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08668

Distr.
LIMITED

ID/WG.277/16
21 November 1978

ENGLISH

United Nations Industrial Development Organization

Technical Course on Criteria for the
Selection of Woodworking Machinery

Milan, Italy, 8 - 19 May 1978

PANEL SURFACE IMPROVEMENT AND SELECTION OF APPROPRIATE EQUIPMENT*

by

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id.78-8188

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Introduction

Utilization of wood based panels, such as blockboard, fibreboard, plywood and mainly particle board, in a direct way, namely, without their surfaces undergoing an improvement from the aesthetic angle, and above all with no improvement of their physic-mechanic characteristics, are gradually disappearing, with the exception of certain kinds of packings.

Surfaces of plywood, fibre and particle board, destined for the building trade, furniture and transport industries, are usually treated and laminated. By the term "surface improvement" we mean the process lending better physic-mechanic characteristics, whereas the term "lamination" relates to that process which, besides improving the aforementioned physic-mechanic properties, imparts also a pleasing appearance.

The main surface characteristics, obtained in improvement through the lamination process, are resistence to scratch, abrasion, moisture and heat, as well as to some household chemicals. These properties may have different values which do not always meet the international rules (for example, DIN, NEMA, etc.) and depend on substrate material, laminating material (papers and resins) and on the system adopted for lamination.

Lacquering and coating processes of boards by means of PVC foils, are not being referred to in this report, since, from the point of view of technology and final characteristics, they are not claimed to be a true lamination.

• Materials for lamination

1. Substrate materials:

- plywood
- fibreboard
- particleboard (owing to its general application in the building and furniture industries it will be more widely covered in this report).

1.2. Laminating materials

- decor laminates
- papers impregnated with melamine
- melamine modified with urea or acrylic resins.

Substrate materials

1.1.1 Plywood (from 3 to 25 mm) bonded with urea resins

The lower grades of plywood are normally utilized by the packing industry, whereas the better grades are used in the production of doors and furniture (in the latter case a further surface treatment is applied, by lacquering or printing and lacquering).

For the time being, the true lamination is realized by means of diallyphtalic or urea as well as modified urea impregnated papers.

Glueing of light papers (about 40 gr/m2) with PVC or PVA copolymers based glues, or urea glues, is also employed. On this purpose, several kinds of papers are available, that we shall describe furthermore, dealing with particle board lamination.

1.1.2 Plywood board, bonded with phenolic resins (marine use)

This kind of board may be manufactured, with treated surfaces, following "one step" or "two steps" process. In the first event, the glued veneer, inserted between phenolic resin impregnated papers, is coated with phenolic resin impregnated papers (TEGOFILM - BK type) and pressed together with the whole panel sandwich. A conspicuous rejection occurs in this process, owing to faulty veneers.

In the second case, the plywood board is first produced with no impregnated papers coating. It will be then controlled, selected and "improved" by pressing in multi-openings press, if coupled with phenolic resin papers, TEGOFILM - BK type, or in single-opening press, if phenolic papers, TEGOFILM - BR type, are utilized.

"Two steps" process is more appreciated and followed by the present trends. Summarized, its characteristics are set down as: pressing time about 6-10'; pressure, depending on wood type, about 15-18 kg/cm2; temperature about 145°C. Some of the most important areas of use of this production are to be found within the building industry (molds), containers, railways wagons, etc. ...

1.1.3 Fibreboard

Apart from fibreboards, being lacquered on their surfaces during production, from panels with printed and lacquered surfaces, or from "compound" boards (2 or more being pressed at the same time), two are the main trends followed in their lamination:

1.1.3.1 Hot/cold process in multi-openings press, mainly with melamine and modified melamine impregnated papers: pressing cycle about 10-15'; working temperature about 140-145°C; pressure about 40 kg/cm2.

1.1.3.2 Hot/cold or hot/hot process in multi-openings press (seldom in single-opening press) by means of diallyphtalic papers. With this kind of paper, the manual or semi-automatic multi-openings press are widely used, thanks to their easy handling, since diallyphtalic papers are very flexible and quite sticky, thereby not particularly suitable for automatic plants, mainly the ultrarapid single-opening ones, K.T. type.

Fibreboard lamination, following K.T. method, with melaminic papers, in single-opening press, has had fairly slow success, because of technological difficulties due to the high specific gravity of the panel and to its structure, obstructing an easy exhaust of gas, produced during lamination.

1.1.4 Particleboard

Since this material has a wide-spread adoption in laminating process, it is particularly necessary to observe the quality requirements. Beyond meeting the various international rules (for example DIN 52360), the panel, to be laminated, must gather a range of properties, in order to grant a good success of the process and the qualities required by rules (DIN 52360, DIN 68761) or by the end-user.

Some of these qualities are:

- constancy of specific gravity throughout the surface and possibly not less than 0.65;
- absolutely uniform surface structure for application of light papers (about 40 gr/m2) with light color and/or low covering capacity, very thin and, if possible, with wood of same species;

- surface free of dust, grease, paraffins, glue stains, eto., perfectly smooth (grain minimum 120) and without "beating" marks of emery-paper, which may occur during sanding operation;
- even thickness (tolerance $\pm$ 0.1 mm);
- perfectly balanced structure, resin content in the surface not less than 12 %.

Due to the lack of wood, particleboards are manufactured with all the wastes, including bark, which make the surface quite uneven, not very pleasant from an easthetic point of view and with poor physic-mechanic properties. In order to avoid such drawbacks, studies and researches are carried on, in pursuit of ever-new solutions, which must have technical and economical validity, such as utilization of "filling-pores" papers, mentioned hereinafter.

1.2 Laminating materials

Apart from mentioning the well-known chemical reactions of resins employed in paper glueing, we shall summarize the kinds of papers used in laminating process (that we shall treat again hereinafter).

1.2.1 Papers impregnated with melamine or modified melamine resins. In hot/cold and hot/hot process, the raw papers weight is usually about 80-120 gr/m2.

1.2.2 Papers impregnated with melamine or melamine modified with urea resin. For the hot/hot process, the raw papers weight is usually about 80-120 gr/m2.

1.2.3 "Pore Filling" papers (2 types) impregnated with urea, applied by means of glues or being self-adhesive. Weight of non self-adhesive papers: 125-220 gr/m2 temperature about 120°C - pressure 18 kg/cm2 time about 120 sec.

Weight of self-adhesive papers: 90 - 200 gr/m2; temperature about 160°C; pressure 12-18 kg/cm2; time about 90 sec.

1.3.4 Totally bakelized papers, impregnated with melamine or modified melamine resins, for application instead of veneering, with natural veneer (artificial wood). They are bonded with urea or vinyl glue. Weight of raw papers about 120-180 gr/m2.

1.2.5 Light papers, impregnated with urea or urea modified by acrylio resins, foreseeing, or not, polyester resins spreading on to the surface, which will be backed on to the surface to be laminated, and may be (or not) next lacquered. Papers weight about 30-40 gr/m2.

1.2.6 Papers impregnated with melamine, urea/acrylic resins, including "hot-melt" spreading, for a direct application under press. Pressing time (provided that bonding paper is already bakelized), about 2 sec.; weight of raw papers: 90-150 gr/m2; pressure about 10 kg/cm2. Temperature depends on "hot-melt" type, but usually it is about 150°C.

1.2.7 Papers impregnated with urea/acrylic resins and micro-pearls of acrylic resins, applied according to vacuum penetrating system. The boards coating is realized at the same conditions as described under paragraph B.6
Weight of raw papers: 90-120 gr/m2.
(it is possible to employ even lighter papers).

All these kinds of papers (except the already bakelized melamine ones) may be pressed with tie plates, reproducing wood pores. Pores may be embossed, during impregnating process, on papers impregnated with modified acrylic resins, or later on, by means of suitable calenders, as well as during the laminating process, being either executed with calender, or in press using die plates or embossing sheets.

Several changings may be found in these papers, depending on the board and on its end-utilization, or on the same producer, who requires specific properties, oonsistent with operating cost and final price.

2. Systems and trends in paper application

Either technology or experience have pointed out four different systems for particleboard lamination that we can summarize as follows:

1) a) impregnated papers manufacturing
   b) particleboard manufacturing
   c) decorative laminate manufacturing
   d) cold or hot coating of decorative laminate

2) a) impregnated papers manufacturing
   b) particleboard manufacturing
   c) hot/cold or hot/hot laminating

3) a) impregnated papers manufacturing
   b) particleboard manufacturing and simultaneous lamination with impregnated papers

4) a) papers manufacturing being impregnated and/or spreaded
   b) particleboard manufacturing
   c) coating with impregnated and/or spreaded papers

No doubt, lamination by means of decorative laminates coating must be almost solely imparted to flat surfaces, owing to its high operating cost. Simultaneous lamination is fairly slow developing, due to technological difficulties, involving machine shop rejection. On the contrary, lamination, according to the enclosed schemes, foreseeing impregnated papers setting and next coating of boards in press, is developing a continuous growth and presents a considerable technological evolution dealing with:

a) resins
b) raw papers (not impregnated) and impregnated papers
c) technology in papers setting
d) applying technology of papers on to surface to be laminated
e) plants for this process realization

Further to the ever-growing requirement of laminated product in several uses, rules requisites have changed too, or the standards, relating to surface properties and running now, (DIN 68754), are not even observed.

Dispute between laminate's quality and low price, in regard to its end-use, is becoming stronger and stronger. Actually, only the user (market) may judge on the matter, obliging technicians to establish new standards, concerning surfaces characteristics and developments in the industry.

Interest in lamination process, realized by all its various systems, is pointed out by statistics: whereas quantity of boards veneered with natural wood is lowering, the amount of laminated boards is increasing. Furthermore, about 23 % of particleboard production is laminated. That is why a continuous progress has been recorded in development and technology of installations destined to realize this process.

3. Technologies for laminates production and new plant development

Base materials (particleboard, decorative laminate and/or impregnated papers) are assemtled according to various systems:

3.1 Applying technologies (hot/cold and Hot/hot), the following systems are being outlined:

3.1.1 Lamination with decorative laminates

It is one of the oldest direct backing system of decorative laminates on to particleboard surface and/or, in general, of the wood based panel. Coating is imparted on both sides, to avoid bending. One surface is covered with a first rate quality material, whereas the other one is backed with a material acting just as a tensions equilizer. Application is very simple as shown in Schemes No.1 - 1A and 2. (Appendices I, II, III).

The sandwich is set up on the loading belt: first a decorative laminate, next a particleboard spread glue with urea or PVA and PVC copolymers-based adhesives and then another laminate. The entire sandwich is then fed into the press.

Press temperature: 100–140°C; pressure: 5–10 kg/cm2.

The time required for pressing depends on: type of adhesive, temperature, plus the laminate's thickness, but usually it does not exceed 90" (1.5 min).

After the press hot cycle the panel is extracted by a vacuum hoist truck or by the same loading belt, if the press is the veneering type.

This system is still being followed to impart particular surface characteristics, corresponding to standards such as NEMA LD1-1-01, DIN 53799 or similar ones. By utilizing a band-tablett plant, shown in Scheme N.2, it is possible to realize also a K.T. lamination, as the press can operate at 25 kg/cm2.

3.1.2 Hot/cold laminating system

This process, illustrated in Scheme No.3 (App.IV), is carried out in multi-opening presses. Impregnated papers, already referred to, are applied to both surfaces of the particleboard substrate.

Two papers are applied to each surface to create better surface uniformity of the laminated panel and to cover possible structural faults of the board.

Papers in contact with the panel are of the sub-layer type, impregnated with phenolic or melamine resins, whereas surfacecoating foils are impregnated with melamine resins. The sandwich (decorative aper, sub-layer, particleboard, sub-layer, decorative paper) is placed between stainless steel cauls covered with "cushion" and then fed into the press by infeed conveyor elements (in some plants the top cushioned stainless steel cauls are fixed in the press).

Approximate pressing conditions are:

- pressure 18-22 kg/cm2
- pressing time dependent on the type of resin but the total cycle usually varies from eight to twenty minutes
- type of papers can be ascertained by reference to the following table which outlines some basic data.

Paper type	Use	Resin content %	Volatility %	Fluidity	Resin type
Overlay: white - color	surface shielding	66-68 72-74	5 - 6,5 5 - 6,5	15 - 20 18 - 25	melamine
Decorative	surface lamination	54-60	4 - 5,5	0,8 - 1,8	melamine
Barrier	like decorative	56-59	4 - 5	2 - 3	melamine
Kraft 150 gr/m2 - 60 gr/m2	particle board fibreboard	38-40 31-34	7 - 10 5 - 7	7 - 10 2 - 2,5	phenolic 240-260 gr/m2 impr. phenolic
Overlay	board's reverse side	60-62	5 - 7	10 - 15	phenolic
Underlay white 100 gr/m2	idem	42-44	5 - 6	6 - 10	phenolic 170-180 gr/m2 impr.

Resin content of decorative papers, used without overlay, depends on their basic weight. Low weight papers need an higher percentage of resins, to assure a good fluidity on the surfaces subjected to pressure, of abt. 18-22 kg/cm2.

Diagram No 1 outlines resin content of papers used in the hot/cold process.

Pressing cycles depend on several factors (panel type and thickness , temperature of laminated surfaces, kind of papers and resins, pressure, plant) but they may be summarized according to diagram No.2 and 3.

Within the hot/cold process, we must remember too a "tandem" system, consisting of installation of two presses. In the first one the product's heating and curing are carried out in standard conditions, whereas the second one imparts cooling. In this manner it seems to be possible to obtain total cycles of approximately 6 minutes, saving about 30 % of energy.

3.1.3 Laminating process in single-opening press (quick hot/hot process with band-tablett).

Laminating cycle in this type of press, employing quick resins, is very short, about 1 min. or less. Its time depends on temperature of decorative surface, speed of heat transmission (this problem, from the thermic point of view, is present in all the plants), resin type, as well as on time the decorative paper remains, without pressure, in contact with the hot surfaces of sheets, on closing speed of the press and on the time necessary to reach the maximum pressure. For lamination, impregnated papers are used with:

a) melamine resin - modified melamine resins (type Medurit 5475 TS, 5458 Casella, melamine 222 Ciba and others type Binda, Goldschmidt, etc.)

b) diallyphtalic resins(currently very seldom used)

Particle and fibreboards must have the aforementioned characteristics. It is possible to laminate particleboard with even lower density than 0.65, owing to the very short time it is subjected to the final pressure and temperature.

For lamination with melamine resins, curing times are from 30" to 90" with temperatures (measured on decorative surface) respectively of 180°C and 145°C, and pressures of 18-22 kg/cm2. See approximative drawing No. 4.

After press loading, it is recommended not to allow the sandwich in contact with platens hot surfaces, when the pressure is not applied, for more than 8 seconds: otherwise, a premature paper curing will occur, not being uniform and/or partial, involving inevitable faults in laminated surface, such as prosity, shadings, etc.

Some technicians think the stay time in press, without pressure, should not exceed 20% of the total curing time. This opinion could certainly be challenged, because too high temperatures could generate yellowing and shading in the surface, even if stay time under pressure does not exceed 60 seconds. After curing and press opening, the board must be unloaded quickly, to avoid overcuring, and then inserted into suitable cooling units, to a temperature less than 60°C. Next a visual control and selection is carried out, for proper storage of the boards.

Scheme No.2 shows a plant for laminating process with band tablett. The charge is set on a belt, and both are next inserted into the press, where the charge is laid down on the hot surface. When doing so, a difference occurs in touch time with platens hot surfaces, between one and the other end of the board. This difference amounts to about 4 sec., obviously depending on board's length.

A main variation of this system, shown in schemes No.4 and 4A (App.V and VI) has been studied and patented by Messrs. Pagnoni. Here the board, once inserted into press, is not laid down until the band-tablett is drawn back, remaining suspended, on edges, between two heating platens. At this point, the press closes and simultaneously the board lowers, touching the hot platen, thus avoiding difference in touch time of papers with platens hot surfaces. This innovation, appeared some months ago on the market, allows to enhance the productive efficiency by approximately 30-40% and it is arousing a great interest among laminates producers, who are still following band-tablett system.

3.1.4 Ultrarapid single-opening press with "drop" loading (Fallbelegung)

In recent years much progress has been made in the development of horizontal press manufacture (since the vertical ones have not reached

the hoped for results); actually curing times have been obtained of about 1.5-2 seconds to reach half end-pressure and dead times of about 16 sec. Pressing cycle is summarized in diagram No.4.
With these times, in the drop loading system press, patented by Pagnoni and Pagnoni-Goldschmidt, it is possible to use papers having bakelizing time of about 18 sec. and total cycles held to 34".

Currently these are the plants which are capable of producing 70 boards/hour, at least, obviously depending on the kind of papers and resins which are employed.

The latter are modified and accelerated with different types and qualities of hardeners, acting approximately as shown in diagram No.5.

The board is set up and inserted into the press, by means of a special truck, provided with arms which release the charge during press closing, thus reducing almost to nothing the touch time of laminating papers with platens hot surface. Complete reaction homogeneity is therefore obtained in papers resins, since heat effect is absolutely simultaneous and even.

This system is shown in schemes No.5-5A,5B,5C,5D. (App. VII,VIII, IX,X,XI). The types of paper utilized here vary from those used for the hot and cold system. Their resins content is illustrated in diagram N.6 Boards characteristics should meet requirements of DIN rule No. 6875)65.

Positive and negative features in K.T. (hot/hot) and K.E. (hot/cold) system.

Positive features in K.T. system:

1) possibility to laminate boards having low specific gravity, without loss of thickness (always for climatized boards)
2) much lower energy consumption (of about 8 times)
3) lower initial investment
4) easier maintenance
5) less labour ($\pm$ 2)
6) productive efficiency: it depends on the plant

Negative features in K.T. system:

1) impossibility to obtain gloss surfaoe (at least for the time being)
2) severe control needed throughout the process for all materials employed)
3) requirement of more sophistioated plants in order to avoid long touoh time for papers with hot surface
4) inferior properties of laminated surface (lower abrasion, staining resistance).

Positive features in K.E. system:

1) possibility to obtain the preferred finish (matt or gloss)
2) superior mechanic properties of surface (abrasion, impact, staining resistance)
3) much easier and safer prooess

Negative features in K.E. system:

1) higher initial investment
2) superior energy consumption
3) additional labour

Based upon these reasons, for and against both systems, it is possible to out-line some technical and economical consideration, whioh are summarized in the following table.

Technical and economical considerations that may be done on plants for hot/cold and hot/hot process :

Process	hot/cold	hot/hot
Press type	multi-openings	horizontal single-opening
Investment	quite high	quite low
1 hour output per press	high: ex. 20 openings - 5 pressing cycles = 100 boards	low: ex. 1 press = abt. 60 boards/hour
Energy consumption	high	inferior
Mechanical stress during working	low	high
Necessary surface	big	inferior
Cooling in press	necessary	not necessary
Boards cooling out of press	not necessary	necessary (it depends on type of papers - resins)
Sheets and cushions costs	high	low
Product quality	very good (gloss surface)	good (only matt surface)
Resins cost	now inferior	now higher
Impregnated papers stability	long	short
Possibility to laminate boards with specific gravity	0,65 - 0,75	even less
Board's deflection	standard (abt. 5%)	inferior (almost nothing)
Safety of technological process	very high	now inferior
Appearance of laminated surface	all shades from matt to gloss (mirror)	now only matt

3.1.5 Simultaneous lamination

In regard to this aforementioned laminating system, economical results appear to be somewhat unattractive, either for the high initial investment, or for productive difficulties. In any event it is still the object of continuous study and research.

3.1.6 Lamination with "pore filling" papers (Grundierfilm)

It is worth commenting on surface treatment by urea impregnated papers, already aforementioned.
Application of these papers, which ensure finished surfaces (with no need of sanding), ready to be printed and lacquered, is carried out in the same foregoing plants, if they are self-adhesive,; otherwise, they are applied on to a board, usually spread with urea resins.

3.1.7 Other applying systems

Beyond the described systems, which may be regarded as classic, other processes have been developed lately, involving variations in raw materials use (papers and resins), in papers impregnating methods, even in the same plants. Principle of these new systems lies in papers glueing by the "wet" or lately "dry" method. (The latter is approximately like the classic laminating methods, total cycle length except that it is shorter).

3.1.8 Glueing papers (see also chapter B)

We can schematically point out the following types:
a) impregnated papers suitable for further lacquering. Weight 80-125 gr/m2. They may be used in veneering presses (Scheme No.2).

b) impregnated papers, containing a coat of lacquer. Weight 80-150 gr/m2. They may be used in veneering presses as well as in quick step plants, or in universal type installations (Scheme No.6) (App.XII).

c) semi-finished papers, which may be used immediately after glueing, or being further laoquered. They are applied according to paragraph b). Weight 80-145 gr/m2.

d) finished impregnated papers, more or less flexible, replaoing esteemed wood species.

e) finished impregnated papers with a layer of solid glue, applied in melted state on to their reverse side (hot-melt), or with a filling glue (Heis-Siegelkleber) applied on the paper's reverse side as micro-crystals, during impregnating process. These papers are backed in all the hot/hot pressing systems.

Very light papers (30-45 gr/m2) deserve a special attention: impregnated with urea resins modified with acrylic, they are applied in quick step presses, oalenders or universal plants. The board, usually glued and coated on one or both sides with paper, is transported into the press by means of a oonveying belt, whioh may be provided with a die sheet in synthetic material, to emboss wood grains on to surfaces of the impregnated papers. This kind of paper may be used either on particleboard, fibreboard, etc.

Glue oontent (depending on type of substrate) is about 50-80 gr/m2, in solution. Indioative pressing times (depending on hardener and wood) are:

- at temperature of 100°C = 25"
- at temperature of 160°C = 10"

Owing to lightness of papers, it is better to use structural die hseets, during pressing operation, to cover any defects of the wooden surfaoe. In any event, the surface must be polished, smooth and even, without "beating" marks which may occur during sanding operation.

A new application system, coming from the thermoplastic materials industry, is the "transfer" method (Scheme No. 8)(App. XIV) which is usually oarried out on a single faoe of the board. One or more layers (some mioron thiok) of aorylic or modified acrylic resins are spread on the surface of film, normally in polyester.

The reeled film is applied on to the surface of the particleboard moving on a oonveying belt, towards oalender rollers, that may be heated from 160 to 200°C.

The upper pressing roller, is generally executed in silicon-rubber and the surface of the rough board must be perfect. Under heat and pressure effect, glueing layer adheres to the board's face, while the substrate-film, bearing the layer, may be torn away or remain as shielding element against scratches, etc., during further operations, being removed from the finished produot, at the end of working or even by the user.

Unfortunately, physic-mechanic charaoteristics, thus resulting, are not so good, and the board's prioe per m2 is still too high.

3.4 Plants for papers application

a) one of the systems, named "quick step", is outlined in Scheme No.6. The line consists of glueing machine, winding unit, and press, with conveying belt, whioh presses the board with papers, glued usually with urea or also vynilic resins. Pressure is held at 10 kg/cm2 and temperature between 110 and 140°C. Pressing time, depending on type of glue, is about 8".

Melamine papers, used in K.T. system, are not available for this method.

b) by suitable modifioations, relating to press capacity and providing a station for melamine papers and for calenders, according to SchemeNo.6, it is possible to realize a "universal line". allowing for the use of any type of papers.

c) calender system, which has lately been developed, aims at employing light papers in place of PVC coating. Actually the latter, challenged from the sanitary point of view and inadequate in physic-mechanic properties, records a loss of oonsequence and diffusion.

Appendix XIII shows the operating principle of this new system. Nevertheless the board, thus laminated, does not meet the running rules, and the same prooess presents up to now conspiouous applying difficulties. Undoubtedly the introduction of calenders in pressing lines (as shown in Scheme No.6) may bring several advantages in technological

appliance, thus improving the finished product. Application speed varies from 15 to 40 mt/min.
Rollers temperature is held approximately at 210°C.
Touch time depends on the speed (in any case, assuming 5 mm. of touching area, it will amount to fractions of a second).

d) Transfer application: Scheme No.8 outlines the principle of this system, which is now under consideration, mainly in regard to the tyickness of layers applied on to substrate, as well as for adhesion to particle boards surfaces.

4. Situations for consideration in selecting plant equipment

In so wide a problem such as lamination, raw materials availability, surfaces and boards quality, output quantity (required by the market), and user's needs are the determining factors in the plants product and output.

Nevertheless choice of a specific type of plant, to produce laminated boards, will always be connected mainly with surface quality, productive efficiency and flexibility of the plant. Initial investment is not always a conclusive factor.

Classic lamination, that is imparted by hot/cold or hot/hot systems, is still the favourite.

For this reason it is impossible to establish precise rules in plant selection.

No doubt, total consumption of laminated material in a specific country, availability of energy and labour, more or less specialized, and possibility of exports and, generally speaking, commercial exchanges, may influence some investors to prefer more or less sophisticated plants, with varying numbers of labourers and suitable for manual or completely automatic operation.

Each situation must be analyzed from time to time, co-operating striotly with the plant's manufacturer, who, beyond seller, must assume the role of friend/adviser of the purchaser.

Only by doing so, is it possible to ultimately reach satisfactory results, thereby helping towards building industrial growth in the various countries of the world.

RESIN CONTENT (%) FOR SURFACE IMPROVEMENT IN RELATION TO THE PAPER DENSITY Gr/m^2 (SURFACE IMPROVEMENT WITHOUT OVERLAY)

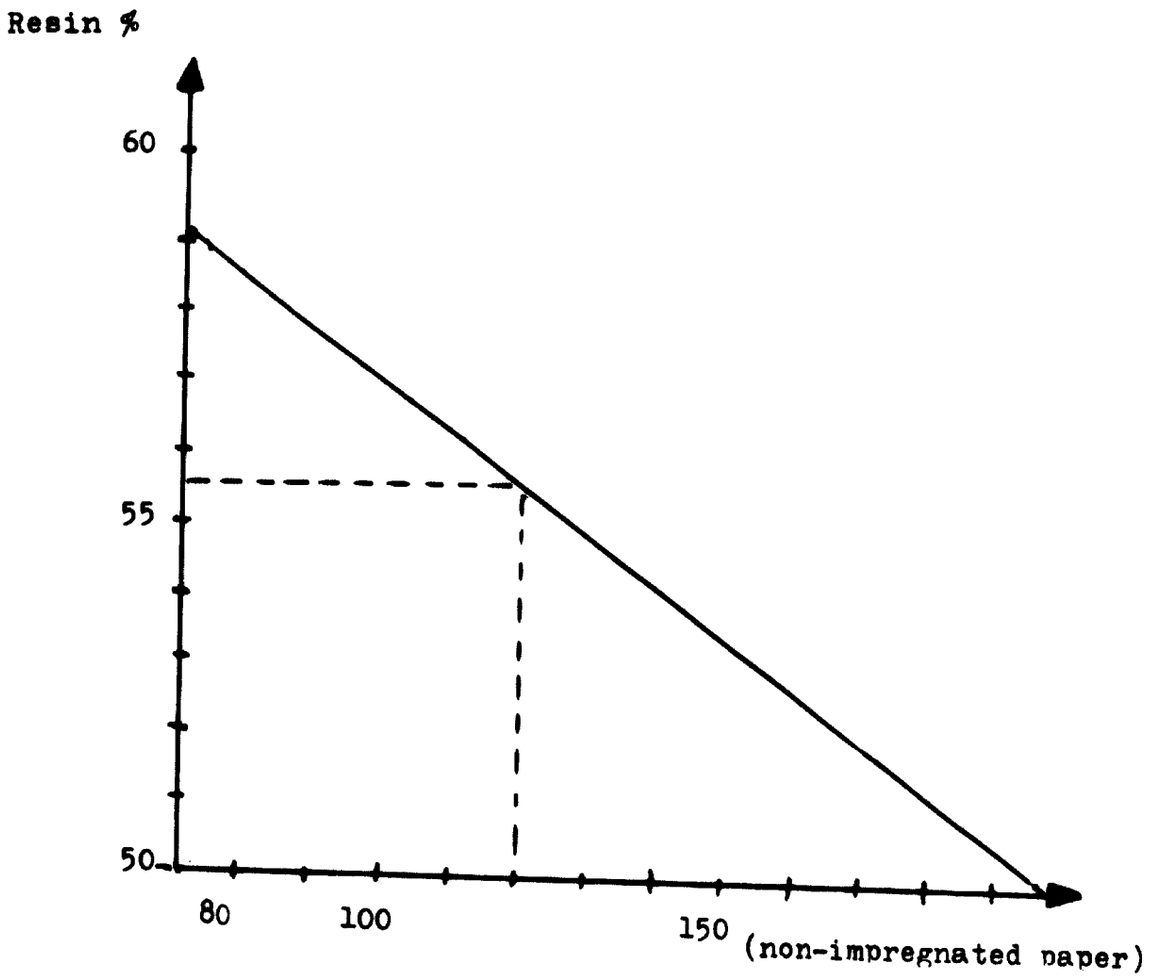


DIAGRAM NO. 1

APPROXIMATE EXAMPLE OF A CYCLE FOR SURFACE IMPROVEMENT
(three difference curves) - Classic process hot/cold

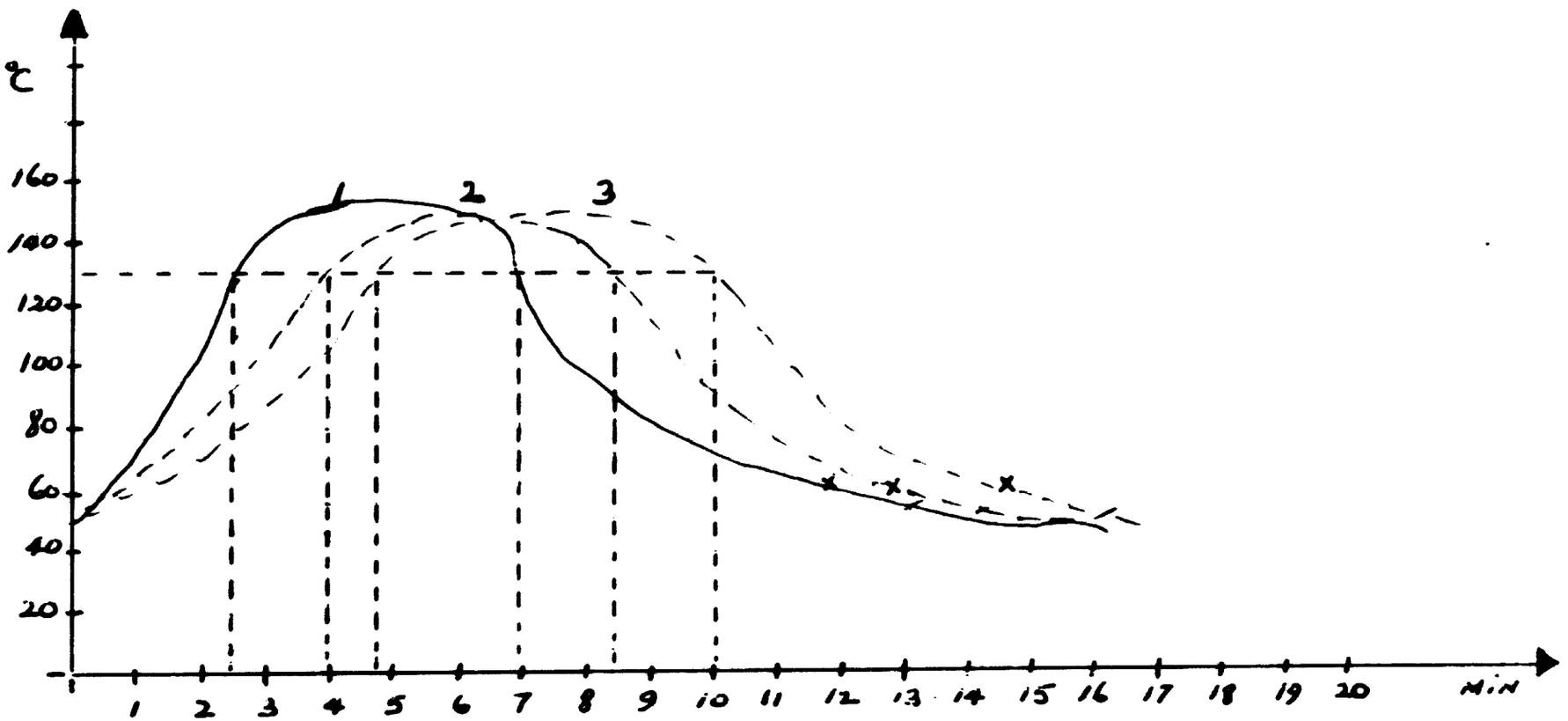
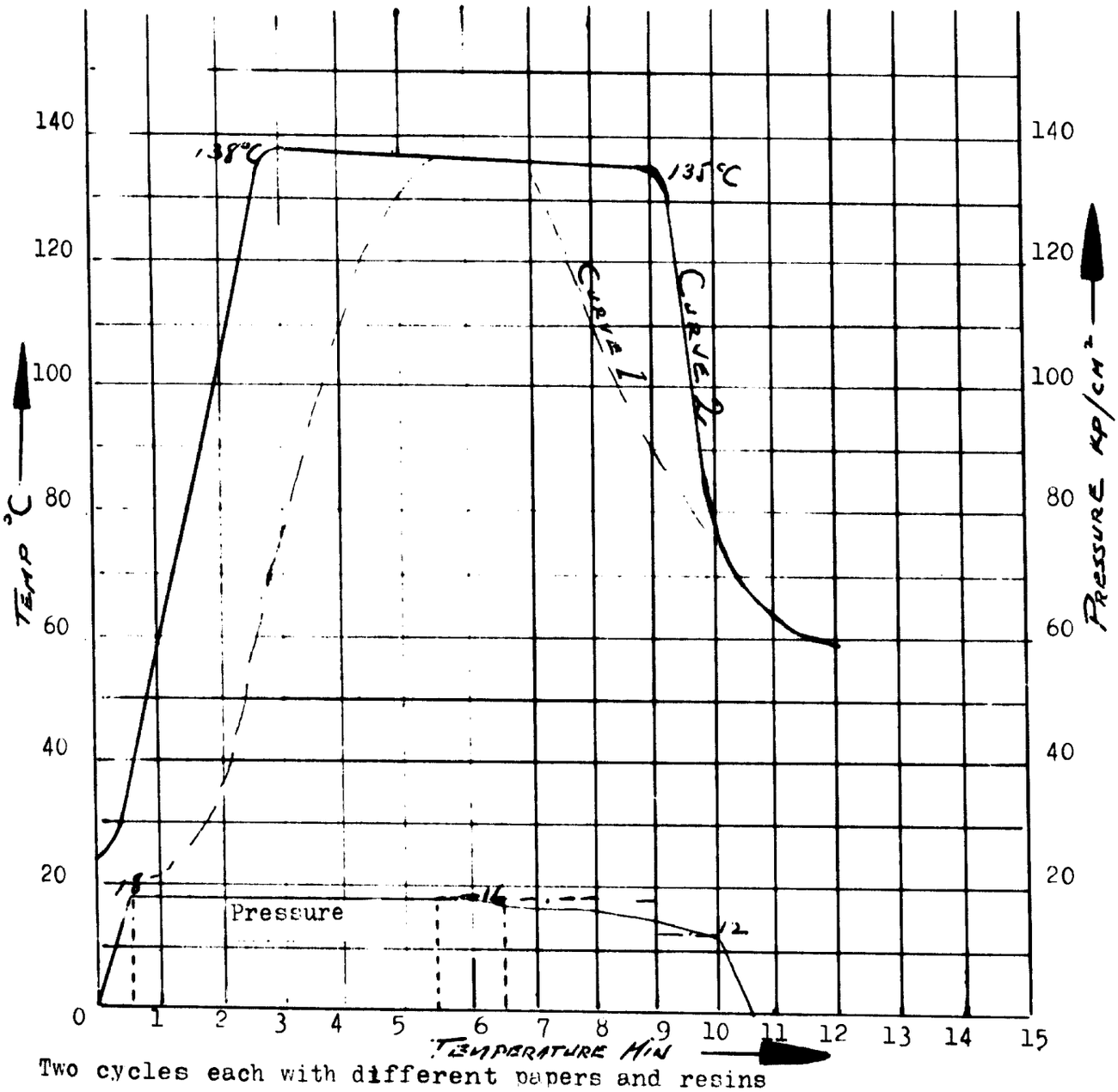


DIAGRAM NO. 2

SURFACE IMPROVEMENT OF PARTICLE BOARD PANELS - HOT/ COLD CYCLES - (APPROXIMATE VALUES)



Two cycles each with different papers and resins

DIAGRAM NO. 3

APPROXIMATE DIAGRAM FOR LAMINATING WITH K.T SYSTEM

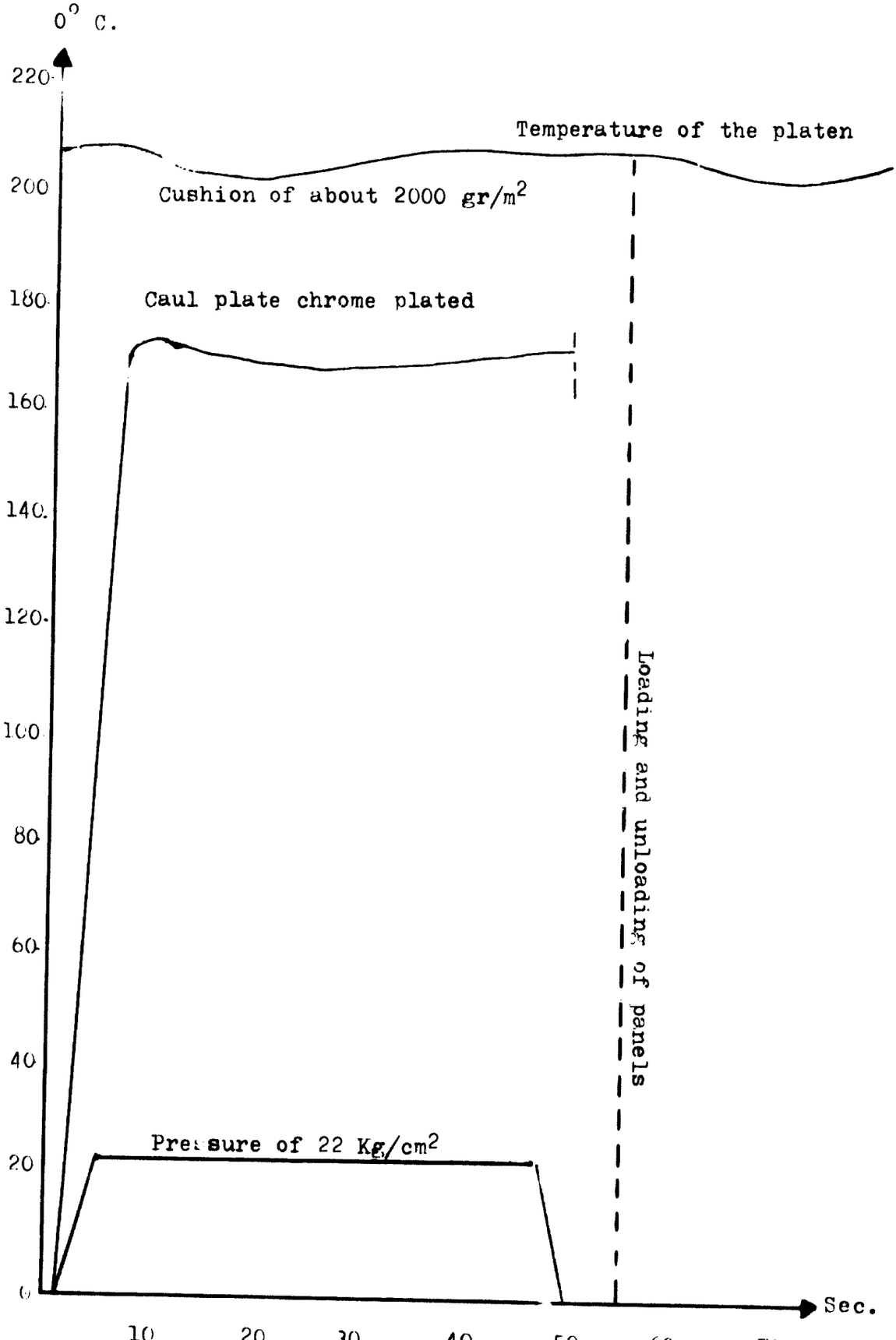
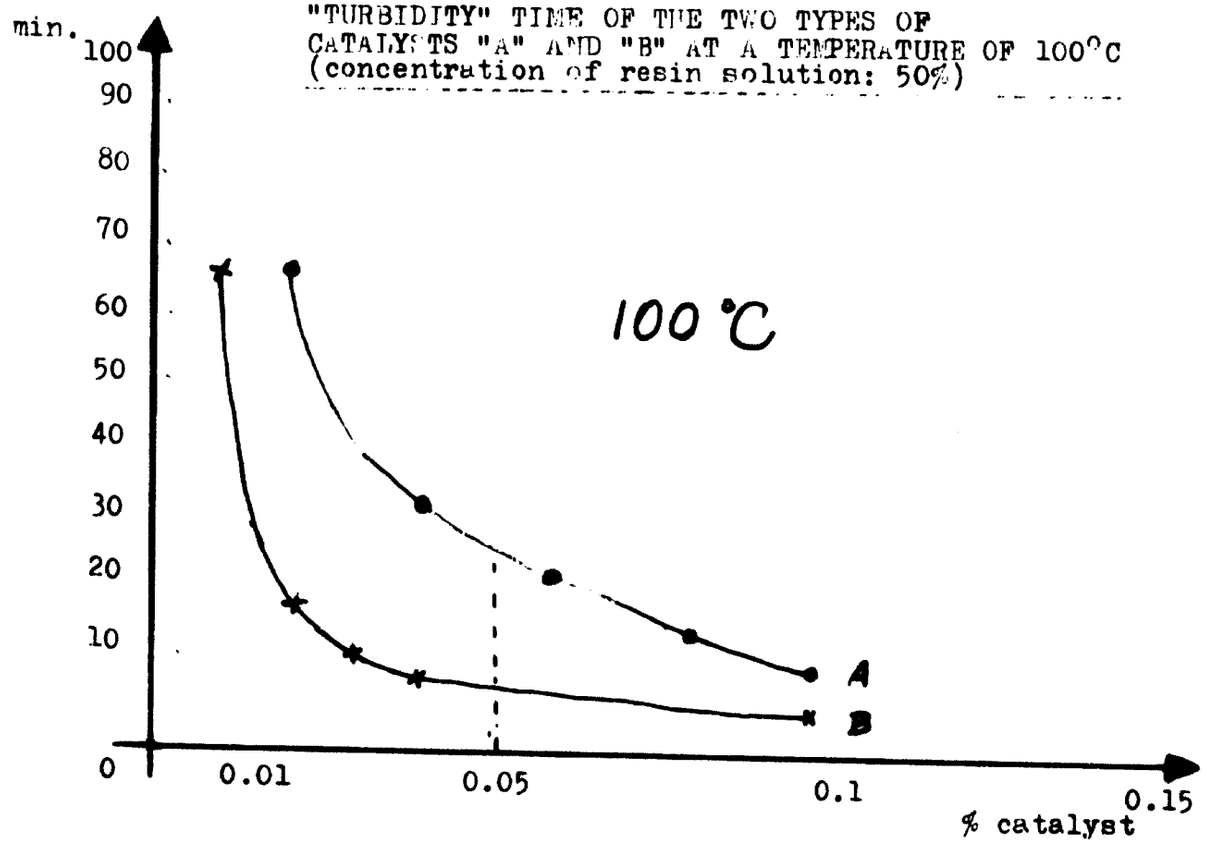


DIAGRAM NO.4:

"TURBIDITY" TIME OF THE TWO TYPES OF CATALYSTS "A" AND "B" AT A TEMPERATURE OF 100°C (concentration of resin solution: 50%)



"TURBIDITY" TIME OF THE TWO TYPES OF CATALYSTS "A" AND "B" - SAME AS IN ABOVE DIAGRAM AT A TEMPERATURE OF 140° C (Concentration of resin solution: 50%)

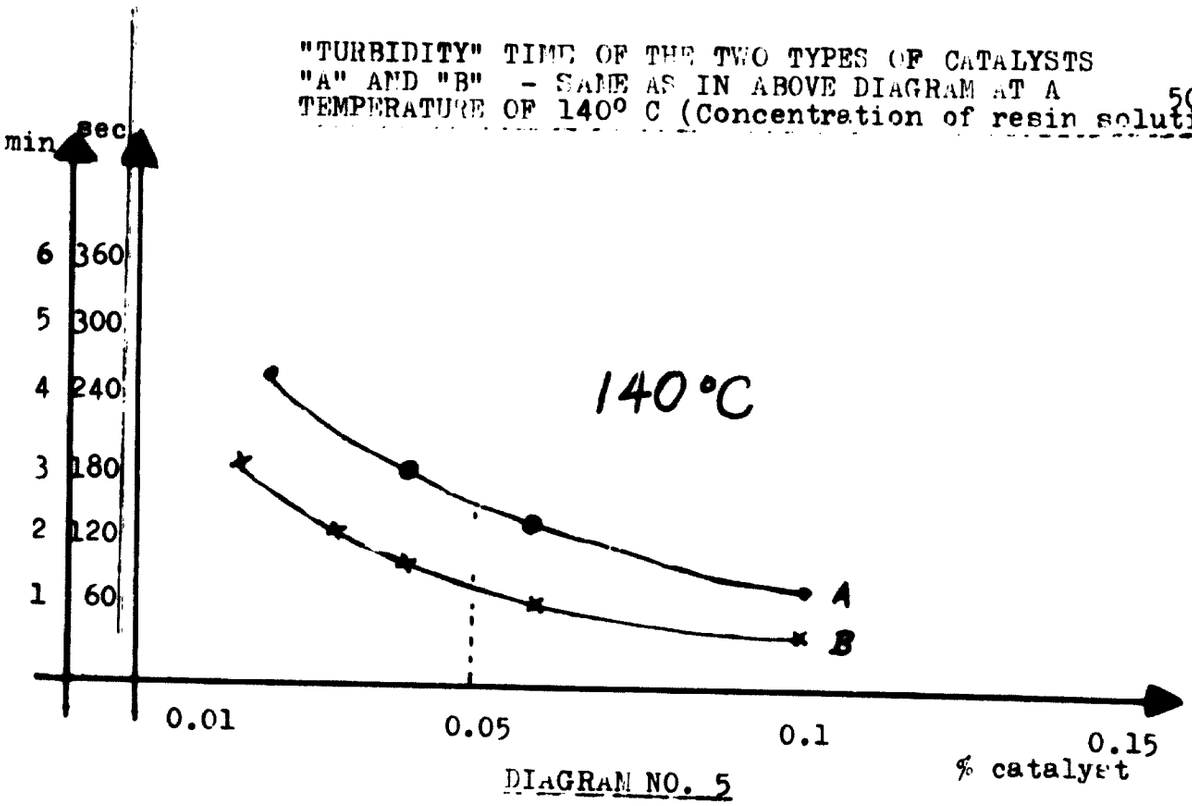


DIAGRAM NO. 5

RESIN CONTENT FOR THE SURFACE IMPROVEMENT - K.T. IN RELATION TO THE BASIC WEIGHT OF THE PAPER (SURFACE IMPROVEMENT WITHOUT OVERLAY)

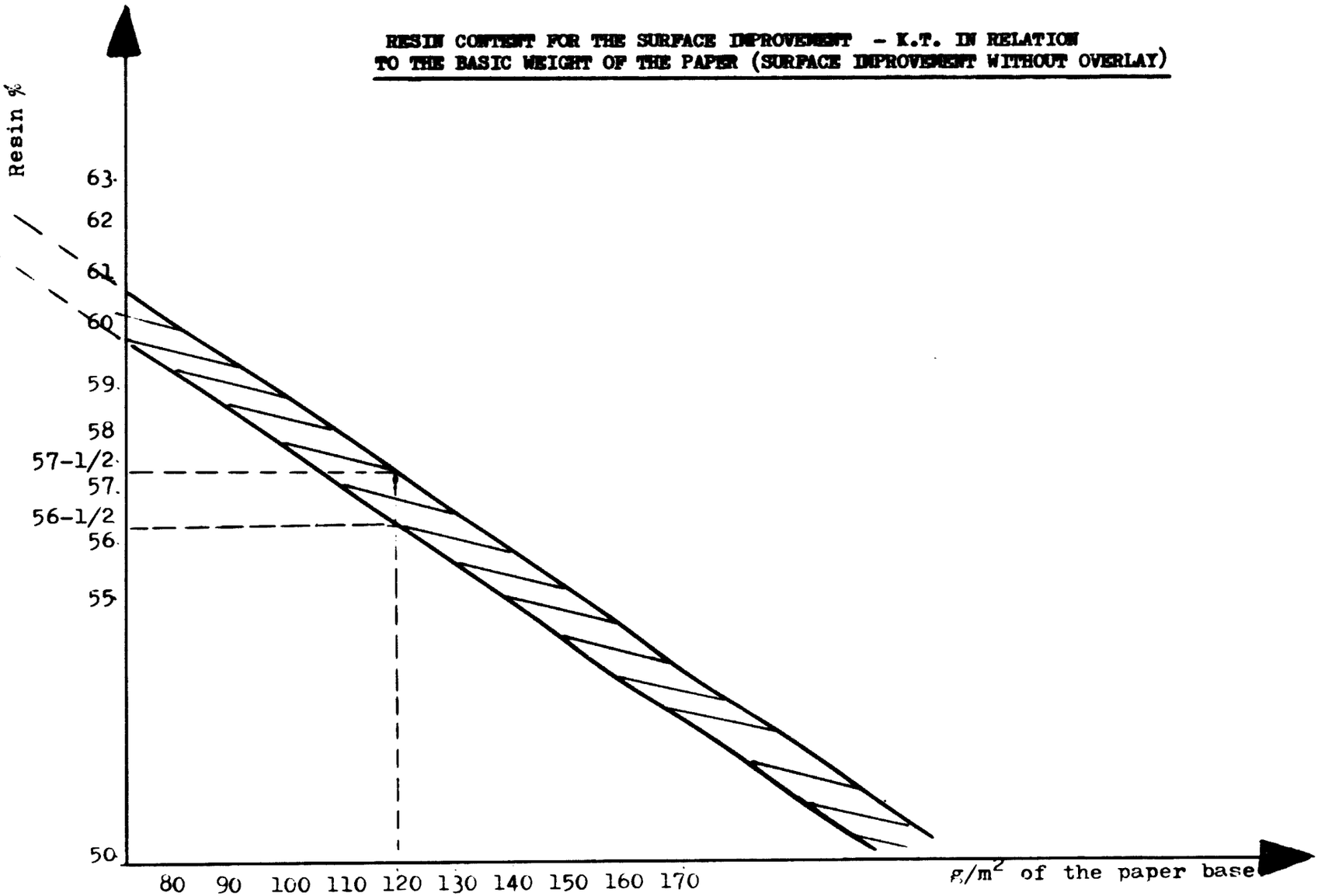
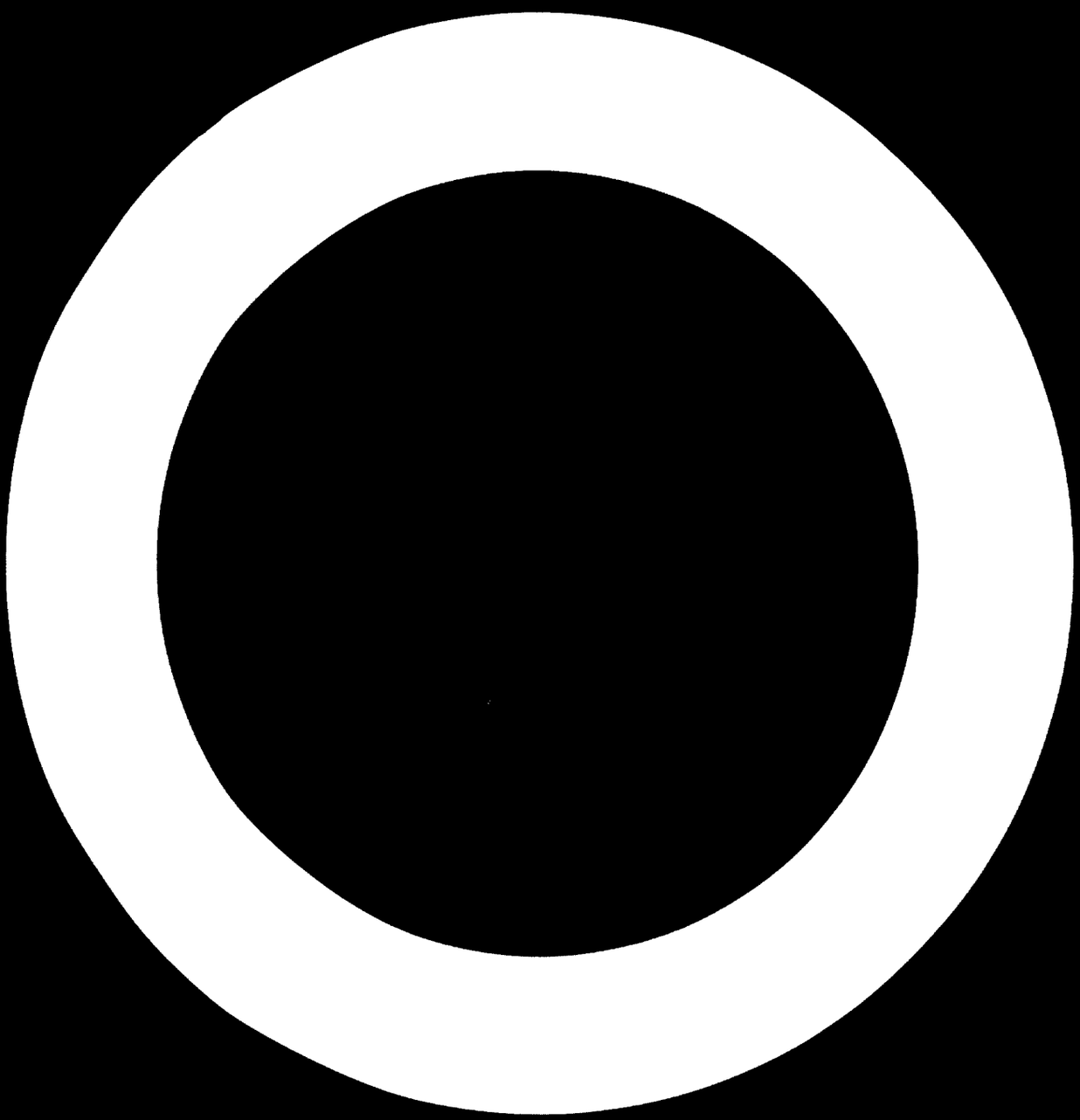
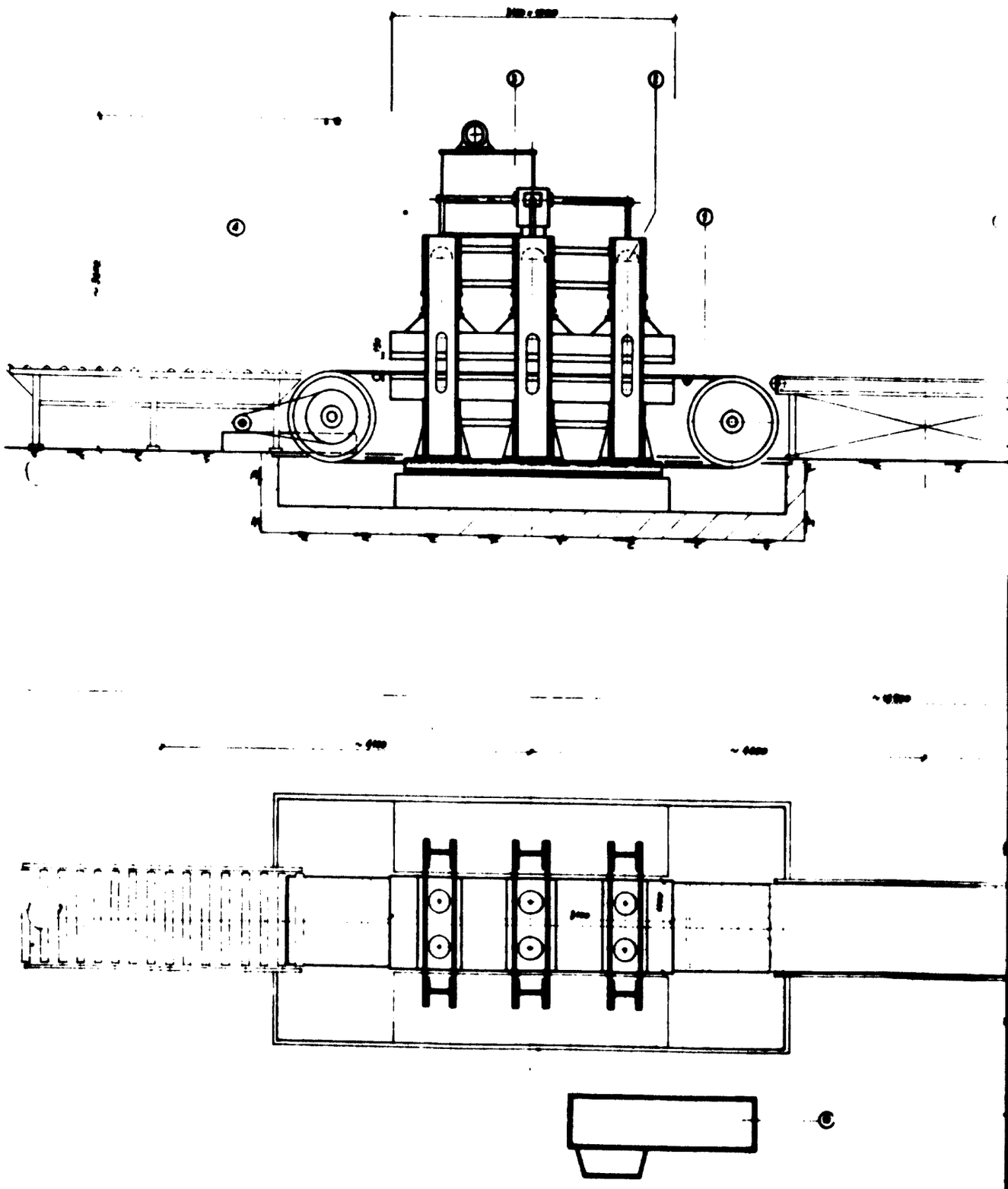


DIAGRAM NO. 6

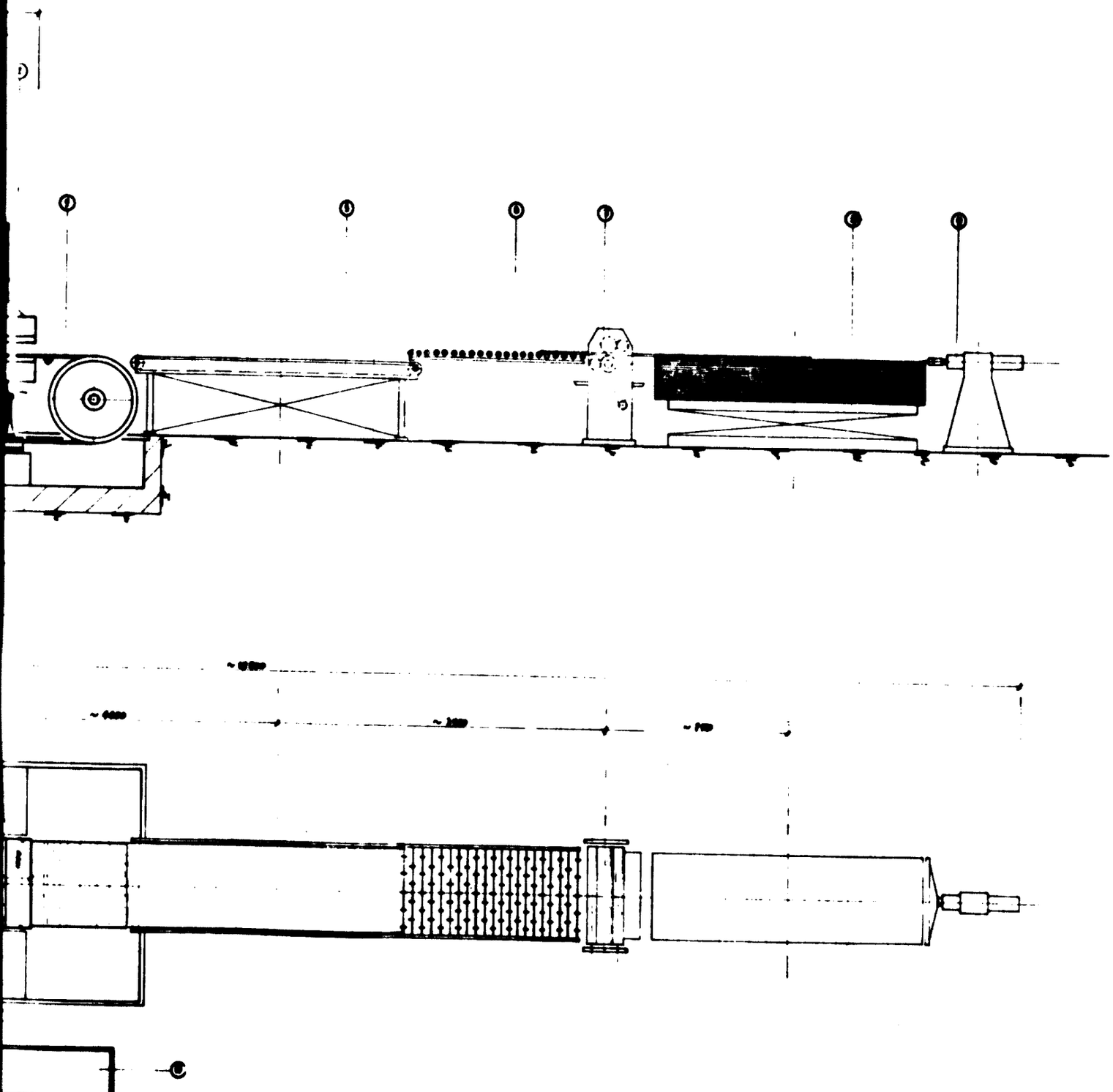




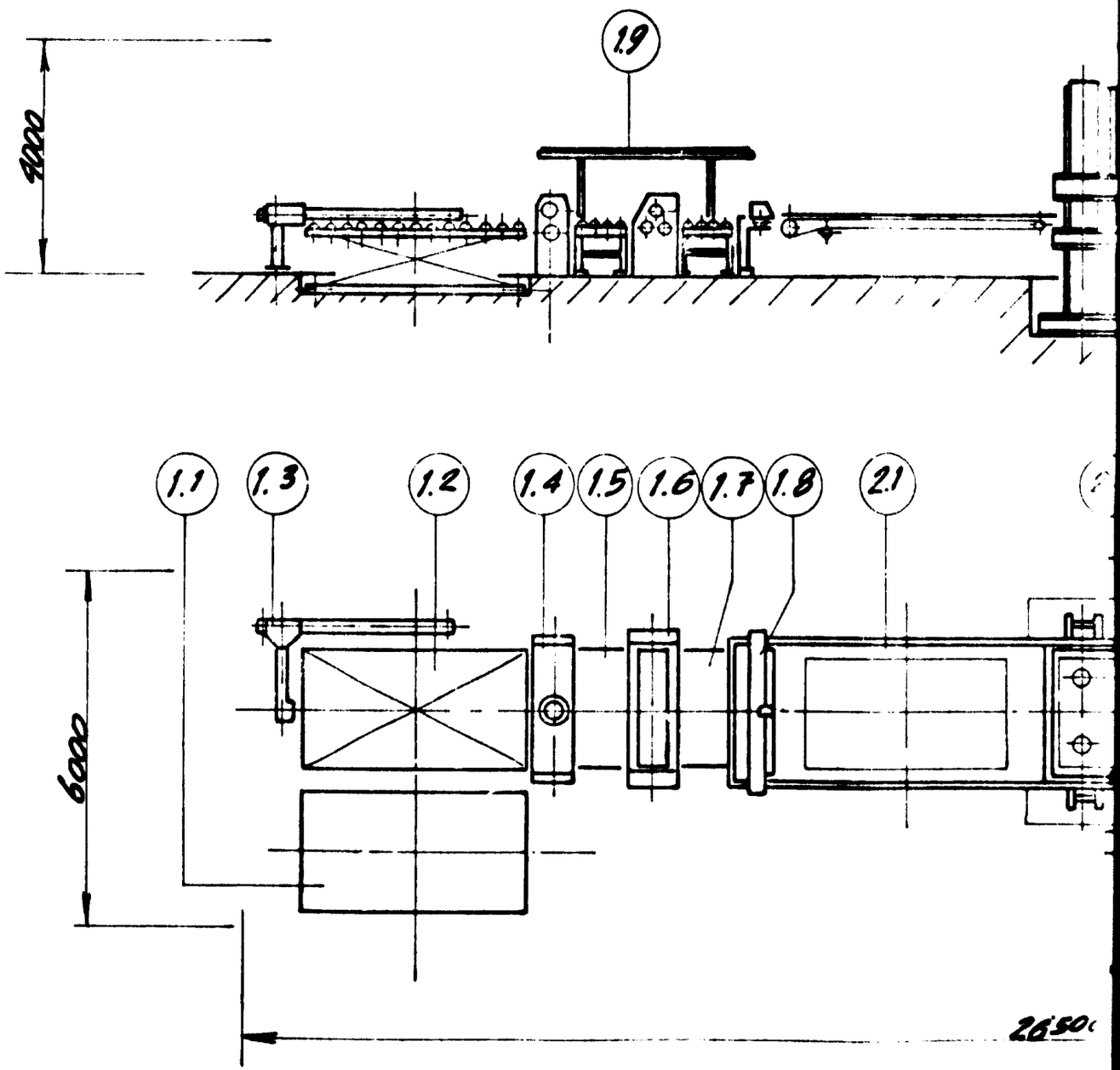
LAMINATION WITH DECORATIVE LAMINATES

SECTION 1

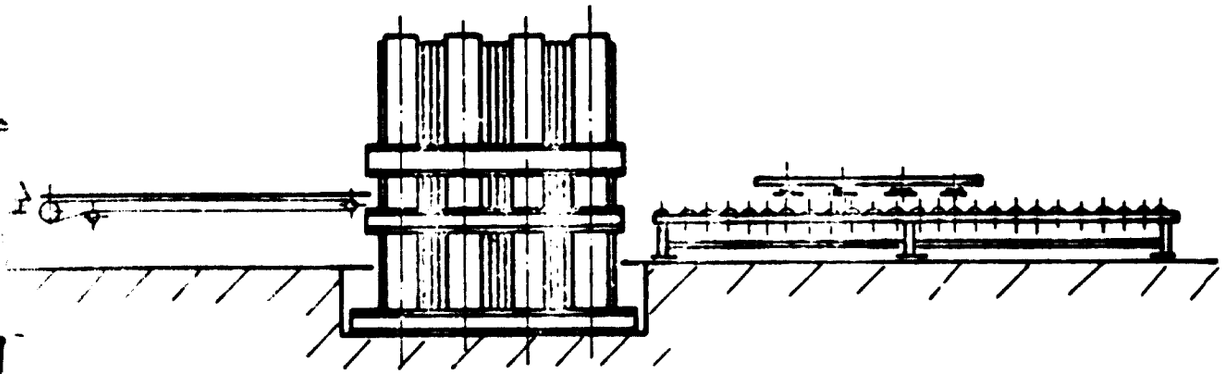
Appendix 1

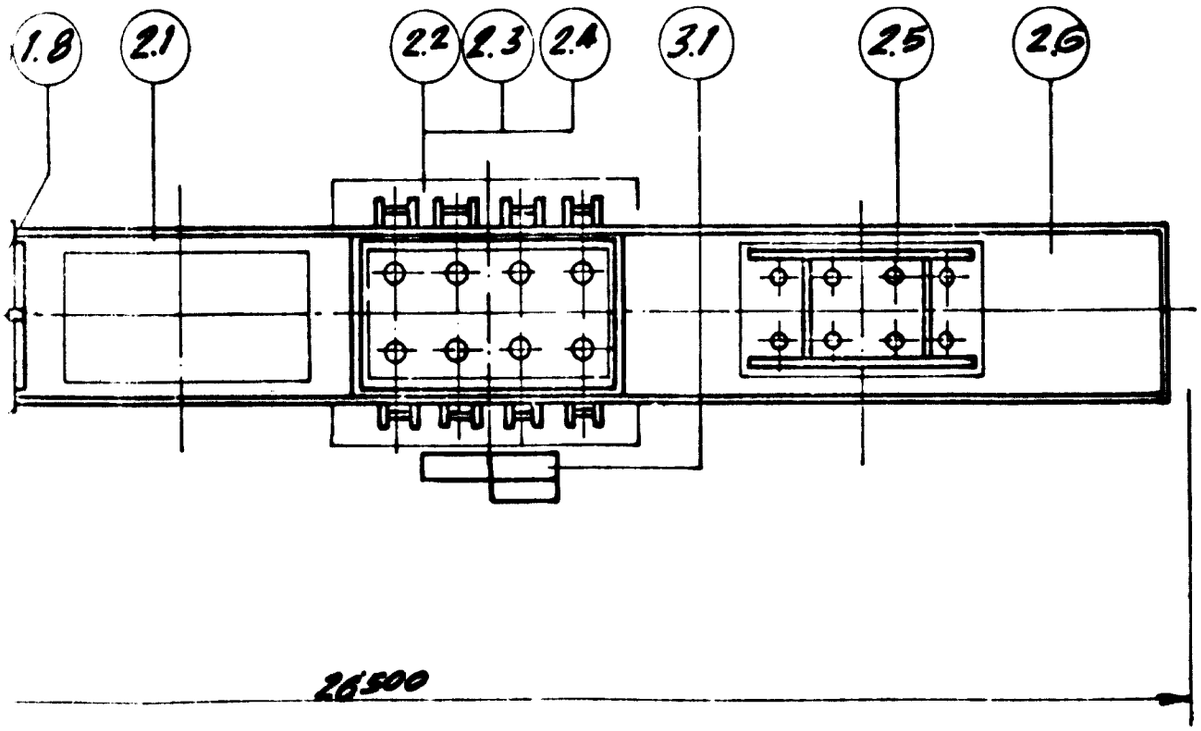


SECTION 2

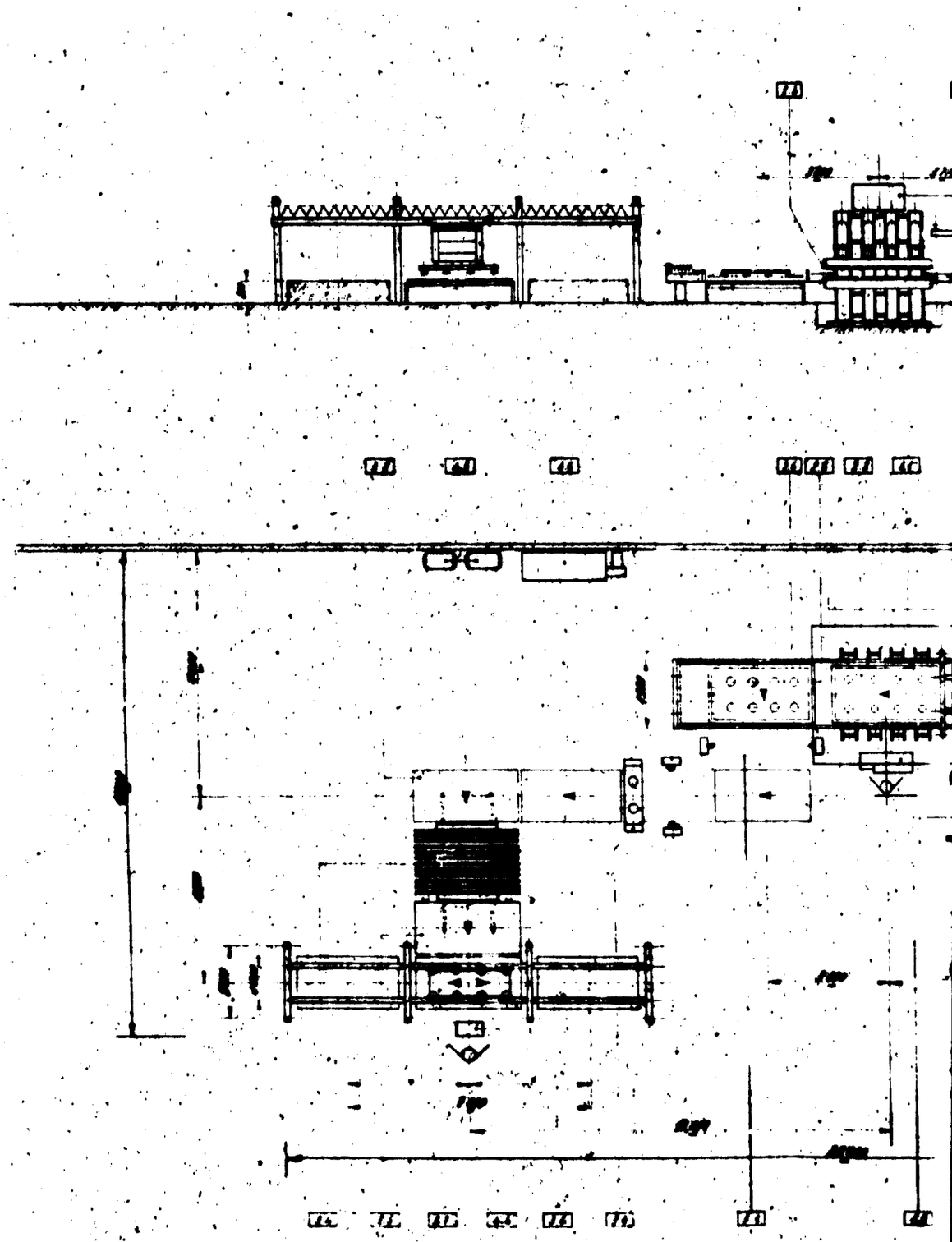


LAMINATION WITH DECORATIVE LAMINATES



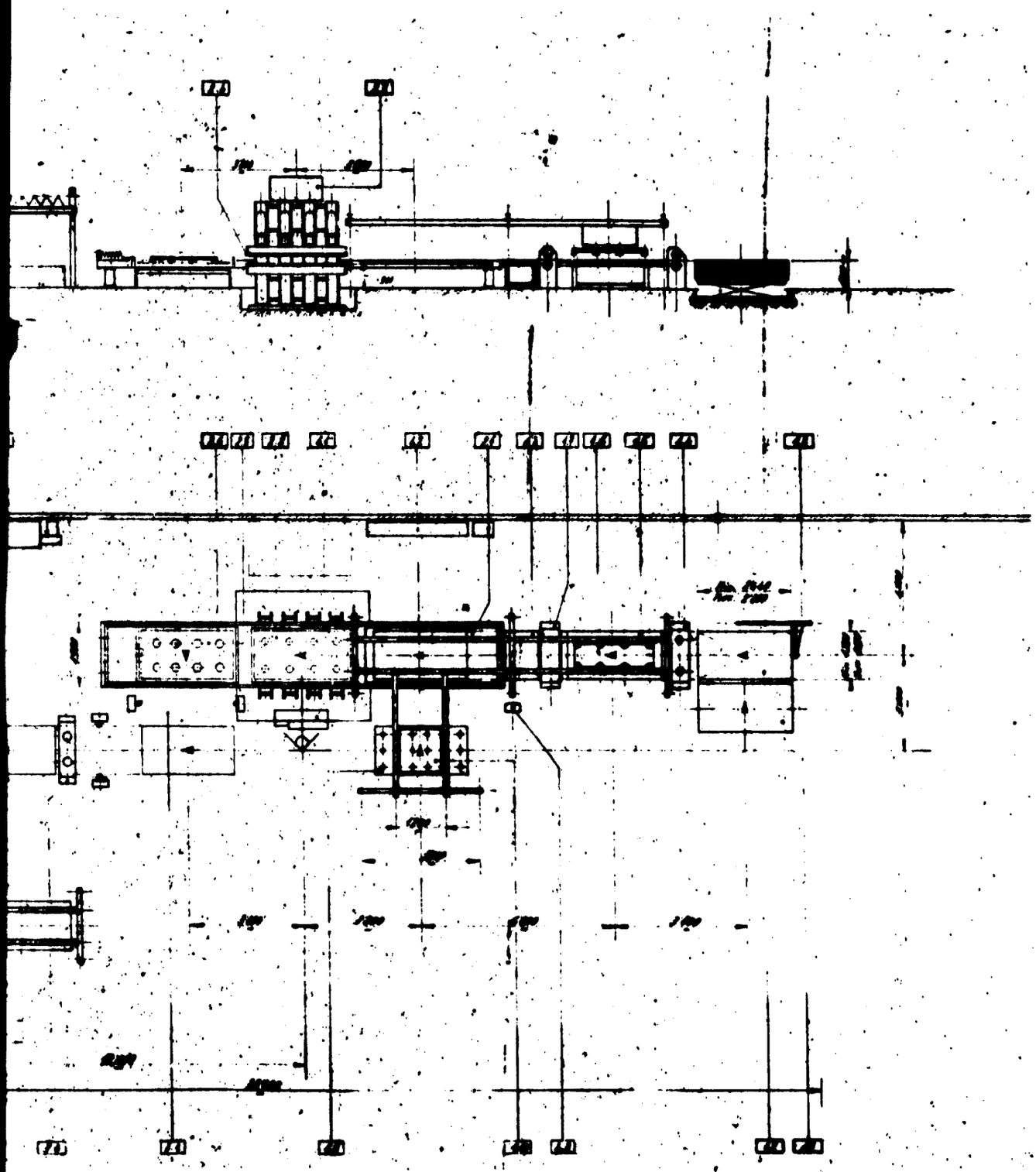


SECTION 2



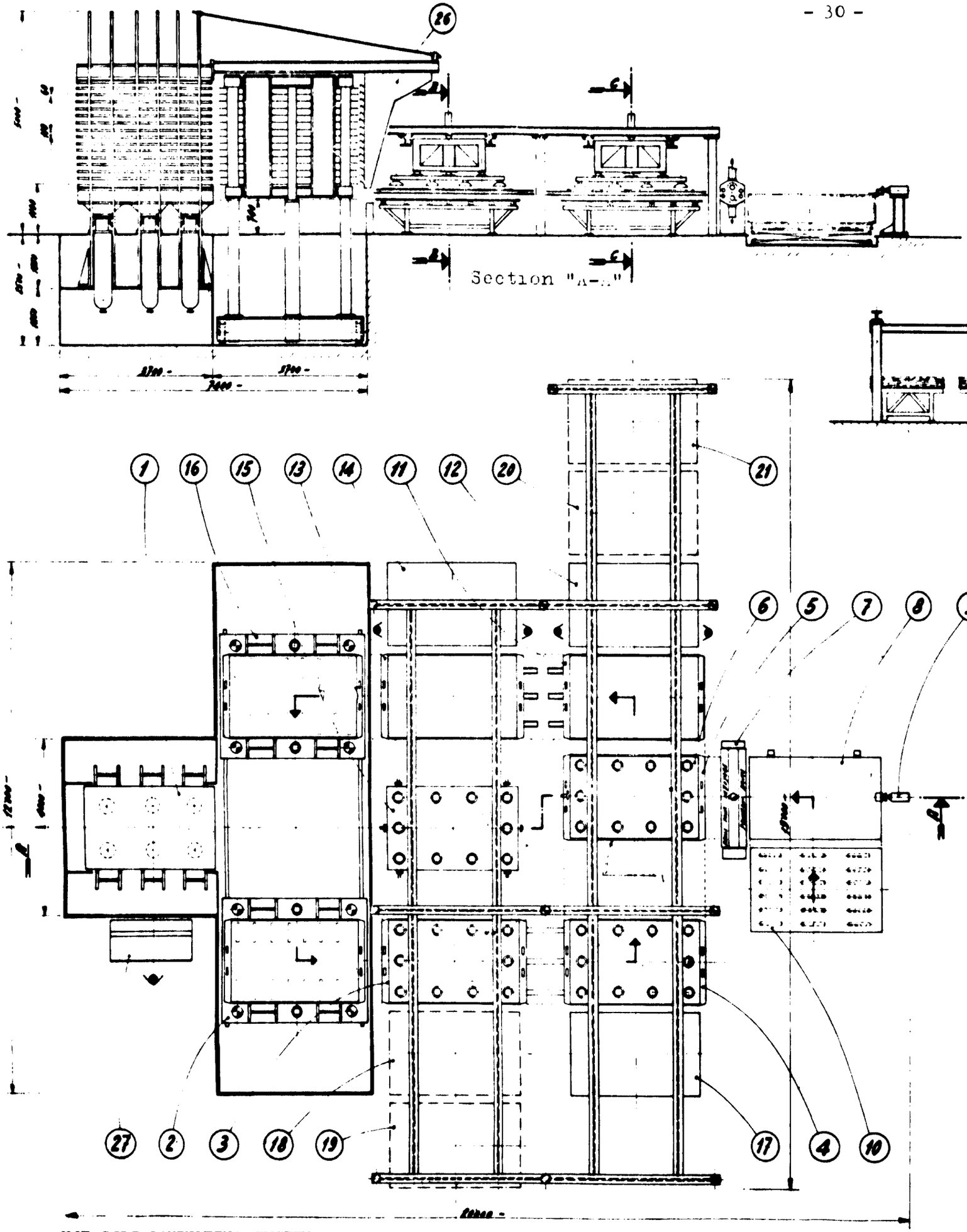
SECTION 1

LAMINATION WITH DECORATIVE LAMINATES



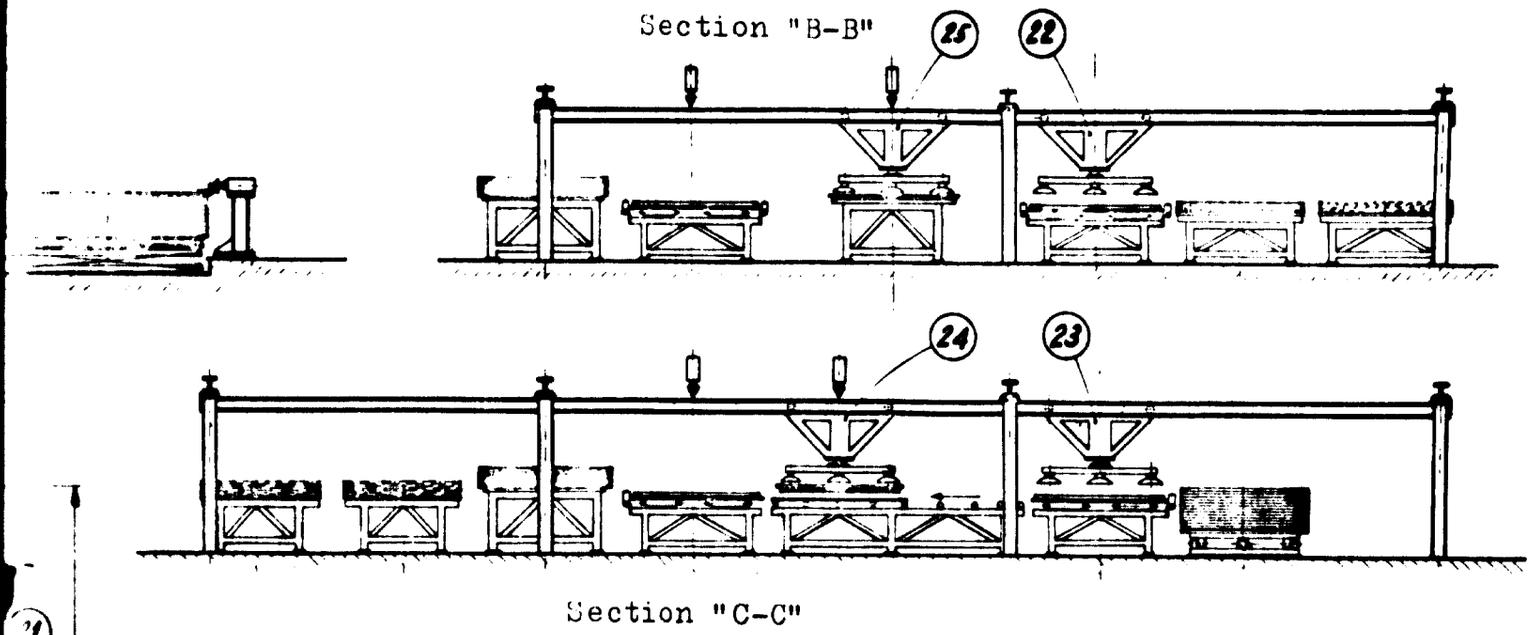
.TES

SECTION 2



HOT-COLD LAMINATING SYSTEM

SECTION 1



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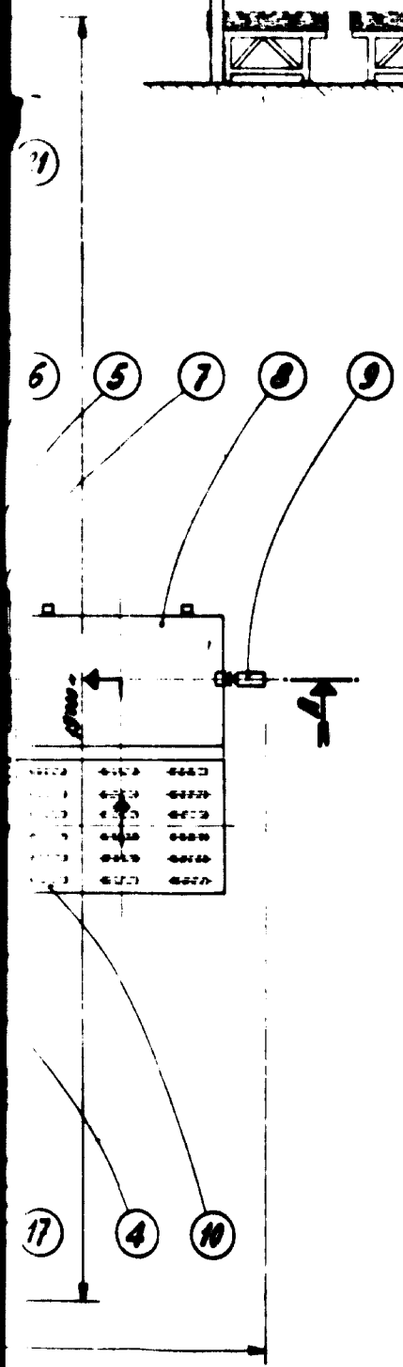


SECTION 2

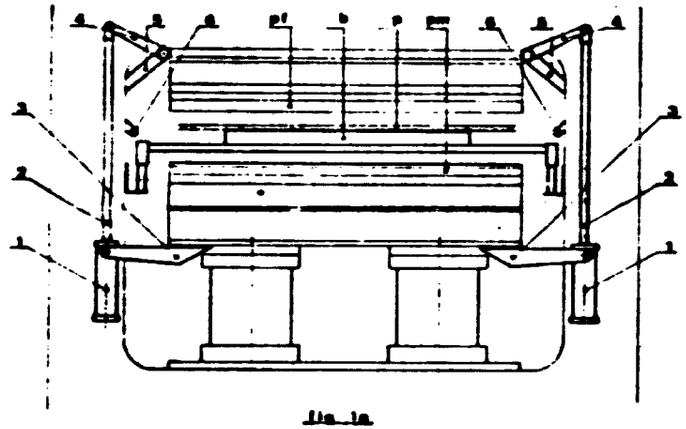


fig. 1a

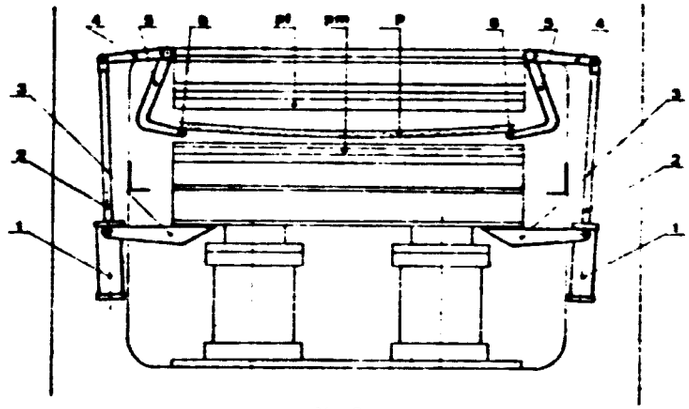


fig. 2a

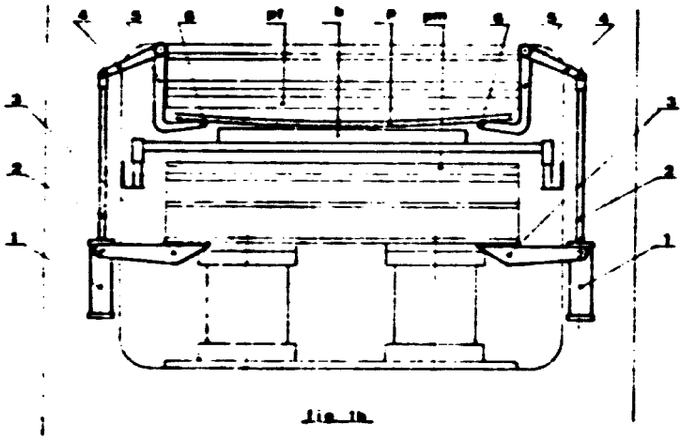


fig. 1b

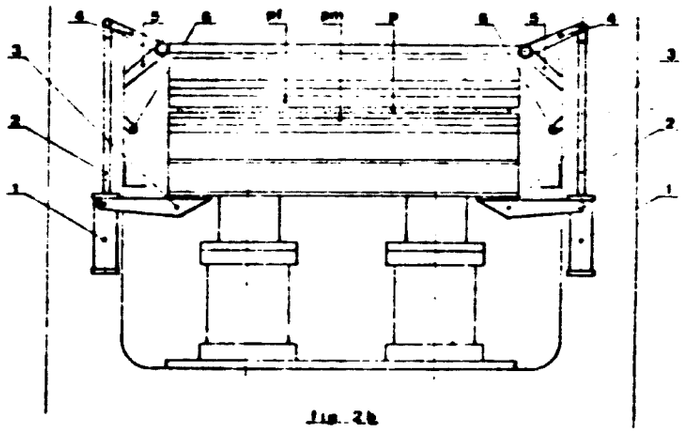
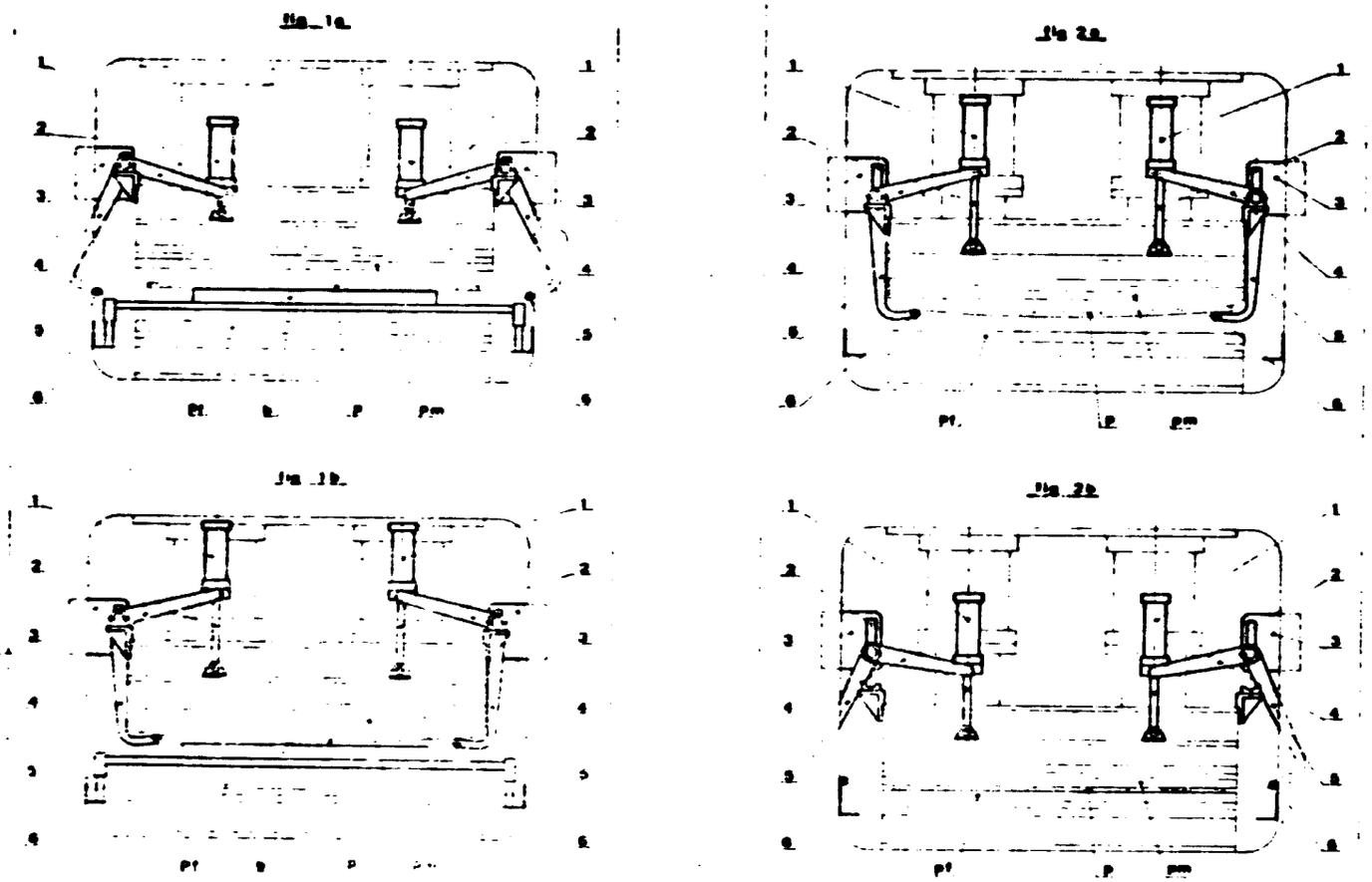


fig. 2b

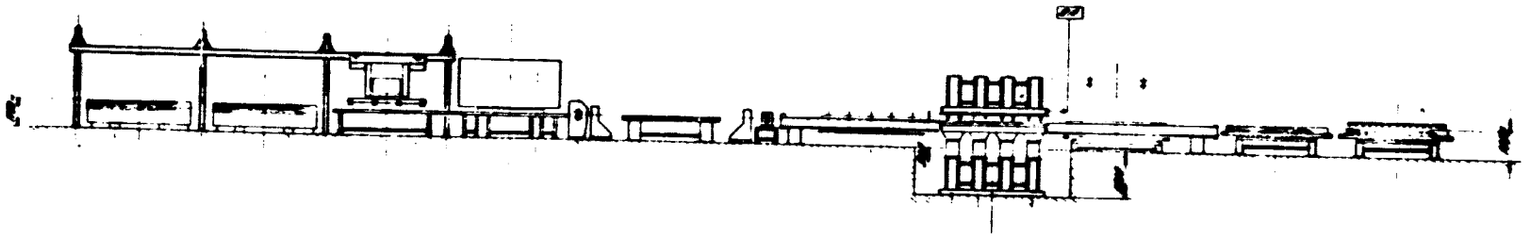
Modified Band-tablett

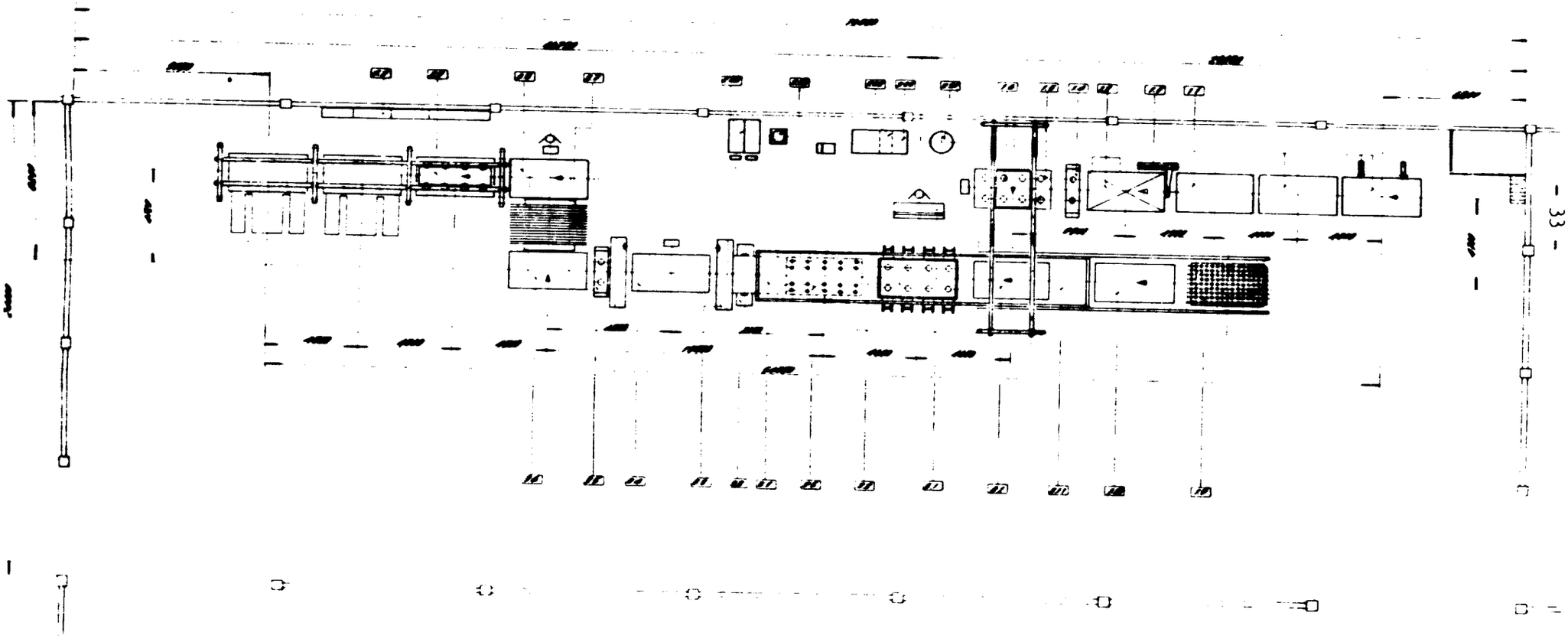
LAMINATING PROCESS USING MODIFIED BAND-TABLETT

Appendix VI

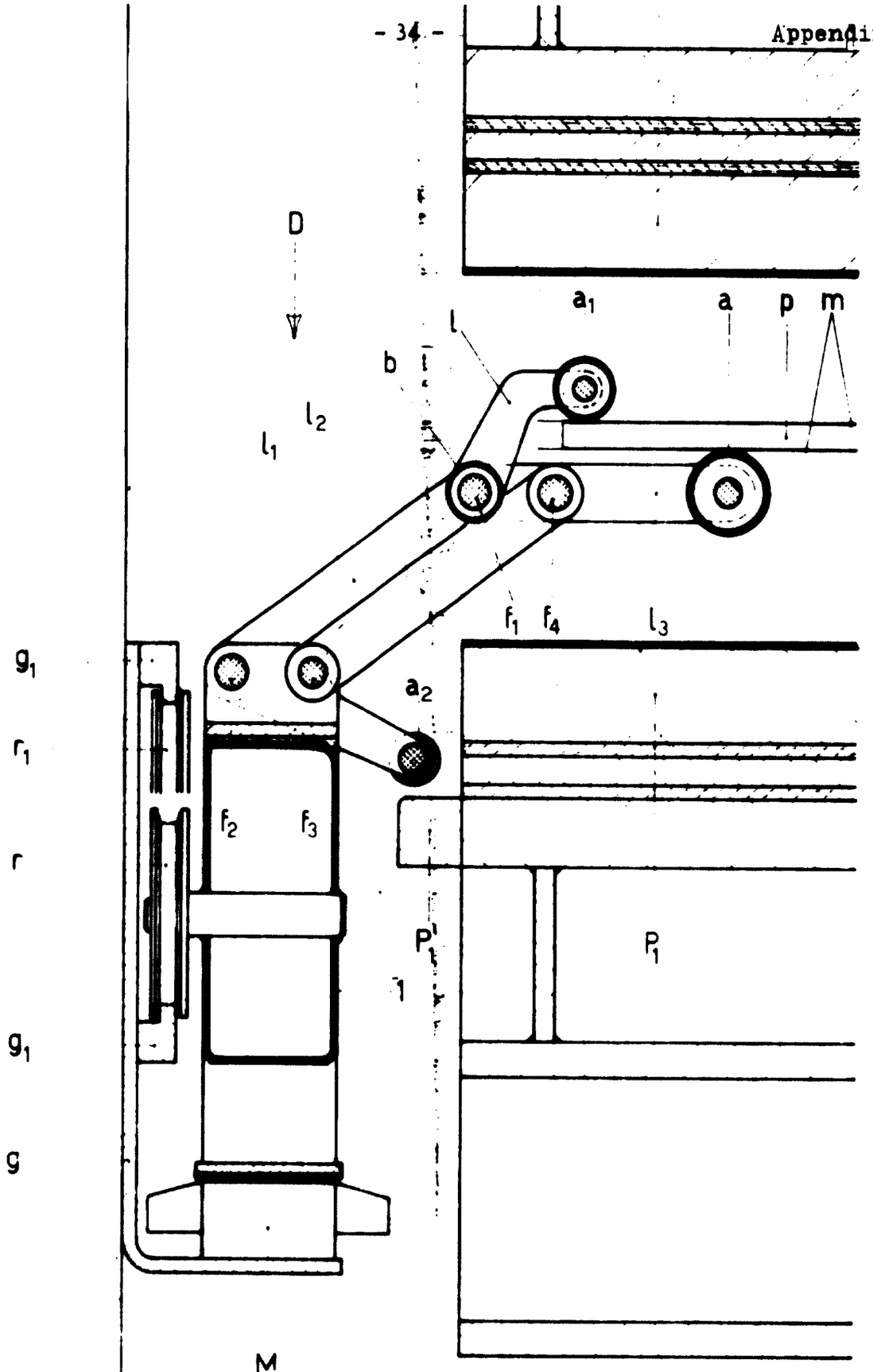


Modified Band-tablett



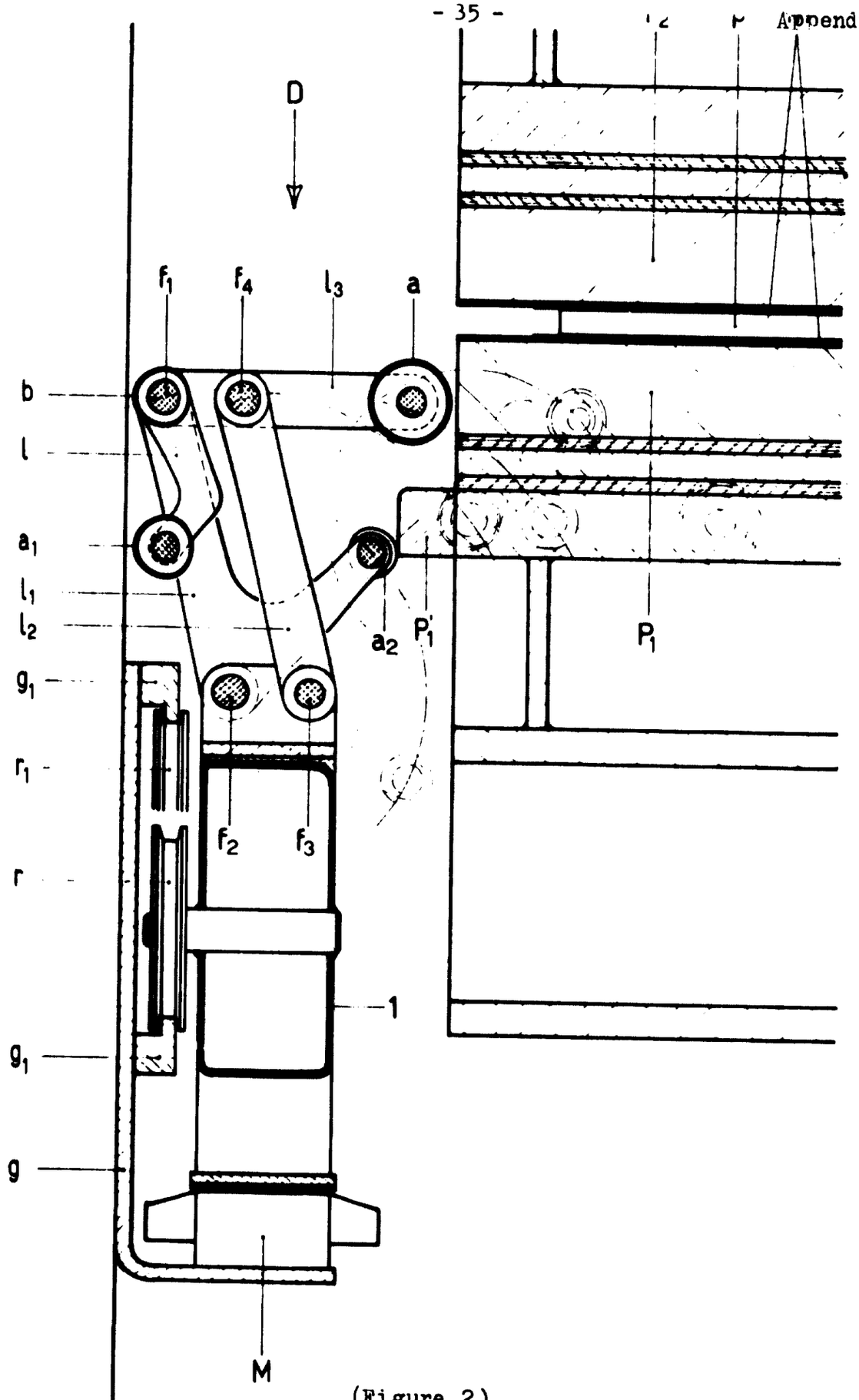


ULTRARAPID SINGLE OPENING PRESS WITH DROP LOADING



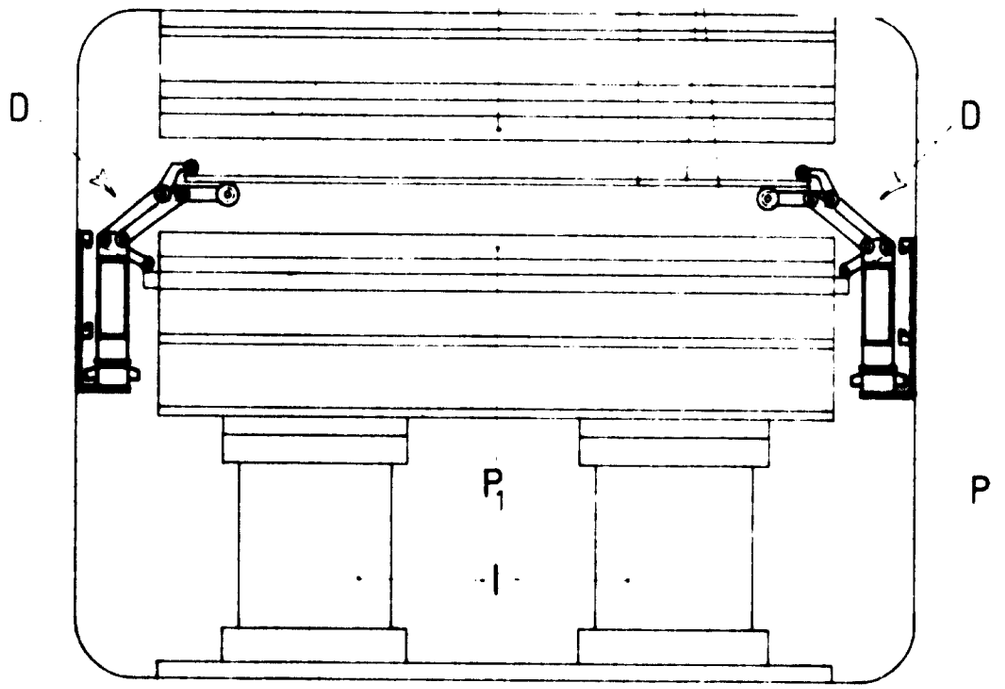
(Figure I)

ULTRARAPID SINGLE OPENING PRESS WITH DROP LOADING (Continued)

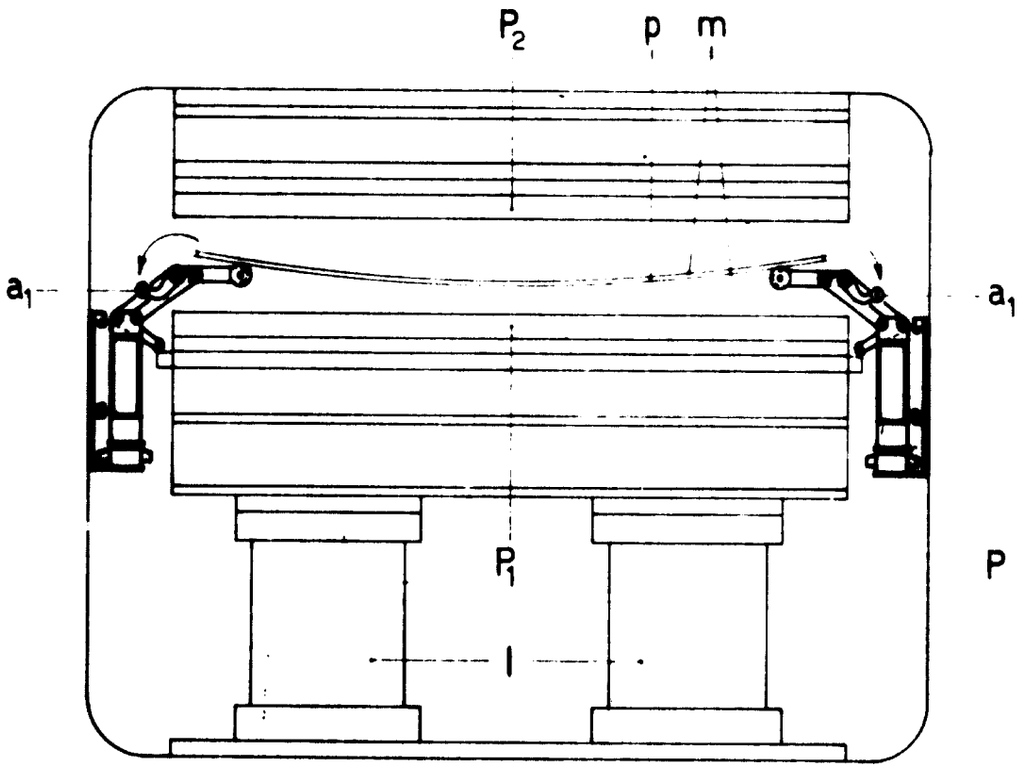


(Figure 2)

ULTRARAPID SINGLE OPENING PRESS WITH DROP LOADING (Continued)



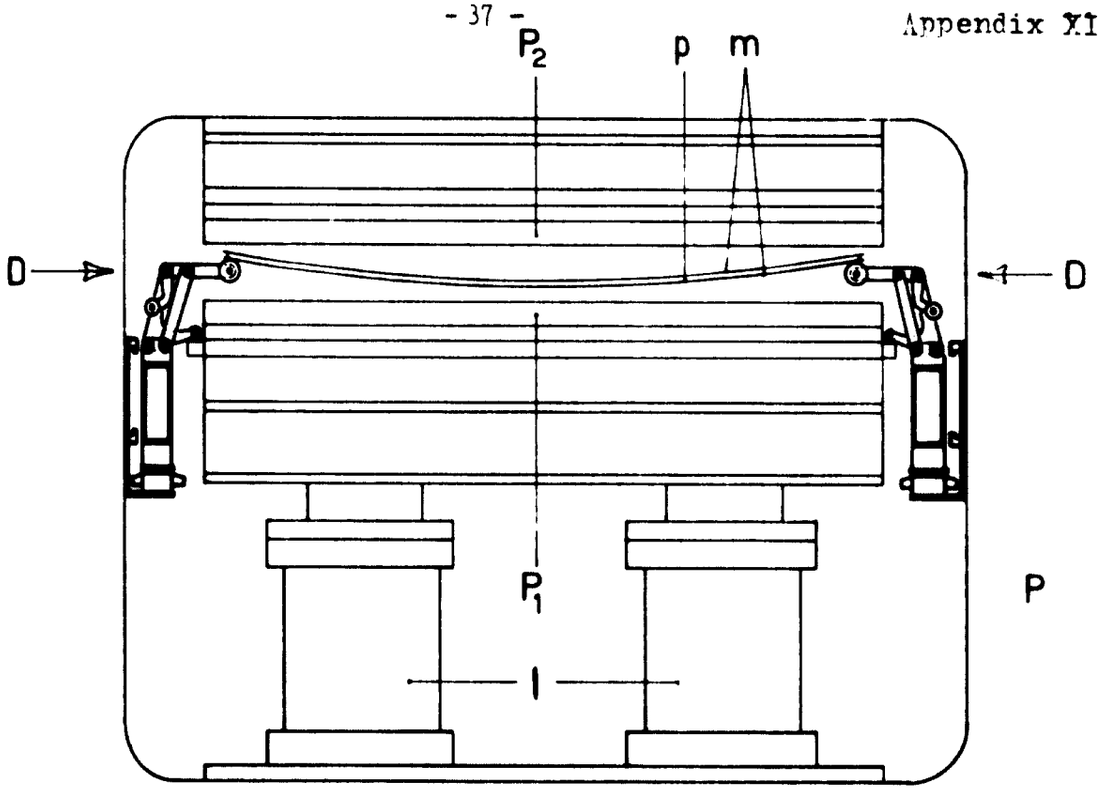
3a



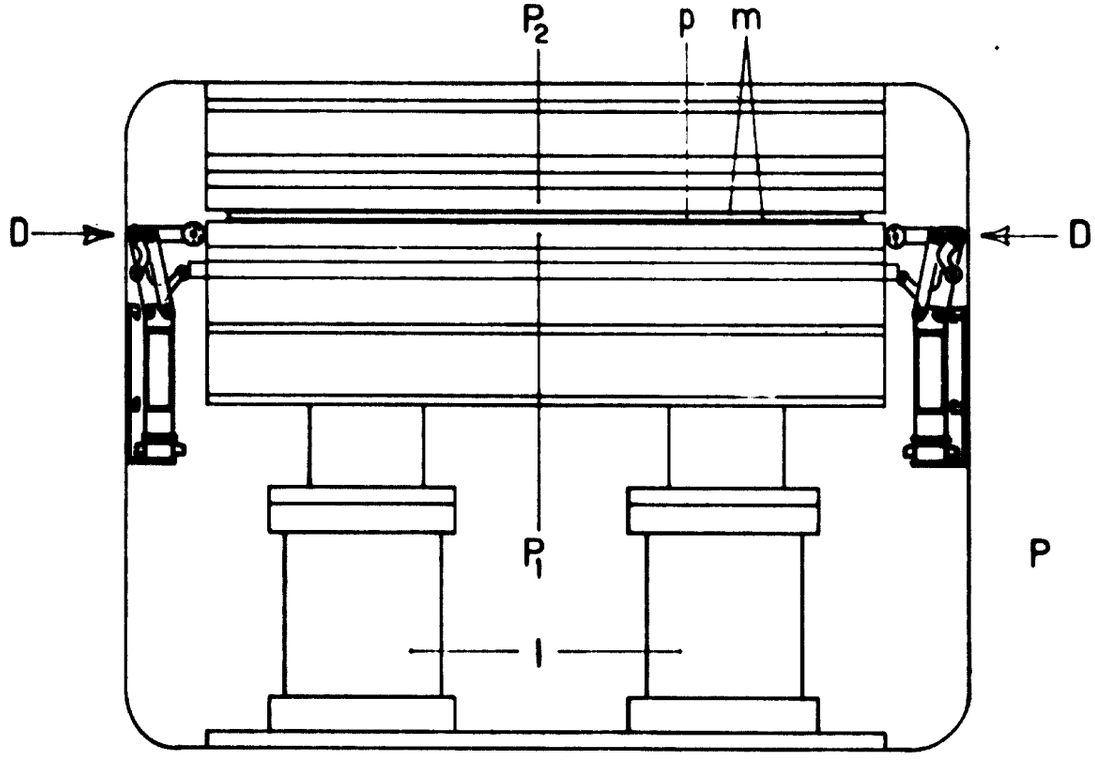
3b

(Figures 3a and 3b)

ULTRARAPID SINGLE OPENING PRESS WITH DROP LOADING (Continued)



4 a



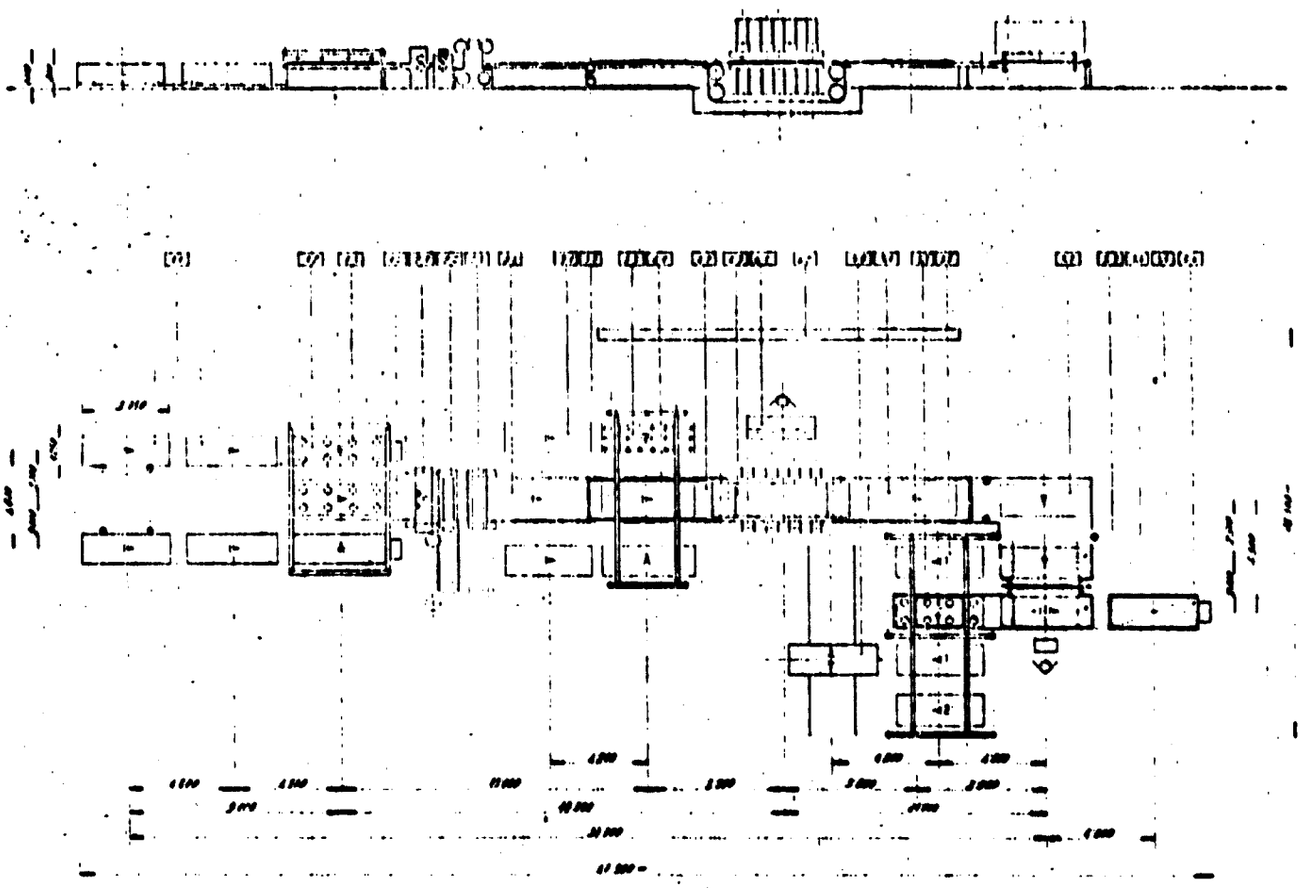
4 b

(Figures 4a and 4b)

ULTRARAPID SINGLE OPENING PRESS WITH DROP LOADING (Continued)

Appendix XII

(Scheme 6)

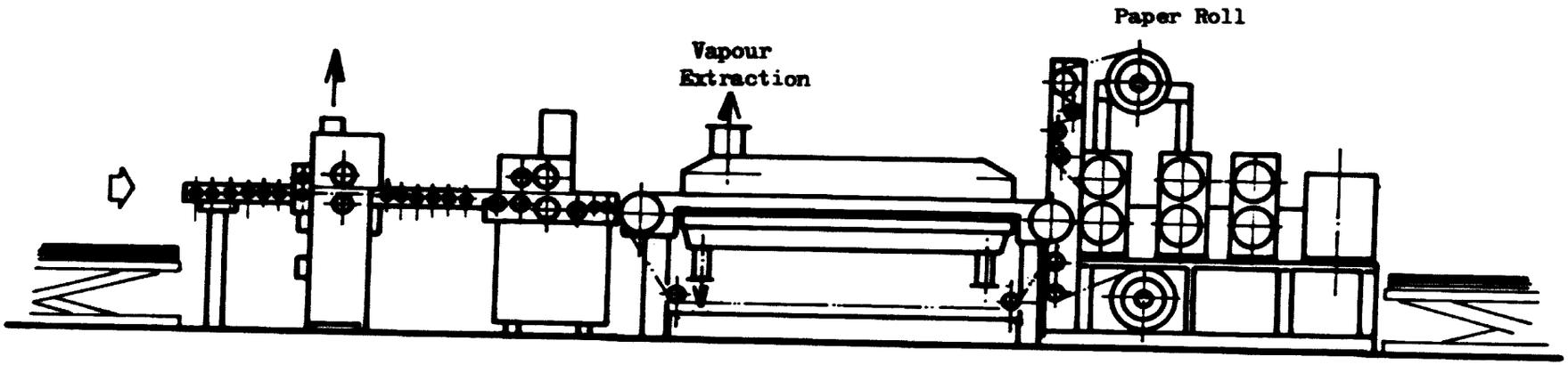


APPENDIX XII - Use of impregnated papers containing coat of lacquer

APPENDIX XIII - Application of finished impregnated papers

Scheme 7

PLANT FOR LAMINATING PAPER SHEETS ON PLYWOOD SHEETS



Brushing machine with distance adjustment entry and exit feeding tables

Glue Spreader

Pre-heating of the glued panels

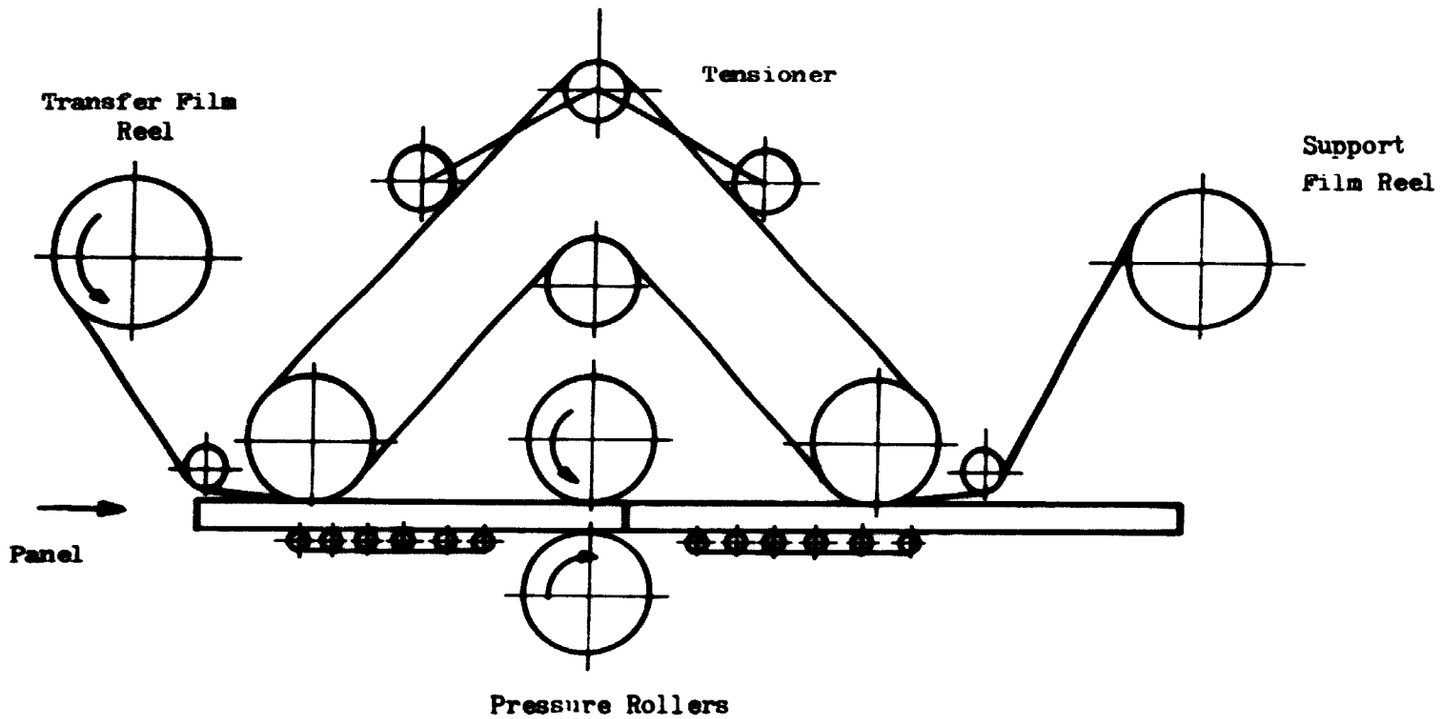
Plant for surface laminating (with callender rolls at approximately 210°C)

Utilizable adhesives:

1) Urea Formaldehyde Adhesives
2) Polyvinylacetate based Adhesives
3) Thermoplastic or thermosetting (dry process)

SCHEME DESCRIBING THE SURFACE IMPROVEMENT BY THE "TRANSFER" PROCESS

Scheme 8



Appendix XV

DETAILED REFERENCES FOR THE FOLLOWING APPENDICES

Appendix No. I

Pressing Line with Hot Single opening press

No. 1 - Brass grating belt
2 - Single-opening press
3 - Oil-hydraulic unit
4 - Roller bench
5 - Settingup belt
6 - Roller bench
7 - Glueing machine
8 - Platform
9 - Pushing arm
10 - Electric control desk

Appendix No. II

Pressing Line with single-opening press for laminates application

Appendix No. III

Pressing Line with single-opening press for veneering and short cycle lamination

No. 1.1 - Motor driven roller bench
2 - Lifting table with motor driven rollers
3 - Pneumatic pusher
4 - Brushing station
5 - Bench with motor driven wheels
6 - Vacuum hoists station for board loading
7 - Glueing machine
8 - Bench with lamellar motor driven wheels
9 - Laying truck for papers and veneers
10 - Vacuum hoists for papers and veneer loading

No. 2. 1 - Feeding truck
2 - Single-opening press
3 - Oil-hydraulic station
4 - Stretching devices for stainless steel sheets
5 - Extracting truck with vacuum hoists
6 - Pneumatic lifting frame

No. 3. 1 - Motor driven bench with trimming heads
2 - Motor driven bench with trimming heads
3 - Brushing station
4 - Boards tipper-cooling device
5 - Idle wheels bench with pusher.
6 - Bench with idle wheels
7 - Station of selecting vacuum hoists

No. 4. 1 - Electric control desk
2 - Electric cellular type board
3 - Push button box for control of feeding the vacuum hoist
4 - Push button box for control of selecting vacuum hoist
5 - Vacuum pumps
6 - Exhauster filter unit

Appendix No. IV

Layout of short cycle lamination plant for boards 8 by 50 in size - 3050 x 1830 No. 15 openings

No. 1 - Press 3150 x 1930 - No. 15 openings, 1700 tons - kg/cm2 30
2 - Lift - unloading truck
3 - Bench for upper stainless steel stripping
4 - Bench for finished boards stripping
5 - Caul plate waiting station for first setting
6 - Fixed frame for rough board centering
7 - Brush for rough board feeding
8 - Trepel for rough board feeding
9 - Pusher for rough board feeding
10 - Frame with motor driven rollers
11 - Bench for first setting
12 - Table for lower papers
13 - Bench for second setting
14 - Table for upper papers
15 - Table for upper stainless steel plate centering/
16 - Lift - loading truck
17 - Trepel for finished board stacking
18 - Upper stainless steel plate picking up for/change
19 - Upper stainless steel plate stacking table
20 - Lower stainless steel plates picking up table
21 - Lower stainless steel stacking table
22 - Vacuum station for upper stainless steel/stripping
23 - Vacuum station for finished board stripping
24 - Vacuum station for rough board setting
25 - Vacuum station for upper stainless steel/plate setting
26 - Loading and unloading pushing arm
27 - Press control desk

Appendix No. VII

Short cycle lamination plant with new feeding and unfeeding system - Press 2000 x 3900 - Boards 1850 x 3750

No.1 - Bench with motor driven rollers
2 - Lifting table with motor driven roller surface
3 - Pneumatic pusher
4 - Rough paper brushing station
5 - Motor driven roller bench with centering/device
6 - Board loading vacuum station
9 - Paper longitudinal loading vacuum station
10 - Micrometric lifting bench

No.2.1- Loading equipment
2.1.1- Board preparation bench
2.2- Single opening press
2.3.1- Low pressure accumulator
3.2- Centrifugal pump
3.3- High pressure accumulator
3.4- Hydraulic piston pump
3.5- Hydraulic station tank
2.4- Sheet stretching devices
2.5- Extracting truck with vacuum hoists

3.1- Idle roller bench with chain pusher
2- Trimming heads for long sides
3- Moveable trimming heads for short sides
4- Trimming bench with motor driven rollers
5- Finished board brushing station /station
6- Bench with motor driven rollers after brushin

No. 3.7 - Board tipper-cooling device
8 - Selection bench with motor driven rollers
9 - Selecting vacuum station

No. 5.1 - Electrical control desk
2 - Electrical control enclosures

Appendix XII

Laminating automatic plant with light papers

No. 1.1 - Bench with motor driven rollers
2 - Oil hydraulic lifting table
3 - Double vacuum hoist for board feeding
4 - Belt type conveyor

No. 2.1 - Brushing device
2 - Glueing machine with four rollers
3 - Paper coupling device
4 - Bench with motor driven rollers

No. 3.1 - Benches with motor driven rollers
2 - Micrometric lifting bench
3 - Vacuum hoist for paper loading

No. 4.1 - Set of rollers for board loading
2 - Belt type conveyor
3 - Single-opening press

No. 5.1 - Belt type conveyor
2 - Trimming station
3 - Bench with motor driven rollers
4 - Board tipper
5 - Bench with motor driven rollers
6 - Oil hydraulic lifting table
7 - Selecting vacuum hoist
8 - Bench with motor driven rollers
9 - Motor driven truck

No. 6.1 - Electric control desk
2 - Electric cellular type board
4 - Control push button box

Appendix XIII

Plant for paper glueing on particle board

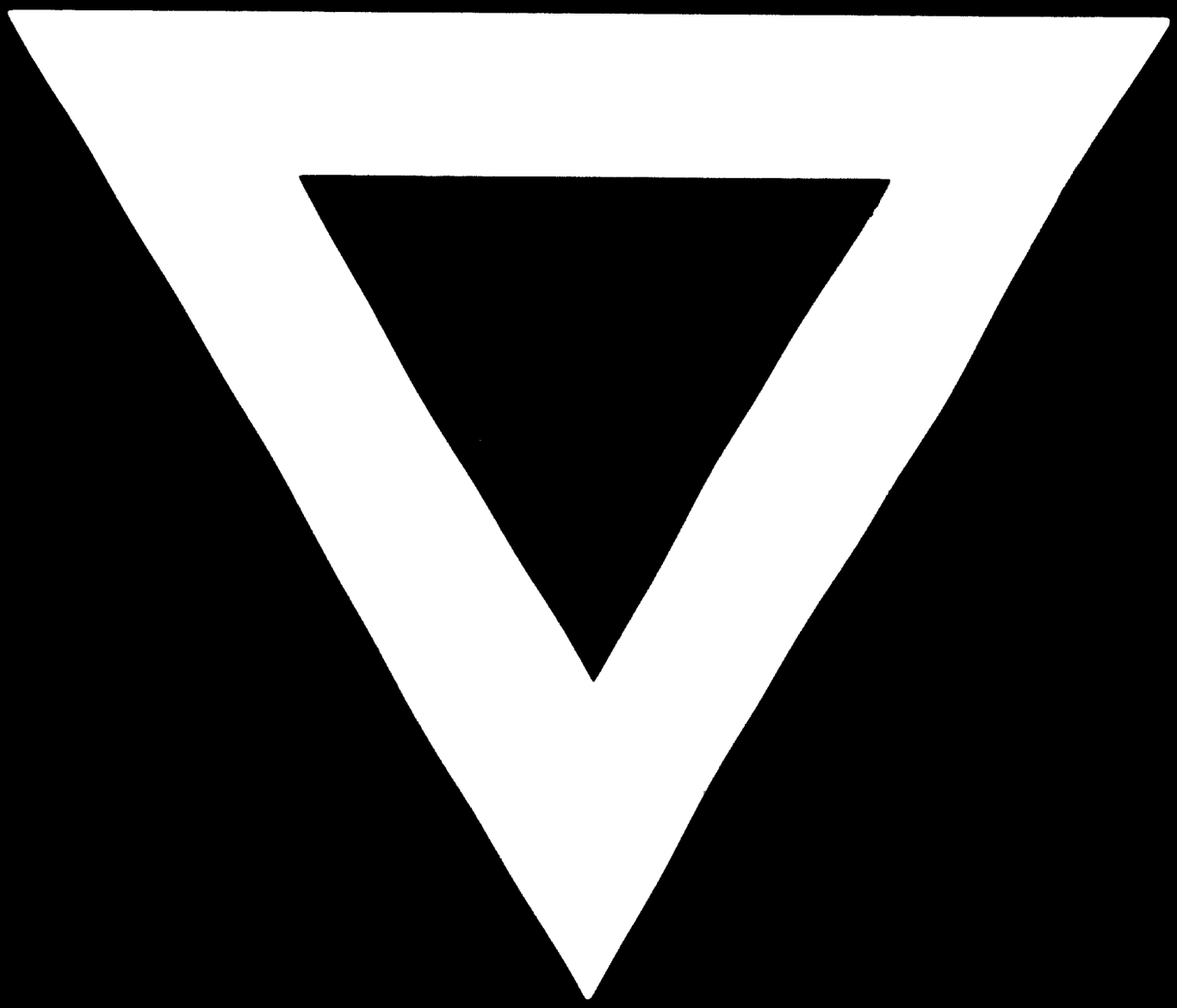
Steam extraction
Paper rolls
Spreader
Pre-heating of glued board
Short-cycle lamination plant with rollers plus embossing machine (rollers temperature abt 210 dgrs C.)
Usable glues (1) urea - formaldehyde bonding, (2) Polyvinl acetate basis bonding and (3) Thermomelting or thermosealing (dry process)

Appendix XIV

Advanced method for application of glue

- Transfer film decoiler
- Stretching devices
- Bearing film coiler
- Boards
- Pressing rollers

B-135



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