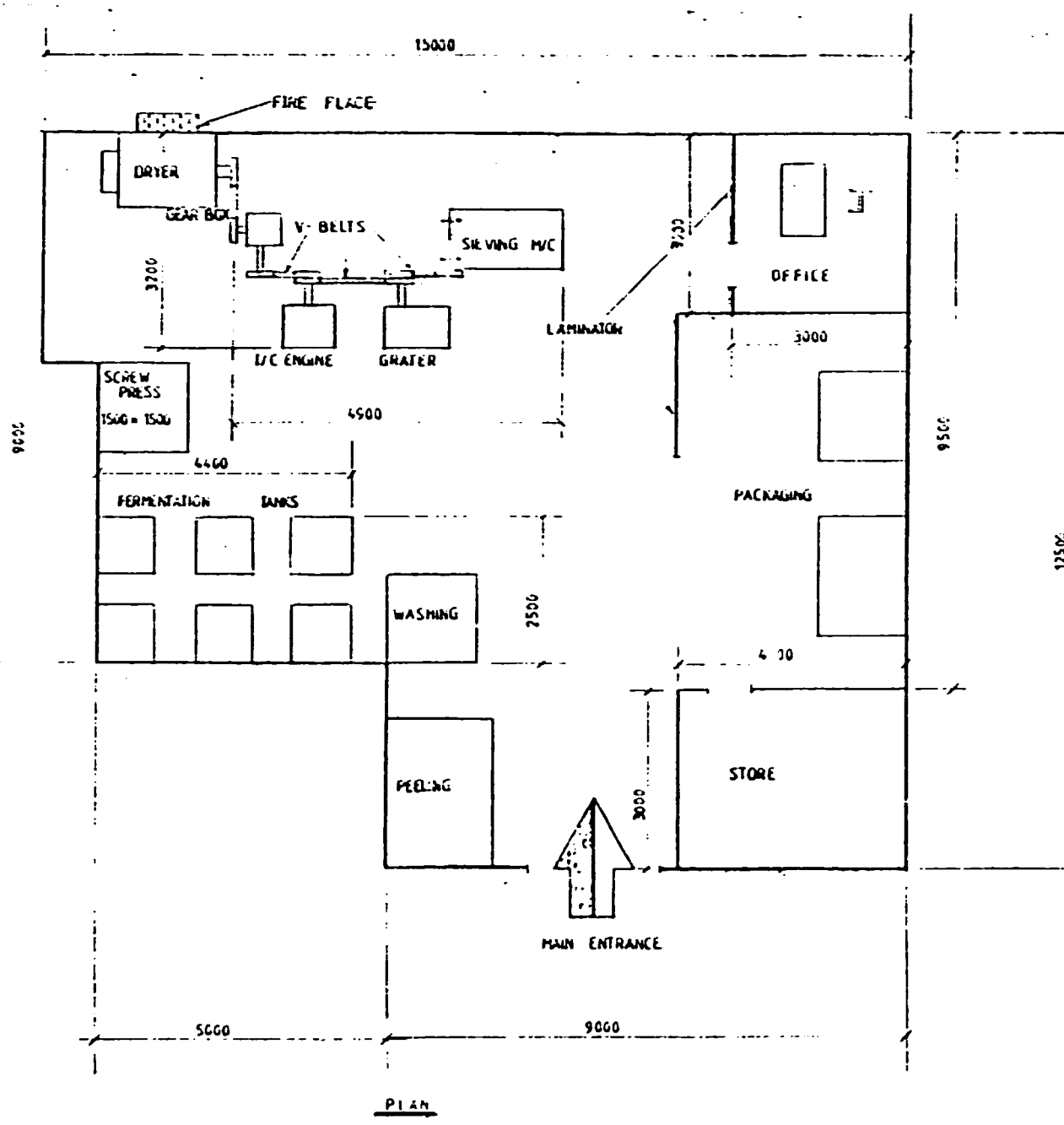

670
ELEVATION
565
GRATING WHEEL
PLAN




ELEVATION


SPRING LOADED PADDLE
SIDE ELEVATION
1650
FRONT ELEVATION
1:30


ELEVATION
1620
1025
WIRE MESH
PLAN


15000
FIRE PLACE
DRYER
GEAR BOX
V- BELTS
SIEVING M/C
3200
I/C ENGINE
GRATER
LAMINATION
OFFICE
3000
SCREW PRESS
1500 = 1500
4500
6460
FERMENTATION TANKS
WASHING
2500
PACKAGING
4 30
PEELING
STORE
3000
MAIN ENTRANCE
5000
9000

PLAN

ANNEX

## GARI GRATER (detailed drawings)

| Title | Drawing No. |
|---|---|
| Gari grater part | 300132O4 |
| " " " | 300130306 |
| " " " | 300130114 |
| | 300130312 |
| | 300130401 |
| | 300130402 |
| | 300130403 |
| | 300130404 |
| Sub assembly | 300130300 |
| Land wheel | 300130106 |
| Front plate | 300130301 |
| Motor support bracket | 300130105 |
| Part detail | 300130308 |
| | 300130003 |
| | 300130109 |
| | 300130307 |
| | 300130107 |
| | 300130108 |
| Bracket | 300130203 |
| | 300130115 |

## SIEVING MACHINE

| Title | Drawing No. |
|---|---|
| Chute and frame | 300110100 |
| Chute sub assembly | 300110200 |
| Structural arrangement | 300140200 |
| Sieve sub assembly | 300110300 |
| Drive sub assembly | 300110400 |
| Frame sub-sub assembly | 300110500 |
| Part detail | 300110303 |
| " " | 300110111 |

## SCREW PRESS

| Title | Drawing No. |
|---|---|
| Part detail | 300210110 |
| | 300210113 |
| | 300210115 |
| | 300210114 |
| | 300220112 |
| | 300210120 |
| | 300210104 |
| | 300210107 |
| | 300210108 |
| | 300210119 |
| | 300210103 |
| | 300210105 |
| | 300210101 |
| | 300210106 |

| | |
|---|---|
| | 300210111 |
| Sub assembly | 300130100 |
| Hopper sub assembly | 300130200 |
| Sectional assembly | 300210100 |
| Gated control sub assembly | 300140500 |
| Sliding gate sub assembly | 300140600 |
| Rod | 300140153 |
| Gate plate | 300140155 |
| Shaft | 300140117 |
| Bottom casing | 300140147 |
| Bottom end cover | 300140149 |

## GARI-FRYER

| Title | Drawing No. |
|---|---|
| General assembly | 1896/89-2 |
| Drive and driven sprocket detail | 5-1896/89-2 |
| Gari paddle and arm sub assembly | 2-1896/89-2 |
| Drum support | 300140143 |
| Aluminium rust protector | 300140121 |
| Feeder gate | 300140144 |
| Gate control disc | 300140111 |
| Lifting handle | 300140109 |
| Bolting log | 300140105 |
| Top half casing | 300140129 |
| Paddle plate | 300140138 |
| Top drum reinforcement | 300140128 |
| Plate | 300140134 |
| | 300140148 |
| | 300140130 |
| | 300110133 |
| Paddle arrangement | 300140300 |
| Gari fryer | 300140100 |
| Paddle arm | 2B-1896/89-2 |
| Housing support | 3-1896/89-2 |
| Housing side cover | 1B/C-1896/89-2 |
| Housing sub assembly | 1-1896-89-2 |
| Shaft deatail | 2A-1896-89-3 |
| Housing detail | 1A-1896-89-3 |
| Charcoal trolley to fryer | 4-1896-89-3 |
| Back cover supports | 3C-1896-89-3 |
| Supporting frame parts | 3A-1896-89-3 |
| Sides cover detail | 3E-1896-89-3 |
| Front cover and development | 3B-1896-89-3 |
| Cover detail | E-1896-89-2 |

| DESCRIPTION | DRAWING NO. |
|---|---|
| FIIRO/UNIDO Gari fryer | 300140100 |
| Main assembly | 030013000 |
| Main " | 300210000 |
| Main " | 300110000 |

MANUAL AGRICULTURAL TOOLS p. 1

Introduction:

A presentation is made of a series of agricultural manual tools, commonly used by farmers in the andean Region, especially in Peru. They are advertised by the project engineers and promoters as capable of providing to the users: Good performance, Quality and ease of work.

| Tools | Application |
|---|---|
| Trident | Tuber Harvest |
| Pick Mattock | Breaking up of hard soils and weeding. |
| Weed-hook | weeding of vegetables |
| Hoe | Weeding, ridging and irrigations |
| Furrow | furrow preparation for seeding and transplanting collections of plants |
| Spike harrow | soil preparation for collection of plants. recollection of weeds and stones |
| Kituchi(Sickle) | in the high jungle areas is used for weeding, and roots harvesting in the high mountains is used for weaning and weeding |
| Chaquitaqlla | Andean manual plough |
| Fork | to handle forrage and stubble |

Glossary of terms used in drawings

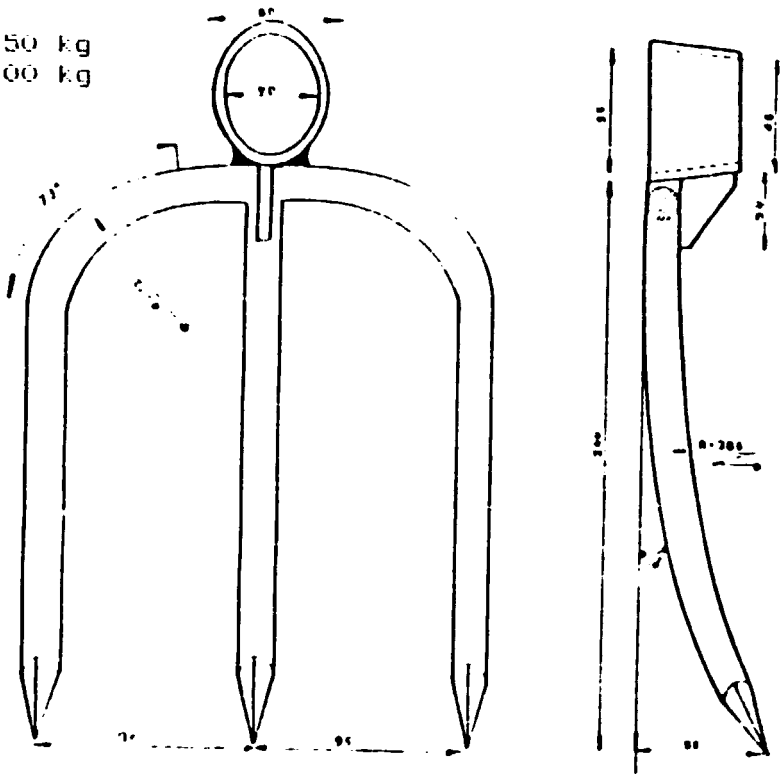
| spanish | english |
|---|---|
| azadon | hoe |
| Chakitaqlla(*) | (original quechua name) |
| escardillo | weed-hook |
| grande | big |
| horqueta | fork |
| kituchi(*) | (original quechua names) |
| mejorada | improved |
| pequeño | small |
| peso | weight |
| picota | pick mattock |
| rastrillo | spike harrow |
| surcador | ridger |
| taquillpu(*) | (original quechua name) |
| tridente | trident |
| uyso(*) | (original quechua name) |

(*) Quechua (peruvians old language) original tool names.

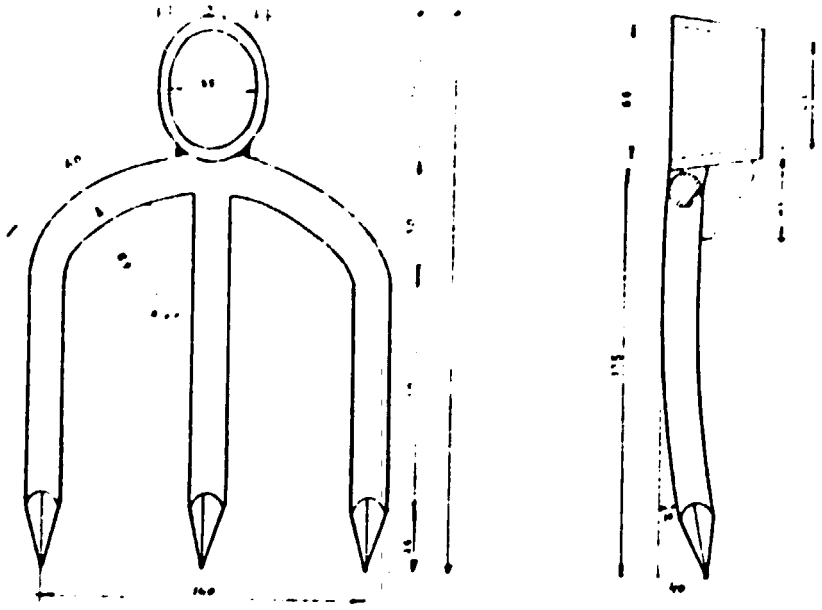
for further information:
Cooperación Técnica del Gobierno Suizo
Cotesu - Herrandina
P.O. Box 378, Lima 100, Perú

MANUAL AGRICULTURAL TOOLS 

TRIDENT
weight:
-big trident 1.50 kg
-small trident 1.00 kg



BIG
TRIDENT

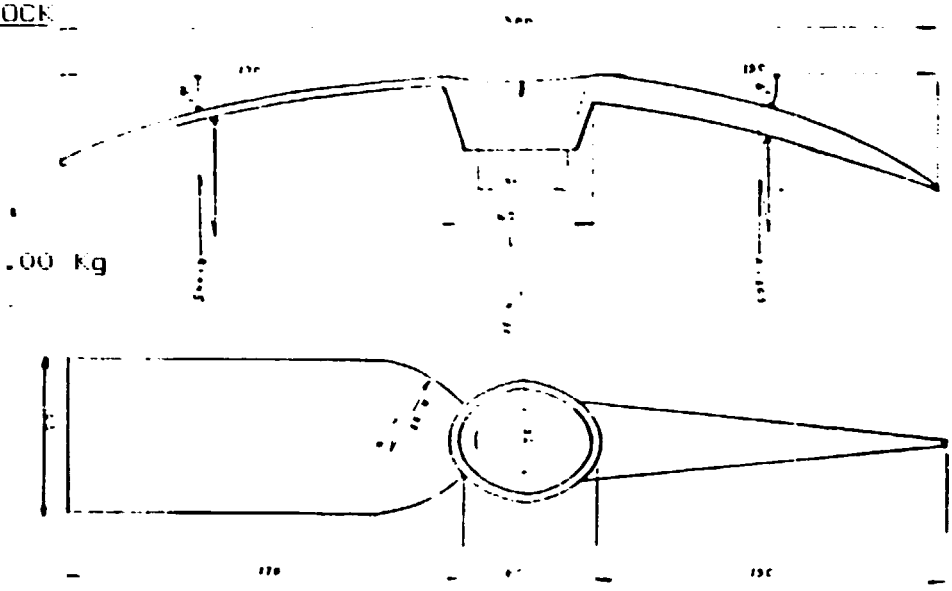


SMALL
TRIDENT

It breaks up the hard soils and removes weeds, taking big lumps, and with the same tool, from the other side it can be used ti hit for clod-crushing.
The width of this trident allows tuber harvesting without damage.

MANUAL AGRICULTURAL TOOLS p. 3

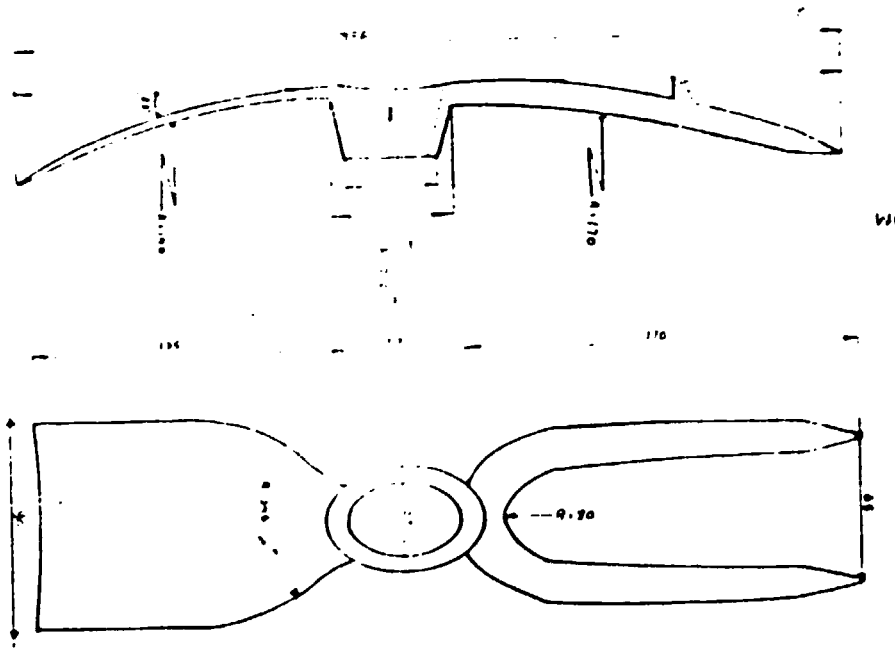
PICK MATTOCK



weight 1.00 kg

used for harvesting of tubers
also used for weeding the fields

WEED-HOOK



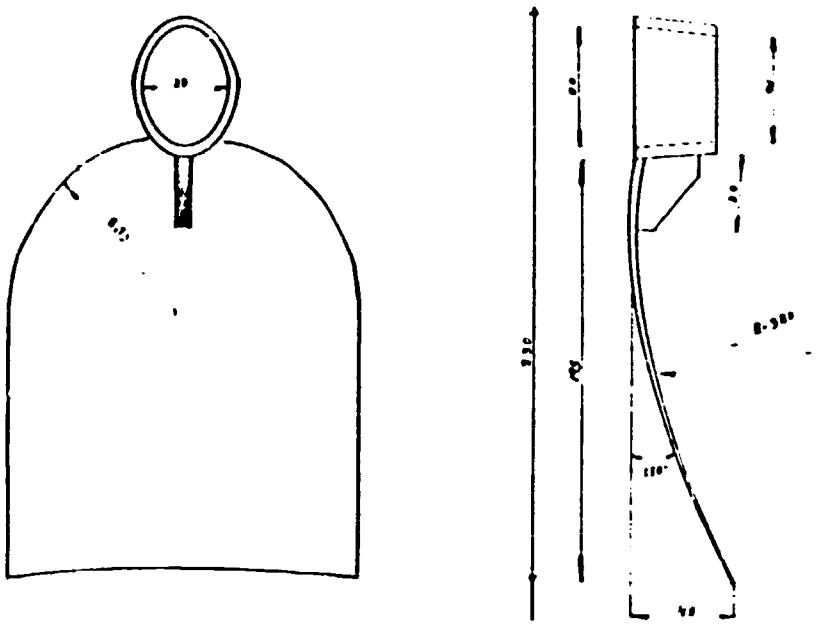
weight 1.00 kg

It is used for weed cleaning, especially in horticultural orchards.
it is also used for removing soils in orchards
this tool is used especial for women and children.

MANUAL AGRICULTURAL TOOLS 

HOE

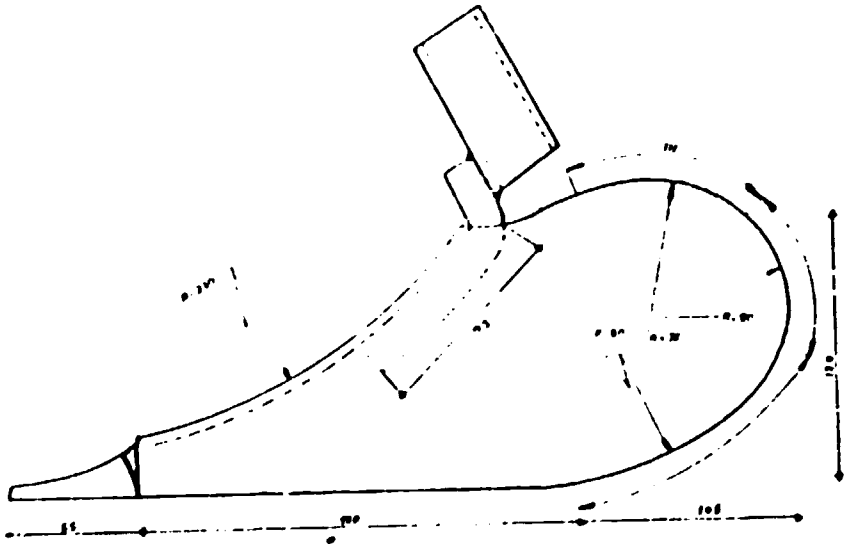
weight 1.00 kg



it is used for weeding, extraction and pulling away of weed, thus cleaning the area.
when ridging, the soil is well hilled, forming the furrows and ridges staight and well shaped.
it is wsed for preparing the irrigation channels

FURROW

weight 1.60 kg



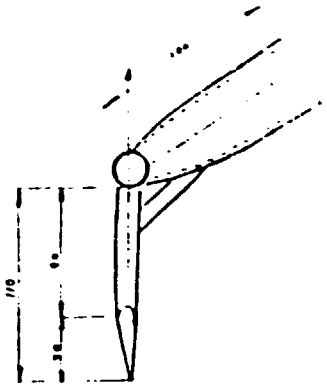
it is used in for vegetables, makes clean and straight furrows.
it is used for irrigation channels preparation
when ridging vegetables, pushes soils around the plant.

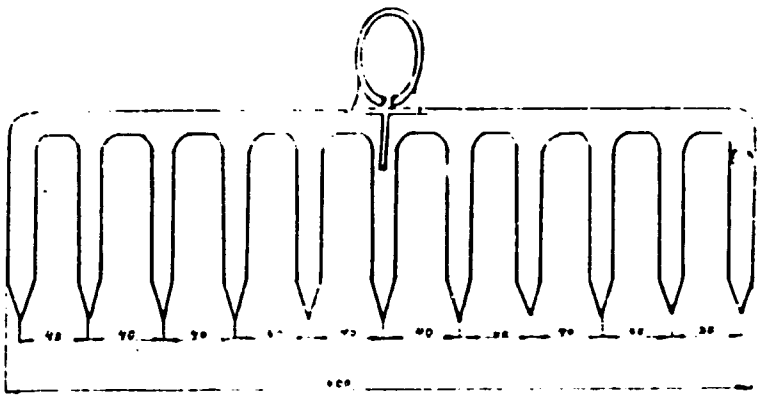
MANUAL AGRICULTURAL TOOLS



SPIKE HARROW

weight 1.50 kg

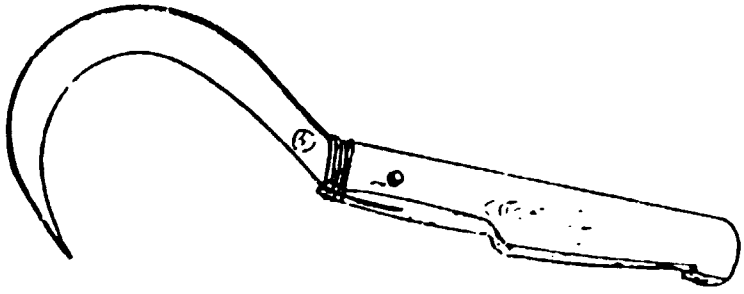




after preparation of plants collections, the remains, weeds and stones are picked with the harrow, it also levels the surfaces around the collections
it can be used in small areas for picking up stones and stubble.
great ease of work for the operator

KITUCHI (ANDEAN SICKLE)

weight 0.80 kg

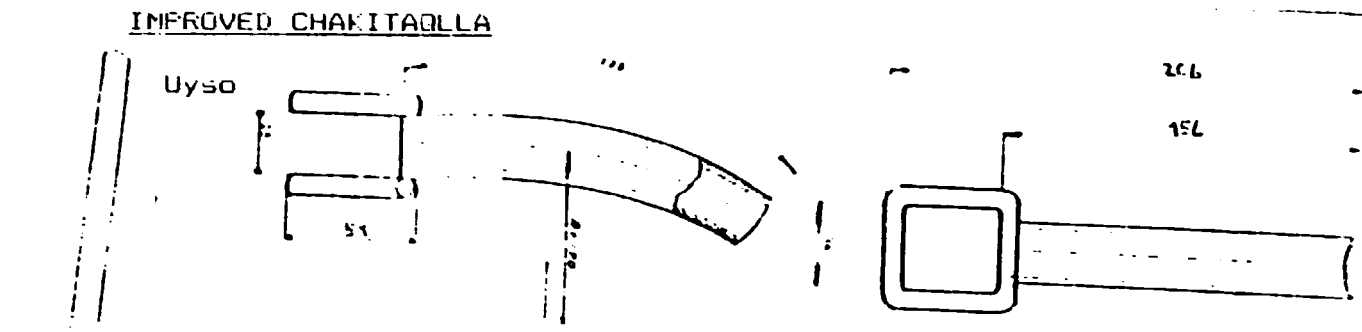


in the high jungle areas is used for weeding, and roots harvesting
in the high mountains is used for weaning and weeding

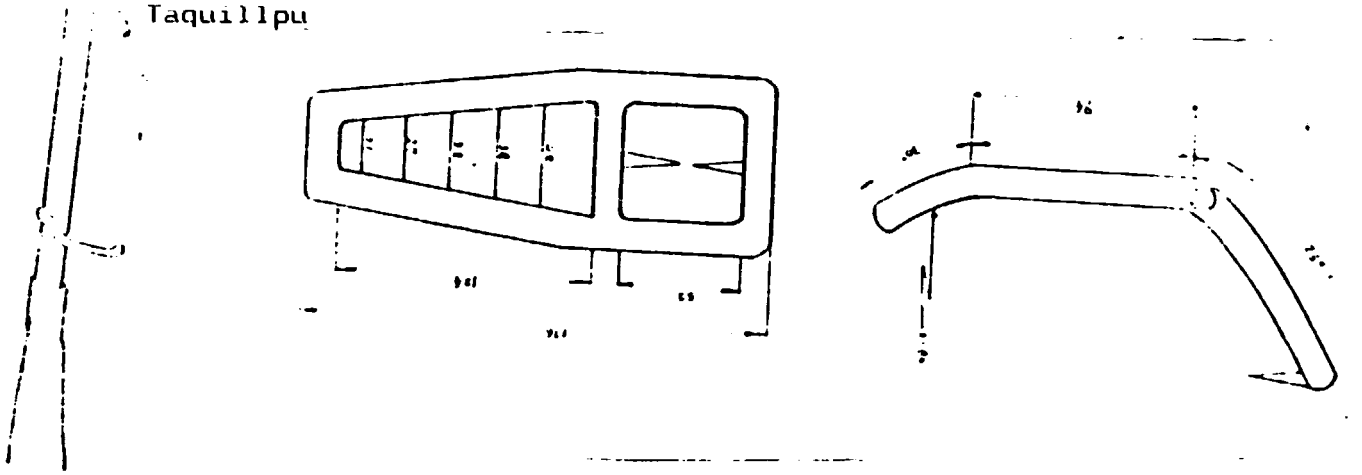
MANUAL AGRICULTURAL TOOLS p. 6

IMPROVED CHAKITAQLLA

Uyso

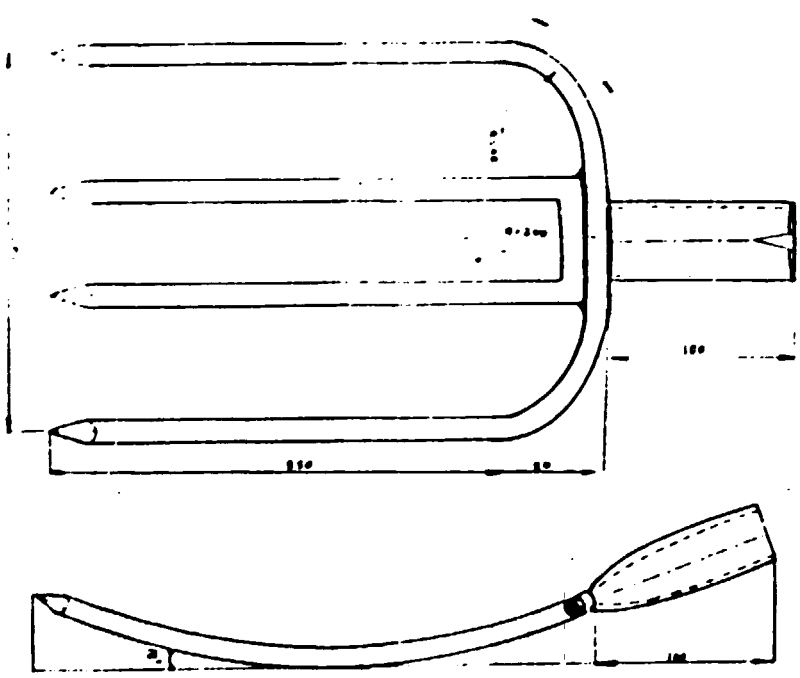


Taquillpu



FORK

weight 1.20 kg



it is used for winnowing the thrashed material, to separate the chaff from the grain
it is used for transporting, loading hay and fodder from one place to another

MANUAL AGRICULTURAL TOOLS p. 7

BIG TRIDENT PARTS LIST

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | Hub | 1 | steel pipe 3/16" x 1 1/2" ø | 16 cm | |
| 2 | side teeth | 1 | corr. bar 5/8" ø | 57 cm | |
| 3 | centre tooth | 1 | corr. bar 5/8" ø | 23 cm | |
| 4 | reinforcement | 1 | flat bar 3/16" x 1" | 2 cm | |
| | electric welding rods | 1 | Cellocord 1/8" ø | 0.028 kg | |
| | electric welding rod | 1.5 | Supercito 1/8" ø | 0.053 kg | |
| | Coal | 0.40 kg | | | |
| | Red Paint | 0.008 gallons | | | |

SMALL TRIDENT PARTS LIST

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | hub | 1 | steel pipe 3/16" x 1 1/2" ø | 16 cm | |
| 2 | side teeth | 1 | corr. bar 5/8" ø | 38 cm | |
| 3 | centre tooth | 1 | corr. bar 5/8" ø | 16 cm | |
| 4 | reinforcement | 1 | flat bar 3/16" x 1" | 2 cm | |
| | Electric welding rod | 1 | Cellocord 1/8" ø | 0.028 kg | |
| | electric welding rod | 1.5 | Supercito 1/8" ø | 0.053 kg | |
| | coal for forging | 0.4 kg | | | |
| | red paint | 0.08 gallons | | | |

MANUAL AGRICULTURAL TOOLS p. 8

PICK MATTOCK PARTS LIST

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | pick mattock | 1 | spring leaf 5/16" x 2 1/2" | 21 cm | 0.7 kg |
| | coal for forge | 2.5 kg | | | |

WEED-HOOK(Pickaxe) PARTS LIST

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | weed-hook | 1 | spring leaf 5/16" x 2 1/2" | 21 cm | 0.70 kg |
| | coal for forge | 2.5 kg | | | |

SICKLE (KITUCHI) PARTS LIST

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | kituchi | 1 | corr. bar 5/8" Ø x 25 cm | | 0.70 kg |
| 2 | handle | 1 | Eucaliptus wood 1 1/2" x 1 1/2" | 31 cm | |
| | wrapping | 0.003 gr. wire No. 16 | | | |
| | coal for forging | 2.5 kg. | | | |

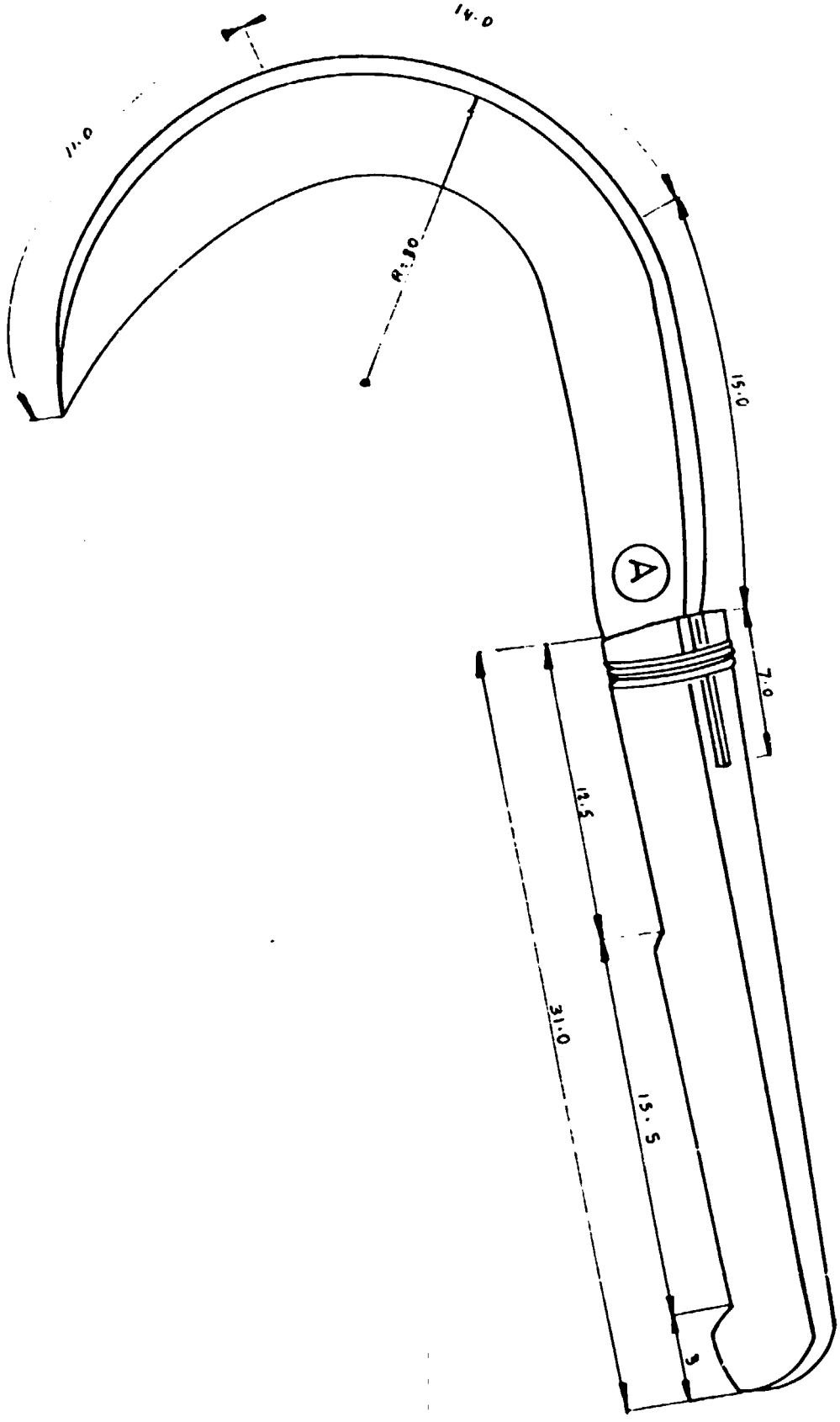
MANUAL AGRICULTURAL TOOLS p. 9

SPIKE HARROW(manual tool) PARTS LIST

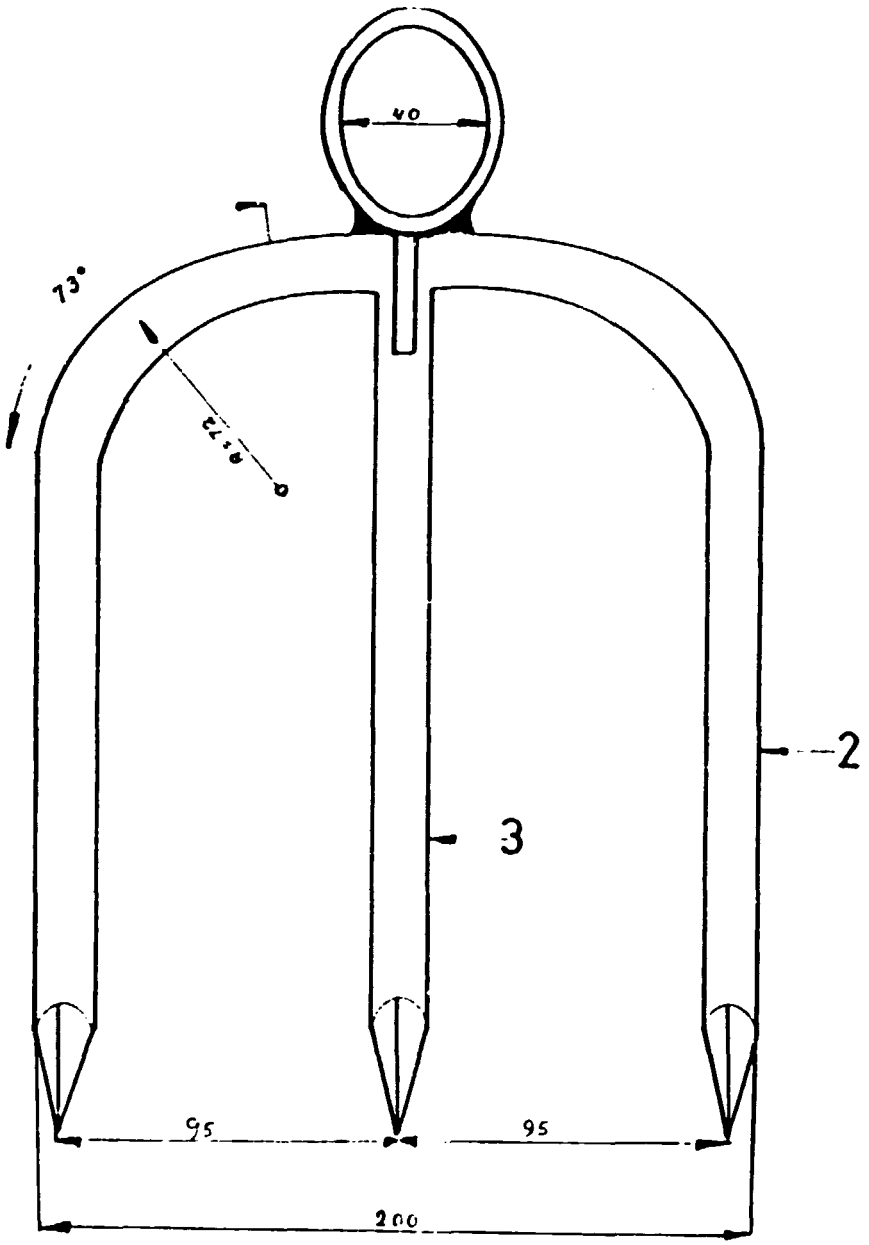
| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | hub | 1 | steel pipe 1" ø | 10 cm | |
| 2 | reinforcement | 1 | corr. bar 3/8" ø | 5 cm | |
| 3 | teeth | 9 | corr. bar 3.8" ø | 9 cm | 81 cm |
| 4 | teeth bar + 2 teeth | 1 | corr. bar 1/2" ø | 38 cm | |
| | electric welding rod | 2.5 | Cellocord 1/8" ø | 0.069 kg | |
| | electric welding rod | 4.5 | Supercito 1/8" ø | 0.16 kg | |

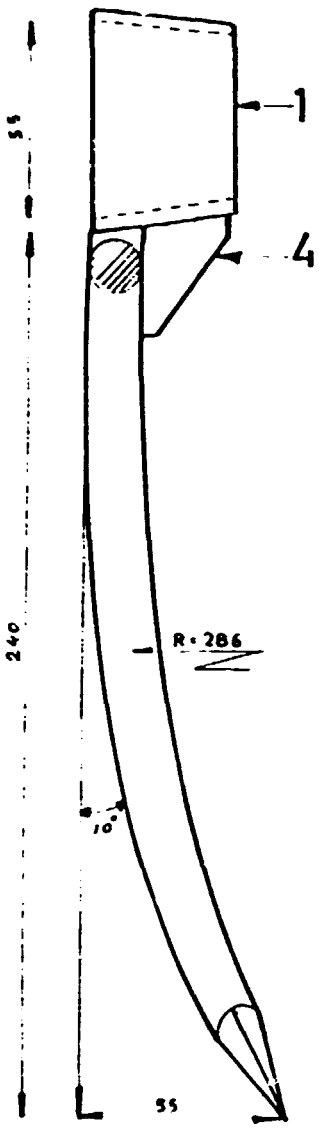
FORK PARTS LIST

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | hub | 1 | steel pipe 1" ø | 10 cm | |
| 2 | side teeth | 1 | corr. bar 3/8" ø | 73 cm | |
| 3 | inner teeth | 1 | corr. bar 3/8" ø | 62 cm | |
| | electric welding | 2 | Cellocord | 0.055 kg | |
| | red paint | 0.005 gallons | | | |
| | coal for forging | 0.10 kg | | | |

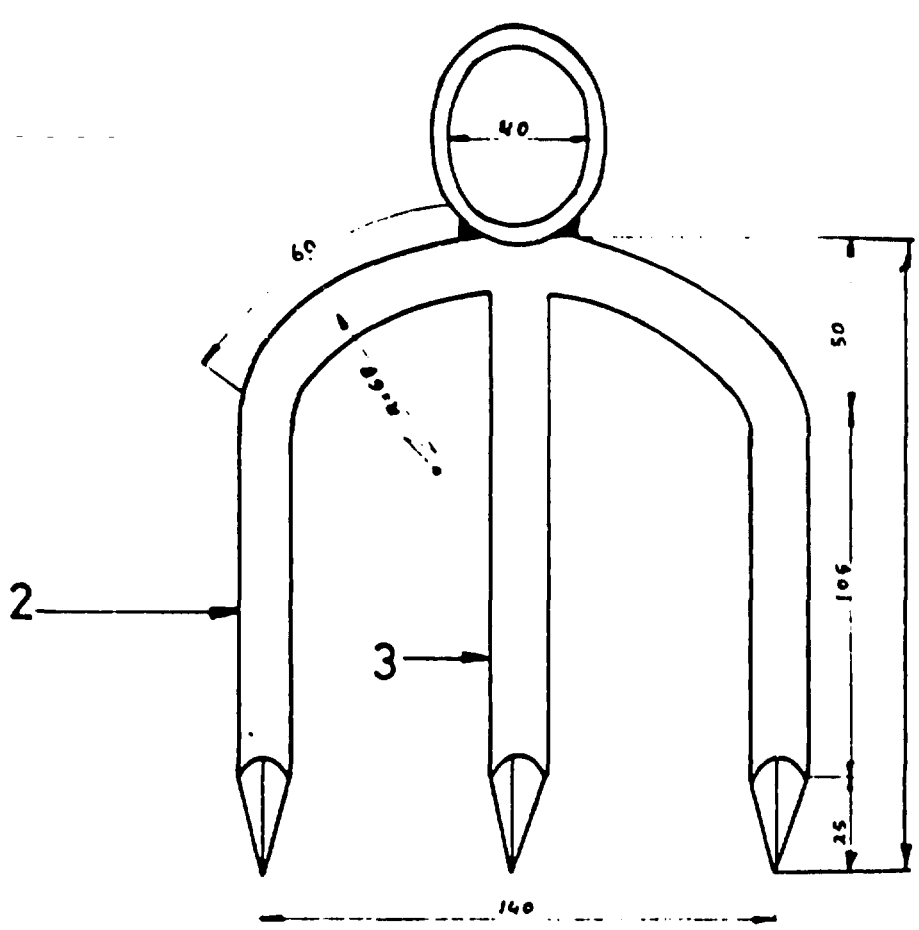


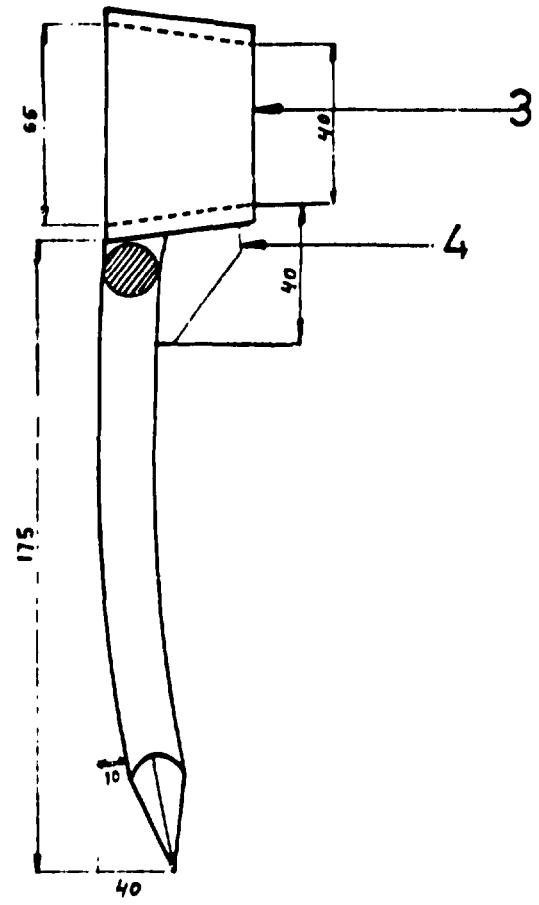

| | | | | |
|---|---|---|---|---|
| KITUCHI | ESCALA 1:25 | | Fecha | Nombre |
| | | Diseñado | 89 | Herrandina |
| | | Dibujado | 6/7/88 | D · N.S |
| | | Aprobado | | |
| HERRANDINA | | | | |



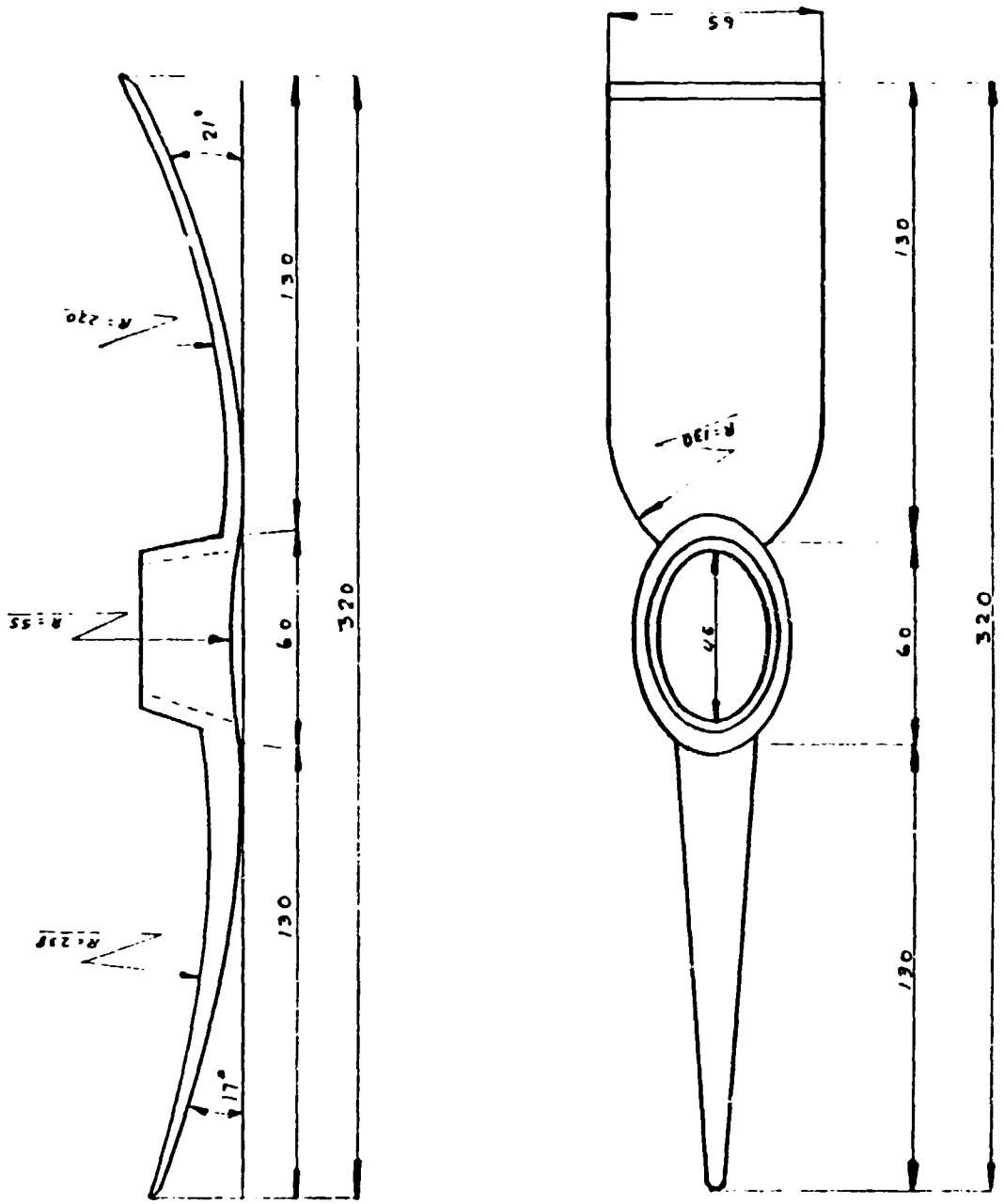




| | | | | |
|---|---|---|---|---|
| TRIDENTE GRANDE | ESCALA 1:20 | Diseñado | Fecha 89 | Nombre HERRANDINA D. N. 6. |
| | | Dibujado 10/07/89 | | |
| HERRANDINA | | Aprobado | | |

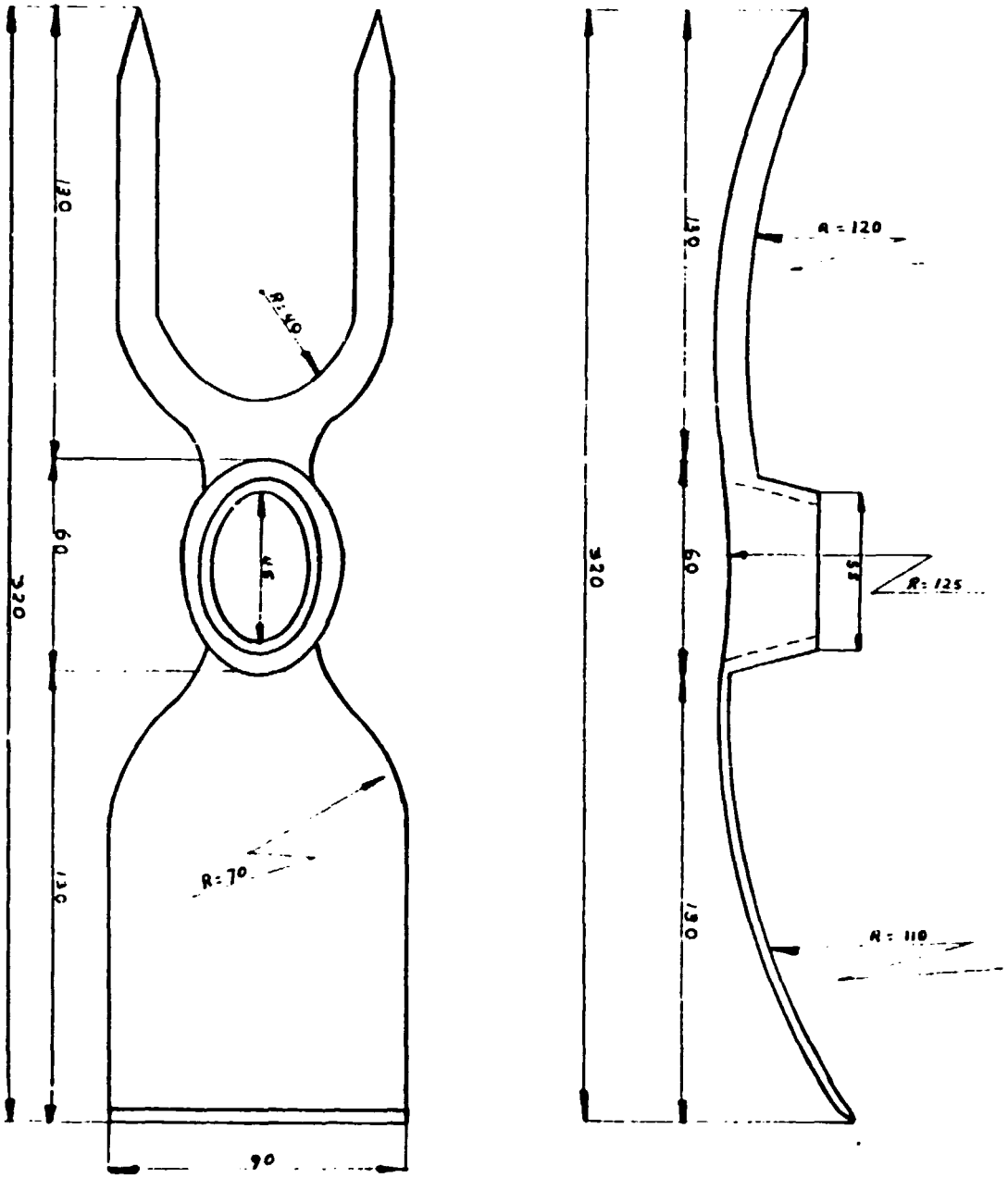


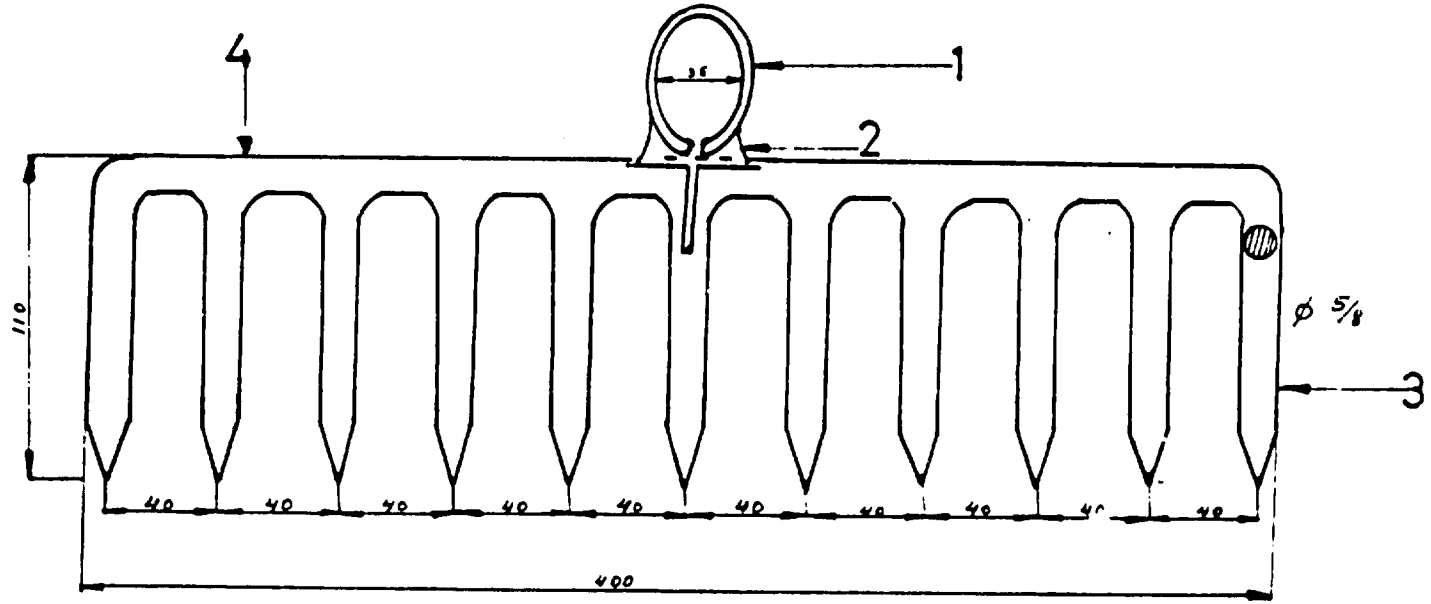

| | | | |
|---|---|---|---|
| TRIDENTE PEQUEÑO | ESCALA 1:20 | | Fecha / Nombre |
| | | Diseñado | 89 / HERRANDINA |
| | | Dibujado | 10/07/89 / D. N. S. |
| | | Aprobado | |
| HERRANDINA | | | |

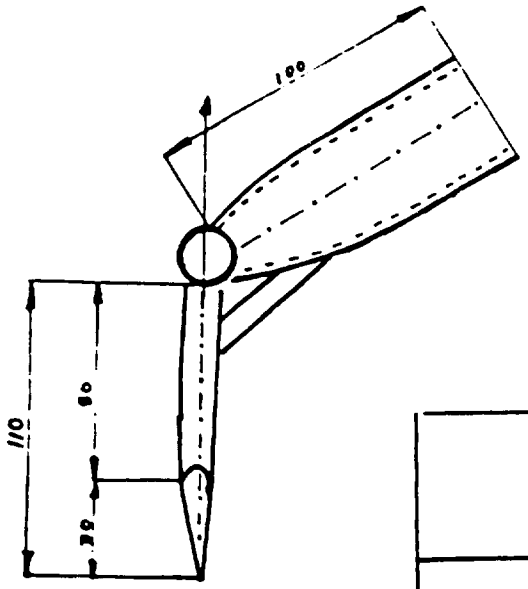



| | | | | |
|---|---|---|---|---|
| PICOTA | ESCALA 1:20 | | Fecha | Nombre |
| | | Diseñado | 89 | Herrandina |
| | | Dibujado | 6/7/88 | D.N.S |
| | | Aprobado | | |
| HERRANDINA | | | | |




| | | | | |
|---|---|---|---|---|
| AZADON TIPO ESCARDILLO | | | Fecha | Nombre |
| | | Diseñado | 89 | Herrandina |
| | | Dibujado | 6/7/88 | D N S |
| | | Aprobado | | |
| HERRANDINA | | | | |



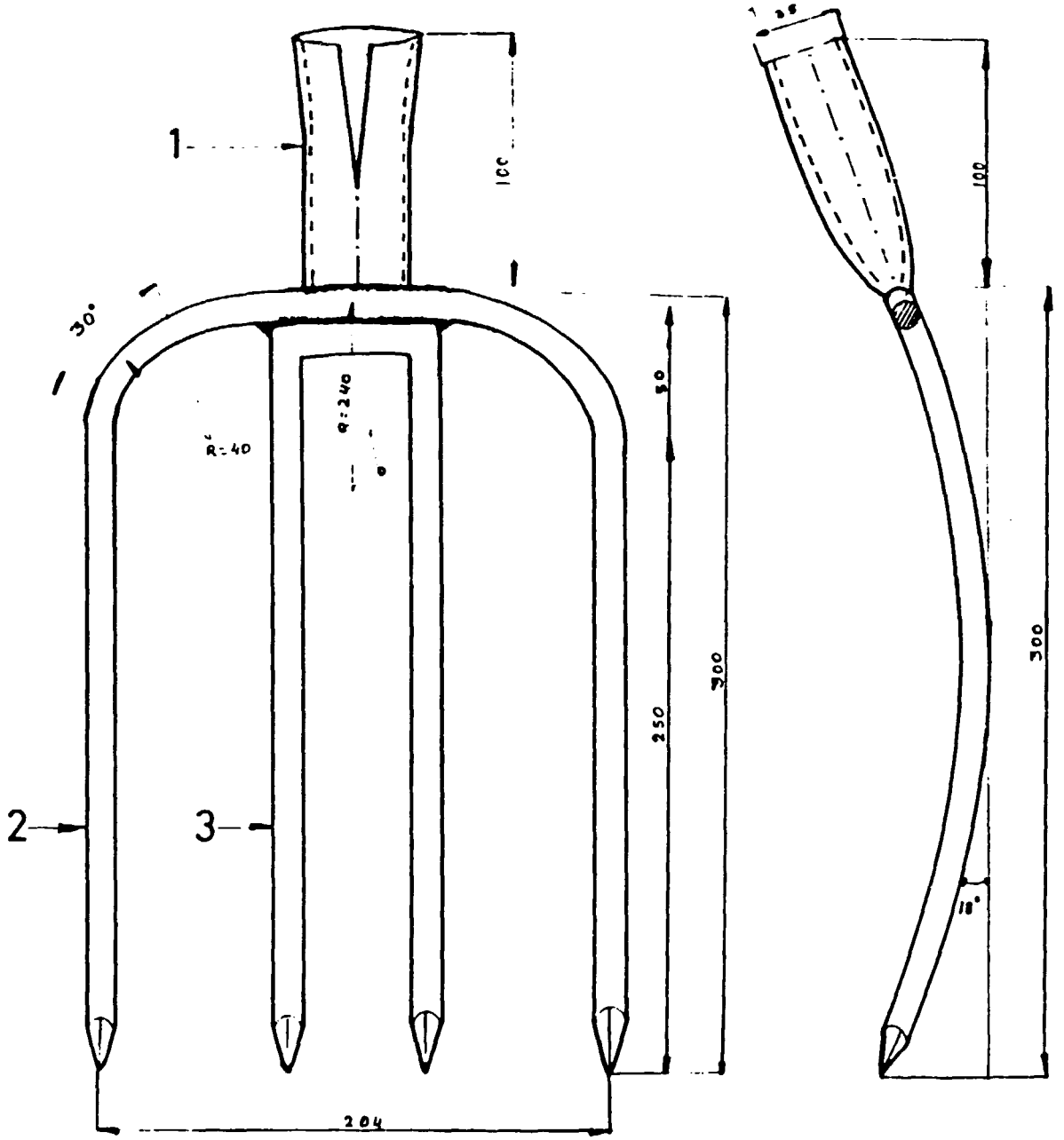




# RASTRILLO

ESCALA 1:25

| | | Fecha | Nombre |
|---|---|---|---|
| | Diseñado | 89 | HERRANDINA |
| | Dibujado | 10/07/89 | D·N·S |
| | Aprobado | | |

HERRANDINA




| | | | | |
|---|---|---|---|---|
| HORQUETA | ESCALA 1:25 | | Fecha | Nombre |
| | | Diseñada | 89 | HERRANDINA |
| | | Dibujado | 10/07/89 | D. N. S. |
| | | Aprobado | | |
| HERRANDINA | | | | |

GRAIN WINNOWER 

Introduction:

A presentation is made of a series of Food processing equipment, currently in application in the andean rural areas, especially in Peru. They have been studied and their engineering drawings and production methods rationalized , for better dissemination among farmers, small manufaturers and handicraftmen in the country, these are been promoted as capable of providing to the users: Good performance, Quality and ease of work.

GRAIN WINNOWER

application: Cleaning of grains, big and small

Advantages:
- more efficiency in the cleaning of grains small and big, it has a capacity of 150 - 250 kg/hr.
- it classifies grains like quinua, cañihua and kiwicha
- easy to operate

Technical data:
- weight 35 kg
- length 1.55 m, width 0.45 m, heigth 0.98 m

technical terms in drawing: spanish - english
- Tolva
  - Hopper
- Ranura para entrada para el material a ventear
  - Inlet opening for material to be winnowed
- Ganchos para colocar dos costales
  - hooks for hanging two bags
- Manivela para accionar el ventilador
  - handle for turning winnower blower
- Ventilador
  - blower
- LIMPIA Y CLASIFICA GRANOS
  - CLEANS AND CLASSIFIES GRAINS

for further information:
Cooperación Técnica del Gobierno Suizo
Cotesu - Herrandina
P.O. Box 378, Lima 100, Perú

## Operation Instructions

Only two persons are required

- Two bags are hung under the Winnower
- The material is loaded thrashed and sifted in the hopper of the winnower.
- One of the operator feed little by little the machine, through the inlet opening, trying to create a uniform curtain of material
- The other operator is responsible for turning the wheel handle to move the blower, giving the necessary and appropriate revolutions according to the type of grain being treated, for small grains like cañihua, kiwicha or quinua, it is slower; for grains like oats, wheat or barley, the blower has to be run faster and for larger and heavier material like tarwi, beans and other pulse, the rotational speed of the fan has to be even faster.
- the big and clean unbroken grains fall by gravity into the first bag, and the smaller broken grains and the unwanted seeds fall into the second bag.
- the refuse and stubble are expelled through the rear part of the machine.
- it classifies the small grains like kiwicha, quinua as well as the wheat, barley and other grains.

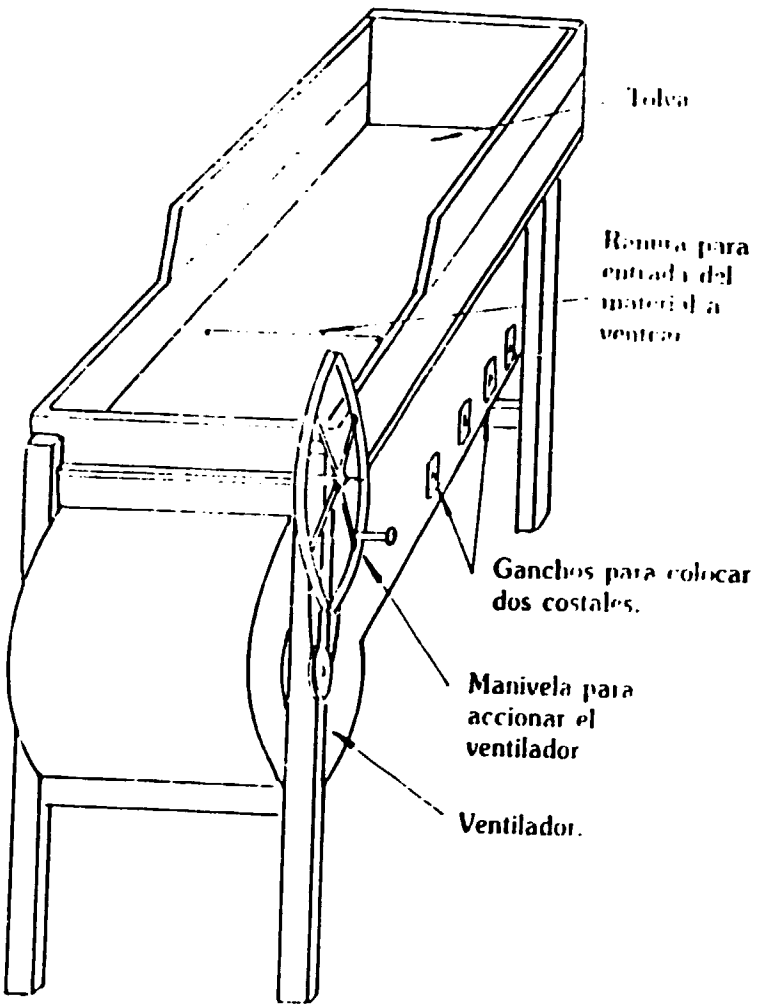
## Performance and operational data

| Crop | handle rpm | Kg/hr |
|---|---|---|
| horsebeans | 95 - 100 | 100 - 150 |
| french beans | 90 - 95 | 400 - 450 |
| tarwi | 90 - 95 | 200 - 450 |
| wheat,barley,oat | 90 - 95 | 200 - 250 |
| quinua | 50 - 60 | 50 - 60 |
| kiwicha | 50 - 60 | 30 - 50 |

* rpm revolutions per minute

GRAIN WINNOWER





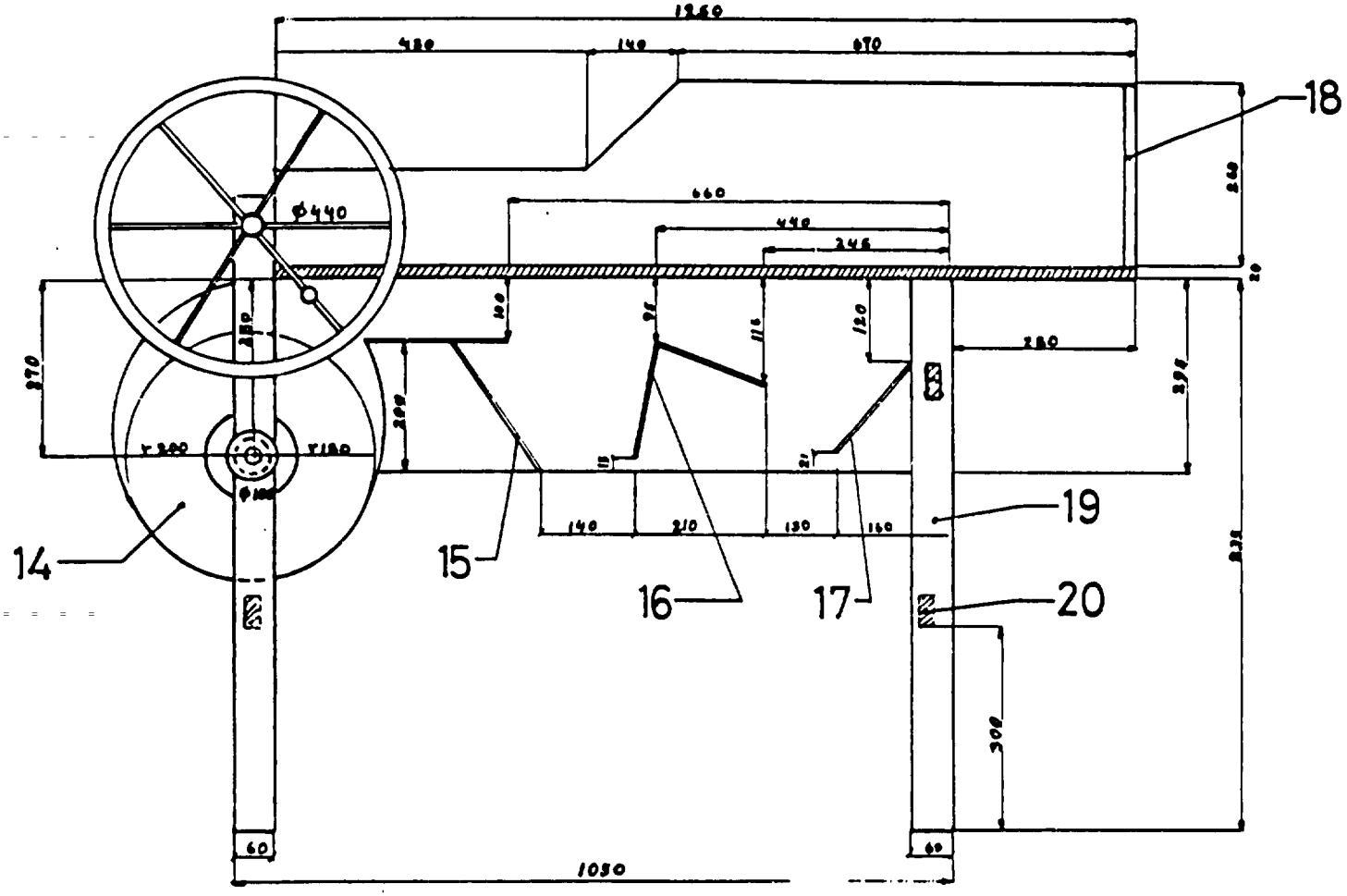
GRAIN WINNOWER



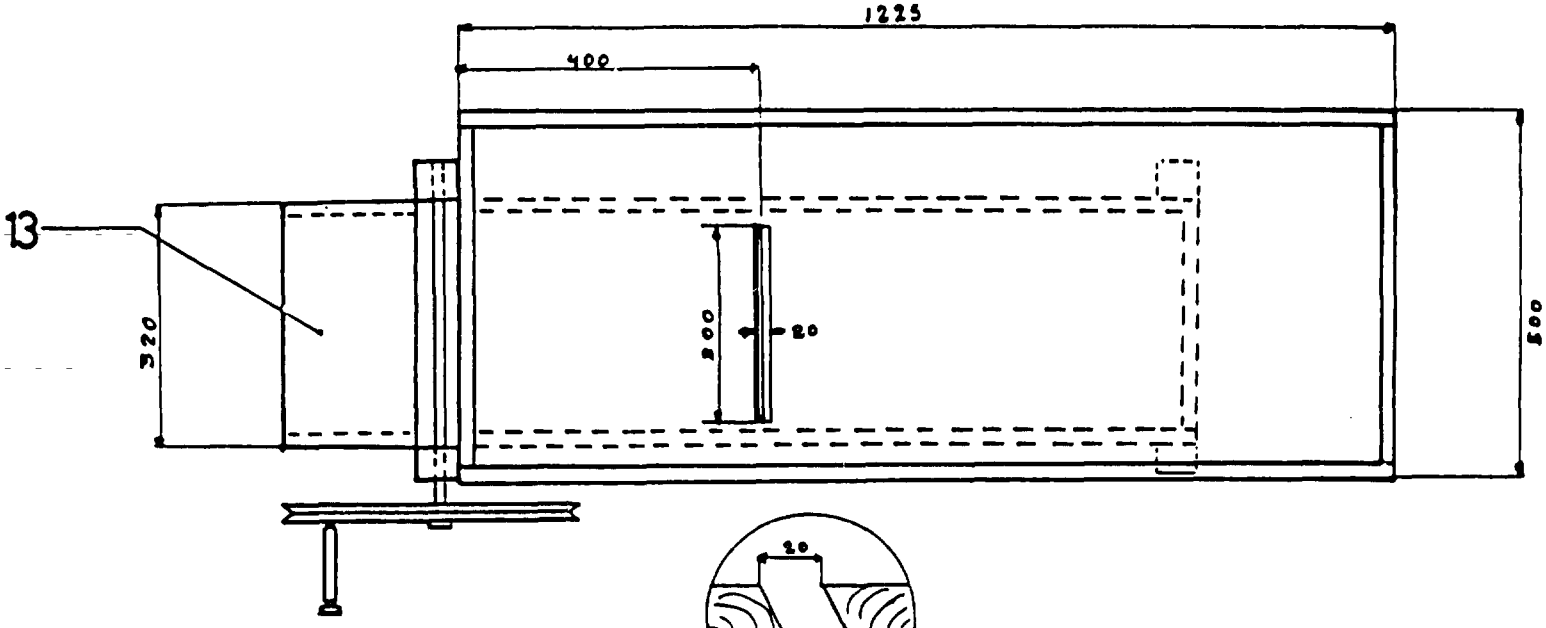
WINNOWER

PARTS LIST

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | Wheel(channel) | 1 | equal angles 1" x 1/8" | 133 cm | |
| 2 | wheel arms | 6 | corr. bar 3.8" ø | 19 cm | 114 cm |
| 3 | handle | 1 | round bar 1/2" ø | 12 cm | |
| 4 | handle sleeve | 1 | steel pipe 5/8" ø | 11 cm | |
| 5 | bushing(wheel shaft) | 2 | PVC pipe 5/8" ø | 5 cm | 10 cm |
| 6 | wheel shaft | 1 | round bar 5.8" ø | 56 cm | |
| 7 | pulley | 2 | steel plate 1/8" | 10 x 10 cm | 0.02 m2 |
| 8 | blower shaft | 1 | round bar 5/8" ø | 48 cm | |
| 9 | fan blades | 6 | steel plate 1/32" | 12 x 28.5 cm | 0.21 m2 |
| 10 | blades bracings | 12 | flat bar 3/16" x 3/4" | 16 cm | 1.92 m2 |
| 11 | bushing(fan shaft) | 1 | galv.steel pipe 5/8" ø | 24 cm | |
| 12 | fixing screw | 1 | screw 3/8" ø x 1" | | |
| 13 | fan cover | 1 | corrugated galv. plate 1/64" | 150 x 34 cm | 0.52 m2 |
| 14 | fan box(lower part) | 2 | wood plank 1" x 6" | 35 cm | 70cm(1.2ft2) |
| 15 | classifier cover | 1 | corrugated galv.plate 1/64" | 36 x 64 cm | 0.122 m2 |
| 16 | classifier cover | 1 | corrugated galv.plate 1/64" | 26 x 34 cm | 0.054 m2 |
| 17 | classifier cover | 1 | corrugated glav.plate 1/64" | 16 x 34 cm | 0.054 m2 |
| 18 | hopper : sides | 2 | wood plank 1" x 6 " | 125cm | 250cm(4.2ft2) |
| | sides | 2 | wood plank 1" x 6" | 80cm | 160cm(2.7ft2) |
| | head end | 3 | wood plank 1" x 6" | 42cm | 126cm(2.2ft2) |
| | bottom | | wood plank 1" x 6" | 47cm | (0.8ft2) |
| 19 | machine legs | 2 | wood, square 2" x 2" | 97cm | 194cm(2.2ft2) |
| | | 2 | wood, square 2" x 2" | 89cm | 178cm(2ft2) |
| 20 | cross bars | 4 | wood, square 2" x 2" | 44 cm | 176cm(2 ft2) |
| | | | TOTAL WOOD | 17.3 ft2 | |




| | | | | |
|---|---|---|---|---|
| VENTEADORA | ESCALA | | FECHA | NOMBRE |
| | | Diseñado | | |
| | | Dibujado | 6/7/88 | D. N. G. |
| | | Aprobado | | |
| HERRANDINA | CORTE | | | |

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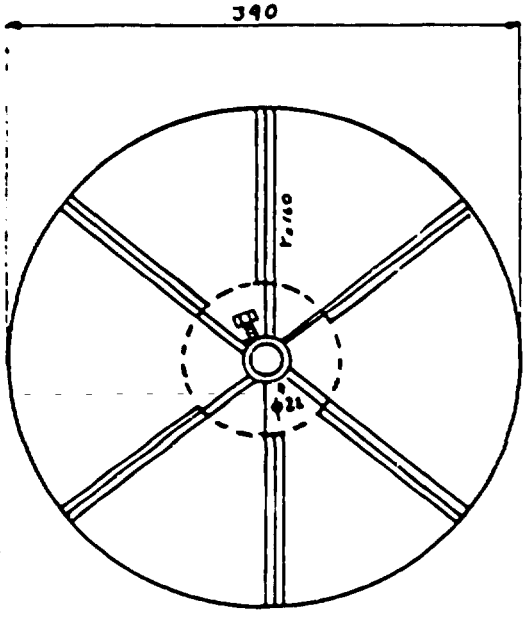
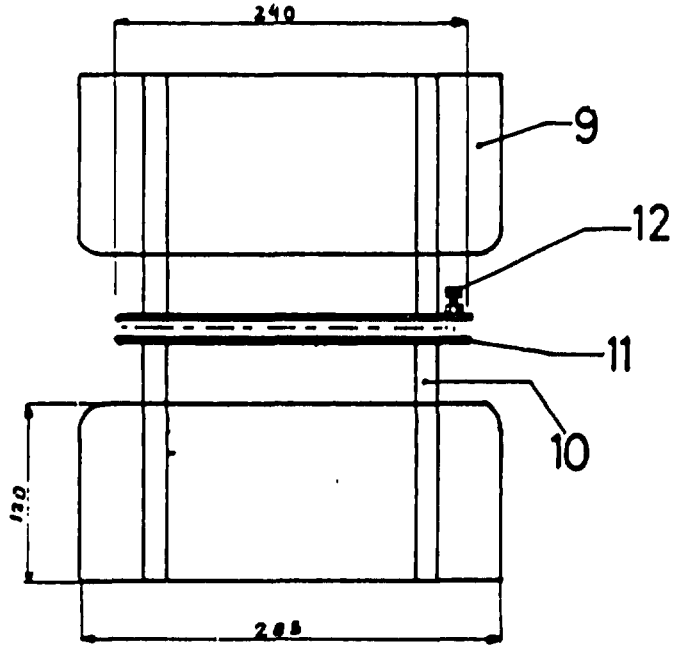
|---|---|---|---|
| VENTEADORA | Escala: 1:10 | Fecha | Nombre |
| | Diseñado | | |
| | Dibujado | 2/88 | D.N.S. |
| | Aprobado | | |
| HERRANDINA | PLANTA | | |

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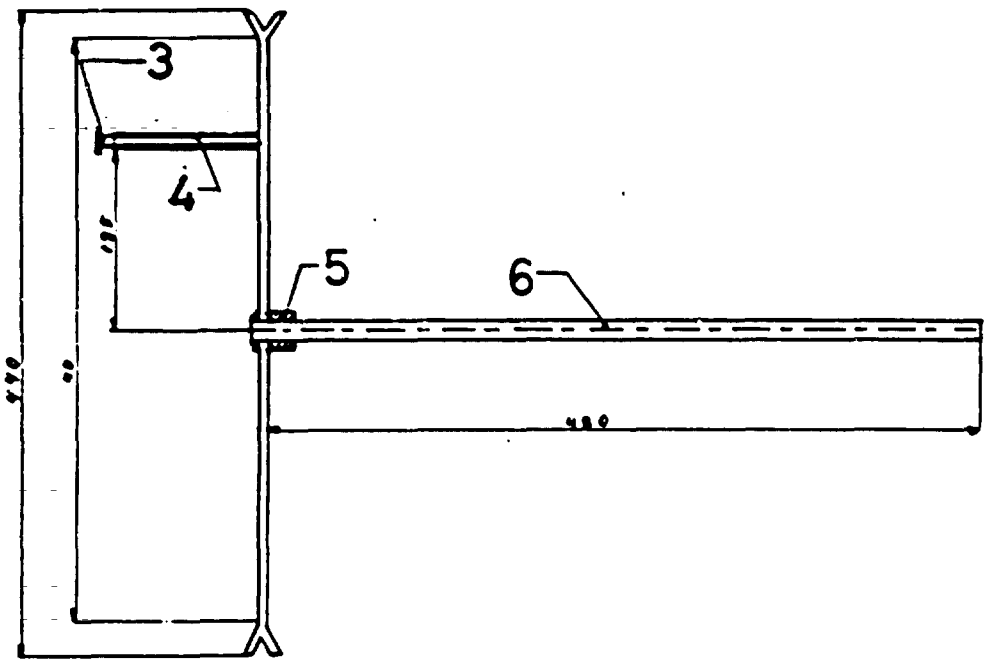
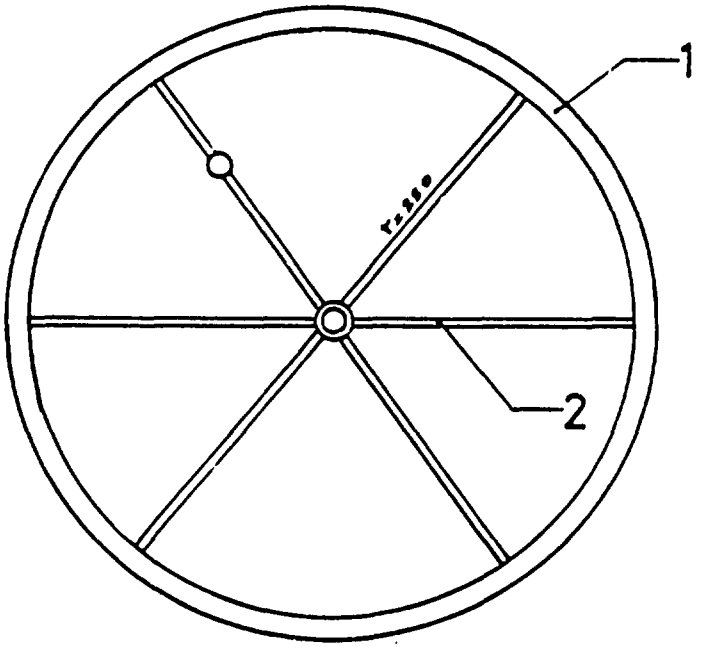
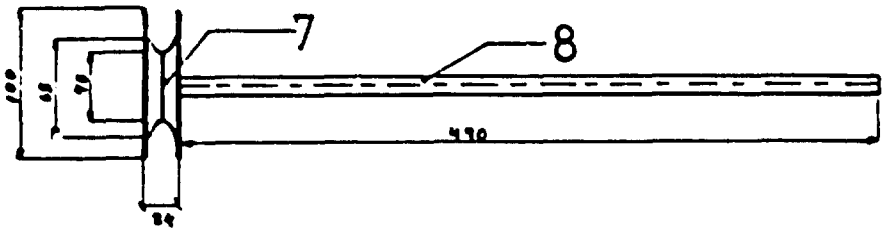
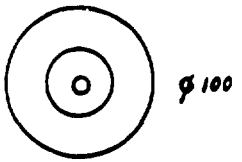
|---|---|---|---|---|
| VENTEADORA | ESCALA 1:10 | | Fecha | Nombre |
| | | Diseñado | | |
| | | Dibujado | 6/7/88 | D. N. S. |
| | | Aprobado | | |
| HERRANDINA | DETALLES | | | |

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|---|---|---|---|---|
| VENTEADORA | ESCALA 1:10 | | Fecha | Nombre |
| | | Diseñado | | |
| | | Dibujado | 6/7/88 | D. N. S |
| | | Aprobado | | |
| HERRANDINA | DETALLES | | | |

HAND CUTTER 

Introduction:

A presentation is made of a series of Food processing equipment, currently in application in the andean rural areas, especially in Peru. They have been studied and their engineering drawings and production methods rationalizaed , for better dissemination among farmers, small manufaturers and handicraftmen in the country, these are been promoted as capable of providing to the users: Good performance, Quality and ease of work.

HAND FORRAGE CUTTER

application:
- cutting of forrage servings for fodder, hay or grass for horses
- better cutting of forrage allows improved consumption and diminishes losses

Advantages:
- forrage can be cut to desired size
- it occupies little space
- easy to handle and maintain

Technical data:
- weight 5 kg
- chopping-knife 22" long
- it can be fixed to the wall or a column

technical terms in drawing: spanish - english
- Guia
  - guide
- Tolva
  - Hopper
- Machete
  - machete, sugar-knife, cutting knife
- contracorte
  - counter-cut, knife cutting base

for further information:
Cooperación Técnica del Gobierno Suizo
Cotesu - Herrandina
P.O. Box 378, Lima 100, Perú

HAND CUTTER

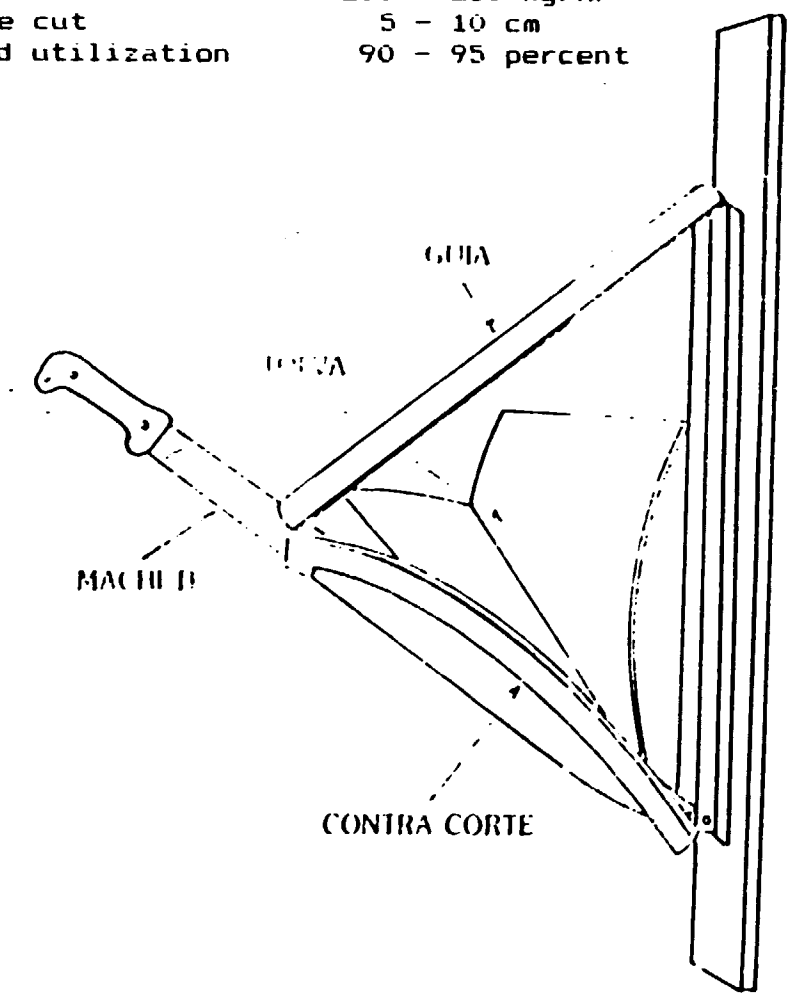


Operation Instructions

- Only one person is required
- a bundle of material to be cut is held with the left hand, introducing it through the hopper, (to cut the desired length)
- with the right hand you pull the knife downwards, to produce the cut
- underneath the cutter you place a blanket or a basket to receive the cut material

Performance and operational data

| | |
|---|---|
| - stubble and dry hay | 150 - 200 kg/hr |
| - fresh or green grass | 250 - 300 kg/hr |
| - leaf of maize | 200 - 250 kg/hr |
| - size of the cut | 5 - 10 cm |
| - animal food utilization | 90 - 95 percent |



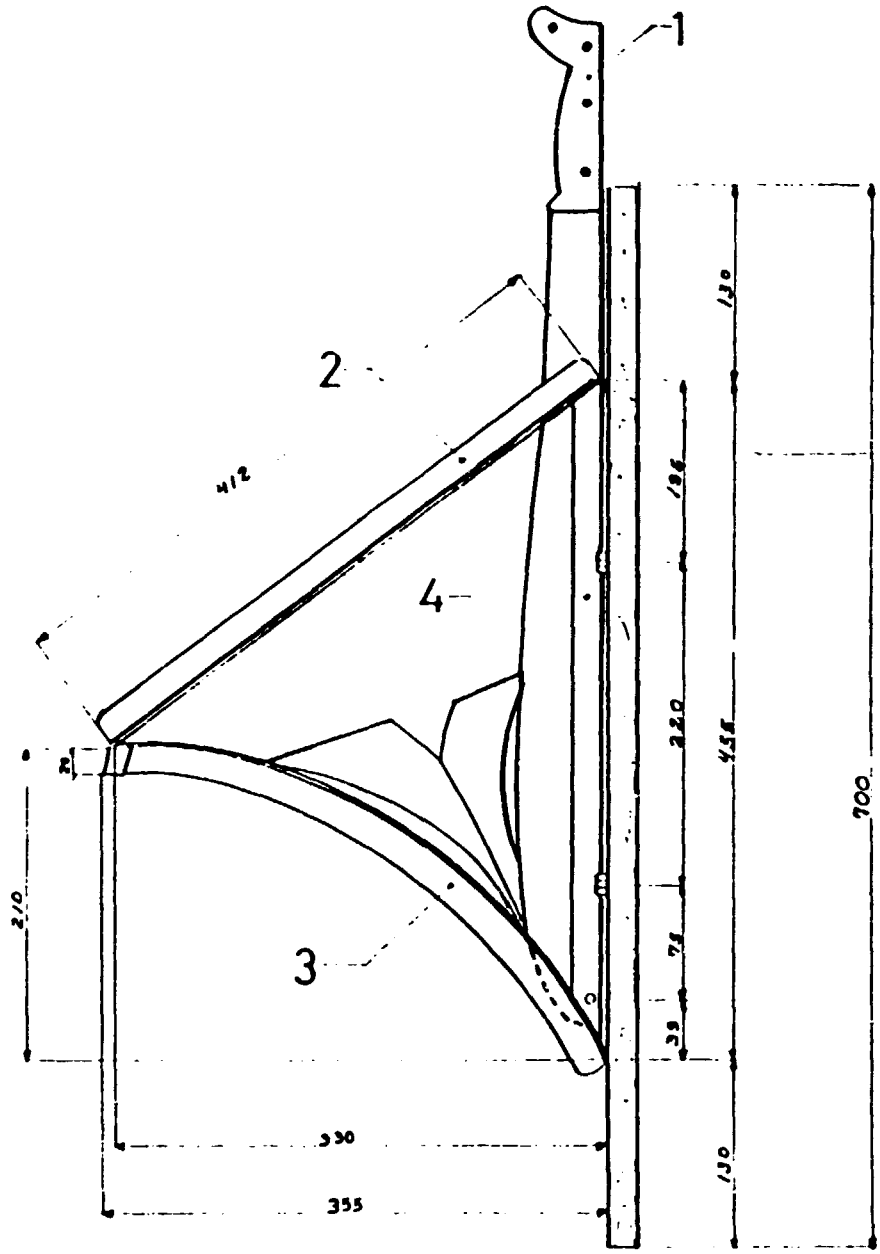
HAND CUTTER



HAND FORRAGE CUTTER

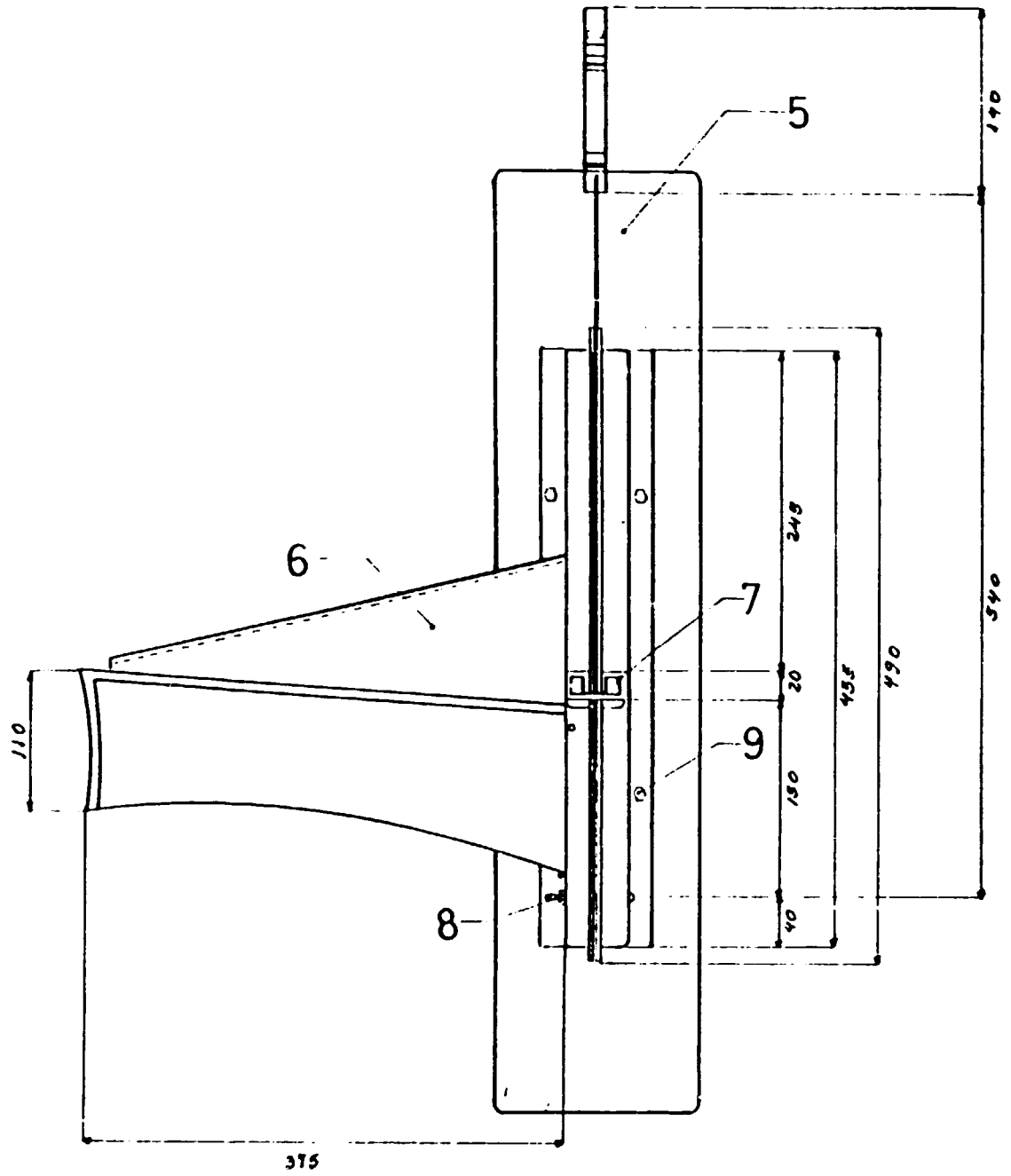
PARTS LIST

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | knife | 1 | machete (knife) | 22" | |
| 2 | knife guide | 2 | equal steel angle 1" x 1/8" | 41.2 cm | 82.4 cm |
| 3 | counter knife | 2 | equal steel angle 1" x 1/8" | 42 cm | 84 cm |
| 4 | support | 2 | equal steel angle 1" x 1/8" | 45.5 cm | 91 cm |
| 5 | wooden support | 1 | wood plank 1" x 6" | 70 cm | |
| 6 | hopper | | corrugated galvn plate 1/64" | 0.17 m2 | |
| 7 | knife stop | 1 | flat bar 3/16" x 1" | 10 cm | |
| 8 | fixing screw | 1 | screw 5/16" Ø x 2 1/2" | or 5/16"Ø | |
| 9 | cutter fixing bolts | 4 | bolts 3/8" Ø x 1 1/2" | optional | |
| 10 | knife support | 1 | flat bar 3/16" x 1" | 10 cm | |
| 11 | hopper fixing bolt | 2 | bolt 1/4" Ø x 1" | | |




10

| | | | | |
|---|---|---|---|---|
| PICADORA DE FORRAJES | Escala 1/6 | Diseñado | Fecha | Nombre |
| | | Dibujado | 6/7/88 | D.M.S. |
| | | Aprobado | | |
| HERRANDINA | PERFIL | | | |




| PICADORA DE FORRAJES | Escala 1/5 | | Fecha | Nombre |
|---|---|---|---|---|
| | | Diseñado | | |
| | | Dibujado | 6/7/88 | D. N. S |
| | | Aprobado | | |
| HERRANDINA | FRENTE | | | |

SPIKE HARROW 

Introduction:

A presentation is made of a series of Agricultural equipment, currently in application in the andean rural areas, especially in Peru. They have been studied and their engineering drawings and production methods rationalized , for better dissemination among farmers, small manufaturers and handicraftmen in the country, these are been promoted as capable of providing to the users: Good performance, Quality and ease of work.

application:
it crushes soil clods

- recollects weeds and other undergrowth
- levels the ground
- covers the seeds

Advantages:

- it creates a good bed for the seeds, it does not compact the soils, it only crushes the clods
- it covers the seeds to a uniform depth, the seeds germinate more uniformly
- pulls and recollects all the weed, leaving it at the side of the terrain
- it can be easily coupled to the andean plough or it can also be pulled with a rope

it is of solid construction and easy to handle

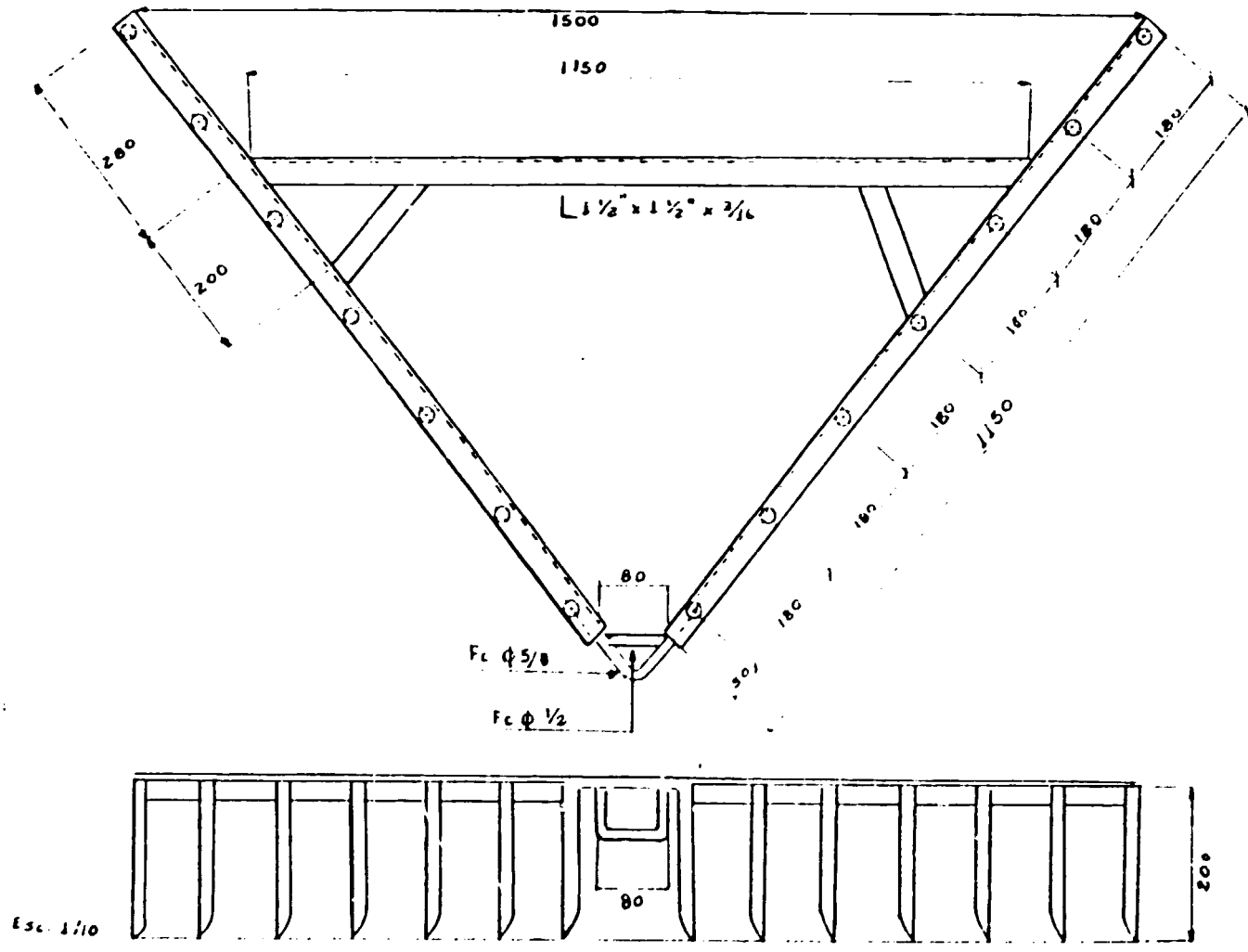
for further information:
Cooperación Técnica del Gobierno Suizo
Cotesu - Herrandina
P.O. Box 378, Lima 100, Perú

SPIKE HARROW



Technical data:

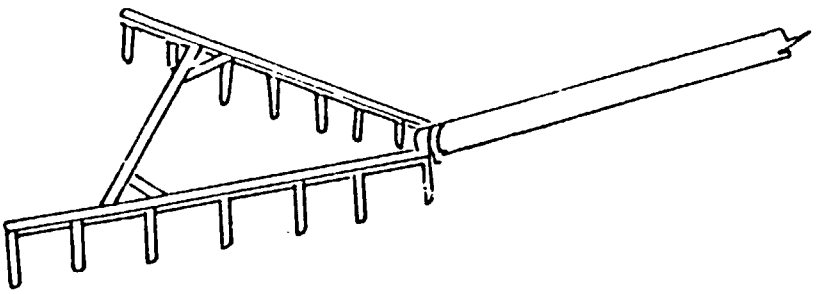
- weight of the harrow 12.5 kg
- width of the work 1.5 m
- number of teeth 2 x 7 = 14 teeth
- distance between teeth 9 cm



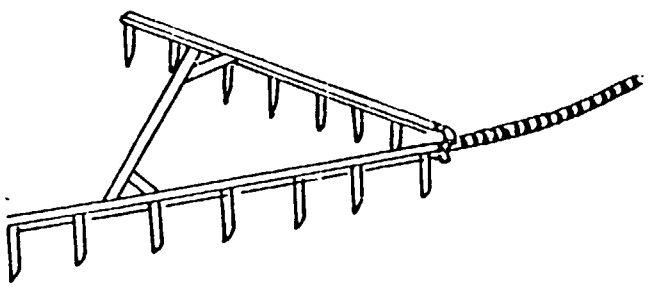
SPIKE HARROW 

Operation Instructions

- the harrow is pulled from the steering bar by a rope or with the andean plough



harrow pulled with a wooden steering bar 3 to 3.5 m long



harrow pulled with a rope, attached to animal yoke

- the harrow's light weight allows an easy transport
- to improve the effect of clod crushing and increasing the depth of work, additional weights have to be installed, the operator or his helper must stand on the harrow

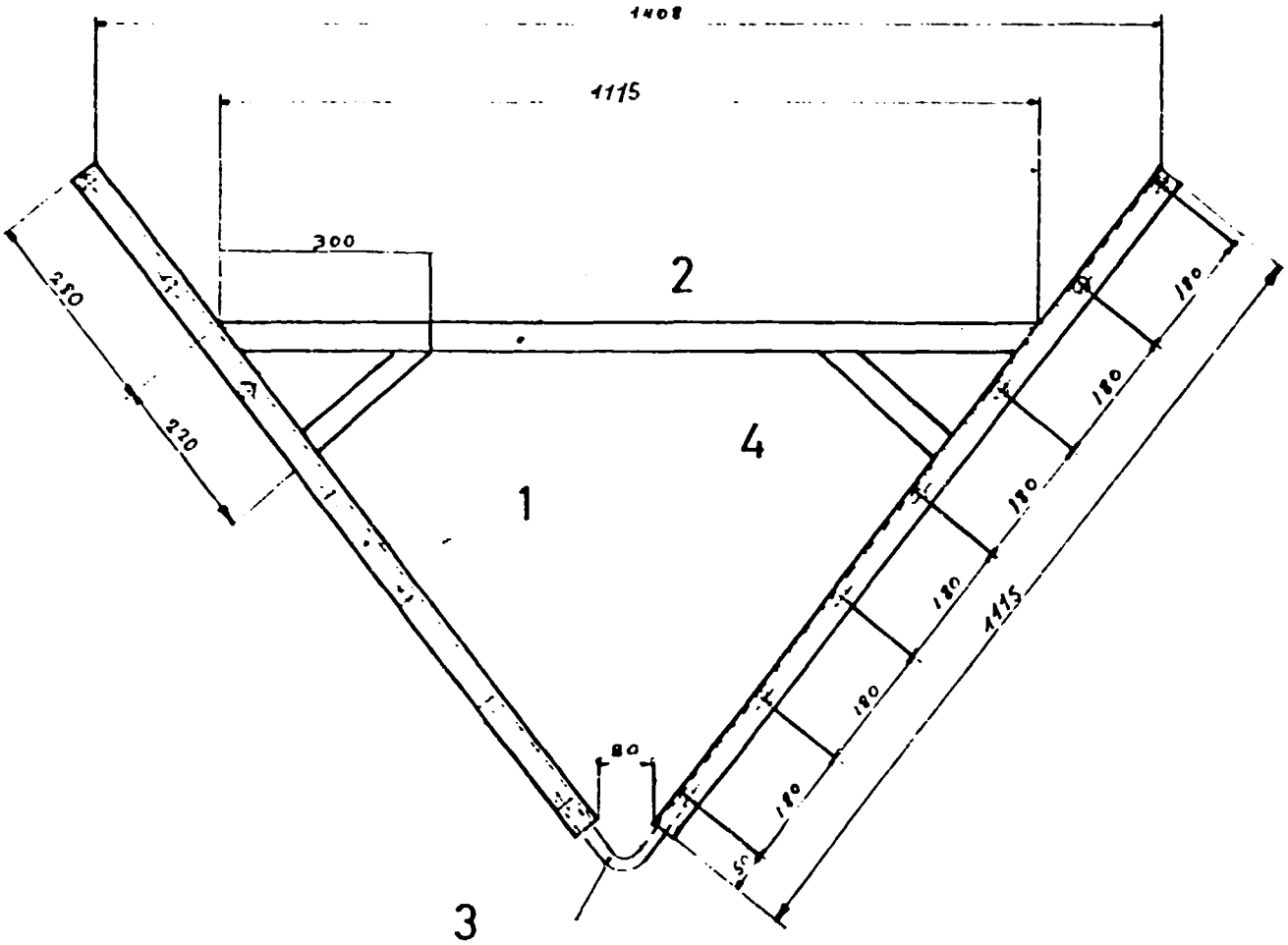
Performance and operational data

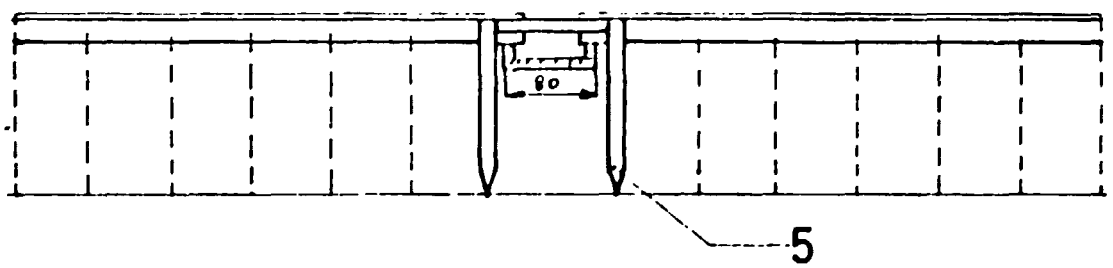
- for weed cleaning, clod-crushing and levelling, it requires approximately 4 hours per hectare
- in recollection of weeds and other undergrowth 90 %
- degree of crushing 78 %
- seeds covered in one pass 83 %
- seeds covered in two passes 95 %
- clod crushing per day 2 hectares
- it covers the seeds when they are hand thrown to the air for seeding
- it covers the seeds and levels the ground when seeding is made in furrows

SPIKE HARROW p. 4

SPIKE HARROW(animal drawn) PARTS LIST

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | side bars | 2 | equal angles 3/16" x 1/1/2" | 115 cm | 230 cm |
| 2 | cross bars | 1 | equal angles 3/16" x 1/1/2" | 115 cm | |
| 3 | ear | 1 | corr. bar 5/8" ø | 25 cm | |
| | | | corr. bar 1/2 ø | 16 cm | |
| 4 | reinforcement | 2 | flat bar 1/8" x 1 1/2" x 28 cm | 56 cm | |
| 5 | teeth | 14 | corr. bar 5/8" ø x 15 cm | 210 cm | |
| | electric welding | 4 | Cellocord 1/8" ø | 0.11 kg | |
| | electric welding | 16 | Supercito 1/8" ø | 0.57 kg | |
| | coal for forging | 1 kg | | | |




| | | | | |
|---|---|---|---|---|
| RASTRA DE DIENTES | Escala 1:10 | | Fecha | Nombre |
| | | Diseñado | 6.7.88 | HERRANDINA |
| | | Dibujado | 6.7.88 | DNS |
| | | Aprobado | 6.7.88 | HERRANDINA |
| HERRANDINA | | | | |

PACKER or BALE MAKER 

Introduction:

A presentation is made of a series of Food processing equipment, currently in application in the andean rural areas, especially in Peru. They have been studied and their engineering drawings and production methods rationalized, for better dissemination among farmers, small manufaturers and handicraftmen in the country, these are been promoted as capable of providing to the users: Good performance, Quality and ease of work.

application:
- preparation of hay and forrage bales, for storing and conservation

Advantages:
- reduces the volume of forrage by 4:1 or 5:1
- allows an easy handling and transportation of forrage
- reduces the losses
- the equipment is of easy handling
- maintains the quality of forrage

Technical data:
- weight of baler 54 kg
- length 1.97 m, width 0.50 m, heigth 0.60 m
- steering bar or lever 2.5 to 3 m

technical terms in drawing: spanish - english
- agarradera de compuerta
  - gate handle
- apertura de llenado de material
  - opening for refilling of material
- corredera de la prensa
  - slipway for the press
- mecanismo de presion
  - mechanism for application of pressure
- palanca
  - handle bar or lever

## Operation Instructions

- fix and adjust properly the cover of the bale maker
- place the material to be packed (hay, stubble, etc.) inside the feeding box and once it is full, pull the lever to press the bale.
- this process is repeated until the material being packed is sufficiently compressed, forming a compact bale.
- the fastening operation is done passing either a wire or a rope through the box slits.
  -Tie up with a yute string or wire.-
- once the bale has been well fastened, the cover is removed and refilled with more material to prepare the second bale that will push out the first bale.
- once two thirds of the bale has come out, the extraction is helped pulling with both hands, to prevent the material from the second bale coming out.
- the cover is replaced in position, the second bale is compresed until it can be fastened; this operation is repeated for the following bales.

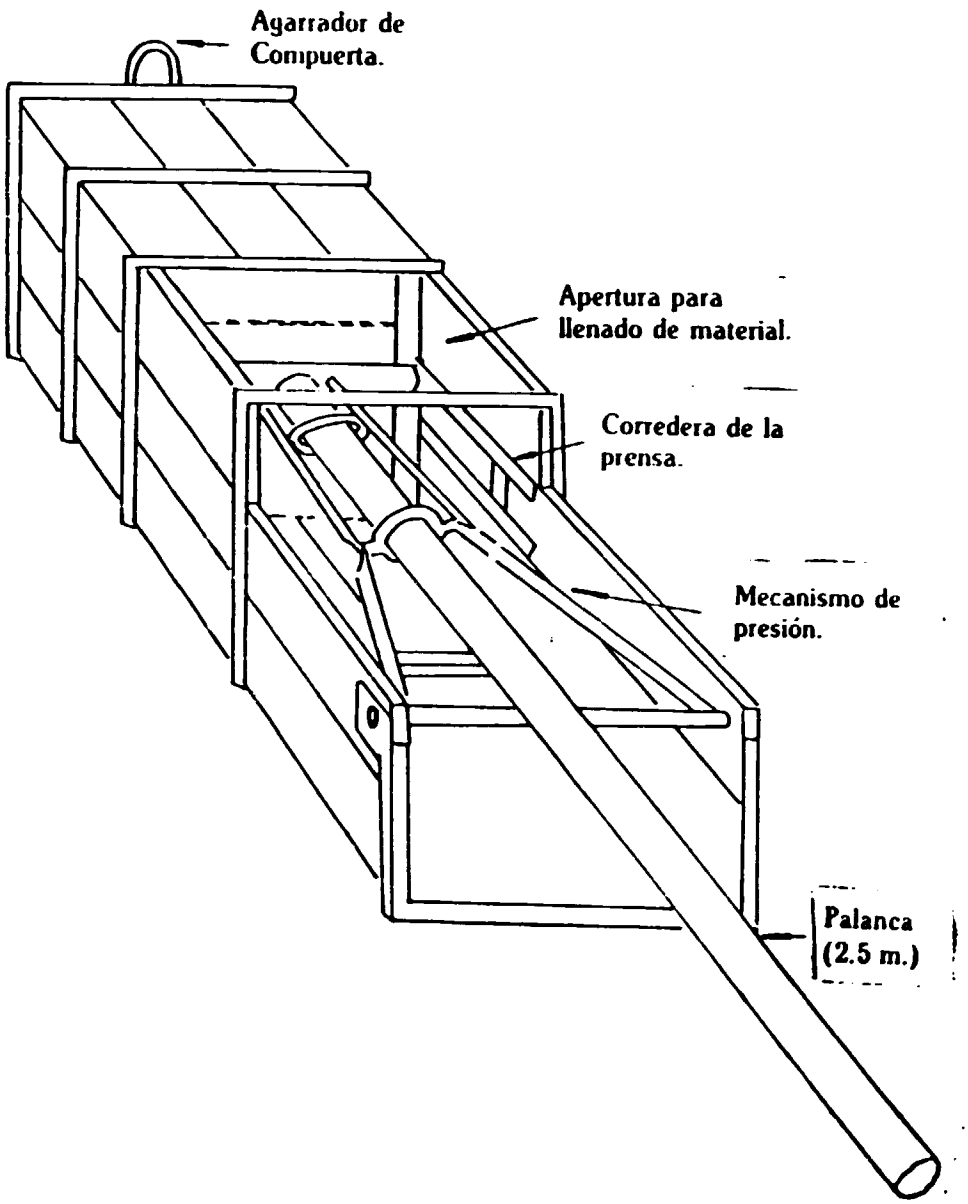
## Performance and operational data

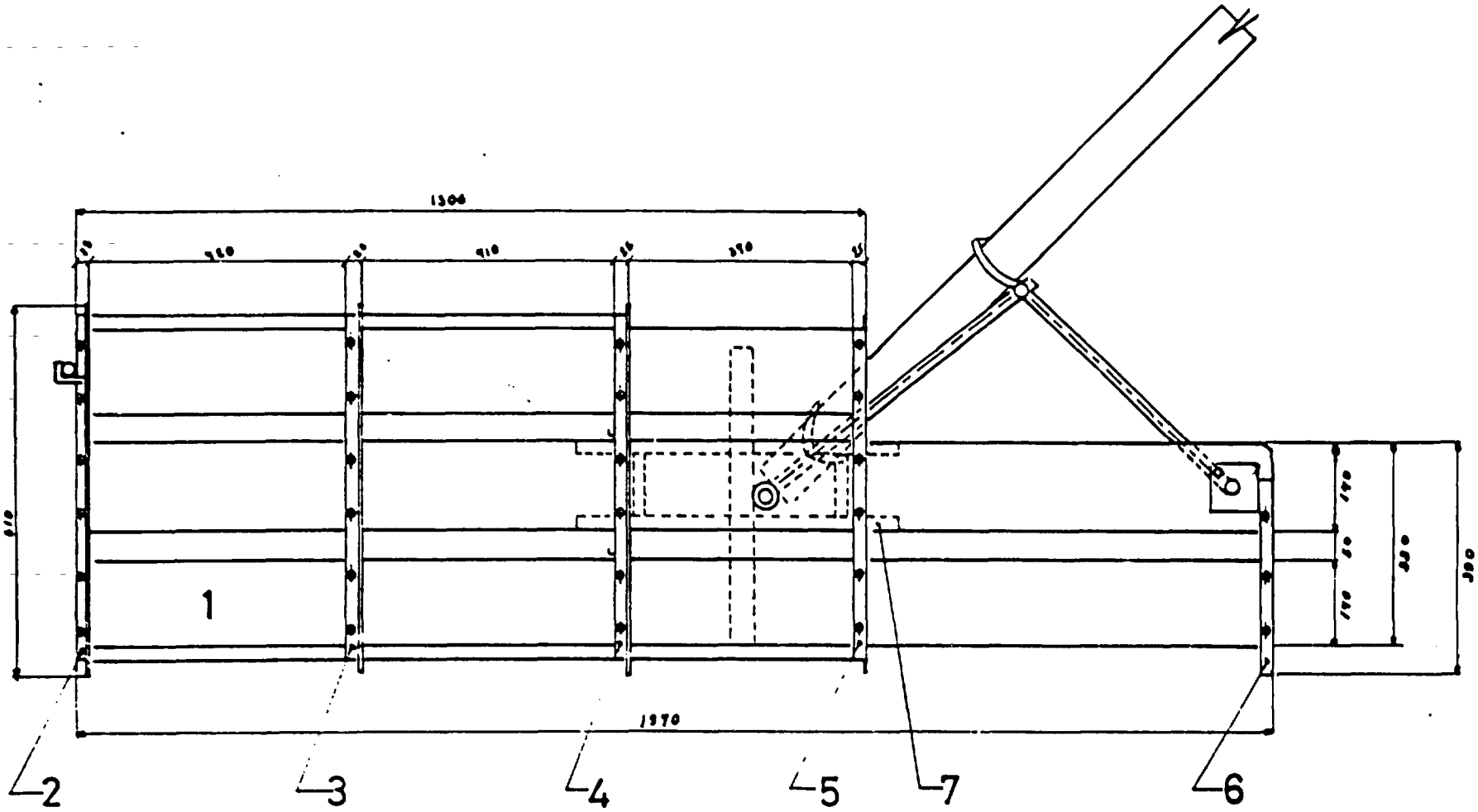
- in one day's work 60 - 80 bales can be completed of hay and stubble
- this labour is done by two or three workers
- the packing of leafe of maize is more laborious and only some 20 bales per day can be obtained

for further information:
Cooperación Técnica del Gobierno Suizo
Cotesu - Herrandina
P.O. Box 378, Lima 100, Perú

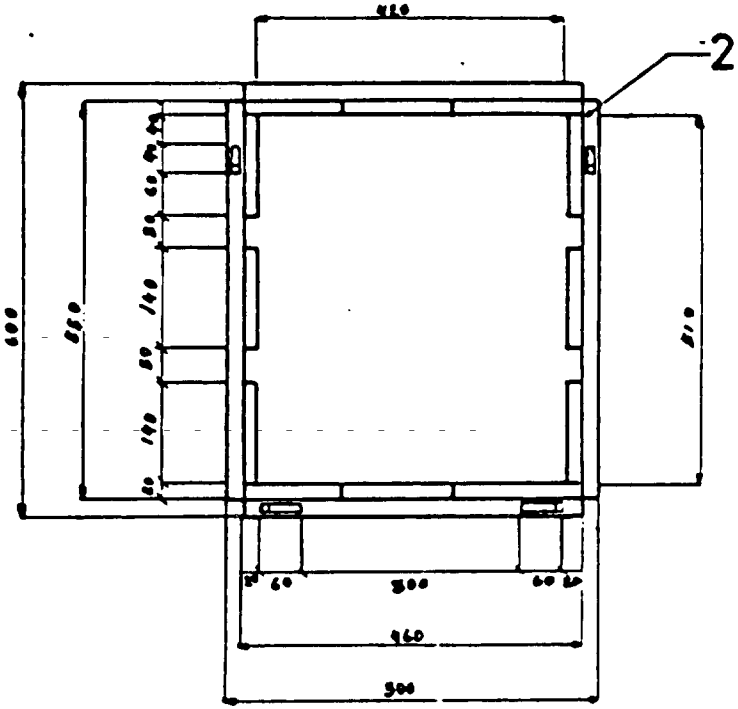
BALE MAKER PARTS LIST

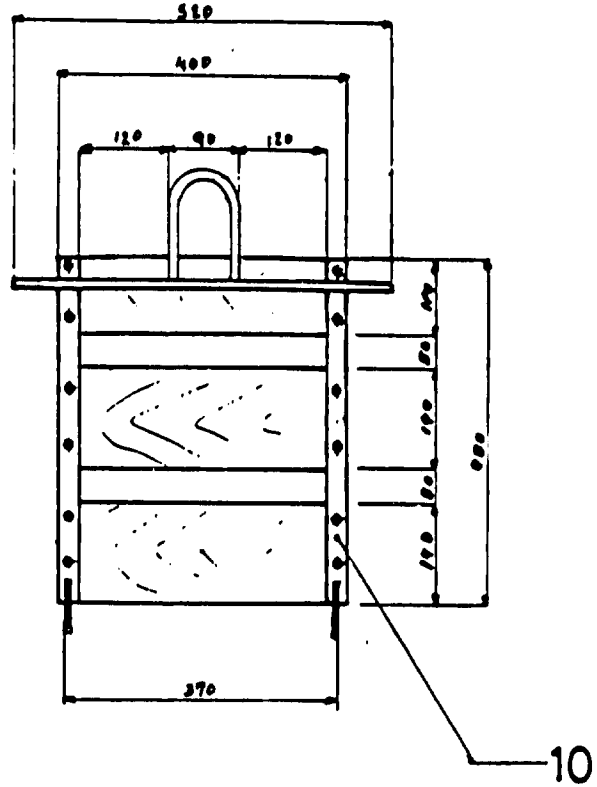
| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | box | 4 | wood plank 1" x 6" | 196cm | 784cm(13.2ft2) |
| | | 5 | wood plank 1" x 6" | 130cm | 650cm(10.0ft2) |
| | | 3 | wood plank 1" x 6" | 90cm | 270cm( 4.5ft2) |
| | press | 3 | wodd plnk 1 1/2" x 5" | 38cm | 114cm( 2.4ft2) |
| | cover | 3 | wood plank 1" x 5" | 38cm | 114cm( 1.6ft2) |
| | | | Total wood | | (32.6ft2) |
| 2 | cover frame | 2 | steel equal angles 1" x 1/8" | 60cm | 120cm |
| | | 2 | steel equal angles 1" x 1/8" | 45cm | 90cm |
| | fasteners | 2 | round bar 1/2" Ø | 6cm | 12cm |
| | | 2 | round bar 1/2" Ø | 7cm | 14cm |
| 3 | intermediate frame | 2 | steel equal angles 1" x 1/8" | 60cm | 120cm |
| | | 2 | steel equal angles 1" x 1/8" | 45cm | 90cm |
| | hooks | 2 | round bar | 5cm | 10cm |
| 4 | inlet frame | 4 | steel equal angles 1" x 1/8" | 55cm | 220cm |
| | | 2 | steel equal angles 1" x 1/8" | 50cm | 100 |
| 5 | press frame | 2 | steel equal angles 1" x 1/8" | 55cm | 110cm |
| | | 2 | steel equal angles 1" x 1/8" | 45cm | 90cm |
| 6 | intermediate ring | 1 | steel equal angles 1" x 1/8" | 45cm | |
| | | 2 | steel equal angles 1" x 1/8" | 32cm | 64cm |
| | | 2 | steel plates 1/8" | 9 x 8 cm | 0.014 m2 |
| 7 | slipway | 4 | steel equal angles 1" x 1/8" | 54cm | 216cm |
| | | 4 | flat bar 1" x 3/16" | 42cm | 84cm |
| 8 | pressure lever | 2 | steel pipe 3/4" Ø | 42cm | 84cm |
| | | 2 | steel pipe 3/4" Ø | 50cm | 100cm |
| | ring for lever | 2 | corr. bar 3/8" Ø | 19cm | 38cm |
| | ring for lever | 1 | corr. bar 3/8" Ø | 26cm | |
| | | 1 | steel pipe 5/8" Ø | 13cm | |
| | | 1 | round bar 5/8" Ø | 17cm | |
| | | 1 | steel pipe 3/4" Ø | 42cm | |
| | lever support | 2 | round bar 5/8" Ø | 13cm | 26cm |
| 9 | press | 2 | steel equal angles 1 1/2" x 1/8" | 46cm | 92cm |
| | | 1 | steel pipe 3/4" Ø | 38cm | |
| | | 1 | steel pipe 1" Ø | 31cm | |
| | pressure plate | 4 | steel equal angles 1" x 3/16" | cm | 68cm |
| | reinforcement | 2 | steel equal angles 1" x 3/16" | 17cm | 34cm |
| 10 | gate frame | 2 | steel equal angles 1" x 1/8" | 36cm | 72cm |
| | | 1 | round bar 1/2" Ø | 50cm | |
| | handle | 1 | corr. bar 3/8" Ø | 40 cm | |
| | | 2 | round bar 1/2" Ø | 10cm | 20cm |


Agarrador de
Compuerta.
Apertura para
llenado de material.
Corredera de la
prensa.
Mecanismo de
presión.
Palanca
(2.5 m.)

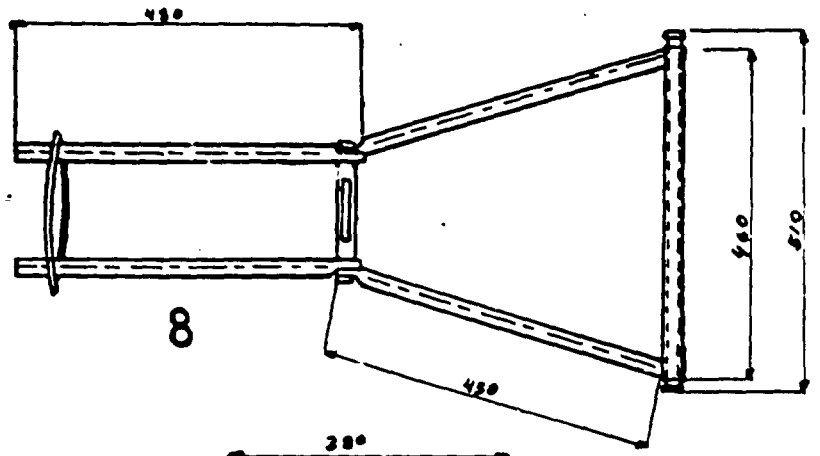


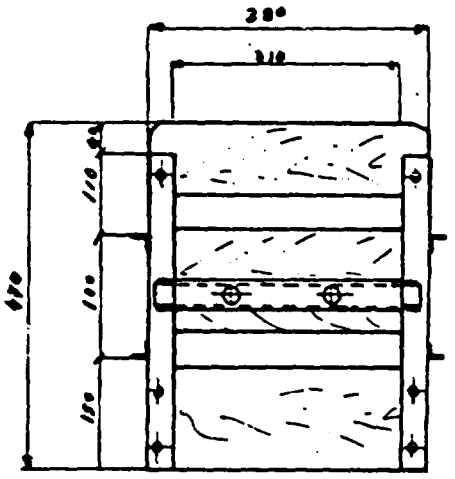

| | | | |
|---|---|---|---|
| ENFARDADORA | Escala: 1/10 | | Fecha / Nombre |
| | | Diseñado | |
| | | Dibujado | 5/88 — J. M. S |
| | | Aprobado | |
| HERRANDINA | PERFIL | | |

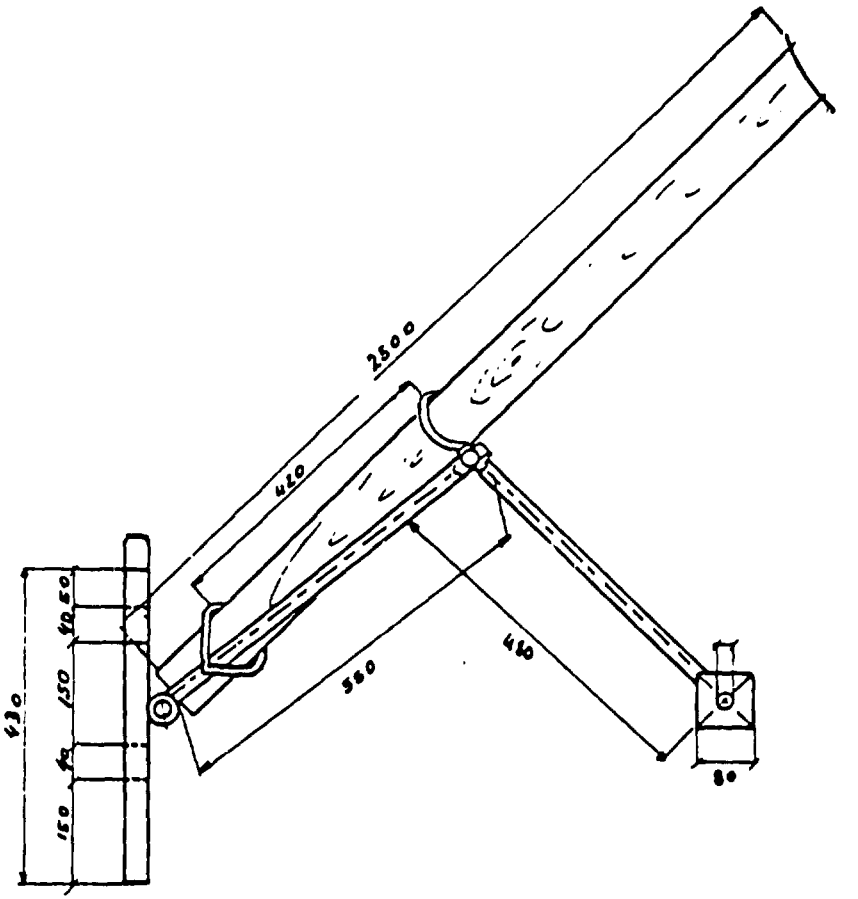



| | | | | |
|---|---|---|---|---|
| ENFARDADORA | Escala: 1:10 | | Fecha | Nombre |
| | | Diseñado | | |
| | | Dibujado | 6/7/88 | D. N. S. |
| | | Aprobado | | |
| HERRANDINA | DETALLES | | | |



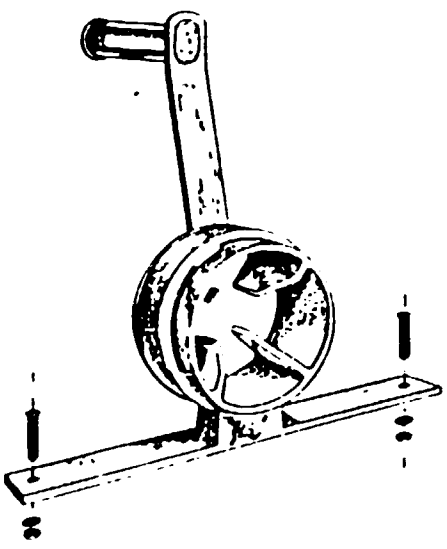

| | | | | |
|---|---|---|---|---|
| ENFARDADORA | Escala: 1:10 | | Fecha | Nombre |
| | | Diseñado | | |
| | | Dibujado | 6/7/88 | D. N. S. |
| | | Aprobado | | |
| HERRANDINA | DETALLES | | | |

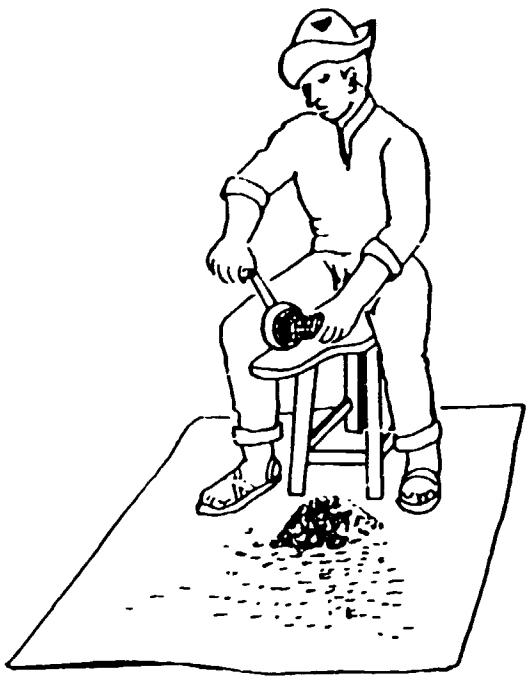
MANUAL GRAIN SHELLER p. 1

Introduction:

A presentation is made of a series of Food processing equipment, currently in application in the andean rural areas, especially in Peru. They have been studied and their engineering drawings and production methods rationalizaed , for better dissemination among farmers, small manufaturers and handicraftmen in the country, these are been promoted as capable of providing to the users: Good performance, Quality and ease of work.

EASY TO HANDLE - LOW COST - EASY INSTALLATION





it separates the hard grain from the cob

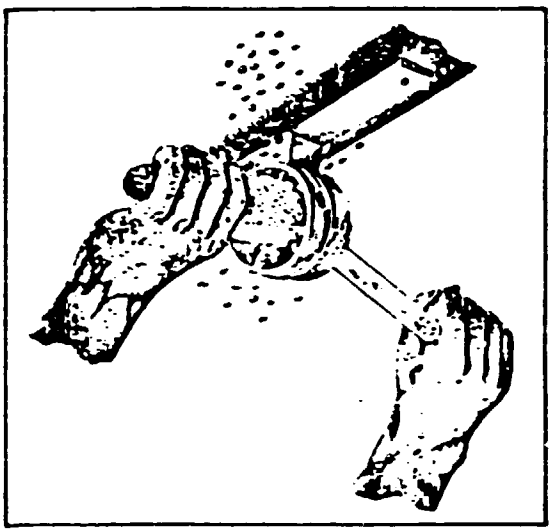
Advantages:
- it facilitates the work
- it does not hurt the hands
- it does not hurt the grain

for further information:
Cooperación Técnica del Gobierno Suizo
Cotesu - Herrandina
P.O. Box 378, Lima 100, Perú

MANUAL GRAIN SHELLER 

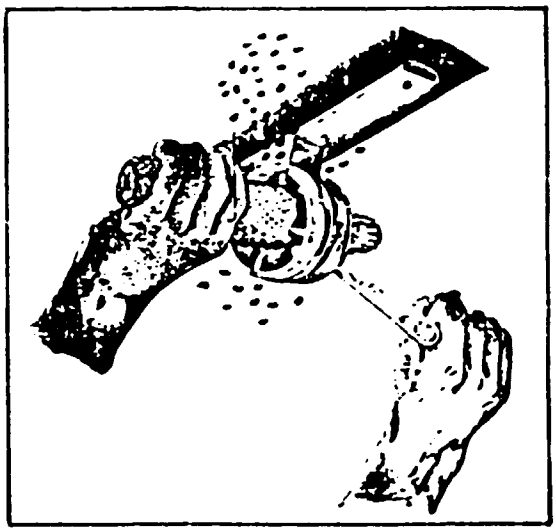
Technical data:
- weight 1.5 kg
- for use it is bolted into a wooden block

utilization technique
- take all the leaves out
- dry the maize



-insert the cob into the sheller and turn the handle

-shell it only half way



-hold the cob from the shelled end

-shell the other half

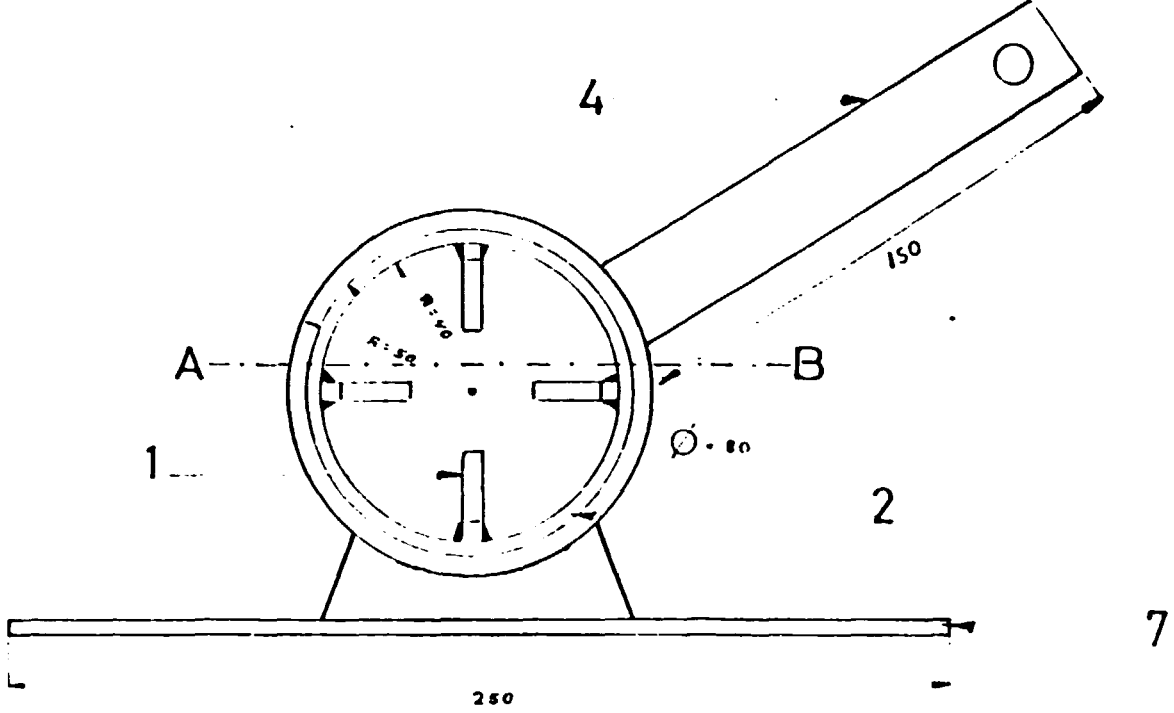
Reccomendations
- for better results use dry maize
- lubricate the sheller as may be required

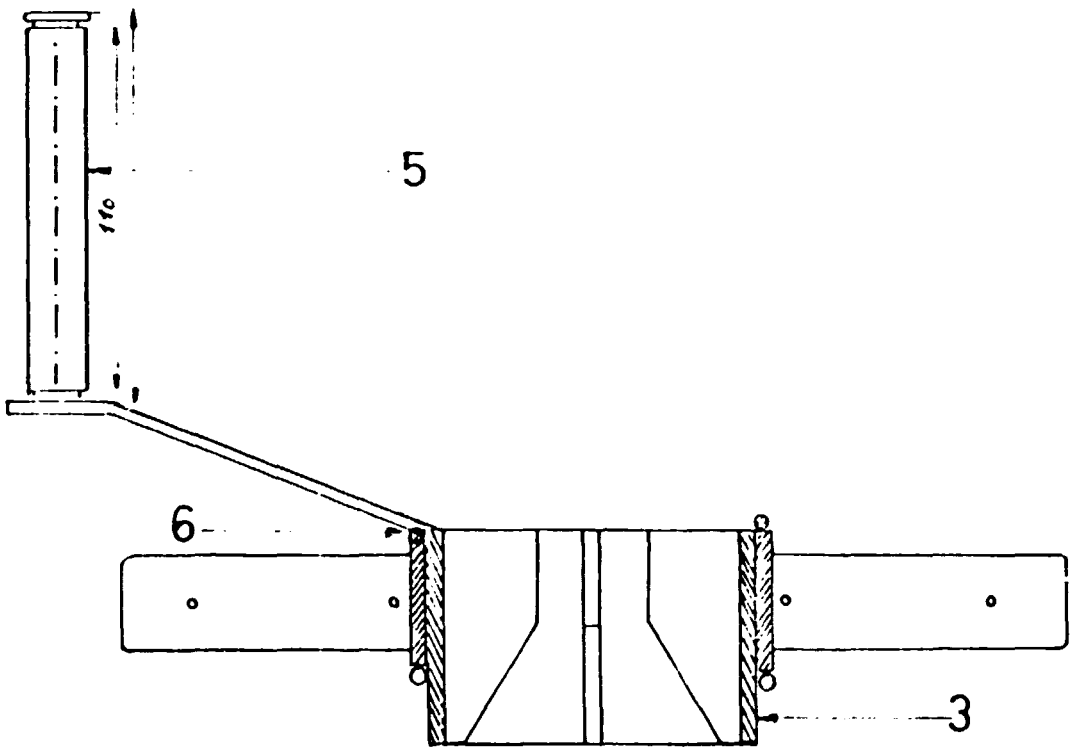
production capacity
- it can yield more than 100 lbs of shelled maize per hour.

MANUAL GRAIN SHELLER p. 3

MANUAL GRAIN SHELLER PARTS LIST

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| 1 | blades | 4 | flat bar 1" x 3/16" | 5 cm | |
| 2 | fix ring | 1 | flat plate 1" x 3/16" | 31 cm | |
| 3 | rotating ring | 1 | steel plate 1/8" x 5 x 26 cm | | |
| 4 | handle | 1 | flat bar 1" x 3/16" | 17 cm | |
| 5 | handle | 1 | steel pipe 3/8" ø | 11 cm | |
| | | | round bar 3/8" ø | 12 cm | |
| 6 | fix ring | 2 | wire No. 8 | 62 cm | |
| 7 | sheller base | 1 | flat bar 1 1/2" x 3/16" | 25 cm | |
| 8 | bracket | 1 | flat bar 1 1/2" x 3/16" | 6 cm | |
| | electric welding | 6 | Cellocord 1/8" ø | 0.166 kg | |
| | red paint | 0.01 gallons | | | |



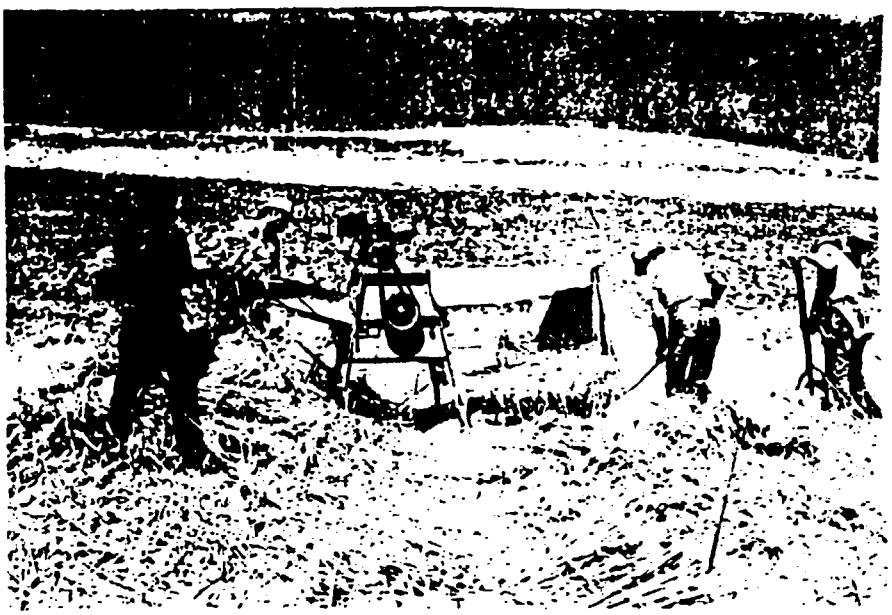

CORTE - AB

| | | | | |
|---|---|---|---|---|
| DESGRANADORA | | 1:20 | Fecha | Nombre |
| | | Diseñado | 89 | HERRANDINA |
| | | Dibujado | 10/07/89 | D·M·S |
| | | Aprobado | | |
| HERRANDINA | | | | |

Introduction:

A presentation is made of a series of Agricultural equipment and food processing, currently in application in the andean rural areas, especially in Peru. They have been studied and their engineering drawings and production methods rationalizaed, for better dissemination among farmers, small manufaturers and handicraftmen in the country, these are been promoted as capable of providing to the users: Good performance, Quality and ease of work.

It can thrash all types of cereals and pulse



EASY TO HANDLE - LOW COST - EASY TO INSTALL

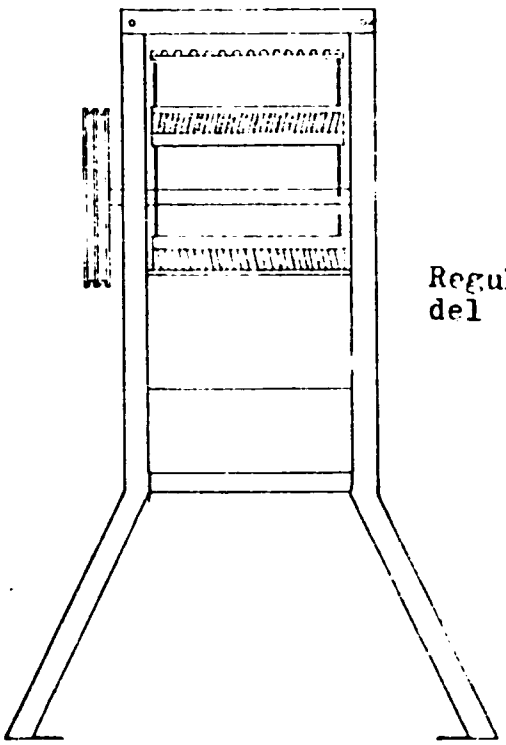
it can be transported by only two persons

for further information:
Cooperación Técnica del Gobierno Suizo
Cotesu - Herrandina
P.O. Box 378, Lima 100, Perú

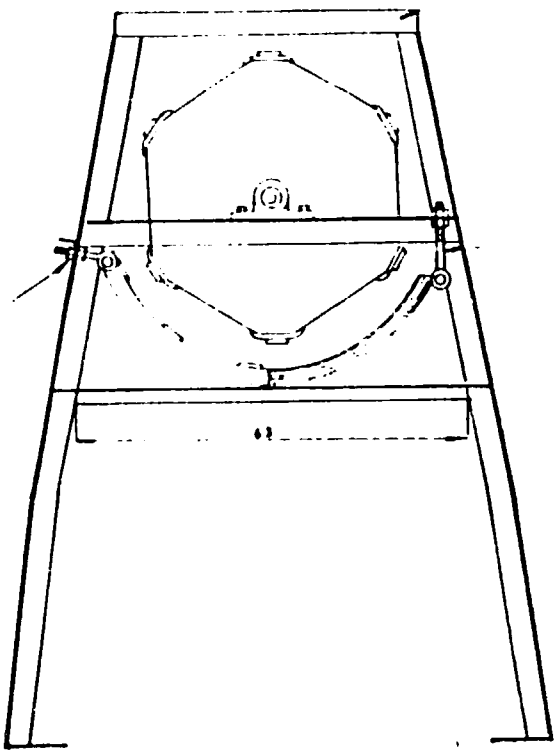
THRESHER p. 2

Technical data

| | |
|---|---|
| weight of the thresher without motor | 68.5 kg |
| weight of accesories | 5.0 kg |
| weight of the motor | 16.5 kg |
| total weight of the thresher | 90.0 kg |



Regulación del Cóncavo



YIELD OF THE THRESHER

| crop | weight after thrashing grain and refuses | weight of clean grain after winnowing kg/hr |
|---|---|---|
| barley | 367 | 310 |
| wheat | 319 | 270 |
| oat | 336 | 300 |
| tarwi | 130 | 120 |
| kidney-beans | 612 | 600 |
| quinua | 177 | 150 |
| kiwicha | 183 | 150 |
| beans | 140 | 120 |

THRESHER



Operation Instructions

- the Thresher is placed in a flat surface, to provide stability
- the concave side of the thresher is regulated in accordance with the size of the grains. For quinua, cañihua, kiwicha, wheat, barley, oat allow 2 mm for inlet and 10 mm for outlet. For kidney beans, vetch, tarwi, beans alow for 18 mm at inlet and 20 mm oulet.
- the material to be thrashed is loaded through the hopper, the thrashed material, grains and refuses come out toghether from the rear end of the machine.

Adjustments of Thresher

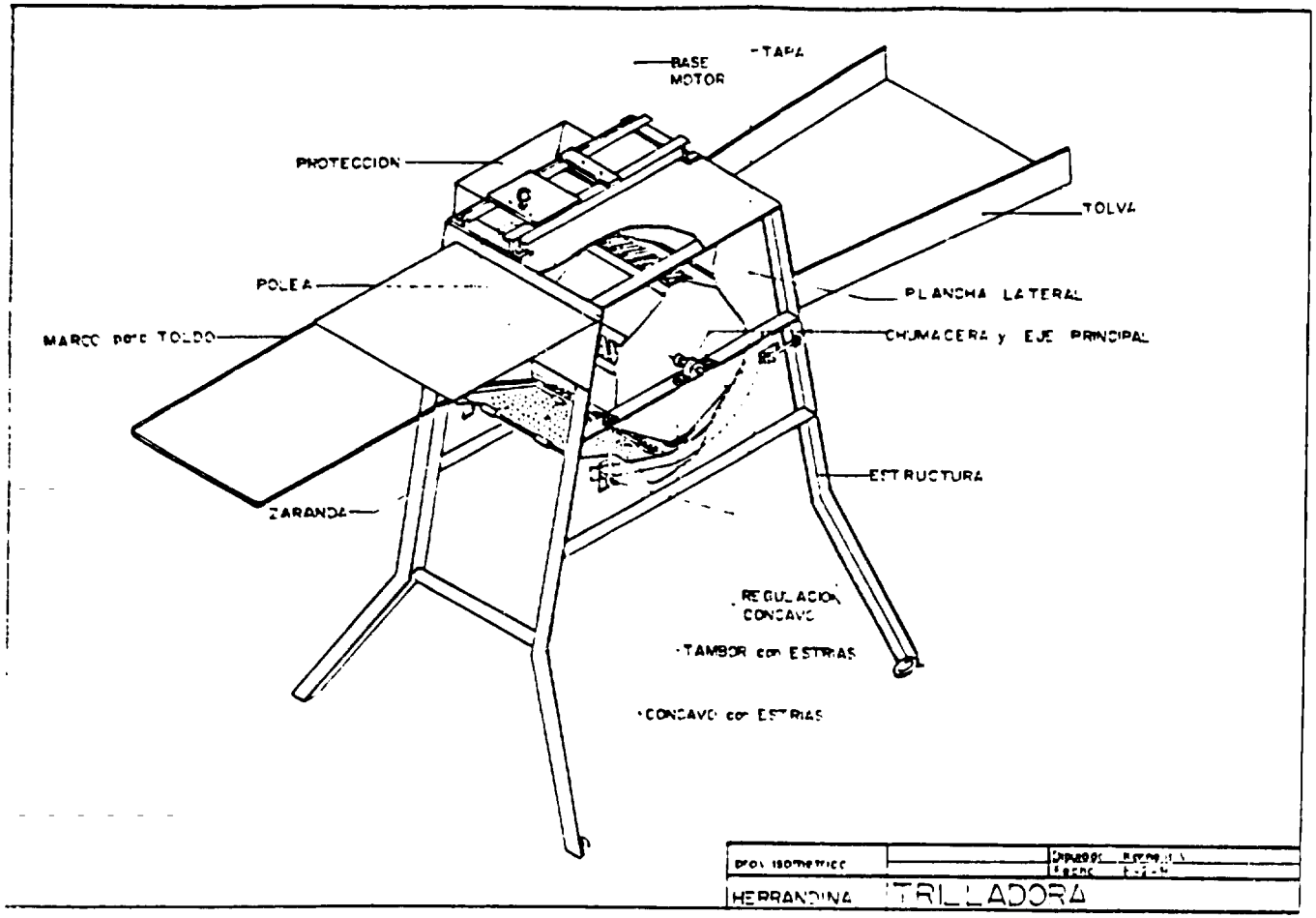
| crop | cylinder clearance inlet mm | concave outlet mm |
|---|---|---|
| barley | 4 | 10 |
| wheat | 4 | 10 |
| oat | 4 | 10 |
| tarwi | 16 | 20 |
| kidney bean | 18 | 20 |
| quinua | 2 | 10 |
| kiwicha | 2 | 10 |
| beans | 20 | 25 |

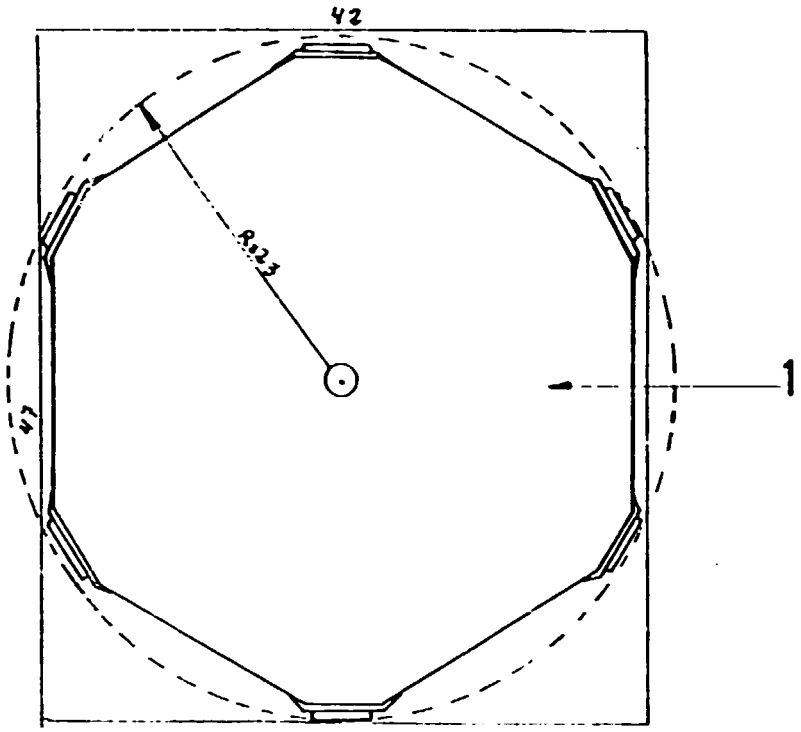
Recommendations.

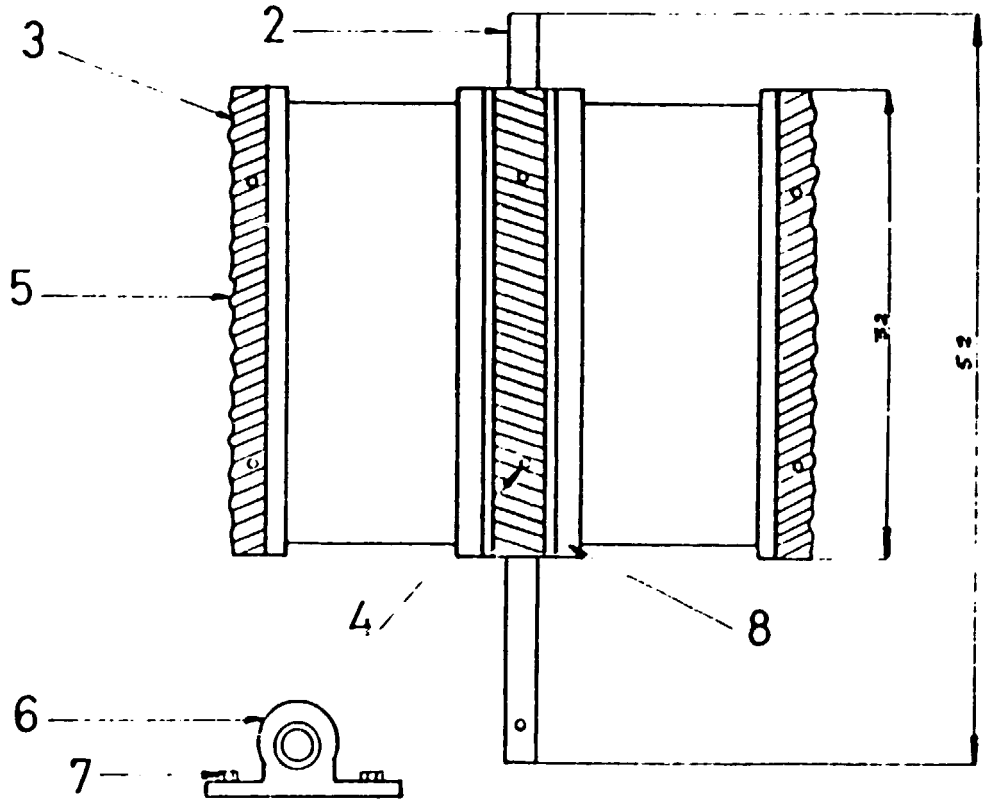
- when threshing kiwicha, quinua and tarwi, only the panicles should be threshed, to improve the yield.
- it is recommended to screen classify the thrashed material, before winnowing, to facilitate the cleaning of grains
- it becomes convenient to place a blanket underneath the outlet to prevent the grains from mixing with the ground dust.

THRESHER — PARTS LIST — p.4

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| DRUM | | | | | |
| 1 | drum face | 2 | steel plate 1/8" | 42 x 47 cm | |
| 2 | main shaft | 1 | shaft 1" ø | 52 cm | |
| 3 | plate for drum teeth | 6 | flat bar 1 1/2" x 3/16" | 32 cm | 192 cm |
| 4 | fixing bolts | 12 | bolts 1/2" ø x 1" | | |
| 5 | teeth | 96 | corr.bar 3/8" ø | 4.8 cm each | |
| 6 | bearing | 2 | oscillating | 1" ø | |
| 7 | bearing fixing bolts | 4 | bolts 1/2" ø x 1 1/2" | standard thread | |
| 8 | teeth support | 6 | plate 1/8" x 10 cm | 31.5 cm | |
| 47 | drum bushing | 2 | shaft 2" ø | 4 cm each | |
| 48 | drum fixing bolts | 1/2" ø x 1/2" + nuts | | + locknuts | |
| CONCAVE | | | | | |
| 9 | concave end bar | 2 | round bar 1/2" ø x 41 cm | for regulation | |
| 10 | concave tensioner | 9 | corr.bar 3/8" ø x 11 cm | each | |
| 11 | concave lining | 1 | plate 1/8" x 48 cm x 33 cm | | |
| 12 | teeth fixing bolts | 8 | bolts 1/2" ø x 1" | + safety nuts | |
| 13 | concave teeth | 64 | corr.bar 3/8" ø x 4.8 cm | each | |
| 14 | base plate for teeth | 4 | flat bar 1 1/2" x 3/16 | 33 cm | |
| 15 | lateral arc | 2 | flat bar 1" 3/16" | 72 cm each + reinf. | |
| 16 | concave support | 1 | plate 1/8" x 33 cm x 10 cm | | |
| 17 | sieve pin | 1 | round bar 5/16" ø x 10 cm | | |
| 18 | sieve or screen | 1 | plate 1/8" x 14 cm x 31 cm | | |
| 19 | vertical regulator | 2 | bolts 1/2" ø x 20 cm | each | |
| 20 | horizontal regulator | 2 | bolts 1/2" ø x 11 cm | each | |
| 41 | hinge | 1 | steel pipe 1/4" ø x 10 cm | | |
| PULLEYS | | | | | |
| 21 | pulley's rays | 6 | round bar 5/8" ø x 9.5 cm | each | |
| 22 | pulley | 1 | square bar 1" x 97 cm | trapez. 5/8" "V"belt | |
| 23 | pulley bushing | 1 | shaft 2"ø x 5 cm | bolt 3/8"ø x2.25cm | |
| 49 | pulley, motor | 1 | square bar 1" x 27 cm | 4" to 4.5" O.D. | |
| 50 | body | 1 | round bar 5/8" ø x 24 cm | | |
| 51 | bushing | 1 | shaft 1 1/4" ø x 4.5 cm | key 3/16" | |
| 52 | bolt | 1 | bolt 3/8" ø x 1" | | |
| STRUCTURE | | | | | |
| 24 | frame | 2 | equal angles 1" x 1/8" | 43 cm each | |
| 25 | bearing support | 2 | equal angles 1 1/2" x 3/16" | 61 cm each | |
| 26 | box frame | 2 | equal angles 1" x 1/8" | 72 cm each | |
| 27 | thresher cover | 2 | plate 1/32" x 51 cm x 73 cm | | |
| 28 | upper lining | 1 | plate 1/32" x 42 cm x 58 cm | | |
| 29 | vertical support | 4 | equal angles 1 1/2" x 3/16" | 120 cm each | |
| 37 | reinforcement | 2 | steel pipe 1" ø x 34 cm | each | |
| 38 | feeding hopper support | 1 | equal angles 1" 1/8" | 33 cm | |
| 39 | upper horiz. support | 2 | equal angles 1 1/2" x 3/16" | 41 cm each | |
| 40 | vert. support base | 4 | corr.bar 3/8" x 17 cm | each | |
| 42 | cover frame | 1 | round bar 3/8" ø | 312 cm | |
| 43 | cover plate | 1 | plate 1/32" x 49 cm x 39 cm | | |
| 44 | inlet hopper | 1 | plate 1/32" x 70 cm x 70 cm | | |
| 45 | hopper reinforcement | 1 | wire 1/4" ø | 280 cm | |
| 46 | cloth cover | 1 | | | |
| MOTOR SUPPORT | | | | | |
| 30 | short support | 2 | equal angles 1" x 3/16" | 6 cm each | |
| 31 | long support | 2 | equal angles 1" x 3/16" | 48.5 cm each | |
| 32 | regulating plate | 4 | flat bar 1 1/2" x 3/16" | 8 cm each | |
| 33 | motor bolts | 4 | bolts 5/16" ø x 1 1/2" | standard thread | |
| 34 | belt tensioner | 1 | bolts 1/2" ø x 3 1/2" | standard thread | |
| 35 | upper lining | 1 | plate 1/32" x 41 cm x 30 cm | | |
| 36 | regulator pin | 1 | round bar 5/16" ø x 15 cm | | |
| 53 | welding rods | 90 | Blue Point | | |
| 54 | electric welding rods | 180 | Supercito | | |


BASE MOTOR
TAPA
PROTECCION
TOLVA
POLEA
PLANCHA LATERAL
MARCO PARA TOLDO
CHUMACERA y EJE PRINCIPAL
ESTRUCTURA
ZARANDA
REGULACION CONCAVO
TAMBOR con ESTRIAS
CONCAVO con ESTRIAS
VISTA ISOMETRICA
HERRANDINA
TRILLADORA

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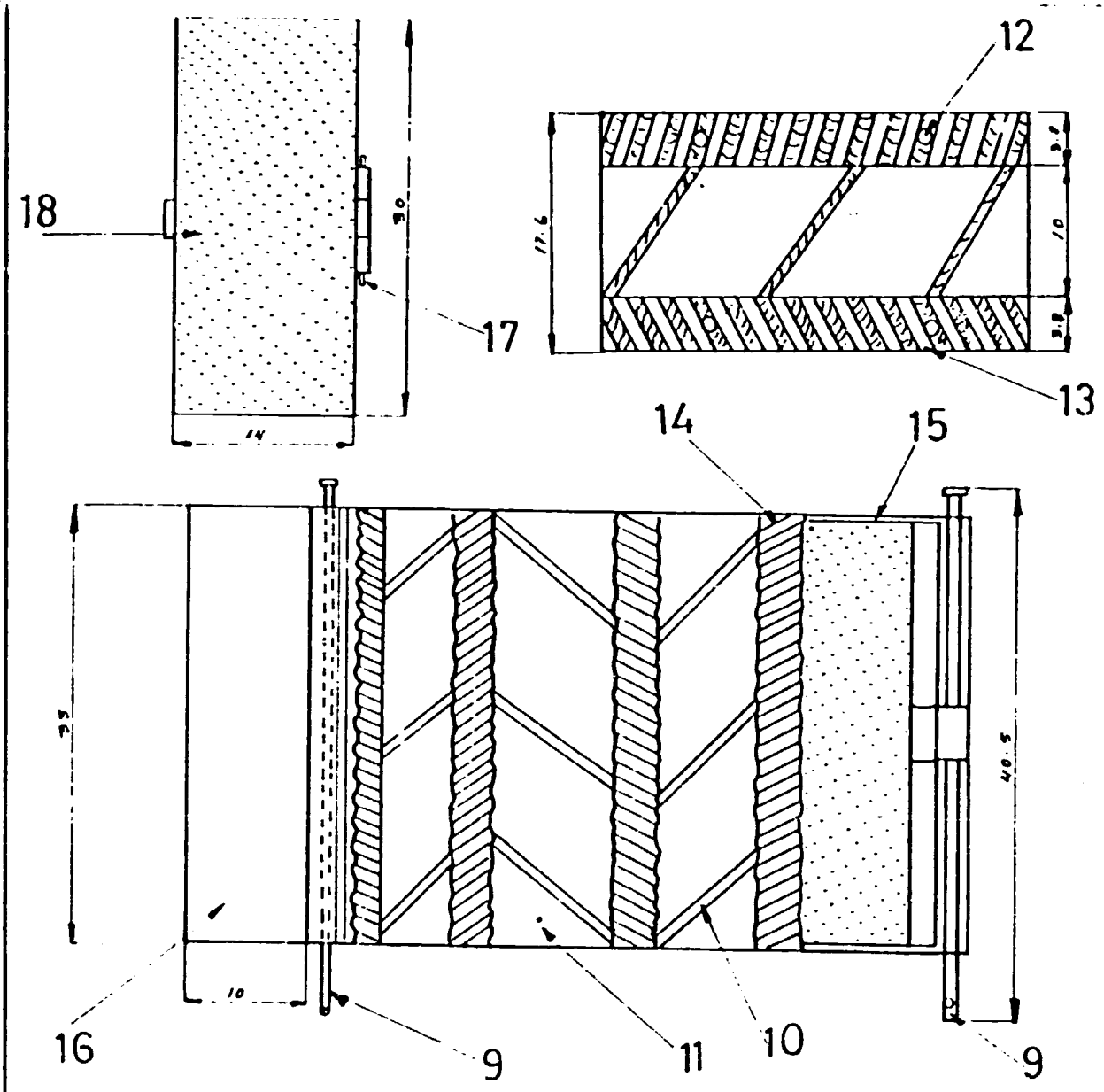
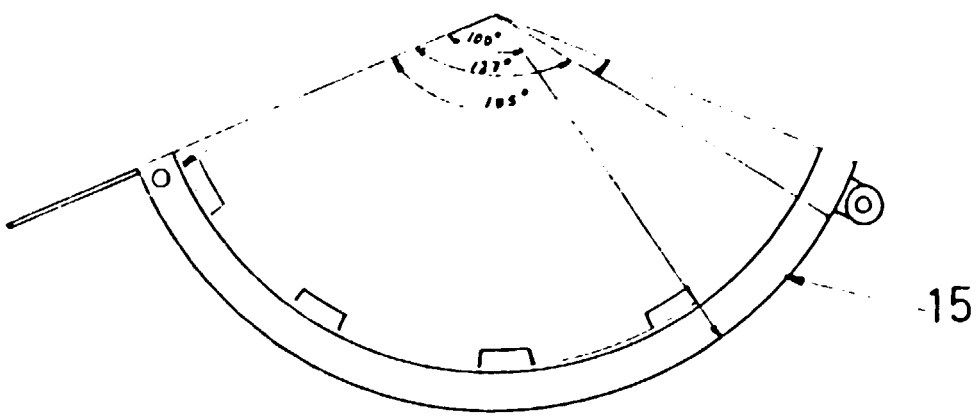
| | | Diseñado | | |
| | | Dibujado | | D.N.S |
| | | Aprobado | | |
| HERRANDINA | TAMBOR | | | |

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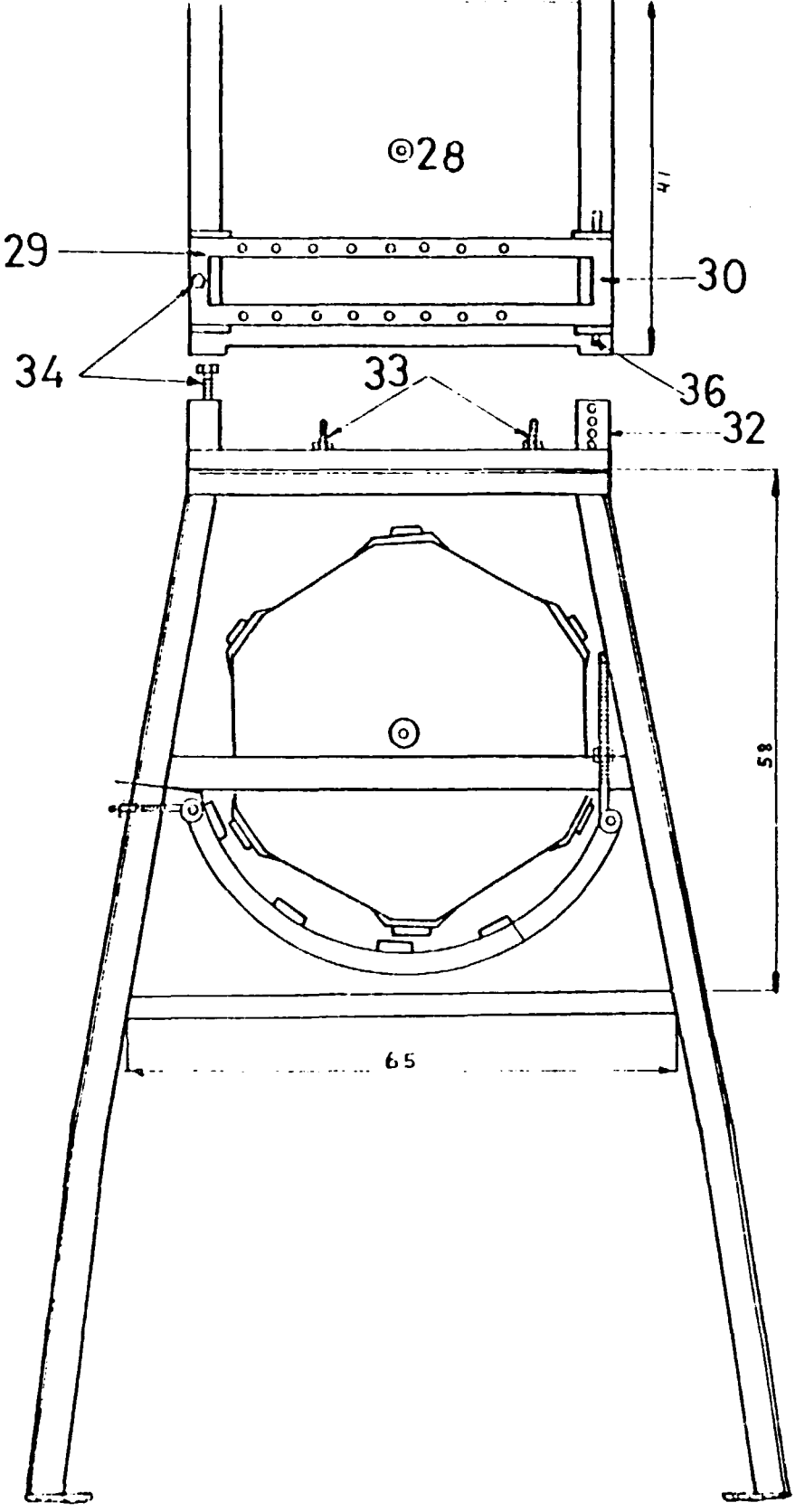
| | | Aprobado | | |
| HERRANDINA | CONCAVO | | | |

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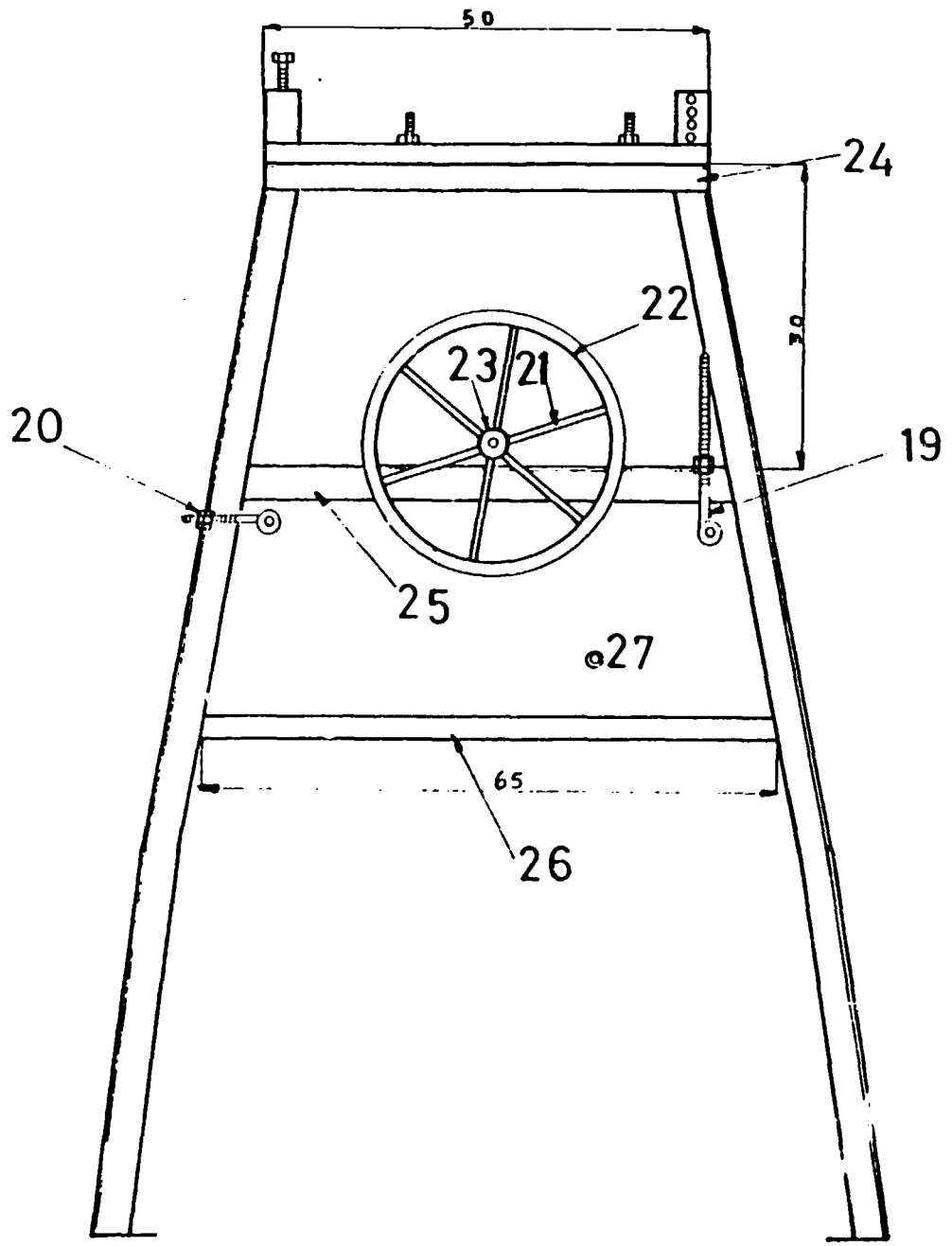
| | | Dibujado | | D.N.S |
| | | Aprobado | | |
| HERRANDINA | CONCAVO Y TAMBOR | | | |

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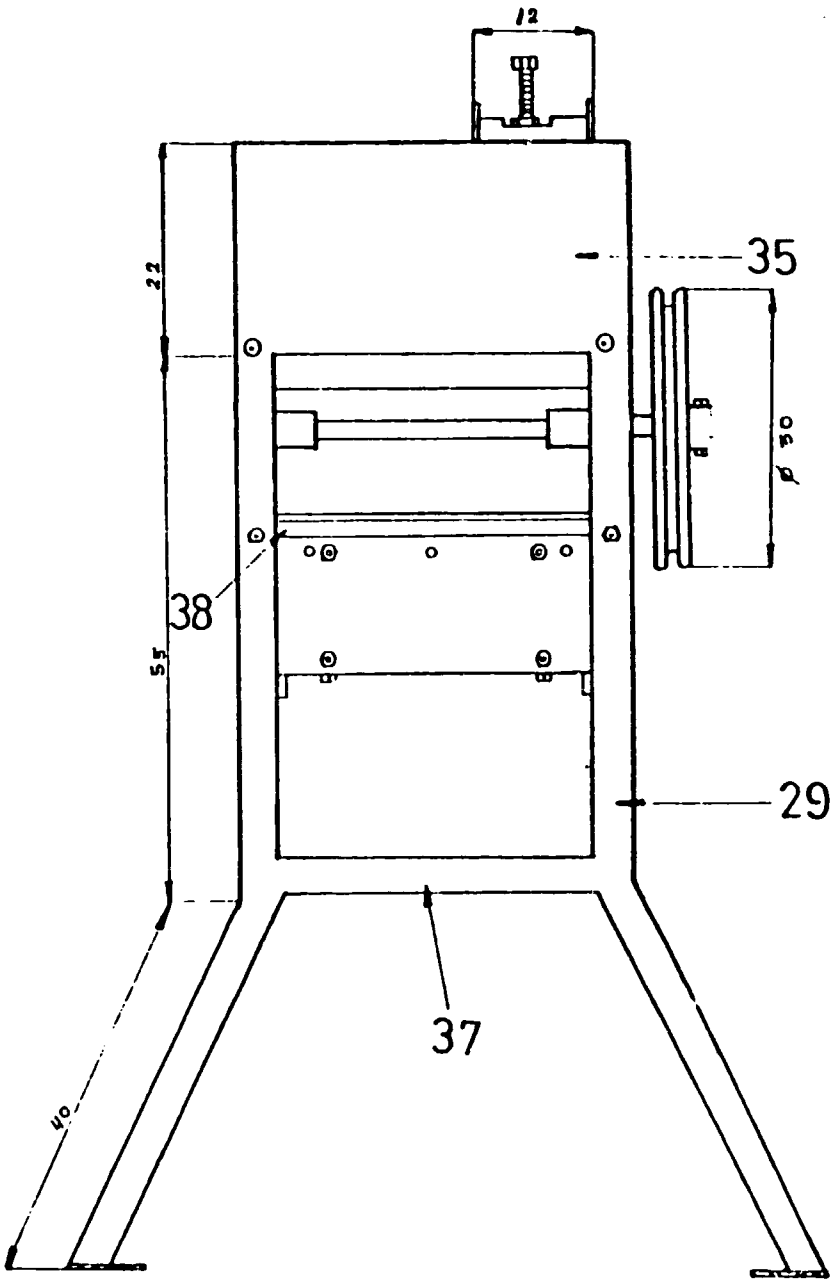
| HERRANDINA | POLEA | | | |

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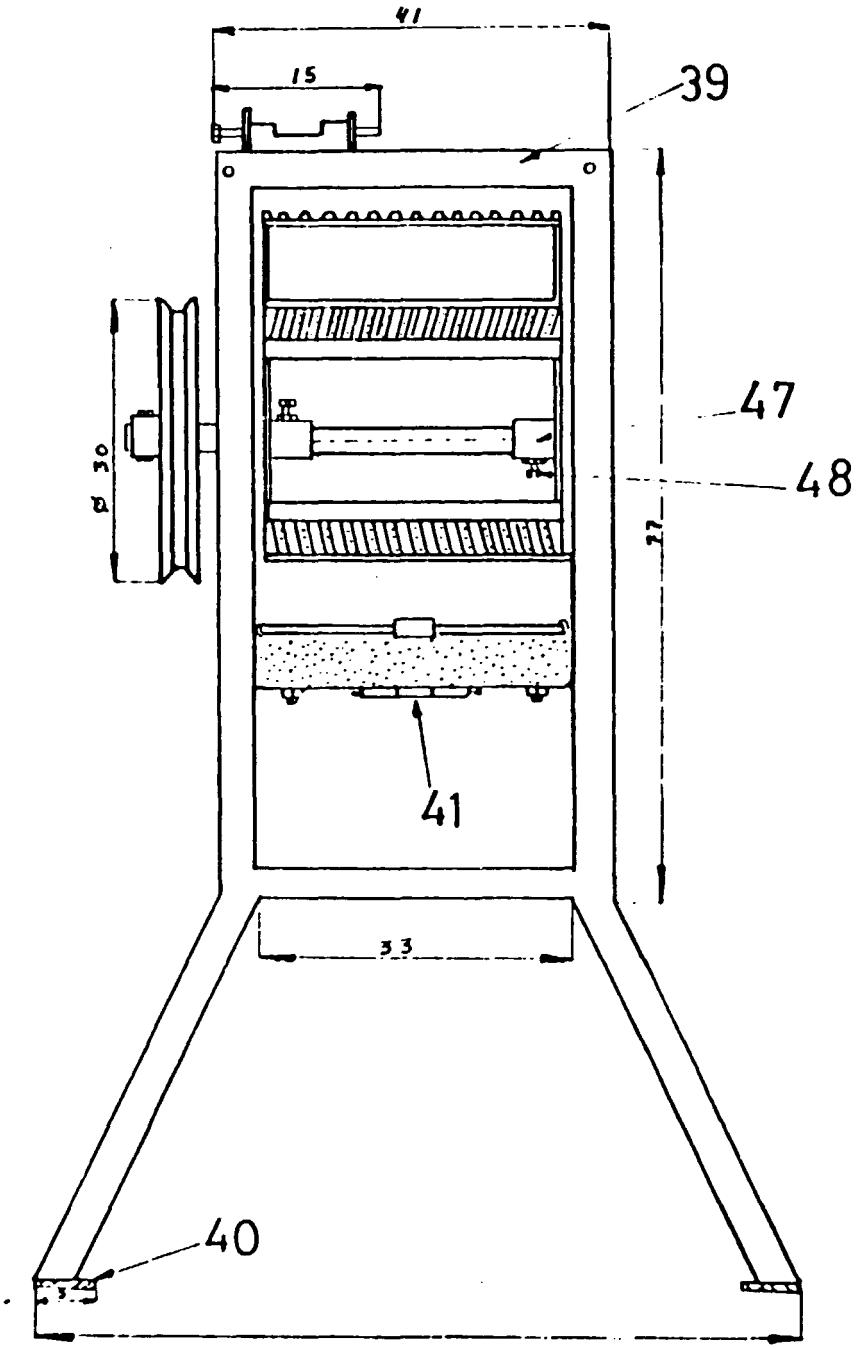
| | | Aprobado | | |
| HERRANDINA | | | | |

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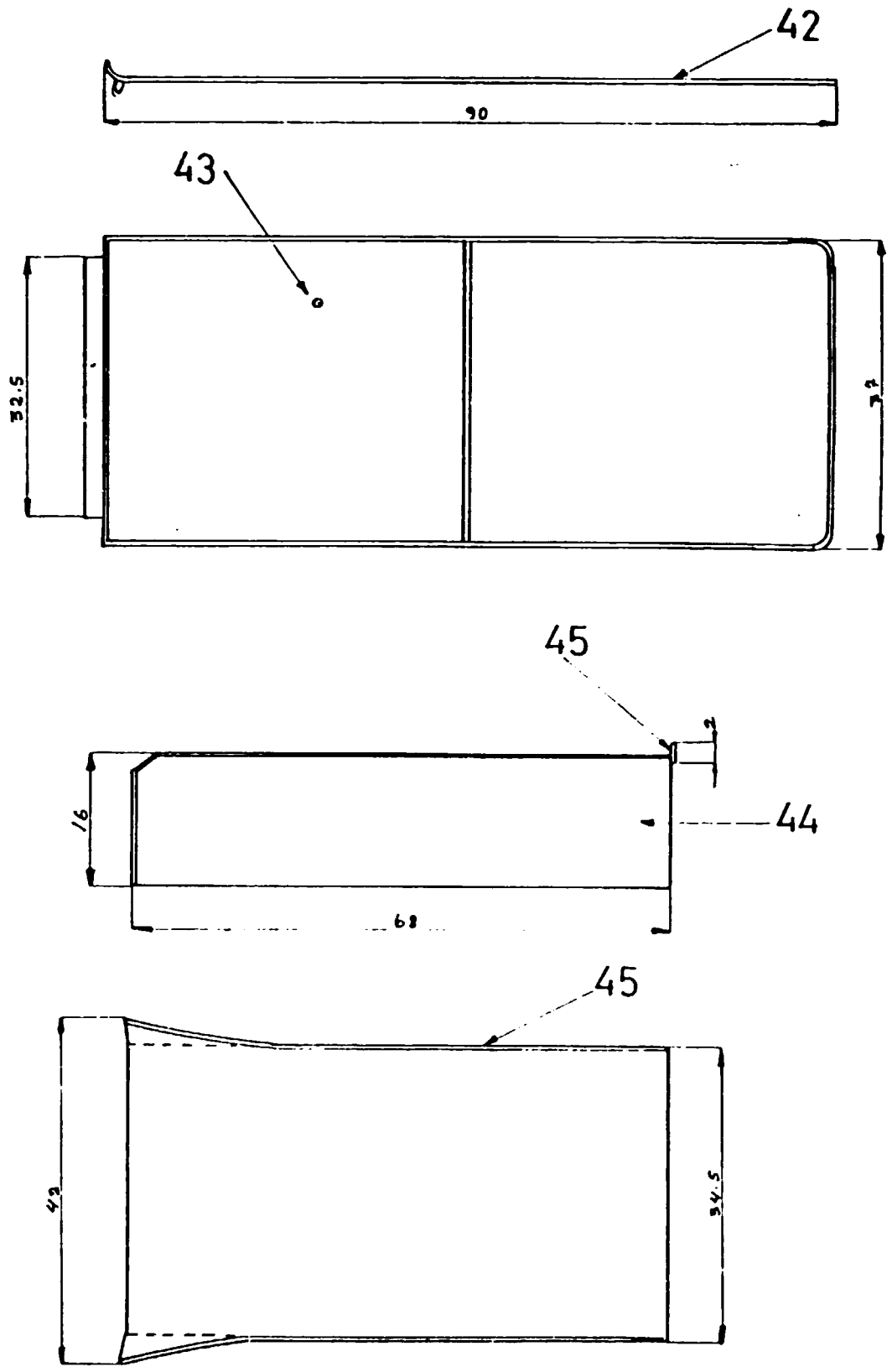
| | | Aprobado | | |
| HERRANDINA | SALIDA | | | |

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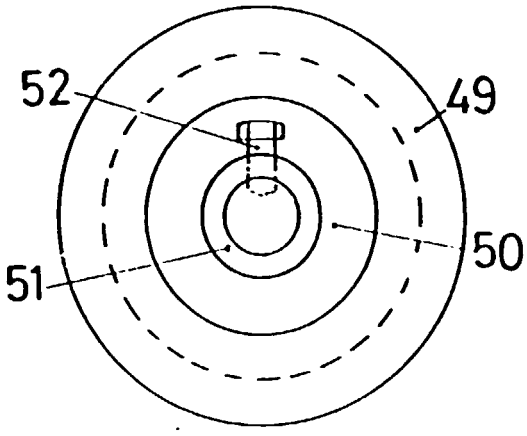
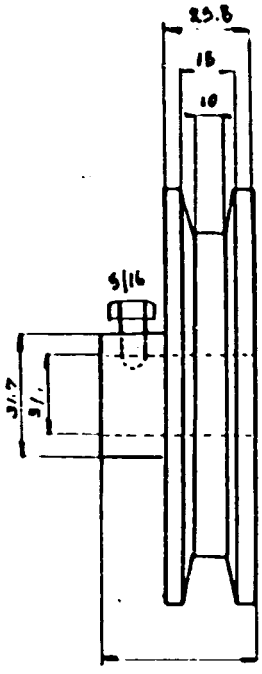
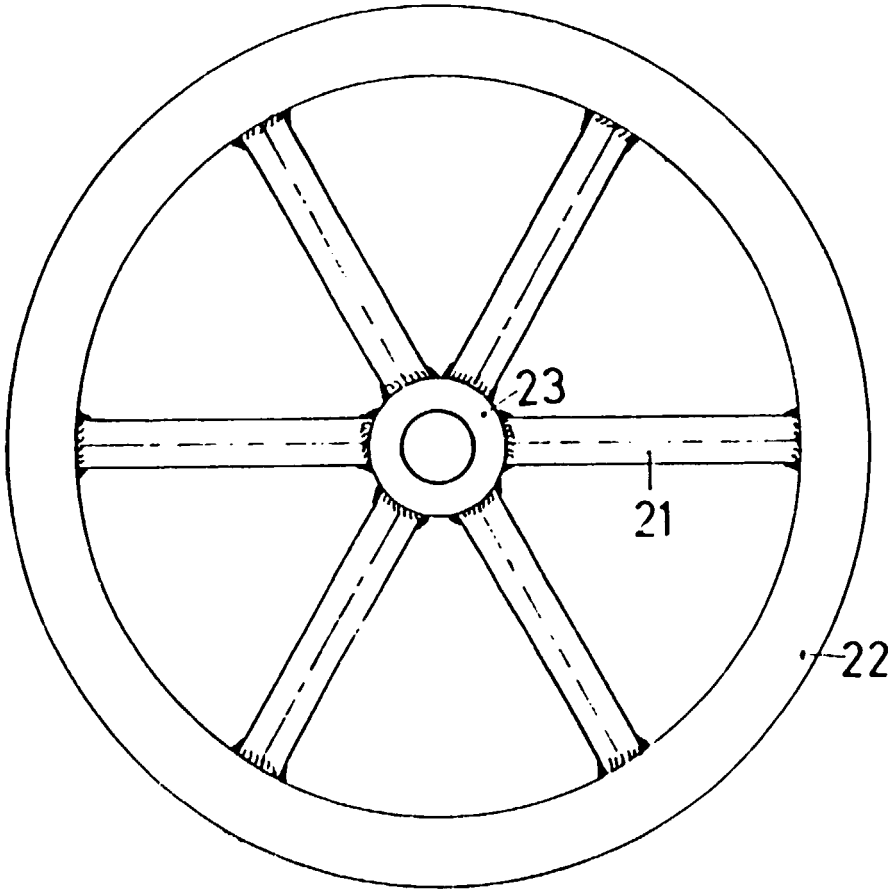
| | | Diseñado | | |
| | | Dibujado | | D.N.S |
| | | Aprobado | | |
| HERRANDINA | | TOLVA | | |

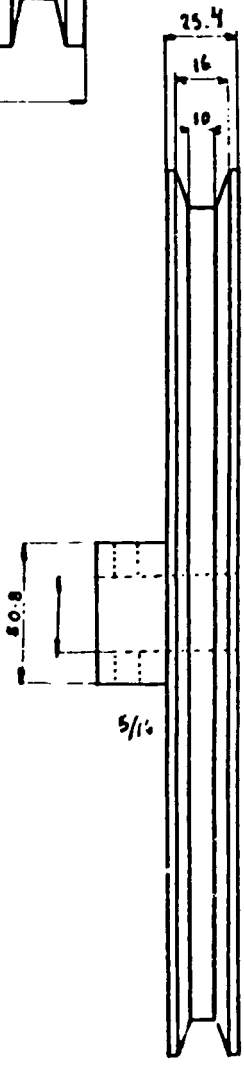
MOTOR




TRILLADORA

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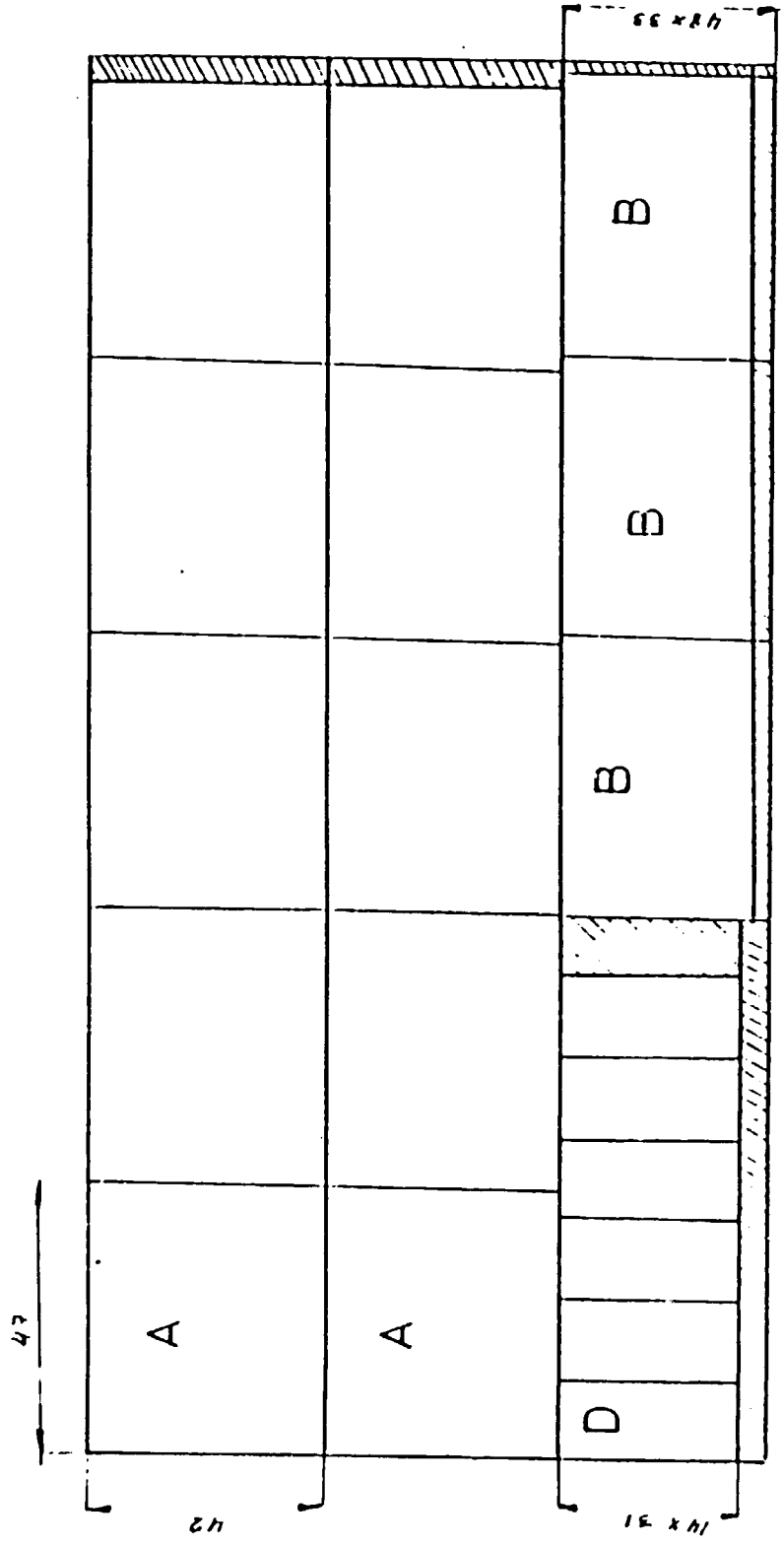
| | | Dibujado | | |
| | | Aprobado | | |
| HERRANDINA | | POLEA | | |



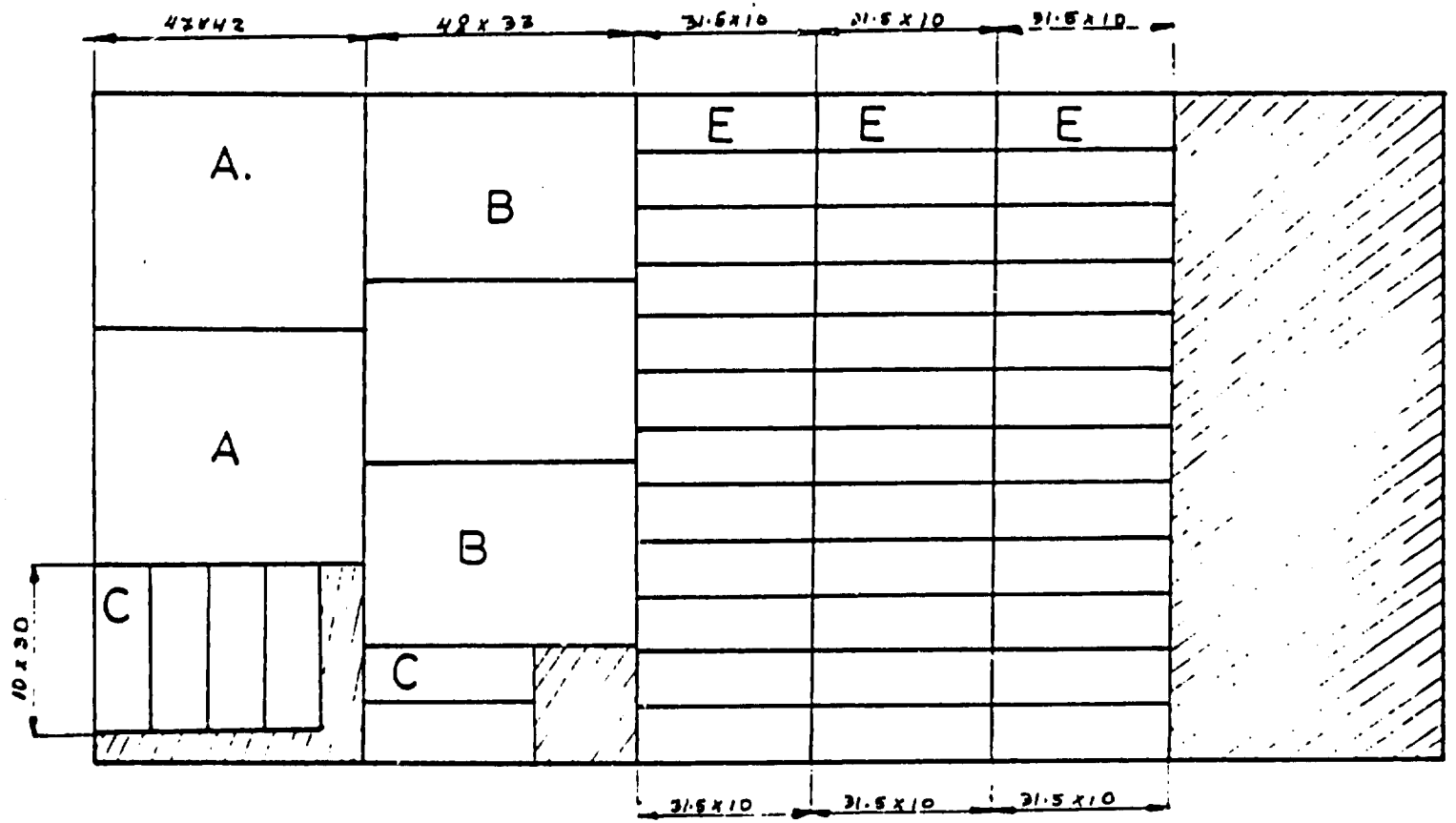

LEYENDA

A: TAMBOR 47 X 42 12 Piezas

B CONCAVO 48 x 33 6 Piezas

D ZARANDA 14 X 31 6 Piezas

| | | | | |
|---|---|---|---|---|
| TRILLADORA | ESC: 1:125 | | Fecha | Nombre |
| | | Diseñado | | |
| | | Dibujado | 12-Ab-89 | D.N.S |
| | | Aprobado | | |
| HERRANDINA | CORTE DE 1/8 | | | |




LEYENDA

C: SOPORTE DEL CONCAVO 10X30 6Piezas

E SOPORTE DE DIENTES 31.5 X 10 36Piezas

| | | | |
|---|---|---|---|
| Nombre | | | D.N.S |
| Fecha | | | 12-16-89 |
| | Diseñado | Dibujado | Aprobado |
| ESC: 1:125 | | | |

CORTE 1/8

TRILLADORA

HERRANDINA

ANDEAN PLOUGH 

This is an Animal drawn plough especially developed for the soil and conditions, common in the andean mountains in Peru, whith heavy gradients and slopes, where the soil is usually hard and tough to work.

This plough that is particularly suitable, for work in those terrains and soil conditions, is capable of performing several different agricultural operations: fallowing and plowing; harrowing and tilling and tuber harvesting; furrowing and ridging,

Advantages of the andean plough.

It can prepare the soils in one or two passes; mixes the vegetable residues with the earth; easy to regulate to different ploughing depths; it works in terrains with up to 45 % gradients; it is versatile as it can be used for several different operations; very rugged it can easily render a useful life of 10 years or more; it can be repaired by almost any semiskilled or non skilled artisan

Technical data.

weight of the assemble equipped with share:

| | |
|---|---|
| for ploughing | 9.6 kg |
| for furrowing/ridging | 11.6 kg |
| for tuber harvesting | 12.4 kg |
| for harrowing/tilling | 13.1 kg |

- length of the plough measured from heel to toe of the mouldboard = 46 cm.
- heigth of the plough assemble measured to top of plough handle : minimum 57 cm
  : maximum 74 cm

Performance of the andean plough

| Implement | furrow width | depth cm | speed m/sec | traction effort- kgf | hours hectare |
|---|---|---|---|---|---|
| plough | 25-30 | 10-15 | 0.65 | 85 | 18.0 |
| furrow | 45-55 | 18-20 | 0.80 | 35 | 5.5 |
| ridger | 45-55 | 18-20 | 0.70 | 45 | 5.5 |
| harrow | 40-50 | 8-10 | 0.70 | 50 | 7.0 |
| harvest | 50 | 15-20 | 0.70 | 80 | 5.5 |

The width and depth present two values, the first is applicable to hard soils (argillaceous) and the second to soft soils.

Recommendations for extended life of the Andean plough

- after each journey, the plough must be cleaned
- put grease on all moving parts of the plough
- the manufacturer should garantee the repair or change of all parts failed, attributable to fabrication.
- parts that fail due to normal wear or due to misuse are not subject to garantee.

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glossary of terms used in drawings

| spanish | english |
|---|---|
| mancera regulable | regulating handle |
| fijador de altura | handle heigth regulator |
| base mancera | handle base |
| guia del timon | steering guide |
| regulador de altura del cultivador | tiller heigth regulator |
| talon | heel |
| soporte de aletas grandes | big plough shares support |
| telera | tie piece |
| regulador de profundidad | work depth regulator |
| abrazadera del timon | steering bar bracket |
| soporte para fijar aletas | plough shares support |
| portarejas | plough share holder |
| timon para el arado | plough steering bar |

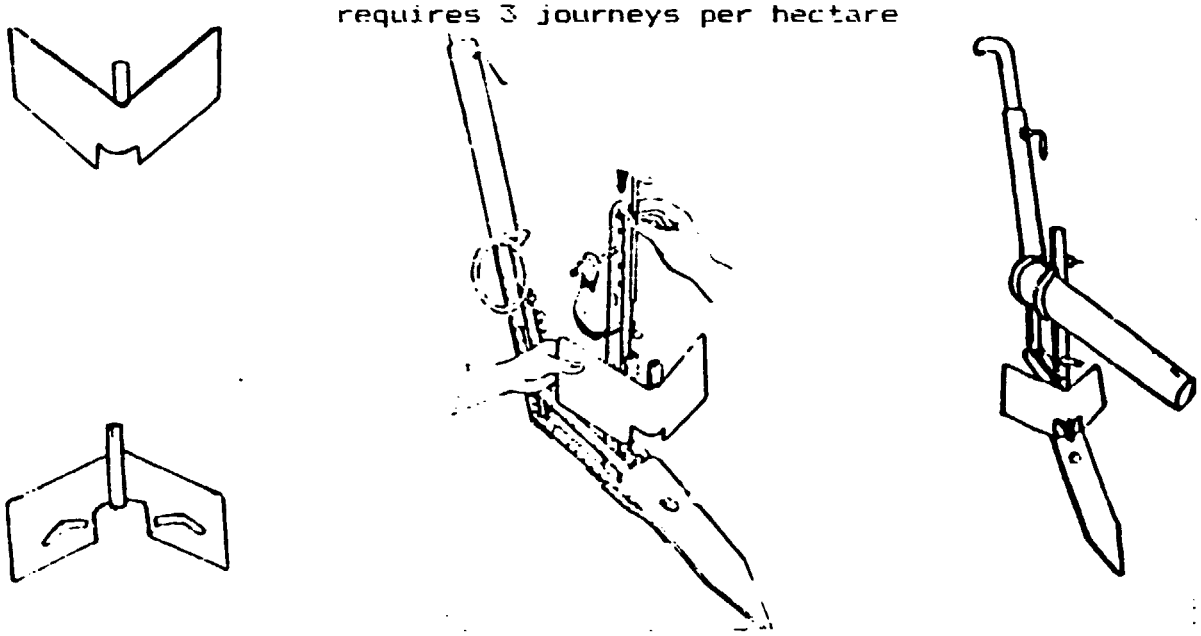
for further information:
Cooperacion Tecnica del Gobierno Suizo
Cotesu - Herrandina
P.O. Box 378, Lima 100, Perú

ANDEAN PLOUGH



## PLOUGH AND FALLOW

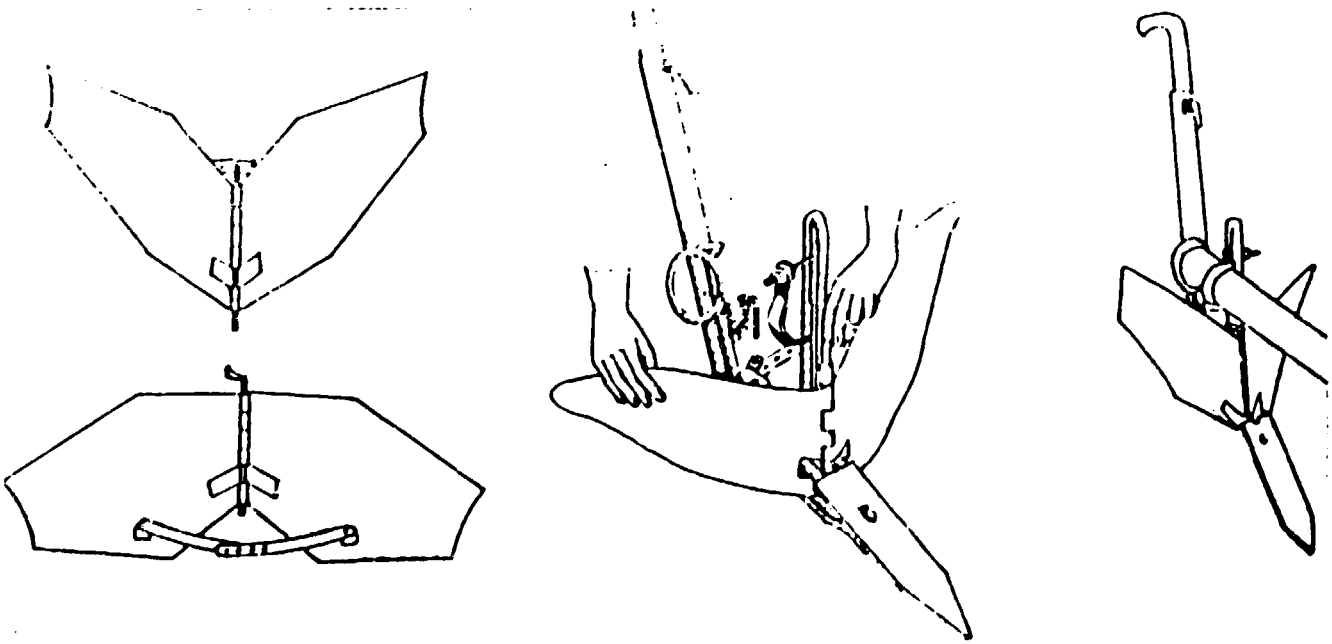
requires 3 journeys per hectare



It works at a good depth and only requires two passes to leave the hectare of terrain well prepared

## FURROW AND RIDGE

requires 1 journey per hectare



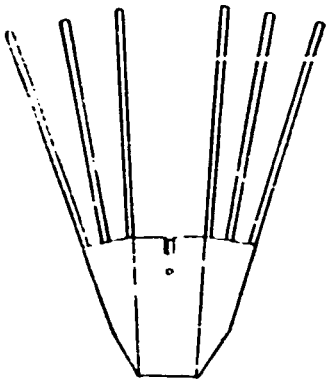
for furrowing and ridging the big plough shares are used, you can make furrows wide, clean and straight

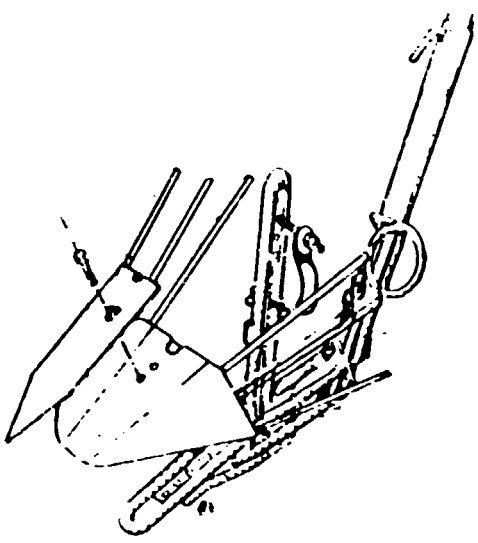
ANDEAN PLOUGH

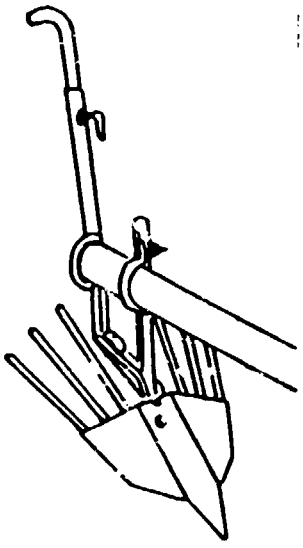


TUBER HARVESTING

requires 1 journey per hectare



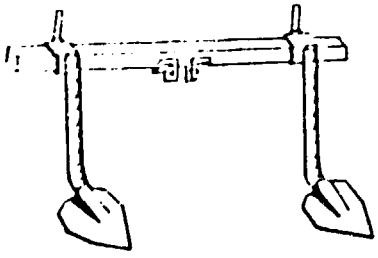


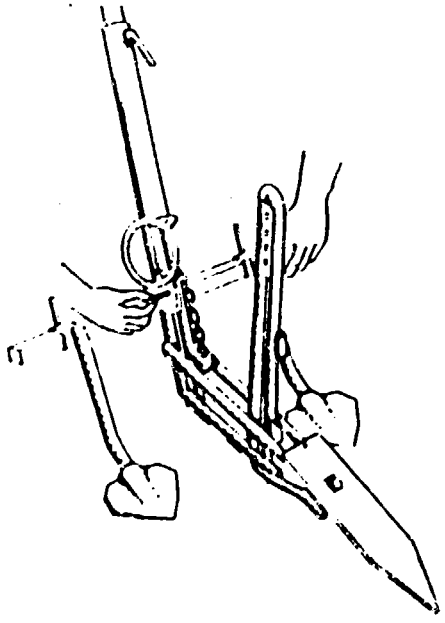


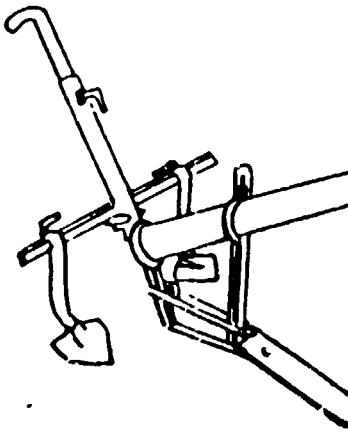
it can harvest all tuber easily and with low effort

HARROWING AND TILLING

requires 1 journey per hectare







it loosens the soil, eliminates undergrowth and
it can also be used to cover the seeds

## TECHNIQUE FOR WORKING WITH THE ANDEAN PLOUGH

### Ploughing.

the depth of plowing must be selected in accordance with:
- the type of soil
- the crop to be sown
- the strength of the animals

- the depth of the plough is regulated at the tie piece, the wider the opening angle formed at the base of the plough and the steering bar, the greater it will be the depth of ploughing,
  therefore, the smaller the opening angle the lesser it will be the depth.
  it is recommended to start, using the second position of the tie piece, counting from the top
- A secondary graduation can be obtained at the plough share, increasing or reducing the free/exposed area of the share, it can also be regulated the length of the idle walk at the oxen yoke end.
- to begin the work two passes should be run, the first in one line, loosening the ridges of previous crops and the second right across to allow removing the earth in between the ridges.

The ground soil should have the adequate humidity.

### Furrowing:

- the width of the plough shares should be graduated.
- the width and depth of the furrow should be regulated.
- to begin with, the furrows should be made in just one pass from end to end, if the terrain is in an slope, the contour lines should be followed.
- The sowing work should be done at ox-tail.

### Ridging:

- Ridging should be done, whenever sowing is done in a furrow, like potato, maize, bean and other.
- it is recommended to use a yoke 1.80 m long, to allow displacement of the oxen through the side furrows.
- if a yoke 1.20 m long is used, the steering bar will work oblique and unconfortable.
- push the earth to the base of the plants, forming good ridges.

harrow - tiller:

weeding

- the graduation is made taking into account the width between the ridges.
- the weed that competes with the crops are eliminated by cutting or pulling.
- this work is done before ridging to leave the area between the furrows loose and clean.
- it eliminates 75 to 80 % of the weed.
- the harrow allows moving the arable layer of earth, after an irrigation by flooding, when the soil found is crusted.
- it improves the physical properties of the soil.

Sowing

- the harrow is useful to cover the seeds that are sown throwing the seeds to the air, like wheat, barley, oats and others.
- for these labours two passes must be run, one longitudinal and one across.

Performance

- it covers 90 percent of the seeds in two passes.
- 5.5 hours per hectare are required.

Tuber harvester

working techniques

- when the furrows are not too wide and the soil is easy, the plough is driven with its harvester by the center of the ridge.
- if the furrows are wide and the soil difficult, the ridges are divided in two halves, making the first pass on one side of the ridge and returning through the other side.
- one furrow should be worked first, to leave two afterwards, before starting another furrow.

recommendations

- the soil during harvest should have the adequate humidity.
- before starting the harvest, all the folliage should be cut.

performance

- the percentage of tuber harvested during the first pass is 75 to 85 percent
- the percentage of tuber harvested after a second pass reaches 90 to 95 percent
- the percentage of broken tuber is minimum (5 percent).
- only women and children are required to collect the tuber.

for further information:
Cooperación Técnica del Gobierno Suizo
Cotesu - Herrandina
P.O. Box 378, Lima 100, Perú

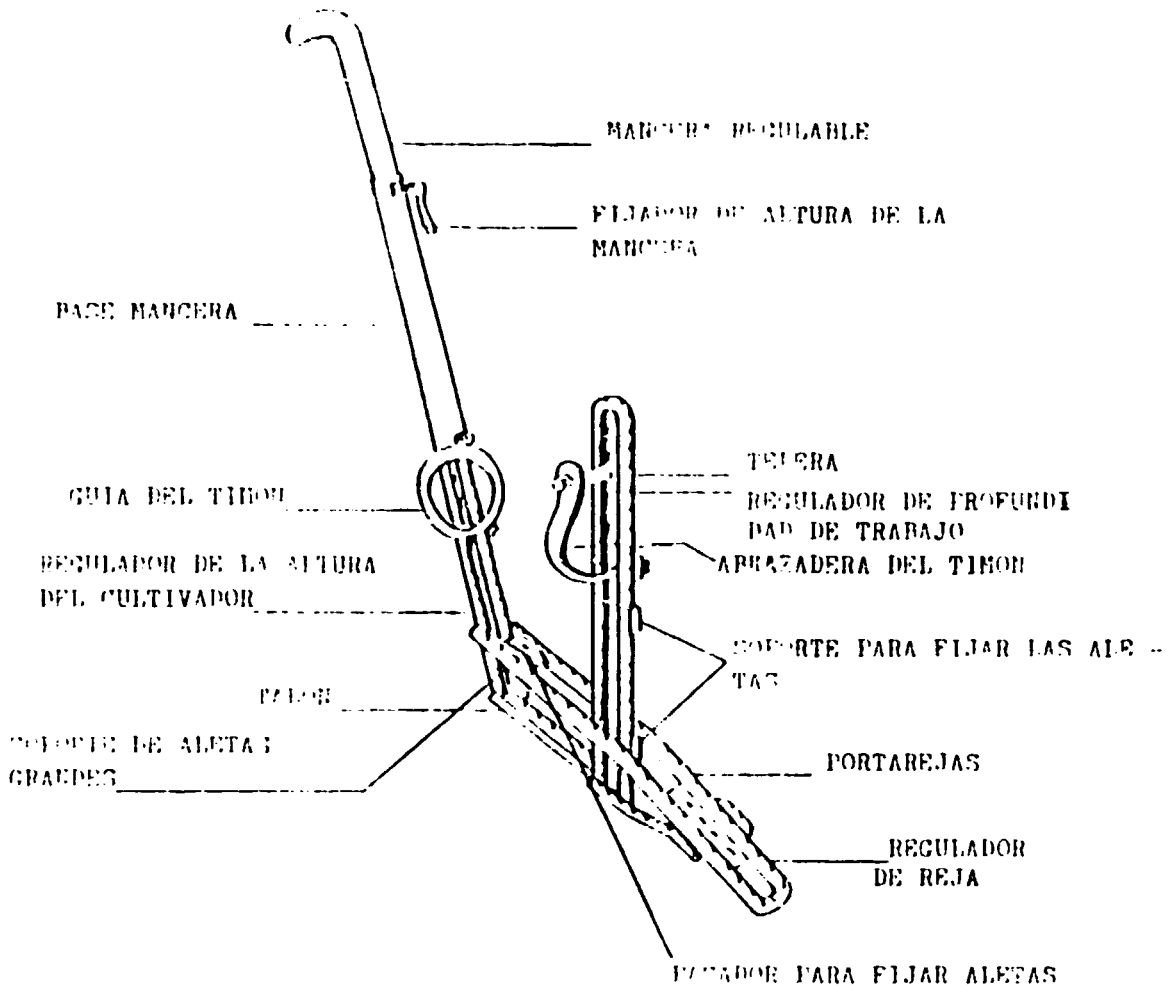
ARADEAN PLOUGH — PARTS LIST — p.8

| Part number | Part name | Qty | Material | Measures | Comments |
|---|---|---|---|---|---|
| HANDLE (MANCERA) | | | | | |
| 1 | handle | | steel pipe 1" ø x 500 mm | | |
| 2 | spanner | | steel pipe 3/4" ø x 30 mm | | forge ring spanner |
| 3 | key | | round bar 3/8" ø x 70 mm | | |
| 4 | pin | | wire No. 12 x 150 mm | | |
| MAIN GUARD (GUARDA PRINCIPAL) | | | | | |
| 5 | guard | | corr. bar 5/8" ø x 750 mm | | |
| 6 | reinforcement | | corr. bar 5/8" ø x 530 mm | | |
| 7 | heel | | flat bar 1" x 3/16" x 220 mm | | |
| PLOUGH SUPPORT (SOPORTE DE REJA) | | | | | |
| 8 | plough support | | corr. bar 5/8" ø x 990 mm | | |
| 9 | plough regulator | | flat bar 1" x 3/16" x 80 mm | | |
| TIE PIECE (TELERA) | | | | | |
| 10 | handle support | | corr.bar 1/2" ø x 480 mm(for 1A & 1B corr.bar1/2"x15) | | |
| 11 | handle | | corr.bar 5/8" ø x 220 mm | | |
| 12 | handle | | corr.bar 5/8" ø x 205 mm | | |
| 13 | bushing | 2 | steel pipe 3/8" ø x 25 mm | | |
| 14 | handle pin | | corr.bar 1/2" ø x 150 mm | | |
| 15 | lock pin | | wire No. 12 x 150 mm | | |
| 16 | plough share pin | | round bar 5/16" ø x 230 mm | | |
| HANDLE REGULATOR (REGULACION DE TIMON) | | | | | |
| 17 | ring | | corr.bar 3/8" ø x 230 mm | | |
| 18 | lower slip | | corr.bar 3/8" ø x 180 mm | | |
| 19 | upper slip | | flat bar 1" x 3/16" x 120 mm | | |
| 19A | reinforcement | | flat bar 3/4" x 3/16" x 100mm | | |
| 20 | joint | | corr.bar 5/8" ø x 35 mm | | |
| 21 | fixing pin | | round bar 3/8" ø x 70 mm | | |
| 22 | locker pin | | wire No. 12 x 150 mm | | |
| PLOUGH (REJA) | | | | | |
| 23 | plough | | spring leaf 3/8" x 3" | | |
| 23a | bolt | | MC 1/2" ø x 2" | | |
| REINFORCEMENT/REGULATOR (REFUERZO/REGULADOR) | | | | | |
| 24 | support reinforcement | | ccorr.bar 1/2" ø x 170 mm | | |
| 25 | plough share regulator | | flat bar 3/4" x 3/16" x 90 mm (alternative:plate 1/8") | | |
| 26 | pin | | wire 1/4" ø x 80 mm | | |
| 27 | chain | | wire No. 12 x 150 mm | | |
| PLOUGH SHARE (ALETA PARA ARAR) | | | | | |
| 28 | plough share | | steel plate 1/8" x 100 mm x 400 mm | | |
| 29 | bushing | | steel pipe 3/8" ø x 100 mm | | |
| 30 | plough share reinforc. | 2 | corr.bar 3/8" ø 180 mm | | |
| 31 | spacer | 2 | corr.bar 3/8" ø x 80 mm | | |

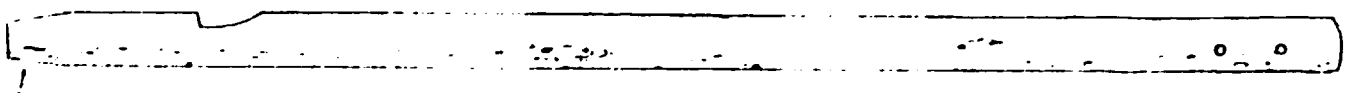
ANDEAN PLOUGH 

| | | | |
|---|---|---|---|
| SHARES FOR FURROWING (ALETAS PARA SURCAR) | | | |
| 32 | share | 2 | steel plate 1/8" |
| 33 | regulating plate | | flat bar 3/4" x 3/16" x 170 mm |
| 34 | bushings | 3 | steel pipe 3/8" Ø x 25 mm |
| 35 | join piece | | wire 1/4" Ø x 45 mm |
| HARVESTER (COSECHADORA) | | | |
| 36 | shovel | | steel plate 1/8" |
| 37 | tuber selector | 2 | corr.bar 3/8" Ø x 450 mm |
| | | 4 | corr.bar 3/8" Ø x 400 mm |
| 38 | reinforcement | 2 | corr.bar 3/8" Ø x 115 mm |
| | | 2 | corr.bar 3/8" Ø x 100 mm |
| 39 | shovel reinforcement | | corr.bar 3/8" Ø x 190 mm |
| REGULATOR SETTER (PEINE REGULADOR) | | | |
| 1 | bracket | | flat bar 1" x 3/16" x 260 mm |
| 2 | regulator setter | 2 | corr.bar 1/2" Ø x 155 mm |
| 3 | guide | | round bar 3/8" Ø x 10 mm |
| 4 | pin | | round bar 3/8" Ø x 120 mm |
| 5 | lock pin | | wire No. 12 x 150 mm |
| SCALE BAR (BALANCIN) | | | |
| 1 | scale bar | | corr.bar 3/8" Ø x 720 mm |
| 2 | scale bar reinforc. | | corr.bar 1/2" Ø x 480 mm |
| 3 | hook | | round bar 3/8" Ø x 190 mm |

## LA ESTRUCTURA DEL ARADO ANDINO



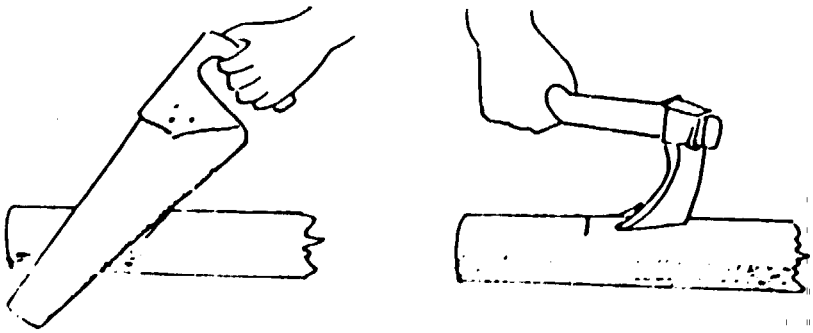

## EL TIMON PARA EL ARADO ANDINO



ata parte
se desgasta

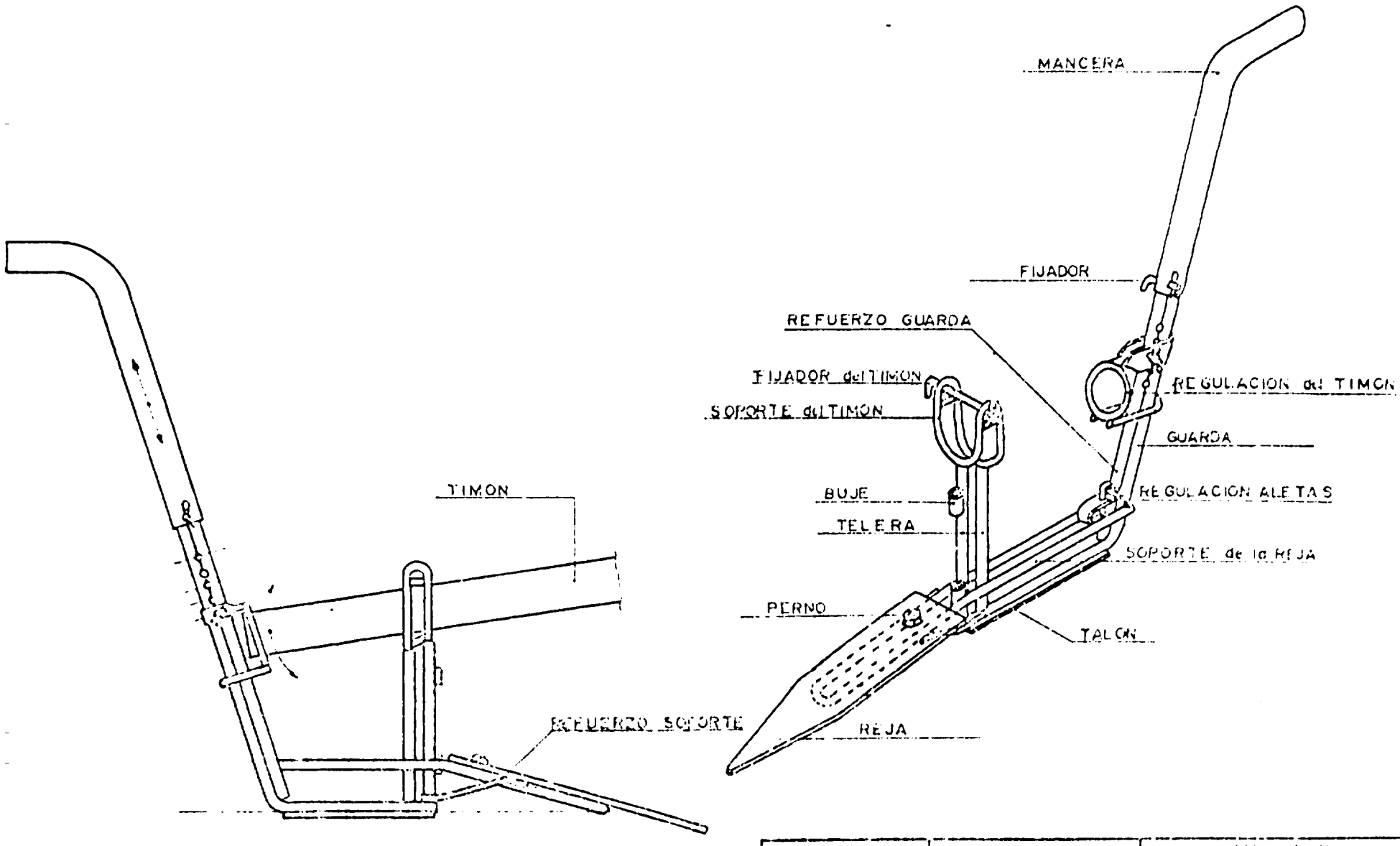
El timon tiene un largo de 3 a 3.2 metros
con um diametro de 7 a 10 cm en la base

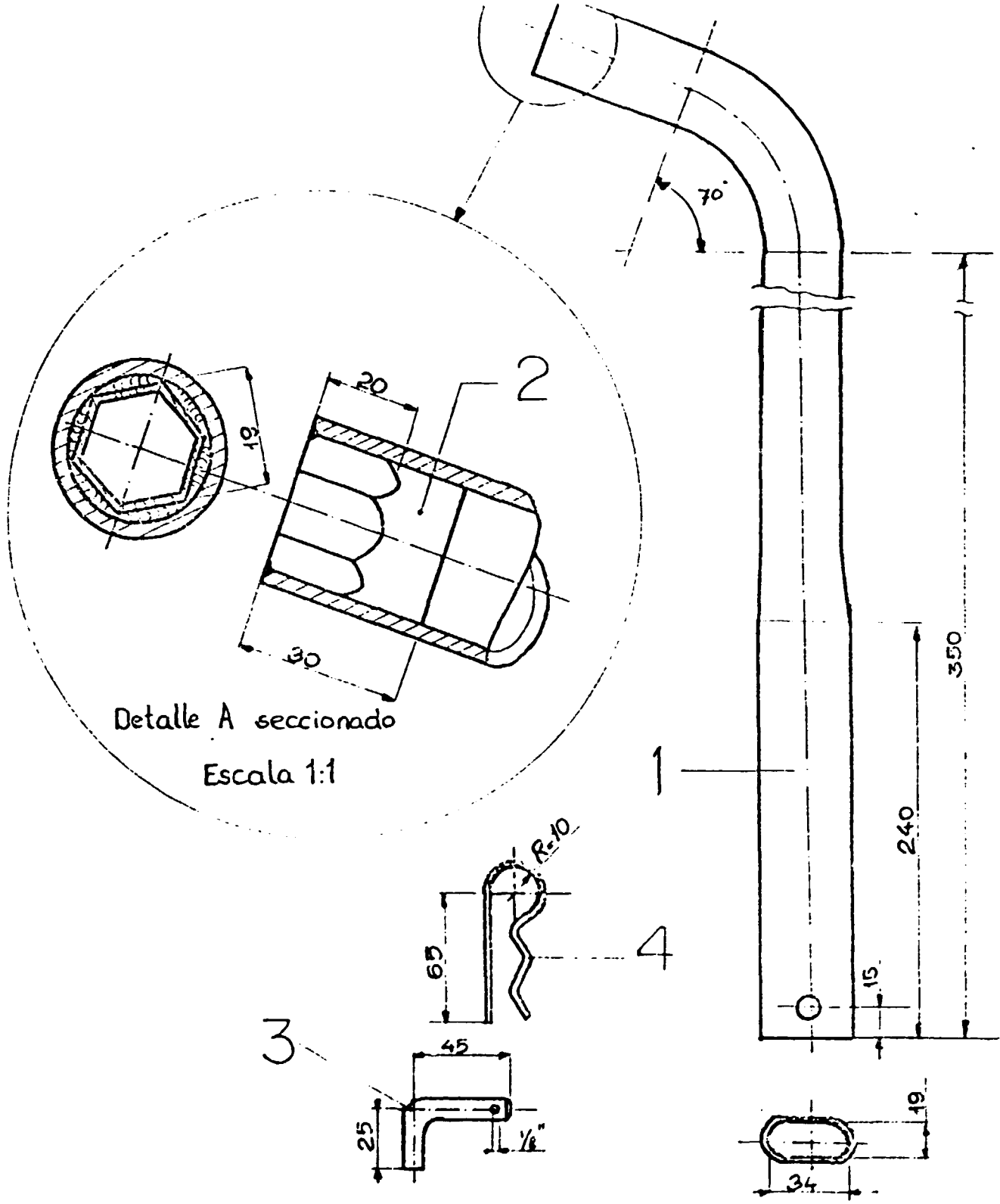
La longitud del timon depende del porte de los animales



En la parte donde el timon va fijado por la abrazadera a la telera se hace un corte en bise como se muestra en la figura

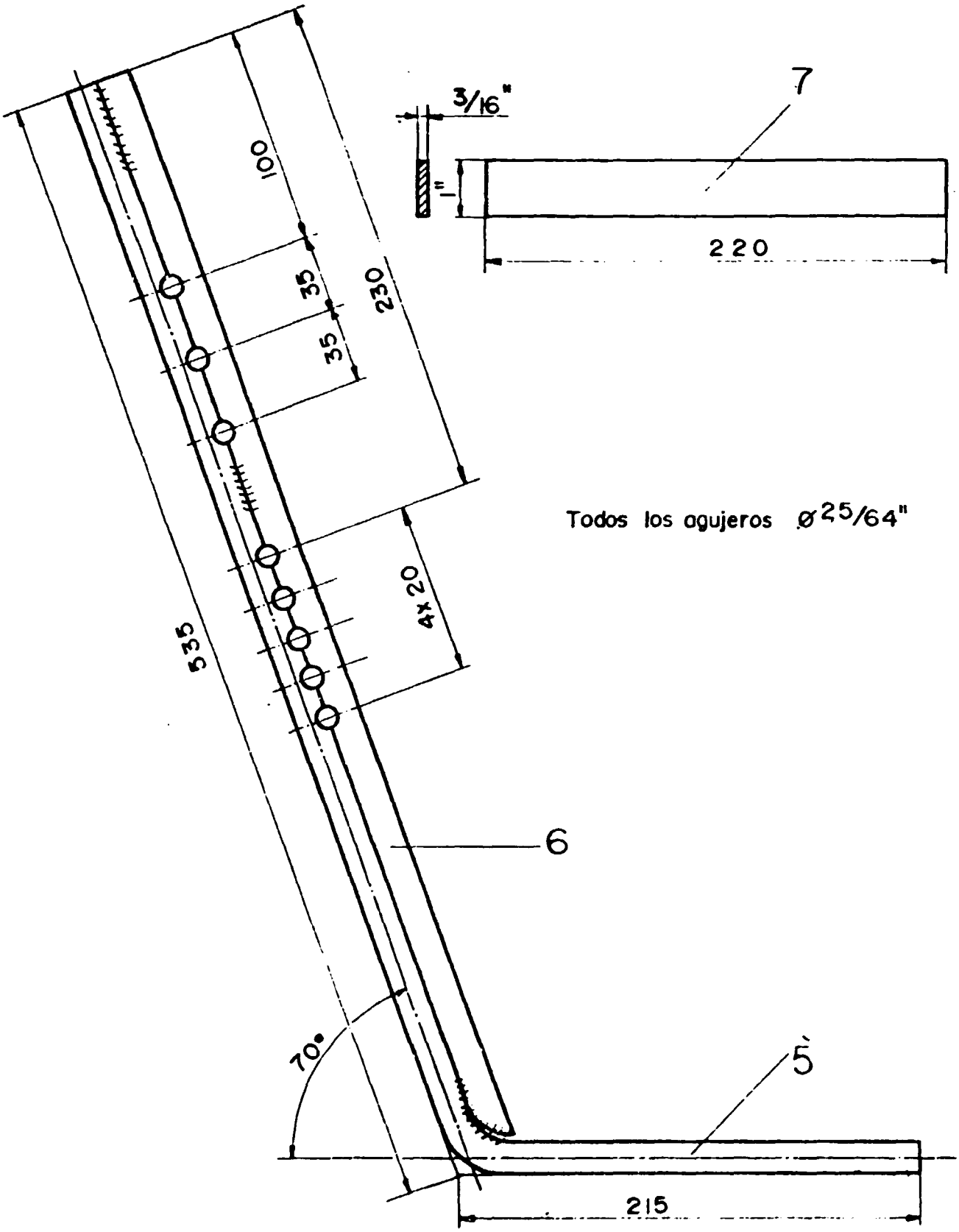
La base del timon se raspa en su parte externa para que entre en la guia del ti


MANCERA
FIJADOR
REFUERZO GUARDA
FIJADOR del TIMON
REGULACION del TIMON
SOPORTE del TIMON
GUARDA
TIMON
BUJE
REGULACION ALETAS
TELERA
SOPORTE de la REJA
PERNO
TALON
REFUERZO SOPORTE
REJA




| | | | | |
|---|---|---|---|---|
| 4 | Pasador | alambre negro | Nº 12 x 150 mm | |
| 3 | Fijador | varrilla lisa | ø 3/8" x 70 mm | |
| 2 | Llave | tubo negro | ø 3/4" x 30mm | forjar llave |
| 1 | Mancera | tubo negro | ø 1" x 500mm | |
| | DENOMINACION | MATERIAL | MEDIDA | OBSERVACION |

| | | |
|---|---|---|
| | ESCALA: 1 : 2·5<br>UNID. de MEDIDA : mm | DIBUJADO: Kornelis V.<br>FECHA : 8-1-91 |
| HERRANDINA | ARADO ANDINO MANCERA | |

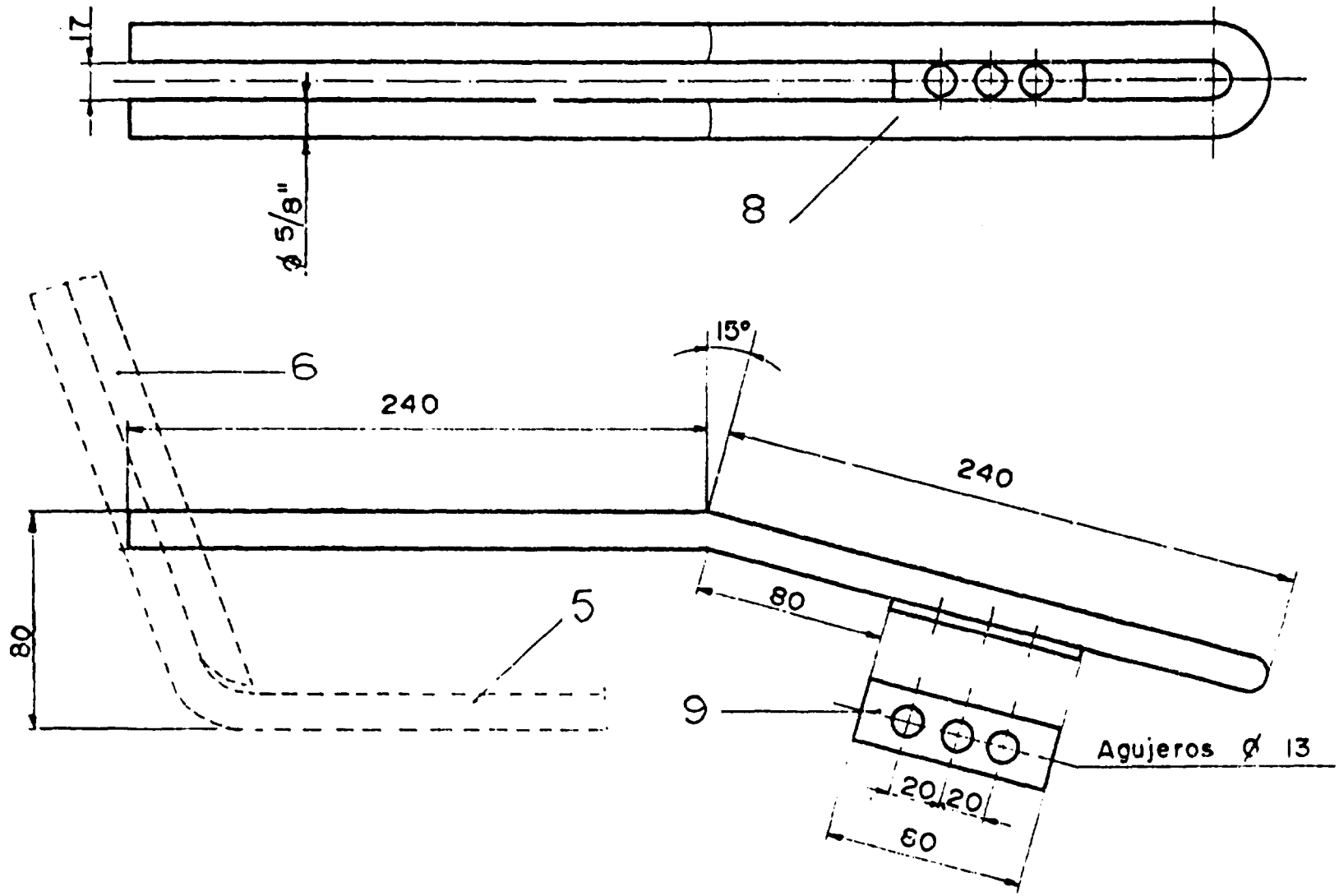



| | | | | |
|---|---|---|---|---|
| 7 | Talón | platina | 3/16"x1x220 | |
| 6 | Refuerzo | varilla corruga. | ø5/8"x530 | |
| 5 | Guarda | varilla corruga. | ø 5/8"x750 | |
| | DENOMINACION | MATERIAL | MEDIDA | OBSERVACION |

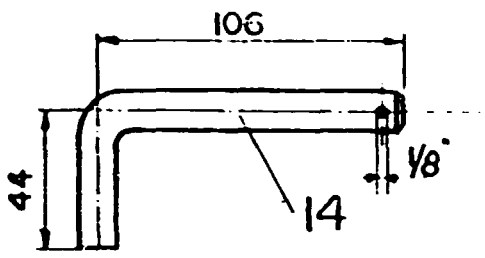
ESCALA: 1:2·5 DIBUJADO: Kornelis V.
UNID. de MEDIDA: mm. FECHA: 8-1-91

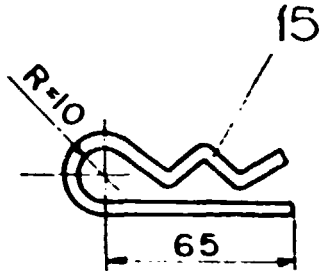
HERRANDINA

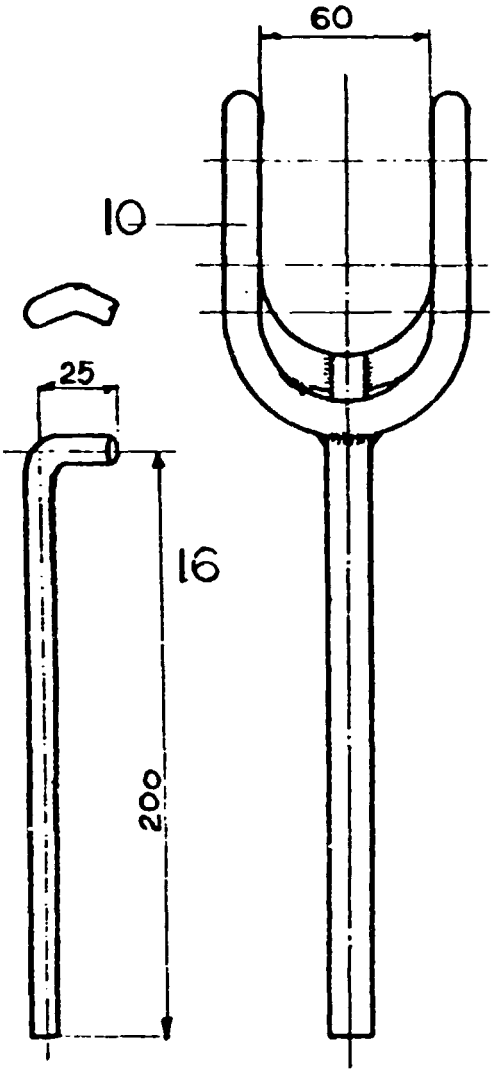
# ARADO ANDINO GUARDA PRINCIPAL

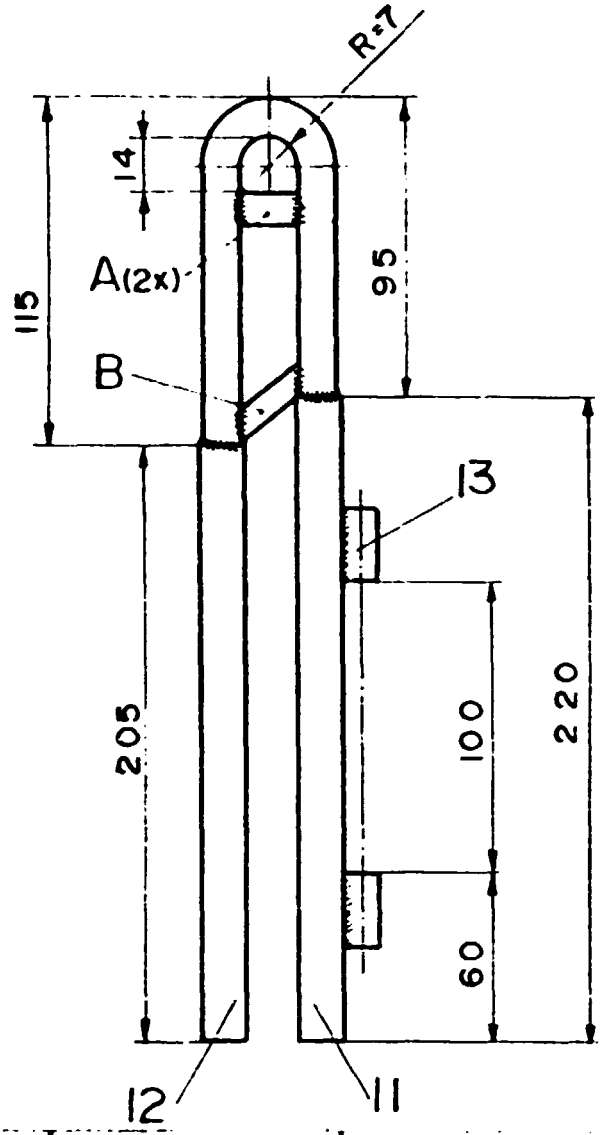



| | | | | |
|---|---|---|---|---|
| 9 | Regulador de reja | platina | 3/16"x1"x80 | |
| 8 | Soporte de reja | varilla corrugada | ø 5/8" x 990 | |
| N° | DENOMINACION | MATERIAL | MEDIDA | OBSERVACION |
| | ESCALA: 1:2.5 | | DIBUJADO: Kornelis V. / Alfredo S. | |
| | UNID de MEDIDA: mm. | | FECHA: 8-1-91 | |
| | ARADO ANDINO | | | |



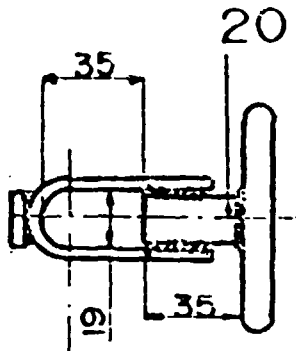



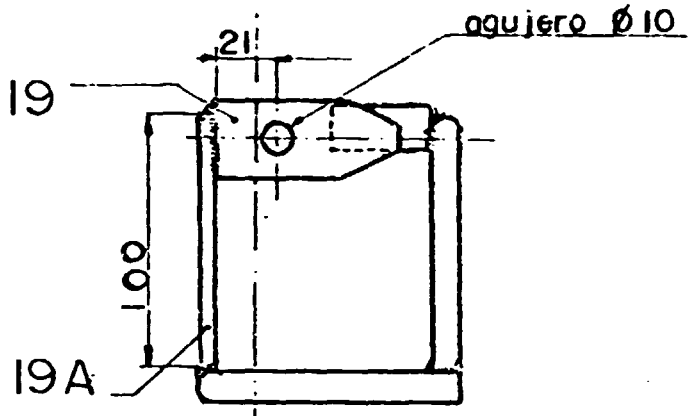



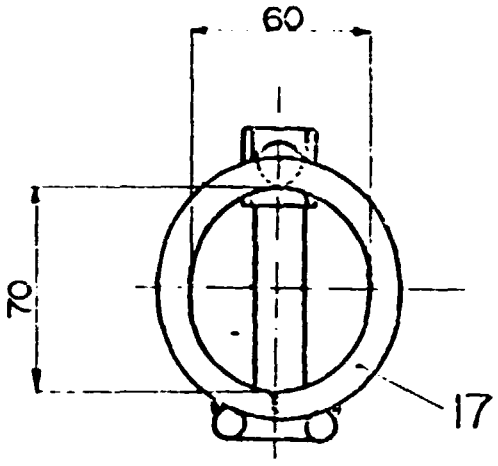



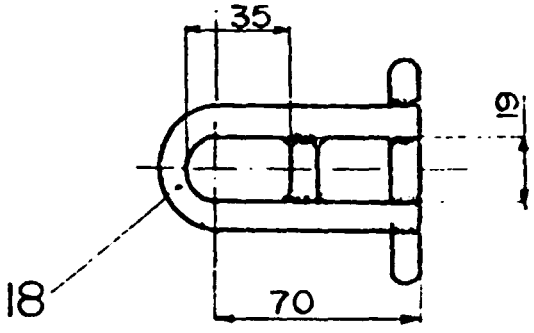

| | | | | |
|---|---|---|---|---|
| 16 | Fijador de aletas | varrilla liso | ø 5/16"x230 | |
| 15 | Pasador | Alambre negro | Nº 12 x 150 | |
| 14 | Fijador de timón | varilla corrug. | ø1/2" x 150 | |
| 13 | Buje | tuvo negro | ø 3/8"x 25 | 2 piezas |
| 12 | Telera | varilla corrug. | ø 5/8"x 205 | |
| 11 | Telera | varilla corrug. | ø 5/8"x 220 | |
| 10 | Soporte de timón | varilla corrug. | ø 1/2"x 480 | Para 1A y 1B Fierro corr ø1/2"x1 |
| | DENOMINACION | MATERIAL | MEDIDA | OBSERVACION |

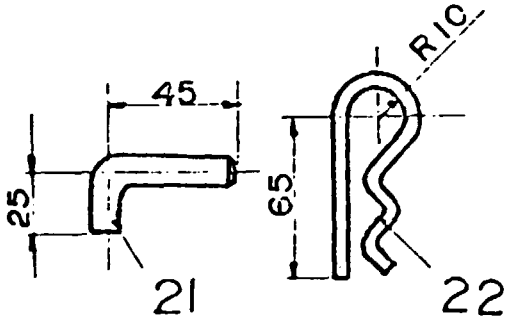
| | | |
|---|---|---|
| | ESCALA: 1:2.5 | DIBUJADO: Kornelis V / Alfredo S. |
| | UNID de MEDIDA: mm | FECHA: 8-1-91 |
| HERRANDINA | ARADO ANDINO | SOPORTE DE TIMON / TELER |



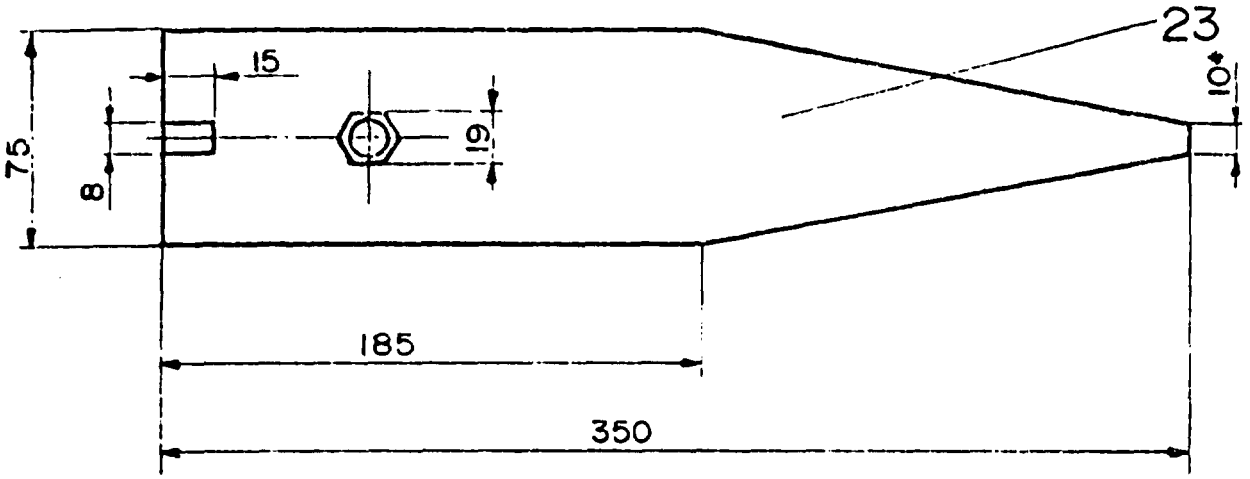



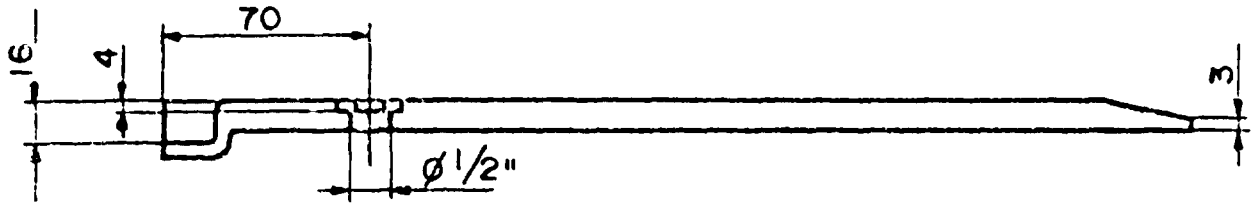



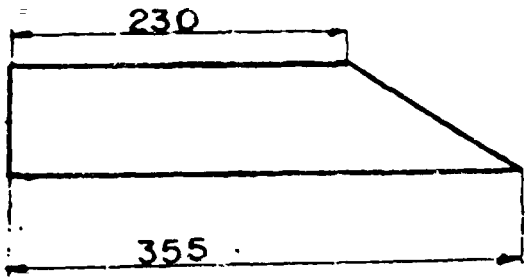

| | | | | |
|---|---|---|---|---|
| 22 | Pasador | alambre negro | N°12 x 150 | |
| 21 | Fijador | fierro liso | Ø 3/8" x 70 | |
| 20 | Unión | varrilla corr. | Ø 5/8" x 35 | |
| 19A | Refuerzo | platina | 3/16" x 3 4 x 100 | |
| 19 | Corredera superior | platina | 3/16" x 1" x 120 | |
| 18 | Corredera inferior | fierro corr. | Ø 3/8" x 180 | |
| 17 | Argolla | fierro corr. | Ø 3/8" x 230 | |
| | DENOMINACION | MATERIAL | MEDIDA | OBSERVACION |

| | | |
|---|---|---|
| | ESCALA 1 2.5 | DIBUJADO : Kornelis V. Alfredo S. |
| | MEDIDAS en mm | FECHA : 8-1-91 correc. 22-4-91 |
| HERRANDINA | ARADO ANDINO REGULACION DEL TIMON | |



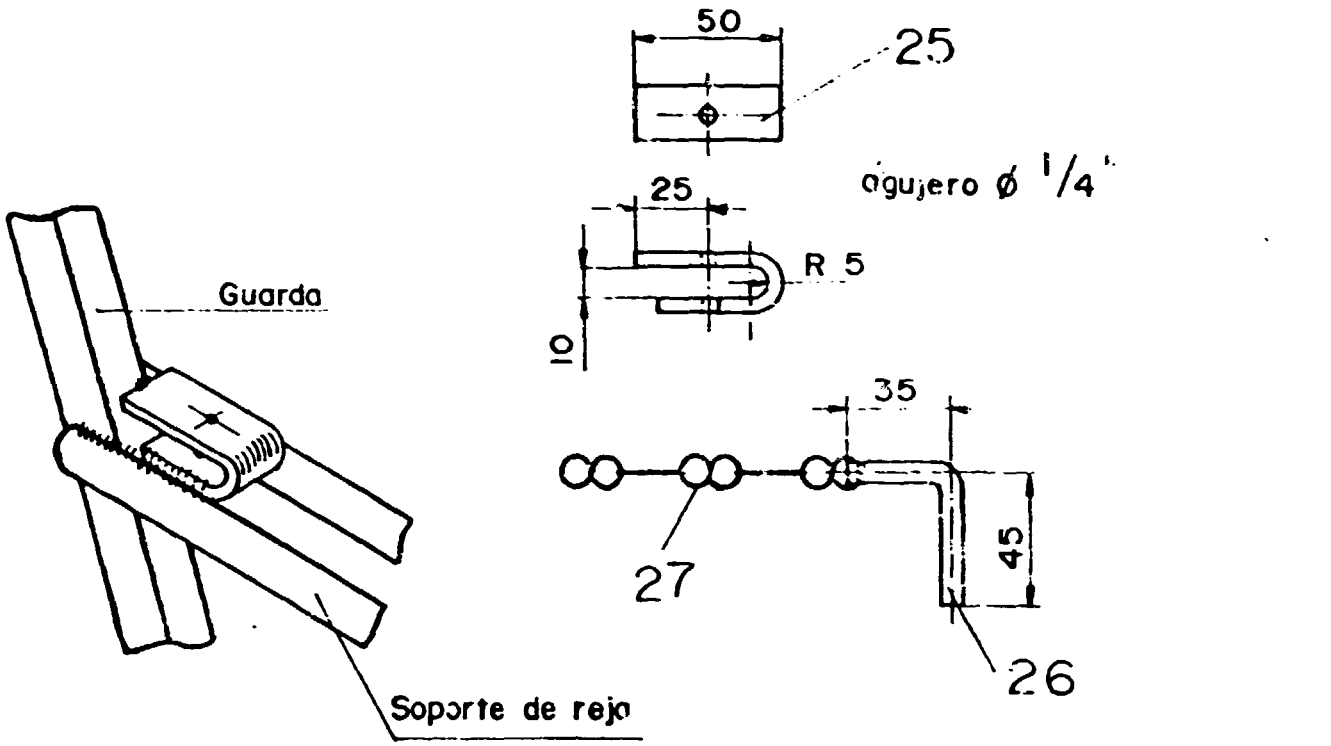

* Es la medida referencial, en algunas zonas puede ser mayor o menor.

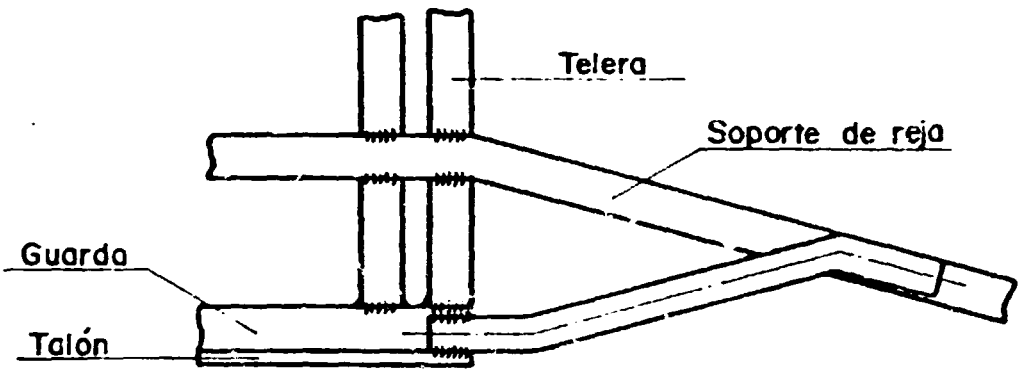


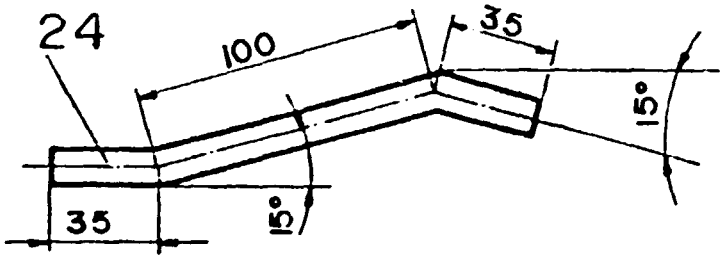




el corte del muelle. Esc. 1:5

| | | | | |
|---|---|---|---|---|
| 23a | Perno con tuerca | | NC 1/2x 2" | |
| 23 | Reja | muelle | 3/8" x 3" | |
| | DENOMINACION | MATERIAL | MEDIDA | OBSERVACION |
| | ESCALA: 1:2·5 | | DIBUJADO: Kornelis V. / Alfredo S. | |
| | UNID.de MEDIDA: mm. | | FECHA: 8-1-91 | |
| HERRANDINA | ARADO ANDINO | | | |

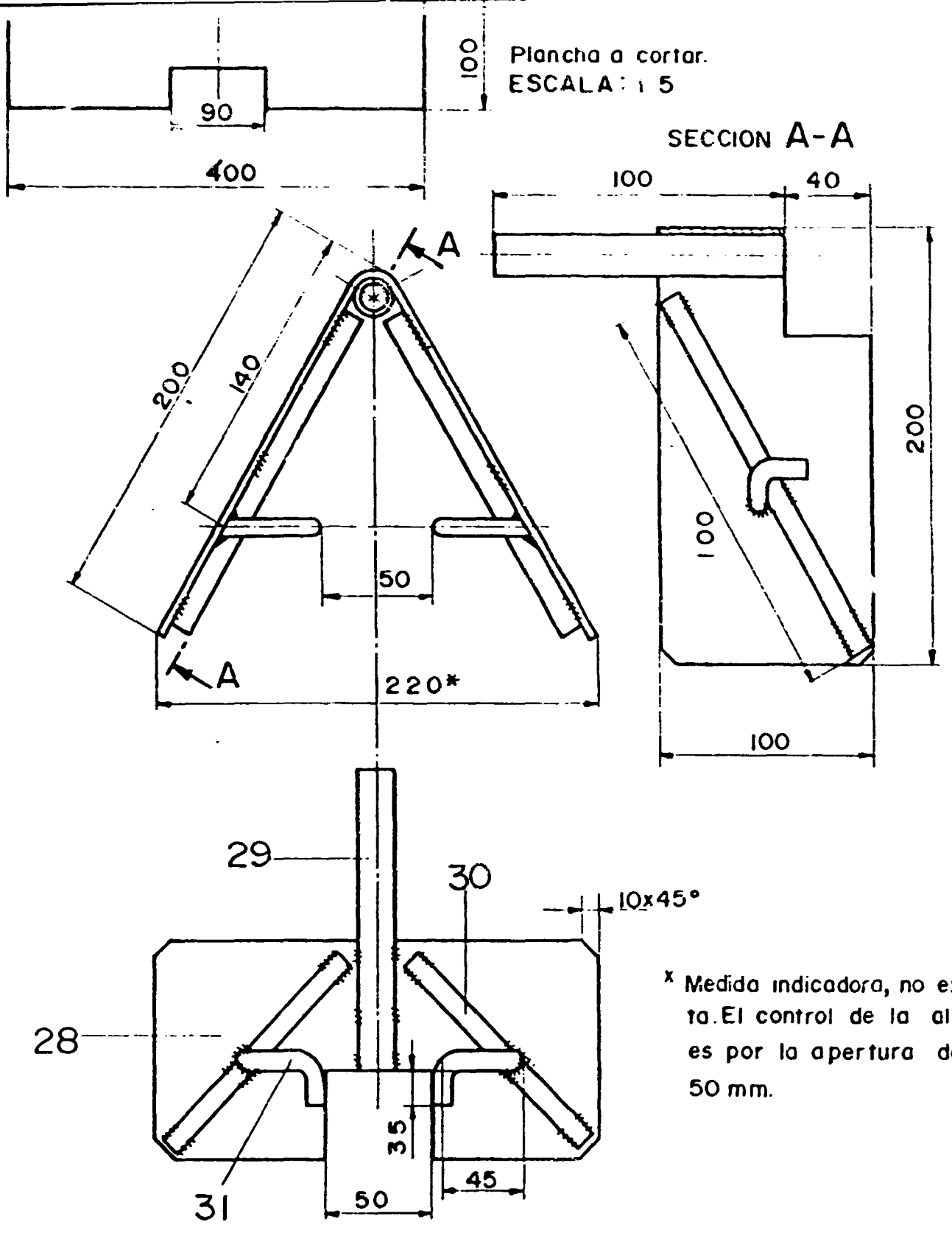



| | | | | |
|---|---|---|---|---|
| 27 | Cadena | alambre negro | N° 12 | longitud 150 mm. aprox. |
| 26 | Pasador | fierro liso | ø 1/4" x 80 | |
| 25 | Regulador de aletas | platina | 3/16" x 3/4" x 90 | puede usarse plancha de 1/8" |
| 24 | Refuerzo de soporte | varilla corrug. | ø 1/2" x 170 | |
| | NOMBRE | MATERIAL | MEDIDA | OBSERVACION |

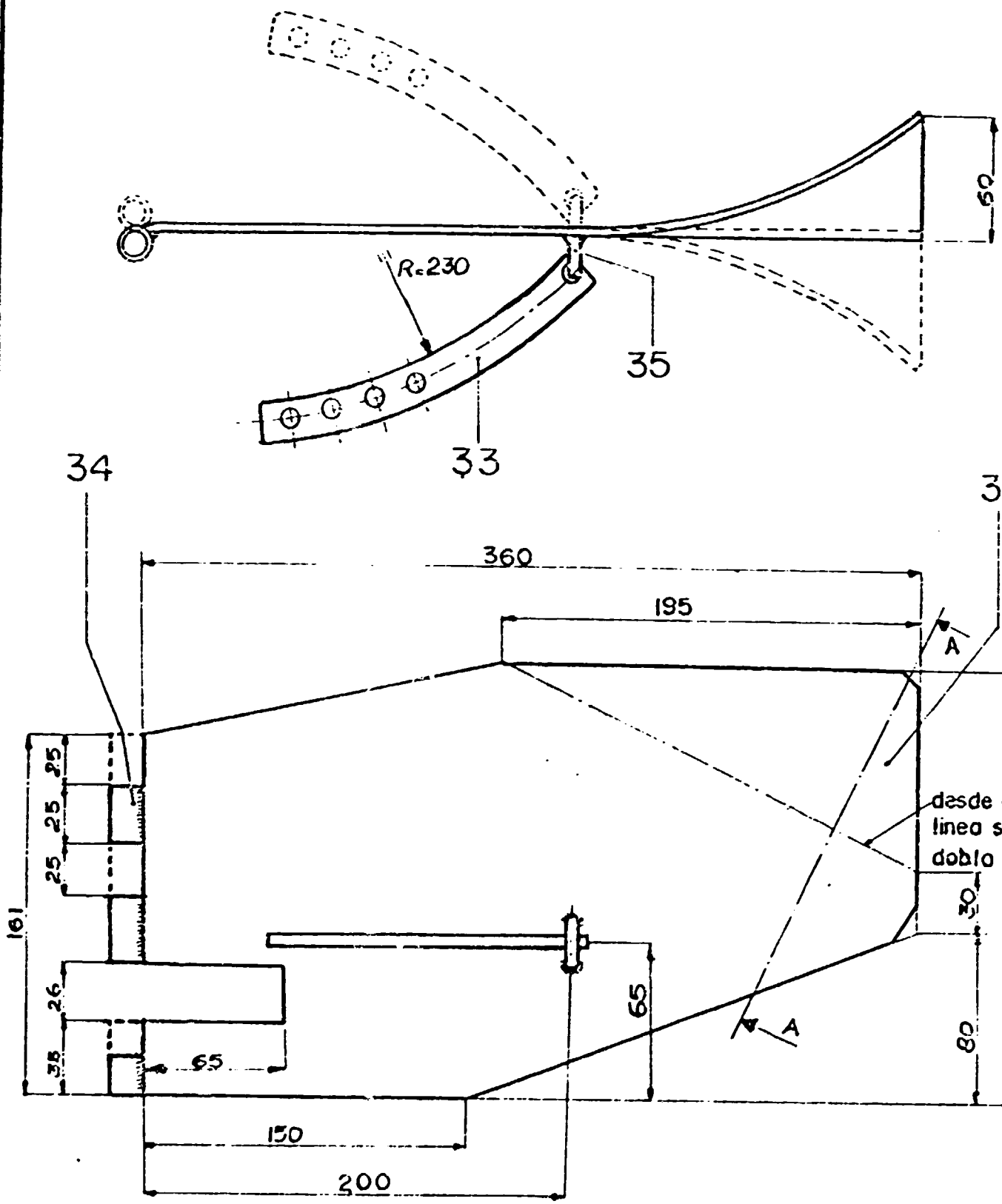
| | | |
|---|---|---|
| | ESCALA: 1:2.5 | DIBUJADO Kornelis V. / Alfredo S. |
| | UNID de MEDIDA: mm. | FECHA: 8-1-91 |
| HERRANDINA | ARADO ANDINO | REFUERZO / REGULADOR. |



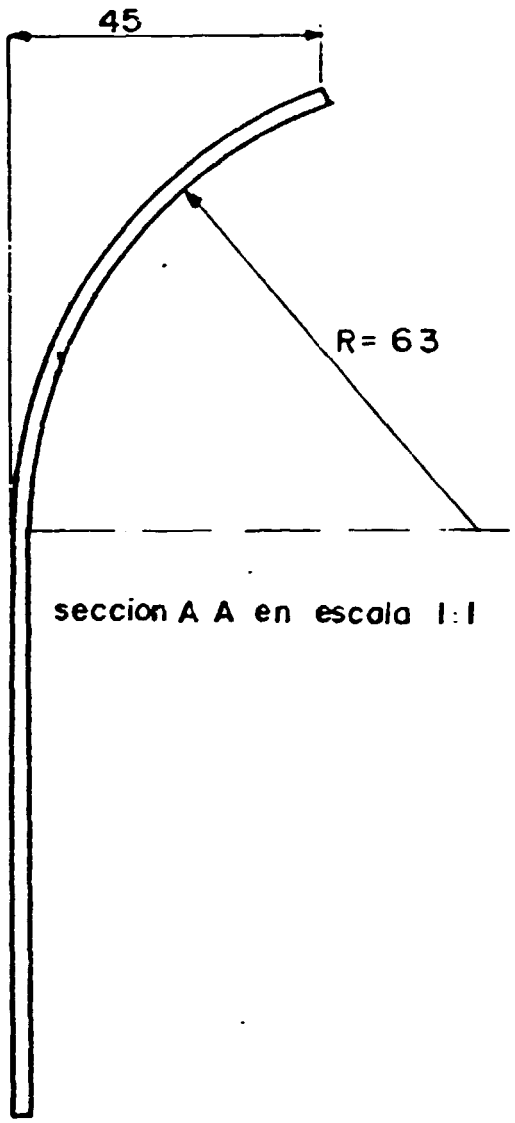

x Medida indicadora, no exacta. El control de la aleta es por la apertura de 50 mm.

| | | | | |
|---|---|---|---|---|
| 31 | Espaciador | varilla corrug. | ø 3/8" x 80 | 2 piezas |
| 30 | Refuerzo de aleta | varilla corrug. | ø 3/8" x 180 | 2 piezas. |
| 29 | Buje | tubo negro | ø 3/8" x 100 | |
| 28 | Aleta | plancha negro | 1/8" x 100 x 400 | |
| | DENOMINACION | MATERIAL | MEDIDA | OBSERVACION |

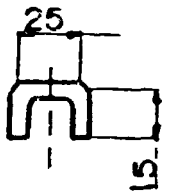
| | | |
|---|---|---|
| | ESCALA: 1:2.5 | DIBUJADO: Kornelis V. / Alfredo S. |
| | UNID. de MEDIDA: mm. | FECHA: 8-1-91 |
| HERRANDINA | ARADO ANDINO | ALETA PARA ARAR. |

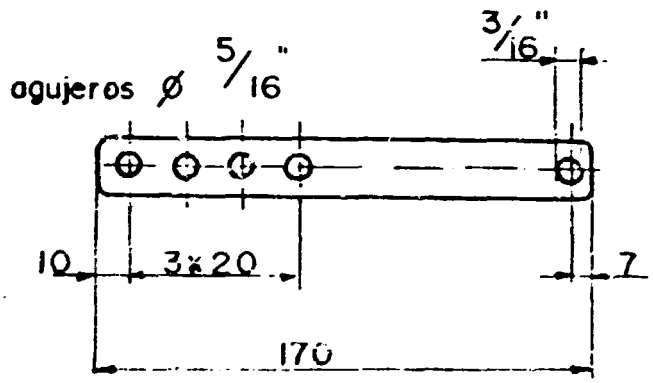



para surcar se necesitan dos aletas, una es la inverso de la otra, en el plano se ha dibujado una aleta, con la linea punteada se indica la otra.




seccion A A en escala 1:1




platina regulor antes de doblar

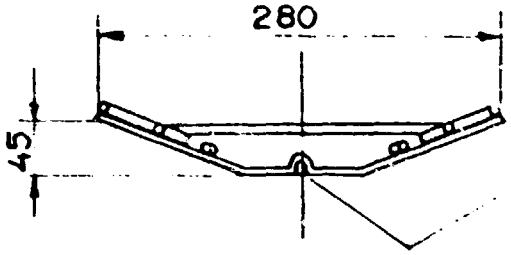
| Nº | DENOMINACION | MATERIAL | MEDIDA | OBSERVACION |
|---|---|---|---|---|
| 35 | Unión | alambrón | ø 1/4" x 45 | |
| 34 | Bujes | tubo negro | ø 3/8" x 25 | 3 bujes |
| 33 | Platina regulador | platina | 3/16 x 3/4" 170 | |
| 32 | Aleta | plancha negra | 1/8" | 2 aletas inversos |

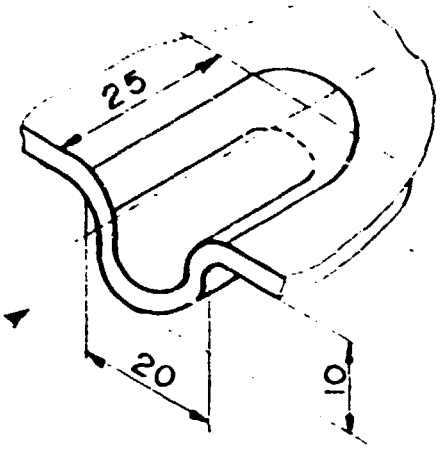
ESCALA 1 : 2.5
UNID de MEDIDA mm
DIBUJADO: Kornelis V.-Alfredo S.
FECHA 8-1-91

HERRANDINA

# ARADO ANDINO ALETAS para SURCAR

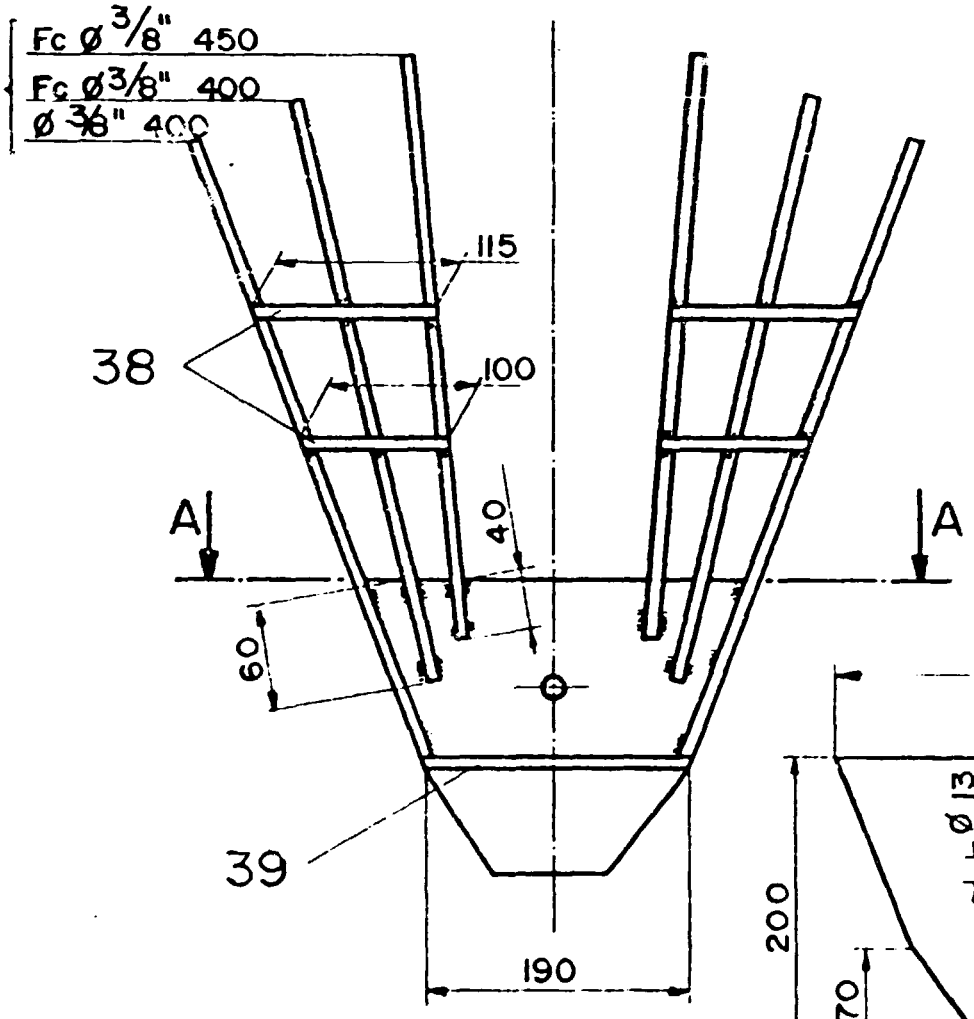
SECCION A-A

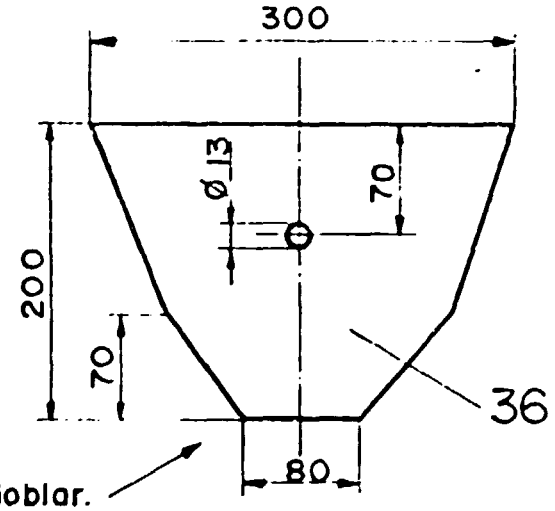



TETON

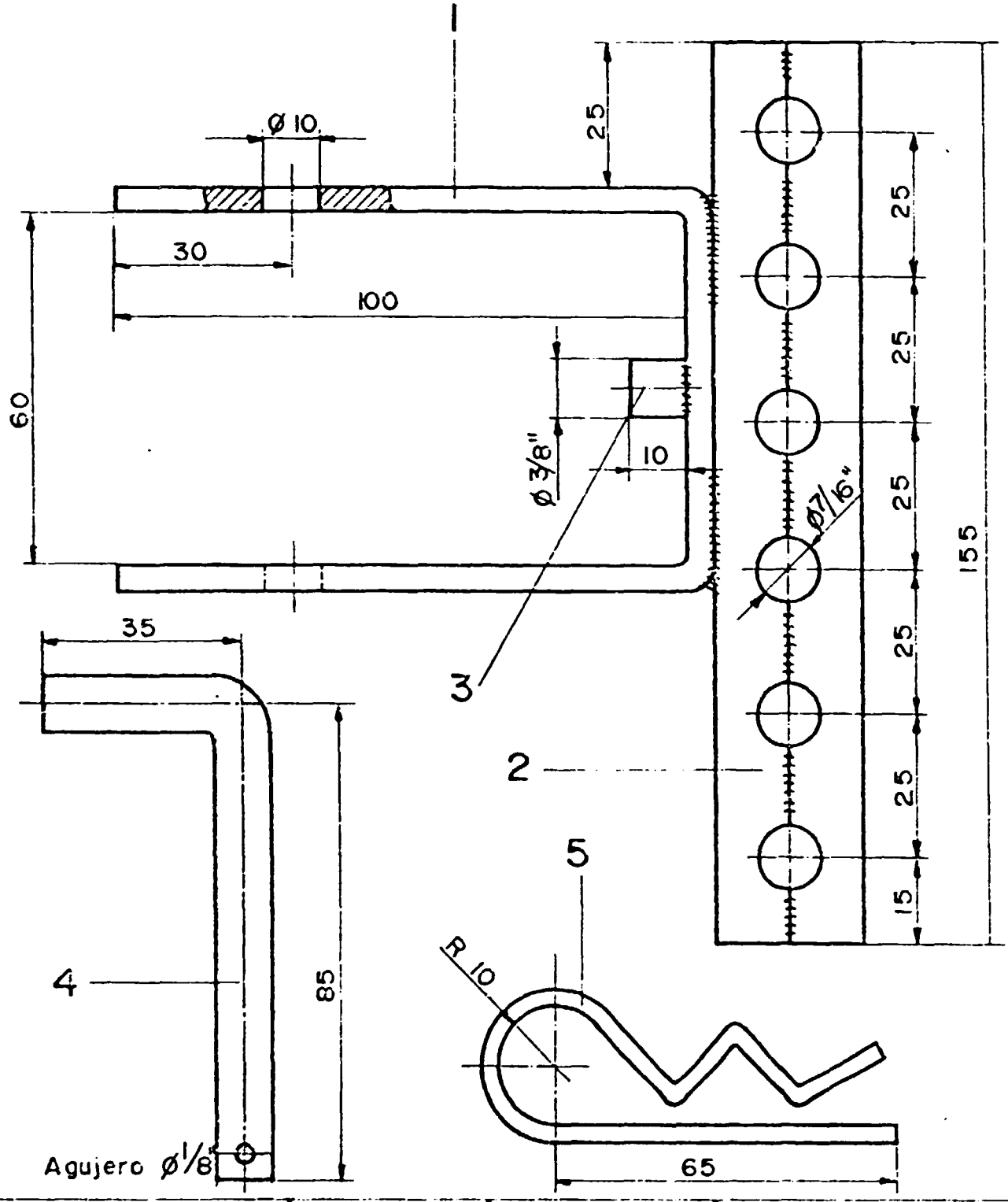
ESCALA: 1:1




Pala sin doblar.

| | | | |
|---|---|---|---|
| 39 | Refuerzo de pala | Varilla corrug. | Ø 3/8" x 190 |
| 38 | Refuerzo | varilla corrug. | Ø 3/8" x 115 (2 pzs.) / Ø 3/8" x 100 (2 pzs.) |
| 37 | Selector de tuberculos. | varilla corrug. | Ø 3/8" x 450 (2 pzs.) / Ø 3/8" x 400 (4 pzs.) |
| 36 | Pala | plancha negra. | 1/8" |
| | DENOMINACION | MATERIAL | MEDIDA |
| | ESCALA: 1:5 | | DIBUJADO: Kornelis V. / Alfredo S. |
| | UNID. de MEDIDA: mm. | | FECHA: 8-1-91 |
| HERRANDINA | ARADO ANDINO | | COSECHADORA |




| | | | | |
|---|---|---|---|---|
| 5 | Pasador | alambre negro | N° 12 x 150 | |
| 4 | Clavija | fierro liso | Ø 3/8" x 120 | |
| 3 | Guia | fierro liso | Ø 3/8" x 10 | |
| 2 | Peine regulador | varilla corrug. | Ø 1/2" x 155 | 2 piezas |
| 1 | Abrazadera | platina | 3/16" x 1" x 260 | |
| | DENOMINACION | MATERIAL | MEDIDA | OBSERVACION |

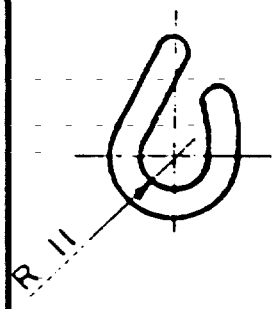
ESCALA 1:1 — DIBUJADO Kornelis V. Alfredo S.
UNID. de MEDIDA mm. — FECHA 8-1-91

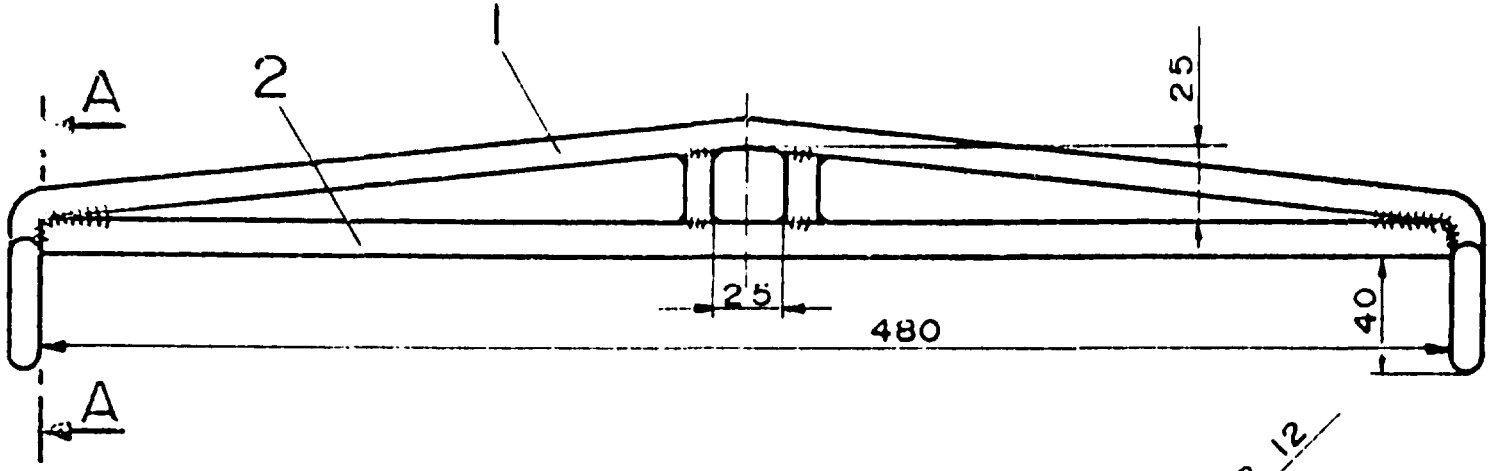
HERRANDINA

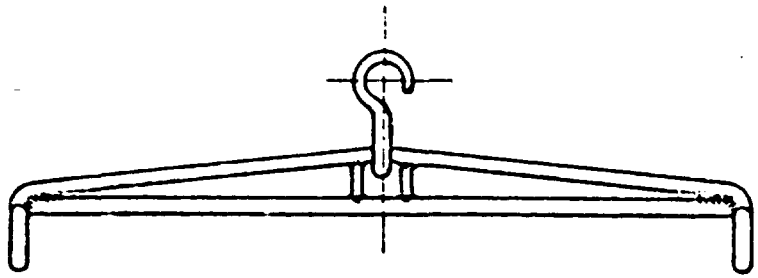
# ARADO ANDINO

PEINE REGULADOR

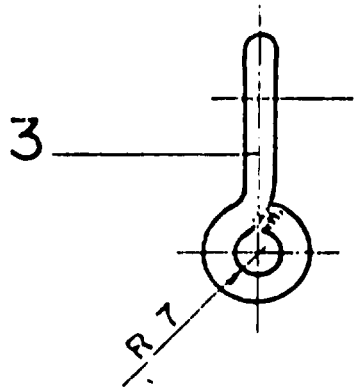
SECCION A-A

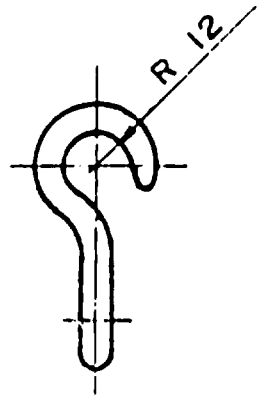


ESCALA: 1:5




| | | | | |
|---|---|---|---|---|
| 3 | Gancho | fierro liso | ø 3/8" x 190 | |
| 2 | Refuerzo de balancín | varilla corrug. | ø 1/2" x 480 | |
| 1 | Balancín | varilla corrug. | ø 3/8" x 720 | |
| | DENOMINACION | MATERIAL | MEDIDA | OBSERVACION |

| | | |
|---|---|---|
| | ESCALA: 1:2.5 | DIBUJADO: Kornelis V. / Alfredo S. |
| | UNID. de MEDIDA: m.m. | FECHA: 8-1-91 |
| HERRANDINA | ARADO ANDINO | BALANCIN |