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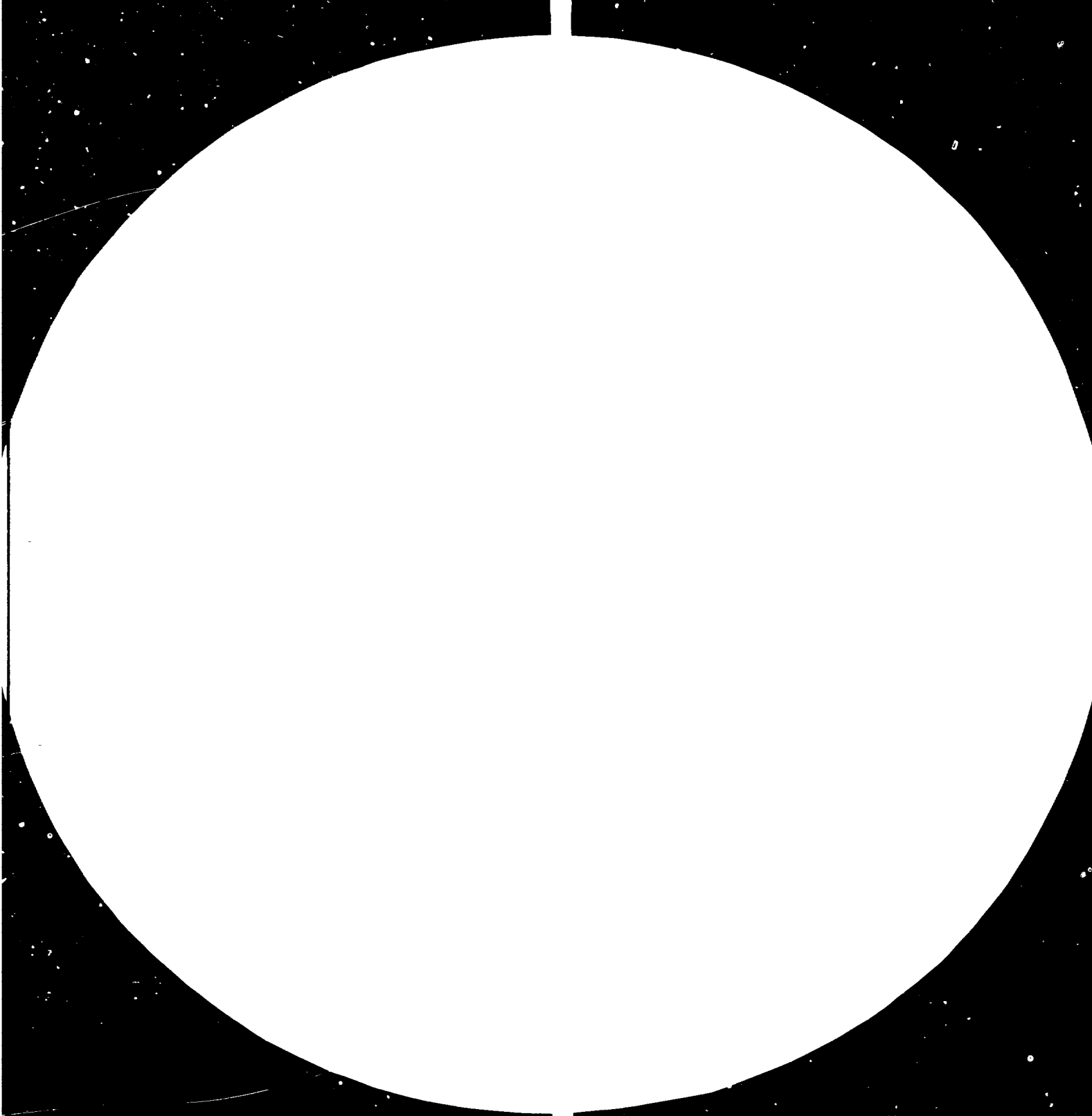
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Seminar on Economic Criteria for the Selection
of Woodworking Machinery and Plant Systems

Hannover, Federal Republic of Germany, 19 May - 2 June 1981

APPROPRIATE TECHNOLOGY IN PENCIL PRODUCTION
FOR DEVELOPING COUNTRIES *

by

Edgar Gössel **

001022

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1. Introduction

The main components of wood-cased pencils, generally known as graphite pencils or colour pencils, are:

- A. Soft, fine-porous wood.
- B. Leads in 19 degrees of hardness and of various colours.

These two components have to be pre-manufactured so that in their quality and their dimensions they are suitable for the

C. Pencil production.

A new modern pencil factory mainly concentrates upon the pencil production as per "C", using bought quality slats and bought quality leads.

After some years when a certain market share is built up a slat and lead production alone can be envisaged without risk.

A. Slat Production

All over the world Californian cedar is used for pencil production. The Californian cedar slats, the dimensions of which are within a certain, narrow range of tolerance, are treated with chemicals that the wood which by nature has an unequal grain becomes as homogeneous as possible. For example the wood is steamed, coloured, wax-impregnated and brought to a uniform moisture of 6 - 8 per cent.

Slat making is a special branch which requires some experience. When a new pencil production is set up the slats are first bought ready for use from specialized factories.

It is of importance not to neglect a future slat production of one's own when planning a pencil factory as there are further species suitable for pencil making, such as the alder, lime, weymouth pine, jelutong, stone-pine and others.

For new projects, especially for plants to be established in developing countries machines should be used only to machine species of wood suitable for pencil making.

B. Lead Production

The raw material for the manufacture of graphite lead (for graphite pencils) is above all graphite and pure clay.

The main components of colour lead (for colour pencils) are:

- Clay, (China clay to a certain limit);
- Talc (=French chalk), calcium stearate;
- Pigments, binding agents, wax and stearin.

The formulas depend on the characteristics of the raw material and are based on experiments carried out by chemists.

A certain production size only (of about 2000 gross in 8 hours) justifies the lead production.

In developing countries lead making should be excluded in the initial stage, since the production needs considerable experience. At present leads can be purchased at favourable prices however.

The future planning of a lead production should include considerations of manufacturing marking chalk, wax crayons and cosmetic leads which require only some additional machining units. Thus, a higher utilization of the lead making machinery will be maintained.

C. Pencil Production

For the production of pencils pre-manufactured slats and leads are used. The machine set up and operation of the pencil making machines should be maintained by skilled personnel such as a mechanical engineer, a foreman, as well as semi-skilled labourers.

When selecting the production machines one has especially to consider the labour costs. For developing countries and that is the result of a feasibility study based on modern individual machines and not on fully automatic production lines.

Fully-Automatic Production Lines always require a high amount of investment. The number of semi-skilled workers to be employed is low; on the other hand engineers and technicians with high salaries for supervision and maintenance are necessary (although often not available even in industrialized countries).

One has to have in mind that an operating trouble of one machine will stop the whole production line.

Modern Individual Machines (automatic operation) having the same production capacity and machining the same pencil quality as on an automatic line require less cost of investment. These machines are less complicated so that in most cases the maintenance and the elimination of troubles, if any, can be performed by semi-skilled operators. Experience has shown that, moreover, the training times are relatively short, and the various jobs are assigned to several different persons.

2. Description of Pencil Production

2.1 Raw Pencil Production

The production of raw, unlacquered wooden pencils, is based on precise machining operations to achieve uniform dimensions for the further processing. The operation sequence is as follows:

- (1) Grooving, parallel sizing and planing of wooden slats;
- (2) Application of glue to the lead grooves and to one slat surface;
- (3) Lead laying and placing the top slat (sandwich);
- (4) Pressing of the joined blocks (sandwiches) for curing glue;
- (5) Cross-cutting of the blocks (sandwiches);
- (6) Profile shaping of the pencils.

2.2 Finishing of the Wooden Pencils

For all pencils:

- (1) Lacquering of pencils with several coats with intermediate drying - 2 to 5 lacquer coats depending on the quality of the pencils;

- (2) Single or double end cutting of the pencils (heading and sizing). In this operation the front ends of the pencils are cleaned from residual lacquer.
- (3) Single stamping (embossing) of the pencils (one-line stamping);
- (4) Pointing of the pencils.

Special operations:

- (5) Double stamping (embossing) or triple stamping of each pencil;
- (6) Dipping of pencil ends in coloured lacquer;
- (7) Fitting of metal ferrules and eraser tips to the pencil ends (tipping).

2.3 Packing of Pencils

It is a tradition in pencil industry to count the wooden pencils, the leads, the slats in gross (= 144 pieces) or in dozens (= 12 pieces).

This is the reason why package sizes are based on 6, 12, 24 or 36 pieces.

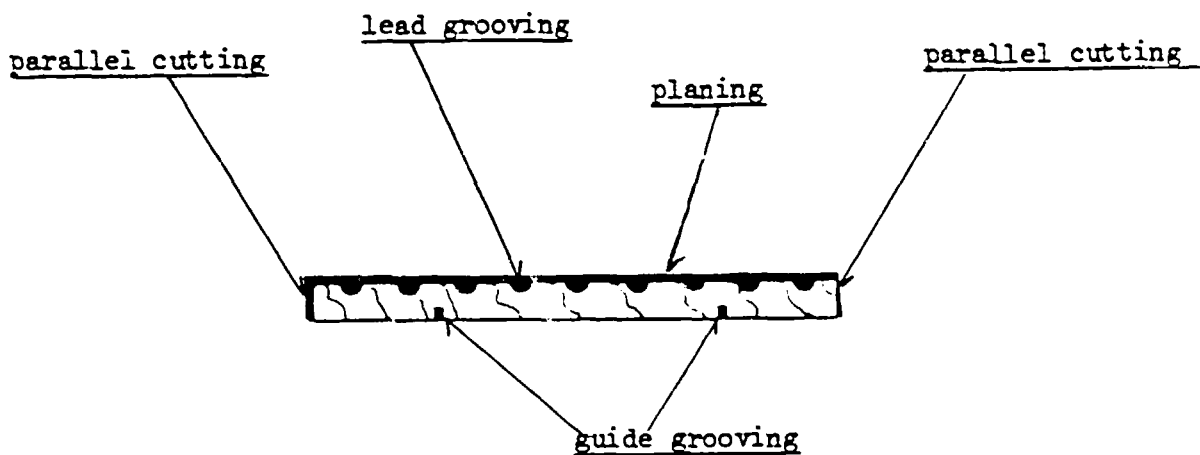
Pencil productions up to 500 gross in 8 hour shifts do not need necessarily feeding equipment and are not economical.

For higher production capacities, semi-automatic machines are suitable for any kind of package and available by specialized manufacturers.

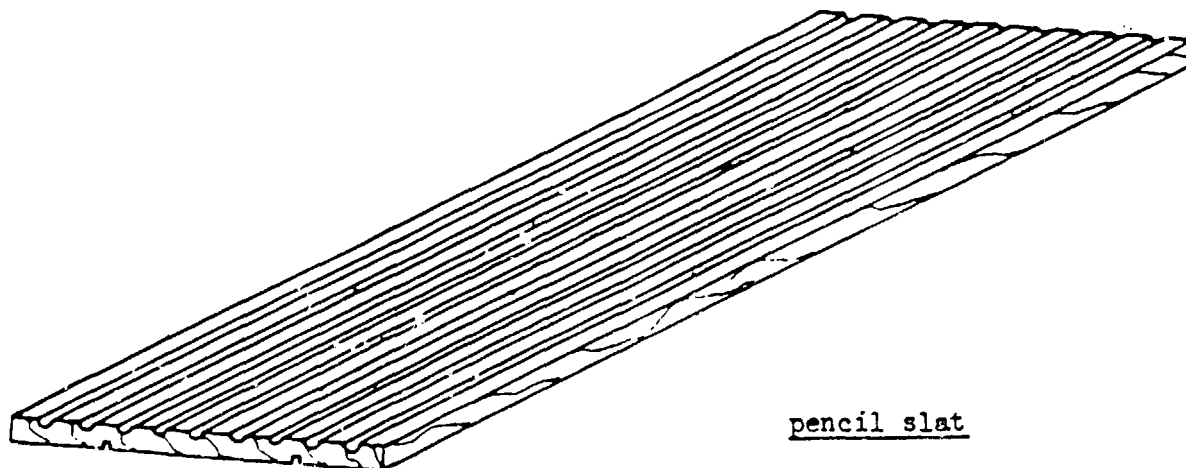
2.4 Illustration of the Individual Working Steps for Pencil Production

2.1.1 Grooving, parallel cutting and planing of the wooden slats

Performed on a grooving or a combined grooving and moulding machine:



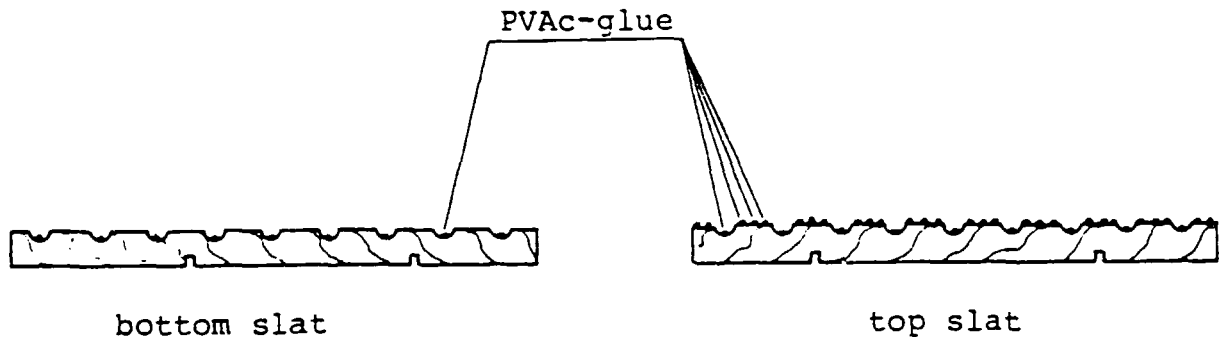
finished slat



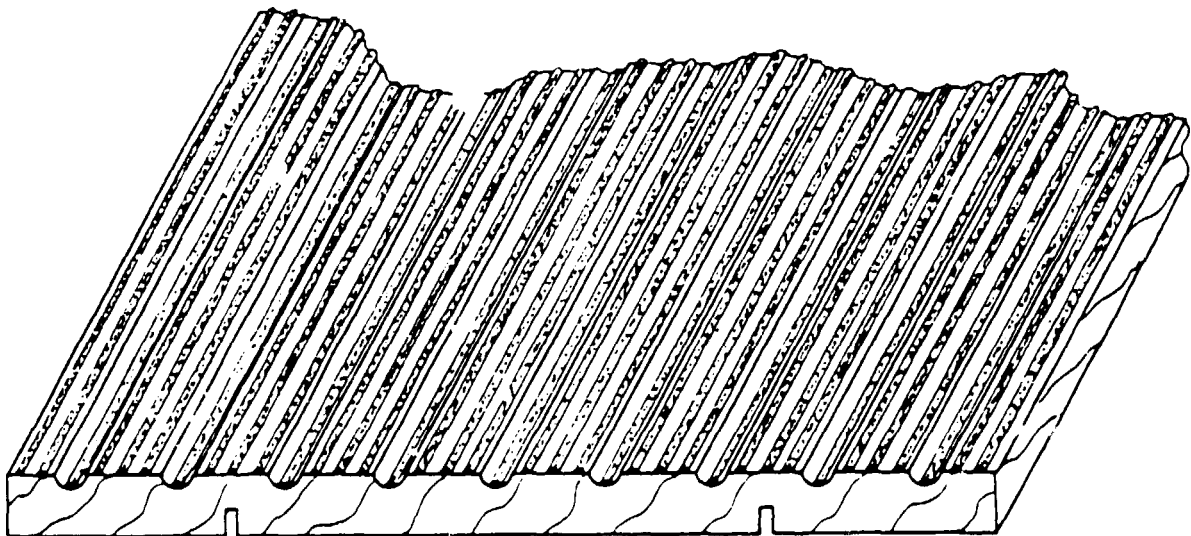
pencil slat

2.1.2 Application of glue to the lead grooves and to one slat surface.

Performed on a gluing machine or on an automatic lead laying and gluing machine:

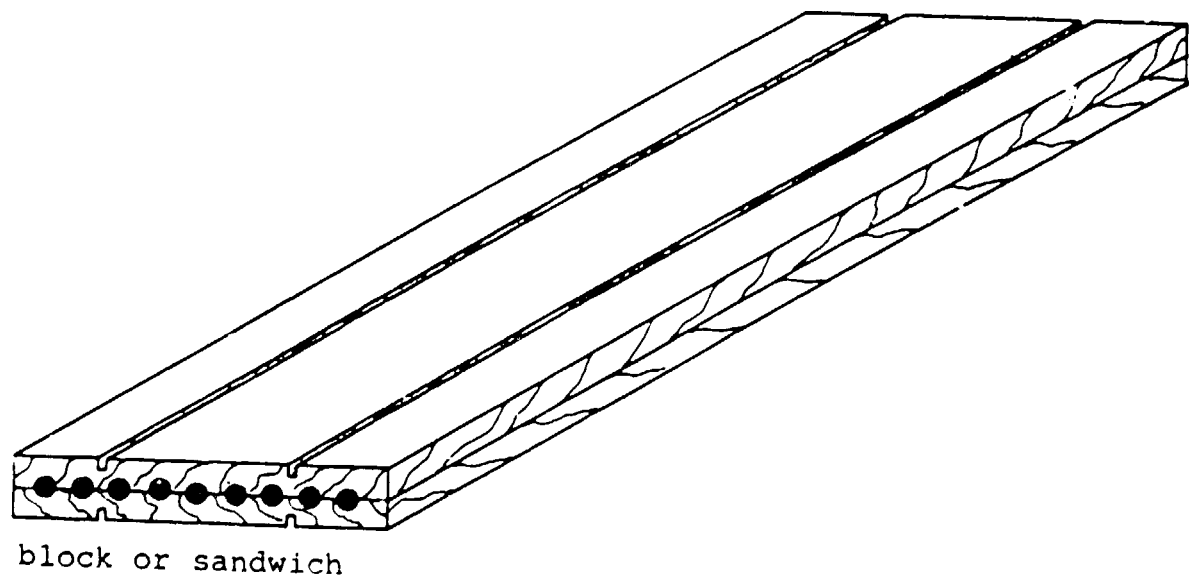
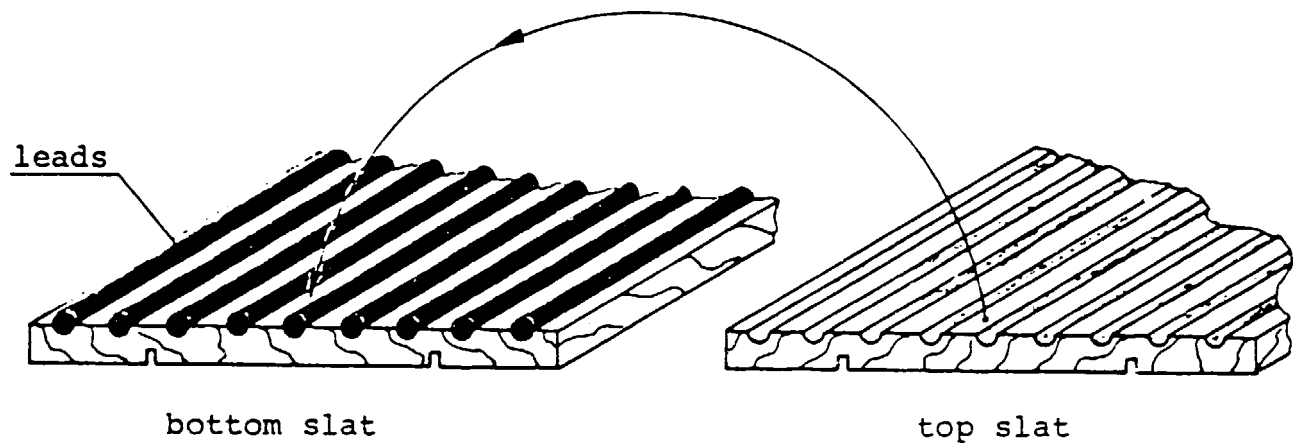


Extruded glue lines on lead grooves and planed surfaces.



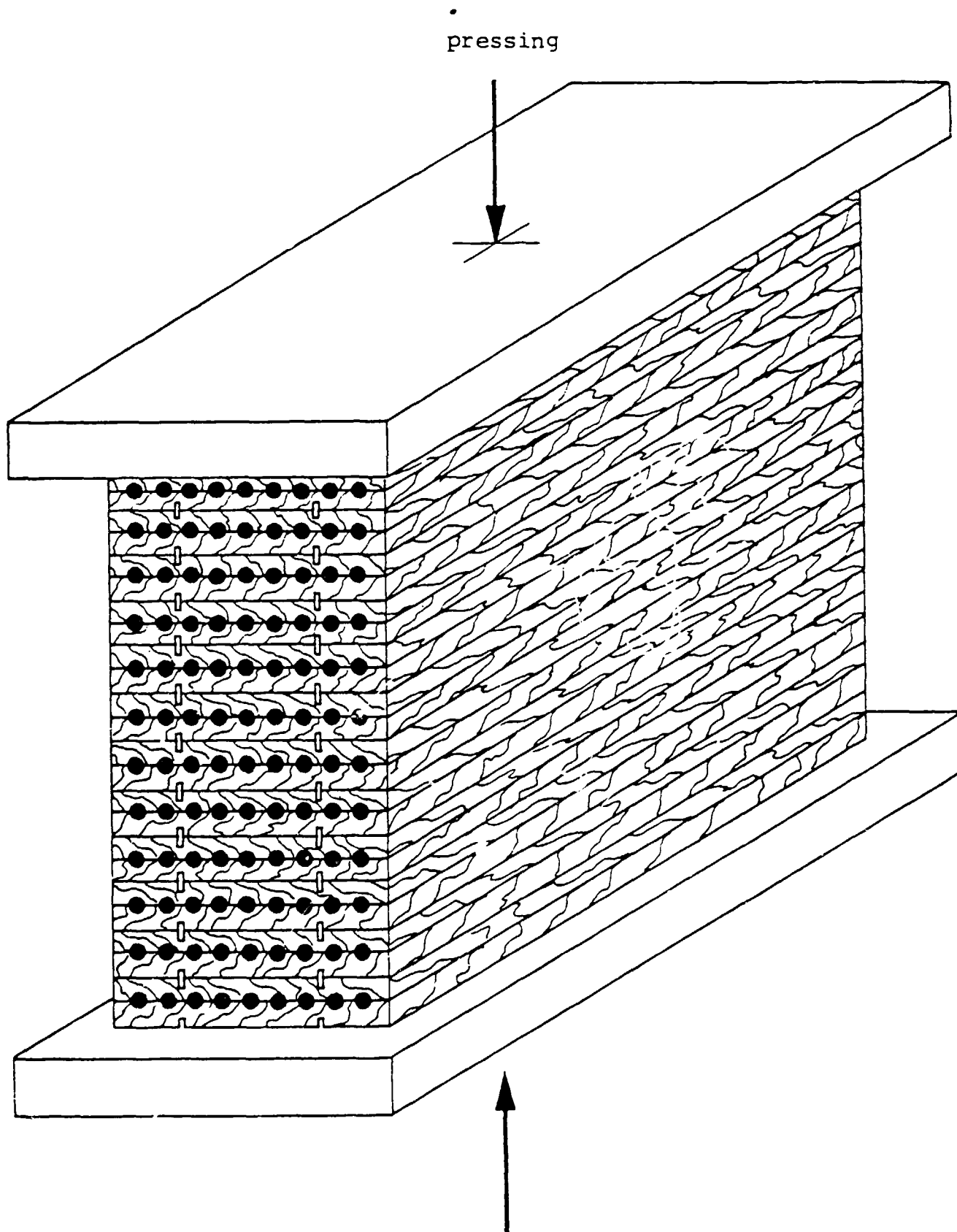
2.1.3 Lead laying and top slat placing (sandwich) by joining two glued slats

Done by hand or on an automatic lead laying and gluing machine:



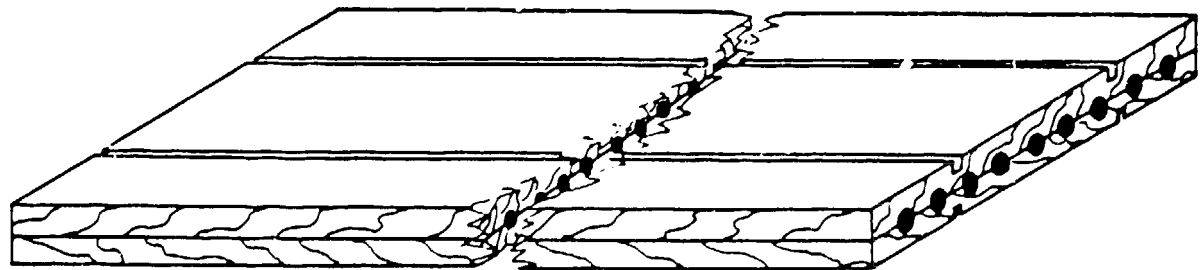
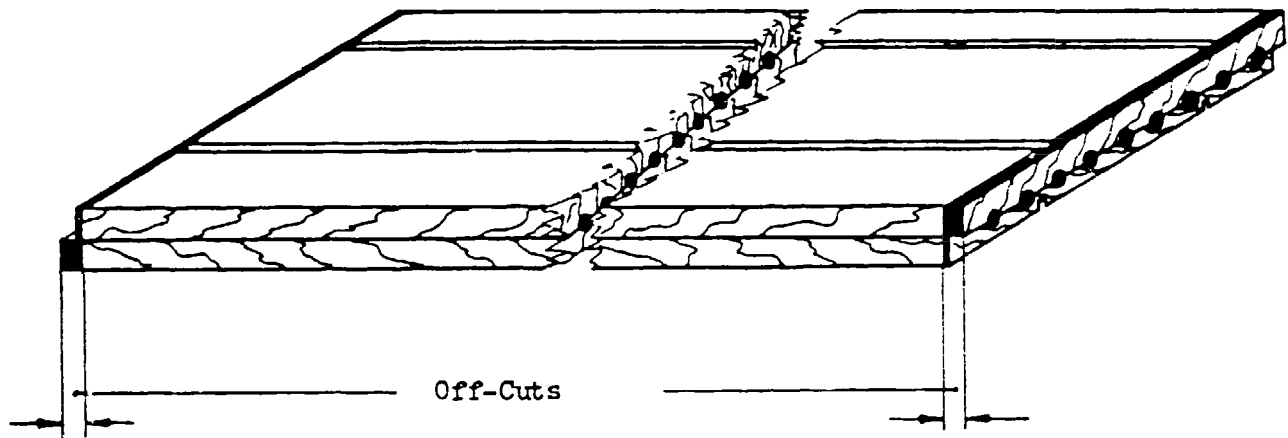
2.1.4 Pressing of the Blocks (sandwiches) and drying of the glue

Performed on a block press:



2.1.5 Cross-cutting of the blocks (sandwiches)

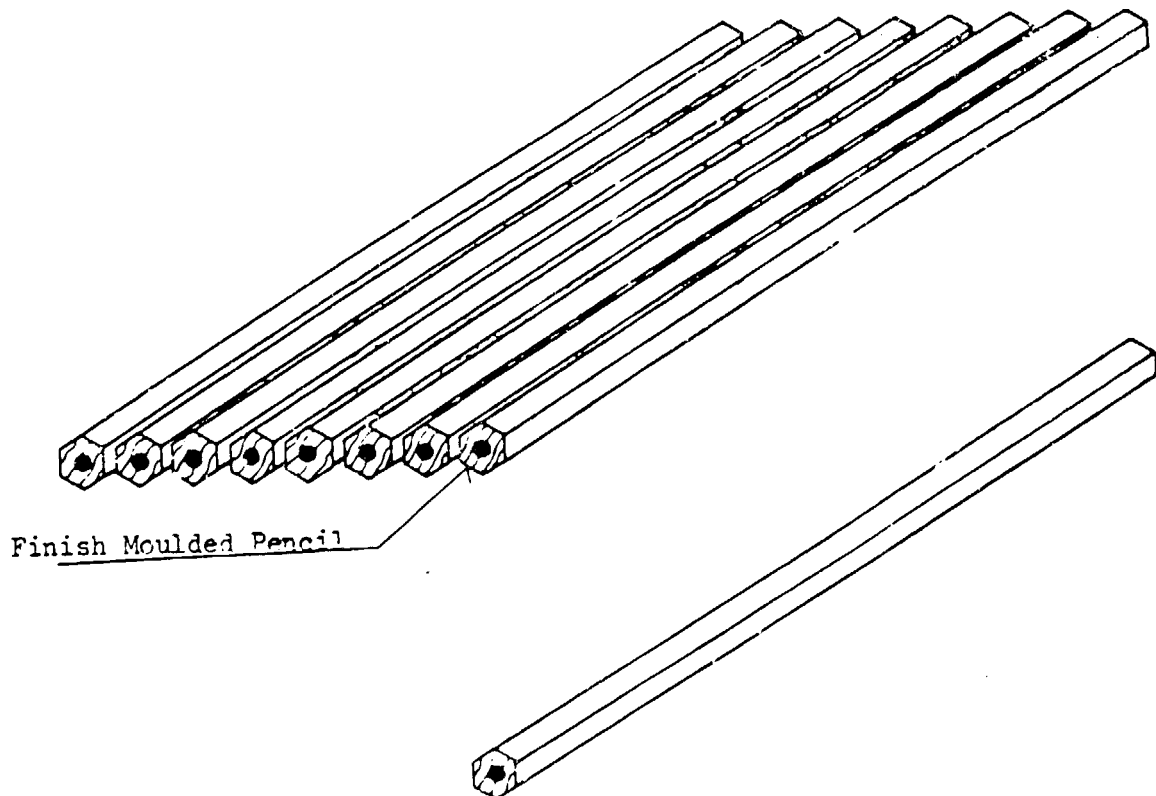
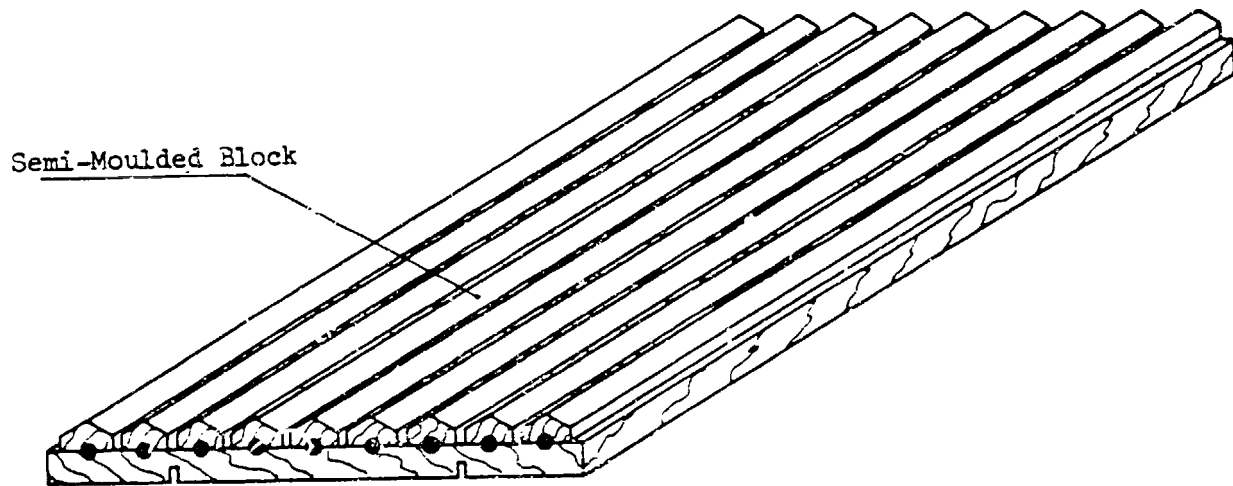
Performed on a double cross-cutting machine:



Sized Pencil Block

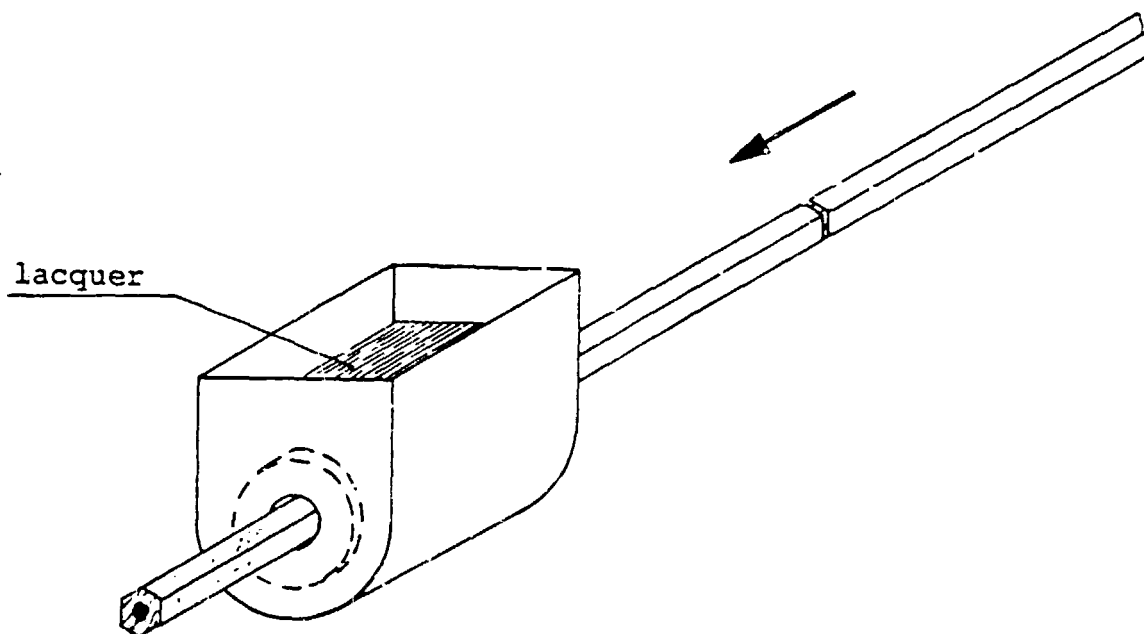
2.1.6 Moulding of the pencils

Performed on a moulding or a combined grooving and planing machine:



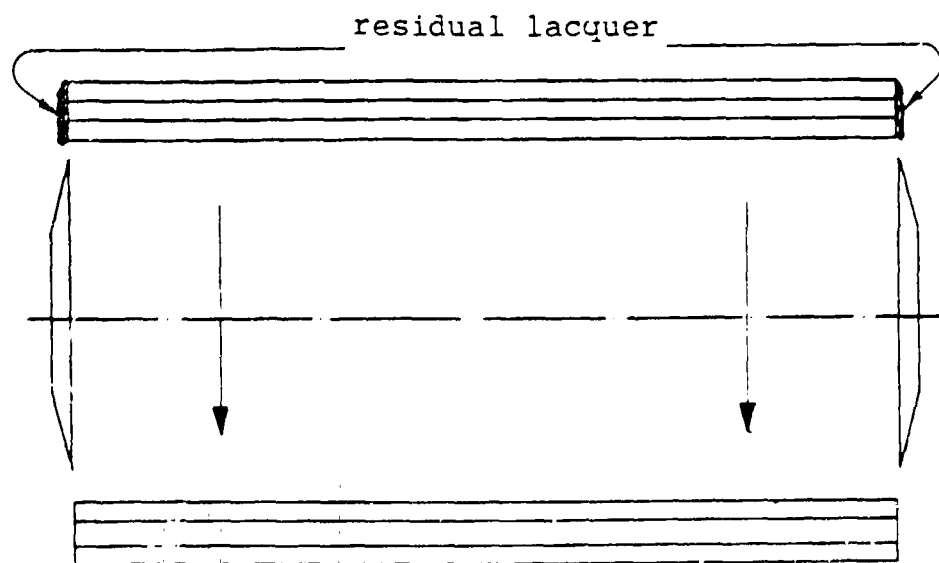
2.2.1 Lacquering of pencils

Performed on a lacquering machine:

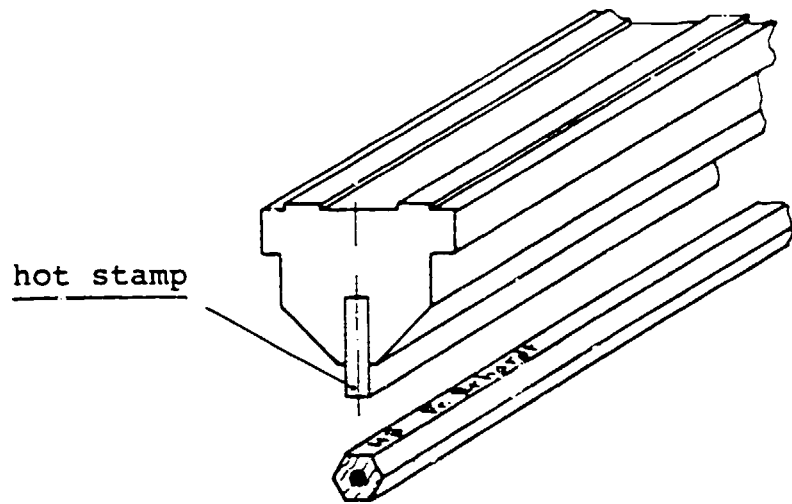


2.2.2 Double-end cutting of pencils (Heading and sizing)

Performed on a pencils end cutting machine (heading and sizing)
or a combined pointing and pencil end cutting machine.



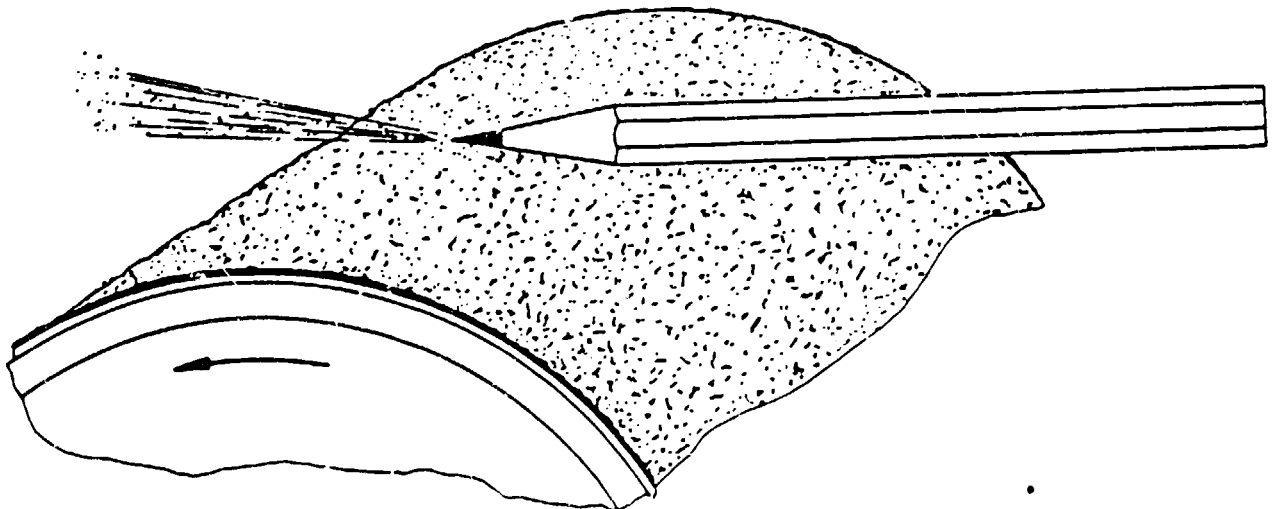
2.2.3 Single side stamping (embossing) of pencils



Performed on a single side stamping (embossing) machine:

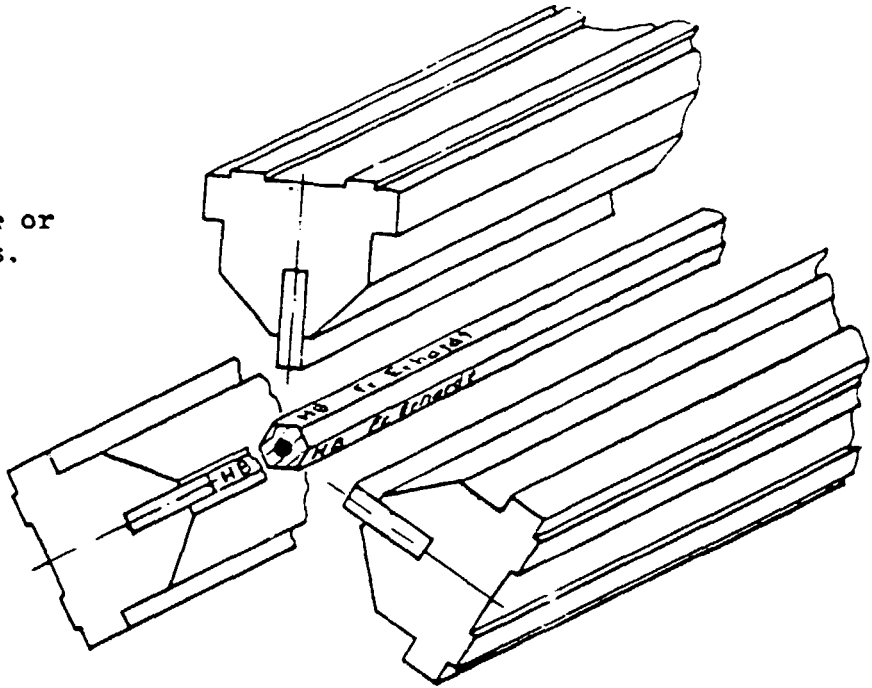
2.2.4 Pointing of pencils with sandpaper

Performed on a pointing machine:



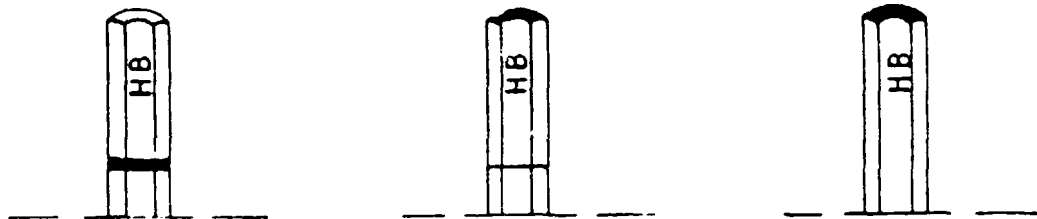
2.2.5 Double stamping (embossing) or triple stamping of pencils

Performed on a double or triple stamping press.



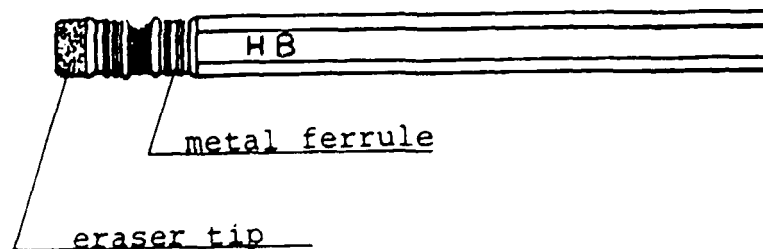
2.2.6 Dipping of pencil ends in coloured lacquer

Performed on a dipping machine:

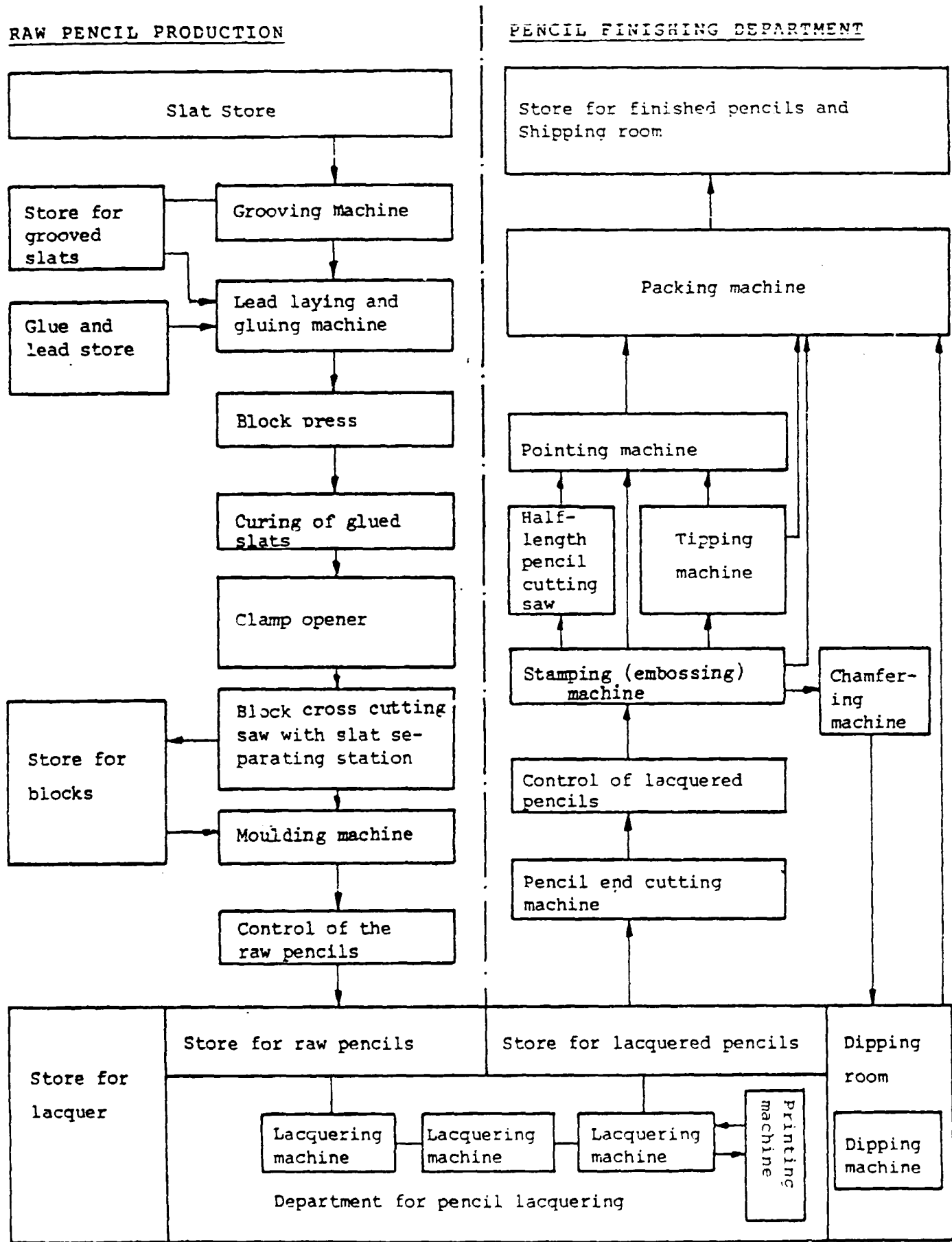


2.2.7 Fitting of metal ferrules and eraser tips to the pencil end (tipping)

Performed on a tipping machine:



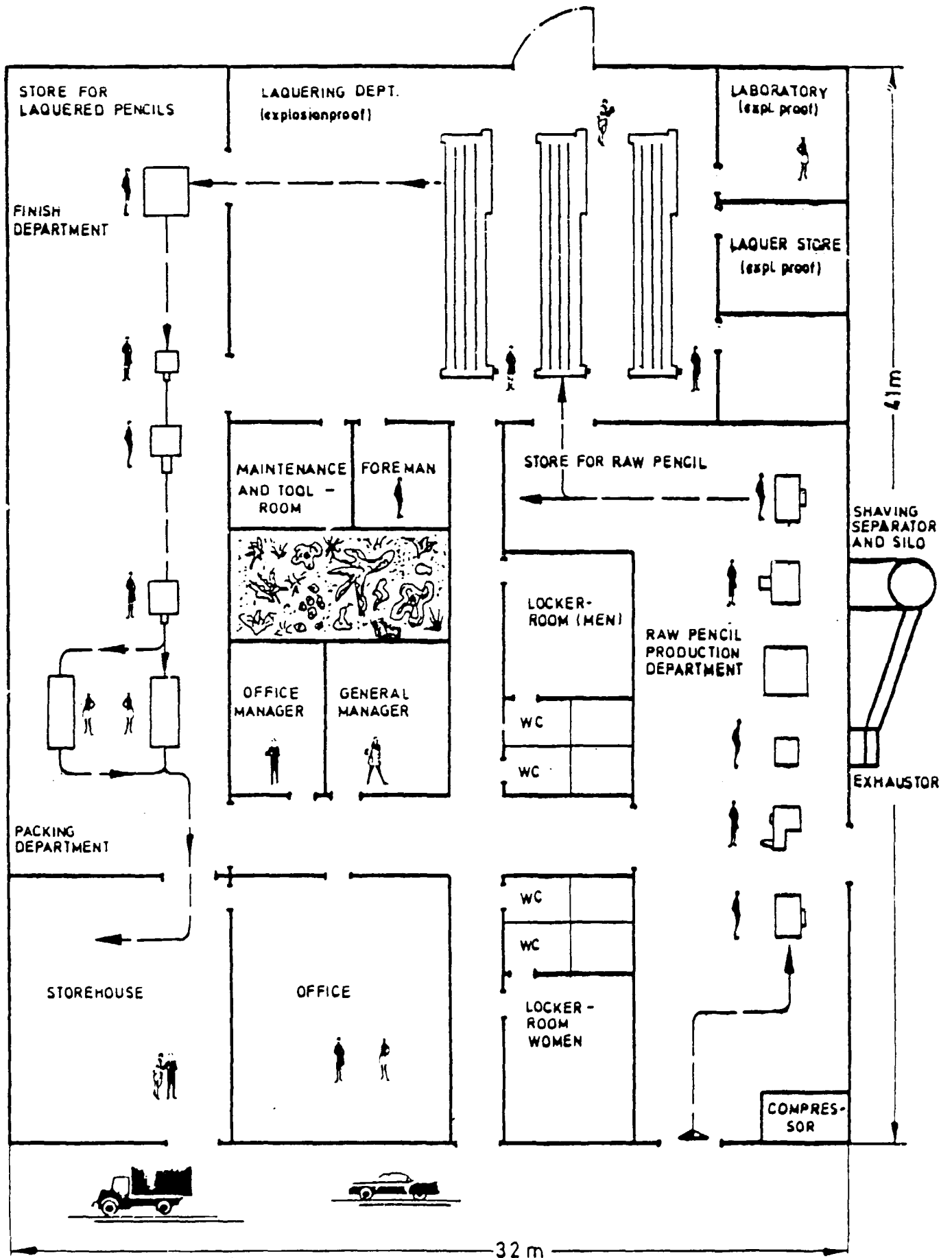
2.5 Production Flow Plan and Pencil Plant Layout



PRODUCTION FLOW PLAN FOR A PENCIL FACTORY

PROPOSED PENCIL PLANT LAYOUT

for a production up to 500 gross pencils per 8 hour shift



Manufacturing capacities of the machines concerned in gross pencils at 8 hour shift when using 70 mm slats and leads of international standard

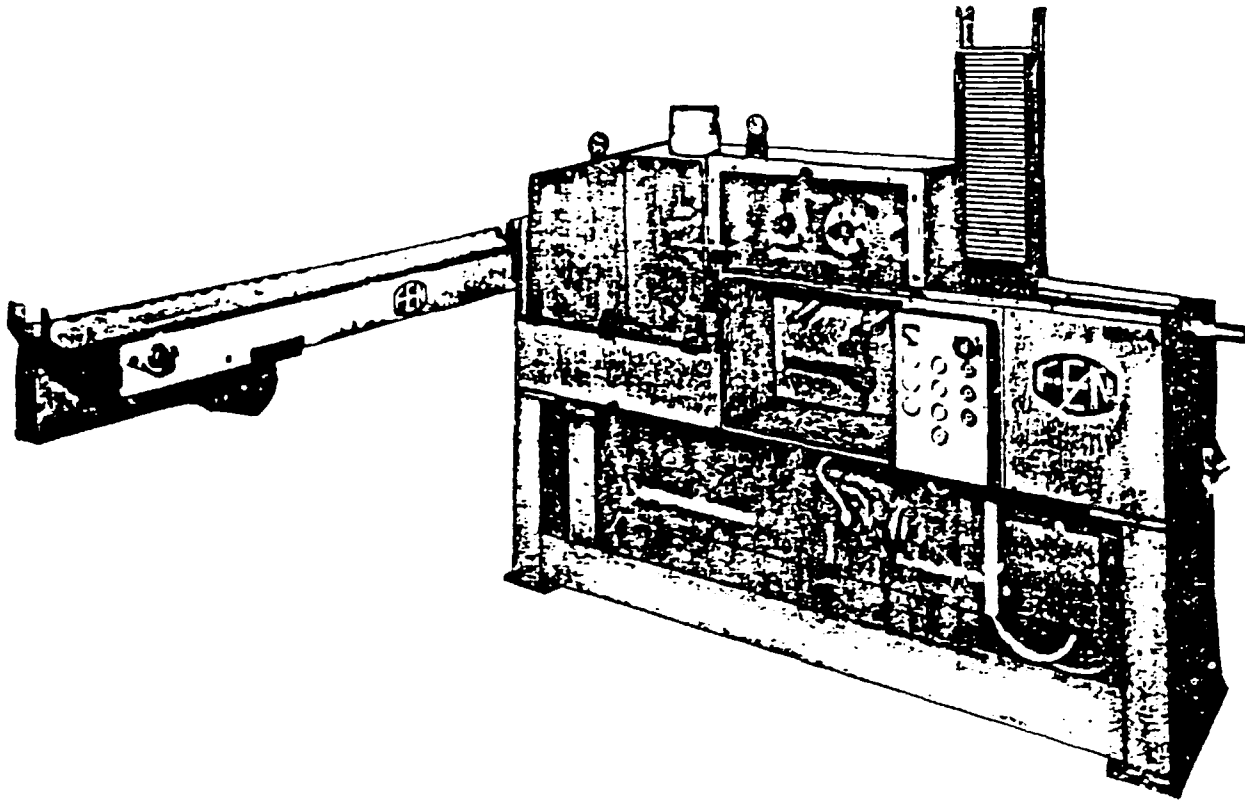
No.	Machines for raw pencil production	Capacity in gross (= 144 pieces)							Price
		125	300	500	700	1000	1500	2000	
2.1-1	Small combined grooving and shaping machine	1 Machine			700				
-1	Standard combined grooving and planing machine	1 Machine							
-2	Slat gluing machine	1 Machine							
-3	Lead laying	by Hand							
-4	Block press	1 Machine							
-5	Block crosscutting, linear system	1 Machine							
								2000	
-1	Standard grooving machine	1 Machine							
-2	Automatic lead laying	1 Machine							
-3	and gluing machine	1 Machine							
-4	Block press add. Device for opening the clamps	1 Machine					1 Device		
-5	Block crosscutting, drum-type	1 Machine							
-6	Standard moulding machine	1 Machine							

3. Machines for Pencil Production
Machines for Raw Pencil Production

Manufacturing capacities of the machines concerned in gross pencils at 8 hour shift

No.	Machines for pencil finishing	Capacity in gross (= 144 pièces)						Price
		125	300	500	700	1000	1500	
2.2-1	Single lacquer coating machine	1 M.		+1 M.				
	Triple lacquer coating machine	1 Mach.		2 Mach.		3 M.	4 M.	5 M.
-2	Single pencilcross cutting machine (heading and sizing)			1 Machine				
-2	Double pencilcross cutting machine (heading and sizing)			1 Machine				
-2	Combined pointing and pencilcross cutting machine	1 Mach.						
-3	Stamping (embossing) machine, linear system	1 Mach.						
-3	Stamping (embossing) machine, drum type			1 Machine			2 Mach.	
-4	Pointing and chamfering machine			1 Machine				
	<u>Machines for special operations:</u>							
-5	Double stamping (embossing) machine			1 Machine			2 Mach.	
-5	Triple stamping (embossing) machine			1 Machine		2 Mach.		
-6	Dipping equipment			several Machines				
-7	Tipping machine	1 Mach.						
2.3	Automatic feeding machine for packing assortments of up to 12 pencils	1 Machine			2 Mach.		3 Mach.	

Machines for Pencil Finishing and Packing



Combined Grooving and Planing Machine.

Outfeed Conveyor Belt, suitable for removal of grooved slats and shaped pencils.

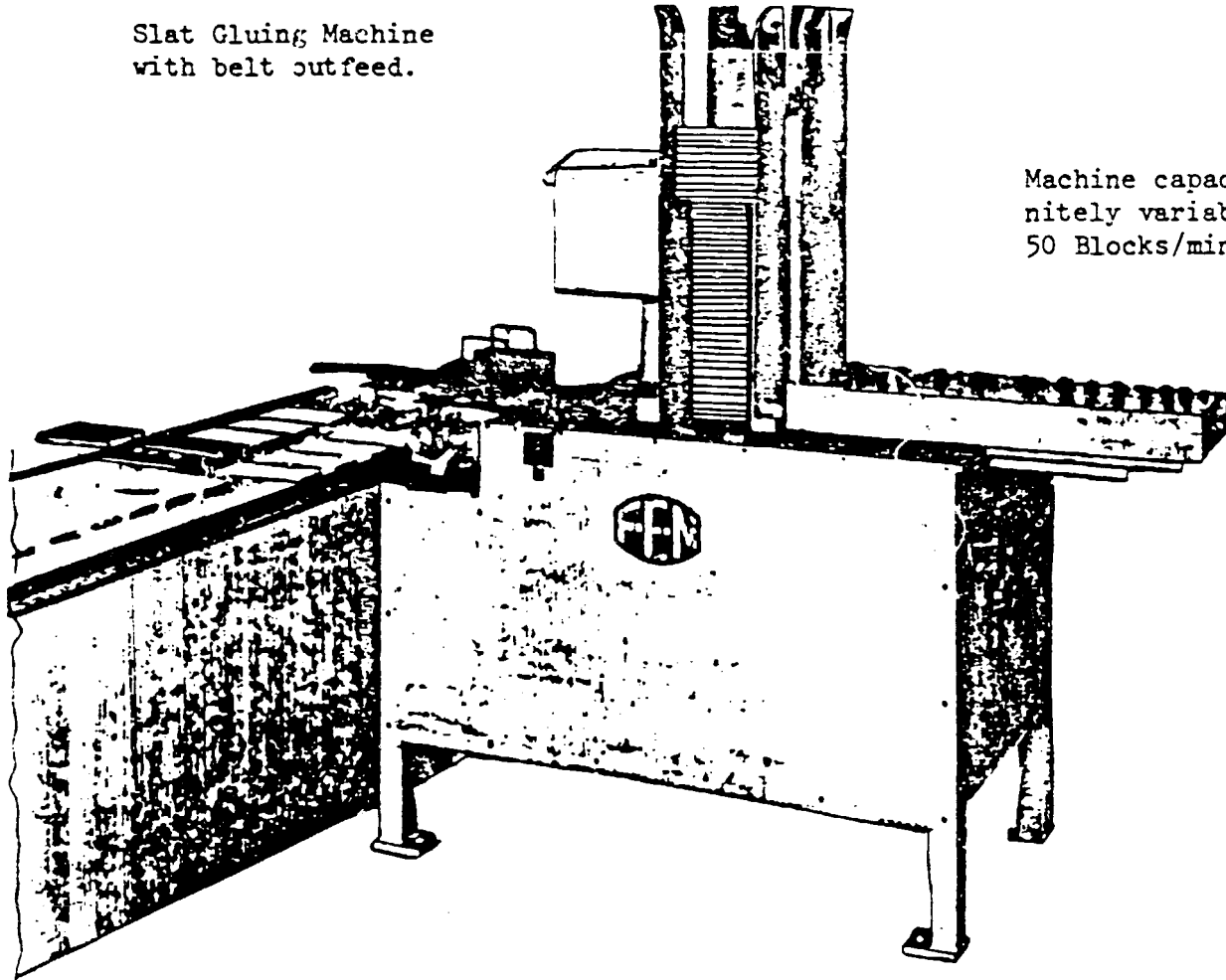
Production of machine infinitely variable:

At grooving (cedar) 150 - 170 Slats/min **

At Planing (cedar) 75 - 85 Blocks/min **

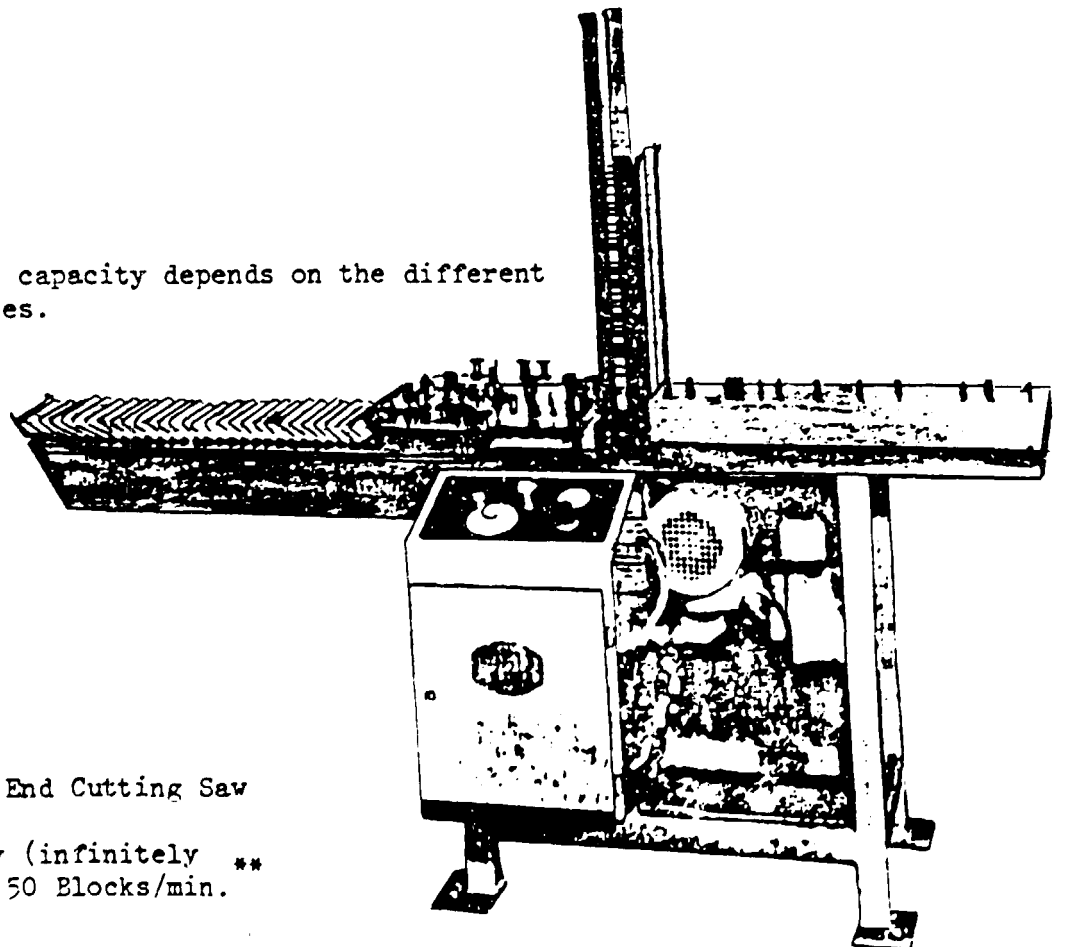
** If other wood is used there might be a divergency of the effective capacity. When using other wood species the capacity may vary.

Slat Gluing Machine
with belt outfeed.



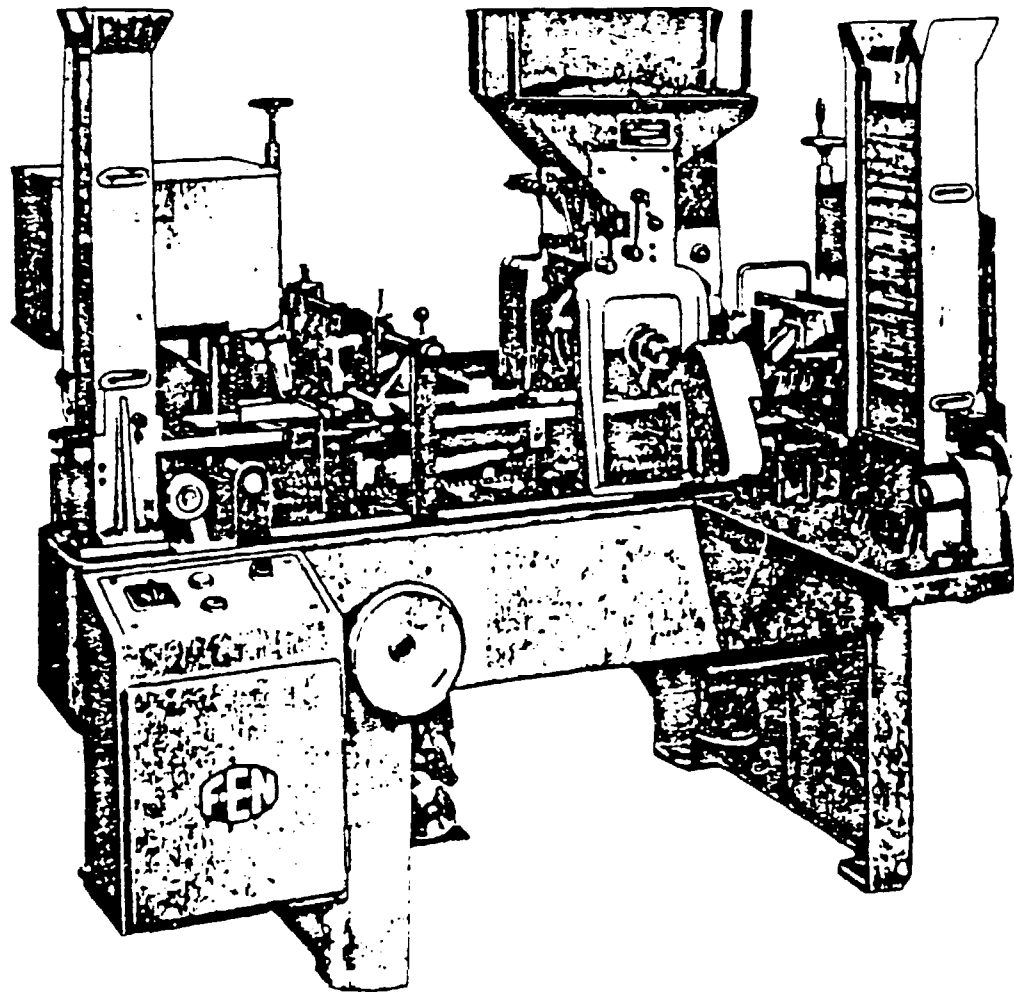
Machine capacity (infi-
nitely variable) 40 to
50 Blocks/min. **

** The actual capacity depends on the different
wood species.



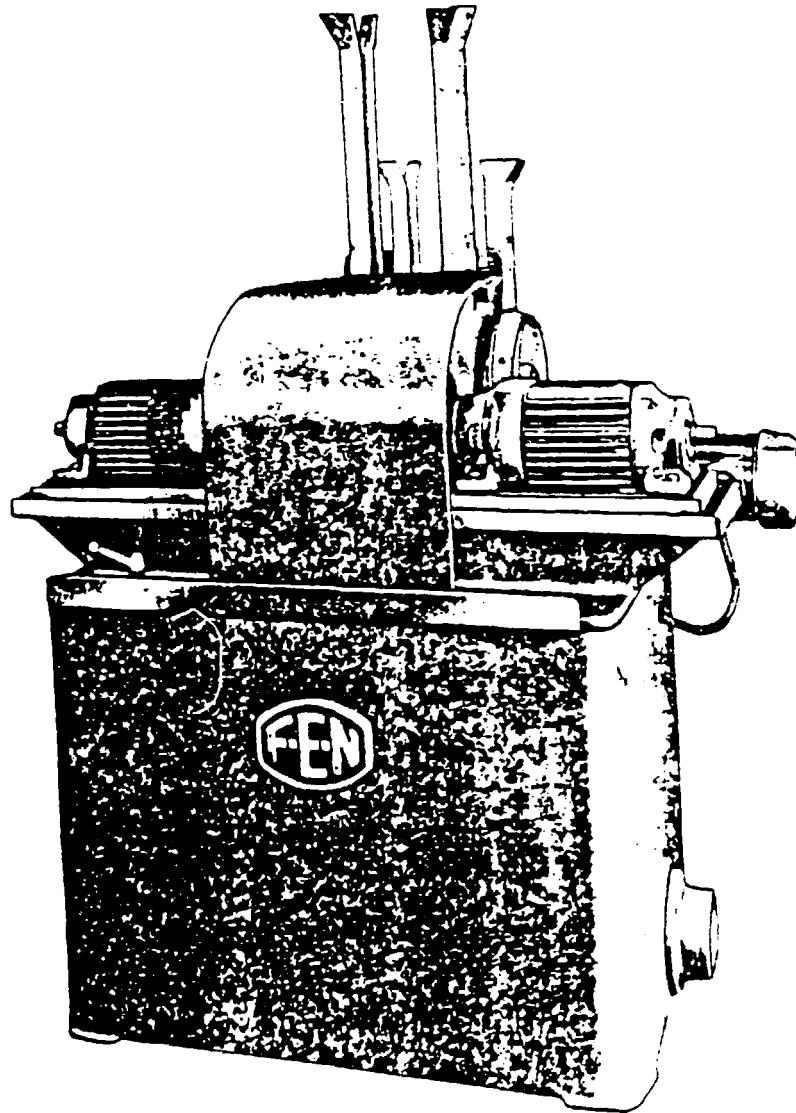
Automatic Block End Cutting Saw

Machine capacity (ininitely
variable) 40 to 50 Blocks/min. **



Glue Spreading Machine.
Machine capacity (infinitely variable)
up to 80 Blocks/min. **

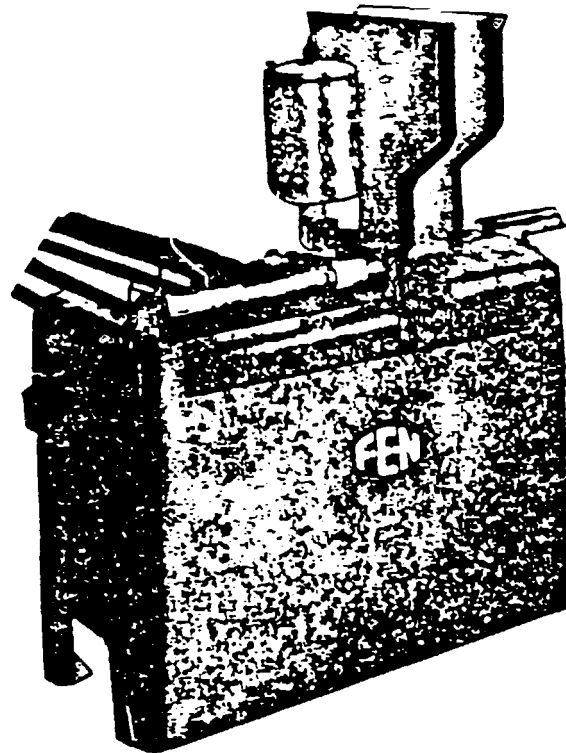
** The actual capacity depends on the different wood species.



Double End Slat Cross Cutting Saw.

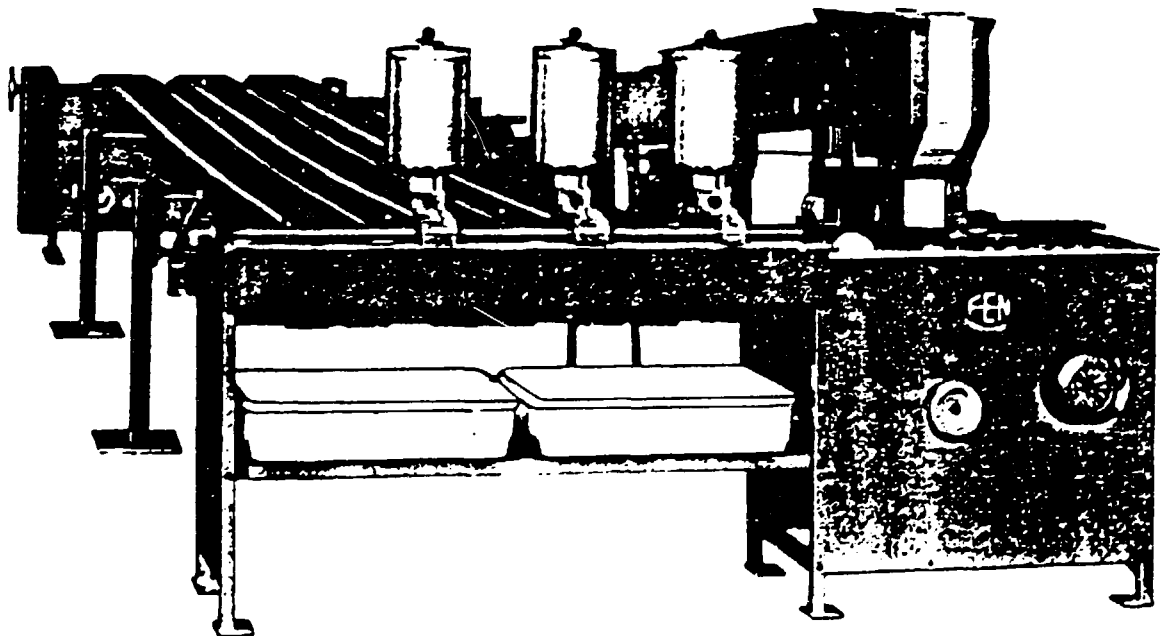
Machine capacity (infinitely variable) up to 110 Blocks/min. **

** The actual capacity depends on the different wood species.



High-efficiency Single
Varnishing Machine.

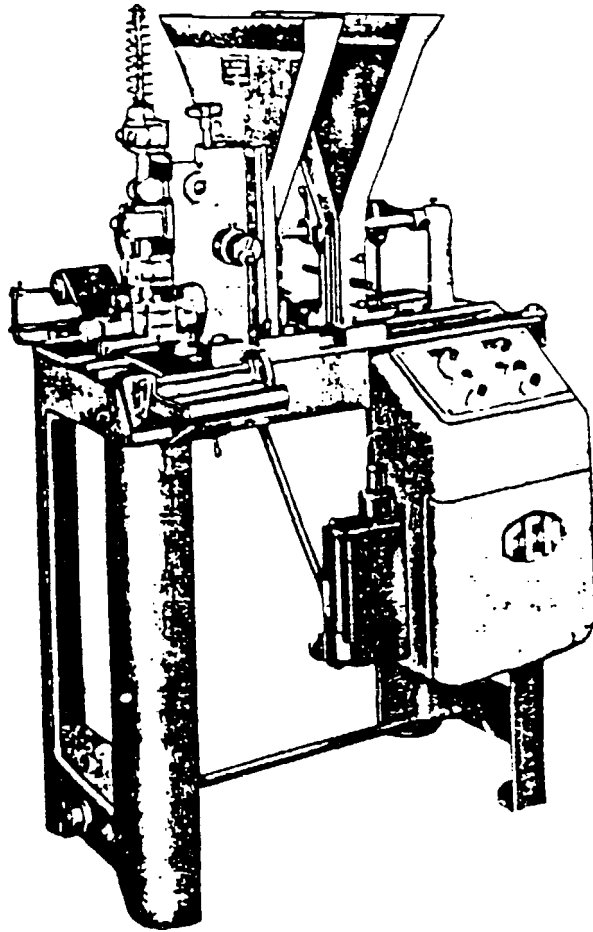
Machine capacity (infin-
itely variable) up to 200
pencils/min \pm 10% **



Super Automatic Triple
Varnishing Machine.

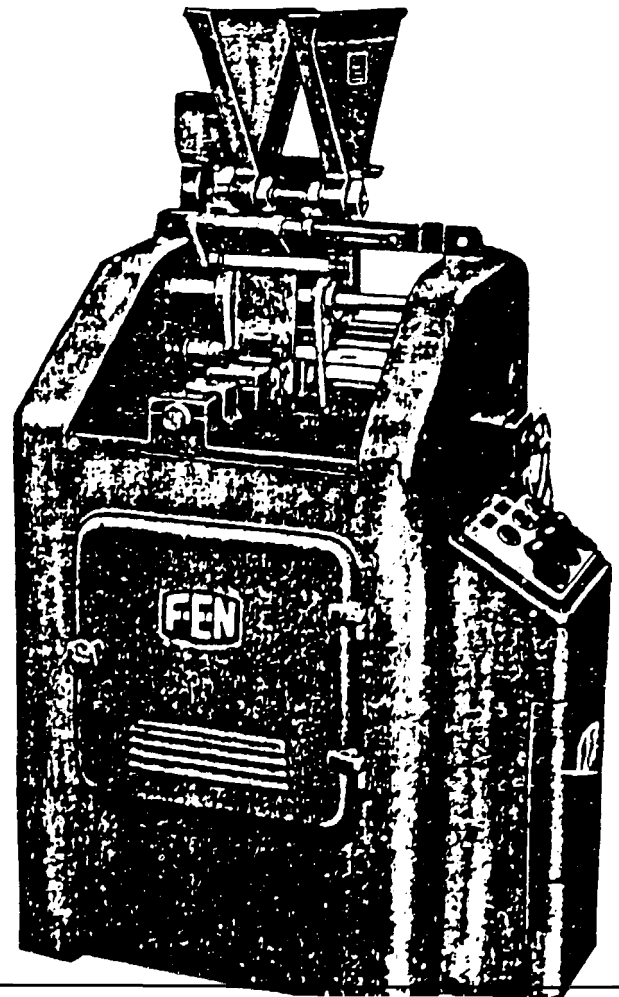
Machine capacity (infinitely variable) up to 600 pencils/min \pm 10%. **

** The actual capacity depends on the different wood species.



Automatic one-line foil-stamping hot press.

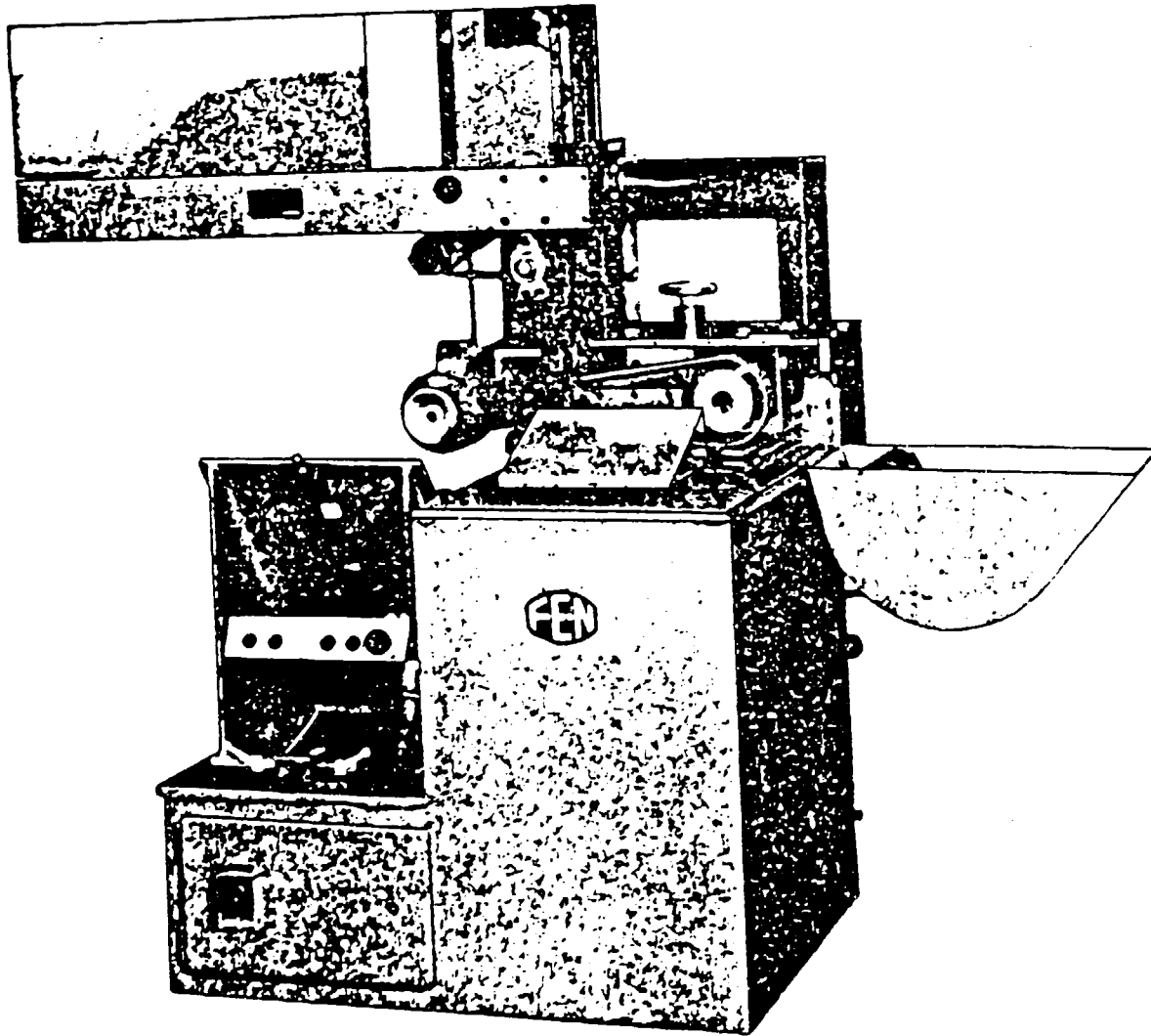
Machine capacity 140 Pencils/min. **



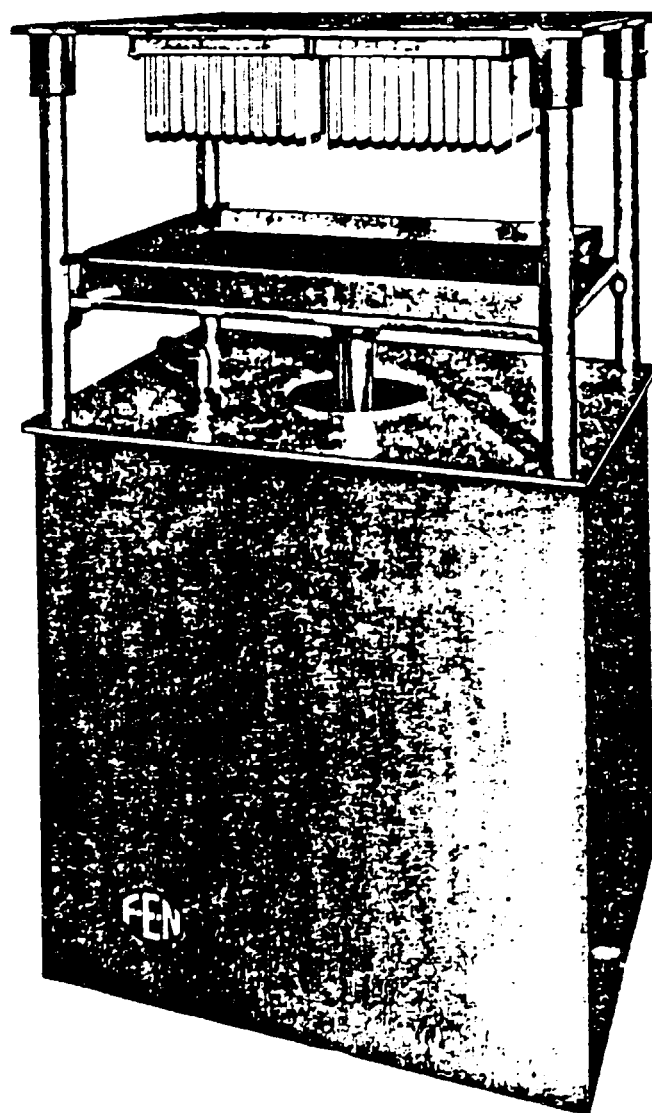
High capacity Stamping (embossing) Machine.

Machine capacity (infinitely variable) up to 360 pencils/min. **

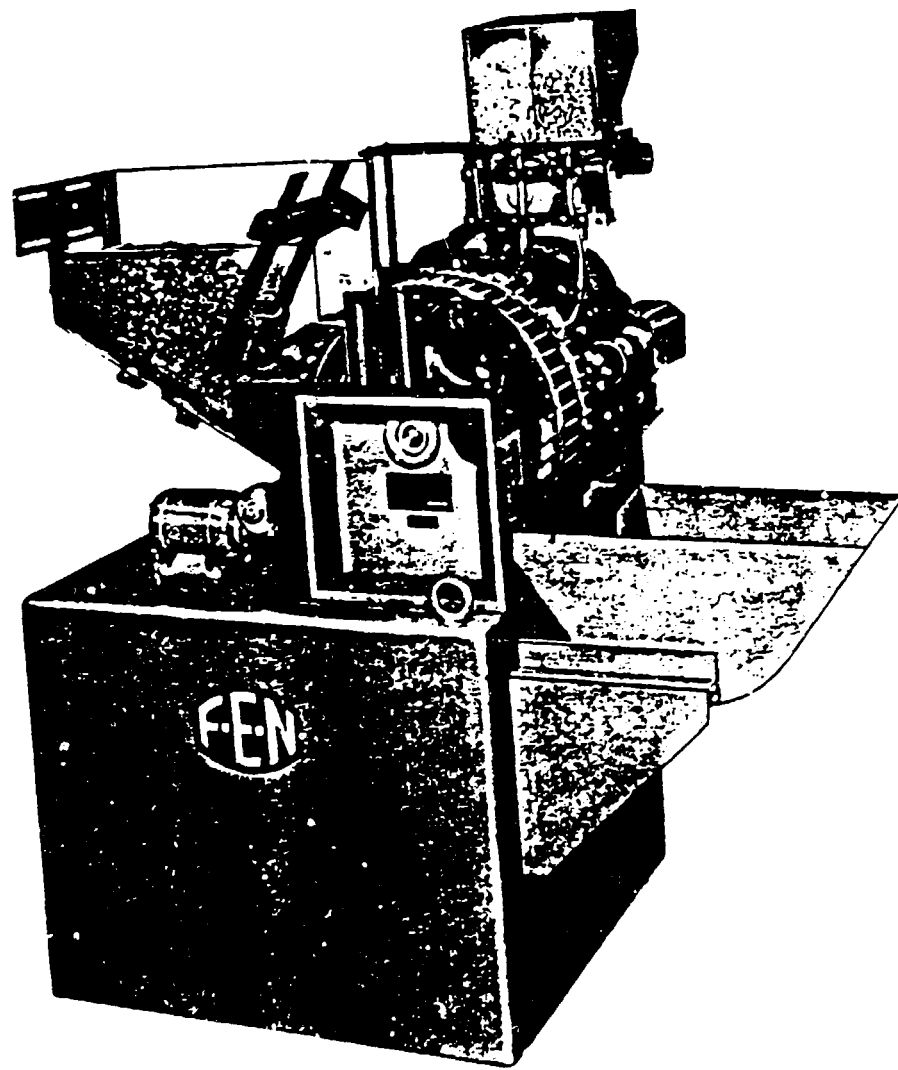
** The actual capacity depends on the various wood species.



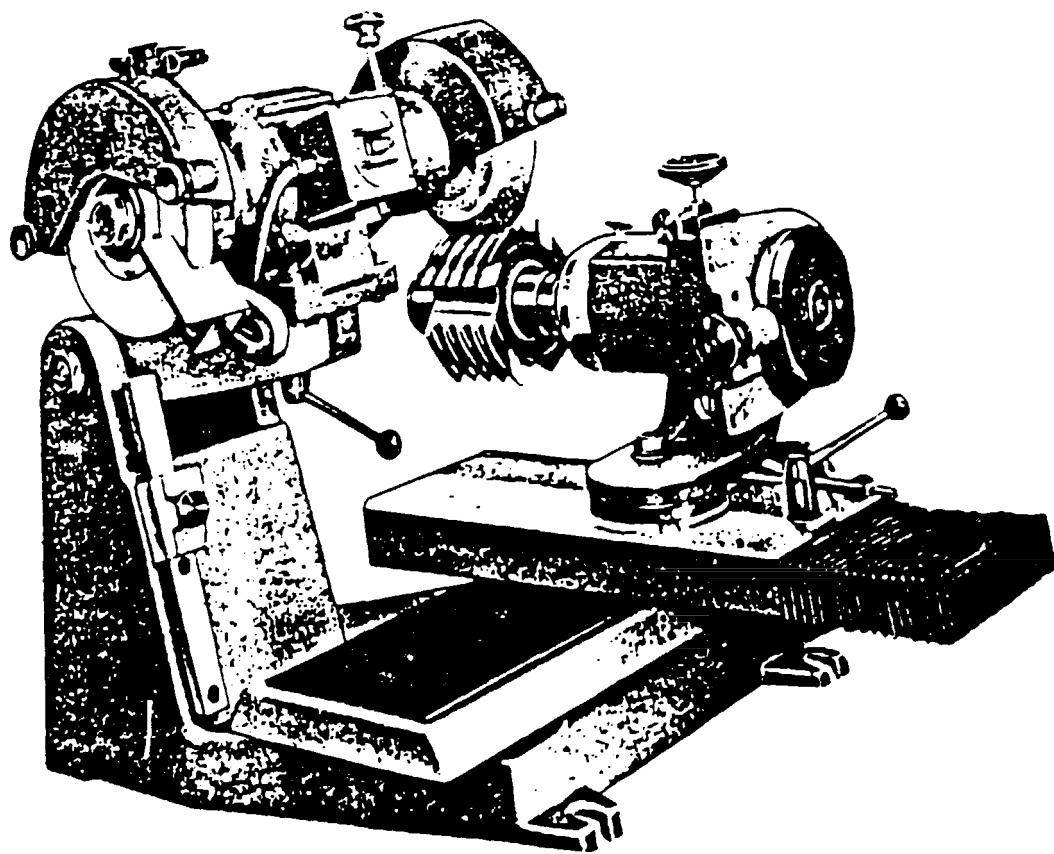
Heavy Duty Pointing and Chamfering Machine.



Hydraulic Universal Dipping Device - Dipping Frames.



Heavy Duty Tipping Machine With Single Stations.
(For assembly of metal ferrules and eraser tips. Fixing by means
of centre-punch or glue.)



Universal Cutterhead Grinding Machine for Grooving and Planing
Heads and Carbide-Tipped Saw Blades.

3.1 List of Machines:

Recommended Storage Size for Lumber and for Finished Products.

Production 125 Gross

Operation Machines (No.)		Pieces
2.1-1	Small combined grooving	1
-6	and planing machines	
-6	Slat gluing machine	1
-3	(manually operated)	-
-4	Block press	1
	Glue clamps	50
-5	Double-end Block cross cutting	
	saw, linear system	1
2.2-1	Single lacquering machine.	1
-2	Combined pointing and	
-4	pencil single-end cross cutting machine	1
-3	Stamping (embossing) machine,	
	linear system	1

Recommended storage size for lumber and for finished products:
for 7500 gross pencils.

3.2 List of Machines:

Recommended Storage Size for Lumber and for Finished Products.

Production 300 Gross

Operation Machines (No.)		Pieces
2.1-1	Small combined grooving and	
-6	planing machine	1
-2	Slat gluing machine	1
-3	(manually operated)	-
-4	Block press	1
	Glue clamps	60
-5	Block double-end cross cutting saw,	
	linear system	1
2.2-1	Triple lacquer coating machine	1
-2	Combined pointing and	
-4	pencil single-end cross cutting machine	1

-3 Stamping (embossing) machine, 1
linear system

Recommended storage size for lumber and for finished products:
for 18000 gross pencils.

3.3 List of Machines:

Recommended Storage Size for Lumber and for Finished Products.
Production 500 Gross

Operation Machines (No.)		Pieces
2.1-1	Standard comigned grooving	
-6	and planing machine	1
	Alternatively:	
	Small combined grooving	
	and planing machine	(1)
-2	Slat gluing machine	1
-3	(manually operated)	-
	Alternatively:	
	Automatic lead laying and	
	gluing machine	(1)
-4	Block press	1
	Glue clamps	100
-5	Block double-end cross cutting saw,	
	linear system	1
2.2-1	Triple lacquer coating machine	1
	Single lacquer coating machine	1
-2	Singe-end pencil cross cutting	
	machine (heading and sizing)	1
-3	Stamping (embossing), machine drum type	1
-4	Pointing and chamfering machine	1

Recommended storage size for lumber and for finished products:
for 30000 gross pencils.

3.4 List of Machines:

Recommended Storage Size for Lumber and for Finished Products.
Production 700 Gross

Operation Machines (No.) Pieces

2.1-1	Standard combined grooving and planing machine	1
-6		
-2	Slat gluing machine	1
-3	(manually operated)	-
	Alternatively:	
	Automatic lead laying and gluing machine	(1)
-4	Block press	1
	Glue clamps	130
-5	Block double-end cross cutting saw linear system	1
2.2-1	Triple lacquer coating machine	2
-2	Single-end pencil cross cutting machine (heading and sizing)	1
-3	Stamping (embossing) machine, drum type	1
-4	Pointing and chamfering machine	1

Recommended storage size for lumber and for finished products:
for 42000 gross pencils.

3.5 List of Machines:

Recommended Storage Size for Lumber and for Finished Products.

Production 1000 Gross

Operation Machines (No.)	Pieces
2.1-1 Standard grooving machine	1
Alternatively to 2.1-1 and 2.1-6: Standard combined grooving and planing machine	(1)
-2 Automatic lead laying and -3 gluing machine	1
-4 Block press	1
Device for opening the glue clamps	1
Glue clamps	120
-5 Block double-end cross cutting saw, drum type	1
-6 Standard moulding machine (see alternatively 2.1-1)	1
2.2-1 Triple lacquer coating machine	3
-2 Double-end pencil cross cutting machine (heading and sizing)	1
-3 Stamping (embossing) machine, drum type	1
-4 Pointing and chamfering machine	1

Recommended storage size for lumber and for finished products:
for 60000 gross pencils.

3.6 List of Machines:

Recommended Storage Size for Lumber and for Finished Products.
Production 1500 Gross

Operation Machines (No.)	Pieces
2.1-1 Standard grooving machine	1
-2 Automatic lead laying	1
-3 and gluing machine	
-4 Block press	1
Device for opening the glue clamps	1
Glue clamps	180
-5 Block double-end cross cutting saw, drum type	1
-6 Standard moulding machine	1
2.2-1 Triple lacquer coating machine	4
-2 Double-end pencil cross cutting machine (heading and sizing)	1
-3 Stamping (embossing) machine, drum type	2
-4 Pointing and chamfering machine	1

Recommended storage size for lumber and for finished products:
for 90000 gross pencils.

3.7 List of Machines:

Recommended Storage Size for Lumber and for Finished Products.
Production 2000 Gross.

Operation Machines (No.)	Pieces
2.1-1 Standard grooving machine	1
-2 Automatic lead laying and	
-3 Gluing machine	1
-4 Block press	1
Device for opening the glue clamps	1
Glue clamps	250

-5	Block double-end cross cutting saw, drum type	1
-6	Standard moulding machine	1
2.2-1	Triple lacquer coating machine	4 - 5
-2	Double-end pencil cross cutting machine (heading and sizing)	1
-3	Stamping (embossing) machine, drum type	2
-4	Pointing-, chamfering-, and pencil double-end cross cutting machine	1

Recommended storage size for lumber and for finished products:
for 120000 gross pencils.

4. Exhaust, Maintenance and Tools

Some of the processing machines have to be connected to a central exhaust system which collects the wooden chips by aid of an exhaustor.

Some machines work with compressed air. Therefore, a central compressor station is recommended.

For resharpening the tools (i.e. the grooving and planing cutter heads, the saws) a tool grinding machine is required.

Therefore, the following machines and units are necessary:
(a) 1 chip and dust exhaustor, (b) one compressor unit and (c) one Universal tool grinding machine. To cover the cost of the necessary tools and spare parts an amount of up to 10 per cent of the machine prices will be sufficient.



