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EUROPEAN PATENT APPLICATION

(21) Application number: 83302230.4

(51) Int. Cl.³: B 42 B 5/10

(22) Date of filing: 19.04.83

(30) Priority: 21.05.82 GB 8214893

(43) Date of publication of application:
30.11.83 Bulletin 83/48

(84) Designated Contracting States:
CH DE FR IT LI

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(54) Improvements in and relating to wire binding machines.

(57) A wire binding machine for closing Wire-O type wire binding elements (10) to bind together a stack (200) of sheets, in which the stack is fed into the front of the machine from a table (210) or a punching machine, and the elements (10) are fed in the form of a strip (52) from an input feed device (80, 82) provided on the right of the machine as seen from the front, the strip (52) being cut into elements (160) and translated to a closing device (188, 190) so that the points (12) of each element are closed downwards into perforations (199) in the stack.

The present invention relates to wire binding machines for closing wire binding elements to bind bundles of sheets. It is particularly applicable to those machines which use binding which are each formed from a length of metal wire bent to form a series of curved hairpin-shaped prongs on which sheets are impaled and which are brought to ring shape by pressing their closed ends or "points" into the vicinity of their open ends or "roots". Such binding elements will be referred to herein as "Wire-O" (Registered Trade Mark) binding elements.

Binding machines of the kind described above will be referred to herein as "machines of the kind set forth".

"Wire-O" binding elements as shown in Figures 5 and 6 of the present application are supplied to machines of the kind set forth from spools in the form of a long continuous "strip" in a so called "open" condition, the end view being as shown in Figure 6. The "strip" is then cut into lengths referred to as "elements" and the "points" shown at 12 in Fig. 5 are formed by a closing device of the machine into the "closed" position so that the end view is approximately circular of a predetermined "diameter" with the "points" formed into the "roots" shown at 14. Wire portions between the roots as shown at 15 will be referred to as "blunts". The distance between the "points" will be referred to as the "pitch" of the strips. The bundles

of sheets to be bound whether in substantially book pad
or like form or variations thereof will be generally
referred to as "bundles" or "stacks".

When Wire "O" binding wire for known binding machines
5 is supplied from a forming machine on a spool, the points
and blunts face inwards to the spool axis and as the strip
comes off the spool, the points are to the right looking at
the outer end of the strip. In the known machines of the
kind set forth this means if the strip is to be fed from
10 the left directly into the input and onto main feed chain
the blunts will be relatively at the back of the machine
and the points at the front. As the wire is moved from
the feed change to the closing jaws, the wire now formed
as an element is rotated 90° so that the points and blunts
15 face forwards towards the operator and the bundle to be bound.
The blunts are now on top. Since it is the points which
have to be inserted into the perforations in the bundle,
the bottom wire forming tool has to press the points of the
wire upwards through the bundle. If the bundle is bound
20 face up this results in the join between points and roots
being at the top or front of the bundle which is unsightly
and not preferred by book and pad makers. To overcome
this problem the bundle has been placed face down on the
book binding table. Whilst this is perfectly satisfactory
25 for pads where the covers are of the same size as the

pages it precludes the binding of oversize covers.

A machine of the kind set forth according to the present invention comprises input feed means arranged to accept binding strip, a feed device arranged to feed
5. the strip from the feed means to a cutting means enabled to cut the strip into binding elements of predetermined length and fed by the feed device, a closing means at a closing station arranged to be fed with the elements, means for translating the elements from the feed device to
10 the closing means, and a bundle feed table on the front of the machine for supporting a bundle at the closing station, wherein the input feed means is provided on the right of the machine as seen from the front of the machine, the elements being translated to the closing means so that the
15 points of each element are above the blunts and the points are closed downwards into the bundle.

The machine of the present invention has the advantage that the points are uppermost in the closing operation thus overcoming the previous disadvantages.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:-

Fig. 1 is a rear view of a binding machine according to the present invention,

Fig. 2 is a front view of an input means of the machine of Fig. 1,

Fig. 3 is a cross-sectional top view of the input means of Fig. 2 taken along B-B,

Fig. 4 is a side view of the input means of Fig. 2 seen from A,

Fig. 5 is a top view of part of a Wire 'O' binding strip for use in the machine of Fig. 1,

Fig. 6 is an end view of the strip of Fig. 5,

Fig. 7 is a side view of translating means, and closing means as seen from A,

Fig. 7A is a side view of an adjustment device for the translating means of Fig. 7,

Fig. 8 is a front view of the input means and spool take off of the machine of Fig. 1,

Fig. 8A is a plan view showing proximity switches forming part of a wire feed device on the right hand side of Fig. 8,

Fig. 9 is a side view from A of the input means and spool take off of Fig. 8,

Fig. 10 is a front view of the closing means of the machine of Fig. 1,

Fig. 11 is a rear view of a feed table of the machine

of Fig. 1,

Fig. 12 is a cross section taken on C-C of Fig. 11 showing table elevating arrangements,

Fig. 13 is a perspective view of an oversize cover
5 gauging device on the table of Fig. 12, and

Fig. 14 is a partial end view of the machine of Fig. 1 seen from X showing the closing means operating mechanism and conveyor drives.

In the example of the machine shown in the drawings
10 as shown in Figure 1 which shows the rear of the machine the frame 1 supports sub frames 4, 6 and 8 which extend from front to rear. The section 20 of the machine outside frame 4 will be referred to as the input feed section; section 22 between frames 4 and 6 will be referred to as the
15 main feed section; section 24 between frames 6 and 8 will be referred to as the binding section; and section 26 outside frame 8 on the end of the machine as seen from X will be referred to as the mechanism section.

In the feed section which is on the right of machine
20 as seen from the front is a spool frame 30 on which are four rollers 32, 34, 36 and 38. (not shown). Rollers 36 and 34 have a rubber roller 35 of coarse textured rubber between them (See Figure 9). The
rubber roller acts to strip a paper web 42 from between
25 layers of binding wire strip on the spool 40. The web 42 feeds over the rubber roller under the spool and is ejected

down a chute 44 (see Fig..9) to the rear of the machine.

Rollers 36 and 34 are driven by a belt 46 through a gear box 48 and by a motor 50. The motor drive is controlled via a clutch device so as to rotate the spool 5 when receiving a signal from one of the proximity switches (300 and 301). The other switches the machine off if the wire tangles on the spool or becomes jammed in the main feed.

Before describing these arrangements it will be appreciated that the machine is arranged to handle twelve or more different sizes of binding wire, these are in one machine:-

	<u>Diameter</u>	<u>Pitch</u>
	1 inch (25.4 mm)	2 to 1 inch (25.4 mm)
15	3/4 inch (19 mm)	2 to 1 inch (25.4 mm)
	5/8 inch (16 mm)	2 to 1 inch (25.4 mm)
	9/16 inch (14 mm)	3 to 1 inch (25.4 mm)
	1/2 inch (12.7 mm)	3 to 1 inch (25.4 mm)
	7/16 inch (11 mm)	3 to 1 inch (25.4 mm)
20	3/8 inch (9.5 mm)	3 to 1 inch (25.4 mm)
	5/16 inch (8 mm)	3 to 1 inch (25.4 mm)
	1/4 inch (6.4 mm)	3 to 1 inch (25.4 mm)
	3/16 inch (4.7 mm)	3 to 1 inch (25.4 mm)
	1/4 inch (6.4 mm)	4 to 1 inch (25.4 mm)
25	3/16 inch (4.7 mm)	4 to 1 inch (25.4 mm)

The diameter has already been referred to as the "closed" diameter and the pitch is the distance between adjacent "points" 12 (see Figs. 5 and 6). Pitch will be referred to as 2:1, 3:1 and 4:1 hereafter, omitting the linear units. Diameter will be referred to hereafter using the above fractions of an inch without the units.

When using a selected diameter Wire-0 strip, this strip shown at 52 comes off the spool onto a pivotally mounted horizontal tray 54 pivoted on to the end cover 302: after passing over the tray the slack in the strip is controlled by proximity switches 300 and 301 which sense the angle deflection of the wire feed tray 54.

In the event of failure of supply of Wire-0 from the spool the feed tray will deflect to its maximum limit triggering the appropriate proximity sensor resulting in the machine being switched off automatically.

After passing over the tray 54 the strip is then fed to one of two feed sprocket wheels 80, 82 one being for 2:1 and 4:1 pitch and the other for 3:1 pitch (see Fig. 3) the sprocket wheels 80 or 82 are aligned with a main feed chain shown in Fig. 3 as a broken line 84 extending from the feed section 22 through binding section 24 to mechanism section 26.

Sprocket wheels 80 and 82 are mounted with their axis 86 in brackets 88 and 90 which are pivotally mounted on shaft 92 which carries an idling main drive sprocket wheel 94 and belt drive pulley wheel 96, wheels 94 and 96 are both fixed to shaft
5 92 so that when the main drive conveyor chain 84 is driven wheel 96 drives a wheel 98 through belt 100 and wheel 98 fixed to shaft 102 drives wheels 80 and 82.

Brackets 88 and 90 are held in an upper position (Fig. 2) by means of a spring loaded plunger 104 mounted on
10 bracket 106 bolted to frame 4, the plunger engaging in a hole 108 in bracket 90. Also on bracket 90 is a knob 110 on shaft 112 which within hollow shaft 102 has a pin 114 which engages with block 116 on which wheels 80 and 82 are mounted.

To shift wheel 80 into alignment with drive chain 84,
15 plunger 104 is pulled, brackets 88 and 90 drops disengaging wheel 82 from the binding wire strip now indicated at 120, knob 110 is pulled moving wheel 80 into alignment with chain 84. The brackets are then pushed upwards engaging wheel 80 with the strip 120 and the plunger 104 is re-engaged
20 to hold brackets up.

It will be appreciated that the drive arrangements to the wheels 80 and 82 are so arranged that the same linear feed speed is maintained between the chain 84 and wheels 80 and 82 which form a part of an input feed means.

Located above the sprocket 82 (see Fig. 4) or alternatively above sprocket 80 whichever is aligned with chain 84 is a "V" shaped guide 122 whose sloping sides 124 and 126 act to guide the blunts 15 and points 12 of the strip 120 respectively, the points being to the rear of the machine. A central guide fillet 128 at the apex of sides 124 and 126 acts to press the connecting portions 10 of the strip (see Figs. 5 and 6) onto wheels 80, 82 and thereafter the strip onto the main drive chain 84. The guide 122 can also be formed as in our copending British Patent Application No. 8111808 filed 14th April 1981, the contents of which are incorporated herein by reference.

The drive chain 84 forming a part of a feed device feeds strip 120 from the input feed means to a cutting means 130 not shown in detail but located in the frame 6 between sections 22 and 24. The drive chain 84 is a link chain forming a main conveyor which has a plurality of strip engaging members formed as plastics cruciform notched chain inserts which are shown in detail with the chain in our co-pending British Patent Application No. 8111808 filed 14th April 1981. The form of the notches allows for differently pitched strip to be firmly engaged whatever the pitch.

The cutting means 130 is a knife and anvil, the knife being adjustable from top of the machine to ensure

that it chops the strip on a blunt portion, adjustment being necessary when the diameter is changed.

The chain 84 extends through section 24 to a chain drive unit 132 mounted in section 26 on frame 8, the
5 unit 132 includes a high capacity main chain drive 1.8° stepper motor 134 driving through a belt 135 a drive sprocket wheel 136 (see Fig. 14).

Running parallel to chain 84 is a skip conveyor chain 140 similarly provided with notched chain inserts
10 whose upper conveying surface is level with the upper conveying surface of chain 84. Chain 140 extends across section 24 and between an idling sprocket wheel 142 (Fig. 1) and a drive sprocket wheel 144 (Fig. 14) driven through a belt 145 by a single 1.8° stepper motor 146 of smaller
15 capacity than motor 134 in unit 132. Motor 146 is of a smaller capacity because chain 140 is shorter than chain 84. The skip conveyor function will be described hereafter.

Adjacent frame 6 is a stepper motor control module
20 (not shown) which controls the predetermined indexing of the stepper motors according to a programme selected on a control panel mounted on the right hand end as seen from the rear (not shown). The cutter and the transfer of wire from chain 84 to chain 140 by a pusher mechanism
25 forming part of a translating means are controlled entirely by the stepper motor control module.

To the rear of the main chain in section 24 and extending from side to side of the section is the pusher mechanism comprising a pusher bar 150 (see Figs. 1 and 7) mounted adjustably on a block 152, the
5 adjustment being relative the block and from front to rear. Adjustment between block and bar is by means of a slot 151 in block 152, lock knobs 154 and fine adjustment screws 310 one each of which is shown in Fig. 7A. The bar 150 has an element pushing surface
10 156 which engages against the points side of a binding element one of which is shown at 160 which has been cut from strip 120. Mounted on pusher bar 150 is a packer member 156 (changed for each wire diameter) from which extends an acrylic adjustable guide plate
15 166 held on by handwheels 168 so that the guide is just clear of the top of an element 160 as it sits on the chain 84. Depending on the wire diameter this guide 166 is adjusted up or down relative chain 84 by providing a packer 156 of a differing height.

20 The pusher bar 150 and mounting block 152 are mounted on piston mountings of a pair of rodless magnetic cylinders 174, one at each end coupled to frame 6 and frame 8. These pneumatic cylinders have 3 magnetic reed switches to enable the pusher assembly to
25 be moved between three positions: namely, a first

position D as shown in Fig. 7 with pusher assembly retracted, a second position E, with pusher assembly moved halfway forward (used when using skip binding facility) and a third position F when pusher assembly is fully forward. In the first position the pusher bar rests against binding elements 160 on the main chain. In the second position the pusher bar moves the element 160 onto the skip chain. In the third position the pusher bar moves the element 160 to a transfer bar 180.

Transfer bar 180 is pivotally mounted on a shaft 181 and movable from the horizontal position shown in Fig. 7 to an upper vertical position where it can hold an element 160 between upper and lower closing jaws 188 and 190. On the upper surface of transfer bar 180 relative its horizontal position is a plastics carrier member 182 retained onto the bar 180 by a dovetail recess in the bar and a dovetail locating plate 184. The member 182 is formed with groups of about five teeth 185 extending up from the bar 180 to about the same level as the top of the chain notched inserts and between each group a higher tooth 186 about twice the height of group teeth 185 is provided. These higher teeth 185 act as book stops in a similar way to the book stops described in our copending British Patent

Application No. 8111828 filed 14th April 1981. The member 182 however holds the elements 160 by the resilience of its material suitably high density polythene. The member 182 must be changed for each
5 pitch and diameter used in the machine since the lateral distance between teeth 185 is relative the pitch and the book stop higher teeth 185 have a height depended on element diameter.

Pivotal control of the transfer bar 180 is by means
10 of a pneumatic actuator (not shown) connected to shaft 182. The pusher bar mechanism and transfer bar arrangement form parts of translating means for translating the elements either singly or in plurality from the feed device conveyor to the closing means of which
15 the closing jaws are a part.

The closing jaws 188 and 190 are separately movable but when closing they hold, then form the wire element into perforations 199 in a bundle 200 on a feed table 210, only the top jaw 188 moving. Top
20 jaw or tool 188 is mounted in a top tool holder 192 and can be removed therefrom by unscrewing retaining screws 194 (see Fig. 10). The lower surface of jaw 188 is curved to the diameter of the element and projections 196 locating between the wire points extend from the
25 curved surface a distance corresponding to the wire gauge. The separation of projections 196 is dependent

on wire pitch, for this reason if pitch or diameter of wire is to be changed the top tool must be changed.

The bottom tool 190 is mounted in a bottom tool holder 198 to which it is retained by further retaining
5 screws 194. This tool also has a curve forming surface to the diameter of the element and projections 196 locating between the wire points extend from the curved surface a distance corresponding to the wire gauge. The separations of projections 196 is dependent on wire pitch,
10 for this reason if pitch or diameter of wire is to be changed, the bottom tool must also be changed.

Bottom tool 190 is adjustable for height by means of a pair of screw jacks drivable via worm wheels 204 and worms 206 from a motor 208 controlled from the
15 control panel.

The top tool 188 is movable by means of a cylinder 228 through a pair of adjustable turnbuckles 216 attached to top tool holder 192 and to a rocker arm 218 on one side and an arm 222 on the other side (see Fig. 10).
20 Rocker arm 218 and arm 222 are linked by a rod 224, a piston rod 226 connecting arm 218 to a piston (not shown) in cylinder 228. Cylinder 228 is pneumatically operated and has a magnetized piston (not shown). Reed switches 230 and 232 are mounted on screws 234 and 236 each driven
25 by a respective motor 238 and 240. The stroke of the piston is adjusted between 3 positions, that is firstly

piston down-upper tool fully up, secondly upper tool partially down - binding element held between jaws, and thirdly upper tool down - jaws closed. The second and third positions are those which have to be adjusted
5 for different wire diameter and these positions are controlled by location of the reed switches 230 and 232 respectively relative to the cylinder. To change the second and third positions the motors 238 and 240 are switched on and the reed switches moved to a new
10 predetermined position as more particularly described in coterminous Patent Application No.

(claiming priority from British Patent Application No. 8214894 of 21st May 1982) incorporated herein by reference.

15 In order to ensure the bundle to be bound is in the correct position for binding relative a particular diameter of binding element, the table 210 is adjustable for height. The table has a projecting rear lip 250 the rear upper edge of which must be level with the
20 blunt portions of the wire elements. The gap between lip 250 and bottom tool 190 is taken up by a filler plate 315 (see Fig. 7).

To adjust the table a simple elevating device is shown in Figs. 11 and 12 comprising a knob 252 accessible
25 from the side of the machine, a pair of cams 254 mounted on shaft 256 supporting two buttons 311 fixed

to the underside of the table. The front of the table has two brackets 312 with half round slots supported on two pivot bars 262 attached to frames 6 and 8. The buttons 311 are always in contact with cams 254. By
5 turning handwheel 252 clockwise the table can be raised to required height. The handwheel can be rotated clockwise only. This is achieved by a freewheel assembly 314 mounted on cam shaft 256 and attached to frame 8. The table assembly 210, 270, 272 can be
10 easily removed off the machine by simply lifting it up and off the pivot bars 262. This is necessary when the machine is linked to an autofeed system for pre-punched stock.

On top of the table 210 is a lay gauge 270 with an
15 adjustable guide fence 272, the gauge being locatable in any one of a number of positions on the table. The gauge is used for aligning bundles. Also on the top of the table is a pneumatic detector 274 which detects the presence or lack of presence of a bundle on the table and
20 with a suitable interlock circuit prevents a further element being presented to the closing jaws before the bound bundle or book is withdrawn from the table. The pneumatic detector can be replaced by an electronic or other suitable detector.

25 The control interlocks and sequencing arrangements

for the machine are obtained by means of latching and de-latching electrical relays, controlled by cascaded electrical limit switches.

Adjustment for different wire diameters and
 5 pitches is described more particularly in co-pending Application No. (claiming priority from British Patent Application No. 8214895 filed 21st May 1982) incorporated herein by reference.

Arrangements for skip binding are described more
 10 particularly in co-pending Application No. (claiming priority from British Patent Application No. 8214896 filed 21st May 1982) incorporated herein by reference.

The provision of right to left feed of the binding
 15 wire ensures that the points are to the rear of the machine prior to location between the jaws. This ensures that the points are pressed downwards into the bundle so that when bundles are fed front uppermost onto the table the junction between points and roots
 20 is at the back of the bundle which is most desirable for a clean binding appearance. Previously bundles had to be placed from downwards on the table. The closing of points downwardly ensures that oversize covers can be bound, the back cover being placed on the
 25 front cover and swung to the back after completion of

binding. The oversize cover can be oversize on all sides except the binding side, that is on three sides.

For oversize binding a special lay gauge 602 shown in Fig. 13 is provided. This has a vertical locating face 606 for locating a pair of oversize covers 608 placed on the lower side of stack 200. A stop arm 610 comprising a weighting bar 612 and fin 613 is pivotted to body 604 by pin 616. Fin 613 has its gauging face 614 engaging with stack 200, which face is parallel to face 606. The distance between the parallel faces 606 and 614 governs the amount of oversize overlap and this is adjusted by means of a screw 618 which joins with pin 616.

In order to make the machine of the invention more flexible it is possible to remove the table 210 and attach to the machine a bulk automatic punching machine arranged to interface with the present binding machine. The punching machine punches the bundles and feeds these directly to the closing jaws 188, 190, the control system of the punching machine being coupled to the controller of the binding machine. After the closing operation and when the jaws open a conveyor shown at 380 in Fig. 14 mounted to the rear of the closing jaws is moved over the transfer bar 180 to receive a bound bundle. The conveyor 380 is kept running as it moves into the binding station so that it engages with the bound bundle and moves this directly to the rear of the binding machine. The conveyor 380 is linearly driven by a linear drive motor (not shown) which operates similarly to the motor for the closing tools.

CLAIMS:

1. A wire binding machine for closing wire binding elements (10) to bind together a plurality of sheets (200) forming a stack into books, pads, calendars or the like, the sheets being perforated, the elements formed from a predetermined length (160) of a strip (52) of wire preformed to have a series of "points" (12) of narrow width adapted to be inserted in the perforations and joined by root portions (15) of the wire of a normally wider width than the "points" so as to form "blunts", the machine comprising input feed means (80, 82) arranged to accept a said binding strip, a feed device (84) arranged to feed the strip from the feed means to a cutting means (130) enabled to cut the strip into binding elements of predetermined length and fed by the feed means, a closing means (188, 190) at a closing station arranged to be fed with the elements, means (150, 180) for translating the elements from the feed device to the closing means and a stack feed table (210) on the front of the machine for supporting a stack (200) at the closing station. characterised in that the input feed means (80, 82) is provided on the right of the machine as seen from the front of the machine, the elements being translated to the closing means so that the "points" (12) of each

element are above the "blunts" (15) and the "points" are closed downwards into the stack perforations (199).

2. A machine as claimed in Claim 1 wherein the strip (52) of wire is rolled on a drum (40), the machine
5 comprising a drum receiving (32-38) and driving means (34, 36, 50) the driving means being controlled by a feed sensor (54) adjacent the input feed means (80, 82).

3. A machine as claimed in Claim 2 wherein the strip (52) of wire is rolled on a drum (40) with a strip of
10 material (42) such as paper for separating layers of the strip on the drum, the machine comprising a strip separator (35) between the drum receiving means (34, 36) and the input feed means (80, 82).

4. A machine as claimed in Claim 2 or 3 wherein the
15 receiving means (32-38) comprises at least a pair of rotatable drum flange engaging surfaces.

5. A machine as claimed in Claim 3 wherein the strip separator (35) comprises a roller having thereon a coarse textured resilient material.

20 6. A machine as claimed in Claim 5 wherein the roller (35) is coaxial with a pair (34, 36) of rotatable drum flange engaging surfaces formed between at least two outer flanged means adapted to prevent extreme drum axial movement.

25 7. A machine as claimed in Claim 2 wherein the feed sensor (54) comprises a pivotal strip engaging device

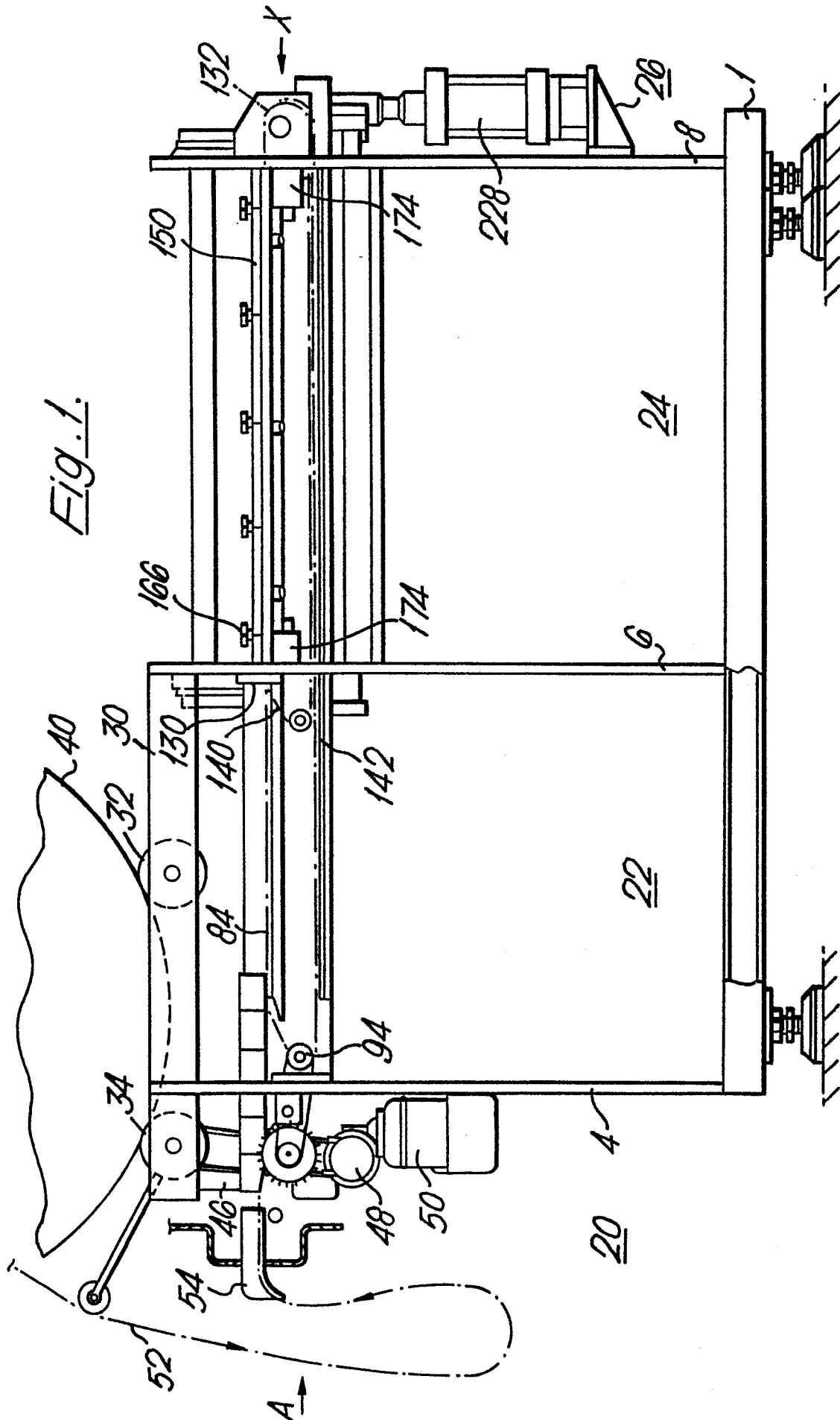
adapted to pivot from a loaded position to a non-loaded position, at least one detector (300, 301) arranged to detect the change of angular position of the engaging device, the detector or detectors arranged to control the driving means (50) to feed the strip in a relatively
5 untensioned state to the input feed means.

8. A machine as claimed in Claim 7 wherein a second detector (301) is arranged to detect a change of angular position of the engaging device beyond a normal
10 feed position and so connected to the driving arrangements of the whole machine such that overtensioning of the strip will halt the whole machine.

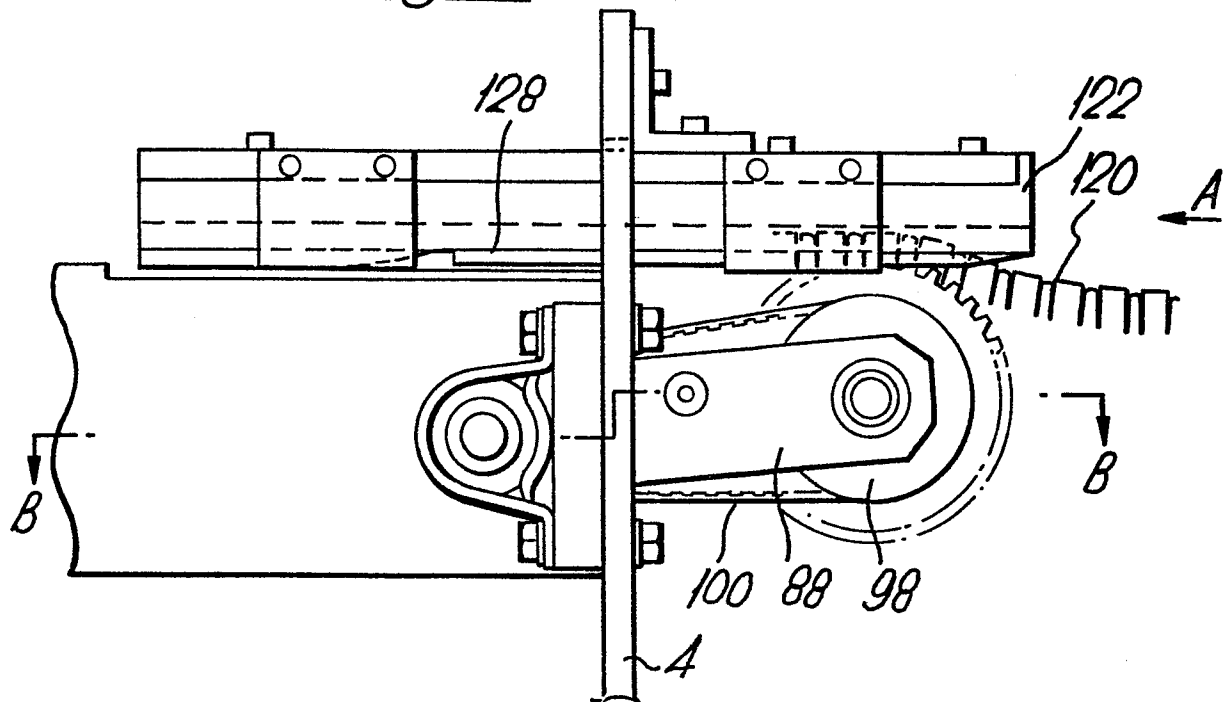
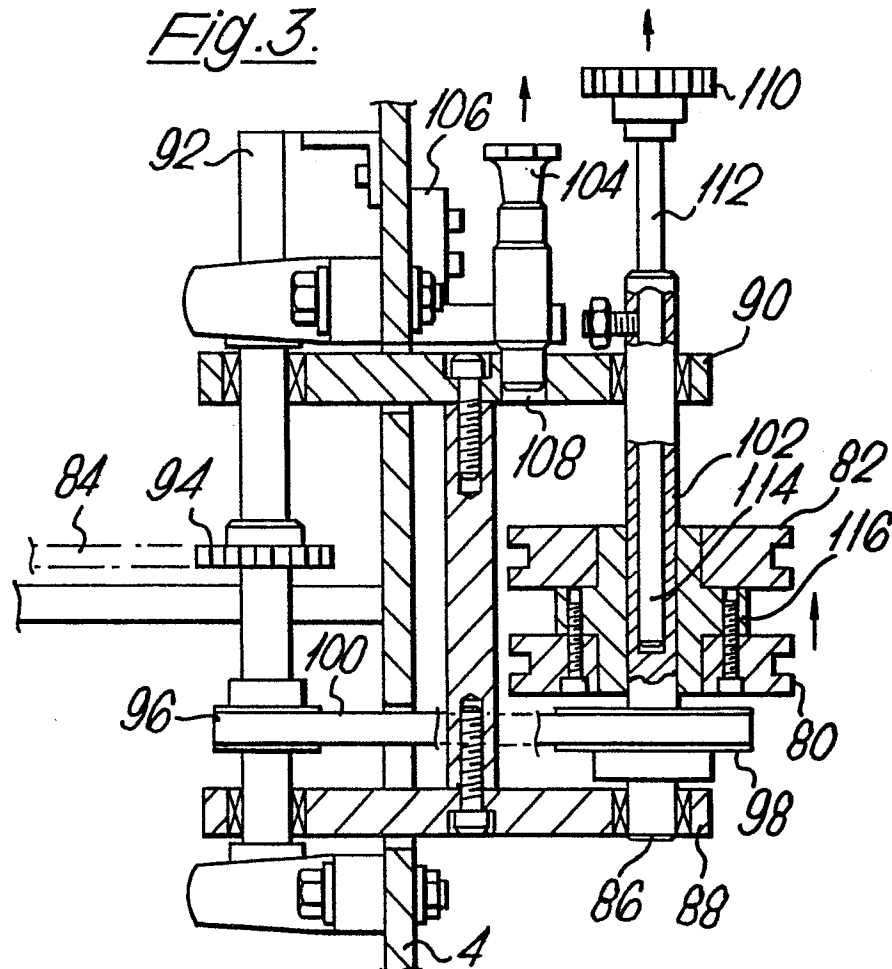
9. A machine as claimed in any one of Claims 1 to 8 wherein the input feed means (80, 82) comprises a toothed
15 strip engaging wheel or wheels, and wherein the feed device comprises one or more chain conveyors (84, 140) having teeth engaging the strip, the conveyor being drivably connected to the strip engaging wheel or wheels (80, 82).

20 10. A machine as claimed in any one of Claims 1 to 9 wherein the translating means (150, 180) comprises at least a pusher mechanism (150) movable from a position D to the rear of the feed device to a position F to the front of the feed device, to push a binding element
25 (160) towards the closing means (188, 190).

11. A machine as claimed in Claim 10 wherein the
translating means further comprises a transfer bar
(180) arranged to swing a pushed element (160) from
the forward position F in front of the feed device (84)
5 to a position between two jaws (188, 190) of the
closing means.



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Fig. 2.*Fig. 3.*

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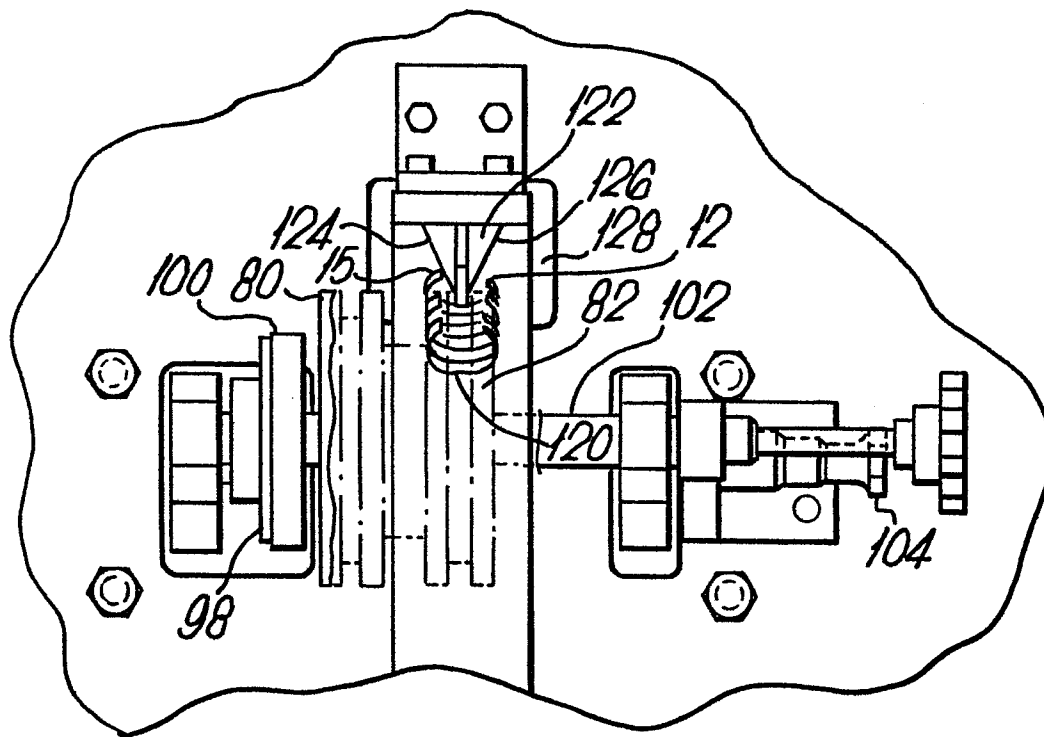
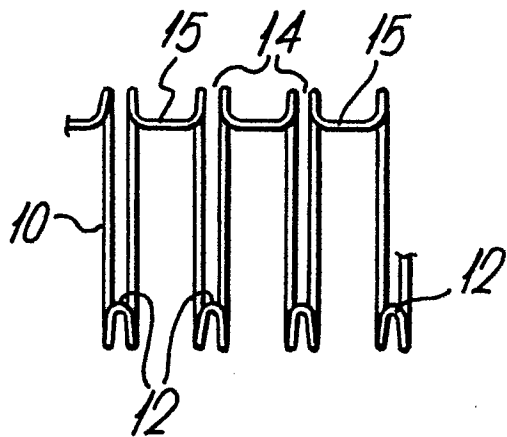
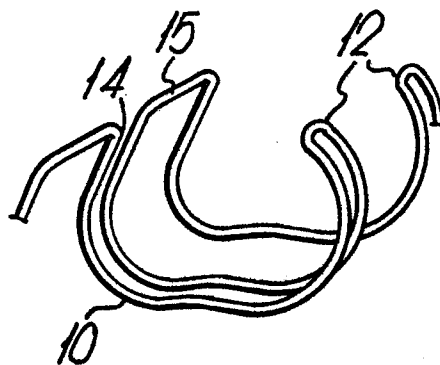
Fig. 4.Fig. 5.Fig. 6.

Fig. 7A.

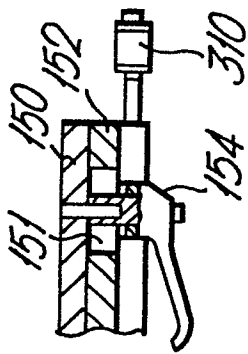
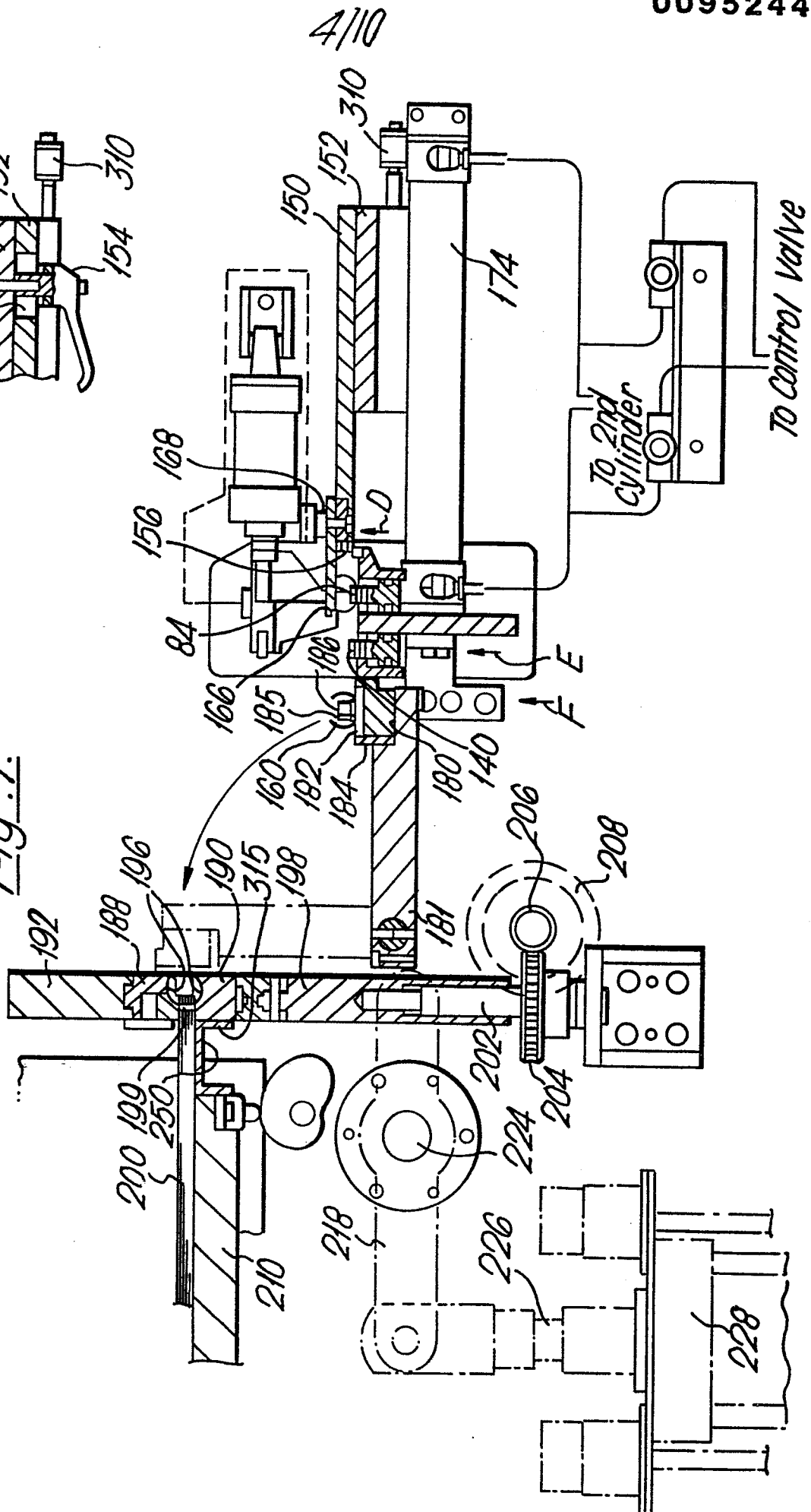
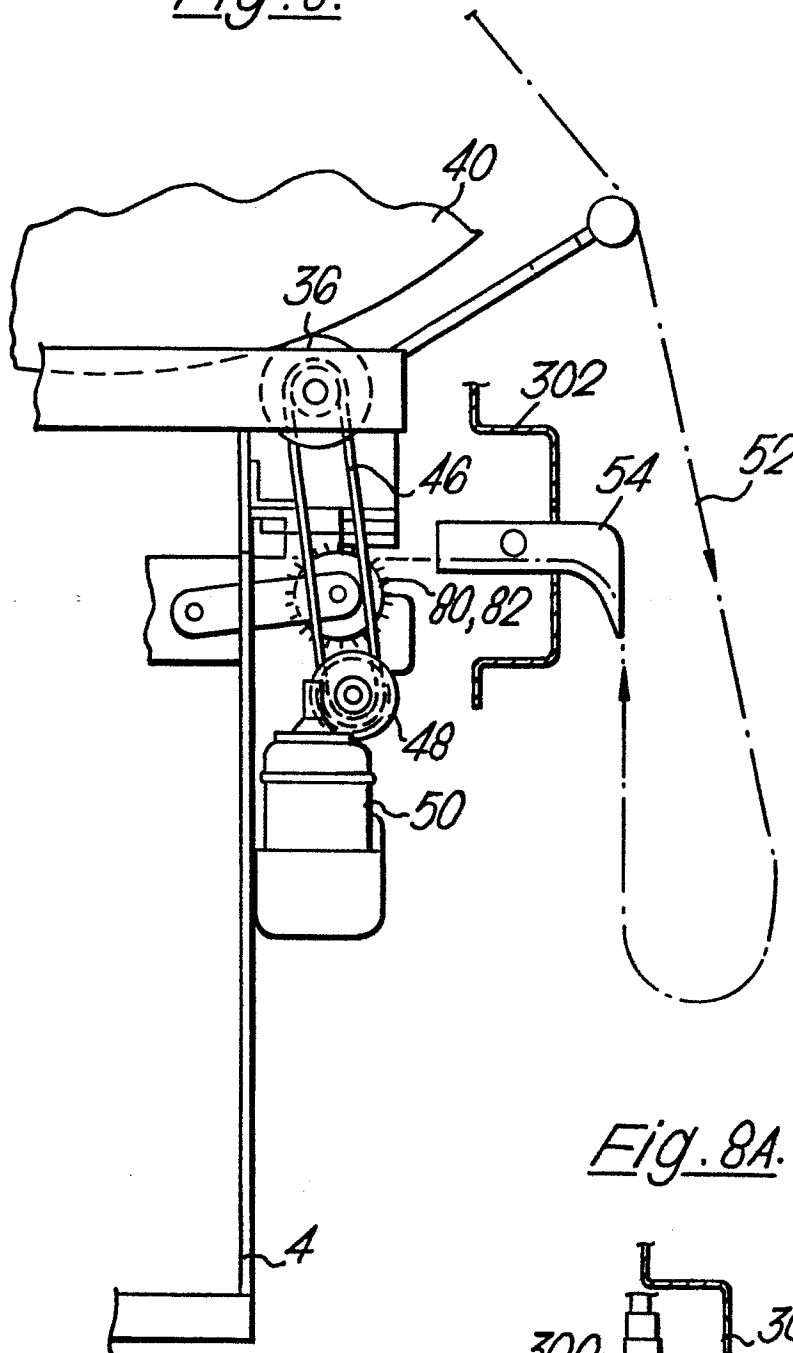
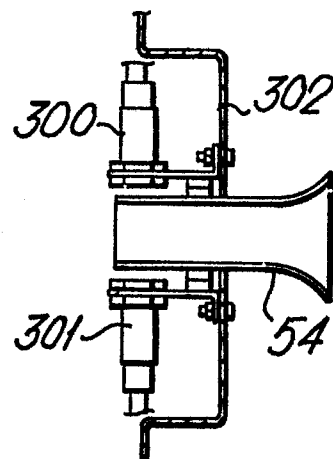


Fig. 7.

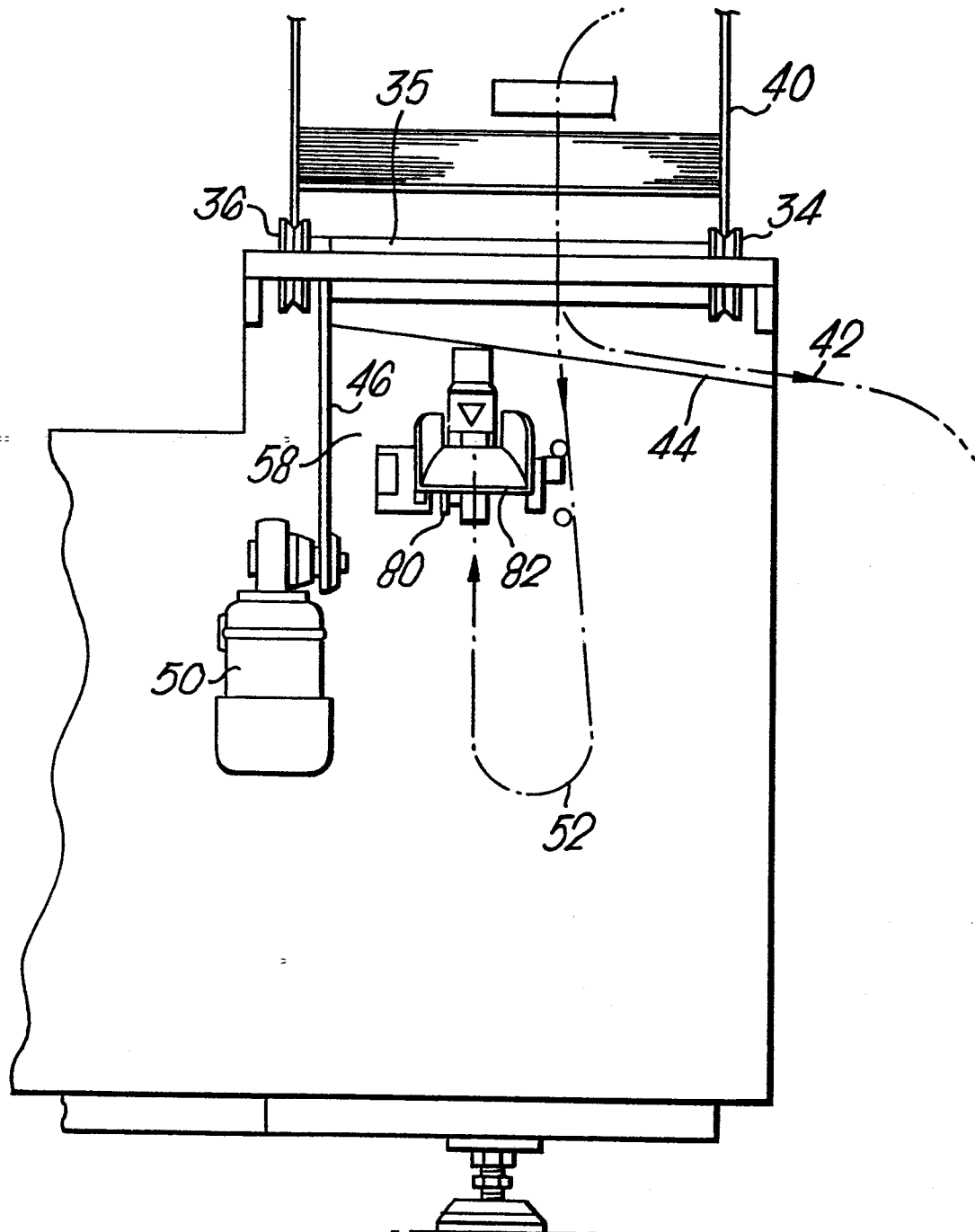


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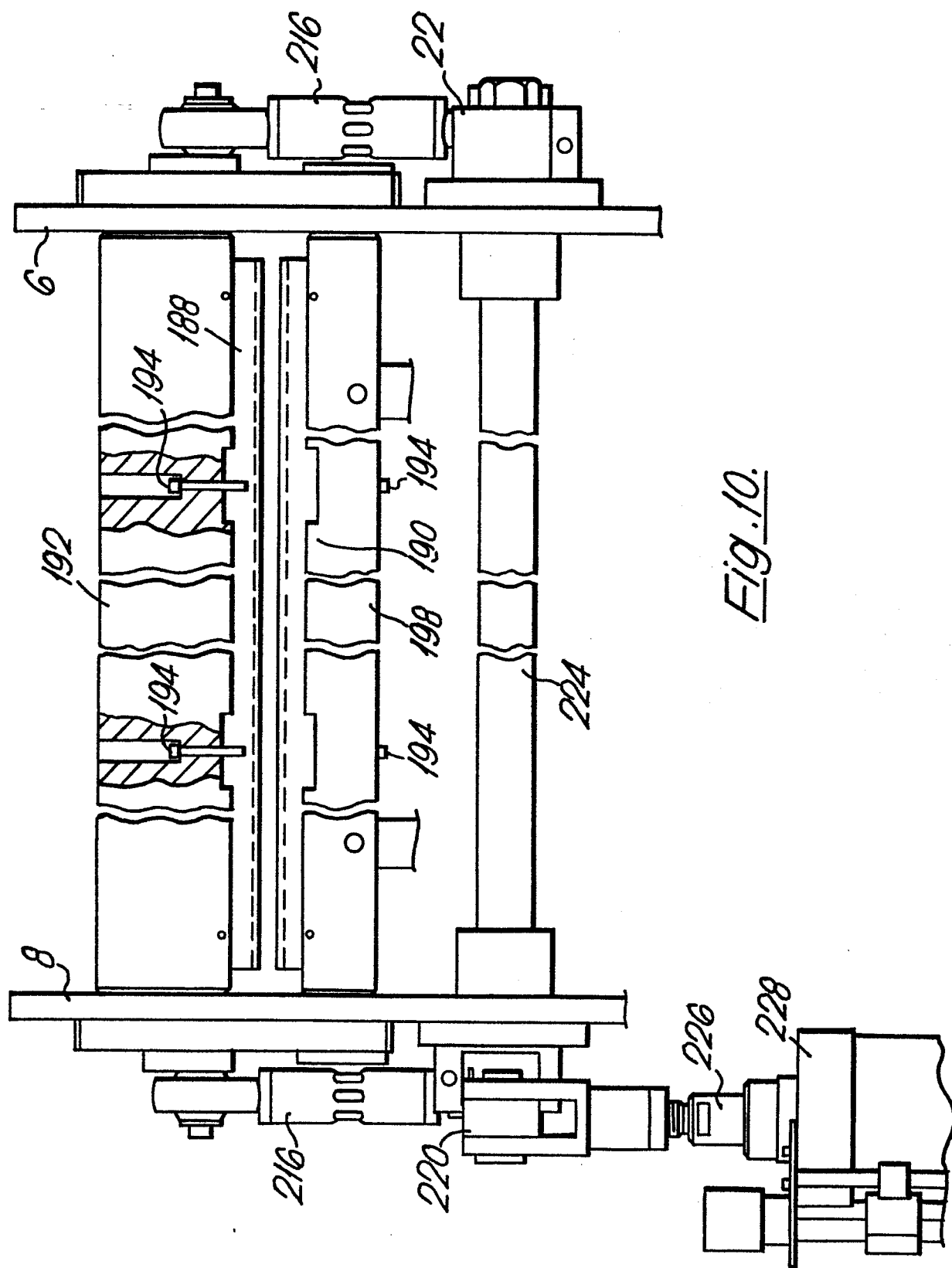
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Fig. 8.Fig. 8A.

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Fig. 9.

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*Fig. 10.*

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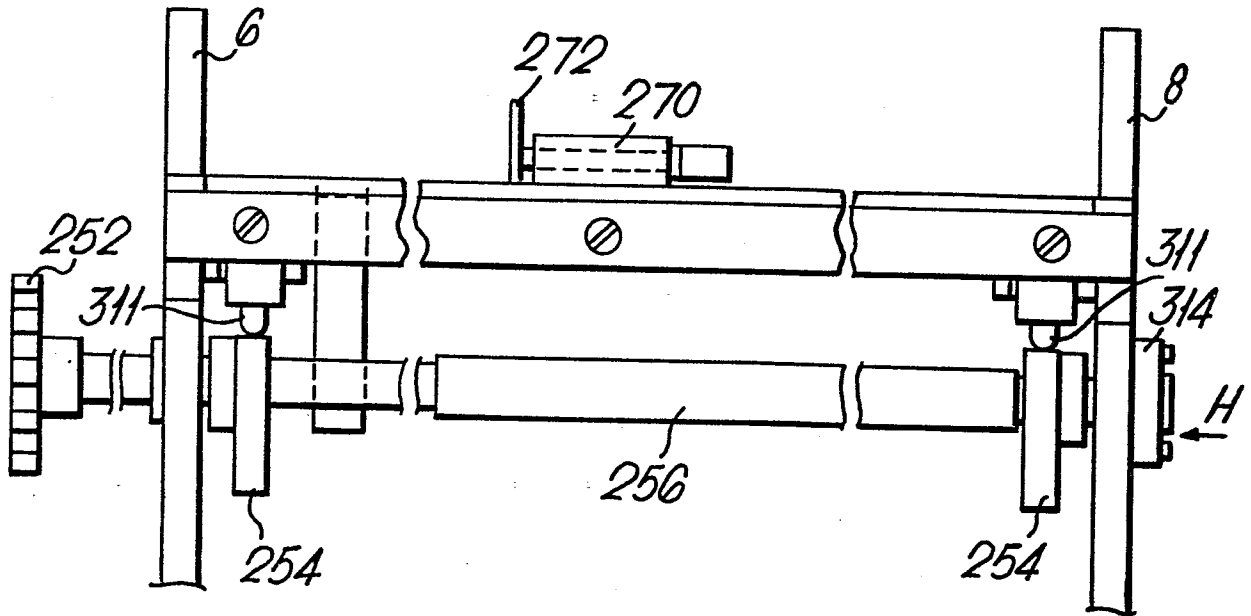
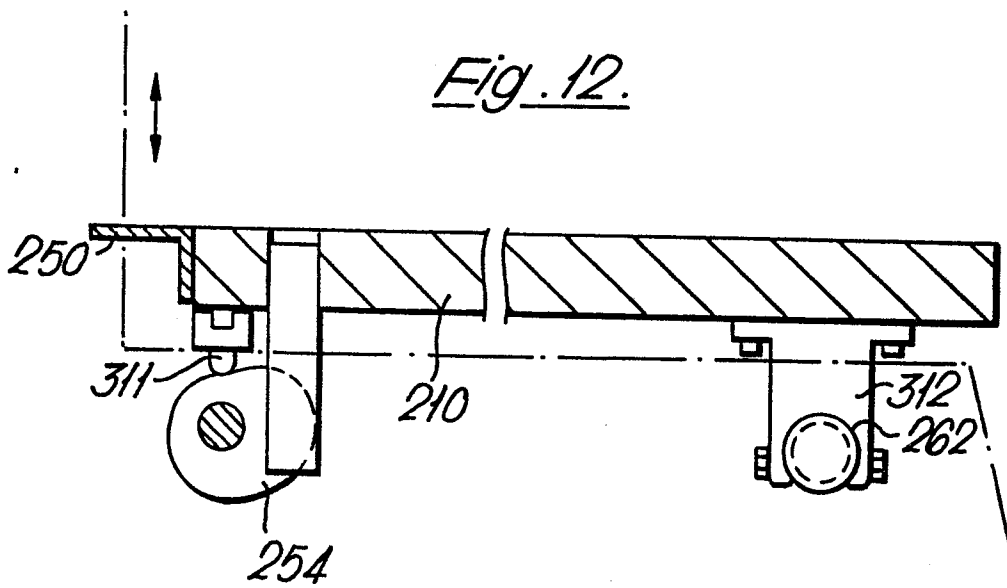
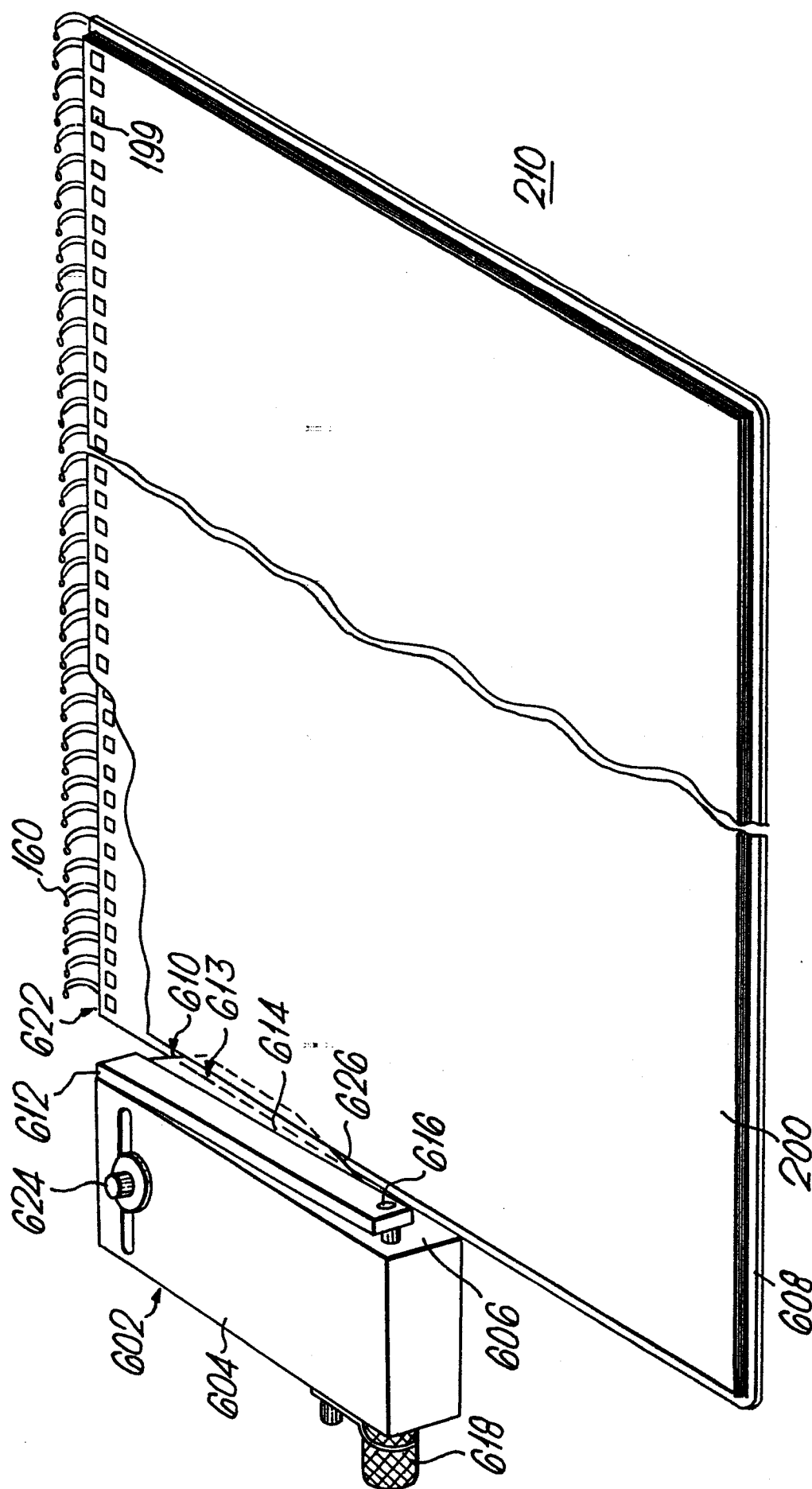
Fig. 11.Fig. 12.

Fig. 13.

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Fig. 14.