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OF A PILOT FURNITURE PLANT

DP/DRK/86/011

THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

Technical report: Training manual on  
processing of veneered furniture parts: trimming, tenoning,  
edge banding and drilling\*

Prepared for the Government of the Democratic People's Republic of Korea  
by the United Nations Industrial Development Organization,  
acting as executing agency for the United Nations Development Programme

Based on the work of Radmilo Malis,  
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\* This document has not been edited

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TABLE OF CONTENTS

	PREFACE	iii
1.	Introduction	1
2.	Basic requirements for trimming and tenoning veneered furniture parts	1
3.	Double end tenoning machine	1
4.	Setting up the double end tenoners and tools	2
5.	Tools for processing veneered furniture parts	5
6.	Operating instructions for a double end tenoner	9
7.	Single edge banding machine	10
8.	Setting up the edge banding machine and adjustment of its tools	11
9.	Hot melt glue and its preparation for application	12
10.	Operating instructions for the edge banding machine	13
11.	Multi-spindle drilling machine	14
12.	Setting up the multi-spindle drilling machine and the drilling tools	16
13.	Operating instructions for the multi-spindle drilling machine	17
14.	Control of the drilling	20
15.	Organization of the work area	20
16.	Safety measures	20
	FIGURES	
1.	Adjustment of a circular saw unit on a double end tenoner	3
2.	Setting of the scoring circular saw	3
3.	Use of dogs for workpieces shorter than 600mm	4
4.	Feeding workpieces longer than 600mm	4
5.	Control of squareness of panels	4
6.	Adjustment of dogs for precise trimming	4
7.	Adjustment of the chain wheels on the shaft	5
8.	Main dimensions of a circular sawblade	6
9.	Hogging set expandable by adding extension cutters	7
10.	An adjustable cutterhead with a turnable design, used for slotting	7
11.	A solid trimming cutter for trimming units of the edge banding machine	8
12.	Various drilling bits	8
13.	Control panel of the double end tenoner	9
14.	General view of a multi-spindle drilling machine	15
15.	Utilization of a gauge for setting the work table in relation to the spindles	17
16.	Utilization of gauges for setting the stops	18
17.	Setting of stops in relation to the spindles	19
18.	Organization of the work area	21
	ANNEX I	23
	ANNEX II	27

## PREFACE

This training manual is one of a series prepared by a UNIDO Furniture Production Expert, Radmilo Malis, while serving as Chief Technical Adviser of a UNDP financed and UNIDO executed project in the People's Democratic Republic of Korea, to assist in the establishment of a Pilot Furniture Plant in Pyongyang (Project DP/DRK/86/011).

This manual deals with processing of veneered furniture parts: trimming, tenoning, edge banding and drilling.

The manuals were written to achieve two major goals, first: to give trainees a broader view of an industrial system and second: to serve as a practical guide to machine operators and assemblers, thus enabling them to better perform their duties.

A particular attention has been devoted to materials and their correct utilization, to the design and quality of products, to the organization of the work areas and to safety measures.

The description of the machines is based on those bought for the Pilot Furniture Plant.

These manuals have been written in such a way that they can also apply to other similar factories and to vocational training institutions.

The entire scope of the training envisaged to be given, with the intended audience for each topic is given in Annex I.

The syllabus, namely the topics, the duration of lectures (theory) and practical work and the level of competence attained after completion of the course on this topic is given in Annex II.

## 1. Introduction

Sizing, edge banding and boring are operations common to all types of veneered wood based panels. Sizing is usually done on a double end panel trimming/tenoning machine with machining units arranged both for sizing and moulding operations. Longitudinal trimming is done before transverse sizing. Sizing must be very accurate, thus suitable surfaces for edge banding are obtained. Edge banding is either done on a single or on a double edge banding machine using hot melt glue. Veneer strips, solid wood laths or strips in plastic or in reels are applied to the edges. Sizing and edge banding are followed by boring. The panels must be bored for dowels, and to take all the hardware required for the final assembly of the unit. A machine with mobile boring heads for both horizontal and vertical drilling can be used.

This manual focuses on the technological operations determined by the machines installed in the Pilot Furniture Plant.

## 2. Basic requirements for trimming and tenoning veneered furniture parts

Basic requirements for trimming and tenoning veneered furniture parts are:

- Accurate dimensions (lengths and widths) of the processed panel parts,
- Accurate "square cut" (precise right angles) of all four corners of processed panel parts, and
- smooth panel edges, without cracked or frayed veneer.

To achieve this, a double end trimming and tenoning machine with appropriate tools must be correctly set-up and carefully controlled.

## 3. Double end tenoning machine

Double end tenoners are used in the secondary wood processing industry, for rectangular sawing to precise sizes, grooving, moulding and tenoning operations. This type of machine has been widely used in the production of case furniture whenever high-grade craftsmanship is required. The high accuracy is achieved by feeding the workpiece into the machine by means of chain drives.

Descriptions and instructions given in this chapter refer to the particular double end tenoner, model SI-136, produced by SHODA, Japan, which is installed in the Pilot Furniture Plant. The main technical characteristics of this machine are as follows:

Workpiece size:	length - unlimited width - 150-1850 mm thickness, max. 50 mm
Feeding speed:	5-15 m/min.
Feeding motor:	1.5 kW (4 poles)
Width setting motor:	0.4 kW (4 poles)
Circular saw spindle:	- tilting 45° max saw blade diameter 305 mm, bore 31.75 mm, revolutions (60 Hz) 3450 RPM power 3.7 kW (2 poles)

Scoring saw spindle:	saw blade diameter 150 mm, bore 25.4 mm revolution (60 Hz) 3450 RPM power 0.75 kW (2 poles)
Overall dimensions (h x w x l):	1500 x 3290 x 2660 mm

The double end tenoner consists of:

- A bed (main body) made of a mono-block cast iron with an upper sliding portion precisely finished to maintain accuracy.
- Columns for supporting circular saw units and cutter spindle units.
- Looking at the machine from the feeding side, the left hand column with its feeding rail is fixed to the bed and the right hand feeding rail is mobile to permit adjustment of widths. However, a double end tenoner with both feeding rails fixed can be ordered.
- Two scoring saw spindles are mounted on the columns with a possibility of making vertical and horizontal adjustments.
- Two pressing beams, equipped with 'V' belts, are located above the feeding chain.
- 'V' belts, with their pulleys, are attached inside the pressing beam and plastic guide rollers are set to hold the 'V' belt.
- Two circular saw units are mounted on the left and right hand of the columns. These can be tilted and adjusted horizontally and vertically.
- Two cutter spindles are mounted on the columns. These can be tilted and adjusted vertically.
- Two cast iron feeding chain rails with chain wheels attached within the rails carry two feeding chains (left and right side). These chains are driven by chain wheels which are connected through a reduction gear to a motor. Both chain wheels are set on the same driving shaft.
- The feeding chains are equipped with a system of dogs which can be pressed down below the surface of the chain, or permitted to rise to their normal position. The locking and unlocking of the dogs can be done by a screw driver.
- For safety purposes, the machine is equipped with limiting switches and safety covers. The tool protecting covers are provided with sleeves for connection to the dust exhaust pipes.

#### 4. Setting up the double end tenoners and tools

The circular saw is directly attached to the motor and the motor is linked to its base. By sliding this base on the column, the motor can be adjusted both vertically and horizontally (see fig. 1). The motor's position can be set on a scale which determines the cutting length of a workpiece. By loosening the fixing nut, the motor base can be tilted and the saw set to any angle, using the indicator scale. Any angle between 0° and 45° can be set.

The scoring circular saws should be set so that it makes a groove in the panel about 3 mm deep (see fig. 2).

The cutter spindles are set to make tenons at both ends of the workpiece. The structure is almost the same as that of the circular saw spindle. Usually, the positions of the circular saws are horizontal while the cutter spindles have vertical motors.

The pressing beam should be adjusted to match the thickness of the workpiece. The speed of the "V" belt and the feeding chain can be adjusted to the same or different.

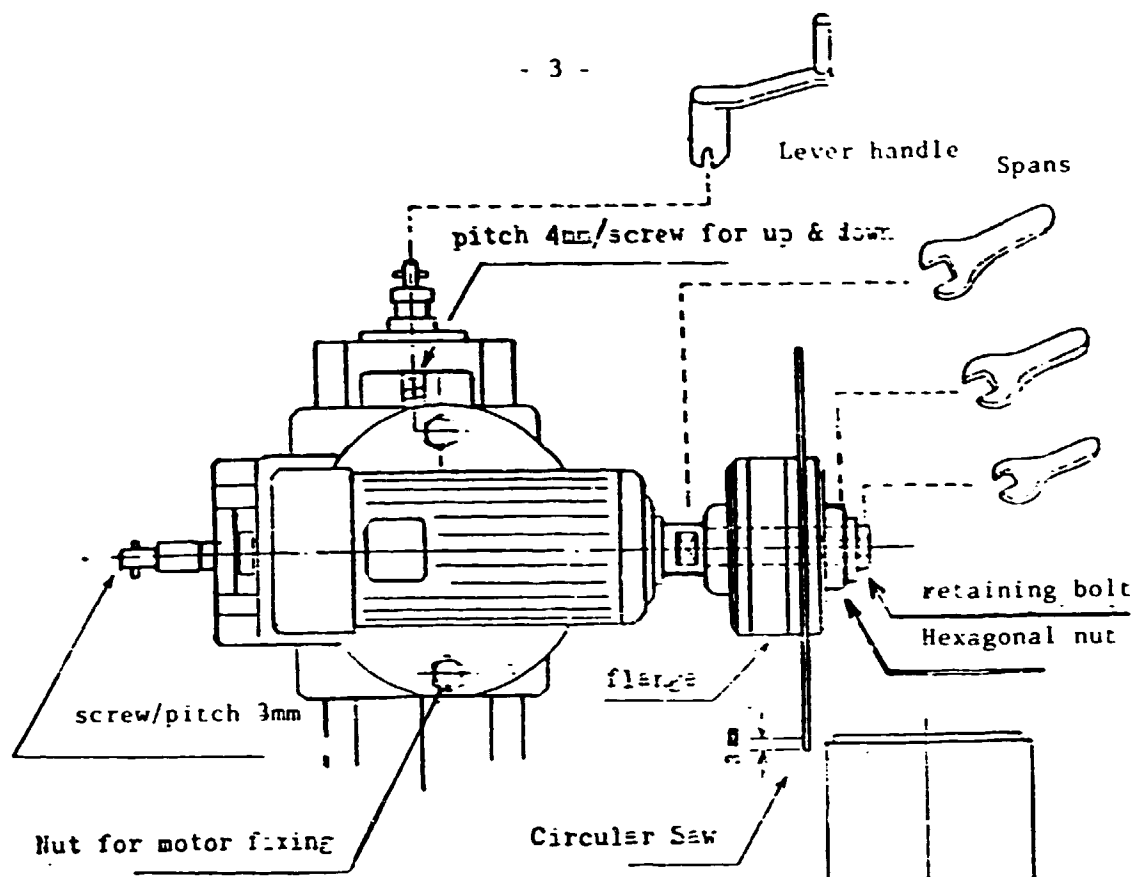


Fig. 1: Adjustment of a circular saw unit on a double end tenoner

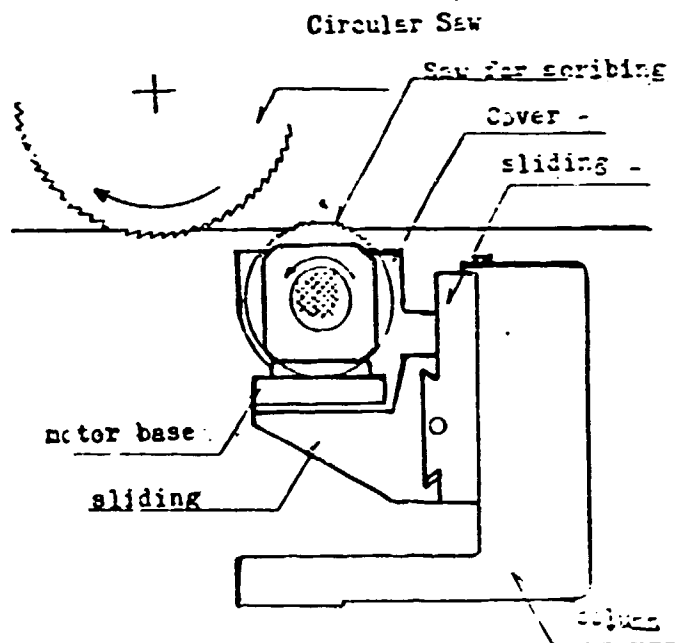


Fig. 2: Setting of the scoring circular saw.

The following rules must be applied when setting the speed of the "V" belt: (a) In case a workpiece is shorter than 600 mm, the belt speed should be equal or lower than the speed of the chain, and the dogs should be used (see fig. 3). (b) If the workpiece is longer than 600 mm, the workpiece should be set right after the dog and the speed of the "V" belt should be slightly higher than the speed of the chain (see fig. 4).

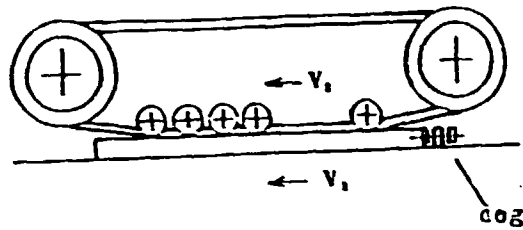


Fig. 3: Use of dogs for workpieces shorter than 600 mm.

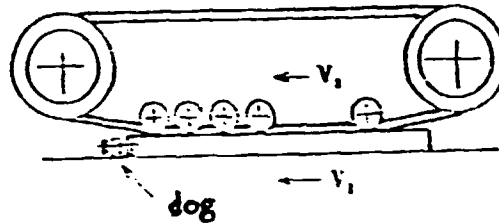


Fig. 4: Feeding workpieces longer than 600 mm

The speed of the "V" belt is adjusted by the wheel handle of the speed control device. By turning the wheel clockwise, the speed is increased and it is reduced by an anti-clockwise rotation.

Feed chains should be parallel to the pressing beams. After cutting a workpiece, its shape must be controlled (see fig. 5) and the following adjustments might have to be made.

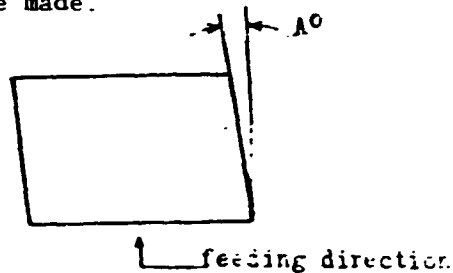


Fig. 5: Control of squareness of panels

Example 1: The right side dog is at an ample of  $A^\circ$ . Therefore, bolt No. 1 should be loosened, the feeding chain moved forward a little, and bolt No. 2 should be tightened. (see fig. 6).

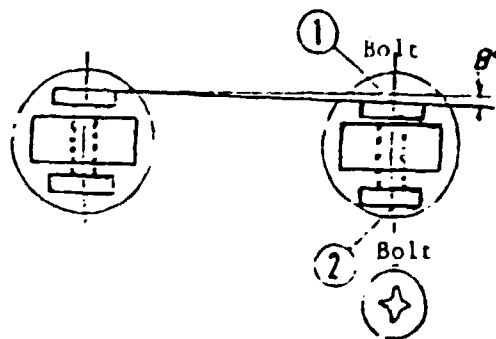


Fig. 6: Adjustment of dogs for precise trimming

Example 2: If there is an angle of  $B^\circ$  between the left and the right feeding chains, the chain wheel on the shaft should be adjusted (see fig. 7).



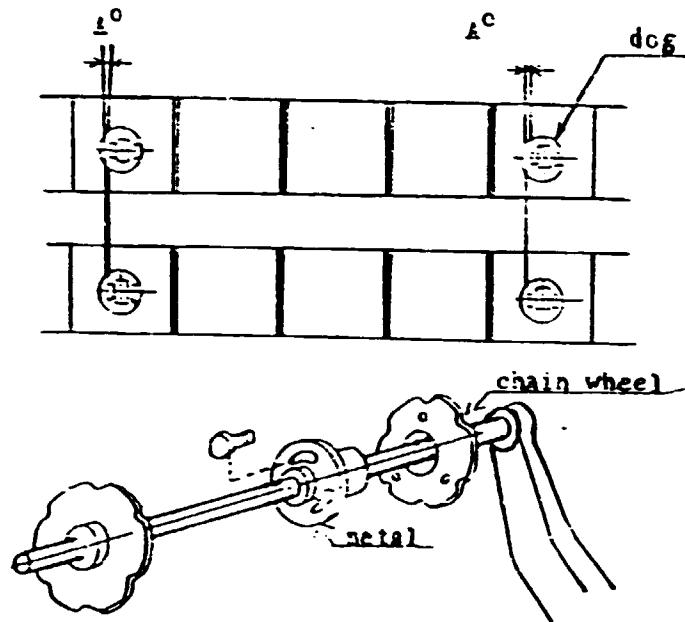


Fig. 7: Adjustment of the chain wheels on the shaft

When installing and adjusting a circular saw blade, a safety cover should be attached first to the flange which is provided at the motor, and then the circular sawblade should be fixed on the spindle. A space between the circular saw and the side of the feeding chain should be 15 to 20 mm. However, depending on the size or the cutting tool, the gap should be adjusted.

The trimming and scoring sawblades must be set in the same plane.

Setting moulder cutters is done in nearly the same way as setting sawblades.

After processing the first workpiece, the accuracy of sawing and cutting must be checked and, if necessary, the tool setting should be corrected. If the surface of the cut is rough and not suitable for edge banding, the tool must be replaced by a sharp one having the appropriate parameters on the cutting edge for the material being machined.

##### 5. Tools for processing veneered furniture parts

The following woodworking tools are used for trimming, edge banding and drilling of panel parts:

- circular saw blades,
- hogging sets,
- moulder cutters,
- edge trimming cutters,
- boring bits.

Circular sawblades are used for trimming, scoring and final cutting operations.

Sawblades with tungsten carbide tipped teeth, with alternate top bevel teeth and positive hook, and with plugged expansion slots are recommended for

trimming veneered wood based panels. The same type of blades can be used as scoring saws, but their diameters must be between 150 and 180 mm.

When ordering sawblades, the following technical details (see fig. 8) should be specified:

- The diameter (D) in mm.
- The kerf (B) in mm
- The bore (d) in mm
- The number of teeth (Z)
- The material to be cut
- The revolution per minute (rpm)
- The rate and kind of feed (mechanical or manual)
- The catalogue number and identification of the item.

The following sizes of sawblades are recommended for the machines installed in the Pilot Furniture Plant:

	Double end tenoner for trimming	for scoring	Edge banding machine for end cutting
D (mm)	305	150	170
d (mm)	31.75	25.4	30
b (mm)	3.2	3.2	2.8
Z	72	24	30

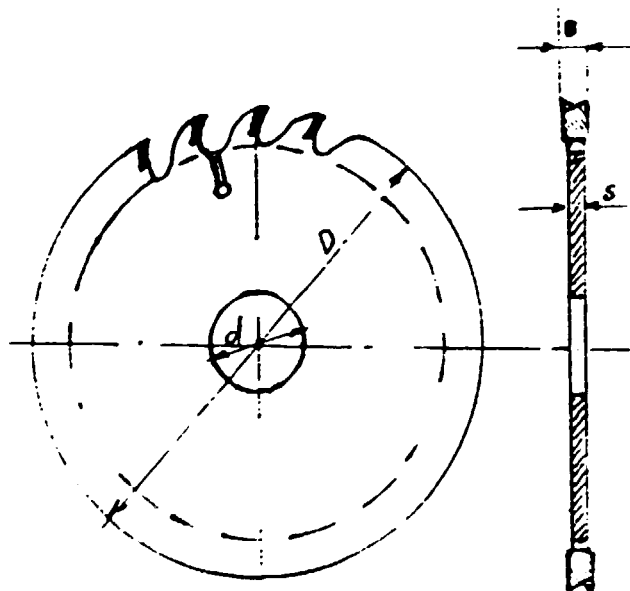


Fig. 8: Main dimensions of a circular sawblade

Hogging sets are compound tools used for trimming of panels which reduce off-cuts to chips. One pair consists of: one each left and right hogging set. One set includes: one sawblade, one basic hogging cutter (one extension cutter) and one flanged sleeve. A hogging set is expandable by adding extending cutters (see fig. 9).

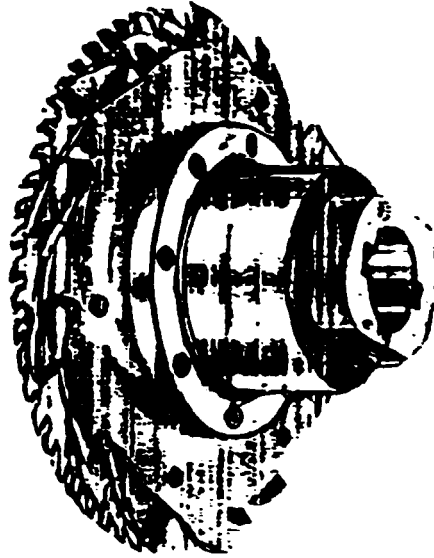


Fig. 9: Hogging set expandable by adding extension cutters

Moulding cutters are used for tenoning, rebating, grooving, and, eventually, profiling. They could be either solid or adjustable cutterheads. Adjustable cutterheads in with a turnblade design are very popular (see fig. 10).

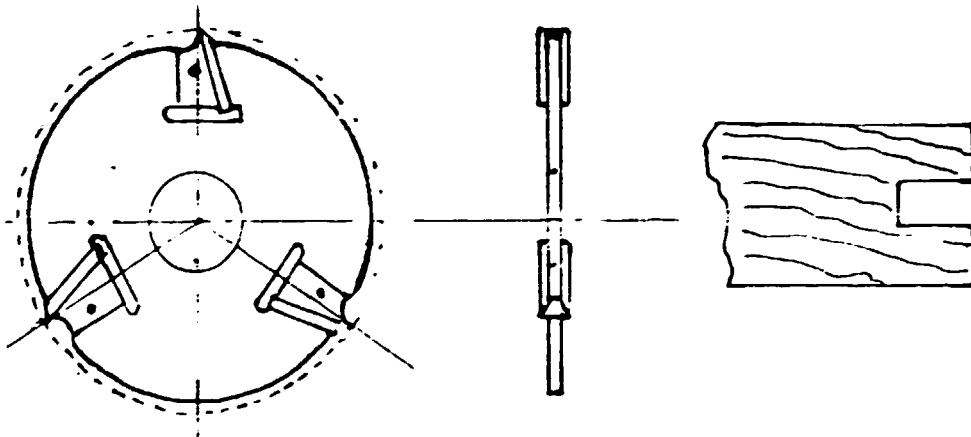


Fig. 10: An adjustable cutterhead with a turnblade design, used for slotting.

The advantage of the cutterhead is that each blade has four cutting edges so that after sharpening, they could be used one after the other.

Edge trimming cutterheads are used as tools for trimming units on edge banding machines. They are available for right and left rotation. These can be designed solid or with a turnblade. Their main characteristics are: the diameter (D), the width (B), the bore (b) and the number of cutting blades (Z) (see fig. 11).

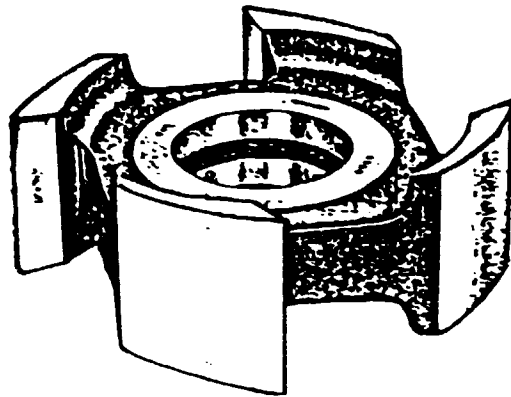
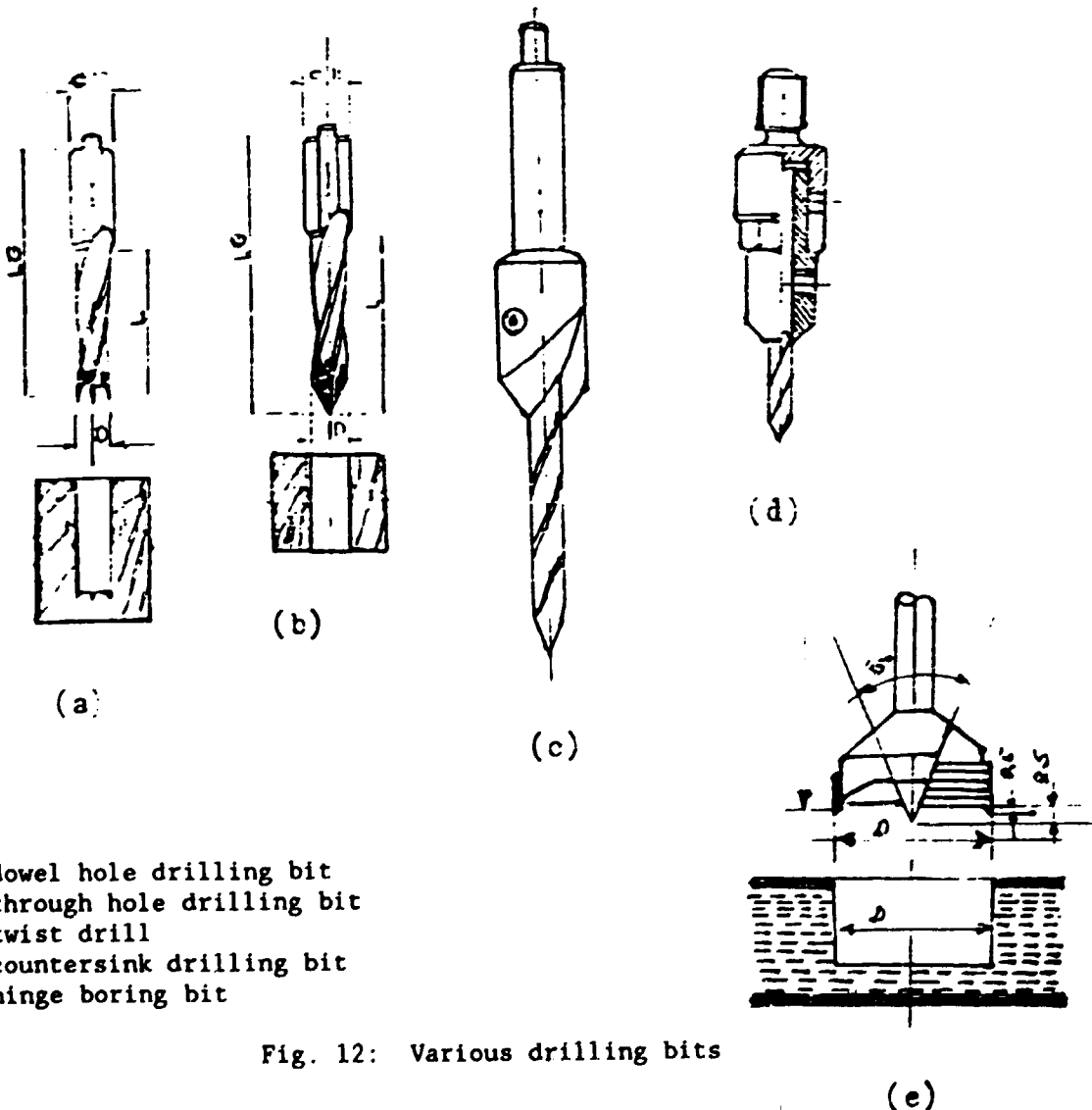


Fig. 11: A solid trimming cutter for trimming units of the edge banding machine.

Boring bits are used for drilling with multi-spindle drilling machines. There are various drilling bits, such as: dowel hole drilling bits, through hole drilling bits, twist drills, hinge boring bits, countersink drilling bits, etc. (see fig. 12).



- (a) dowel hole drilling bit
- (b) through hole drilling bit
- (c) twist drill
- (d) countersink drilling bit
- (e) hinge boring bit

Fig. 12: Various drilling bits

The main characteristics of boring bits are: the diameter of the hole (D), the diameter of the shank, the full length (LG), and the length of the drilling part (L). (See fig. 12)

Twist drills with two flutes, two spurs and a centre point are used for drilling accurate holes in solid wood and panels.

Hinge boring bits are used for drilling clean blind holes for hinges and furniture fittings.

Countersink boring bits are used to drill holes and to countersink them in one operation.

6. Operating instructions for a double end tenoner

After setting the working units properly, the width of the panels should be set. The main on/off switch should be turned on (see fig. 13) (the power light must light) and the push-button for the width adjustment motor is turned on to move the sliding side to the required width. It can be controlled on a millimeter scale and a pointer which is on a sliding support.

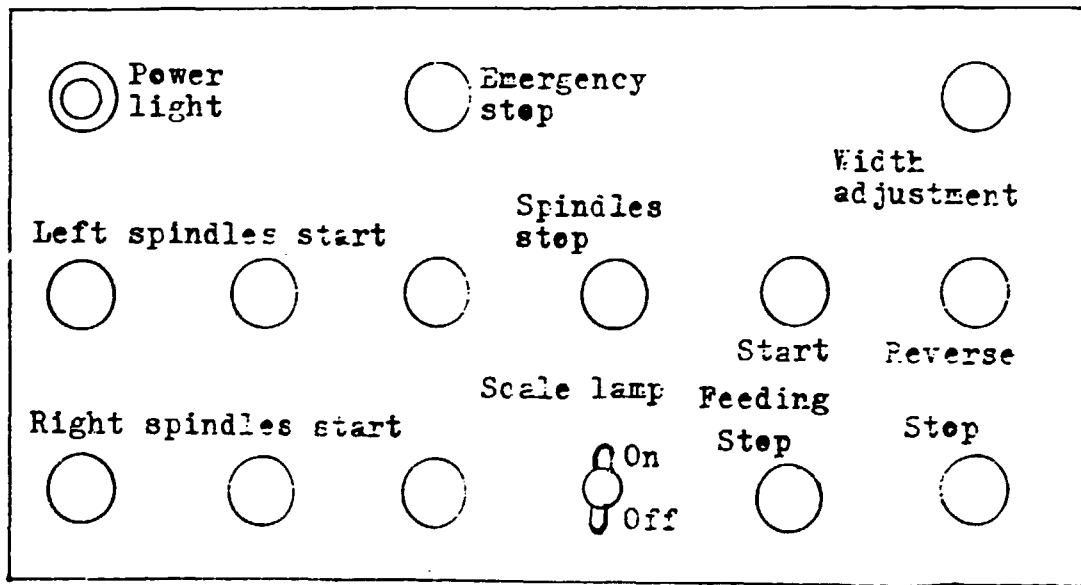


Fig. 13: Control panel of the double end tenoner.

The pressing beam and limiting switches must be checked as well as the position of the feeding fence on the left side.

Then each working unit must be started one at a time, and if all are sound normal, the conveyors may be started.

Narrow parts (less than 600 mm) should be fed into the machine in front of the dogs and the wide parts pressed against the dogs from behind.

After trimming and tenoning the first part, its dimensions, the squareness of the right angles and the profiles of the tenons must be checked. If any deviations occur, these must be corrected before continuing with the machining of other blanks. Once all the requirements are met, the operation can be resumed.

## 7. Single edge banding machine

Gluing straight edges is normally performed on automatic edge banders using thermoplastic adhesives.

The following instructions refer to the SCM (Italy) single edge banding machine, model B5L, which is installed in the Pilot Furniture Plant. This machine's main technical characteristics are as follows:

Panel thickness	10-60 mm
Edge banding material thickness	0.4-13 mm
Minimum working width:	
- for strips and material in reels	70 mm
- for solid wood laths	110 mm
Minimum working length:	
- for strips and material in reels	140 mm
- for solid wood laths	200 mm
Feed speeds: 2	10 and 15 m/min.
Revolutions of edge trimmers	9000 rpm
Revolution of double end cutting unit	8500 rpm
Cutting speed of sanding unit	15 m/sec.
Tilting of gluing unit	0° to 6°
Tilting of double end cutting unit	0° to 15°
Tilting of trimmers	0° to 45°
Tilting of sanding unit	0° to 6°
Motors:	
- two speed feeding	2.2-3.3 kW
- double end cutting unit (each)	0.33 kW
- trimmers (each unit)	1.5 kW
- sanding unit	1.1 kW

The machine's main parts and the working units are:

- The base is made of tubular steel.
- The operating units are anchored on sturdy columns.
- The feeding conveyor is attached to the cylindrical guides which guarantees the straightness of the panels feeding.
- The glue's heating pot has a capacity of 4 kgs of glue.
- The glue spreading roller is protected by a steel shield.
- The automatic magazine for feeding edge banding material is equipped to feed solid wood lippings, veneer strips or plastic tapes in reels.
- Pressure rollers which press the edging materials to the panel.
- A pressing beam with two rows of rollers pressing the panels on the feeding conveyor.
- An infeed fence, giving the alignment guide to the panels to be edge banded.
- A table supporting the adjustable roller, which can be adjusted to the required position depending on the width of the panel.
- The double end cutting unit for cutting the excess edges of the panels.
- A trimming unit which consists of a top and a bottom trimmer.
- A sanding unit.
- A pneumatic system.
- A dust exhaust system.
- A control panel for the electric system.

In order to operate the machine correctly and safely, it must be firmly positioned, leveled and the connections to the electric lines and compressed air system must be correct. A proper grounding connection must also be assured.

#### 8. Setting up the edge banding machine and adjustment of its tools

All operating units and tools on the edge banding machine require an appropriate setting in order to stick edging strips to the panels and to obtain a precise cutting and trimming of edging material exceeding the panel's net dimensions.

- The heated pot containing the glue should be filled up with hot melt glue so that it only covers slightly the central rib in the bottom of the container.

- The switch for heating the hot glue pot should be turned on.

- Both thermostats, one for the hot glue pot and the other for the glue spreading roller, must be set on 120-130°C. After 20 minutes, the glue hot glue pot's thermostat should be set at 180°C and the glue spreading roller thermostat at 220°C.

- The glue film's thickness is adjusted by positioning the spreading roller to reach the best distance between the roller and the panel.

- The magazine banding material's automatic edge should be set in order to adjust it for the type, width and thickness of the material being used. Each edging material calls for a different way of feeding it and the magazine should be set to correspond with the feeding method used.

- The pin head roller for feeding the edging material should be adjusted to the letter's thickness.

- The pneumatic shearing device should be moved forward to cut the continuously fed reeled strip material.

- The pressing beam should be adjusted to the thickness of the panels.

- The double end cutting unit should be adjusted at the required tilting angle, thickness of cut and adequate pressure.

- The vertical and horizontal copying devices, the tilting angle, the vertical and horizontal positions of the cutters against the copying devices, bigger or smaller cuts and spring load should be adjusted in order to set the trimming units.

- The sanding unit must be set in order to adjust its height and depth in accordance with the edging material's thickness, the pressure on the pad unit and the pressure of the oscillating belt.

- The pressure of the compressed air must be set at 6 bars.

- The protective covers should be unscrewed for setting the tools, and after the tools are set, these must be attached and the screws tightened.

Over and above instructions, those given by the machine's producer should also be observed and strictly followed.

#### 9. Hot melt glue and its preparation for application

Hot melt glues are solid products obtained by mixing vinyl acetate copolymers with resins and mineral fillers. In furniture production, these glues are used for edge banding operations.

Gluing with hot melt glue is done as follows:

- The glue is melted. It can thus be applied on the surface to be bound and wet it.
- The surfaces are then quickly coupled and pressed.
- Glue changes from the liquid to the solid state on the cooling line and the bond is achieved by applying pressure.

The viscosity of the glue is tested only at a temperature of 120° to 140°C with a rotary viscometer. The viscosity is related to the temperature. Changing the temperature of application the glue's viscosity which affects its wetting and application characteristics.

Choosing an incorrect working temperature can cause various bonding defects. Excessively low temperatures increase the viscosity to levels where the adhesive will not wet the surface to be bonded, thus causing glue failures.

Various (not standardized) tests have been developed by certain laboratories in order to determine the resistance to heat, the ash value, the bond strength, the resistance to ageing at high temperatures and the open time. These values are measured mainly in order to improve the product and to determine the optimal application conditions.

Resistance to heat has little significance in application, but a factor which must be known is whether a furniture product will be exposed to higher temperatures during its use.

The bond strength shows the cohesive strength of the glue line. A satisfactory strength is between 30 and 60 kg/cm<sup>2</sup>.

The resistance to aging at high temperatures is important because it shows how many times glue can be heated to 220°C and cooled to the ambient temperature. During heating and cooling cycle, the viscosity is increased. After the third cycle, it is about 100-150 per cent greater than after the first one.

Open time is a very important characteristic which indicates the maximum time allowed from the moment when the glue is spread to the moment pressure is applied without impairing the bond.

When using hot melt adhesives for edge banding, the working conditions should be carefully controlled to ensure correct gluing. Above all, the ambient temperature and the temperature of the material to be glued must not be lower than 15°C. The humidity of the material must be between 8 and 12 per cent.



The panel's edges must be precisely squared, free from dust and clean.

The glue must be melted in the tank and be at a temperature of 220°C. During any interruption of work, this temperature should be reduced to 140-160°C.

When the glue is sufficiently fluid, the spreading roller's motor must be started and the glue flow checked by means of a spatula, directly on the spreading roller.

A lower speed (10 m/min) is required for gluing solid lippings whereas a higher speed (15 m/min) is better for gluing veneer or plastic tapes in reels.

Glue spreading - which is always done with knurled rollers - can vary from 150 to 300 gr/m<sup>2</sup>, depending on the porosity of the substrate.

Based on experience, the working conditions for hot melt glues which can be recommended for edge banding are as follows:

- Tank temperature	170-190°C
- Roller temperature	200-230°C
- Temperature of material	min. 5°C
- Pressure	5-10 kg/cm <sup>2</sup>
- Spread	200-250 gr/cm <sup>2</sup>
- Conveyor speed	10-20 m/min
- Moisture content of materials	8-10 per cent

#### 10. Operating instructions for the edge banding machine

The most important points to control in operating the edge banding machine is the appropriate setting of the temperature in the glue tank and on a glue spreading roller, as well as the setting of all the operating units. The correct temperature is 180°C in the glue tank and 220°C on the glue spreading roller.

The correct pressure and oiling of the compressed air should be observed.

The pressure required is 6 bars.

The magazine containing the material used for edging must be adapted to the type and thickness of the edges. The pin headed roller should be checked to ensure that it is set for the specific thickness of the edging material used.

The correct pressure should be set for the pressure rollers, depending on the thickness of the material. The pressure depends on the thickness of the edging material.

The pressure beam should be set for a specific thickness of panel. The extending roller table should be fixed at an appropriate distance, corresponding to the width of the panels.

The tilting angles on the double end cutting and trimming units should be checked, and, if necessary, adjusted.

The air pressure on the double end cutting and sanding units should be set as required.

The sanding unit should be adjusted to the thickness of the edges.

All unnecessary material should be removed from the machine. Edging strips should be located in the magazine feeding the edging material automatically. The panels to be edge banded should be brought to the right hand side of the operator.

The double end cutting, trimming and sanding units should be turned on and checked to ensure normal work performance.

The feeding of edge banding material should now be switched on.

The glue flow to the spreading rollers should be checked.

The panels should be fed against the infeed fence and pushed towards the conveyor.

The result of edge banding, end cutting, trimming and sanding operations should be checked. If necessary, units which do not work properly should be readjusted.

Work can continue, the control is repeated until a satisfactory result is achieved.

Panel feeding can continue.

From time to time, the level of glue should be checked and small quantities should be added. This is done frequently to ensure that the temperature will not decrease.

If any abnormality is noticed, the machine should be stopped by pushing an emergency push-button. These are installed on the pressing beam, on the feeding end and on the unloading end of the machine.

The reason for the abnormality should be checked and the machine should not be restarted until the situation has been clarified and measures to remedy it have been taken.

In case the interruption of the work is longer, the temperature of the glue tank and the glue spreading roller should be set at 150°C and the time should be used to add more glue, thus giving it ample time for melting.

Before stopping the feeding conveyor, the compressed air pipes should be opened for one minute to clean the machine. The machine should be kept clean and free of strips and chips.

#### 11. Multi-spindle drilling machine

The automatic multi-spindle drilling machine for horizontal and vertical bottom boring existing in the Pilot Furniture Plant is described hereunder. It is model B57, produced by SCM, Italy.

The main technical data of this machine are:

- Centre distance between spindles	32 mm
- Number of horizontal head chucks	21
- Horizontal head motor power	1.5 kW
- Number of chucks for each of the two vertical heads	18
- Motor power for each of the vertical heads	1.5 kW
- Maximum panel thickness	60 mm
- Maximum boring depth	75 mm
- Maximum height of horizontal boring	50 mm
- Spindle speed	2800 rpm
- Working pressure of compressed air	6 bars
- Overall dimensions	1800x3200x1390 mm

The machine consists of a main body on which sliding supports for drilling heads, a work table with stops and a pressing beam with pressers are mounted. The machine needs electric power and compressed air. The switch button control panel is positioned on the pressing beam. The drilling heads are activated by pressing a pedal.

The left and right turning drilling chucks are placed alternately and marked. The right chucks are smooth and rotate counter-clockwise and the left ones are grooved and rotate clockwise.

It is a universal multi-spindle drilling machine which is easily adjustable and therefore has a high productivity. A general view of this machine is shown in fig. 14.

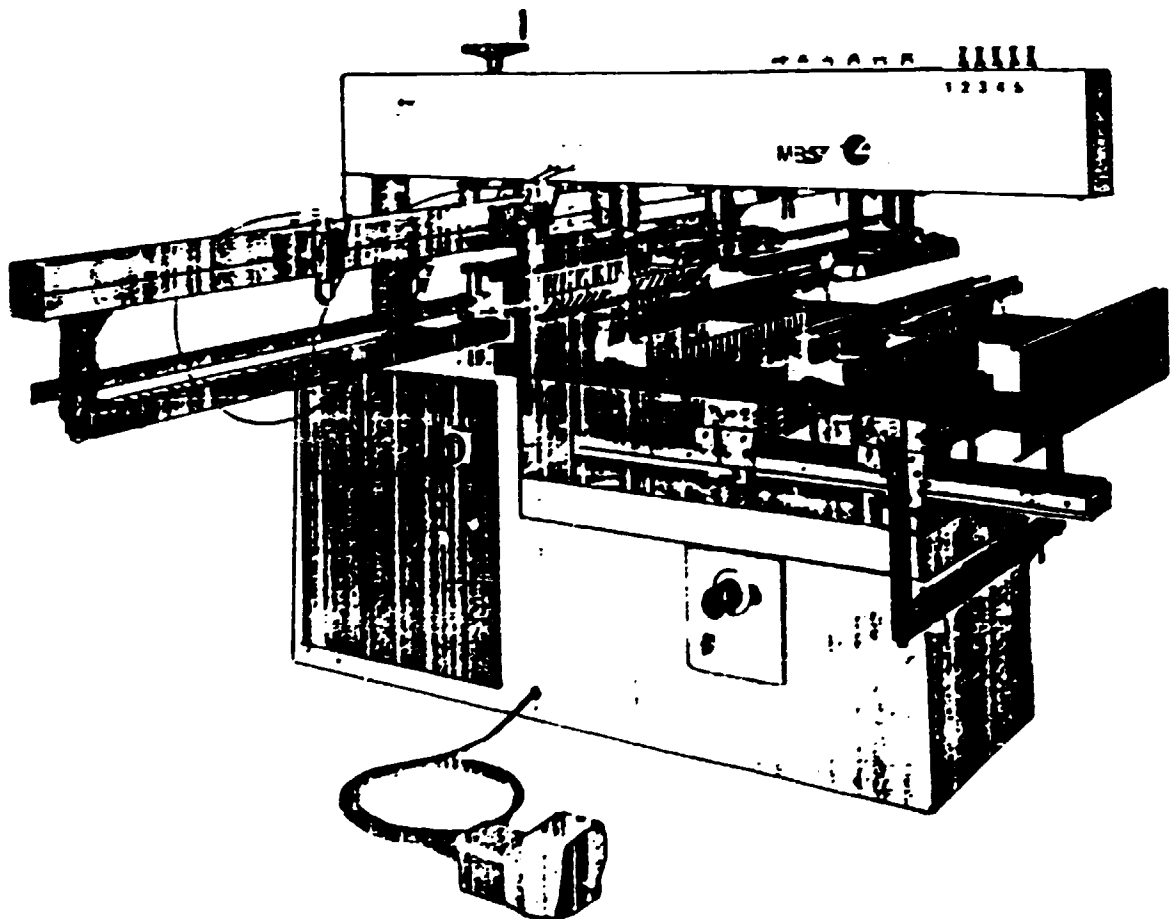


Fig. 14: General view of a multi-spindle drilling machine.

## 12. Setting up a multi-spindle drilling machine and its drilling tools

The machine should be connected correctly to the electricity and compressed air sources. The working pressure must be at least 6 bars. The oil reservoir of the air lubricator unit should be about 3/4 full and the normal oil flow of two drops per minute should be checked.

To position the vertical drilling heads, the main switch should be turned on. Using a pneumatic selector switch, position 1 should be chosen for the first and position 2 for the second drilling head, the drilling heads should be turned manually to the desired position and the switch should be then set on "0" to lock the heads. They can rotate 360°.

The four-position selector should be set for simultaneous or alternate drilling cycles, with the motors always on or off at the end of the cycle. Each drilling position is independent and before switching from one to the other the main contact should be positioned and the motor starting switches must be turned off.

The general contractor should be set and the emergency push-button released. Using the levers next to the main switch, separately for horizontal and vertical heads, the operation of drilling heads should be set on either automatic or manual.

The vertical heads should be positioned using the handle and referring to the calibrated ruler and vernier scale.

The drilling bits should be set in the chucks taking care to place left and right drilling bits in the correct chucks.

The distance between the work table and the top of the drilling bits should be checked. The penetration of drilling bits should be adjusted, adding this distance to the required depth of the bore. The depth of the bore in horizontal drilling is adjusted in the same way.

For drilling the panels, the front and rear stops must be adjusted sliding them along their graduated guides in relation to the vernier scale on each stop and locking them by using the handles.

The drilling position is set based on a detailed drawing of a part to be processed

The central stop can be adjusted in relation to the graduated ruler, and moved to be used as a side stop for both end. Each stop is lowered by pushing the buttons which have the same numbers as the stops.

Additionally, the speed of drilling, both in the drilling and the return cycle of the drilling heads can be adjusted, on the throttle control, rotating it with a screw driver, counterwise to increase the speed and vice versa.

The machine is now set, and ready for drilling operations. A gauge should be used to set the work table relative to the drills. (see figs. 15 and 16).

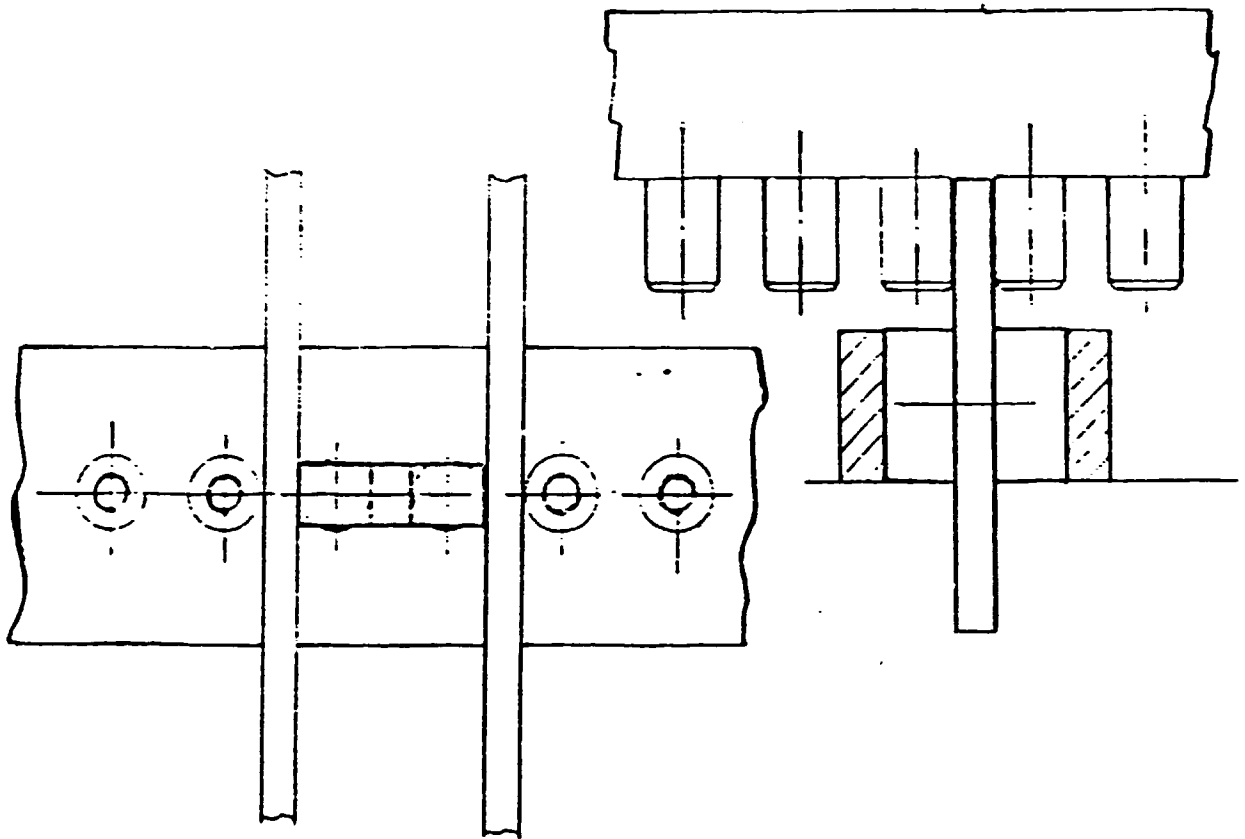


Fig. 15: Utilization of a gauge for setting the work table in relation to the spindles.

13. Operating instructions for the multi-spindle drilling machine.

The panels to be processed must, after being inserted, be brought up against the side stop and against the programmed stop (front and rear). Once the panel has been positioned, the foot control which starts the drilling cycle should be pressed. After the first drilling is carried out, the button corresponding to the stop used should be lifted and the panel slid to the following stop. The drilling cycle can be repeated up to five times.

In order to reduce the machine setting time, it is advisable to start drilling those parts which require numerous holes and finish with the ones requiring the least. Thus the setting is simply changed by removing drilling bits which are not needed for the next part. It is assumed that a design system indicating the position of the holes in the furniture parts exists. The positioning of stops is shown in fig. 17 hereafter.

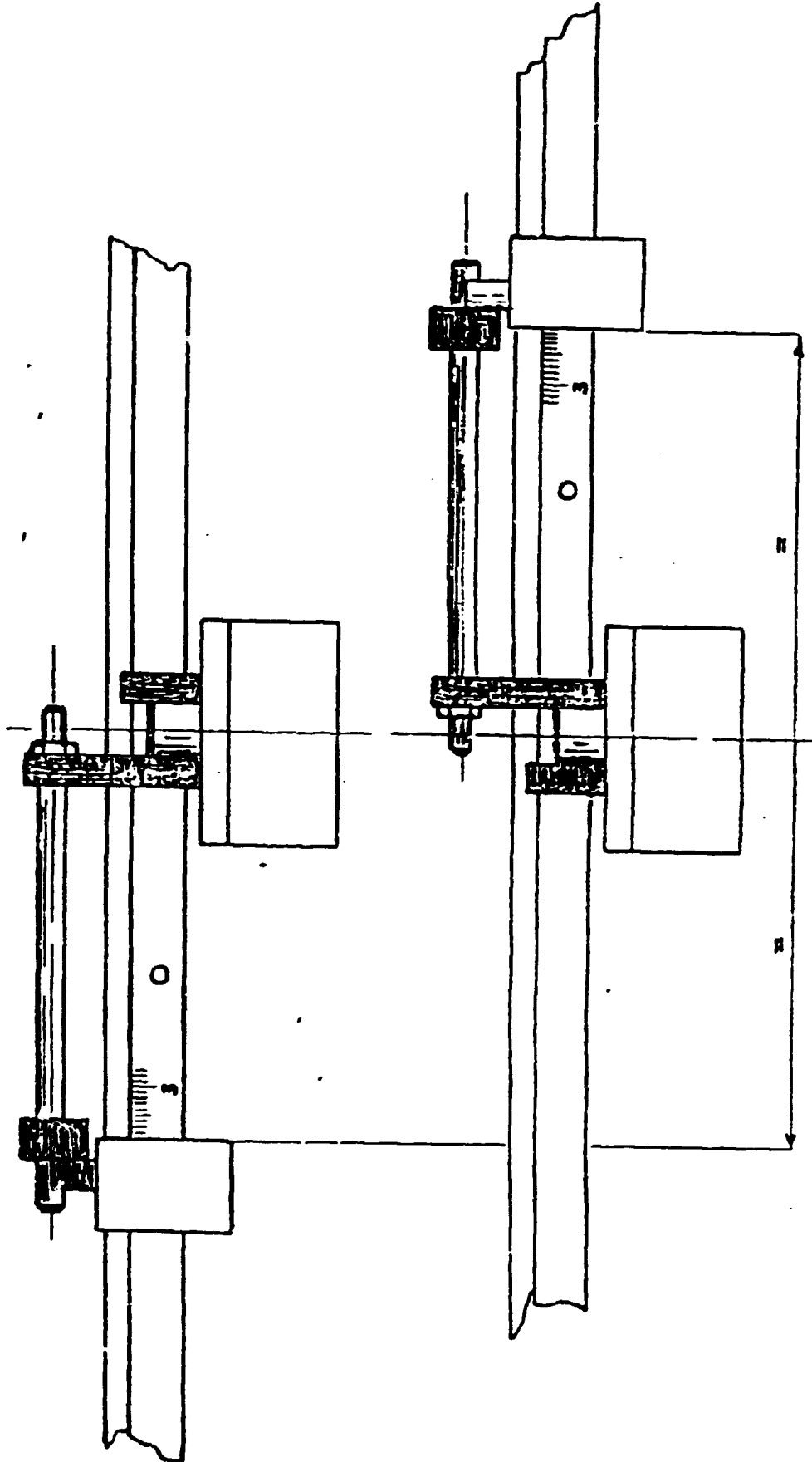


Fig. 16: Utilization of gauges for setting the stops.

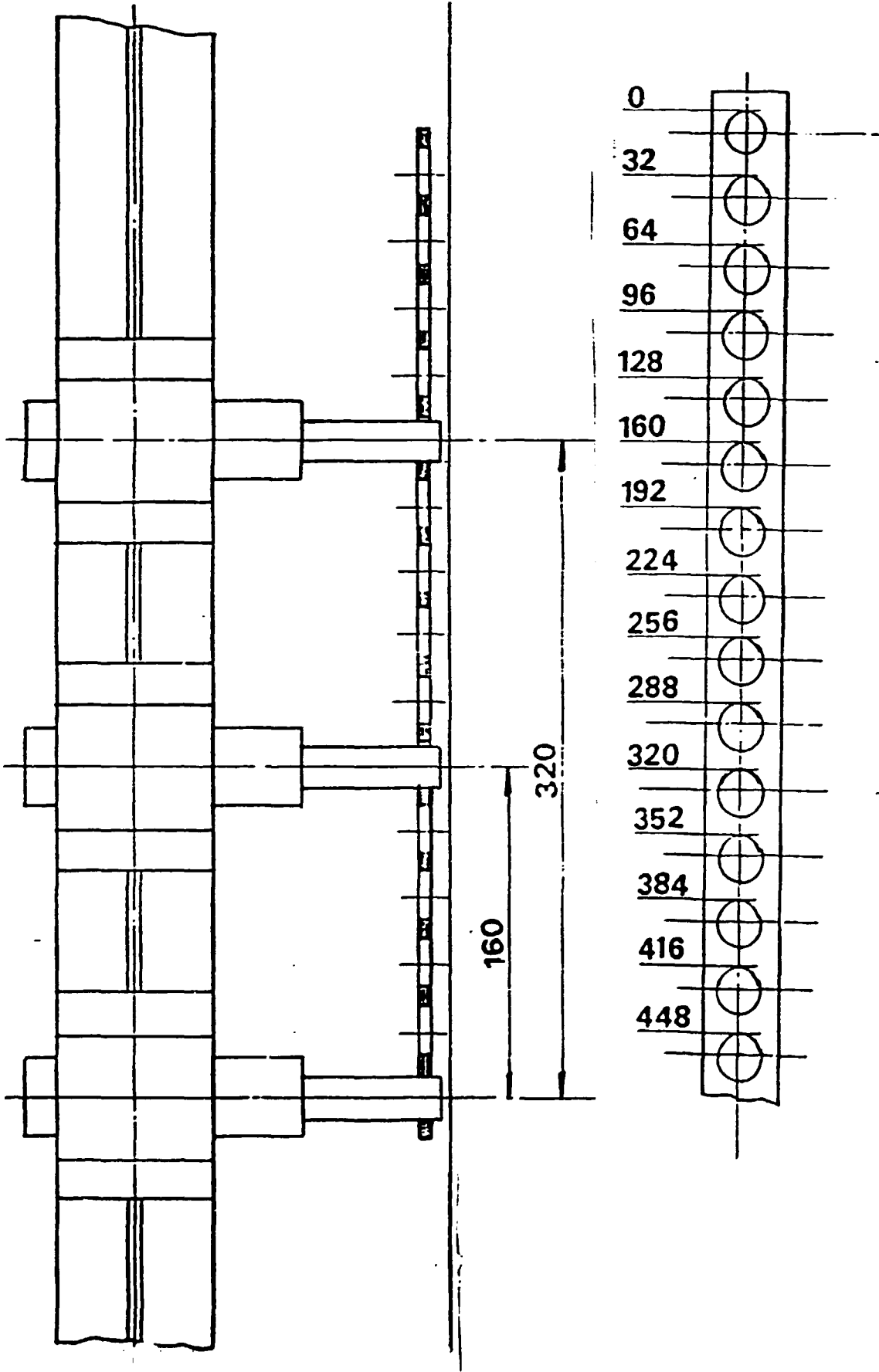


Fig. 17: Setting of stops in relation to the spindles.

#### 14. Control of the drilling

The first workpiece must be controlled after each start-up, in order to check the accuracy of the machine's setting. In order to control drilling, gauges should be available. Such a control must be repeated until the desired accuracy is achieved. A vernier caliper can be used to control the diameter as well as the depth of the hole.

The most important points to check are the distance of the first hole from the edge of a panel and the rectangularity of the drilling head with the edge of the panel. Measuring gauges can be made to have pins positioned on four sides and set to control four different drillings.

#### 15. Organization of the work area

The same double end trimming/tenoning machine can be used for both lengthwise and crosswise trimming. Enough space must be foreseen at the feeding and unloading sides, as well as for a return transport way. As each panel part will be passing through the single side edge banding machine one to four times, depending on how many edges will be banded, enough space must be foreseen at the feeding and unloading sides and for a transport return way. The pallets with the panels to be drilled and for the drilled parts should be placed next to each other in front of the multi-spindle drilling machine, on the right hand side of the operator.

The controlling gauges for the control of drilling should be placed on a vertical board next to the machine, on the left hand side of the operator (see fig. 18).

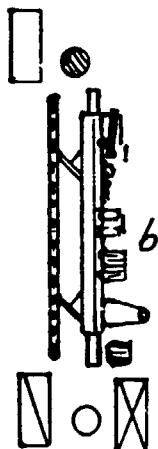
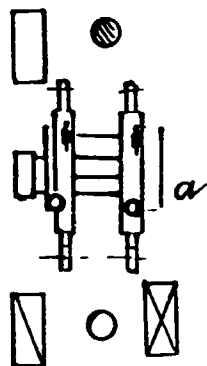
#### 16. Safety measures

The following safety rules must be observed in order to prevent injuries and damage to the machines.

- The protective devices should always be used and these should always be in perfect working condition.
- The machine should always be brought to a full stop before removing any protection parts.
- The electric motors and the metal frame of the machine should be properly grounded, and this should be checked.
- Whenever a machine is stopped for adjustment, the main switch should be positioned on "zero".
- In order to prevent accidents, the sleeves of the operators must be securely tightened, their clothes buttoned; no necktie should be worn, the hair should be gathered inside with a cap or with suitable devices and stronger footwear should be worn.
- Workpieces which are too small or too big for the machine should not be processed.
- Blades or tools which are cracked or warped should not be used.
- Tools should never operate at a higher speed than the limit specified on them.
- All rotary tools must be correctly balanced and centered, sharp and accurately keyed and balanced.



- An important safety precaution is a thoroughly clean machine.
- All the adjusting keys and wrenches should be removed.
- Everybody except the operator should be kept away from the machine.
- Tools should not be stood on.



- Operator
- Assistant
- Parts to be processed
- ▧ Parts to be returned for processing
- ⊠ Finished parts
- a* Tenoner
- b* Edge bander
- c* Drilling machine
- d* Shelf for gauges

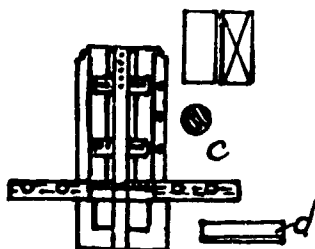


Fig. 18: Organization of the work area.

In addition to these general measures, there are the following specific safety measures related to each of the machines:

**Double end trimming/tenoning machine:**

- Both the left and right covers of the chain case must be attached.
- The protective covers of the circular saws and spindle cutters must be firmly fixed and connected to the dust extraction pipes.
- Limit switches are installed for safety purposes. One is located on the side of the feeding chain rail. The switch's roller should be set 3 mm above the level of the feeding chains. The other switch is at the pressing beam. The height of the switch should be set at the level of the "V" belt. Both limit switches will confirm the thickness of the workpieces during the operation. When the switch is adjusted higher than the thickness of the workpiece, it will not be pressed and the feeding system will automatically stop.
- The timer for the belt speed, relative to the speed of the chain, must be adjusted to prevent the workpiece from skipping out.

**Single side edge banding machine:**

- The pressing beam should be correctly positioned in order to avoid the uncontrolled movement of a workpiece.
- Extreme care should be taken when operating next to the glue tank, due to the risk of burning.
- The compressed air should be switched off from the machine before operating on an element of the shear device or near movable elements of the frame.

**Multi-spindle drilling machine:**

- Operation should be familiar with the tool characteristics, their applications, their limitations and the potential hazards peculiar to them.
- Only the correct tools must be used and maintained in top condition. These should not be forced.
- The operator should not reach over, he should always keep his balance.
- Before changing drilling bits, the machine should be switched off.
- The drilling bits should never hit against the worktable when drilling through holes.
- The pressers must be perfectly positioned on the work table.

ANNEX I

TRAINING PROGRAMME FOR FURNITURE MANUFACTURING

1. Introduction

This training programme is designed to accomplish the objective and outputs foreseen in the project "Assistance in the Establishment of a Pilot Furniture Plant" (DP/DRK/86/011).

Referring to the project document, the immediate objective is to "train wood technicians and machine operators in the efficient operation of all the machinery and maintenance of tools, so as to manufacture furniture of medium quality", and also to "train managerial staff in overall management techniques including introduction to the marketing of furniture products".

This objective will be achieved through the accomplishment of outputs Nos. 6, 8 and 10.

Output No. 6 states: "20 wood machinists, 10 assemblers and four team leaders trained in the efficient use of the available manufacturing equipment, able to manufacture furniture of medium quality acceptable for export."

Output No. 8 states: "Two wood technicians trained to design and make the required production fixtures aimed at attaining accurate machining of components parts."

And output No. 10 states: "Design of overall factory organization, with established work preparation, cost accounting and management procedures, with managerial staff trained in (a) factory management based on modern industrial production methods and in (b) the basic elements of marketing."

The planned activities of the quoted outputs are:

For output No. 6:

- 6.1 Prepare a training programme for furniture manufacturing.
- 6.2 Prepare a training manual for each of the major production operations.
- 6.3 Train 20 machine operators, 10 assemblers and four team leaders to manufacture furniture of acceptable quality.

For output No. 8:

- 8.1 Train two wood technicians to design, produce and maintain jigs and other furniture production fixtures.

For output No. 10:

- 10.3 Train factory management in modern industrial production methods.
- 10.4 Acquaint the managerial staff with the basic elements of export marketing.

Training labourers is an integral part of production in modern industrial enterprises. Technical and technological developments are offering, practically on a daily basis new products and methods which make human work easier, safer and more productive. To follow such advances, people working in industry have to learn and to train in order to acquire new knowledge and skills necessary for the handling of modern equipment and processes.

In developing countries, such training has a decisive importance for the fuller utilization of new production techniques and for mastering new technological processes. To avoid unnecessary mistakes and to gain indispensable skills, training courses are the most rational mode, because people can learn, in a short time, the best ways of performing their production duties.

## 2. Training programme for the Pilot Furniture Plant

This training programme is designed to meet the specific requirements of the Pilot Furniture Plant. The main topics covered in the programme are:

1. Wood, affiliated products and other materials used in the production of case furniture;
2. Furniture products: design, construction and quality standards;
3. Production organization and work preparation;
4. Panel sizing;
5. Veneer trimming and joining;
6. Veneering;
7. Processing of veneered furniture parts: trimming, tenoning edge banding and drilling;
8. Moulding and routing;
9. Sanding;
10. Finishing;
11. Preassembling, assembling and packaging;
12. Tools, jigs and measuring instruments;
13. Quality control;
14. Safety measures in the furniture production;
15. Management based on modern industrial production methods;
16. Basic elements of marketing.

The main goals of this training are to enable workers, not only to learn how to perform their jobs, but also to understand the industrial production system as a whole.

Courses numbers 1, 2, 3, 12, 13 and 14 are foreseen to be attended by all workers to be trained, while the other courses are intended only for the workers who will perform the respective production operations.

All these courses are independent from one another, but in their totality they represent an integral training programme for the production of casegoods furniture in a medium size factory.

### 3. Methodology of training

There is an old Chinese wisdom which says "What I hear I will forget, what I see I will remember, and what I have done I will know." The output of this training should be knowledge learned by workers who will increase their ability for effective production. To achieve this, the training method will rest on three steps as follows:

1. Explain (to hear),
2. Demonstrate (to see), and
3. Try (to do).

Short manuals, written in a simple language, understandable to the workers, will be prepared for each course, translated into Korean and distributed to the trainees. All graphs, tables and formulae will be adjusted to the level of understanding of the people to be trained.

Theoretical teaching will take place in a classroom and its duration will be adapted to the minimum of theory which has to be known for a certain job. This part of the teaching will be performed by the expert (CTA) and the Chief of the Technical Department in the Pyongyang Wood Processing Complex (PWPC).

The practical part of the training will be organized at work areas for the respective work operations. For that purpose, the work areas must be organized correctly, including production documents, materials, tools, jigs, gauges, pallets, protective devices and everything that is necessary for productive, safe and good quality work. The expert will explain and show how to check a machine, tools, jigs and, in the case of wrong adjustments, how to correct them and prepare the equipment for correct use. The expert will show the correct way of performing operations and continue to supervise these operations until he concludes that proper work is fully accepted and that the quality of production is satisfactory.

The Chief of the Technical Department and other engineers who have undertaken training abroad will also collaborate in performing this practical training. Some practical experience of the trainees will help in the practical part of training.

Course No. 12 (tools, jigs and measuring instruments) should be conducted by the Tool Maintenance Expert.

Course No. 13 (Quality control). The manual prepared during the CTA's first mission can be used.

Courses Nos. 15 and 16 ("Management based on the modern industrial production methods" and "Basic elements of marketing") are foreseen for the managerial staff and will be conducted in a way to initiate discussion and an active participation of the trainees.

4. Selection of trainees

The persons to be trained will be selected by the counterpart, according to their duties and to the topics of the training programme. Besides workers who will directly perform particular production operations, all other people concerned with certain aspects of the production, such as foremen, members of the management, maintenance personnel etc. could be included in the training.

It is recommended that in selecting the trainees attention should be paid that their physical and psychological abilities be in accordance with the requirements of the pertinent jobs.

The list of trainees is an integral part of the training programme, and it determines the number of copies of the training manuals to be prepared and distributed for every course.

5. Training programme

TITLE	TRAINING HOURS	
	Theoretical	Practical
1. Wood, affiliated products and other materials used in the production of case furniture	4.5	1.25
2. Furniture products: design, construction and quality standards.	2.75	0.5
3. Production organization and work preparation	4.75	2
4. Panel sizing operation	2.75	3.5
5. Veneer trimming and joining	2.75	4.5
6. Veneering	5	4.5
7. Processing of veneered furniture parts: trimming, tenoning, edge banding and drilling	4.5	9.25
8. Moulding and routing	2.75	4.75
9. Sanding	0.25	4.75
10. Finishing	4.25	6.75
11. Preassembling, assembling and packaging	4.5	8.5
12. Tools, jigs and measuring instruments	5.75	4
13. Quality control	5	2.5
14. Safety measures and work protection in the furniture industry	5.5	1.25
15. Management of production in a modern industrial factory	10.25	4
16. Basic elements of marketing	5.25	-
GRAND TOTAL	70.50	62.00

Detailed syllabi for each topic are given in Annex II.

ANNEX II

Topic 7: Processing of veneered furniture parts: Trimming, Tenoning, edge banding and drilling.

ITEM	TOPICS	TRAINING TIME (in hours)		LEVEL OF COMPETENCE TO BE REACHED
		Theoretical	Practical	
7.1	Introduction	0.25	-	Understanding the purpose of the course.
7.2	Basic requirements for the trimming and tenoning of veneered furniture parts	0.25	-	Knowledge of the purpose of trimming/tenoning of veneered furniture parts and requirements for precision and quality of cuts.
7.3	Double-side trimming and tenoning machines	0.5	0.5	Knowledge of the construction and working principles of the machine.
7.4	Setting-up the double-side trimming/tenoning machine and its tools	-	1	Ability to set-up the machine and its tools for any required operation.
7.5	Tools for processing veneered furniture parts	0.5	0.5	Knowledge of the types of tools used for the processing of veneered furniture parts, and the tools' parameters.
7.6	Operating instructions for edge trimming/tenoning machines	0.5	1	Ability to operate a double-side trimming/tenoning machine
7.7	Single edge banding machine	0.5	0.5	Knowledge of the single edge banding machine and its working principles.
7.8	Setting up the edge banding machine and the adjustment of its tools	-	1	Ability to set up the machine and its tools for a production operation.
7.9	Hot-melt glue and its preparation for application	0.25	-	Properties of hot-melt glue and its preparation.
7.10	Operating instructions for the edge banding machine	0.5	1	Ability to operate the edge banding machine.
7.11	Multi spindle drilling machine	0.5	0.5	Knowledge of the construction and working principles of the multi-spindle drilling machine
7.12	Setting up of multi-spindle drilling machines and their drilling tools.	-	1	Ability to set up the multi spindle drilling machine and its drilling tools.
7.13	Operating instructions for the multi-spindle drilling machine	0.5	1	Ability to operate the multi-spindle drilling machine

ITEM	TOPICS	TRAINING TIME (in hours)		LEVEL OF COMPETENCE TO BE REACHED
7.14	Control of drilling	-	0.5	Knowledge of the procedures to check the precision of drilling and how to use gauges and other controlling instruments.
7.15	Organization of work area	--	0.25	Understanding the importance of a well organized work area and to know how to prepare the workplace.
7.16	Safety measures	0.25	0.5	Understanding the potential dangers if the machines (double side trimming, single-side edge banding and multi-spindle drilling) are operated incorrectly, and knowledge about safety measures for these machines.
TOTAL		4.50	9.25	