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United Nations Industrial Development Organization

ORIGINAL: ENGLISH

MULTI-PURPOSE MACHINES AND MULTI-PURPOSE PROCESSING LINES FOR THE WOODWORKING INDUSTRY [1]

by

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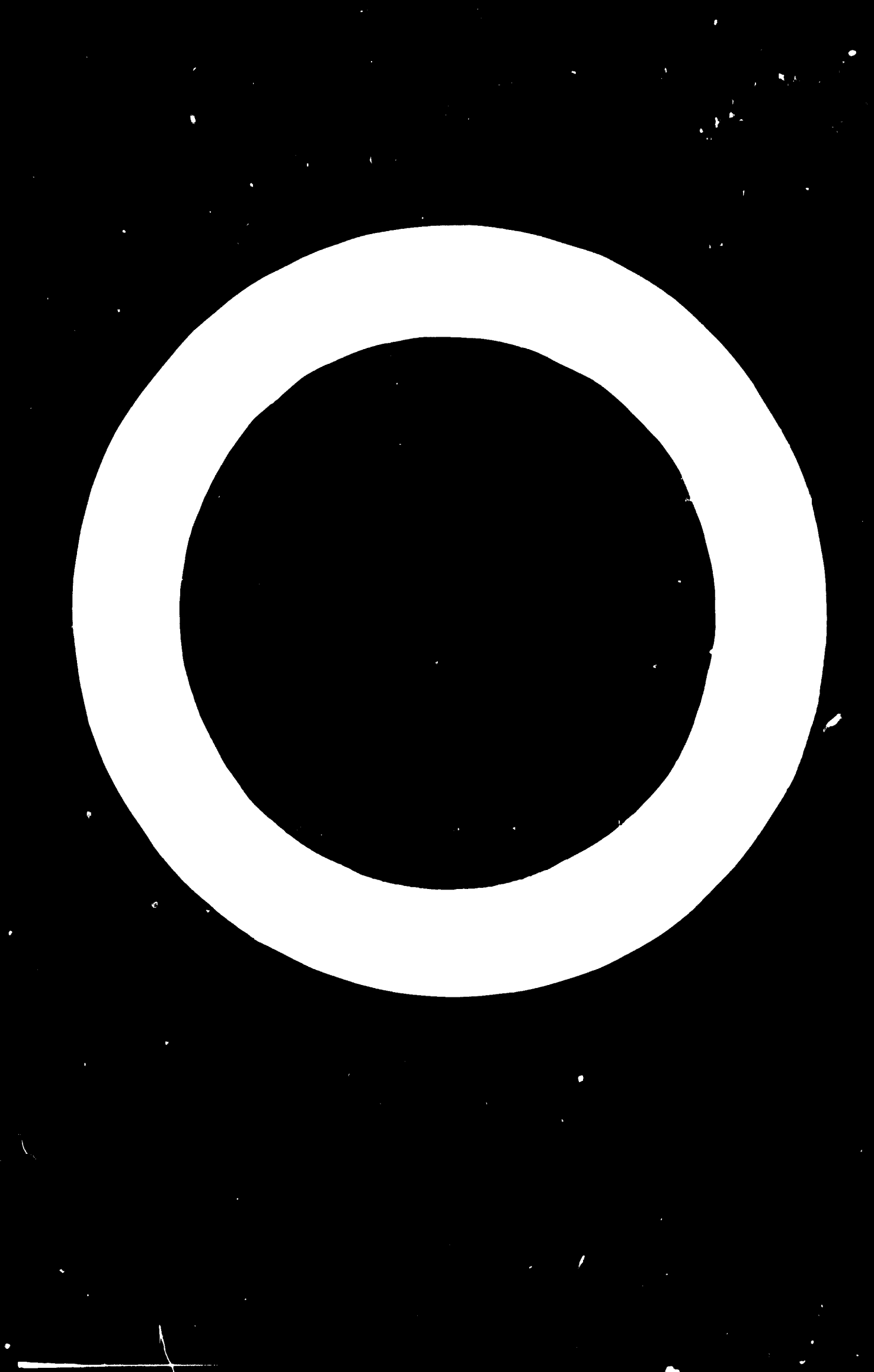

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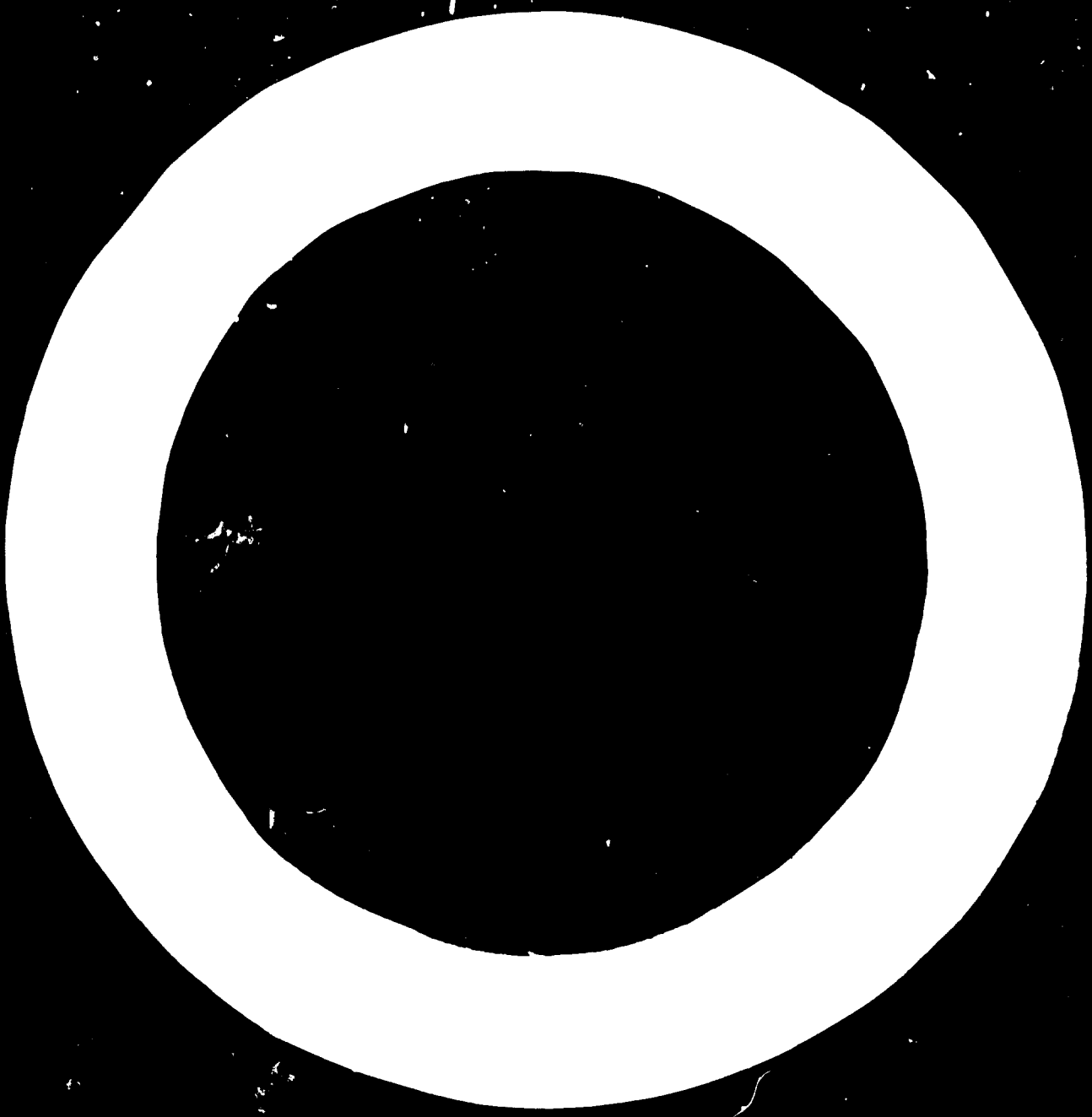


I. DEFINITIONS

1. Multi-purpose Machines

1. A multi-purpose machine uses several different working methods. In machines of this type workpieces, after initial entry, are fully processed without further manual assistance. A multi-purpose machine is also termed a "machine combination based on the sequence of machining operations". Workpiece handling between operations is eliminated.

Definition:

A multi-purpose woodworking machine is a unit covering several different machining heads of different processes on which workpieces, after initial entry, are processed without any manual assistance before being rejected.

2. In metalworking these machines are mostly called machining centres. The automated production technique in the woodworking field requires more and more production lines which can be established by linking multi-purpose machines or by linking basic units, machining cannot be compared with a simple multi-purpose machine.

2. Multi-purpose Processing Lines

3. Multi-purpose processing lines can be of the linked version or of the transfer system. A linked line can be of a sequence

of individual single operation machines,
of multi-purpose machines, or
of multi-purpose and single operation machines.

Transfer systems incorporate besides machining and/or assembling operations handling operations.

Definition:

A multi-purpose processing line is a production facility of linked multi-purpose machines and individual single operation machines or ready built transfer systems which include handling and repositioning operations.

Workpieces ready for assembly or for surface treatment.

II. CLASSIFICATION OF MULTI-PURPOSE MACHINES AND MULTI-PURPOSE PROCESSING LINES

4. Incorporated in the following descriptions and analisis is a classification system for both groups of machinery which appears in compact form as Annex I in this paper, and as Annex II in th paper entitled "Standardized Classification and Terminology for Woodworking Machinery" (ID/WG.151/14).
It is an expansion of the present EUMABOIS class 8, represents current development trends, and allows for additions as they may occur.

III. DIFFERENT MULTI-PURPOSE MACHINES (81) AND THEIR APPLICATION

1. Machines for making Joints (81.1)

81.11 Tenoning machines

81.111 Single-end tenoning machines

81.111.1 Combined circular saw and spindle moulder-tenoner

81.111.2 Standard single-end tenoner

81.111.21 with horizontal saw-spindle and vertical tenon-spindle

81.111.22 with horizontal saw-spindle and two horizontal tenon shaper heads

81.111.3 Combined single-end tenoner and spindle shaper

81.112 Double-end tenoning machines

81.112.1 with sliding table (reciprocating operation)

81.112.2 with rotating feed clamp

81.112.3 with continuous feed

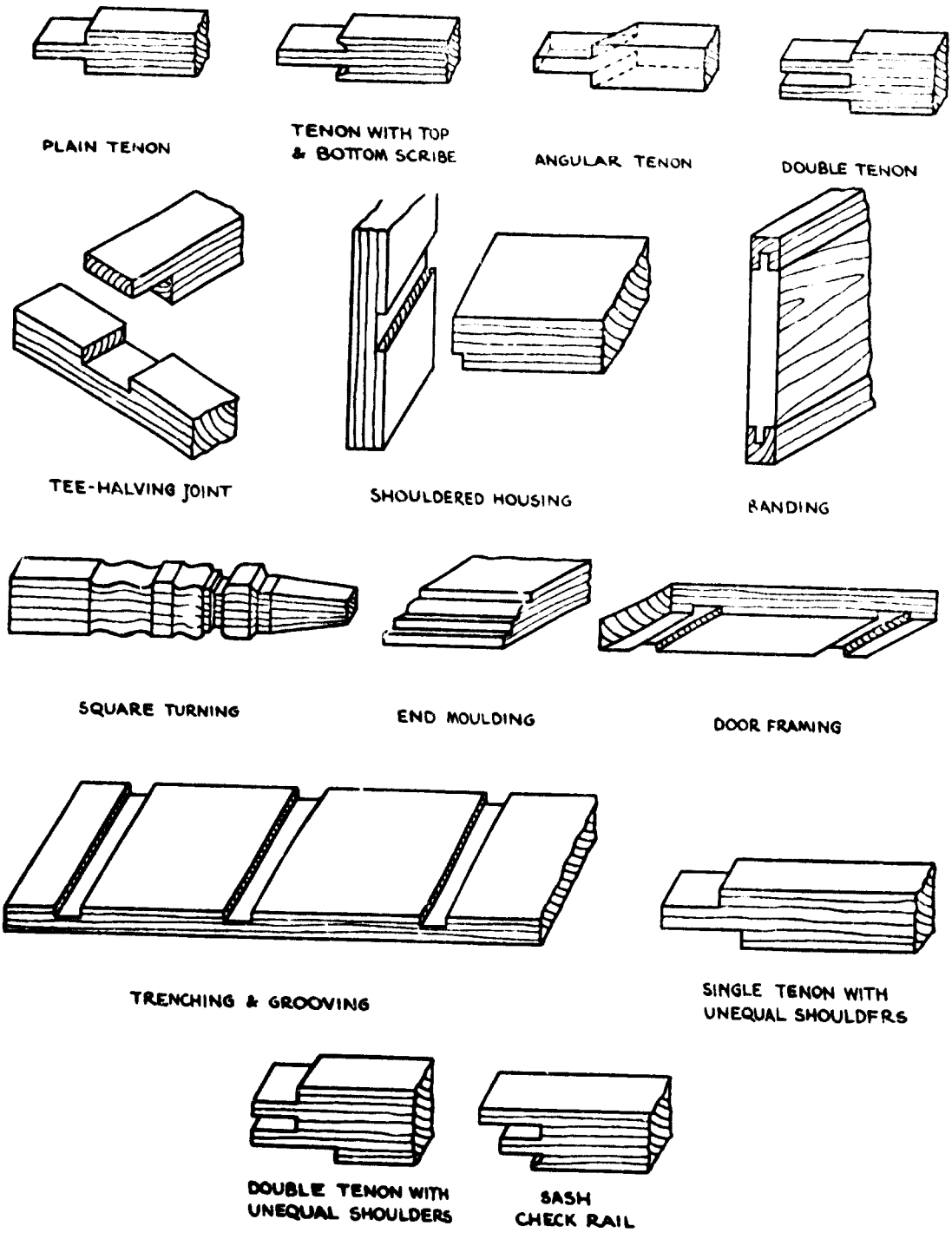
81.112.4 with interrupted continuous feed

5. The tenoning operation led first to the design of multi-purpose machines, that it, tenoners. Over the years they have been used to machine the following patterns of end or edge joints: (see also Figure 1)

mitre lock joints
square lock joints
finger joints
coping and blind dado
tenon and cope on door rail
mitred furniture rail

Fig. 1

Operations that can be done on a single end tenoner



shaped panel
recess for drop-leaf hinge
tape and ferrule cut on leg
mitre, dado, clamp rail groove
sill horning
dovetail for sills and stiles
straight and angular dado
blind dado and relished tenon

6. The form of the different end or edge shapes is generated by passing the workpieces past several tools. As the machine designs vary, one has to consider how to use the machine. The combined sawing moulding machine is designed as a panelsizing saw bench, which can be used for board edging and, depending on the spindle location can operate as a single-end tenoner. When applying modern production techniques, a medium- duty tenoner with saw spindle and tenoning spindle (81.111.21) will do the job.

7. It should be mentioned that round-end tenoners are available which are not of multi-purpose type. The combined tool set moves around the workpiece while shaping the tenon. (Figure 2).

8. Also end splicers or end matchers derived from the single-end tenoner do not belong to the group of tenoners. End splicers are indexed under item 81.12 finger-jointing machines. End matchers when used in pairs and designed to machine tongue and groove floorboards, are classed as specialized flooring machines.

9. The combined single-end tenoner and spindle shaper (81.111.3) is a very efficient machine for sash manufacture. When the sliding table has passed the tenoning head, it stops in alignment with the shaper fence so that the sash rail will be fed along the shaper fence for profiling operation. This machine is available for manual or for semi- or fully automatic operation. Workshops which have already rationalized some operations in window production should consider this equipment.

10. The double-end tenoner (Figs. 3 and 4) was designed in sequence to the single-end operated equipment. The workpieces can be conveyed on a sliding table or can be carried on endless feed chains held down in the cutting zone by rubber-faced overhead V-belts. Double-end tenoners have in most cases not the wide variation of tools as double-edge machines for panel production. In most cases double-end tenoners will be used in window and door production.

Fig. 7

Round End Tenons
machined on tenoners equipped
with tool sets

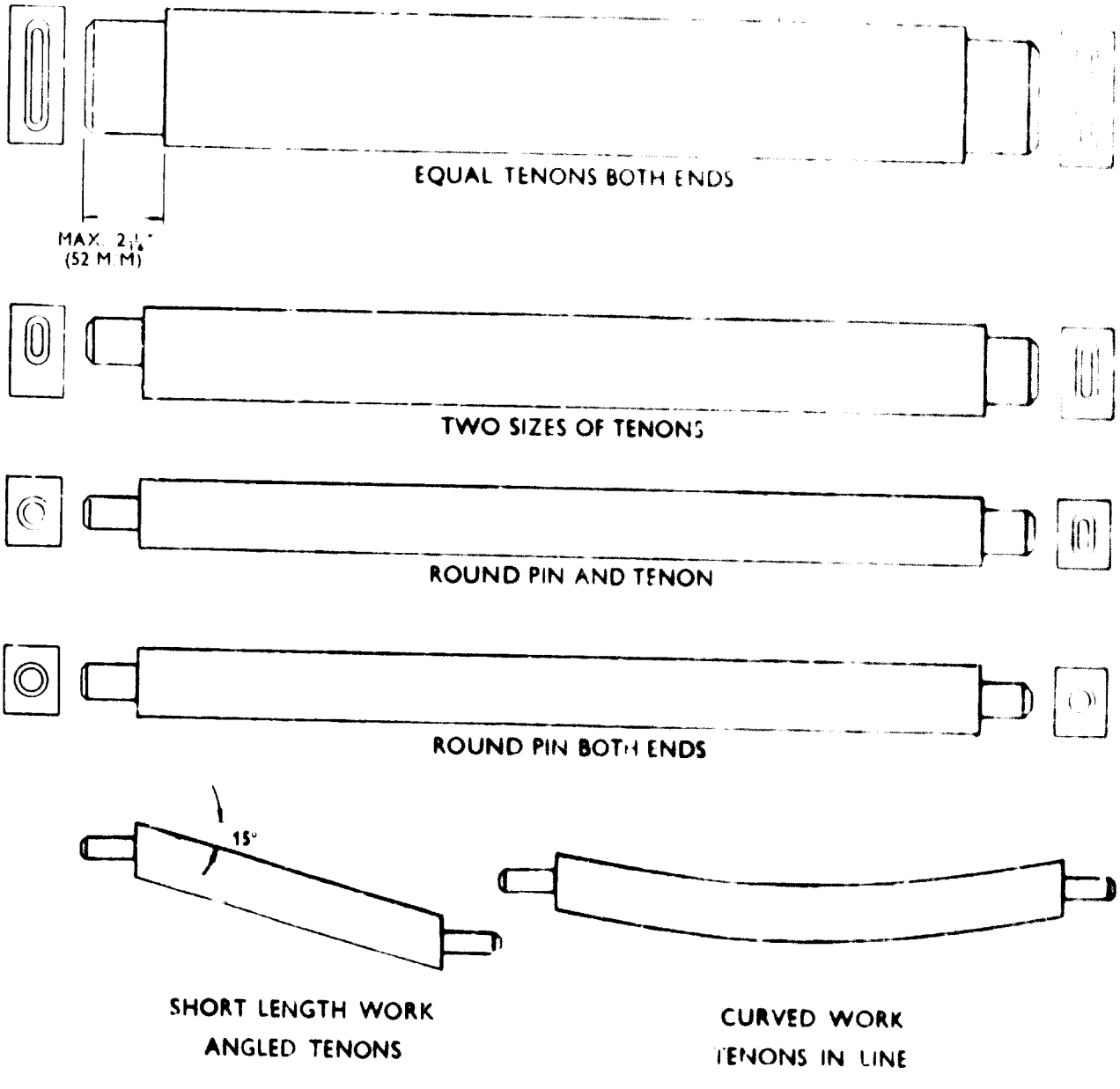
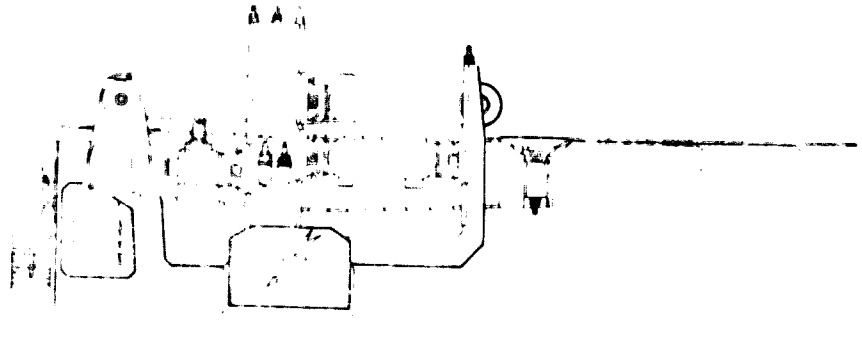
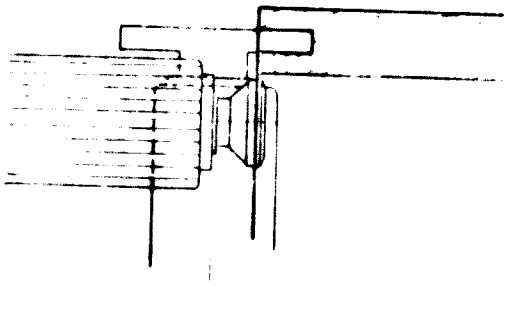


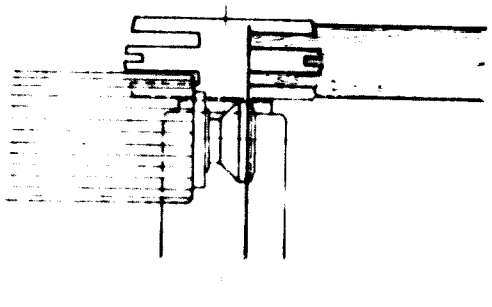
Fig. 1

Double End Tenoner 1.111.123
(for sash and door production)

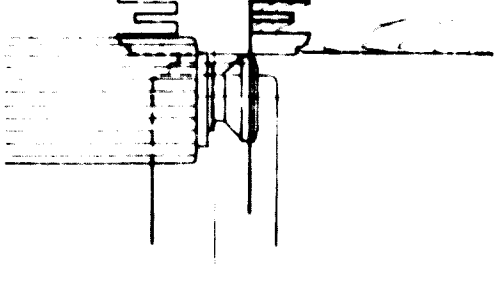




cut-off and tenoning heads



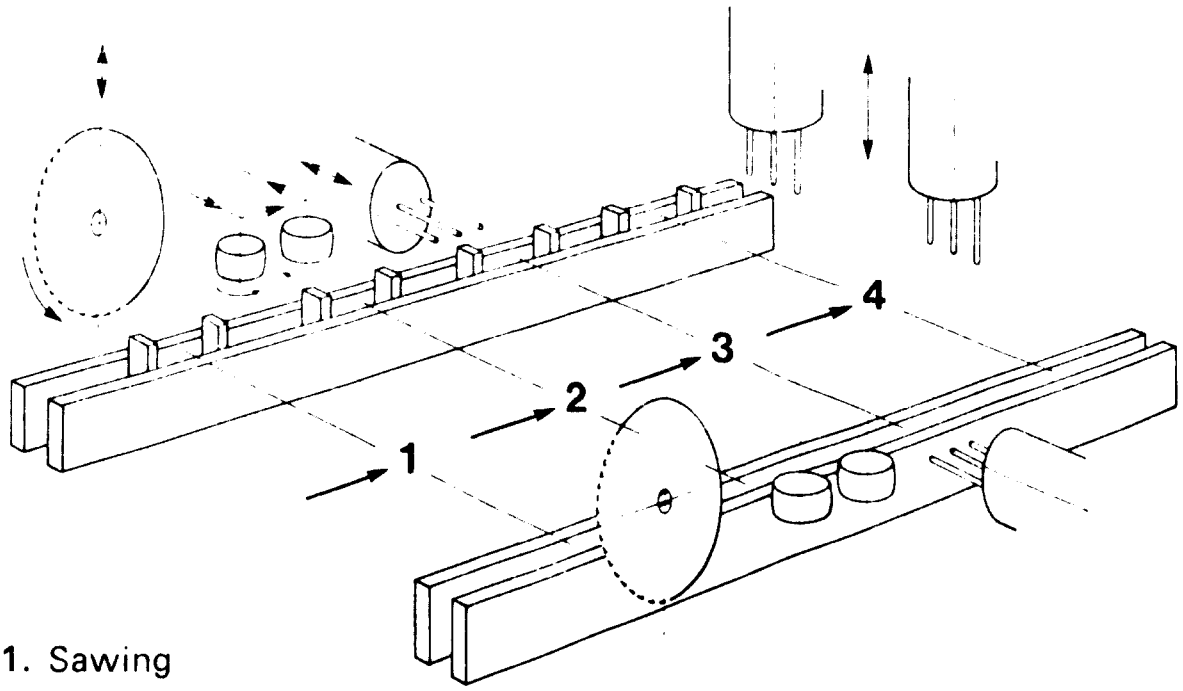
cut-off and twin ten heads (under cut off shoulders)



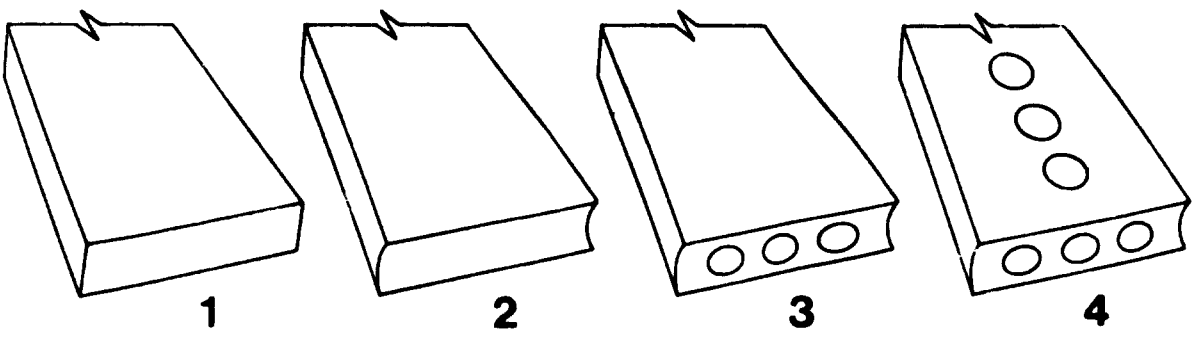
cut-off and twin ten heads (profiled shou

Fig. 4

Double-End Shaper with
interrupted continuous feed
1.111.124



1. Sawing
2. Moulding
3. End boring
4. Face boring



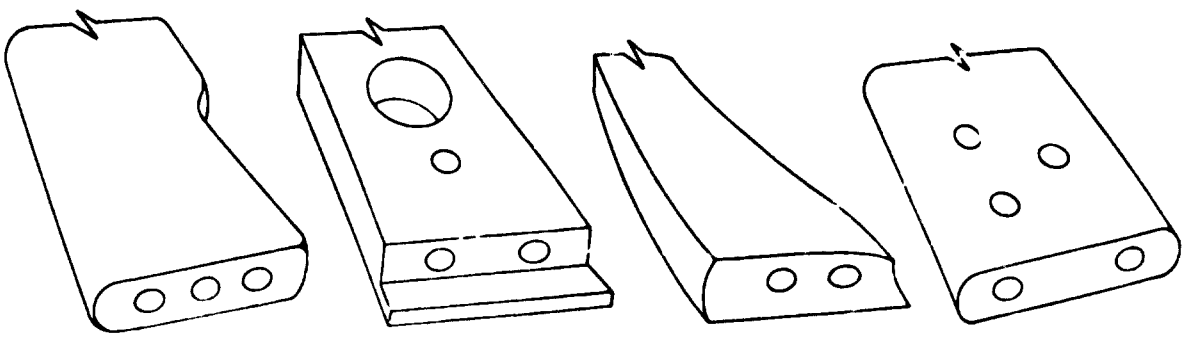
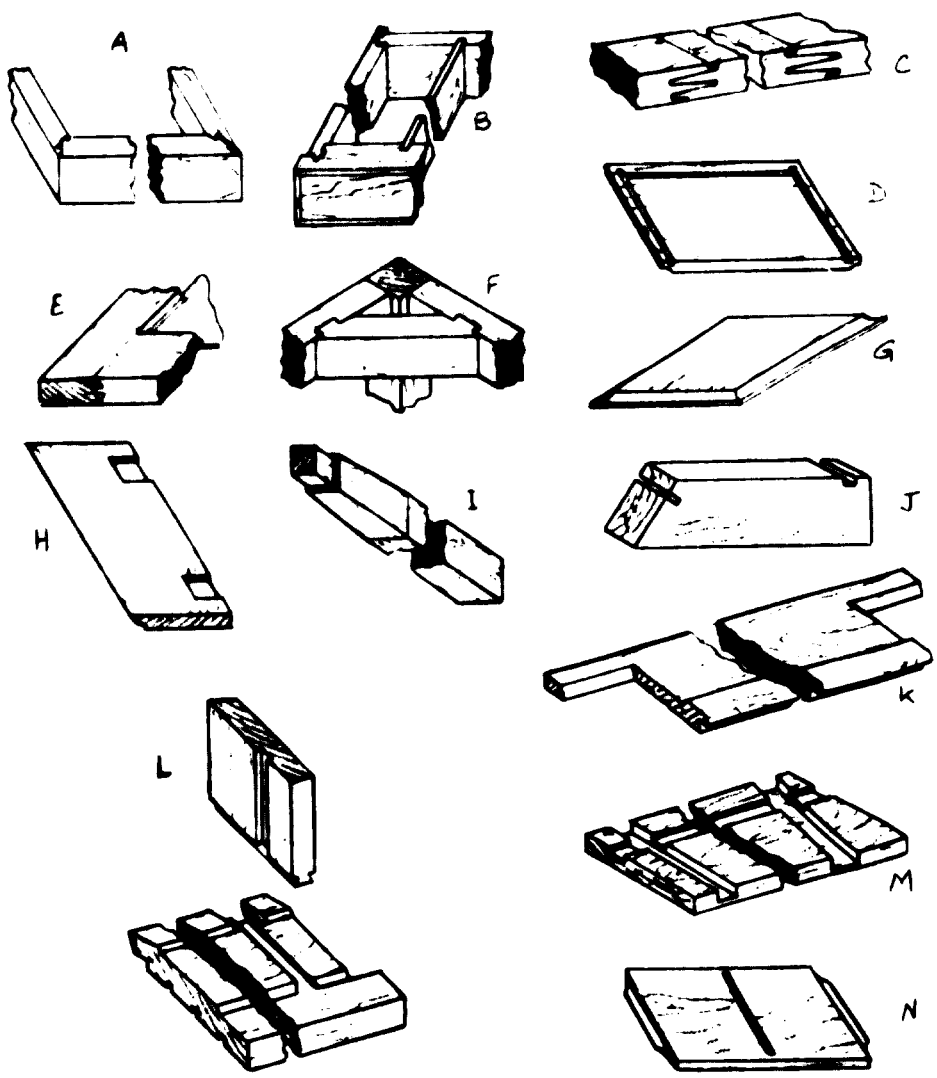


Fig. 5 Typical patterns produced on a double-end tenoner.



A. Mitre lock joint
B. Square lock joint
C. Finger joint
D. Coping and blind dado
E. Tenon and cope on door rail
F. Mitred Furniture rail
G. Shaped panel.
H. Recess for drop-leaf hinge
I. Taper and ferrule cut on leg
J. Mitre, dado and clamp nail gr
K. Sill-horning
L. Dovetail for sills and stiles
M. Straight and angular dado
N. Blind dado and relished tenon

81.12	Finger jointing machines
81.121	for mitre and joining
81.122	for end joining
81.122.1	with cutting operations
81.122.2	with embossing operation
81.123	for side joining

11. Finger jointing machines were developed to save lumber. Random lumber, cross-cut at the salvage saw mill will be jointed by finger joints. The fingers are tapered, and to have maximum stiffness in the joint, their length and shape are standardized. In recent years the mini and micro-finger joint have been introduced. A very good and progressive application is the mini-mitre finger joint for window sashes. Special machinery is already available. Micro finger joints with the grain are applied to ends of boards and glued.

12. One of the latest developments is the die-forming operation of mini finger joints (81.122.2). (See figure 6). Two boards are placed opposite each other. The die moves down and embosses the cross section of the boards. At the upstroke movement of the die a comb glue applicator glues the fingers before the lumber parts are pressed together. This process is preferably used for soft-wood lumber and in combination with an automated cut-off saw.

81.13	Dowelling machines
81.131	Dowel end-shaping
81.131.1	Single-end dowel shaping and boring machines
81.131.2	Double-end sawing and dowel end-shaping machines
81.132	Dowel hole boring with various operations
81.132.1	Single-end sawing, shaping, boring machines
81.132.2	Double-end sawing, boring (chucking), gluing dowel driving machines

13. A very special machine is the dowel forming and boring machine for drawer parts (81.131). Two adjacent joining parts of a drawer are clamped to the machine. In one operation the dowels are formed on to one part and the corresponding dowel holes into the other part.

14. The single-end sawing, shaping, boring machines (81.132) are a special design for making joints on Scandinavian chairs. The joint profile is a special glue joint. In addition to this, dowel holes are bored. These operations are all done in one pass. (See figure 7).

Fig. 6

Die-form Finger Jointing Machine

81.122.2

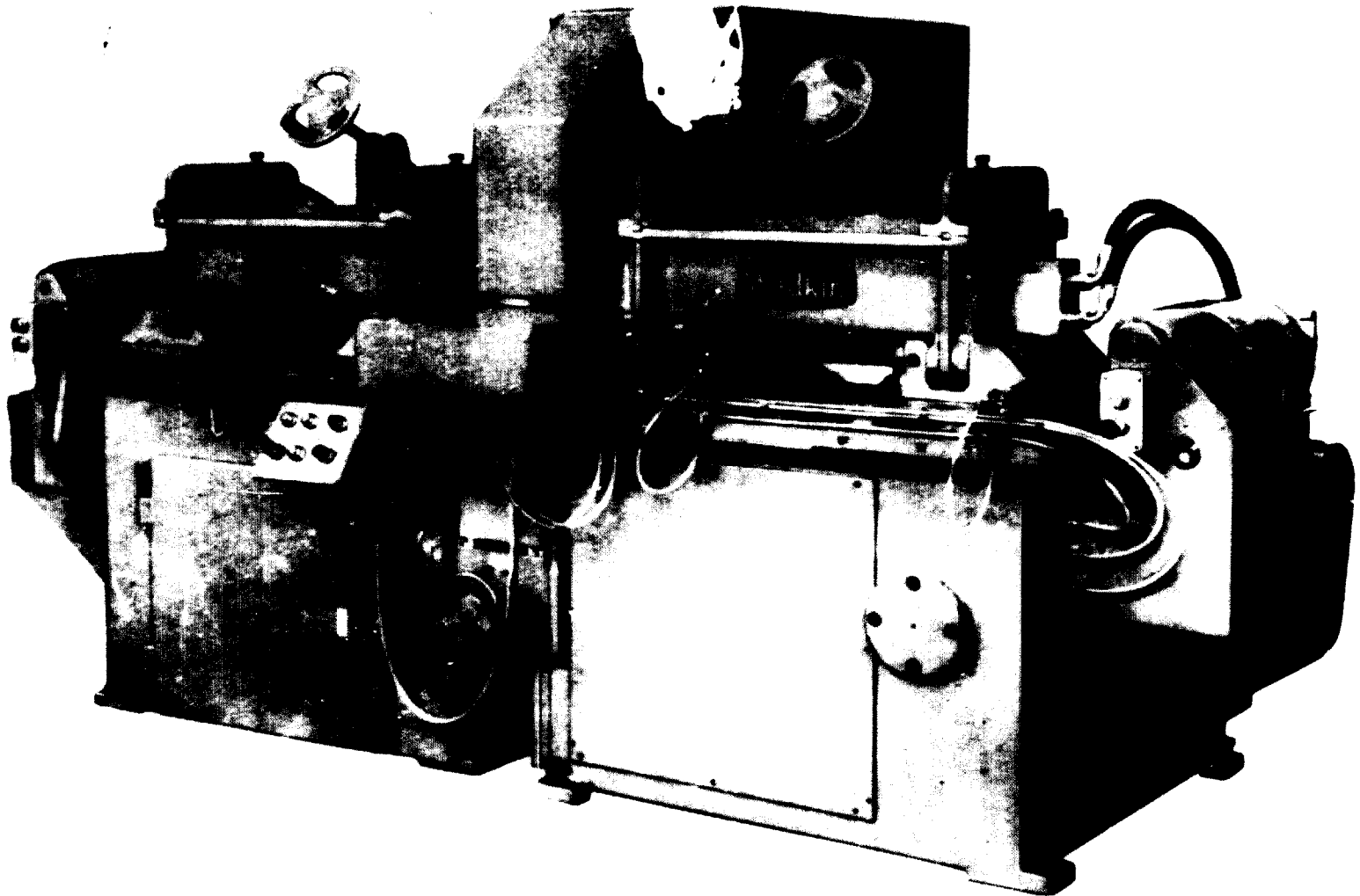


Fig. 7

Double-End Sawing, Boring
or Chucking Machine 81.132.2

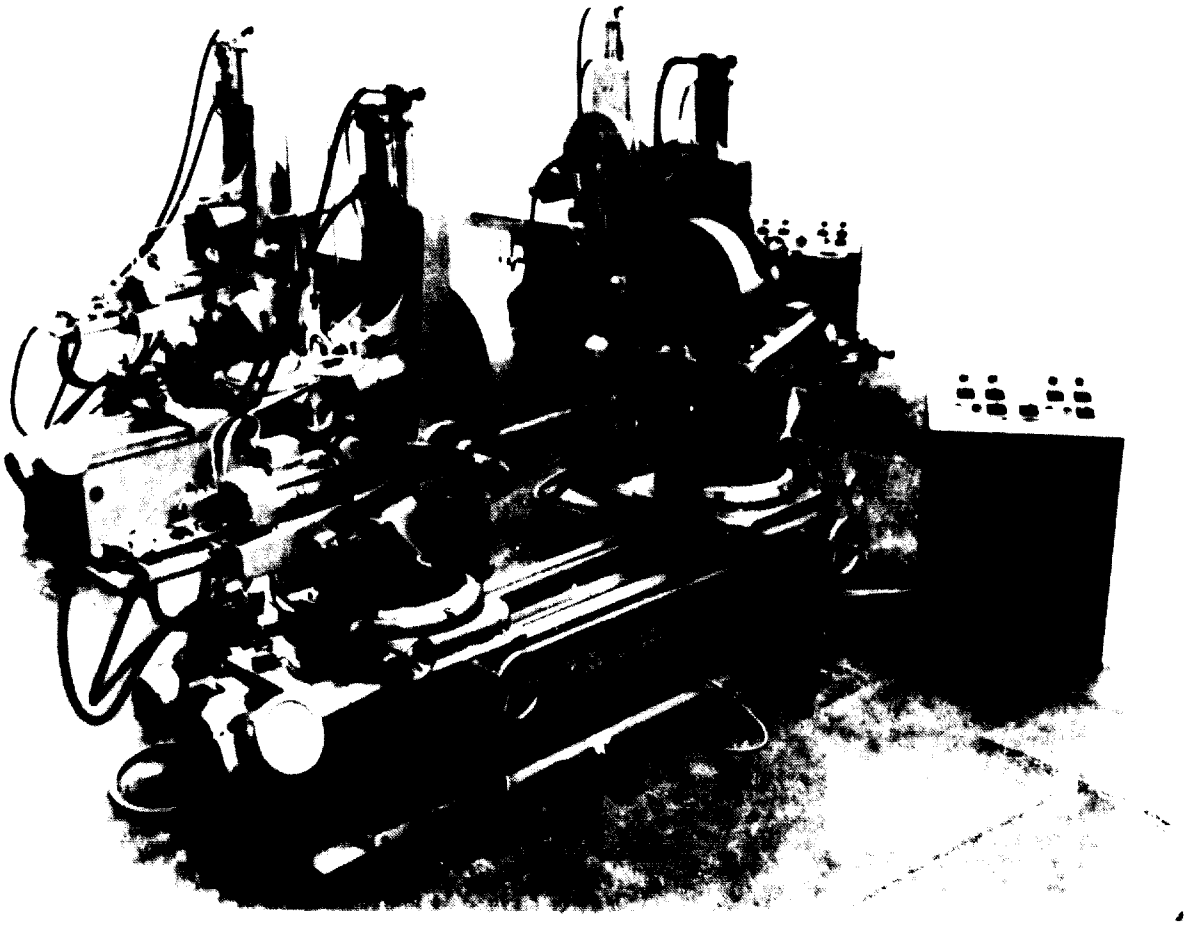


Fig. 8

Double-End Sawing, Boring, Gluing
and Dowel Driving Machine (81.132.2)

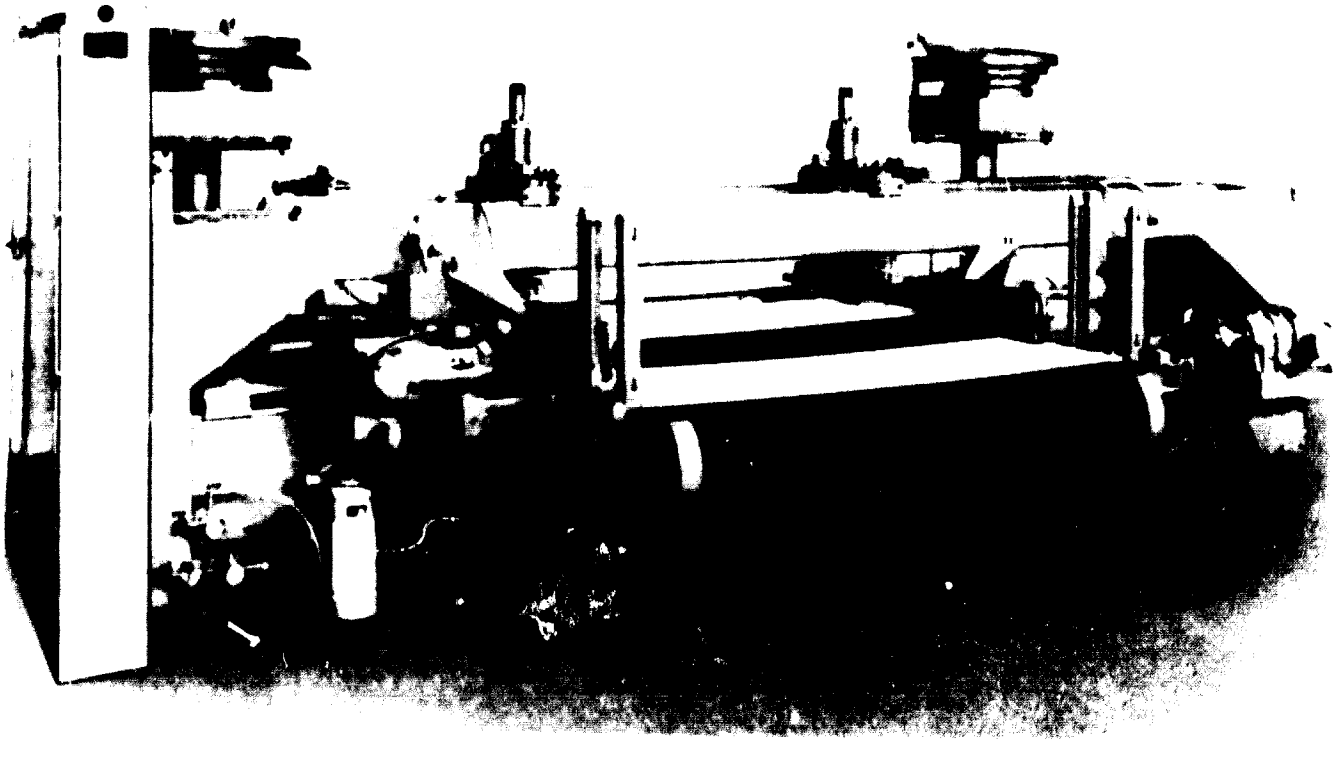
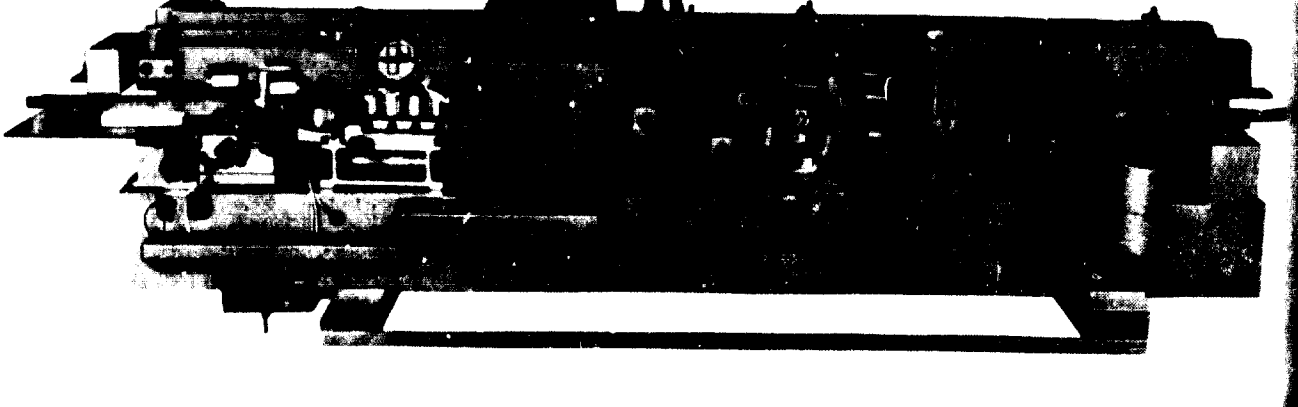


Fig. 9

Double-Edge Bander

81.221.212



15. The double-end sawing,boring (chucking), gluing, dowel-driving machine (81.132.2) is primarily used in the chair and upholstery industry. (See figure 8). Solid wooden parts or chipboard rails are machined on this equipment. When square turnings or tapered rounds are to be end-shaped, chucking heads instead of boring heads will be used to shape the ends. Other rail parts will be cut to length, bored, the hole will be spread with glue and the dowel driven. Additional holes can be made by attaching boring units.

2. Machines for Forming Edges (81.2)

16. This group includes double-end tenoners, edge-banders and similiar machines. Double-end and double-edge equipment is here separated for the first time because of the development of "double-end tenoners" for panel machining operations. As these machines differ from the tenoning version, some manufacturers name them profilers, multi-purpose machines, or double-end machines.

81.21	Single edge operations
81.211	Workpiece in horizontal position (edge-gluing, banding, flush sawing, end trimming, sanding)
81.212	Workpiece in vertical position
81.212.1	Machining tool feeding
81.212.3	Workpiece feeding

17. First in this group are edge-banding machines with workpieces in horizontal position (81.211) for glue spreading, veneer edge pressing, flush sawing, end trimming, edge rounding or bevelling, and sanding. (See figure 9)

18. The edge bander with workpiece in vertioal position is one of the machines designed for workshops. After banding the veneer edge a cross slide with flushing saw is guided manually along the edge (on rails).

19. The present practioe is to use in most cases hot-melt glues. There are some cases known where hot-melt glues have created some failures in tropical olimates.

81.22	Double edge operation
81.221	Double edge multi-operation
81.221.1	with sliding table
81.221.2	with continuous feed of workpiece
81.221.21	edge machining only
81.221.211	chip cutting operations

81.221.212 sizing and edge banding operations

81.221.22 edge and surface machining

81.221.3 with moving machining units

20. The double edge multi-operation is simply performed on double cut-off saws with sliding table and shaping attachments. Different shaping heads can be affixed for the varying operations. The saw arbor as well as the shaping attachment can be tilted. But low-cost double-edge machines with continuous feed chains are already available for workshop operations (81.112).

tenoners are mostly equipped with double cut-off saws, top and botto

21. While double-end/tenoning heads, relishing and sill horning attachments and dado units, the double-edge machine is equipped with saw-hogging unit and scoring saw, top and bottom shaping units, cam-generated shaping head, dado and jump dado heads. Figures 10-14 illustrate some of the many operations that can be done on these types of machines.

22. To expand the application of double edge machines, a gantry can be added for attaching gain (notch) units. boring units, routing units. This gives the machine a very wide range of application.

23. On some machines, edge sanding units and surface shaping units are also available.

24. Edge banders lately include double-end cut-off saws, so that sizing and edge-banding will be done in one pass. For taper cutting of panels a continuous feed cannot be applied. Instead, the workpiece is clamped and the shaping units pass along the edges.

3. Machines for Forming Sides (81.3)

81.31 Single side operations

81.311 With travelling shaping, sanding, sawing unit

81.312 With rotating table and fixed sawing, shaping, boring and sanding heads

81.32 Double and/or up to five side operations

81.321 For longitudinal shaping sanding operations

81.322 For longitudinal and crossworking operations sawing, hogging, shaping, sanding, boring (chucking)

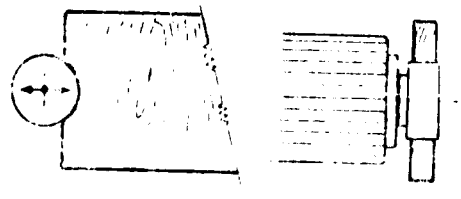
81.323 For crossworking operations

81.323.1 two- or three-station operation, fixed machining units

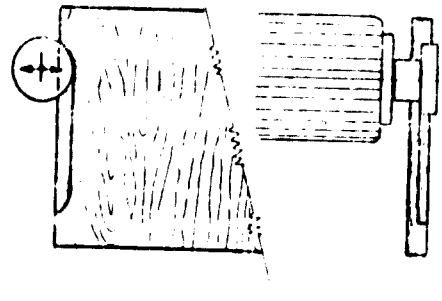
81.323.2 multi-station operation, moving machining units (machining center)

Fig. 10

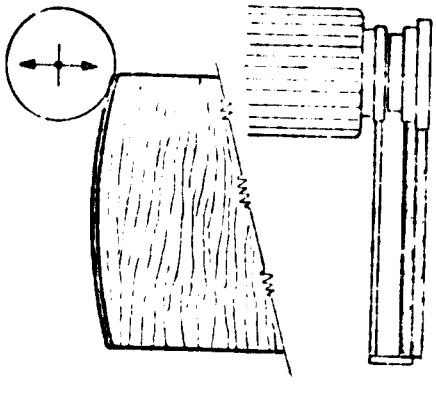
Cam-Controlled Operations on Double-Edge Machining Equipment



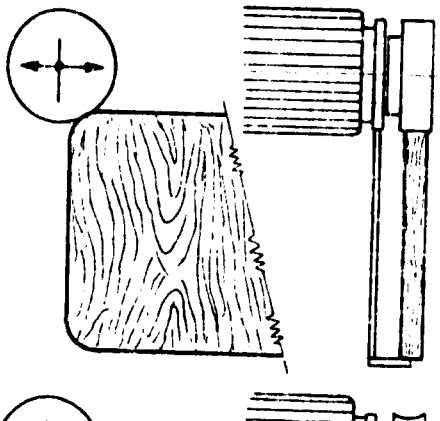
edge sink shaping



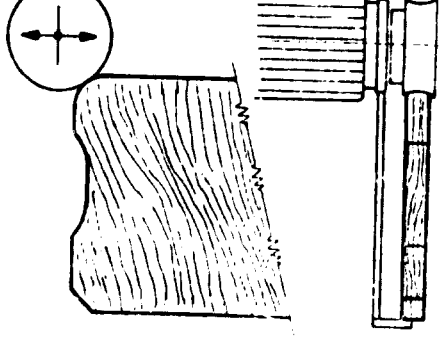
stopped rebating



slide edge rounding



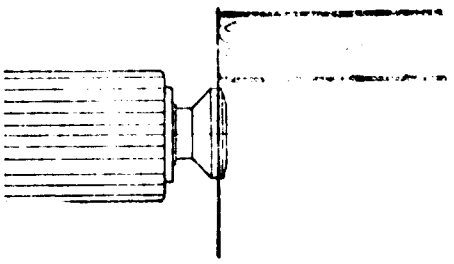
corner rounding



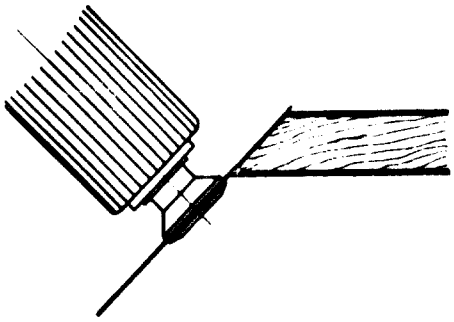
contour shaping

Fig. 11

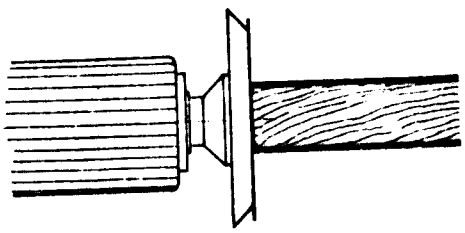
Double-Edge Machining Operations



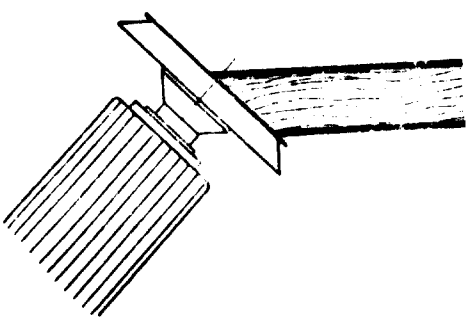
sizing



mitring



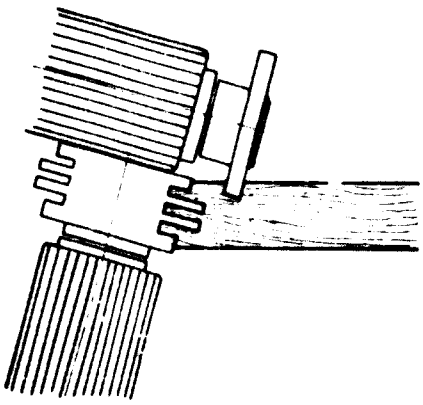
sizing and hogging



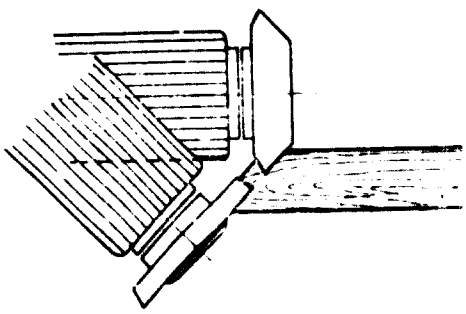
mitring and hogging

Fig. 12

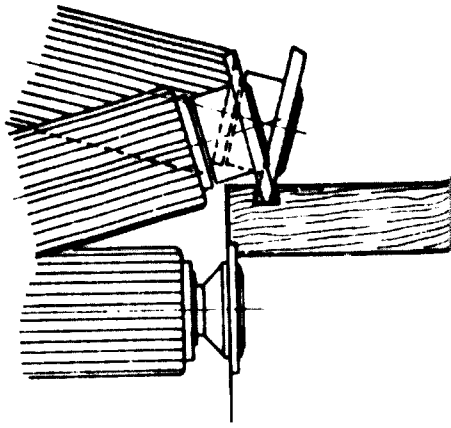
Double-End Joint Machining Operati



corner locking and notching



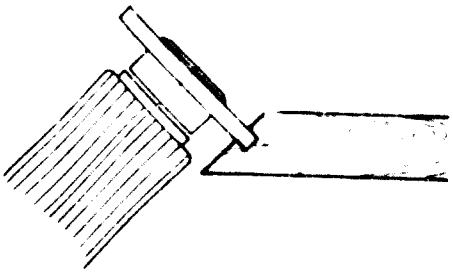
male dovetailing



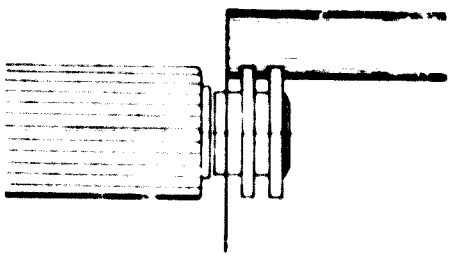
sizing, rebating and female dovetailing

Fig. 13

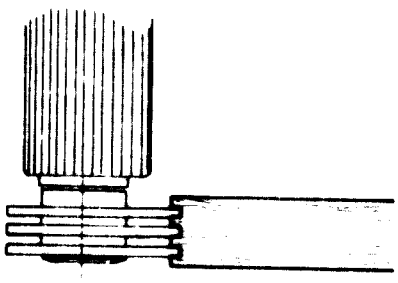
Double-Edge or End Machining Operations



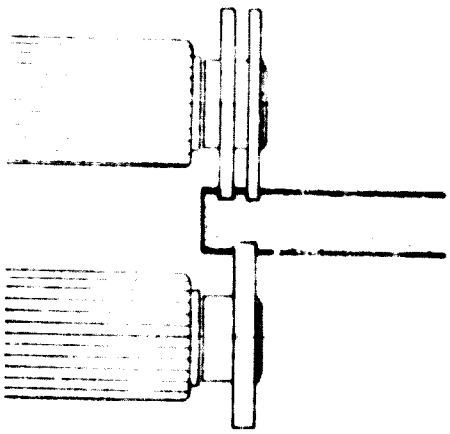
mitre grooving



sizing and bottom face grooving



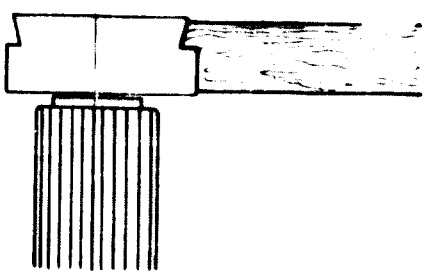
edge multi grooving



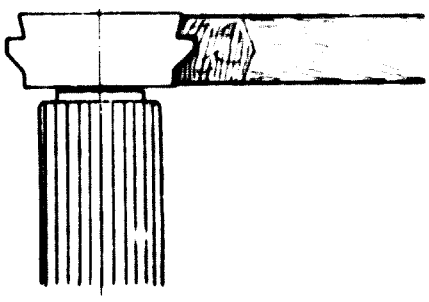
top face grooving and bottom face dadoing

Fig. 14

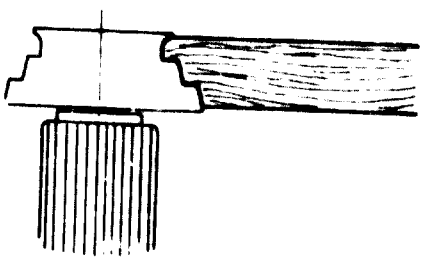
Double Edge Machining Operations



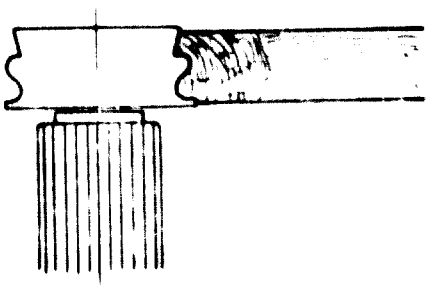
rebating



lock grooving



double rebating



edge moulding

25. The following principles were considered when developing the classification system:
- for end-forming operations, the workpieces are preferably of solid wood, but are straight and the width is less than the length.
- for edge-forming operations, the workpieces are preferably of panel-sized derived-wood products (particle board, block board, plywood etc.)
- for those operations on workpieces which have a rather small width in relation to their length, but are contoured; the adjacent surfaces must be considered as "sides", rather than edges or ends.

26. On the other hand, these machines are used to machine workpieces with a shape similiar to panels (e.g. chair backs), but for which the axis is not straight and the joining recesses and bores are sometimes angled to adjacent sides (e.g. back posts of chairs).
Equipment which is used to machine those irregular parts differs very much from that which operates on edges or ends of workpieces.

27. Three different types are available:
machines with reciprocating feed (see figure 15)
machines with continuous feed
machines with rotating feed (see figure 16)
Most variations of those machines have either reciprocating or rotating feed.

28. Advantages of reciprocating side-dressing machines with reciprocating feed:

a. straight operation on two sides
b. when twin-loading, workpieces can be shaped on 4 sides in one pass.
c. when a long workpiece slide is used, two or three workpieces of a chair can be machined as an assembly set.
d. when using a hopper feed, two or three machines can be handled by one operator.
e. these machines fit into automated production lines.

Disadvantages:

a. idle return feed
d. no all round shaping of table tops or seats

29 Advantages of rotating side-dressing machines:

a. continuous operation
b. machining of assembly sets, (but to a limited extent)
c. when using a hopper feed, two machines can be handled by one operator.

Fig. 15

Double-Side Shaping Sanding Machine
with reciprocating slide
1.132.1

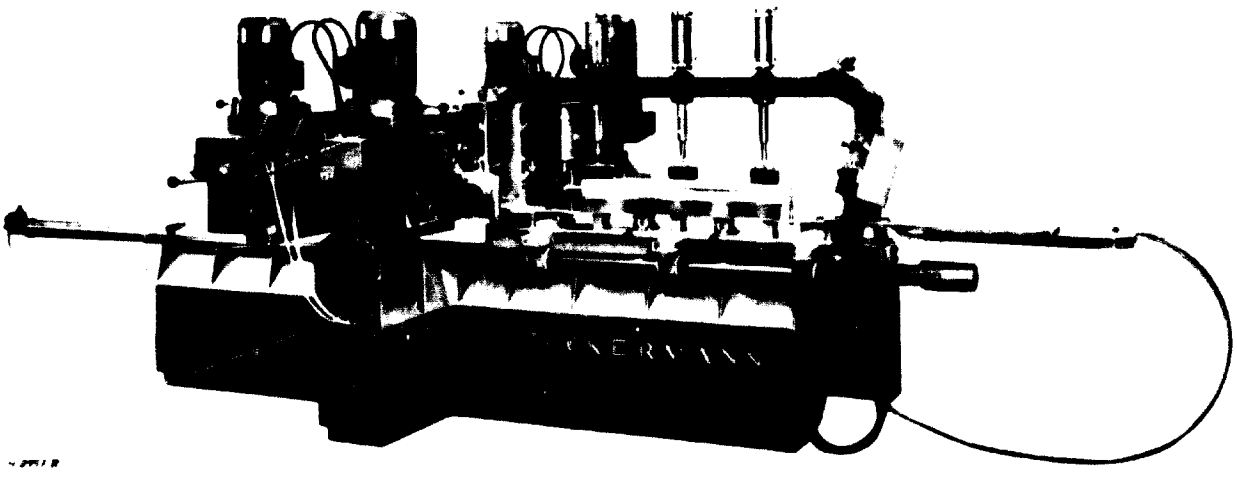
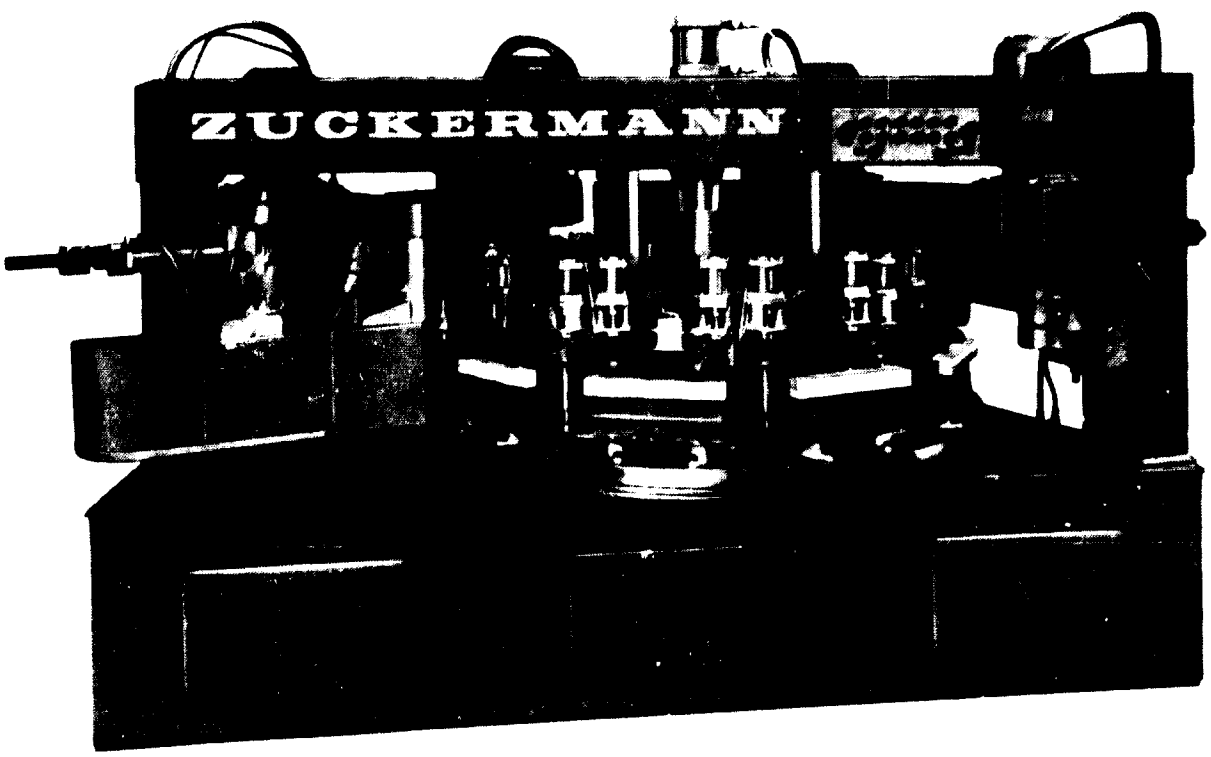


Fig. 16

Single Side Shaping Sanding Machine
1.131.2
(with rotating table)



d. all round shaping of round, oval or similiar mouldings.

Disadvantages:

a. single-side machining only

b. when machining identical parts, several equal templates are necessary.

30. Single-and double-side shapers are available in a very broad range. Up to four shaper units can be set onto each side of a contour shaper. The spindles can be equipped with shaping and/or sanding tools.

31. When using a contact roll, the unit operates with a sanding belt. Sanding mouldings by discs is limited to radius operations. The use of more than one shaper-head renders it possible to shape in an up-and-down milling operation in one pass when the grain direction changes on contoured stock.

32. As soon as contour shapers are equipped with cross-feed operating units, (81, 322) the reciprocating double-side shaper-sanders change into automatic multi-machining systems that render it possible to complete a workpiece by several operations in one pass.

33. The automatic double-side shaper-sanders (fig. 17) with cross-feed working operations can handle up to 23 operations in one pass. The same number of machining units around a rotating table would expand the table diameter and oomplicate the system.

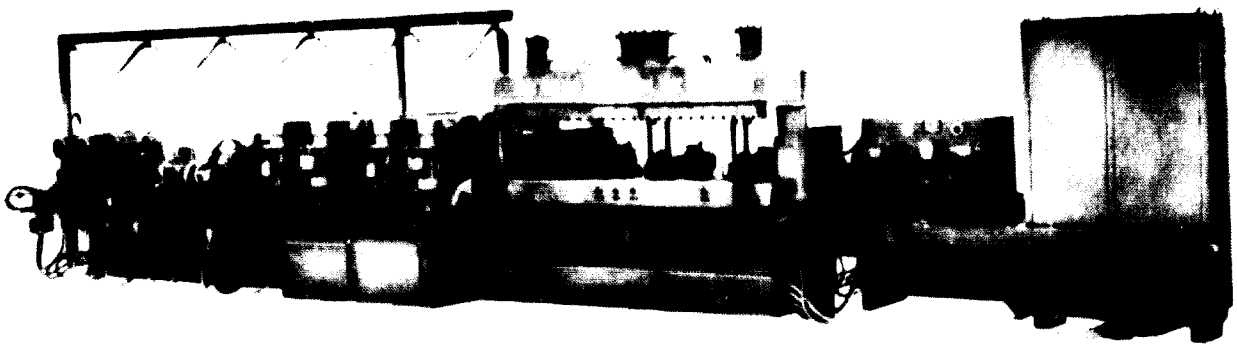
34. Here is an example of the unit arrangement:

first station:	double-end sawing, hogging mortising and boring	cross feed operation workpiece stationary
seoond station:	double-side contour-shaping	longitudinal operation
	jointing, moulding	travelling workpiece
	belt-sanding, disc sanding	
third station:		
left hand:	end chuoking, shaping boring, mortising	cross feed operation
right hand:	end chucking or tenoning boring, shaping, tenoning	workpiece stationary

35. Different production oapacities and batch sizes are factors whioh

Fig. 17

Double-Side Shaping Sanding and
Crossworking Machine
(machining of 5 adjacent sides)
ó1.322



can require compatible machine sets. Two double-contour shaper-sanders (81.321) and one shaping, mortising and boring machine (81.322) can provide a very flexible arrangement for production of batches of 50 to 150 pieces.

36. Another development which should be mentioned here is the "machinery center" which is numerically controlled (NC). An ingenious roller positioning system feeds the stock by point-to-point positioning. At any point where the feed stops, different operations will be performed by machining heads. All operations are printed on a tape so that all manual work is eliminated. This machine can be used for many joinery operations. (See fig. 18)

4. Machines for Forming Panels and Boards (81.4)

81.41 Core stock composing machines (gluing, clamping, sawing)

81.42 Board gluing and sawing machines

81.43 Board dovetailing, gluing, driving machines

37. Several different machines have been developed for the production of plywood with a block core. Furniture manufacturers have used a combined binding and sawing machine (81.41) for preparing their own ply cores whereby ripped blocks for strips are laid on a table to a preselected width and clamped tight to size. Two or three grooves are cut by a saw, and feeding the saw across the strips, a paper string is pressed into the groove; a simple hand device for the job.

38. Plywood producers have also used the more advanced automatic equipment (81.42). Wood laths are loaded to a feed chain, and before one lath is pressed on to the preceeding one, a glue applicator spot glues the lath which is followed by the clamping operation. This continuous operation is repeated up to the preselected width. The glued-up lath core passes a double cut-off saw for sizing.

39. Similiar sequenced operations are performed for block gluing-up to prepare squares for solid wooden seats. The glue cures under high frequency or in heating tunnels. This equipment eliminates the time-consuming glue curing operation on clamp carriers.

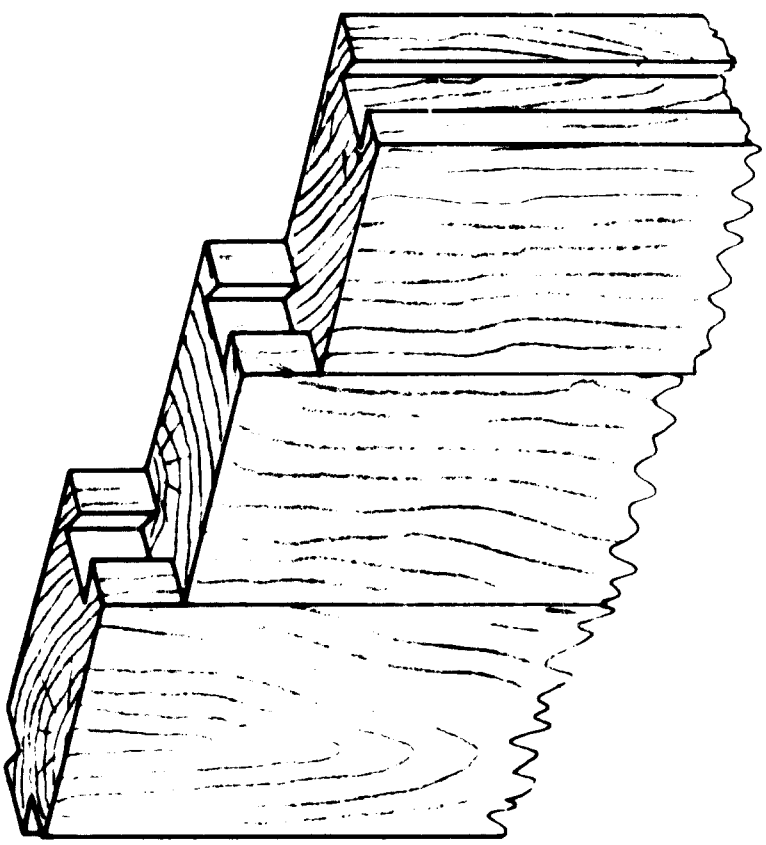
40. One of the well known panel gluing systems for the manufacture of solid wooden table tops, work benches etc. is the "L I N D E R M A N N - System". Edges are dovetailed, glue is spread, and driven along the dovetail edge. It generates a very strong tight joint (See fig. 19).

Fig. 18

Machining Center
Multi-Station Operation, Moving Machining Units
81.323.2

Fig. 19

Lindermann - System



5. Machines for Forming Frames (81.5)

41. For series productions of window sashes very interesting machines and machine systems for sawing, scoring, shaping, gluing clamping and nailing are available. (figures 20-23). Automic sash making machines can be loaded manually or by hoppers. Inside moulded sash parts are positioned by stops which release the slide movement by passing the cross-cut and tenoning heads and glue spreaders before they are clamped and nailed. (Figure 21). These sashes are ejected to the top of the machine before being transferred to the sash shaper.

6. Machines for Mounting Hardware (81.6) and Glass (81.7)

42. Whether furniture or doors and sashes or prefab systems, for any operation multi-purpose machines are available. (Ex. see fig. 24). Hooking hardware for bed side rails will be taken from a hopper, positioned and nailed at both ends simultaneously. Off-set hinges for cupboards can be mounted automatically. The sequence of operations is: setting of the hinge, positioning of the mounted part to the screw driving unit and driving of the sorews.

43. In a similiar manner, bore-hinges can be mounted automatically. Doors will be placed vertically or horizontally, then clamped and bored before the hinge is driven. Two, three or four hinges can be set in one operation.

44. To automate the production of sashes for prefab windows, a glass-setting maohine has been developed. Twin sashes for windows will be placed into the infeed belt and oonveyed to the first station at whioh the putty is spread automatioally into the rebate The operation is controlled by the operator. A vacuum conveyer pioks up the glass sheet and places it into the sash rebate and again a putty layer will be spread before being conveyed to the second station. Here the glass mouldings are placed manually and are nailed automatioally.

7. Various Different Multi-Purpose Machines

45. There are many different multi-purpose machines which are not yet at a stage that allow them to be exactly grouped, viz. log profilers (fig. 25) a machining system where logs are ohipped into squares before break-down on multiple blade saws. (Fig. 26). Several manufacturers have developed different types of this equipment.

46. There are turning machines incorporating double cut-off units, or boring units, (fig. 27) and in the field of brush and broom making, the boring and brush bundle plugging operations are oombined.

Fig. 20

Rough Mill for Automated Sash Production

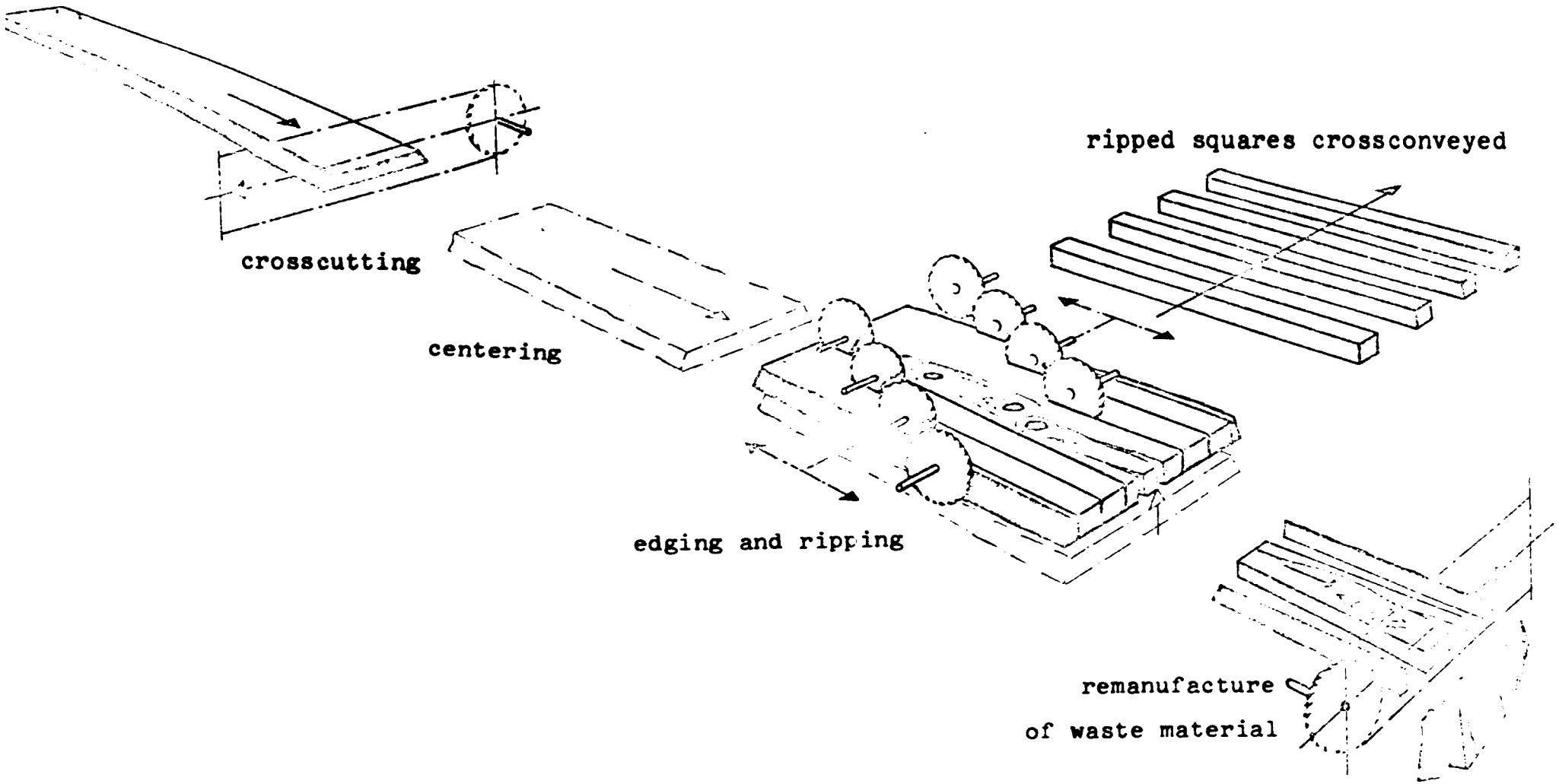
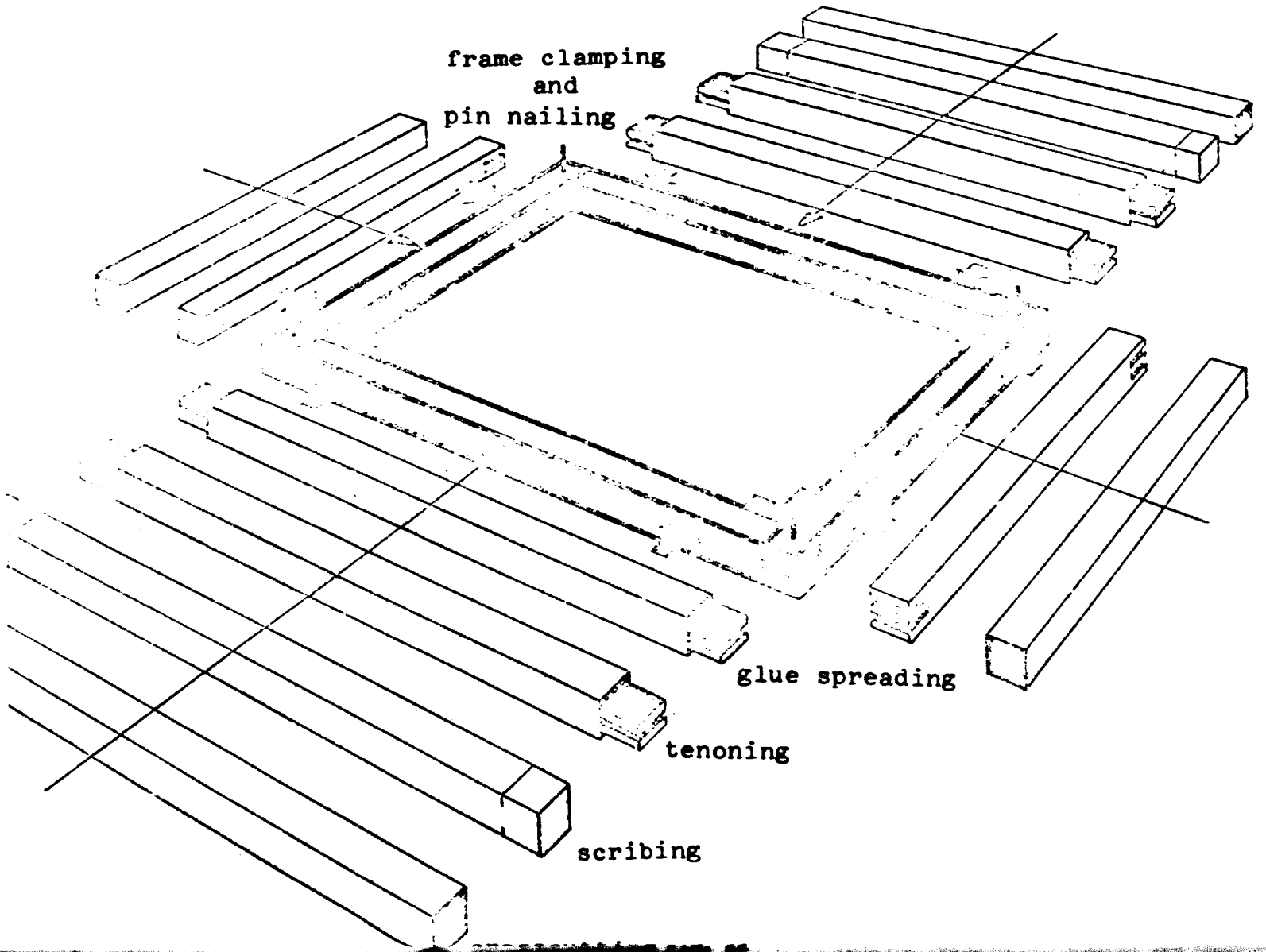


Fig. 21

Automatic Clamping and Nailing



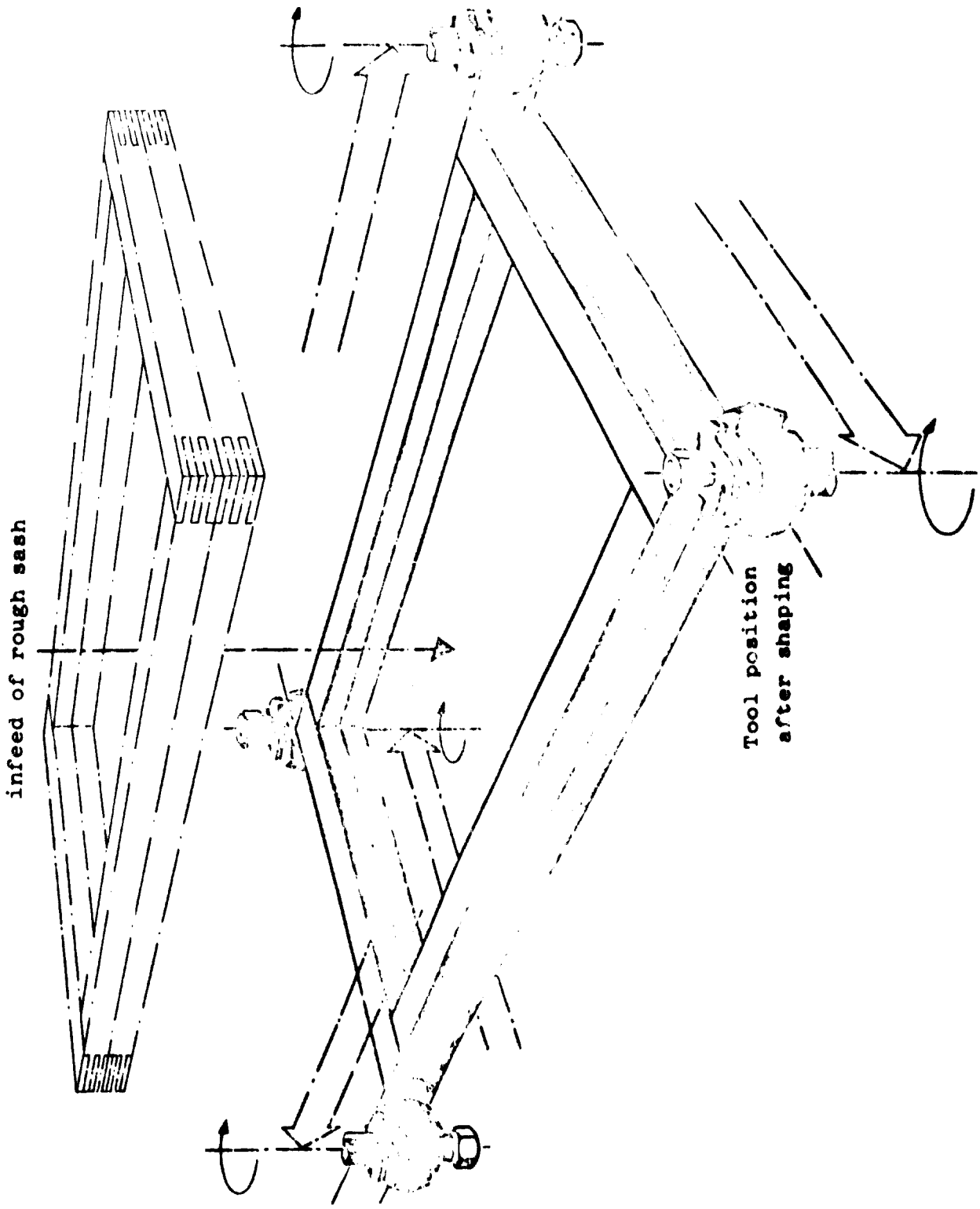

infeed of rough sash
Tool position
after shaping

Fig. 23

Automatic Mortising and Hardware Setting

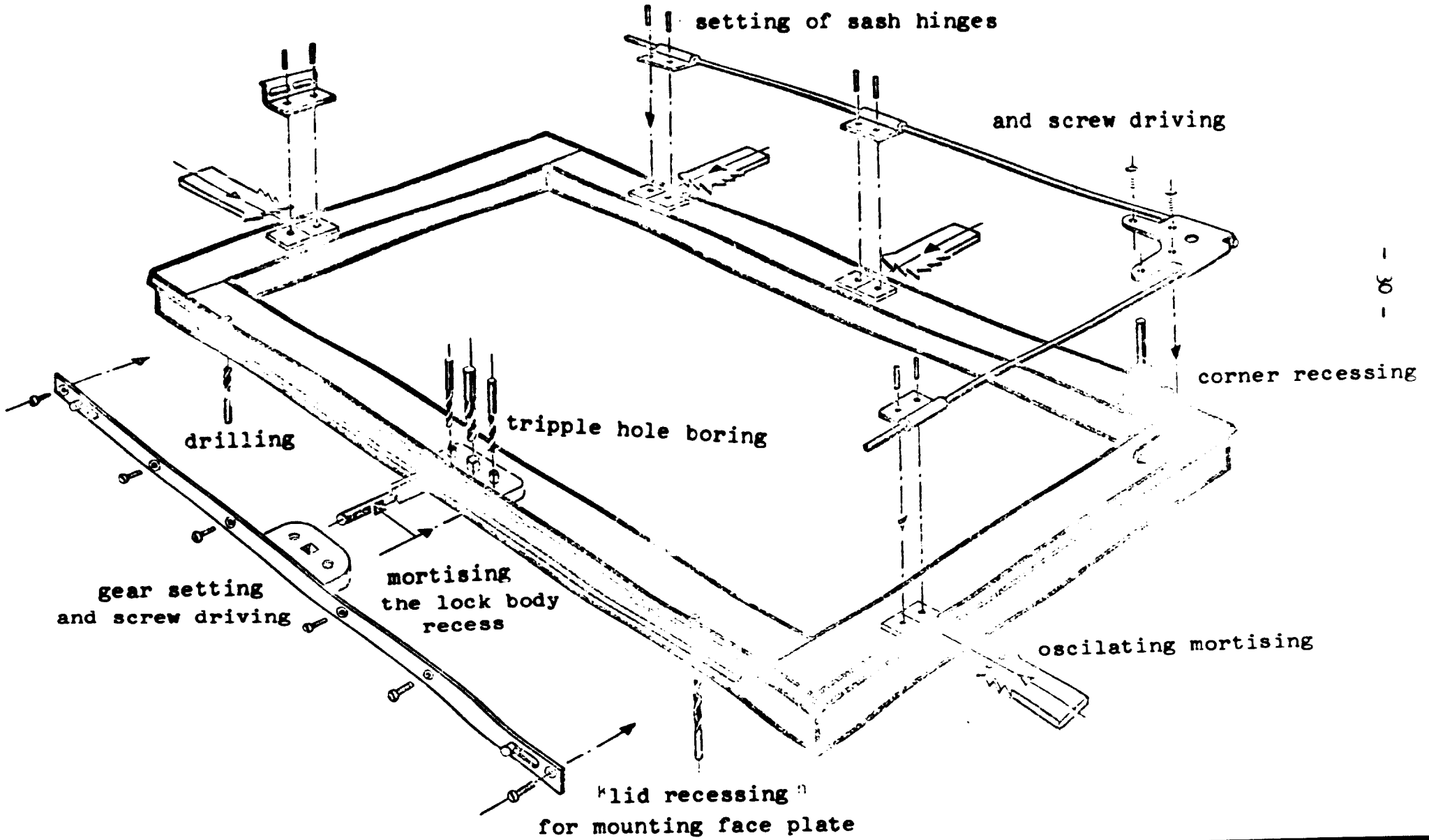


Fig. 24

Hardware Boring and Recessing
and Mounting for Doors
81.7

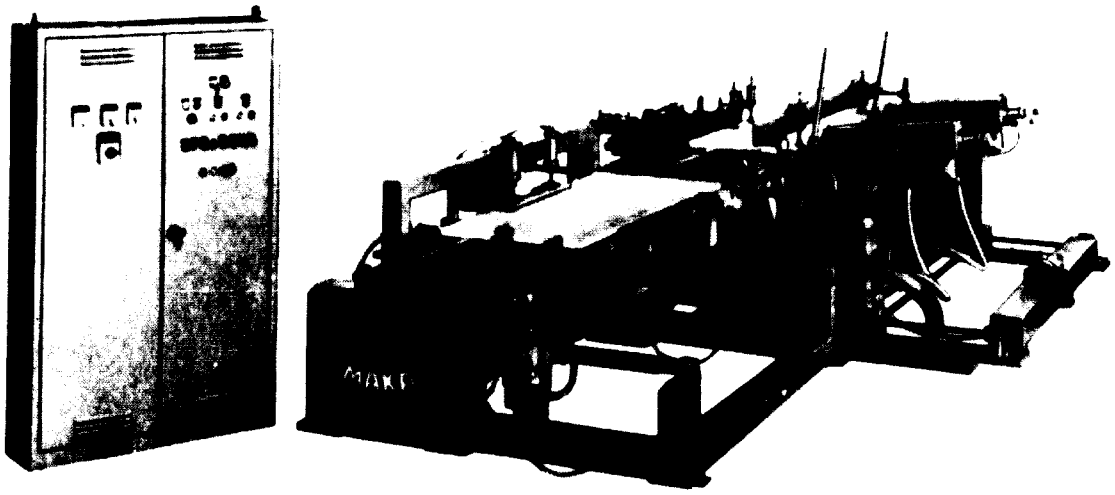


Fig. 25

Log Profiling Machine
(chip-n-saw)

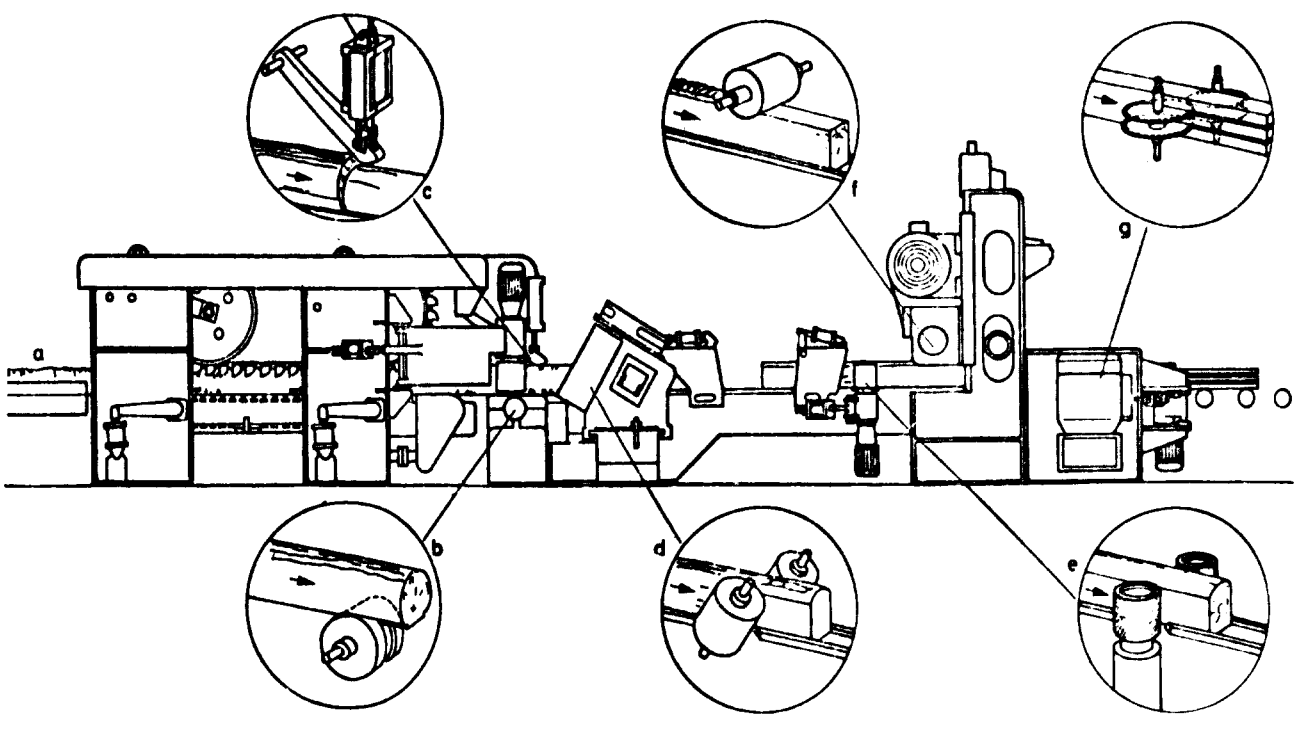
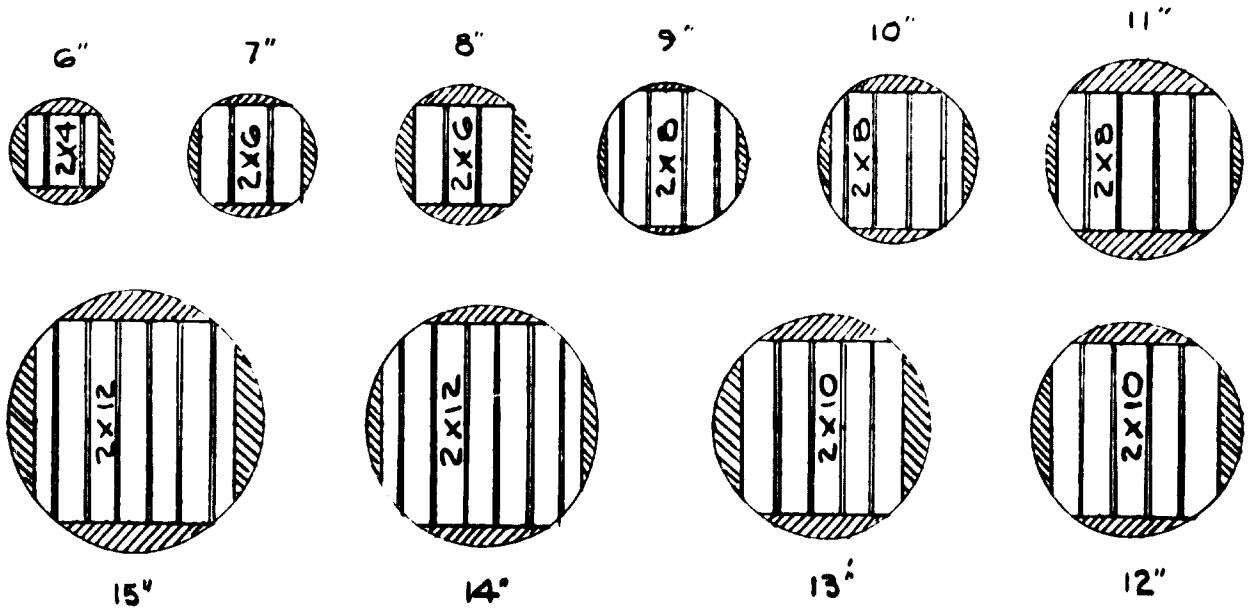
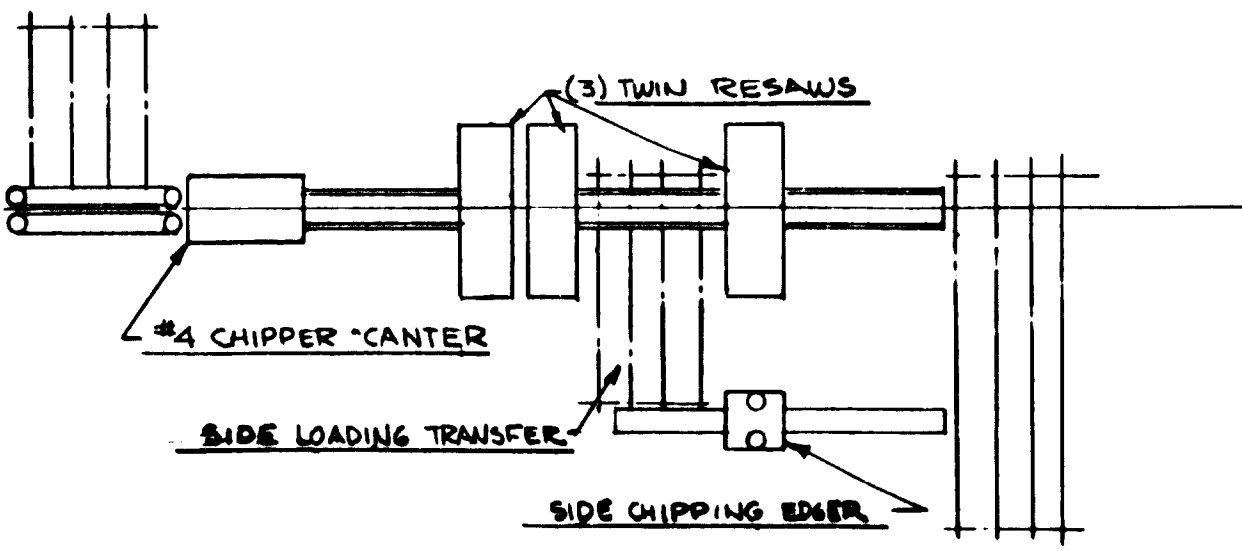


Fig. 26

Two Suggestions for Log Breakdown by Chipper Canter Equipment in Line with Twin Saws





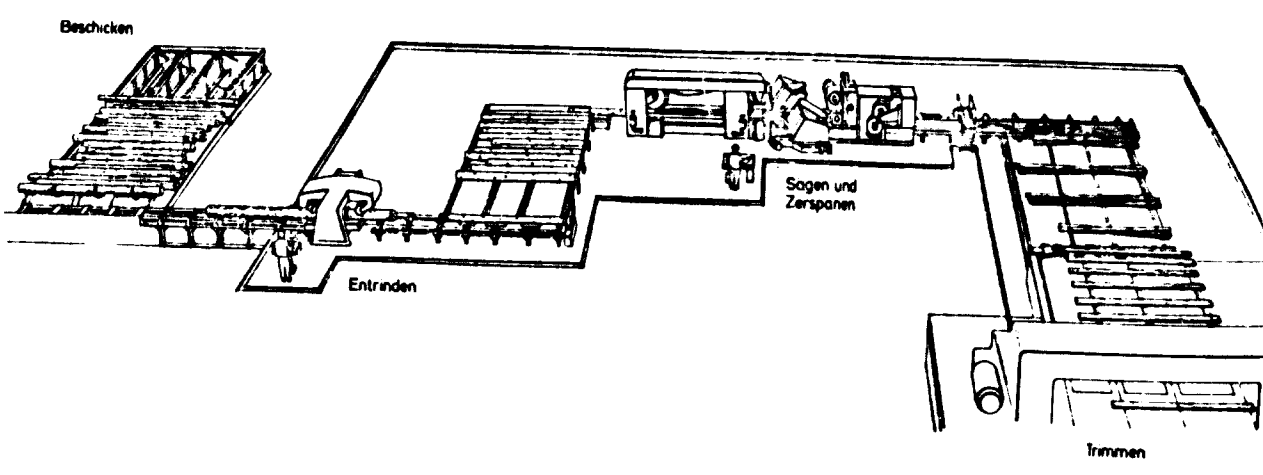
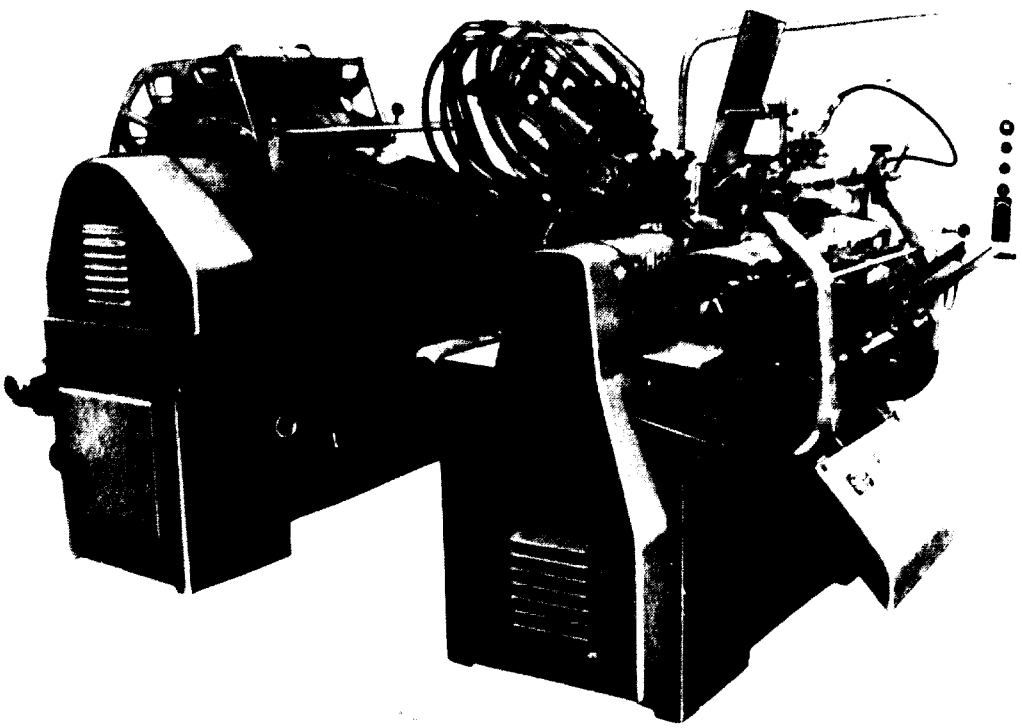


Fig. 27

Twin Boring, Turning, Sanding Line



47. But not only in the line of chip-cutting machinery are multi-purpose combinations on the market. About two years ago, a lacquer coating machinery manufacturer demonstrated the first multi-purpose coater: the combined roller-curtain coater for lacquers. With the introduction of other chemical surface coats other multi-purpose coating systems will be soon available for industrial application.

IV. DIFFERENT MULTI-PURPOSE PROCESSING LINES (82) AND THEIR APPLICATION

1. Linked Processing Lines with Continuous Flow (82.1)

Panel Processing Lines (82.21)

82.11 Straight flow line (see figure 28)

82.12 Angle flow line (see figure 29)

82.13 Reverse flow line (see figure 30)

82.24 Staggered flow line (see figure 31)

2. Transfer Processing Lines with Cycling Flow (82.2)

82.21 For panel production

82.22 For solid wood production

82.221 Straight flow line

82.222 Angle flow line

82.223 Reverse flow line

82.224 Staggered flow line

48. The development of furniture workshops into real industrial plants has led to many ideas for increasing production. Automatic production lines required by the furniture industry could not have been developed years ago so far had it not been for the quality increases and developments in particle boards, adhesives and lacquers.

49. The first stage in the development of line production was the linking of double-end tenoners. In sequence to this, the dowel hole boring machine was added, later on the edge-bander and, at the end, the wide-belt sander.

50. The classic linked production line (as below) was in many cases and still is the up-to-date line for flat furniture parts:

A. manually loaded	B. automatically loaded
(limited to feed speeds of 18 m/min.)	(up to feed speeds of 60 m/min.)
1. double end sizer (12.132.21)	1. loading system (51.2)
2. double-edge bander (81.6)	2. combined sizer/edge-bander (81.221.212)

3. double-end profiler (81.221.211)	3. double-edge multi-purpose machine (81.221.22)
4. dowel hole boring machine (12.432)	4. dowel hole and hardware boring machine (81.6)
5. top and bottom wide-belt sander (12.732)	5. combined cross-sanding system (12.74)
6. stacker (51.2)	6. stacker (51.2)

51. The linked line A was the first step, the linked line "B" is the most up-to-date linked production line. There are furniture manufacturers who run these lines with a feed speed of 60 m/min., but this speed is above the speed of the machine manufacturers' guarantee. Wherever possible, the straight line system should be applied.

52. The development of the combined double-end sizer and edge bander is an example of compacting the production line. Machining systems which include all of the above mentioned machines and one feed system only are called "transfer lines". Panels are fed through the line and at each machining unit individual operations are performed. A transfer line of this type developed in Japan incorporates the following stations:

shaping
rebating
boring
cutting off
edge clamping
nailing
planing.

Some of these operations are performed on two edges or sides. The transfer line operates with a ten-second cycle.
Transfer lines are three times shorter than linked production lines.

Processing lines for Solid Wood and Frames (82.22)

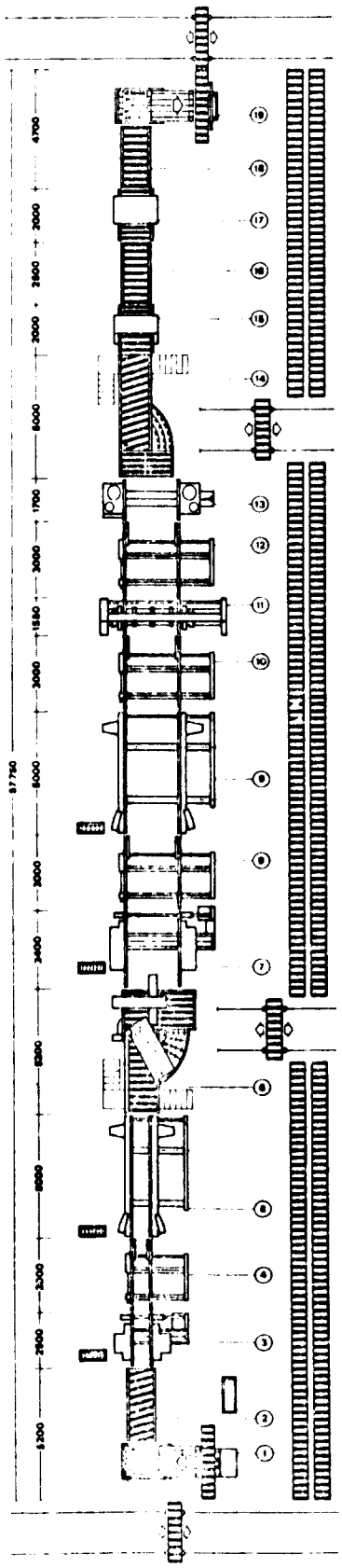
53. In the field of sash making, linked production lines are well known. Two parallel lines run sashes and frames up to the prefab assembly of a window. These processing lines include: rough mill system; moulding line; sash assembly; coating line; glass mounting line; prefab assembly line.

54. By far the most up-to-date transfer systems have been developed for solid wooden parts such as are used in chair production, easy chair frame part production, school furniture production and similar parts. (See for example figure 32).

55. Contrary to the chain feed in multi-purpose machines and multi-

Fig. 28

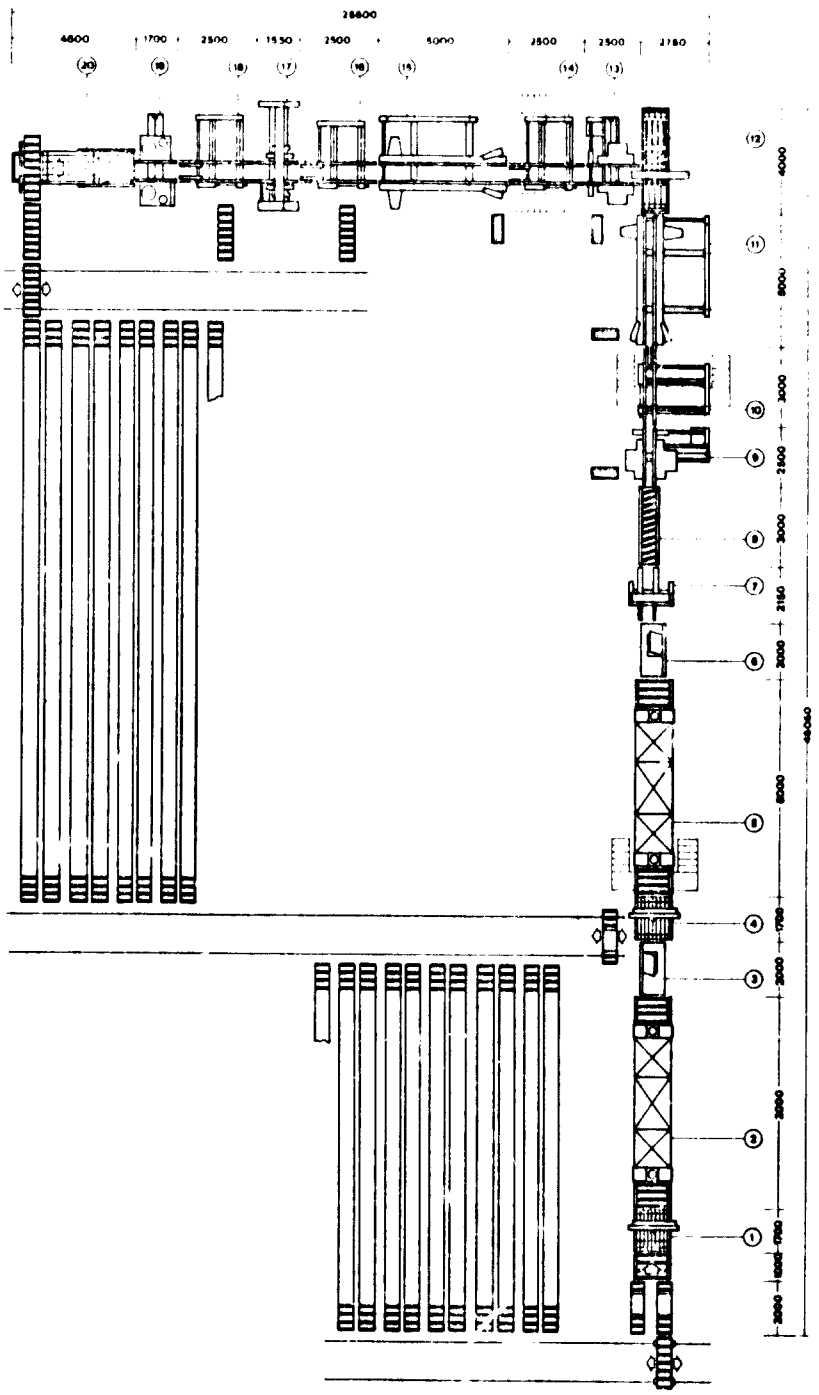
Straight Panel Production Line
(stream line flow)



1) Loading Device
2) Live Roller Way
3) Double Edge Sizing
4) Belt Conveyor
5) Double Edge Banding Machine
6) Panel Turn Conveyor
7) Double Edge Multi Purpose Machine
8) Belt Conveyor
9) Double Edge Banding Machine
10) Belt Conveyor
11) Dowel Hole Drilling Machine
12) Belt Conveyor
13) Dowel Driver
14) Panel Turn Conveyor
15) Bottom Wide Belt Sander
16) Roller Way
17) Top Wide Belt Sander
18) Roller Way
19) Stacking Device

Fig. 29

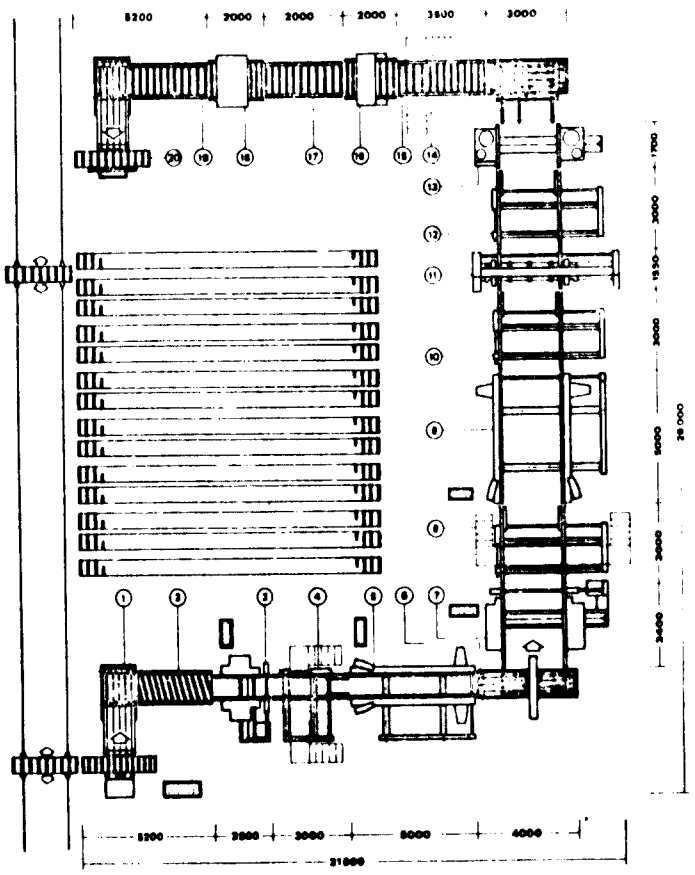
Combined Surface Coating and
Staggered Processing Line



1) Lacquer Spraying System
2) Lacquer Curing Tunnel
3) Assembling Station
4) Lacquer Spraying System
5) Lacquer Curing Tunnel
6) Assambling Station
7) Trim Clamp
8) Infeed Roller Way
9) Double Edge Sizing Machine
10) Belt Conveyor
11) Double Edge Banding Machine
12) Crossveyor
13) Double Edge Multi Purpose Machine
14) Belt Conveyor
15) Double Edge Banding Machine
16) Belt Conveyor
17) Dowel Hole Boring Machine
18) Belt Conveyor
19) Dowel Driving Machine
20) Stacking Device

Fig. 30

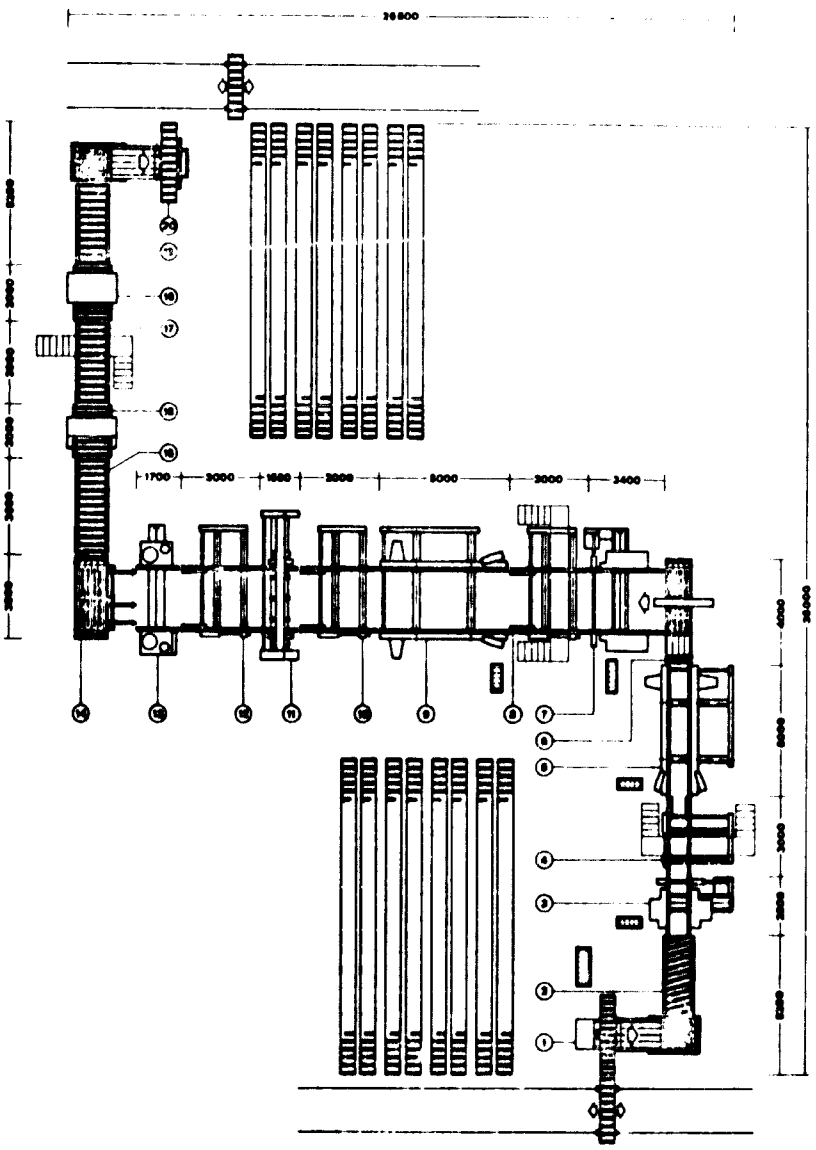
Staggered (U-shaped) Panel Production Line



1) Loading Device
2) Live Roller Way
3) Double Edge Sizing Machine
4) Belt Conveyor
5) Double Edge Banding Machine
6) Crossveyor
7) Double Edge Multi Purpose Machine
8) Belt Conveyor
9) Double Edge Banding Machine
10) Belt Conveyor
11) Double Hole Boring Machine
12) Belt Conveyor
13) Dowel Driver
14) Crossveyor
15) Roller Way
16) Bottom Wide Belt Sander
17) Roller Way
18) Top Wide Belt Sander
19) Roller Way
20) Stacking Device

Fig. 31

Staggered Panel Production Line



1) Loading Device
2) Infeed Conveyor
3) Double Edge Sizer
4) Belt Conveyor
5) Double Edge Banding Machine
6) Crossveyor
7) Double Edge Multi Purpose Machine
8) Belt Conveyor
9) Double Edge Banding Machine
10) Belt Conveyor
11) Dowel Hole Boring Machine
12) Belt Conveyor
13) Dowel Driving Machine
14) Crossveyor
15) Roller Way
16) Bottom Wide Belt Sander
17) Roller Way
18) Top Wide Belt Sander
19) Roller Way
20) Stacking Device

purpose processing lines is the palletised cycling system which is applied to transfer systems for solid wooden parts. The fully automatic machines transfer line such as is shown schemetically in figure 33, workpieces to be ready for assembly. The workpieces are fed to the infeed station by conveyor belt, pallet pile or hopper. The cycle begins with loading and positioning of the workpiece before clamping to the pallet slide. There are 18 stations which are limited by the pallet slide length of 1800 mm. At the end of each pitch, travel controls of the machining units are released and operate at the same time within 9 seconds. Generally the following operations are performed:

loading

double-end cut-off and hogging

preshaping and mortising

finish shaping, profile and sanding and horizontal triple boring

vertical triple boring

end-grain triple boring and boring counter sinking

flip-turning of the workpiece and reclamping

end-grain shaping

preshaping and angle shaping

finish shaping and profile sanding

slide and workpiece dusting

ejecting

The sequence of operations can vary depending on the workpiece shape. Up to 30 machining units can operate simultaneously. When two short workpieces can be loaded onto one slide, the piece time is half the cycle time.

The transfer line described above is a combined system for machining longitudinally as well as crosswise to the feed direction.

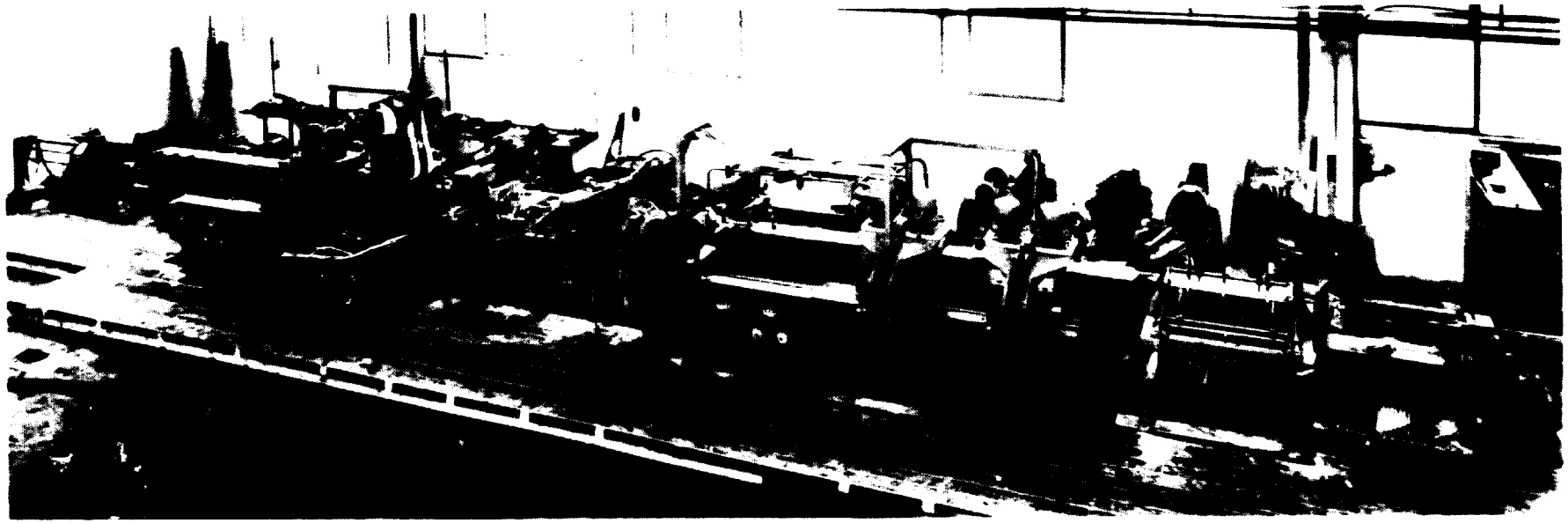
56. A transfer line for crosswise machining only is also available to shape 5 adjacent surfaces of a workpiece. This transfer line can be equipped with up to 16 machining units.

3. Multi-purpose surface-coating lines (83)

57. The equipment will vary in size and style depending on the coat to be applied. Panel lines are thus equipped with roller and belt conveyors or chain-driven trolleys. Chairs, frames, sashes will travel preferably on overhead rails.

Fig. 32

Transfer Processing Line
with Cycling Flow for the Production of Solid Wooden Parts
82.22



58. A surface-coating panel line includes the following stations:

loading
brushing
prime coating
drying
grain denibbing
first and second coat (wet on wet)
flash-off drying
ejecting

Panel coating lines are mostly equipped with curtain and roller coaters and chair coating lines mostly operate with spray coaters. New developments eliminate the manual operation.

V. THE RIGHT MACHINE FOR THE JOB TO BE DONE

1. General Considerations

59. The many variations of machines and equipment create difficulties in choosing the right machine. Main technical data of manufacturers' literature give the first and basic information when comparing machines of different manufacturers. One should bear in mind that the product which has to be machined, provides the basic information for selecting a machine. A multi-purpose machine is a money saver only when it is in action for over 70 per cent of the time.

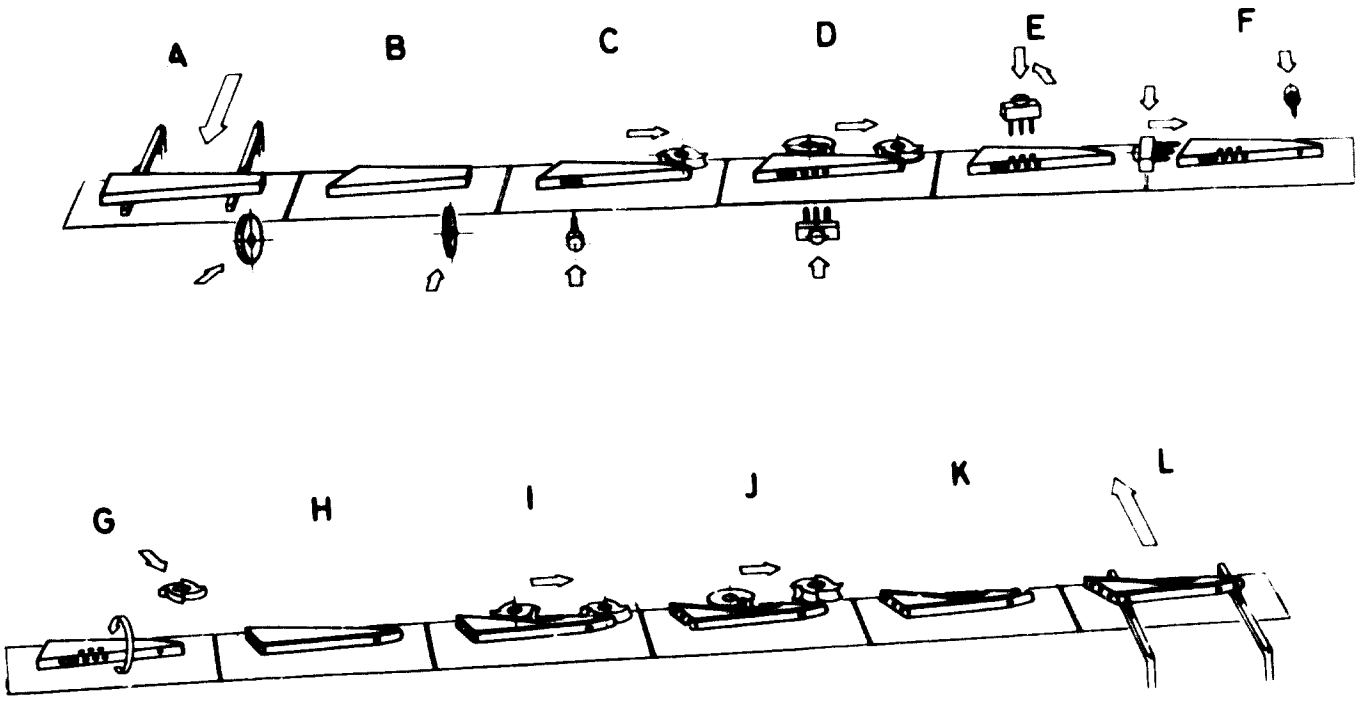
60. A multi-purpose machine will, when fully utilized, increase production. Other machines may then have to be replaced too as productivity is increased following introduction of a multi-purpose machine, since bottlenecks may consequently be shifted either forward or backward along the line. Multi-purpose machines require costly toolings and two tool sets should be available, so as to minimize down time.

61. Skill - It is easy to train a young man on individual machines, viz: bandsaws, circular saws, spindle moulders, jointers, thicknessers, single-end tenoners and the like. A trained machine operator from time to time should operate different machines. Very soon one will find out which of the operators trained in this step-by-step way are qualified to operate the more complicated specialized equipment, or to be trained further as foreman operating as machinist in the machine room. Basic training on the job is necessary to have specialized laborers available when operating on a higher production level. These can then easily shift to working on multi-purpose machinery.

Figure 33

Schematic Representation of Fully Automatic Transfer Line
for
Machining Solid Wooden Parts

A.	Hopper feed loading and positioning
B.	Double-end cut off and hogging
C.	Pre-shaping and slot-mortising
D.	Finish-shaping, profile sanding and triple-hole boring
E.	Triple-hole boring
F.	Triple-hole boring (end grain) and counter sinking
G.	Workpiece turnover (180^{o})
H.	End-grain shaping
I.	Pre-shaping and angle-shaping
J.	Finish-shaping and profile sanding
K.	Workpiece and slide dusting (and chips exhaust)
L.	Ejecting and transfer to assembly line.



62. Maintenance - A trained machine operator who knows how to work with machines, will soon find out that a machine will not run satisfactorily without a certain amount of maintenance. The "Service Manual" should thus, for good maintenance, be handy to the operator. In many cases the trouble-shooting chart will give the operator an idea what mistake he made in operating the machine. A good sharp tool is only sharp so long as the operator stops machining wood before it is dull. Dull tools are dangerous and can overload the drive of the machine, dust and dirt should not be allowed to build up on moving parts. These points are particularly important when operating very expensive and sophisticated machinery.

63. Batch-size - Whenever more than one piece is to be produced, one should think of easing the manufacture by preparing the work for several workpieces. One workpiece machined on different machines means adjusting the equipment for each operation. Thus economic production begins not only with repetitive or multiple operations, but with identical operations or machining actions on different pieces. Any machine room has its limit in setting the minimum or maximum batch size. The best figure for a batch size is when most of the machines are in operation and workpieces are in a lot which can easily be assembled. Whenever a bottleneck in production rooms arises it is, in most cases, caused by a poor batch size. The best production batch is evidenced by a short through-flow of time from the rough mill to shipping departments.

64. As soon as several multi-purpose machines are in operation, one should think about faster production by linking this equipment, a development which leads to automated production. Manufacturers producing a standardized machinery system can serve the woodworker far better because of the flexibility of the unit system. System built machinery is "custom sized" in any case.

65. The hourly cost of a cycling through-feed veneering press (Fig. 34) increase, for example, with decreased usage.

use	100 %	75 %	50 %	25 %	10 %
operating time (hours/year)	1760	1320	880	440	170
production in m^2/yr.	260000	195000	130000	65000	26000
total costs (DM)	170500,-	145500,-	120500,-	95500,-	80500,-
hourly costs (DM/hr.)	97,-	110,-	137,-	217,-	458,-
production costs (DM/m^2)	0.66	0.74	0.93	1.47	3.09

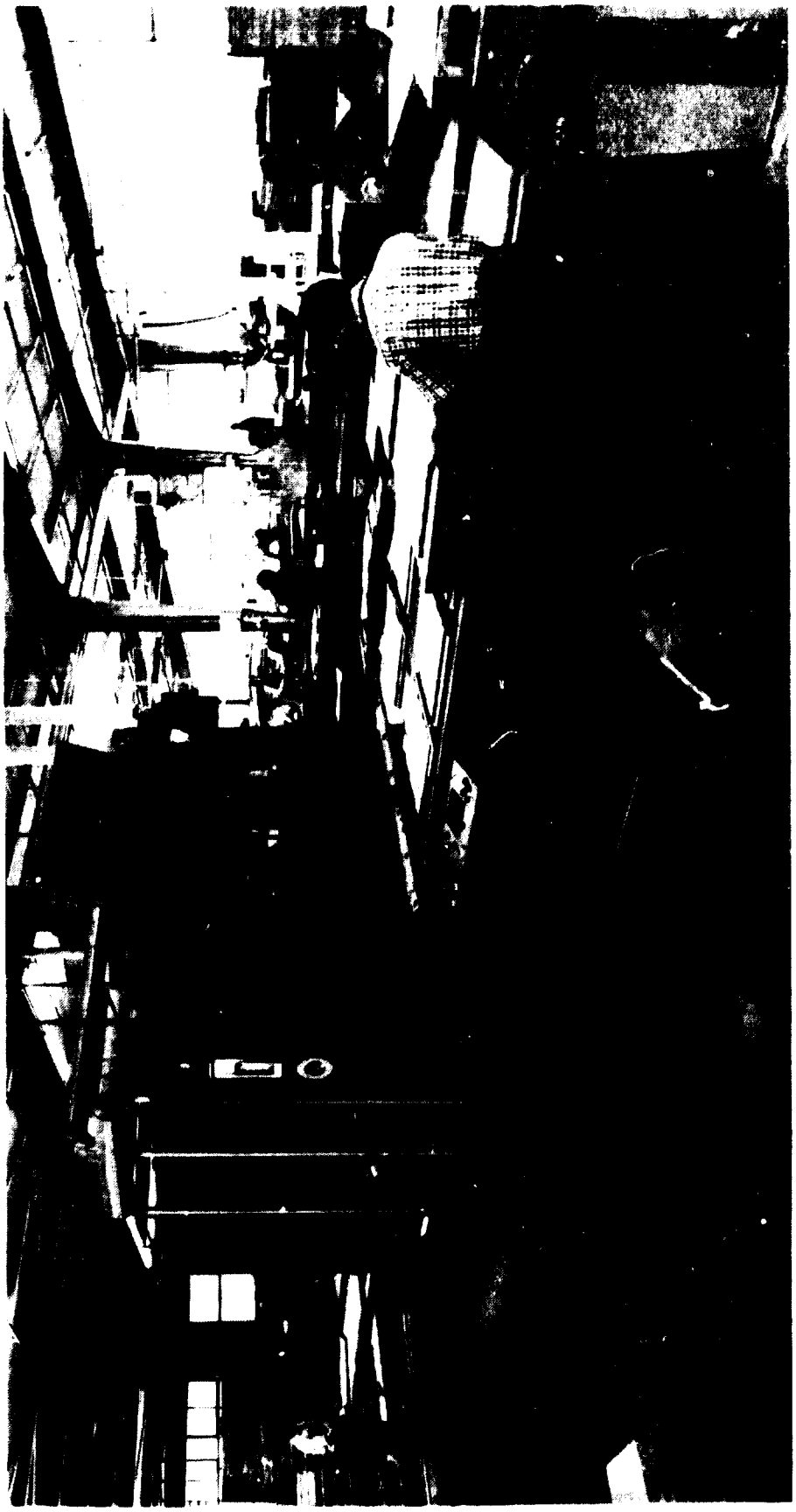


Fig. 34

Cycling Through-Feed Veneering Press

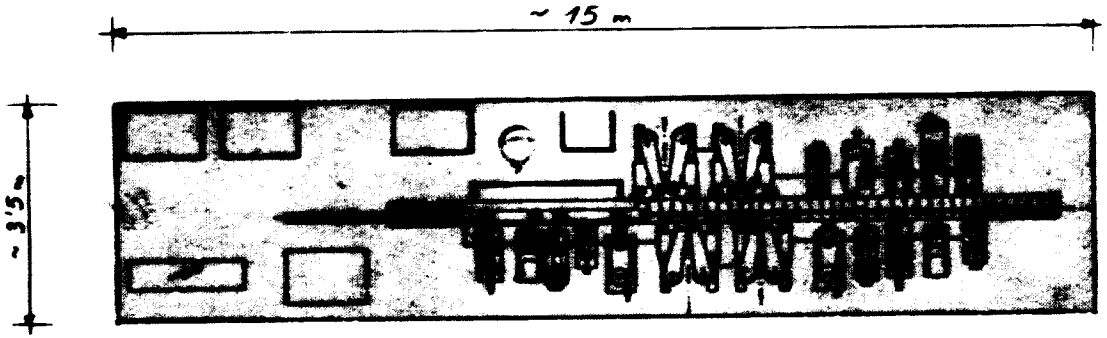
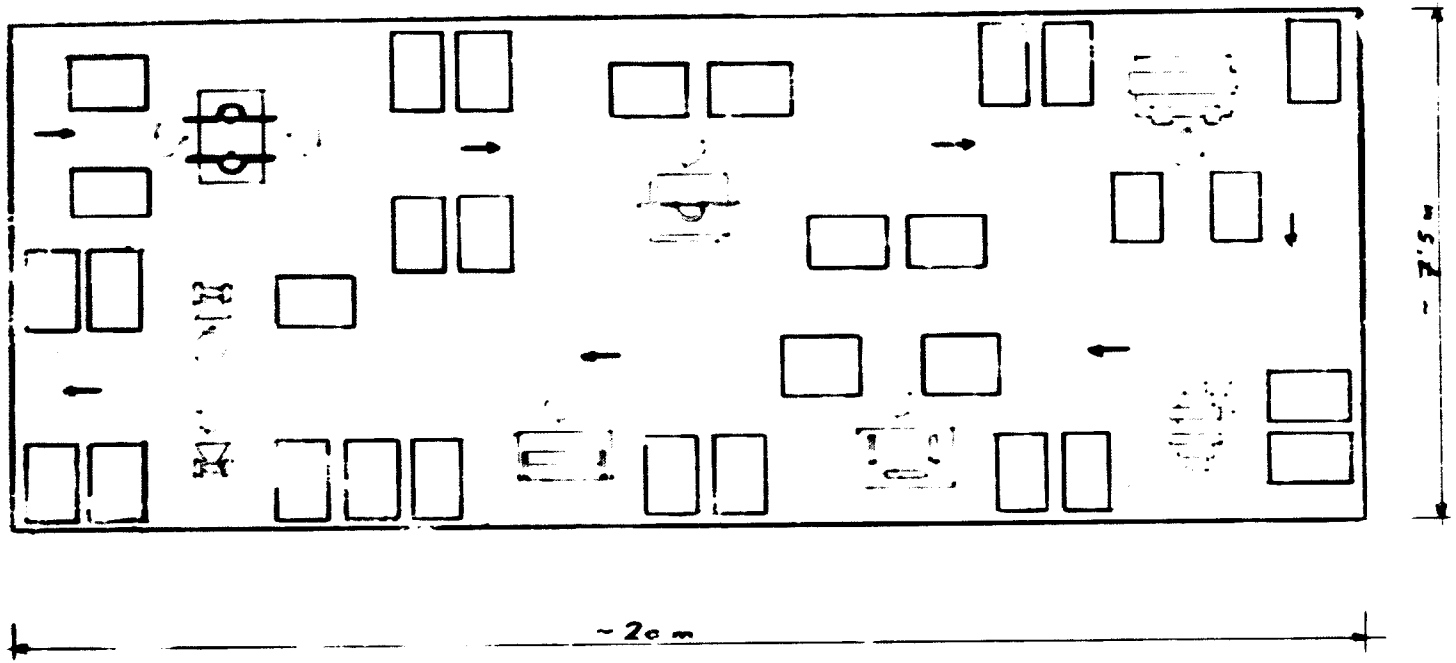


Fig 35 COMPARISON

of production space and operators required for an automatic machine or individual machines



These costs include fixed and variable costs, space costs, operator costs, operational material costs, repair costs, maintenance costs.

66. When using a high production machine as described the total costs by a use factor of 10 % are nearly half of the full-time operation costs but the hourly costs increase from DM 97,-- to DM 458.--.

Price of a cycling through-feed press	approx.	150.000 DM
Price of a 5-daylight press	approx.	21.000 DM

Capacity of a cycling through-feed press	150 m^2/h
Capacity of a 5-daylight press	100 m^2/h

The costs in DM/m^2 give an idea how they increase if a cycling through-feed veneering press is utilized less than 75 per cent of the time.

67. An automated machine which replaces several basic machines has many advantages. The drawings (fig, 35) shows that the automatic shaping, sanding, boring, mortising, tenoning machine:

covers 15 m x 3,5 m = 52,5 m^2,
which replaces 8 individual machines
covering 20 m x 7,5 m = 150 m^2;
space relation is about 1 : 3,
operator relation is 1 : 9.

68. A chair manufacturing company who replaced their individual machines with this automated machine now has the following gains. Annual savings based on production of nine different parts.

	machine time		direct labour costs	labour costs to produce
individual machining method	1073 hours	x	$ 2,21/hour	$ 2.371,--
automatic machining method	145 hours	x	$ 2,21/hour	$ 320,--
direct labour savings/month, 1st shift				$ 2.050,--

Assume 2nd shift efficiency to be 90% of the 1st shift

direct labour savings/month 2nd shift	$ 1.910,--
direct labour savings/month two shifts	$ 3.960,--
indirect labour savings/month one material handler	$ 500,--
Total estimated monthly savings, two shift basis	$ 4.460,--

69. The training costs reflected in the first 8 month operation as follows:

first year labour savings estimated at	$34.250,--
thereafter, annual labour savings estimated	$53.520,--
	$ 53.520,--
	$ 34.250,--
Training costs	$ 19.270,--

which includes $ 1,94 average operator rate and 14% fringe

maintenance costs benefits:

70. The maintenance costs of an automatic machine will in general not exceed those of the individual machines replaced.

3. Payback and Long-term Profitability

71. Payback = 3,5 years on a two shift base

True rate of recovery of equivalent annual earning rate 2 ,5 %

72. The operation of this automatic machine made it evident that too much material was being used to produce nine special parts. A job change, resulting in material and labour savings amounting to .0891 cents/piece, has been since instituted on these parts.

Total annual savings due to job change $ 8.304,--

4. Investment and Costs of a Linked Case-good Production Line

73.

Equipment	Investment in DM
Loading device	60.000,--
Double-end tenoner	100.000,--
Double-edge bander	45.000,--
Crossveyor	16.000,--
Double-end tenoner	100.000,--
Double-edge bander	45.000,--

Crossveyor	12.000,--
Dowel hole boring machine	33.000,--
Finishing sander	32.000,--
Wide-belt sander	42.000,--
Turn conveyor	6.000,--
Wide-belt Sander	42.000,--
Roller conveyer	12.000,--
	550.000,--
Plant heating	55.000,--
Exhaust system	80.000,--
Converter	74.000,--
	759.000,--

All costs including 5 operators, compressed air, operational material power etc. are estimated to be DM 570.000,-- per year.

74. On a single 8 hours shift of 220 days, the production line runs 1760 hours, less 2 hours adjustment and equipping time per day = 1320 hours, when calculating a maximum operating rate of 80 per cent the line will run 1060 hours a year.

Hourly costs: $\frac{\text{DM } 570.000,-}{\text{hours } 1060}$ about DM 540,- DM/hr or DM 9,- per minute of production.

Any increase in down time will raise the costs considerably.

5. Productivity of a Plant

75. An analysis of furniture factories in two different West European countries showed that with nearly the same population the furniture production is in one country 4,5 times larger. The manpower is only double. Such a situation clearly gives rise to high productivity. The output per man is of DM 50.000,- compared to 24.000 DM in the industry of the other country. When comparing the machining operations the efforts are based on production line systems.

76. Flow-line production is the key to advances that have been made in the past years but in any development of automated production lines there are limits of application. Many companies prefer the semi-automated way with its greater manufacturing flexibility.

77. These are good examples of factories in developing countries

operating with individual machines. Labour costs, wood sources, skilled labourers and good mechanized production facilities are factors which nelp form a strong base for productivity in developing countries. With the cheaper but highly developed individual woodworking machines in connexion with multi-purpose machines it is easy to reach the higher production stage provided that first the market problem is solved. Production line systems can not be operated without a good deal of skill and will pay only when a market has been established.

VI. CONCLUSION

78. The high degree of industrialized woodworking in West Europe has required in the last two decades and still requires multi-purpose machines and multi-purpose production lines to overcome the lack of labourers.

79. Flow line systems generally increase productivity. Intercompany comparisons have shown that companies with multi-purpose processing lines compared to others with the same output have a 60% over-rated productivity. But a flow line production will not pay if the batch size is not tuned to the equipment available.

"A N N E X I"

81	MULTI-PURPOSE MACHINES
81.1	Machines for Making Joints
81.11	Tenoning machines
81.111	Single-end tenoning machines
81.111.1	Combined circular saw + spindle moulder=tenoner
81.111.2	Standard single-end tenoner
18.111.21	with horizontal saw-spindle and vertical tenon-spindle
81.111.22	with horizontal saw-spindle and two horizontal tenon shaper heads
81.111.3	Combined single-end tenoner and spindle shaper
81.112	Double-end tenoning machines
81.112.1	with sliding table (reciprocating operation)
81.112.2	with rotating feed clamp
81.112.3	with continuous feed
81.112.4	with interrupted continuous feed
81.12	Finger jointing machines
81.121	for mitre joining
81.122	for end joining
81.122.1	with cutting operations
81.122.2	with embossing operation
81.123	for side joining
81.13	Dowelling machines
81.131	Dowel end shaping
81.131.1	Single-end dowel shaping and boring machines
81.131.2	Double-end sawing and dowel end-shaping machines
81.132	Dowel hole boring with various operations
81.132.1	Single-end sawing, shaping, boring machines
81.132.2	Double-end sawing, boring (chucking), gluing dowel driving machines

Footnote: This proposal classification also appears as part of Annex II in ID/WG.151/14

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1 OF 2

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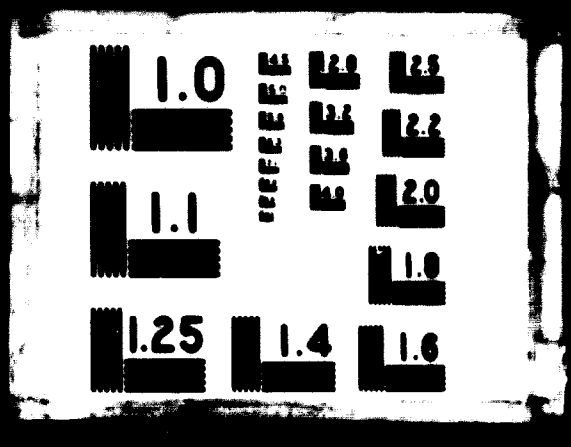

81.2	Machines for Forming Edges
81.21	Single edge operations
81.211	Workpiece in horizontal position (edge gluing, bonding, flush sawing, end trimming, sanding)
81.212	Workpiece in vertical position
81.212.1	Machining tool feeding
81.212.2	Workpiece feeding
81.22	Double edge operation
81.221	Double edge multi-operation
81.221.1	with sliding table
81.221.2	with continuous feed of workpiece
81.221.21	edge machining only
81.221.211	chip cutting operations
81.221.212	sizing and edge banding operations
81.221.22	edge and surface machining
81.221.3	with moving machining units
81.3	Machines for Forming Sides
81.31	Single side operations
81.311	With travelling shaping, sanding, sawing unit
81.312	With rotating table and fixed sawing, shaping, boring and sanding heads
81.32	Double and/or up to five side operations
81.321	For longitudinal shaping sanding operations
81.322	For longitudinal and crossworking operations sawing, hogging, shaping sanding, boring (chucking)
81.323	For crossworking operations
81.323.1	two- or three-station operation, fixed machining units
81.323.2	multi-station operation, moving machining units (machining center)
81.4	Machines for Forming Panels and Boards
81.41	Core stock composing machines (gluing, clamping, sawing)
81.42	Board gluing and sawing machines
81.43	Board dovetailing, gluing driving machines
81.5	Machines for Forming Frames (sawing, scoring, shaping gluing, clamping nailing)
81.6	Machines for Hardware Mounting (recessing, boring, routising,1/ hardware mounting, screwing and/or nailing)

1/ Combines the operations of routing and mortising.

82.2	Transfer Processing Lines with Cycling Flow
82.21	For panel production
82.22	For solid wood production
82.221	Straight flow line
82.222	Angle flow line
82.223	Reverse flow line
82.224	Staggered flow line
83	MULTI-PURPOSE SURFACE COATING LINES

United Nations Industrial Development Organization

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9 July 1973

ORIGINAL : ENGLISH

Technical Meeting on the Selection
of Woodworking Machinery

Vienna, 19-23 November 1973

MULTI-PURPOSE MACHINES AND MULTI-PURPOSE PROCESSING LINES FOR THE WOODWORKING INDUSTRY 1/

by

Heinz Eldag
Consultant
Vienna, Austria

SUMMARY

With the development of combined machines which cover two or more different operations it was necessary to define the multi-purpose machine. As in automated production, the linking of these machines is one of the main features of multi-purpose processing lines, a definition is given, but also with the view to transfer lines.

At first the multi-purpose machines are classified to show up that tenoning machines, finger jointing machines, dwelling machines are those for making joints. Another development of the multi-machining operations are those for edge forming panel products. And the third group covers those forming the sides of a contoured workpiece. Other groups are multi-purpose machines for forming panels, boards, frames or for hardware or glass mounting.

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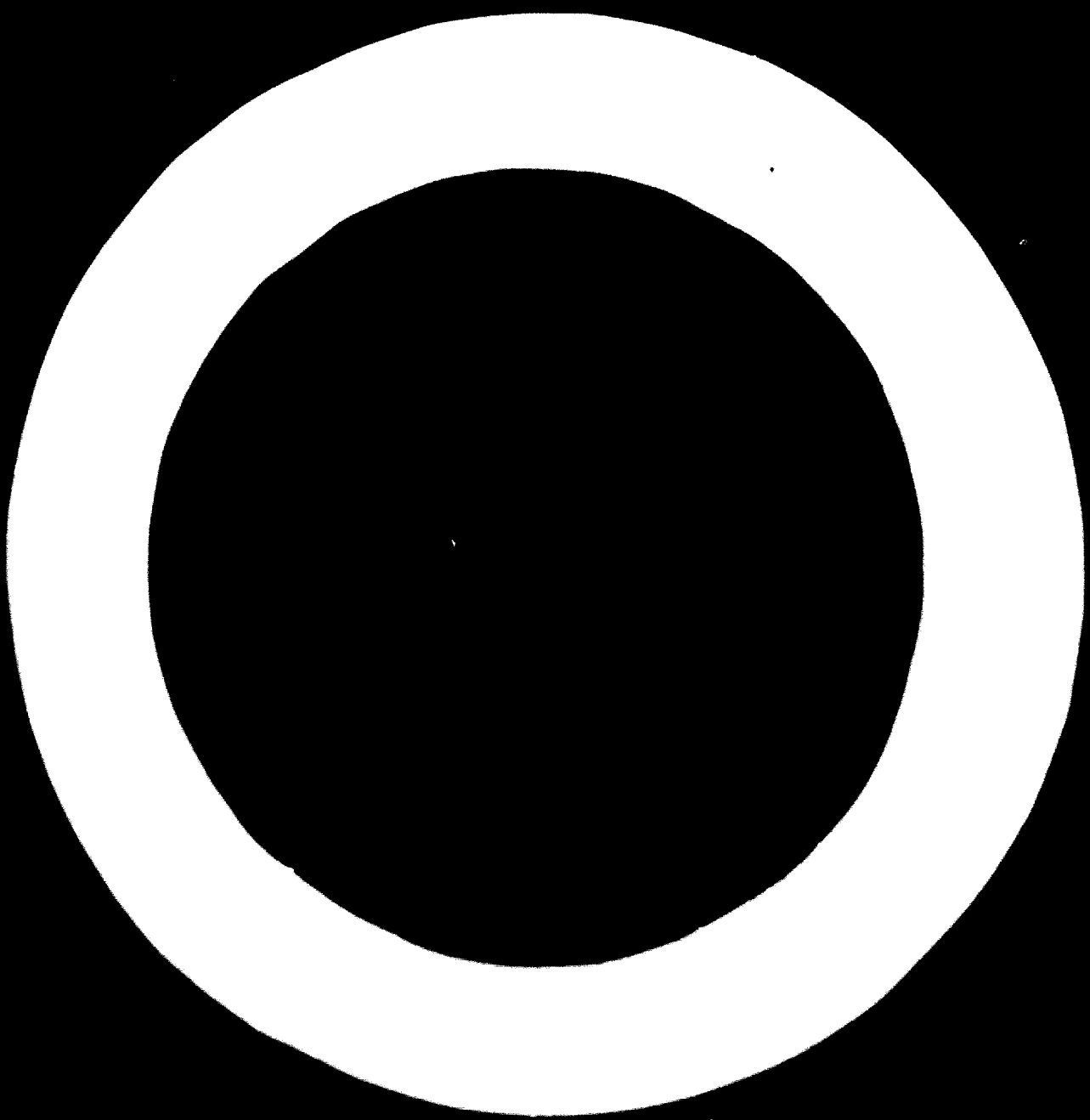

New ideas have been generated when setting multi-purpose processing lines. In panel and carcase furniture production the linked processing line is well known in Western European furniture companies.

The latest development is the transfer processing line with cycling flow. Main feature of this system is the resting of the workpieces while machining. All machines can be applied to do different operations in different sequences. The form of the different end or edge shapes is generated by passing the workpiece past several tools - or tool units - pass along the workpiece edge. The designs vary very much so that for most operation sequences the right machine is available. Special feature of setting the machine units tighter to avoid link units is the sizer-edgebander. Scoring, sawing, glue spreading, edge pressing, cutting, bevelling, sanding are operations following in sequence.

In this connexion a Japanese manufacturer has developed a transfer line for machining panel products.

For machining solid wooden parts an Austrian company has developed a transfer system. Pallet slides move in a 9 second cycle and pass, in the preselected sequence, all machining units.

Some comparison figures about machine prices, machine maintenance, down time, setting time and productivity give an idea about changing factors when switching over to automated equipment.

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Corrigendum

Page 51 Insert the following above the text:

81.7 Machines for Inserting Glass into Sashes

82. MULTI-PURPOSE PROCESSING LINES

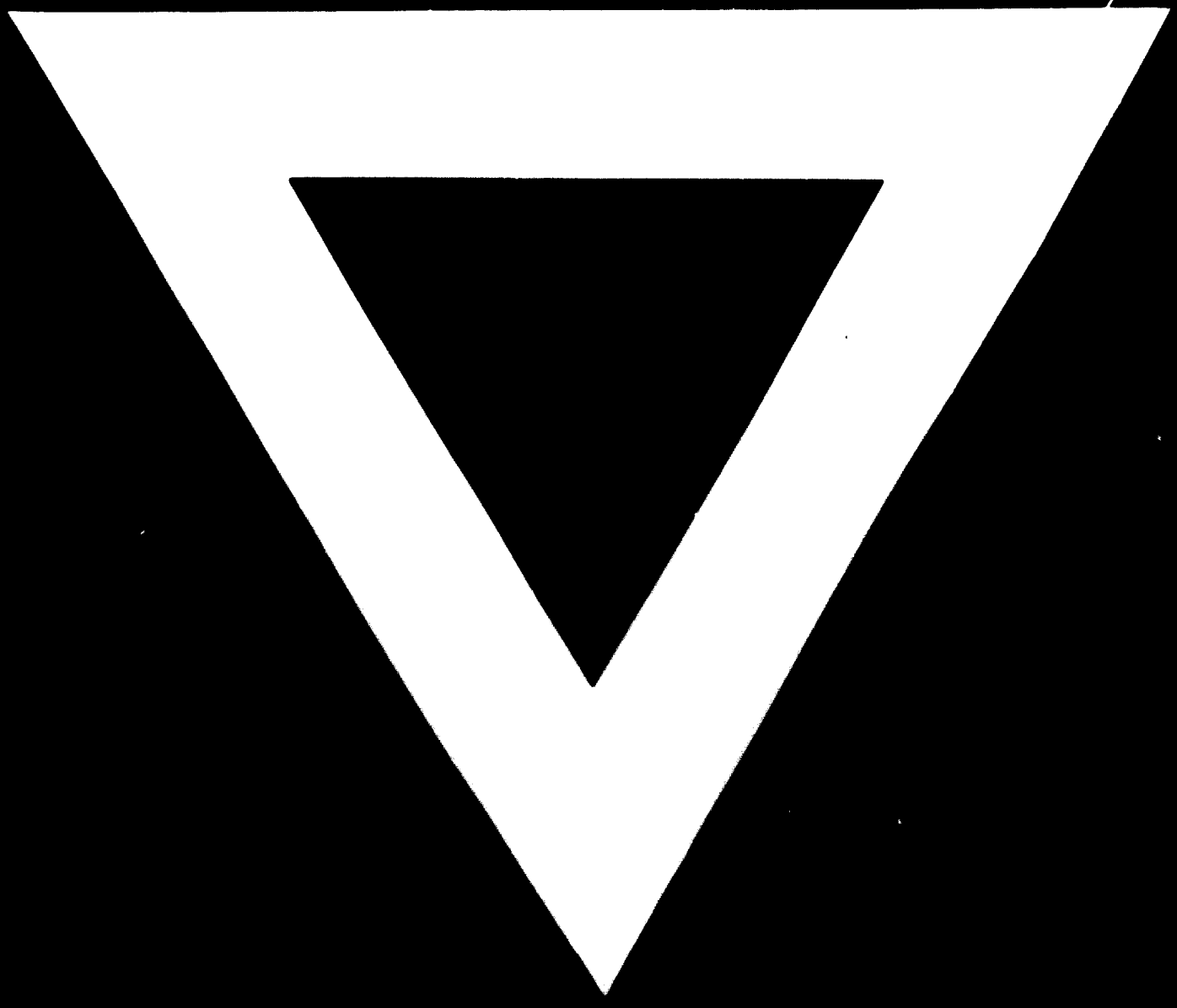
82.1 Linked Processing Lines with Continuous Flow

82.11 Straight flow line

82.12 Angle flow line

82.13 Reverse flow line

82.14 Staggered flow line



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