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Technical Course on Criteria for the Selection of Woodworking Machines

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CRITERIA FOR THE SELECTION OF GENERAL PLANT FOR WOODWORKING FACTORIES 1/

by

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INTRODUCTION

The continuous evolution of production machines and plant and the growing need for more safety and greater well-being in work environments have brought greater attention to the design and realization of general plant, also in the woodworking field.
It has been understood that the design of general plant must proceed at a pace equal to that of civil buildings and technological plant, so that choices to be made in specific cases are compatible and coordinated. Since general plant normally concerns services, its choice must follow the criterion of the greater functionalism of the whole works, besides its own, always keeping in mind both economy of construction and running as well as the requirements of future development of the company.
This report would aim at being a guide to the application of an overall plan for general plant without, however, wanting to exhaust this complex topic, which is of course subject to continuous improvements and up-dating.
In the succeding chapters the following plant will be examined :

1. Shavings and saw dust suction
2. heat production and distribution
3. compressed air
4. water supply and distribution
5. electrical system
6. internal transport.

1. SHAVINGS AND SAW DUST SUCTION PLANT (APPENDICES 1 to 5)

1.1 <u>Type of plant</u>

This plant can be of the 1) centralized, 2) substation, 3) mixed type.

1.1.1. When power consuming machines are grouped together in an area which is not very large and are situated near the central services then it is more convenient to adopt centralized plant, characterized by having a piping network directly connected to an ensilage station.

1.1.2 In more spread-out works which have various groups of disconnected machines, the choice must fall on the substation type of plant.

In this type of plant each group of machines is connected to a filter-suction unit (substation) fitted with a quite large collection hopper. From this hopper the shavings and/or the sawdust are removed continuously or periodically and sent through a secondary piping network to the central silo. Although this plant might seem more costly it is to be preferred, especially in large works, for the following advantages it gives :

a) The power necessary for the suction turns out to be less because the substations are situated near the machines. (Successive transport of the shavings from the substation to the silage group requires low power and piping of small dimensions because it is possible to adopt relatively high shavings weight/air volume ratios).

b) For the same reason suction of the various machines is more uniform.

c) There is a reduction in risks of break-down : if the substation stops then the operations on the machine at the other substations are not interrupted. Furthermore, whenever the suction-filter units are fitted with an ample collection hopper, suction is never reduced even when there is temporary cut-out of the ensilage station.

d) The works can be completed with further substations without the existing ones or the silage station undergoing modifications. It is also simpler to carry out modifications to the piping network of the existing substations.

e) Any possible fire (an ever present danger in this type of plant), can be restricted to the substation and rarely involves the ensilage station particularly with substations with hoppers periodically emptied and controlled by an operator who can draw attention quickly to the presence of smoke.
It is a good rule, furthermore, even when not specifically requested by the authorities, to site the substation outside the works and fit fire gates to the suction piping.

1.1.3. In some works there are numerous groupings of machines concentrated, in one spot and another group sited away from the silo.

In this case the principal machines take suction power from a centralized plant and a substation is installed for the decentralized machines.
This mixed system is, moreover, often the most convenient solution when it is necessary to carry out extension of the existing centralized plant.

1.2 Suction plant components

The suction plant comprises a piping network, fans, and eventual silo substations.

1.2.1 The piping network must be designed with a width adequate both to allow for the later addition of suction machines, and to avoid excessive air velocity (and therefore an excessive load loss), with the consequent waste of electricity. It is opportune, furthermore, for the speed of the air velocity not to go below 25 m/sec. to avoid the deposit of shavings along the piping, obstructing it.

1.2.2 The fans can be crossed by the shavings or not, according to whether the silo is under pressure or in depression.
In the latter case there is less wear on the fan blades giving high efficiency.
It is advisable to couple the motor and the fan wheel by belt transmission and to initially limit the rotation speed to 1,200 r.p.m. It will be thus possible to increase, later, the speed and therefore the capacity of the air in order to adapt it to eventual extensions to the plant.

1.2.3 The substations are made up of a parallelepipedon metal structure and contain a series of hose filters which hold, at their base collection hoppers with extraction devices. The filters must be fitted with (preferably pneumatic) shaking devices for periodic cleaning.

The hopper shavings extractors use a worm screw or a chain with a reedler.

After the extractor it is necessary to insert a rotating star valve which gives the discharge dose and keeps the pneumatic transport circuit separate from that of the filter zone.

When the hopper is designed for heavy loads, it often happens that the material forms a bridge and extraction becomes difficult. It is necessary in this case, to install a series of rotating paddles above the extractor to free the shavings.

1.2.4 The silo can be constructed in masonry (or in reinforced concrete), or else in sheet steel. The minor cost and the ease of assembly makes the second alternative the most interesting. The silo base section can be square, circular or polygonal.

Currently, metal silos are constructed with polygonal bases (with 8, 12 and 16 sides), which allows flat panels to be used, easily prefabricated in the factory and adaptable, with minor modifications to various diameters.

It is however advisable to have the square base because the shavings extraction device does not remove mat erial from angles.

In the upper part of the silo there are situated hose filters with periodic cleaning apparatus.

The area underneath is intended for the storage of the shavings and sawdust. The height of this area must be limited to about twice the diameter of the silo because otherwise the material has a tendency to form bridges.

The extractor for the discharge of the shavings is situated in the base. There are different types of extractor in operation which give good results. Some of these are illustrated in the appendix sheets attached.They are all widely experimented types to be trusted. It is however essential that the mechanical parts immersed in the shavings are very robust because their breakdown could necessitate manual emptying of the shavings, something which, especially in high-capacity silos, is never easy.

This inconvenience is less for the scraping cone type extractor which has it mechanical parts outside the shavings area.

Various fittings complete the silos, such as :

- ladder for access to the filter chamber
- access door for shavings level inspection
- manual emptying flaps poitioned in the base
- overload rapid-opening doors
- sprinkler fire fighting system.

The latter can be controlled by a detector situated in the silo.

In this case it is necessary for the base of the silo to have doors which open automatically to let out the water otherwise the hydrostatic thrust would be too great.

2. HEAT PRODUCTION AND DISTRIBUTION PLANT (APPENDICES VI to VIII)

2.1 Heating plant

Recently the production of heat for heating and technological needs has developed greatly, on the one hand because of the greater demand for greater well-being in the in work environments, on the other because of the necessity of speeding up, using higher temperatures, those processes and treatments which, with ordinary temperatures would require times incompatible with modern productivity requirements.

Given the importance heat generators have, it is essential that the choice of number, capacity and type is the end result of a careful examination of the heat requirements and the type of fuel oils available.

Considering the number of boilers to be installed, the choice, is very wide. In less important works a single boiler can provide for technological uses and heating working in the summer period on partial load and in winter with a load near to the maximum.

In large plants the installation of two or more units is considered to be the most favourable even from the standby point of view.

Referring on the other hand to the heat needs and the type of fuel oil available, the choice of boiler is made on the basis of the following classifications :

1) constructional materials : cast iron
steel

2) the type of feed :
liquid fuel oil
gaseous fuel oil
solid fuel oil
several fuel oils

3) the type of combustion : in depression
under pressure

4) the type of fluid : water
diathermic oils

5) working temperature : up to 100°C
above 100°C

6) constructional type : smoke piping
water piping

In the specific field of woodworking, on the basis of the given table, the following constructive choices are adopted :

1) The material used is generally steel.
2) The availability of scrap to be used suggests the installation of boilers suitable for the use of fuel oil both naphtha or gas and wood in the form of sawdust and/or off-cuts.

   Material feed could occur :

   - manually, for wood off-cuts
   - mechanically, by means of worm screw or conveyor belt

- pneumatically, for the sawdust and shavings, by means of a fan and connection tubing between the silo extractor and the boiler.

Material to be burnt can be conveyed directly to the boiler or to a refractory pre-oven connected to the boiler. This second solution, although more costly, and requiring greater maintenance, is advisable because it gives better combustion even with wet material and gives easier manual feeding of off-cuts and the various scrap to be burnt.

3) The boilers working only on wood or the mixed type are of the depression type and generally have mechanical draw. The combustion chamber and the secondary smoke circuit are in depression in relation to the atmosphere and resistance to the smoke flow is overcome by a fan inserted between the boiler and the chimney.

The naphtha or gas boiler, often installed in parallel with the mixed types when the availability of wood scrap is insufficient, besides being in depression can also be of the pressurized type, characterized by having a slight over-pressure between the combustion gas and the external atmosphere.

These boilers have greater output and are more compact for the higher calorie yield in relation to the exchanger surface.

4) 5) The use of steam or superheated water is limited to temperatures which are not too high because of the high pressures in play (at a temperature of 200°C there is a corresponding pressure of 20 kg/sq.cm.

The use of diathermic oils allows high temperatures at atmospheric or low pressures to be reached.
For these advantages, in the woodworking field, where high temperatures are required (in the drying of veneers for example), the use of generators working on diathermic oils is spreading.
It should be kept in mind however that the use of wood scrap as fuel is still not completely safe in these boilers and this is a serious limitation for the industries where these wastes are abundant.
In industries where heat only at a low temperature is required (for example for heating and/or the drying of paints), and where the distance between the production and the utilization is limited, the installation of hot water boilers at temperatures lower than 100°C is more advisable for the advantages of greater economy and simplicity in the plant itself and its running.
In large plant and where a higher temperature is needed for technological uses (for example presses for drums, veneers, etc.), steam and superheated water (above 100°C) are used as fluids with a preference for the latter due to its advantages of :

- elimination of costly or delicate fittings such as condensate dischargers, filters and condensate recovery tanks
- less corrosion in the piping

- greater efficiency of the plant (in the condensate recovery tank there is always steam that escapes into the atmosphere)
- Supply water purification plant of a more simple type and size
- greater "thermic wheel" for the greater quantity of heat stored in the piping.

6) The boilers and smoke tubes are constructed in such a way as to permit the flow of the combustion products through the inside of the tubes while the water is found in the cover which surrounds the tubes.
The high water content which characterizes them gives quick adjustment to the brief load variations. On the other hand, the working pressure of these boilers does not exceed 15 kg/sq.cm.
In the boiler with water piping, the water circulates in the interior of the tube while the combustion products circulate on the outside. These boilers have higher performance and can have high working pressures and can be more easily repaired by the replacement of defective piping.
The boilers with water tubes, because of their configuration, can have a more rational pre-oven and are therefore to be preferred when there is an abundance of wood scrap together with a high temperature heat requirement as for example in veneer planing.

2.2 Heat use and distribution

The piping networks supplying the heat users must if possible be separated from those of the technological uses, both for the difference in temperature in play and for the different variability.

The use of heat for heating purposes occurs in very different ways :

- radiators and the convector heaters are more suitable for offices and service areas
- radiant panels are suitable for the heating of areas adjacent to non-heated zones
- The areothermic units are more versatile and economic apparatus for the heating of big and small spaces
- convector fans and fan units are usually used in air conditioning.

The technological use of heat in woodworking is very varied and each use often requires a particular temperature.

It is therefore impossible to examine, within the terms of reference of this report, those cases which could arise and to point the most convenient solutions.

One factor, however, is to be underlined and it is that of the flexibility of the fluid distribution network.

All the piping must be easily accessible for maintenance, extensions to and modification of the plant.

It must run therefore, as far as possible, in view along a suitable support framework, both inside and outside the works.

The ducts, when they are indispensable, must be easily inspected.

2.3 Smoke purification

It is advisable, and often laid down by the authorities, that the installation of smoke purifiers to remove soot deposits and incombustable material suspended in the smoke.

The apparatus normally used is :

a) dry purifiers

b) washing purifiers

Among dry purifiers the most used are the cyclone type, several cyclones often being grouped together to guarantee high efficiency with few inconveniences.

The washing purifiers comprise a chamber, into which the smoke enters, fitted with nozzles for the automization of the washing water. The soot deposit is collected at the base of the tank . This apparatus, although of greater efficiency compared with the dry type, has the inconvenience of requiring non-corrosive material and the smoke must be cooled and the soot discharged in the form of mud, both difficult to handle.

3. COMPRESSED AIR PLANT

The use of compressed air as a means of increasing productivity has developed greatly, also in woodworking plant.

It is therefore necessary to examine, using the criteria of function and economy, the choice of the type and number of compressors to adopt and the proportioning of the compressed air distribution network.

3.1 Compression station

Air compressors divide into two categories : volumetric and aerodynamic compressors.

In the volumetric compressors the air, sucked into a chamber, is compressed by the forced diminuation of the volume of the chamber.

With aerodynamic compressors the air is sucked in by a fan and delivered at a high speed. The kinetic energy aquired by the air is then transformed into pressure energy in a subsequent diffuser.

The machines most used in the woodworking field are those in the first category and the choice is further restricted to alternatives of piston, rotary screw and rotary paddle compressors.

With the alternative compressors compression occurs in one or more cylinders in which the pistons, with their rectilinear alternated movement vary the volume in the compression chamber.

The particular solidity and simplicity of maintenance of these machines makes them still more preferable when heavy duty and continuous service is required.

The screw compressors are made up of two rotors, rotating in opposite directions, housed in a chamber. The air sucked in from an inlet to the chamber is compressed between the rotors and discharged through the delivery outlet. Since, with these compressors, there is not contact between the rotors and between them and the chamber, lubrication is not necessary.

These machines are therefore particularly suitable where compressed air totally free from oil is required.

The paddle rotating compressor are made up of a hollow cylinder in which a second cylinder with paddles fitted situated radially turns eccentrically.

The volume contained between two successive paddles is reduced, between the suction inlet zone and the delivery outlet zone, determining the compression of the air.

These compressors have the advantage of being without vibrations and therefore they do not require base supports and are easily adaptable to variations in air requirements but they have high oil consumption and require careful and regular maintenance.

All these compressors can be air or water cooled.

The choice must occur on the basis of the latter and the possibility of installing a system for its recovery and re-use.

Besides constructional characteristics, compressors are chosen also on the basis of the specific consumption of electricity which one tries to keep below 9 hp/mc/min. The compressors must, if possible, be grouped together in one station which supplies a single network for all the works.

In this case the advantages are the following :

a) greater yield because more powerful units can be installed
b) a lesser number of stand-by compressors is needed
c) greater ease of supervision and maintenance
d) the possibility of siting the station in the most suitable place.

The compression station must be sited at a point that minimises the costs of electric wiring, cooling water piping and waste discharge. Normally the position of the compression station coincides with the other services (boilers transformer cabins, suction chambers etc.), with the advantage of making use of the same supervision and maintenance services.

Particular attention must be paid to air filtration and the absorption of noise and vibrations.

In the compression station essential fittings such as final coolers and compressed air collection tanks are also installed.

In the past few years the use of cooling plant for very quick cooling of compressed air and the consequent condensation of the water it contains has spread. The formation of condensate is thus completely eliminated in the distribution network.

3.2 Compressed air distribution

To guarantee maximum efficiency, safety and economy in running, the compressed air distribution network must guarantee :

a) low fall in pressure between the production and utilization of the compressed air

b) efficient elimination of condensate

c) the possibility of carrying out rapid modifications to the network for extensions and new users.

The containment of the fall in pressure within acceptable limits (usually between within 0.3 Kg/sq.cm.), is a direct consequence of the correct dimensioning of the piping, even taking into account future increases in compressed air consumption.

It is opportune, furthermore, in order to ensure better distribution of the air, to connect the piping lines in a ring circuit.

The condensate, when it is not completely eliminated in the station must be discharged from the piping by suitable drains. Connections to users must be made to the upper part of the main pipes and will be fitted with a condensate trap with suitable drainage.

To ensure maximum flexibility of the plant and also to facilitate the control of air losses, it is opportune for the piping to be sited in view in the works. Other devices to be adopted are the sectioning of the line with valves and the use of threaded couplings between the leads to the users and the main network.

4. WATER SUPPLY AND DISTRIBUTION PLANT SYSTEM (APPENDIX IX)

The availability of water is one of the factors to take into consideration in the choice of site for an industrial complex. The water must be supplied by an external Water Board or must be taken directly from a surface watercourse or from the water table underground using suitable pumping equipment.

In important plant where the water supply is not ensured continuously, reserve tanks connected to a system of surge tanks is installed.

Water users can be grouped together as follows :

a) water-sanitary services

b) technological services

c) fire fighting

While the mains which transports the water to services a) and b) can be connected together (when the water is supplied already drinkable), the firefighting piping must always be separate right from the supply point.

The fire fighting mains must always be kept in sound working order and it is therefore laid underground and closed in a ring round the buildings. Hydrants will run off from this ring as well as the sprinkler system for the protection of particular areas such as the silos, the stores for particularly inflammable materials, etc.

Often, within the area of the works, there are underground tanks for the collection of rainwater which act as stand-by tanks for fire-fighting

Water is lifted from these tanks and sent through the mains by motor-driven pumps worked by electric generators or by simple motor pumps.

The quantity of water necessary for the water-sanitary services essentially depends on the personnel present in the factory area besides the type of work they carry out, while the technological service depends on the particular process and the other general plant (compressors, boilers etc.)

For the ever increasing difficulty of supplying water, industrial water tends to be recycled. When, as is more or less the case of furniture factories, the water undergoes, during industrial use, a simple heating process, it is possible to easily re-use the water by installing evaporating towers.

Water which receives, during the process, polluting substances, must be suitably purified before discharge.

Purification processes depend on the quantity and quality of the polluting substances and often require notable intervention even for relatively small quantities of water to be purified.

A case that generally arises in furniture factories is the purification of water from spray painting cabins for spray painting and this is carried out in two successive stages : in the cabin tank the pigments and the solid parts of the paint are thickened and precipitated using special inhectors and then the residual solvents are absorbed by activated carbon.

5. ELECTRICAL SYSTEM (APPENDICES X to X 1)

The electrical systems can be subdivided as follows :

5.1 Transformation room

5.2 Distribution and supply to machines

5.3 Lighting equipment

5.4 Earthing and lightning conduction system

5.5 Auxiliary plant.

5.1 Transformation room

The ever increasing decentralization of works in relation to general transformation stations and the ever increasing request for electricity makes the supply of mean-voltage electricity almost indispensable.

This opportunity invites the designer to foresee and arrange for in a factory development area a "delivery cabin-transformation cabin" from a mean voltage to the one necessary.

For small to medium works the two "delivery and transformation" elements are usually connected while for bigger works these are separated and the transformation cabin will be placed close to the user centre.

The transformers, with their relative earth switches, insulation and general switchboard will be situated in the transformation cabin. The manoeuvre and start-up line apparatus to the various departmental switchboards will be fitted in the latter.

The rephase condensers are situated in one panel of the switchboard.

5.2 Distribution and supply to the machines

The most frequently adopted distribution is the radial type : from low tension voltage cabin bars, insulated with a general switch, there leaves different lines which supply the departmental switchboards.
The dislocation and number of the latter is essentially determined by the machines themselves.
One tries therefore to assign a switchboard to each department and/or service to be placed in a central position easily accessible from the department itself.
The main cables (those which run from the cabin to the departmental switchboards); are normally situated within the PVC tubing network running underground with frequent inspection wells.
Secondary distribution occurs usually though prefabricated plant.
These can be classified in two types :

5.2.1 Bus duct system
5.2.2 Box system

Bus duct systems are made up of rectangular section copper or aluminium bars contained in a duct structure and fitted with a wide range of accessories to permit the rapid application of lead and protection bars.
Advantages met with are :

- freedom from restrictions imposed by the building structure and siting of the user
- possibility of proportioning the system to working needs
- possibility of re-using the plant should the works be turned over to other uses
- quick assembly and disassembly

The disadvantages :

- greater cost compared with cable systems
- necessity of a separate plant to take the lighting fittings and distribution of the relative supply
- lower possibility of sectioning the lines compared with cable systems.

The box systems are made up of channels in sheet steel fixed to the structure of the building within which the distribution lines are sited using isolated copper conductors.
This type of system is the one most adapted to woodworking because besides having the best part of the advantages of the bus duct system, also has the following :

- under the channels it is possible to fix the lighting fittings for normal, night and emergency lighting, laying the cables for the various supply in the channels.
- cables for signalling, personnel call systems, sound systems etc. can be laid in the channels
  various groups of machines, for example sizing and edging machines with a line separated from the pressing line can be supplied directly from the departmental switchboard.

- it is always possible to strengthen a line by adding, in parallel, another cable to the existing one.

In certain processes the two systems, bus duct and in channels are complementary and can exist, with the general mains in the channels, with certain secondary leads in the bus duct type.

For example : supply to the bridge crane is carried out using a bus duct trolley; in the assembly chain, subject to rapid modifications, lengths of bus duct are used; on cutting benches for fabric and skins bus duct trolleys to feed the cutters are used; for sewing machines small ducts are adopted.

Machinery supply

The leads to the machines are carried out in PVC or iron tube in which the supply or earthing cables are placed. Protection down from the machine is ensured by a fused switch.

5.3 Lighting equipment

The lighting system comprises :

5.3.1 Normal lighting

Distribution for normal lighting must be made in such a way as to ensure ~~the~~ as far as possible even distribution, of light without shadows and harmful reflections. For medium height sheds (5.5 mt.) light fittings with 65 W fluorescent lamps giving greater economy and lux parity are preferably used.

The illumination values to be adopted are 200-250 lux for workshops, 80-100 lux for stores.

5.3.2 Night and external lighting

Using a separate circuit, a series of lamps is supplied (normally fluorescent, 20 W) for night illumination.
A second circuit feeds the external lamps. Both circuits can be controlled by an automatic relay dimmer.

5.4 Earthing and lightning conduction system

All the electrical apparatus and the metal elements must be earthed.
There must be, therefore, around the inside of the works a closed line, if possible of the ring type, of suitable dimensions, earthed through dispersion wells.
It is also opportune to provide for a lightning conductor to cover the works area.

5.5 Auxiliary plant

This comprises all the equipment which, although not essential meets various needs.
It is made up of plant for :

- personnel call of the radio-signalling or sound and/or luminous signalling type
- internal telephone extensions
- sound diffusion
- security lighting, ensured by accumulator batteries emergency motive power produced by electric generators when the electricty mains supply is cut off.

6. INTERNAL TRANSPORT (APPENDIX XII)

In the woodworking industries internal transport systems have contributed in a notable way to an increase in productivity and reduction in the manual work of personnel. The range of transport apparatus is very wide (running from simple idle roller conveyors to overhead birail conveyors); moreover, each process requires particular types.

We would mention, therefore, here, the most widely used and tested system for the transport and storage of panels. This system is essentially based on simple idle rollers or adjacent rollers which allow the longitudinal movement of single or stacked panels.

Transversal movement of panels for unloading and the feeding of the various roller conveyors is ensured by a trolley, also fitted with rollers that can be moved along the rail situated perpendicular to the roller conveyor.

These trolleys can be turned to feed roller conveyors with runways meeting at right angles. The panel transport plant comes complete with apparatus and carries out control movements (motorized roller conveyor, strap conveyors etc.) or particular movements (alignment, panel turning, turnovers, loaders and unloaders, etc.)

Besides the transport of materials and the motor powered fittings a plant for the transport of documents between the various points of the works (offices, materials arrival bay, forwarding, hardware storage etc.), must be provided for.

Pneumatic document movement systems solve this problem in a simple and functional way.

APPENDIX I

1	Suction piping
2	Transport piping
3	Extractor
4	Self-contained waterproof unit
5	Recycle
6	Section B-B
7	Gallery and door to filters
8	Inspection door
9	Inspection ladder
10	Silo access door
11	Boiler blower
12	Extractor
13	Section A-A
14	Self-contained waterproof unit
15	Self-contained waterproof unit
16	Ground floor plan
17	Services to station
18	Hardware storage
19	Maintenance workshop
20	Silo
21	Suction system

APPENDIX II

1 Sub station with mechanical cleaning of filters and depression transport

2 Materials entrance

3 To the silo

4 Materials entrance

5 To the silo

6 Substation with filter cleaning in counter current and high pressure transport

APPENDIX III

1 Scraping chain extractor

2 Rotating worm screw extractor.

APPENDIX IV

1 Half-elliptic spring extractor

2 Scraping cone extractor

APPENDIX V

1 silo

2 extractor

3 star valve

4 transport piping

5 blow fan

6 pre-oven

7 boiler

APPENDIX VI

1 To discharge

2 To services

3 Tunnel painting

4 Opaque painting

5 Dryer

6 Press

7 Diagram of superheated heating-water plant - naphtha cooling - water services

APPENDIX VII

1 Pressure switches
2 Level regulator
3 Level indicators
4 Discharge
5 Fire control door
6 Ash extraction door
7 pre-oven loading door
8 under-grill inspection door
9 burner
10 pilot light
11 gauge
12 manhole
13 safety valve
14 general steam intake
15 service steam intake
16 feed
17 eyebolt
18 smoke suction
19 smoke
20 manhole
21 discharge
22 smoke by-pass
23 flue
24 soot burner
25 inclined grille
26 flat grille
27 air regulation lock

28 Concrete

rammend lining

firebrick and asbestos

mineral wool

insulating br ick

29 Steam generator - Superheated H_2O

WITH SMOKE TUBES

MIXED WORKING

NAPHTHA - GAS - COAL DUST - PROCESS WASTE

APPENDIX VIII

1	**Ashpit**
2	**Cross section**
3	**Ash extraction trap door**
4	**Yard**
5	**Ashpit access ladder**
6	**Load door**
7	**Smoke pipe**
8	**Yard**
9	**Mechanical chimney**
10	**Plan**
11	**Front elevation E.**
12	**Water pipe boiler**

APPENDIX IX

1 Workshop and stores

2 Silos

3 Fire prevention line to silos

4 Thermal station

5 Surge tanks

6 Pump room

7 Well with submerged pump

8 Canteen and changing rooms

9 Industrial water well with submerged pump

10 Industrial water delivery points

11 Fire-fighting outlet to wall, UNI 45 type with hose and nozzle

12 Underground ring circuit - mean depth 1 mt.

13 Offices and display

APPENDIX X

1 lux

2 trolley

3 bar/transport

4 bar/distribution

5 bus duct plant

APPENDIX XI

Box system

APPENDIX XII

Roller conveyor system

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