OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

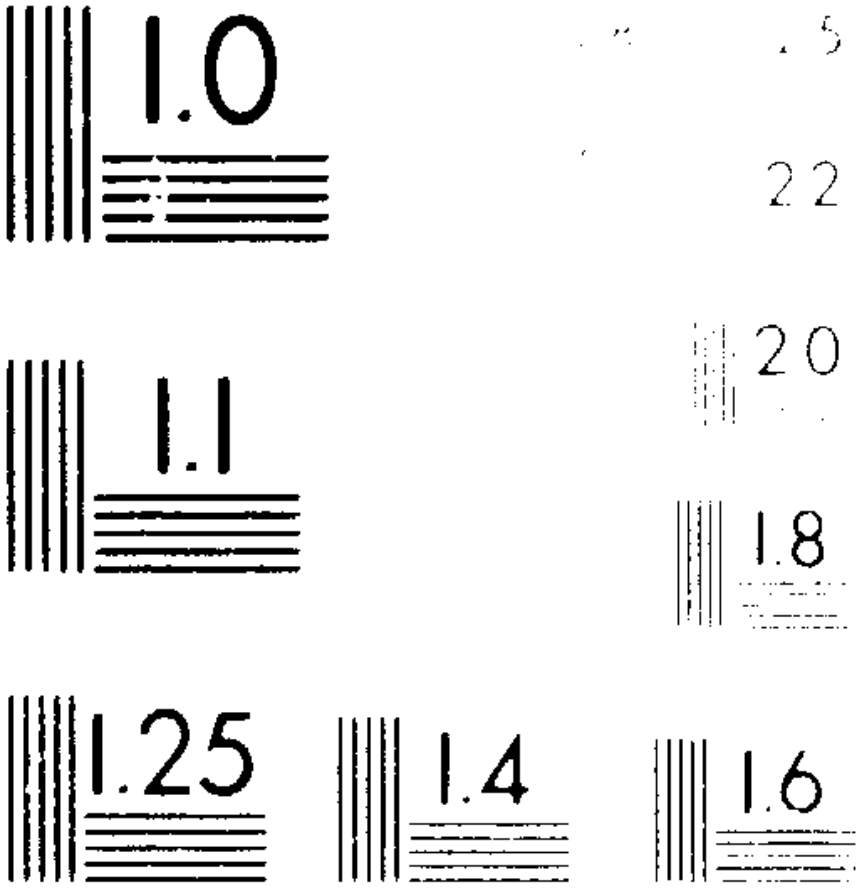
FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2

UNIDO/UNDP

14548

ASSISTANCE TO THE DEVELOPMENT OF SMALL INDUSTRY IN INDONESIA

(PROJECT DP/INS/78/078)

[redacted]

ARTEMEN PERINDUSTRIAN

KTORAT JENDERAL INDUSTRI KECIL

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

(ASSISTANCE TO THE DEVELOPMENT OF SMALL INDUSTRIES

DP/INS/78/078

Indonesia.

FOOD PROCESSING MACHINERY.

Page:

CONTENT:

FOOD PROCESSING MACHINERY.

INTRODUCTION.

UNIDO Industrial Engineer, Jakarta, was some time back requested by the Agricultural based Food Institute in Bogor to provide some designs for machinery for processing of food.

This partly referred to machinery for which they had already made prototypes but wanted alternative solutions and improvements in existing designs. Partly it also referred to new developments required to solve processing problems that the institute saw as important to find improved solutions to.

We hence made the 13 machine designs as presented in the continuation. For 3 of the machines has already been made prototypes that we have tested together. This refers to the vegetable slicer, the fruit pulper and the juice press. For the juice press we found it after the testing adviceable to present a totally new design, carrying both simplification and improved efficiency. For the 2 other machines only notes were given about manufacturing and use of the equipment. It is anticipated that prototypes for the further equipment will be made as soon as budget means are available.

May we suggest, as soon as the different machines have been made and tested, and possible further corrections being done, that the drawings will be made up a bit more thorough and detailed, printed and made available in a common leaflet for the private food industry as well as for the machine manufacturers.

FRUIT PULPER.

The fruit pulper design is specified in fig. 1.
The pulper is intended to work together with the juice press fig. 2.

The fruit will first, after washing, peeling and deseeding, be pulped to an even mass in the pulper, whereafter the juice will be pressed out in the next machine.

Motivation. This is a machine, alternative to an earlier design of the food institute where pulping and pressing is done as a common process in one machine. One may find that the new design is more labour intensive, but on the other hand having a higher yield, lower costs and being easier to use and to maintain.

General construction. The pulper has a vertical 20 liter stationery cylindrical pulping container, with a single high speed stirring and cutting knife rotating concentric inside. The pulper fixed on a vertical single floor stand, with the knife fastened directly on to an extended shaft of the electric motor, erected vertically on top of the machine. The rotating knife remains on the machine during all operations, while the container is snap-on fixed, and can easily be lifted off after each charge for discharging of the content.

The container. It is proposed to use a standard 20 liter milk churn of the same type as used by farmers for sending milk to dairies etc. These churns are well constructed for the purpose, and are low cost, strong, durable, and easy to clean and handle. The diameter of the opening is large enough to permit easy use and small enough to prevent any splashing during the operations without using any lid.

The container will, when placing on the machine, be lifted up over the knife, placed on the hook on the machine stem, pressed against the rubber buffers on the sides and locked firmly in position with the locking handle having a rubber covered holding finger on the upper edge of the container. A filling funnel is not specified in the design, but can be fit semipermanently on the stem for easier filling.

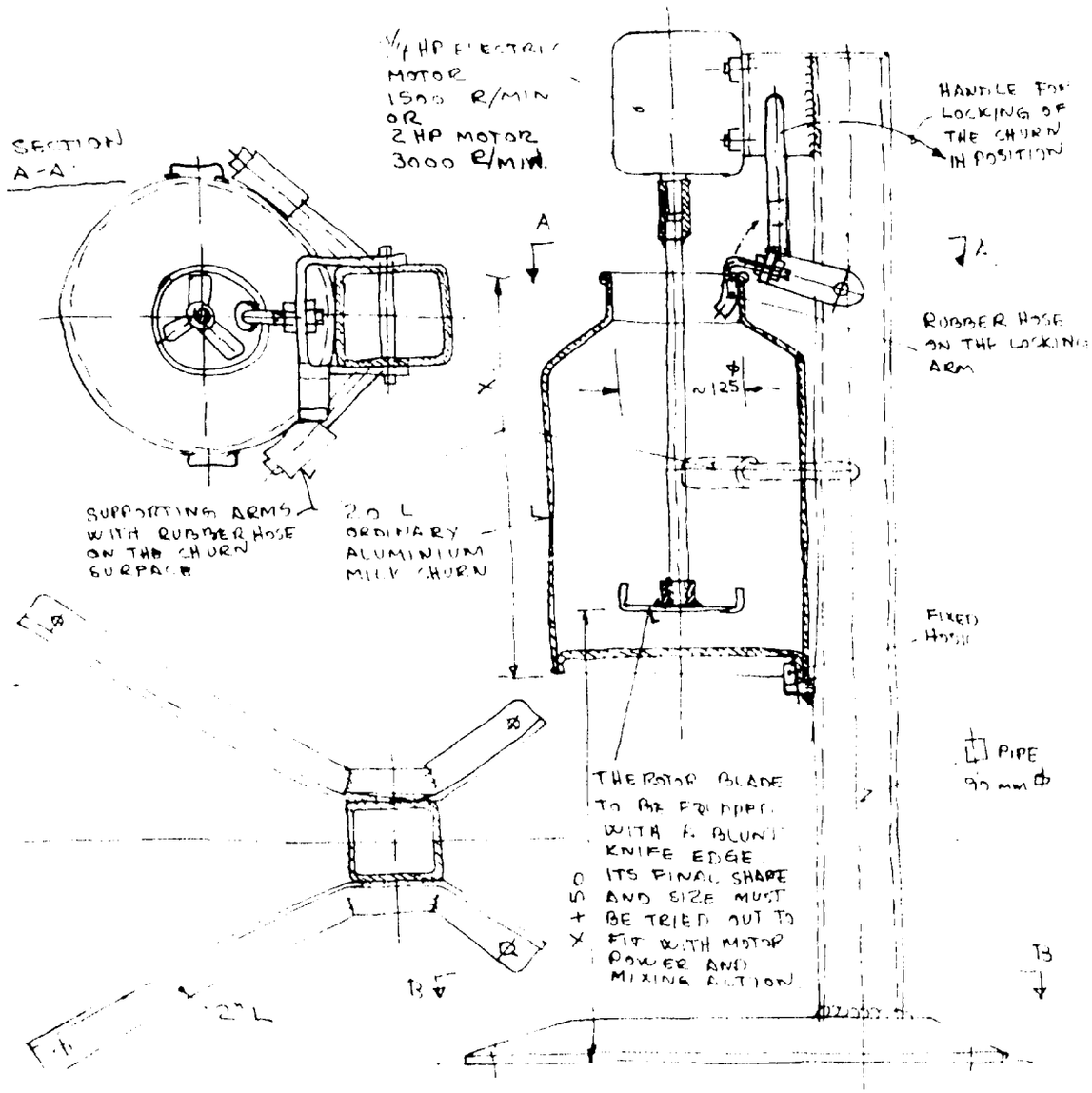
The rotating knife should have a diameter to fit with the effect of the motor, large enough to utilize the motor energy, but not so large that it will be overloaded.
Different fruits may require different size and shape of knife, and it should also be possible to dismantle the knife for maintenance, the knife centre having treads to fit on the prolonged shaft of the motor. The prolonged shaft to be firmly fixed to the motor shaft without any outside screws or hooks that can catch on to the fruit or the operator.

As long as a motor with solid ball bearings is being used, no further bearings are required.
A 3000 R/min 2 HP motor is recommended, but a 1.500 R/min 3/4 Hp motor may be used where less power is available.

Operation. The container to be lifted on and fixed in position, and rotation started, whereafter the prepared fruit to be filled in slowly. Dependant on the fruit consistency, about 10 min pulping may be required before stopping the motor, lifting down the container and pouring the content over into the next process.

A prototype has been built and tested and was working well, except for some small building errors to be corrected, and the use of a less suitable soldered container.

FIG. 1



FRUIT PULPER

THE PULPER STANDS ON THE FLOOR AND HAS A FIXED STIRER DIRECTLY IN PROLONGATION OF THE MOTOR SHAFT. THE MOTOR FIXED TO ITS UPPER PART.
AN ORDINARY MILK CHURN, 20 L OR SIMILAR CONTAINER TO BE USED AS THE VESSEL (2 SIMILAR CONTAINERS MAY BE PROVIDED.

THE EMTY CONTAINER LIFTED UP ON THE STIRER AND QUICKLY SNAPPED IN POSITION.
FRUIT TO BE ADDED WHEN STIRER ROTATING

AFTER COMPLETING PULPING CONTAINER TO BE LIFTED OFF AND EXCHANGED WITH AN EMTY ONE.

SCALE ~ 1:5

UNIDO INC. 78/078
INDUSTRIAL ENGINEER
JAKARTA
15/3 84 PB/2

FRUIT JUICE PRESS.

The design as shown in fig. 2 is ment to be used for pressing the juice of pulped fruit, in conjuction with the pulper above.
The press has 20 liter capacity, the same as for the pulper.

Construction. A press cylinder container has a loose bottom plate with rigid woven mesh in stainless steel on a support frame.
Along the inner cylinder surface is a loose ring, from similar mesh.
Inside are 2 loose drainage mesh plates and a press plate on top similar to the bottom plate. The mesh ring is fit to drain juice along the inside cylinder walls without needing any perforation of the cylinder.

The container rests loosely in a support ring, borne on 4 legs and holding the swing-out traverse arm with a hinge bolt in one side and an end stop in the other.
A press screw treads through the traverse, presses the upper press plate through a snap on fastener, agitated with a winding handle with fly weights.

All parts in contact with the fruit are from stainless steel and are easily removable for cleaning.

Operation. Firstly the traverse arm is swinged out with the press plate in upper position with the cylinder container bottom plate and sieve ring in position. A filter cloth is placed over the container and 1/3 of the fruit pulp filled in. The filter cloth is folded in on top of the pulp and a distance mesh plate placed on top.
Similarly 2 further filter cloths to be filled with the rest of the pulp, before the traverse arm to be put in position and the press plate slowly pressed down using the winding handle.
Juice to be collected in a bucket under the press cylinder.

On completion of the compression, the remaining mass may be cooked with water and thereafter pressed, adding together 2 or 3 batches. The finally remaining fibre may be dried or processed otherwise to be used as human or animalfeed.
1st and 2nd press juice may, dependant on circumstances, be mixed or used for different qualities of juice.

A prototype with plane square press plates has already been built and tested based on using filter bags. The process appeared more cumbersome and the design was therefore changed.

Some fruitpulps are more closed against draining than others. Working with difficult pulp, it may be necessary both to use further draining mesh plates, and to rearrange the pulp during the pressing.

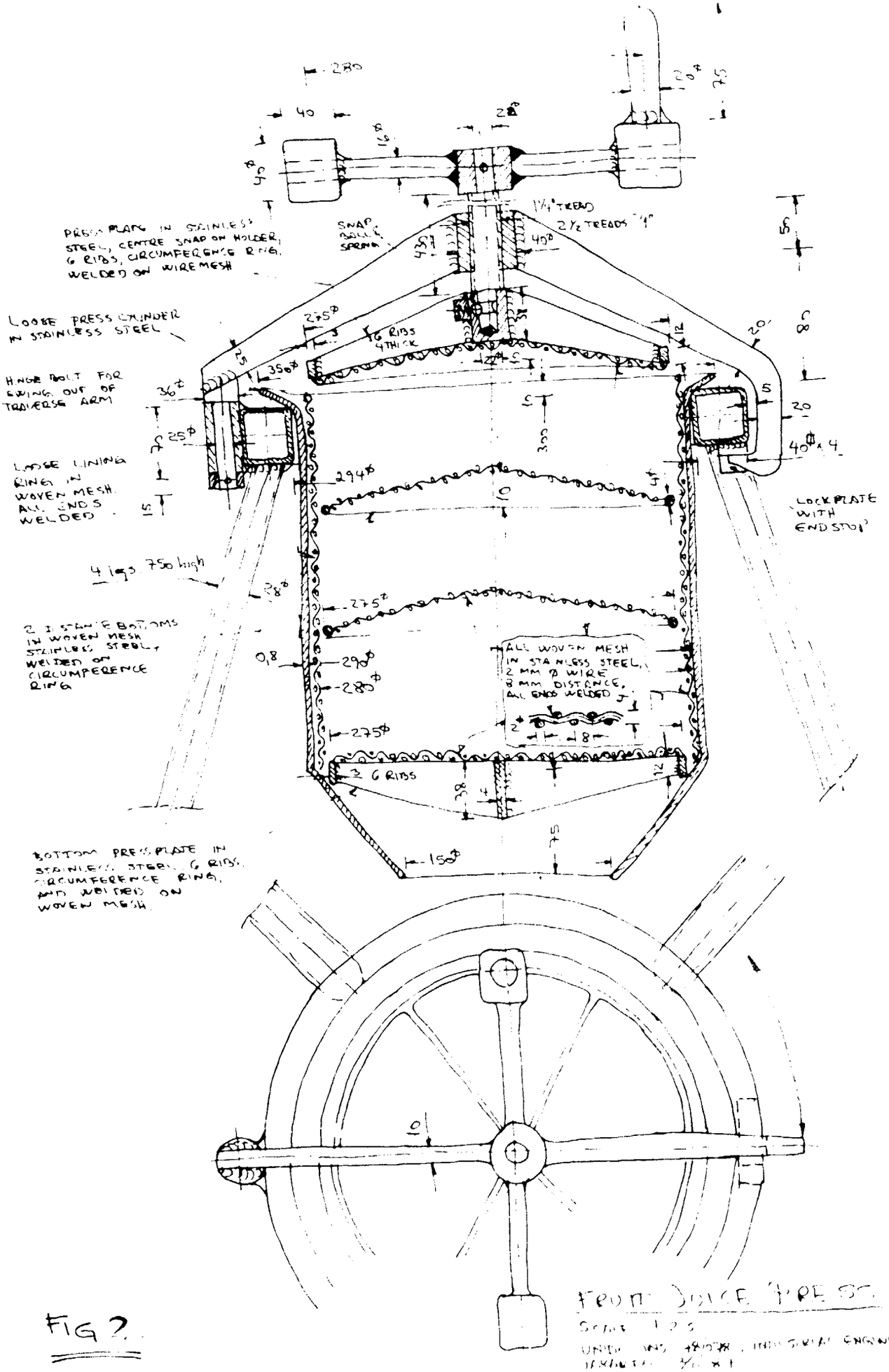

PRESS PLATE IN STAINLESS STEEL, CENTRE SNAP ON HOLDER, 6 RIBS, CIRCUMFERENCE RING, WELDED ON WIRE MESH
SNAP BALL & SPRING
1¼" TREAD
2½ TREADS 1"
LOOSE PRESS CYLINDER IN STAINLESS STEEL
6 RIBS 4 THICK
HINGE BOLT FOR SWING OUT OF TRAVERSE ARM
LOOSE LINING RING IN WOVEN MESH ALL ENDS WELDED
LOCK PLATE WITH END STOP
4 legs 750 high
2 STAINLESS BOTTOMS IN WOVEN MESH STAINLESS STEEL WELDED ON CIRCUMFERENCE RING
ALL WOVEN MESH IN STAINLESS STEEL, 2 MM Ø WIRE 8 MM DISTANCE, ALL ENDS WELDED
6 RIBS
BOTTOM PRESS PLATE IN STAINLESS STEEL, 6 RIBS, CIRCUMFERENCE RING, AND WELDED ON WOVEN MESH
FRUIT JUICE PRESS

FIG 2.

SLICING MACHINE FOR VEGETABLES, ETC.

The slicer, as specified in fig. 3, is ment for slicing of cassava roots, potatoes and other vegetables for drying or for other purposes. With a knife plate with 3 knives and 1.500 R/min motor it gets a high capacity of 4.000 slices/min. When that capacity is not needed, one may also use a 750 R/min motor with fewer knives, and may get a slightly better control of the process.

Construction. An electric motor is fixed vertically on a single consile stem. A disc knife with 3 knife blades is fixed to a prolongued shaft of the motor.

Under the disc knife is a collection funnel to lead sliced products into a container. Over the knife is a protection cover that is hinged on for easy maintenance. Through the protection cover is fixed to it a feed funnel to guide the vegetable in right position on to the knife disc. A press plug must be used for the last vegetable ends to protect the operator hands.

The knife plate, the outlet funnel and the feed tube must be in stainless stell. The knives may be formed as a part of the disc as specified, bu the fitting of loose knives is also possible. Rather than adjusting the knives for different slicing thicknesses, may it be better to exchange the knife discs.

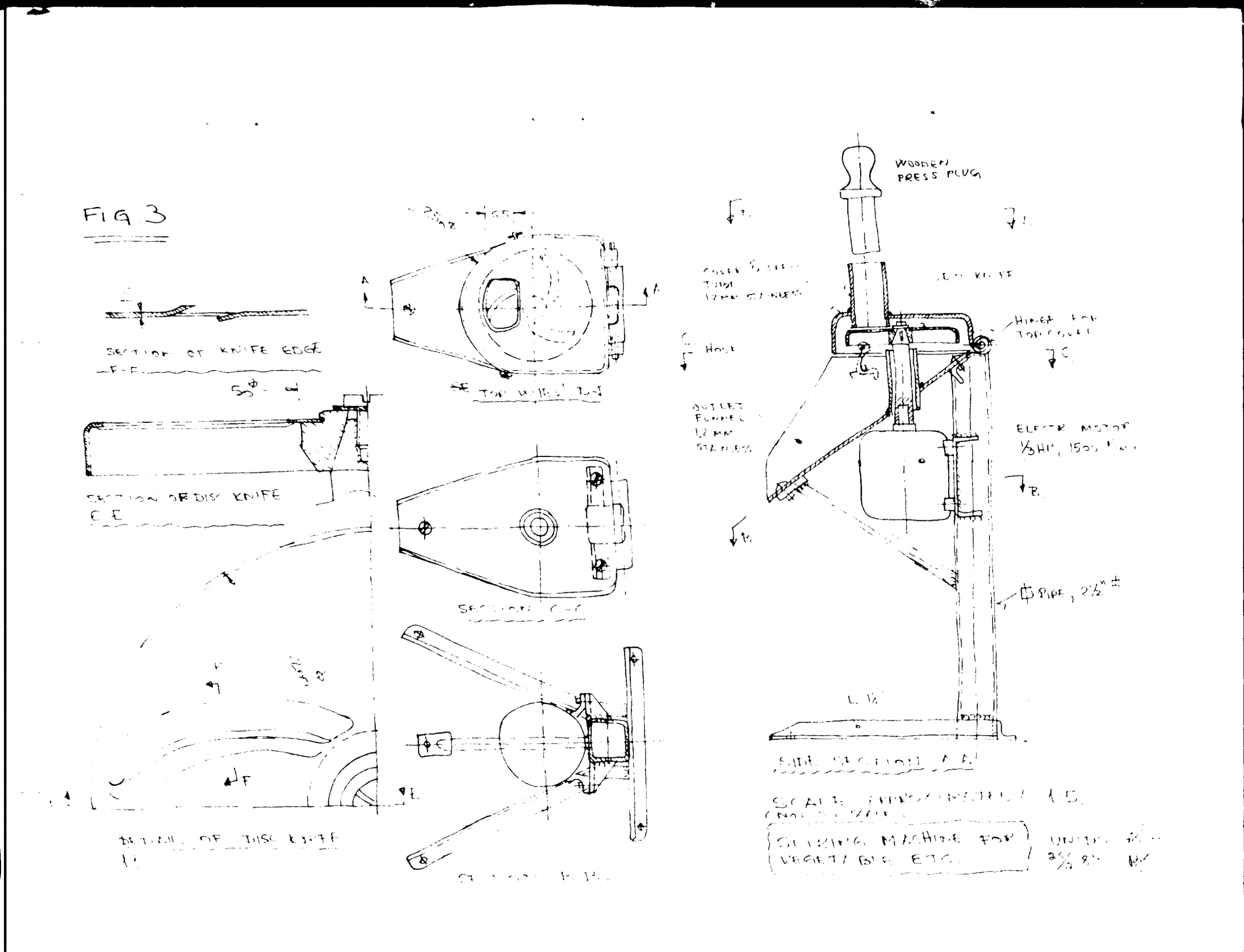
Knife angles. Important is it observe the knife angles as inlicated in the design being responsible for the quality and the power requirement of the slicing. The knives can not be arranged radially in the disc, but must form a angle with the radius so as to obtain a sliding knife edge effect that is required for cutting of most products.

If arranged in an arch, a constant angel with the radius will be obtained, but a straight knife is also possible to use and will generally give sufficient results.
The edge angels of the knife must also be kept slim to obtain a nice cut.

The feed tube. The section of the feed tube can not be larger than that its total surface is covered by the knife movements. It must not have any inside hindrances against the product feed and it must be prolonged as close to the knife edge as possible.

A prototype has already been built and was working well, even if being built unnecessarily complicated and not taking all of the above notes into account. That can however easily be rectified.

FIG 3


WOODEN PRESS PLUG
SECTION OF KNIFE EDGE
OUTLET FUNNEL 1.2 MM STAINLESS
ELECTR MOTOR
PIPE, 2½"
SCALE
SLICING MACHINE FOR VEGETABLES ETC.

PEANUT SHELLER.

The desig[illegible] of the peanut sheller, fig. 4, is related to earlier developments within the institute, and represents in general only simplifications and operational improvements of an earlier prototype.

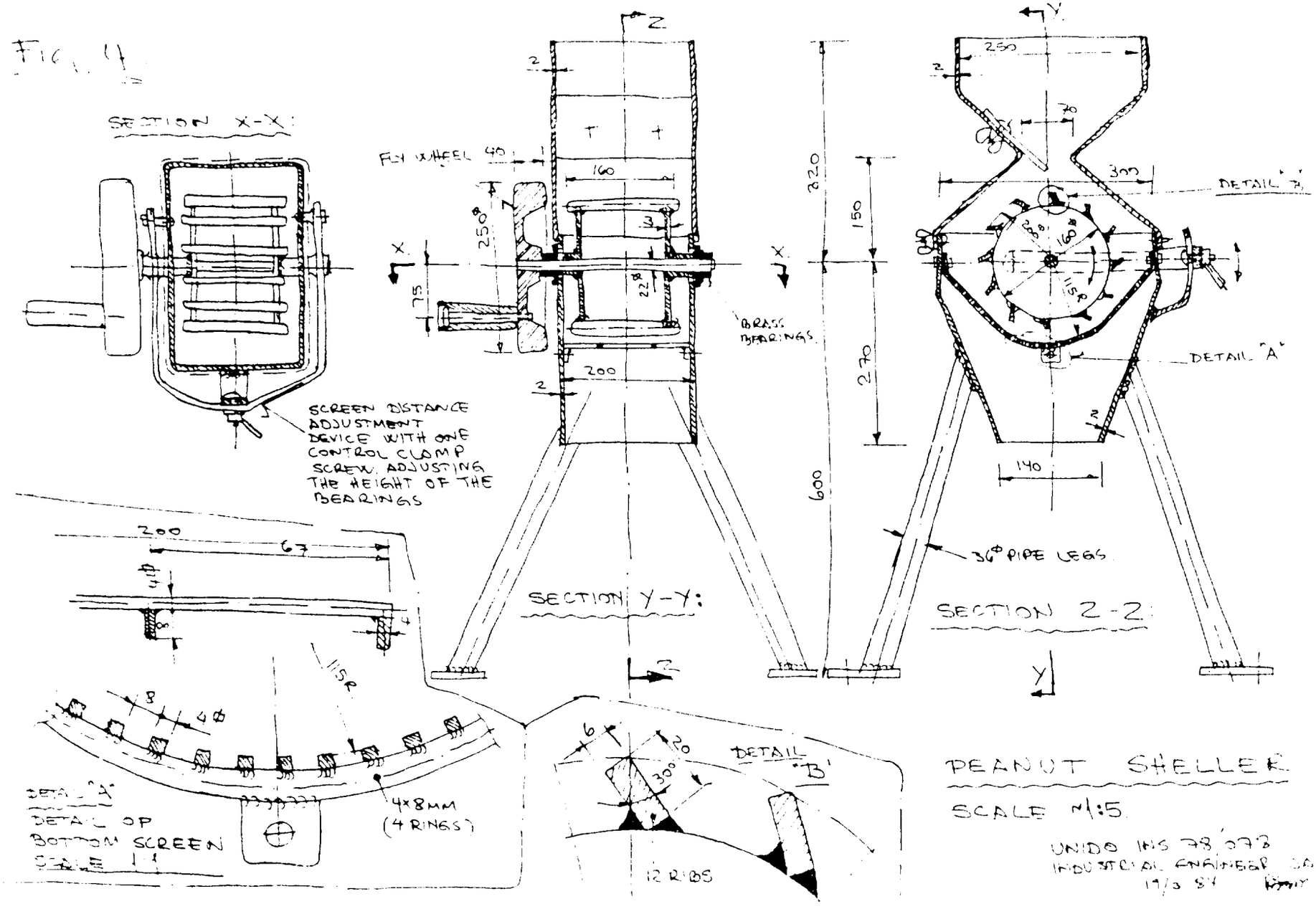
Construction: The sheller has a rotating drum with shovelarms that breaks the larger unpeeled peanuts against the arched bottom screen letting the smaller peeled peanuts and the shells through.

The shovelarm drum is driven by a hand crank fixed to a fly wheel. Its shaft is supported in two simple brass bearings. The bearings are fixed to an adjustment arm hinged in one end outside the casing of the sheller, while the other end has a quick operating locking screw. Hence moving the adjustment arm up or down, the distance between the shovel drum and the screen will be changed, to adjust for the sort of products that are being peeled.

The bottom screen is arranged with axially arranged thin square bars in a distance of 8 mm, providing slots for passing of nuts and peels but not unpeeled products.
The bars are fixed to 4 supporting rings, holding the screen together and permitting positioning. The screen is fixed with 6 screws and may easily be exchanged for different products.

The lower part of the housing has 4 pipe floor legs. The upper part is in one end held on 2 control pins, and in the other by one wing nut fastening screw, hence easy to lift off for maintenance etc. The upper part also has a built in silo with an adjustable flow control plate in the bottom.

FIG. 14



PEANUT SHELLER

SCALE N/:5

UNIDO INS 78/073
INDUSTRIAL ENGINEER DAKAR
19/3 84

EMPING MELINJO SHELLING MACHINE.

The emping melinjo seed has a hard brittle shell. According to the experience of the Institute, peeling can best be created through a sharp impact after roasting.
The institute has already developed a methode for simplified impact peeling.

Our design in fig. 5 is only an improvement of the design of the already existing prototype of the machine, aiming at reduced costs and size, simplification and easier maintenance.

Operation: The seeds are fed into the receiving funnel in a continuous steam. The seeds will pass into the centrifugal throwing pipe that rotates with 3.000 R/min and hence be thrown with impact against the inside of the rib ring.
When cracking against the ring rib corners, a part of the shell goes through and falls out through the disc charger opening outside the ring.

The seeds with some remaining shells comes out through the inner discharge opening.

The impact, and hence the degree of shell breaking and also seed breaking is as long as the rotation speed is constant, determined by the radius or the lenght of the centrifugal throwing pipe.
The proposed lenght seem at 3.000 R/min to correspond with the earlier experiences of the institute.

One may however after trials need to adjust the lenght, so as to obtain a highest possible degree of shell cracking and a lowest possible degree of seed cracking. It would be possible to have an adjustable lenght of the throwing pipe through fitting an outside sliding pipe.

This however seem being an unnecessary complification of the machine. Extra balancing precautions would then also be required.

Construction: The centrifugal throwing pipe is fastened directly on to the shaft of a 1/4 Hp, 3.000 R/min ordinary flanged electric motor. The throwing pipe should be balanced agains vibrations. The motor is flanged on to the casing of the machine, the casing being held by a single floor console. A cone impact ring with ribs is held into the casing by the same 4 screws with wing nuts, easy to open, as holding the front cover.

The casing has a discharge opening for shells, while the front cover has an inlet funnel and a discharge opening for the products.

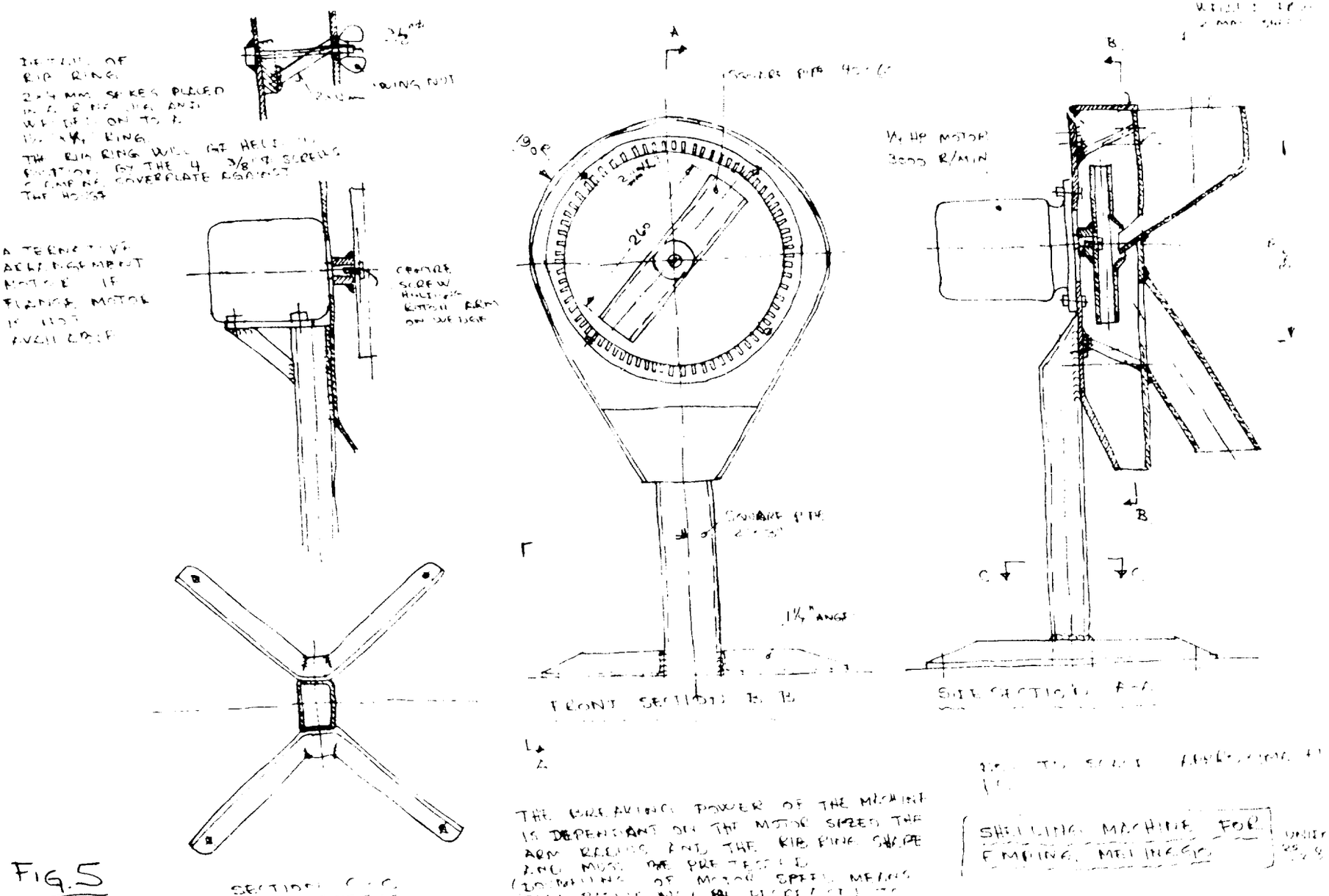


Fig.5

THE SPINNING POWER OF THE MACHINE IS DEPENDANT ON THE MOTOR SPEED THE ARM RADIUS AND THE RIB RING SHAPE AND MUST BE PRE TESTED

SHELLING MACHINE FOR FORMING METAL DISCS

ROASTER FOR EMPING MELINJO, PEANUTS, ETC.

The roaster is simply a rotating drum with tumbling ribs inside and gas heating outside. The drum is rotated by a direct hand crank on a fly wheel. The drum can be tilted for easy product discharge and a hood is arranged over the drum to collect the heat and the combustion gases via a pipe over the roof.

The design is shown in fig. 8 and refers to an earlier design of the Institute, here only having been simplified in construction for decreased costs and simplified operation and maintenance.

Construction: The rotating drum is horizontal cylindrical with a cone opening in one end and a plane bottom in the other. The 3 inside ribs provide sufficient tumbling of the product and the cross of ribs in the bottom are necessary for the holding of the one end shaft.
The drum body should be made from heat resistant or stainless steel. The long bearing pipe with a brass lining in each end gives the required support during rotation from the adjacent hand cranked fly wheel.

The 2 gas burner pipes and the swing fork are fastened to the bearing pipe. The swing fork is supported in the swing bolt each side, positioned 70 mm above the gravity point (when half filled) of the tilting construction. A locking pin is fit in to the fork to prevent unvanted tilting.

The swing fork is held by the swing bolts in a double A-console standing on the floor. The gas hood is fastened to the console.

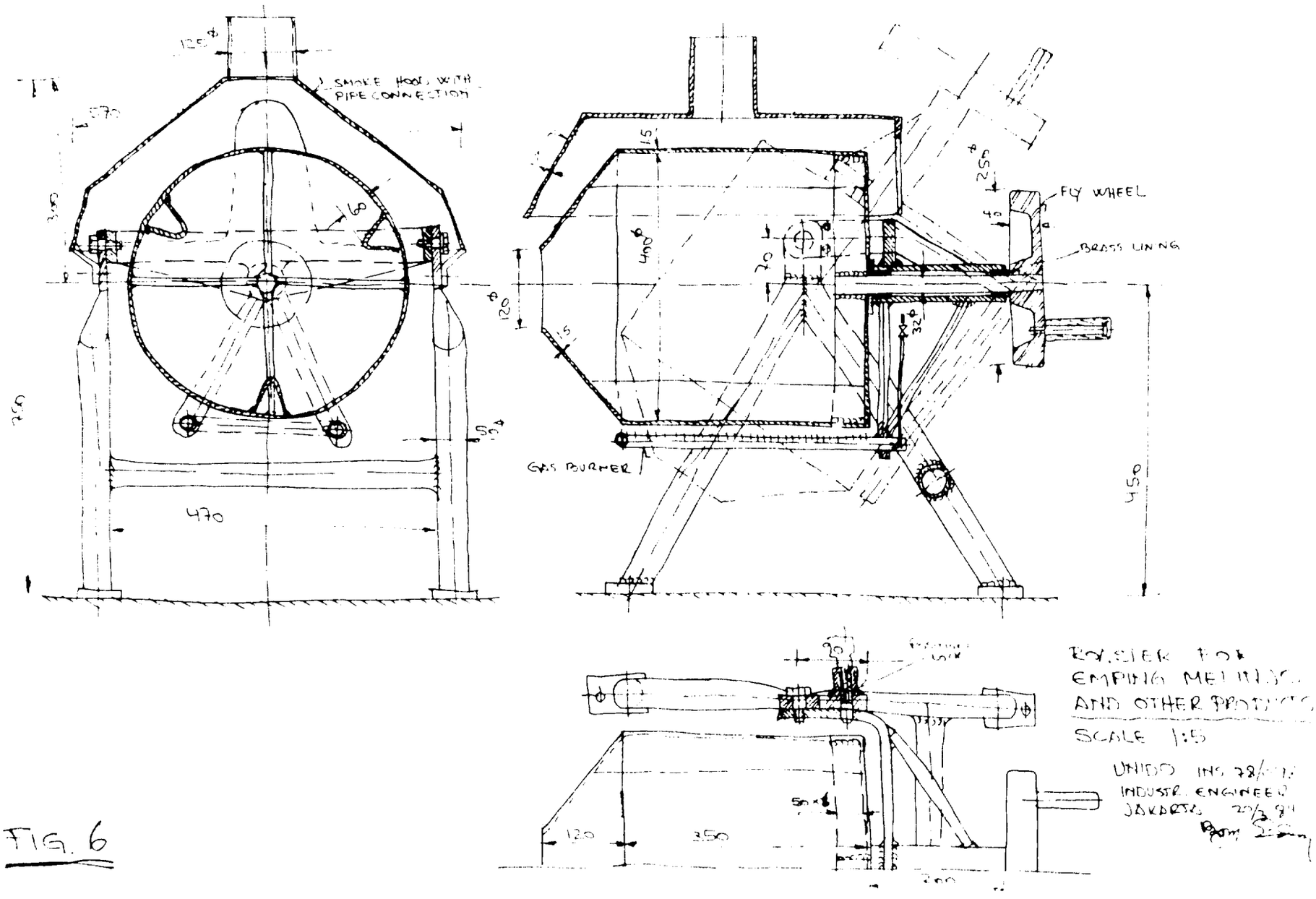


FIG. 6

BOILER FOR EMPTING MELTING AND OTHER PROCESS

SCALE 1:5

UNIDO INS 78/...
INDUSTR. ENGINEER
JAKARTA, 27/3 81

EMPING MELINJO ROLLING MACHINE.

General. Emping Melinjo Krupuk, a traditional Indonesian product is widely used locally and has a large potential for increased export, being not much known outside Indonesia, but still being appreciated everywhere as a delicious and nutritive food cracker and snack.

Emping Melinjo Krupuk traditionally is formed through hammering flat emping melinjo seeds that have been shelled, roasted, and heated. The hammering is done by hand and is a quite tiresome process.

The seeds are flattened by hammering because it can then be done everywhere without any costly tools.

However,in a more modern production, to reduce the cost of processing, and to give better returns to the operators, rolling of the product is a easier way of flaking than hammering.

It would be possible to mill the emping into a paste, flake it in continuous rolling machines available for sundry bakery products, stamps it out into shapes and sizes as required, and finally dry it before packaging and sales.
However, the machine proposed in fig. 7 aims at flaking of the individual seeds, to maintain the product in its traditional form. Any prototype of this machines is yet to be made. The intention hence is to get a prototype made as to the design, whereafter possible adjustments may have to be made. Some initial rolling tests have already been made, promising well under the consideration that the roller diameter must be large enough.

The rollers. 2 rollers with 400 mm diameter are proposed. The design in fig. 7 has not provided any forced turning of more than one of the rollers.

It is however most likely that a cogring will have to be fit on the 2 rollers to secure equal rotation.
A roller surface of well planed hard chromed steel will probably be adequate, provided they will be well lubricated with edible oil during operations.

The selection of roller diameter is a question both of catching the seed, getting the necessary press power, and also obtaining a squeezing of the seed in all 4 directions.
The larger roller diameter the better results, but also the higher the cost of the machine.

We do recommend that when making machine prototype for testing, the 2 rollers being made first and tested together with seeds, e.g. in a lathe machine, to determine whether the proposed diameter really will be sufficient.

We have for the powering of the rotation proposed a worm gear drive 10 R/min, 0,25 Hp. The distance or pressure between the rollers to be easily adjusted. We have specified both rollers to be supported by 2 ball bearings to fit into excentric pipes, clamped into the console with roller lock screws as specified.
With turning handles on the excentric pipe, the pressure can easily be adjusted.

Further constructive measures: Further will there on the rollers be required a feeding funnel to secure the feeding of seeds one by one, a lubrication wick for edible oil and a doctoring knife for products that may stick to the surface.

For the feeding control is proposed a silo magazine with a small outlet opening with adjustable gap leading to a narrow feeding funnel to position the seeds in between the rollers.

A small vibrator (e.g. a demolceified doorbell) with adjustable vibration force to secure the feeding.

To secure even feed, a small simple control feeder securing seed supply one by one from a small cylinder magazine may also be used if the proposed one will bring any problems. These feeds are however slightly more expensive.

Roller surface lubrication may be arranged with a wick cup arranged on each roller, and spring loaded knives under the pressing area should be sufficient to clear of krupuks and particles that may stick to the roller surfaces.

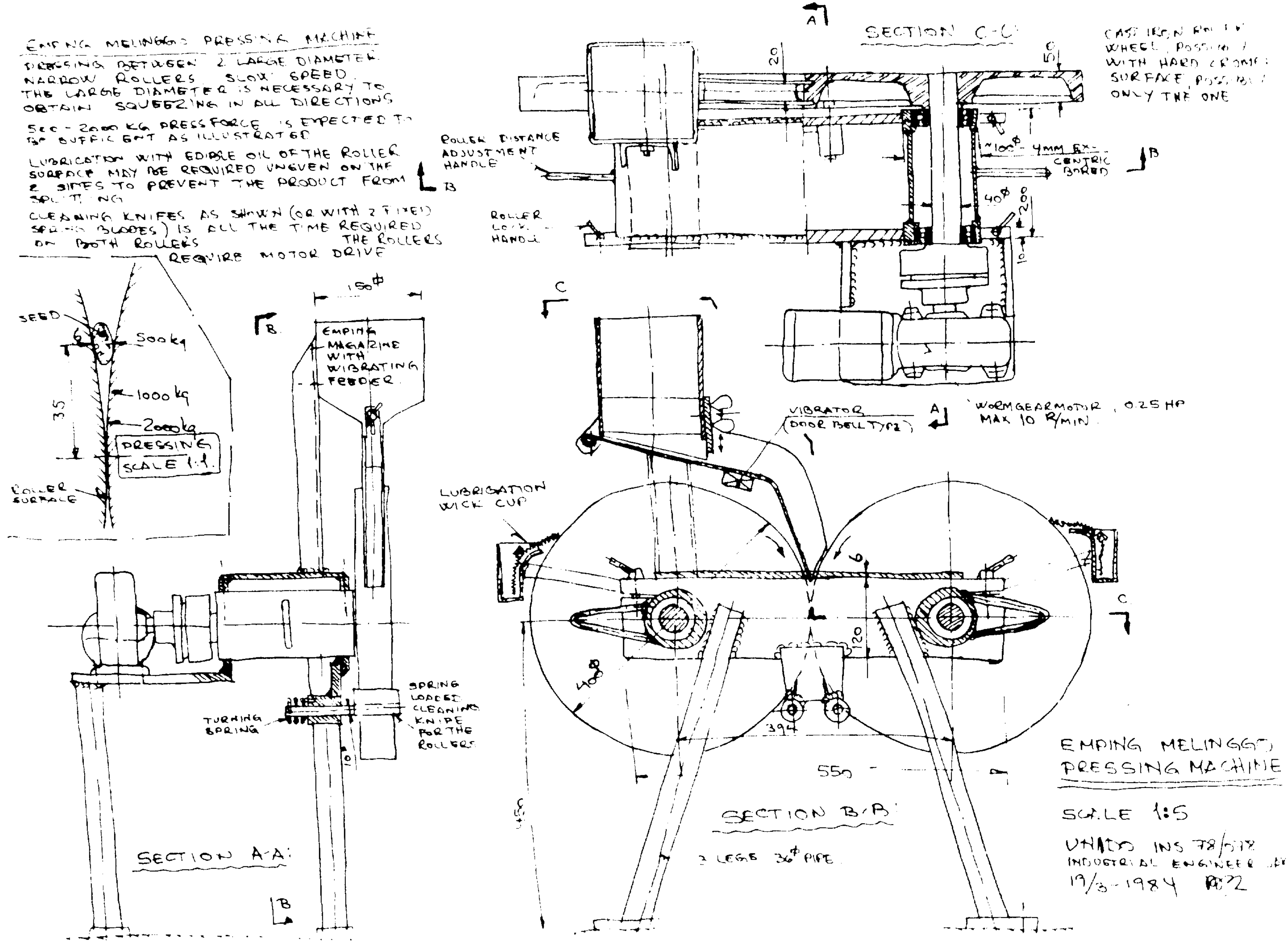
EMPING MELINGGO PRESSING MACHINE

PRESSING BETWEEN 2 LARGE DIAMETER NARROW ROLLERS SLOW SPEED. THE LARGE DIAMETER IS NECESSARY TO OBTAIN SQUEEZING IN ALL DIRECTIONS

500 - 2000 KG PRESSFORCE IS EXPECTED TO BE SUFFICIENT AS ILLUSTRATED

LUBRICATION WITH EDIBLE OIL OF THE ROLLER SURFACE MAY BE REQUIRED UNEVEN ON THE 2 SIDES TO PREVENT THE PRODUCT FROM SPLITTING

CLEANING KNIFES AS SHOWN (OR WITH 2 FIXED SPRING BLADES) IS ALL THE TIME REQUIRED ON BOTH ROLLERS. THE ROLLERS REQUIRE MOTOR DRIVE



EMPING MELINGGO PRESSING MACHINE

SCALE 1:5

UNIDO INS 78/578
INDUSTRIAL ENGINEER
19/3-1984

Fig. 7

HUSK AND PEEL SEPARATOR.

Emping melinjo, peanuts, beans, maize and sundry other products require separation of peels, husk, dust, straw, soil, stones, and other pollutions before processing.

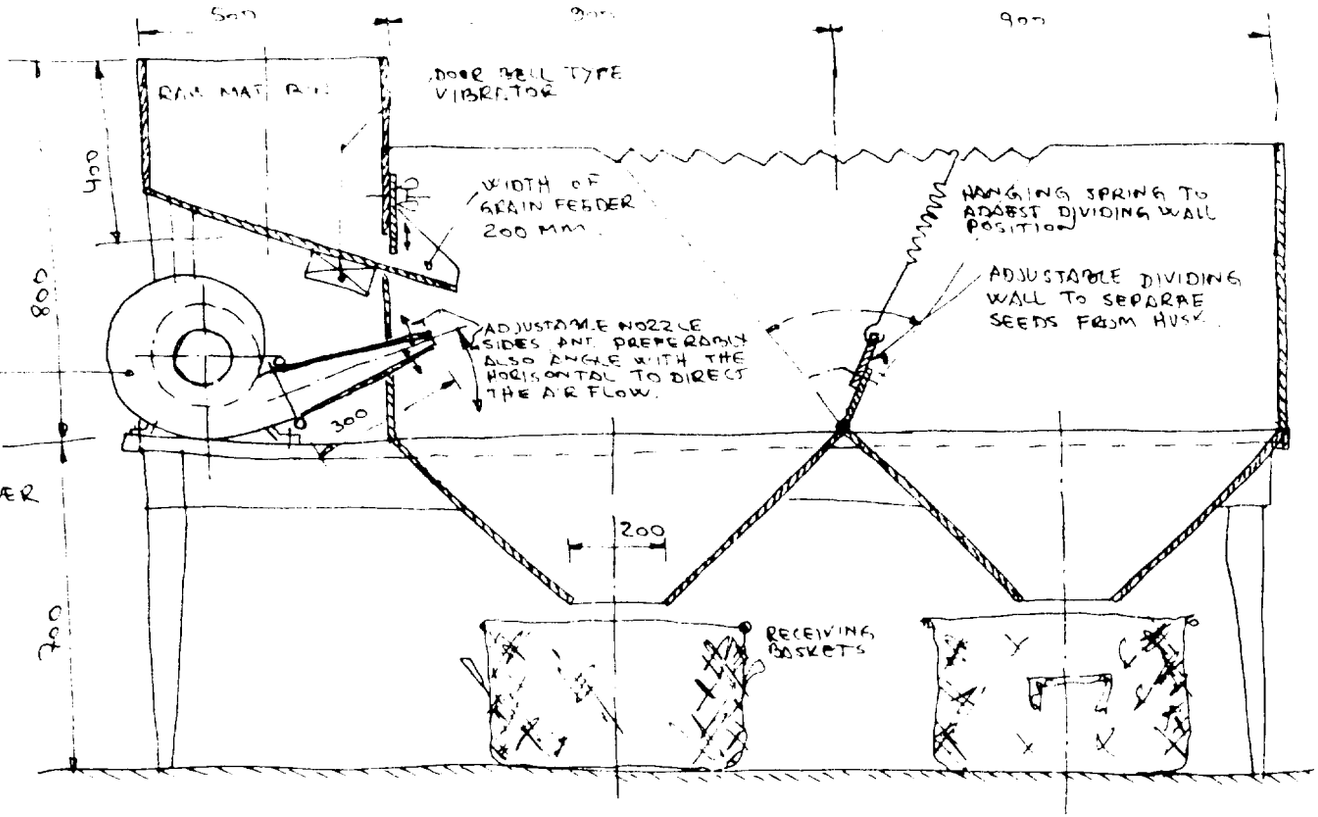
All these pollutions can fairly easily and quickly be separated in a blowing sepator as specified in the design, fig. 8. Light and large items are more easily carried along in a steam of air, while heavier and smaller ones will not be carried as far.

Construction: 2 discharge funnels are arranged in a blowing box, one close to, and one far from the blowing fan arranged in the inlet end. Having a dividing wall that conveniently can be moved in lenght and height to change the division between the 2 compartments, one can move it to a position that fits well for the particular separation that is carried out.

The fan must as indicated have a relatively long nozzle widening out to the full width of the box and narrowing down to a thin spalt to provide an even and sharp stream of air. The nozzle thickness should be adjustable.
The raw material bin to be erected above the fan, having a sloping bottom with outlet just in front of the fan nozzle opening in only half of the width. A vibrator arranged under the bottom and an adjustable opening height to control the produce flow.

Operation: Filling the produce into the bin, adjusting the spalt of the air nozzle as well as the distance and height of the separation wall, one can secure that produce falls into the first, and pollutions into the 2nd bin, or for stones and heavy pollutions the oposite.

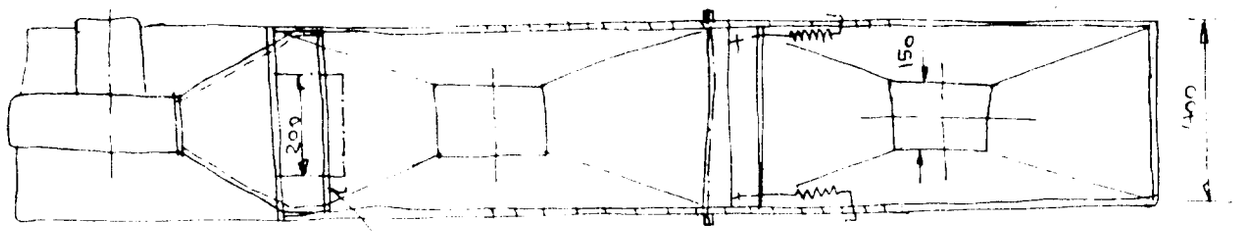
The discharge to be collected in baskets under the funnels. Both produce and pollutions may be run through the machine once again to further improve the degree of separation.



SCALE 1:10

AIR BLOWING SEPARATOR

TO SEPARATE SEEDS FROM HUSK FOR DIFFERENT GRAIN PRODUCTS BASED ON THE FACT THAT THE HUSK BLOWS FURTHER AWAY WITH THE WIND.



NOZZLE = WIDTH = TOTAL WIDTH OF THE CATCH BOX

UNIBRAW INS 78/078
INDUSTRIAL ENGINEER
JAKARTA 20/3 84

FIG. 8

SMALL SCALE PRODUCE DRYERS.

Drying in general consumes much energy for evaporation of moisture. Therefore, as much as possible, drying should be done in the sun. When that is not possible, or for obtaining a dryness that can not be reached in the sun, a technical dryer may be required.

When ever it is possible, especially for grains and other bulk products, drying through forcing dry warm air through a stationery bin or silo use to be the most rational.

When that for one or another reason is not possible and movement of the drying product is necessary, the bin may be exchanged with a whirlbed, a tumbling drum, or some stiring may be installed. For more delicate products, the bin may be exchanged with a system of trays, small quantities in a cabinet, and larger quantities in a tunnel with tray wagons.

In the continuation 5 different dryers suitable for different situations are specified:

1. Small bin dryer for limited quantities of grains or other bulk materials.

2. Silo dryer with 2 silos and grain transport system for larger quantities of grains etc.

3. Cabinet tray dryer for limited quantities of delicate products.

4. Sunheated tray dryer for a bit larger quantities of delicate products

5. Sunheated/Heat pump heated tunnel dryer for large quantities of delicate products.

Counter current air circulation: Which ever arrangement of the drying products, one must always as much as possible make sure that the warm dry air comes into the dryer where the products are the dryest (the discharge end) and leave again near the product in take where the product is still at the wettest.
The drying ability of the air and the economy will than be the best.

Heat pump drying: A normal way of drying is to heat the air so it becomes hot and dry and can absorb much moisture when being in contact with the wet product. That is not an efficient way of drying in Indonesia , the air temperature is already reasonably high, and more important, the air is so humid that it can not absorb much more moisture.

Heat pump drying has therefore proved more efficient and economical. The same units as in a normal air conditioner is being used; an air circulation fan and a freon system with a compressor, cooling evaporator and heating condensator.

The wet cool air returning from the dryer bin or cabinet first passes along the evaporator. The temperature in the air decreases drastically and the moisture condensates on the evaporator where after it will be collected and drained out of the system.
The cooled air thereafter passes along the condensator where it again will be heated and becomes hot and dry before being passed into the drying room again.

Hence the same air circulates in the system all the time, and no heat escapes. The amount of heat that is required to evaporate moisture in the product will be returned back into the system through condensation on the evaporation coil. The only energy that hence is required is the electricity that the circulation fan and the compressor require. Dependant on circumstances this may be less than 20 % of what would be required in a heating system, and these consumptions also goes for a slight increase of the temperatures in the dryer.

Typically the conditions of the air may change through the system something like the following:

	Final air temperature	Moisture in the air. % Saturation.	Moisture in the air. kg water /kg air	Heat content in dry air. Kcal/kg	Heat requirement for evaporation. Kcal/ kg air.	Heat from condensation. Kcal /kg air
The air being cooled down through the evaporator	6°C	100	0,0065	1,8	-	5,1
The same air after heating again in the condensator	50°C	10	0,0065	12	5,1	-
The same air after having absorbed moisture through the drying product	25°C	80	0,015	5,8	-	-

Hence each kg of air passing through the dryer may absorb 0,0085 kg moisture, or each m^3 of air about 0,012 kg water.
An air circulation of e.g. 1.000 ^{3}/h may hence dry out 12 kg of water and probably consume somewhere around 1 - 2 Kw of electricity for compressor and fan, whereas a well arranged conventionally heated system would require more than 10 Kw.

The heat pump system has been recommended for all the specified dryers in the continuation.

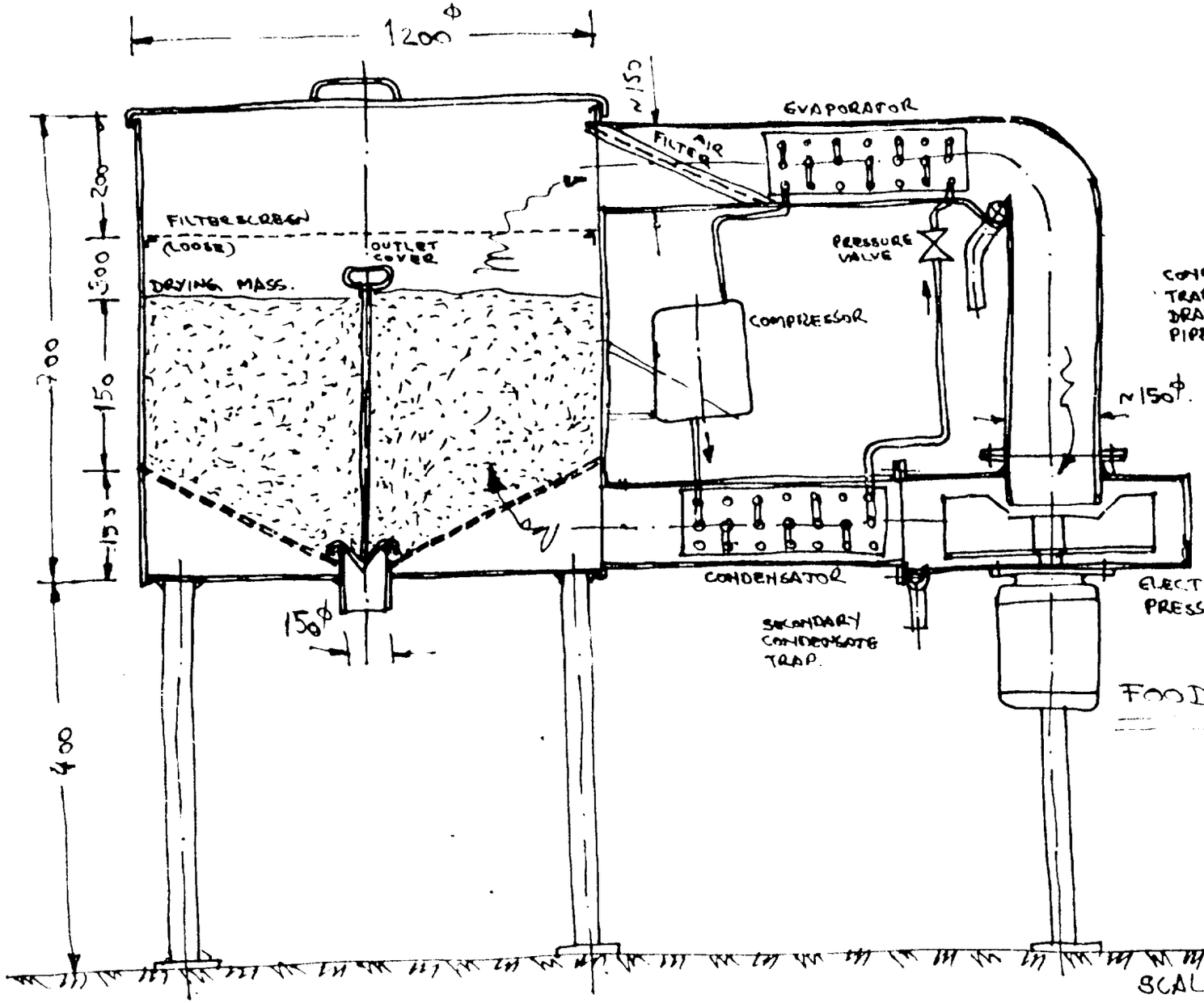
1. Small bin dryer for grains etc.

The system is specified in fig. 3. It is ment for drying of batches of e.g. grains.

The size of the bin and the air conditioning elements will determine the capacity of the unit.
The bin has a perforated bottom for air inlet (normally a metall mesh screen), a bottom discharge outlet, a lid.
A filter may be required in front of the air conditioning unit as indicated.

The air circulate in a closed system, and any additional heating is not provided unless drying is required at an elevated temperature.

FIG 9



FOOD DRYER

SCALE 1:10

UNIDO 78/57
8/5.84 pmz

2. Silo dryer system, larger scale grain drying.

The system is shown in fig. 10 and is in the principle the same as for the above bin dryer, only being more complex because of using 2 silos for alternate prime and secondary drying, and because of also containing a system for filling and discharge of the product.

As can be seen from the figure, the system contains one common transport fan for filling and discharge of grains for both silos.

During filling of the system, bags of grain to be filled and the inlet funnel next to the transport fan. Keeping inlet air pipes open, and controlling the damper of the inlet funnel, grains will pass through the fan to the empty silo, directed by the selection flap in front of the silo.

Inlet to the silo being arranged tangentially and keeping the centre outlet open, no cyclone will be required.

During discharge of dried products from one of the silos, the transport fan operates, the flaps in the transport pipe is directed to the outlet for bag filling where a woven bag on the scale is connected to the outlet pipe, the damper of the inlet funnel is closed, and the bottom damper of the silo is opened carefully and closed again when the bag is full.

During drying the air circulation fan and the freon compressor operates. The 4-way circulation valve must be positioned so that wet air is taken in from the bottom of the silo containing the wettest products, passes over the cooling evaporator where the moisture is condensated and drained, whereafter the air passes via the circulation fan, over the air heating condensator before being directed into the bottom of the silo containing the dryest product.

The silo has a fine metal mesh cone bottom, the air passes up through the silo and across to the other silo with the wettest product. (Both silo top outlets are kept closed).
The air passes down through the silo with wet product before again being recirculated.

Exchange of drying direction. When the dryest silo becomes dry, the content will be exchanged with fresh moist products, as described above.

Now simply the 4 way air direction valve will be turned over, and the air circulates the other way around, first up the other silo that has now become most dry and then down the first one, before again being recirculated.

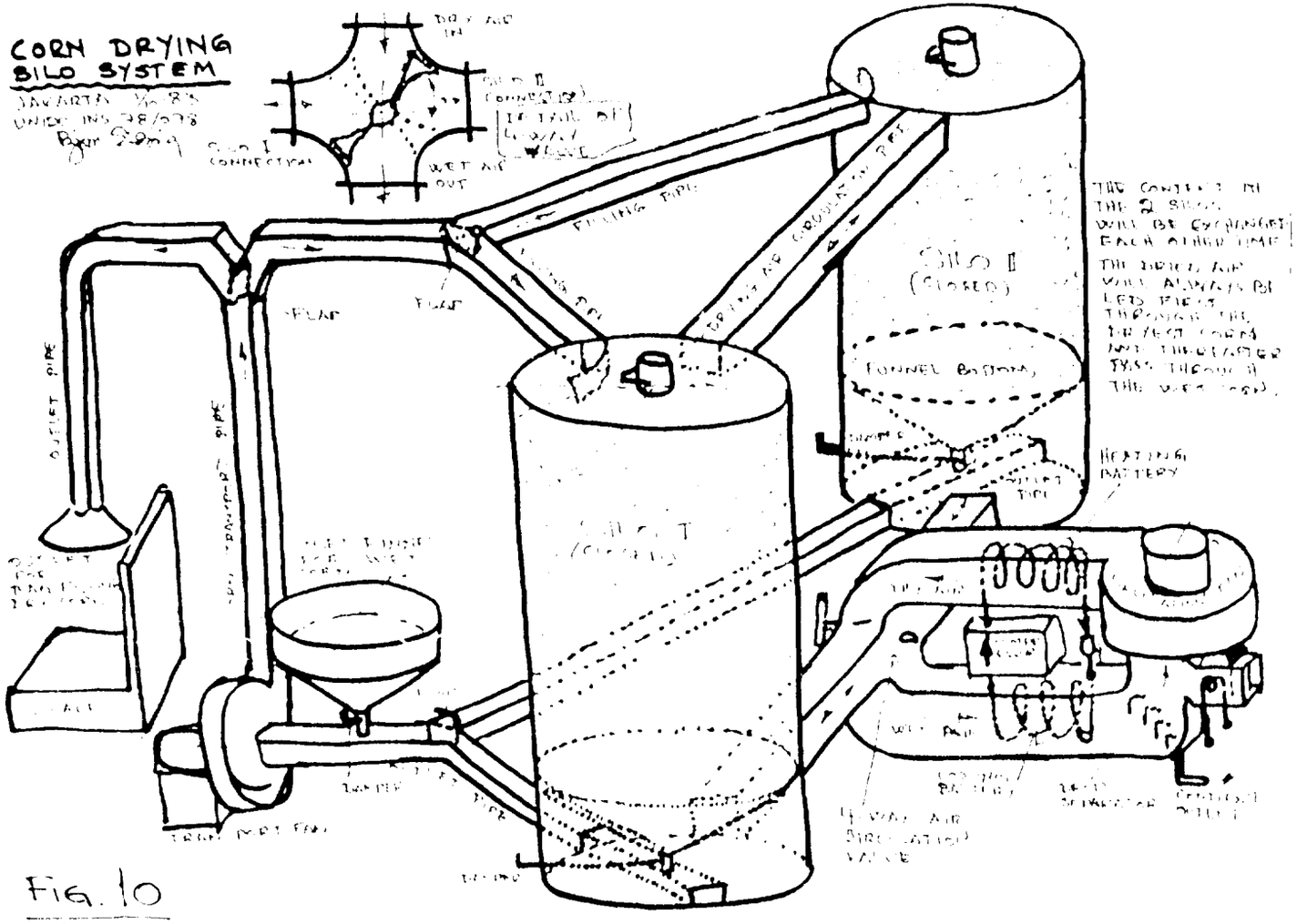

CORN DRYING
SILO SYSTEM
JAKARTA
DRY AIR IN
WET AIR OUT
FLOAT
FLOAT
OUTLET PIPE
SILO II
(CLOSED)
FUNNEL BOTTOM
HEATING BATTERY
THE CONTENTS IN THE 2 SILOS WILL BE EXCHANGED EACH OTHER TIME
THE DRIED AIR WILL ALWAYS BE LED FIRST THROUGH THE HARVEST CORN AND THEREAFTER PASS THROUGH THE WET CORN.

Fig. 10

3. Cabinet Tray dryer.

The cabinet dryer is shown in fig. 11 and is meant for drying of moderate quantities of delicate products to be plattred out on shelves or trays during drying.

Normally in a production, the products for drying will become available ready for drying on a continuous basis.
The dryer hence must have a capacity that is matching the production and trays be exchanged as they are becoming dry and as new ones are being filled with fresh products.

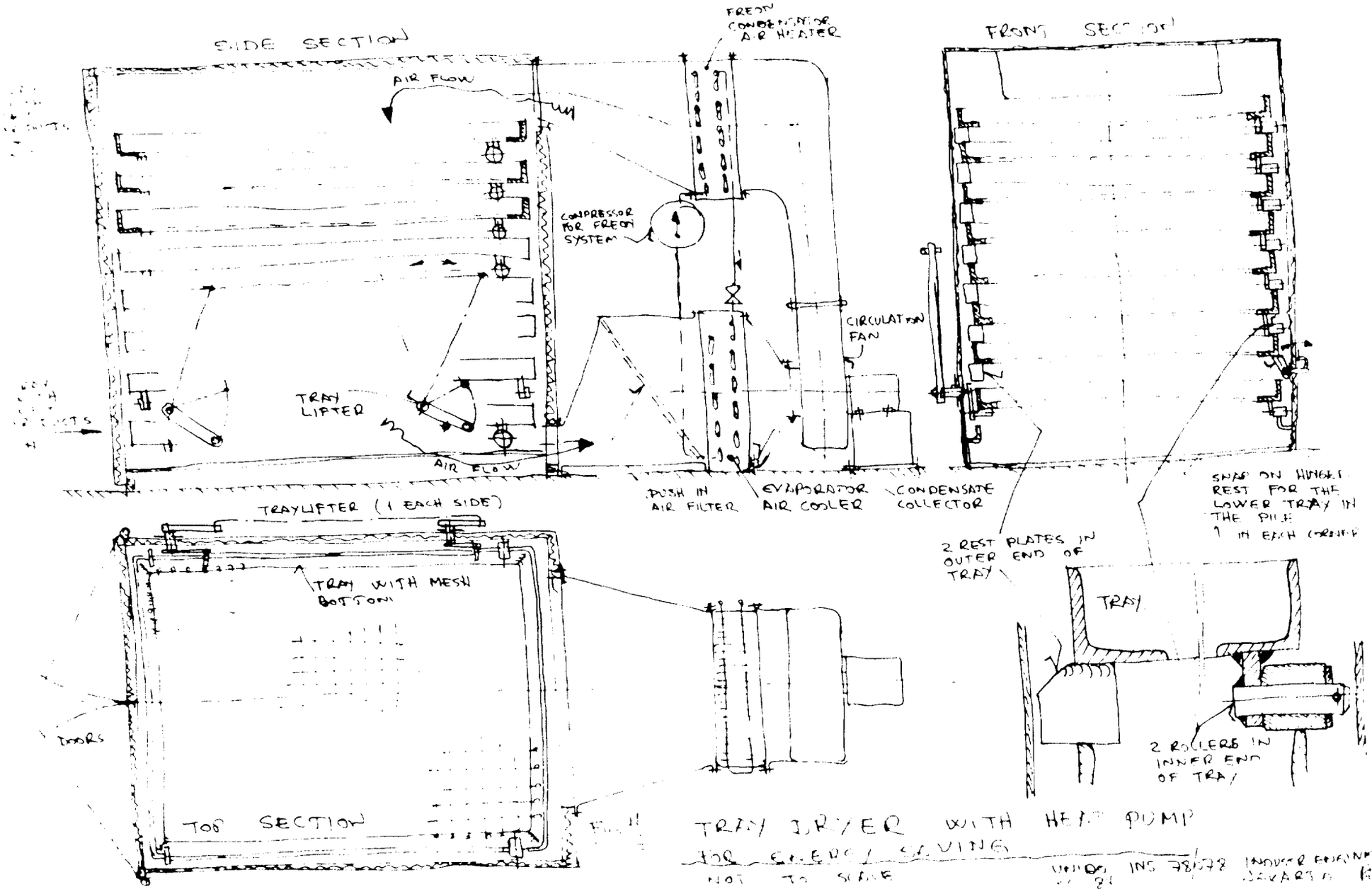
Air circulation. The dryer has air circulating system as describe above for closed circulation of the air through the system, from top to bottom through the trays with drying products, through a filter, via the evaporator where the air is being cooled and moisture will condensate, further through the circulation fan and over the heating condensator before again being recirculated from the top of the drying cabinet.

The working principle of the dryer. It is very important in this system to ensure counter current drying, i.e. that the drying air is passing down through the trays at the same time as the product in the trays are being pushed upwards, taken in wet at the bottom level, and discharged dry at the top.

The cabinet has large doors in the front. The doors are opened and the dry tray on the top is taken out, carried by one man on each side. The removal is easy since when lifted in front the tray in the back has 2 single wheels rolling on the edge of the tray underneath, sideways discharge hindered by close cabinet side walls.

Another tray refilled with fresh products are immediately replaced in the bottom of the dryer. Before that can be done, the pile of trays in the cabinet must be lifted one step up. That is done with the tray lifting arms outside the cabinet (simultaniously on both sides).
When moving the handle forward, the lifting arms inside will fetch under the bottom tray and lift the whole pile up until the bottom tray snaps in position on the hinged rests.

The handle is returned, and the next tray can be pushed in in the bottom position. The only rail in the cabinet is hence the one in the bottom for pushing in fresh trays.



UNDP/INS 78/078 INDUSTRIAL EQUIPMENT JAKARTA

4. Sunheated Tray dryer.

Fig. 12 indicates an alternative to the cabinet dryer, but mostly economical for a bit larger capacity, a tray dryer based on indirect sun heating.
The dryer may also preferably be fit for products with a bit longer drying time, based on a batch drying in whole rack loads.

The dryer is arranged in a special room with an outside roof placed where and so that it can be reached maximally by the sun rays. The sun shines on the thin iron sheet roof. When the distance between the roof and the ceiling underneath is small, the fan circulated air in the room will strike along the surface with speed, and a heat of up to 1.700 kcal/m^2 can be collected per hour as long as the sun shines. Excharge of air through controlling the opening of the flaps is necessary to the extent that it absorbs moisture.

When there is no sun, the air circulation to be changed from over to under the insulated ceiling and the heat that has been gained may be retained. If need be, an air conditioning heat pump as specified may be installed and operated when there is no sun shine.

The system require an operator to control the different dampers as the weather conditions change.

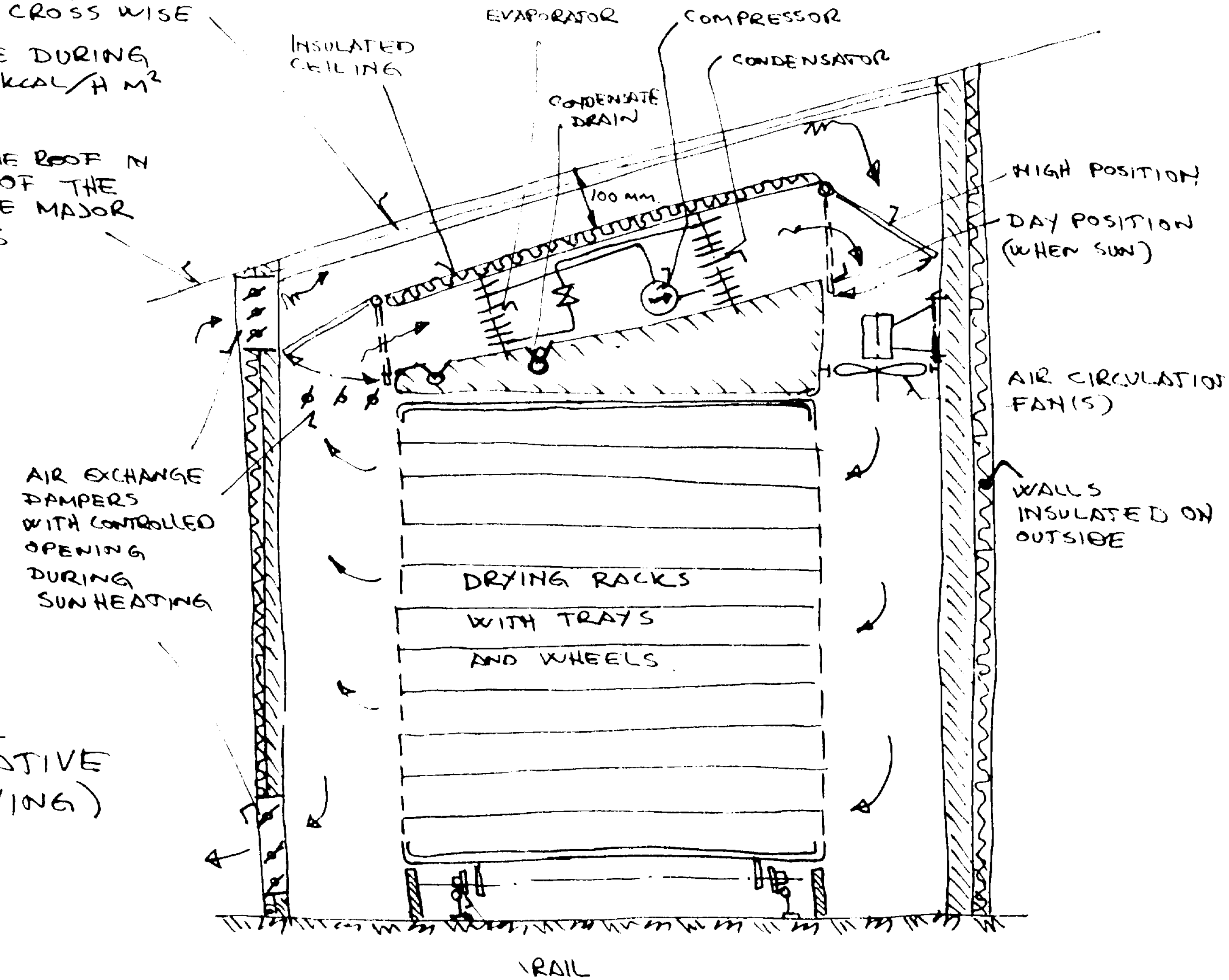


Fig. 12

SUN HEATED TRAY DRYER

(WITH ALTERNATIVE HEAT PUMP DRYING)

UNIDO INS 78/078
INDUSTR ENGINEER,
JAKARTA
6/11.84

5. Tunnel dryer with tray rack wagons.

This, as specified in fig. 13, is in the principle the same as the 2 above tray dryers, only that it is fit for a much greater capacity and to operate on a 24 hours continuous basis. The size of the trolleys and the lenght of the tunnel can be made to match the capacity demand and the installations must have capacities correspondingly.

A good counter current will be achieved, and the system is rational to operate.

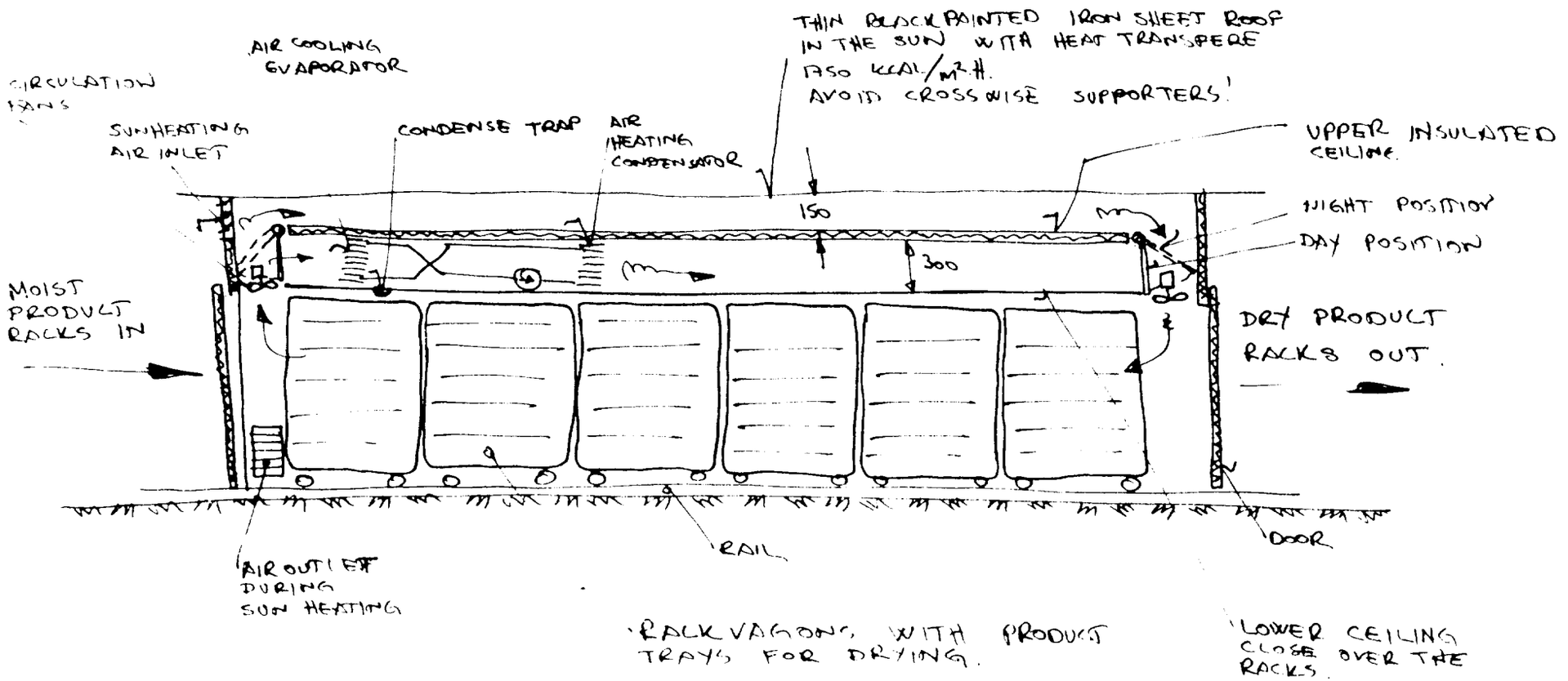


FIG 13

TUNNEL DRYER WITH RACKS
FOR SUN/ALTERNATE HEAT PUMP DRYING

NOT TO SCALE
UNIDO INS 78/078, Jakarta 6/11 84 pgr