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FURNITURE INDUSTRY TECHNOLOGY[1/]

by

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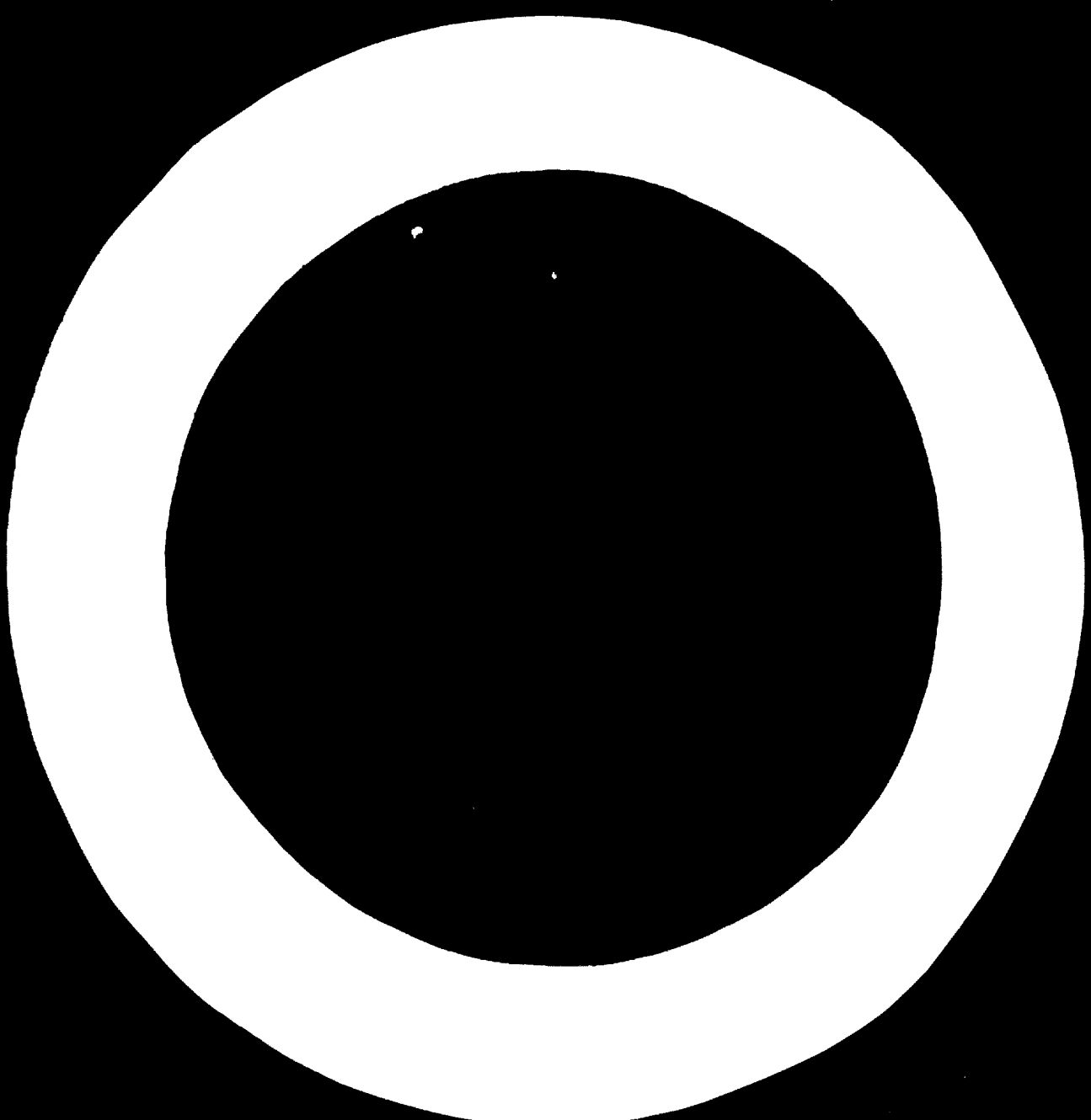


9.1 Special features of the furniture industry

Products of the furniture industry represent the highest degree of refining as comparered with the products of other secondary wood processing industries. Characteristic of the furniture products is that their external appearance has a decisive effect on the ability to compete on the market. In the northern climatic conditions the demand of funiture varies according to season. Furthermore, the products are considerably sensitive to fashions which means that the life of a particular design often is very limited. Furniture manufacture can seldom be real mass-production because comsumers are not willing to buy identical items for their individual homes.

Typical is also the large number of wood species that are used for veneering or as solid components, in many cases lacquered in natural colour or stained in different shades. At the moment, painting furniture in bright colours is also very popular and fashionable.

The greatest production problem in most furniture factories is, however, the great assortment of different items. In many cases the number of different kinds of work pieces in variuous phases of machining may be many hundreds or even thousands.

A solution to this problem is specialization. This means limiting of the production programme in one way or other. The basis of specialization can be, for instance:

1. Kind of product (e.g., a factory may specialize in chairs only)

2. Product group and end purpose of the product (home, office, etc.)
3. Raw material and construction (solid wood, particle board, etc.)
4. Manufacturing method (special machines or techniques)

A very practical way is also the use of subcontractors from whom such parts can be ordered that are not suited to the production programme of a particular manufacturer.

9.2 Production mode

Furniture is almost without exception made in series production. The number of items made at the same time usually varies from a few hundred to a few thousands depending on the kind of product manufactured.
The following features are characteristic of series production of furniture:

1. Stock areas are needed between different phases of manufacture (fig. 9.1)
2. Transport costs amount to a significant proportion of production costs. (The term transport here has been expanded to cover all stages of the process in which the value of the product does not increase).
3. The components are usually transported on pallets (fig. 3.2) using hydraulic handoperated lift trucks. This method of transport is the most flexible in series production.
4. Belt conveyors and other types of conveyors can be used to a limited extent only (assembly, surface finishing).

The manufacture of furniture as a continuous process is, of course, possible in principle. In this mode of production, manufacturing is done in a fixed production line without stock areas. This, however, requires a large expansion of marketing area. In any case, a clear trend towards extended use of machine lines and automated production can be noted in recent years.

9.3 Accuracy of manufacture

The accuracy of woodworking machines is, at the most, approx. $\pm$ 0,05 millimeters when the bearings are new. The actual accuray of work-

ing pieces in practice is ±0,1...±0,3 millimeters, taking into account the changes in measure due to moisture content variations under manufacture.

The advantages of a high accuracy in manufacturing are the following:

1. Parts of products belonging to different series are interchangeable
2. A sliding fit between parts is possible without manual fitting in assembly
3. Joints are strong and easy to assemble
4. Manufacture in large series is possible

In order to achieve a high accuracy the following measures are used:

1. The machines are regularly serviced according to working instructions
2. Dimensioned working drawings are used throughout; the numerical values indicate the nominal dimension to be achieved
3. Gauges and templates are used to control the dimensions during machining (fig. 9.3).
4. Jigs are used in machining and assembly, whenever possible (fig. 9.4).

9.4 Drying of timber

Nowadays the timber is usually dried in sawn lengths before cross-cutting. Loss of material due to end checks is in this way minimized. The drying kilns are in a separate building or in connection with the factory building itself. The kiln charges are usually transported by means of railed wagons.

9.5 The arrangement of phases of work into machining

The order of machining phases of different parts in furniture manufacture is generally that indicated in figs. 9.5 and 9.6.

9.6 Machining

Special attention in machining should be paid to following points:

Cut material is transported for edging usually on pallets, but a rotating circular sorting table or other methods can be used (fig.9.9). The edging saw machine usually saws from above and is provided with a feed chain and a return belt conveyor. The position of the blade is made visible on the surface of the board by means of a shadow-line device (fig.9.10).

The cross-cutting and edging are done according to a piece list. Other raw materials needed can also be marked on the same list (fig.9.11).

Band sawing

Band sawing is a necessary step in the manufacture of all curved parts (round tabletops, parts of chairs etc.). The sawing is done either along a drawn line (drawn with template) or with a jig

Surface planing, thickness planing and moulding

The cross-cut and edged pieces are usually first machined in a surface planing machine and thereafter in a thickness planing machine. The pieces emerge from these phases with a rectangular cross-section. The surface planing machine can be provided with an automatic feed attachment, which is installed on the rear table side (fig.9.7).

When more complicated profiles are machined, a four-side moulding machine is an efficient machine provided the production scale is big enough. In the furniture industry, especially machines like that of fig.9.12 are used. These have a long front table for planing the downside of boards.

Trimming to final dimensions

Trim sawing is done in a furniture factory using one of the machines listed below:

1. Single-blade circular saw bench (often with sliding table)
2. Single-blade trimming saw machine
3. Double-blade trimming saw machine
4. Double-end tenoning machine

1. The machining should be done in continuous through-feed whenever possible. This must be taken into account in the design phase already
2. Protective devices must always be used
3. Chip and dust exhaust system is a necessity
4. The use of tungsten carbide tipped tools is advantageous, especially when machining particle boards and very hard woods. Proper tool maintenance is of prime importance
5. The right choice of feed speed strongly affects the quality of finish
6. Automatic feed attachments (fig. 9.7) increase the machine capacity, quality of finish and safety
7. Machines with many working heads (e.g. four-side moulders, double-end tenoners, etc.) are advantageous in the case of large series. In small-scale production the setting costs are too high.

Below, some of the most important machining phases and their special features are treated briefly.

Cross-cutting and edging

Cross-cutting is done usually with a horizontally moving circular saw machine. The timber to be cut is usually loaded on a wagon, which can be pneumatically or hydraulically lifted (fig. 9.8) The cutter must possess a good working skill in order to achieve small material losses (usually 5...20 per cent). The cutting margin varies between 10 and 50 mm depending on the length of the pieces.

In small and medium-sized production a double-blade trimming saw machine (fig. 9.13) is very efficient and versatile, if

fitted with tilting bladee. This machine is particularly suitable for trimming panels.

A double-end tenoner trims the piece among many other machining phases like tenoning and moulding.

Mortising and boring

The mortises needed in furniture joints can be machined by means of the following machines:

1. Hollow chisel mortising machine
2. Chain mortising machine
3. Slot mortising machine
4. Oscillating mortising machine
5. Dowel hole boring machine

(fig. 9.14)

Hollow chisel mortising is the traditional way of making mortises. The tool is hand-fed. Therefore, the efficiency of this machine is small and this method is poorly suited for modern production.

Chain mortising is mainly used in the joinery industry for making deep mortises. Slot mortising machines make a hole rounded at the ends. The tenons must, accordingly, be machined in a special machine in order to achieve corresponding form. For this reason, the slot mortising machine is not used very widely.

Mortising machines with oscillating tools make a rectangular mortise like the hollow chisel mortising machine does. By combining several mortising units the capacity can be increased. The dowel joint is nowadays one of the most important jointing methode in furniture. The machining is usually done with multi-spindle boring machines where the standard pitch usually is 32 mm (fig. 9.15). For boring narrow parts of chairs, drawers etc. special spindle heads with fixed or adjustable spindle centres are used (fig. 9.16).

Tenoning

For machining corner-lock, groove-and-tongue, and stub tenon joints, the following machines are used alternatively:

1. Vertical spindle moulder with a special attachment
2. Single-end tenoning machine
3. Double-end tenoning machine

The tenoning machines proper are provided with many tool heads, and they also always trim the piece to be machined by length with the aid of circular blades (fig. 9.17 and 9.18).

Many models of double-end tenoners can be provided, in addition to horizontal and vertical working heads, also with router units which machine grooves as the working piece goes through the machine. The machine can be programmed to make different kinds of cut-outs and other complicated phases of machining.

Vertical spindle moulding

The vertical spindle moulder (fig. 9.19) is one of the most versatile machines used in furniture industry. The following working purposes are most common:

1. Grooves and rabbets
2. Roundings and more complicated profiles
3. Tenons and slits
4. Moulding with template

By means of a feed attachment the capacity can be considerably increased. The quality of finish is also improved and accident risk is diminished. A considerable proportion of accidents in furniture factories occurs in connection with careless use of a vertical spindle moulder.

Sanding

Sanding is the last working phase before assembly or surface finishing. The quality of surface finishing depends greatly of the quality of sanding. The most important sanding machines are nowadays:

1. Narrow-belt sanding machines
   - with vertical belt
   - with horizontal belt
2. Wide belt sanding machines
3. Special-purpose sanding machines
   - profile sanding machines
   - curve and form sanding machines

Narrow-belt sanding machines with vertical belt are especially used for sanding edges and sides of assembled drawers. Horizontal-belt machines are chiefly used for sanding veneered boards. The newest type of sanding machine is the wide-belt sanding machine, which has rapidly become prevalent in the furniture industry because of its versatility and good quality of finish. This machine is suitable for sanding solid parts as well as veneered boards. One construction principle is shown in fig.9.20.

Of the abrasives used in sanding belts, aluminium oxide is most important. Silicon carbide, however, is better suited for sanding hard species of wood. In sanding soft woods, belts with open structure of abrasive material are used. The backing is paper or cloth (for heavy sanding).

The sanding is best done in at least two separate phases, but sometimes a third sanding is necessary. The coarseness is usually selected as follows:

first sanding	number	50... 70
second sanding		80...100
third sanding		120...140

There is considerably danger of through-sanding when sanding thinly veneered boards (0,7 mm veneer), and thus in this case the numbers 50...70 should be avoided.

3.7 Veneering

The surface veneering of furniture is usually made with veneers of about 0,7 mm thickness. For veneering edges and for blindveneer (crossbanding) thicknesses of 1,5...3 mm are used. The veneer is cut with veneer saws or guillotines. Veneer sheets coming to surface veneering are usually composed according to fig.9.21.

The pieces are joined together with glue tape or zig-zag-machine. The tape has to be sanded away after veneering, but the plastic thread used in the zig-zag-machine melts and is left underneath the veneer.

Carbamide glue is used, and the pressing is done hot (100... 120°C) with a many-plated hydraulic press. Recently, a type of press presented in fig.9.22. has become more common. The boards are fed to the press by means of a moving steel band. For edge veneering, devices with pneumatic cylinders or firehose presure units are used (figures 9.23, 9.24, 9.25 and 9.26). The pressure of compressed air in the network of a factory is usually 6...8 kp/cm^2. In large factories, edge veneering machines (fig.9.27) are already quite generally used. These machines have several additional working units.

Formerly, assembly was always the next phase after machining. Nowadays one usually strives to complete the surface finishing before assembly whenever possible. In this connection, the curtain coating machine can be used advantageously. The main phases of assembly are the following:

1. Detail assembly (drawers, frames, bases etc.)
2. Final assembly (cabinet cupboard frames etc. are fitted into parts coming from detail assembly

The glue used in assembly commonly is PVA-glue which sets rapidly and is strong.

The most important tools and equipment are the following:

1. Glue spreaders (fig. 9.28 and 9.29)
2. Dowel driving machines
3. Staple guns
4. Mechanical screw drivers
5. Assembly jigs (fig.9.4)
6. Frame and carcass clamps (fig. 9.30)

All manual fitting should be avoided in assembly.

Assembly series cannot usually be made as big as the machining series, because of storage space limitations. For this reason,

assembling is done in smaller lots according to orders received. It is possible, however, to store the products as ready-machined parts even in the case of very large production series. In order to improve the competitive capacity of the factory, one can in this way try to achieve short delivery times.

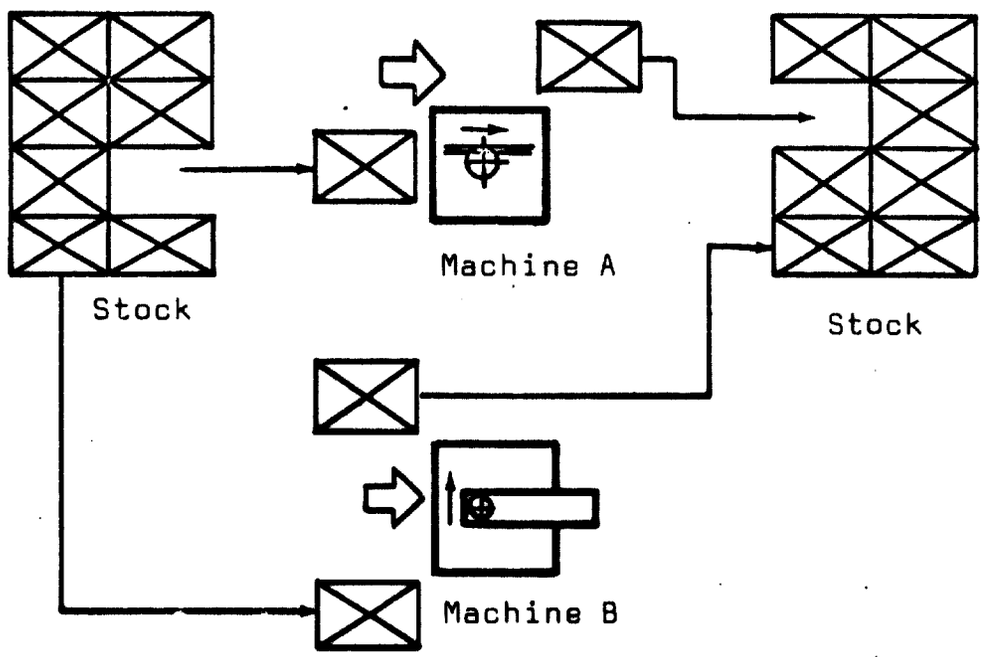


Fig. 9.1 Stock areas between different stages of manufacture.

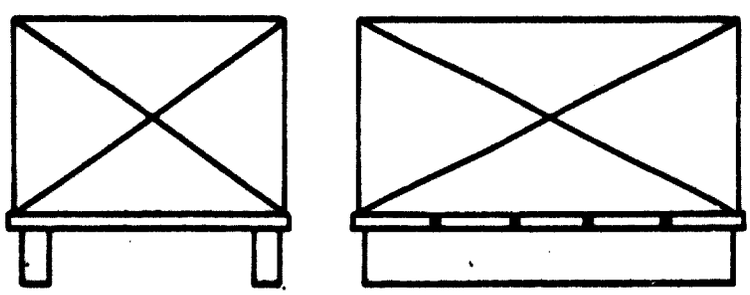


Fig. 9.2 Pallet

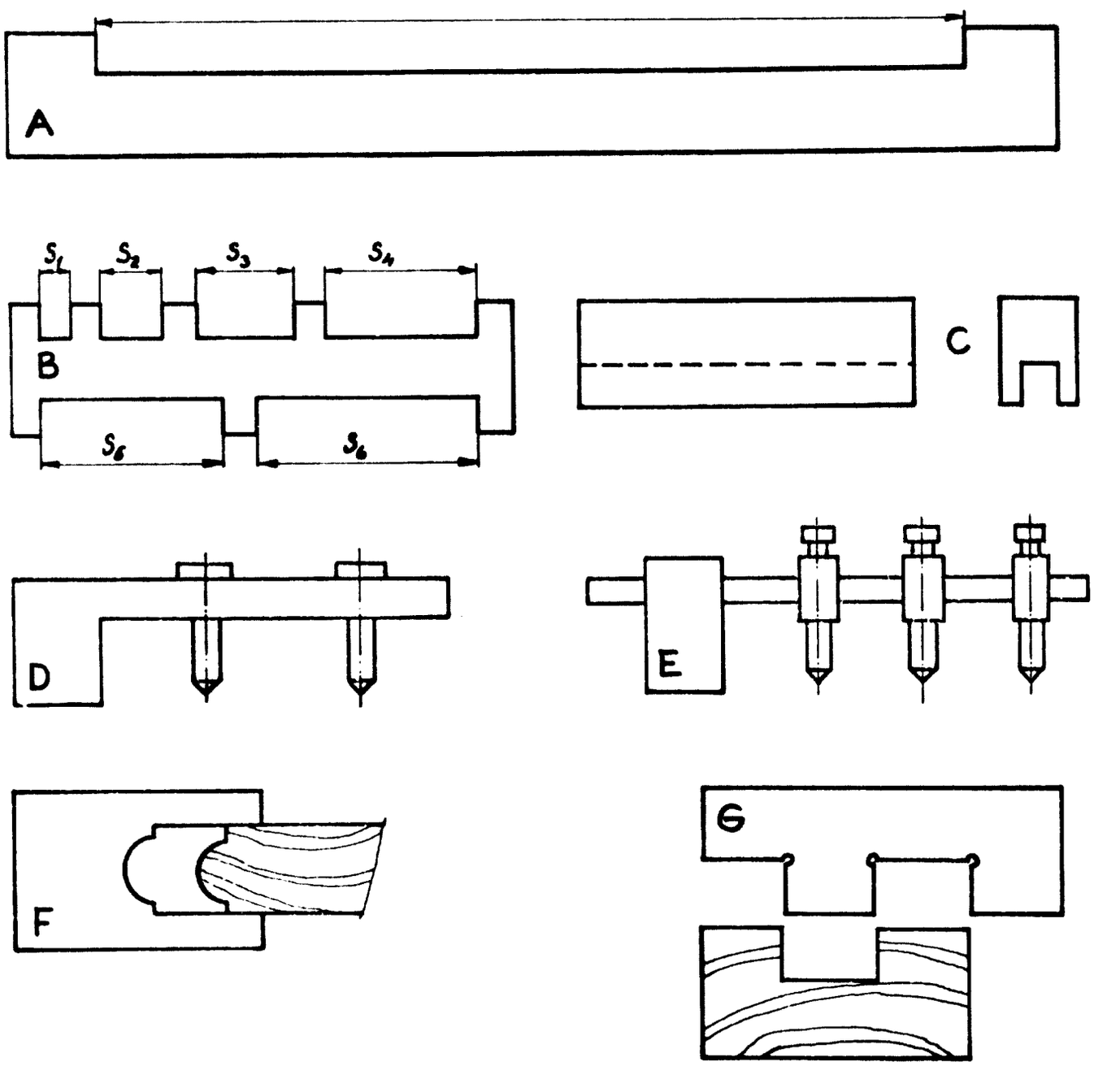


FIG. 3

Gauges and templates for different measuring purposes.

A: length for trimming
B: thickness (for thickness planing)
C: thickness (of tongue, etc.)
D: dowel joint pitch
E: dowel joint pitch
F: profile
G: profile

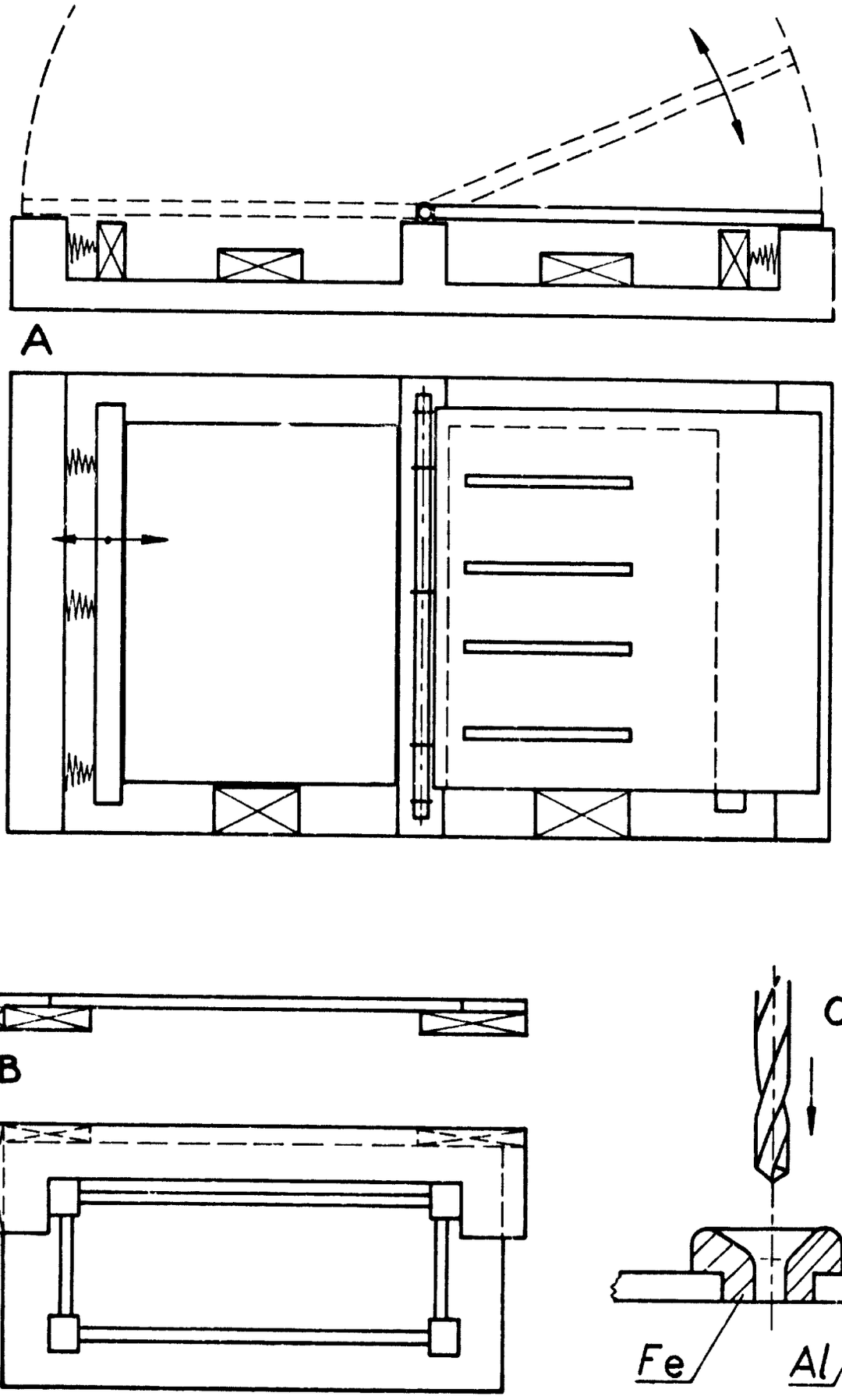


FIG. 4

A: Jig for fixing of wooden draw supporting strips by staple gun on inside surfaces of left and right panel of drawer unit
B: Assembly jig fixing of cabinet base
C: Detail of boring jig.

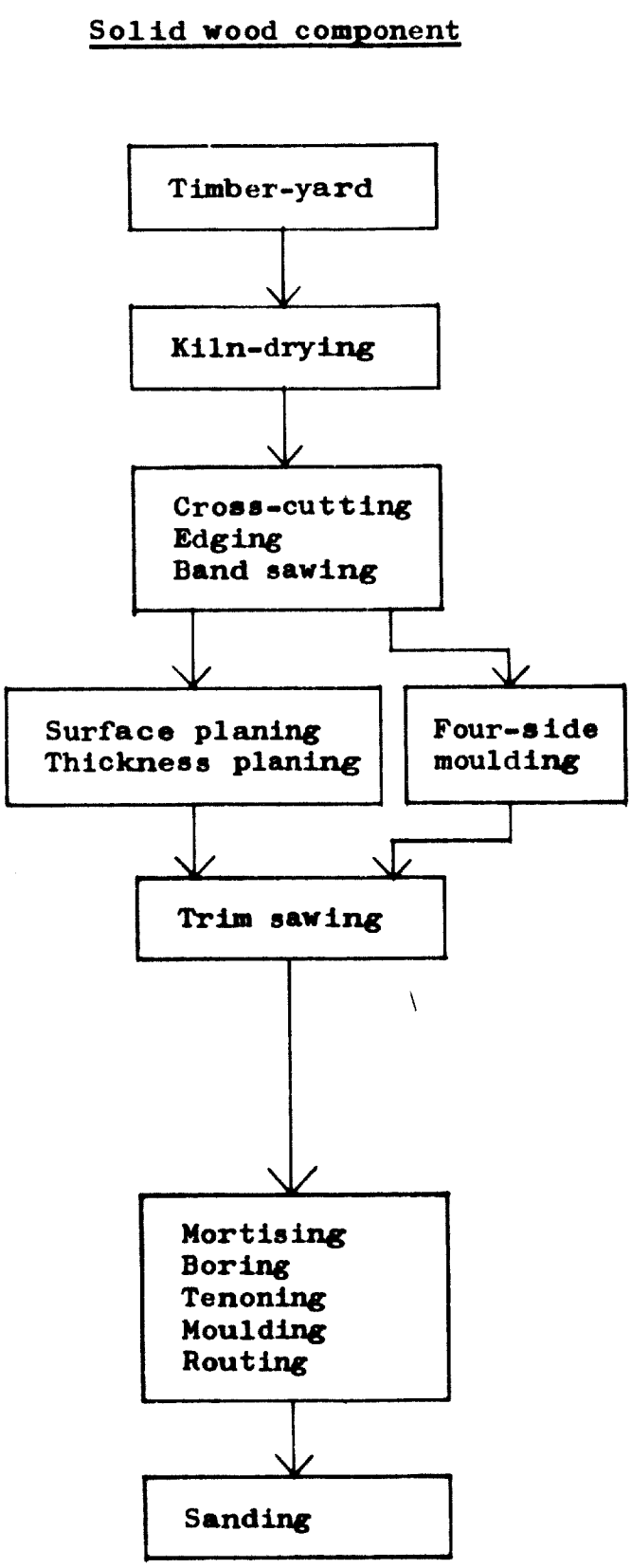


FIG 5

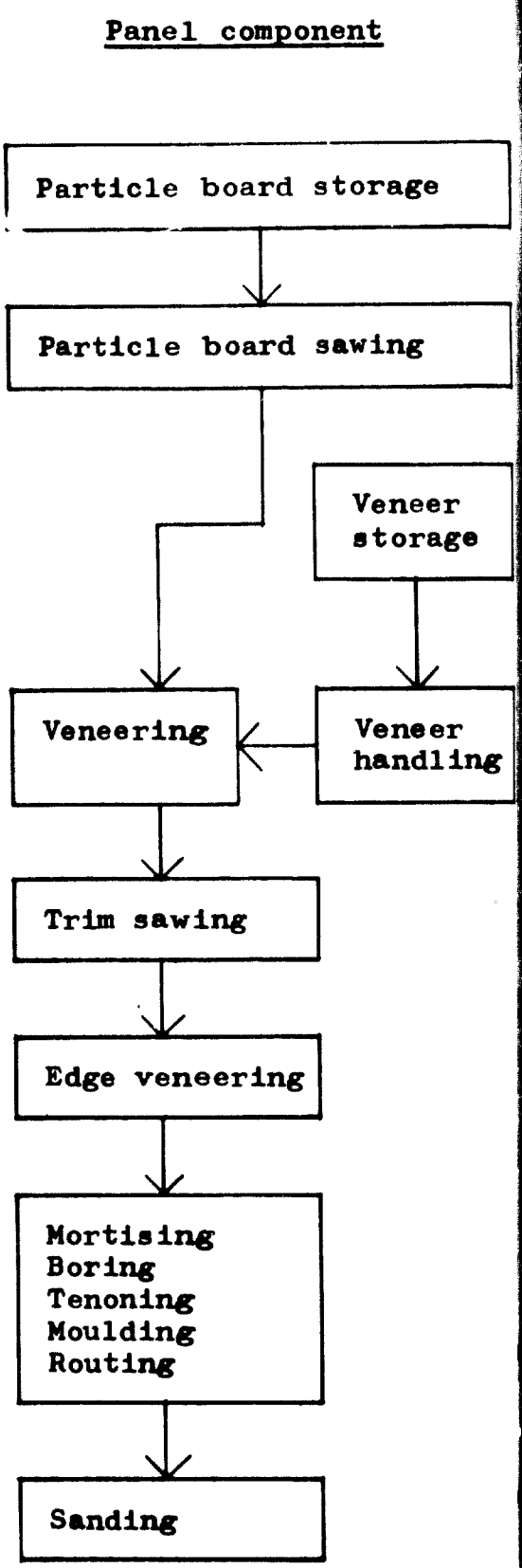


FIG 6

Order of machining phases in furniture factory

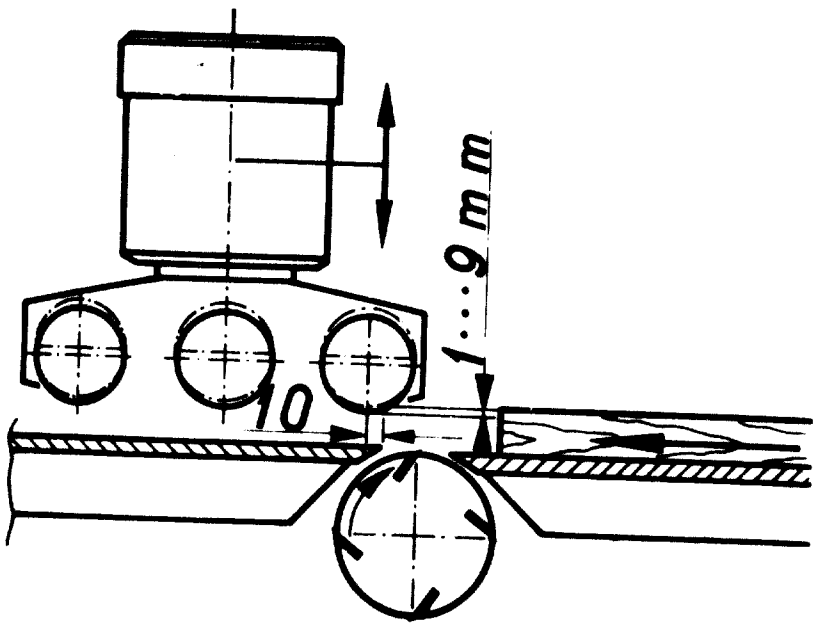


Fig. 9.7

Placement of automatic feed attachment

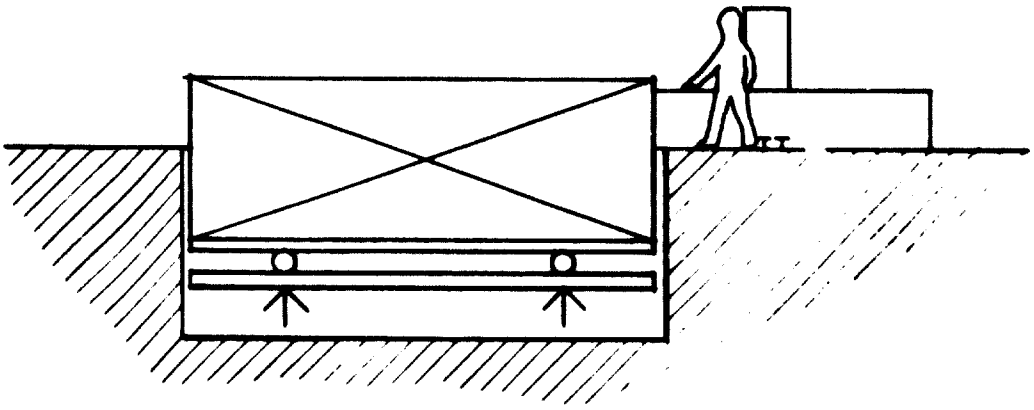


FIG 8
Timber wagon on lift-table

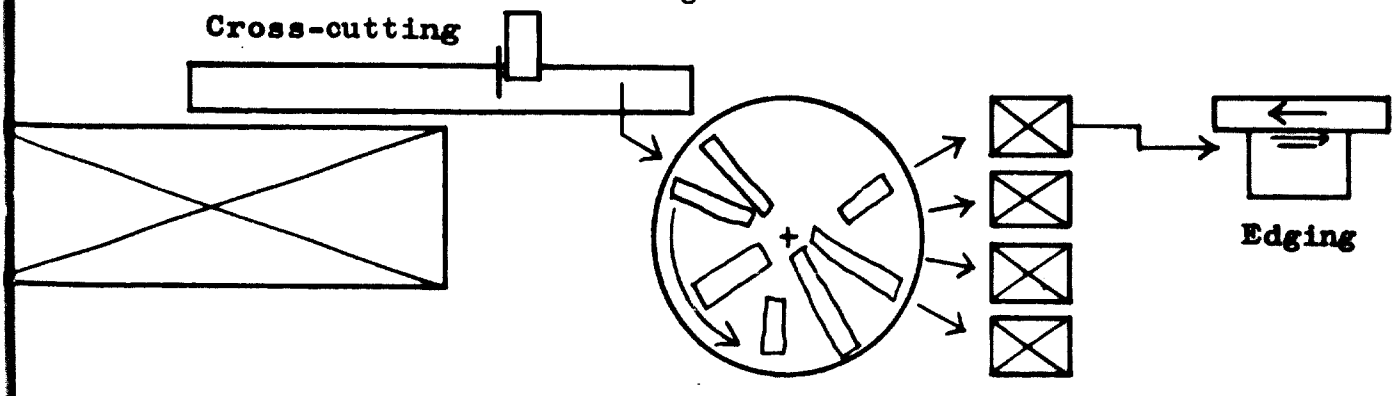


FIG 9
Rotating circular sorting table between cross-cutting and edging phases.

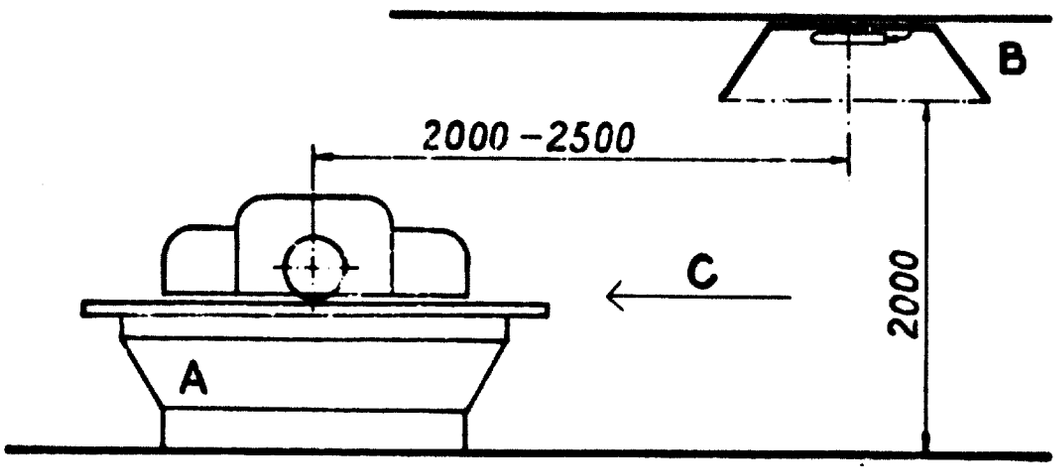


FIG.9.10

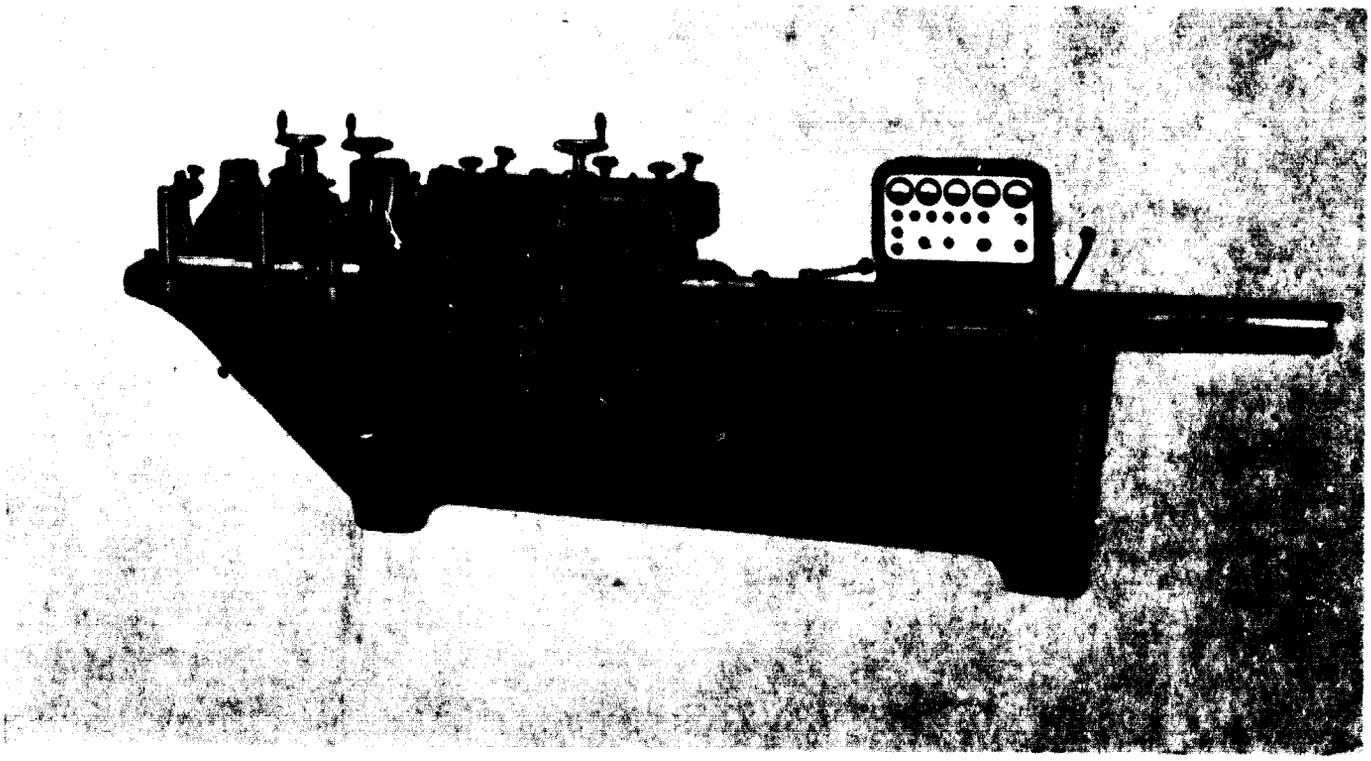
Edging saw (A) with shadow-line device (B)

FIG. 9.11 Piece list for cross-cutting and edging

PIECE LIST

Product:

Pcs.	Item	Wood, particle board, etc.					Blindveneer		Surface veneer Plastic laminates, etc.			Remarks
		Final dimension			Material	Quality	Material	Thick-ness	Material		Thick-ness	
		Length	Width	Thick-ness					Face	Reverse		



Direction of feed

Fig. 9.12

Four-side moulding machine with long front table

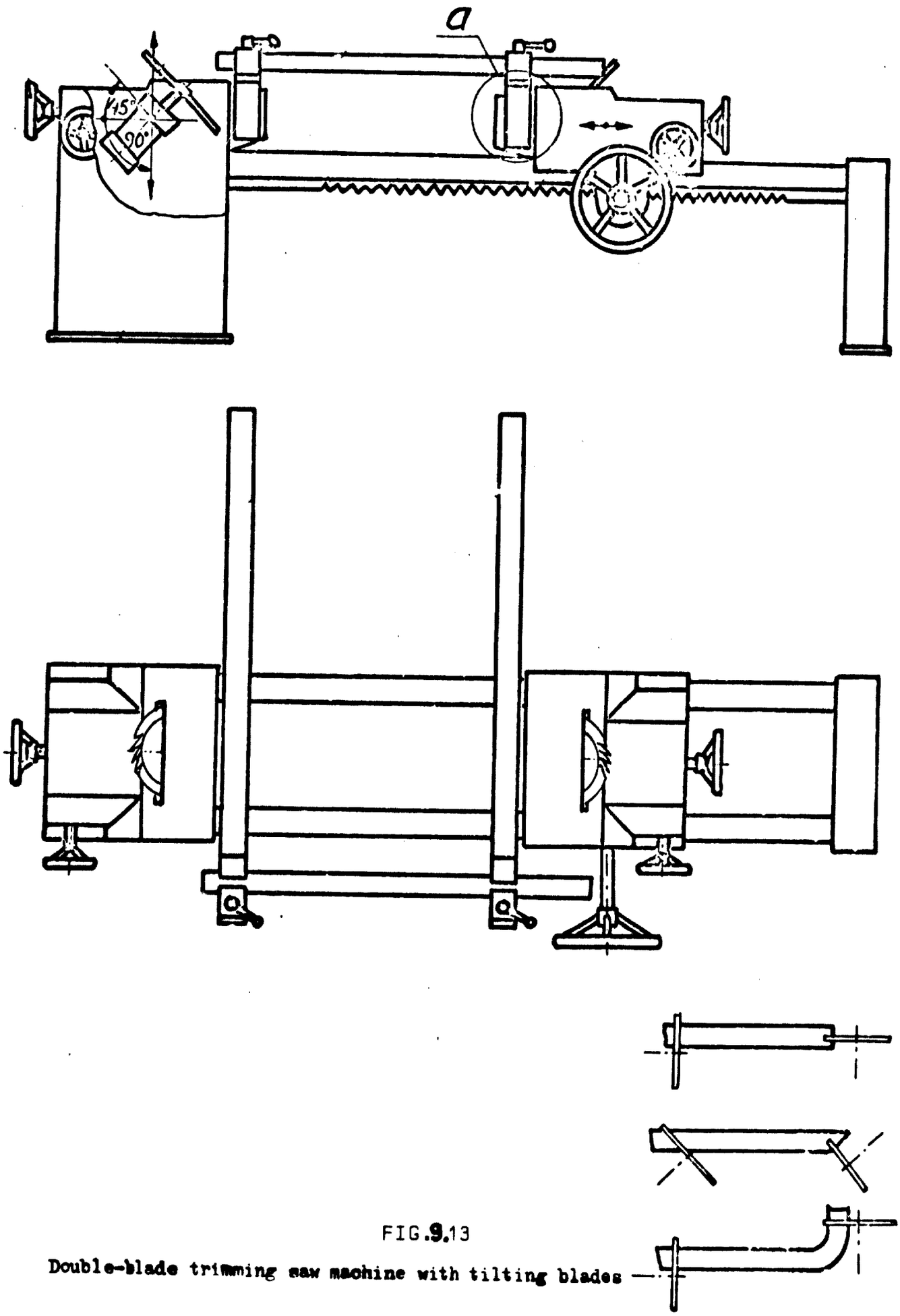


FIG.9.13

Double-blade trimming saw machine with tilting blades

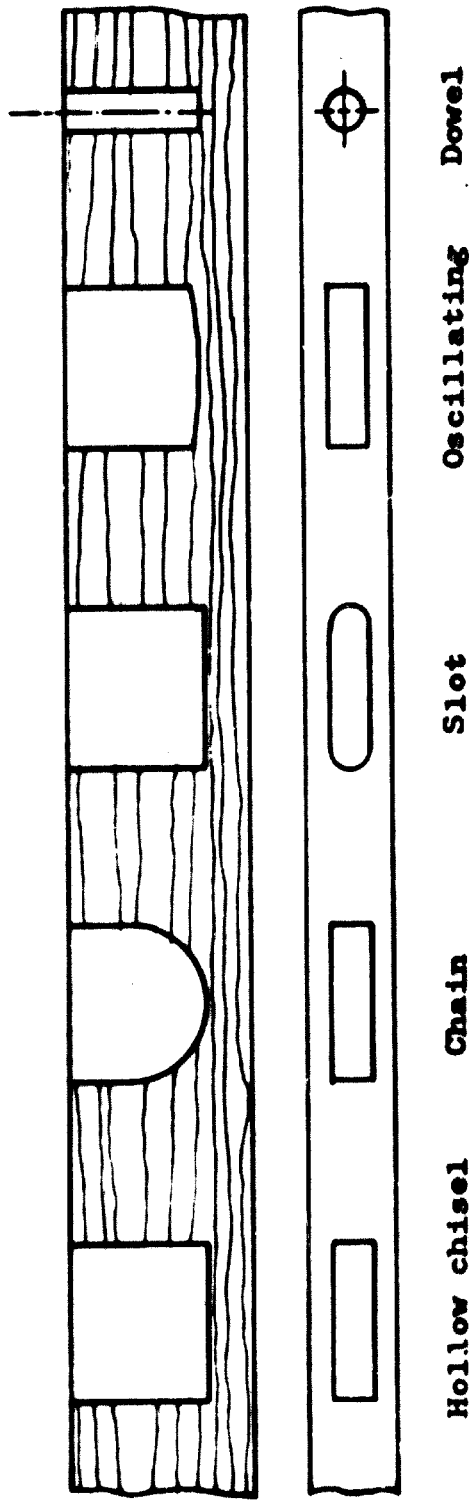
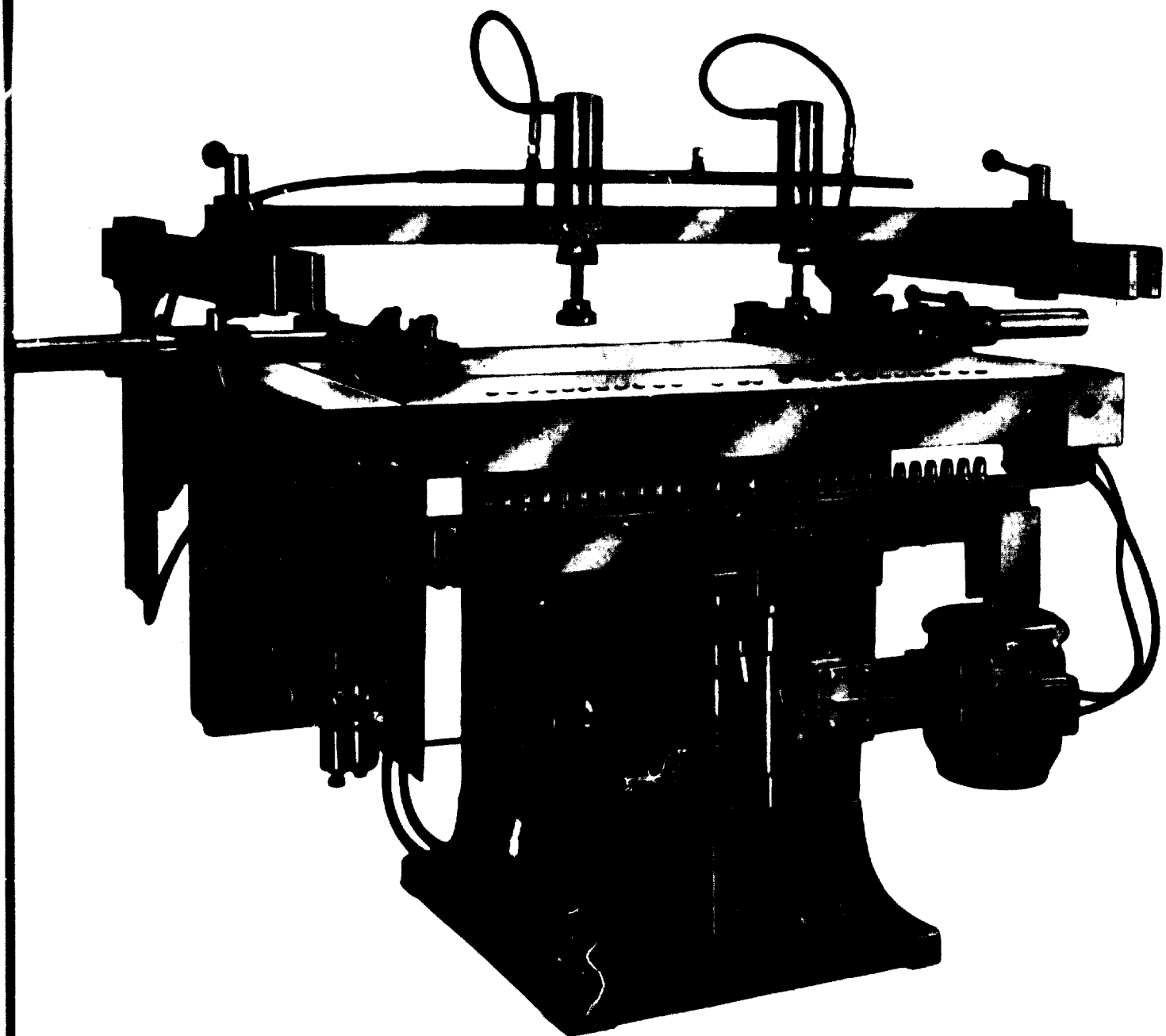


FIG. 14

Mortises produced by different mortising machines



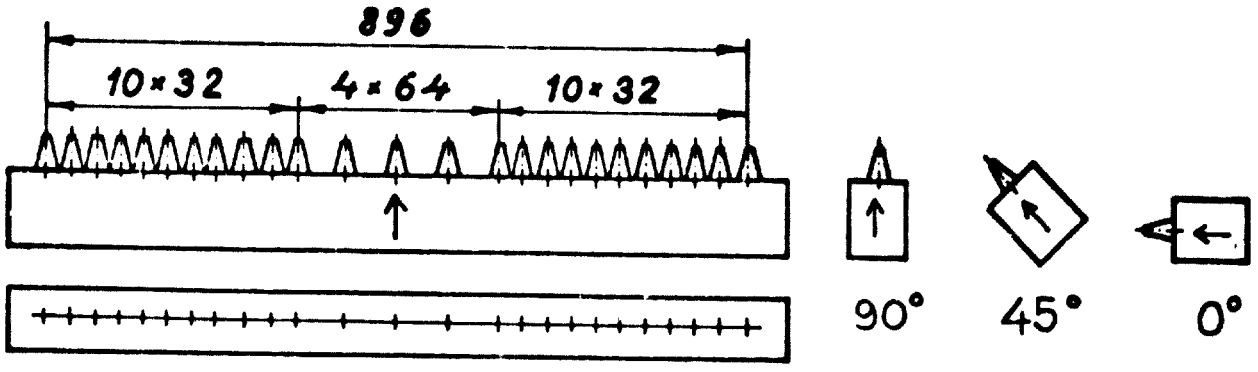
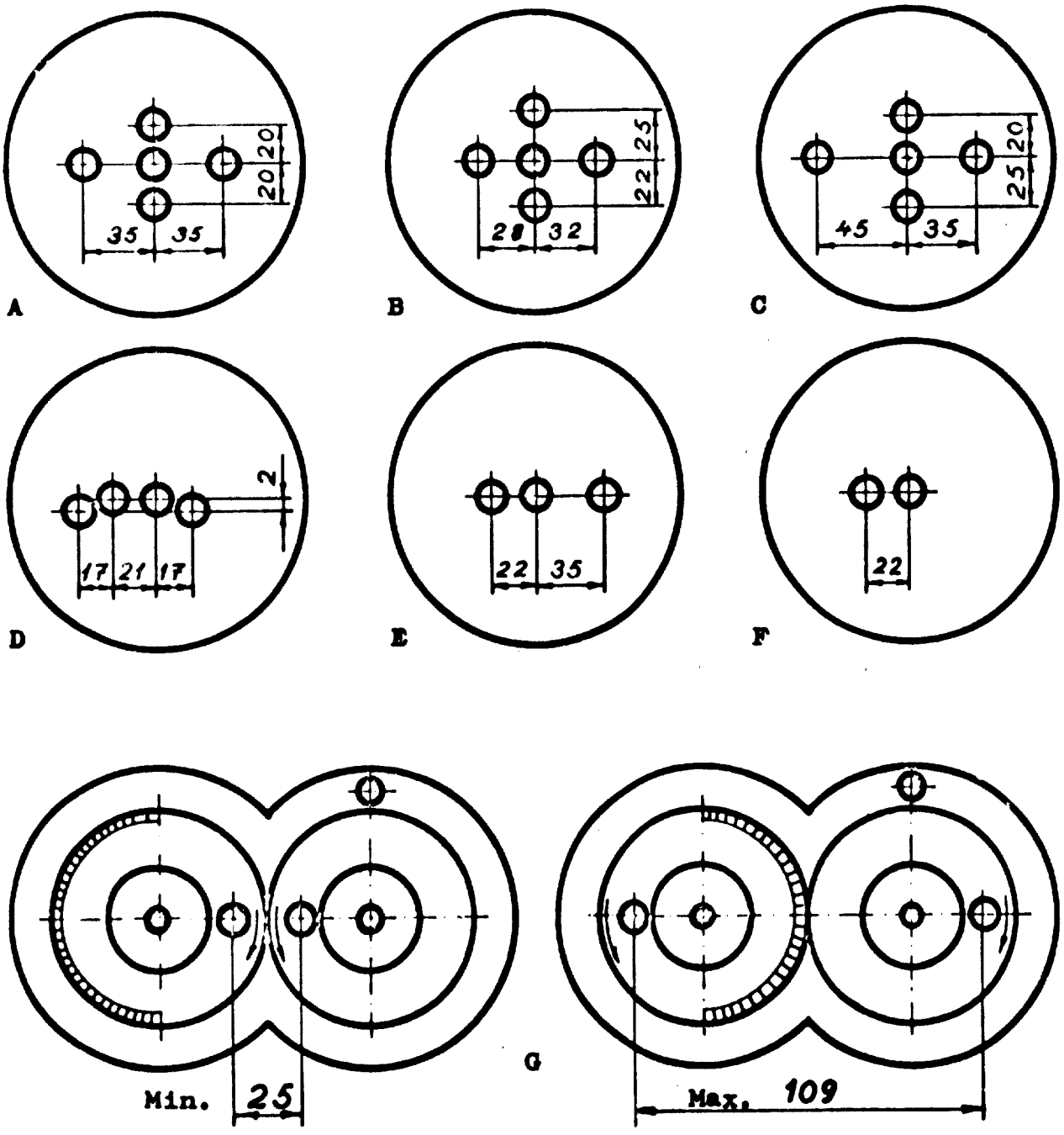


FIG. 15

Multi-spindle boring machine. Detail shows construction of spindle head with standard pitch.



A,B,C,D,E,F : With fixed spindle centres

G : With adjustable spindle centres

FIG 16

Spindle heads for boring narrow furniture parts.

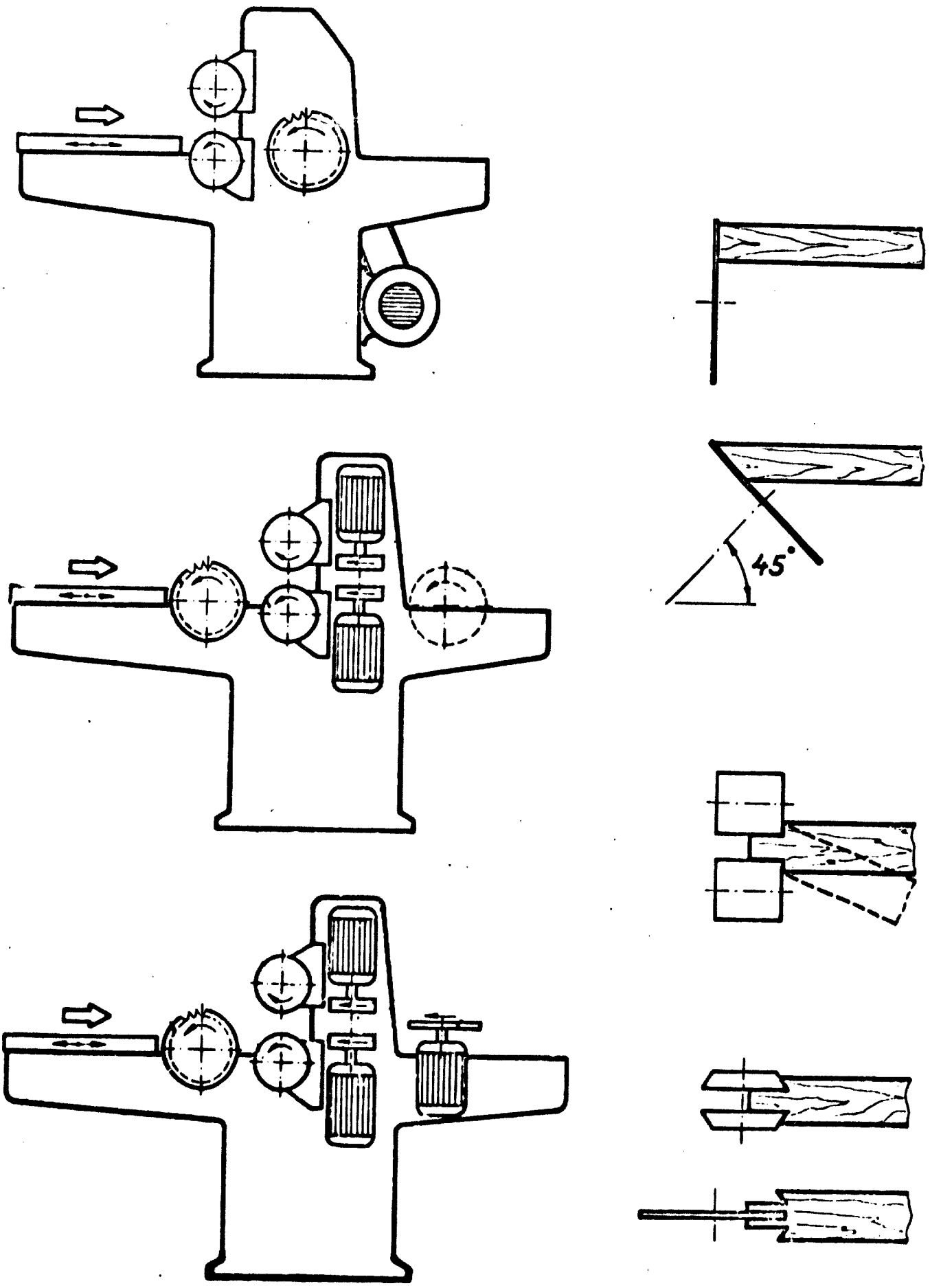


FIG. 17

Different constructions of simple-end tenoning machine

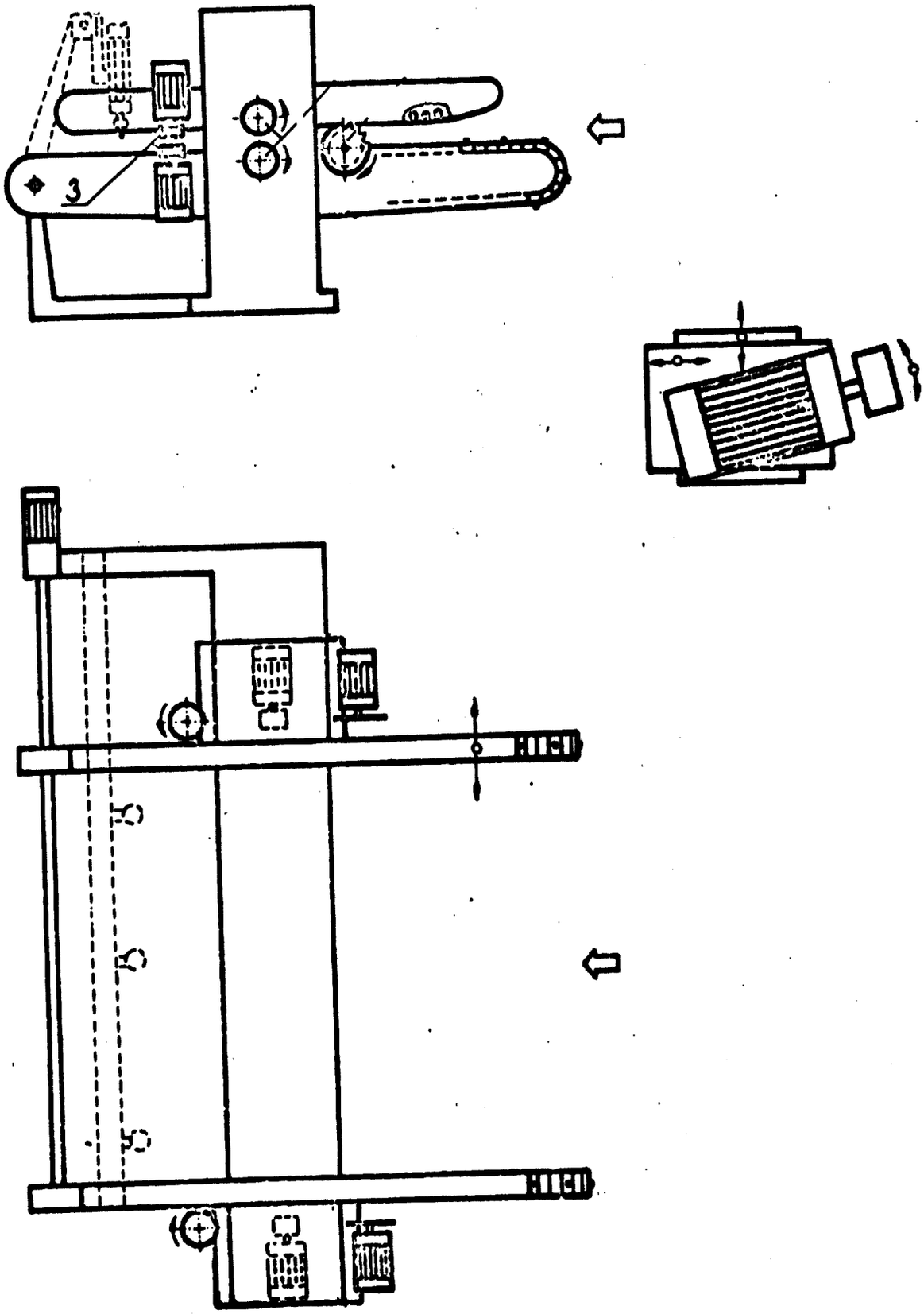


FIG. 10

Double-end tenoning machine

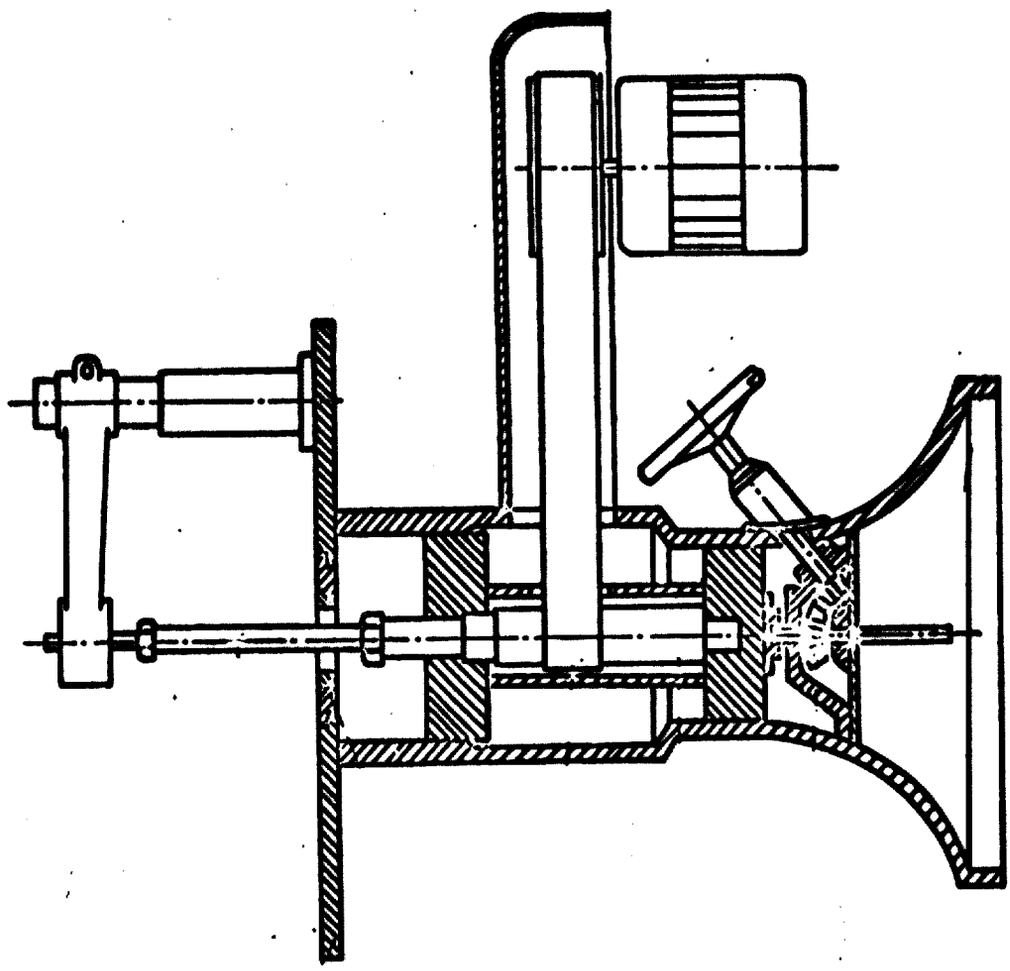


FIG 19

Vertical spindle moulder

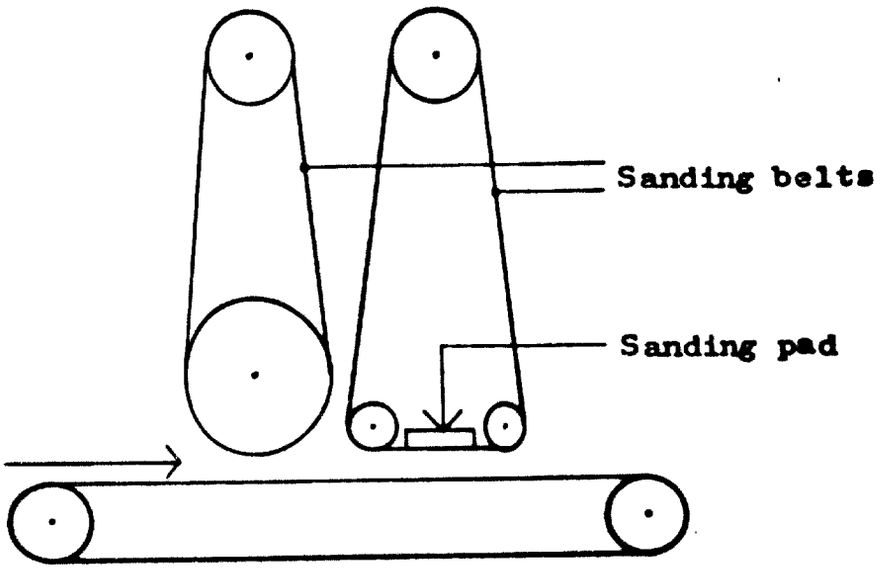


FIG. 20

Wide-belt sanding machine

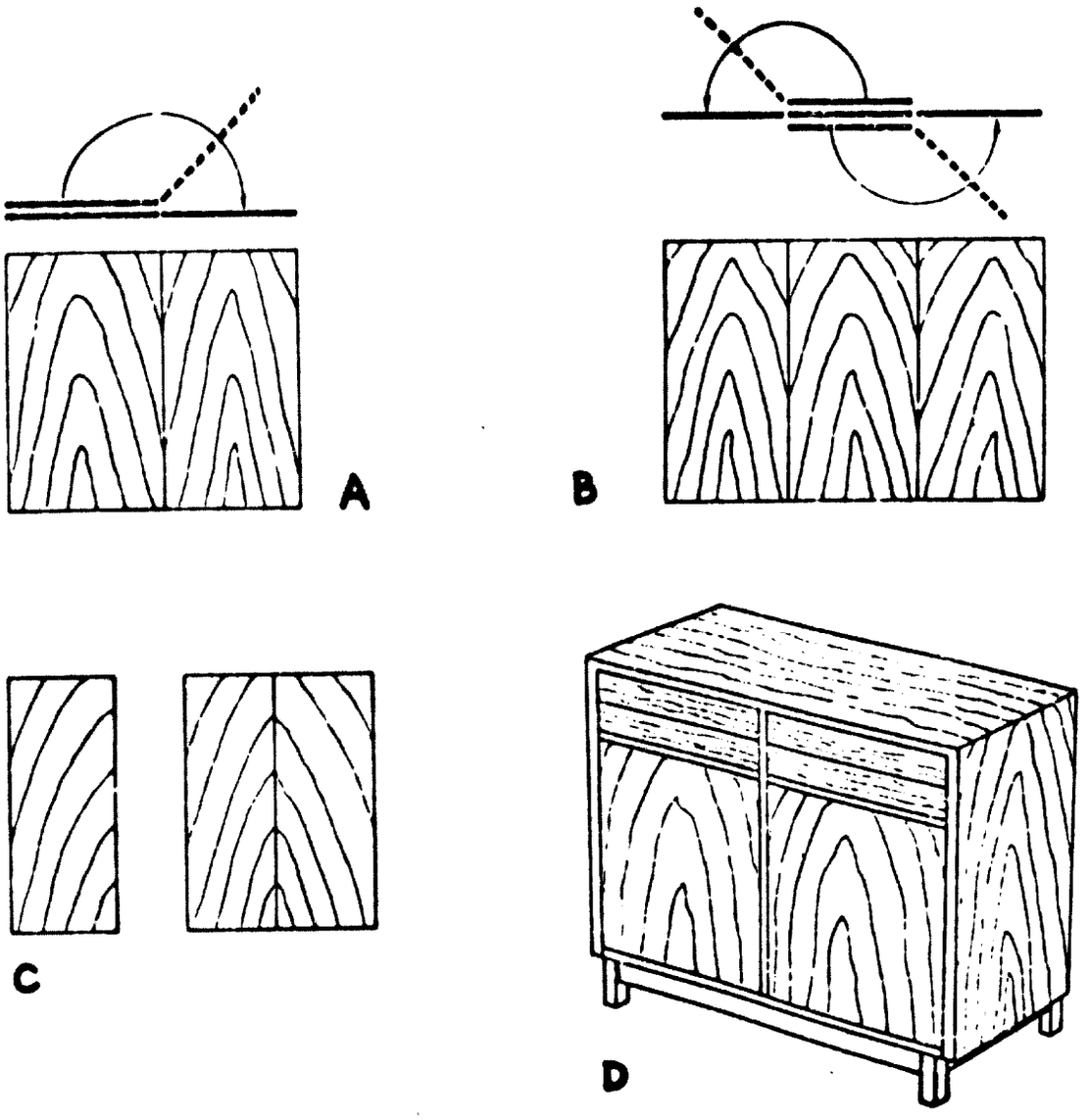


FIG. 21

Composing of veneer sheets

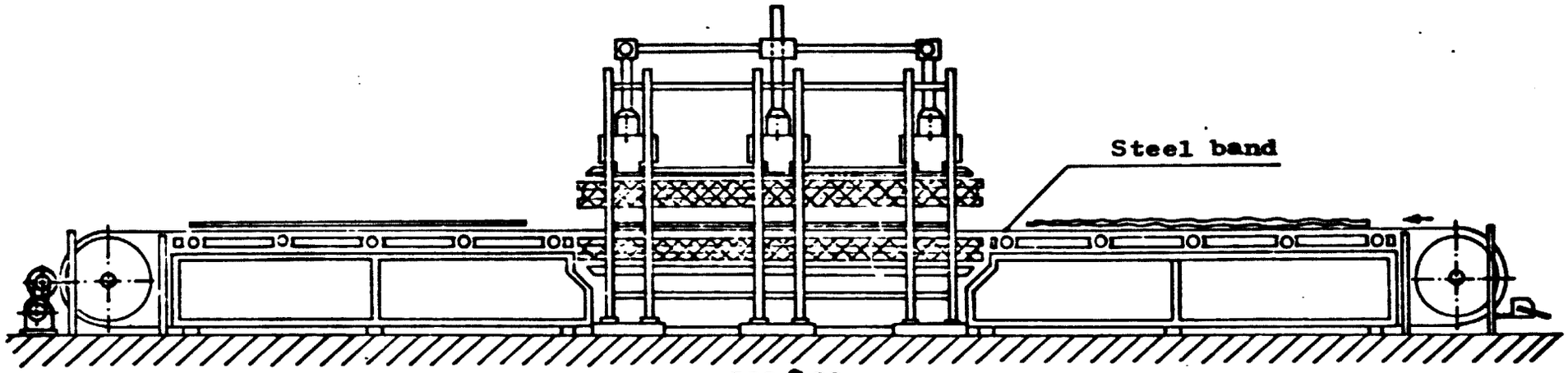


FIG 9.22

Hydraulic veneering press with steel band feed conveyor

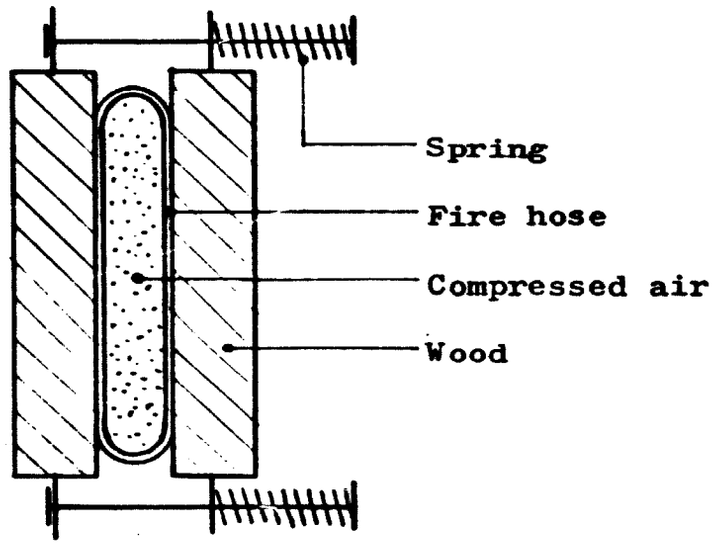


Fig. 9.23

Principle of fire-hose pressure unit

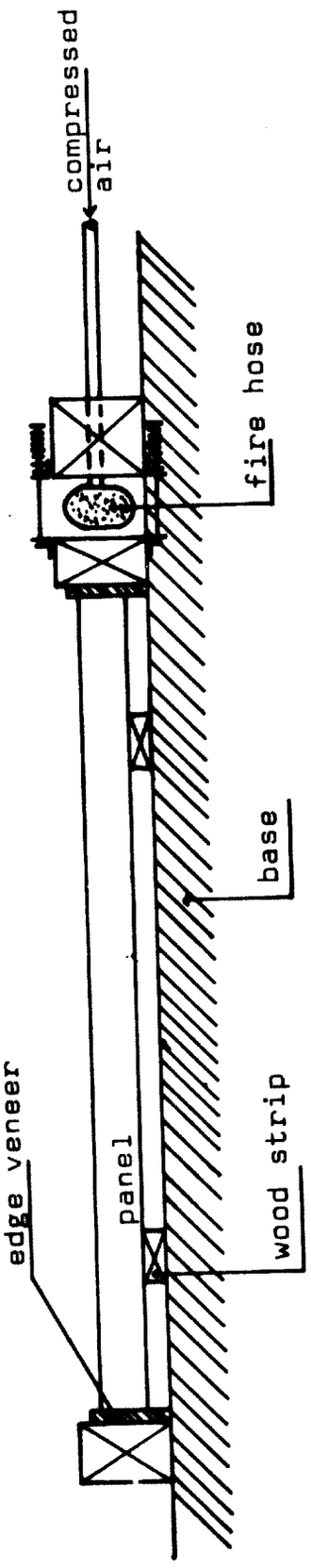


Fig. 9.24

Set-up for edge veneering using fire-hose pressure unit

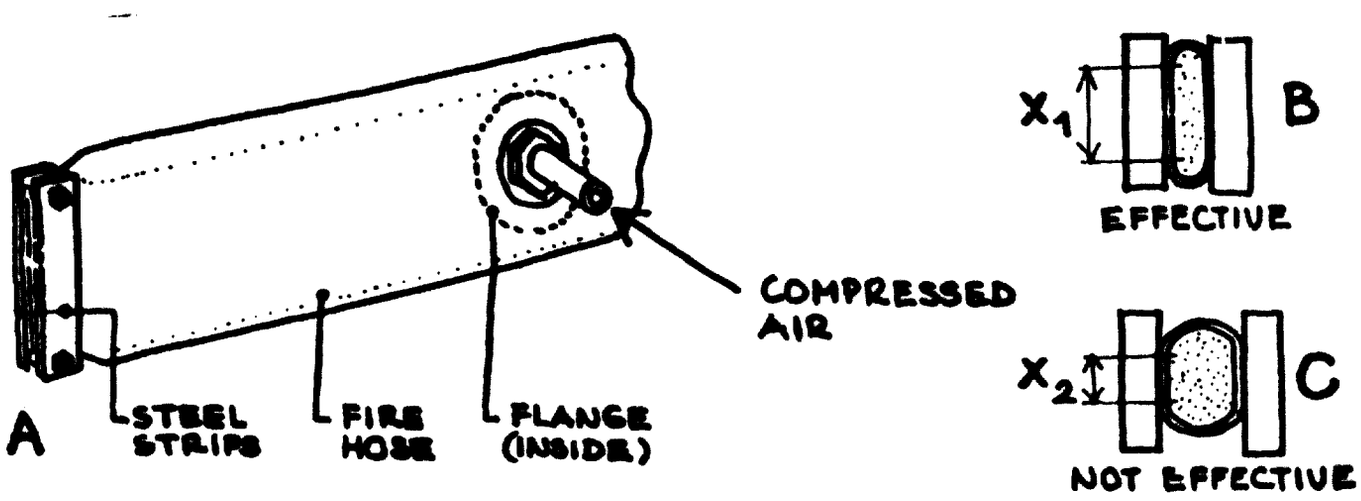
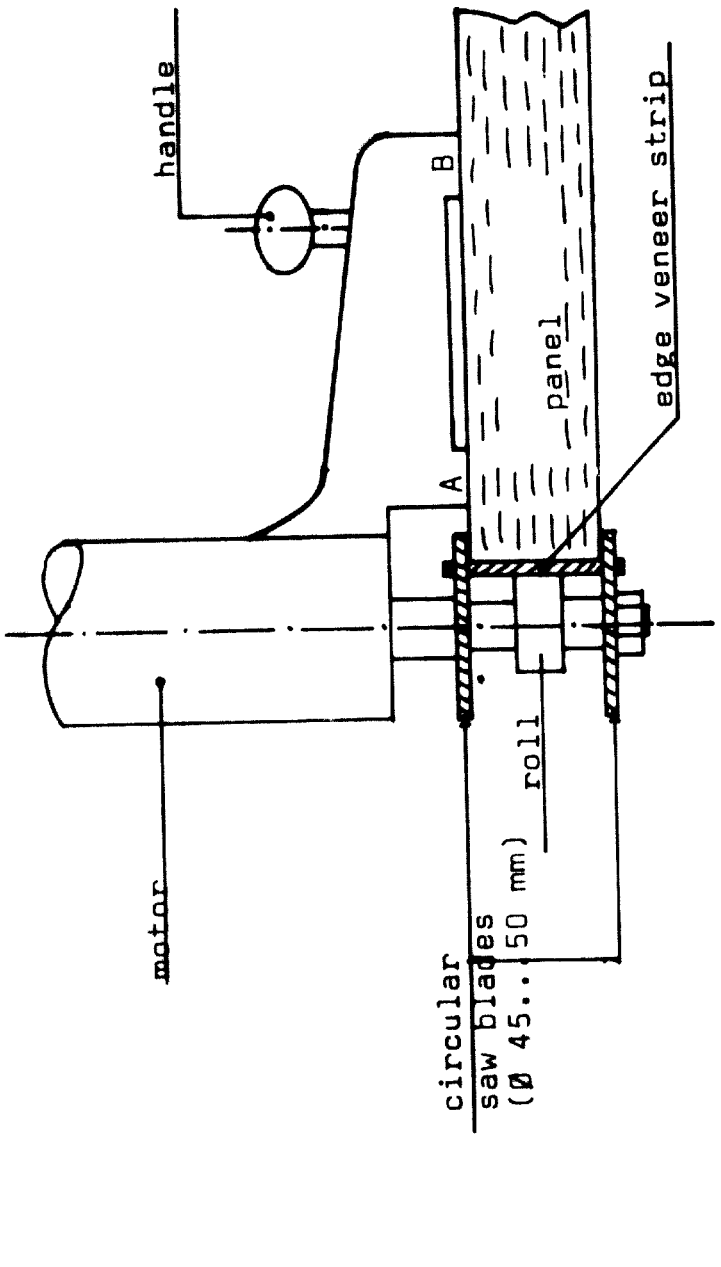


Fig. 9.25

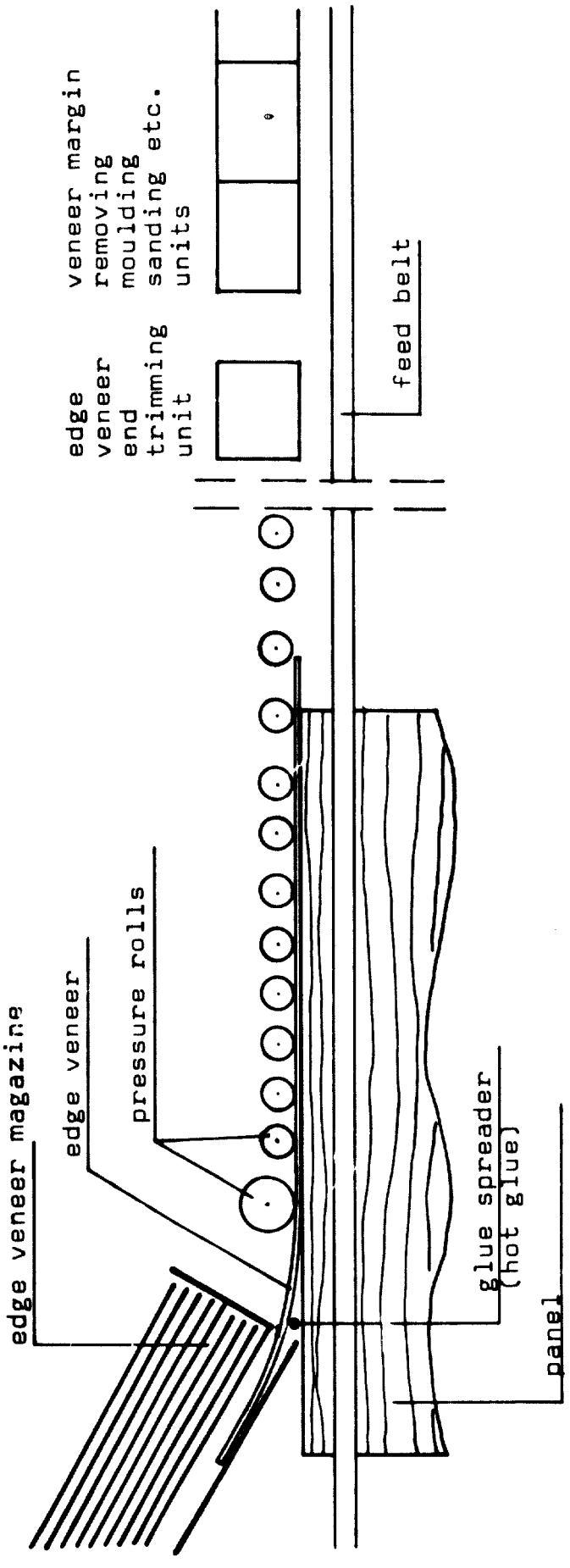
A: Construction Unit

B, C: Pressure force is directly dependent on contact with surface



A, B = guiding surfaces

FIG. 9.26 **Hand-guided machine for sawing of edge veneer work margin**



(seen from above)

FIG. 9.27

Principle of automatic veneering machine with additional working units. Machine uses thermoplastic glue

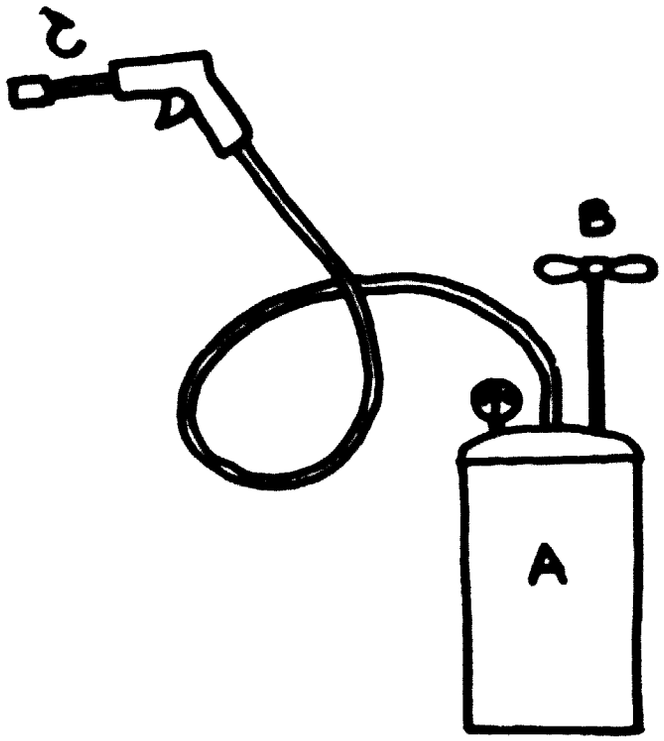


FIG. 9.28

Glue spreader for furniture joints

A: Glue tank (glue under pressure)
B: Hand pump for producing compressed air
C: Glue pistol with interchangeable nozzle (different forms for different joints)

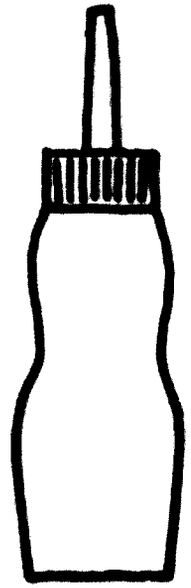


FIG. 9.29

Solt plastic bottle is a practical and effective glue spreader for joints

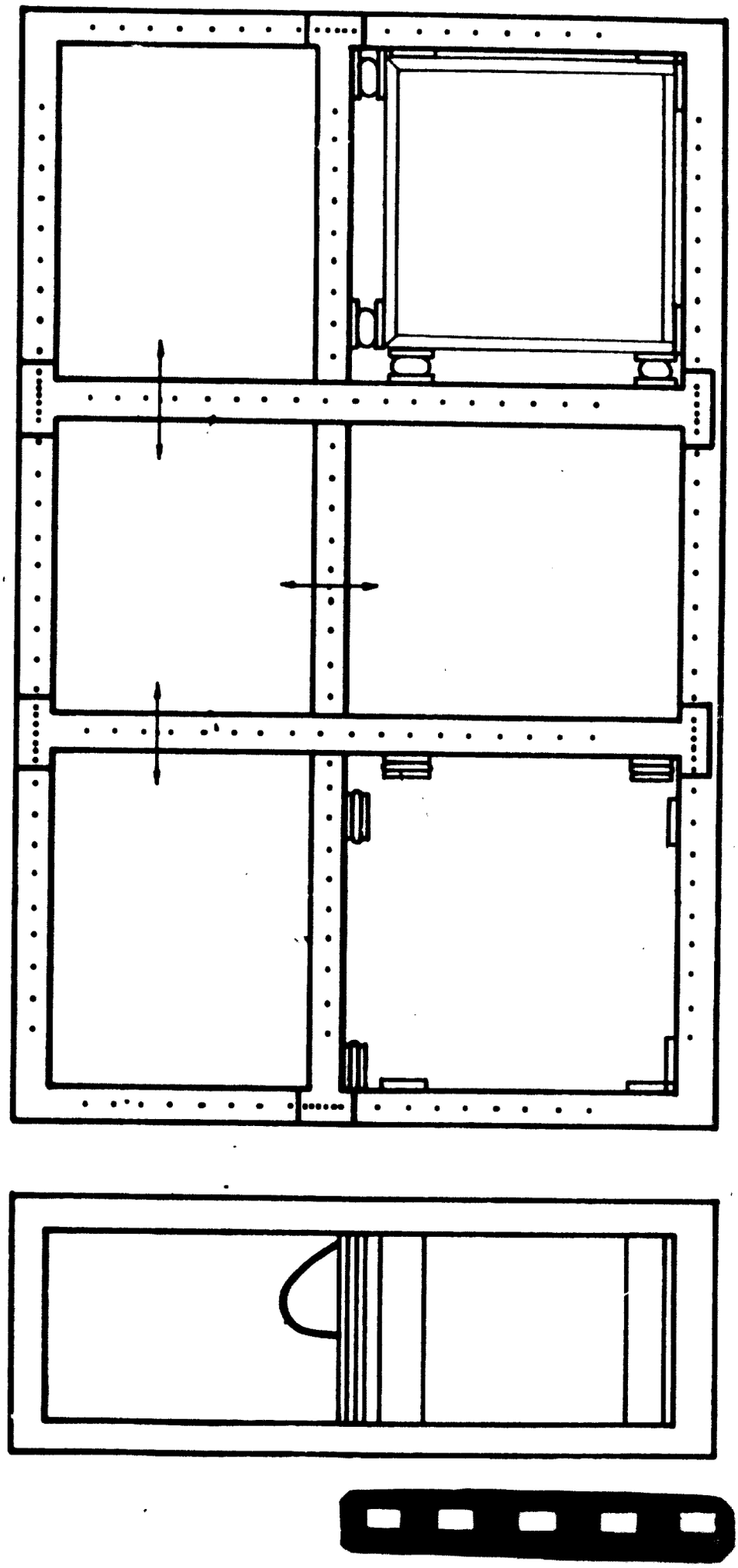
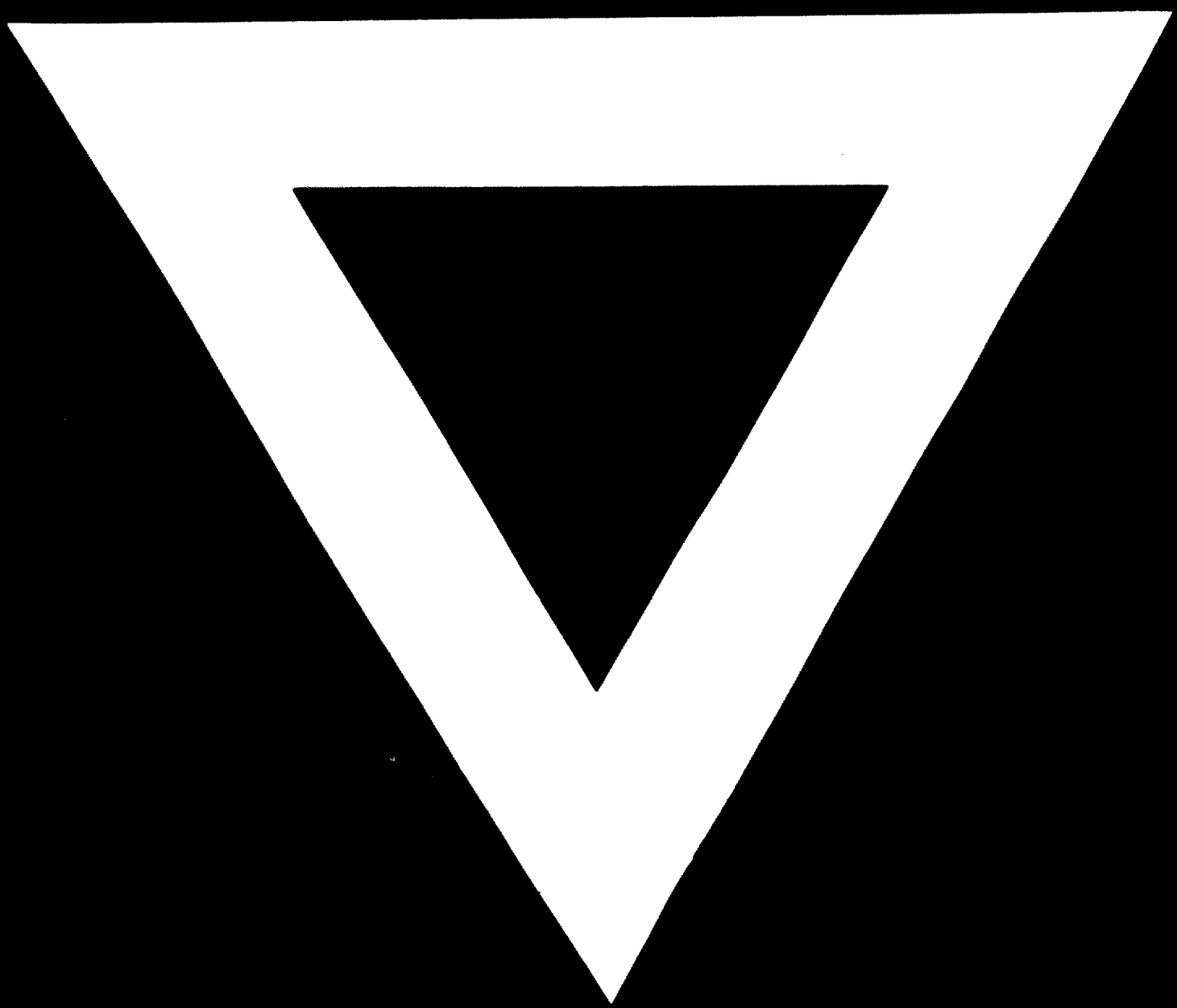


Fig. 9.3 Carcass clamp with fire-hose pressure units. Two cabinets can be assembled at the same time.



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