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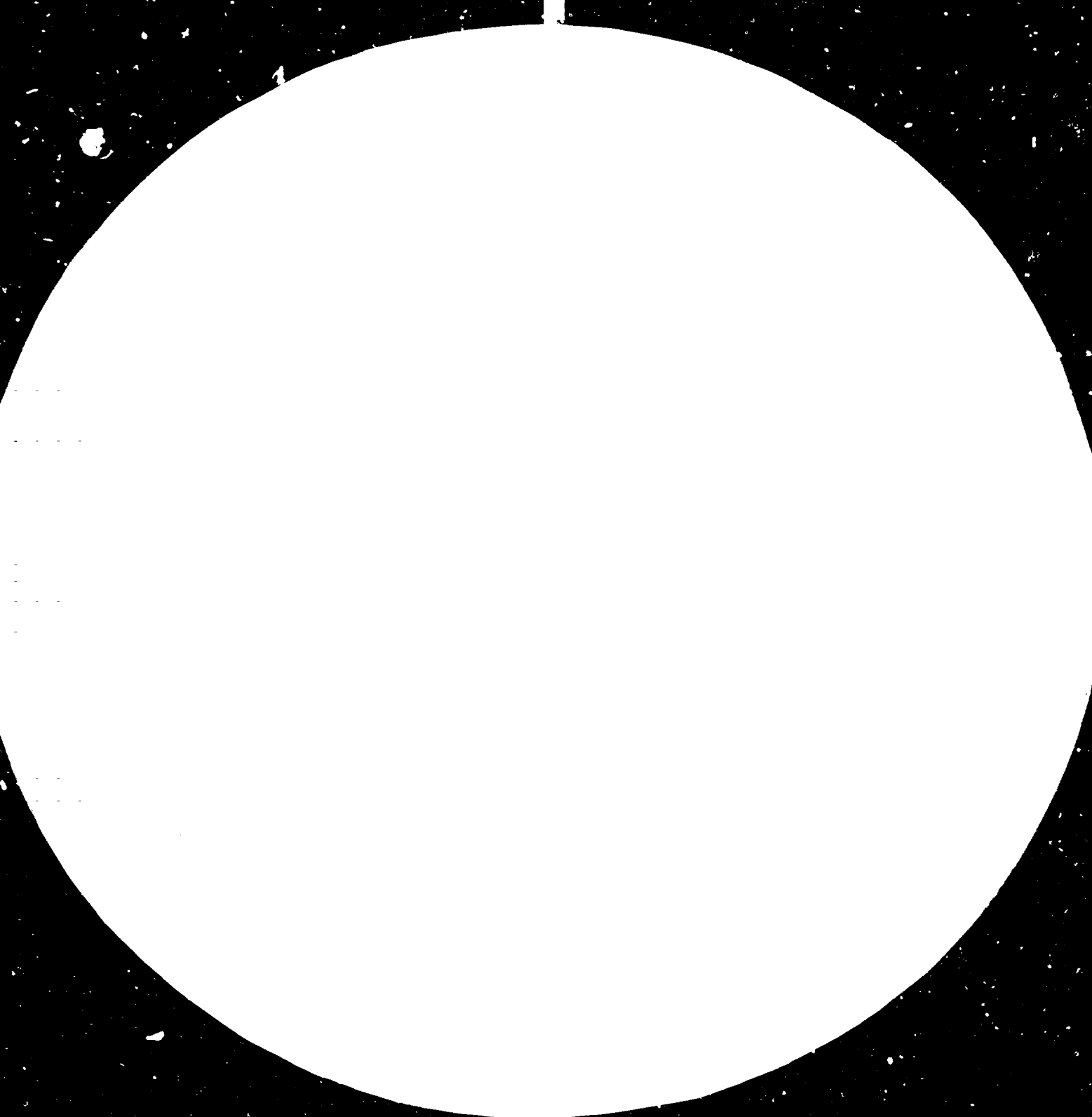
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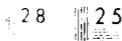
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EVALUATION OF TECHNOLOGICAL OPTIONS - VENEER, PLYWOOD, BLOCKBOARD<sup>1/</sup>

by

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1/ The views expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document was reproduced without formal editing.

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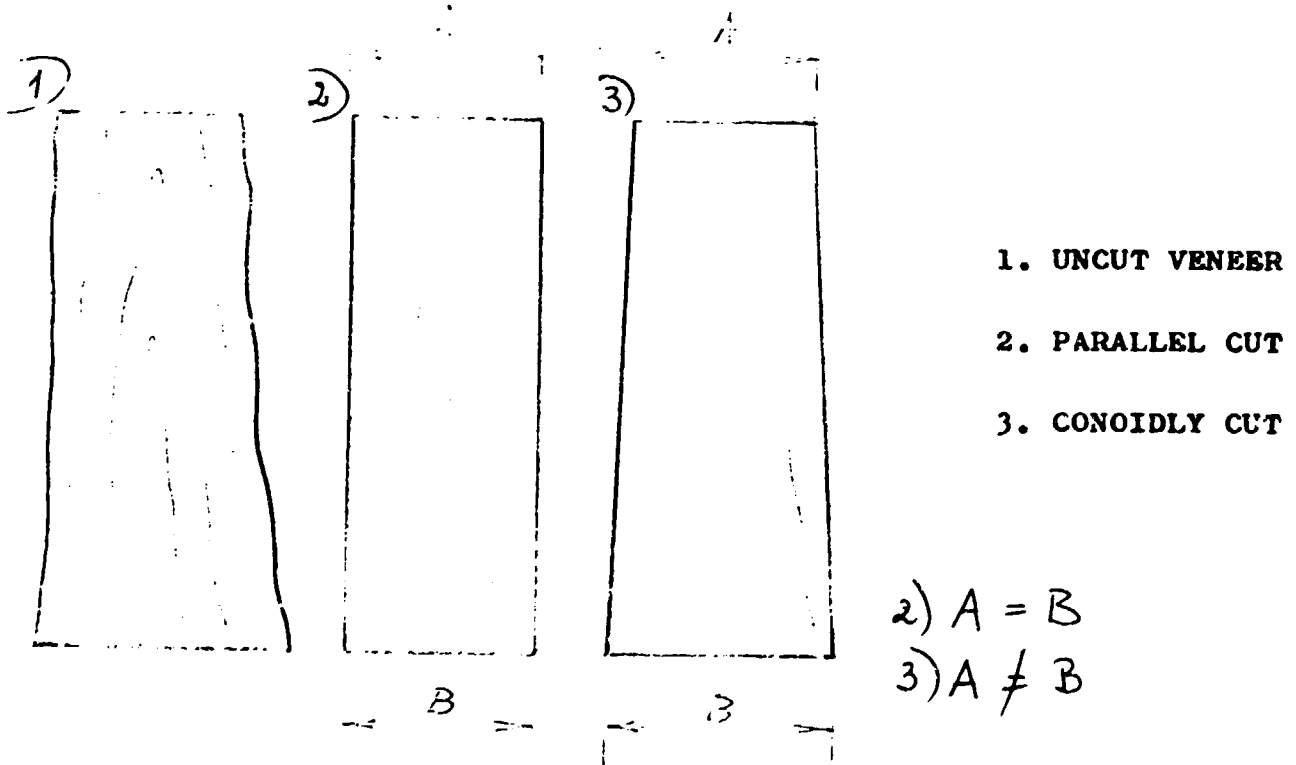
VENEER - GENERAL CHARACTERISTICS.

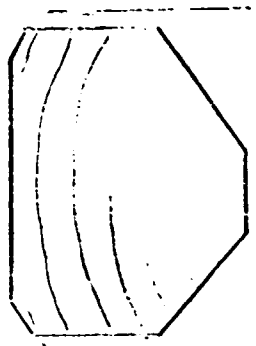
Veneer is wood transformed into thin layers (sheets), 0.20 -10 mm thick. Veneer was already known by the ancient Egyptians in 3000 B.C. Industrial production started in the 19th century. The first veneer factory in Yugoslavia began operation in 1913 in Slavonski Brod.

Concerning methods of production, three major types exist: sawn, sliced and rotary cut (peeled) veneers.

As to its use in further processing, we distinguish between decorative veneer used for visible surfaces of furniture and "blind" veneers used for plywood production.

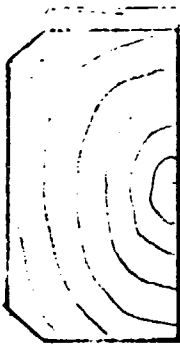
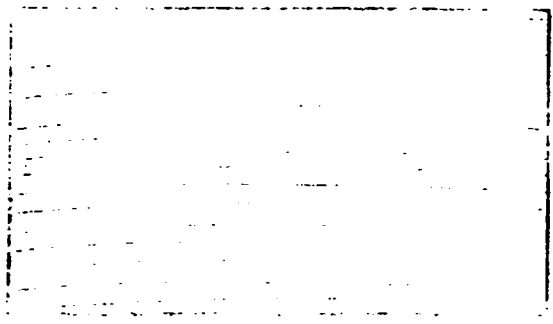
Veneers are trimmed (parallel or conical) or untrimmed. The position of annual rings in transformation produces lined, half-flanked and flanked veneers.





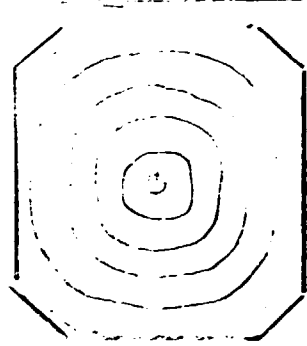
(1)

**STRIPED OR  
RADIAL VENEER**



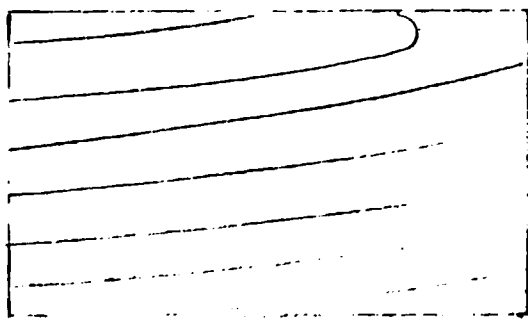
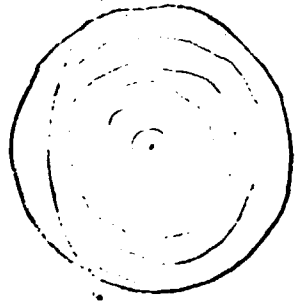
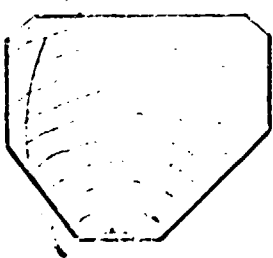
(2)

**HALF FLANKED**



(3)

**FLANKED**



Concerning the order of succession of veneer sheets in a package, we distinguish between blocks (orderly succession of sheets as in the log itself) and combined goods (where the sheets in the packet are at random). The technological phases for the production of veneer are given in Figure 1, while Figure 2 indicates the generation of waste in the production of veneers.

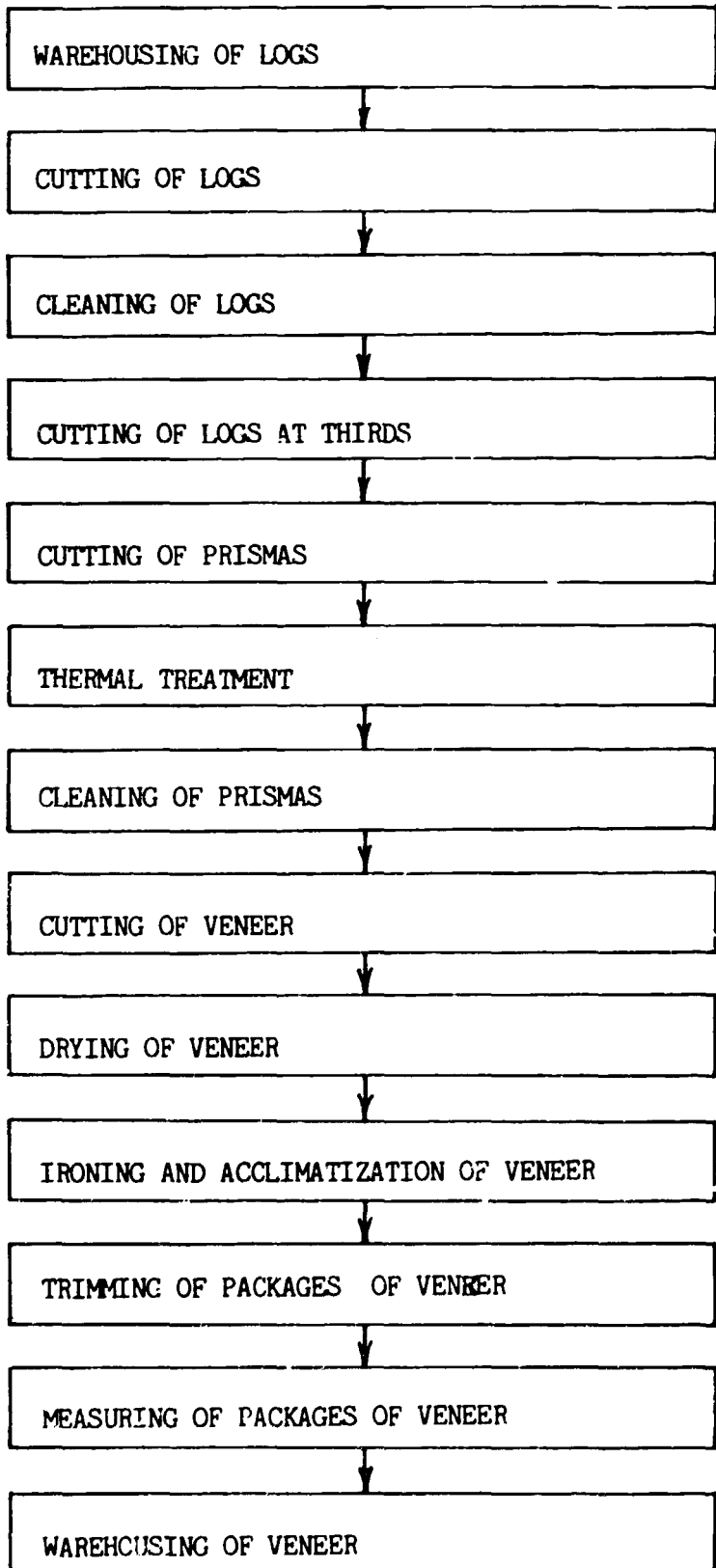
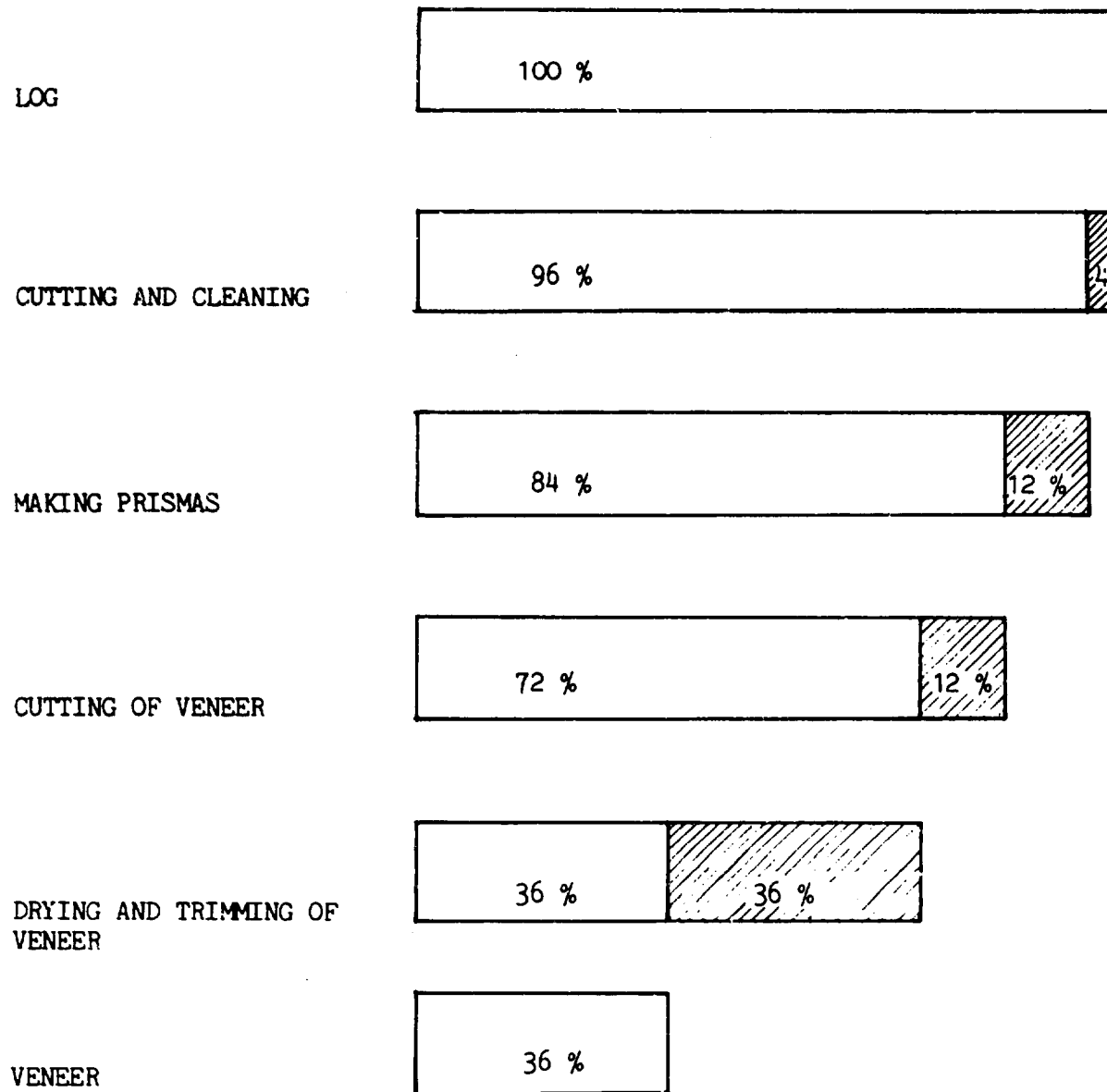


FIG. 1

TECHNOLOGICAL PHASES  
FOR THE PRODUCTION  
OF VENEER

Review of exploitation of raw materials in the  
production of veneer



Use of rests and wastes

sawdust 1 % - for heating  
bark 3 % - for heating

sawdust 4 % - for heating  
wastes in 8 % - for sale  
pieces

wet waste veneer 4 % - for heating  
cores 8 % - for sale

dry waste veneer 36 % - for heating



RAW MATERIALS FOR DECORATIVE VENEERS

Decisions on the choice of logs for veneer production are based on their aesthetic properties (colour, texture, faults, dimensions, specific weight, and suitability for slicing and peeling). The availability of an adequate quantity, possibilities of transportation and storage, and resistance to fungi are also important.

In conformity with the Yugoslav standards, logs for sliced veneers are marked with F, logs for peeling with L. The Yugoslav standards are as follows:

JUS Standard for logs - 1967 Valid from 1 October 1967:

- JUS - D.B4.020 - 1967: Veneer logs of deciduous trees. General conditions
- JUS - D.B4.031 - 1967: Veneer logs of deciduous trees. General conditions for oak.
- JUS - D.B4.040 - 1967: Veneer logs of deciduous trees. Special conditions for all species except oak.
- JUS - D.B4.021 - 1967: Veneer logs of coniferous trees.
- JUS - D.B4.022 - 1967: Deciduous logs for slicing. Special conditions
- JUS - D.B4.032 - 1967: Deciduous logs for slicing. Special conditions
- JUS - D.B4.023 - 1967: Coniferous logs for slicing.

"F" quality logs must be straight, of full bole, must not contain knots, cracks, decay, changes of colour, eccentric pith and developed fibre, because healthy and good quality logs are a pre-requisite to obtain good veneers. Various organic and inorganic matter in the cells and intercellular pores, such as silicon crystals, resins, oils, etc., should also be avoided as they cause damage to the cutting edges of tools and other difficulties in transformation.

The minimum length of the logs is 2m and over for domestic species and 4m and above for African logs, the minimum average diameter is 30cm for domestic species and 60 cm for tropical species. Logs of medium specific weight (from 0.4 to 0.7 kg/m<sup>3</sup>) are best suited for processing into veneer.

Logs of domestic origin are delivered to us from several parts of Yugoslavia, while our tropical logs come mainly from West and Central Africa. Most of the timber is inspected by our agent in the forest or in the producer's yards prior to buying.

Logs must be protected immediately upon cutting. Attention should also be given to appropriate transportation. The rate of spoiling depends a great deal on the climate. The bark of most species gives the wood sufficient protection, while the bark of some others contains substances that attract insects; these logs must be protected by painting with an appropriate insecticide. Another danger are the seawater pests that attack African logs in the period of floating in the sea before they are loaded on ships. It is preferable not to store logs in the holds of ships, as they are liable to fungal attack (blue and grey stains will form on the wood) on account of the poor air circulation, high humidity and heat.

When they enter the factory, the logs are inspected both with respect to quality and size. Logs that have not yet been protected, especially in the summer months, must be treated immediately (sprayed with a synthetic resin to which are added softeners, additives, fillings and fungicides) for protection against insects and fungi, and the log ends smeared with the same synthetic resin against cracking. Logs that have already been affected must be processed without further delay.

The logs are classified by diameter and quality into piles on wooden platforms. Each "F" quality log in the storage area receives a number which later accompanies it through all the phases of production. In summer, the logs are sprinkled with water for protection against cracking due to excessive drying.

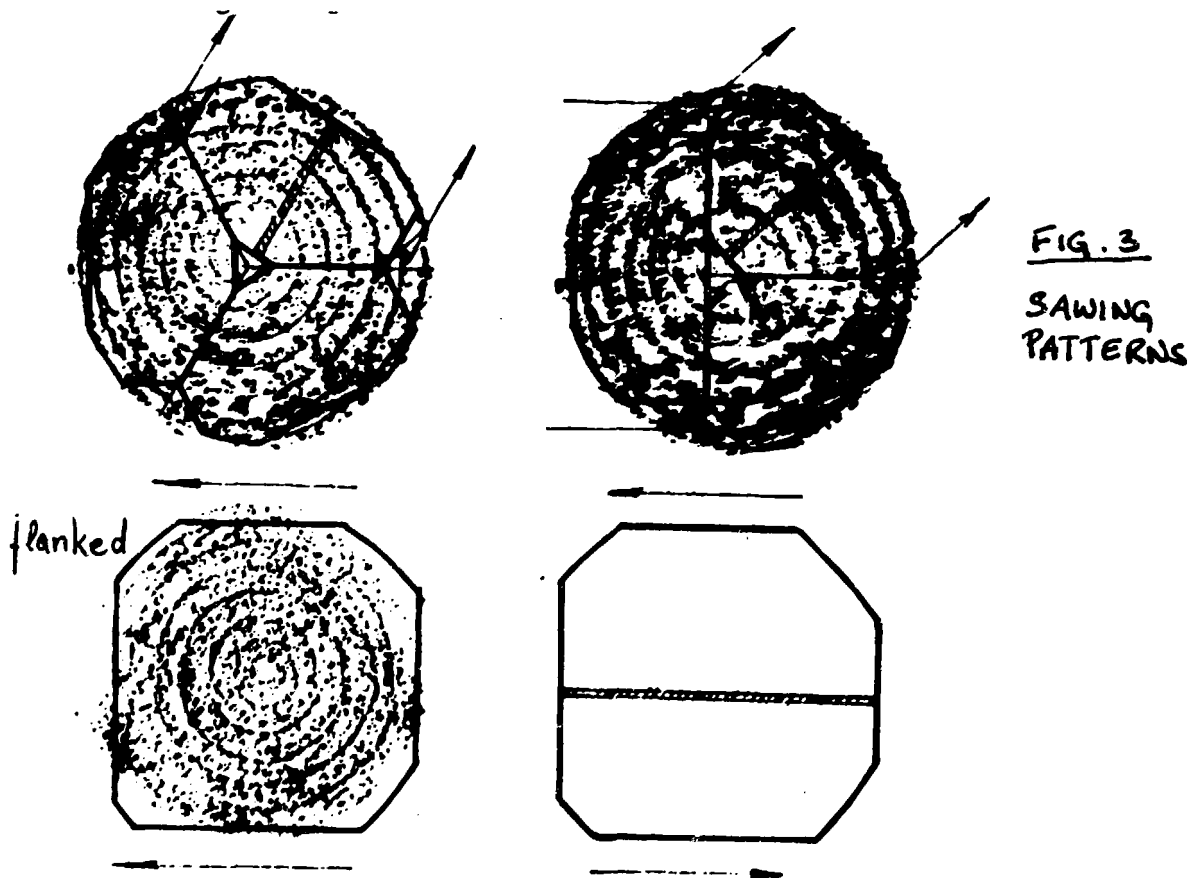
In Yugoslavia, the domestic species most often processed are: Oak, Ash, Beech, Maple, Pine, the imported species are: Sapelli, Aniegré, Koto, Guarea, Framiré, Okoumé, Makoré, Afrormosia, Moabi, and some others.

Most logs are delivered by rail: only a small part is shipped on trucks.

Preparation of the logs for cutting:

The logs undergo mechanical and thermal preparation. Mechanical preparation is done in the sawmill. The logs are cleaned and cross-cut to dimensions that ensure the optimum utilization both qualitatively and quantitatively, the fullest utilization of the dimensions of the steaming vats, and correspondence to the demands of the buyers of the veneers. A certain overmarking in length must be allowed, to guarantee against eventual damage in further treatment.

Because of limitations of the band heading in our factory, logs of over 100cm diameter are halved on the horizontal chain saw, then the two halves are further sawn on the band saw. All logs of under 100 cm are also processed here. The way in which logs are sawn depends on the diameter, tree species and faults on the log; sawing patterns are shown in figure 3 hereunder, that is, the sawing of logs into halves, thirds, quarters and other shapes.



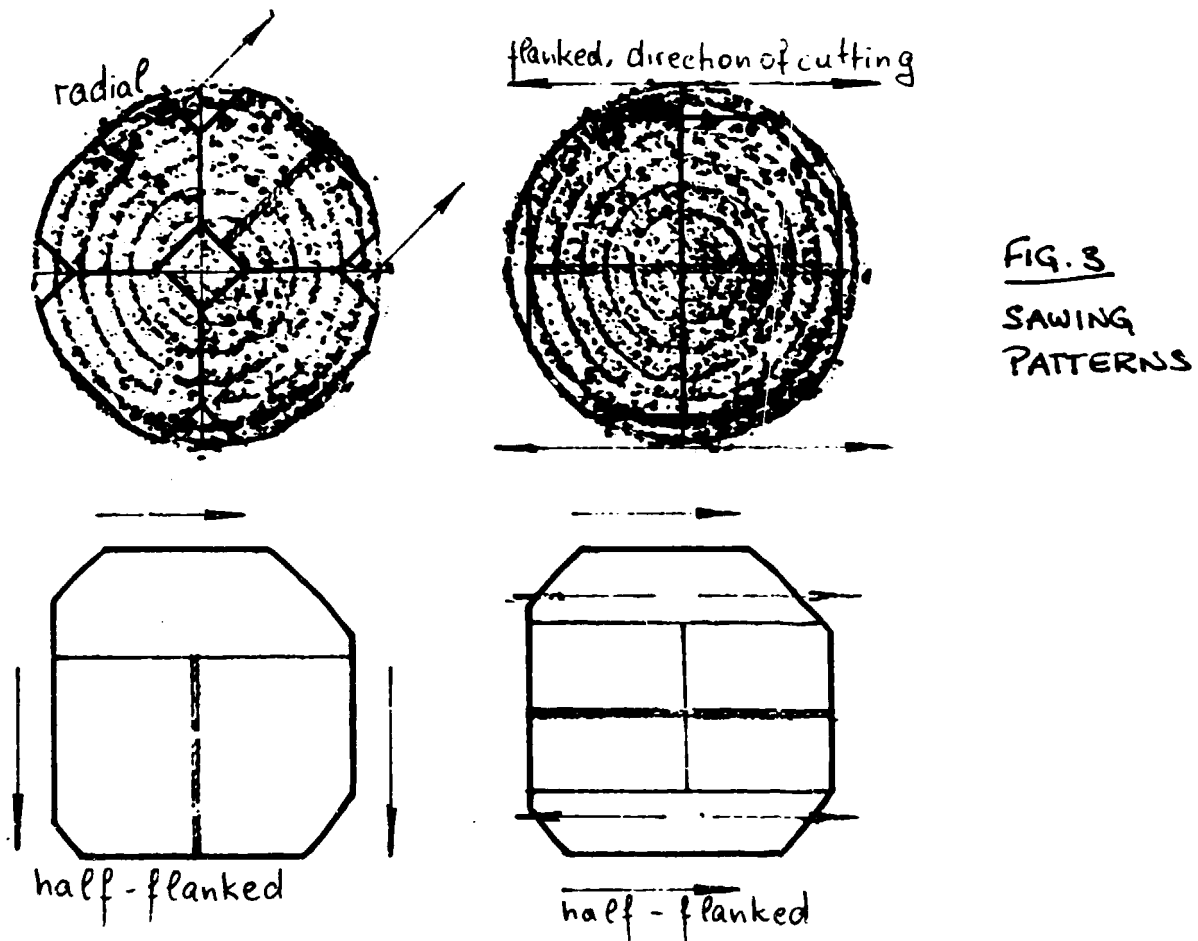


FIG. 3  
SAWING  
PATTERNS

In our plant, two thirds of the working time of the saws is spent in the sawing of flitches and one third in the sawing of logs into sawwood.

The flitches obtained from the logs are taken by the gantry crane to the steaming vats.

#### Thermal Treatment

The purpose of thermal treatment is to:

- (a) give the wood plasticity for easier and more effective slicing by the knife;
- (b) change the colour of the wood;
- (c) destroy any pests still left in the wood and to permit the elimination of resins, oils and tannins.

Thermal treatment is given in the form of (a) heating, (b) steaming, and (c) cocking.

The duration and method of thermal treatment depends on the particular properties and on the demands of the market concerning colour.

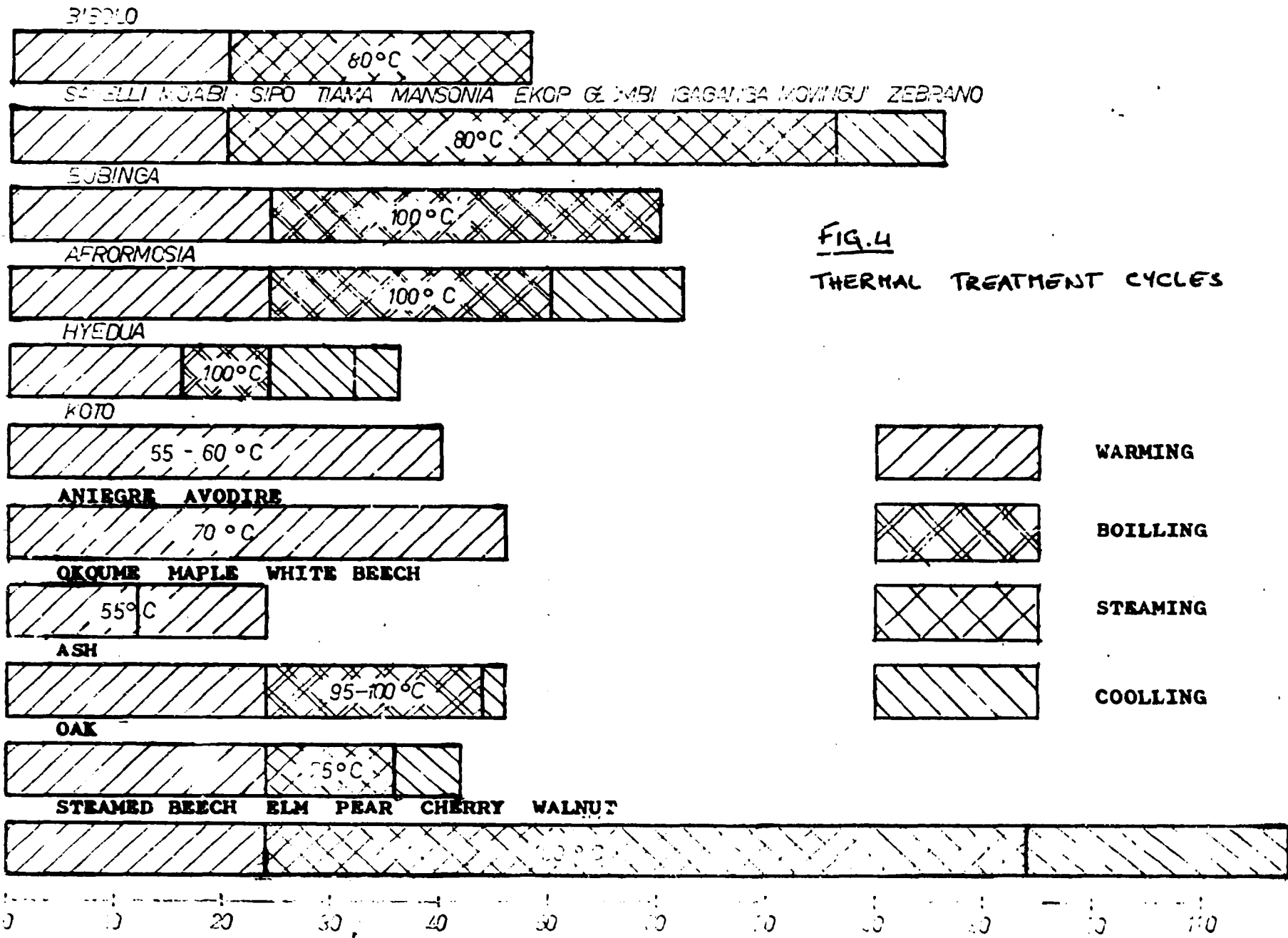
The vats are built in a row. A heating coil, consisting of a pipe is fixed on the bottom of each vat, through which hot water at 180°C and 25 atm is circulated continuously. The pipe is immersed in about 0.5 m of mains water, which evaporates and heats the logs in an indirect manner. An iron grate protects the pipe from the logs. The covers of the vats are of wood.

A passage is necessary in the ground along the side of the vats. The walls of this passage are lined with hot and mains water pipes, connecting to the vats with the necessary regulating valves. The thermal cycles for the vats are regulated here, controlled with thermometers installed in the covers over the vats.

Should the cycles be badly chosen or the thermal treatment carelessly supervised, incorrigible damage can be done to the wood, such as cracking, only partial colouring (in the case of beech) and red veneer (in the case of ash).

Thermal treatment cycles are shown in figure 4 hereunder.

Thermally treated logs are then carried by the crane to the cleaning site, where they are cleaned of bark and dirt, cut to size if necessary, and transported on carts to the lathe or slicer.



### Slicing and Peeling Rotary Veneers

Veneers are sliced on veneer slicers, with a vertical slanted knife. The moving part (rising and falling) of the vertical knife is the flitcher prism support. A sheet of veneer is sliced off by the blade every time the prism is raised, while the head with knife and pressure bar (which does not move) is pushed closer to the prism by the thickness of a veneer sheet. The machine we have has a maximum number of strokes of 90 per minute, but its average speed of operation is 27 slices per minute. The working width of our machine is 4000 mm, the slicing angle  $19^{\circ}$ . As they are sliced off, the sheets drop on a ribbon conveyor, faces turned up in sequential order, corresponding to their position in the log. From this conveyor, they are picked up by two workers and deposited on board on an elevating platform.

Slicers with a slanting knife are basically a combination of the vertical and horizontal machines. They differ from the ones with a horizontal knife in that the conductors slant from the horizontal plane at an angle of  $25^{\circ}$ . They differ from the vertical knife in that the head with knife, and the platform supporting the flitch both move towards each other. When a sheet of veneer is sliced off on contact and ejected from the machine, it is intercepted by the workers and placed on the elevating platform. After each slice, the flitch is raised by the thickness of the veneer sheet. The maximum number of strokes on the slanting knife is 65 per minute, though, on the average, it operates at 18 strokes per minute. The working width is 5200 mm, the slicing angle  $18^{\circ}$ .

Wood is best sliced from the core outwards. The position of the knife and pressure bar is shown in figure 5 hereunder.

In our plant, rotary cut (peeled) veneer is produced on a lathe whose working length is 2700 mm, speed from 18 to 140 rotations per minute (average number of rotations under our conditions is 42 per minute), set for cutting veneers of thicknesses ranging from 0.2 to 1.0 mm. The purpose of peeling is to produce veneers of appearance similar to those obtained from a slicer, working mainly on small diameter logs that cannot be cut up for slicing.

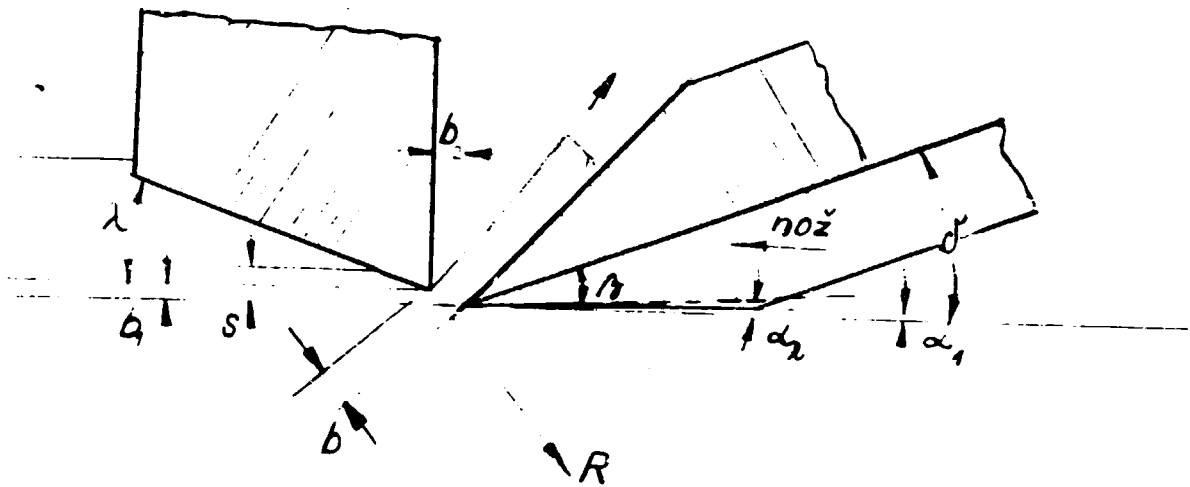


Fig.3: Position of knife and pressure bar

LEGEND:

$S$	THICKNESS OF VENEER	
$b_1$	VERTICAL CUTTING	$0,75 S$
$b_2$	HORIZONTAL CUTTING	$0,40 S$
$b$	PROPER CUTTING	$0,92 S$
$\alpha_2$	FREE ANGLE	$1^\circ$
$\beta$	ANGLE OF KNIFE	$18^\circ$
$\delta$	ANGLE OF CUTTING	$19^\circ$
$\lambda$	ANGLE OF PRESSURE BAR	$15^\circ$



The method of inserting logs for eccentric peeling is shown in figure 6 hereunder.

In our plant, veneers are withdrawn manually. In the veneer production hall transportation is lengthwise, done by roller lines, movements across the hall by cars aligned at the height to the roller lines.

Cores are sent back to the saws. Veneer waste is taken by a conveyor to the chipper and from there to a silo and to the boilers.



FIG.6: LOG INSERTION FOR ECCENTRIC PEELING.

## Drying

Before further treatment, sliced and peeled veneers must be dried down to 8-12 percent humidity. This is done in veneer dryers that operate on a continuous line. The dryers contain a heating and cooling field, and are supplied with a conveying mechanism consisting of the conveyor lines and a propelling block. The dryer is a large enclosed box. On one side of this box heating pipes are arranged on the ceiling through which hot water, heated to 180-200°C, circulates. Ventilators are located along the whole length of the box on the other side, ensuring air circulation past the heating pipes onto a set of flat pipes on the lower end of the dryer. The flat pipes have holes on their under sides. Through these, the heated air is driven on the veneers moving through the chamber on the conveyor line. A portion of the cooled and damp air is let out of the dryer, while a part is returned back to the ventilators and circulated once more.

The veneers pass through the dryer at three levels, in the form of the letter "S". This arrangement saves space; on the other hand, it leaves less room for exact moisture regulation of the air circulating in the dryer, and fewer possibilities for the attendant to supervise the quality of drying. Air temperatures in the dryer is between 110 and 140°C. Drying times depend on the thickness (usually 0.5-1.5mm) and moisture content of the veneers at entry (50-70 percent), on air temperatures in the dryer and on the desired final degree of humidity.

The dryness of the veneers is regulated by changing the speed of passage through the dryer and/or by regulating relative humidity of air in the dryer. Maximum possible speed of passage through the dryer depends on its design characteristics. The dryer installed in our plant can operate at 12, 24 and 40 meters per minute.

The loading and unloading of the dryer is usually done manually. The dried veneers are stacked by the workers into packages of 32 sheets, in the sequence in which they were produced.

### Trimming

The veneer packages are trimmed to ensure parallel edges on a group of guillotines. The group consists of four machines (two for longitudinal cuts and two for trimming the ends), a table for quality control, a binding machine, and an electronic measuring device. The packets are trimmed lengthwise and at the ends, first from one side and then from the other. Unusable sheets are ejected at the quality control table. The binding machine binds the packages at two or three places, depending on their lengths. Only even numbers of veneer sheets are registered. Packages then pass under the photo-cells of the measuring device which measures the length of the packages rounding off downwards to the nearest five centimeters, and the width to the nearest one centimeter. From these data, the area is calculated electronically and printed on a control card and a label.

The label is stuck onto the package, see figure 7, the cards filed for control of the quantity of production.

The trimmings are chipped mechanically, conveyed by the ventilating system to the silo and further on to the boiler room.

The trimming removes faults (cracks, knots, decay, etc.) and shapes the packages into forms that are accepted commercially.

Once trimmed and measured, the packages are loaded on an appropriately dimensioned pallet. Stacks that are made up of more than one log are appropriately marked. A fork-lift takes the stacks to the warehouse.

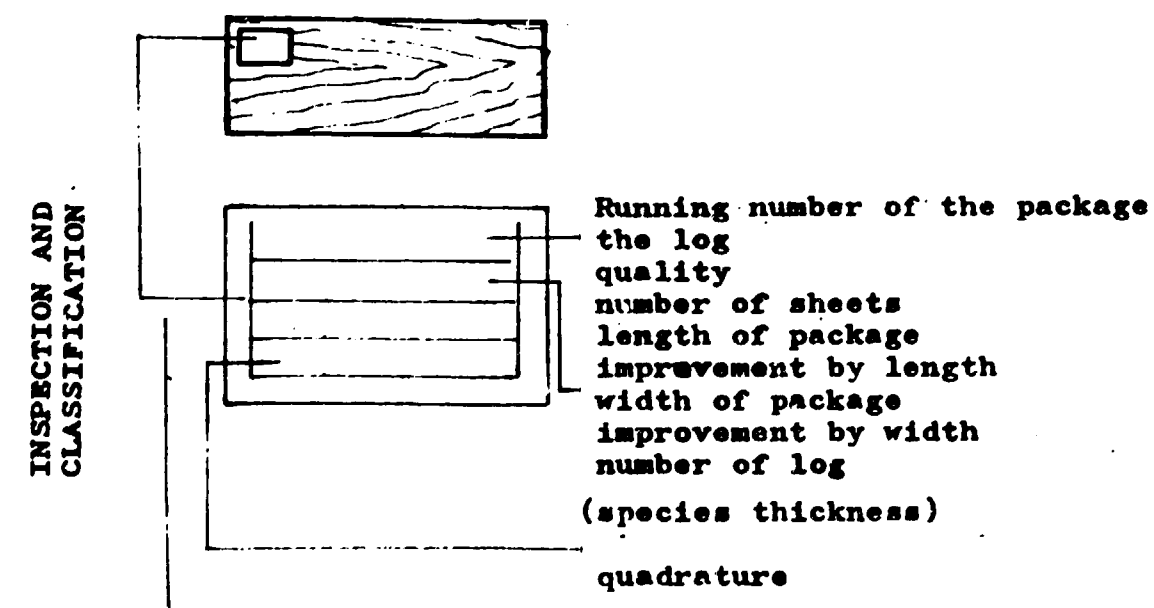
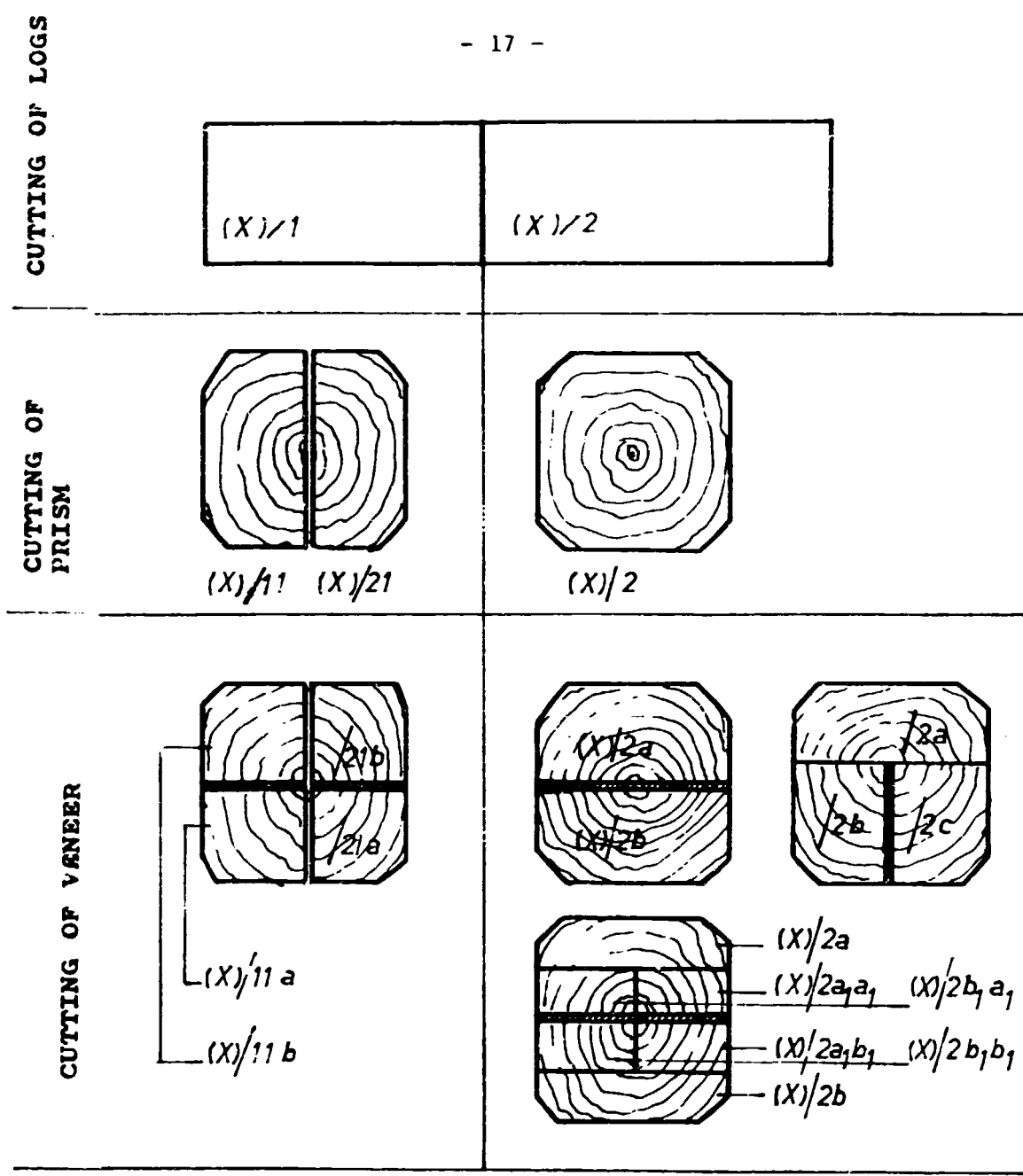


FIG. 7: LABEL FOR PACKAGE OF VENEER

### Warehousing

In the warehouse, the veneers are classified and prepared for dispatching. Classification is carried out according to quality, length and width. Veneers from domestic species are usually classified into four classes: I, II, III and package goods.

Veneers from tropical species (Ako, Koto, Lauan, Sapelli, Sipo, Tiama, etc.) are classified into five classes: I/A (extra), I, II, III, and package goods.

Veneers are dispatched in trucks and railway cars and must therefore be packed appropriately. The wooden base board is covered with left-over veneers and PVC sheeting or plastified kraft paper. Two to three thousand square meters of veneer are stacked on this base. The stack is also covered over the top, a wooden grate laid over, and the whole package bound with metal strap, 19 mm, 0.6 mm thick. On the wooden edge of the package, the veneer type, the number and the buyer's address are marked.

Transportation and handling in the warehouse is done with fork-lifts having battery and internal combustion engines. Production of decorative veneers demands practical experience, theoretical knowledge, and precision at all phases. The processing stages are interconnected and interdependent. For this reason, badly or untimely executed work at any stage of the process can render useless all previous efforts to ensure a high quality of the product.

### Logs for Peeling

Mostly Beech and soft broadleaved species are peeled in Yugoslavia. Other wood species such as Maple, Birch, Pine and Fir are peeled in smaller quantities.

Beech logs with few faults peel well and produce the greatest possible number of whole sheets. (The faults considered to be more severe for Beech are overgrown knots and twisted wood fibre.) Poplar is the most important among the soft broadleaved species. It is lighter than Beech and is better suited for plywood production.

It should be mentioned that in Yugoslavia Poplar is also grown on plantations, which is bound to foster its use as a raw material in plywood production in the future. In JAVOR, logs of tropical species are also used, in quantities of 15 to 20 percent of the total (about 3,500 m<sup>3</sup>). This consists for the most part of the peeling of Okoumé, Ilomba, and Samba as well as some other species occasionally.

Timber for peeling and production of veneers is among the most valuable of forest products, and must be well protected during storage to preserve its value in the time interval between its felling and transformation. Various mechanical aids driven into the log-heads are applied to prevent cracking, or the heads smeared for protection. Best protection is given by keeping the logs under water. Alternatively, where abundant water supply is at hand, the logs are sprayed.

#### Plywood

Plywood is a product of wood and adhesive. It can be further subdivided into plywood, blockboard, and other products.

In our factory, we produce standard plywood, "improved" plywood, water-resistant plywood for use in ship-building and construction, standard and "improved" five-ply blockboard, and seats and seat-backs of various shapes and construction. Plywood has a number of advantages over solid wood, and its production has developed rapidly throughout the world. The advantages include economy, firmness, resistance to cracking, durability of form, large surfaces, and symmetry of surface pattern.

The plywood board normally has an odd number of layers (3, 5, 7, 9, etc.) glued together at right angles to the direction of the wood grain on the layers. For this reason, the possibility of contraction and expansion in the direction of the grain is greatly reduced. Contraction and expansion in thickness is equal to that of the species used in manufacturing the plywood.

### Dimensions and quality of plywood

Length is measured in the direction of the grain of the exterior veneers. It is rounded off into whole centimeters and written down in front of the figure for width. Width is measured perpendicular to this direction. Thickness is rounded off into whole millimeters and written down behind the figure for width.

Longitudinal plywood is normally produced. The Yugoslav standard no. JUS D.C5.040 1982 allow production of up to 15 percent of transverse plywood.

We produce plywood in lengths of 180 to 250cm, and in widths of 80 to 150cm, by 5cm increments, with a tolerance of plus or minus 5mm. Thicknesses of 3, 4, 5, 6, 7, 10, 12mm and more are produced with a tolerance of plus or minus 0.3 mm (for 3mm thicknesses) and plus or minus 0.5 mm (for all other thicknesses).

Concerning quality we distinguish between classes I, II "mercantile", and III. Plywood is sold by the cubic meter.

### Technology of Plywood Production

The preparation of logs for peeling consists of heating, cutting to dimension, debarking, and detecting metal components. Usually only beechwood is steamed. Other tree species are only heated if necessary. Logs are steamed indirectly at temperatures of up to 100°C. Through steaming, the colour of the wood is changed, the bark is more easily removed and the wood gains in plasticity, which facilitates peeling. In our factory, we have concrete steaming vats. Logs are transported with a gantry crane and fork-lifts. The prepared log is centered in the veneer lathe and rotated on its axis. The rotating log moves closer and closer to the knife and once contact between the log and the knife is made, veneer is produced on the other side of the machine. Thicknesses of one and more millimeters are cut. For the ties between the wood fibres not to loosen excessively, a pressure bar is applied on the back side of the emerging veneer, opposite the knife. The cutting

angle of the knife is  $20^{\circ}$  (see figure 5). The knife deviates from the vertical plane at tangent to the log at a free angle of  $0^{\circ}$  to  $5^{\circ}$ . This angle diminishes as the peeling progresses. Modern lathes which automatically adjust the free angle to the decreasing diameter of the log are normally used. These can peel logs with diameters of up to 120 cm, up to 260 cm long. A cylindrical core 10 cm in diameter is left when the peeling is over. The median diameter of logs peeled in our plant is about 42 cm.

The veneer emerging from the peeling operation is wound on special spools. It is next clipped when still wet with a clipper (guillotine shear). Modern clippers operate at 100 cuts per minute, the veneer ribbon passing at speeds of up to 60 metres per minute. Ideally, clipping is done to obtain the required size of veneer sheet, but faults that cannot be tolerated on finished boards are clipped out of the veneers. On Beech wood we get up to 10 percent of whole sheets.

Further processing consists of drying on roll-type dryers. The veneers are dried down to 6 - 10 percent humidity. Humidity before drying is 30-110 percent and even more, depending on the state of the logs taken into the process. In drying the veneers contract in length by up to 0.5 percent, up to 5 percent radially, and up to 10 percent tangentially. The dryer has a built-in device for humidity control. Drying utilizes hot water at temperatures of up to  $170^{\circ}\text{C}$ . Drying is followed by cooling.

The next stage is the sorting of the veneer sheets. Sheets with faults are withdrawn. Domestic tree species which we peel have a large number of knots. In a mechanized process, the faults are clipped out and the holes plugged.

Veneer packages then have their edges clipped. Once thus aligned, adhesive is laid on immediately for the transversal jointing of veneer sheets. These treated packages are then kept for a time before the sheets are jointed together by the jointing machines.

Plywood is then put together on the hydraulic press. Formaldehyde and melamine adhesives are used, and occasionally phenol adhesives. Various degrees of water resistance of the plywood are thus reached. The adhesive is



laid on the veneers with rollers by very accurate machinery. Working temperatures of the press are adapted to the various adhesives applied, working pressure to the particular wood species. The press fills and empties automatically. Pressing times are kept to a minimum.

Finishing treatment includes trimming, plugging and sanding.

A package trimmer is used. It is supplied with two longitudinally set blades and a saw for cross-cuts. The packages of board are moved forward on a conveyor. The boards are inspected for correct glueing and trimming. Faults are also repaired by plugging and plastering, i.e. using putty.

The boards are next sanded on both sides on a roller sanding machine. A wide-belt sander is also used. The working speed here is 6 to 18 meters per minute. In sanding about 0.15 mm on each side of the board is removed.

"Improved" boards are usually also sanded on narrow belt sanders.

Prior to delivery to the warehouse, the boards are classified and branded with dimensions, class, type of glueing, and producer's mark. Overseas transport demands appropriate packing.

Transport inside the factory is carried out by conveyors and fork loaders.

#### Utilization of Wood

The degree of wood utilization in plywood production depends for the most part on the wood species, diameters and quality of logs, the preparation of logs and on the type and state of the machines.

In our factory, we reach the following average yields in the utilization of logs

Beech and Poplar	about 34 percent
Okoumé	about 54 percent.

Our plywood is produced to conform to the Yugoslav standard D.C5.050/1982. The standard determines types of boards and quality of glueing.

Conditions for the testing of the firmness of glueing distinguish between four types of board:

- type Tp 20
- type Tp 67
- type Tp 100
- type Tp 100 T.

Type Tp 20 denotes boards intended for use in environments of low humidity. They are used in furnitre and other interior fixtures.

Type Tp 67 denotes boards intended for use in environments of increased humidity. They are used for kitchens, bathrooms, cellars and similar.

Type Tp 100 denotes boards intended for outside use and are resistant to general influences of the atmosphere. They are suited for use in outside doors, windows, stairways, fences, and similar end uses.

Type Tp 100 T denotes boards intended for use in the worst climatic conditions, resistant to the influence of water and the tropical climate.

#### TECHNOLOGY OF BLOCKBOARD PRODUCTION

Blockboard consists of a core with veneers on the faces. The core is always composed of narrow wood strips, produced by sawing on multiblade circular saws. The width of the strips must not exceed 26 mm if the basic properties of the blockboard and its stability are to be guaranteed. Strips are produced from sawwood of conifers and soft broadleaved species. The finished board can be composed of three or five layers, in which latter case the three-ply board is made first with waste veneer, the veneers lying perpendicular to the strips. The next pair of veneers of better quality can then be laid parallel to the strips, or again across them, though this will not do for high quality veneers.

### Preparation of laths

The sawnwood planks are delivered by outside sawmills and other sawnwood is obtained through the sawing of various inferior grades of wood.

Fir and pine planks are taken to the storage area. The best thickness is 23-24mm.

The wood is manipulated manually into stacks, of 125 x 125 x 3 or 4 meters in length. The stacks are loaded on cars for the kilns, two on each car, one on top of the other, or taken by a fork lift to piles on the sawn wood storage area.

### Drying sawnwood

The wood is dried down to eight percent humidity in four two-track drying chambers with a total capacity of 36 cars (112 m<sup>3</sup> of sawnwood). Drying cycles are reduced to the shortest time possible, in spite of the comparatively high starting humidity which is expected on account of the elimination of longer period of natural drying. Superheated steam at 125°C and 6atm is used for drying. This method is the most economical in consumption of electrical and thermal energy, while the colouring of the wood's surface, which is its side effect, is of no significance as the wood is used in the core.

In order to produce 1 m<sup>3</sup> of blockboard, 1.3 m<sup>3</sup> of sound wood is used for the core. When using inferior quality wood, 1.46 m<sup>3</sup> are needed for 1 m<sup>3</sup>, and this quantity is used to calculate annual wood supply for the core strips. For the production of about 15,000 m<sup>3</sup> of blockboard, one must be supplied with about 22,000 m<sup>3</sup> of sawnwood.

One car holds 3.78 m<sup>3</sup> of wood, which means that some 26 cars of wood must be dried daily. The drying chambers are operated on a continuous basis for five days per week (excluding Saturdays and Sundays). The comparatively low capacities of the kilns prevent the necessary flexibility of manipulation,

and stoppages were originally also disregarded, though they represent about 10 percent of the total time. New drying capacities are being installed, with an easier regime of 80°C at 3 atm and a somewhat longer drying cycle.

#### Sawing of wood

One by one the cars with dried wood are pushed on an elevating platform, from which the three sawing lines are furnished.

A worker unloads the wood onto a roller conveyor, which carries it forward to an automatic oscillating circular saw and finally to a parallel multi-blade circular saw.

On the oscillating circular saw, the wood is shortened and the ends evened into laths up to 90cm long. During the process, all faults are cut out. The shortened laths, sawn up into strips of required width, represent the future core.

Strips leaving the multi-blade circular saw are assorted manually and individual strips evened by three attendants.

Thus prepared, the strips are deposited manually (the feed speed is 20 metres per minute) on belt and roller conveyors, from which they are picked up by other workers and put into a trough conveyor. The strips are next deposited automatically onto a wide transversal belt conveyor which is at the height of the heads of the workers on the ground floor of the production hall. The belt conveyor spills the strips into the doser, which finally arranges the strips of various lengths across the whole width of the vibrating composition line described hereunder.

#### Composition line

This consists of two parts: (1) forward vibrating platform and (2) conveyor.

The vibrating platform is 4390mm long and 2650mm wide. It is composed of a series of grooved rolls at a distance of 95mm from each other; the strips are shaken into these grooves by the quick vibrations of the platform. The rolls carry the strips forward at a speed of 15 to 45 meters per minute. With the second part of the composition line turning at a much lower speed than the first, the strips are forced to push into each other tightly in their separate grooves and a closely knit continuous ribbon of the core is formed.

### Conveyor

This is 13.20m long and 2.90m wide and is composed of rolls which are grooved; the strips gradually leave this part of the conveyor and begin to pass between pairs of horizontal rolls. These rolls continue driving the strips forward, while vertical rolls on the sides begin to push the strips together in a horizontal direction, until when the strips are all pressed together into a tightly closed ribbon which the line carries forward to the glue spreader. Core strips are mostly sawn from 24mm sawnwood, varying between 22 and 26mm on account of the different ways of sawing. In this sense, the uncalibrated thickness of the wood used represents the width of strips making up the core.

The vibrating part of the composition line has 70 grooves. Calculating with a uniform overmark of 0.3mm for the laths or sawnwood, the widths of the core ribbon produced will be the following:

$$18.3 \times 70 = 1280 \text{ mm}$$

$$22.3 \times 70 = 1560 \text{ mm}$$

Boards with lengths of 1220mm and 1520mm are thus standard products, while any other intermediate length can be produced for larger orders on demand of the buyer. The 1550mm length is exceptional. With manual laying and arranging of strips on the composition line, thicknesses of the laths can be up to 24mm, and the final thickness of the board between 14 and 30mm. Considering that the prevailing demands of the market are for 16mm and 18mm boards, the capacity must be calculated on the base of a 17mm thickness. The normal length of the strips is 500 to 900mm, although posing the strips manually onto the middle of the vibrating platform permits the use of lengths

of 200 to 300mm. Such strips are not only better fitted for manipulation by the conveyors described, it is also held valid that short and mutually unattached strips are a factor of better stability of the finished board. Before the core ribbon leaves the conveyor, it is automatically bound across with a nylon string of diameter 0.45mm and 41 kgs resistance. The ribbon must be bound the moment it leaves the conveyor and passes into the glue spreader, as the core would otherwise fall apart.

#### Glue spreader

The tightly closed and continuous core ribbon leaves the conveyor and passes on through the glue spreader. The mouth of the distributor adjusts itself to the thickness of the core as it enters, while if the advancement of the core ribbon is stopped for any reason a pneumatic system automatically retreats the distributing and applying rolls. This can be done automatically with the help of a photo-cell, should empty spaces between the strips form on the grooved part of the composition line. Failure to look after the faults would result in a hollow core and in interruptions later along the line.

The glue spreader is mobile on a cross rail to facilitate withdrawal from the line for daily cleaning and repairs

Urea formaldehyde adhesive is normally used for hot pressing. Calculation of capacity is based on the use of this adhesive. Other adhesives, such as phenol formaldehyde or melamine reinforced urea formaldehyde for water-resistant blockboard can also be used. In this case, the capacity of the line will be lower on account of the longer times of polymerization.

#### Composition of veneer faces

The blockboard factory is usually supplied with veneers 2.1 to 3.1mm thick, the 2.1mm thickness predominating, delivered by a plywood factory. Veneer sheets 100 to 600mm wide are used, with the edges already trimmed and humidity at 8 percent.

From the glue spreader, the continuous core ribbon, laid with adhesive, enters the machine for the composition of veneer faces. The machine has two composing work fields, one above and one below the core ribbon. The sheets are entered from the sides. In the field above the ribbon the cracked side of the veneer must face upwards; it is then pushed down on the ribbon in circular motion, settling on the adhesive with the cracked side down. Sheeting the core from below, veneer sheets are entered from the side with the cracked side facing down, eventually to be pushed against the adhesive on the under side of the core.

The sheets are therefore entered in the usual manner of transverse jointing machines. The machine is supplied with a double system of conveyor chains. The accompanying system conveys the veneers to the forepress and moves forward as fast as the core, while the passing system for veneer sheets moves 30 percent faster, in this way ensuring the tight fitting of the edges of the sheets.

#### Fore-press

Sheeted on both sides with veneers, the core enters the fore-press. The fore-press is composed of four strongly heated bars (heaters) that splice the veneer sheets or rather the whole composition cross-wise, giving it sufficient firmness to enable it to be taken into the moving press.

The four 10mm hot bars are synchronized with the moving press and move, open and close simultaneously with the press. Immediately prior to the compression of the fore-press, a mechanism is triggered on both sides of the ribbon, pushing the core together to ensure that there are no open spaces inside the core. The outside hot bars press the composition over the edge strips and thus prevent the strips from loosening, even before the ribbon is passed into the main press. The hot bars of the fore-press are in fact four rectangular pipes 8500mm long heated with steam.

#### Moving press

The main hot press is a moving, one-daylight press. It has only one daylight. It closes and opens on 76 cylinders attached to the upper plate.

It opens 80mm, has a maximum specific compression of 13kg/cm<sup>2</sup>, the plates are 90mm thick, 8600 x 1700mm in size, total weight is 64 tons.

The press compresses the composition of core and veneers along four one centimeter wide belts, moving with the composition at a constant speed. At the end of the passage it opens and returns quickly to its starting position, and closes again on the composition of core and veneers repeating this cycle continuously.

The speed is regulated according to the type of adhesive used and to the temperature of the press.

Our programme is normally adapted to 100 seconds and to 30 seconds for the return passage and closing and opening of the press. The passing speed of the continuous ribbon of core and veneers is therefore

$$\frac{16,000}{3.320 \times 60 \times 1.41 \times 0.017} = 7.35 \text{ metres per minute}$$

Where: 16,000 represents m<sup>3</sup> annual capacity;  
3,320 are the hours of annual effective time of the line, working in two different shifts of 320 minutes of effective work per shift;  
1.41 is the average net width of ribbon in meters, i.e. length of finished board;  
0.017 is the average thickness of the finished board in meters.

With an orderly supply of strips and good wide veneers, a feed speed of 7 to 9 meters per minute could be achieved on this line. One of the obstacles to the attainment of this result is the urea adhesive, which polymerizes very slowly so that one's lowest compression values are set at 75 seconds per compression.

The speed of the individual parts of the line, from the conveyor to the applying of adhesive, composition of veneer faces, the fore-press, press and



down to the trimming saws - is synchronized through a unified propelling base which blocks automatically in cases of interruption of any part of the system and stops the whole line.

#### Trimming saws

The end product of the line is a continuous ribbon of blockboard of a certain length. Leaving the press at a constant speed, the ribbon passes through a longitudinal trimmer. Its knives trim the blockboard lengthwise; in the course of the same operation the trimmings are chipped and conveyed by the ventilating system to the boiler room. The ribbon is then automatically cut across to the desired dimension. All these operations, pressing, trimming, and cross-cutting to dimension, are wholly mechanized, no labour is needed for handling of materials.

The blockboard can be cut to sizes of 183 to 365cm. Longer or shorter dimensions are also possible; in this case a worker must supervise this operation and the boards must be taken off the line manually.

#### Plugging Line

The blockboard is stored for 5 to 7 days. During this time the additional humidity which was introduced with the adhesive spreads even and equalizes, contributing to the stability of the board. An adequate temperature must be maintained all this time. The boards are then taken to mechanized and hand plugging. Each blockboard is checked manually and plugged and puttied if required. They are then again set aside for 2 to 3 days before being taken to be sanded.

#### Sanding

The blockboards are taken to an elevating platform in front of the sander with a 3.5 ton battery fork. An automatic device pushes the boards one by one off the platform into a two-sided contact sander. Coming out, they are classified by a controller who directs them automatically by pushing buttons,

to their separate piles. Directing the boards is the only job of the worker at the sander. He also controls the sanding, the branding of the blockboards and the perfect work of the machinery.

The process of production is thus concluded. The finished blockboard is transported daily to the warehouse, where stacks are built to four and more metres in height to make full use of the space available. From here the boards are loaded on trucks and railway cars and transported to buyers and consumers.



