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REPORT ON THE INSTALLATION OF WINGED BEAN DEHULLING PLANT AND TECHNICAL MANUAL

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INTRODUCTION

The winged bean (Psophocarpus tetragonolobus) is a minor and edible tropical legume with a high dietary protein content of (29-37%) (1). It is particularly suitable for cultivation in the humid tropics . All parts of the winged bean plant, i.e. seeds, tubers, leaves and flowers are edible. The seeds, which are of particular interest to this manual, are found to be very similar nutritionally to soybeans and have a pleasant sweet flavour. The unripe seeds are sometimes eaten as a vegetable similar to peas, when they are used as ingredient for soups and curries. The mature dried seeds,which consist of approximately 12% skin and 88% edible material are reported to cook with difficulty and are also rather indigestible. They are often utilized as source of protein foodstuffs, edible oil and soap and have the potential to substitute soybean if commercial production could be developed (2). It has been reported that the winged bean flour is suitable for milk substitution in the treatment of children suffering from kwashiorkor (3). The winged bean was introduced into Ghana in 1976 by Agricultural Research Station (University of Ghana) and Crop Research Institute (CRI) of the Council for Scientific and Industrial Research (CSIR). The Food Research Institute (FRI) also of the CSIR has successfully developed a number of food formulations based on the winged bean. It has also been incorporated into other Ghanaian diets and results of trials conducted showed that it has a great consumption potential in Ghana (4).

However, peeling of the bean has been identified as the major problem facing its processing on a larger scale. The practice of soaking the seeds overnight and employing labour to peel manually, gives between 1 and 2kg of peeled seeds per person per day. This low rate of peeling the seeds has thwarted the FRI's efforts in promoting the use of processed winged bean products nationwide. In an effort to solve this problem, a technique developed by Central Food Technological Research Institute(CFTRI) of India which employs a scientific conditioning method to loosen the husk and removing the same in improved dehusking machine was identified. The United Nations University (UNU) sponsored the acquisition by FRI of the Winged Bean Dehulling Plant (WBDP) designed by CFTRI and fabricated by Messrs S.A.K. Industries of India in 1983.

The plant was received at FRI with only a proposed plant layout without an installation/operation manual and all efforts to get the manual failed.

In June, 1988 a four-member task force made up of engineers from FRI and Industrial Research Institute (IRI) was inaugurated by the Director of FRI and tasked to identify the various units of the plant and also find out the possibility of installing the plant in an uncompleted structure at the Pilot Plant premises earmarked for the construction of a milling shed. The membership of the task force included Dr. M.F. Damptey (IRI), F. Djokoto (IRI), P. Adjei-Boateng (FRI) and D. Blay (FRI), the author. The task force in its report to the Director of FRI, recommended inter alia the use of the part of the uncompleted structure dimensioned 9metre x 15metre for the installation of the plant and the construction of a 6metre-high building to accommodate the plant whose maximum height was to be reduced to 5.4metres (5).

This report is in two sections: Section One covers the activities involved in the installation of the plant and Section Two is in the form of a technical manual which is vital for the operation of the plant.

SECTION ONE

INSTALLATION OF THE WINGED BEAN DEHULLING PLANT

1.0 MATERIALS AND METHODS

The installation of the plant involved the following :
- modification and reconditioning of the plant
- the conversion of the 1.2metre-high uncompleted structure into a 6.0metre-high building to house the plant
- installation and testing of the plant

Drawings relevant to the installation work were designed by the author and are presented in Appendices I to V. The installation work was carried out by a local engineering firm, Amitaab Ltd., under the supervision of the author.

1.1 MODIFICATIONS AND RECONDITIONING

MODIFICATIONS

Modifications of the plant became necessary because the 0.5 ton per hour capacity plant was simply too big for the winged bean supply component of the project to cope with. In order to avoid underutilization of the plant and also to reduce the cost of installation, it was found necessary to reduce capacity of the storage facilities of the plant. The following units of the plant were therefore affected:

i) Tempering Bin - The height of each of the two tempering bins was reduced from 4.8 metres to 2.4 metres. Two cylindrical sections were removed from the columns of each tempering bin, resulting in a tempering bin consisting of an inverted cone and one cylindrical section as shown in Figure 1 of Appendix I.

ii) Tempering Bin Support - The height of one half of the support which carries the second tempering bin was increased from 2 metres to 2.55 metres. This was done by welding onto that part of the support a 0.55 metre high, 1.46m x 1.5m structure constructed from 50mm x 100m channel steel as presented in Figure 2 of Appendix I. The increase in height made the outlet chute of the second tempering bin higher than the hopper of the dehuller, thus making it possible for normal delivery of materials from the former to the latter.

iii) Double elevator - The height of the double elevator, i.e. the distance between the elevator centres was reduced from 7.8 metres to 5.4 metres. This was done by assembling the double elevator with only two of the 2.4 metre-high trunks for each of the trunkings instead of three.

RECONDITIONING

The plant which arrived in the country in 1983 had been lying idle at the pilot plant premises for over five years. Most parts of the plant had gone rusty, some lubricating pots had dried up and some parts had suffered physical defects during transportation and handling. Such condition of the plant called for its reconditioning and servicing of appropriate parts.

Rusted parts of the plant were cleaned and coated with antirust red oxide paint before giving the outer paint. All lubricating pots and lines were cleaned and filled with appropriate lubricants. Physical defects were corrected and the entire plant was painted in appropriate colours. All the fourteen electric motors on the various units of the plant were checked and given thorough servicing.

1.2 BUILDING FOR WBDP

In consultations with the Institute's draughtsman, Mr. R. Addo, the drawing for the proposed milling shed shown in figure 1, Appendix II, was modified to suit the changes made in paragraph 1.1 and presented in figure 2 of the same Appendix. The maximum height of the 9m x 15m (30ft x 50ft) part of the original structure was increased from 4.2 metres to 6.0 metres. The shape of the roof was changed from that of a slope roofing to a gable roofing. The left doorway was widened to 3.2 metres wide, 2.5 metres high whilst the five other doors were made 0.8 metres wide and 2 metres high.

1.3 INSTALLATION WORK

The installation work was carried out in conformity with the drawings provided in Appendices I to V.

1.3.1 PLANT LAYOUT

The plant layout (figure 1, Appendix III) was used in the determination of the positions of the various units of the plant. The design of the plant layout took into consideration the following, among others:

- the winged bean dehulling process
- the convenience in operating the plant
- the functions of each unit of the plant
- the nature and form of the feed and product of each unit
- accessories to various units of plant.
- space for operating, maintenance and servicing of the various units of the plant.

1.3.2 CIVIL WORKS

Concrete platforms of different shapes and sizes were constructed for the various units of the plant. Channel-shaped concrete bases with appropriate foundation bolts embedded in them at positions corresponding to bolt holes were constructed for the grader-aspirator, splits separating sieve and the husk aspirator (figure 1, Appendix IV). Simple square and rectangular shaped platforms, 0.15 metre high were constucted for the elevators, oil mixing machine, splitter, and conditioning units and 0.3 metre high ones for the tempering bin support and the dehulling machine. Ducts, 0.15 metre wide and 0.15metre deep, were dug from the main switchboard to the positions of the grader-aspirator, splitter, splits separating sieve, the two control panels of the conditioning units, the dehuller and the husk aspirator for electrical cables connecting these units to the main switchboard (figure 2, Appendix IV).

1.3.3 MECHANICAL WORKS

The oil mixing machine and the conditioning units were raised to specific heights on metallic supports, to ensure smooth and continuous transfer of materials from one unit to the next. Figures 1 to 4 of Appendix V show the drawings of the metallic supports constructed for the above mentioned units of the plant. Materials used for the construction include steel angle, steel U-channel and flat steel bar.

The various units of the plant were firmly bolted onto their respective bases. Hoppers, outlet chutes, inter-linking chutes and other accessories were all fixed in their respective places. Figure 2, Appendix III shows the process flow sheet with installed heights of all the units of the plant.

1.3.4 ELECTRICAL WORKS

Electric power to the plant was supplied from the main switchboard. Various lengths of 4x1.5mm² PVC/SWA/PVC (armoured) cable were connected from the motor starters on the main switchboard to the terminals of the motors on the elevators, grader-aspirator, oil mixing machine, splits separating sieve and the husk aspirator. Two lengths of 4x2.5mm² PVC/SWA/PVC cable were similarly connected to feed the splitter and the dehuller. Two lengths of 4x35mm² PVC/SWA/PVC cable were connected from the two 100-amp, three phase and neutral (TPN) main switch (on the main switchboard) to the two control panels of the conditioning units. Finally, a 4x70mm² PVC/SWA/PVC cable from the terminals of the 200-amp. TPN main switch on the main switchboard was connected to the main power supply station of the pilot plant complex. It must be noted, that some parts of these cables servicing the grader-aspirator, splitter, splits separating sieve, the control panels of the conditioning units, the dehuller and the husk aspirator were buried as mentioned in paragraph 1.3.2. Cables servicing the oil mixing machine and all the elevators were laid in a 300mm-wide wooden duct which passes along the wall behind the main switchboard and through the trusses from where they are dropped to their respective motor terminals (see Appendix IV).

1.4 TESTING OF INSTALLED PLANT

Due to non-availability of winged bean at the time, the plant was tested without load. Each unit was started from the main switchboard by switching on its main switch and motor starter. The two conditioning chambers unlike the others were started from their respective control panels after switching on the two 100-amp TPN switches on the main switchboard. The conditioning unit's heater output corresponding to 12 kwatts and 24 kwatts respectively were put on and temperatures in the conditioning chamber's inlet and outlet ducts were recorded.

2.0 RESULTS AND DISCUSSIONS

All the units instantly responded when their respective motor starters and heating elements were put on. Air Temperature profiles in the chamber´s inlet and outlet ducts are presented in figures 1 and 2 of Appendix VI.The graphs show that:

i) With heater output of 24 kwatts, both the inlet and the outlet temperatures rise exponentially and settle at 94°C and 70°C respectively.

ii) With heater output of 12 kwatts, the inlet temperature rises exponentially and settles at 72°C whilst the outlet temperature rises slowly and settles at 31°C.

iii) Temperature differences at the stabilized temperatures for heater outputs of 24 kwatts and 12 kwatts are 24°C and 41°C respectively.

3.0 CONCLUSIONS

The winged bean dehulling plant has been successfully installed and tested without load.

All the individual units of the plant respond instantly when powered.

Temperature profiles of the chamber inlet and outlet ducts are of exponential characters.

Maximum temperature of 94°C is achieved after 18 minutes when heater power output is 24 kwatts.

4.0 RECOMMENDATIONS

i) Efforts should be made to have the plant tested with the winged bean.

ii) In the absence of winged bean, the plant should be adapted if necessary to dehull locally available grain legumes.

iii) A techno-economical evaluation of the plant should be carried out for each product.

SECTION TWO

TECHNICAL MANUAL

The non availability of Technical Manual for the Plant called for the need to develop one. This technical manual contains the descriptions of the dehulling process and the various units of the plant and also instructions covering initial preparations for use, operations and related technical information.

1.0 DEHULLING PROCESS OF WINGED BEAN

The winged bean is dehulled using the technique developed by CFTRI as presented by the flow chart in figure 1. It involves the cleaning and grading of the seeds into different sizes. The graded sizes are in turn mixed with a quantity of edible oil and allowed to equilibrate for about 2 hours. The seeds are then split and allowed to stand for another 2 hours in jute bags. After this the seeds are sieved to separate the splits from the brokens and the splits are conditioned at 75°C and tempered for 6 hours. The conditioning and tempering are repeated after which the seeds are dehulled and the husk finally separated from the dehulled seeds.

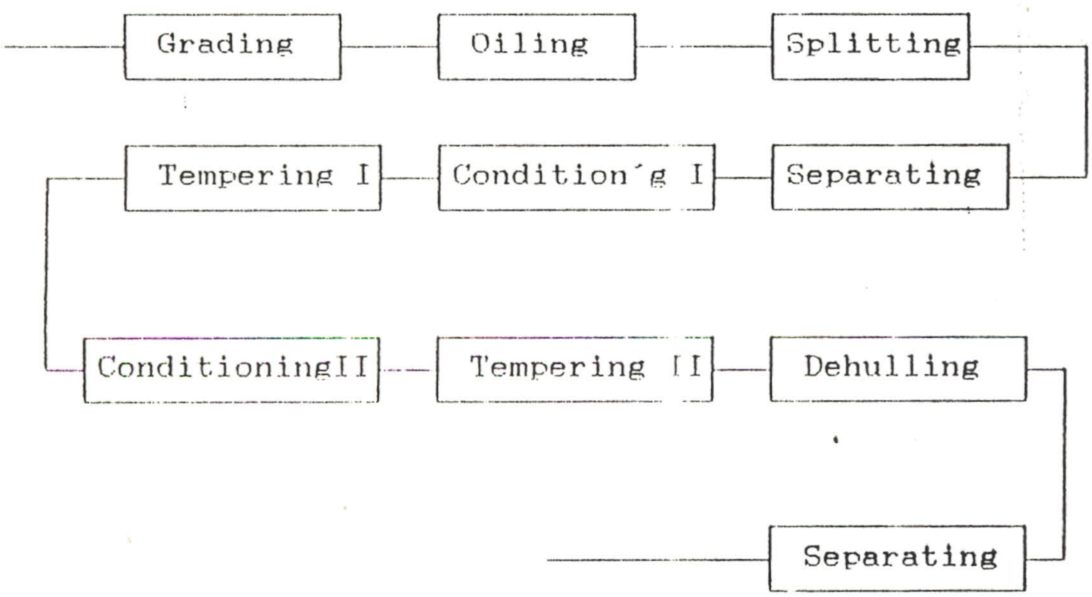


Figure 1: Process Flow Chart of dehulling winged bean

2.0 WINGED BEAN DEHULLING PLANT (WBDP)

The 0.5 ton per hour capacity winged bean dehulling plant installed at the Pilot plant complex of FRI comprises four sections and a main switchboard.

These are:

1. The cleaning and oiling section which consists of
   - i) Grader-aspirator
   - ii) Bucket elevator
   - iii) Oil mixing machine

2. Splitting section which consists of
   - i) Disc sheller (splitter)
   - ii) Bucket elevator
   - iii) Splits separating sieve

3. Conditioning section consisting of
   - i) Two electrically operated conditioners, each made up of a 2800-rpm blower, electrical air heater with control panel and grain chamber with inlet and outlet air ducts.
   - ii) Two tempering bins with air vents mounted on a single frame.
   - iii) One double bucket elevator and two single bucket elevators.

4. Dehulling section consisting of
   - i) Pearling (dehulling) machine
   - ii) Bucket elevator
   - iii) Husk aspirator

5. Main switchboard which is connected to the external electric supply line, distributes power to the various units of the plant using bus-bars and appropriate devices.

2.1 DESCRIPTION OF WBDP

Below are a brief description of the various machines and unit operations they perform, operation instructions and technical data.

3.1.1 GRADER-ASPIRATOR

The aspirator-grader consists of a hopper, a fan, a rectangular box containing three screens and four outlet chutes. The screens have different opening diameters(6mm; 8mm; 10mm) , the biggest on top and the smallest at the bottom and are inclined at an angle of 5°to the horizontal. The reciprocating movement of the box is caused by an eccentric which is driven by a 0.75kwatt-electric motor. The fan is also driven by the same motor through pulleys and a V-belt (figure 2).

During operations, the grains are fed into the machine through the hopper. The base of the hopper has a shutter which controls the quantity of grains leaving it. Before they fall onto the topmost screen, the fan extracts the unwanted materials which are mostly lighter in weight from the mainline. On the topmost screen the grains experience the effects of the slope and the reciprocating movement of the box which causes the bigger grains to fall off through the first outlet chute whilst the smaller grains pass through and fall onto the next screens where similar treatment is experienced till the smallest grains are collected after passing through the third screen and the fourth outlet chute.

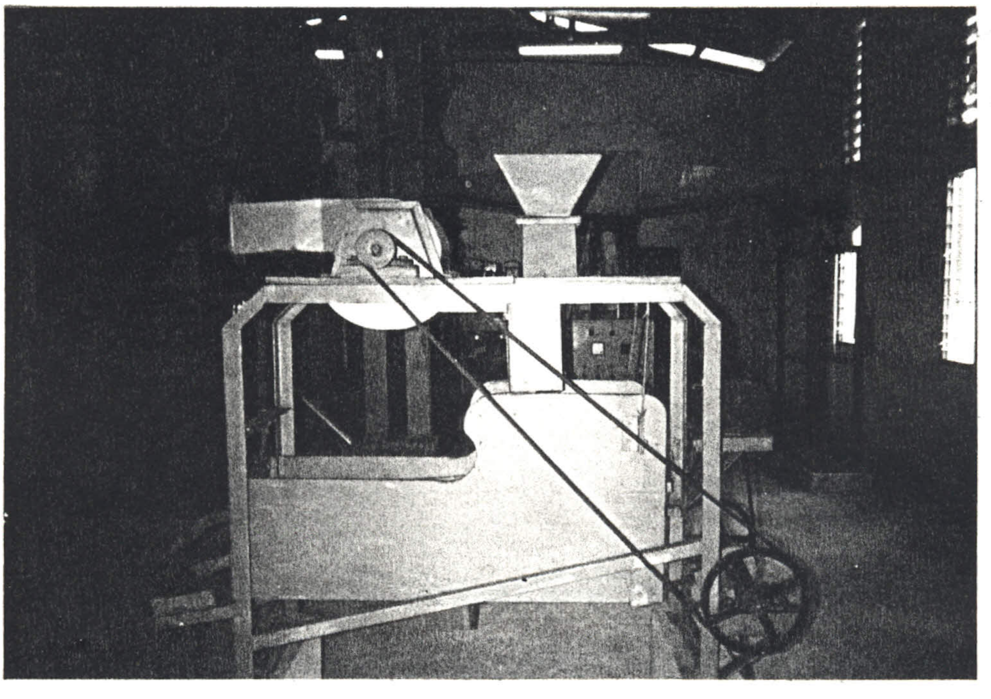


Figure 2: Grader-aspirator

Operation

1. Ensure that all bolts and nuts are tightened
2. Lubricate areas where necessary
3. Tension belt if necessary
4. Ensure that the hopper, sieves, discharge chutes and all other parts of the machine are clean.
5. Hang sack at the end of the extractor fan outlet duct.
6. Place collection bowls under all discharge chutes.
7. Start the grader motor (and the elevator motor)
8. Adjust the shutter position to control flow of grains if necessary.
9. Stop motor after cleaning and grading are completed
10. Use brush and duster to clean areas mentioned in (4) after use.

Technical Data

Motor Power , kwatt	: 0.75
Motor Speed , rpm	: 1400
Box internal dimensions	
length , mm	: 1200
width , mm	: 385
height , mm	: 360
Sieve opening diameters, mm	: 6; 8; 10.
Capacity ,kg/hr	: 500

3.1.2 BUCKET ELEVATOR (Single and double)

The bucket elevator consists of a lease piece where the materials to be transported are directed into, a pair of trunkings and a top piece with a 0.375kwatt electric motor. The lease piece carries a hopper on its top and a shaft with a cylindrical pulley at the middle of its material chamber. The position of the shaft can be adjusted upwards and downwards by means of a pair of adjusting bolts at the sides of the lease piece. The pair of trunkings are positioned on top of the lease piece and the canvas belt carrying the buckets pass through one trunk empty (after delivering the materials to the outlet chute) and the other filled with materials (to be delivered). For the double elevator, the lease piece is divided into two chambers with two pairs of trunkings positioned on it. In each case, the canvas belt is driven by the motor positioned on the top piece through a pulley, V-belt, the shaft of the lease piece and the counter shaft of the top piece (figure 3).

During operation, the buckets fall through one of the trunkings towards the lower shaft and scoop the material after passing the shaft and comes up through the other trunk towards the counter shaft and release the materials into the elevator discharge chute.

Operation

1. Adjust and tension the canvas belt carrying the bucket.
2. Close the hopper gate and fill the hopper with the materials to be elevated.
3. Ensure that the receptacle for the elevated materials is in place (in this case, the aspirator-grader should be in operation).
4. Start the elevator motor and open the hopper gate.
5. Replenish the hopper with materials if necessary.
6. Stop the elevator motor at the end of operation.
7. Remove the remaining materials from the lease piece and clean the elevator.

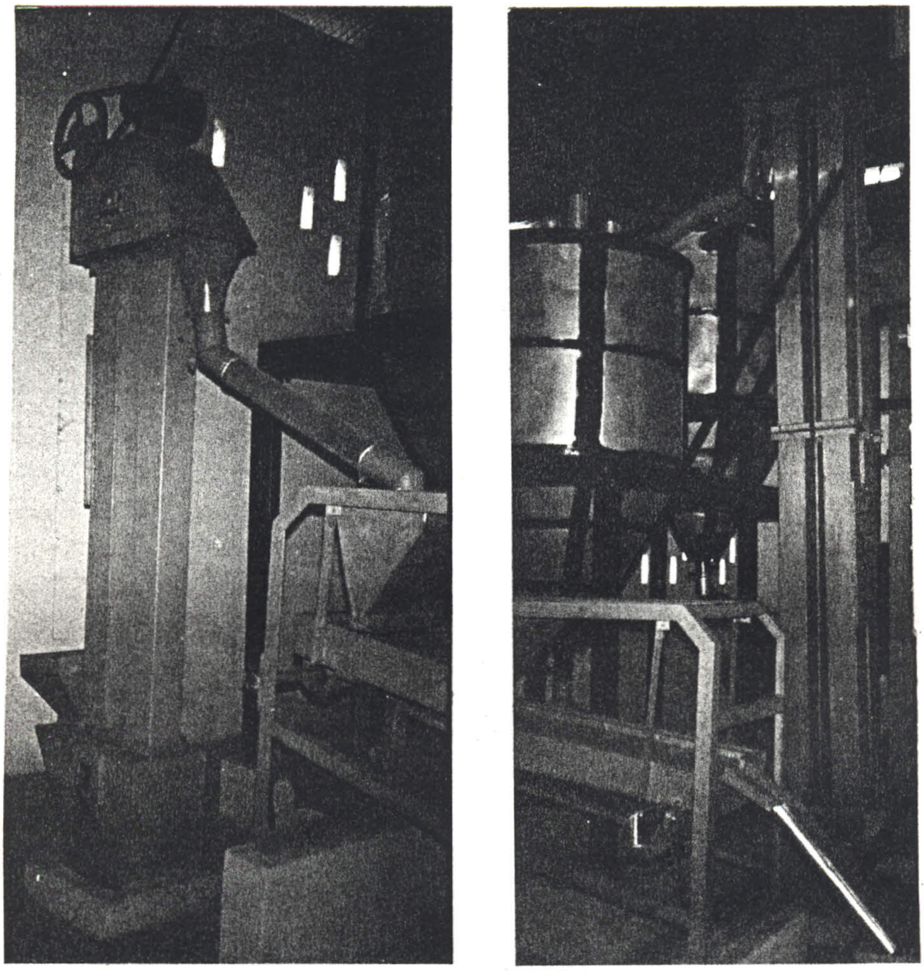


Figure 3: Bucket elevators a) single ; b) double

Technical Data

Motor power, kwatt	: 0.75
Elevator centres, mm	: 1385
Bucket size,cu.mm	: 80*75*55
Bucket speed, m/s	: 4.0
Bucket spacing, mm	: 320
Capacity, kg/hr	: 500

3.1.3 OIL MIXING MACHINE

The oil mixing machine comprises a hopper, an oiling can with valve controlled outlet, a screw conveyor driven by a 0.75 kwatt electric motor and a semicylindrical body with flat top and a discharge chute. The hopper and the oiling can are located at the inlet part of the machine at one end whilst the motor and the outlet chute are at the other end (figure 4).

When in use, grains from the hopper are oiled from the oiling can and with the right direction of rotation of the screw conveyer, the grains are oiled and transported from the inlet side to the outlet chute, mixing throughout the distance.

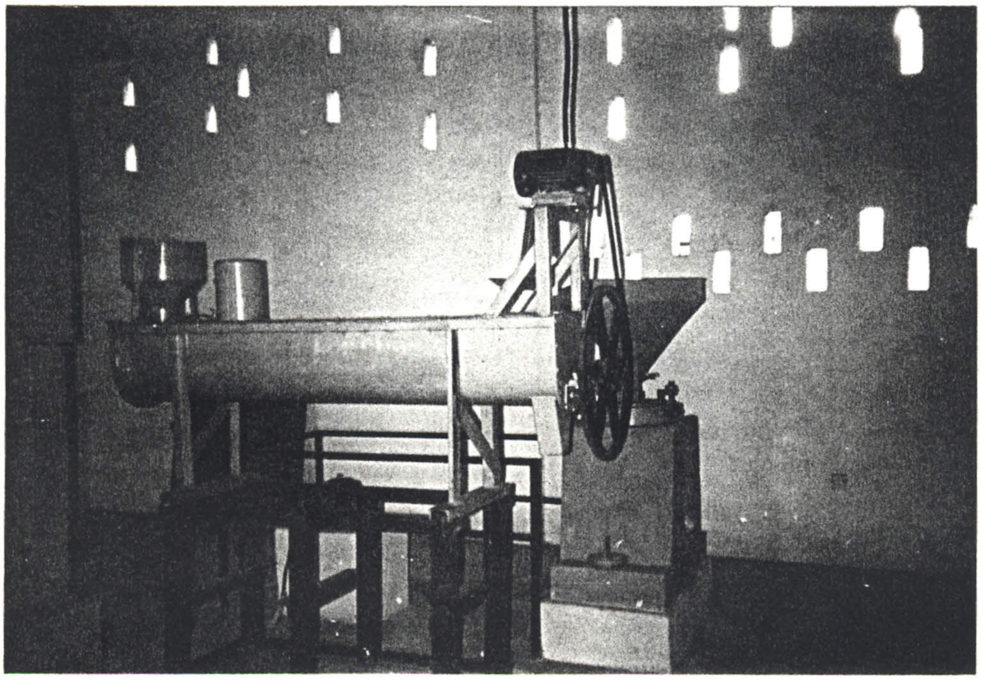


Figure 4: Oil mixing machine

Operation

1. Fill the oiling can with recommended edible oil.
2. Place receptacle at the end of the outlet chute.
3. Close hopper gate and fill the hopper with the grains.
4. Turn the valve to give required oil flow rate.

5. Start the motor and open hopper gate to allow required quantity of grains to pass through, replenishing the hopper when necessary.
6. Stop motor after oiling.
7. Clean the machine.

Technical Data

Motor power, kwatt	: 0.75
Motor speed, rpm	: 1400
Mixing worm length, mm	: 1600
Mixing worm speed, rpm	: 235
Oil can volume, litre	: 4.5
Capacity, kg/hr	: 500

3.1.4 SPLITTER (DISC SHELLER)

The disc sheller consists of an upper stationary concrete disc with a hole at its centre to allow grains to flow from the hopper into the lower rotating disc which is driven by a 2.2-kwatt electric motor. The position of the lower disc can be moved upward and downward by means of two adjusting screw knobs provided at the sides of the machine (figure 5).

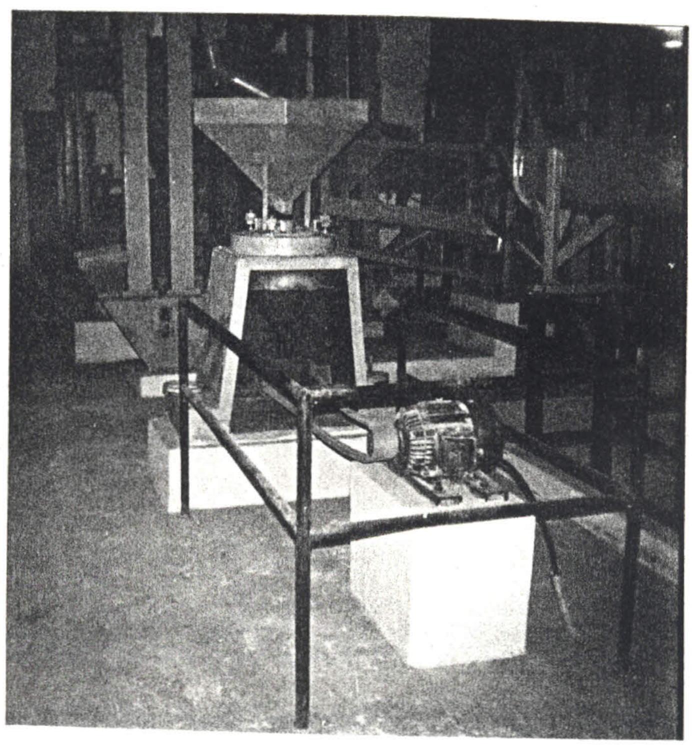


Figure 5: Splitter (Disc sheller)

During operation, the grains are directed onto the lower disc where they are split after experiencing a sheer action from the two concrete disc. Under the influence of centrifugal force,the splitted seeds are thrown off from the lower rotating disc into the conical body and consequently through the outlet chute.

Operation

1. Set the gap between the two discs by means of the two adjusting screw knobs.
2. Close the hopper gate.
3. Fill hopper with grains
4. Position a receptacle at the outlet.
5. Start the motor.
6. Check the products and go to (1) if necessary.
7. Stop the motor after splitting.
8. Clean the machine.

Technical Data

Motor Power, Kwatt	:	2.2
Motor speed, rpm	:	1410
Concrete disc speed, rpm	:	425
Diameter of disc, mm	:	450
Capacity, kg/hr	:	500

3.1.5 SPLITS SEPARATING SIEVE

The split separating sieve consists of a hopper with a gate at the inlet part, a rectangular box containing sieve with 3mm x 15mm rectangular openings and two outlets for splits and broken grains. The box is inclined at an angle of 5° to the horizontal and is subjected to reciprocating movements by an eccentric driven by a 0.75 - kwatt electric motor (figure 6).

During operation, splitted grains from an elevator received in the hopper are allowed onto the sieve where the reciprocating movement of the inclined sieve causes the broken splits to pass through the openings and collected at the lower outlet chute whilst the split grains are transported on the sieve to the second outlet chute (into an elevator lease piece).

Operation

1. Place receptacle(s) at he outlet(s) where necessary.
2. Fill the hopper with split grains or allow elevator to feed the hopper.

3. Start the motor.
4. Open hopper gate to allow required quantity of grains onto sieve.
5. Stop motor after sieving.

Technical data

Motor Power, kwatt	:	0.75
Motor Speed, rpm	:	1400
Box dimensions- Length, mm	:	1700
Width, mm	:	400
Height, mm	:	30
Sieve frequency,osc./min	:	466
Sieve opening, mm*mm	:	3*15
Capacity, kg/hr	:	500

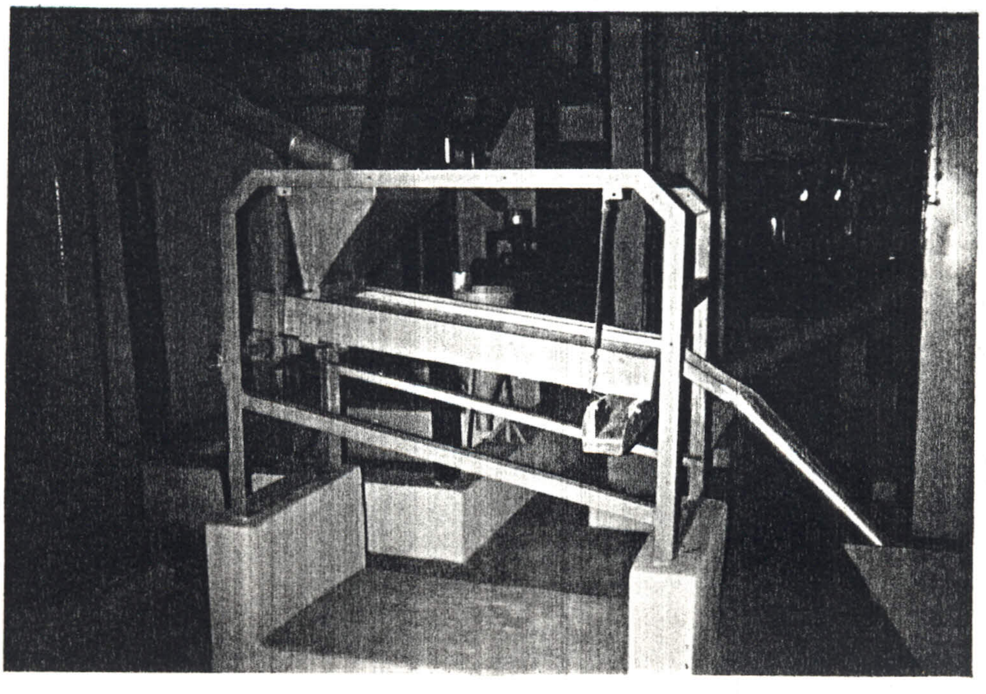


Figure 6: Splits separating sieve

3.1.6 CONDITIONING UNIT

There are two conditioning units each consisting of a high-speed blower (2800rpm) connected to an inlet air duct and leading to an electrical air heater. The heater is connected to the grain chamber via an outlet air duct. The blower is driven by a 2.25 kwatt electric motor and has a shutter which regulates the air flow across the heater into the grain chamber. Heated air is evenly distributed into the grain chamber by six perforated horizontal pipes located in the chamber at the air entry point. The outlet air duct is fitted with a thermostat for temperature control and the grain chamber is fitted with a thermometer for temperature measurements (figure 7).

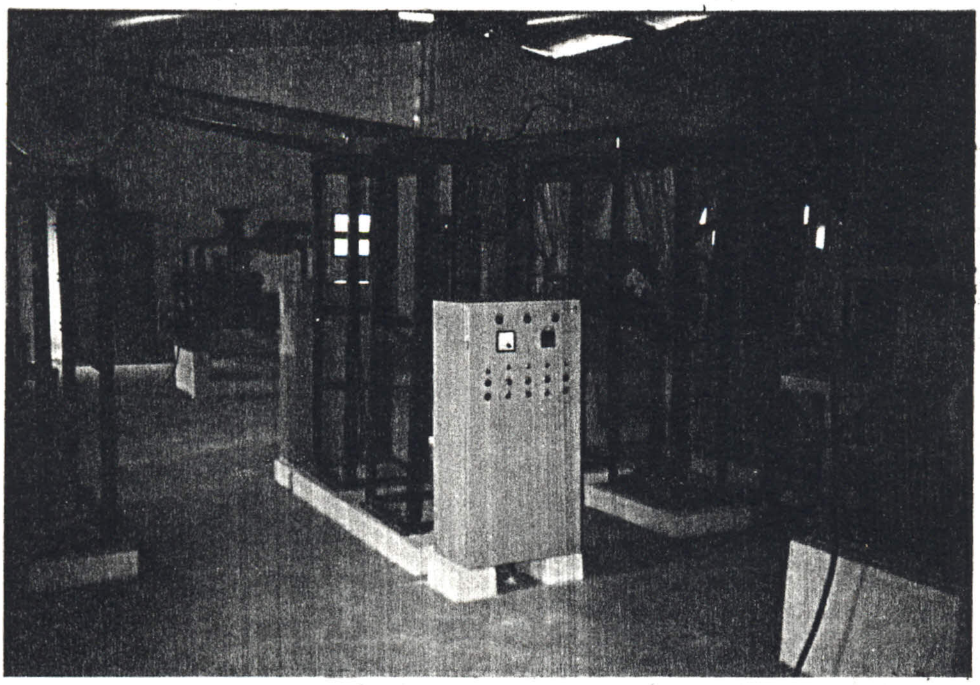


Figure 7: Conditioning unit

During operation, cold air is blown by the blower across the heater to attain required temperature into the grain chamber. Grains are lifted into the grain chamber where they come into contact with the heated air and are consequently conditioned after the expiration of the resident time. Heated grains are let out of the chamber through a gate at the discharge chute of the chamber into the double elevator.

Operation

1. Switch on the 100Amp main switch serving the conditioner control panel.
2. Switch on the thermostat and set the required temperature.
3. Start the blower and adjust the shutter to deliver the required air flow rate.
4. Allow temperature at grain chamber to stabilize at the set temperature.
5. Introduce grains into chamber by an elevator.
6. At the end of the resident time, open the gate at the exit of the chamber to allow the heated (conditioned) grains into the lease piece of the double elevator.
7. Switch off the heater and thermostat at the end of conditioning.
8. Allow the blower to cool the heater for about 5 minutes before switching it off.
9. Switch off the main switch serving the control panel.

Technical Data

Blower motor power, kwatt	: 2.2
Blower speed, rpm	: 2800
Heater power output, kwatt	: 24
Maximum temperature, °C	: 200
Volume of chamber, cu.m	: 0.108

3.1.7 TEMPERING BIN

The plant has two tempering bins, each of which is made up of two perforated semi-cylindrical segments forming the upper part joined to a lower inverted perforated cone and mounted on a frame with six legs. Air vents are installed in the bin by means of bin spiders for effective distribution of air through the grains in the bin (figure 8).

Conditioned grains are stored in the tempering bin and allowed to cool. During this cooling period the bond between the husk and the cotyledon is loosen. The bin is fed by the double elevator and the grains are discharged through the outlet at the apex of the cone. The first bin discharges into the lease piece of an elevator feeding the second conditioning chamber whilst the second bin discharges into the dehulling machine.

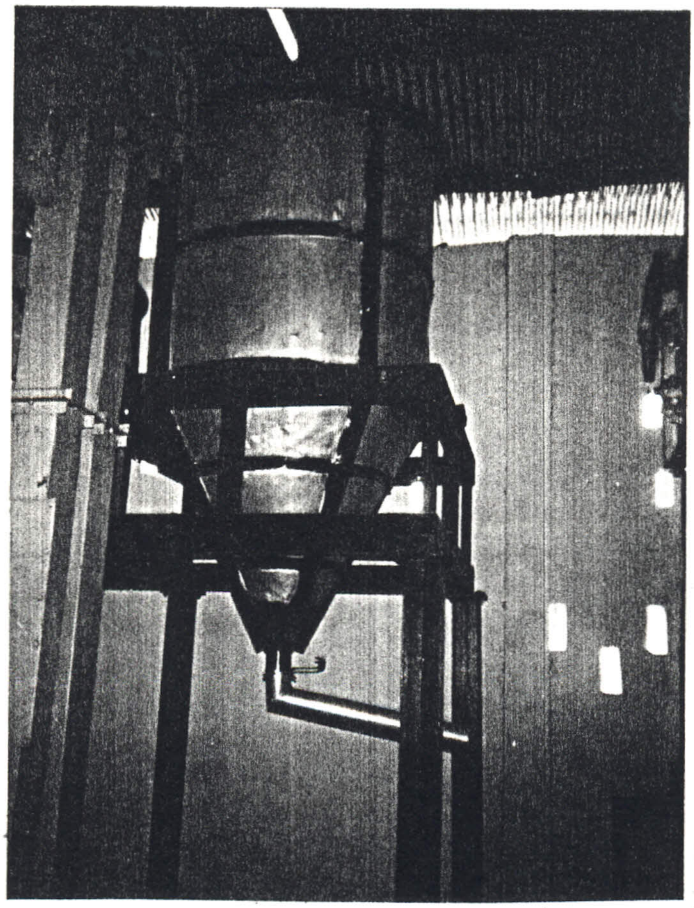


Figure 8: Tempering bin

Operation

1. Close the discharge chute gate.
2. Fill the bin with grain using the double elevator.
3. Allow the grain to cool(for about 6 hours).
4. Open discharge chute to discharge grain after cooling period.

Technical Data

Diameter of bin, mm	:	1200
Height of cylindrical part, mm	:	1200
Height of cone, mm	:	1200
Air vent dimension		
Diameter, mm	:	100
Height, mm	:	1800
Holding Capacity, kg	:	1500

3.1.8 DEHULLING MACHINE

The dehulling machine basically consists of a hopper, a dehulling chamber and a discharge chute. The dehulling chamber is made up of a horizontal cylindrical mass with a centre shaft in its middle and a pulley at one end of the shaft. The cylindrical mass is made of concrete with the discharge part having a smoother surface compared with the rougher surface of the inlet part. A metallic worm is fixed at the end of the mass towards the inlet part directly under the hopper to transport the grains through the dehulling chamber.Two metallic semi-cylindrical segments with perforated lower part form the body of the dehulling chamber (figure 9).

During operation, with the discharge chute gate closed, the space between the cylindrical mass and the body is filled with the grains by means of the worm. The grains come into contact with the rotating mass where the husks are removed. The worm makes it possible for the grains to mix within the dehulling chamber.

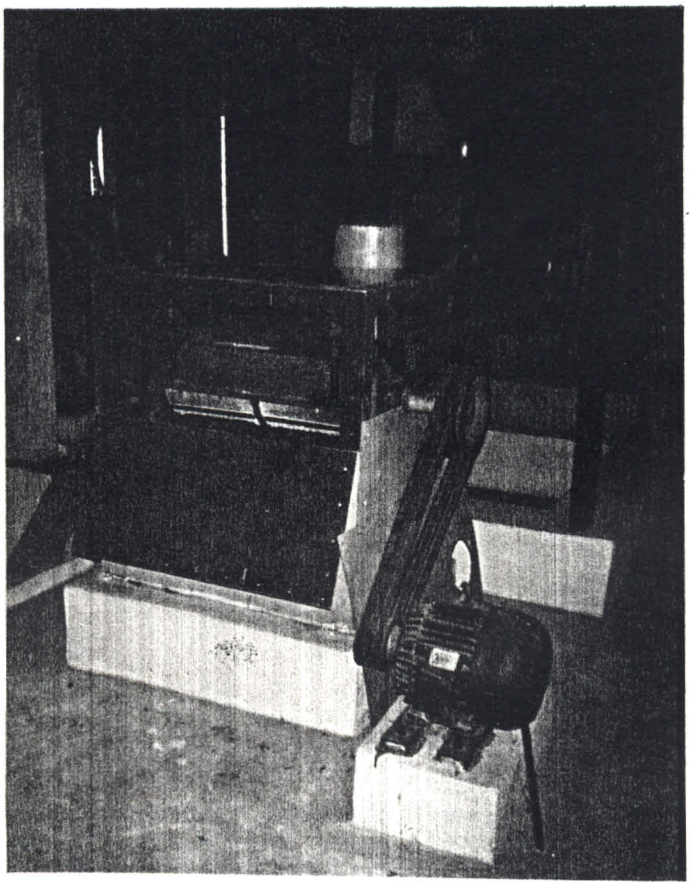


Figure 9: Dehulling machine

Operation

1. Fill hopper with grains.
2. Close discharge chute gate.
3. Start the motor.
4. Allow the grains to fall in the dehulling chamber till they can no longer enter the chamber.
5. Allow some moments to pass and open the discharge chute gate a little to check if grains are dehulled.
6. Open the gate fully if the grains are dehulled and if not, close the gate and repeat (5).
7. Allow the next batch of grains to fall into the dehulling chamber and repeat (5).
8. Stop the motor at the end of dehulling
9. Repeat the dehulling process from (1) to (8) if dehulled grains are not satisfactory.
10. Clean the dehuller after use.

Technical Data

Electric motor power, kwatt	: 5.5
Cylindrical mass diameter, mm	: 20
" " length, mm	: 1200
" " cover diameter, mm	: 75
" " " length, mm	: 1450
Length of worm, mm	: 20
Capacity, kg/hr	: 500

3.1.9 HUSK ASPIRATOR

The husk aspirator consists of two rectangular slightly inclined screens, and a box containing an extractor fan and located between the two screens. The top screen is inclined downward to the left whilst the bottom screen is inclined downward to the right (figure 10).

During operation, the top screen directs the grains into the box where the husks are removed from the bulk by the extractor fan. On the bottom screen, the grains experience reciprocating movements which cause the dehulled grains to be collected from the overflow discharge chute whilst the broken ones are collected from the underflow discharge chute.

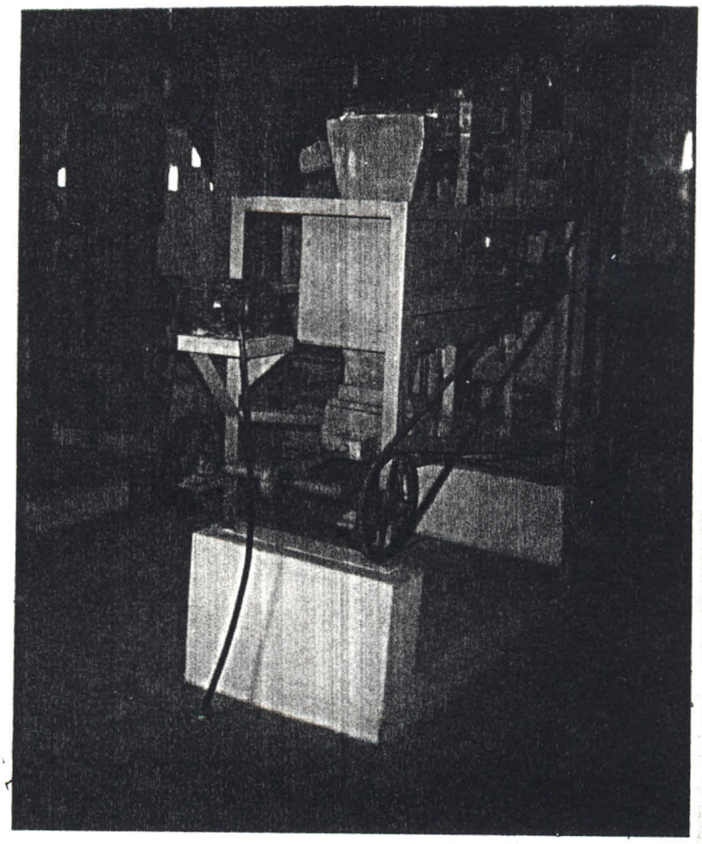


Figure 10: Husk aspirator

Operation

1. Place receptacles at exits of discharge chutes
2. Hang sack at the end of the extractor fan outlet duct.
3. Put on the main switch controlling the motor starter.
4. Start the motor.
5. Feed the topmost screen with materials by elevator or manually.
6. Stop motor and switch off the main switch at the end of operation
7. Clean the aspirator.

Technical Data

Motor power, kwatt	: 0.75
Motor speed, rpm	: 1400
Extractor box dimensions	
length, mm	: 920
width, mm	: 380
height, mm	: 450
Sieve size, mm*mm	: 750*260
Sieve frequency, osc./min	: 466

3.1.10 MAIN SWITCHBOARD

The main switchboard accommodates a 200-amp TPN switch which is supplied with electric power from the main power station of the Pilot Plant Complex. The 20-amp switch sends power to a system of bus-bars from which the various machines of the plant are powered through appropriate switches and motor starters.I The switchboard has two 100-amp, one 32-amp and eleven 16-amp TPN switches;one 6-12 amp star-delta, five 15-amp and six 1.6-amp starters. There is also a voltmeter (0-600 volts) with three indicating coloured bulbs (red, blue and yellow) for phase checking and a 3-way switch labelled R-B, R-Y, B-Y). All the switches and starters are earthed (figure 11).

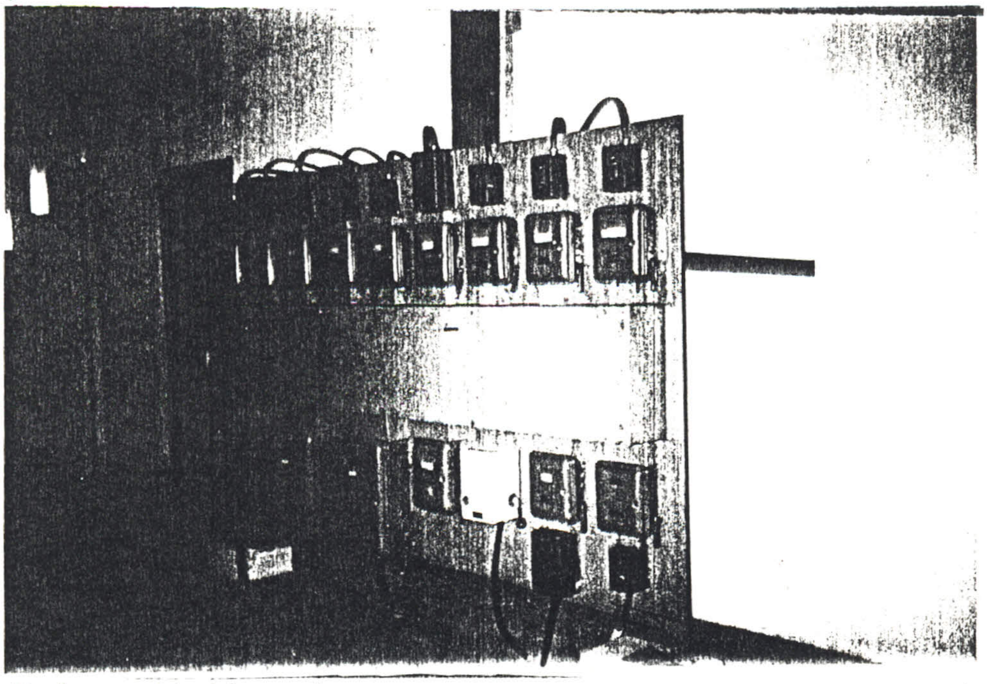


Figure 11: Main switchboard

4.0 REFERENCES

1. Cerny, K., Kordylas, H., and others. 1971. Nutritive value of the winged bean. Br. J. Nutr., 26, 293-299.

2. Kay, D.E. 1979. Food Legumes. Tropical Products Institute, London.

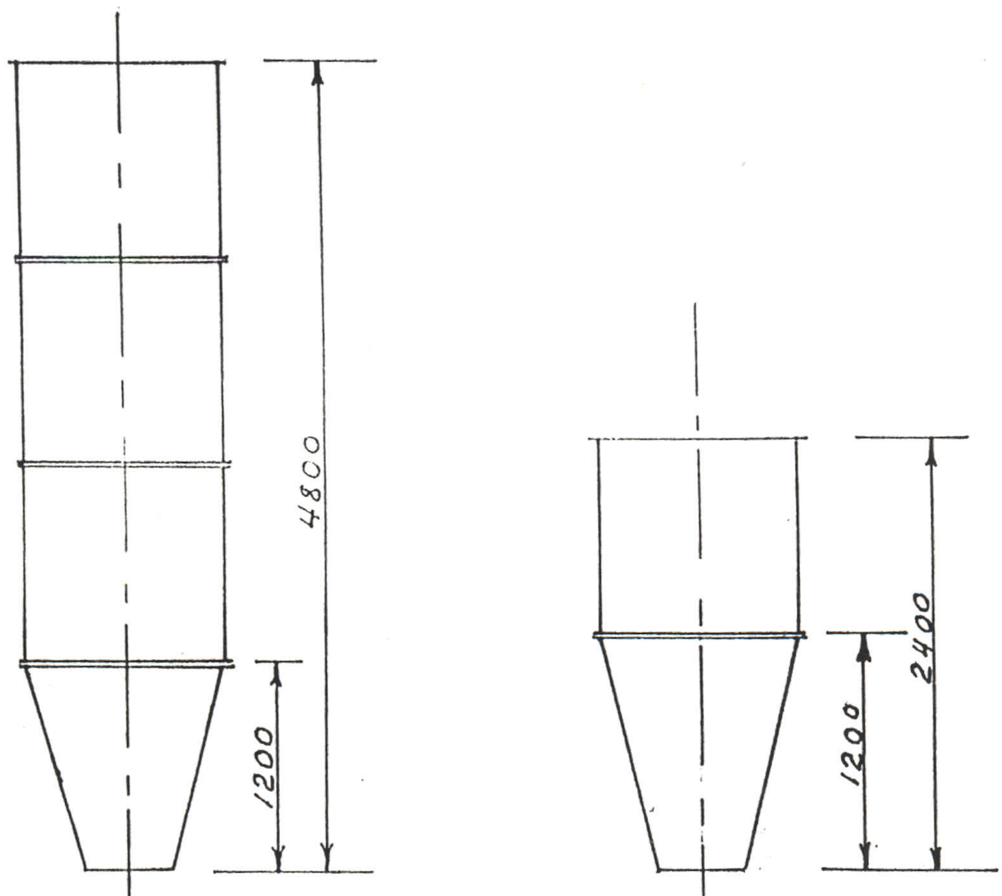
3. Cerny, K., Addy, H.A. 1973. The winged bean in the treatment of kwashiorkor. Br. Journal Nutrition., 29, 105-111.

4. Amoah, A.G.K., Report of a training course on winged bean dehulling plant at CFTRI, Mysore, India. July 1982 to October, 1982.

5. D. Blay, P. Adjei-Boateng, F. Dzokoto and M.F. Damptey, 1988 Report on the possibility of installing winged bean dehulling plant at the pilot plant, Okpongio" FRI Special Assignment Report.

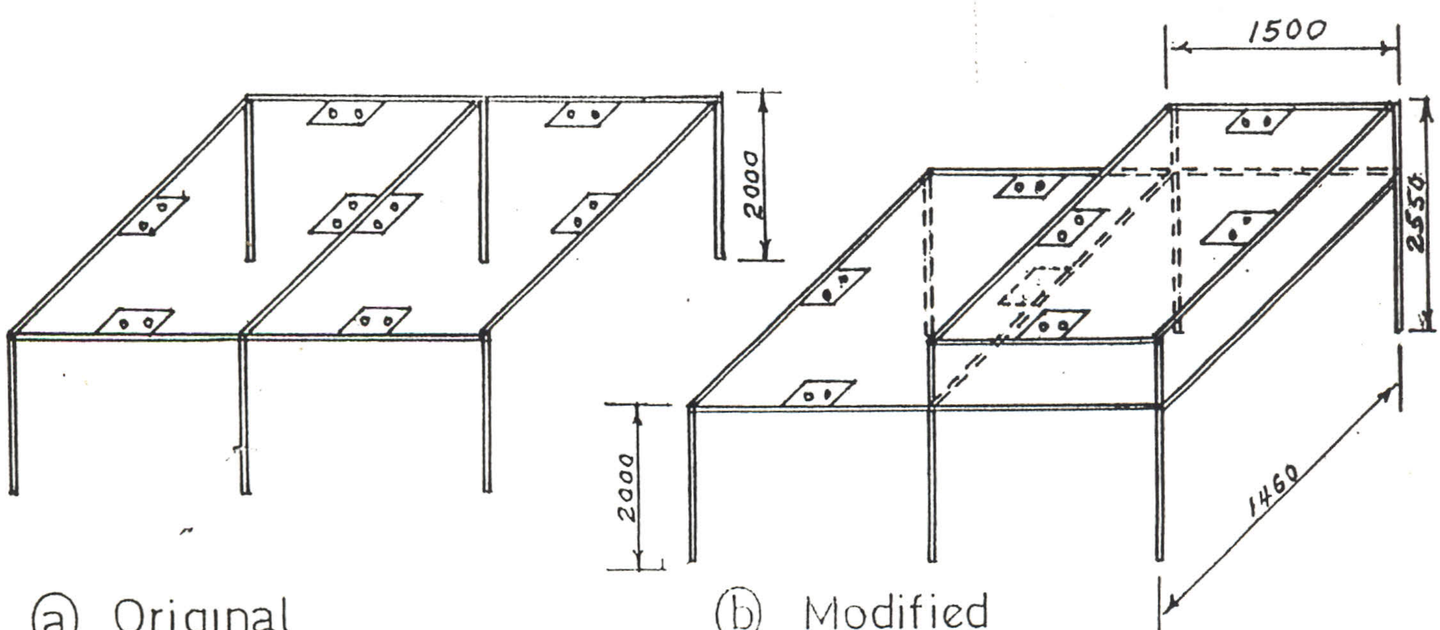
APPENDIX 1 MODIFICATIONS

Fig. 1. Tempering Bin.



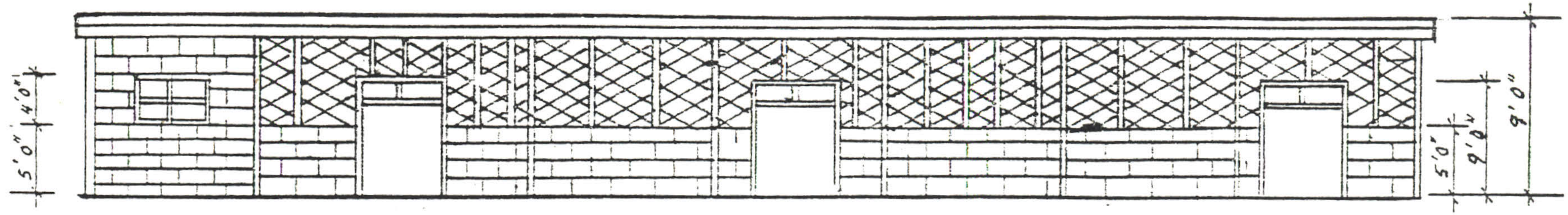
(a) Original (b) Modified

Fig. 2. Tempering Bin Support

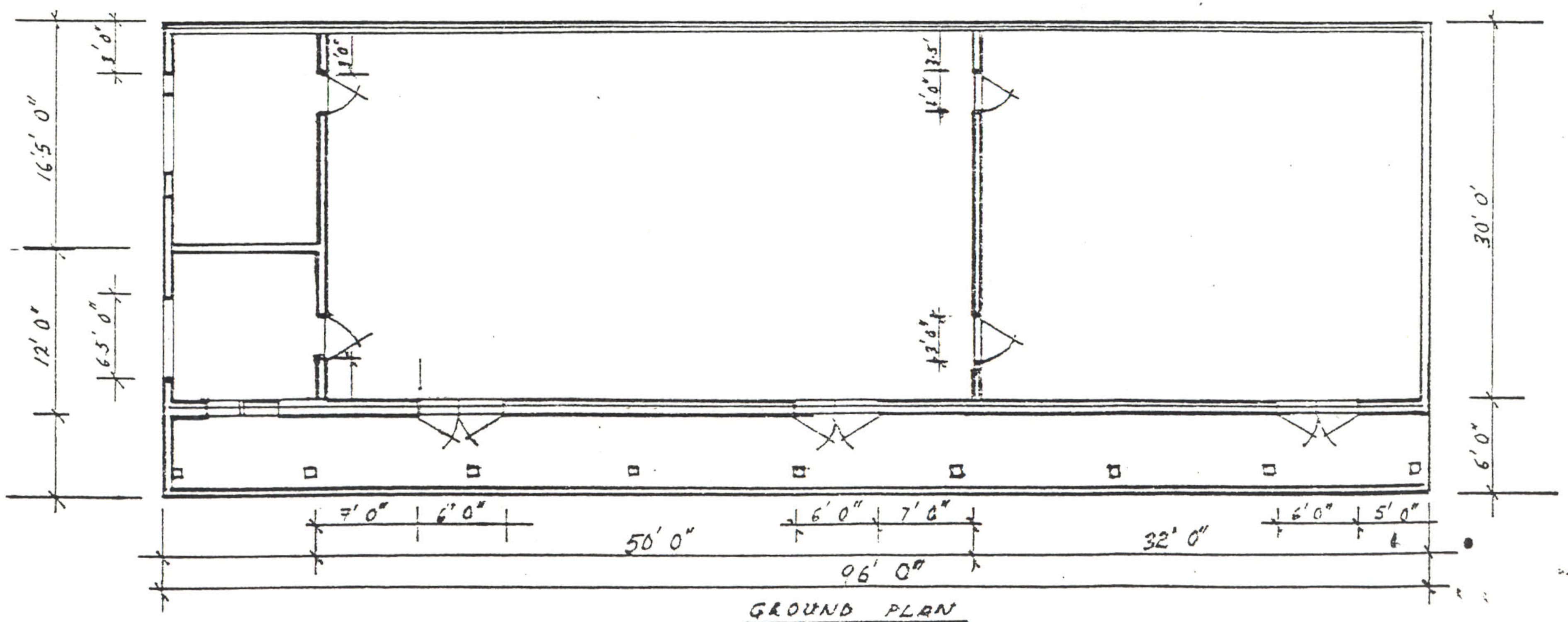


(a) Original (b) Modified

APPENDIX. II Fig.1 Proposed Milling Shed

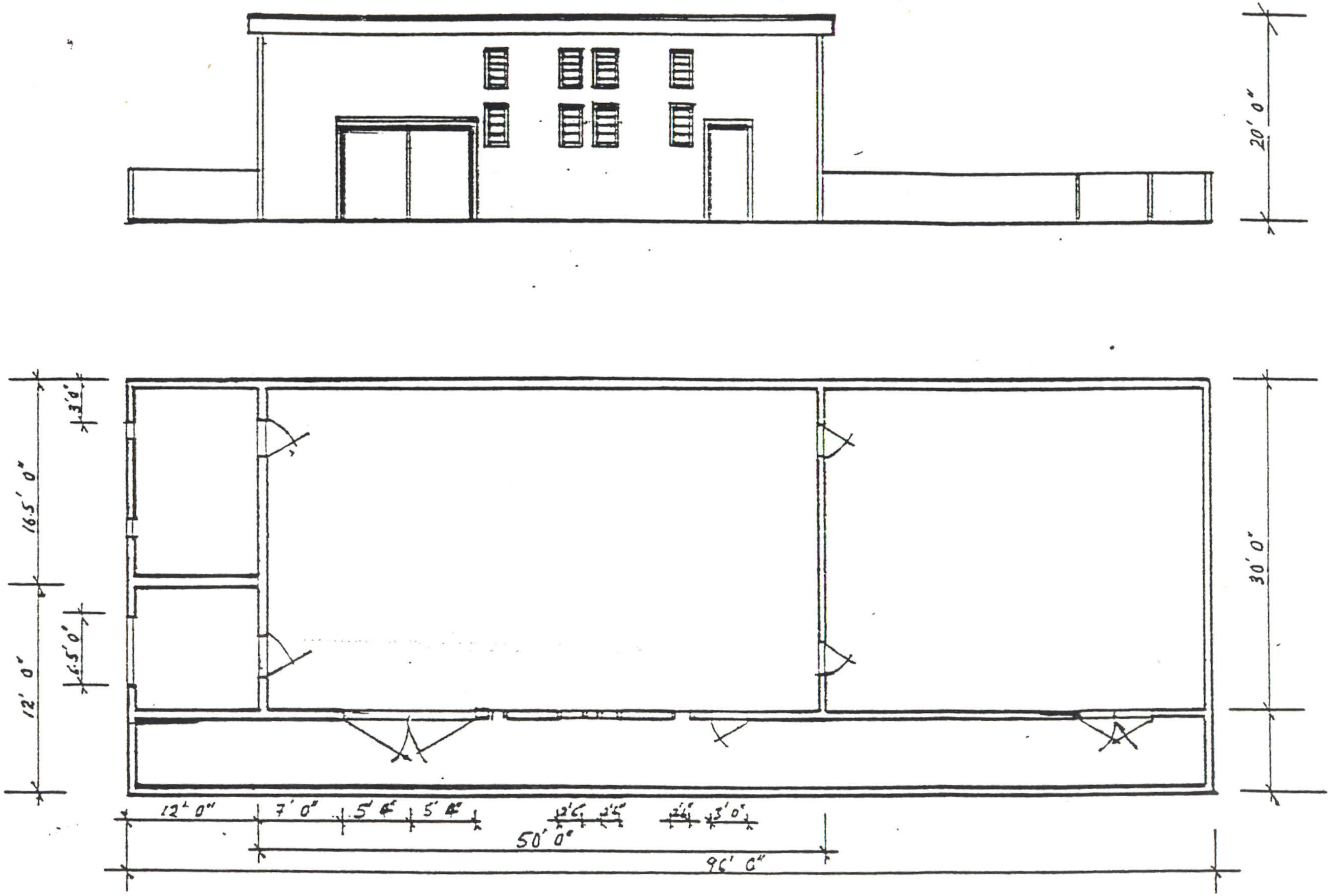


FRONT ELEVATION



GROUND PLAN

Fig. 2. Winged Bean Dehulling Plant House.



APPENDIX. III FIG 1. PLANT LAYOUT (PLAN)

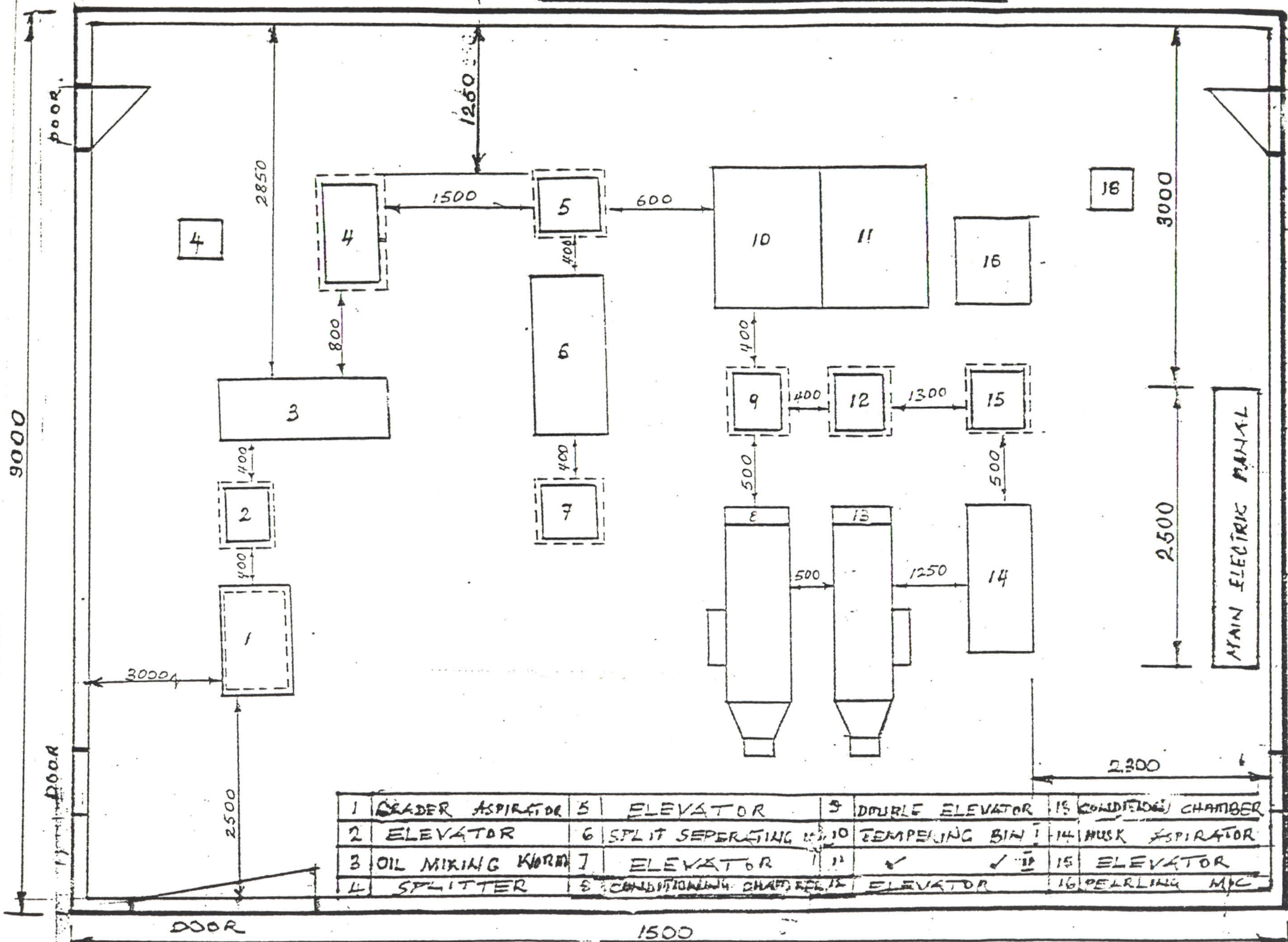
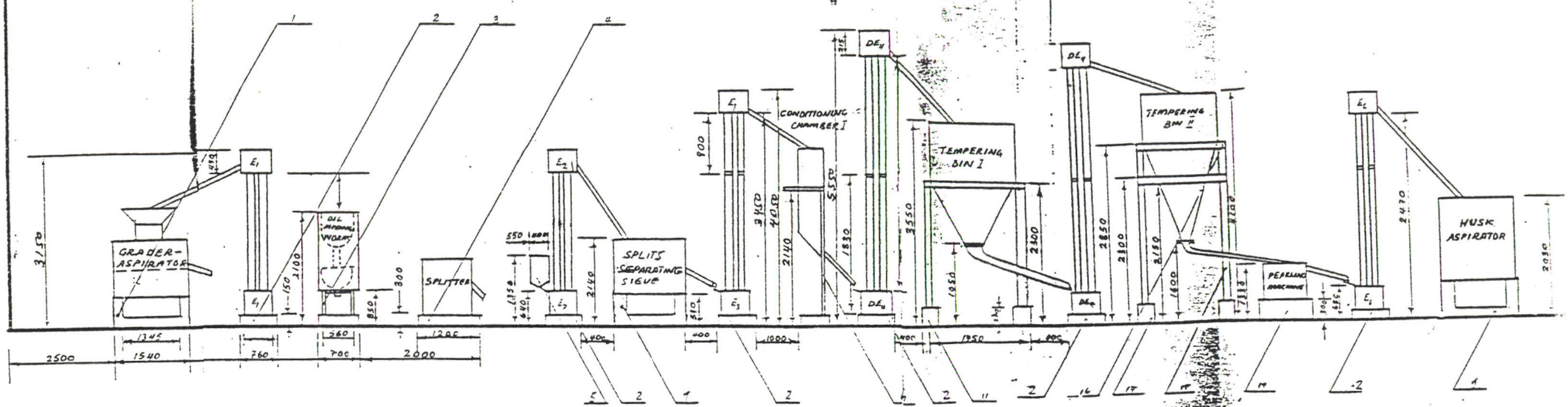


FIGURE 2. PROCESS FLOW SHEET WITH INSTALLED HEIGHT FOR PLANT



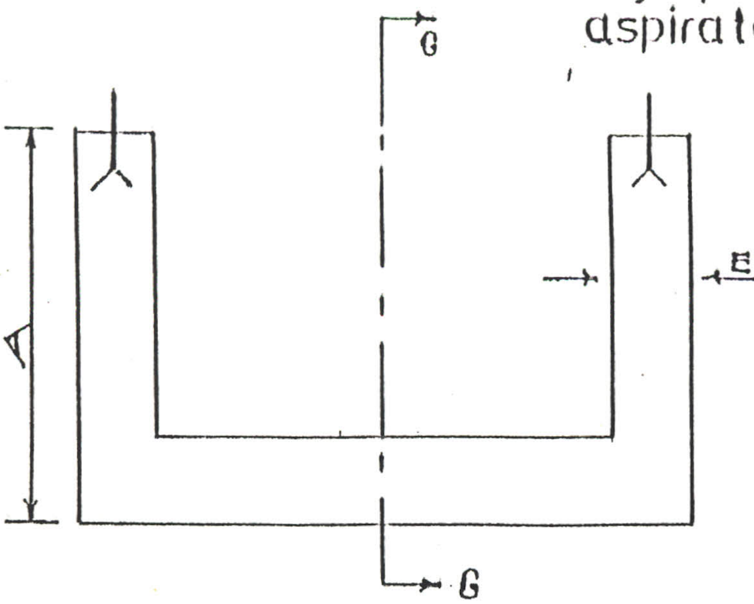
Nº	DESCRIPTION	QTY
1	CONCRETE PLATFORM	1
2	CONCRETE PLATFORM (E1)	1
3	METALLIC SUPPORT	1
4	CONCRETE PLATFORM	
		1

Nº	DESCRIPTION	QTY
5	ELEVATER HOPPER	
6	CONCRETE PLATFORM (E2)	
7	CONCRETE PLATFORM	
8	CONCRATE PLATFORM	
9	CONDITIONING CHAMBEP SUPPORT	1
10	CONCRATE PLATFORM 'DE'	
11	'TEMPERING BIN' CONCRATE BLOCK	
12	'TEMPERING BIN' FRAME LEG	
13	CONCRATE PLATFORM 'E'	
14	[illegible]	

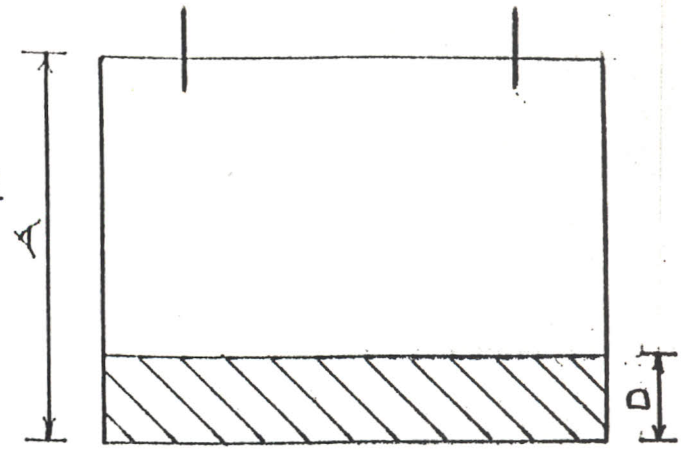
Nº	DESCRIPTION	QTY
15	DE CONCRETE PLATFORM	1
16	AD TEMPERING BIN [illegible] SUPPORT	1
17	FRAMELEG CONCRETE BLOCK	6
18	TEMPERING BIN [illegible] LEG	6
19	'PIT' CONCRETE PLATFORM	1
20	[illegible] CONCRETE PLATFORM	1
21	[illegible]	1
22	CONCRETE PLATFORM	1
DE	DOUBLE ELEVATOR	1
E	ELEVATOR	

APPENDIX.IV.

Fig.1. Concrete support for grader-aspirator, split separating sieve and husk aspirator.

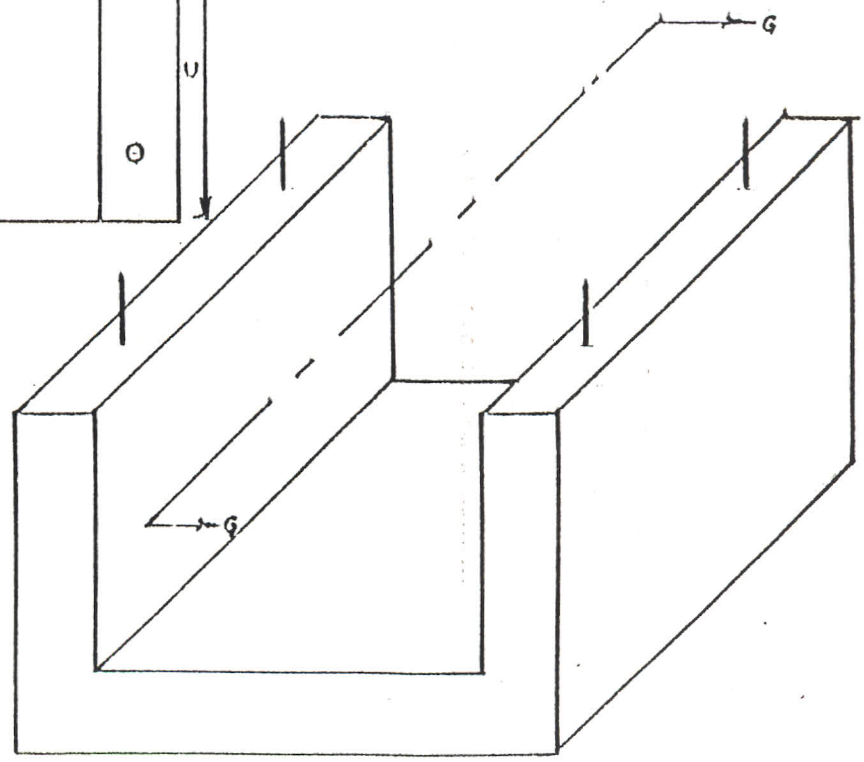


FRONT VIEW



SECTIONAL END VIEW G-G

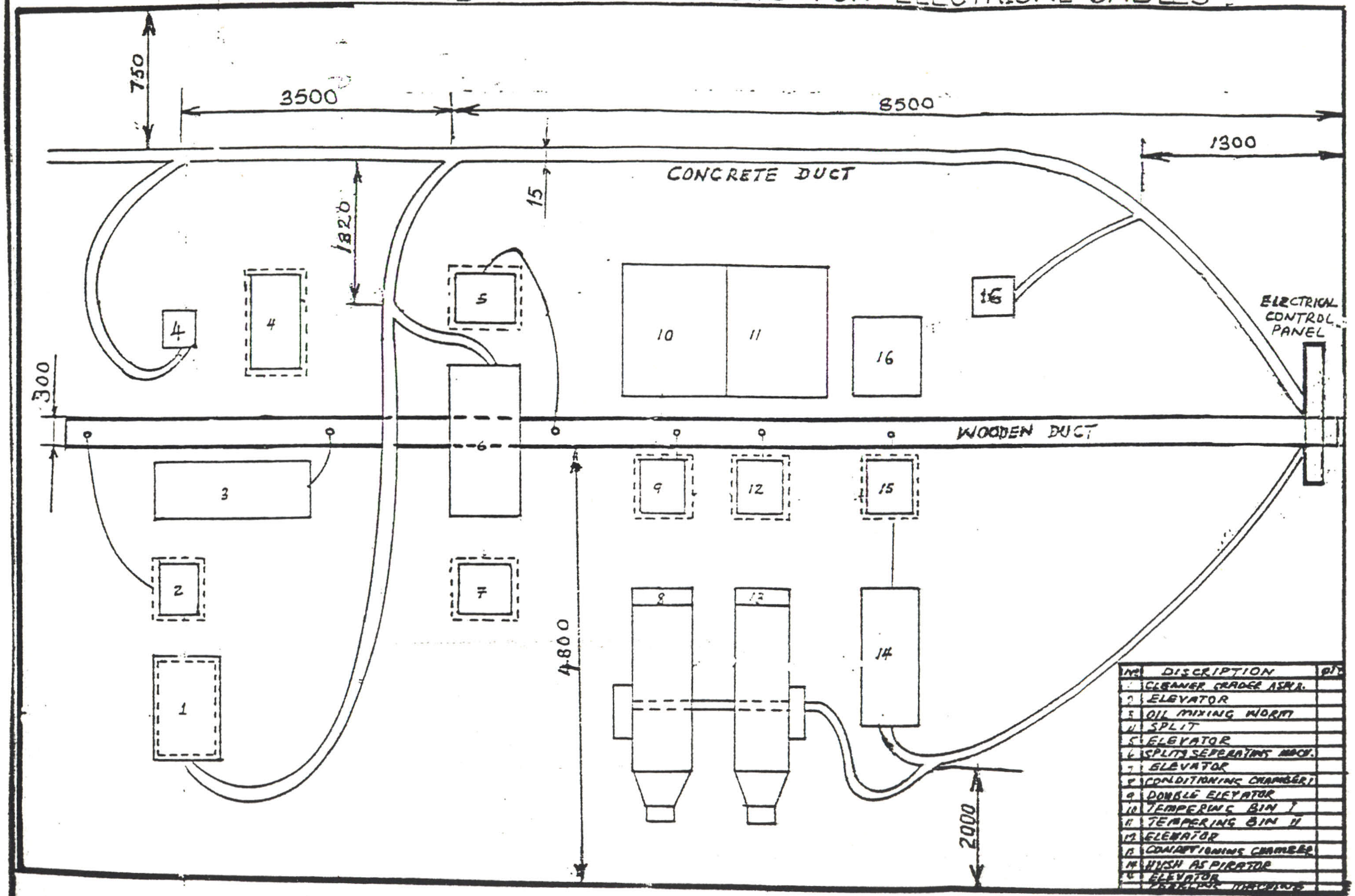
PLAN



OBLIQUE PROJECTION

ITEM	GRADER ASPIRATOR	SPLITS-SEPARATING SIEVE	HUSK-ASPIRATOR
A	520	560	500
B	1490	1490	1470
C	790	720	730
D	180	180	180
E	170	170	170

APPENDIX:- IV. FIG.2 PLAN OF DUCTS FOR ELECTRICAL CABLES



APPENDIX. V

Fig.1 Metallic support for Oil Mixing Machine.

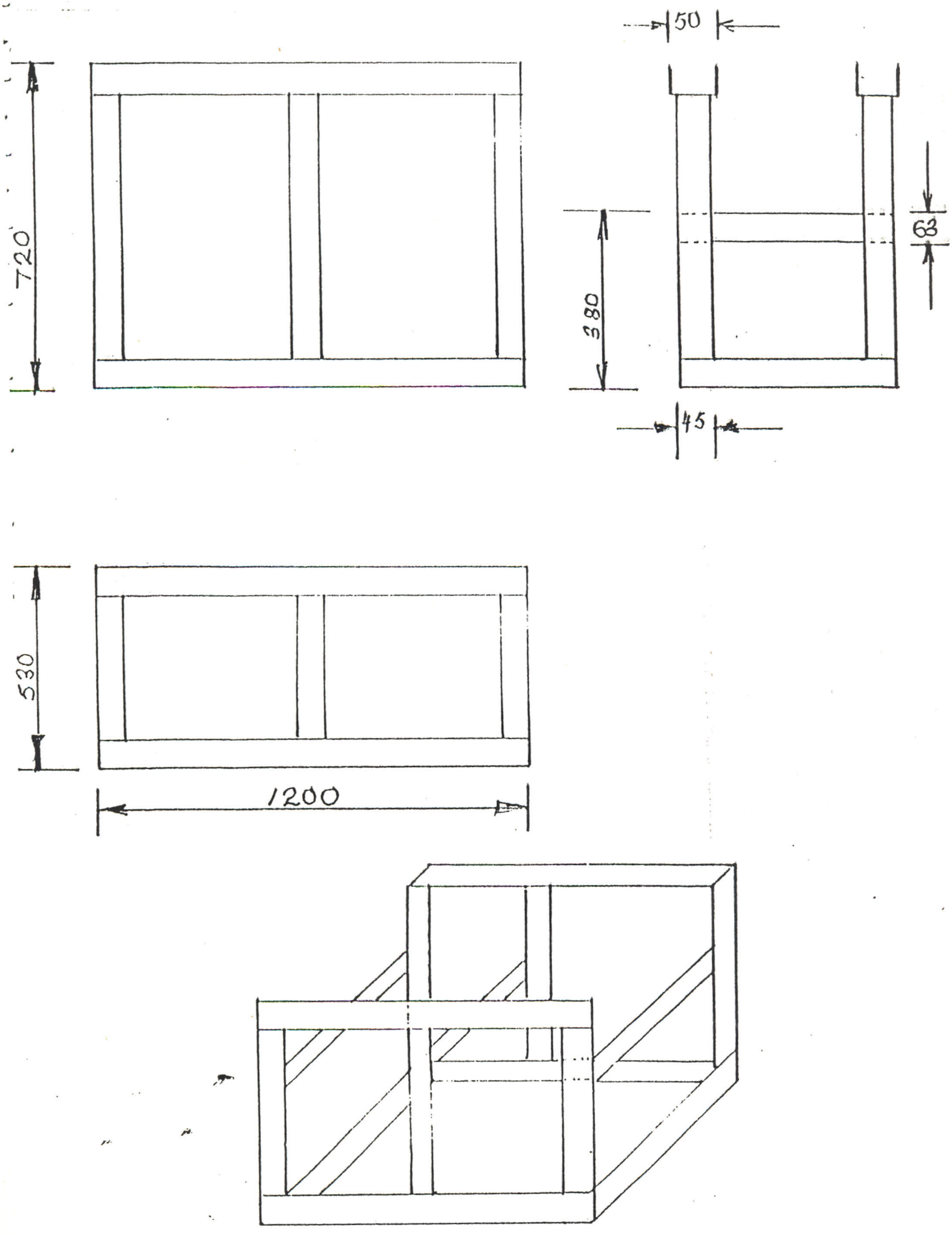
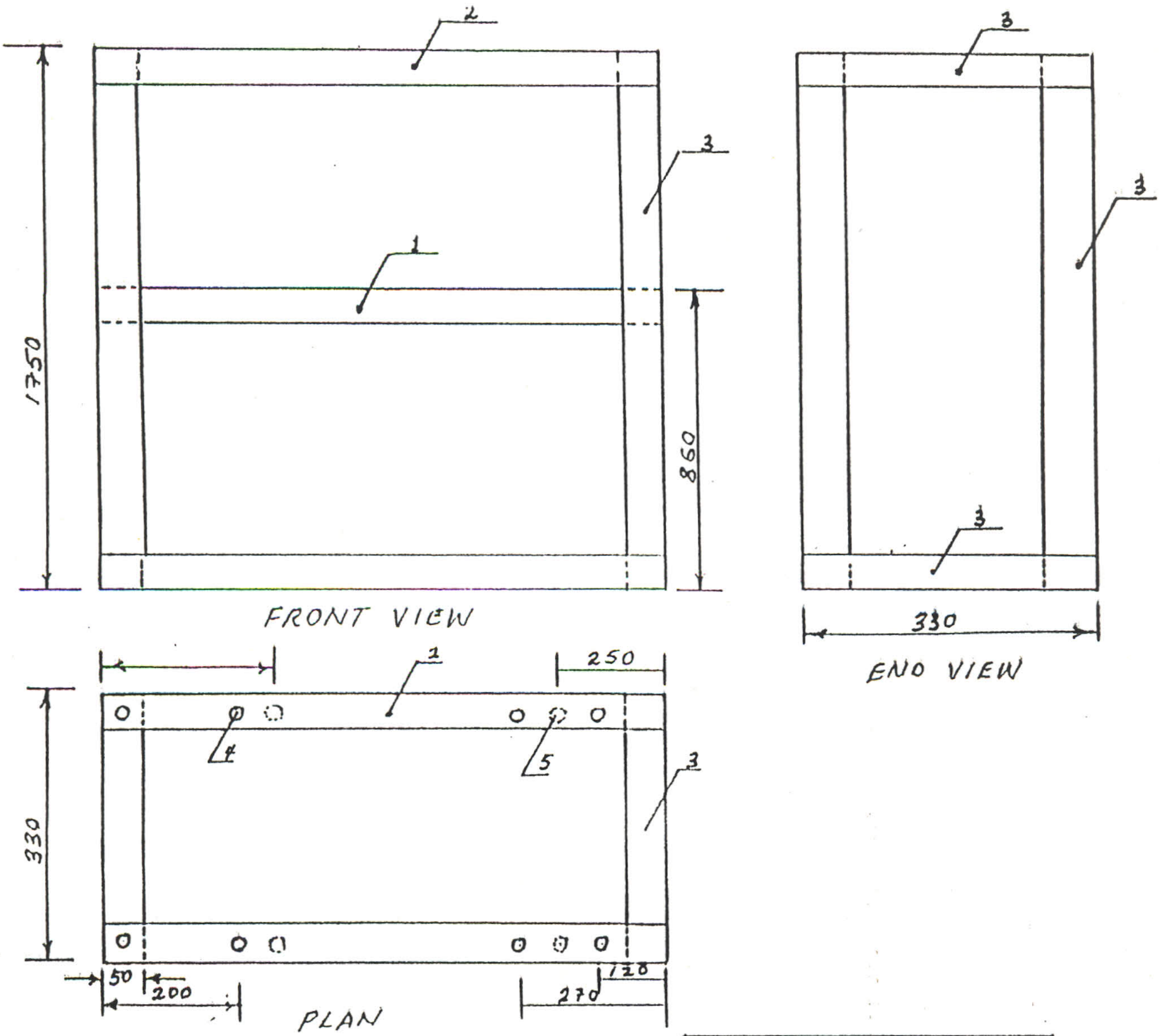
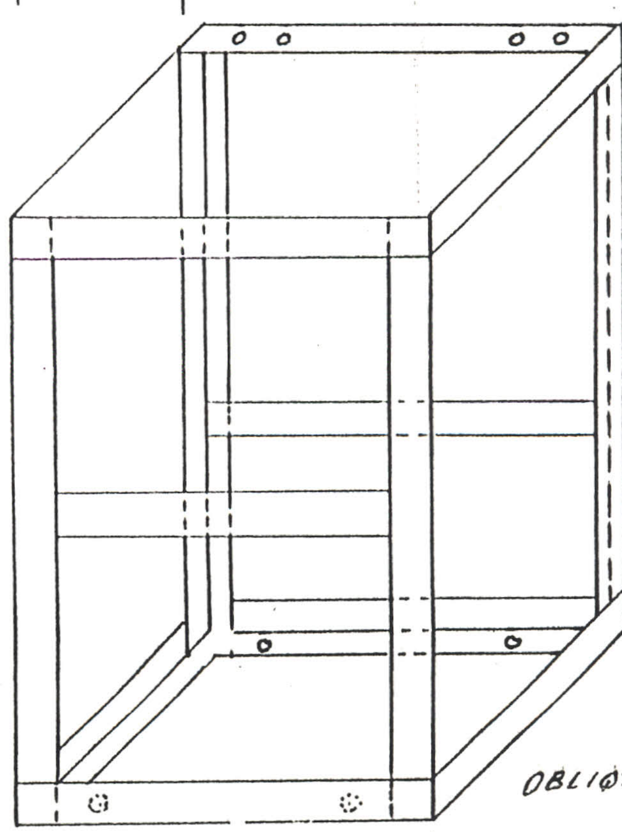


Fig.2 Metallic support for two Blowers.





OBLIQUE PROJECTION

ITEM	REF	DESCRIPTION	QTY
A	1	FLAT BAR (STEEL) 60mm×6mm L=1270	2
B	2	CHANNEL IRON (80×40mm) L=1270.	2
[illegible]	3	ANGLE IRON (60×60mm) L= 1750, 330, 1270	4,4,[illegible]
D	4	HOLE ø	8
E	5	HOLE ø	4

Fig.3 Metallic support for Heater.

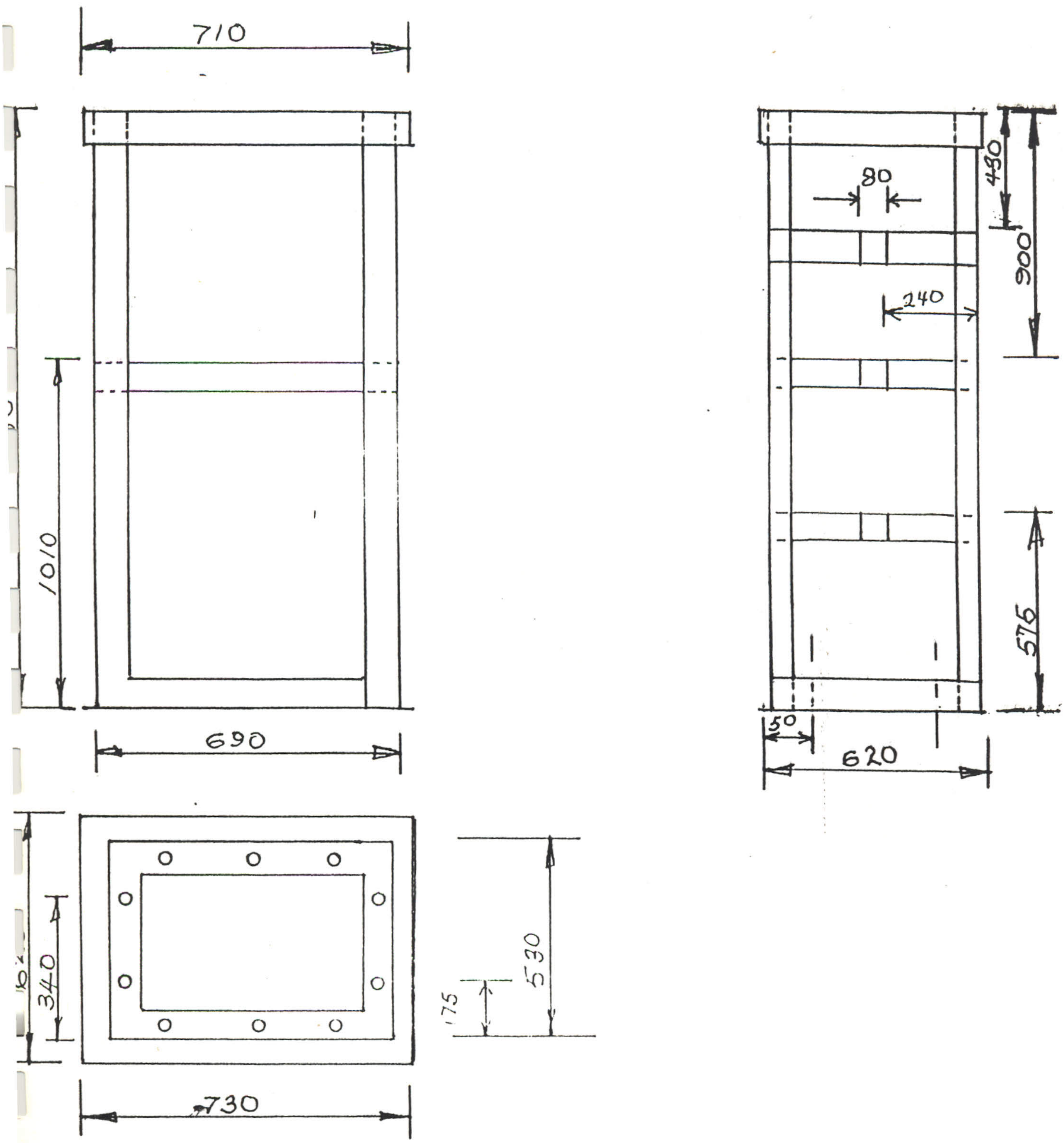
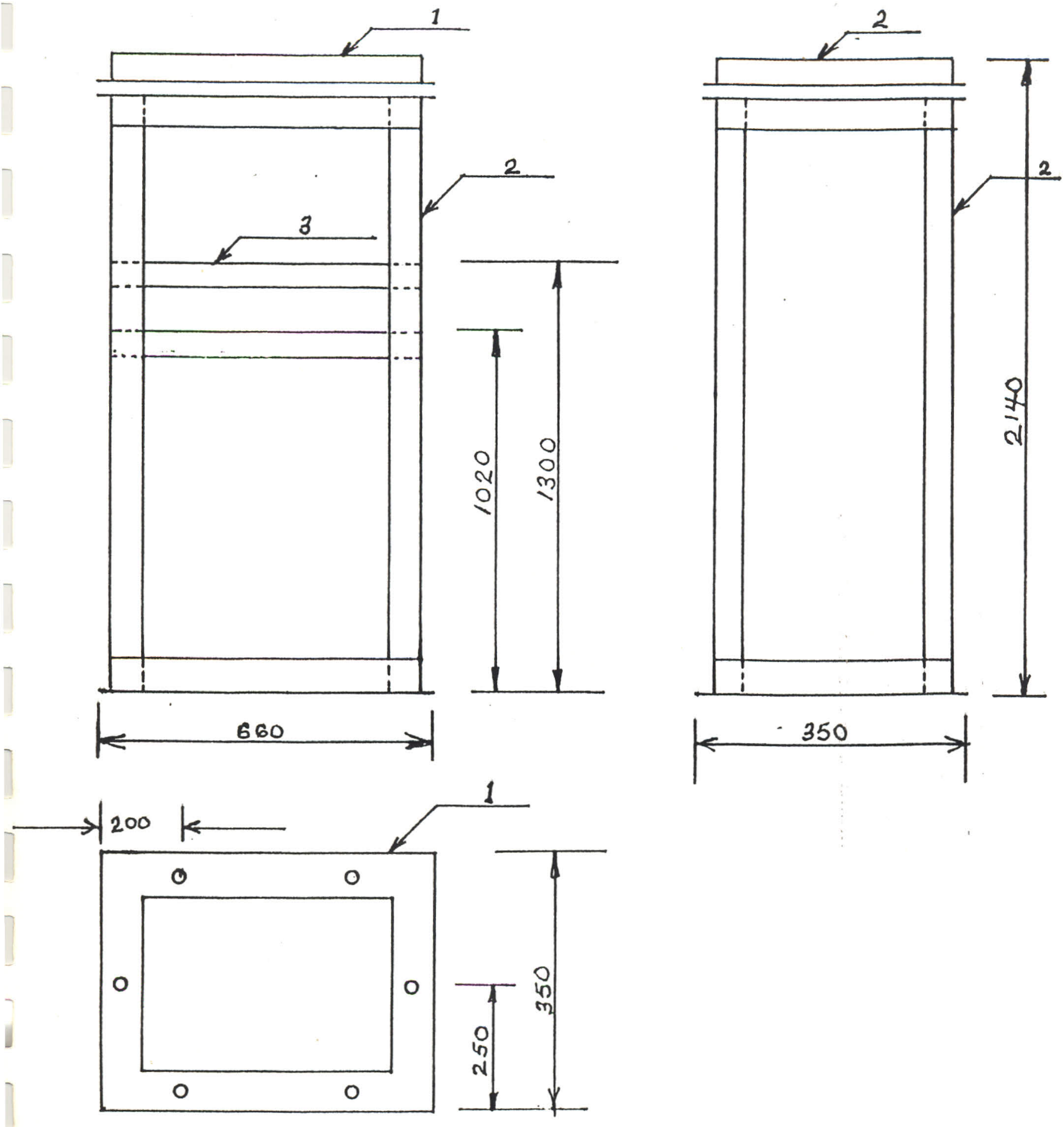


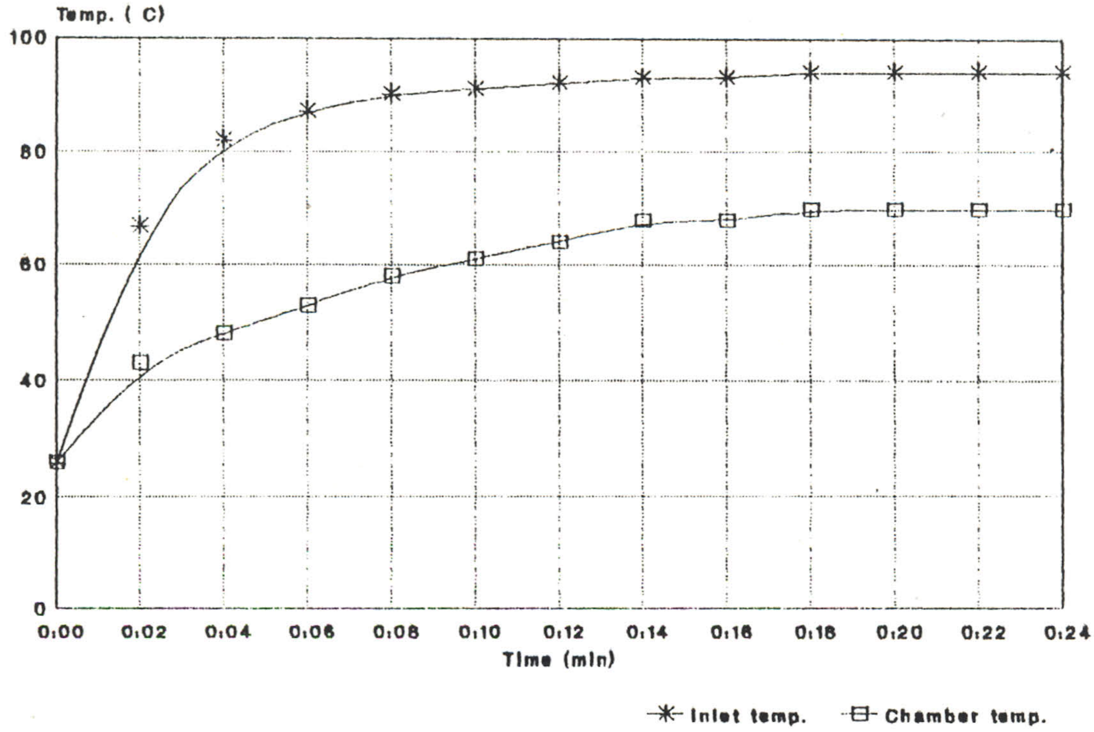
Fig. 4. Metallic support for Conditioning Chamber.



ITEM	REF	DESCRIPTION	QTY
A	1	ANGLE IRON (63 × 63mm)	
B	2	ANGLE IRON (60 × 60mm)	
C	3	FLAT BAR 60 × 6 mm	

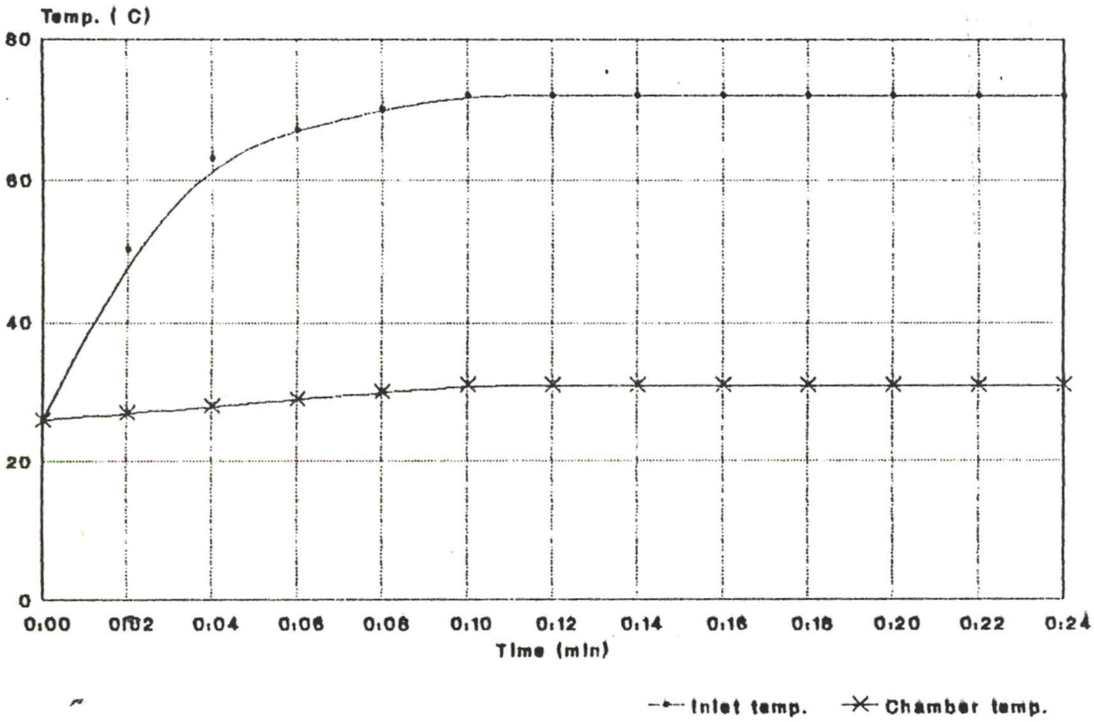
APPENDIX VI

TEMPERATURE PROFILES
for chamber inlet and outlet ducts



Heater output: 24kw

TEMPERATURE PROFILES
for chamber inlet and outlet ducts



Heater output: 12kw