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Technical Course on Criteria for the  
Selection of Woodworking Machinery  
Milan, Italy, 8 - 19 May 1978

TECHNOLOGY AND MACHINERY FOR THE PRODUCTION OF  
CASEWOOD FURNITURE\*

by

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1. Introduction

The production of case good furniture, a modern reflection of the image of the traditional cabinet maker is an attempt for industrialization which has always been considered as the prerogative of a craftsman.

(Drawing 1) covers the following three sections:

- a) sides, bottoms, tops, backs;
- b) doors, drawers;
- c) shelves or other special parts.

The individual components have suitable finishes and technical characteristics for assembling to build up a finished product.

Assembly is achieved with suitable types of hardware or simply with wooden dowels and vinyl glue.

In order to give as much realism as possible to descriptions of production processes and machinery, the three following quantitative production levels are taken as references:

- Level A: Small daily output; craftsman production techniques; a few employees.
- Level B: Medium daily output; a few dozen employees.
- Level C: High output; industrialized production employees can be more than hundred.

## 2. Panel Material

The initial processes in the production of case good furniture are usually three but may be reduced to two or even one depending on the type of board material used. The components assembled to a product can be made of:

- a) hollow core board;
- b) particle board;
- c) blockboard or lamin board;
- d) particle board coated with melamine products;
- e) particle board for coating with paper or PVC;
- f) plywood;
- g) other bonded panels.

Depending on the type of board applied the first three production operations are:

- 1) sawing panels to size;
- 2) preparation of hollow core board;
- 3) preparation of veneer

### 2.1. - Panel sizing (Drawing 2)

As already mentioned, the type of panel, purchased in various standard sizes, can vary according to its end use. Whatever its successive operation is it must be sawn into pieces with oversized having its dimensions (of a part making up the product) increased by up to 15 mm to allow a tolerance for squaring up operations. Panels on the market can vary from 130 to 250 cm wide and 250 to 600 cm long. According to the daily capacity required a panel sizing circular saw can handle the work for workshops of:

1. Level A

It is sufficient to have a circular saw with a sizing carriage supporting the panels while sawing. Three operators will handle the production rate of 5-10 m<sup>3</sup> of panels in eight hours. As in some cases this machine could also be useful for further operations, this machine should be equipped with a scoring saw, to avoid splintering.

2. Level B

In this production level the machines used for sawing panels are of the vertical single blade type. This involves a structure to support the pack of panels (positioned edgewise) and a blade, guided by a suitable arm, for both longitudinal and transverse sawing. To pick up the single panels and position them on the machine, a vacuum grip should be used on an overhead hoist. The production of 8 to 15 m<sup>3</sup> in eight hours can be handled by operators.

3. Level C

Sizing large quantities of panels very sophisticated are applied with one or more blades, sawing panel packs positioned on a fixed or moving table longitudinally and transversally. Three systems are well known:

a) machine equipped with multiple blades for simultaneous longitudinal sawing panel packs; a top sawing unit is arranged for transverse sawing.

b) machine with a single blade sawing unit swivelling by 90° longitudinally and transversally.

c) sizing plant of two units first machine with one saw, and a bottom scoring blade, to saw the pack of panels longitudinally. Transverse sawing is then done on a second machine (Drawing 3). The entire pack or

the single strips are moved by a conveyor.

On all plants at Level C both longitudinal and transverse sawing can be mechanically or programme controlled. Automatic loaders and unloaders can be used for the packs of panels.

The number of operators can be from one to three while productive capacity which varies considerably according to differentiated or standard sizing operations, can vary from 20 to 100 m<sup>3</sup> in eight hours.

## 2.2. - Preparation of hollow board (Drawing 4)

Hollow core boards are built up by a frame of low cost softwood which must be dried to avoid twisting the rails and stiles. Wood or paper can be used as core material.

The covering panels can be plywood, particle board or other wood based panels.

The machining operations of rails and stiles for the frames are:

1. boards are rip sawn, thickness of the board = width of rails and stiles.
2. thickness of the planed board after planing the thickness of rails and stiles, the width of this material is rip sawn.

The types of plant, varying considerably according to the quantity of panels to be produced:

### 1. Level A

Boards are purchased already dried. The first operation is sawing to the required length with a band saw.

The boards are rip sawn on a circular saw and planed on a thicknessing machine. A stapler is used for joining rails and stiles to form the frame. The filling material (honeycomb) is then inserted and held with a few

staples and the frame is passed through the gluespreading machine for application of urea glue on both sides. The covering panels are applied and curing follows in a two platen hot press.

With the temperature of the water circulating in the platens at 90°C, curing cycle, depends on the thickness of the covering panels and can vary between 5 to 7 minutes.

Cooling and conditioning follows before the next machining operation starts.

## 2. Level B

The same operations as in Level A are used but with the following machines:

- single blade cut off saw;
- multi-blade circular sawing machine for ripping;
- thickness planing machine if necessary;
- band saw for cutting the cross members and any dowels required for the inside of the frame;
- bench with hand stapler for joining rails and stiles
- double side glue spreading machine;
- multi-platen hot press;
- disc conveyor linking the glue spreader and the press.

## 3. Level C

Large quantity production of panels is involved and therefore much more complex and sophisticated machines and equipment are used.

It will be necessary to begin with drying the raw material in suitable driers.

Stock will be unstacked automatically and fed to the multi-blade cut off saw. The boards whose rail and stile lengths represent the members of the frame, are conveyed to the multi-blade rip sawing machine. In this way stile and rail stock has the length required passing along a conveyor for checking and selection.



Stiles and railstock are placed in position of the assembling frame. Frame assembling can be done on a machine which carries out the entire stapling operation automatically.

Stiles and rails can be joined (automatically) either by staples or gluing.

Panel to frame assembly follows in multi-platen presses as described in Level A or B.

### 2.3. - Preparation of veneer (Drawing 5)

Preparation of veneer begins with the selection of the purchased packs, trimming the packs to length and jointing to the required width and then splicing.

These operations are closely tied to the ability of the operator.

The qualitative choice of material and the technique used to splice the sheets are in fact of major importance.

After being spliced the sheets are inspected and numbered. The machines used in each level are as follows:

#### 1. Level A

- Veneer pack trimmer and jointer;
- Paper tape splicing machine.

#### 2. Level B

- Veneer pack trimmer;
- Veneer pack jointer;
- Splicing machine;
- Inspection table.

#### 3. Level C

According to the required capacity a number of machines of 2. Level B has to be installed.

### 3. Panel Coating

As mentioned before, oversize panels will be machined. Assembled hollow core boards or particle boards will be processed as follows:

- a) veneering;
- b) application of finished materials (papers or PVC);
- c) application of fillers or prime coats.

#### 3.1. Veneering (Drawing 6)

After glue spreading, the veneer is normally applied to the panel, pressed and cured.

Machines and equipment vary according to the production level.

#### 1. Level A

After preparation, the glue is applied to the panel with a roller glue spreader and the sheets of veneer, prepared before, are positioned to both sides of the substrate which is then placed in a double-platen hot press (90°C). Pressing cycle varies considerably according to the type of veneer used, its thickness and the type of glue hardener used. However, experienced cycle times are 2 to 3 minutes. Pressure is about 3.5 kg/cm<sup>2</sup>.

#### 2. Level B

As the panels have to undergo successive operations on precision sanding machines, it is necessary, before applying the veneer, to calibrate the panels on a sanding machine equipped with coarse abrasives.

The machine can operate only on one side of the panel. For double side sanding the panel has to pass the sander twice. Glue spreading and pressing can be as for Level A, using single or multi-platen presses according to the required production capacity. Furthermore, it is necessary to provide after the glue spreading operation, a panel disc conveyor. The lower part of the discs dips into a water basin. The panel is supported from the time it leaves the glue spreading machine until its assembly by the operator.

Glue mixing equipment will facilitate the preparation of the urea glue mix.

### 3. Level C

In this category an automatic pressing plant is installed by linking different machines so that a panel is processed in one pass.

Equipment for automatic pressing:

- automatic press loader (can be thrust type);
- linking element;
- double side sanding machine;
- double side glue spreading machine;
- bench on which operators arrange the sheets of veneer on glue covered panels;
- automatic two-platen press.

The latter machine is linked to a loading conveyor on which the various panels are laid in front of the press which is a cycling single opening press with endless belt. All the pressed panels leave the press while, simultaneously, those laid up at the loading conveyor are fed in. The conveyor on the outfeed end also acts as an automatic unloader.

#### 3.2. Laminating of synthetic materials (Drawing 7)

Due to the high cost of plant involved, this type of coating is only of interest in Levels B and C. There are two main groups of synthetic laminating material:

1. papers treated in various ways;
2. thermoplastic foils.

#### PVC Papers

Papers can be used as substitutes for wood veneers and therefore must undergo a coating operation after application. The paper can be impregnated and therefore used directly as the decorative finish of the panel, as is also possible with thermoplastic foils made from polyvinyl chloride.

In the two latter cases the production cycle is substantially reduced because all the sanding and coating phases are avoided. It can also be mentioned that by using sheets of PVC (polyvinyl chloride) it is possible to coat panels on both faces and edges with the same sheet.

It is also possible by using certain machines described later, to obtain the body of a furniture unit from a single PVC coated panel.

Plant for applying PVC:

2 - Level B

Panel loading element:

- top and bottom brushing machine;
- top and bottom unreeling machine for rolls of PVC with roller pressing unit for stretching the foil on the panel and clipping;
- conveyor belt and final roller press.

Due to the application of vinyl glue the panels must carefully be stacked and conditioned.

3- Level C

Plant is the same as that for Level B with the addition of automatic panel loading and unloading equipment.

The plant is equipped with a hoist to bring PVC rolls from stores to the unreeling unit.

3.3. Application of fillers or prime coats (Drawing 8)

This operation is also carried out on panels (hollow core board or particleboard) to provide a base on which to apply the final decorative laminating or coating.

The aim is to obtain the grain effect of a particular wood specie by printing during coating, or to obtain coloured finishes with pigmented varnishes.

The filler used must be polyester based and is applied, according to the panel type which can vary from 200 to 500 g/m<sup>2</sup>.

Machines required are:

1. Level A

For this category it is advisable to purchase panels already treated by the supplier due to the very high cost of suitable equipment.

2. Level B

The following plant is required for applying fillers:

- single type sanding machine;
- filling machine;
- ultra-violet drier

Drying time for the coat (30 to 40 s) varies according to type of U.V. light used, as foreseen in the same level for veneered panels.

3. Level C

For higher production the plant described above (Level B) must be complemented:

- automatic loader;
- linking element;
- sanding machine;
- brushing machine for removing dust and wood particles before applying filler;
- filling machine;
- linking element;
- drier;
- automatic unloader.

4. Sizing - Edge banding - Boring and various operations on the panel (Drawing 9)

According to the type of panel and coating material we have so far dealt with manufacturing processes and consequently machines and plant, differing from each other.

This phase, on the other hand, is common to all types of basic panels and will be treated without any particular sub-divisions except for quantitative levels and a special processing technique suitable and recommended only for PVC laminated panels.

1. Level A

For this category, the sizing (both longitudinal and transverse) panels is carried out with a simplified twin-blade panel sizing machine and, if required, with automatic or even manual panel feed. Sizing must be very

accurate to obtain surfaces suitable for edge banding with veneer or thermoplastics bands.

Edge banding can be done on a single head machine using hot melt glue; the edges being of veneer or other material in strips or on reels.

On this type of machine, only one edge can be applied to the panel at each pass.

Sizing and edge banding is followed by the boring operation.

The panels must be bored to take all the hardware required and for final assembly of the unit.

A single mobile boring head machine can be used to allow for both horizontal and vertical drilling.

For various auxiliary operations it is important to have other indispensable machines available such as high speed routers.

## 2. Level B

To mechanize and automate handling and greatly reduce floor to floor times three basic machines, which can be used in line are indispensable for this category. The machines would, however, have to be positioned so that they could be used individually.

The machines are:

- double end trimmer/panel sizing machine with machining units arranged both for sizing and moulding operations. With this machine longitudinal sizing precedes transverse sizing.
- double edge banding machine grouped with the panel sizing machine and linked by a driven conveyor which can be removed to use the two machines independently. The two heads of the edge banding machine must be exactly the same and capable of being used with edges in wood or thermoplastic materials in strips or on reels. In the case of wood edges the plant must incorporate automatic sanding units.
- automatic multi-spindle boring machine for horizontal and vertical top and bottom boring. The number of heads will depend on the various possibilities of the boring operations. The machine will also be grouped with the panel sizing and edge banding machine so that, when transverse sizing and edge banding is carried out, all the boring operations required can be done in one pass.

For other successive operations on the panels, the following auxiliary machines are necessary:

- highspeed - router - edge banding machine for contoured edges - single-head boring machine - circular saw with scoring attachment.

### 3. Level C

For large scale production, sizing, edge/banding and boring are done on a completely automated line consisting of:

- double station loader;
- panel sizing machine;
- edge banding machine;
- board turning unit;
- panel sizing machine;
- edge banding machine;
- automatic boring machine;
- dowel driving machine (when working on finished products melamine and PVC);
- board turning unit;
- double station unloader.

Very careful thought should be given in choosing this plant by evaluating the quantity and type of production involved. The following are some of the more important considerations to be borne in mind:

- a) the output of a complete sizing/edge banding line is closely tied to the quantity of identical parts fed into it. In fact, as shown in the diagram (Drawing 10) derived from practical data (quantities of identical panels shown in abscissas and production in units of time in ordinates), productivity begins to be optimized from only 1000 identical panels and more.

It is therefore obvious that, if the quantity of panels to be produced is well below the figure given above, the complete production line is no longer efficient and becomes uneconomical for very small quantities (100 to 200). In this case it would be well to split the line into two single production lines with independent boring units.

There are two main advantages of the single line:

- 1) by removing the boring machine from the line, tooling up time (most of which is taken up by the borer) is reduced to an extent which gives productivity advantages of up to 50 per cent (results obtained in practice) .
- 2) the down time of the whole line whenever mechanical or production troubles occur on one machine is avoided.

Whenever a line is automated (with automatic loading and unloading) and the sizing/edge banding operation is done on machines where dimension changes are programmed electronically, the final result will be a considerable increase in productivity.

- 3) It is interesting to follow the line (Drawing 11) indicating the effective production obtainable (linear metres per min.) as a function of the length of the workpieces.

This curve demonstrates that productivity does not vary greatly for workpieces over 150 cm long. Below this value productivity decreases sharply.

Evidently this consideration is fundamental because production capacity changes considerably as a function of the type of furniture unit produced. Therefore the choice of machines and their characteristics must be evaluated very carefully in consideration of what has been explained above.

As already mentioned, the help of some machines outside the line for certain auxiliary processes carried out after the sizing/edge banding operations, can be considered indispensable.

In this quantitative production category, some fundamental and diversified aspects of the technologies adopted can be analysed; in particular:

- a) Separation of boring unit from the automatic sizing/edge banding line.

It is interesting to consider the separation of the boring machine from the automatic line although the line could, with advantage, be equipped with an automatic boring machine only for horizontal boring operations. This allows for rapid tooling up and, furthermore, avoids the condition where the line feeds up to the limit spots of the borer. All special boring operations that identifies the part in the pre-assembly stage, can be done on a special machine being programmed for many dimension changes and arranged to carry out many different boring operations.



b) Processing of laminated panels melamine and, above all, PVC sawn into folding boards.

Sizing and edge banding is done lengthwise only. The length of the board is the same as the total peripheral development of the body of a furniture unit. The board is passed to an integrated linear system for simultaneously boring as well as the V grooving for folding the board to form a carcass (Drawing 12).

#### 5. Lacquer Coating

All panels which have been veneered or treated with fillers have to be sanded on faces and edges before lacquer coating.

As will be described later, lacquer coating panels before assembly can be avoided. For certain types of finish it is possible to sand the faces and edges, assemble the unit before staining and lacquer coating.

For the three levels so far referred to, systems and plant change considerably according to capacities required; in particular they vary according to the type of coating material. The problem will be dealt with here only as far as the three quantitative levels are concerned. The individual application systems, will be subject of a special report.

#### 1. Level A (Drawing 13)

Sanding of raw faces and edges can be carried out with a manually operated belt sander: the same machine being used for sanding the coated faces and edges.

Staining and coating of faces and edges with prime and finishing products is done in a spray booth with a filter wall and exhaust system to eliminate all the air-borne residues from the compressed air spray guns. The panels are then placed on suitable supports and the spray left to catalyze in free air.

#### 2. Level B (Drawing 13)

Sanding of raw and coated panel surfaces can be done with a separate automatic machine chosen according to type of veneer or coating material used.

Sanding of rough edges, mentioned previously (4.) will be done on the edge banding machine equipped with sanding units. Curved wood edges on panels are sanded on a single-head contour sanding machine, the number of passes being equal to the number of edges to be treated. Coating of edges is done on stacked panels by spraying in the spray booth. Drying in open air.

For surface treatment a semi-automatic plant can be used:

- brushing/staining machine for applying one coat of stain;
- stain drier (infra-red or hot air);
- roller coating machine for application of prime coat;
- lacquer drier (infra-red or hot air) according to type of coating material;
- lacquer sanding machine for denibbing raised grain;
- curtain coating machine, with one or two heads;
- rack trolleys with chain feed. After curtain coating the panels

are loaded on rack trolleys which coupled to the chain conveyor, pass through a drying tunnel. Heating systems and fans are arranged in two different zones: one at low temperature for the flash period of the solvents and one for drying the coat at a higher temperature. Finally the panels can be cooled in open air or in a forced ventilation zone. A single-head edge sanding machine is used for smoothing the coated edges.

The finish coat can be applied with the same plant described above or, as explained later, applied on the assembled unit.

### 3. Level C (Drawing 14)

After edge coating of the stack in a spray booth and subsequent drying, the panels enter an automatic surface lacquering plant. The prime coating plant can be as follows:

- double automatic loader for two lines of panels;
- sanding machine, with two or three cross belt sanding units for finishing veneered surfaces;
- staining and prime coating with rollers, as explained for Level B above the only difference being that there can be more coating machines and driers the aim being to obtain a better finish with less coating films. Furthermore the size and capacity of the driers is proportional to the feed rate of the line to allow completion of the quantity of panels planned for production;
- automatic sanding machine for intermediate sanding of coat;
- brushing/cleaning machine for making surfaces perfectly clean;
- automatic lining-up unit preceding the curtain coating machine;
- curtain coating machine with special conveyors to allow coating to be synchronized with a complete load for the drier;
- if required, automatic loader for the drier;
- multi-deck drier with possibility of varying the temperature, in the

two drying and flash off zones, according to the type of coating material. The drier also includes a cooling zone and automatic unloading device.

The panels then enter a plant for sanding the coated surface. It can be a linked line for cross sanding operations and double automatic sanders (in line) for edge sanding.

Panels can be coated with a finishing material on a separate line:

- a vibrator unit to remove dust and any small scratches on the coated surface;
- a panel cleaning unit;
- a single-head curtain coater;
- a drier which (linear or rotary)

Both for Levels B and C it is possible to insert in the coating line, after the staining phase, a printing machine which gives, on the stain, a good reproduction of the grain of a veneer. This process can be carried out on panels having polyester coated fillers or, for a better effect, on panels veneered with second grade wood. The great advantage of this system, besides considerable cost reduction, is that of giving the panels a uniform surface; a feature much appreciated in large scale production of modular unit furniture.

The application of the first prime coat on the printed surface is possible after a short flash off cycle and is a completely automatic operation.

#### 6. Pre-Assembly - Assembly - Packing

We have so far dealt with the processing of the panel to prepare it for final assembly into a finished furniture product.

Independently of quantities, the basic concept for programming the whole manufacturing process can be detailed as follows (Drawing 15)

- a) work order with integral flow for the whole manufacturing process including assembly and control of finished product stores availability;
- b) work order with integral flow for the whole manufacturing process including carcass assembly only while identification with the front is

- carried out according to market demand. Control of finished product stores availability;
- c) work order with integral flow up to pre-assembly. Assembly is according to delivery requests with cycle programming and control of semi-finished product stores availability;
  - d) work order for components with control of semi-finished product stores and assembly according to delivery requests with cycle programming;
  - e) work order for components with control of semi-finished product stores and assembly according to delivery requests with cycle programming;
  - e) integral work order including assembly according to delivery requests with cycle programming.

It is evident from the above that assembly systems and methods can be quite diversified as detailed in item 6.1.

#### 6.1. - Assembly and packing of units with finished panels

This sector deals with assembly of panels having surfaces completely finished i.e., all panels laminated with PVC or coated with lacquer finishing material. (Drawing 16)

##### 1. Level A

All the hardware (frames, accessories, drawer guides) must be applied to the panels at the work bench with manual tools (screwdrivers, drills, staplers).

After the fitting of hardware and wooden dowels the panels can be handled in two different ways:

- packed loose (with cardboard, polyester and polystyrene protection) so that assembly may be done by the end user;
- assembled,

in which case the carcass will be assembled first using vinyl glue and a pneumatic clamp for squaring up the carcass.

Doors and drawers (previously assembled) will then be fitted to the body on a work bench and the units packed in cartons with suitable protection.

##### 2. Levels B and C

Special machines and equipment are required for medium and large scale production and for their choice certain rules must be observed:

- eliminate all unnecessary material handling;
- store all semi-finished parts close to the assembly line to fully utilize space permitting easy pick up;
- avoid conveying parts on the floor and pick up of semi-finished parts once they have been put on the assembly line;
- carry out all pre-assembly, assembly and packing operations (manual and mechanical) during the progress of the unit along the production line;
- during pre-assembly, carry out the boring not previously effected, according to the established assembly programme.

The assembly plant can include the following machines and equipment:

- automatic dowelling machines;
- machines for auxiliary boring and automatic application of some types of hardware as required;
- mat type or slotted conveyor belts, operated by variable speed motor drive reduction gears for pre-assembly, with structures for holding equipment and overhead adjusted pneumatic tools and hardware containers so that the operator has, within reaching distance, the right piece of hardware and the right tool for the operation involved;
- clamps for squaring up the units;
- automatic tipper;
- slotted conveyors, variable in height (even automatically), for applying doors, drawers or other parts to the units as they advance at a pre-established rate.

At the end of the assembly line the units must be suitably protected from damage (in stacking and transport to stores) up to final delivery. In particular, veneered furniture must be protected to prevent alteration to the wood's shading by exposure to the light.

This type of product is normally packed in cartons, corners are protected with polystyrene and delicate surfaces with tissue paper.

The cartons can be closed at the end of the line with automatic strapping or taping machines.

For all those units with uncoated surfaces, and particularly unassembled units, packing with shrinkage foil wrapping is of interest. It is applied with a machine consisting of an automatic unreeper of the shrink foil rolls, a splicer and an electric oven which, at a temperature of about 200°C, shrinks the foil which wraps **tightly** around the surfaces to be protected.

#### 6.2. Assembly of units with unfinished panels (Drawing 17)

Unfinished panels can be divided into two categories:

- a) veneered panels, with a prime coat after having been sanded on faces and edges, are assembled as described in 6.1. and on the same assembly line the assembled units enter a prescribed booth where the finishing coat is applied with a spray gun. The units are then conveyed (automatically) into a drier. Packing as described before.
- b) veneered and sanded panels, which have not been stained and prime coated are assembled to obtain raw units. All the operations for staining, various prime coats, sanding and finishing prime coats, are done on the assembled unit, thereby obtaining special finish shadings such as antique, etc.

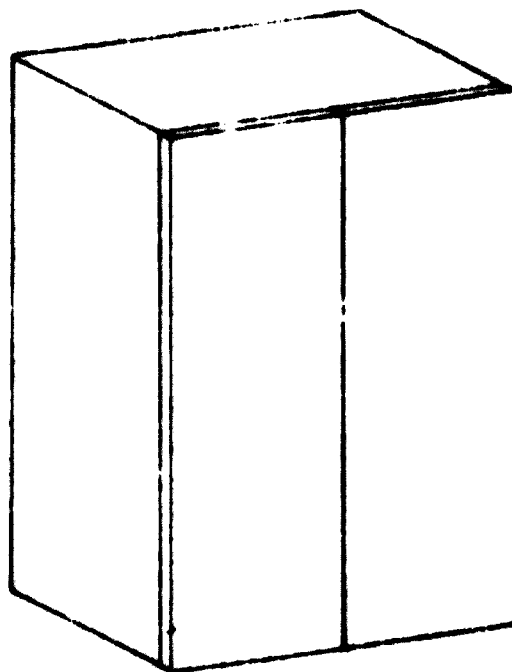
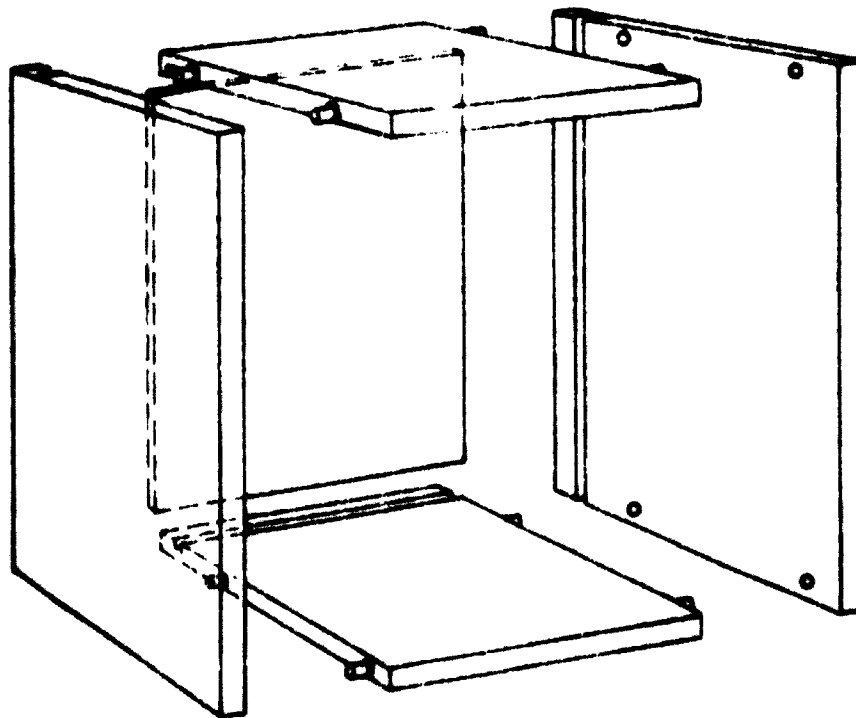
For large scale production, all the above operations take place in succession as the unit moves forward on a conveyor belt at a given speed and passes through the spray booths and driers as shown on Drawing 17. On leaving the plant the units are packed in the normal manner.

#### 7. Conclusion

After assembly, the furniture units can be stored for delivery against orders and dispatched to the customer. Alternatively they leave the assembly and packing lines ready to be sent to the customer.

We have attempted to deal with the various cycles and processes for the production of case good furniture as detailed as possible. In view of the extent of the problems involved, the subject should certainly be treated more thoroughly, however, it is hoped that these notes are sufficient to give at least a guide to those interested in the choice of machines and in the production processes for the particular type of furniture they intend to produce.

Drawing No. 1 - Assembly of Panel Furniture

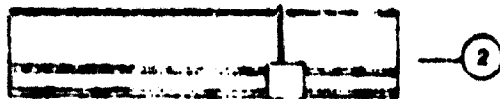


Drawing No. 2 - Layouts for Panel Sawing

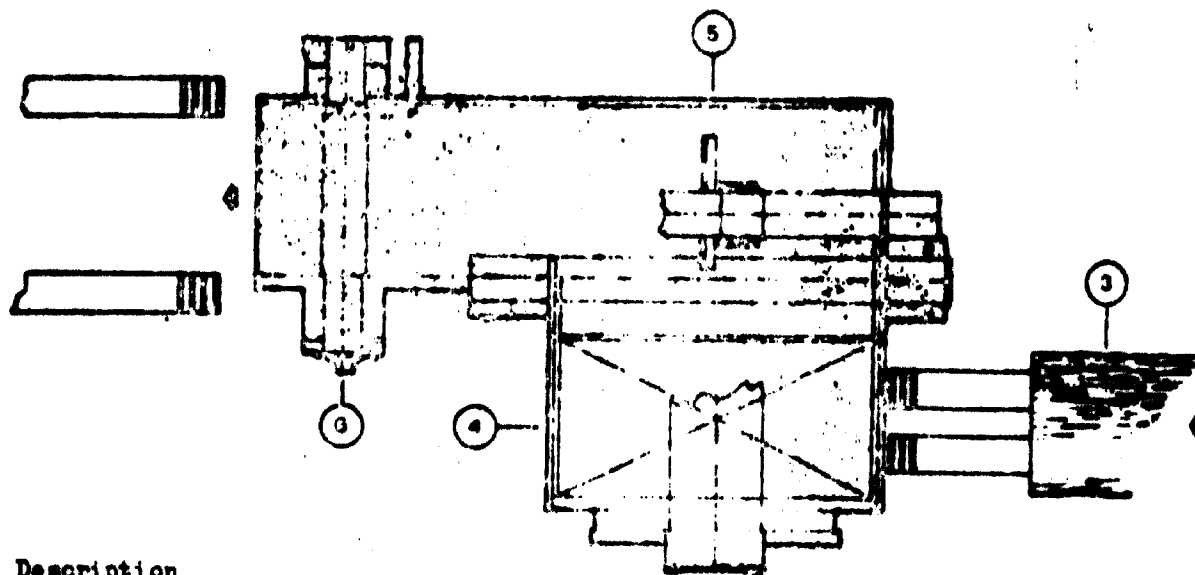
Level A



Level B



Level C

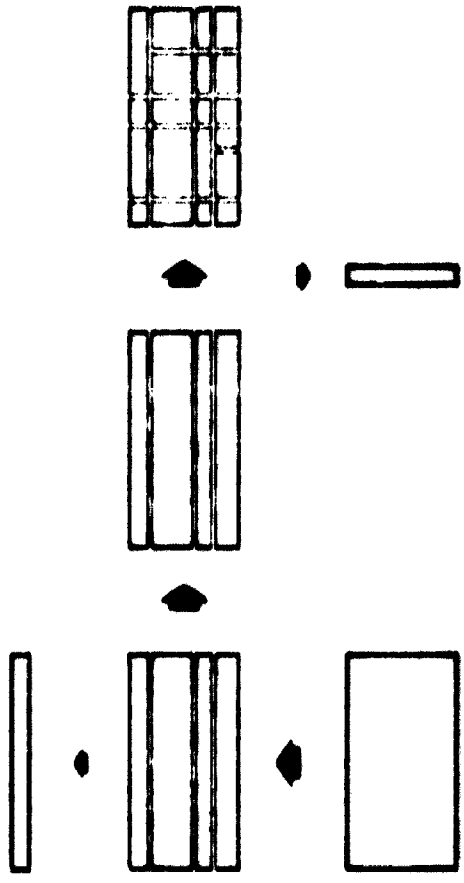


Description

- ① Circular saw with sliding table
- ② Vertical single blade panel saw
- ③ Panels to be loaded
- ④ Automatic loader
- ⑤ Longitudinal panel sawing
- ⑥ Transverse panel sawing

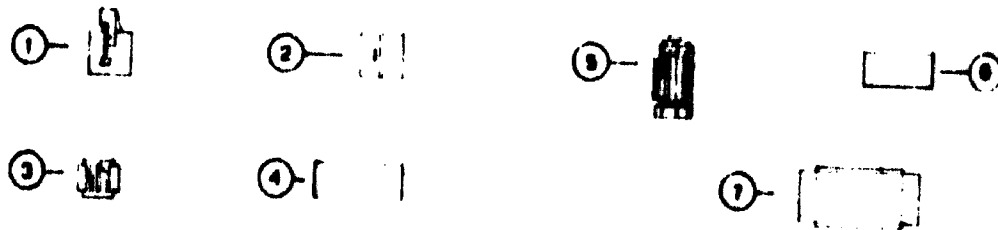


Drawing No. 3 - Panel Sealing Flow Diagram

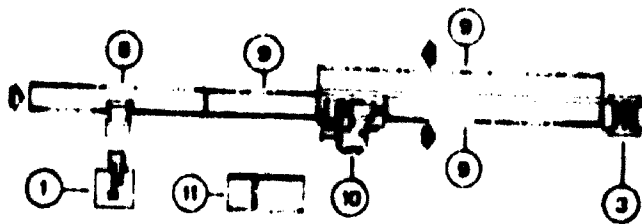


Drawing No. 4 - Layouts for Preparation of Hollow Cork Boards

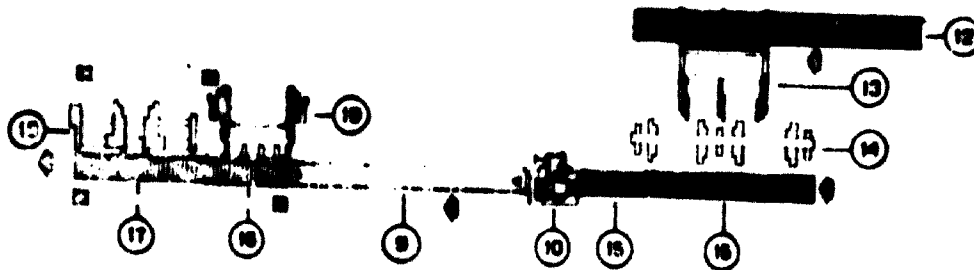
Level A



Level B



Level C



Descriptions:

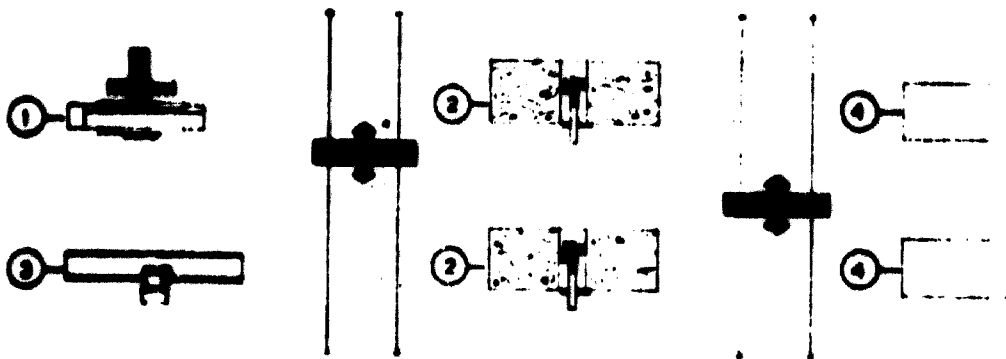
- |                             |  |
|-----------------------------|--|
| ① Band saw                  | ⑪ Surface planer                             |
| ② Circular saw              | ⑫ Roll way for feeding board stacks          |
| ③ Thickness planer          | ⑬ Automatic stacker                          |
| ④ Bench for frame assembly  | ⑭ Automatic board saw                        |
| ⑤ Glueing spreading machine | ⑮ Multi-blade saw roll way feeder            |
| ⑥ Disc conveyor             | ⑯ Turning unit (90°) for feeding out off saw |
| ⑦ Hot platen press          | ⑰ Roll way linked to unloader                |
| ⑧ Out off saw               | ⑱ Automatic unloader                         |
| ⑨ Conveyor belt             | ⑲ Automatic out off saw                      |
| ⑩ Multi-blade rip saw       |  |

Drawing No. 5 - Layouts for Preparation of Veneers

Level A



Level B

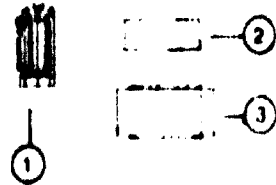


INSTRUCTIONS

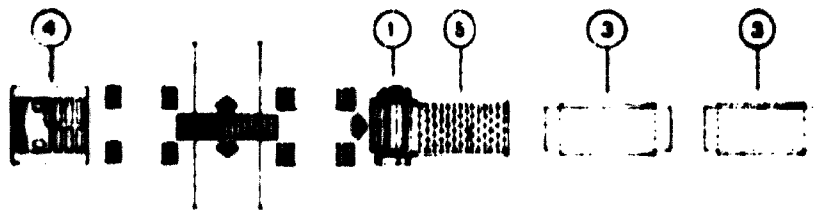
- ① Trimmer
- ② Splicer
- ③ Saw
- ④ Inspection tables

Drawing No. 6 - Layouts for Veneering

Level A



Level B



Level C

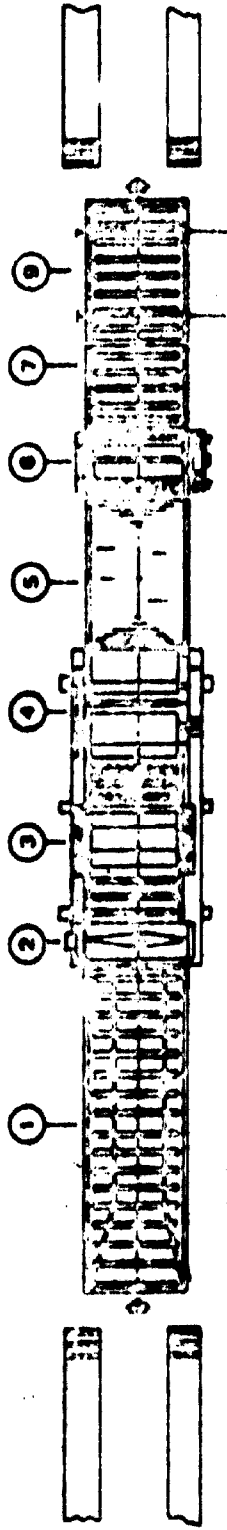


Descriptions:

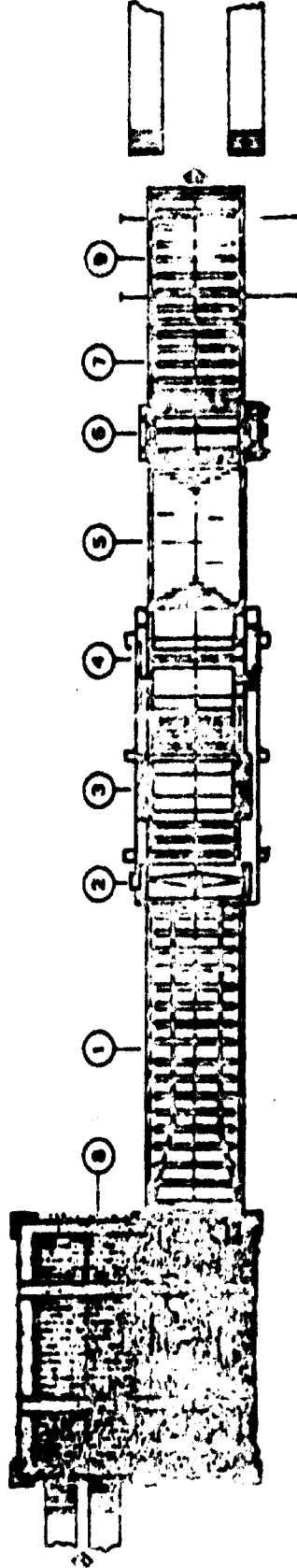
- |                             |                                      |
|-----------------------------|--------------------------------------|
| ① Glueing spreading machine | ⑥ Automatic loader for pressing line |
| ② Preparation table         | ⑦ Herringbone element                |
| ③ hot press                 | ⑧ Conveyor belt                      |
| ④ Sander                    | ⑨ Automatic press                    |
| ⑤ Disc type conveyor        | ⑩ Out feed conveyor belt             |

Drawing No. 7 - Layouts for Application of Synthetic Materials

Level B



Level C



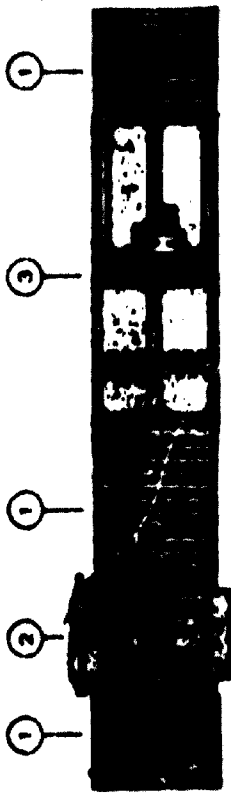
Descriptions:

- ① Infeed unit
- ② Brusher
- ③ Unreeler
- ④ Clipper
- ⑤ Conveyor belt

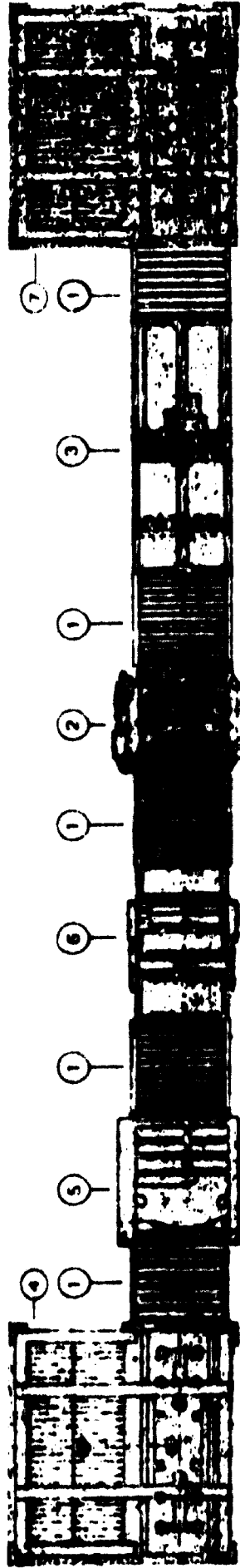
- ⑥ Roller press
- ⑦ Outfeed element
- ⑧ Automatic loader
- ⑨ Conveyor slide

Drawing No. 6 - Layouts for Application of Miller

Level B



Level C

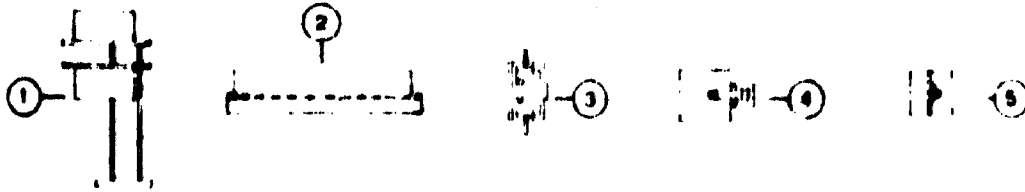


Description:

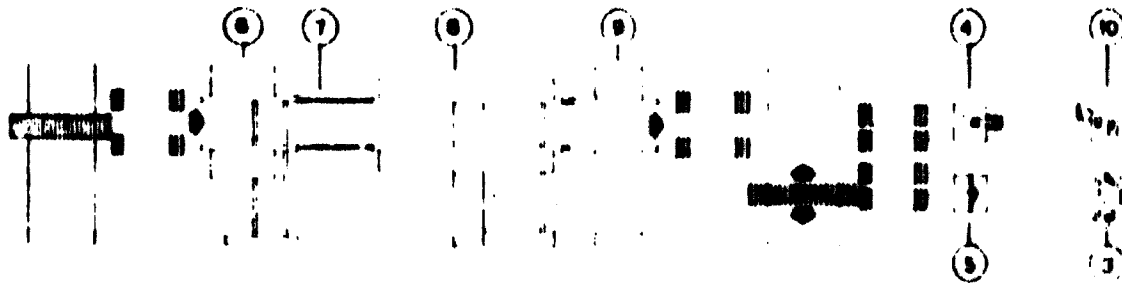
- ① Linking element
- ② Filler machine
- ③ Ultra-violet drier
- ④ Automatic loader
- ⑤ Sender
- ⑥ Brusher
- ⑦ Automatic unloader

Drawing No. 9 - Layouts for Sizing Edge Banding and Boring

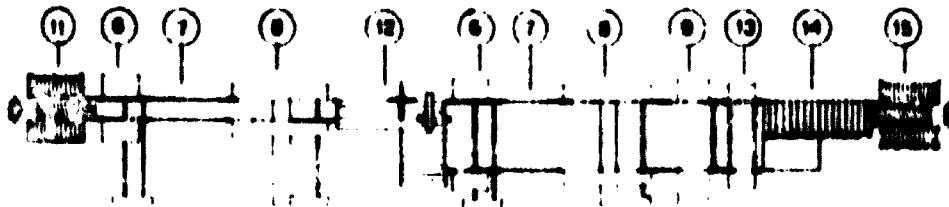
Level A



Level B



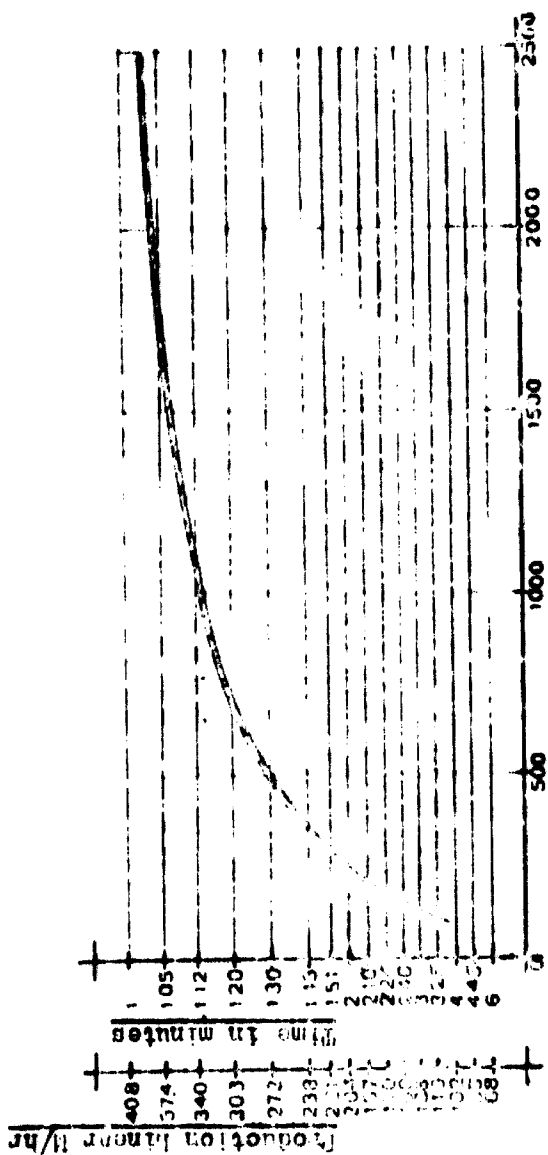
Level C



Description:

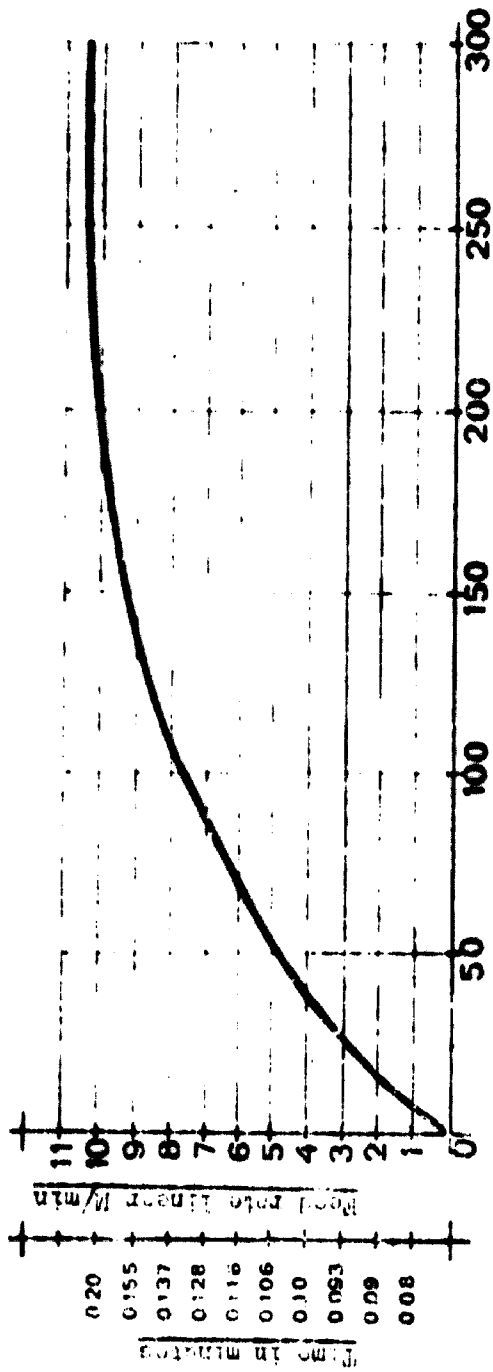
- |                                   |                                |
|-----------------------------------|--------------------------------|
| ① Plain panel sizing machine      | ⑨ Automatic boring machine     |
| ② Single-end edge banding machine | ⑩ Contour edge banding machine |
| ③ Single-end boring machine       | ⑪ Double station loader        |
| ④ Router                          | ⑫ Board turning unit           |
| ⑤ Spindle moulder                 | ⑬ Dowel driving machine        |
| ⑥ Automatic panel sizing machine  | ⑭ Board turner                 |
| ⑦ Linking element                 | ⑮ Double station unloader      |
| ⑧ Automatic edge banding machine  |                                |

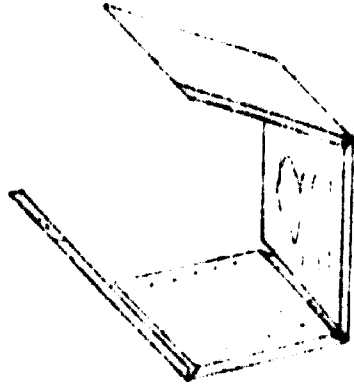
Drawing No. 10 - Productivity Diagram of a Panel Sizing Line as a Function of Panel Quantity (UCCI)





Drawing No. 11 - Production Diagram of a Panel Sizing Line as a Function of Panel Length (SOX)

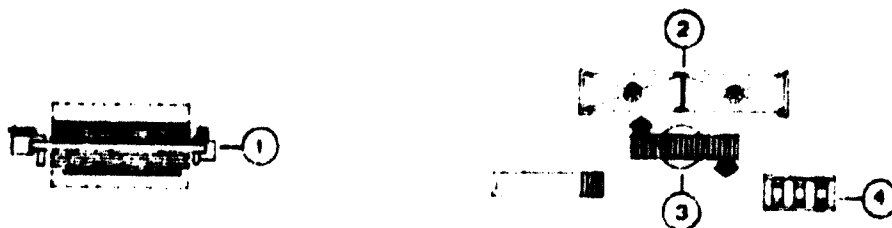




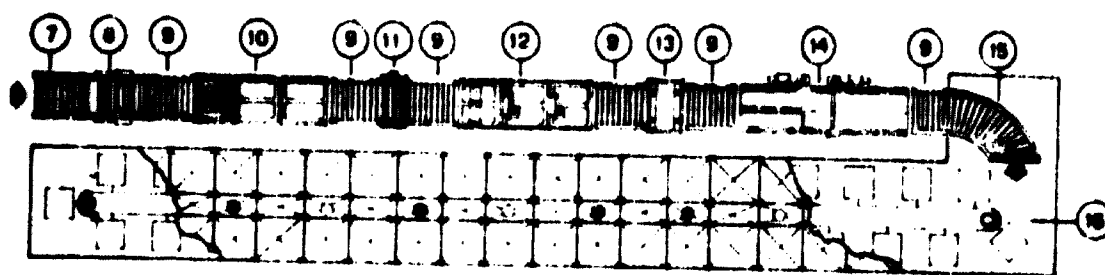
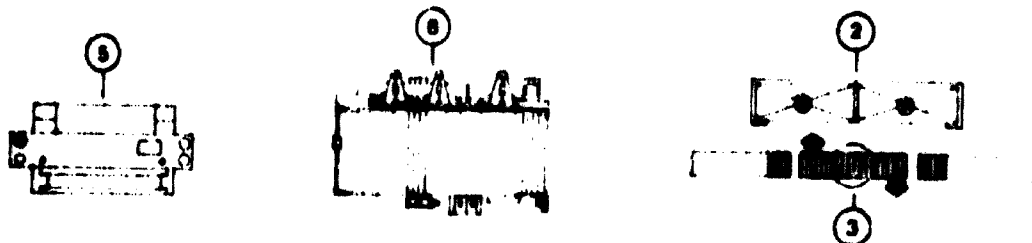
Drawing No. 12 - Sizing and Edge Bending - Lengthwise Only

Drawing No. 13 - Layouts for Lacquer Coating

Level A



Level B

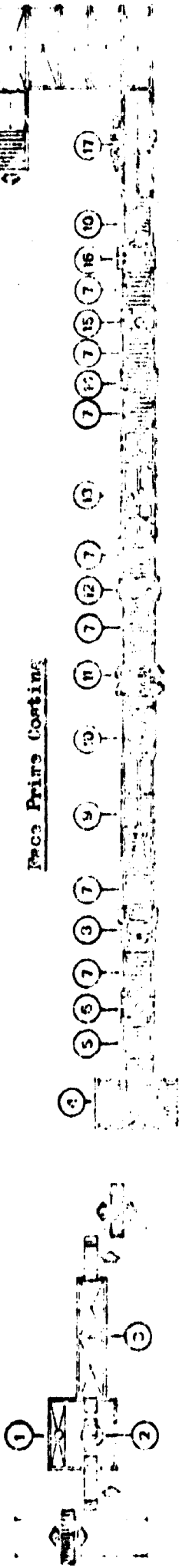


Description:

- |                           |                            |
|---------------------------|----------------------------|
| ① Manual belt sander      | ⑧ Linking element          |
| ② Spray booth             | ⑩ Hot air drier            |
| ③ Rotating table          | ⑪ Coating machine          |
| ④ Trolley                 | ⑫ Ultra-violet drier       |
| ⑤ Automatic sander        | ⑬ Sanding cleaning machine |
| ⑥ Single-head edge sander | ⑭ Curtain coating machine  |
| ⑦ Infeed unit             | ⑮ Curtain coater unloader  |
| ⑧ Automatic sander        | ⑯ Rotary type drier        |

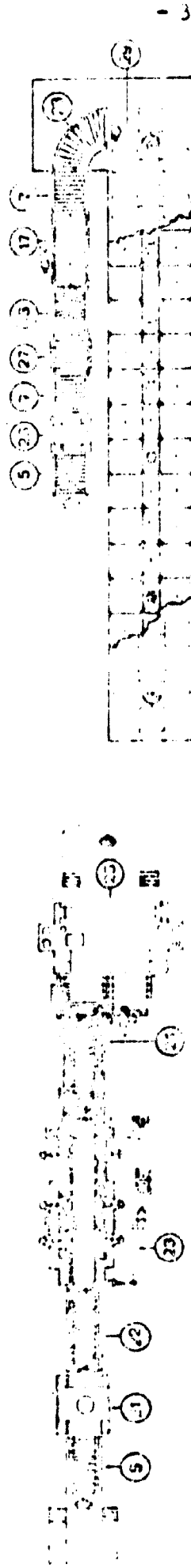
DRAWING No. 14 - Layout for Locomotive Coasting (Level C)

EDGE Coasting



Face Prime Coasting

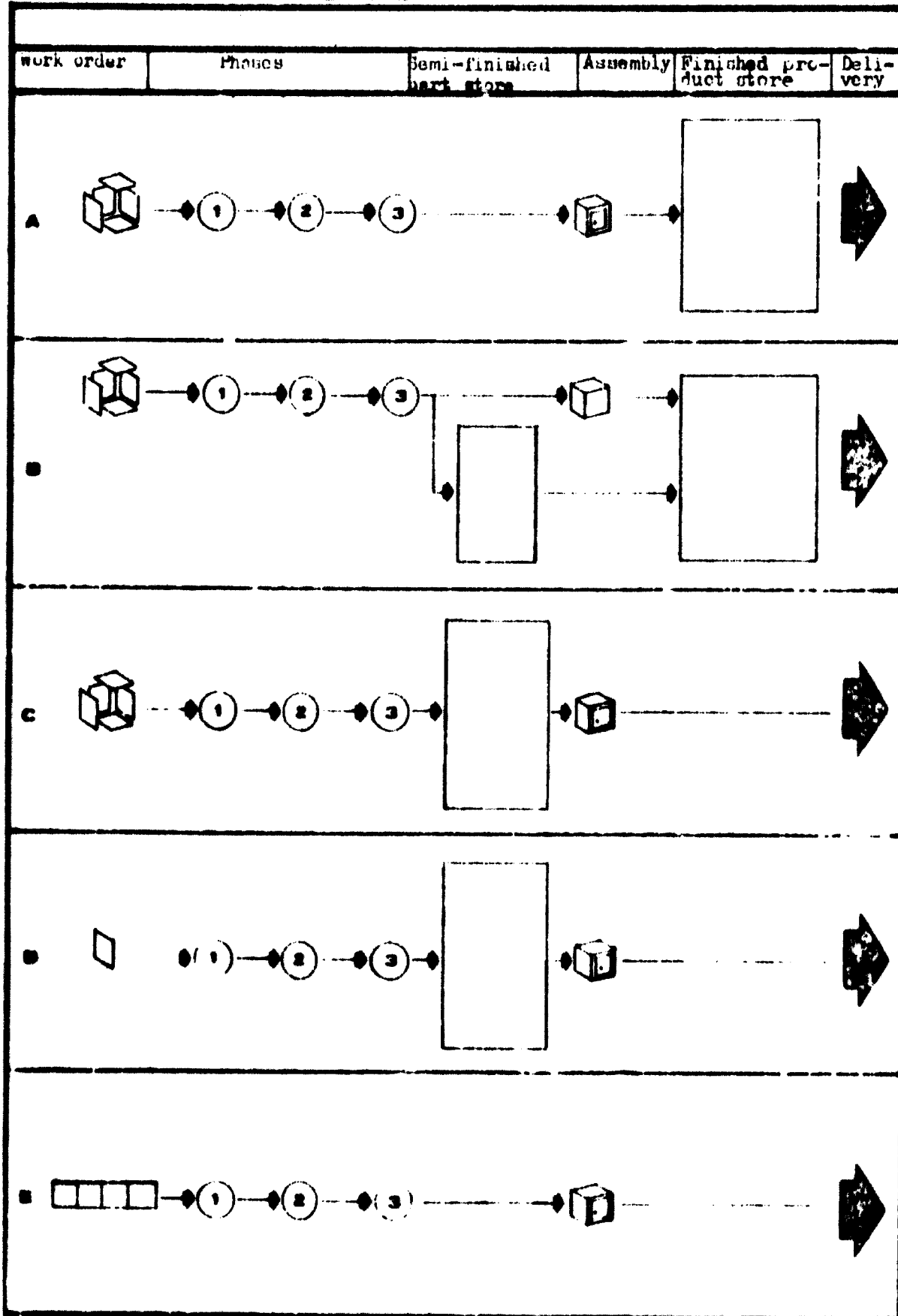
Face Prime and Finish Coasting



Description:

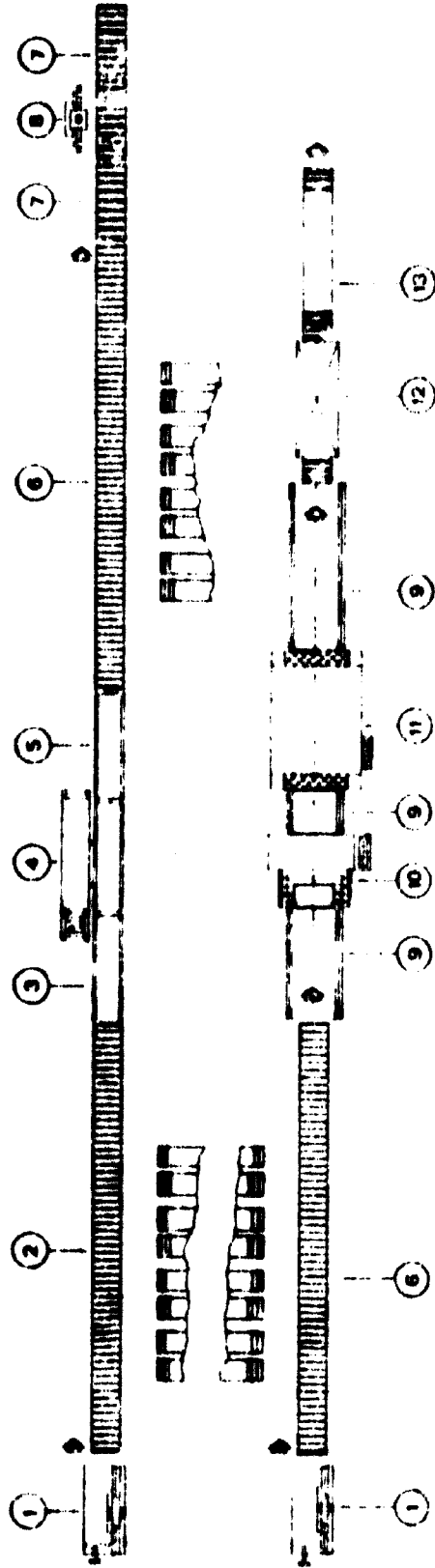
- |    |                           |    |                                   |
|----|---------------------------|----|-----------------------------------|
| 1  | Spray booth               | 20 | Transverse sanding machine        |
| 2  | Rotating table            | 22 | Inclined roller linking element   |
| 3  | Drier                     | 23 | Double edge sanding machine       |
| 4  | Double station loader     | 24 | Board turning unit                |
| 5  | Infed unit                | 25 | Longitudinal sanding machine      |
| 6  | Belt sander               | 26 | Vibrator unit                     |
| 7  | Linking element           | 27 | Cleaning machine                  |
| 8  | Pushing/staining machine  | 28 | Curved infed roller way for drier |
| 9  | Hot air drier             | 29 | Chain fed rack trolley drier      |
| 10 | Herringbone element       |    |                                   |
| 11 | Ultra violet drier        |    |                                   |
| 12 | Bushing cleaning machine  |    |                                   |
| 13 | Automatic sanding machine |    |                                   |
| 14 | Cleaning/brushing machine |    |                                   |
| 15 | Curtain coating machine   |    |                                   |
| 16 | Multi deck drier          |    |                                   |
| 17 | Inspection table          |    |                                   |
| 18 | Unloader                  |    |                                   |

Drawing No. 15 - Main Flow Diagrams



Drawing No. 16 - Layouts for Assembly and Packing (Furniture Units with Finished Panels)

Levels B and C



Description:

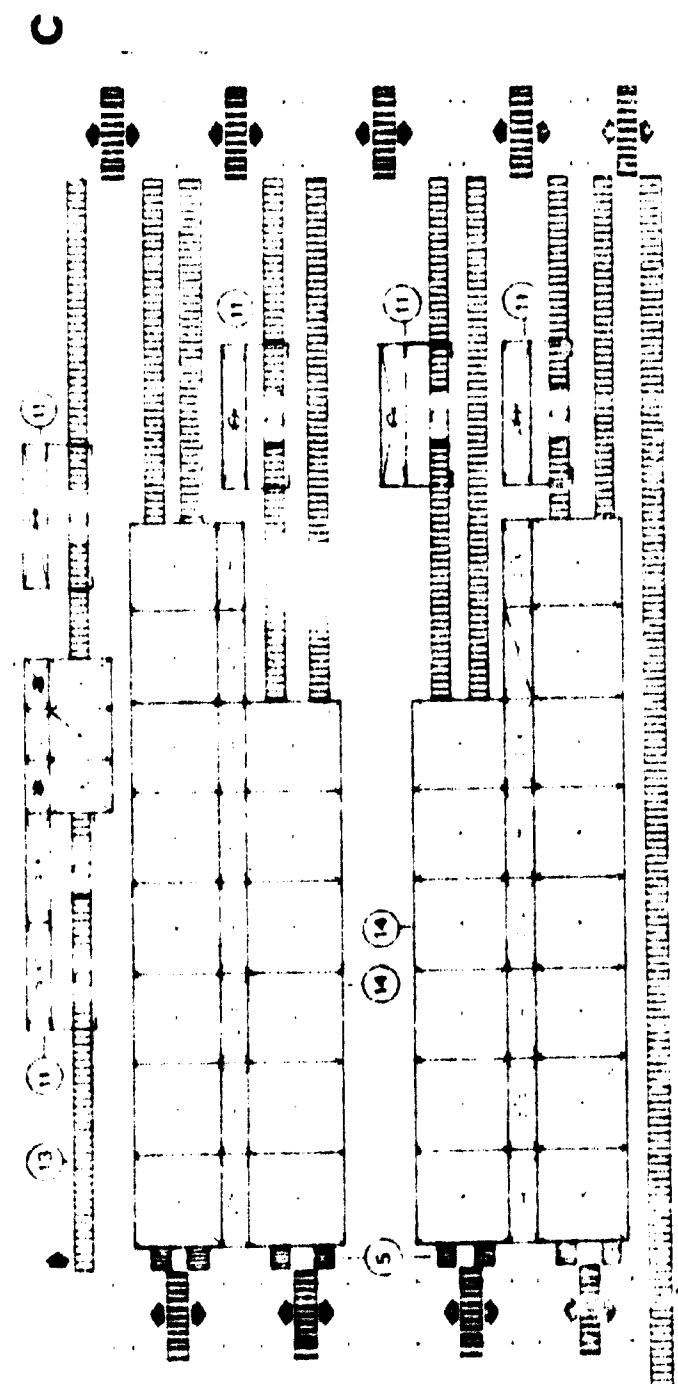
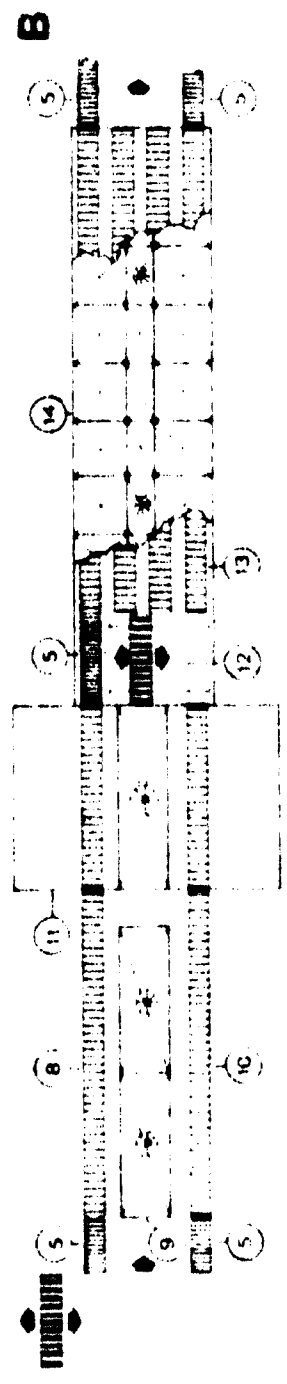
- |   |                                   |   |                                    |
|---|-----------------------------------|---|------------------------------------|
| ① | Auxiliary boring machine          | ⑧ | Packing tilter                     |
| ② | Slotted conveyor for pre-assembly | ⑨ | Conveyor belt                      |
| ③ | Infeed unit                       | ⑩ | Reeler for shrinking coil wrapping |
| ④ | Automatic clamp                   | ⑪ | Electric orier                     |
| ⑤ | Loading conveyor                  | ⑫ | Treppel (?)                        |
| ⑥ | Slotted assembly conveyor         | ⑬ | Unloading roller conveyor          |
| ⑦ | Dead roller way                   |   |                                    |

Training No. 17 - Layouts for Assembly of Furniture Units with Undercabinet Panels



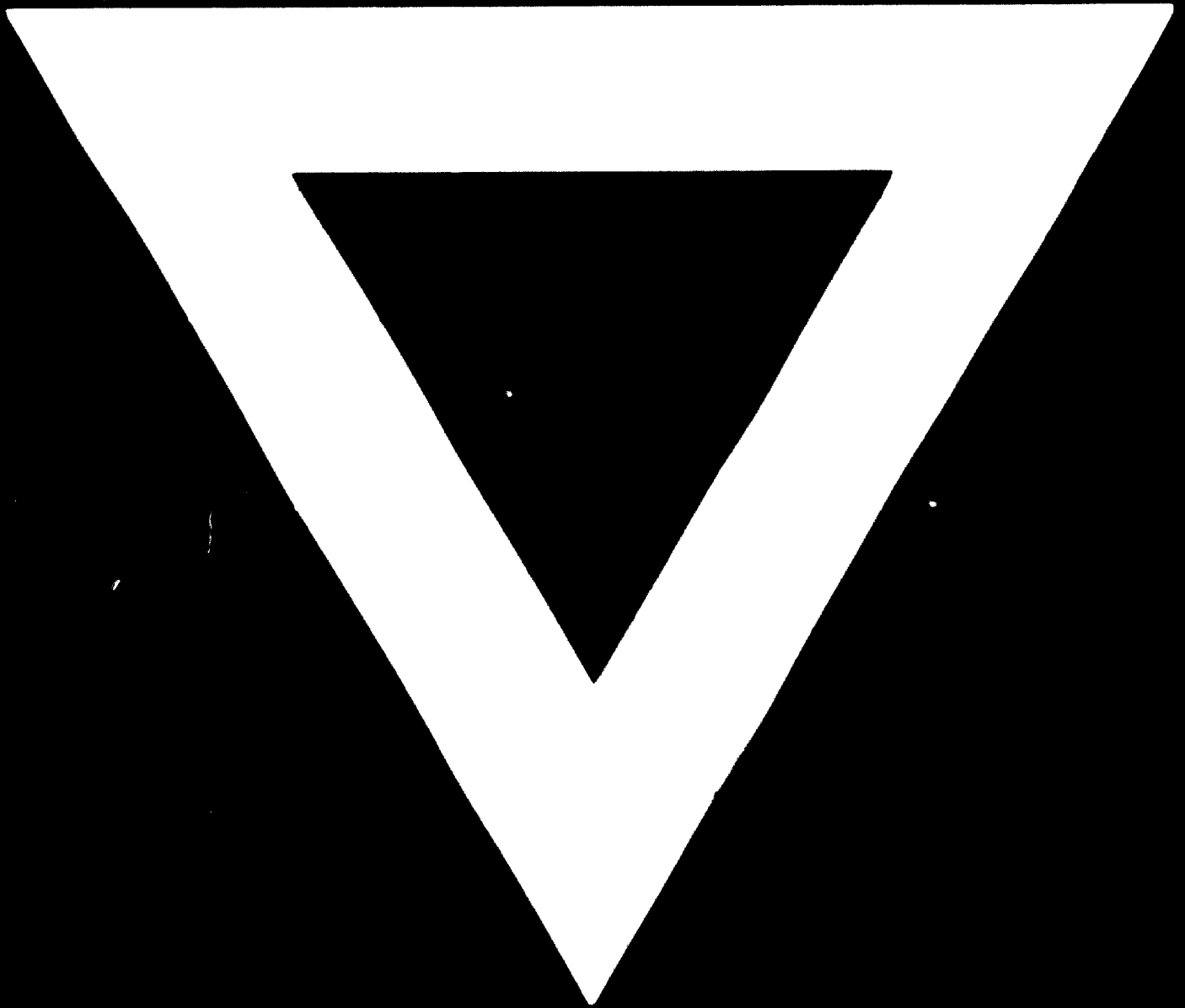
Description:

- A- Packing of furniture units
- B- Satin finishing on assembled units
- C- Staining and Vernish Prime Coating and Satin Finishing on Assembled Units



- 1. Automatic boring machines
- 2. Slotted re-assembly table
- 3. Automatic crane
- 4. Slotted assembly table
- 5. Roller way
- 6. Packing tilter
- 7. Ball table
- 8. Outboard spring line
- 9. Exhaust well
- 10. Spraying line for small units
- 11. Spray booth
- 12. Truck trolley
- 13. Slotted conveyor
- 14. Driver

**C-13**



**79.11.15**