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# ECONOMIC EDGE MACHINING OPERATIONS WITH NEW TOOLING SYSTEMS*

by

U.A. Hartl**

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CONTENT

## Introduction

Tungsten Carbide has become known over the years as a very important factor for the economic processing of wood and wood based materials. The woodworking and plastics industry is absolutely dependent on the cutting material tungsten carbide.

The economic utilization of tungsten carbide tools results in extended longevity and the possibility to sharpen very often, provided the right carbide has been selected for the material to be machined.

Being continuously in touch with the industries leaves many possibilities open for research and development, todays ideas are tomorrows technologies.

## 1. Particle board development

The production of wood based particle board is increasing all the time. Special requirements such as decreasing costs, force the industry to produce many furniture parts plastic laminated instead of veneered. Therefore plastic laminated particle board is showing a rapid growth.

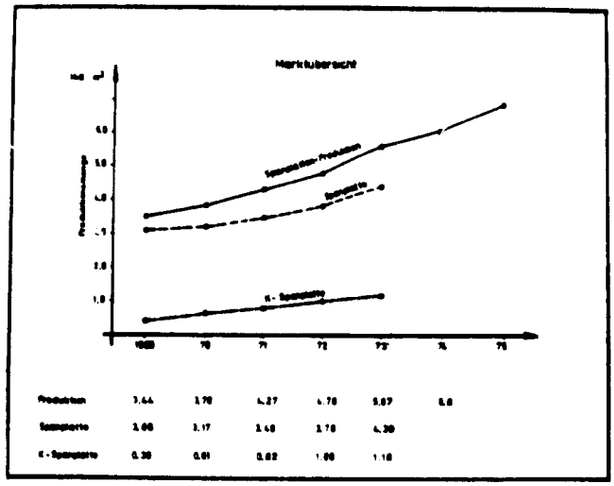


**Fig.1:** Development of particle board production in the Federal Republic of Germany

## 2. Machining properties

Sawblades, trimming hoggers and cutterheads are being used for finish cutting of board materials on double edge sizing machines and combined sizing edge-banding machines.

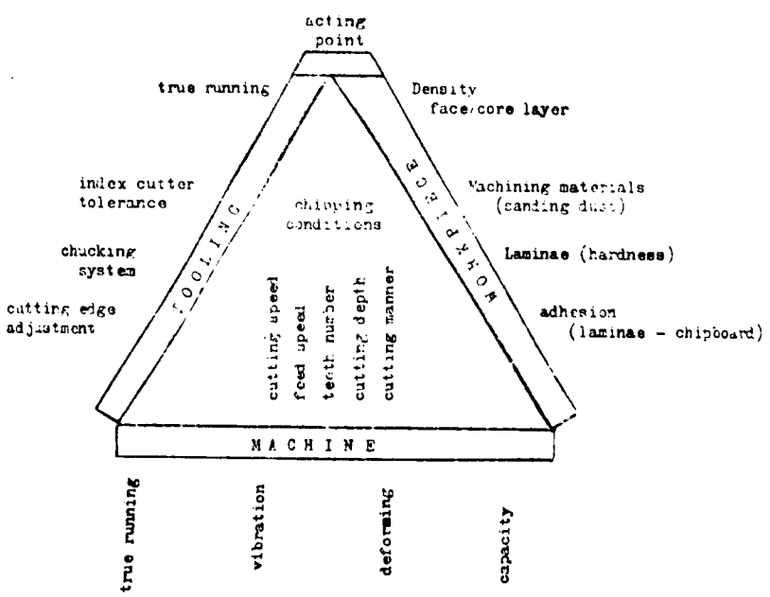
Very important in selecting tools are the cutting properties of the material to be machined:

"For every material the right tool".

| Material | machined by |
|---|---|
| chipboard rough<br>chipboard veneered | circular saw blade<br>hogging cutter |
| chipboard laminated with base coat foil<br>chipboard laminated with paper foil<br>chipboard laminated with PVC foil | on trial cutting decision |
| chipboard filler coated polyester<br>chipboard curtain coated polyester<br>chipboard laminated melamin<br>chipboard covered with laminae | milling cutters |

When different materials have to be machined in one pass, the tools are selected according to the most domirant material.

## 3. The cutting system: Workpiece - Machine - Tooling




Good cutting conditions result by carefully selected material, machine and toolings. The possibilities of each machining operation have to be well-known for evaluation of the cutting results.

| Chipboard | | veneered | laminated |
|---|---|---|---|
| cutting length wise | average feed speed | 40 | 20-25 |
| | max. feed speed | 60 | 40 |
| cross wise | average feed speed | 15-20 | 15-20 |
| | max. feed speed | 25 | |

Feed speed analyse in meter per minute.

## The Machine

### 3.1 Feed

All machines have to be used to an optimum, especially in linked systems.
Length and width of the workpieces are the criteria to fully utilize the sequencing machine.

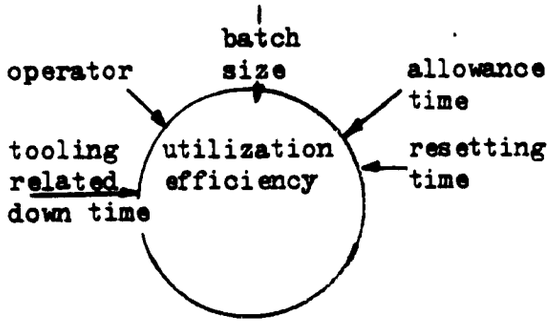
Veneered furniture parts (bedrooms, doors and bed sides) are mostly rectangular, whereas plastic laminated parts (kitchen cabinet sides and fronts) are nearly square. Machining veneered boards, the second machine has to run faster than the first.

Machining plastic laminated boards both machines run at the same feed speed.

### 3.2 Spindle Speed/rpm

On standard double-end machines and combined sizing/edge banding machines the spindle speed variation is performed by frequency changers.

| Frequency | rpm |
|---|---|
| 50 hz | 3.000 rpm |
| 100 hz | 6.000 rpm |




Influences to the utilization factor

### 3.3 Utilization efficiency

It is necessary to use the full capaoities of machines and toolings in order to work economically.
With right toolings down times for tooling exchange can be reduced to a minimum.

Progressive tool manufacturers have done a lot in research to minimize or eliminate down times.

Following advantages resulted in the development of:

- quick-changing systems for sawblades and trimming hoggers;
- cutter systems with re-adjustable knives in operation;
- quick-changing systems and combination chucks for boring machines.

## 3.4 Requirements on working conditions

The humanisation of working conditions are added to todays requirements, besides all requirements concerning quality.

Therefore all manufacturers of machines and toolings are supporting this demand of the woodworking industries.

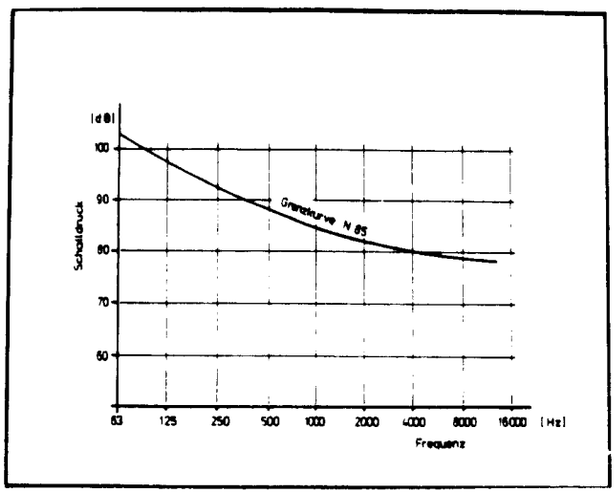



Fig.2: Noise load limit N 85 according to ISO standard.

The ISO standard limit N 85 shows the maximum noise level a worker is allowed to face in an eight hours day. Therefore the N 85 limit is considered in all noise reduction attempts.

For noise reduction on sizing machines the following possibilities can be considered:

Noise reduction by secondary measures:

- enclosed machinery
- enclosed motors
- insulation of machine, building, etc.

Noise reduction by primary measures:

- reduction of noise source
- low noise tooling
- low noise motors

## 4. Machining processes

### 4.1 Milling cutters (moulding, matching, etc.)

Cutting against the feed director is the best way of cutting particle board on finish sizing machines.

Advantage of cutting against the feed - upmilling machining

- better chipping of the core layer material;
- better results on edged finish;
- longevity

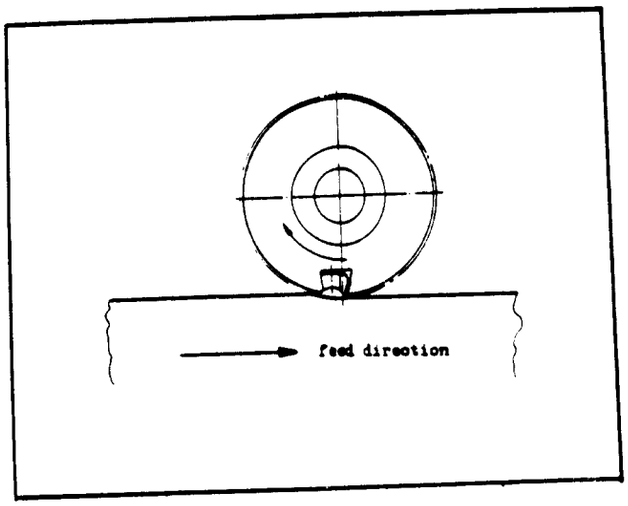



Fig.3: Upmilling machining

### Trimming hogger and scoring saw

Cutting with the feed gives the best results in using scoring saws and trimming hoggers.

Advantage of cutting with the feed - down milling machining:

- every tool determines the finish of its entering angle;
- cutting pressure towards centre of board;
- standard tooth shape - flat tooth;
- best operating conditions
- cost/longevity

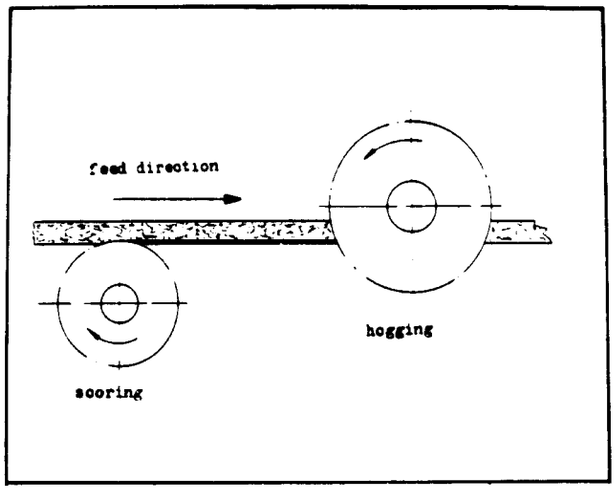



Fig.4: Down milling machining

4.11 Cutting tool and number of teeth

In view of the cutting quality, the number of teeth on cutters are based on the "center chip gage" "hm".

| Requirements on cutting surface quality | hm-value for milling mm |
|---|---|
| rough | 0.16 - 0.20 |
| average | 0.12 - 0.15 |
| fine | 0.08 - 0.10 |

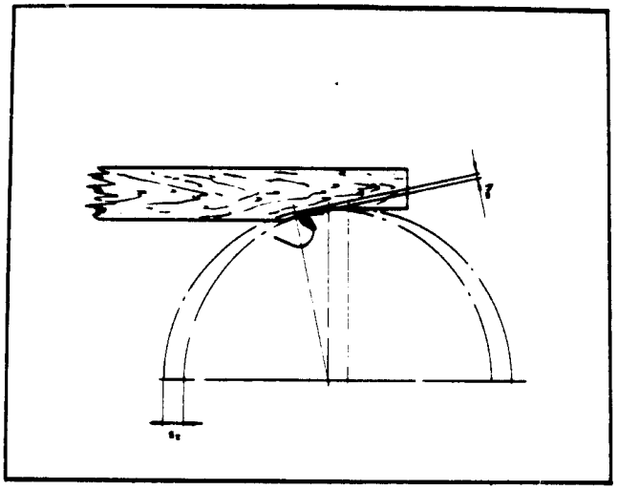


Fig.5: Determination of the center chip gage "hm"

The following numbers of teeth are necessary on cutters of 180-220 mm diameter for sizing plastic laminated particle board by 1 - 2 mm cutting depth:

| feed speed m/min | number of teeth (milling) n = 3000 U/min | n = 6 000 U/min |
|---|---|---|
| 5 | 1 | 1 |
| 10 | 2 | |
| 15 | 3 | 2 |
| 20 | 4 | |
| 25 | 5 | 3 |
| 30 | 6 | |
| 35 | 7 | 4 |
| 40 | 8 | |

Fig.6: Determination of teeth number of milling cutters

4.12 Sawblade and number of teeth

The same as on milling cutters, the number of teeth is based on the "medium center chip gage" "hm".

The "hm" can only be influenced by the saw diameter, cutting depth, feed speed and number of teeth.

The rpm "n" is tuned to the optimum cutting speed "v".

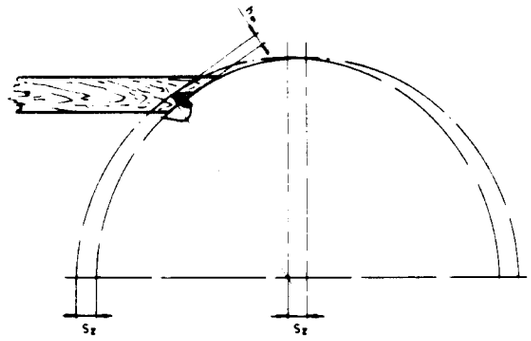



Fig.7: Determination of feed way per tooth "Sz".

The determination of the number of teeth is based on "Sz" which means feed way per tooth.

| Material | Sz-values/mm |
|---|---|
| Laminated board | 0.03 - 0.55 |
| Thin sensitive veneers on substrates or chipboard with low strength | 0.05 - 0.08 |
| Veneered chipboard, block board, or hardboard | 0.07 - 0.10 |
| Partiole board | 0.06 - 0.12 |

Experience values "Sz" for saw blades

4.2 Cutting speed

The cutting speed has to be tuned to the material to be machined. The cutting speed in rpm and the tool diameter is the basis for calculating the best cutting conditions. The rpm can vary from 3.000 to 6.000 rpm on most double-end tenoning machines and combined sizing double edge banding machines.

| | Material | cutting speed "V" m/sec |
|---|---|---|
| soft ↑ | Chipboard | 45-70 |
| | Blockboard | 35-50 |
| | Densified laminated board | 30-60 |
| ↓ hard | Laminated board | |

Optimum cutting speed

Optimum cutting speed as prerequisite for:

- quality edge finish
- optimum hogging of core layer
- cutting longevity = reduced costs

Exceeding optimum cutting speed resulting in decreased longevity.

Falling below optimum cutting speed resulting in low edge finish quality

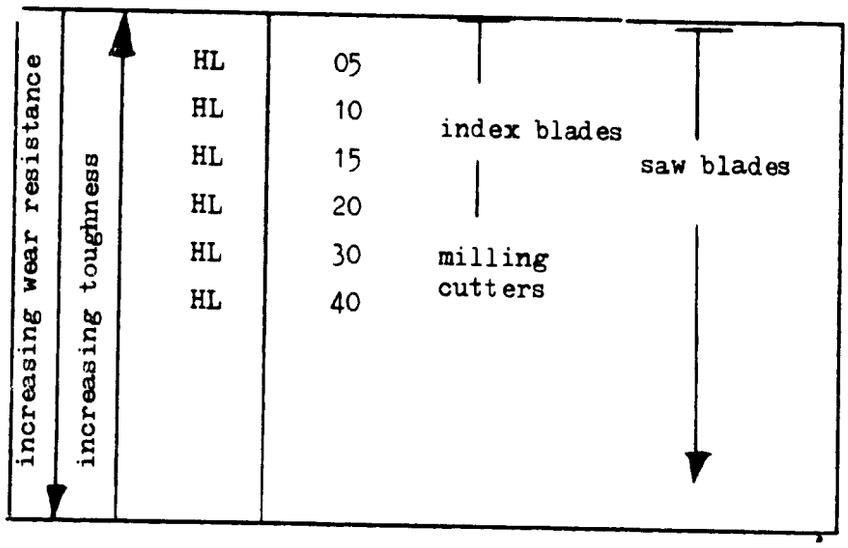
Deviation above or below optimum cutting speed resulting in increased costs.

## 5. Selection of cutting material

Tungsten carbide.

Tuning the material to be cut, the machine and the tooling, the selection of proper cutting material, is of importance.

It is always an advantage when a tool manufacturer also manufactures tungsten carbide himself. In that way he can always select the specific carbide grade for the material to be machined.




LEUCODUR * - Carbide grades

* Grade classification of LEUCO-carbides in relation to ISO standards for wood and plastic machining.

## 6. Milling sequences

### 6.1 Pre-hogging

Pre-hogging is necessary wherever wood-based boards have to be sized. Scoring, hogging the edges and sizing is done in one pass.

The trimming hogger with the sizing saw is machining and hogging the board to accurate size.

Sizing of laminated boards can be done by pre-hogging and sizing as tight as 1 mm to the finish size by a second unit chipping the excess of 1 mm.

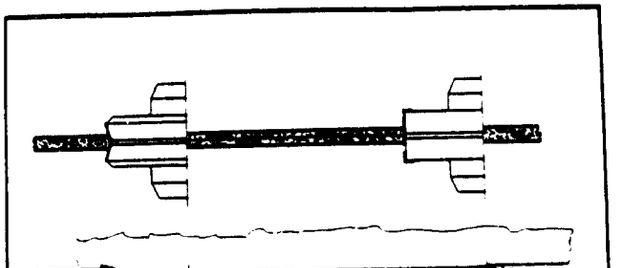


Fig.8: Pre-hogging and finish sizing in one pass

**Advantages:**

Just 1 mm cutting depth is adjusted for finishing laminated board. High edge finish quality , longevity of cutting tool, reduced noise.

Trimming hoggers with automatic adjustment will be used when more than 10 mm edge width will be machined.

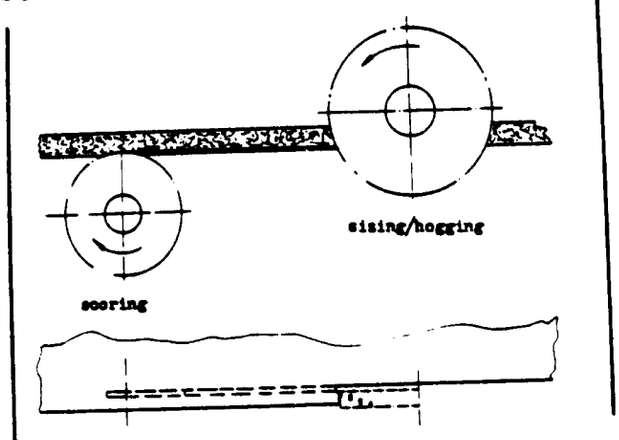



Fig.9: Finish sizing/hogging on rough chipboards

## 6.2 Finish machining

### 6.21 Rough particle board

Sizing of particle boards will be done by machining with scoring saws and hoggers by down milling operations. The optimum quality will be achieved by shaped teeth on:

| | | |
|---|---|---|
| Saw diameter | = | 200–250 mm |
| RPM | = | 6.000 |
| Hogging width, max. | = | 72 mm |
| Machining operation | = | down milling |

### 6.22 Plastic laminated particle boards

Because of the plastic laminae homogenity the boards will be machined with jointing heads of centerline parallel cutting edges.

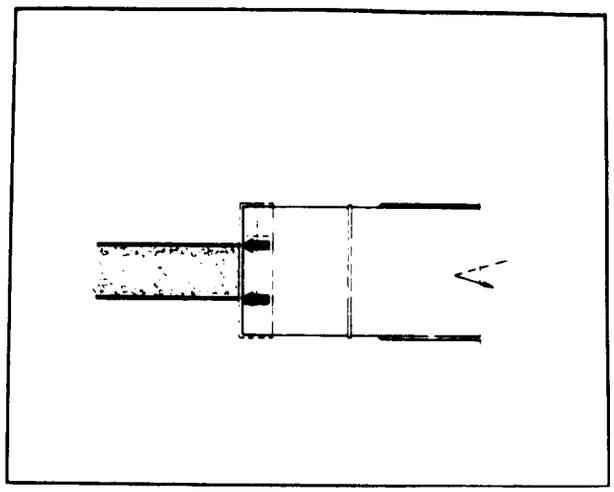


Fig.10 : Double side duroplastic laminated particle board.

6.23 Direct laminated particle board
(Melamin faced, etc.)

Edge tearing is very common on melamin-faced boards, due to the very thin layer. To achieve good edge quality, saws with helically shaped teeth have to be used.

The cutting force is directed to the centre of the boards.

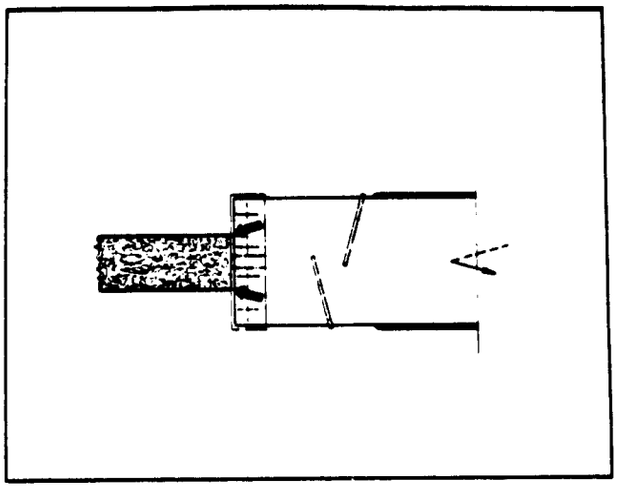


Fig.11: Laminated particle board
(K-type chipboard)

Herring bone knife cutters with indexed throw-away knives of various tooling head designs.

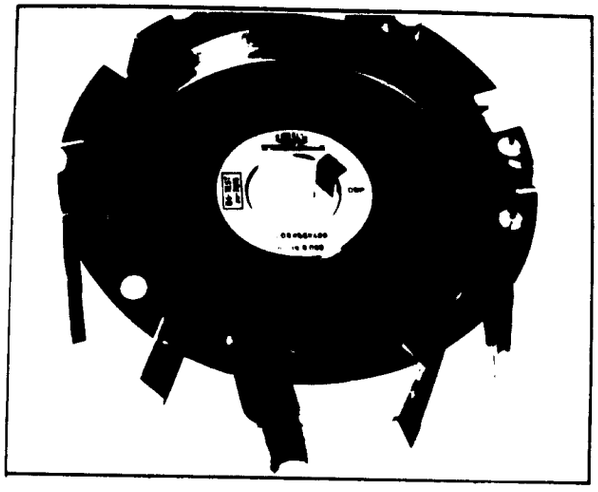


Fig.12: Solid jointing head with indexed knives

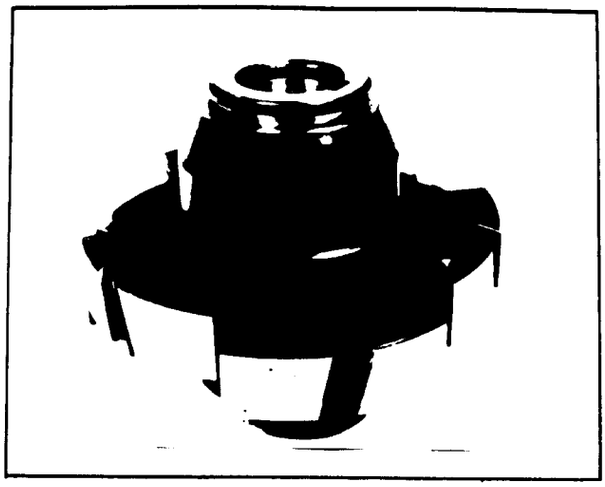


Fig.13: Twopart adjustable jointing head (synchronously adjustable)

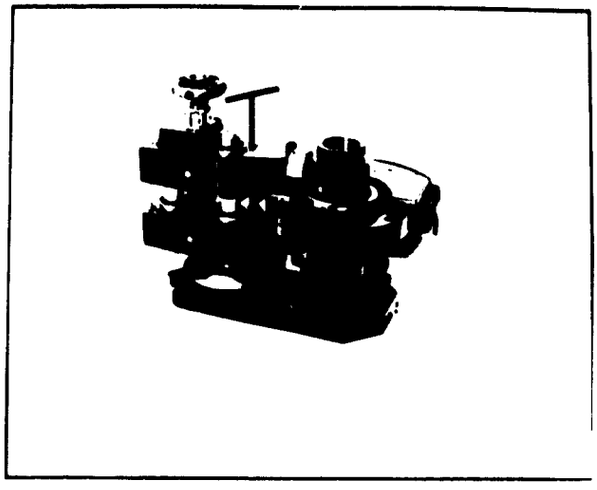


Fig.14: K-System jointing head manually adjustable

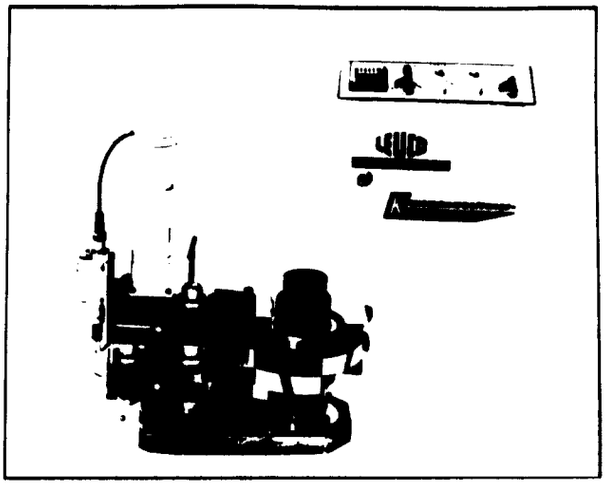


Fig.15: K-System jointing head automatically adjustable

In cost considerations one of these jointing heads should be applied.

Data

| | | |
|---|---|---|
| Spindle speed, rpm | = | 3.000/6.000 |
| Number of teeth, Z | = | 2 x 3/2 x 4 |
| Saw blade, diameter, mm | = | 180/200 |
| Cutting direction | = | up milling |

Best edge quality is achieved at optimum hogging of the core layer.

## 7. Cutterhead systems

### 7.1 Pre-trimming cutterhead

The indexed two way knife cutterhead for pre-trimming is a universal tool for machining laminated particle boards.

The tool can be synchronously adjusted manually at still stand of motor.

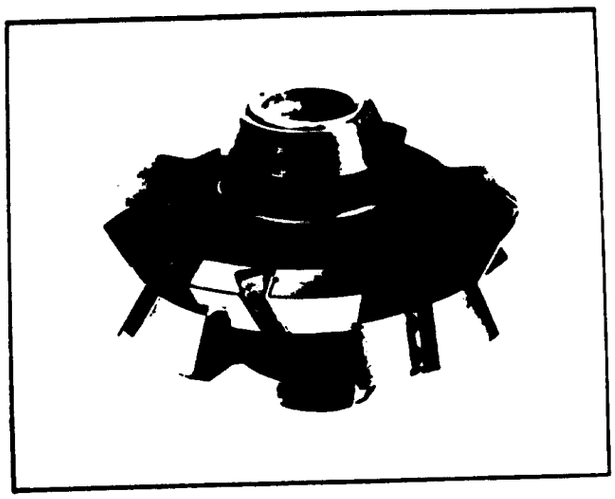


Fig.17: Width adjustable pre-trimming cutterhead

After width adjustment the motor has to be re-adjusted in relation to the feed chain:

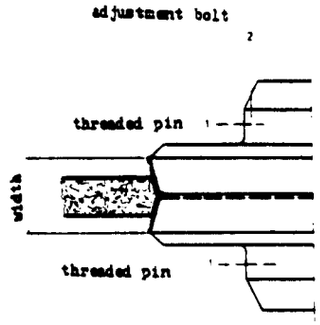



Fig.16: Pre-trimming synchronously adjustable two part cutter head

This cutterhead can cut up to 10 mm width and get as close as 1 mm to the finish size.

1. Loosening the threaded pin
2. Axial re-adjustment of tool parts one turn of wrench equals 3 mm width adjustment
3. re-tighten threaded pin
4. motor re-adjustment according to table
5. re-adjustment of motor

If the finishing cutter has only 1 mm to cut a very high quality and cutter longevity is the result. The pre-trimming head is cutting at an angle of 14° resulting a V-shaped edge. Depending on the thickness of the melamin up to 16 adjustments are possible.

## 7.2 Finishing cutter head

The finishing cutter with its indexed (turnover) knives is a special tool for finish cutting of melamin-faced particleboard, based on the same principle as the pre-trimming cutter head.

The synchronous adjustment is done manually at stillstand of the machine.

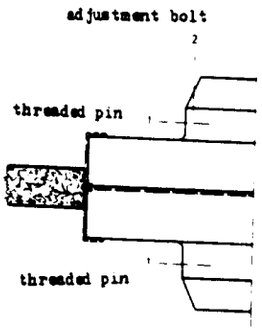



Fig.18: Width adjustment of finishing cutter head

The width adjustment of this finishing cutterhead follows into each other:

1. Loosening the threaded pin
2. Adjustment into each other one wrench turn equals 3 mm width
3. Re-tighten threaded pin

The finishing cutter performs a straight joint edge with an optimum finish after pre-trimming. Adjusting the knives to each other the cutting edge is always straight by the synchronious adjustment of the two cutter parts.
The re-adjustment is approx. 0.8 mm. 7 re-adjustments of the indexed knife can be achieved when machining 16 mm thick particle board. Each set of cutters provides a maximum of 28 adjustments depending on the thickness of the board.

## 7.3 Edge finishing system

The edge finishing system for melamin-faced particle board operates fully automatically.

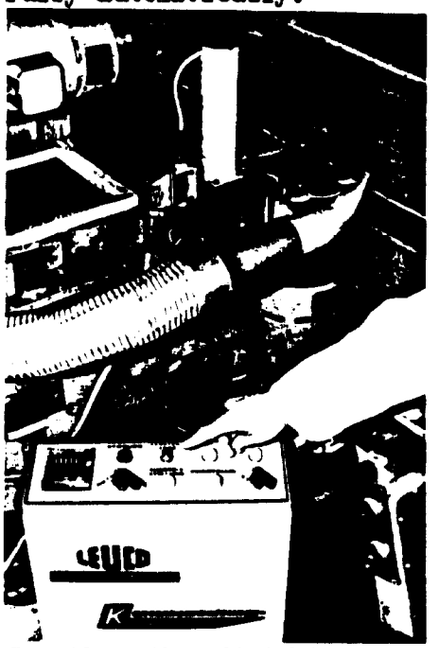


Fig.19: Edge finishing system

The spare cutterhead will be set on to the motorshaft, bolted and re-tightened.

After wearing down of the cutting edge a yellow light signals "re-adjustment" and the arms return automatically into zero position.

The adjusting arms are being moved away from the cutterheads and the worn cutterhead can be replaced.

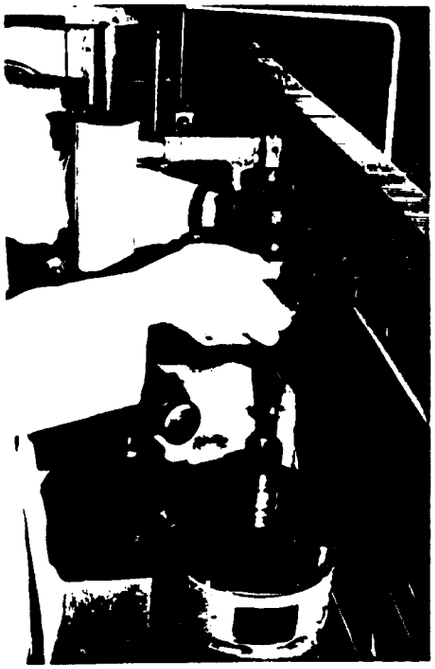


Fig.20: Replacement of cutterhead

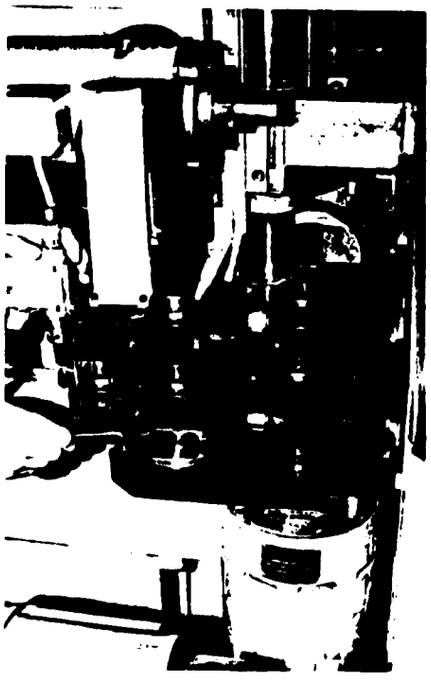


Fig.21: The tracing arms are moved into position for re-adjustment.

Fig.22:
The cutter parts will now be adjusted to the supporting rollers.

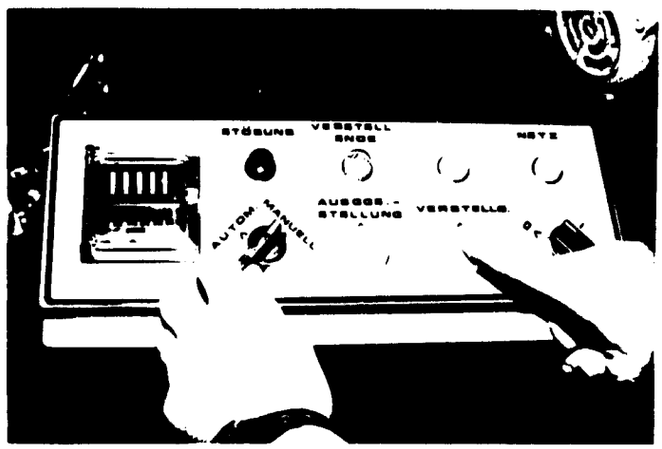



Fig.23: Tool controls

The 2 parts of the cutter head are tightened together via controls and remain in this position, while the support rollers return to zero position.

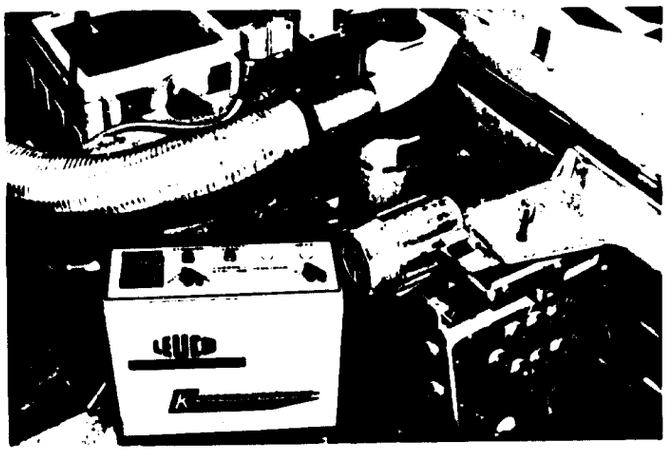


Fig.24: Close up view of tool controls

The switch on the control panel is released to "automatic" and the change of the cutting edges into a new cutting position follows automatically into the final position. The yellow light signals the re-adjustments.

Pre-selecting the board meter capacity

The pre-selected board meter capacity is based on the particle board quality and the machine. The meter capacity value is based on experience data. The meter dial is set to maximum meter value. As soon as the edge quality is not any more satisfactory, stop machining and take meter reading.

The pre-selected value is set in such a way that the re-adjustment is executed before the edge quality becomes unsatisfactory.

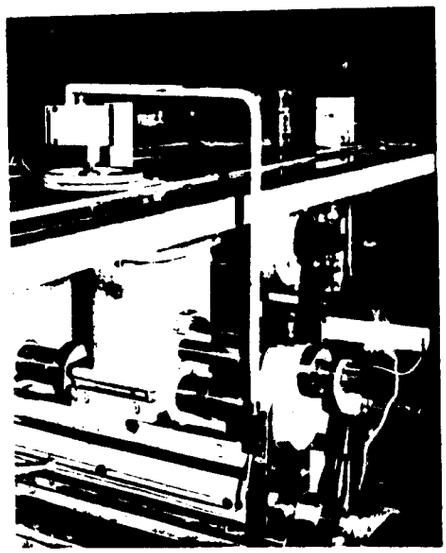


Fig.25: Metering by impulse transmitter

All standard double edge sizing and combined sizing/edge banding machines can be equipped with the Edge trim tooling system without any change on the machines.

This means, even older machines can be updated to the latest technology.

7.4 Quick-tool-clamping system

Double edge sizing machines, combine sizing/edge banding machines as well as special machines and can be equipped with the quick-tool-clamping-system for scoring and trimming hogger units.

The quick-clamping unit for trimming hoggers consists of a clamping flange mounted on the motor spindle and a hogging part with trimming saw which are exchangeable parts.

Clamping and fastening of the hogging part is achieved by a bayonet lock. The clamping elements are permanently locked and are only released via valves by compressed air for the time of tool changing.

Up to now all trimming hoggers had to be changed as complete units. This means the hogging part including the take-off bushings have to be removed. Now only the hogging part has to be taken off.

Further features of the clamping part being stationary on the motor spindle are the accurate balancing, the true axial running and the low noise.

Advantages of the quick-clamping-system

Quick tool change at short down times.
No positioning of tools after changing, as the motor remains always in its working position.

Trouble free change of tools, no force on to the motor spindle.
Tool changing without hammers, spanners or wrenches.

Tool body remains permanent on motor spindle, therefore accurate balancing, smooth running and true axial running.

The robust tool construction has proven long service life.
Less weight for changing of tools.
Handling of the system without problems and free of maintenance.

Quick-clamping-system

Scoring Saw

The clamping part for scoring remains on the motor shaft. The machines can be equipped with various tooling bodies for different machining operations within very short time.

Flange for scoring saw (basic component)

..... scoring and

..... grooving

Gauge 2 - 2.2 mm other gauges of blade, see below

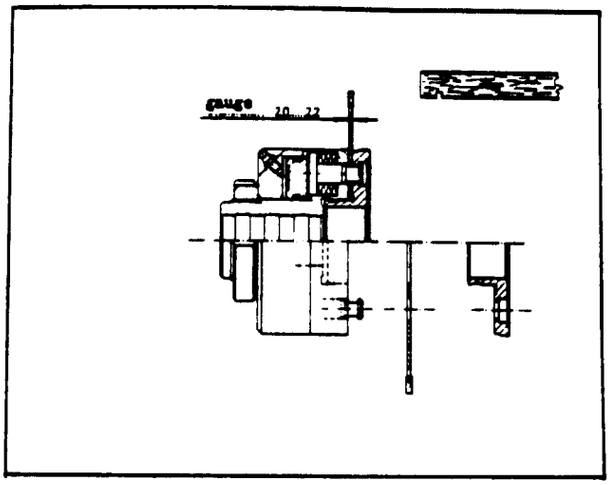



Fig.26: Quick-clamping system for scoring saw

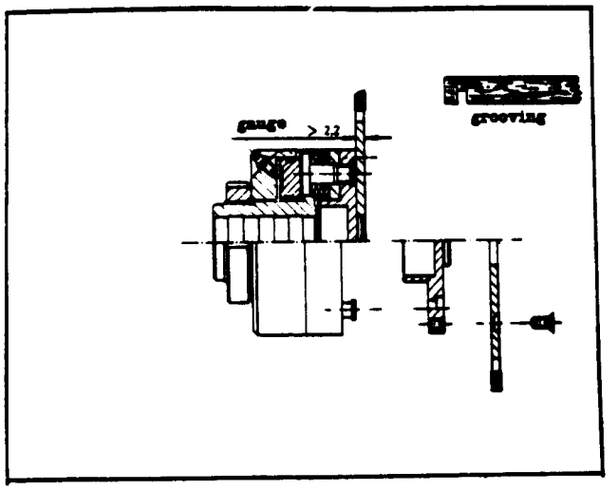



Fig.27: Quick-clamping system for grooving saw

Blade gauge more than 2.2mm on special flange.

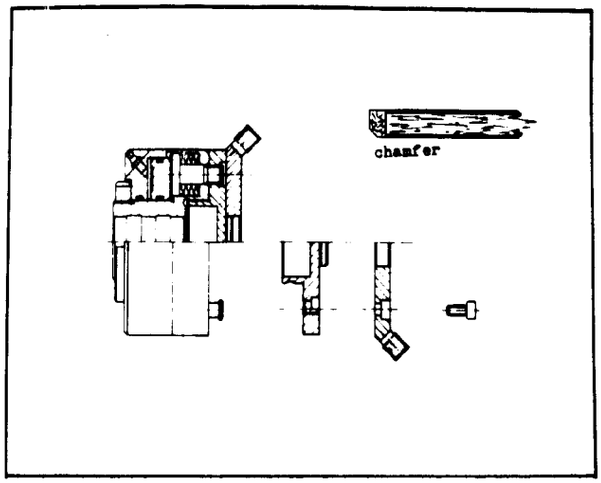



Fig.28: Flange with chamfering disc

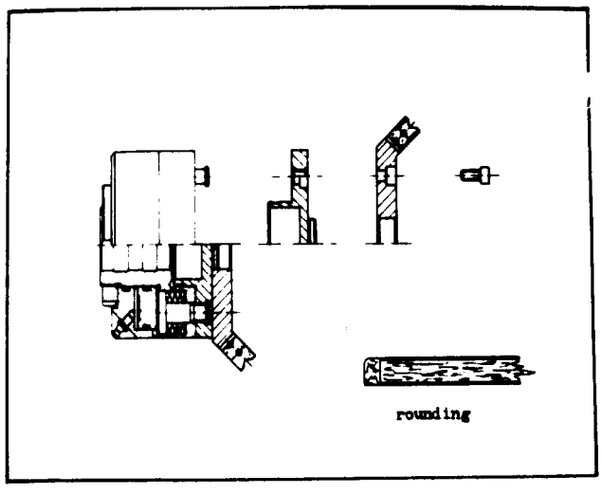



Fig.29: Special flange with rounding disc with indexed knives

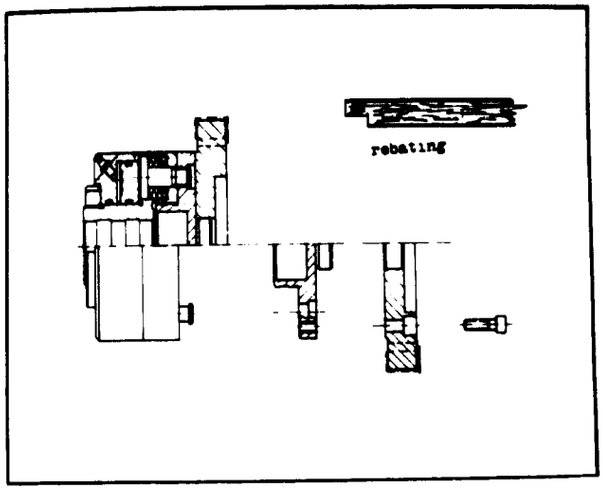



Fig.30: Special flange with rebating disc

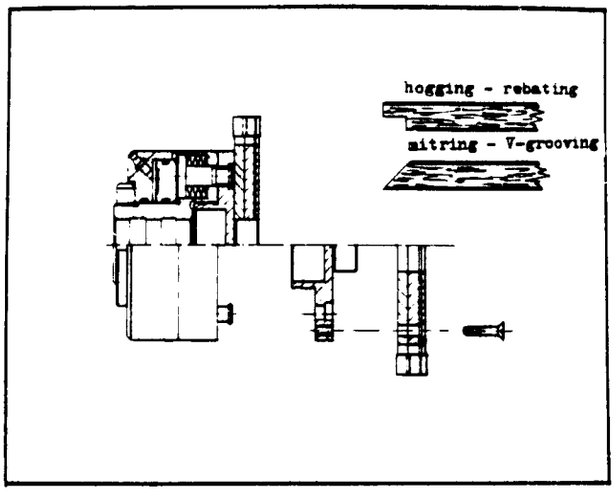



Fig.31: Special flange with staggered saw-grooving cutter (mini-hogger also used as V-grooving cutter).

Clamping part - trimming hogger

The clamping part of the trimming hogger remains on the motor shaft. The machines can be equipped with various tool bodies for different machining processes within very short time.

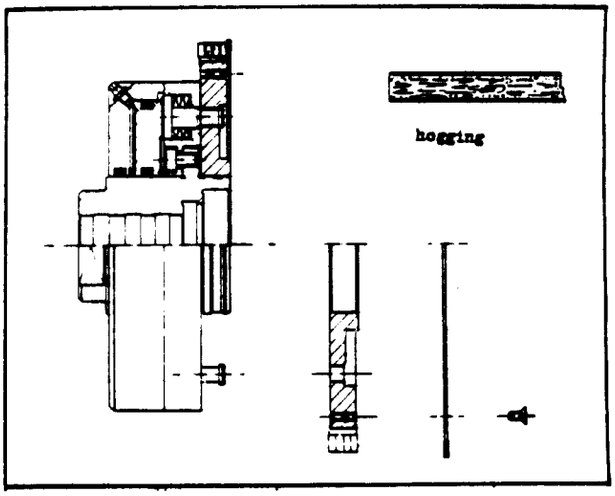



Fig.32: Clamping Part - Hogging (basic component)

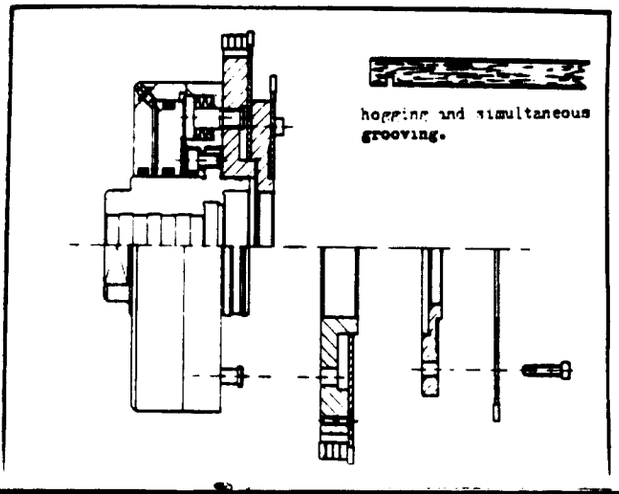



Fig.33: Special hogging unit with flanged groover

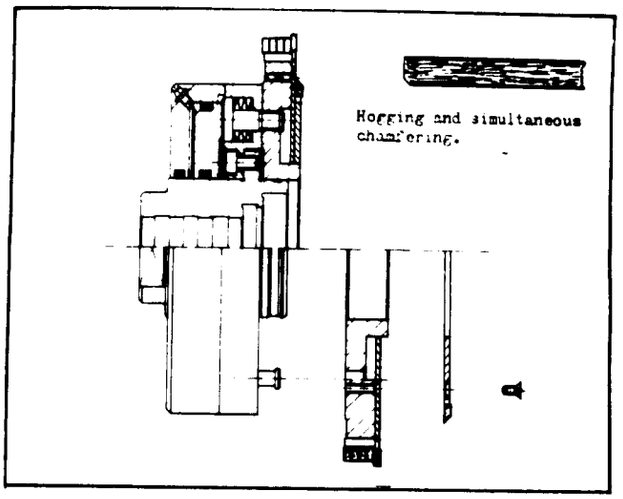



Fig.34: Special hogging unit with flanged chamfering tool

Fig.35: Special flange with grooving and chamfering sawblade.

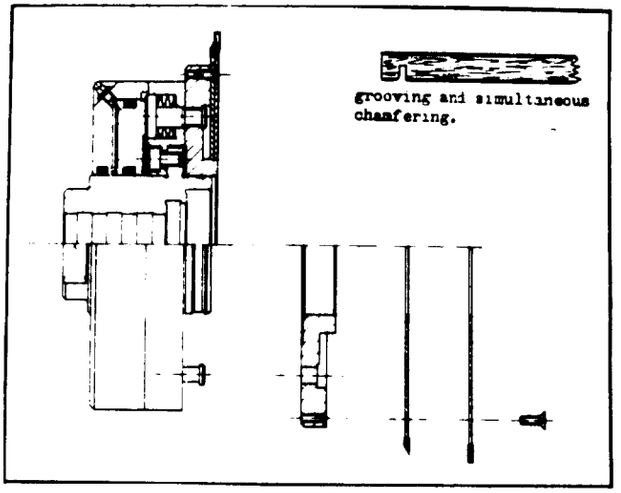



Fig.36: Hogging part for V-grooving

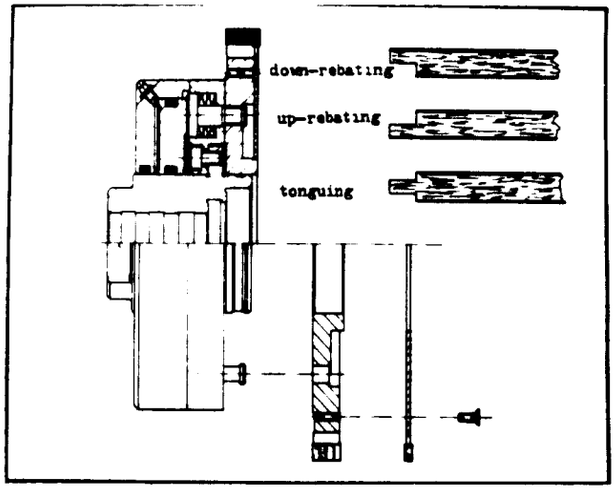
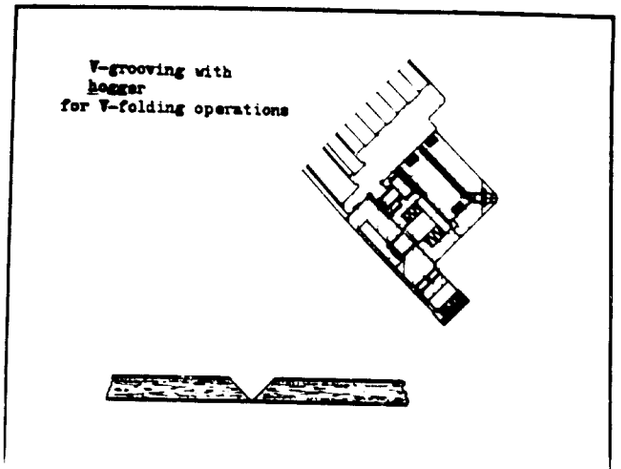



Fig.37: V-grooving with hogger for V-folding operations



## 8. Propositions for tooling up machines

The use of these tools is today possible on all machines for machining boards double edge banded already. They are quipped with jumping scoring motors or with standard motor units for finish cutting.

The appropriate sequence of the motor units depends on the type of machine. All toolings required are standard toolings, on stock.

Fig.38: Tooling sequence single edge banding

1. pre-milling left upmilling
2. pre-milling right upmilling
3. finish milling left upmilling
4. finish milling right upmilling
5. pre-milling right upmilling
6. premilling left upmilling
7. finish milling right upmilling
8. finish milling left upmilling

finished part with 3 edge banded rims

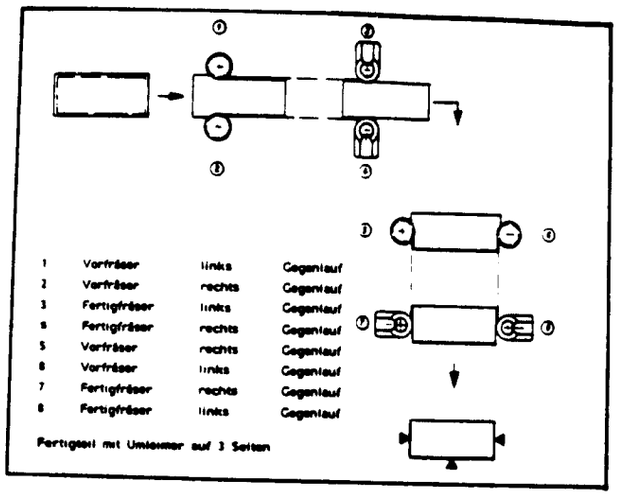
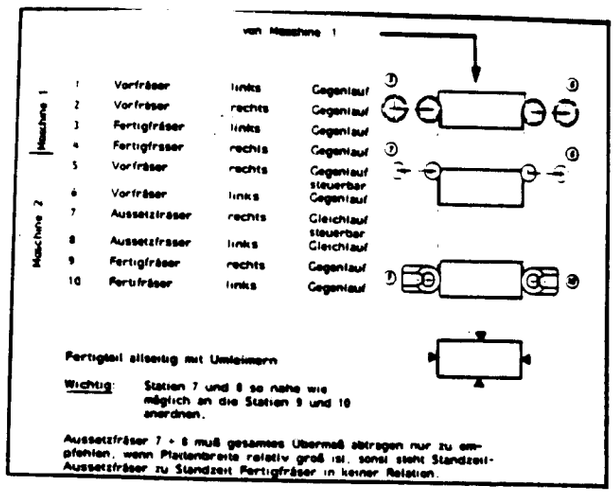



Fig.39: Tooling sequence double edge banding second machine

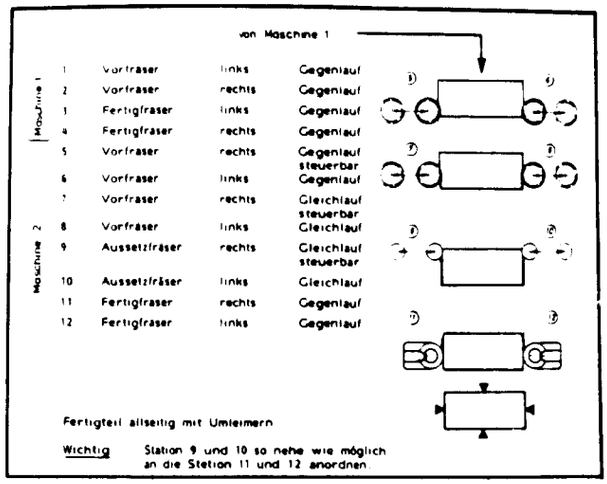
1. pre-milling left upmilling
2. pre-milling right upmilling
3. finish milling left upmilling
4. finish milling right upmilling
5. pre-milling right upmilling
6. pre-milling left upmilling
7. jump milling right downmilling controlled
8. jump milling left downmilling
9. finish milling right upmilling
10. finish milling left upmilling

finished part four edge banded rims




Note: Arrange unit 7 and 8 as close as possible to unit 9 and 10. Jump milling cutter has to machine full oversize can be recommended only when the board width is relatively large, otherwise longevity of jumpmilling cutter is not tuned to longevity of finish milling cutter.

Fig.40: Tooling sequence
double edge banding second machine

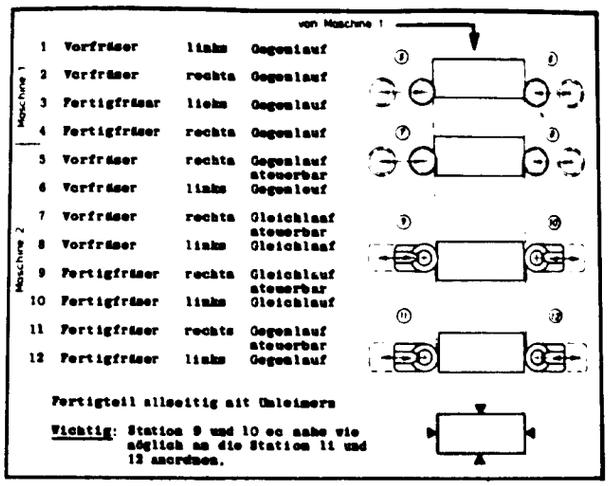



1. pre-milling left upmilling
2. pre-milling right upmilling
3. finish milling left upmilling
4. finish milling right upmilling
5. pre-milling right upmilling controlled
6. pre-milling left upmilling
7. pre-milling right downmilling controlled
8. pre-milling left downmilling
9. jump milling right downmilling controlled
10. jump milling left down milling
11. finish milling right upmilling
12. finish milling left upmilling

finished part four edge banded rim

Note: Arrange unit 9 and 10 as close as possible to unit 11 and 12

Fig.41: Tooling sequence
double edge banding
second machine




1. pre-milling left upmilling
2. pre-milling right upmilling
3. finish milling left upmilling
4. finish milling right upmilling
5. pre-milling right upmilling controlled
6. pre-milling left upmilling
7. pre-milling right downmilling controlled
8. pre-milling left downmilling
9. finish milling right downmilling controlled
10. finish milling left downmilling
11. finish milling right upmilling controlled
12. finish milling left upmilling

finished part four edge banded rim.

Note: Arrange unit 9 and 10 as close as possible to unit 11 and 12.

Tools for pre-trimming and finishing

| OPERATION | MATERIAL | TOOLING | REMARK |
|---|---|---|---|
| Pre-trimming | melamin-faced particle board | pre-trimming cutter teeth = 2 x 4 | - synchroniously adjustable with chamfer<br>- pre-trimming and chamfering<br>- universal use<br>- high feed rates<br>- minimum down time<br>- full utilization of turnover knives<br>- numerous cutting positions |
| Pre-trimming and finishing | rough particle board<br><br>melamin-faced particle board | scoring saw and mini-hogger | - universal tool for all wood based materials<br>- high quality at low power consumption<br>- pre-trimming and finishing<br>- hogging width up to 72 mm<br>- high feed rates<br>- process approved in application many years |
| Pre-trimming and finishing | rough particle board | quick-clamping system for scoring and hogging | - universal tool for all wood based materials<br>- high quality at low power consumption<br>- pre-trimming and finishing<br>- high feed rates<br>- hogging design approved many years<br>- minimum down time by tool design |
| Finishing | plastic laminated particle board | jointing cutter knife edge paralell to ℄<br>Teeth = 2 or 4 | - ideal tool for plastic laminated boards<br>- limited use for melamin-faced boards<br>- number of teeth in relation to feed rate<br>- cutting force rectangular to tool axis |
| Finishing | melamin-faced particle board | herring bone knife jointing<br>Teeth = 2 x 2<br>or 2 x 3 | - optimum tool for melamin-faced boards<br>- divided cutting pressure<br>- drawing cutting directed to center of board<br>- extremely good edge finish |
| Finishing | melamin-faced particle board | synchronously jointing adjustable cutter<br>Teeth = 2 x 3<br>or 2 x 4 | - double part tooling<br>- synchronously adjustable<br>- full utilization of indexed (turnover) knives (up to 28 cutting positions)<br>- re-adjustable cutting edge in operation |
| Finishing | melamin-faced | edge-finishing system manually adjustable | - adjustable during operation<br>- adjusting on one spindle only<br>- numerous cutting positions<br>- synchronously adjustable<br>- full utilization of machine capacity |
| Finishing | melamin-faced | edge-finishing system automatically | - minimum down times for changing tools<br>- automatic adjustment during operation<br>- not dependent on machine operators |

## Possibilities of tooling combined machines

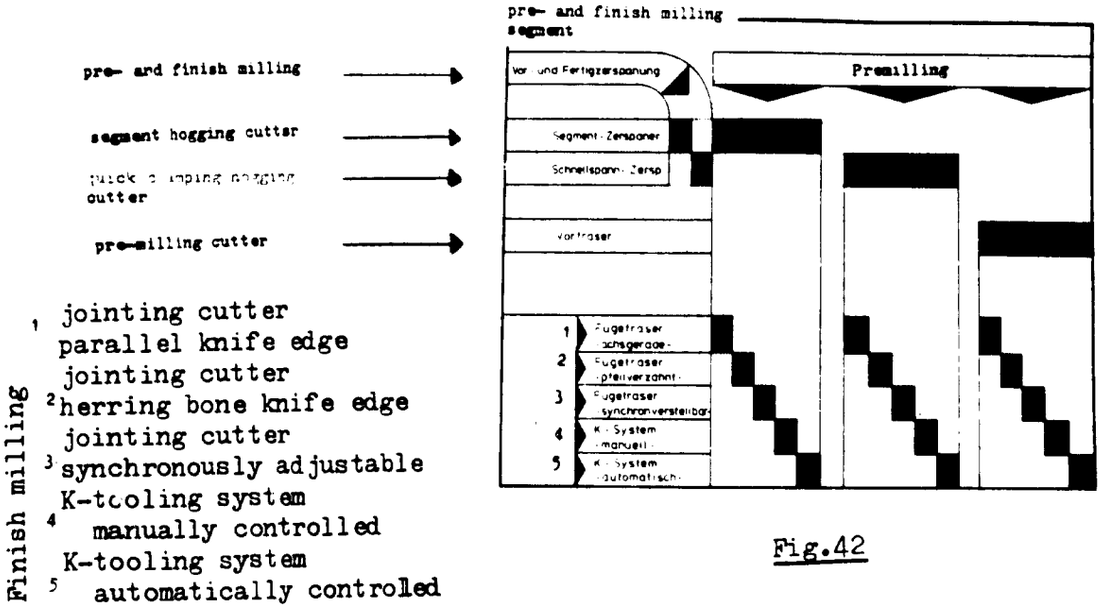



Fig.42

In adjusting the toolings and machining processes an optimum tuning can be achieved for the material to be cut and the machining operations.

With the aforementioned, it has been tried to give a small insight into the wide spectrum of edge trimming and finishing.

The rapid development in the field of edge machining and the permanent requirement of automatedoperations force the machine and tool manufacturers to keep up-to-date with improved technologies.

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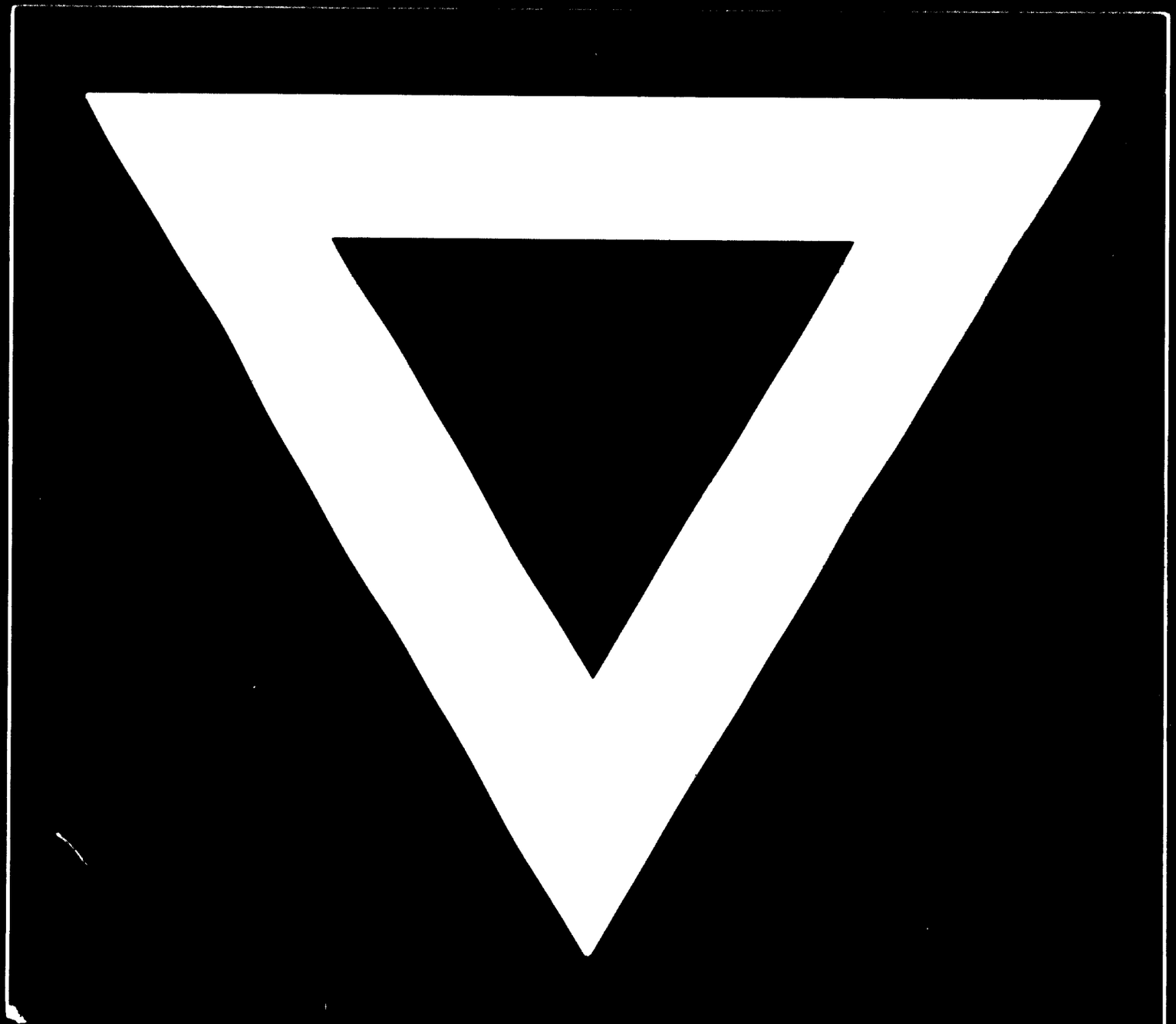

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