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08667

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.277/14
10 November 1978

ENGLISH

Technical Course on Criteria for the Selection of Woodworking Machinery

Milan, Italy, 8 - 19 May 1978

PRODUCTION LINES FOR PLYWOOD AND VENEER*

by

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id.78-7889

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I. Introduction

Almost a century has gone by since plywood panels were first manufactured in 1884. These panels are made of several thin sheets of wood glued together one on top of the other crossing the grain direction by 90°. Industrial production of plywood began around 1910 and it became an important product during the following decades. In the last twenty years world plywood production has almost tripled and in Japan it has increased 800 per cent during the same period.

The forecasting of future developments is of prime interest to managers and business men. FAO experts estimate that in the year 2000 world plywood requirements will be twice that of today's production.

Increases will stimulate progress in woodworking technology. This is a constant process which has increased notably during the last ten years.

For years now scientific laboratories, wood research centers, industrial plants, wood engineers, etc. have been conducting research and experiments on the exploitation of forest resources.

The building industry has been using more and more plywood in recent years, even though the traditional building industry has been going through a slack period. This is true both in Europe and in the United States and everybody knows why: building costs have become "impossible".

This is why prefabricated buildings which use a large quantity of plywood are increasing in the suburbs of the big cities in the US. This is a valid method of building economical homes which suit people's incomes. And in the USSR dozens of small towns made from fireproof wood are being built along the second Transiberian railroad.

In Central Europe the use of wood in modern buildings is increasing. Today many prefabricated houses are made of plywood. These buildings are very elegant, rational, comfortable and ecological because today's technology can solve all the problems involved in the use of wood and complementary materials in building.

In the traditional building industry, wood is generally used for making forms for concrete and reinforced concrete. Sawn boards may be reused three or four times at the most whereas the right type of plywood panels may be reused 10 to 15 times. These panels are manufactured in standard or modular dimensions and they render it possible to save much time, material and skilled labour. Other advantages are the adaptability to any type of construction, the stability of the structures, easy transport and assembly as well as a nice and smooth outlook of the concrete surface obtained by using plywood panel.

The plywood packaging sector is expanding too. In developing this product flexibility, and other features are important when choosing ply packaging material.

There are other reasons besides mechanical resistance for using plywood for wooden packaging: the large surfaces eliminate cracks and the fact that making plywood packages involves less work than the traditional method of nailing a number of boards and cross pieces together.

In recent years, plywood packaging has also been used as an appropriate advertising medium. Form and lettering and drawings in eye-catching colours have become important.

In the furniture and interior decorating industry, the international exhibitions held in recent years show that plywood panels are increasingly, being used instead of plastics or metal.

Plywood has become more important for indoor use in the building industry (doors, door frames, and wall coverings), in manufacturing technical and sports goods, in boat building and so on.

In the future, traditional products will be replaced by new ones and the plywood sector will be influenced by manufacturing methods with constantly evolving technologies.

2. Panel classification

Plywood panels may be classified according to use and type of wood as follows.

Classification by composition:

- Three layer plywood from 3 to 8 mm thick;
- Plywood with more than three layers, from 8 to 40 mm thick; these panels are a type of improved wood;

Classification by use:

- Normal or "interior" plywood is used when moisture resistance is not required;
- "Exterior" plywood gives extended resistance to moisture;
- "Marine" plywood resists all atmospheric agents, immersion in cold water (both fresh and sea water), attacks by fungi and insects;

Classification by form:

- Flat panels;
- Curved, convex, corrugated or shaped panels.

In order to facilitate our study of the criteria for selecting machines for manufacturing plywood, we will only examine the most important sector: flat plywood panels with three or more layers.

The right type of wood and glue are used in order to obtain either interior, exterior or marine plywood panels.

Some plywood panels are veneered (about 0.5 mm) of face quality veneer on one or both sides. These veneers are cut with a slicer.

3. PRELIMINARY CONSIDERATIONS FOR PLANT LAY OUT

The following factors influence the criteria for selecting the machines in the various sectors of the plywood panel plant:

- wood specie maximum and average size;
- overall dimensions of panels and their physical and qualitative characteristics;
- desired output;
- degree of automation; this depends on output and environmental conditions.

In general, this plant can be divided into sectors, in accordance with the step by step transformation of the raw material. Let us suppose that the raw material has already been checked and that the low grade logs are sorted out.

The production process includes the following operations:

- preparing and selecting logs;
- peeling and clipping in standard and substandard sizes;

- drying;
- splicing the smaller pieces;
- preparing the glue;
- panel forming;
- pressing;
- squaring and sanding.

3.1 Selecting and preparing logs

The problem of stroing and selecting logs will only be dealt with briefly because each plant has its own particular problems and it is impossible to find a general solution.

The logs used in plywood manufacture must have both suitable physical characteristics and shape for peeling. Logs in bad condition or with obvious physical defects - shakes, cracks, etc. cannot be utilized because much material and time would be wasted during peeling. The same applies to logs with irregular (not cylindrical) shapes.

The logs which have been selected are piled in the log yard. These logs must be kept in good condition and free from cracks. The size of this log yard depends on plant size and delivery frequency.

If space and water is available, the logs can be kept in a pond or vats.

Sometimes it is impossible to make the logs retain the right degree of moisture content for peeling. When log deliveries are several months apart, some of the logs may be too dry for peeling. In this case the logs are steamed or soaked in hot water in special steaming vats which is absolutely necessary for some hardwoods: it softens the fibre structure for better peeling.

These vats are made out of concrete and they are very large. They are usually rectangular, 6 m x 12 m, and more than 4 m deep. A coil which is connected to the heating plant is located at the bottom of the vat and it is covered with water. The logs are placed in these vats which are closed with special covers so the logs are surrounded by the evaporated water.

Today gantry cranes are mostly used for handling logs. These cranes are more versatile and they have replaced the overhead and derrick cranes because this hoisting and transporting equipment is more efficient and secure. The logs usually have different characteristics and lengths so that they must undergo some preliminary operations before they can be peeled. The first of these is cross-cutting them to the proper length (which depends on the production cycle). During this operation, the unsuitable portions of the logs are rejected.

Chain saws are used for cutting off the logs. These saws are usually mounted on a two-wheel carriage. Obviously saw size and blade length depend on the maximum log diameter.

If output is large, it is advisable to use cross cut stations on log conveying lines. The saw is placed between the infeed and outfeed conveyors and two independent hoists are used to bring the axis of the log horizontal and hold it in place while the saw cuts vertically. The cut is perpendicular on the log and less material is wasted. (Appendix A).

The logs which have been cut to size have to be debarked. Different methods are used, depending on log diameter and the type of wood involved.

For logs less than 70 cm in diameter which are green or steamed and with rather thick bark, rotor debarking machines are best. These are automatic machines which consist of a sturdy frame which supports two chain conveyors (one on each side). Each conveyor is equipped with feed rollers or discs.

These conveyors feed the log and center it with respect to the rotor. The rotor is a ring rotating around its center. Adzing tools are mounted on this ring and a spring pulls the tip of the knife towards the center of the ring. When passing the log through the ring, the tools move in cutting position and springs press them against the circumference of the log.

As the ring rotates, the knives interfere against the outside of the bark. Pressure and friction generate the debarking operation. Scoring knives work the log before it goes through the debarking rotor; they score into the bark for easier removal.

For logs 70 cm to 2 meters in diameter the type of wood and the shape (including the defects) must be carefully studied. Unfortunately, this operation is usually not done very carefully even though it has a notable affect on the overall cost.

One type of debarking machine has two arms; each arm has a spindle and the log is held between these two spindles (Appendix A).

The log turns very slowly and an oscillating cutter at the end movers along the log (the feed speed is less than the cutter width). A hydraulic system is used to press the tool against the log. The cutter removes the bark and a small amount of wod, and leaves a screw shaped mark on the log.

But today the most widely used debarking machines have two oscillating arms with two different cutters. These cutters rotate at high speed removing the bark by combined hammering and cutting action. Large toothed wheels mounted on two parallel shafts turn in the same direction for turning the log. The log is placed in the space between the wheels and the shafts are driven by a variable speed motor. A hydraulic system presses the cutter arms against the surface of the log and they move lengthwise along the log while it rotates.

A variation of this machines operates as follows:
the outter arms do not move along the log but the log rotates on a feed carriage. This type of debarking machine is less rigid but more practical because of easier loading as the carriage can move the log and position it. The log is unloaded from the other end. Several loading stations at different utilization zones can be arranged. These operations can be maintained when chain conveyors for straight and cross conveying are installed Unfortunately when the logs have deep hollows or holes the cutter cannot debark the log completely. This has to be done manually.

Debarking cutters may also be used for small and medium diameter logs with thin, bark covering the log, such as beech.

Both rotor and cutter debarking machines have a high capacity so that one machine can operate on several produotion lines, especially when the plant has a good conveyor and bark collection system.

3.2. The Peeling Section

With the peeling operation one has to select maching groups which fit into the allover production lines for plywood manuracturing.

The logs pass the preliminary operations and are partially machined having similar characteristics. Modern technologies applied to plywood production include automated equipment for continuous manufacturing processes. The layout represents a oontinuous production line for conversion of logs into green peeled veneer (C). This plywood production line is suitable for peeling medium sized logs of 0.45 to 1.2 meters in diameter. Layouts for plywood production converting large diameter tropical logs and also small diameter show that different equipment is required.

3.21 Log centering

A log deck unit conveys the logs lengthwise and crosswise to the peeling station; the log deck capacity covers at least ten logs which is necessary to ensure continuous operations. Before peeling, the logs will be centered so that waste material will be kept to a minimum. This operation is quite important from an economic point of view. Centering is done according to the shape and butt end of the log. Out-of-center heartwood, splits, cup shakes and other defects in the log are features that determine the axis of rotation which is most suitable for a higher yield of the log.

Geometrical centering is done automatically by optical control in four different points 90°C apart. Two different cross sections of the log, about one-third from each end, are measured. Once the log has been centered according to shape, several concentric circles are projected on to both buttends for the operator's final check. Two mirrors enable the operator to see these projections on both ends and by pressing two push buttons he can adjust the axis of rotation for maximum utilization of the raw material.

The arms of an overhead crane grip the logs at the butend (Appendix B) and transport it to the peeling machine. These spindles hold the log on the selected axis of rotation. After chucking the log, the overhead crane is automatically disengaged and it travels back to the starting position to pick up another log which has been centered in the meantime. The operation cycle for centering and transporting is about 45 seconds. This means that about 80 logs an hour are fed to the peeling machine: with a minimum log diameter of 0.45 m no peeling machine on the market today can operate at that.

The most up to date peeling machine in design and development introduced in recent years will be discussed. Today high outputs of technically perfect peeled wood can be produced both rationally and economically.

In modern plants, the controls are located on top of one of the columns of the peeling machine (C.3) so that the operator can control and view the whole peeling operation. This cycle may be divided into the following operations: transport of the log to the centering machine, centering the log and transport to the peeling machine, peeling, sorting out waste and round-ups, transport of the peeled veneer to the automatic reeling system (C.6) transport of the reels to the reel raok and placing an empty reel (C.7) on the machine, unloading the peeler core (C.2). In traditional plants (even the recent ones), at least four people are required for all these operations (and output is lower) so naturally we want to know how it is possible for a single operator to do all the above operations. (Appendix C identifies location of those functions under No. 1 to 15 inclusive).

Basically, the reasons are:

- the highly automated plant permits the use of continuous production lines; all the normal operations are program controlled so the operator only has to intervene occasionally to adjust for the different logs;
- all plant controls are located in one control desk. they are arranged according to a general scheme which corresponds to the production process;
- the operator controls the peeling operation both before and after the peeling machine and he intervenes when a defect tends to appear. Normally he only has to press one or two push buttons to reestablish optimum working conditions at a given moment.

Under actual working conditions, the operator's experience, together with a highly versatile plant, normally allow the operator to intervene even before the log defects can disturb the continuous process.

Therefore a modern peeling machine must be equipped with:

- two telescopic spindles because when peeling begins the log is held by large jaws which are automatically withdrawn when the log becomes smaller. The peeling process continues without any interruptions until the log has been worked to its minimum diameter (which is equal to the diameter of the internal spindles if the log's characteristics allow it to be peeled to this diameter).
- viable speed main electrical operation, consisting in a direct current motor and its power supply. A great deal of power is required since peeling rate can be as high as 300 m/minute. Therefore the motor must develop more

than 100 kW output power at up to one-third of maximum rpms.

The speed must be varied automatically to maintain constant peripherial speed and provision must be made for operator adjustments according to the various requirements. A detector with integrator constantly measures the peripheral speed of the log, converts it into electric signals which are transmitted to the conveyor belts and the reeling equipment so that these three operations all proceed at the same rate. To get a good idea of the concept of automatic reeling, imagine that you have to unreel a roll of paper (which represents the log), transport the strip of paper and reel it on an empty rotating reel about six meters away. (C.6) The paper is unreeled from the rool and automatically reeled on the reel, neatly and without tensioning the paper.

- prent change of thickness, with at least two different thicknesses plus one large thi-ckness for use during the initial phase when the log is being rounded. It must be possible to change thicknesses during peeling without interrupting the cycle. The distance between the blade and the pressure bar must be automatically changed every time the thickness is changed.
- device for rapid drawing the pressure bar from the blade and for re-adjustment. This device is used when pieces of veneer or bark jamming between the blade and the pressure bar; it must be rapid action so that the peeled band will not break;
- non- bending or counteraction device which presses against the rotating log and prevents it from bending forced by the cutting action. This is especially important when the log diameter becomes very small. The peeling machines for a medium and small diameter logs must be equipped with devices which press against the whole length of the log, but on the larger peeling machines this device is required only in the center part of the log. These devices are hydraulically operated and pressure can be adjusted in accordance with actual conditions;
- backlash compensaion on knife-holder feed screws. During peeling, sideways motion of the knife-holder must be continuous and uniform so that the thickness of the peeled veneer is accurate. Backlash compensation may be either mechanical, with double lead screws held together by springs,

or hydraulically with backlash cylinders;

- operating controls located in the control panel.

Just like an automobile, where the driver has a good instrument panel, a peeling machine needs instruments which assist the operator. For example, an ammeter connected to the main motor shows how much energy is required for peeling. When this value is above the limit, an experienced operator will know that it is time to change the knife or adjust the knife holder. One or more manometers gauges connected to the spindle cylinders show whether the log is properly fitted or not (if not, the center of the log is not solid). The tachometer is also very useful because it shows the spindle rpms; etc.

- the whole peeling machine must be sturdy in design. Above all, it must be rigid because any bending, buckling or twisting under stress would influence the thickness accuracy of the peeled veneer.

Sometimes peeling machines are judged on the basis of their weight. This criterion may be partially valid but it is by no means the only one. The most important characteristic of a peeling machine - rigidity - basically depends on the design which takes all the various loads into account and distributes them over large areas. The larger the areas, the smaller the individual stresses. Using the right materials is also important. Not verybody knows that a welded steel frame reacts to bending twice as much as the same frame made out of cast iron. This is why more and more frames are being made out of structural steel, especially when rigidity is the main objective.

The peeling operation produces three different products: unusable round-ups, usable round-ups and continuous veneer strips.

- The round-ups peeled off the outer portion of the log have an irregular shape and cannot be utilized in plywood manufacture. This veneer is peeled in thicknesses of about 4 mm to speed up this operation.
  A belt conveyor transports (C.4) this waste material to the chipping machines where it is transformed into chips. These will either be used for fuel or for making particleboard.
- The rest of the veneer which is peeled off before the log is cylindrical, is used for the inner layers of the plywood panels (core veneer). On three layer panels, the center layer is twice as thick as the top layers.

This peeled veneer is placed on a belt conveyor (C.5) and transported to a storage container consisting in a series of conveyors, one on top of the other (C.8). This is called the zig-zag system and it enables a large amount of peeled veneer to be stored in a limited space.

All the conveyors must have another belt on top which keep the peeled veneer flat so it can easily be conveyed.

The storage container (C.8) is divided into two or three sections which can be operated either separately or simultaneously by the operator on either the peeling (C.3) machine or the clipper placed after the store (C.9). This operation is fairly simple because the peeling machine produces round-ups periodically only whereas the clipper works full time.

While the peeling machine sends the peeled veneer to the first section of the storage container (C.8) which is set at the same speed as the peeling machine, the second section (C.8) feeds the clipper (C.9) at a lower speed.

When the log has become cylinderical and the continuous band of peeled veneer is being made, the first section of the storage container is being connected to the second section and is used to feed the clipper.

This plant is equipped with an automatic clipper (C.9) for clipping irregular pieces of peeled veneer into parallel bands with different widths.

The pieces of peeled veneer are fed to the clipper on a variable speed belt; another set of belts is used to keep them flat. Another conveyor at the back of the clipper transports the veneer to the storage (C.10). The clipper's knife is operated by compressed air. Plastic hold-down rollers keep the veneer in position while clipping. The cutting cycle lasts only 1/20 of a second so the clipper can be operated on the moving veneer band at up to 80 m/min.

An electronic scanning device consisting in a row of photoelectric cells detects any defects in the shape of the pieces of peeled veneer before they are fed to the clipper and decides where the cut should be made, both front and back. This device which is able to separate the usable pieces of veneer from the waste is rightly called an "optimizer".

After this operation the bands of peeled veneer are automatically stored in special containers (C.10) and the waste veneer is conveyed to the chipping machines. The operator on the clipper just has to adjust the conveyor speed according to the amount of waste material. Occasionally he has to speed up the conveyor belt to the chipper when the pieces of peeled veneer are particularly hard.

- The continuous strip of peeled veneer is reeled on metal reels about 80 cm in diameter. When the reels are completely reeled they are lifted away and transported to the storage area.

  Automatic peripheral reeling (C.6) has been widely adopted in recent years. Basically, this system consists of a series of drive belts mounted on moveable arms which surround the reel. The belts are pressed against the edge of the reel so it turns and winds up the band of peeled veneer. The speed of these belts and the conveyor which transports the wood from the peeling machine to the reeling station is synchronized with the peripheral speed of the log. Two bands of adhesive paper are automatically applied to the two ends of the full reel to prevent reeling. At the end of the reel storage area there is an automatic unreeling station (C.11) where the continuous strip of peeled veneer is cut into sheets of the desired sizefor making plywood panels. Two or more stacking machines (C 13-14) stack the veneer sheets.

The best automatic stacking machines are operating mechanically. These machines have pairs of rubber rollers which rotate in opposite directions. The rollers are pressed on top of the veneer sheets and fed to the adjusted height of the scissors lift. The above system of manufacturing veneer sheets is most suitable for medium sized first grade logs more than 50 cm in diameter because a large number of sheets can be stored in a limited space.
Naturaly, there are more sophisticated solutions, such as multilevel storage areas used to increase the quantity of peeled veneer or to keep the reels with different thicknesses of peeled veneer separate.
The schematic diagram (D) shows a plant suitable for processing logs less than 50 cm in diameter. This is called the "deck system" (D.6) and it is used when the continuous strip of peeled veneer is not long enough to justify the reeling operation. Furthermore, with small logs the different

phases of the peeling operation come in more rapid succession and the deck system ensures that the clipper will have enough veneer to cut even with the limited stock of peeled veneer which is on the deck system belts (D.6). The storage system (D.7) for the veneer peeled during the second phase operates on the principle described above. The only difference is that the deck system has two flaps, one at the beginning and one at the end of the conveyor: while the first flap connects the peeling machine (D.3) with one deck for loading, the other flap connects a different deck to the clipper (D.10) for unloading. Magnetic clutches which are controlled by flap position are used to adjust belt speed to either peeling rate or the feed rate of the clipper. The clipper is driven by compressed air and the conveyor belt at the back of the clipper has a device for automatically cutting sheets to the present length. The clipper automatically (D.10) cuts full size half or quarter sheets. Naturally, the defective portions are eliminated. The stacking machines (D.11-12) at the end of the line automatically separate the sheets according to size. The full size sheets are divided according to quality: first and second grade. (Appendix D identifies the functions under items No.1 to 13 inclusive.)

3.22 Peeling and clipping

The next operation is drying of the wet peeled veneer. Two different drying methods are applied; the difference is the conveying system for the sheets fed through the dryer. Endless belt dryers (B.12) and roller dryers (E.4) . The basic difference between these two systems from the technical point of view is that in the first case the peeled veneer is fed through the dryer in band form with the grain perpendicular to direction of feed and the veneer is clipped to size after drying (B.12..17), whereas in the second case, the peeled veneer is clipped while it is in wet condition (C,11.15) and the sheets are fed through the roller dryer with the grain parallel to the feed direction (E.1..8). (Appendix E)

In recent years, continuous belt dryers are being utilized more often because of economic reasons and not for production quality. The plant lay out (B) shows a continuous dryer with five different levels. The upper four are used for drying; the lower one is separated from the dryer and is used for cooling the dried veneer so that the remaining moisture is uniformly distributed.

Continuous dryers undoubtedly offer several advantages: the most obvious one is that if the peeled veneer has already been dried when it is clipped (B.13) the sheets will be exactly the right size because of not shrinkage. Furthermore, small strips of peeled veneer will have straight parallel edges and will be ready for splicing. This type of dryer also saves labour and it is easy to operate.

Continuous operating dryers can be used profitably for drying kinds of tropical species and with thin bands of peeled veneer in this case speed can go up to 50 m/min.

Unfortunately, when the veneers are much narrower than the dryer, volumetric production will obviously drop.

Today's continuous dryers offer many different arrangements and capacities; thus they are able to solve all the problems arising from different kinds of wood and different thicknesses. For example, twin level drying lines have been built, with each level moving at a different speed, depending on the type of wood being dried and its thickness. The market offers modern, automatic control equipment for adjusting dryer temperature and the mixture of steam and air used for drying. Thus dryer temperature and humidity can be adjusted according to the characteristics of the peeled veneer (B 18-18 a) (E 9-). Roller dryers (E.4) are normally used for drying difficult woods.

Usually these woods contain a large amount of moisture which is not distributed uniformly. When this moisture evaporates, uneven shrinkage occurs and the dried veneer will have ripples in it. When roller dryers are used there is almost no danger of splitting because the sheets are small and free to shrink.

The most rational use of roller dryers can be obtained by classifying and collecting the sheets according to moisture content during the chipping operation. This calls for a certain familiarity with the type of wood; the peeled veneer has different colours, depending on its moisture content, and this aids in classification. Poplar is a typical example: the white areas stand out against the darker zones which contain large amounts of moisture.

Either portable or fixed instruments are used to control the moisture content of the dried sheets. These instruments continuously show the percentage of moisture content. This equipment can be used to automatically regulate dryer temperature and feed rate. The sheets which are not sufficiently dry are automatically sprayed with a special colored liquid so they can easily be identified for recycling.

Roller dryers (E.4) offer another important advantage as far as production quality is concerned: the rollers press the sheets during the whole drying process so the finished sheets have harder and smoother surfaces.

Today the amount of labour required for operating roller dryers has been reduced by using completely automatic feeders and automatic unloading and stacking machines (E 1..3), (E6..8). (Appendix E)

The right type of dryer - continuous or roller type - must be selected above all on the basis of the kind of wood used and its quality. These two systems rarely compete directly with each other even though the tendency is to use continuous operating dryers in modern production lines. Roller dryers offer more advantages when different types of wood with different characteristics have to be dried and when quality is an important factor in the production of dried sheets.

3.23. Drying the peeled veneer

Some secondary operations have to be considered in plywood manufacture because they do allow maximum recovery of the peeled veneer, requiring a large amount of labor. It is common knowledge that raw materials account for about half the final cost of plywood.

Sheets with knots, worm holes or other small defects are "repaired" by cutting out the defect and patching the sheet by gluing a piece ofpatch veneer in the patch hole. The bands of peeled veneer with defects can be used to form a new band of peeled veneer. The method used in splicing these strips depends on whether they were clipped when they were wet or dry. In the first case, the sheets must be jointed on knife jointers or cutterblock jointers for jointing the packs of veneer. Two splicing methods are known:

In the first case a glue string is placed in zig zag form, across the joint. In the second case thermoplastic glue spots cover the joints. Today, the most modern machines are equipped with a conveyor belt; the bands of peeled veneer are laid side by side on this belt and all the operations - jointing, splicing, glueing and clipping - are done automatically.

But it is not always necessary to splice the strips: on medium quality panels, the strips used for making the inner layer may simply be placed side by side when the panels are being made up before pressing.

3.24 <u>Preparing the glue</u>

This section of the plant works independently and its operation differs from plant to plant. As a separate section in plywood production it has to be discussed in a separate paper.

3.25 <u>Laying of ply sheets</u>

The sheets of peeled veneer are placed one on top of the other according to the desired arrangement and in the desired quantity. The plywood panels are made from these ply layers.

In many plants, these layers are made up by hand in the following order: first ply, not glue spreaded, core ply double side glue spread, third ply, no glue spread, etc.

But modern plywood plants use vacuum lifting equipment to pick up the ply sheets from piles, transport them and place them on the laying table. The most commonly used glue spreading machines are the roller type double side glue spreaders. Sometimes "curtain" type spreaders - where a thin glue curtain drops through a calibrated slot - are used. The sheet of wood passes underneath this slot and the amount of glue deposited on the surface depends on the feed rate of the sheet.

This type of glueing spreader can only spread glue on one side of the veneer. Therefore when the panels are made up they are not symmetrical with respect to the center layer. These panels do not always have a uniform surface after pressing. This problem can be eliminated by pre-pressing the spread ply layers before hot pressing.

3.26 Plywood pressing

In modern plants, no matter which glueing system is used, cold pre-pressing offers the following advantages:

- the aluminium cauls holding the layers togehter will be eliminated when the prepressed panel is loaded to the hot press;
- the height of the press openings can be decreased from 120-140 mm to 60 mm; this means that the presses are more compact with rapid closing;
- automatic loading and unloading equipment can be used; this equipment loads the panels into the press in seconds and unloads the pressed panels at the same time, no matter how many openings the press has;
- the moisture contained in the glue is more evenly distributed throughout the different layers in the panel^
- defects and rejects caused by sheet slippage during handling and feed are reduced;
- curing time is shorter.

A single opening press is used to prepress piles of panels about one meter high (G.3) (sometimes the press has two openings). Pressure varies between 15 and 20 kg/cm2, depending on the type of wood and sheet thickness.

Normally the panels stay in the cold press for a few minutes, depending on the adhesive properties of the glue at room temperature. The glue may be either ureic or phenolic.

As modern plywood plants have high production rates, the hot presses have a minimum of 16 (Appendix H) openings and they may have as many as 40.

Bonding pressure varies from 10 kg/cm2 for softwood plywood to 25 kg/cm2 for hardwood plywood.

The most functional presses are designed so that loading and unloading is done on the long sides of the heated rectangular platens, even though from the mechanical point of view this solution leads to less compact and more costly machinery.

The most modern presses are also equipped with devices which opens and closes all the platens simultaneously which are chrome-plated to eliminate corrosion, improving the appearance of the panel surfaces and facilitates heat transmission. For four millimeter panels, press time is only three minutes.

Today, high-temperature water is used to heat the platens in the presses. This water circulates at a convenient speed and is re-cycled. Thermal oil can also be used: temperature can exceed 100°C without having pressure of the liquid. In larger lants where presses have more than 20 openings, there are two lines for preparing the "ply layers" (H.1-1). Single opening presses have been introduced in the last decade. With these presses, the rationalization of the technological and production processes is achieved on a very different basis. Instead of having a seris of platens stacked one on top of another with one panel in each opening, the single opening presses have two platens only which are large enough to press several panels side by side at the same time.

These presses offer the following advantages;

- the whole area of the platen is used even when different sized panels are being pressed;
- the time lost in non-productive operations - opening and closing the press, feeding and unloading the panels - is decreased. Loading and unloading is done by a long conveyor belt passing through the press;
- the single opening presses are easier to build and operate and they can easily be applied to manufacture of special types of panels.

The platens may be up to 2.80 m wide and up to 12 m long; maximum pressure is 25 kg/cm2.

Obviously this type of press does not offer a very high production rate and it is often necessary to install several machines in the same plant. Single opening presses are suitable for applying decorative veneered panels.

3.27 Squaring and sanding the panels

Squaring consists in skinning all four sides of the panel to remove defects along the edges.

Two skinning machines with two blades each are used together with a transfer unit so all four edges of the panel can be machined in one pass. Two circular carbide tipped blades driven by frequency electric motors are used to cut the panels.

Usually, the circular saw blades are combined with hogging cutters for chipping the trimmed edges. This makes it easier to remove waste material from the work area.

The panels are sanded so that they will have a smooth surface and a pleasant appearance.

All modern sanding machines use flexible abrasive belts. Some of these machines are just for finish sanding but some have more than one abrasive belt and can be used for thicknessing and finish sanding plywood panels.

Both sides of the panels can be sanded in just one pass when two sanders are linked in line. One of these machines is a top sander and the other is a bottom sander.

The most modern machines have two or more abrasive belts both on top and bottom.

3.28 Veneer Slicing

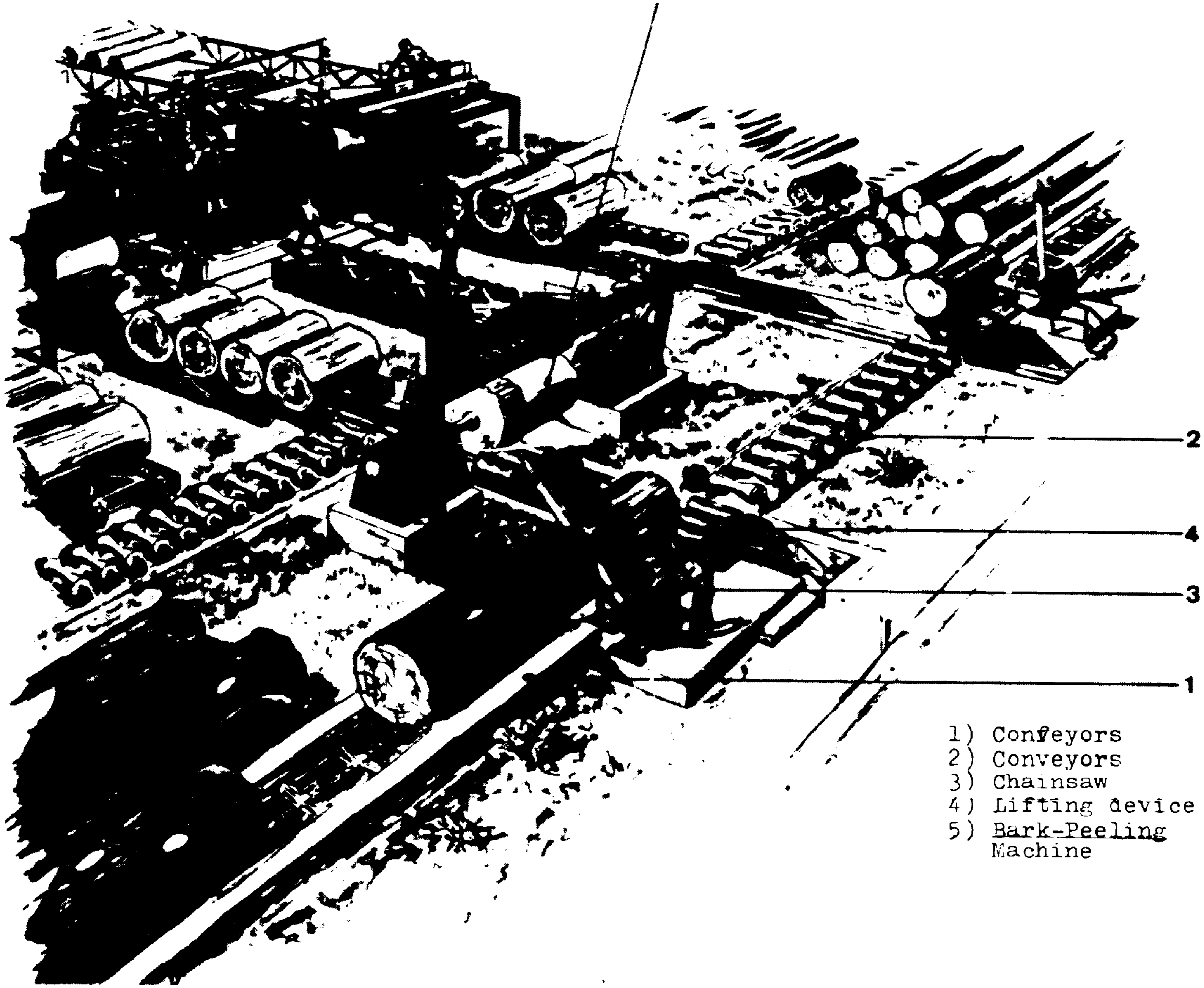
Our final topic deals with plywoods which are face veneered. These veneers are about 0.6 mm thick and they are sliced from flitches. They are "decorative veneers".

Since this operation is often included in plywood plants, a lay out for a slicing plant is included . (Appendix F)

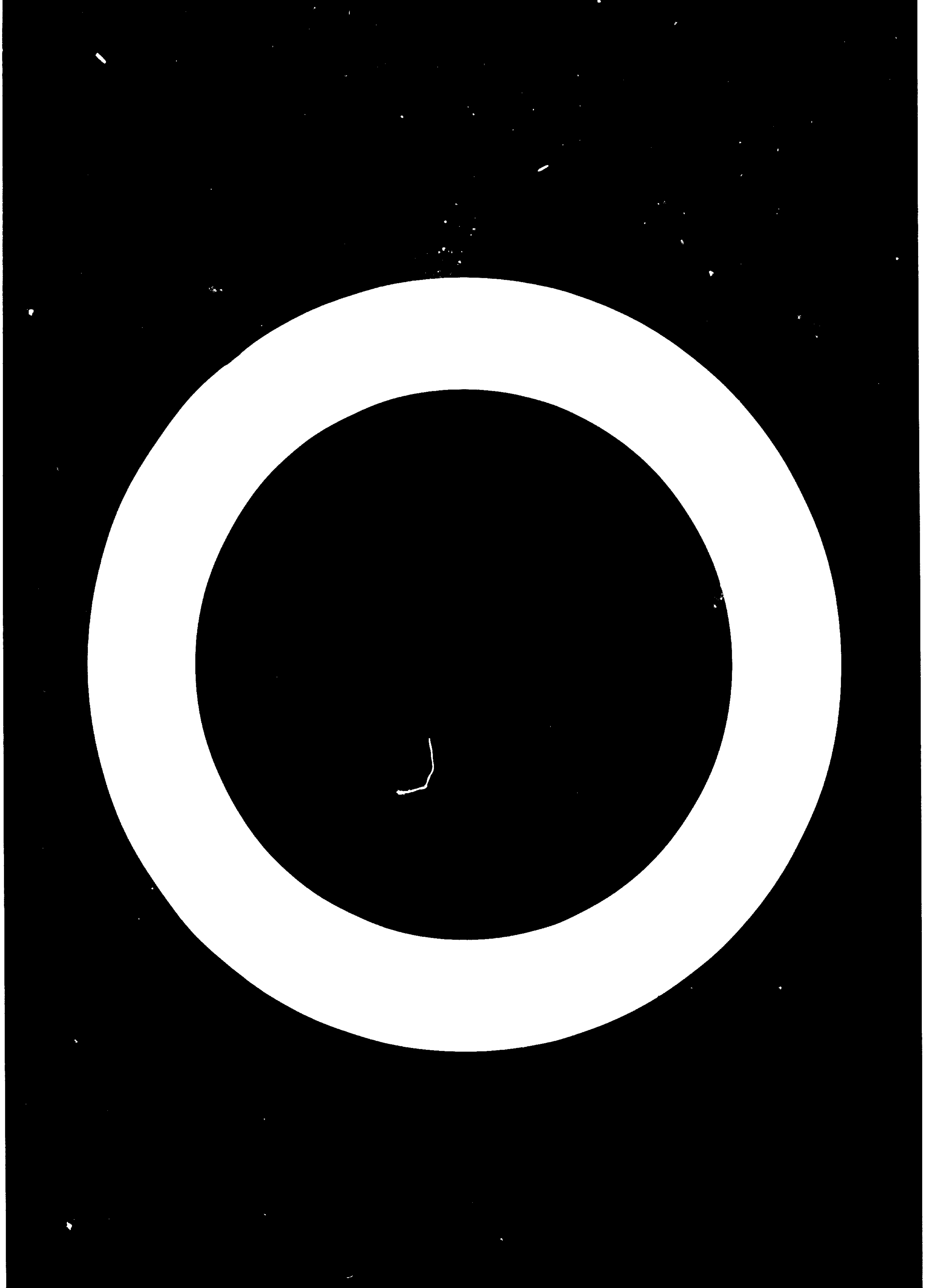
4. Outline of a Plywood Plant (Appendix I)

In conclusion an outline for the makeup of a Plywood plant capable of utilizing exotic logs as the source of raw material. operating the peeling lathes and presses on a double shift basis, with the dryers, trimming machines, taping machines and finishing line is being made part of this report.

LOG BARKPEELING AND CUTTING TO SIZE PLANT AND CORRESPONDING TRANSPORT TO THE PEELING LINES.



1) Confeyors
2) Conveyors
3) Chainsaw
4) Lifting device
5) Bark-Peeling Machine



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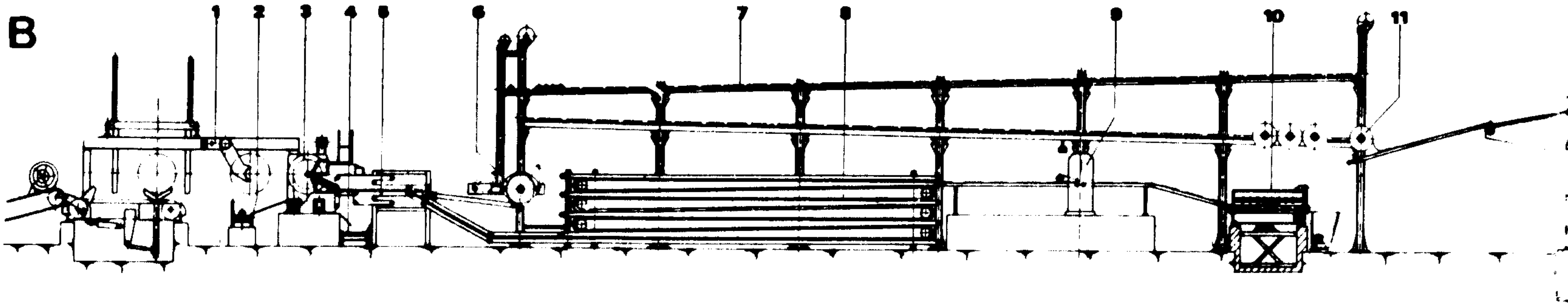

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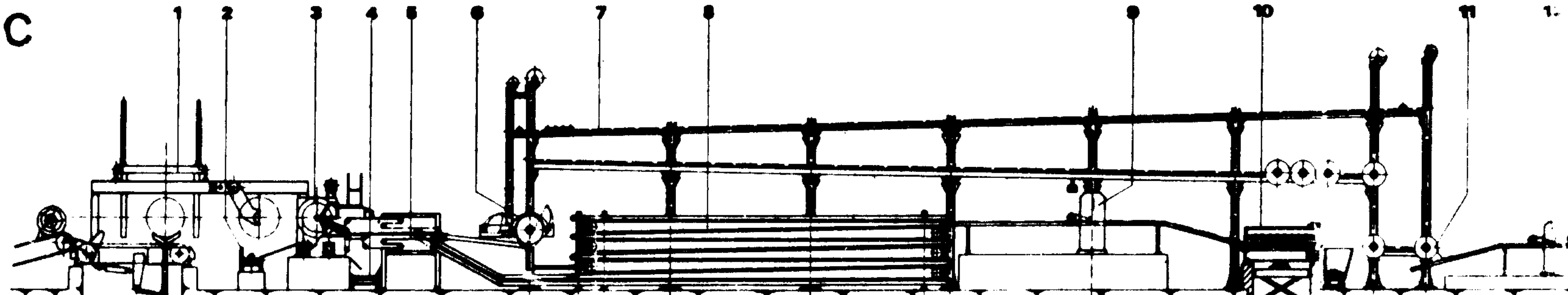
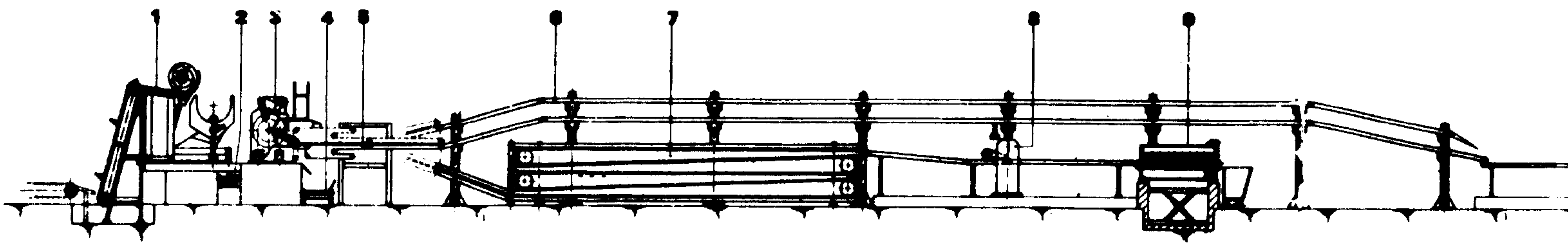
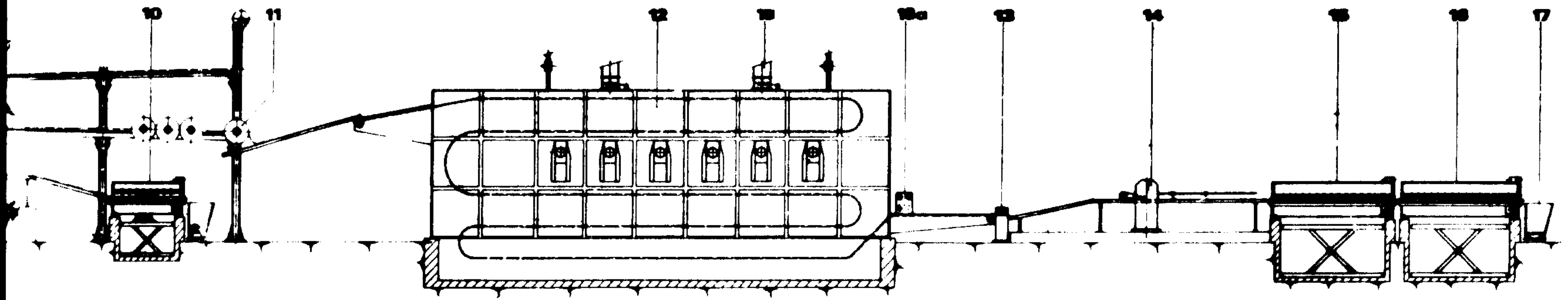


APPENDIX C - CONTINUOUS LINE FOR THE TRANSFORMATION OF LOGS INTO WET PEELED SHEETS

D



APPENDIX D - CONTINUOUS LINE FOR THE TRANSFORMATION OF LOGS INTO WET PEELED SHEETS (DECK SYSTEM)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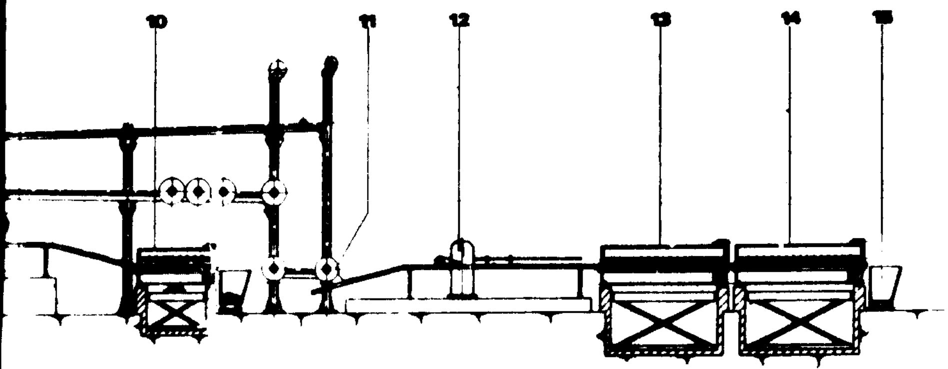
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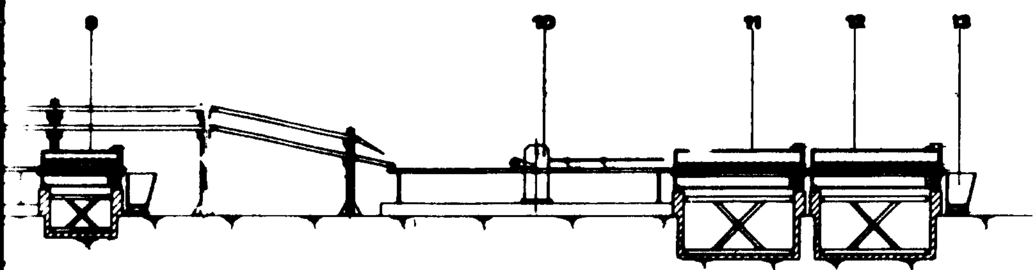
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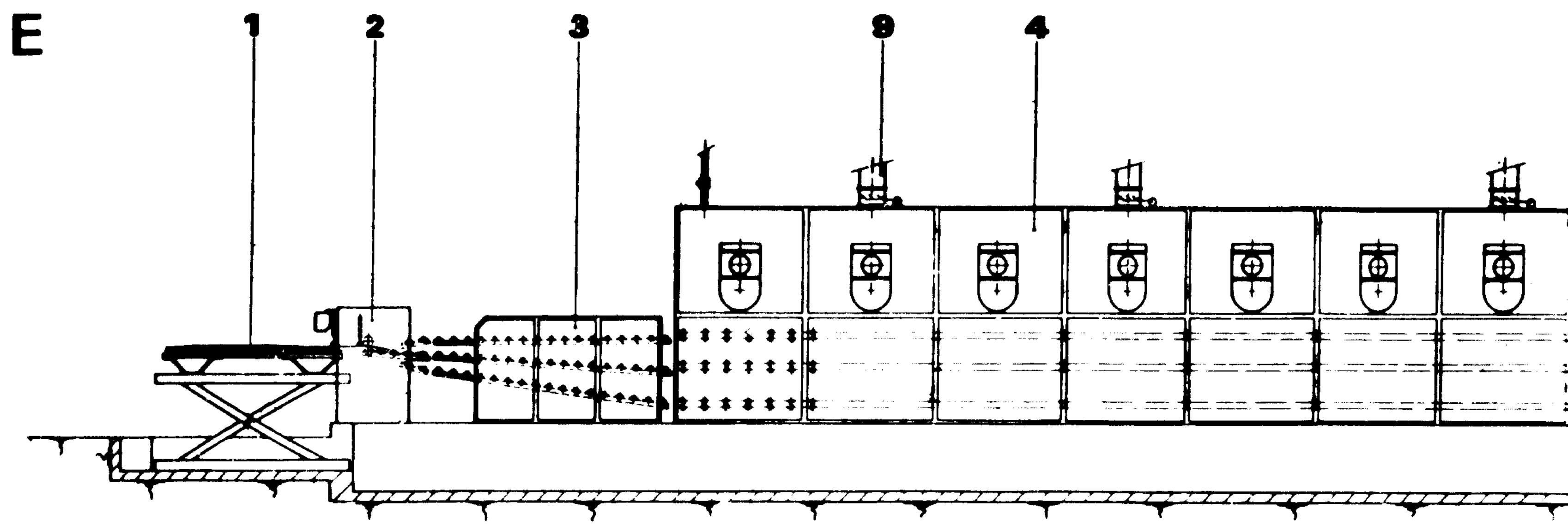
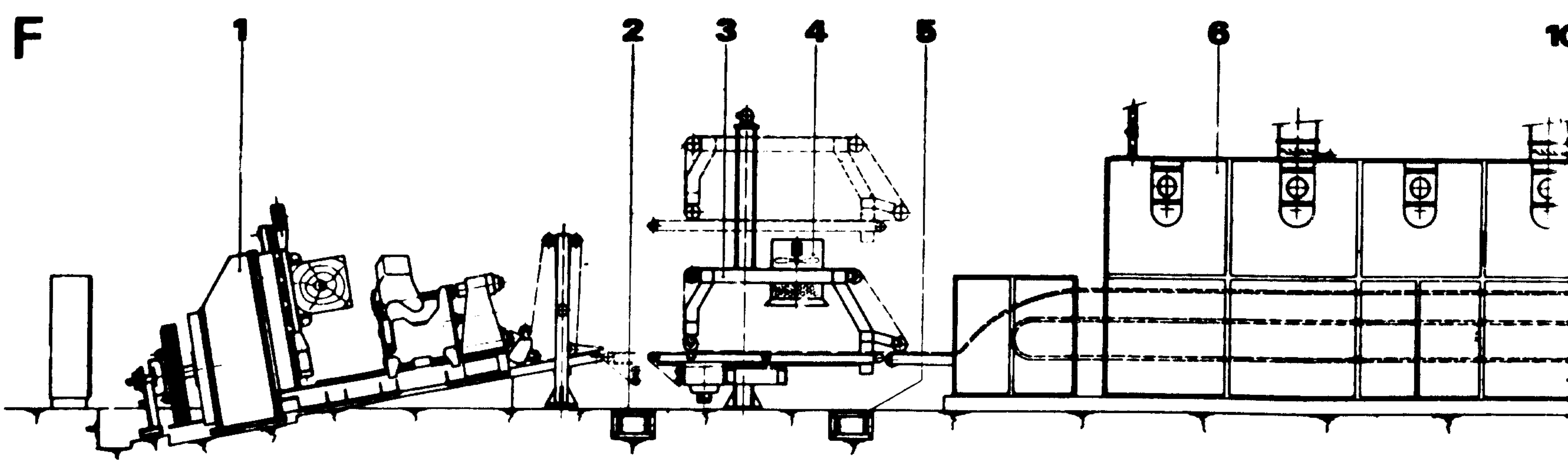
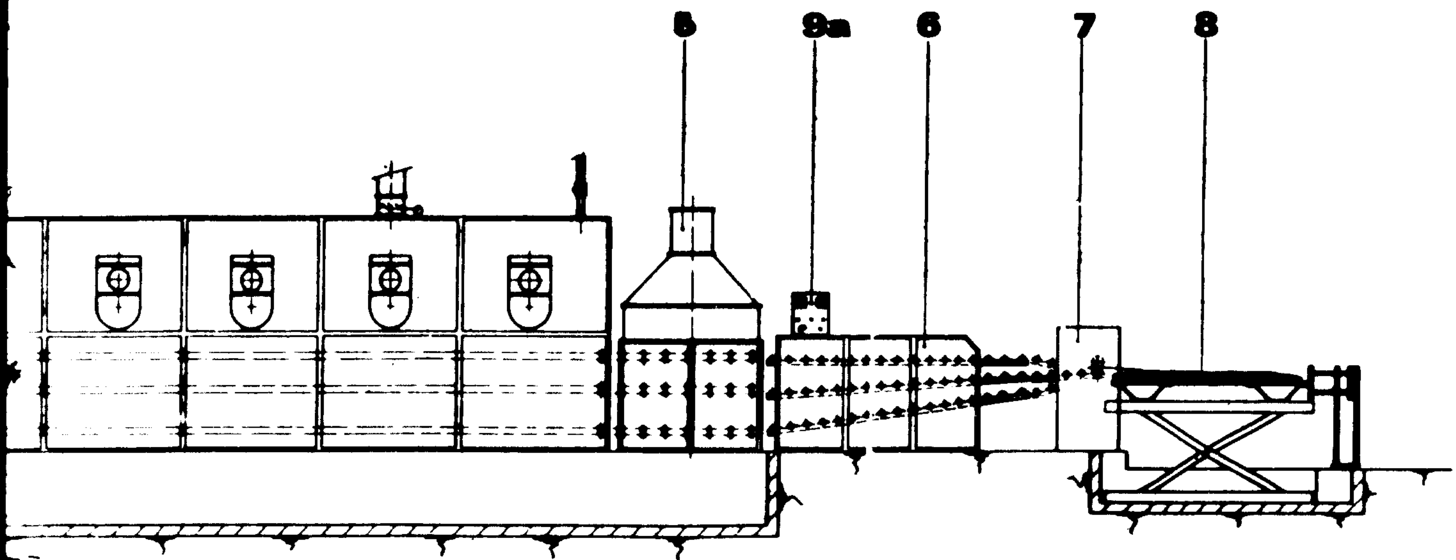


APPENDIX E - ROLLER DRYER WITH AUTOMATIC LOADING AND UNLOADING OF PEELED VENEER SHEETS



APPENDIX F - CONTINUOUS LINE FOR THE TRANSFORMATION OF LOGS INTO DRY SLICED VENEER



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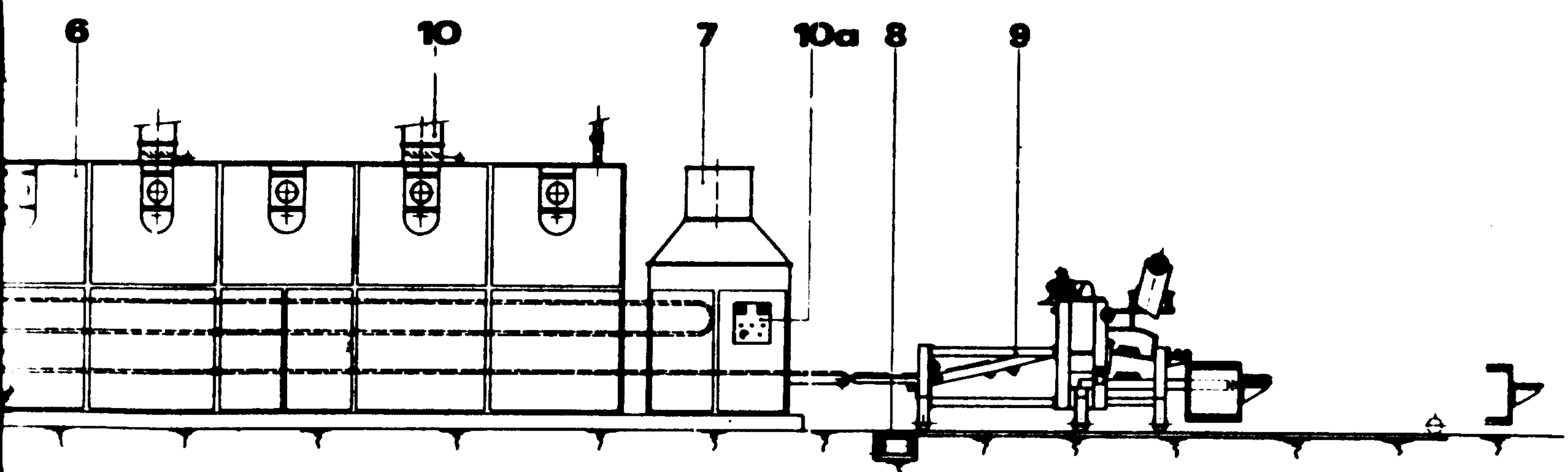
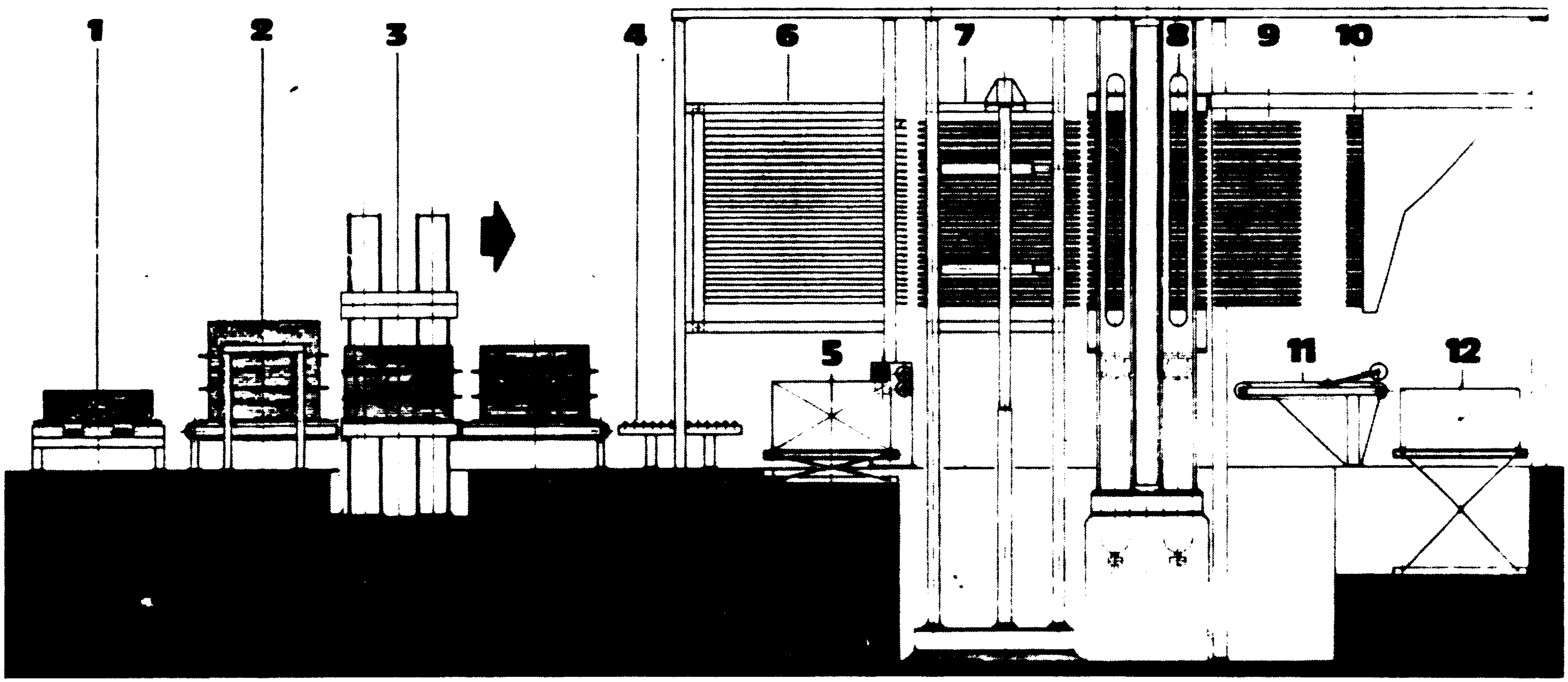
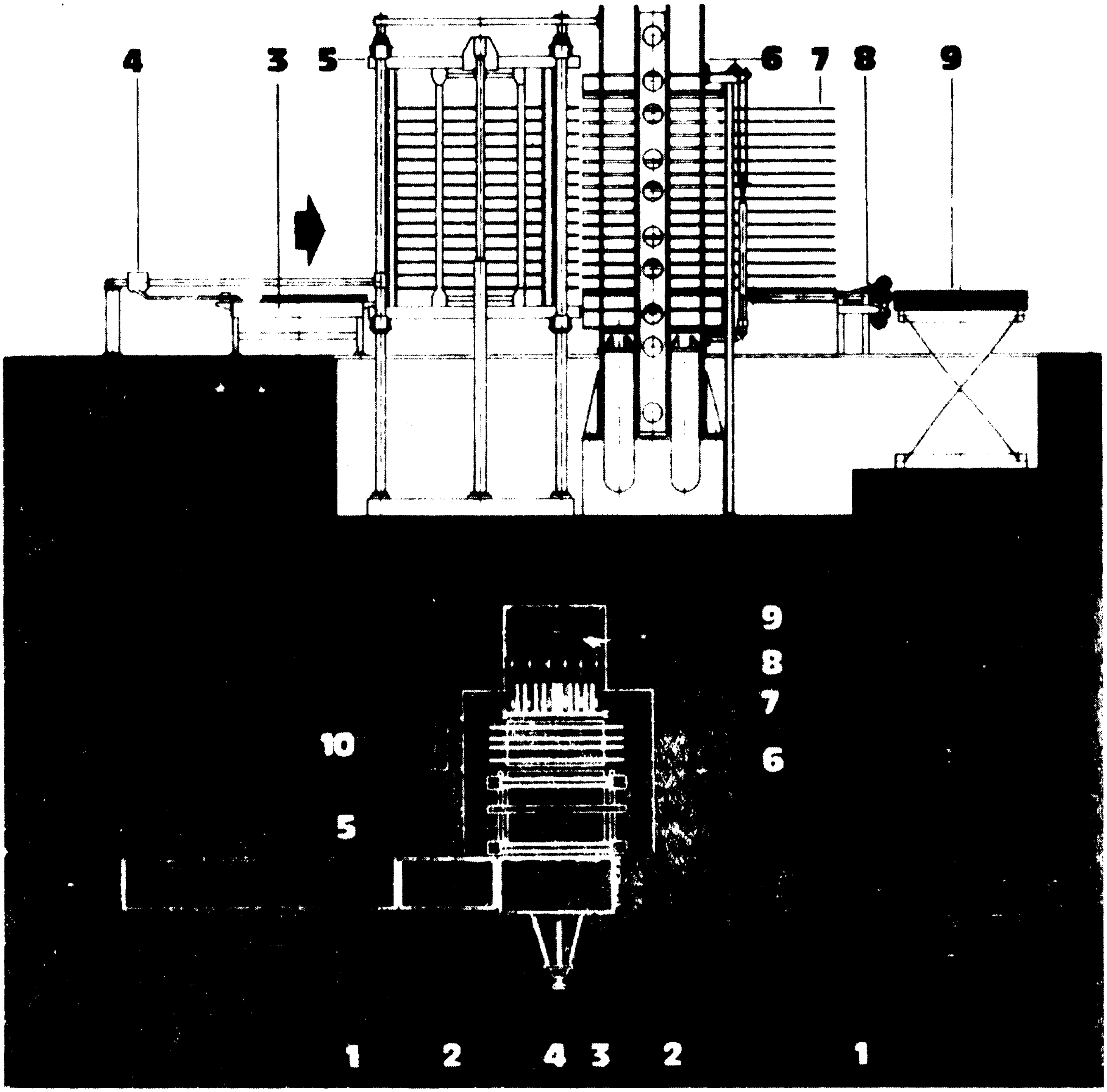


VENEER



Appendix G - Automatic **Pressing Lines with Pre-Press**

1) Book building conveyor
2) Pre-press conveyor
3) Oil-hydraulic pre-press
4) Intermediate conveyor
5) Board loading device
6) Pushing arm in the press
7) Loading lift
8) Multi-opening hydraulic press
9) Unloading lift
10) Press extracting unit
11) Board ejecting unit
12) Piling platform



Appendix H

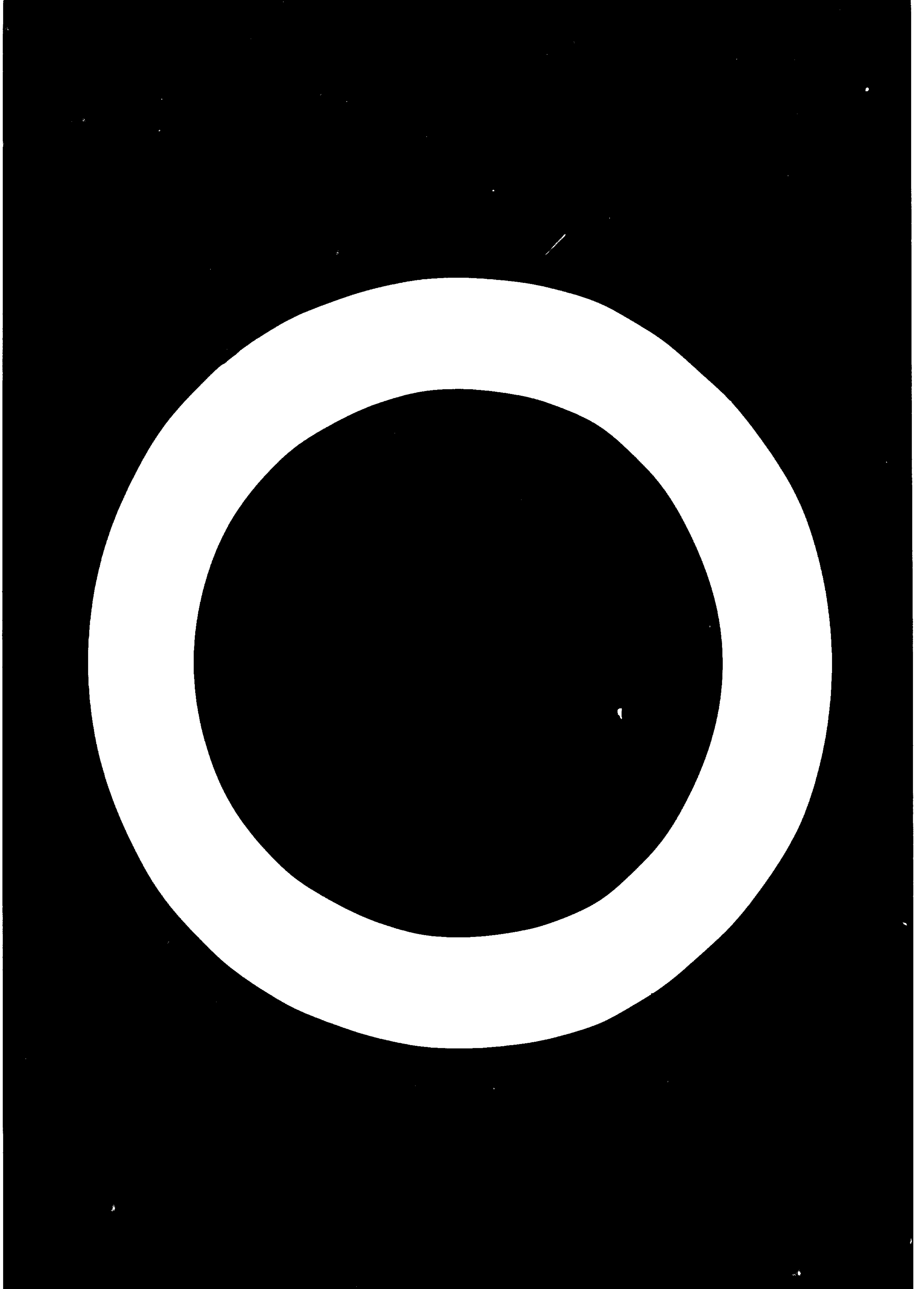
MULTI-OPENING PRESSES WITH AUTOMATIC LOADING AND UNLOADING DEVICE

1) Book building bench
2) Intermediate bench
3) Inserting bench
4) Oil-hydraulic pusher
5) Automatic loading lift
6) Press with heating platens
7) Unloading lift
8) Extracting arm
9) Piling platform
10) Control desk

APPENDIX I

Details of a plywood plant as shown in Drawings 1/a and 1/b

1)	2 electric chain-saws
4)	1 log debarking machine
5)	1 electric hoist
6)	3 electric hoists
7)	runways for electric hoists
8)	2 optical centering and loading devices for logs
9)	2 peeling lathes
10)	2 complete lines for waste utilization
11)	1 oonveyor for rest rolls
12)	2 oonveyors for peeling wastes
13)	1 chip-forming machine for wastes
15)	2 hanging trucks for reel transport
16)	Supporting framework for reeling truck
17)	2-floor reel store
18)	2-floor reel store
19)	1-floor reel store
20)	80 reeling reels
21-22-23)	5 pneumatioally controlled clippers
24)	2 automatic clippers
25)	2 belt conveyors
26)	1 continuous dryer with cooling chambers
27)	2-floor belt conveyor
28)	2 roller dryers with cooling chambers
29)	1 electrohydraulic elevator
30)	Contact sanding machine with upper band
31-32)	3 automatic trimming clipping machines
33-34-35)	3 automatic clippers for peeled veners
36-37)	2 clippers with 2 symmetrical sections
38)	4 belt oonveyors
39-40)	2 transversal jointing machines
41)	4 longitudinal splioing machines
45)	3 glue mixers
46-47)	4 oylinder gluers
48-49)	6 electrohydraulic elevators with roller table
50)	2 roller tables
51)	4 double roller tables
52)	Hydraulic oold pre-press for panels 2440 x 1220
53)	Hydraulio pre-press for panels 3050 x 1525
54)	Hot-plate press for panels with 32 openings
55)	Hot-plate press for panels with 32 openings
56-57)	11 electrohydraulio elevators
58-60)	2 double squaring machines
59)	1 intermediate device between the squaring machines
61-62)	5 roller and ball tables
63-64)	8 electrohydraulic elevators with roller table
65)	1 contact sanding machine with lower band
66-68)	2 motorised roller tables
67)	1 contact sanding machine with 3 upper bands



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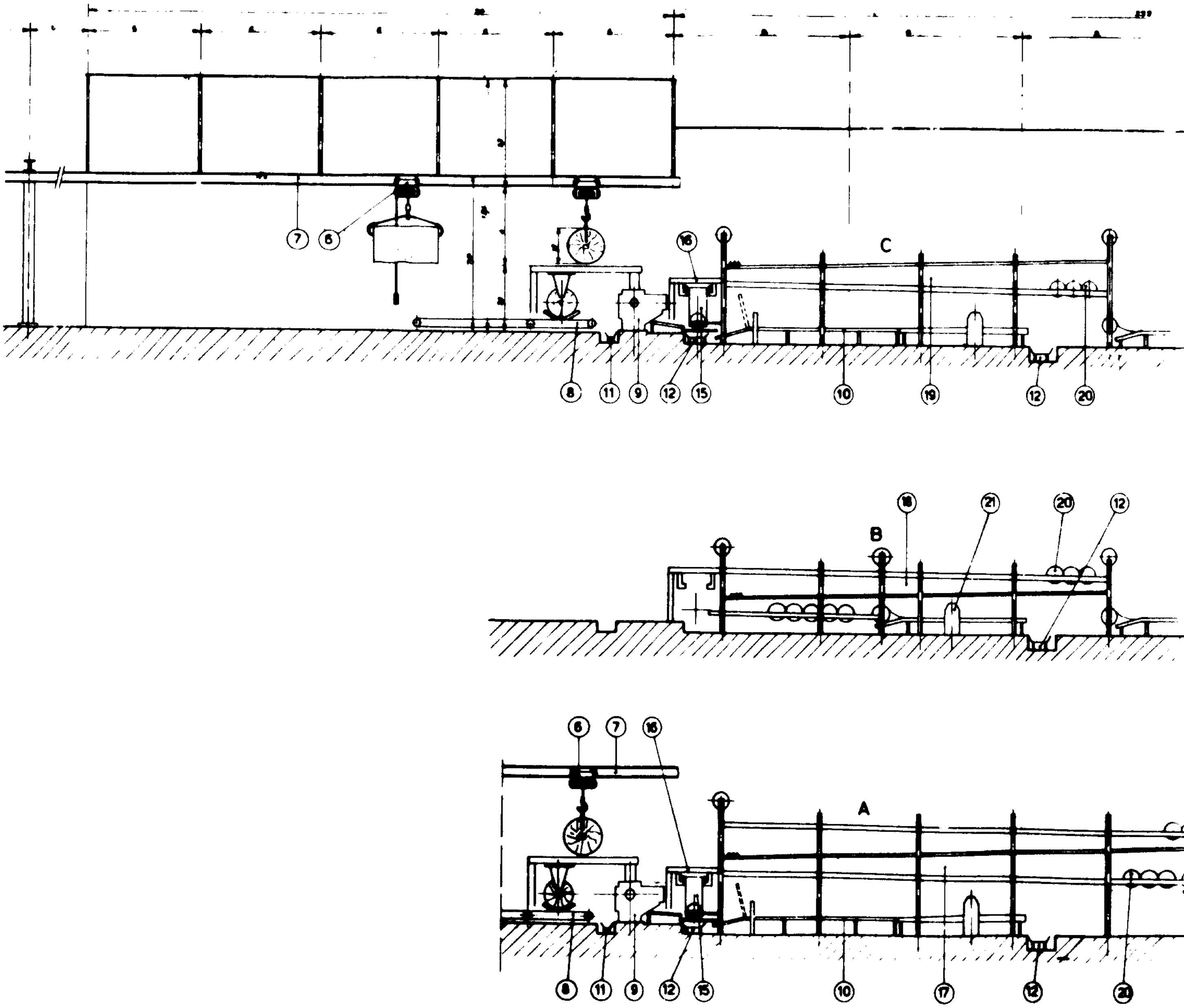
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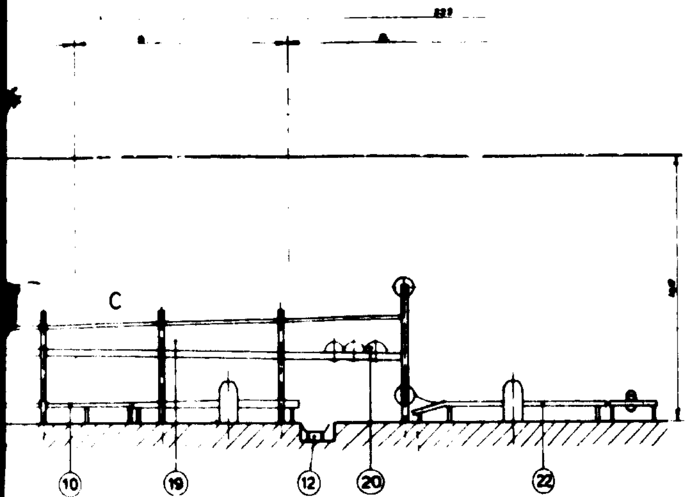
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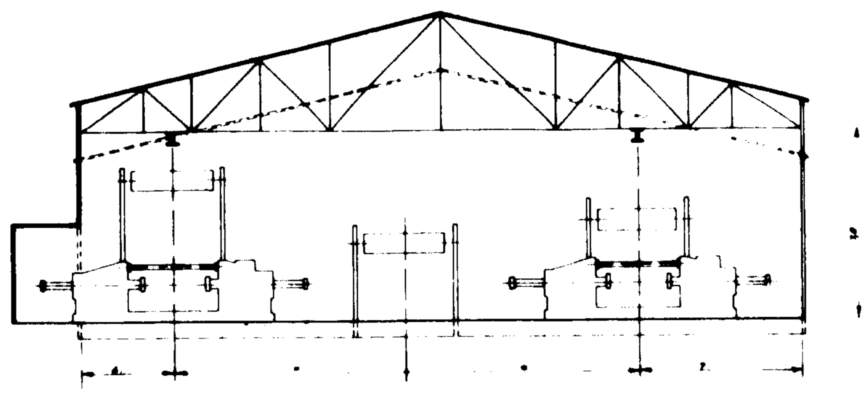

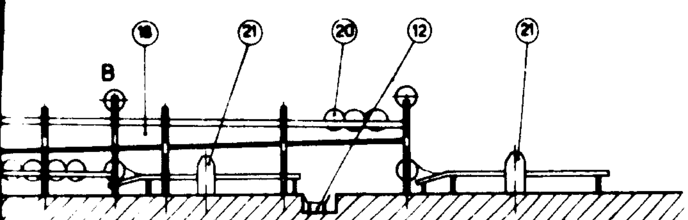
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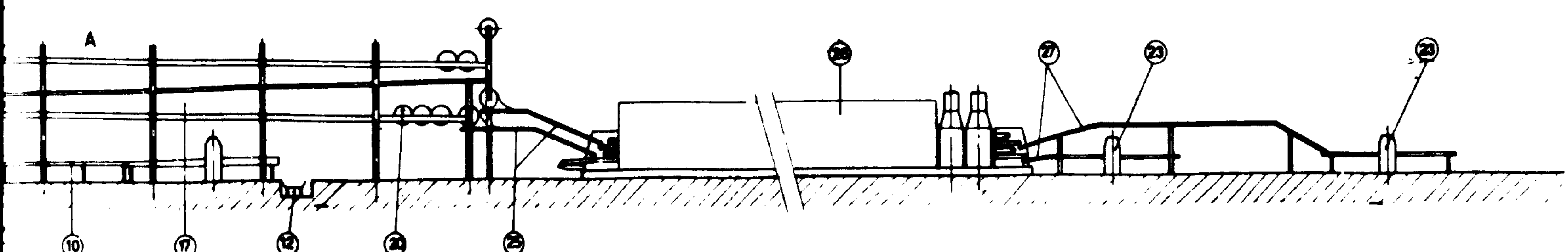
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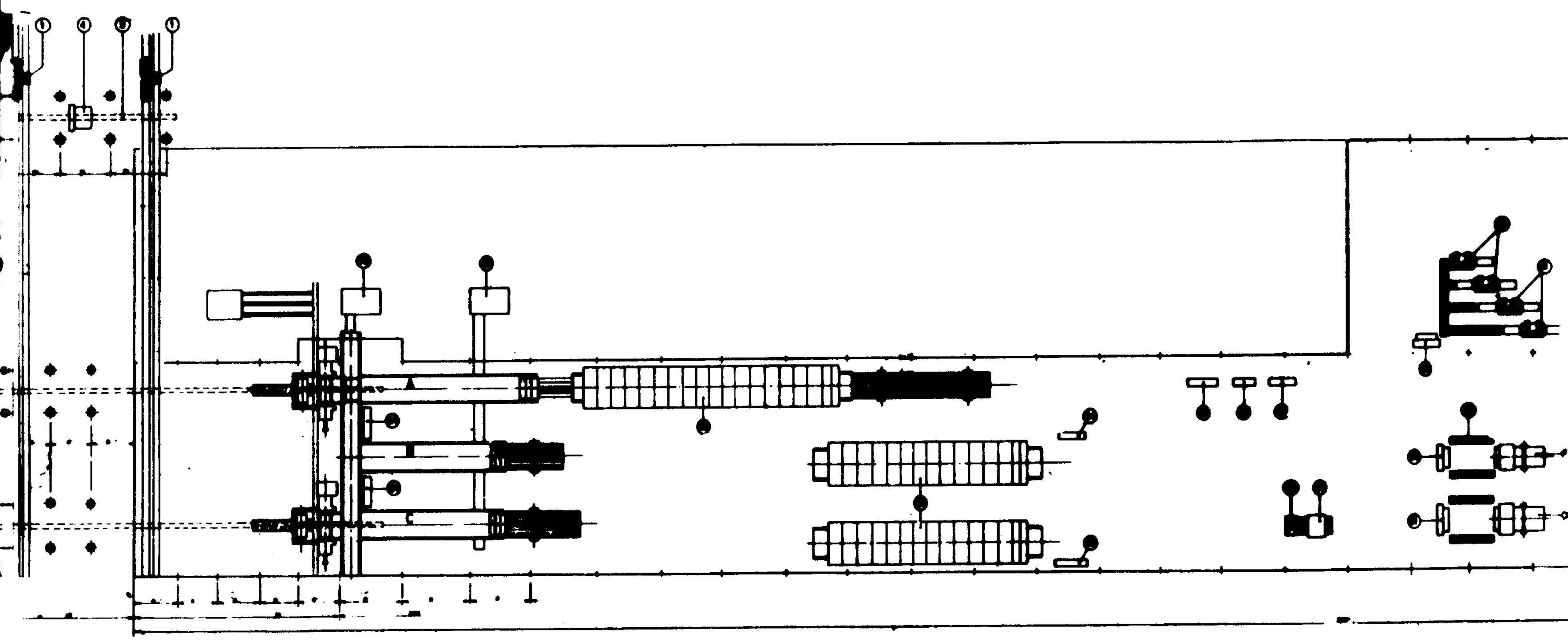
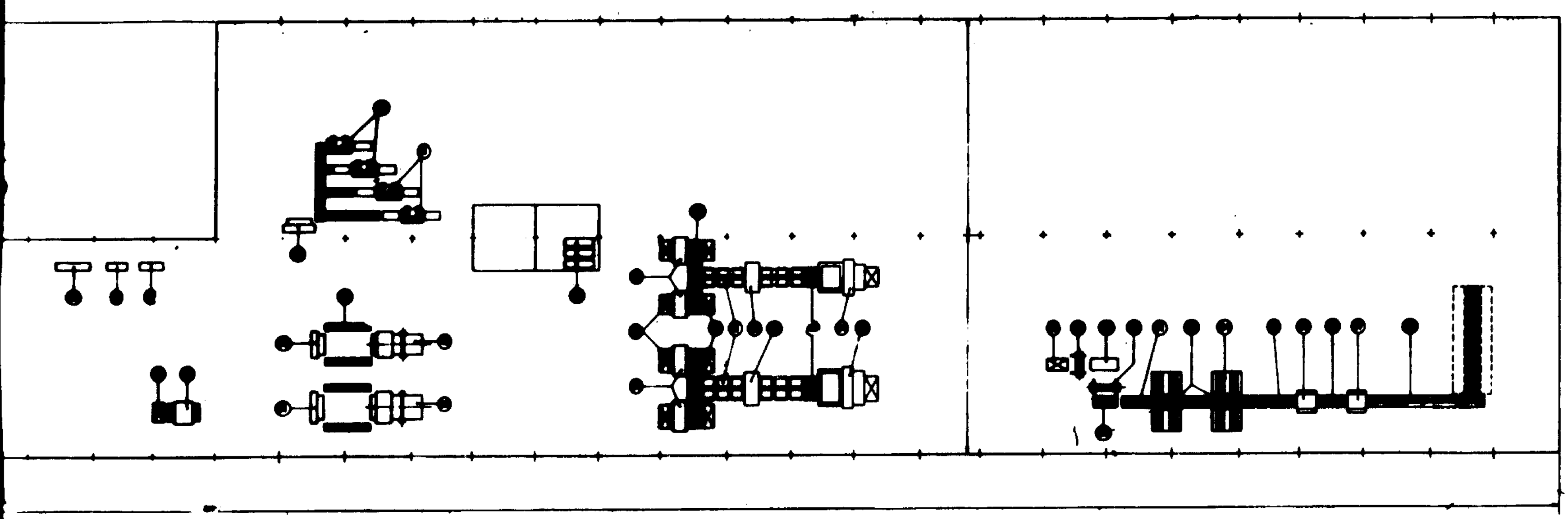
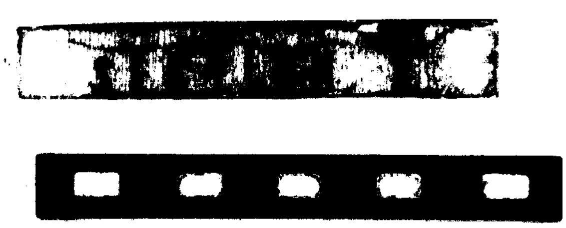
?PENDIX I (CONTINUED)

I/b







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