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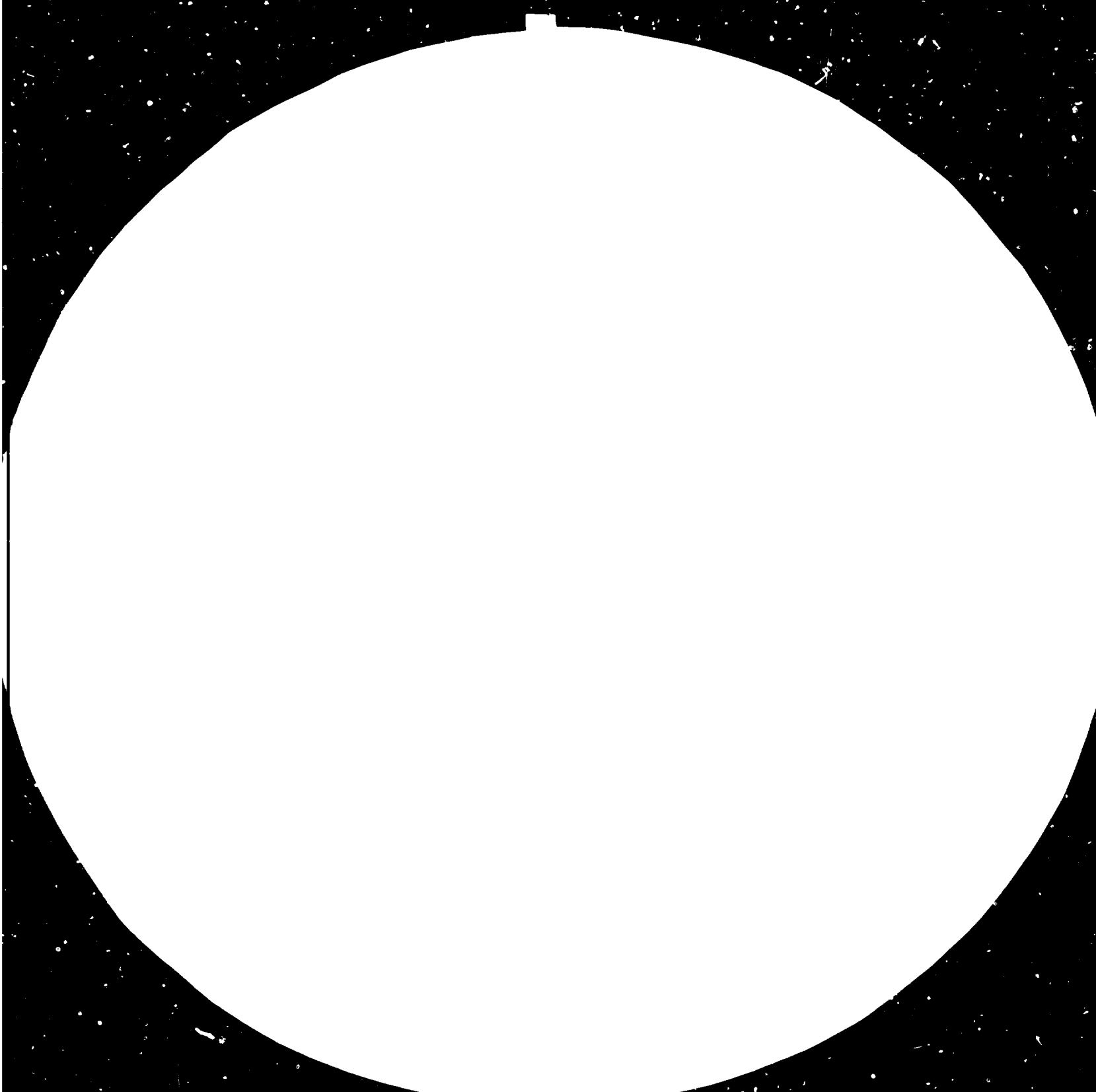

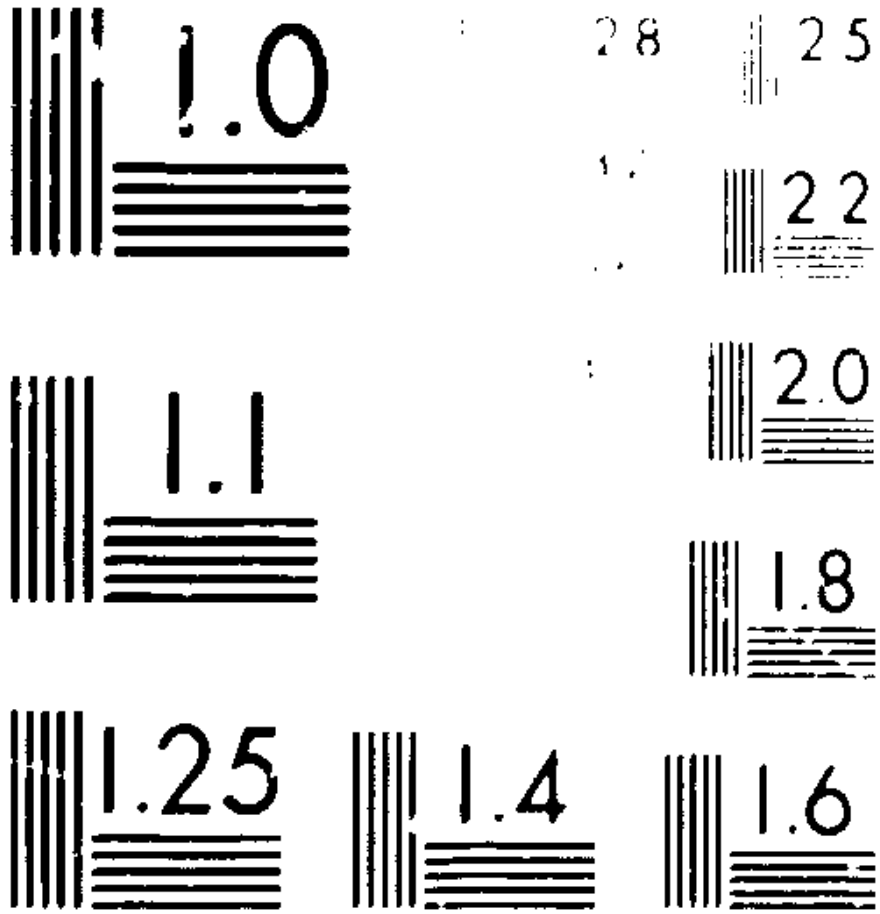
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WOODEN PACKAGING FOR FRUIT AND VEGETABLE PRODUCTS *

by

D. Castelli **

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Because of the possibilities offered by the latest technologies in the manufacture of wooden packaging for fruit and vegetable products, industrial packaging and pallets display a broad array of differences, and that the machines involved in making and assembling these three types of products are equally different and specific, it has been decided to deal with each of them separately.

I. WOODEN PACKAGING FOR FRUIT AND VEGETABLES

Introduction:

These so-called "lightweight" containers are typically used for harvesting, storing, preserving, refrigerating and marketing fruit and vegetable products. Their shape is generally rectangular, and they feature the usual mean maximum and minimum external measurements (in millimeters), i.e.:

- length 400 - 600
- width 300 - 400
- depth 80 - 280

These containers can be either open (lidless) or closed (with lid).

Before going on to describe the various aspects of specific manufacturing processes, from the simplest to the more sophisticated semi-automatic and automatic, it would first be wise to examine and analyse the actual containers that will be referred to, starting with their "conventional" names: "plateau", or stacking tray; box; wirebound box; crate; baskets; etc.

All these types are illustrated in Figures 1 and 2.

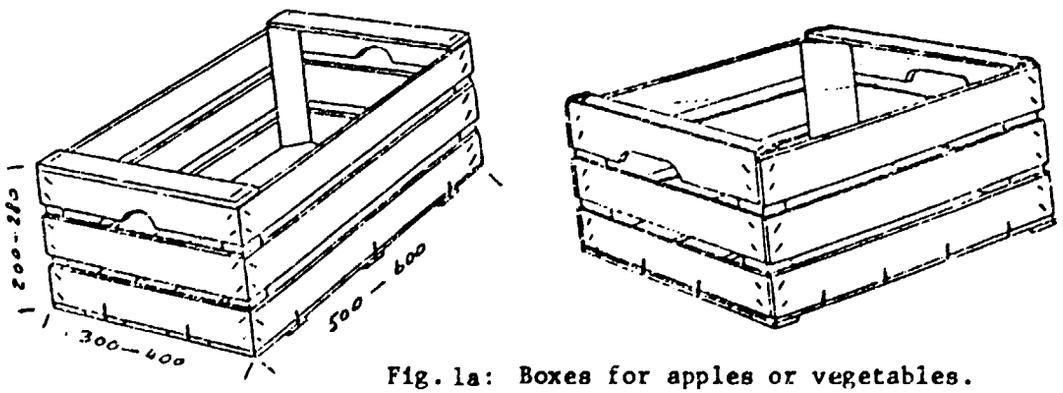


Fig. 1a: Boxes for apples or vegetables.

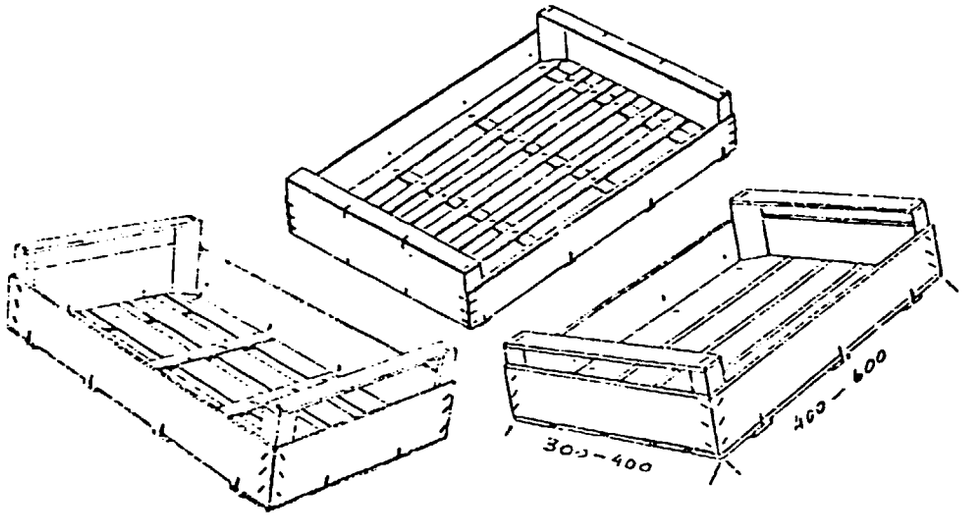


Fig. 1b: Trays for fruits

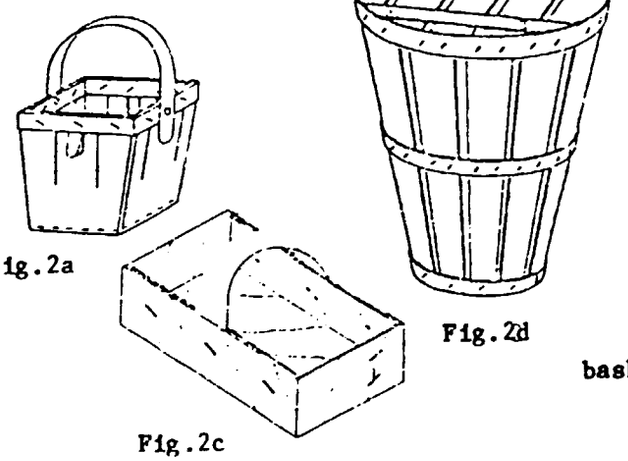


Fig.2a

Fig.2c

Fig.2d

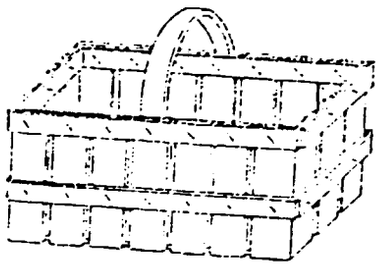


Fig. 2b

baskets

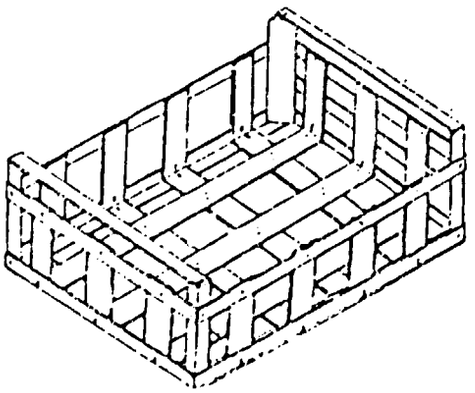


Fig. 2e: Box for cabbage, salads, etc.

The various manufacturing phases and technologies are described hereunder as follows:

(A) Preparation of parts for assembly;

(B) Assembly of parts and completion of end-products.

(A) Preparation of parts for assembly

The parts to be assembled can be grouped as follows:

- boards for making end panels (short side - width);
- boards for making side panels (long side - length);
- boards for making bottoms and lids;
- slats or strips for making bottoms, lids and handles;
- triangular angle blocks or corner stiffeners;
- "chamfered" square-sawn sections for making wirebound boxes.

(A)1. Simple preparation of parts (sawn)

This sequence of operations starts with the timber logs that reach the factory in standard lengths.

Figure 3 (layout and machinery list) refers to the various steps in this manufacturing process:

(1) debarking of logs;

(2) sawing of logs into planks;

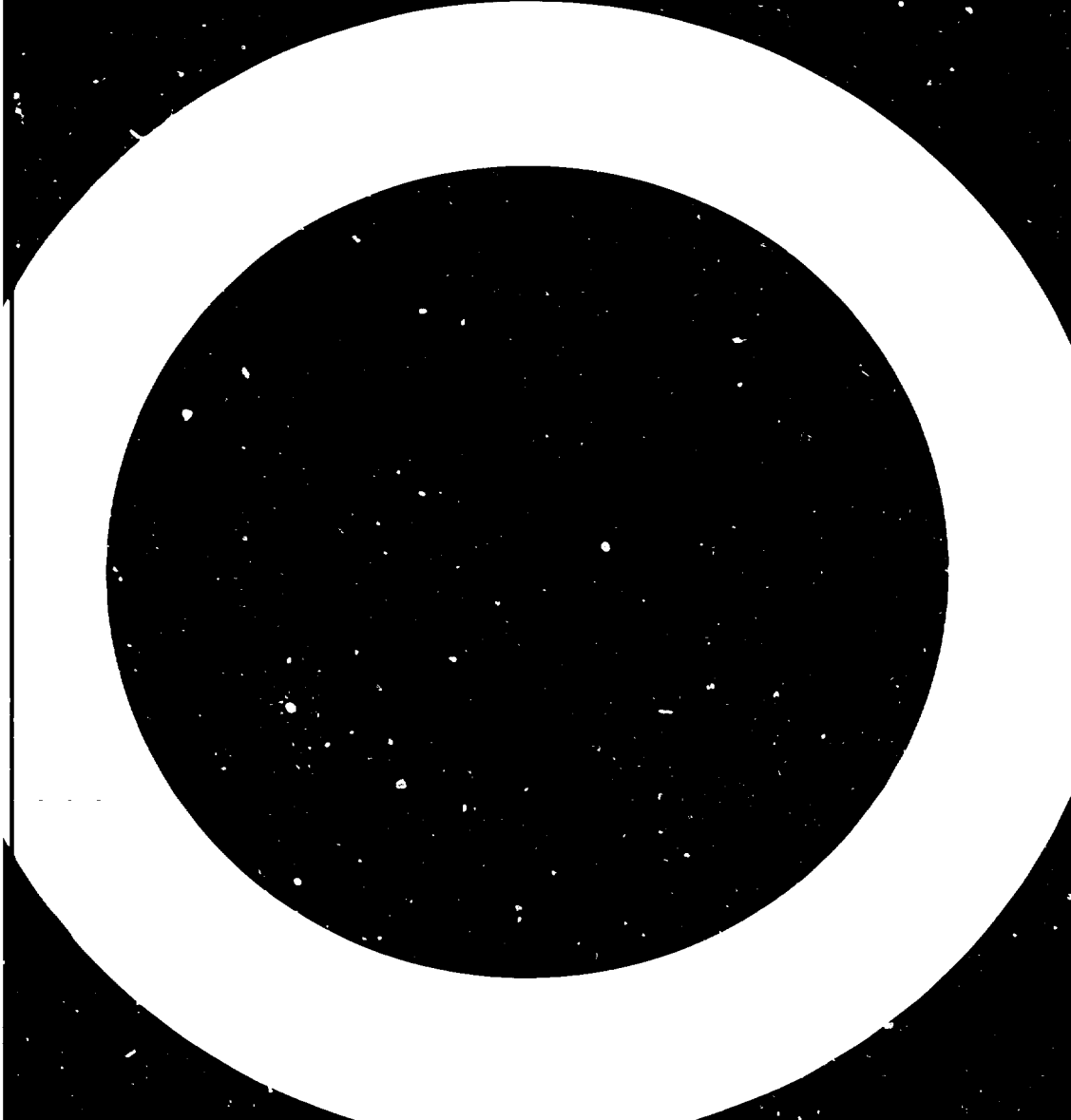
(3) longitudinal trimming of planks;

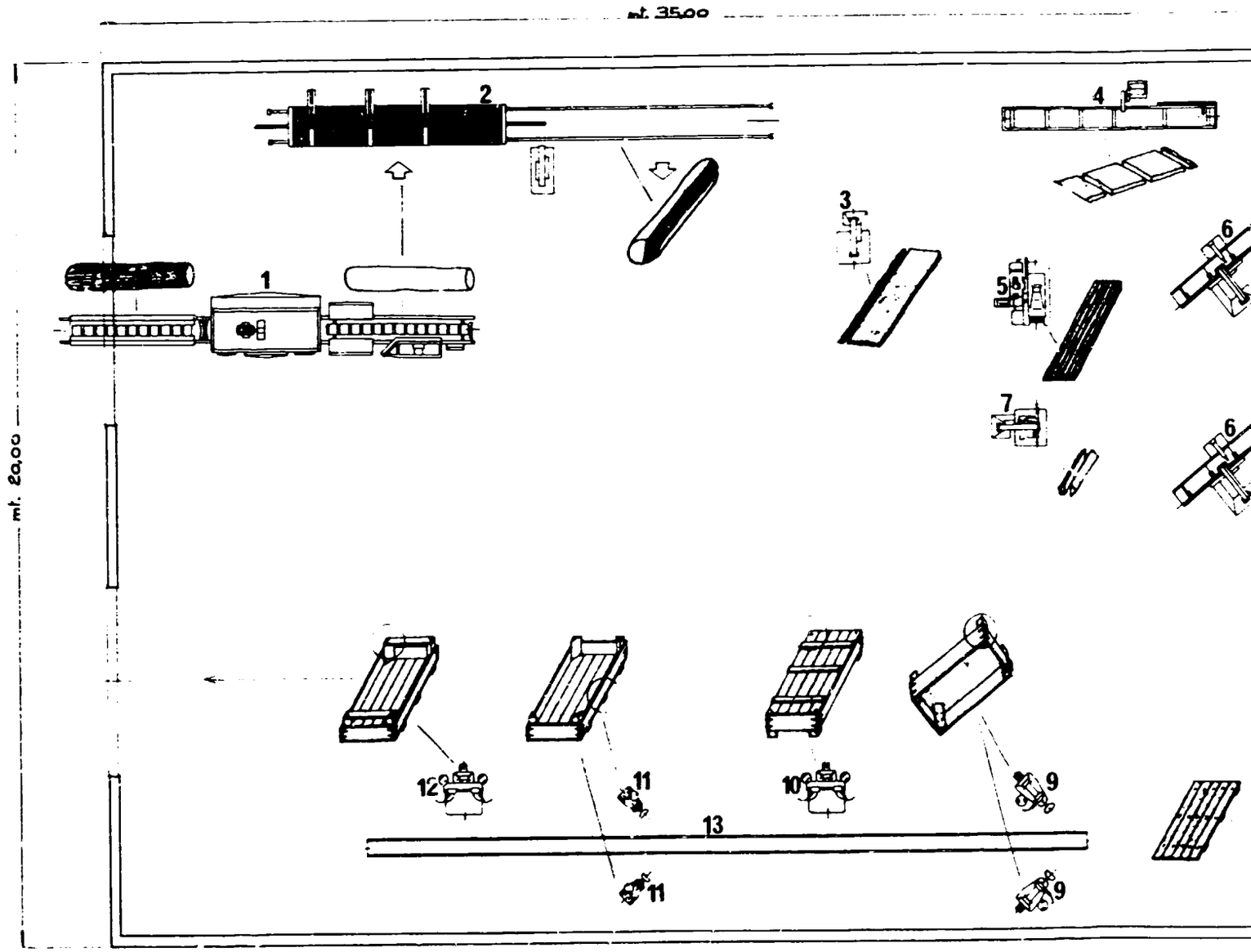
(4) cross-cutting of planks into suitable lengths for boards;

(5) cutting of logs by gang saw into square-section lengths for making angle blocks;

(6) automatic sawing of plank lengths into boards, slats and strips;

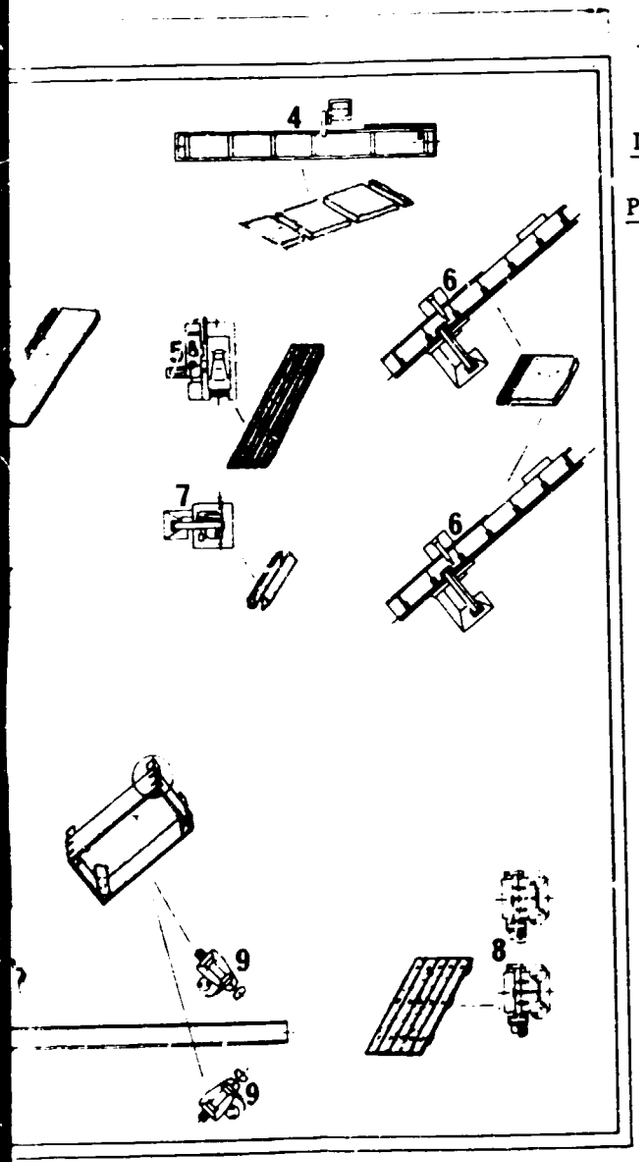
(7) cutting off and diagonally splitting of square-sawn sections into triangular angle blocks.





SECTION 1

Fig. 3

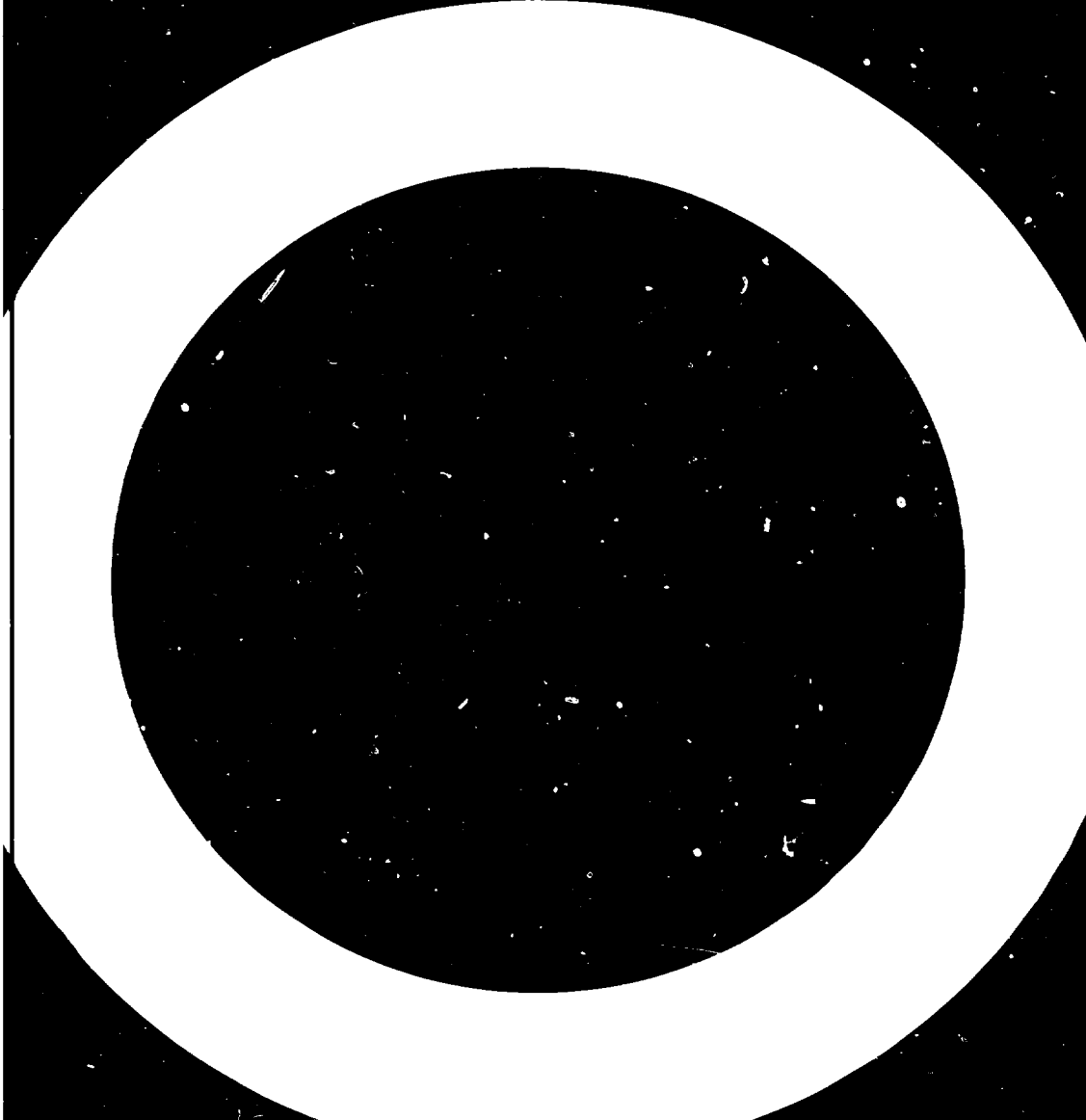


Simple preparation of parts

Hourly production rate: trays: 500-700
boxes: (3-slatted) 200-220

LIST OF MACHINERY

Position	Quantity	Description
1	1	F.800 Debarking machine
2	1	Bandsaw with carriage Ø 1110mm
3	1	Bandsaw for final trimming operations Ø 1000mm
4	1	Pendulum saw
5	1	Multi-blade circular saw
6	2	SL.30 Lath cutter
7	1	M.48 Angle block cutter with bandsaw
8	1	M.75 Stitching machine with two or more heads for stitching box bottoms
9	2	M.52 Stitching machine for assembling frames
10	1	M.22B stitching machine for assembling frames to box bottom
11	2	M.65B Bottom stitching machine
12	1	M.22B Handle stitching machine
13	1	Conveyor belt



(A)2. Simple preparation of parts (sawn and sliced veneer)

Figure 4 (layout and machinery list) shows the same positions as Figure 3 from 1 to 7, plus the following:

Pos. 8 - Plank Cutter : for cutting pre-heat-treated planks into boards, laths and strips, especially those for making storage tray bottoms, and also tray and box frames, when the timber is "suitable" for slicing.

(A)3. Preparation of parts (sawn, sliced and peeled veneer)

Figure 5 (layout and machinery list) shows the same positions as Figure 3 from 1 to 6, plus pos. 8 in Figure 4. Along with these positions, the following machines have also been added to increase the hourly production rate (1,000 - 1,200 trays) by producing veneered boards and strips:

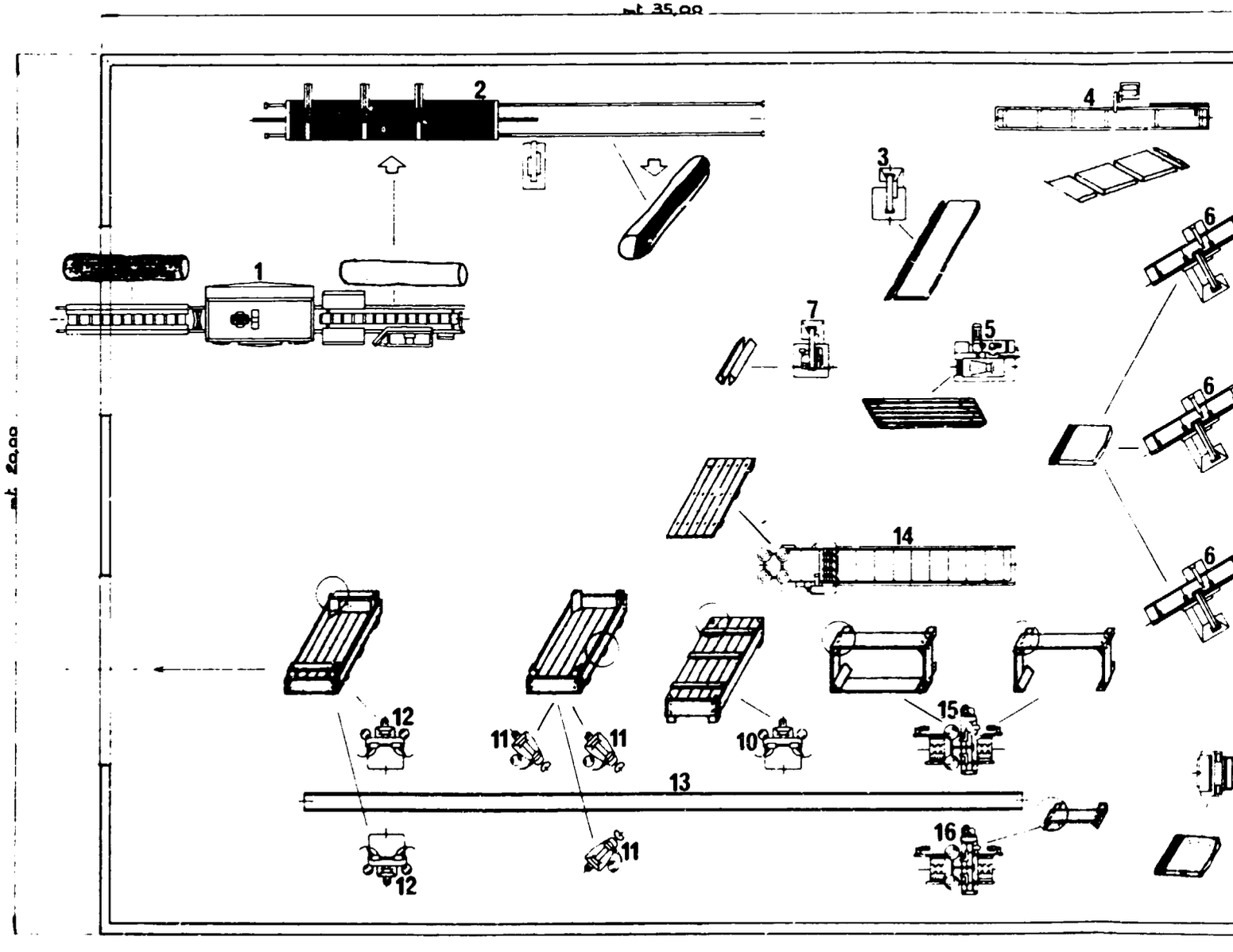
Pos. 18 - Cross-Cutting Saw : for cross-cutting the logs to sizes suited to veneering into boards, strips and laths of required length.

Pos. 20 - Rotary Veneer lathe with log lifter arm and centre-square device, for obtaining suitable veneer thicknesses for making container parts.

Pos. 22 - Veneer Slicer : for cutting veneers into suitable widths for making various container parts (boards, strips, etc.).

Pos. 24 - Square-Sawn Length Cutter : for cross-cutting square lengths into suitable sizes for making triangular angle blocks.

Pos. 27 - Angle Block Cutter : for longitudinally cutting square-sawn lengths into two triangular angle blocks.



SECTION 1

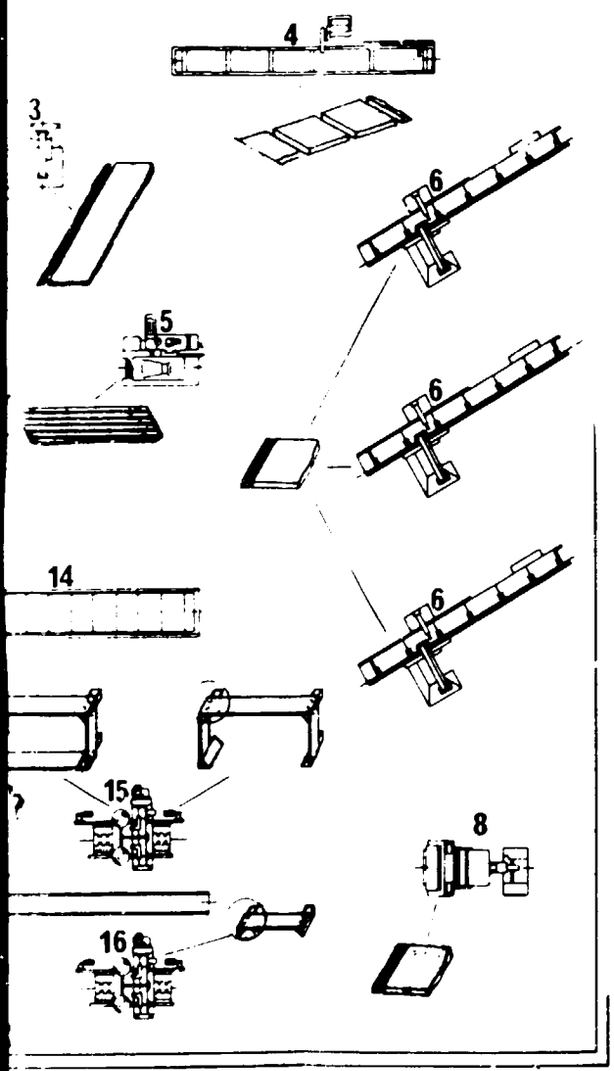


Fig.: 4

Simple preparation of sawn and sliced veneer parts

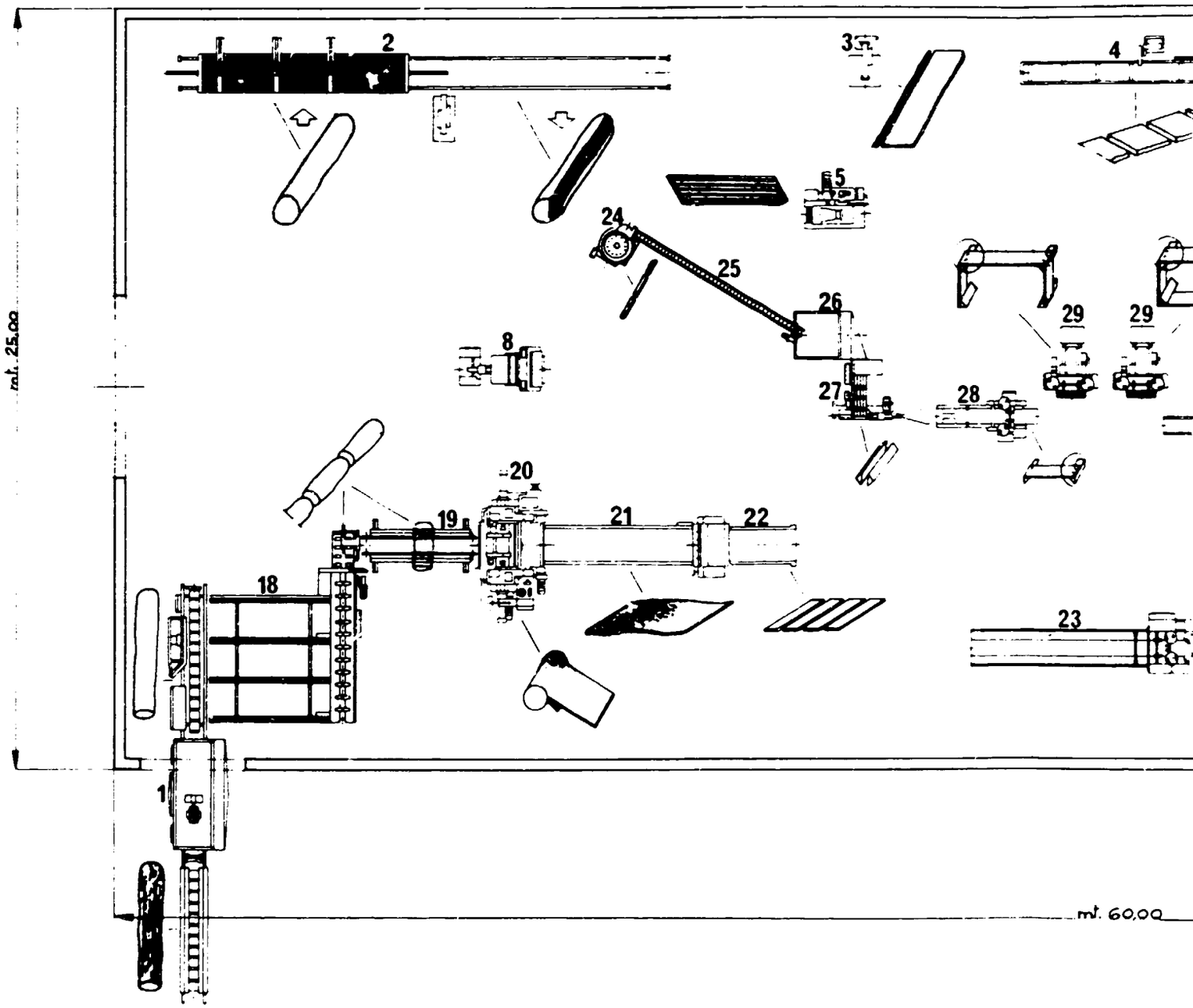
Hourly production rate: trays: 700-900

boxes (3-slatted): 250-300

List of machinery

Position	Quantity	Description
1	1	F.800 debarking machine
2	1	Bandsaw with carriage (Ø 1100)
3	1	Bandsaw for final trimming operations (Ø 1000)
4	1	Pendulum saw
5	1	Multi-blade circular saw
6	3	SL.30 Lath cutter
7	1	M.48 Angle block cutter with bandsaw
8	1	M.54 Plank cutter
10	1	M.22B Stitching machine for assembling frame to box bottom
11	3	M.65B Bottom stitching machine
12	2	M.22B Handle stitching machine
13	1	Conveyor belt
14	1	M.76 Bottom stitching machine
15	1	M.50S Stitching machine for assembling frames
16	1	M.50S Stitching machine for assembling end panels

SECTION 2



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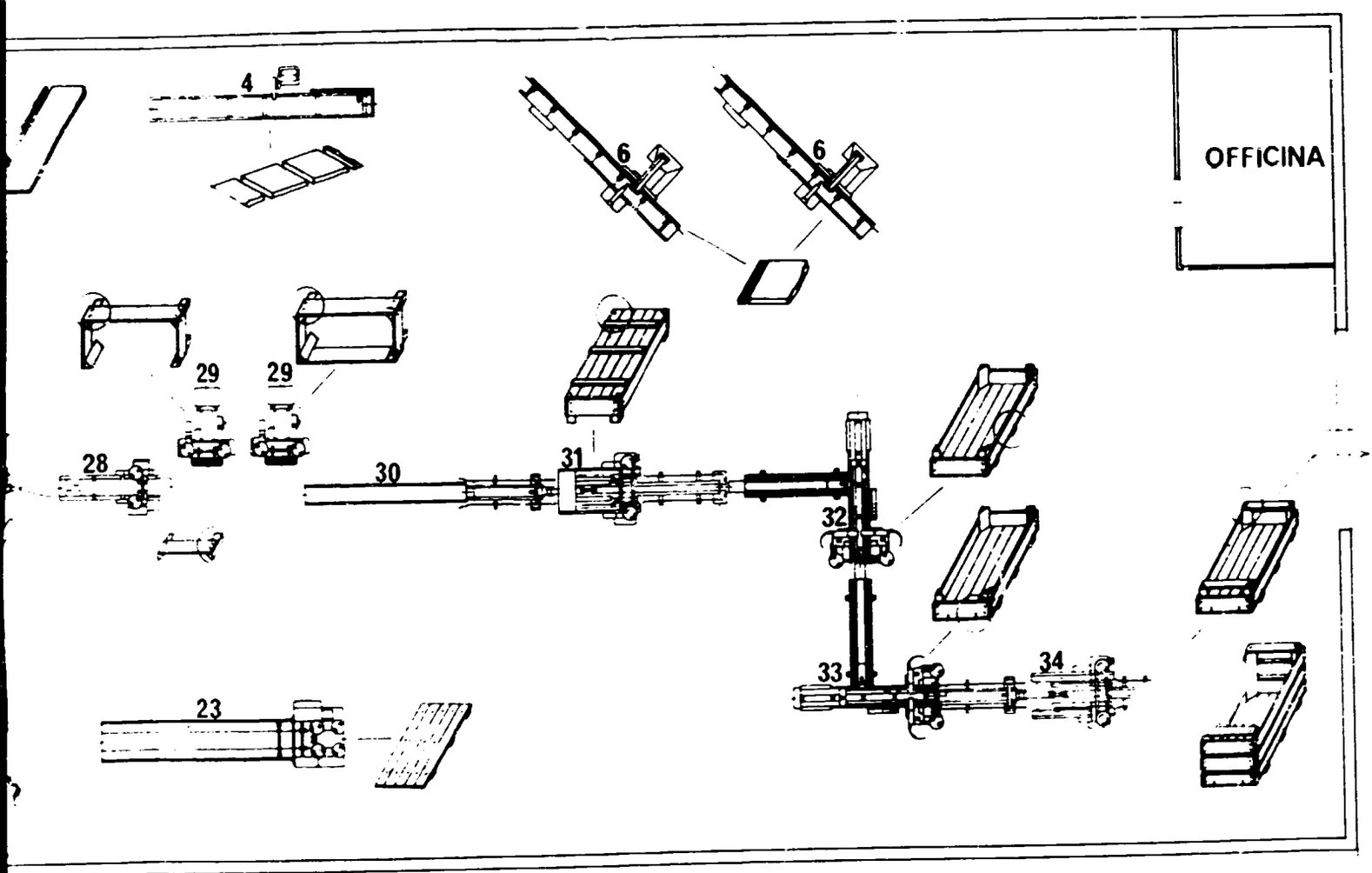

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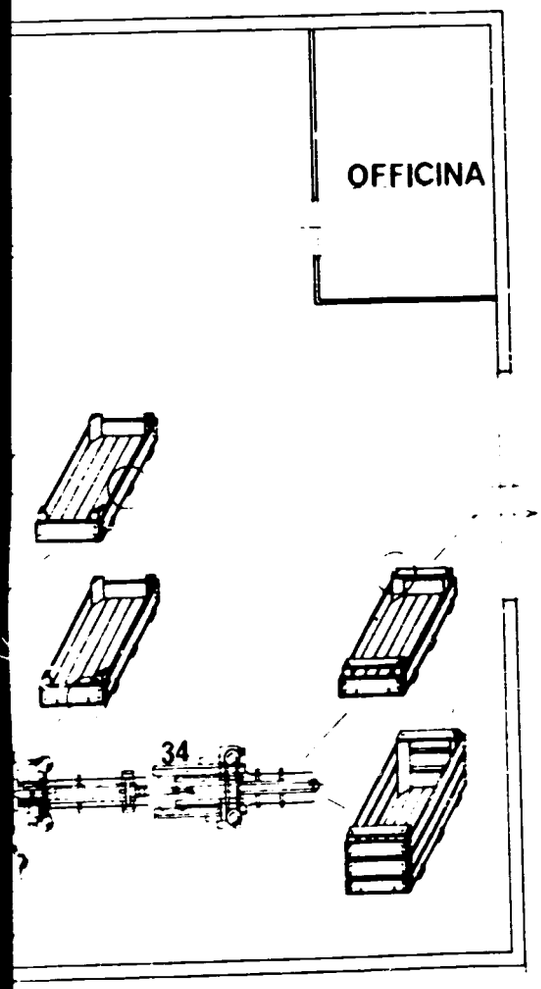


Fig. 5

Preparation of sawn, sliced and peeled veneer parts

Hourly production rate: trays: 1200 - 1500
boxes (3-slatted): 400 - 600

LIST OF MACHINERY

Position	Quantity	Description
1	1	F.800 Debarking machine
2	1	Bandsaw with carriage (Ø1100)
3	1	Bandsaw for final trimming operations (Ø1000)
4	1	Pendulum saw
5	1	Multi-blade circular saw
6	2	SL.30 Lath cutter
8	1	M.54 Round section and plank slicer
18	1	M.85B Cross-cutting saw
19	1	Log chain conveyor
20	1	M.82S Rotary veneer peeler with screw-type centre-square device
21	1	Veneer conveyor belt
22	1	M.66 veneer slicer
23	1	M.64 Bottom stitching machine
24	1	M.108 Machine for cutting-off lengths of square-sawn timber
25	1	Conveyor belt for square-sawn lengths
26	1	Storage bin for square-sawn lengths
27	1	M.109 BN Angle block-cutter
28	1	M.126 Automatic end panel stitcher
29	2	M.125 Semi-automatic frame stitcher
30	1	Frame conveyor belt
31	1	M.145 Stitching machine for attaching bottom panel corners to frame
32	1	M.127L Stitching machine for attaching bottom panel to frame (end panel)
33	1	M.127N Stitching machine for attaching bottom panel to frame (side panel)
34	1	M.146 Handle stitching machine

Figure 6 (layout and machinery list) describes another manufacturing line with an even faster hourly output rate of 2,000 to 2,200 storage trays.

It includes positions 1 to 8, and 18, 19, 21, 24, 25 and 26 of Figure 5; and to increase the line's automation even further, the screw-type centre-square device mounted on veneer cutter M/82-S has been replaced with an automatic horizontal centre-square version (position 36).

The two-bladed M/66 veneer slicer in Figure 5 has been replaced with a four-bladed version (M/95, position 37), and in position 38, angle block cutter M/109-D (double) replaces the previous M/109-N (standard) model (position 27, Figure 5).

Before reviewing the various parts assembly lines (making box bottoms, lids, end panels, etc.), and final container assembly lines (making finished trays, boxes etc.), it should first be mentioned that the machines included in the various lines will not be discussed in detail. Brief and simple indications will only be given in relation to the specific operations performed by the machines in each specific plant situation, though other uses may be made of the same machinery for making other types of packaging containers.

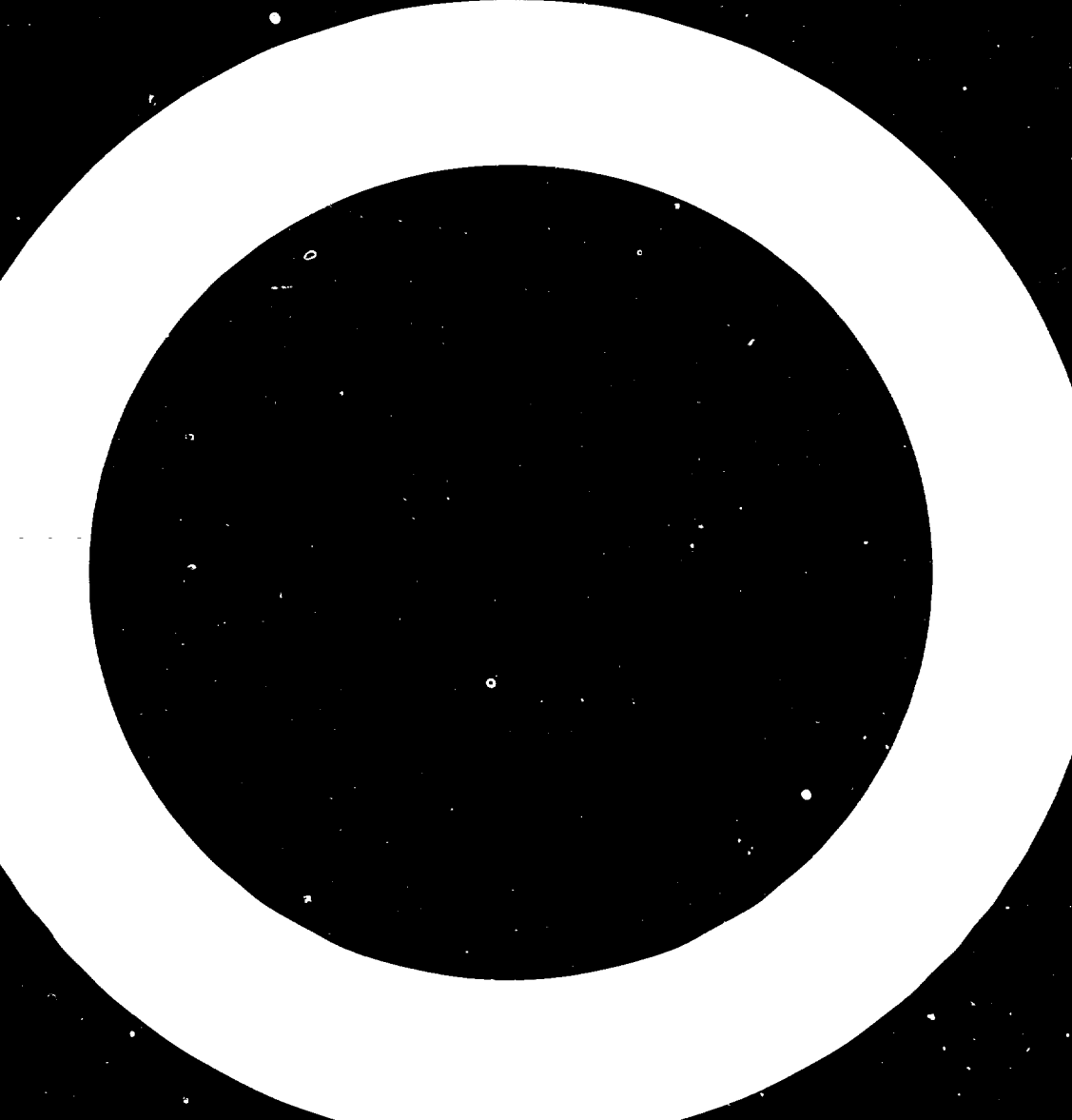
The reason for this approach is to focus more clearly on the strictly fundamental aspects of each specific operation.

For the same reason, no details are provided about materials handling or operations related to the transferral of parts between machines.

This paper includes layouts and drawings of the four plants under examination. Detailed literature is available to those requiring further information on the design features and options offered by the various machines - from the simplest model to the most sophisticated one.

(B) Preparation of parts and final assembly of finished container

How the various parts of the packaging containers are prepared, and how the finished items are assembled, is now described.



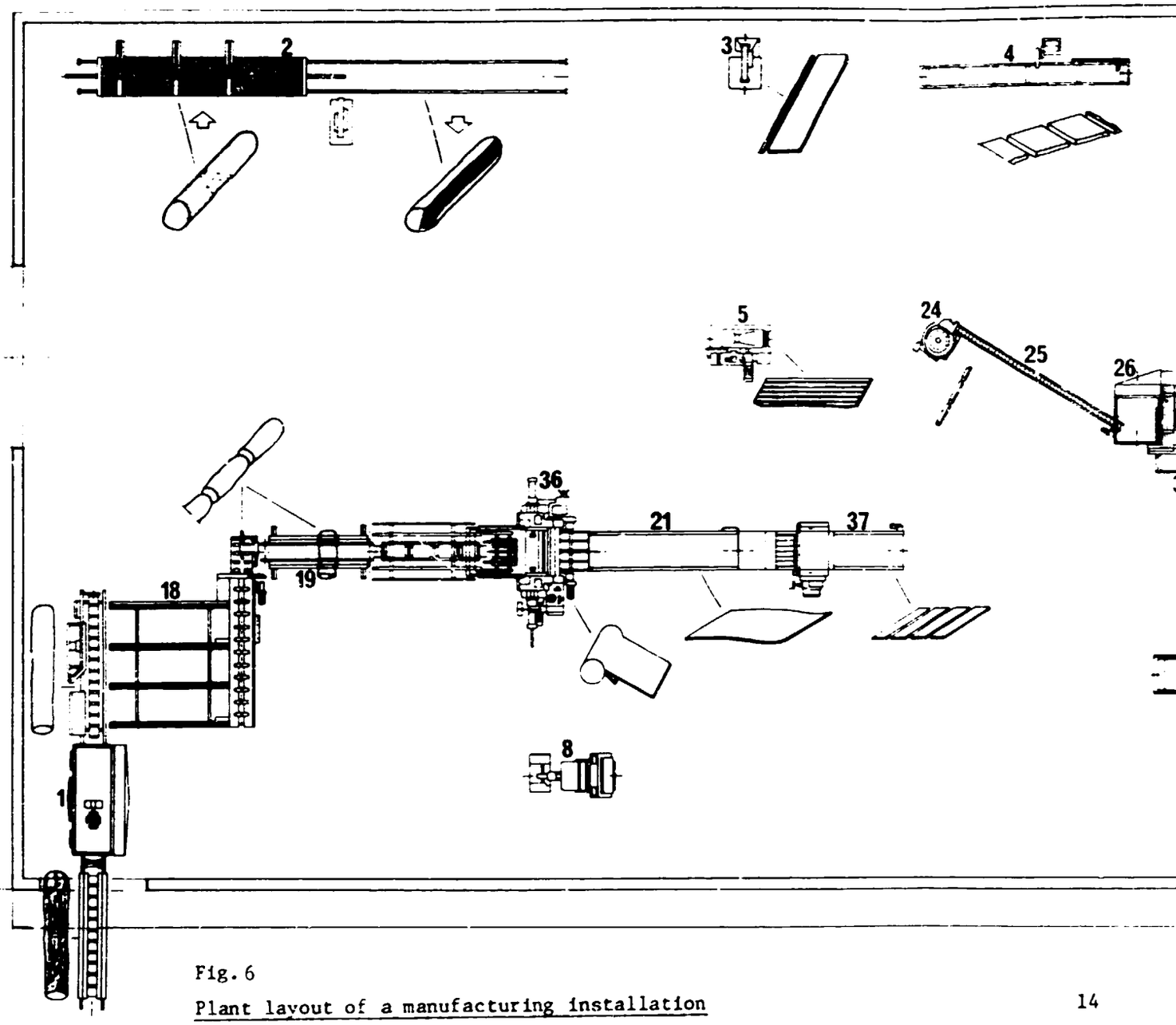


Fig. 6

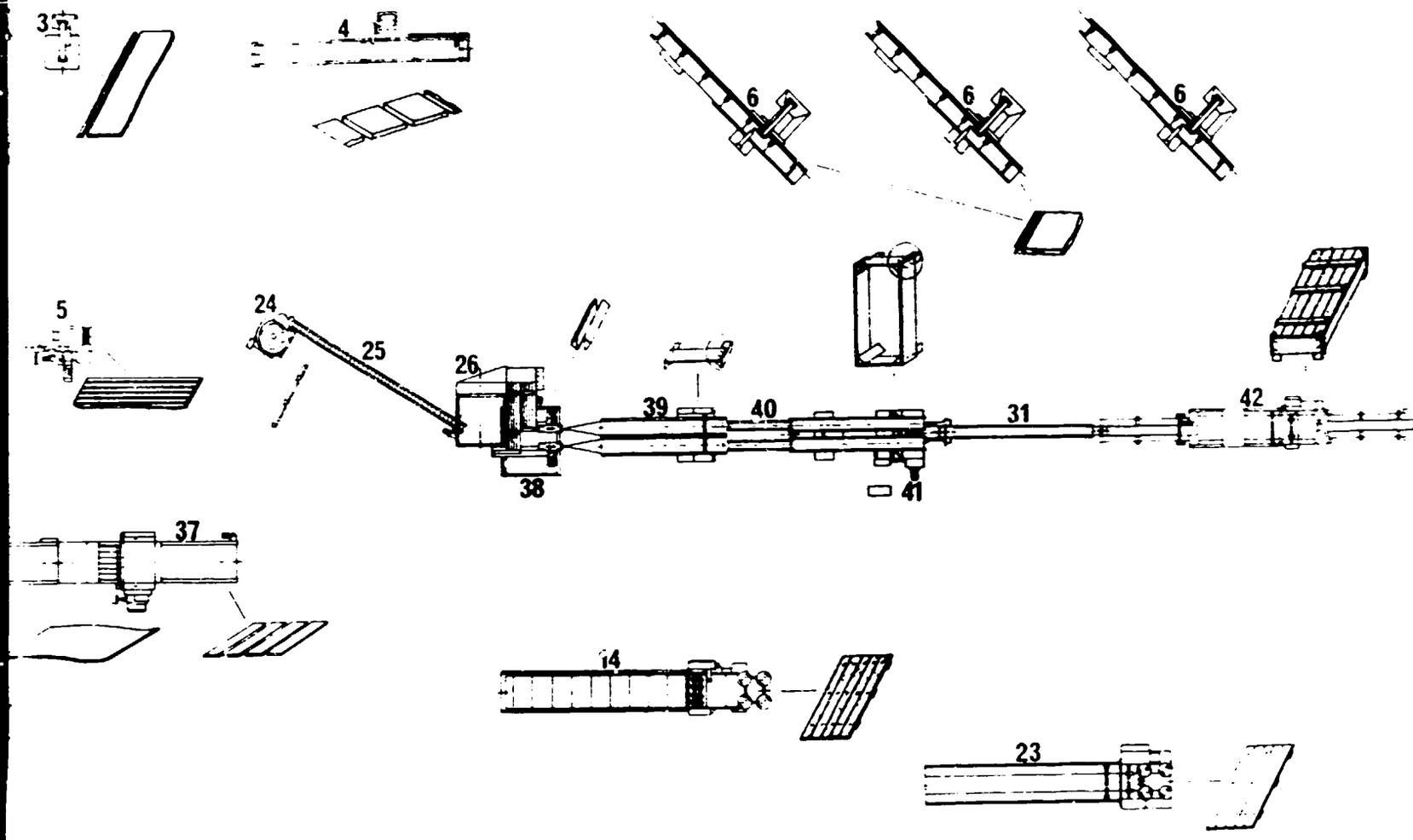
Plant layout of a manufacturing installation

Hourly production rate: trays: 1800 - 2000

boxes: (3-slatted) 800 - 1200

LIST OF MACHINERY

Position	Quantity	Description
1	1	F.800 Debarking machine
2	1	Bandsaw with carriage (Ø1100)
3	1	Bandsaw for final trimming operations (Ø1000)
4	1	Pendulum saw
5	1	Multi-blade circular saw
6	3	SL.30 Lath cutter
8	1	M.54 round section and plank cutter



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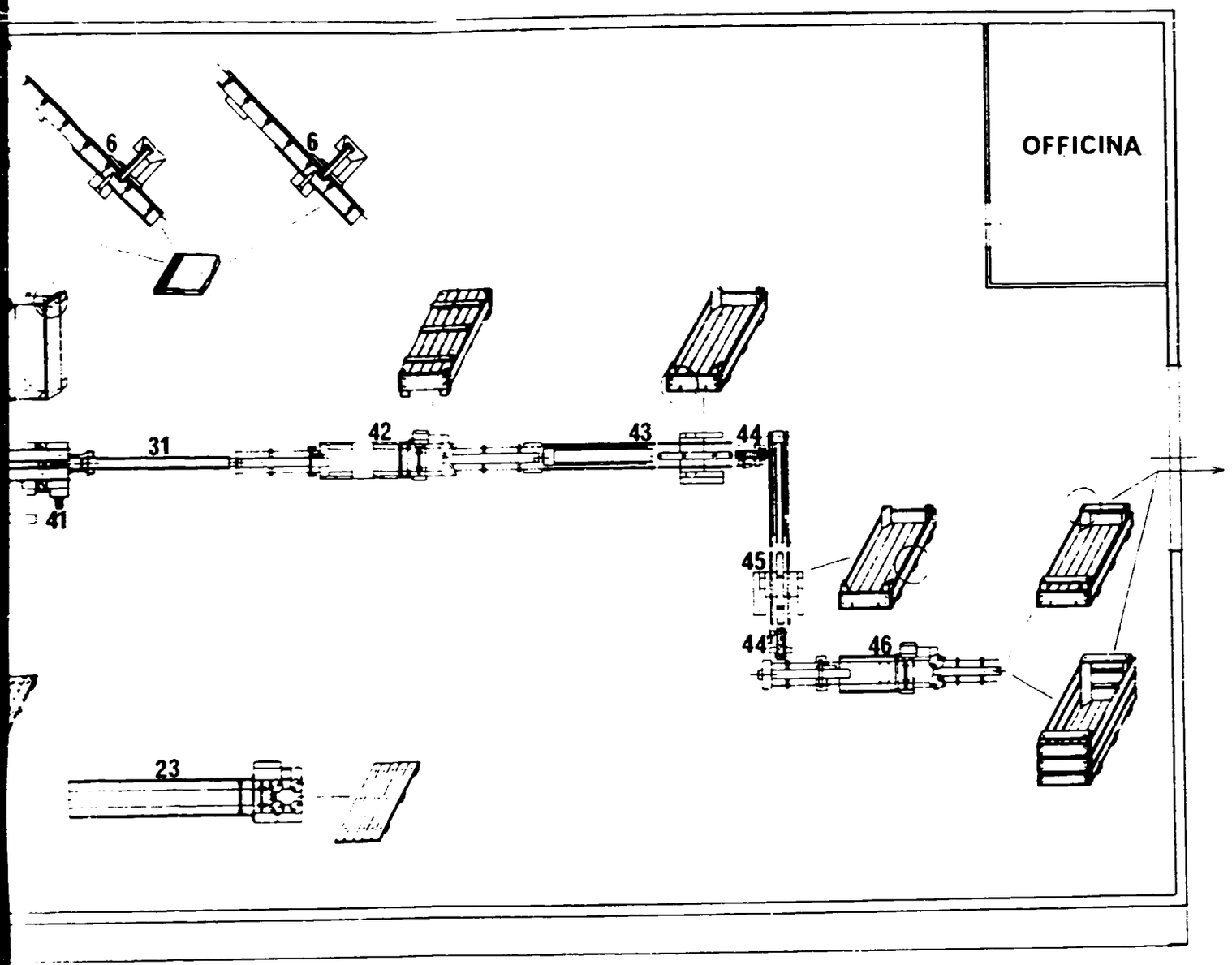
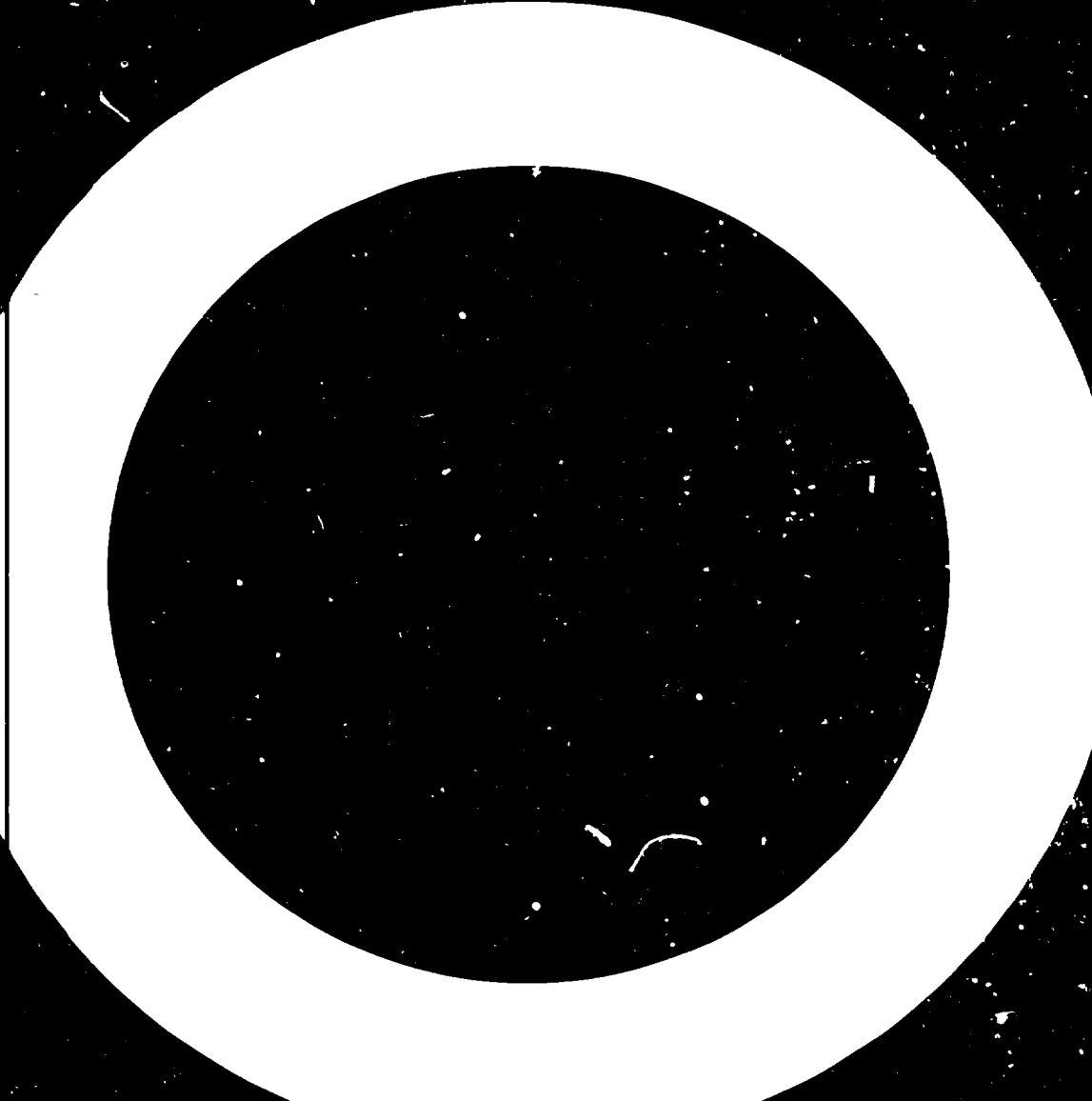
	14	1	M.76 Box bottom stitcher	38
	18	1	M.85B Cross-cutting saw	39
800 - 1200	19	1	Log chain conveyor	40
	21	1	Veneer conveyor belt	41
	23	1	M.64 box bottom stitcher	42
	24	1	M.108 Machine for cutting off lengths of square sawn timber	43
100)				
ng operations (Ø1000)	25	1	Conveyor belt for square sawn lengths	44
	26	1	Storage bin for square sawn lengths	45
	31	1	Frame conveyor belt	
	36	1	M.82S Rotary veneer peeler with horizontal centre-square device	46
lank cutter	37	1	M.95 Veneer slicer	

SECTION 2



? :cher	38	1	M.109D Angle block cutter
saw	39	1	M.151 Automatic end panel stitcher
	40	1	Overhead end panel conveyor
	41	1	M.148 frame stitching machine
cher	42	1	M.78B Stitching machine for attaching bottom panel corners to frame
tting off lengths of	43	1	M.139L Stitching machine for attaching bottom panel to frame (end panel)
uare sawn lengths	44	2	Fast conveyor
re sawn lengths	45	1	M.139N Stitching machine for attaching bottom panel to frame (side panel)
eeler with horizontal	46	1	M.79B Handle stitching machine



(B)1. Preparation of bottoms

The parts making up box or tray etc. bottoms (boards, slats, laths) are no longer nailed manually or "tacked" together; they are now joined by means of stitchers.

Stitchers are devices or machines that apply "stitches" out of wire drawn automatically and continuously from skeins of various sizes supplied by wire manufacturers. These stitchers must not be mistaken for mechanically or pneumatically powered staplers or stitchers employing prefabricated staples.

Going back to Figures 3, 4, 5 and 6 - featuring different output rates - it can be noted that various types of stitchers have been adopted, displaying various degrees of automation.

Figure 3, showing the simplest line, features a non-automatic stitcher with two or more stitching heads (position 8), whose speed largely depends on the capability and rapidity of the operator handling the machine, and of the workers placing and positioning the boards and strips in the containers on the stitching line.

Figure 4 shows an electronic automatic two or more headed conveyor belt type stitcher (position 14) which, with the same number of attendants as on the previous simple line, can achieve a two to three times higher production rate.

Figures 5 and 6 feature the same type of high-speed conveyor belt stitcher with two or more stitching heads (position 23) as in Figure 4; this model, however, is capable of attaining even higher output rates.

Automatic conveyor belt type stitcher (two or more heads)

This machine deserves a more detailed description, it is an automatic conveyor belt type stitcher with a "loading belt" that is in continuous motion during the operation.

The "loading" line conveys a series of containers (or holders) - forming a "belt" - designed and arranged to receive the boards and slats that go into making up box and tray bottoms.

The stitching heads (and respective strikers) are supported and fixed to swinging bars, so that efficient stitching is ensured even when the belt is moving. The heads are electronically controlled, and only operate when the containers pass under them.

As the machine is totally automated, no specially skilled workers are required; the job simply consists in filling the containers moving along the line with appropriate parts.

(B)2. Preparation of lids

Lids are prepared and stitched just like bottoms, using the same stitching machines, be they the non-automatic version with two or more stitching heads, or the automatic electronic conveyor belt type model, also with two or more stitching heads, depending on the desired lid output.

In Europe, very limited use is made of fruit and vegetable trays or boxes with lids; thus the four factory layouts do not include lid stitching machines.

If necessary, lids can be stitched on the same machines used for making bottoms, by simply scheduling a few extra operating hours.

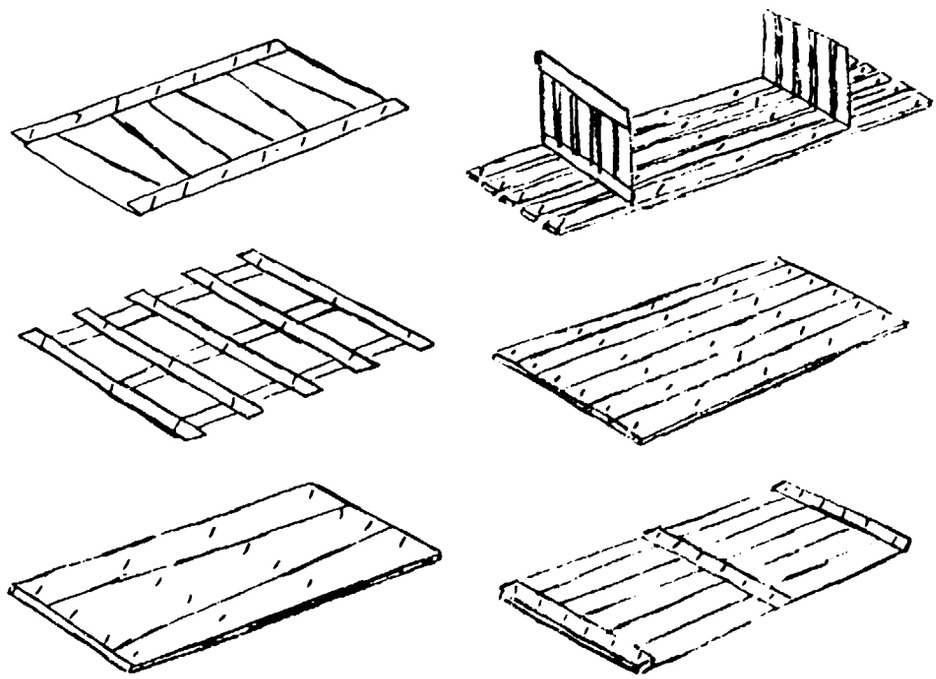


Fig. 7: Various types of lids

(B)3. Assembly of packaging containers

(B)3.1 Assembly plant - Figure 3 layout

(hourly production rate : 500 - 700 storage trays; or
200 - 220 3-slatted boxes).

This is the simplest possible machinery available to replace the old hammer-and-nails assembly method.

A separate stitching machine (position 9) is used to attach short (end) and long (side) panels to the triangular angle blocks at each corner.

The "frame" thus assembled then goes to the two-headed stitcher (position 10), where the bottom panel, previously prepared, is fixed to the four angle blocks, by flat-topped full-depth stitches.

Following this operation, the frame, with its bottom panel "tacked" at each corner to the four angle blocks, then moves on to another stitcher, which finishes securing the bottom panel to the two long side panels, and, if necessary, to the end panels, by applying V-shaped stitches to the strips reinforcing the bottom (supporting strip).

The subsequent step is attaching the handle strips to the four angle blocks by means of flat-topped full-depth stitches applied by the two-headed stitcher (position 12).

(B)3.2 Assembly plant - Figure 4 layout

(hourly production rate : 700 - 900 storage trays; or
250 - 300 3-slatted boxes).

Compared to the previous plant, this line has a 40-60 per cent higher production rate. To obtain this productivity enhancement, two automatic two-headed stitching machines were added, with two synchronized carriage units (positions 15 and 16).

The first stitcher applies flat-topped full-depth stitches to join together end panels and angle blocks. Thus prepared, the end panels are then put into the carriages of the second machine in pairs, and by means of the same stitches, the side panels are fixed to the angle blocks already attached by the previous machine to the two end panels.

Subsequent stitching operations are performed on the same machines as described previously, plus the following:

- a two-headed stitcher (position 10) designed to apply flat-topped full-depth stitches to join the bottom panel with the four angle blocks;
- three stitchers (instead of two) for carrying out the final attachment of the bottom panel to the long side panels (position 11), by means of V-shaped stitches applied to the reinforcing strips across the bottom;
- two two-headed stitchers (instead of one) (position 12) designed to attach the two upper strips (handles) to the four angle blocks, via the usual flat-topped full-depth stitches.

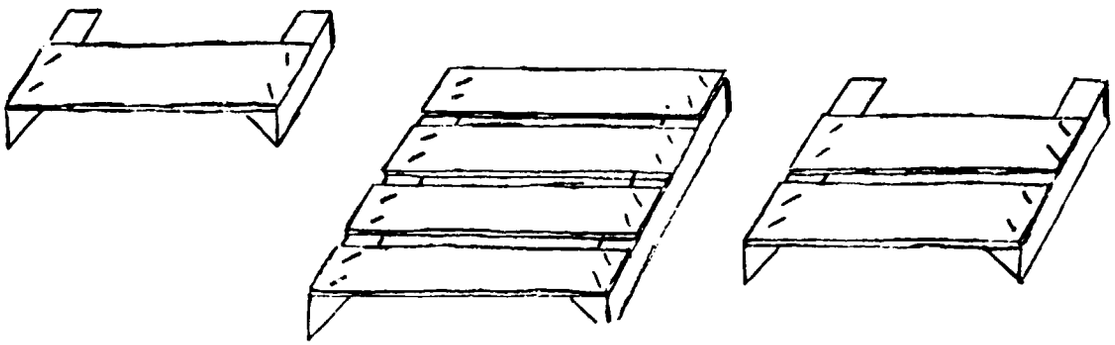


Fig. 8: Various heights of ends showing position of stitches

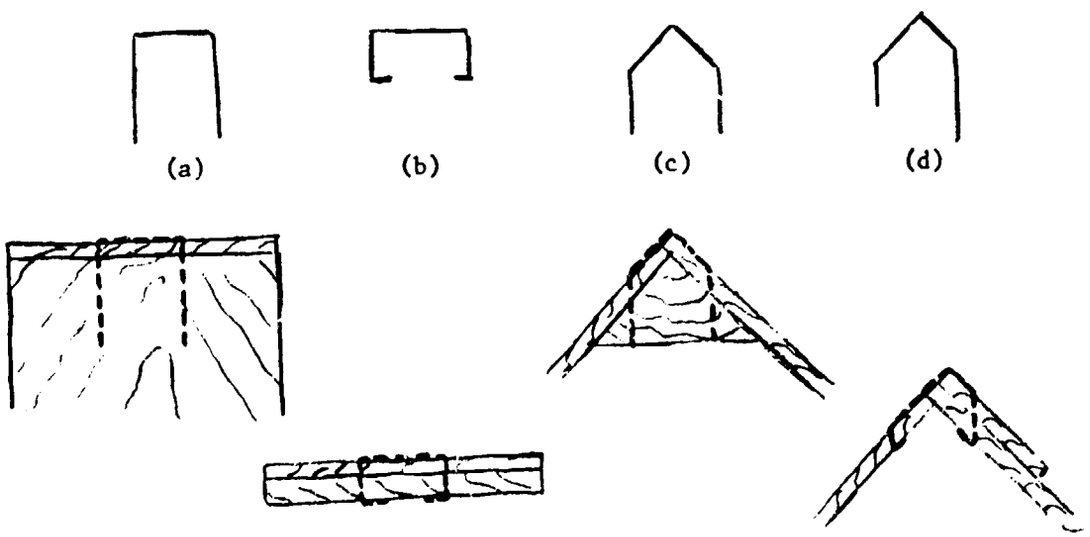


Fig. 9: Various types of stitches: (a) flat topped; (b) flat topped clinched; (c) V-shaped (d) Asymetric V-shaped

(B)3.3 Assembly plant - Figure 5 layout

(hourly production rate : 900 - 1,200 storage trays; or
400 - 600 3-slatted boxes).

Figure 5 illustrates a semi-automatic plant designed to provide trouble-free production changeovers, and thus ensuring the utmost versatility. Changeovers from the assembly of storage trays to boxes, and vice versa, require only some relatively simple adjustments and modifications, involving the addition or removal of tools and/or parts of loaders, etc.

Once the bottom panels have been prepared, the following operations take place in the order listed in the layout:

(a) On emerging from the angle block cutter (position 27), the triangular angle blocks automatically slip into the guides that channel them into the loading line of the automatic two-headed stitcher (position 28), which produces finished end panels.

To make the end panels, the machine operator has to place the boards or strips in the loader; a moving conveyor then automatically deposits them on the angle blocks, to which the stitcher secures them by applying flat-topped full-depth stitches.

(b) Thus stitched, the end panels are brought to the automatic two-headed frame stitchers (position 29), which a worker manually feeds with side panels in special loaders located at the back of the machines, while another worker (one per machine) loads the two end panels that will form the frame, into the front of the machine. As soon as the operator inserts the two end panels, one of the two strips needed to complete the frame will automatically come to rest upon them; the machine then stitches the strip to the angle blocks using the usual flat-topped full-depth stitches. The resulting half-frame is then unturned by the operator and once again placed on the stitcher which automatically attaches the second side panel, thus completing the frame.

(c) The operator then places the frames on a conveyor belt that takes them to the automatic two-headed stitcher (position 31), which they enter automatically. Once the frames are on the loading line, an operator places a bottom panel on top of each; the stitcher automatically joins the bottom panel to each of the four angle blocks, by means of four flat-topped full-depth stitches.

(d) After this operation has been completed, the next step involves the automatic two-headed corner stitcher (position 32), which stitches the bottom panel to the two side panels, by means of V-shaped corner stitches.

(e) After the bottom panel has been fixed to the side panels, another automatic stitcher (position 33) applies more V-shaped corner stitches so as to join the bottom panel to the two end panels.

(f) Now that the storage tray is almost finished, with its bottom panel securely fixed to the four side panels forming the frame, it is automatically conveyed to the loading line of the next automatic two-headed stitcher (position 34); an operator places two strips (handles) in the two special side loaders. Prior to the actual stitching operation, the conveyors that direct the box or tray under the stitching heads also pick up these two strips which are eventually fixed to the four angle blocks by means of four flat-topped full-depth stitches, thus forming the handles.

This concludes the assembly operation, and the resulting tray is ready for use.

(B)3.4 Assembly plant - Figure 6 layout

(hourly production rate : 2,000 - 2,200 storage trays; or 800 - 1,200 3-slatted boxes).

This last plant layout is the most advanced, the most automatic, and the most productive available world-wide for the production of storage trays and boxes. We will thus be listing and describing each of the operations involved in achieving the complete assembly of the finished box or tray, starting with pre-stitched bottom panels.

After being cut into suitable lengths by a specific cutter, (position 24) fed by an operator, the square-sawn sections (that will later become angle blocks) travel by conveyor (position 25) to a storage bin (position 26), from which they are dropped into the angle block cutter (position 38); here they are cut diagonally to form triangular angle blocks of appropriate length, and finally removed by an operator in preparation for the next operation.

The triangular angle blocks are automatically channelled on to the loading line of the automatic four-headed end panel stitcher (position 39), which applies flat-topped full-depth stitches to two end panels at the same time.

The operator in charge of the automatic stitcher (position 39) feeds the automatic loader-distributors with the laths making up the two end panels. The machine stitches the end panels, which are now automatically conveyed to the next operation, performed by an automatic four-headed frame stitcher (position 41). Another operator feeds side panels (long side) into the machine's automatic loader-distributors; the stitching heads apply flat-topped full-depth stitches joining these side panels to the angle blocks at each corner.

The "frames" emerging from the automatic stitcher (position 41) all fall in exactly the same position on the conveyor belt (position 31), which takes them at a pre-set pace to the conveyor-loader of the automatic two-headed stitcher (position 48); here, an operator places a bottom panel on each frame moving towards the stitching heads. The two parts are stitched together at each corner by means of two flat-topped full-depth stitches.

Two automatic two-headed stitchers (positions 43 and 45) finally join the bottom panel to the end panels and side panels by means of V-shaped corner stitches. The tray is automatically fed into these two stitching machines, upturned, stitched, withdrawn and ultimately conveyed to the next two-headed stitcher (position 46), where the operator in charge feeds the strips that are to become the handles into the two loader-distributors. The machine stitches these two handles to the four angle blocks by means of flat-topped full-depth stitches.

The result is a finished tray which, as in the previous assembly lines, is stacked on pallets, loaded and conveyed to the factories, where the fruit and vegetables are cleaned, sorted and packed prior to their storage, preservation and marketing.

Several hundred similar plants have been set up in Europe, but there are thousands of plants along the lines of those described in Figures 3, 4 and 5 throughout the whole world, especially in Western Europe, with its highly developed fruit and vegetable growing industries in: France, Greece, Italy, the Netherlands, Spain, the Federal Republic of Germany and Yugoslavia.

Many other manufacturing lines and machines are located in Eastern Europe: Poland, the U.S.S.R. etc.

Wirebound Boxes

This special type of box requires a few specific observations concerning its construction and assembly, rather than the production of its component parts (boards, laths etc.).

- Preparation of parts (laths)

The same machines are used for making laths as for making the previously described box and tray parts (band-saw, veneer slicer, veneer cutter).

The only special machine needed on the factory line is the chamfer-cutter, used for precision cutting and chamfering plank lengths to the required size.

Once machined, the parts then pass through the multiple-blade saw, which delivers the square-sawn lengths - cut-off and chamfered to perfection - required to make the box.

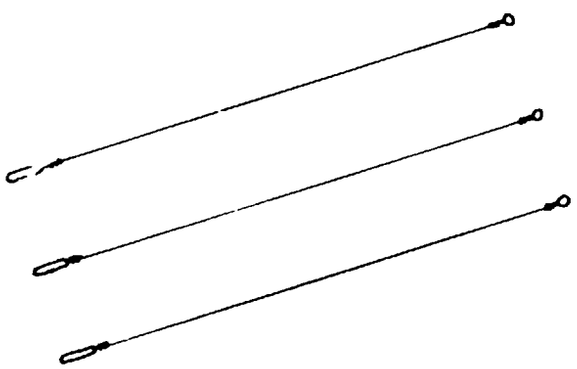
- Parts assembly - open frame

Box frames can be circled with "reinforcing wire" by means of a separate conveyor-belt type stitcher; laths and square-sawn lengths are positioned on the stitching line, and "pre-looped" band wire is employed to join them (Figure 10a).

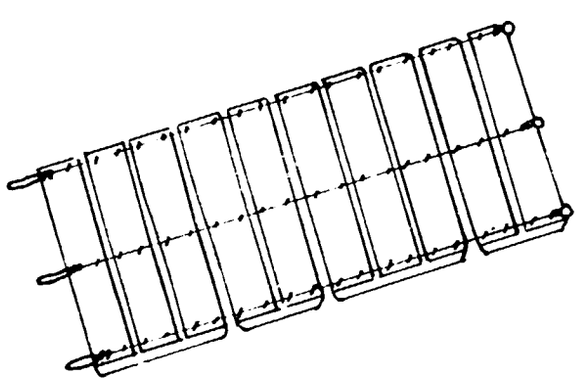
Band wire is available from suppliers in pre-looped form, and in the required sizes, or it can be looped as needed using a cutting and looping machine handling skeins of continuous wire.

The stitcher comes either equipped with hooks or pins designed to handle pre-looped wire, or in a second version built to handle skeins of continuous wire; in the latter model, the wire is cut to a specific length by special rotary shears mounted on the machine at the exit of the stitched frame.

Thus stitched, and with the band wires cut, the frame is placed on a bench where two workers equipped with a sort of hammer-cum-pliers tool, loop the wire ends, and hammer them into the wood (Figure 10b).

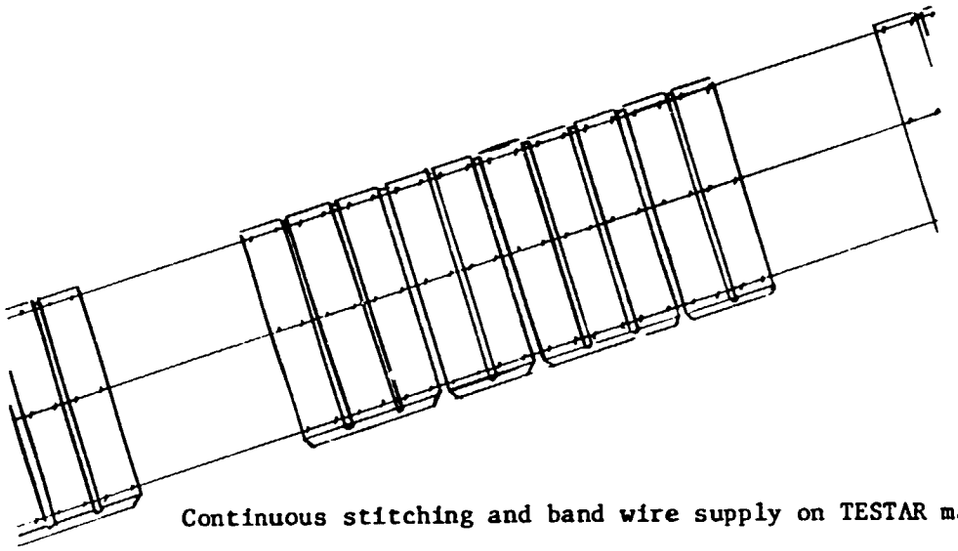


Previously looped band wires

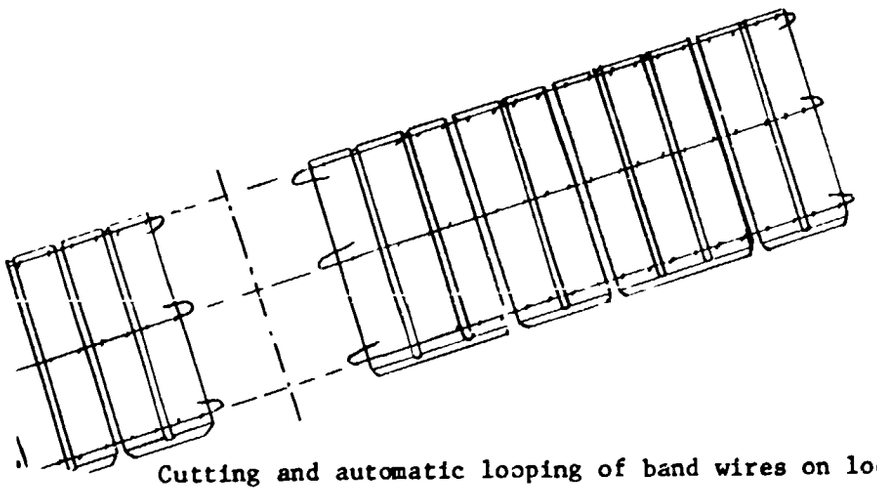


Continuous looping of band wires on TESTAR machine

Fig. 10a: Sheet manufacturing technique for wire-bound boxes



Continuous stitching and band wire supply on TESTAR machine



Cutting and automatic looping of band wires on looping machine

Fig. 10b: Sheet manufacturing technique for wire-bound boxes

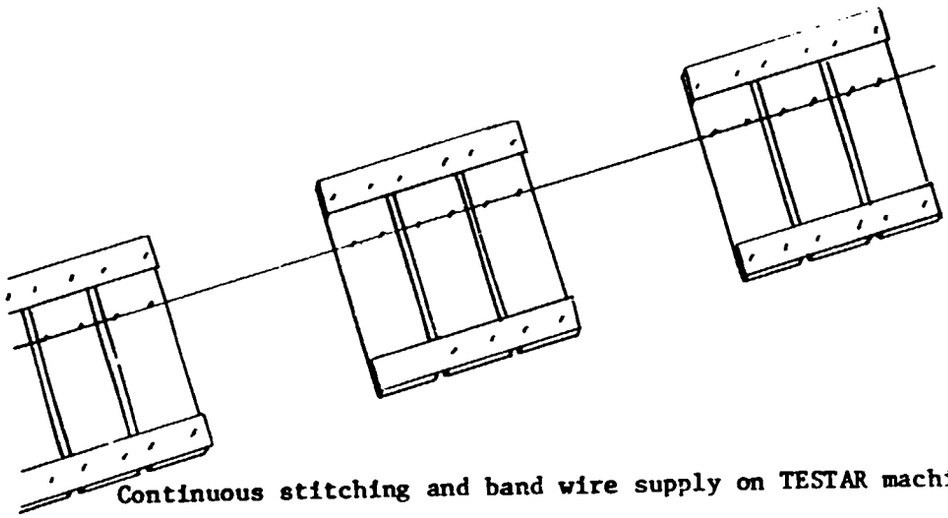
Box frames can be assembled and looped on an "automatic line" employing a continuous supply of skein-fed band-wire. The line comprises two machines; an "automatic electronic multiple-head stitcher" for stitching continuous band-wire to the strips and square-sawn sections - but there are no square-sawn sections in the central parts - which then move to the second machine, an "automatic wire looper", synchronized with the first machine, which cuts off the wires, loops them and flattens the ends against the wood, in a fully automated process (Figure 10 b)

- Parts assembly - end panels

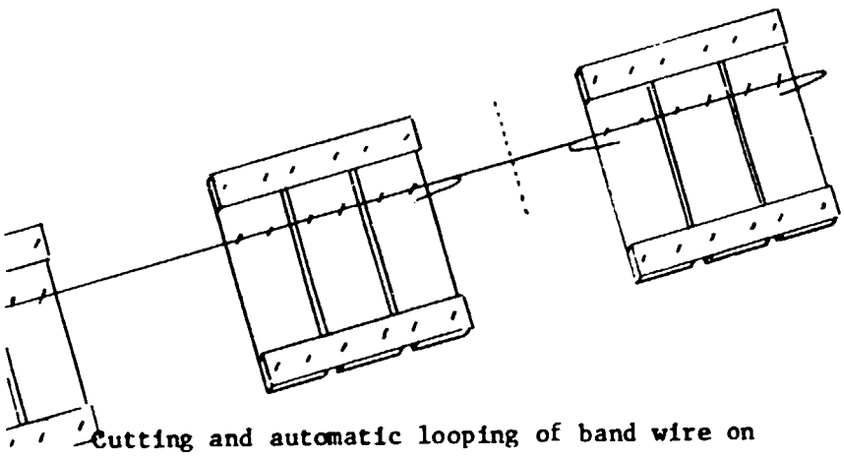
End panels can be made out of a single piece of plywood or fibre-board or any other similarly strong, flexible, bonded material, or else they can be made out of wooden boards, joined by stitched strips.

End panels can be "reinforced" with pre-looped band-wire, or with continuous band-wire cut after stitching and then hand-looped, or else they can be reinforced on a "two-machine reinforcing line", consisting of an automatic electronic stitcher and a synchronized automatic loop-former (see frame assembly). A separate M/80 type semi-automatic looping machine can be used for applying the looped wire to the plywood, fibreboard or woodstrip end panel (Fig. 11 a).

End panels consisting of boards and strips are stitched by the same stitchers used to make box and tray bottoms.

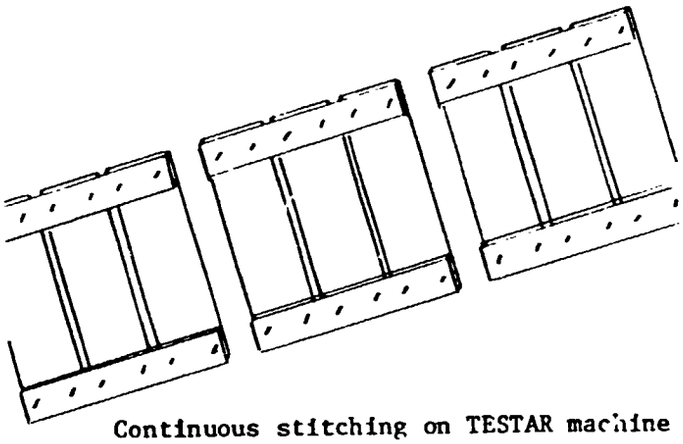


Continuous stitching and band wire supply on TESTAR machine

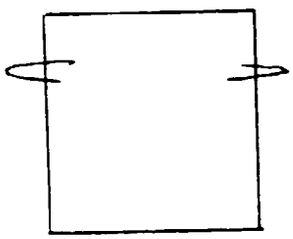


Cutting and automatic looping of band wire on looping machine

Fig.11 a: End panel manufacturing technique for wire-bound boxes



Continuous stitching on TESTAR machine



Semi-automatic looping on separate machine type M80

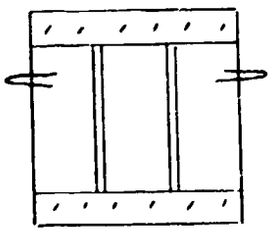


Fig.11 b: End-panel manufacturing technique for wire-bound boxes

Other types of packaging containers

After describing the various technologies involved in manufacturing storage trays, boxes and wirebound boxes, the picture must be completed with a brief outline of the processes and machines used in the production of some other common types of packaging containers; crates, baskets, etc.; these are chiefly used for lettuce and vegetables, but also for fruit.

The boards, laths and strips that are processed for the production of crates are prepared on the same machines that are used for working box and tray parts, i.e. automatic or semi-automatic band-saws, veneer slicers, as well as circular gang saws and angle block cutters for forming the angle blocks generally present on all crate types; the machine of major importance in the making of baskets is the rotary veneer cutter.

To make the square baskets and round tapered containers illustrated in Figure 2a on page 2, the rotary veneer cutter must be fitted with a back-roll unit, and with "roughing knives" as well as the usual lateral veneer cutting knives.

Just what is this back-roll unit? "Back-roll" is the name given to the unit complete with roughing roller (cylinder embedded with knives); while the rotary cutter is operating, the roughing roller presses down on the rotating log, cutting it to the required width, shape and depth, prior to the actual veneer cutting operation, so that the result is not a continuous veneer sheet, but a series of boards, or parallel or tapered laths, all perfectly finished and in the desired shape.

The rotary veneer cutter thus mounted with the above-described back-roll unit can also be installed in plants manufacturing storage trays and boxes only (no baskets or crates at all); it will in this case produce boards or laths without necessarily having to cut the veneer to size using a separate veneer slicer. The veneer slicer is nevertheless essential, since not all logs suitable for veneering can also be handled by the back-roll unit to convert them into boards or laths. We cannot obviously list all the cases in which it is either unadvisable or impractical to employ the back-roll unit. For instance, the back-roll cannot be used for making boards or laths over 3-4mm thick out of beech logs measuring more than 600-700mm and not previously heat-treated; while the same logs, measuring the same length can be peeled using M/82 rotary veneer lathe into sheets even 6-8mm thick.

As regards the stitching machines required for manufacturing crates, the same models used for making storage trays and boxes can be utilized; however, the manufacture of baskets does require at least one special stitcher capable of applying flat-topped staple-type stitches.

Basket - fig. 2(a)

These baskets typically come in four different sizes, designed to hold 10, 5, 3 or 2 kilograms of carrots, onions, fennel roots, celery, artichokes, etc.

It is stitched "open" by means of an automatic electronic conveyor belt type stitcher equipped with multiple stitching heads; the machine is fitted with special hook-on receptacles or holders arranged to handle the strips and weave them (mainly for the bottom of the basket). After stitching the open element, a worker uses a separate stitcher featuring stitching arm and striker (no bench is involved) - either an M/70 or M/20 - to securely close and stitch the basket by means of flat-topped staple-type stitches.

Basket - fig. 2(b)

This basket is assembled by means of a special automatic stitcher (M/83) which applies flat-topped staple-type stitches to both sides. The stitcher features a moving loading line, to which special "receptacles" or "forms" are attached; the "forms" receive the following parts in this order: the lath that forms the bottom of the basket and two sides, the "handle", and the strip previously shaped into a frame by means of a separate stitcher applying flat-topped staple-type stitches (M/70 or M/20). The first stitcher (M/83) simultaneously fixes the frame to the two sides, and attaches the handle via a stitch to the centre of the same two sides.

Basket - fig. 2(c)

The first stitching operation that applies flat-topped full-depth stitches to join the various parts together (minus the handle) is performed by an automatic electronic multiple-head stitcher. The resulting "open" element is then closed by means of a separate stitching machine (an M/70 or M/20), that applies flat-topped staple-type stitches; the handle is then riveted on so it can be folded down for stacking during transportation, and also to avoid damage.

Basket - fig. 2(d)

The lid and bottom of this basket are stitched by means of an automatic electronic multiple-head stitcher, the same model used for making storage trays; the stitcher fixes lid and bottom to frame by means of wire loops or "pre-looped" wire, the same used for reinforcing wirebound boxes.

The frame is stitched by means of an automatic stitcher that applies flat-topped staple-type stitches; the machine is also fitted with a special device to which a rotating container of the same shape as the basket is attached. As many tapered box veneers as are needed to form the frame are placed vertically in the container, and immobilized. The stitcher then applies flat-topped staple-type stitches to the three horizontal veneer strips holding the standing box veneers in place.

This brings us to the conclusion of our description of the manufacture of lightweight wooden containers for fruit and vegetable products.

II. INDUSTRIAL PRODUCTS PACKAGING

In view of the large number of different shapes and sizes in which the three major types of wooden packaging come, only a general outline can be given as to their construction. The three major types, or categories, of wooden packaging are the following: heavy-duty boxes (for sea transportation), standard boxes and crates - all designed to contain a vast variety of goods, and to cover long or short hauls, either overland (by road or rail), by sea or air.

As regards the preparation of the various wooden components (planks, boards, strips, beams, laths, etc.) that go into making the above packaging, so much depends on the type of timber used, and on the country it is worked in, that no detailed information can be provided.

For instance, in many countries logs are sawn into planks by means of automatic or semi-automatic band saws in some places, and single or multi-blade circular saws in others.

The following information can be provided in relation to the assembly of the various box and crate parts (bottoms, lids and sides).

If part sizes are such that nailing or stitching machines can be used to assemble them (on average up to 1,200 x 1,400 mm), and the machinery investment is justified by the demand, then usually the above mentioned equipment featuring the necessary degree of automation is chosen. However, if output is limited and the size range is broad, then assembly operations are generally performed utilizing manual stitchers (applying ready-made staples), or manual nailing equipment (usually pneumatically driven) fed with suitable nails.

Special lightweight goods transported overland or by air can also be contained in lighter "looped-wire" crates and boxes, as shown in Figure 10. These containers have successfully solved the problem of storage in confined spaces, since the three parts of the packaging container (lid, side and bottom) can be stored separately, unassembled.

The boxes or crates thus need only be assembled (by inserting wire loops into slots) when actually required, and once they have been emptied of their contents, upon reaching their destination, can again be dismantled and shipped flat - ready for immediate re-use, providing valuable savings in transportation costs, even over long distances.

Modern Manufacturing of Wooden Pallets

We shall leave to others the task of describing the latest and most advanced machines and technologies available for the preparation of pallet boards, cubes (or blocks) and strips.

The purpose of this paper is to furnish accurate and detailed information on the most advanced technologies existing in the field of the assembly of normal and double-face two-way entry, and American and Pool (EUR) type four-way entry pallets.

As far as pallet assembly machines and materials are concerned, there are two different approaches - one employs nails, the other staples.

It must be specified that there are two kinds of staples. There are staples supplied ready-made for use with staple guns - the least suitable method of making medium to heavy-duty pallets - and there are staples made automatically by the stitching machine that applies them, out of continuous wire drawn from reels. The latter type are ideal for stitching pallets and can be made to measure up to 90mm in length, with a wire diameter of up to 3.2mm.

Pallets assembled via this latter method (i.e. with staples made to measure by the stitching machine) have proven in comparative tests conducted by the specialized agencies listed here below, to be far superior to pallets constructed using normal or helical nails:

- Delft Packaging Institute, the Netherlands;
- Politecnico di Milano, Italy;
- Politecnico di Torino, Italy;
- Centre National de l'Emballage et du Conditionnement, Paris, France (on behalf of the French Railways).

The tests concluded that stitched pallets are stronger and most certainly last longer than nailed pallets.

In particular, pallets made of hardwood require "pre-perforation" prior to nailing operations, even if special hardwood nails are used; no pre-perforation is required prior to stitching.

Pallets assembled with ready-made staples applied by special staple guns are fast losing popularity, since they are known to be far weaker than either nailed or machine-stitched pallets. However, these lightweight, "disposable" pallets are still used for palletizing light, low-cost goods that do not require tough, durable pallets.

Nailed Pallets

For low pallet output rates (100-200 daily), featuring a broad sized range, manufacturers tend to prefer nailed pallets assembled using either pneumatically powered nailing guns applying ready-made nails supplied in "sticks" or "rolls", or guns fitted with automatic magazine-type loading units providing continuous nail feed.

Various types are available; however, in all versions, the nails are fed automatically and continuously into the channel or duct that takes them under the gun's percussion-pin which then drives them into the wood.

Manufacturing lines featuring hand-operated mechanical or pneumatic nailing guns involve much hard work, and require trained personnel willing to withstand tiring and stressful working hours.

Larger-scale manufacturers with a daily output rate of over 400/500 pallets, of similar type but different sizes, typically choose automatic machines or lines.

Nailed Pallets - Pool type four-way entry (EUR)

Hourly production rate : 40 - 60 pallets.

As illustrated in Figure 12, a single 36-nail nailing machine is sufficient to cover an hourly output of 40 to 60 pallets. This machine assembles the bridges (or skis) on one side, and attaches the upper part of the pallet to the bridges on the other.

After being stitched, the bridges return to the workers, who turn them around and move them to the other side of the cross slide.

The machine can handle different sizes of nails (both normal and helical), since the reciprocating cross slide can be "programmed" to simultaneously nail together all the parts of the four-way entry type pallet.

Other equipment can be combined and synchronized with the nailing machine, to form an entirely automated line producing finished pallets, i.e. pallets featuring chamfered corners, milled edge strips to facilitate fork-lift truck handling operations, and branded cubes or blocks; lastly, the pallets are either stacked on top of one another, or inside one another to save space, as shown in the layout in Figure 12.

Higher production rates of up to 200 pallets per hour can be achieved by combining and synchronizing several nailing machines - needing only 6 to 8 workers in attendance. Such a high output level would obviously demand minimum variations in the range of types and sizes produced.

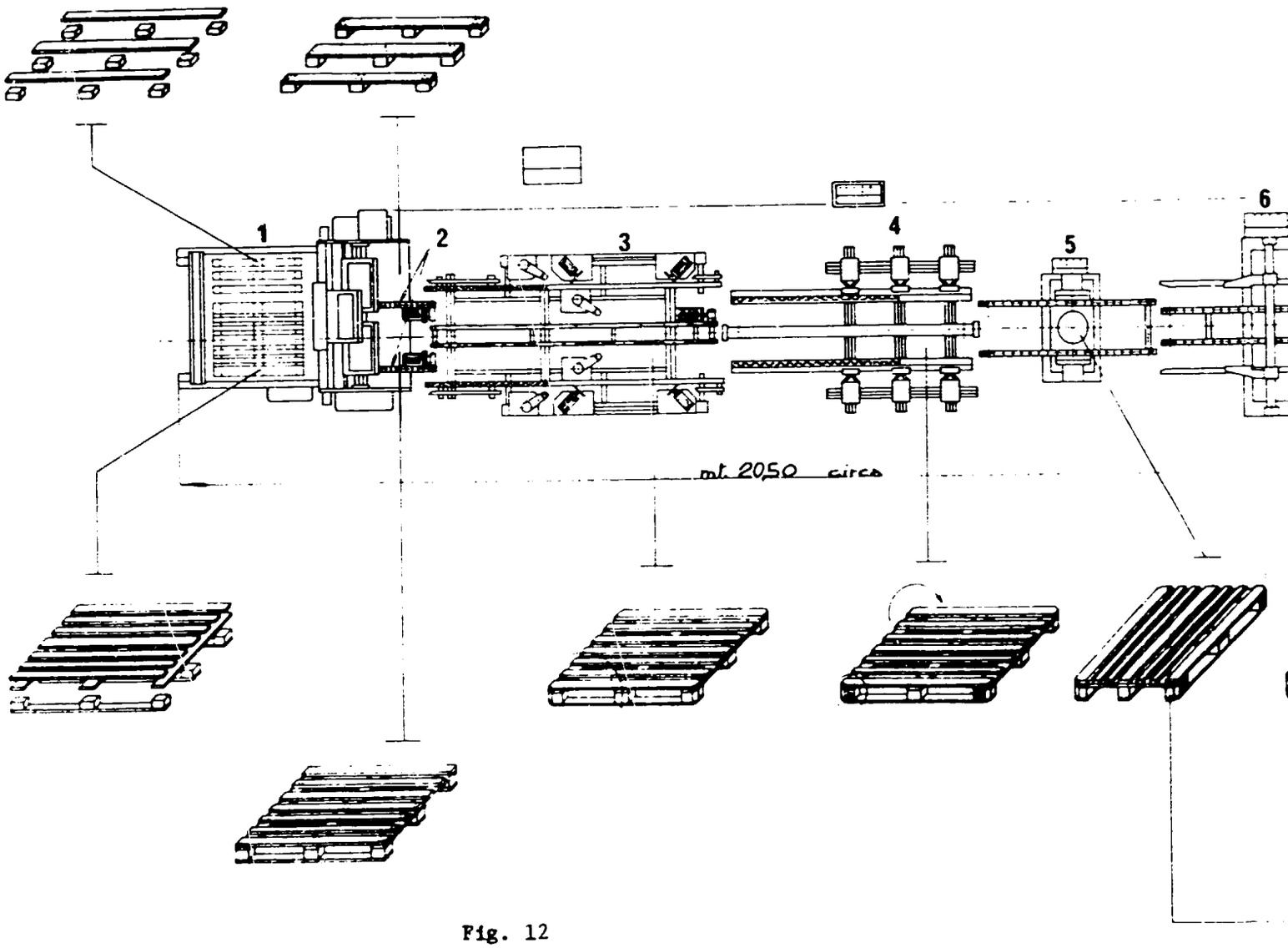
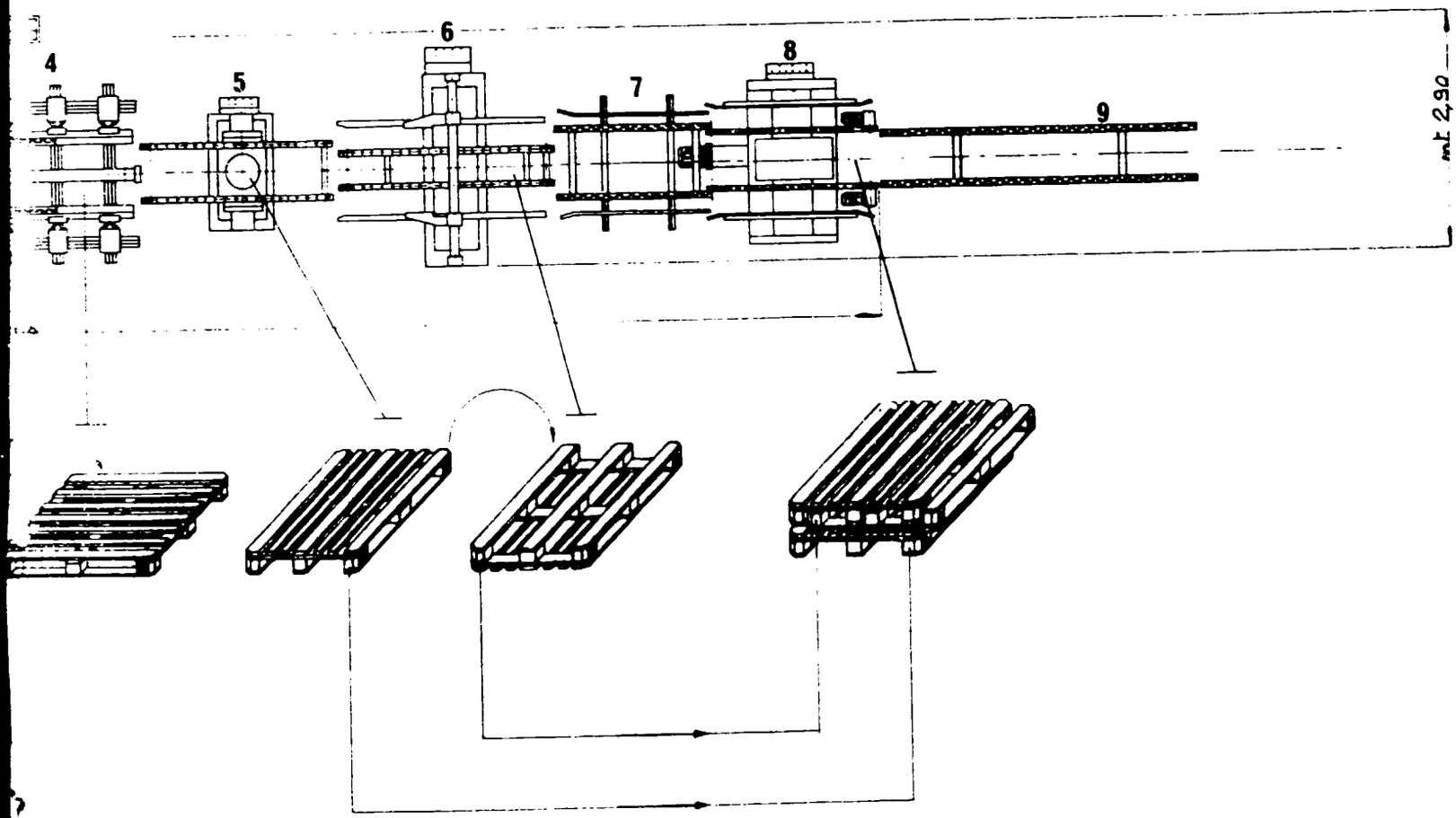


Fig. 12

Pallet nailing plant

Hourly production rate: 40 - 60 four-way entry pallets

Position	Quantity	Description
1	1	M/133-E Nailing machine
2	1	Chain conveyor
3	1	M/136-B Chamfering machine and M/155 milling machine
4	1	M/129 Branding machine
5	1	M/144 Rotary table
6	1	M/104-S Flip-over mechanism
7	1	two-meter link-up roller conveyor
8	1	M/156-S stacker
9	1	four-meter roller conveyor



four-way entry pallets

ng machine

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over mechanism

k-up roller conveyor

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SECTION 2

Stitched Pallets - Pool type four-way entry (EUR)

Hourly production rate : 40 - 60 pallets.

Fig 13 refers to the stitching (i.e. assembly by means of staples) of 40 to 60 pallets per hour.

One three-headed stitching machine is sufficient both to stitch the bridges, and then attach these to the boards forming the upper surface of the pallet, once one of the attendants has rotated the pre-stitched bridges, and placed them in the container on the conveyor.

This machine features an automatic reciprocating traverse-reverse slide; the machine's stitching programme is operator-controlled, and the finished pallets are ejected mechanically.

The slide has two work stations; the first stitches the underside of the pallet, and the second stitches the upper side.

The machine may be fitted with from three to five stitching heads, depending on the type of stitch required, and on the diameter of the wire out of which the staples are made.

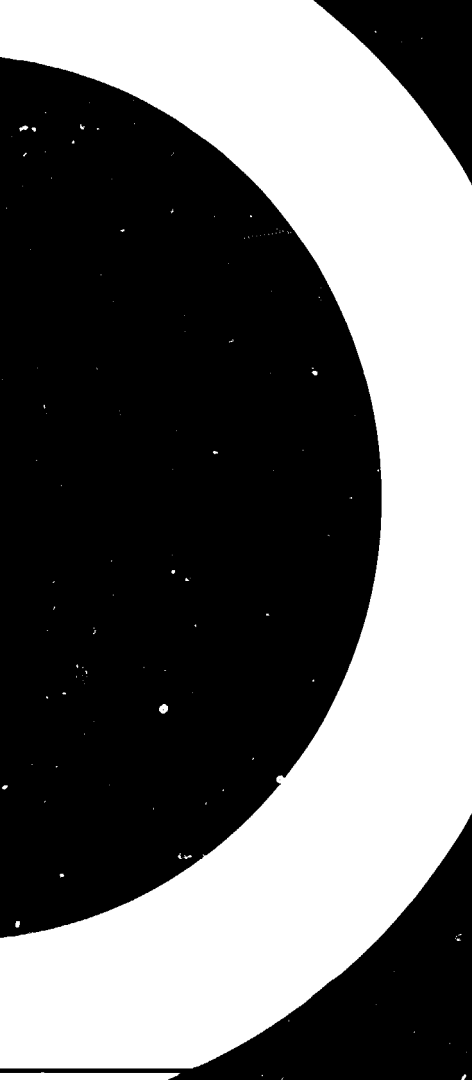
Stitched pallets may either be stacked directly, or fed into subsequent machines synchronized with the stitcher, to form a complete line producing finished pallets, with chamfered corners and branded cubes (or blocks); these pallets may either be stacked on top of one another, or upside down inside one another, to save space.

Stitched Pallets - double-face two-way entry, or America type four-way entry

Hourly production rate : 80 - 90 pallets.

An hourly production rate of 80 to 90 double-face two-way entry or America type four-way entry pallets can be obtained by using a three to five headed stitcher featuring a reciprocating slide attachment, appropriate stitching programme, two work stations, and an automatic pallet flip-over mechanism that enables pallets to be stitched on both sides.

This automatic stitcher may be included in a synchronized production line arrangement, ending up with stacked, finished pallets. (See fig. 14)



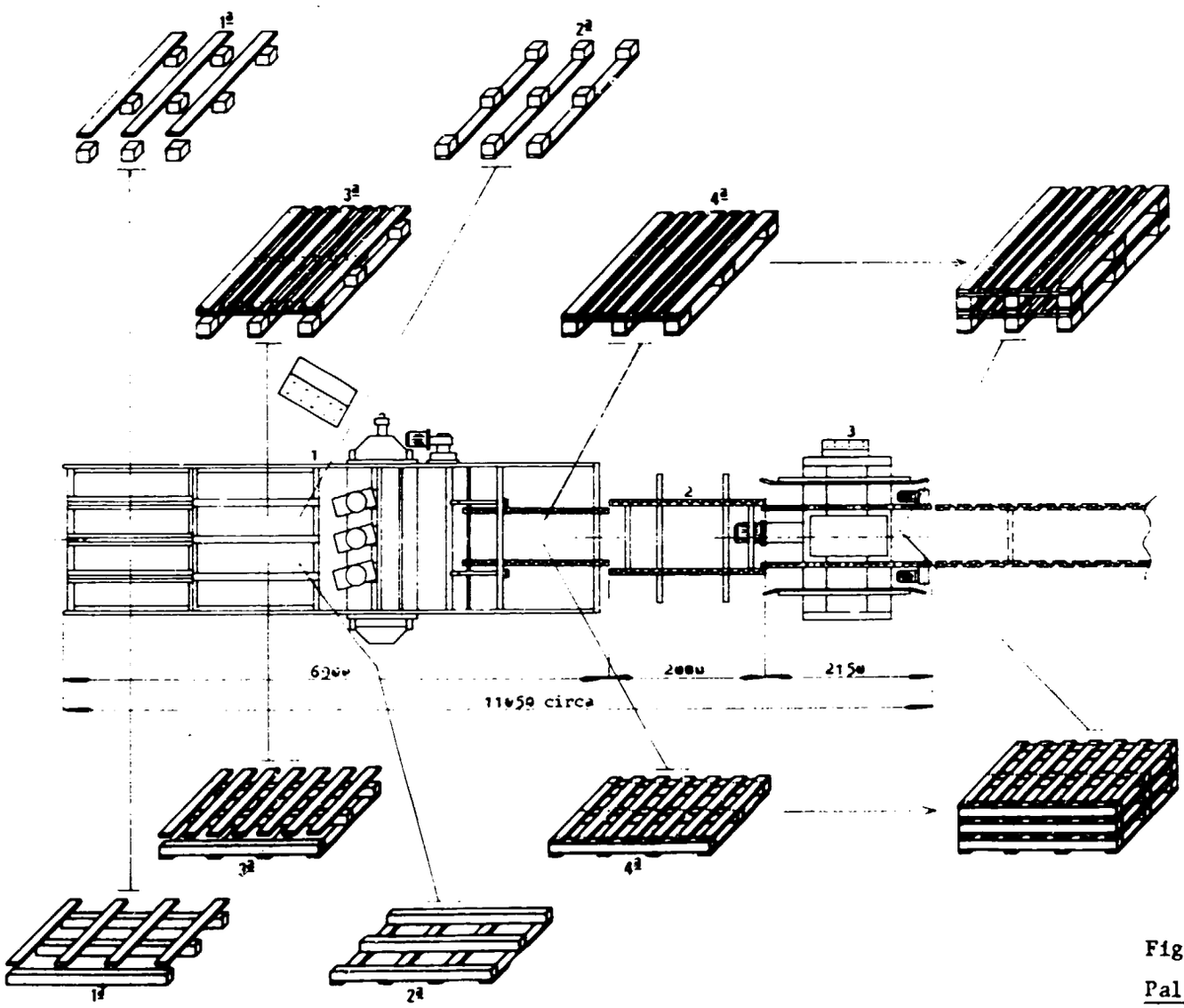


Fig. 13

Pallet s:

Hourly

Position

1

2

3

SECTION 1

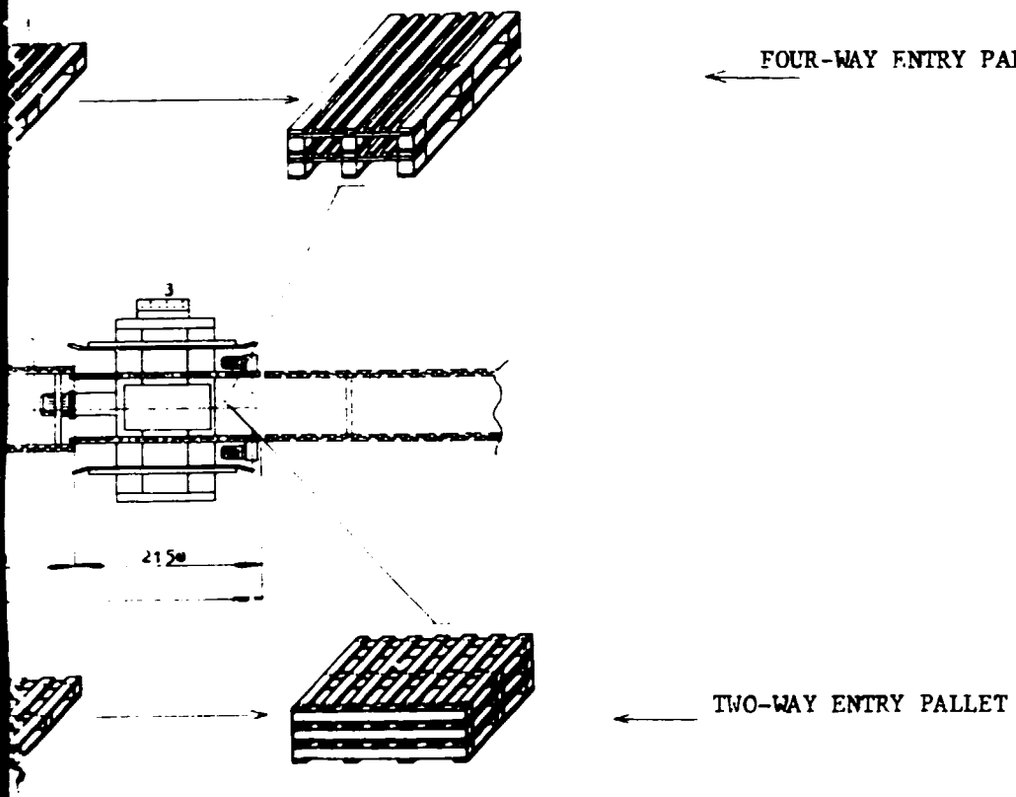


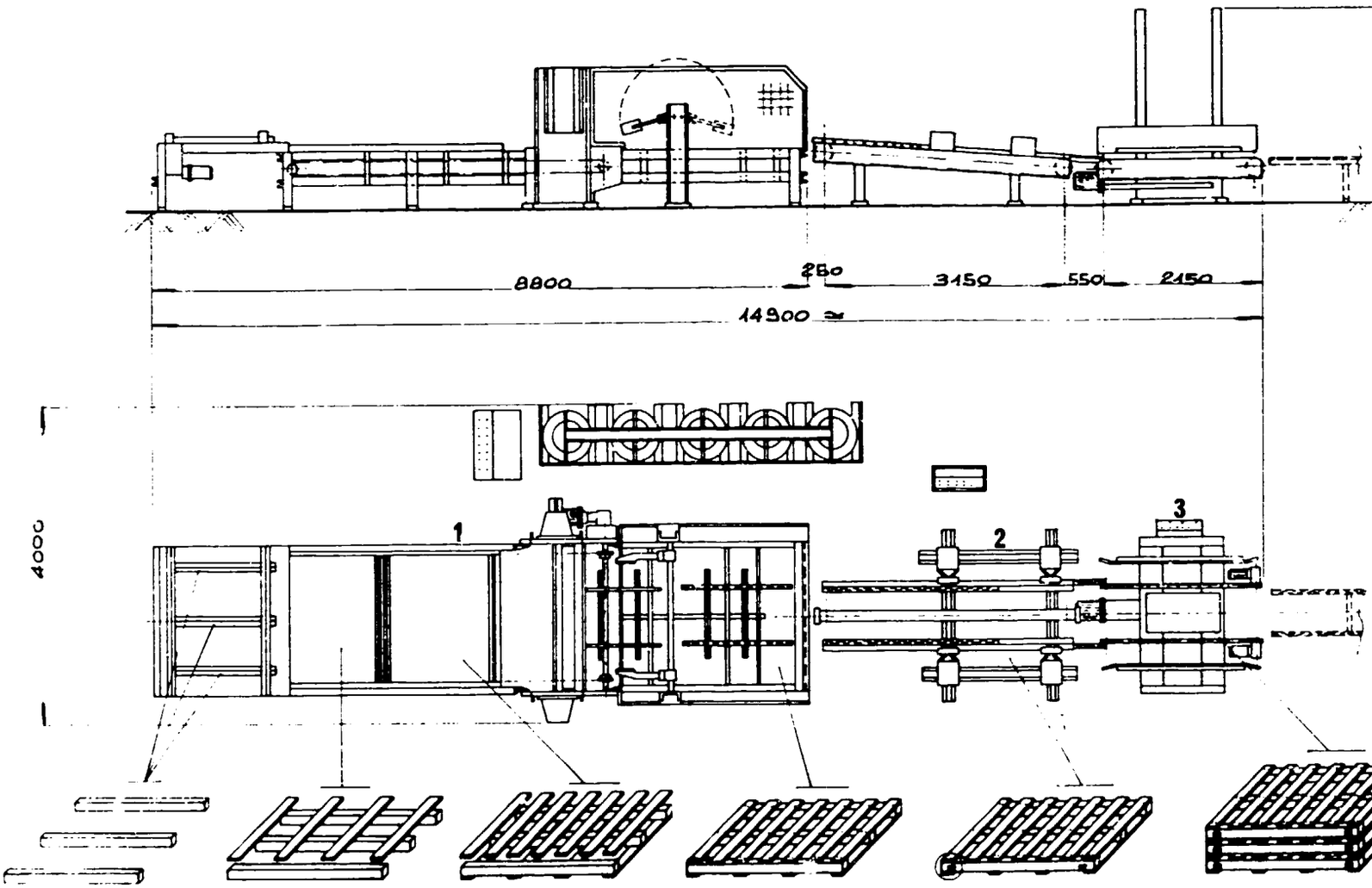
Fig. 13

Pallet stitching line

Hourly production rate: 40 ~ 60 two-way entry pallets and four way entry pallets

Position	Machine
1	M/97-B stitching machine
2	two-meter roller conveyor
3	M/156 stacker

SECTION 2



SECTION 1

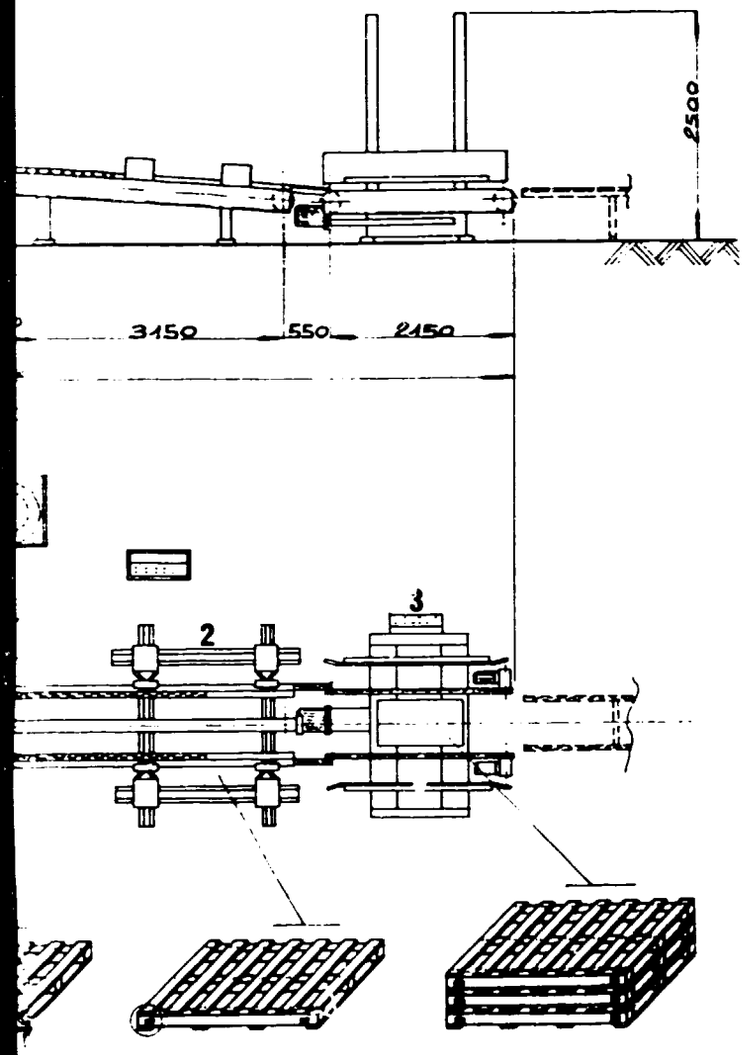


Fig.14:

Stitching line for two-way entry pallets

Hourly production rate: 80-90 two-way entry pallets

Position	Machine
1	M/97-D Stitching machine
2	M/129 Branding machine
3	M/156 Stacker

SECTION 2

Stitched Pallets - double-face two-way entry and America type four-way entry

Hourly production rate : 250 - 350 pallets.

Figure 15 describes a line initially comprising two stitching machines enabling a limited number of machine attendants loading pallet parts to produce from 250 to 300 pallets per hour.

Even just one of these stitchers is capable of stitching 250 - 300 single-face two-way entry pallets per hour; no more than three or four workers are necessary.

Automatic Stitching Line : for double-face pallets

- two-way entry : hourly production rate - 250/300 pallets;
- four-way entry : hourly production rate - 160/200 pallets.

An automatic stitching line (applying staples) requiring only five people to load and/or feed pallet parts, can produce 160/200 Pool type four-way entry (EUR) pallets, or 250/300 double-face two-way entry, or America type four-way entry pallets per hour. This is the most highly automated, least labour-intensive, and fastest line ever achieved world-wide (300 pallets per hour).

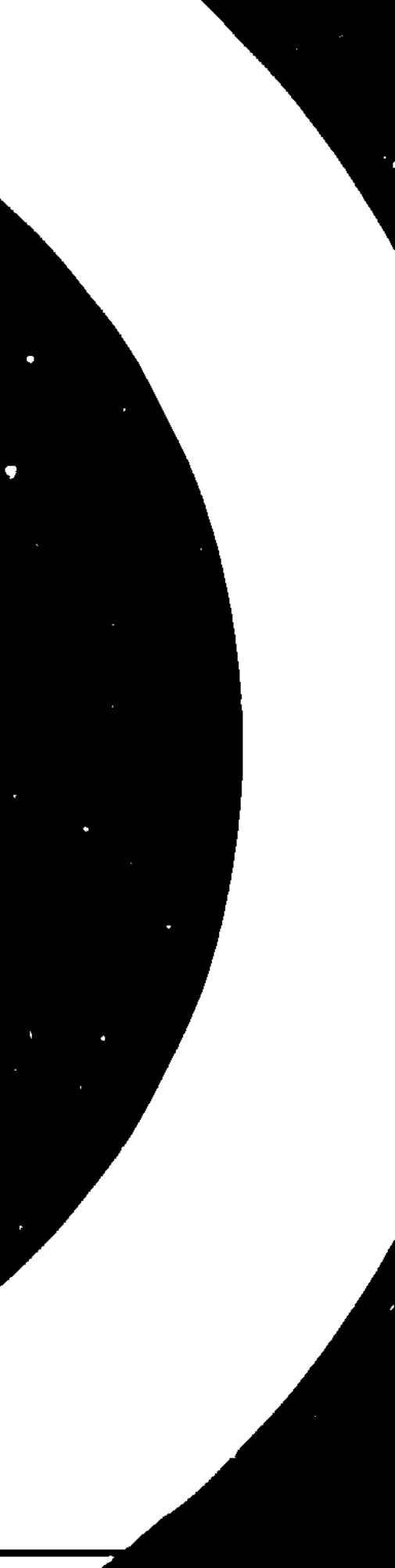
Figure 16 shows the sequence of operations involved in assembling Pool type four-way entry pallets (EUR).

Pos. 1 - Three-headed stitcher: for assembly of upper surface of pallet, consisting of three boards, across which five to seven laths are stitched.

Pos. 2 - Stacker; for stacking and packing scheduled batches of pallet tops.

Pos. 3 - Destacker; upon which the batches of pallet tops formed previously (Pos. 2) are shifted. The destacker is located on the roller conveyor at the delivery end of the stacker.

Pos. 4 - Three-headed stitcher; an operator feeds the stitching line with pallet cubes (blocks); these are conveyed until they are located under the pallet top that has already been automatically removed from the stack and brought to the line. The pallet top is thus lowered on to the cubes and stitched to them.



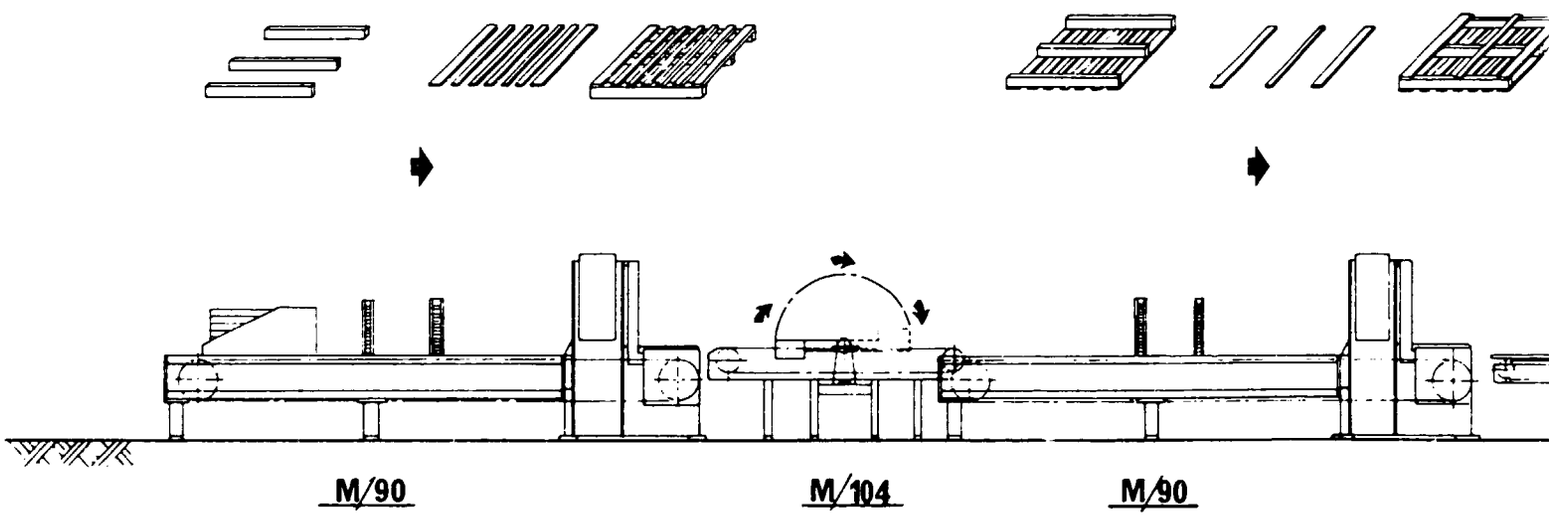


Fig. 15: Automatic sti

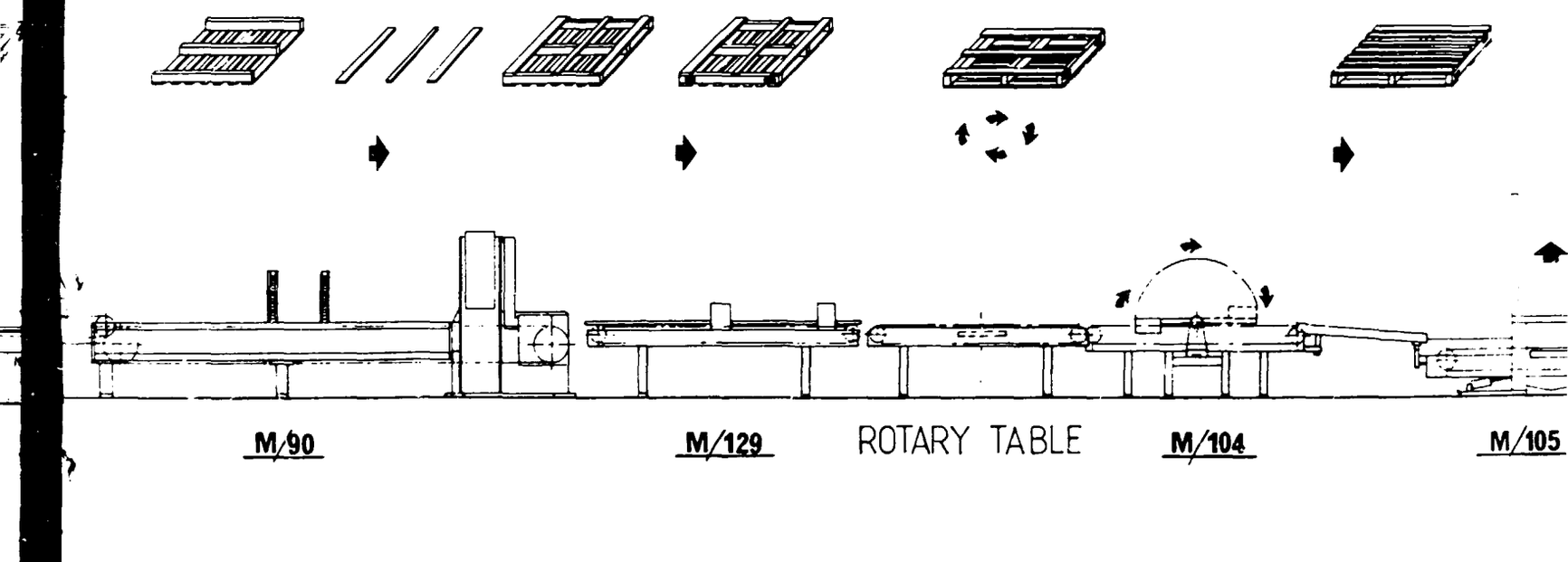
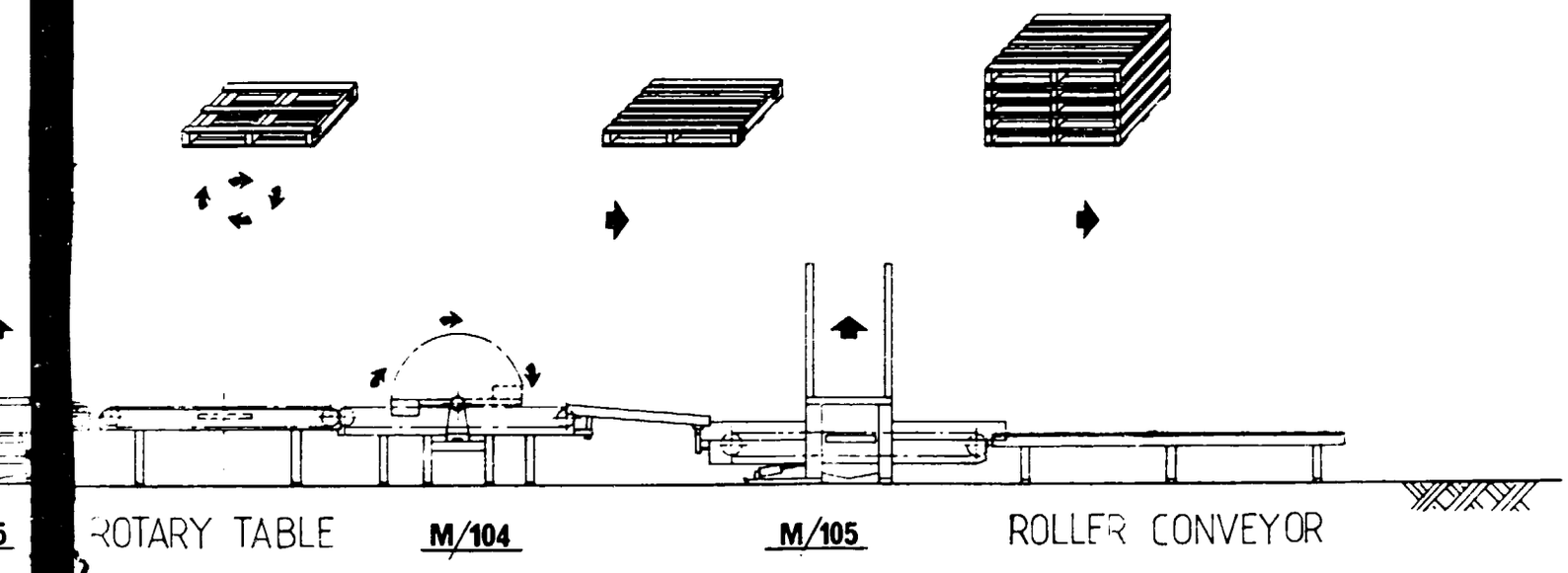


Fig. 15: Automatic stitching line for two-way entry pallets

SECTION 2

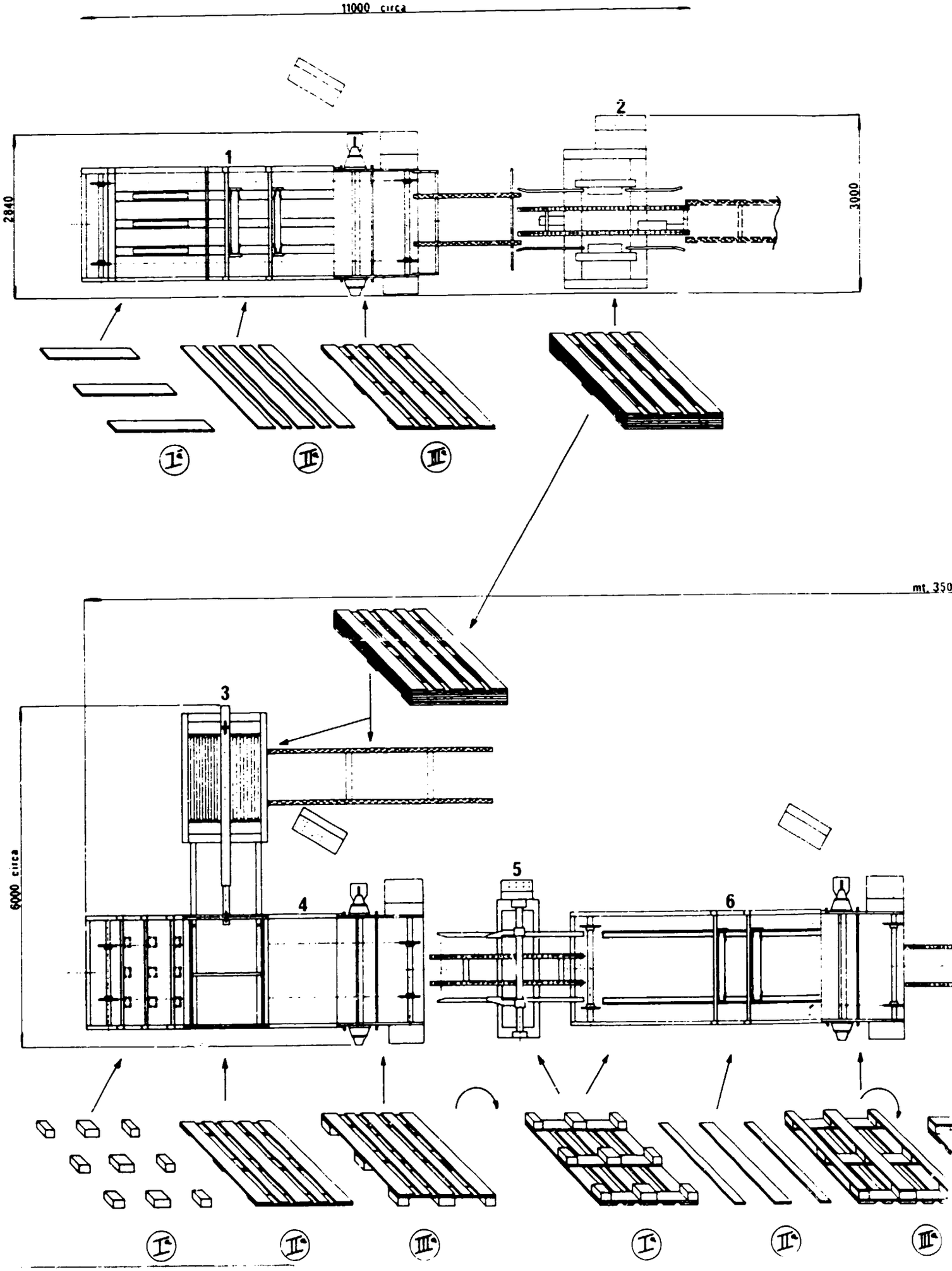


wo-way entry pallets

Pos. 5 - Pallet flip-over mechanism; the pallet top, now stitched to the cubes, is grasped by the flip-over mechanism arm, and placed (upside down) on the conveyor belt that takes it to the next machine.

Pos. 6 - Three-headed stitcher; the operator loads the appropriate laths on to the stitcher line receptacles; the laths are placed on the pallet in arrival from the previous operation; the entire element is then passed under the stitching heads.

Pos. 7, 8, 9, 10, 12 and 13 - Subsequent operations - chamfering, milling, branding and stacking - are all automatic; the scheduled number of fully stitched and finished pallets thus emerges on the roller conveyor at the delivery end of machine, Pos. 10.


11000 circa
2
1
2840
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SECTION 1

Fig. 16
Pallet st
Hourly pr

Position
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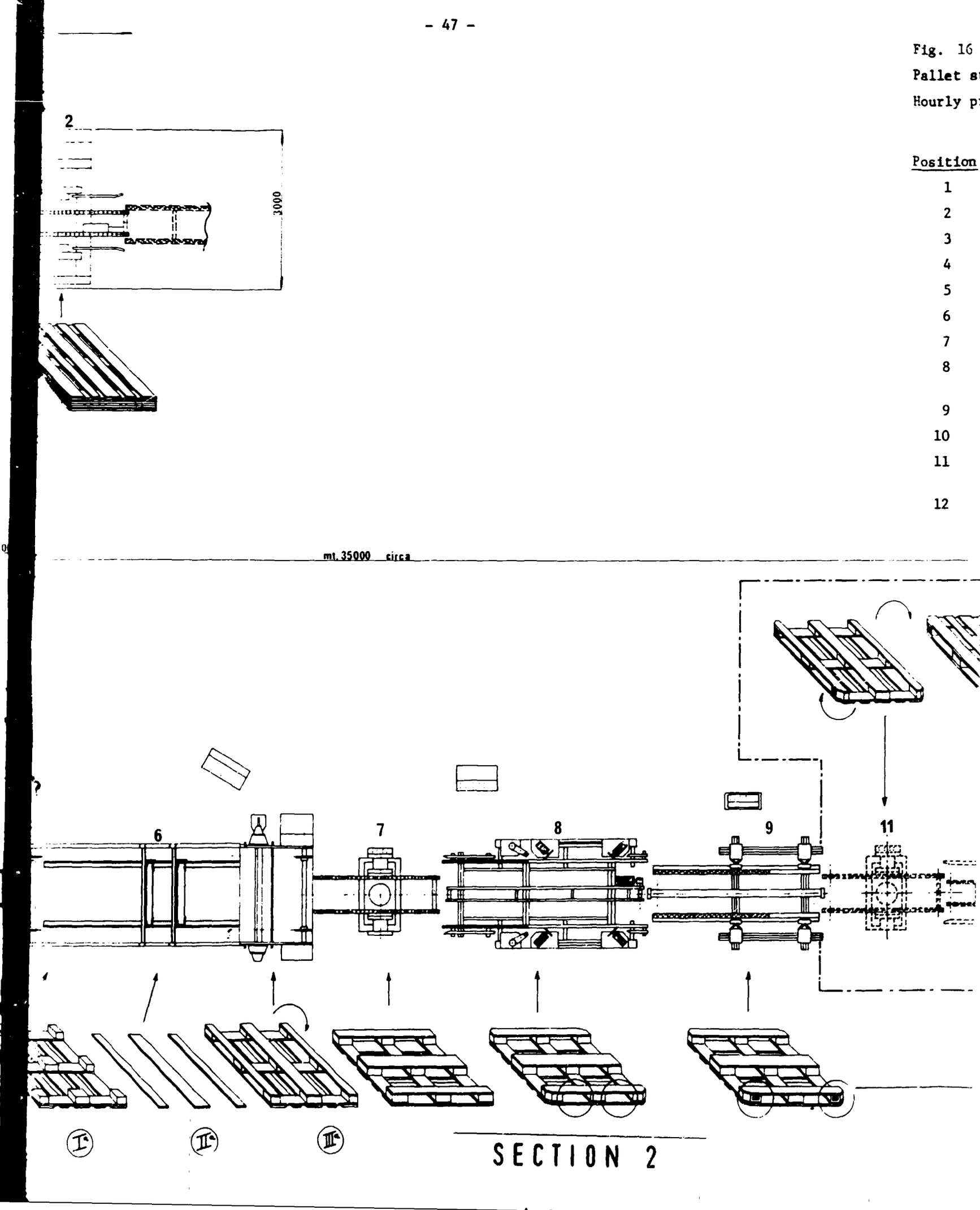

SECTION 2

Fig. 16

Pallet stitching line

Hourly production rate: 160 - 200 four-way entry pallets
250 - 300 two-way entry pallets
(excluding positions 1, 2 and 3)

Position	Quantity	Machine
1	1	M.90 stitcher with 3 x 90/50 heads
2	1	M.156 stacker
3	1	M.111 destacker
4	1	M.90 stitcher with 3 x 90/90 heads
5	1	M.104 pallet flip-over mechanism
6	1	M.90 stitcher with 3 x 90/75 heads
7	1	M.144 rotary table
8	1	M.136-B + M.155 chamfering machine and milling machine
9	1	M.129 branding machine
10	1	M.156-S stacker
11	1	M.144 rotary table (machines for stacking pallets telescopically)
12	1	M.104-S pallet flip-over mechanism