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Technical Course on Criteria for the
Selection of Woodworking Machinery

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POWER SUPPLY AND MAINTENANCE SYSTEMS IN WOOD PROCESSING INDUSTRIES *

by

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CONTENTS

Introduction

The continuous evolution of machinery and production systems, plus the growing need for safety, improved working conditions, as well as adhering to environmental requirements, has developed a better design and construotion approach to the furnishing of power supply facilities, especially those which are applicable in the field of wood processing.

It is therefore understood that the design of power supply facilities must proceed hand in hand with those pertaining to manufacturing units so that where a choice has to be made it will be c,mpatible and co-ordinated accordingly.

As power unit systems are essentially service installations they must be chosen for the purpose of ensuring efficiency of the entire plant, at the same time being so designed as to allow for future expansion. The purpose of this paper, therefore, is to suggest a guideline for general design of these installations, without claiming to cover exhaustively the complex matter, which is always subject to continuous improvements and innovations. The chapters which follow shall deal with:

- Electricity supply and distribution plants
- Chip and dust conveying systems;
- Compressed air stations;
- Heat generation and distribution plants;
- Water supply and distribution plants.

1. Electricity Supply and Distribution Plant (Appendices 1 and 2)

Electric systems consist of:

- Transformer Station;
- Supply and distribution to machinery;
- Lighting;
- Earthing and lightning conductors
- Auxilliary installations

Transformer Station

Since factories are sited more and more removed from general transformer stations and power demand is ever increasing, a medium tension supply is becoming the general rule.
The designer must then make provision for the erection within the factory site of the "intake transformer house", where current is received and transformed from medium to the desired voltage. In medium to small factories the two facilities, intake and transforming, are usually adjacent but are separate in larger factories, where the transformer house is located at approximately equal distance from the users.
Transformer houses contain the transformers together with their switchgear, fuseboxes and main board. This board contains all control switches and feeder connections to the locally mounted panels. A section of the board contains the phase advancers.

Supply and distribution to machinery

The most frequently used system of distribution is the radial type: from low voltage busbars, protected by a circuit breaker, located in the transformer house, depart various feeders to the locally mounted panels. Quantity and location of local panels depend essentially upon the layout and arrangement of the machinery.
Normally each bay and/or service facility should have its panel, located centrally to the bay and in a way to guarantee easy access to it.
Primary cables (those from transformer house to local panels) are usually laid in underground PVC tubing, with frequent inspection wells.
Secondary distribution is achieved usually by means of prefabricated systems. These may be classified in two types:

Busbar System:

Consists of rectangular section copper or aluminium bars closed inside a supporting structure complete with a wide range of accessories designed to allow quick connection of shunts and protections.

Advantages to be found are:

- independence from ties imposed by building structures and location of users;
- it is possible to adjust system to process demands;

- it is possible to dismount and re-use the installation in case of changed utilization of the sheds;
- rapid installation and dismantling.

Disadvantages:

- more expensive than the cable system;
- a separate system must be provided to support and feed lighting fixtures;
- line isolation is less feasible with busbar systems than with cable systems.

<u>Box System:</u>

Consists of metal channels supported by the building structures within which copper conductors are laid. This type of installation is usually preferred in the woodworking industry as, in addition to possessing most of the advantages of the metal enclosed conductor system it has also the following:

- lighting fixtures for normal, night and emergency; lighting can be attached under the trays placing the corresponding cables inside the trays;
- in these trays can be laid the cables feeding signal, personnel call, sound systems, etc.,
- it is possible to feed from the local panel various groups of machinery, for instance all the machinery making up a sizing-edging line, suing a feeder separate from that bringing power to the pressing machines;
- it is always possible to give more power to a line by adding a new cable in parallel with the existing one.

In some cases both systems, busbar and cable tray, complete each other so that there may be a main system of the cable in tray type and some secondary branches of the metal enclosed busbar type. For example: bridge cranes are fed by trol-e-duct: for assembly lines, subject to quick load variations, sections of metal enclosed busbars are used; trol-e-ducts are installed above cloth and leather cutting benches; small busbars are used for sewing machines.

Supply to machinery

Connections to machinery shall be by PVC or iron tubes containing feeder and earthing cables. Protection upstream of the machine is ensured by a fuse switch.

Lighting

The installation includes:

Normal lighting

Distribution of normal lighting should be as much as possible uniform, without shadows or pernicious reflections.
Lighting fixtures with 65 W fluroescent bulbs, the cheapest at equal lux, are usually preferred for average height sheds (5.5 m).
Lighting values adopted for workrooms are 200-250 lux and 80-100 lux for warehouses.

Night and External lighting

A separate circuit feeds a series of lamps (normally 20 W fluroescent lights) which supply lighting by night.
A second circuit feeds lamps outside buildings. Both circuits can be actuated at twilight by an automatic relay.

Earthing and lightning conductors

All electrical equipment and metal masses must be placed underground. This is accomplished by laying a suitably dimensioned line in a closed, and if possible circular circuit inside the factory and connecting it underground through dispersion wells. It is also recommended to have a lightning conductor capable of covering the whole extension of the factory.

Auxilliary facilities

These include all those facilities which, although not essential, satisfy wide-spread demands. They are:

- personnel call systems, either by radio signal, sound signal and/or light signal type;
- internal telephone system;
- sound emission;
- emergency lighting, supplied by accumulator batteries;
- emergency motive power, supplied by current generators, in case of failure of the main supply.

2. Chip and dust conveying systems

General

This installation usually has two functions:

- to collect chips, saw dust and sanding dust generated in wood processing;
- to convey these waste materials from one area of the plant to another

Plants working on wood and manufacturing wood panels will need mainly the first function and hence here more attention must be given to chips and dust collection regardless of the amount of power consumed.

Plants manufacturing particle boards and in general where wood chips and dust are the raw material to be processed, the second function shall prevail. In this case a study should be made of the convenience of pneumatic conveyance against mechanical systems in use.

A pneumatic system has these advantages:

a) simple mechanics;
b) feasibility of complex runs with minimum amount of duct lines;
c) conveyor can pass above buildings, roads, etc., or underground and generally can be routed through areas where access for maintenance would be difficult;
d) easy to modify installation.

Disadvantages are:

a) high power consumption (five times as much approximately, as that required by mechanical conveyors)
b) limitations imposed on size of material to be handled;
c) difficulties arising from separation of air from conveyed material at outlet, which imposes the use of costly and cumbersome filtering units.

Systems applied

Exhaust system (Appendix 4 a)

The advantages are:

- simple construction

- can be connected to machinery or stockpiles;
- material does not pass through the fan;

The disadvantages are:

- limited capacity, as it is difficult to go below 0.4 atm. vacuum using fans and 0.9 atm. using pumps;
- at higher vacuums air is rarefied and hence does not carry material satisfactorily.

Pressure System

Advantages:

- it is possible to increase pressure at will;
- higher air density hence better carrying capacity;

Disadvantages:

- cannot be used to collect chips and dust from the machine;
- greater difficulties regarding intake of material into the system.

Combined exhaust pressure systems:

These meet the various needs for collection and transport with a combination of the systems mentioned above.

Selection of suitable system

Not considering for the moment whether it should be a pressure, vacuum or combined system we shall make a first classification:

- centralized systems;
- substation systems.

Centralized System (Appendices 4a, 5a)

When processing machines are grouped in an area not too wide and located near the Utilities Plant, it becomes more convenient to adopt the centralized system with its network of vacuum piping connected directly to a central storage facility.

Substation System (Appendices 5b and c)

In larger factories where groups of machinery are located on various areas apart from each other, a substation system should be preferred. In this system every group of machines is joined to its own exhaust filter unit (substation) equipment with an adequately sized storage hopper. Chips and dust are picked up from this hopper, either continuously or at scheduled intervals and sent by way of a secondary piping system to the central storage bin or silo.

Although at times more expensive than other types, this system is preferable, particularly for large factories, because of its advantages:

a) less power required for suction since substations are located near the machinery (also subsequent conveyance of chips from the substation to the central silo requires a lower power rating and small diameter piping as it is possible to select relatively high shavings weight to air volume ratios)

b) for the same reason it is possible to obtain a more uniform exhaust from the machines;

c) fewer risks of breakdown: failure of one substation does not stop the operation of machinery served by the other substations. Furthermore, if exhaust filtering units are equipped with an adequate storage hopper, exhaust will be sustained even through a temporary stoppage of the central storage station;

d) the factory can expand, adding new substations, without any modifications to the existing substations or to the central storage station. It is also easier to make modifications to the existing substation systems;

e) any fire (an ever-present risk on this kind of plant) can be limited to the substations and rerely does it reach the storage station: this is particularly true in the case of substations with hoppers periodically emptied by an operator, who will then be able to notice any presence of smoke. It is a good rule furthermore, even when not prescribed by Safety Regulations, to locate substations outside the factory, placing fire baffles on exhaust piping.

Combined System:

In some factories sometimes there is a large group of machinery concentrated in one area and another group on a peripheral area with respect to the silo. In this case the larger group of machines will be served by a centralized exhaust system and for the peripheral ones a substation will be provided. (Appendix 5d)

The above combined system is usually adopted by furniture manufacturing plants, in which case the substation serves the non grouped machines. A combined system, moreover, is usually the most convenient solution when it becomes necessary to expand an existing "centralized" system.

Components of an exhaust plant

The exhaust plant consists of a piping network, fans, substations if any and silos.

Exhaust hoods

Usually machines are sold complete with exhaust hoods. Unfortunately they are not always rationally construc ted and at times fail to satisfy particular manufacturing conditions and must therefore be modified or adapted. A check vane shall be installed between the hood and the exhaust. The hood can be connected to the piping system by means of fixed pipes in case of stationary equipment and flexible piping for mobile equipment the latter wears quickly, especially at bends, bednging sections should be avoided or else constructed of metal sheet.

Pipe Components

The piping shall be steel for medium and high pressure installations and sheet for low pressure. In this case wall thickness should be: $T = 0.5 + \frac{\qquad}{1000}$ mm. Pipe size must be determined in excess, both with a view to allow for future addition of machines to be served, and to prevent an excessive air velocity (and consequently excessive load loss) with ensuing waste of electric power. It is advisable however, to maintain air velocity above 25 m/sec. in order to avoid chip piling inside the piping causing clogging.

Fans

Centrifugal fans are used on low pressure systems (max. 0.6 atm.) and when the blower is corssed by the flow due to their relatively low cost, quite good efficiency and because they are unaffected by the material. Medium to high pressure conveying systems require rotary blowers with a pressure capacity of 4 atm.

Fans must be heavy duty types and if the blades are to be crossed by the material they should be designed to favour the passage.
Fan to motor cojpling is usually carried out by belt and pulley so as to ensure, in addition to a smoother start-up, that capacity and head can be varied by varying the number of revolutions of the fan. As is known, capacity is in proportion to the number of revolutions:

$$O/O' = n/n'$$

and head is in proportion to the square of velocity:

$$H/H' = n^2/n'^2$$

It is therefore advisable to install fans with a small number of revolutions (1300 - 1400 rpm) so that it will be possible to increase performance if it should become necessary as a result of plant expansion or modifications.

Air separators

At the point of arrival of the transfer line it will be necessary to install units to separate chips and dust from air. The most widely used are cyclones and filters.

Cyclones

Cyclones consist of a conical or cylinder-conical shell into which the flow enters tangentially. By virtue of the centrifugal force acting upon the solid matter transported, this slows down and falls to the bottom while the air flows out at the top.

The smaller the diameter the greater the efficiency of these cyclones since the centrifugal force is inversely proportional to the radius of the cyclone.

$$Pc = \frac{Gv^2}{gr}$$

where:
- G = particle weight
- v = velocity
- r = radius of cyclone

If then a higher rate of separation is desired it will be necessary to install several cyclones in parallel or multi-cyclones.

Because: $d_{min} \quad 0.5 \quad \frac{D}{V_i \gamma_m}$ in cm

where: d_{min} = min. particle diameter

D_c = cyclone diameter, metres

V_i = inlet velocity, m/sec

γ_m = specific weight of material

Filters

A more efficient separation can be achieved if the flow passes through a filter which also collects dust.
Such a filter is usually composed of a series of textile tubes (cotton, nylon, etc.) inside a box. The flow enters the box, goes through the tubes, deposits the dust and leaves. The textile tubes are cleaned periodically by shaking off the dust to fall to the bottom of the box. (Fig.IVa,b).
Figures Va and b illustrate more efficient methods of cleaning the textile tubes. The first one possesses a number of jets that release compressed air inside the tubes thus dislodging the dust attached to the external surface. In the second one automatically controlled dampers reverse the flow of air through the tubes. These devices contribute to maintaining a virtually constant efficiency of the filters.

Substations

Substations consist of a metal structure housing a certain number of tube filters. Underneath they have a storage hopper equipped with an extraction mechanism.
Filters must be equipped with a vibratory device (ideally pneumatically operated) for periodical cleaning.

Chips can be removed from the hopper by means of screw conveyors or raker conveyors ("Reedler"). Downstream of the extractor it will be necessary to install a rotary valve to proportion discharge and separate pneumatic transfer system from the system local to the filters.

The silo can be in masonry, reinforced concrete construction or even metal construction. Lower costs and ease of erection usually motivate the choice of the second solution. The cross section of the silo could be square, circular or polygonal.

Nowadays metal silos are constructed on a polygonal base (8,12,16 sides) which makes it possible to use flat sheets easily pre-fabricated and adjustable with few modifications, to the various diameters.

A square cross section is not recommended as the chips extractor cannot remove shavings from the corners. The upper part of the silo houses the tube filters and their cleaning devices.

The center part is used for dust and chip storage; its height should not be more than approximately twice the silo's diameter because otherwise the material would tend to "bridge". At the bottom there is the extractor for dumping chips. At present there are in operation various types of extractors that give a good performance. Some of these are shown on Appendices 8 and 9. They are aill widely proven and completely dependable. It is however essential that any mechanical part buried in the shavings be of the heavy duty type since in case of failure shavings must be removed by hand which, as is the case particularly with large silos, is never an easy operation. Such setback is less frequent with the conical scraper extractor as its mechanical parts are outside the chip area.
Various accessories complement the silo:

- ladder leading to filter chamber
- doors for inspection of shavings level
- gates for manual discharge at bottom
- quick-opening explosion-proof doors
- sprinkler system

Sprinkler system

The sprinkler system can be actuated by a fire detector located inside the silo. In this case the lower part of the silo must have doors which shall open automatically to discharge the water, otherwise the hydrostatic pressure created would be excessive.

3. Compressed air plant

Compressed air as a means to boost productivity has found many applications also in woodworking plants.

It is therefore necessary to examine from the standpoint of performance and cost the choice of type and quantity of compressors to be installed and sizing of the pneumatic piping system.

Compressor station

Air compressors belong essentially to two categories: positive displacement blowers and dynamic compressors. Positive displacement blowers take in air and force it into a chamber where the confined volume determines compression.

In dynamic compressors air is sucked in by the action of a rotor and made to acquire high velocity. Kinetic energy developed by the air is then transformed into pressure energy by a subsequent diffuser.
In the woodworking industry the former equipment is generally preferred and the choice is further narrowed down to the reciprocating, screw and blade types. Reciprocating compressors achieve compression by means of one or more cylinders, inside which pistons moving rectilinearly and alternately cause variation to the volume of the compression chamber.
As these machines are particularly robust and easy to maintain, they are even now preferred where continuous and heavy duty is required.

Screw compressors possess a rotor chamber within which two rotors rotate in opposite directions. Air enters through the suction inlet, is compressed between the rotors and leaves the chamber through the discharge outlet. As no contact exists between the rotors and between these and the chamber walls, there is no need for lubrication. Hence these machines are especially suitable where there is a requirement for totally oil-free air.

Blade compressors have a cylindrical casing inside which rotates eccentrically another cylinder equipped with blades arranged radially. The volume of air between the blades diminishes progressively from inlet to outlet, thus determining air compression. These compressors are virtually vibration-free and therefore do not need a supporting pad, respond quickly to demand fluctuations, but do have a high oil consumption and need careful and regular maintenance.

All the machines described above can be air-or water cooled.

Water availability and possibility of adding facilities for its recovery and re-use must guide the choice of the type of cooling. In addition to design and mechanical considerations, also power consumption, which ideally should be kept below 9 hp/m3/min, should be borne in mind when selecting one type or another.

Compressors should be grouped together in a single unit which supplies a single network for the whole factory. In so doing the following advantages can be envisaged:

a) greater efficiency as more powerful equipment can be installed;
b) fewer spare units required;
c) easier supervision and maintenance;
d) the unit can be located most suitably.

The compressor unit should be erected at a location which entails the least expenditure for power lines, cooling water and drainage provisions. Usually such a location can be found at or nearby the other services (boilers, transformer room, extraction plant, etc.) so that the same supervision and maintenance service can look after everything.

Particular care should be given to air filtration and noise and vibration abatement.

Essential accessories, such as aftercoolers and air storage drums, must complete the installation.

The addition of a supercooler is lately becoming quite common; forced cooling induces the moisture to condensate and this prevents condensate formation inside the piping.

Compressed air system

In order to ensure maximum efficiency, safety and reduced operating costs, the compressed air system must meet the following requirements:

a) small pressure drop between generation and operating units;
b) reliable condensate elimination;
c) changes to the system for extension
d) connection of new operation units must be possible and rapidly carried out.

Pressure drop can be kept within acceptable limits (usually 0.3 kg/cm2) provided piping is correctly dimensioned and this should take into account also future increases of air requirements.

It is furthermore advisable to loop-connect the piping in order to ensure a better air distribution. Condensate, whenever it is not completely eliminated at the compressed air plant, must be drained from the piping by means of suitable drains.

Branch-offs to users must be connected to the upper part of the main pipes and shall be equipped with a condensate drum and drainage.

With the purpose of ensuring maximum system flexibility and facilitating checking of air leaks, the piping should run in view inside the factory. Other good practices include installation of valves to section lines and use of treaded connections and fittings between main line and branches to users.

4. Heat generation and distribution plant (Appendices 10 and 11)

Boiler station

Lately heat production for ambient heating and process purposes has undergone important developments, on the one hand to satisfy a demand for a greater comfort on the work site and on the other as an answer to the need of accelerating, through higher temperatures, those processes and treatments which, at lower temperatures, would require times unacceptable by modern productivity standards. Owing to the importance of the duty to be performed by heat generators, it is necessary that the choice of number, capacity and type be the result of a careful study of all heat requirements and the types of fuel available.

With regard to the number of boilers to be installed there is a wide range of possibilities.

For small to medium plants a single boiler can meet both heating and process requirements, operating at partial load in the warm season and at almost peak load during cold seasons.

For larger plants, two or more units are usually to be considered, in view also of the advantages of spare capacity. With regard to heat requirements and fuel types, boiler selection is effected bearing in mind the following alternatives:

- construction material: cast iron
  steel
- fuel: liquid
  gas
  solid
  mixed
- firing: reduced pressure
  pressure
- fluid: water
  diathermic oils
- operating temperature: up to 100°C
  above 100°C
- principle of construction: smoke tubes
  water tubes

On the basis of the above distinctions, in the woodworking industry in particular the principles guiding selection are the following:

- steel is generally chosen as the material of construction;
- availability of wood waste makes it advisable to install boilers suitable for burning either oil, gas or wood, be it wood dust and/or chips.

The wood material can be fed to the boilers:

- manually for coars material and waste offucts;
- mechanically, by means of screw or belt conveyor;
- pneumatically for dust and chips by means of a fan and pipe duct running from the extractor of the silo to the boiler.

This material can be fed directly into the boiler or into a hogging system in front of the boiler. The latter solution, although higher costs and with greater maintenance demands, is still recommendable because it has the advantage of a better combustion even if the material is wet and permits manual feeding of wood pieces and other waste to be incinerated.

a) Boilers fired exclusively on wood or mixed fuels are low pressure operated and generally have a forced draught. The combustion chamber and the secondary smoke runs are kept at a pressure lower than the atmospheric pressure and a fan installed between boiler and chimney induces the smoke movement.

Oil or gas boilers, often installed in parallel with mixed fuels boilers when wood waste fuel is not sufficient, can be either vacuum or pressure operated; in the latter system, combustion gases are kept at a pressure slightly higher than the atmospheric pressure. This kind of boiler offers a greater efficiency and is also more compact owing to the higher calorie yield per equal exchange surface.

b) Use of steam or superheated water is restricted to temperatures not very high due to the high pressures involved (at 200°C we have a pressure of 20 kg/cm2).

Use of diathermic oils permits to reach high temperatures at atmospheric or low pressures. For this reason the adoption of heat generators employing diathermic oils is spreading in the woodworking industry, where high temperatures are necessary in many processes (for instance drying of veneer sheets).

In those industries where heat is needed only at low temperatures (for instance for heating and/or lacquer coat drying) and when the distance between point of generation to points of use is limited, hot water boilers below 100°C are the most advisable solution in view of reduced installation and operating costs as well as an uncomplicated erection.

In large plants and other industries requiring higher temperatures for process reasons (for instance presses for drum panels, veneers, etc.) steam and superheated water are used (above 100°C) with a preference for the latter medium because of its advantages:

- no need for accessories like steam traps, filters, condensate drums, which are costly and liable to break down;
- less corrosion inside piping;
- greater efficiency of the plant (a certain amount of steam is always lost to the atmosphere in the condensate drum);
- simpler and smaller feed water purifier;
- better heat conservation due to greater quantity of heat accumulated in piping.

c) Smoke tube boilers are designed to allow flow of flue gases through the tubes, surrounded by the water that fills the shell. By virtue of the fair amount of water content, these boilers can quickly adapt to short load variations. On the other hand, their operating pressure does not exceed 15 kg/cm2.

In water-tube boilers the water flows inside the tubes whilst flue gases circulate around them. These boilers have a greater efficiency, can operate at higher pressures and damaged tubes can be replaced easily.

The design of water-tube boilers render possible to construct a more rational forehearth and are therefore preferred when there is a large supply of wood waste coupled with a need for high temperatures as, for instance, in the case of factories making veneer sheets.

Distribution and use of heat

Piping serving ambient heating outlets should be kept separate, if possible, from piping serving process outlets because of the difference in temperature requirements and the different load variations.
Heat from ambient heating is delivered in a variety of ways:

- radiators and convectors are more suitable for offices and service rooms;
- radiating panels are useful to heat parts of an unheated ambient;
- unit heaters are the most versatile and cheap equipment to heat small and large areas;
- fan convectors and airfin units are the classical air-conditioning equipment.

Uses of heat for process purposes in the woodworking industry are the most varied and often requires a particular temperature. It is therefore impossible, within the limits of this paper, to discuss the cases which may be encountered and put forward suitable solutions.

However, one important factor must be mentioned, i.e. that maximum flexibility must be ensured for the fluid distribution system.

All the pipes must be easily accessible for maintenance, additions or modifications to the system. They should therefore run, as much as possible, in full view on suitable supporting structures, both inside and outisde the factory. Trenoh ducts, whenever they cannot be avoided, must be easily inspectable.

Smoke purification

Often prescribed by the authorities - but in any case always recommendable - smoke purification, designed to trap soot and unburnt suspension, is usually carried out by means of:

a) dry purifies;

b) water injection purifiers.

The most widely used "dry" purifiers are the cyclone types, often used in banks (multicyclones) which guarantee a good efficiency with few troubles. Water injection purifiers consist of a chamber through which flue gases pass, with spray nozzles which pulverize the water to wash the gases. The sludge is collected on the bottom of the chamber. Such equipment, although more efficient than the dry type, has a few drawbacks: it must be constructed with corrosion resistant material, it has a cooling effect on flue gases and it reduces soot into sludge, which is quite troublesome to handle.

5. Water supply and distribution plant (Appendix 12)

Water availability is one of the factors to be borne in mind when choosing a site for a plant. Water can be supplied by an external board, or it can be taken directly from a surface stream or pumped up from underground water beds.
Large factories and wherever a continuous supply is not guaranteed, shall install storage tanks connected to an autoclave system.

Water users may be grouped as follows:

a) for utility-sanitary uses;

b) for process uses;

c) for fire-fighting.

While systems a) and b) can be united (when the water is already portable), water for fire-fighting must be carried by a separate system right from the point of supply. This system must always be efficient and it is therefore buried and laid in a loop around the buildings. This loop shall supply hydrants and sprinkler system protecting particular areas like silos, storehouses housing flammable materials, etc.

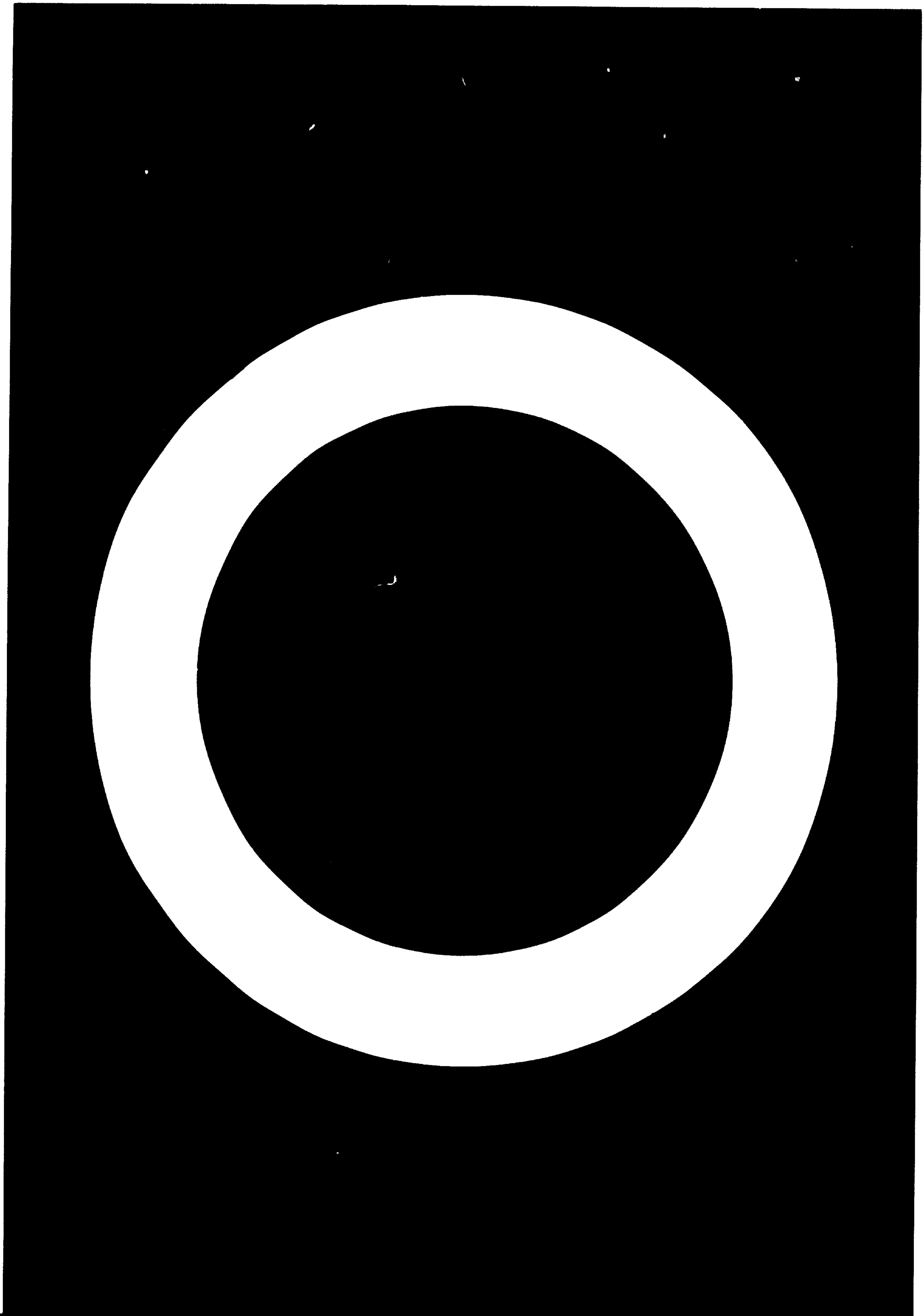
Often within the factory limits underground tanks collect rainwater to be used as emergency water for fire-fighting. This water is pumped up and fed to the system by means of electrically driven pumps operated by a generator unit or by diesel pumps.

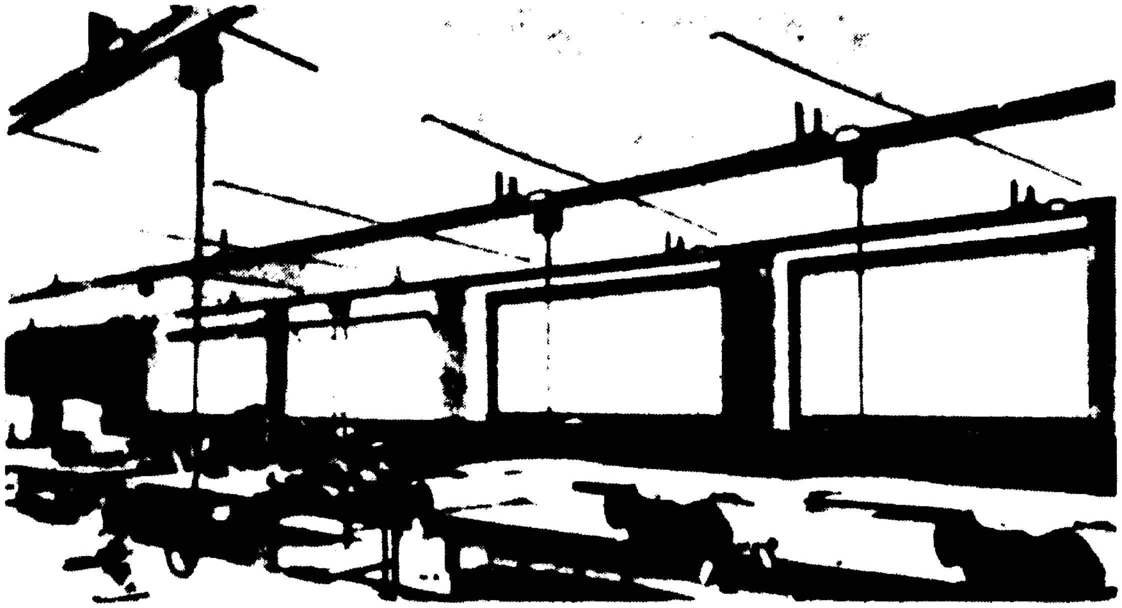
The amount of water required for utility and sanitary uses is essentially in relation to the number of people working at the factory besides the type of woodworking activity carried out, whereas the amount required by process depends on the type of activity and the consumption of the other general facilities (compressors, boilers, etc.).

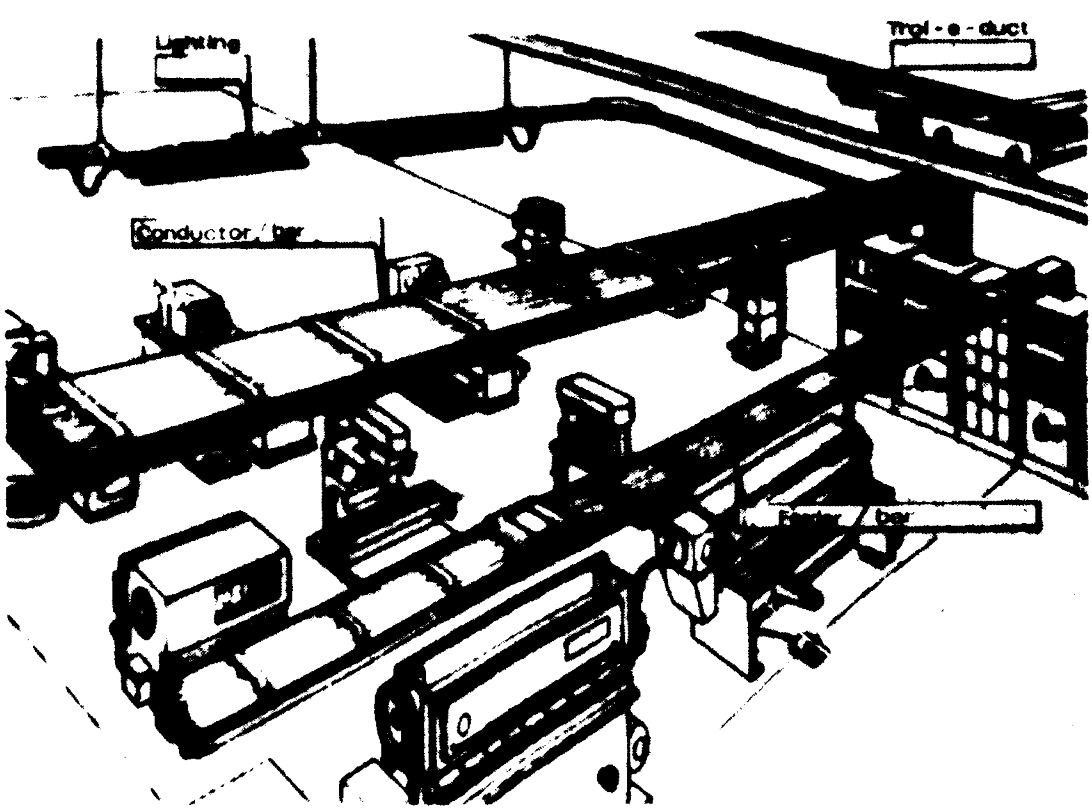
Owing to ever-growing water supply difficulties, there is a need for recycling industrial water. When the water is only heated during the industrial process, as is the case in most furniture making factories, then it is easy to recover it by means of cooling towers. When it collects polluting substances through the process, it must be adequately purified before discharging it.

The type of purification treatment depends on the quality and quantity of pullutants and often requires a sizeable investment of money, even for relatively small quantities of water to be purified.

A case met in general in furniture making factories is the need to purify water coming from spray booths which is dealt with in two successive stages: special injectors cause paint pigments and solid particles to thicken and precipitate into the tub, afterwards solvent residues are absorbed by activated carbon.

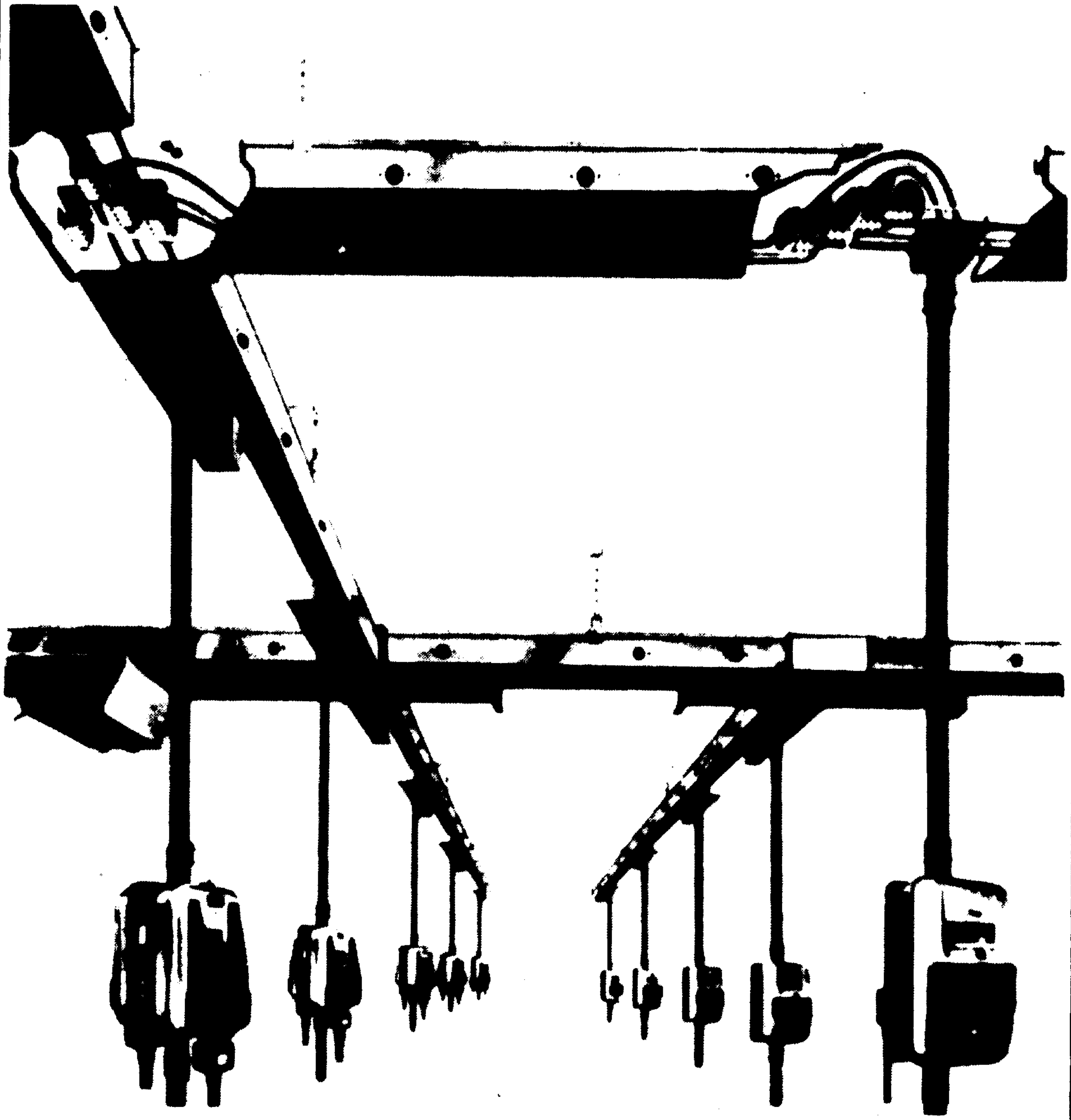






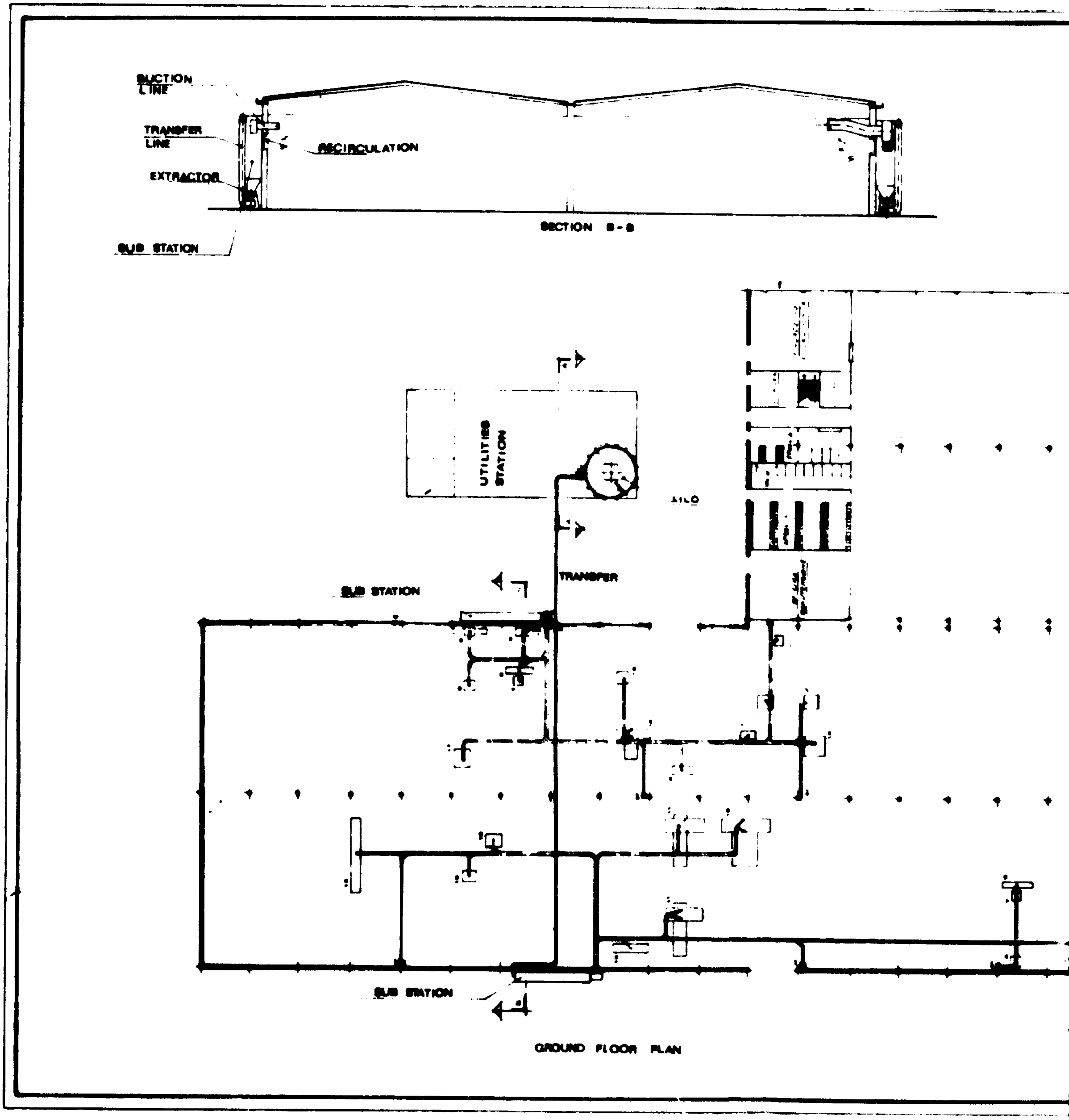
BUSBAR SYSTEM

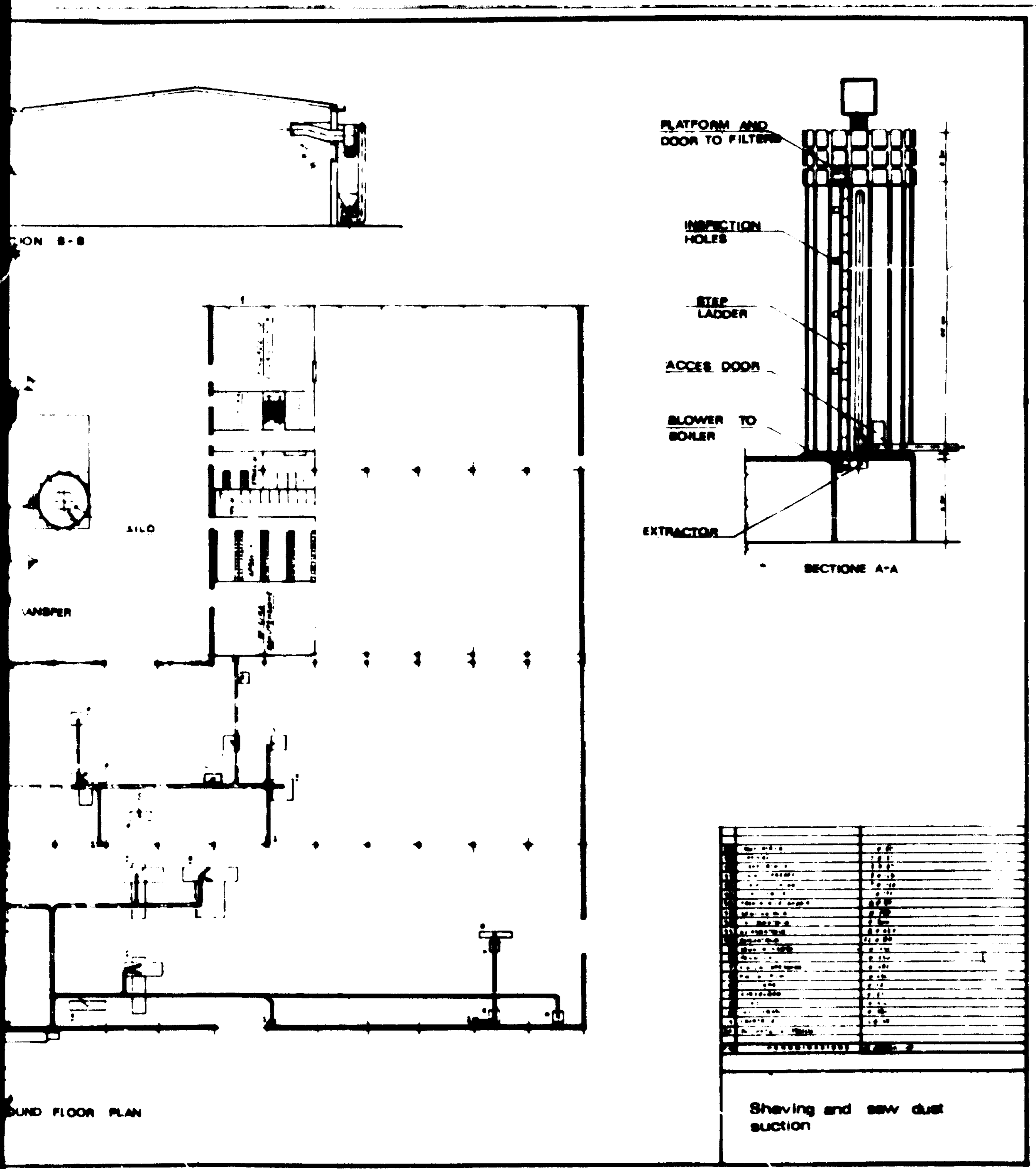
Appendix 1



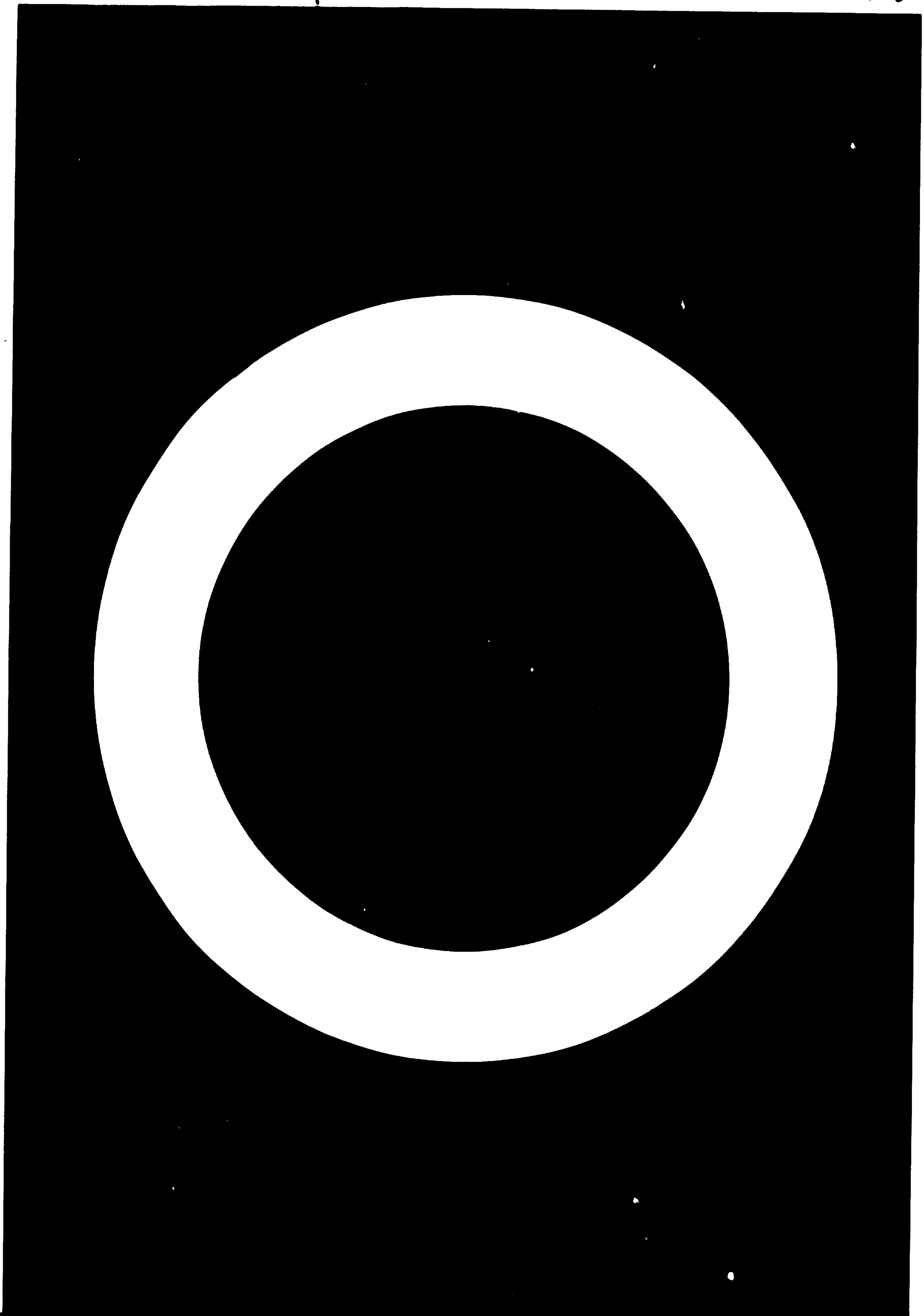
BOX SYSTEM

Appendix 2

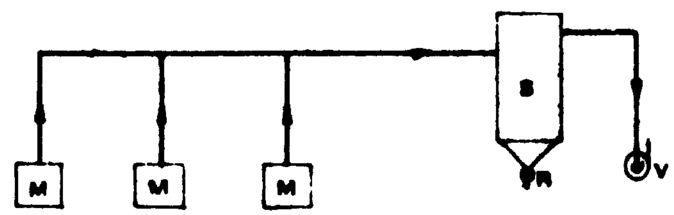

SUCTION LINE
TRANSFER LINE
RECIRCULATION
EXTRACTOR
SUB STATION
SECTION B-B
UTILITIES STATION
SILO
TRANSFER
SUB STATION
SUB STATION
GROUND FLOOR PLAN


PLATFORM AND
DOOR TO FILTERS
INSPECTION
HOLES
STEP
LADDER
ACCES DOOR
BLOWER TO
BOILER
EXTRACTOR
SECTIONE A-A
SILO
Shaving and saw dust suction

Appendix 3

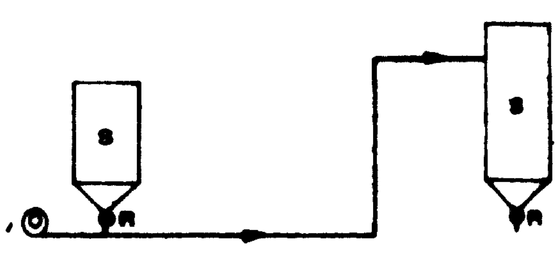


SUCTION SYSTEM



a)

PRESSURE SYSTEM



b)

M : Machine

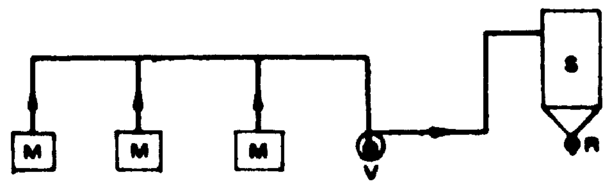
S : Silo or Substation

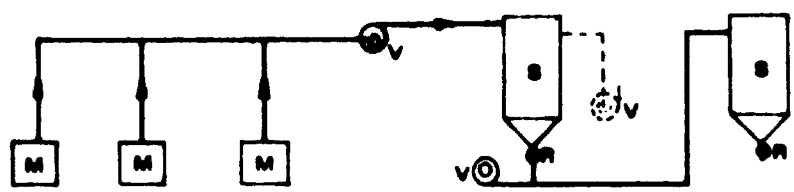
V : Fan

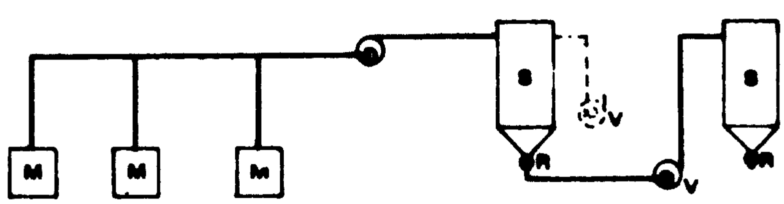
R : Rotary Valve

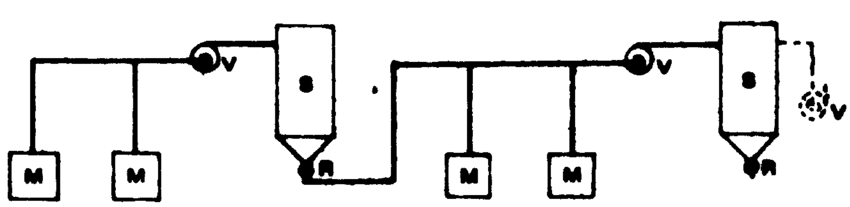
Appendix 4

MIXED SYSTEMS









M : Machine

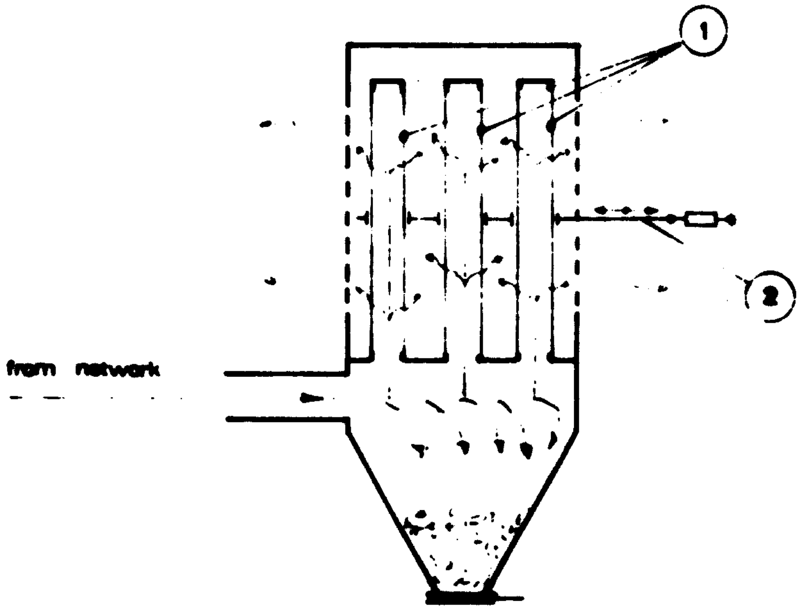
S : Silo or Substation

V : Fan

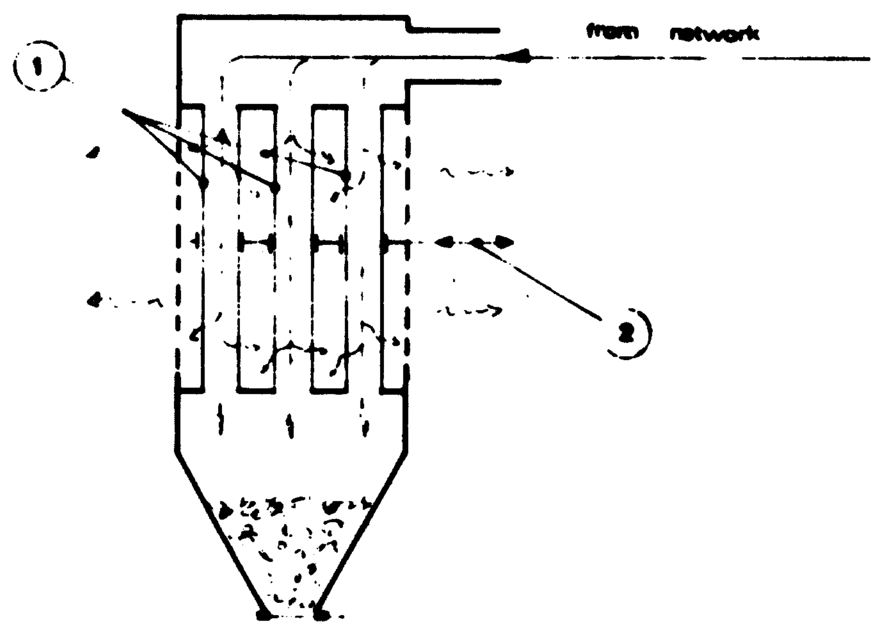
R : Rotary Valve

Appendix 5

BOTTOM INLET FILTER



TOP INLET FILTER

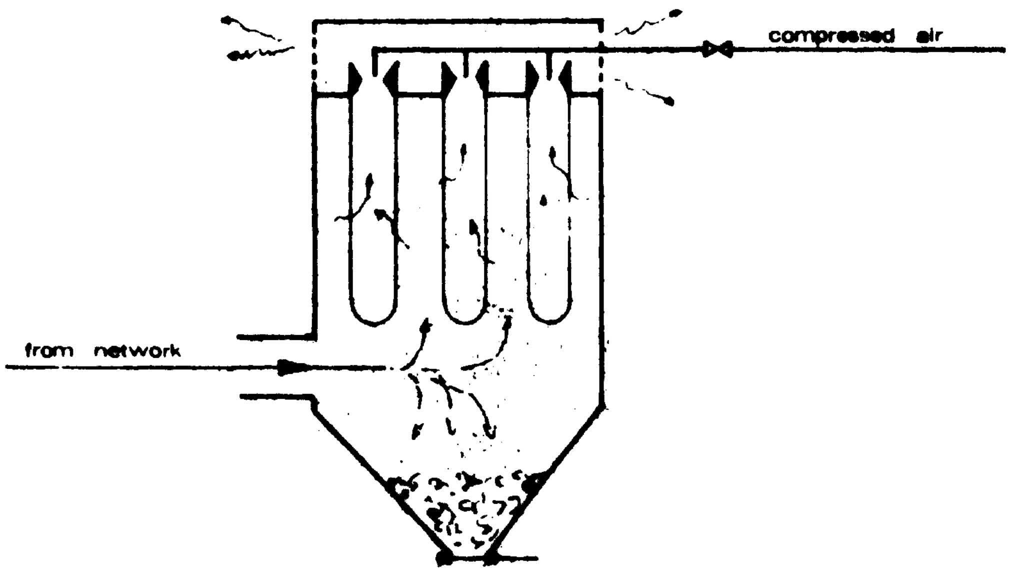


1 Filtering Hoses

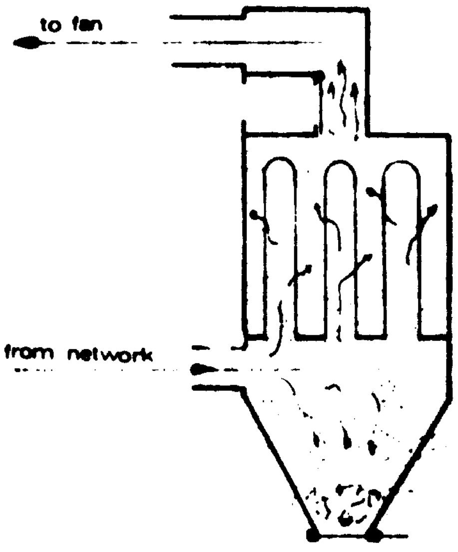
2 Vibratory Frame

Appendix 6

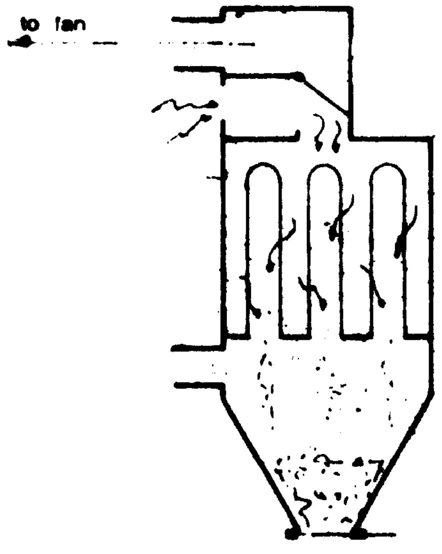
a) COMPRESSED AIR WASH FILTER



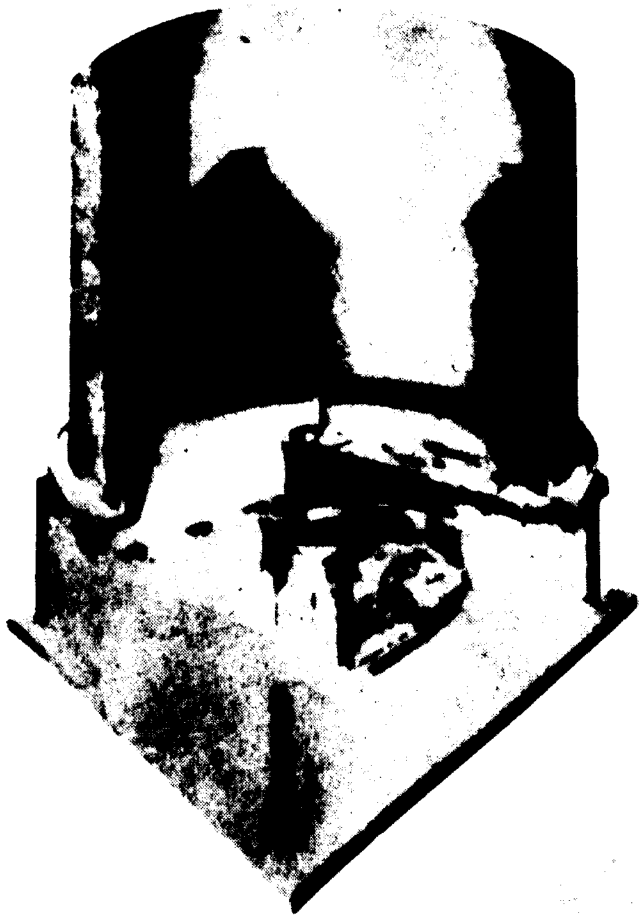
b) BACKWASH FILTER



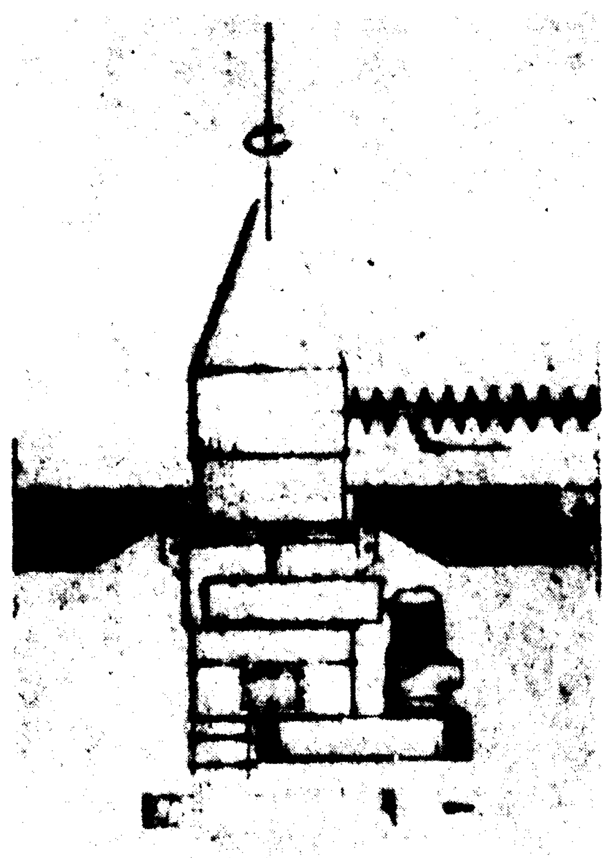
CELL IN OPERATION



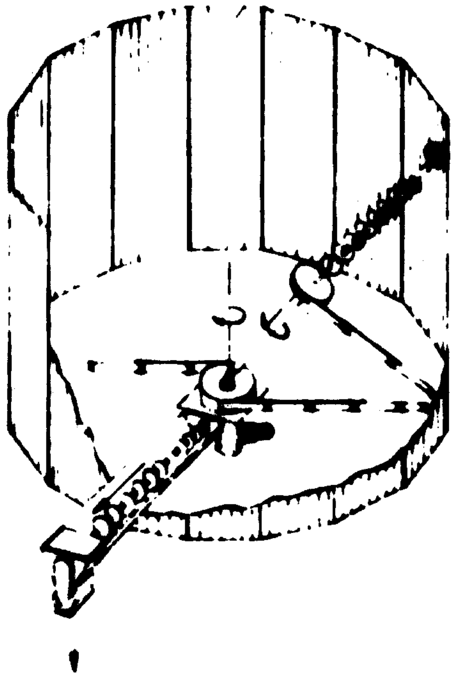
CELL DURING BACKWASH



SCRAPING CHAIN EXTRACTOR

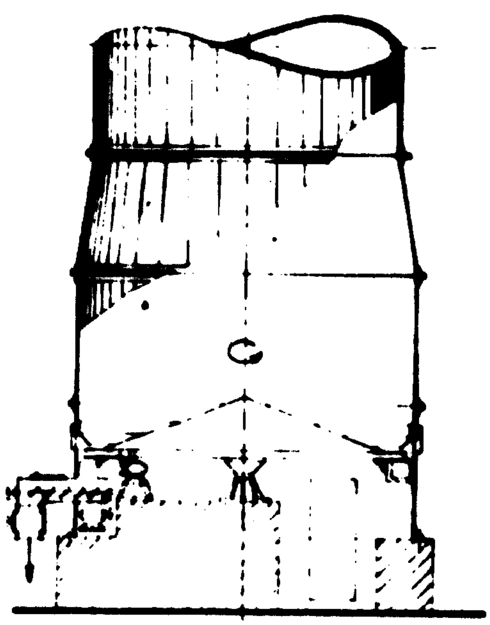


ROTARY SCREW EXTRACTOR

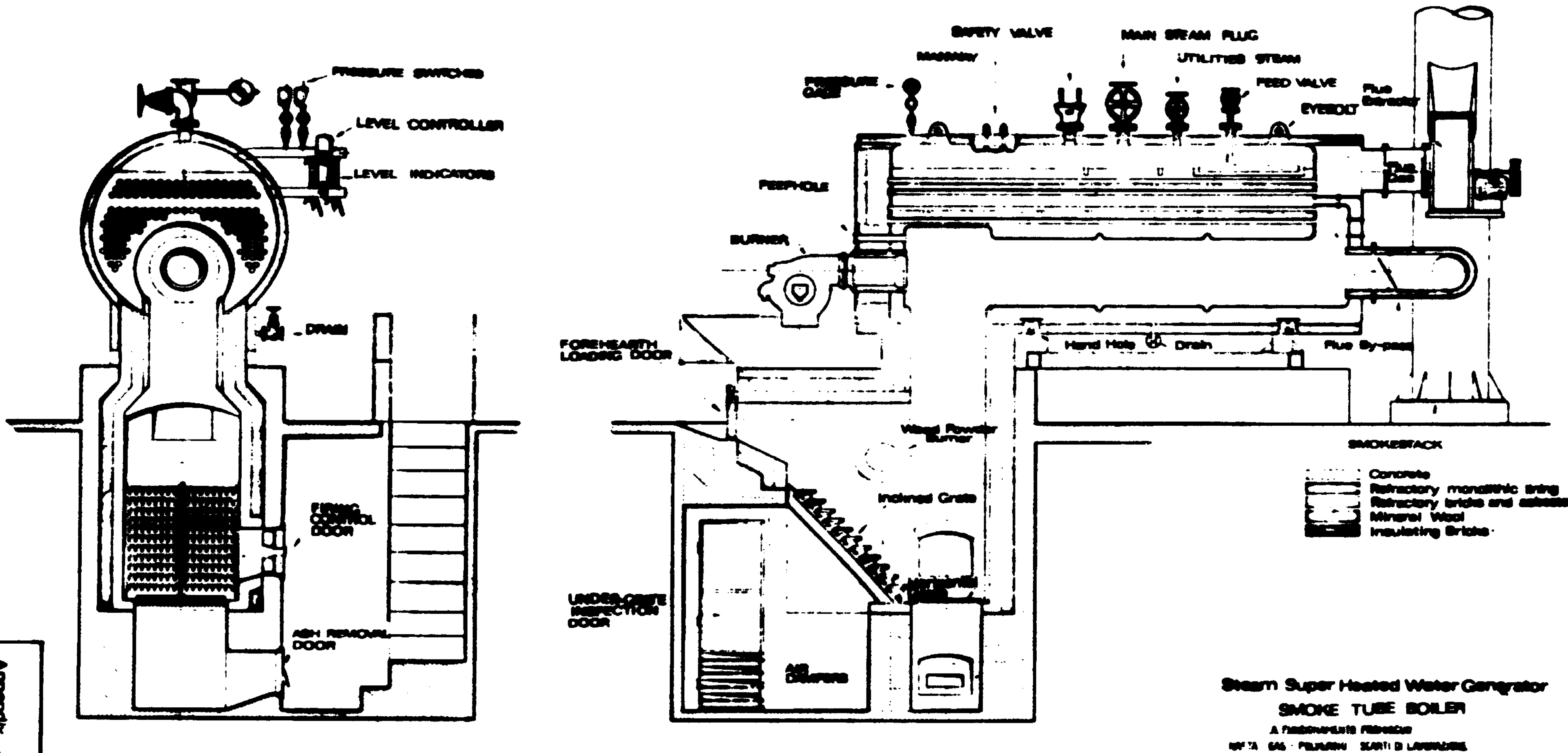


LEAF SPRING
EXTRACTOR

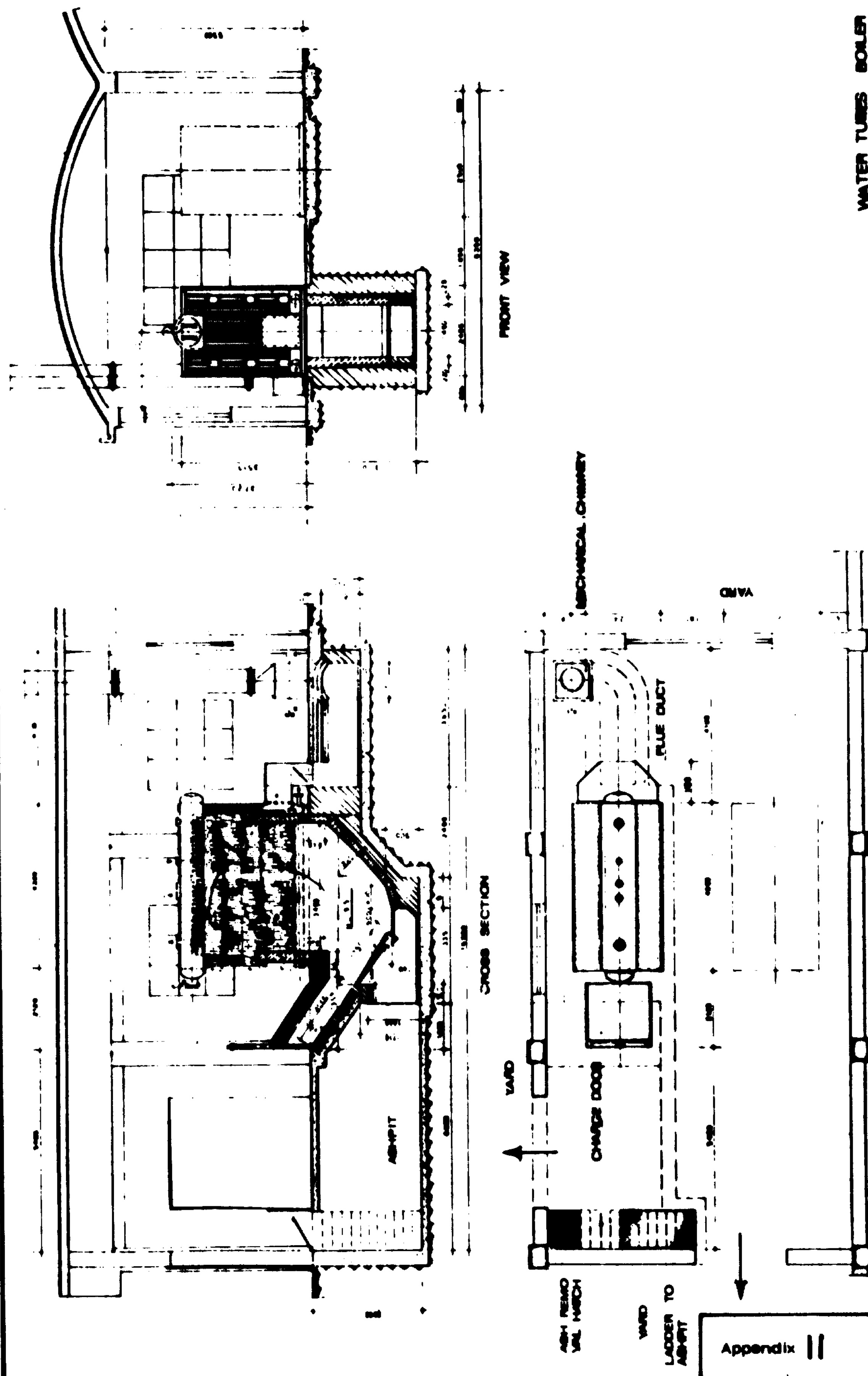
SCRAPING CONE
EXTRACTOR



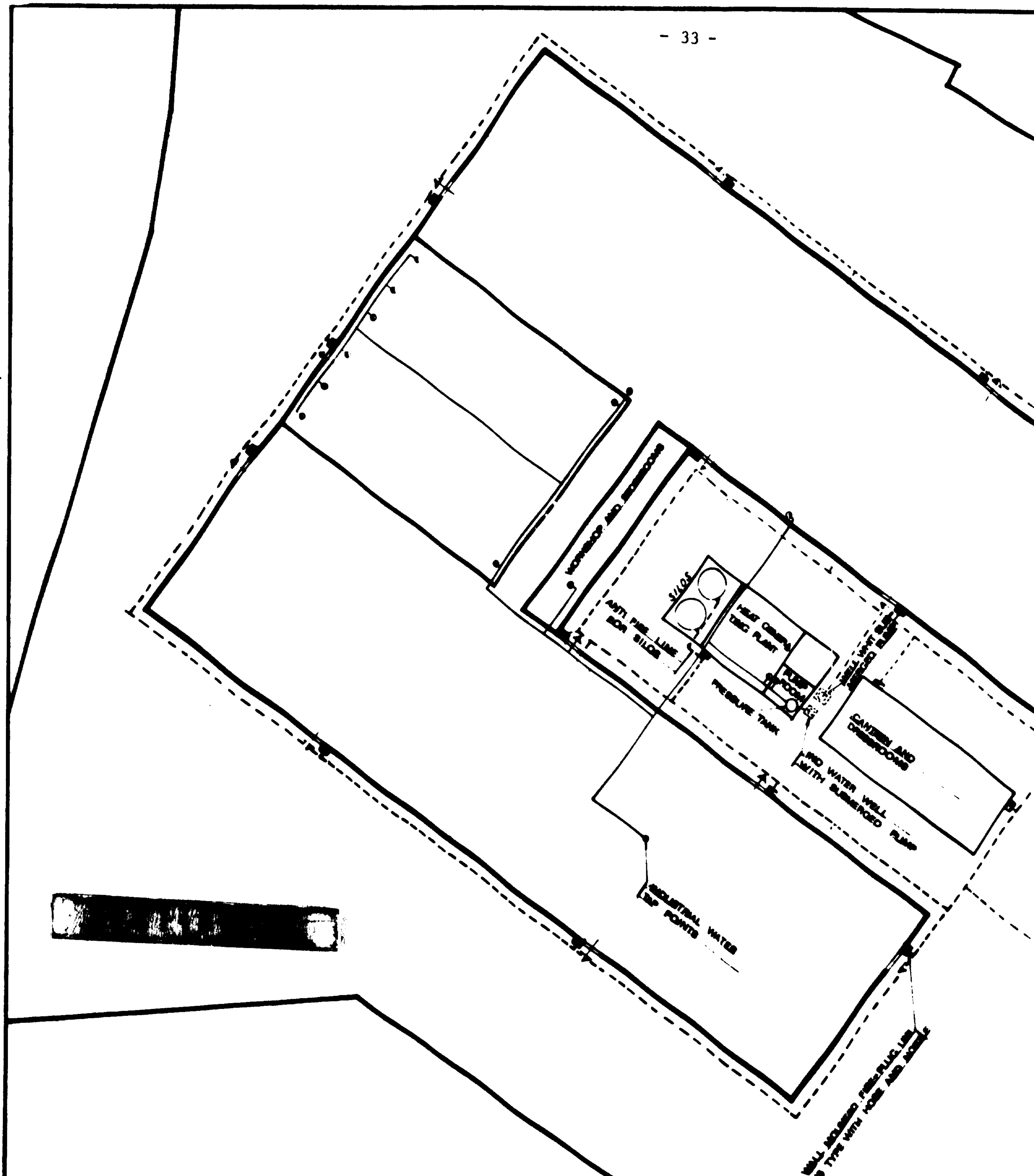
Appendix 9


PRESSURE SWITCHES
LEVEL CONTROLLER
LEVEL INDICATORS
DRAIN
FIRING CONTROL DOOR
ASH REMOVAL DOOR
SAFETY VALVE
MAIN STEAM PLUG
UTILITIES STEAM
FEED VALVE
EYEBOLT
Flue Extractor
PRESSURE GAGE
PEEPHOLE
BURNER
FOREHEARTH LOADING DOOR
Hand Hole
Drain
Flue By-pass
Wood Powder Burner
Inclined Grate
UNDER-GRATE INSPECTION DOOR
AIR DAMPERS
SMOKESTACK
Concrete
Refractory monolithic lining
Mineral Wool
Insulating Bricks
Steam Super Heated Water Generator
SMOKE TUBE BOILER

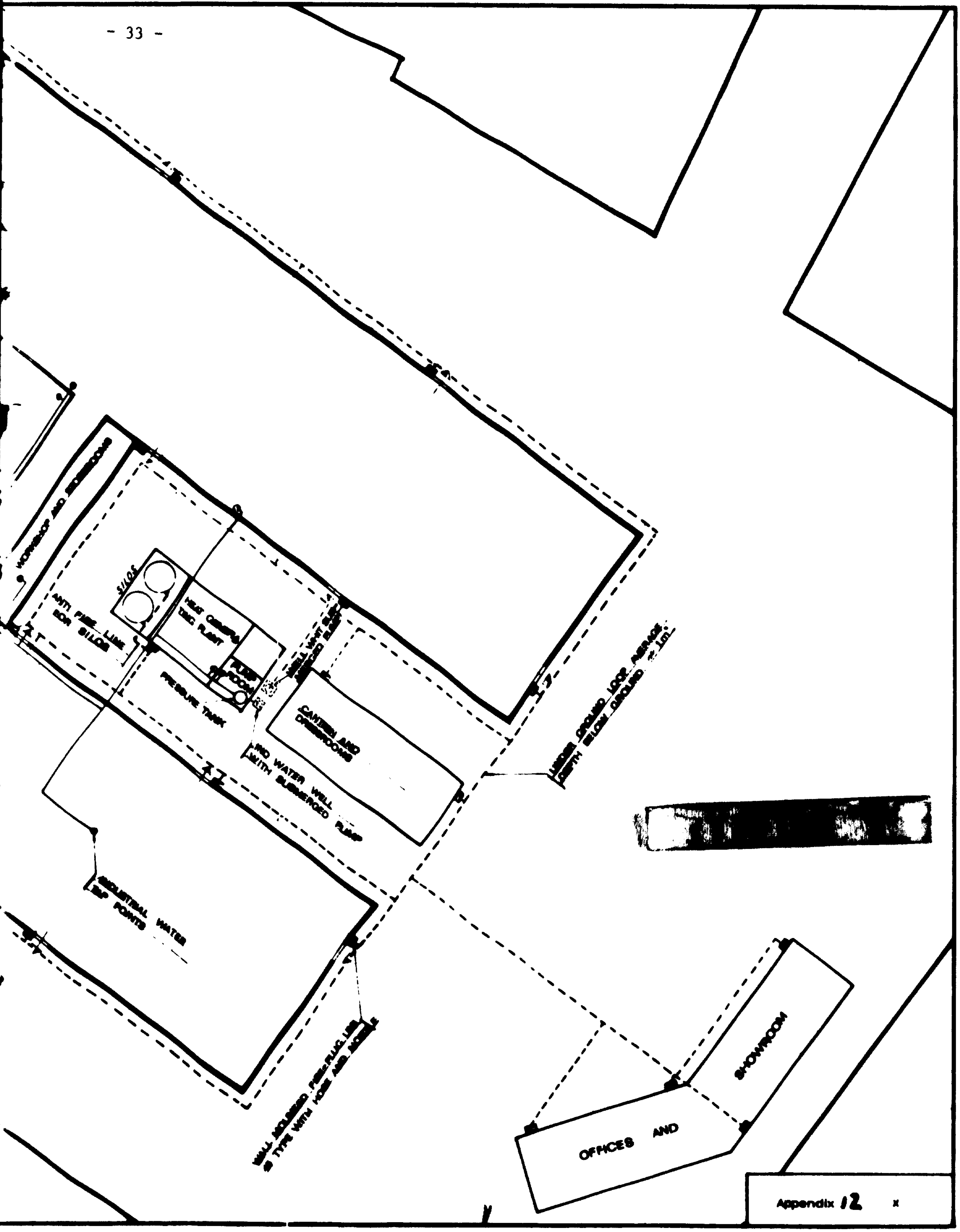
Appendix 10


WATER TUBES BOILER
FRONT VIEW
CROSS SECTION
ASHPIT
PLAN VIEW
MECHANICAL CHIMNEY
YARD
FLUE DUCT
CHARGE DOORS
YARD
ASH REMOVAL HATCH
YARD
LADDER TO ASHPIT

Appendix II



WATER SUPPLY AND DISTRIBUTION PLANT


SILOS
ANTI FIRE LINE FOR SILOS
PUMP ROOM
PRESSURE TANK
CANTEEN AND DRESSROOMS
AND WATER WELL WITH SUBMERGED PUMP
INDUSTRIAL WATER TAP POINTS
OFFICES AND
SHOWROOM

Appendix 12

B - 79

80.02.04