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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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Technical Meeting on the Selection
of Woodworking Machinery

Vienna, Austria, 19 - 23 November 1973

SELECTION OF FINGER JOINTING MACHINES[1/]

by

Hans Sybertz, Technical Manager
Hüberl & Platzer Maschinenbau-Gmbh
Bad Kreuznach, West Germany

SUMMARY

Finger jointing is the most reasonable and best method to joint wood together preferably in a lengthwise direction. It leads to an improvement in quality of the wood and the products manufactured thereof. Wood is better utilized and can become an engineered material.

Today's most commonly used sizes of fingers in the woodworking industry range between 30mm (1 1/4") and 7 mm (5/16").

Before any investment is made in finger jointing machinery sufficient testing of wood should be undertaken, especially when relatively unknown species are to be used. Furthermore certain provisions will have to be made depending on the machinery and material to be used.

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As far as the investment is concerned the technical and financial efforts must stay within a reasonable relation to the improvement of the product and should only be carried out as far as necessary.

Today's machine industry offers simple and standard equipment as well as semi and fully automatic equipment. The various finger jointing lines are basically designed either to work short stock or long stock.

Considering more or less automatically operating equipment there are two basic systems.

In a transfer-system the various operations take place at different locations while the work pieces are conveyed in crosswise and longitudinal direction

In a straight through system the board is moved only in a longitudinal direction and the essential and main operations are executed while the boards remain in a fixed position.

Consideration should be given to the question if a particular finger jointing plant thought of can be adequately and appropriately operated and serviced.

Finger jointing of wood deserves more large scale application than is presently the case.

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of Woodworking Machinery

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SELECTION OF FINGER JOINTING MACHINES 1/

by

Hans Syberts
Technical Manager
Hüberl & Platzer Maschinenbau-Gmbh
Bad Kreusnach, West Germany

CORRIGENDUM

Replace Table 1 on page 32 by Table 1 overleaf.

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TABLE 1 Comparative Analysis of Var

Type	estimated Production (joints / minute)	approximate capital investment (x 1000 DM , May 1975)
1. Non automatic process		
Finger jointing of short stock – stockwise (see Fig. 2)		
a) Shaper with cutoff saw	5 – 15	40 – 70
b) Shaper without cutoff saw	3 – 10	30 – 40
2. Semi-automatic process		
2.1 Finger jointing of short stock – stockwise (see Fig. 3)		
a) one shaping machine	6 – 12	70 – 100
b) two shaping machines	10 – 20	80 – 190
2.2 Finger jointing of long stock – single pieces (see Fig. 4)		
a) one shaping machine	1 – 2	100 – 120
b) two shaping machines	3 – 4	120 – 190
3. Fully automatic assembly line-transfer systems		
3.1 Finger jointing of short stock – stockwise (see Fig. 5)		
a) one shaping machine	15 – 20	100 – 190
b) two shaping machines	15 – 20	
3.2 Finger jointing of short stock – single pieces (see Fig. 6)	30 – 60	300 – 900 (900 = maximum investment for c
3.3 Finger jointing of long stock – stockwise (see Fig. 7)		
a) one shaping machine	8 – 12	400 – 600 (600 = maximum investment for l
b) two shaping machines	8 – 12	
3.4 Finger jointing of long stock – single pieces (see Fig. 8)		
a) one shaping machine	4 – 6	390 – 490
b) two shaping machines	4 – 6	
4. Fully automatic assembly line – straight through system		
4.1 Finger jointing of long stock – single pieces (see Fig. 9)		
a) without pre-jointing	3 – 4	300 – 450
b) with pre-jointing	4 – 6	390 – 490

Various Finger Jointing Lines

Percent of maximum investment (short stock)	(long stock)	Labour requirements Unskilled	Number
0 - 15			*)
5 - 8			*)
15 - 20			*)
20 - 30			*)
	15 - 20		*)
	20 - 25		*)
25 - 30			**)
			**)
60 - 100			**)
	65 - 100		**)
			**)
	60 - 75		**)
			**)
	50 - 75		**)
	60 - 75		**)

For short stock = 100 % → 60 - 100

For long stock = 100 % → 65 - 100

*) A skilled person (mechanic) should be available upon request.

**) A high qualified person has to be available upon request.

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Hans Sybertz, Technical Manager
Hüper & Platzer Maschinenbau-GmbH
Bad Kreuznach, West Germany

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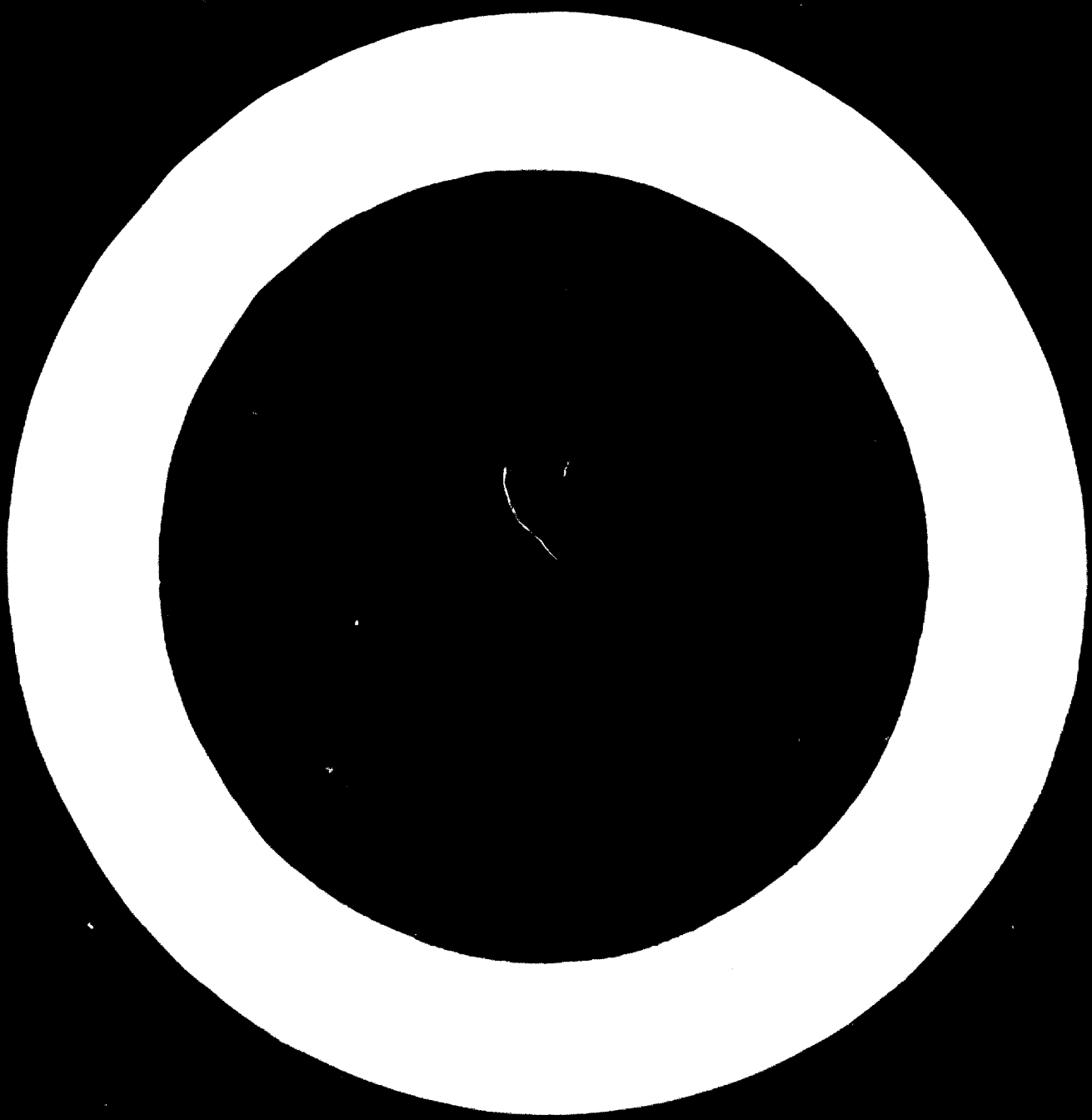


TABLE OF CONTENTS

		Page
I	INTRODUCTION	1
II	THE VARIOUS KINDS OF FINGERS	2
	1. Shape and size of fingers	
	2. Application of the various shapes	
III	ASPECTS FOR THE USE OF FINGER JOINTING	5
	1. Technical aspects	
	2. Economical aspects	
IV	THE CHARACTERISTIC OPERATIONS TO PRODUCE A FINGER JOINT	8
V	MACHINES AND PRODUCTION SYSTEMS FOR FINGER JOINTS	9
	1. Standard equipment and process	9
	1.1 Finger jointing of short stock - stackwise	11
	2. Semi-automatic machinery and respective process	12
	2.1 Finger jointing of short stock - stackwise	12
	2.2 Finger jointing of long stock - single pieces	14
	3. Fully automatic assembly lines, transfer system	17
	3.1 Finger jointing of short stock - stackwise	18
	3.2 Finger jointing of short stock - single pieces	19
	3.3 Finger jointing of long stock - stackwise	20
	3.4 Finger jointing of long stock - single pieces	24
	4. Fully automatic assembly lines, straight-through system	26
	4.1 Finger jointing of long stock - single pieces	26
	5. Remarks	28
VI	CONCLUSIONS	29
	APPENDIX: Addresses of Principal Manufacturers of Finger Jointing Equipment	30
	REFERENCE NUMBERS FOR FIGURES	31

I N T R O D U C T I O N

1. What is a finger

1 The finger joints which are used in today's woodworking industry probably originate from the long-scarf-joint. If one "folds" a long scarf several times a number of fingers would be obtained. Depending how often the long-scarf is folded the fingers received have a certain size and are more or less numerous.

2 It seems that fingerjointing is the most reasonable and best method to joint wood together preferably in a lengthwise direction.

2. Advantage of fingerjointing

3 Fingerjointing of wood means an improvement in quality of the wood and the products manufactured thereof. Wood is better utilised and finally can become an engineered material. Thus the aim is to overcome the malformations and imperfections of nature in respect to the properties of wood and the goal will be to produce more wood as an engineered material with predetermined properties.

4 In the phase of fingerjointing one tries to modify the suitability of wood in order to achieve better applications.

5 Especially when fingerjointing wood a certain degree of homogenization is achieved. This means a technical gain, because fingerjointed wood for example can be better than solid wood of the same size. The more pieces are jointed together the more homogenization takes place. The variabilities are reduced and an internal compensation occures. It is obvious that this homogenization finds its ultimate application in the laminated beam.

6 On the other hand it should be pointed out that any improvement in quality is tied with higher cost.

3. Application of fingerjointed wood

7 The following products are typical applications of fingerjointed wood:

windows and window frames, doors and frames, boards for wall panelling, strips, boards and solid beams for construction purposes, conversion of random length stock into solid given length, laminated beams for large-span buildings.

1. [illegible] of fingers [illegible]

[illegible] the long and unprotected shapes of fingers the ones which are cut perpendicular to one side of the board have survived and succeeded.

[illegible] until recent years the length of fingers ranged from 60 mm (2 3/8") down to 8 mm (5/16"). The perception was that the longer the finger the stronger the joint. This has even been firmly established in the German standard DIN 68140.

[illegible] A study in recent years in this field revealed that a joint with even rather small fingers gives very high strength properties to the joint, especially under certain geometrical conditions. In some of these cases the strength of a joint using these short fingers even surpasses slightly the strength of a joint using long fingers.

Four groups of finger shapes should be considered:

1) The first could be called normal fingers or long fingers or a conventional finger. Their length ranges from 60 mm (2 3/8") down to 30 mm (1 3/4").

2) The finger length of the second group ranges between 30 mm (1 1/4") and 10 mm (3/8").

3) The third group would be called mini fingers ranging from 10 mm (3/8") to 5 mm (3/4).

4) The fourth group are micro fingers. They would be anywhere below 5 mm (3/4").

2. Application of the various shapes

1) Finger groups 1, 2 and 3 are suitable for finger joints being exposed to normal to high load. All fingers within these groups have a slope on each side of approx. 7 degrees.

2) The fourth group, the micro fingers, have a medium to low strength. A joint of these fingers combined is applied for practical purposes in lightly loaded joints for frames etc.

[illegible] fingers in the woodworking [illegible]

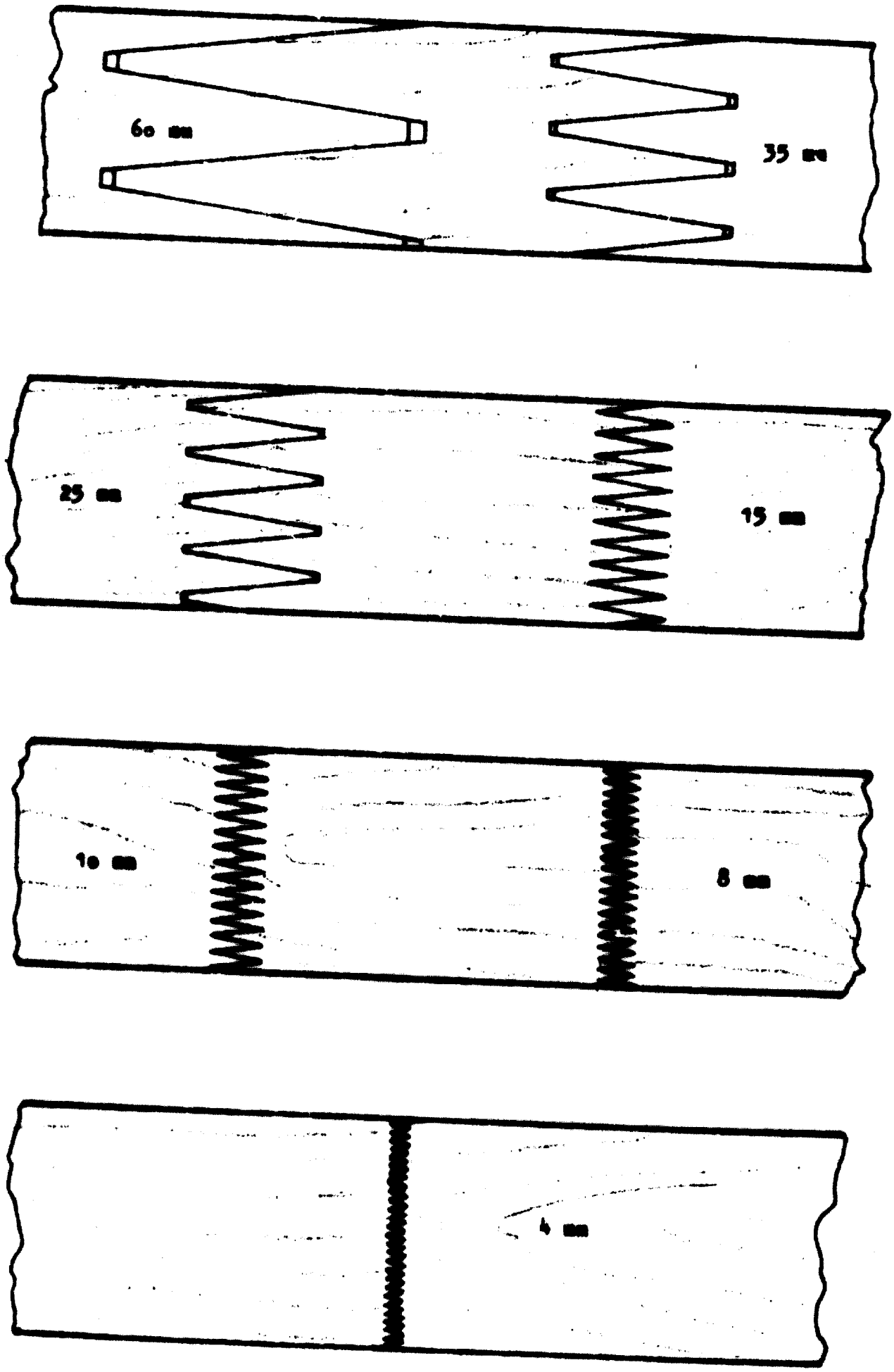


Fig. 1 Shape and size of fingers (full size)

18 In general it would be hard to state what size suits what application best. There seems, however, to be a certain advantage when using mini fingers, because of a rather high initial strength of the joint immediately after pressing due to high pressure which can be applied when using this size of fingers. It is assumed that some kind of interlocking takes place in this case.

19 In many cases where one can take advantage of this effect the wood just jointed together can be machined or otherwise handled before the glue has cured. By the way: a mini finger joint has a nice appearence.

III ASPECTS FOR THE USE OF FINGERJOINTING

1. Technical aspects

20 The moisture contents of two pieces of wood to be jointed together should not differ too much. The moisture contents have to be in the neighbourhood of 1 - 12 % based on ovens dry wood.

21 Furthermore the moisture contents of the joint should be the same one as could be expected on the place of installment. If possible the two wood ends to be jointed together should have a similar structure(grain pattern).

22 In some cases drying of wood can be accompanied by problems since some species especially of tropical wood show a particular behaviour during the drying process: once the outer surface has lost its moisture, the surface acts like a shield or capsule, thus complicating further drying.

23 The machinability deserves close observation. Some species may be machined with poor results. Especially machining of certain hard woods may result in rapid dwilling of the tool and make their use uneconomical. On the other hand wood with low density or fast growing wood might create problems during machining or subsequent operations.

24 The gluing of a finger joint is performed with various types of glue depending on the application of the product.

25 PVA glue is the most common one used for products being installed in dry surroundings. Modified PVA glue can be used for products in moist or damp surroundings, whereas resorcinol and urea resins are water resistant glues.

26 Most coniferous wood is easy to glue and all previously mentioned types of glue would be applicable. The situation can be different when it comes to hard woods and to certain tropical species.

27 Some species contain substances complicating the gluing or rather resulting in lower strength of the joint than could normally be expected. Sometimes different types of glue which are not commonly used may improve gluing results(e.g. epoxy resins).

28 It would be advisable to carry out sufficient testing before investing in any finger jointing machinery when uncommon wood species are to be used.

29 The curing of the glue of the fingerjointed wood normally takes place at room temperature, i.e. at least temperatures above 20 centigrade (70° F). The period in which the glue can be considered cured depends on the surrounding temperature. The higher the temperature the faster the glu cures. To give an example: surrounding temperature 20 centigrade (70° F) - curing time 15 hours; surrounding temperature 50 centigrade (120° F) - curing time 5 hours; surrounding temperature 70 centigrade (160° F) - curing time 2 hours.

30 If for some reason a faster curing than that corresponding to room temperature is desired, the finger jointed wood can be stored in a drier.

31 Another possibility would be to heat up the two ends of wood immediately before jointing to a temperature of approx. 80 centigrade (180° F).

32 Radio frequency, also a mean of curing a finger joint in a very short period of time, should only be used if large scale industrial production makes this essential.

33 A precondition for the use of radio frequency is the possibility of good service and the availability of specialists.

When these conditions cannot be met one should refrain from using high frequency.

2. Economic aspects

34 As usual technical and financial considerations must stay within a reasonable relation to the improvement of the product. Furthermore the improvement of the material should only be carried out as far as necessary. It would be of importance to consider all facts and conditions as described under chapter III 1.

35 Another question is whether the equipment which is to be installed can be operated and serviced adequately. How good is the most modern and sophisticated production line if after the first breakdown no one will be able to get it back into operation again.

36 This statement does not necessarily mean that one should select the most simple or primitive installation. Simple and primitive does not necessarily mean economical

37 Production equipment should be selected to be heavy enough to handle the stock to be jointed together. As far as the production rate of an installation is concerned it should be considered to stay within controllable limits. It obviously seems better to stay on two legs instead of staggering on one big leg.

THE CHARACTERISTIC OPERATIONS TO PRODUCE A FINGER JOINT

38 The stock to be used has to be dried to a moisture content of approx. 10 - 12 % on bone dry basis.

39 The next operation will be to free the boards from defects like knots, areas of cross grain; warped and twisted boards have to be cut down to smaller lengths. Especially the ends of the boards which are to be jointed together have to be cleared of splits and knots. The latter for instance is mandatory for the production of laminated beams.

40 Shaping the fingers at the end of the board is either performed by travelling tool or travelling work piece. In any case a firm hold of the wood is essential. Vibration of the work piece results in an imprecise finger shape as well as in reduced tool life.

41 Long fingers should be preslotted prior to shaping the finger. It also seems important that the two board ends to be shaped be securely referenced to each other to avoid subsequent off-set of the finger joint.

42 Glue is either applied on one or both sides of the finger shaped work pieces. In some cases glue application on both sides is a mandatory regulation.

43 Usually glue is applied by a die which matches the exact shape of the fingers, by means of a profiled roller or by a rotating brush. In case of long and short fingers the method of die or profiled rollers has proven to be the most common one, whereas a brush seems to do a better job on mini and micro fingers. The kind of glue used for a finger jointing process also may influence the selection of the glue applicator.

44 Jointing the two pieces of wood together and applying pressure on the joint would be the last main operation. If the finger jointing assembly line is a transfer system, provisions will have to be made for the two pieces of wood to reach a proper predetermined position where they will fit in each other exactly.

45 The pressing time averages a few seconds and should not be below two to three seconds.

46 The following operations such as cutting off the beam, discharging it, stacking and storing can be done according to several methods.

MACHINES AND PRODUCTION SYSTEMS FOR FINGER JOINTS

47 In the following chapter the most common types of finger jointing machines and production lines will be introduced. Prior to this information will be given for the better understanding of the description.

48 The capacity indicated on several illustrations shall only give a rough comparison between two possible production lines, i.e. between the version shown on the left hand side and the version shown on the right hand side. If for instance both versions are marked 100 % this should indicate that both versions would have approximately the same rate of output.

49 The output capacity in finger joints per minute mentioned in connection with all versions described in this chapter is to be understood at a capacity rate of 100 %. The number of joints per minute depends in many cases primarily on the wood section to be used. Therefore the indicated number of joints per minute shall only give an expected rate of output under normal and average conditions. Other factors affecting output are: incorrect setting, insufficient preparation of stock,(i.e. twisted, knots in finger area, splitting during pressing due to cross grain) and the wide range of human error.

50 The number of operators for the particular production line is an estimated number and could be varied depending on certain conditions.

51 In the following illustrations all machine systems are shown in symbols. A finger joint shaper for instance is symbolized by the tool and the movement of the tool. Whether the shaping tool has a horizontal or a vertical movement was not considered to be of any importance for the understanding of a working operation. The same applies also for example for the glue applicator. Whether the glue applicator would consist of a roller, a brush or a die, the symbol is always the same.

52 For the various examples of production lines it is assumed that the raw material to enter the process has already been pre-treated, i.e.knots and other defect areas in the stock have been cut out, bent or twisted pieces cut to smaller sizes, etc. For identification of machines see the reference list on page 31. Table 1 lists the caracteristics of each system (page 32).

1. Standard equipment and process

53 For the simplest method of finger jointing wood only the basic machinery would be necessary, In this case only single machines would

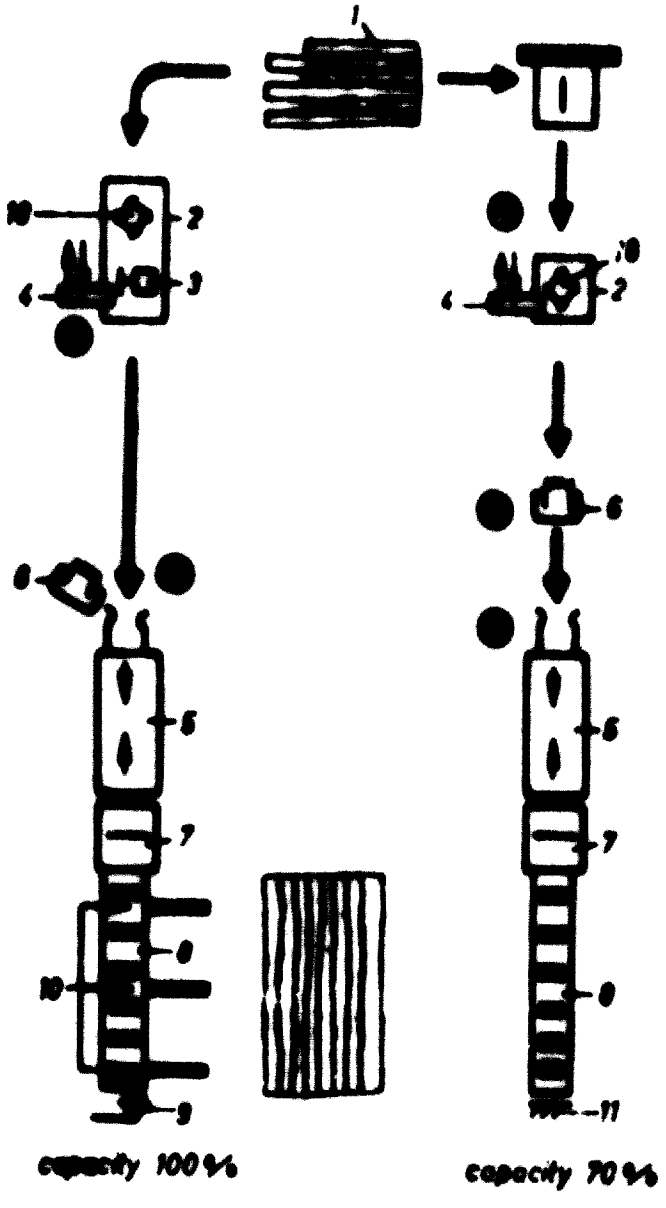


Fig. 2 Finger jointing of short stock - stackwise

be used and all transport of stock between the individual operations would be done by hand or simple transport equipment.

1.1 Finger jointing of short stock - stockwise (Fig. 2)

54 According to the version on the left hand side the stock(1) is machined in small packages on a standard shaper(2) equipped with a trim saw(3). The operator aligns several boards and actuates the working stroke by hand, unless the shaper is equipped with a self-actuated sliding table(4).

55 Some shapers can work in an opposite sense, i.e. the working table with the stock remains stationary, whereas the tool and the trim saw move.

56 After this operation the operator turns the wood package by 180 degrees, aligns the ends and repeats the same operation as before.

57 The press(5) is equipped with a nearby glue applicator(6). In this case an operator will apply glue to one or two ends of each piece and at the same time feeds the press(5). The press is followed by a cut-off saw(7) and a roller table(8) with an electrical stop(9) and a discharger(1o). As the wood beam hits the electrical stop(9) it actuates the cut-off saw(7). After the cut-off saw(7) has performed its operation the discharger(1o) ejects the finger jointed beam, thus immediately making room for the finger jointed beam to follow. Rate of capacity: 100 %.

58 The version on the right hand side is very similar except that the shaper(2) is not equipped with a trim saw(3). In this case the cutting off of the board ends is performed in a separate operation preceding shaping.

59 A next operator receives the machined stock and applies glue to one or both ends of each piece. A third operator feeds the press(5) by putting piece after piece into the press(5) and also actuates the press operation by a switch unless the press is not equipped with a device for detecting the wood ends and then actuating the press automatically.

6o Right after the press(5) a cut-off saw(7) and a roller table(8) with stop is located. As soon as the wood beam hits the stop(11), the operator actuates the cut -off saw(7) and empties

the roller table(6) by removing the ready assembled beam. Rate of capacity: 70 %.

61 The output could be rated with 5 to 15 joints per minute based on 100 % capacity.

Semi-automatic machinery and respective process

62 In this production line two or more operations are combined in one unit. Most movements either of a machine part or of the work piece to be machined are performed automatically. Certain transfers or transports are executed manually. The various movements of machine parts are done by mechanical, pneumatic, and in some cases by hydraulic means.

2.1 Finger jointing of short stock - stockwise (Fig. 3)

63 The production line shown on the left hand side is equipped with a shaper(2) including trim saw(3) and a self-actuated sliding table(4). The operator takes several pieces of short stock (1), aligns all pieces on one side and the shaping of the profile is performed by the shaper(2).

64 The operator turns all boards by 180 degrees and the same operation is repeated on the other side of the board. Thereafter he stacks the boards in a nearby magazine (12).

65 An outfeed system(13) removes piece by piece from the magazine(12), and each piece passes a glue applicator(6) which applies glue on one side of the board.

66 Following this, piece after piece is moved into an infeed equipment(14) which itself feeds the press(5) and the following machinery. The press (5) is self-actuating, i.e. the press operation is performed each time the board ends to be jointed together are located between the press shoes. Registering of the two board ends is done by mechanical or electrical sensors.

67 The press(5) is followed by a cut-off saw(7) and a roller table(8) with discharger(9) as well as provisions for stacking the end jointed timber in a stack(15). This stack(15) may then be moved in a crosswise direction with a cross feeder(16) to its final storage place(17). Compared to the version on the right hand side this production line could be rated with a capacity of 60 %.

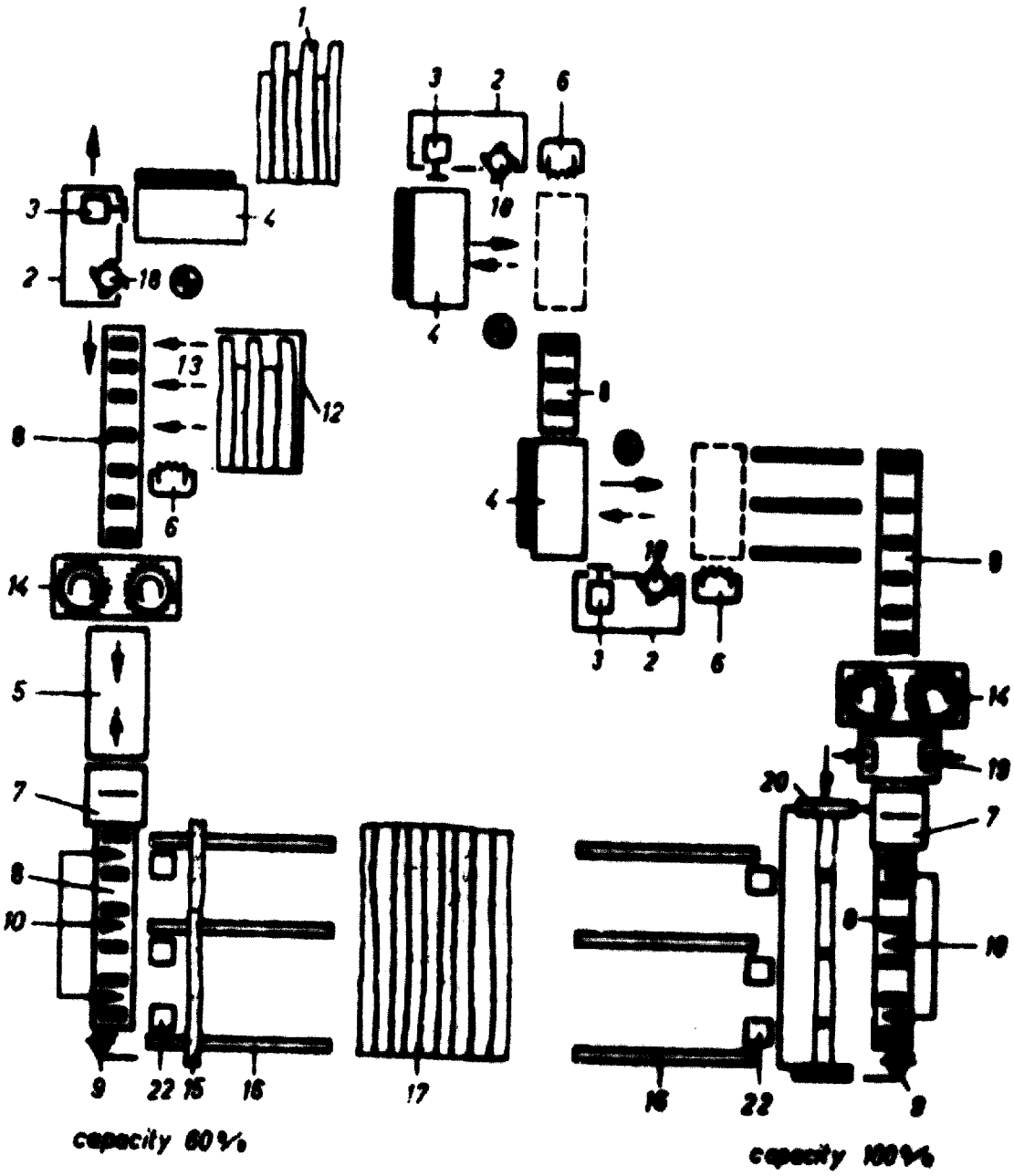


Fig. 3 Finger jointing of short stock - stackwise

[illegible] The production line on the right hand side is equipped with [illegible] fingering machines(2) at the beginning of the [illegible] each fingering machine(2) incorporates a trim saw(3), [illegible] glue application [illegible] and a self-actuated sliding table(4). Each fingering machine(2) machines only one side of the stock. A roller table(5) connects the two sliding tables(4) of the above mentioned machines(2) when they are in a certain position.

6) After the machining of the second machine piece by piece is transported into an infeed system(14) followed by a pressure build down zone(15) which joints the stock together under light pressure. This assembly line furthermore consists of a cut-off saw(7) and a roller table(8) with electrical stop (9). After the assembled stock hits the electrical stop(9), it is cut off and cross fed into a squeezing station(2o) where the final pressure on the assembled stock is applied. This squeezing station(2o) also can be incorporated into the roller table(8) following the cut-off saw(7).

2o The ready assembled beam now is ejected, stacked and cross fed on a cross conveyor(21) to its final location for the glue to cure. The capacity of this production line can be assumed as 100 %.

21 The output of this assembly line ranges between 1o and 2o joints per minute at a capacity of 1oo %.

[illegible] finger pointing of long [illegible] - angle pieces (Fig. 4)

22 The production line on the left hand side consists of 2 finger joint shapers(12) with trim saw(3). These machines face each other and are connected with a roller table(5) in a certain position. The operator puts each individual board into position on a stationary table(11) where the end of the board will be machined. After each step the operator rolls the board on said roller table (5) to the next machine where the respective machining of the other end takes place in the same manner.

23 Now the ready shaped board is brought on a roller table(8) with a nearby glue applicator(1) where an operator applies glue to one end of the board and sets it in an infeed system(14) for the pre [illegible].

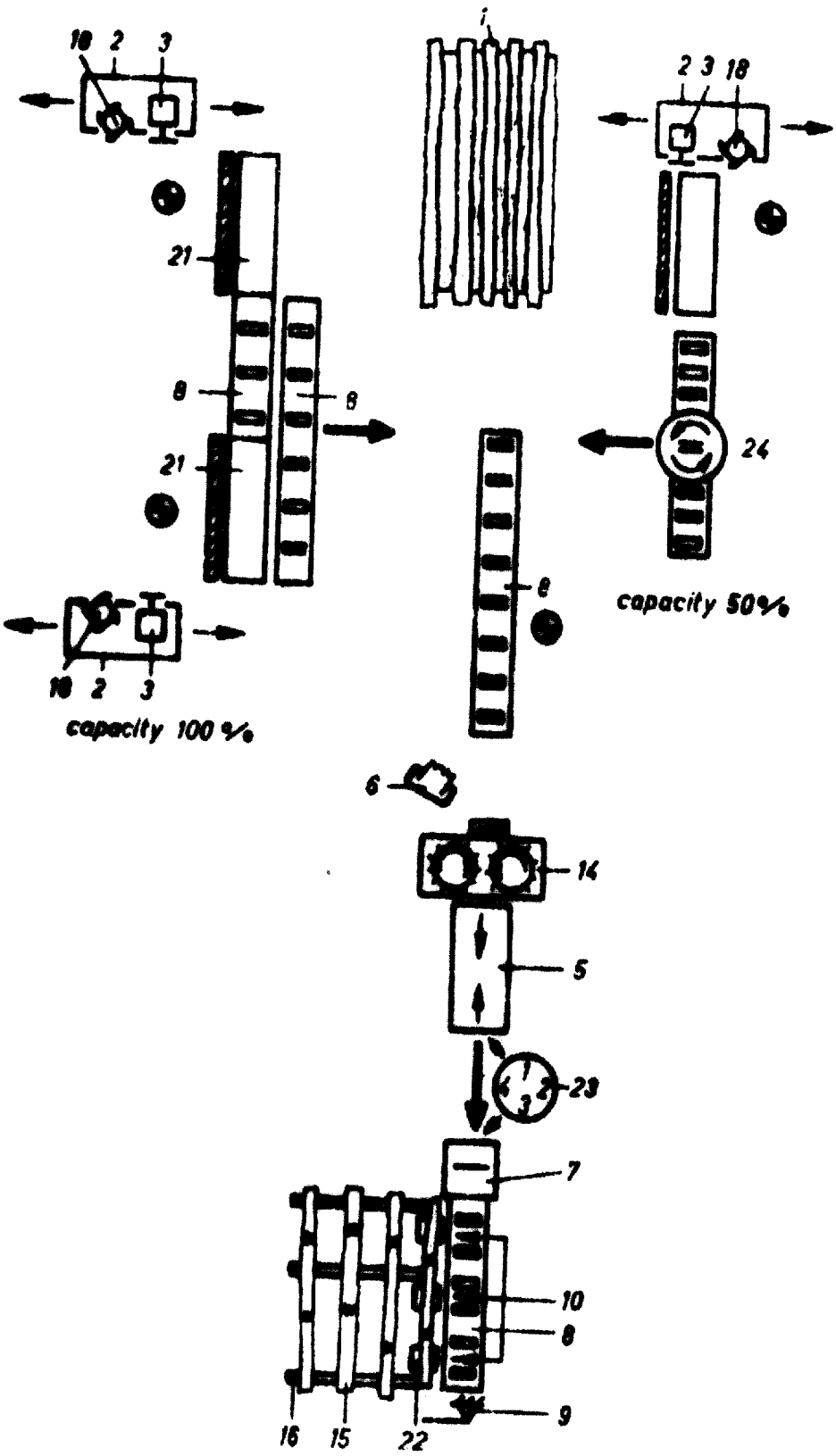


Fig. 4 Finger jointing of long stock - single pieces

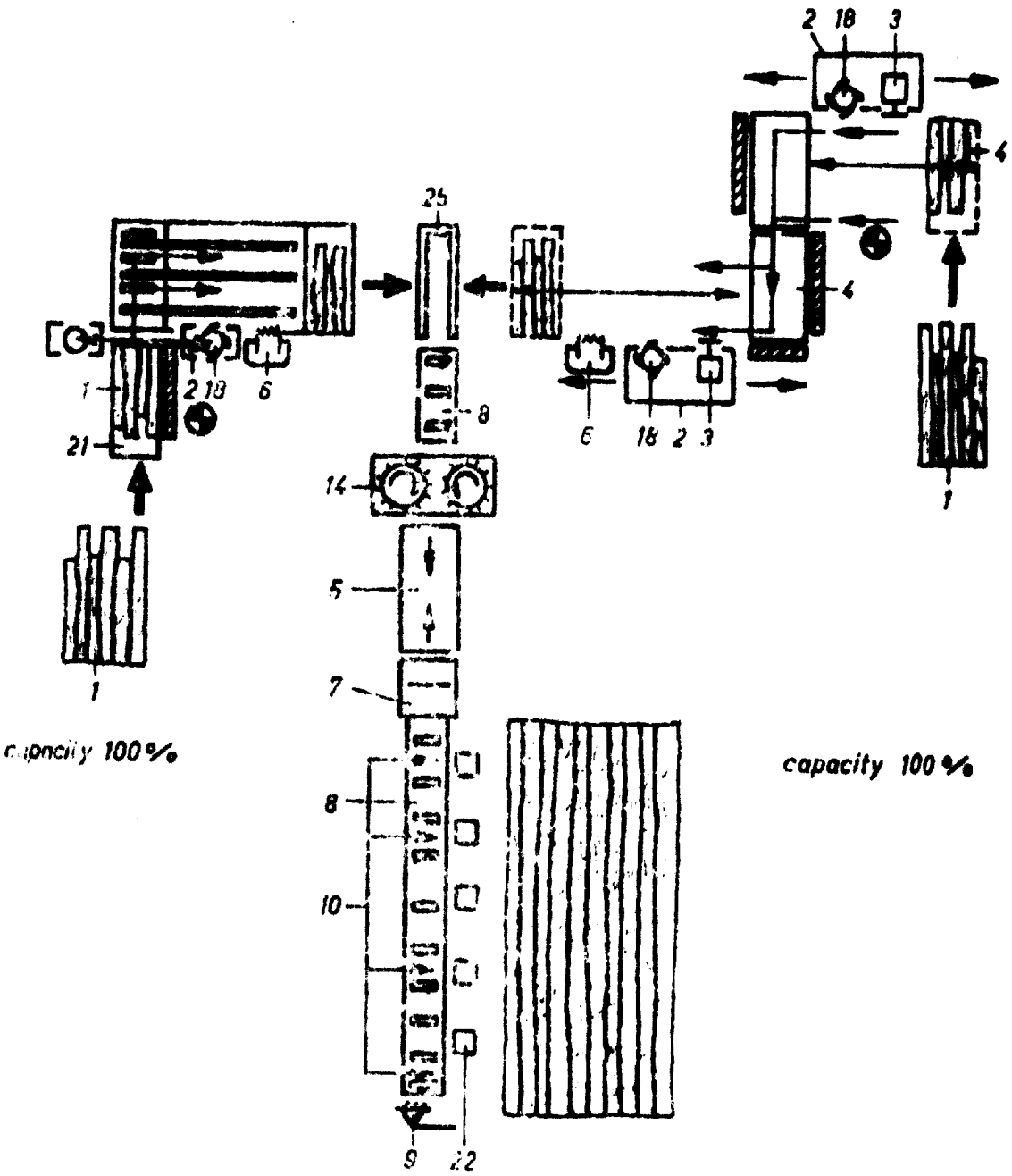


Fig. 5 **Finger jointing of short stock - stackwise**

74 The press(5) can be self-actuating by electrical or mechanical means. The press(5) is followed by a cut-off saw(7), discharge table(15) with stacking device(23) and cross feeder(16) where the ready stacked beams(17) can be stored.

75 The length of the assembled beam can either be detected by an electric stop(9) or by a counting wheel(23) which would actuate the cut-off saw(7). The complete production line as described above is rated at a capacity of 100 %.

76 The finger jointing system on the right hand side compared to the one on the left hand side differs mainly in the finger jointing operation. In this case the shaping machine(2) operates in connection with a rotating table(24) where the board is rotated by 180 degrees after each shaping operation. The capacity of this version can be rated as 50 %.

77 A remark on this assembly line: The glue applicator(6) could also be installed within the shaping machine(2). Furthermore it would be possible under certain conditions to machine two or more boards at a time especially when small cross sections are to be used.

78 The output of a production line as described above is approximately three to four joints per minute at a rate of capacity of 100 %.

3. Fully automatic assembly lines, transfer system

79 The following machine systems operate automatically in such a manner that the boards pass the production line without being touched once they have entered the first machine.

80 During the various operations which take place at different locations the boards are transfered by a variety of systems such as conveyor belts, driven roller tables, cross feeders, tilting mechanism, turn tables to rotate boards etc.

81 Depending on the machine system the stock is machined and glued stackwise or as single pieces. From thereon all systems assemble the boards piece by piece. The assembly line can operate either continuously or intermittently. The various movements of the machine parts are done by mechanical, pneumatic or hydraulic means.

7.1 Finger jointing of short stock (see fig. 7)

82 The production line shown on the left hand side shows a finger joint shaper(2) with a double heating tool(16). A stack of short stock is laid on a stationary working table(21). When the tool(16) passes the working table(21) all board ends are shaped in one operation. After the operation the shaping tool (16) remains in its position while the stack on the working table(21) is pushed into position on the opposite side of the machine(2). It is clamped then while the tool(16) moves back to its original position shaping all board ends.

83 During this short operation the operator has already prepared another stack of short stock. The previously shaped stack is moved in a transverse direction passing a glue applicator(6) entering an unstacking device(25).

84 From thereon piece after piece is moved into an infeed device(14) feeding the press(5). The press(5) is actuated by electrical or mechanical scan detecting the two board ends to be jointed together.

85 The end jointed item passes the cut-off saw(7) and moves along the discharge table(10). When the item hits the electrical stop(9) it is cut off and discharged for example on a stacking device(22).

86 The production line shown on the right hand side uses two separate off-cut finger joint shapers(2) facing each other with trim saw (3).

87 The operator brings several pieces of short stock into position on the sliding table(4). After the stock is clamped the sliding table(4) begins its stroke, passing the trim saw(3) and the shaping tool(16). At the end of the stroke all stock is transported automatically in longitudinal direction to the aligned sliding table(4) to the second finger joint shaper(2).

88 After being put into position and being clamped the same operation as before takes place except that all pieces of short stock pass a glue applicator(6) before shaped. The complete stack is now [illegible] and automatically brought into the acting range of the infeed device(14) of the press(5). From thereon the finishing takes place in the same manner as described before.

[illegible] Both production lines shown above can be rated with a capacity of [illegible] product. a line according to [illegible] between [illegible] and [illegible] joints per minute.

Finger jointing of part of the single piece: (Fig. 6)

The [illegible] high production finger joint shaping machine for single piece operation consists of two off-set finger joint shapers combined with two overlapping cross conveyors travelling at the same speed.

According to Figure 6 the stock(1) is fed automatically on to a conveyor(26) equipped with evenly spaced lugs. The lugs carry the stock under a holddown device which keeps the stock in secure position while it passes the first finger joint shaper(2) where the stock ends are trimmed and shaped. The stock then continues to move forward and is automatically shifted laterally by a diagonal transfer conveyor(27) which brings the opposite end of the stock in an exact position in relation to the second finger joint shaper(3).

After the proper machining of the second end has taken place the stockthen passes a glue applicator(6) where glue is applied to one side of the stock. The stock continuous its forward movement and is drawn into a feeding unit(14) preceding the press(5).

From this point on two possibilities for the assembling line will be dealt with.

The assembling line on the left hand side shows a continuously operating press(5). Right after the press(5) a two to four side planer(28) may be installed for immediate machining of the assembled beam.

The beam then passes a traveling cut-off saw(29). This saw could be actuated either by a counting wheel(23) possibly electronically operated, or by an electric stop(9) at the end of the roller table(3) where a discharge device(30) could be provided.

The assembling line on the right hand side could be compared to the one described in Fig. 5, right hand side, paragraph 69.

97 It is also possible that this complete finger jointing and assembly line works long stock if the two finger joint shapers and their related transport equipment would be changed respectively.

98 The output of this production line ranges from 30 to 60 joints per minute.

3.3 Finger jointing of long stock - stackwise (Fig. 7)

99 A fairly high capacity automatic machine system to finger joint and assemble stock is shown in Figure 7 . Both versions shown operate with the long stock being stacked during the shaping and gluing operation. The machine system on the left can also be used for short stock by shortening table (4) and conveyor (16).

100 In the finger jointing line shown on the left hand side several boards are stacked and securely clamped on a sliding table(4). The charging of this sliding table(4) is done automatically. The sliding table(4) with the stock then moves to its other position and thus passes the trim saw(3), shaper(18) and the glue applicator(6).

101 In this position the clamping of the wood is released and all boards are pushed with their unmachined ends in a longitudinal direction to a predetermined position in relation to the same machine set-up on the opposite side of the first machining unit.

102 From thereon the wood stack on the sliding table(4) is moved past the trim saw(3), shaper(18) and glue applicator(6). During this operation the first sliding table(4) has already been reloaded and has begun its movement through the shaping unit(2).

103 All boards of the wood stack have now been machined and glue has been applied on both ends. The stack is now discharged from the sliding table(4). By means of an unstacking system(25) board after board will now enter the infeed unit(14) for the press(5). This press(5) is preferably continuous operating press which keeps the pressure on the joint for a certain period of time.

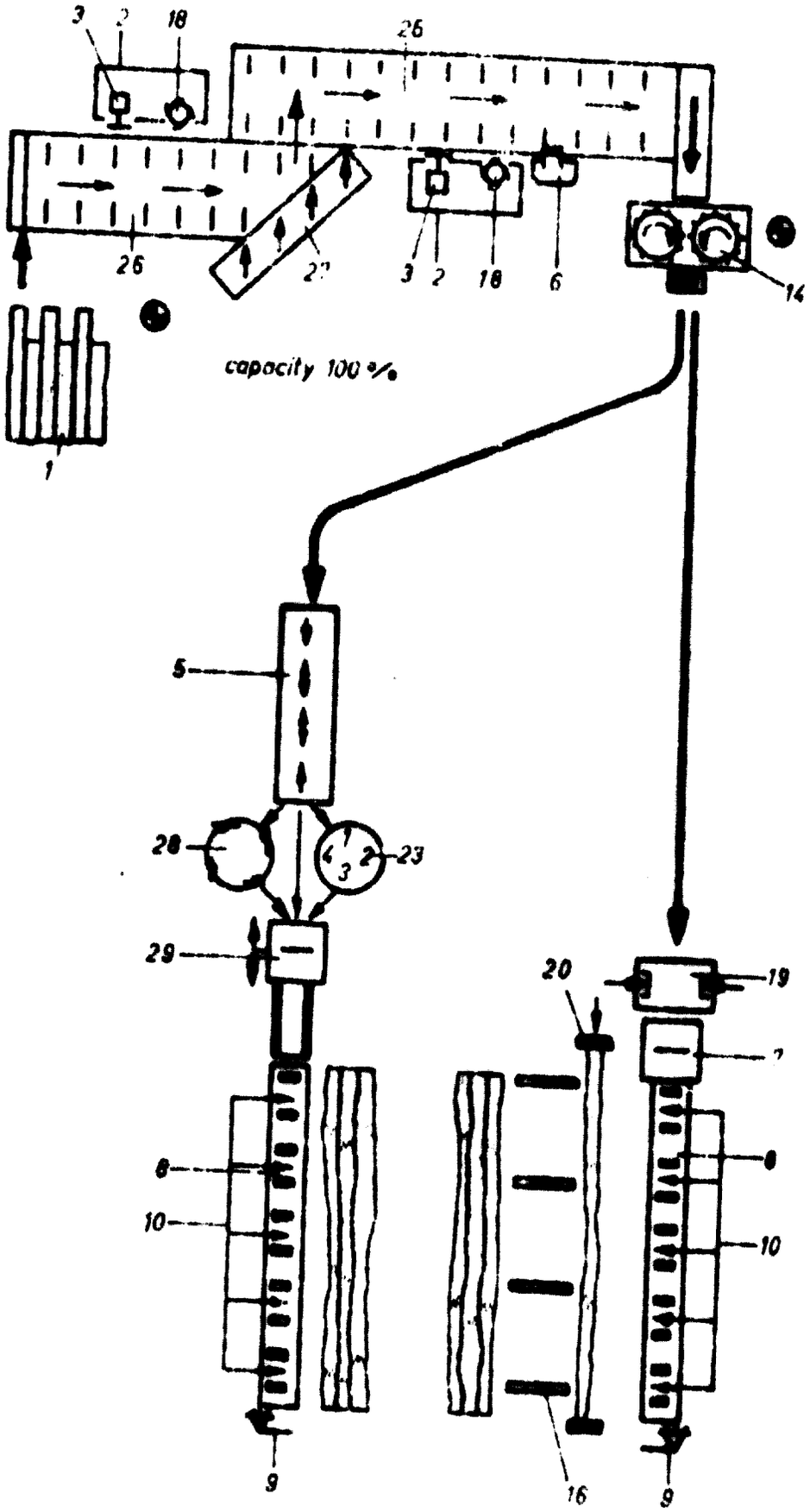


Fig. 6 Finger jointing of short stock - single pieces

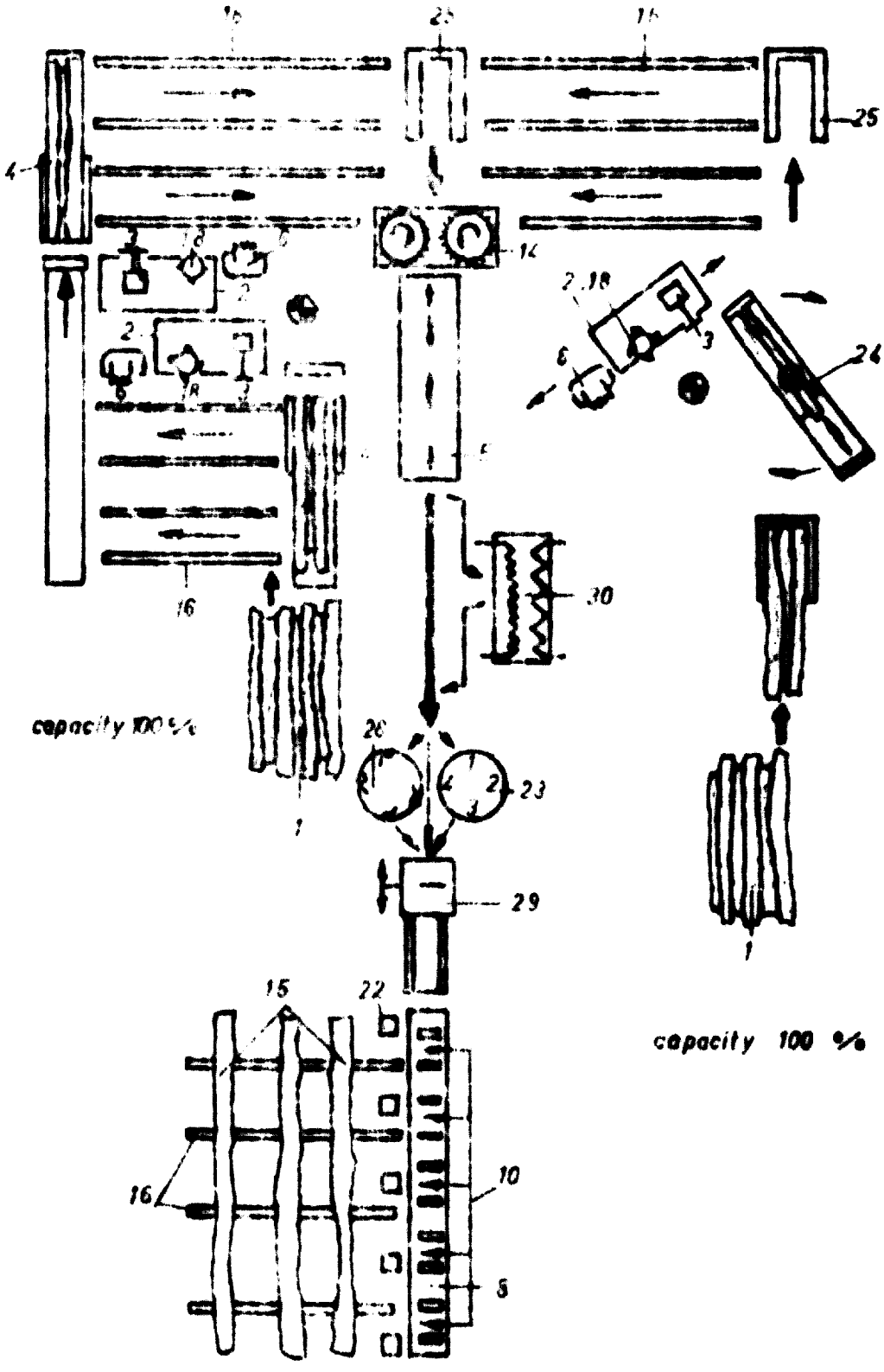


Fig. 7 Finger jointing of long stock - stackwise

1o4 To decrease curing time, a radio frequency tunnel(3o) can be installed after this press(5) or within the press(5) if this equipment is designed accordingly.

1o5 Before the jointed beam enters the traveling cut-off saw(29) it can be planed on two or four sides if desired.

1o6 Furthermore in this area the ready assembled beam passes an electronic counting wheel(27) for measuring the board length. The travelling cut-off saw(29) then cuts the jointed stock to the desired length which has been predetermined according to the setting of the electronic counting wheel. In this layout this particular set-up should be preferred compared to an electrical stop at the end of the discharge table(1o) which interrupts the flow.

1o7 It should be mentioned at this point that with the use of an electronic counting wheel in connection with a tape controlled electronic preselector a complete program for the production in a certain sequence of various beam lengths can be executed.

1o8 The beams then are conveyed to a discharge table(1o) followed by a stacker(22). The stacked beams(15) then will be placed on a cross conveyor(16).

1o9 The machine set-up shown on the right hand side consists of a turn table(24) which is charged with a number of boards. The turn table(24) then rotates to a certain position, all boards will be aligned and clamped and a machine unit(2) cuts the profile on all board ends and applies the glue. Then all boards are conveyed to the other end of the turn table(24) while the latter itself rotates by 18o degrees. In this position the same operation is executed as described before.

11o The turn table(24) then rotates in a position which allows the discharge of all boards in a unit(25) which unstacks the boards on to a cross conveyor(16). From thereon board after board is drawn into the infeed device(14) which precedes the press(5).

111 The following operations would be the same as described before. Both finger jointing lines have a capacity of 100 %. The output can be assumed between [illegible] and 12 joints per minute.

7.4 Finger jointing of long stock - single pieces (Fig. 8)

112 The various finger jointing lines which will be described under this section and the next can be considered as very common for use with long stock.

113 According to the production line on the left hand side board after board is being fed to a shaper(2) which shapes both board ends simultaneously after they have been brought in a proper and predetermined position. The boards then are cross conveyed to a glue applicator(6) which applies glue to one or both ends of the boards.

114 After gluing the boards are again cross conveyed to the infeed device(14) preceding the press(5).

115 According to one possibility the boards enter a continuously operating press(5) which is followed by a travelling cut-off saw(29). Cutting action will be initiated by an electronic counting wheel(27) which should be preferred instead of an electrical stop(9) at the end of the discharge table(1o).

116 A two or four side planer(28) can alternatively be installed between the press(5) and the travelling cut-off saw(29). After the beam is cut to length it is discharged to a stacker (22) and can be stored on a cross conveyor.

117 Another possibility would be the use of a single stroke press(5) in connection with a stationary cut-off saw(7). A planer (28) and/or an electronic counting wheel(27) can be installed between the press(5) and the cut-off saw(7). An electric stop(9) instead of the electronic counting wheel can alternatively be used.

118 Ready jointed beams now enter the discharge table(1o), can be stacked and cross conveyed.

119 The finger jointing line shown on the right hand side works in conjunction with two off-set finger joint shapers (2) facing each other. Each single board is clamped on a sliding table(4) and passes through the first machining unit (2) which shapes and applies glue to one side of the board.

12o After this operation the board is moved in a longitudinal direction to enter the second sliding table(4). After the board is clamped and its end treated in the same way as described above.

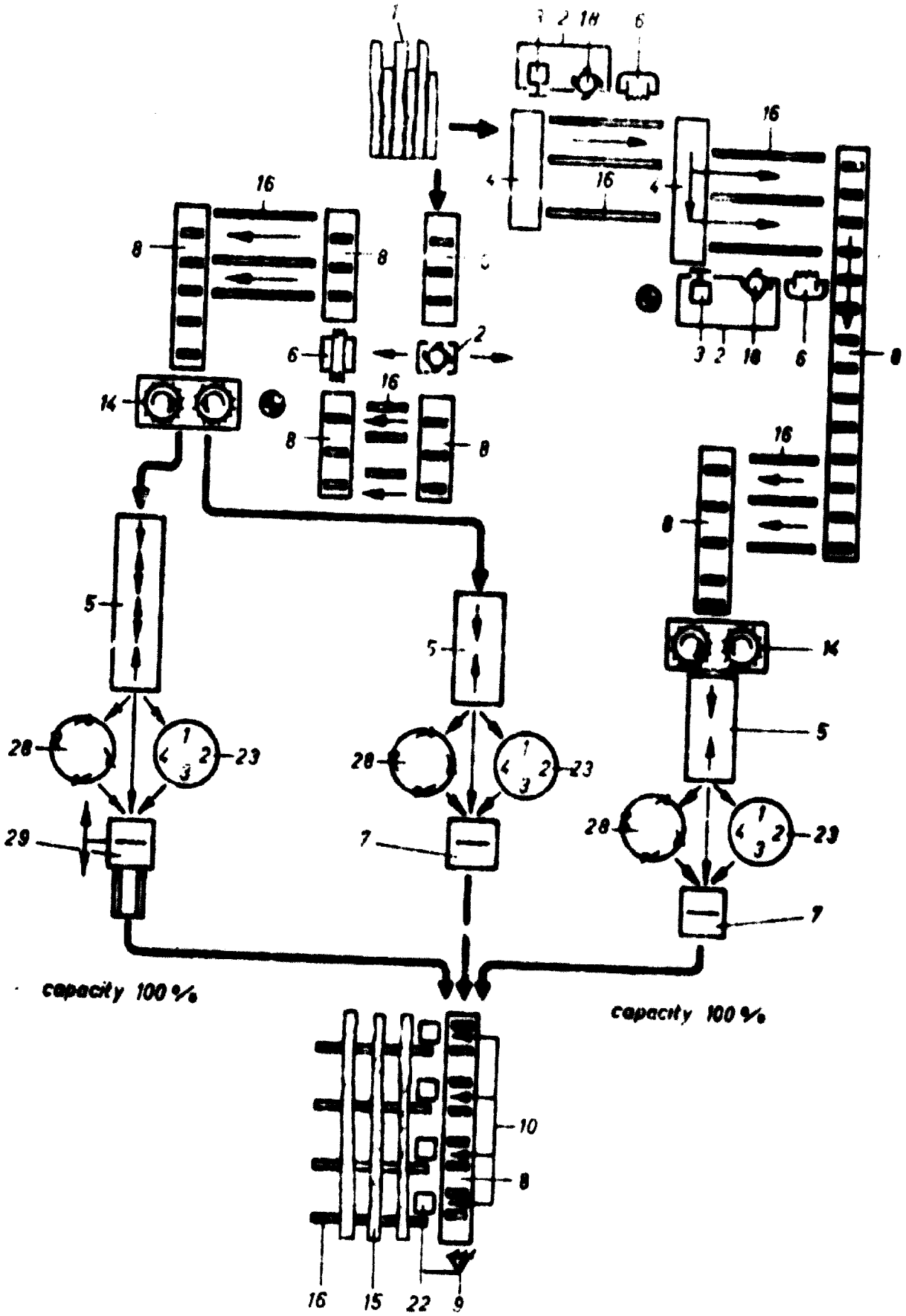


Fig. 8 Finger jointing of long stock - single pieces

[illegible] veyor [illegible] which [illegible] preceding the press [illegible] a [illegible] be executed in [illegible].

122 Both finger jointing lines described above have a capacity of 100 [illegible]. The output ranges between 4 and 6 joints per minute.

4. Fully automatic [illegible] through system

123 The machine system described in this chapter operate automatically. The [illegible] production line without being touched once a board has entered the [illegible].

124 Contrary to the automatic assembly lines as described in paragraph [illegible] the [illegible] straight through this production line and is not conveyed in any direction but in a longitudinal one.

125 The essential [illegible] machining operations are executed while the board remains in a fixed position.

4.1 Finger jointing of [illegible] stock - single pieces (Fig. 9)

126 The finger jointing line shown on the left hand side is fed with [illegible] the [illegible] system (1).

127 The two boards which are to be jointed together are brought in an exact and predetermined position to each other and in respect to the [illegible] and gluing unit (2). While the two boards are held firmly in position [illegible] ends are being shaped simultaneously by the [illegible] and during the return stroke glue is applied on both ends.

128 As soon as the work path has been cleared of the shaper (2) and glue applicator (), the two board ends are pressed together under high pressure.

129 Now, after completion of the joint the beam is pulled out by an outfeed [illegible] while the new [illegible] ready to be jointed together with the [illegible] work in the same manner as described before.

130 The [illegible] two or four side planer (29) or will be moved [illegible] but the crosscutting saw (29).

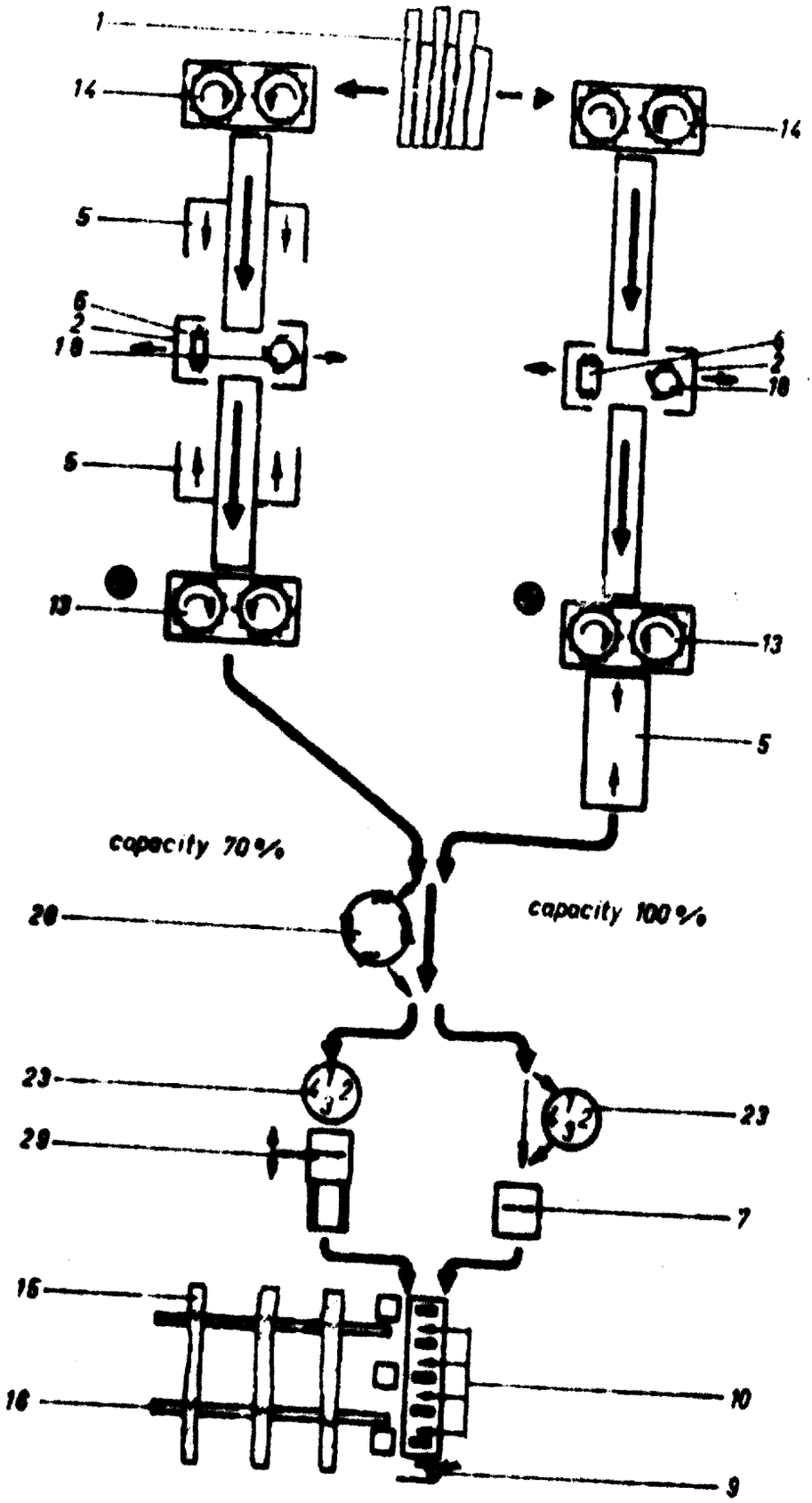


Fig. 9 Finger jointing of long stock - single pieces

The latter can be equipped with an electronic counting wheel (23) for measuring the beam length and actuating the cut-off saw(29). After reaching the discharge table(10) the beam is ejected and stacked. The various stacks(11) can be stored on a cross conveyor(15).

131 The finger jointing line shown on the right hand side operates basicly the same way as the one described before on the left hand side, except that the two boards after shaping and glue application are only jointed together under light pressure, while leaving this area immediately thus making way for the beginning of the next joint. The actual press operation takes place in the press(5) behind the outfeed system(13).

132 The beam can pass a two or four side planer(28) if desired before being transported through the cut-off saw(7) and the discharge table(10). Cutting action of the cut-off saw(7) can either be controlled by electronic counting wheel(23) or by electrical stop(9). Discharging, stacking and storing of the beams can take place in the usual manner.

133 The capacity of the latter described finger jointing line is assumed to be 100 %, whereas the preceding finger jointing line is rated with a capacity of 70 %.

134 Output at 100 % capacity ranges from 4 to 6 joints per minute.

emarks

135 All systems and machines described before do not necessarily epresent all possible means and ways available on the market. pecial requirements sometimes might make it necessary to modify the oduction systems described above.

136 For a large number of cases the systems described above will e suitable. Table 1 summarizes the systems referred to above.

137 Furthermore all systems, preferably those described under sections 2, 3, 4, can additionally be equipped with such material as untacker for stock, manually or automatically operated defect saw, ol ture control etc.

VI CONCLUSIONS

138 When it comes to the point where the application of finger jointing wood is to be considered again economical aspects will arise. There are cases where finger jointing wood should not be considered at all. In other cases the manufacture of certain products is impossible unless wood is finger jointed. In the latter case the study alone can determine what particular finger jointing equipment is best suited for the manufacture of a particular product.

139 It could be advisable to begin with small steps if circumstances justify this in order to obtain basic knowledge and get acquainted with finger jointing of wood. However, even the selection of more sophisticated finger jointing equipment can be considered if the respective provisions can be met. Anyway the tendency in developed countries shows the trend to more or less automatic equipment.

140 In countries having large resources in wood this material is probably not used to its full advantage.
Just consider how many industrial buildings, halls, large assembly rooms, churches, bridges, and similar buildings could be manufactured using wood as material in conjunction with finger jointing and laminating. Probably a considerable industry could arise to manufacture these products.

141 Processing short stock can be done in finger jointing plants according to Sections 1. - 3. of chapter V. These production lines would also be suitable for boards with small and medium cross sections with jointed beam lengths up to 8m to 10m (25' - 30').

142 Processing of long stock or heavy cross sections or producing jointed beams exceeding 10 m (30') should be done in finger jointing lines described in sections 2, 3 and 4 of chapter V sections 3 and 4.

A P P E N D I X

Equipment for finger jointing wood is manufactured by several companies. Among others there are (listed in alphabetical sequence):

- DIMTER GMBH & CO., 7918 Illertissen, P.O.Box 246, West Germany
- HÜBEL & PLATZER Maschinenbau-GmbH, 4550 Bad Kreuznach, P.O.Box 4e7, West Germany
- INDUSTRIAL WOODWORKING MACHINE CO. INC., Garland, Texas 75o4o, P.O.Box 1466, United States
- SAUTER Maschinenbau KG., 7519 Zaisenhausen, West Germany

REFERENCE NUMERALS FOR FIGURES

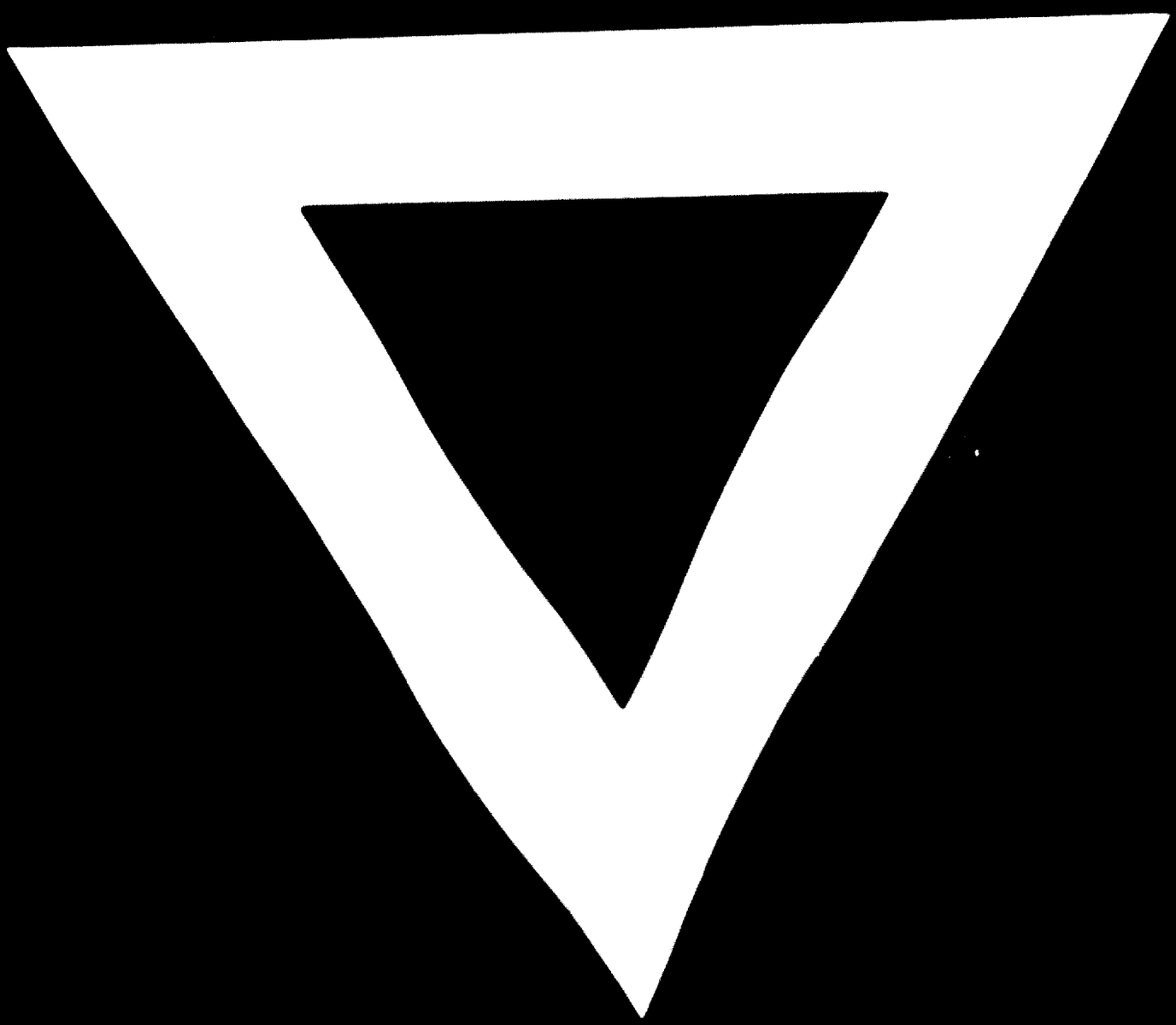
1 Stock
2 Shaper, shaping machine
3 Trim saw
4 Sliding table
5 Press
6 Glue applicator
7 Cut-off saw, stationary saw
8 Roller table
9 Electric stop
10 Discharger, discharge table
11 Mechanical stop
12 Magazine
13 Outfeed system
14 Infeed system
15 Stack
16 Cross feeder, cross conveyor
17 Storage place
18 Shaping tool
19 Pressure hold down shoe
20 Squeezing station
21 Stationary table
22 Stacking device
23 Counting wheel
24 Rotating table, turn-table
25 Unstacking device
26 Conveyor with lugs
27 Diagonal transfer conveyor
28 Planer
29 Travelling cut-off saw
30 Radio frequency tunnel

TABLE 1 Comparative Analysis of Various Finger Jointing Lines

Type	Production (joints/minutes)	Labour requirements Unskilled	Number
1. Non automatic process:			
Finger jointing of short stock - stackwise (see Fig.2)			
a) Shaper with cutoff saw	1 - 1½		2 *)
b) Shaper without cutoff saw	2 - 3		3 *)
2. Semi-automatic process			
2.1 Finger jointing of short stock - stackwise (see Fig.3)			
a) one shaping machine	6 - 10		1 *)
b) two shaping machines	10 - 20		2 *)
2.2 Finger jointing of long stock - single pieces (see Fig.4)			
a) one shaping machine	1 - 2		2 *)
b) two shaping machines	3 - 4		3 *)
3. Fully automatic assembly lines-transfer systems			
3.1 Finger jointing of short stock-stackwise (see Fig.5)			
a) one shaping machine	15 - 20		1**)
b) two shaping machines	15 - 20		1**)
3.2 Finger jointing of short stock-single pieces (see Fig.6)	30 - 60		2**)
3.3 Finger jointing of long stock-stackwise (see fig.7)			
a) one shaping machine	8 - 12		1**)
b) two shaping machines	8 - 12		1**)
3.4 Finger jointing of long stock-single pieces (see Fig. 8)			
a) one shaping machine	4 - 6		1**)
b) two shaping machines	4 - 6		1**)
4. Fully automatic assembly line-straight through system			
4.1 Finger jointing of long stock-single pieces			
a) without pre-jointing	3 - 4		1**)
b) with pre-jointing	4 - 6		1**)

*) A skilled person (mechanic) should be available upon request.

**) A high qualified person has to be available upon request.



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