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(54) Wire processing system.

(57) A wire processing system, comprises:

a) structure to advance a wire of selected cross-section generally endwise toward a primary station, the wire having a forward portion;

b) a wire deformer at the primary station to form at least one bend in the advancing wire;

c) a clamp at the primary station to clamp the forward portion of the wire that has passed the deformer;

d) a cutter to sever the wire after a selected length of wire has advanced past the cutter, whereby a wire section of predetermined length is formed;

e) and conveyor apparatus operable to grip the formed wire section and the convey that section along a generally longitudinally extending travel path away from the primary station after the clamp releases the wire, and with at least one end of the formed wire section presented laterally for processing, as for example insulation stripping and attachment of terminals to stripped wire ends. Wire sections of the same or different bend configuration may be controllably spaced on and by the conveyor apparatus.

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WIRE PROCESSING SYSTEM

This invention relates generally to the processing of wire, and more particularly to automated apparatus, and method, to automatically select wires of different diameters materials, colours, insulation types and thickness, and other characteristics to process same into wire sections of selected lengths, and to process the ends of such wire sections as by stripping off insulations, applying terminals to metallic wire ends, etc.

There is need for fully automated apparatus and processing method, to selectively process wires of different diameters as by de-reeling same, and then sequentially process sections of such different diameter wires. For example it is desirable that different diameter wires be sequentially cut into sections of different lengths, so that wire harnesses can be easily assembled, the harnesses made up of different length wires of different diameters of size. Also, different terminations of such different wire sections are desirable. I am not aware of prior apparatus capable of meeting these needs in the manner of the present invention which provides new and unusual combinations of structure, functions and improved results, as will be seen.

It is a major object of the invention to provide apparatus, method and system meeting the above needs. Basically, the apparatus of the invention comprises:

a) first means to advance a wire generally endwise toward a primary station, the wire having a forward portion;

b) wire deforming means at the primary station to form at least one bend in the advancing wire;

c) clamp means at the primary station to clamp the forward portion of the wire that has passed the deforming means;

d) cutter means to sever the wire after a selected length of wire has advanced past the cutter means, whereby a wire section of predetermined length is formed,

e) and conveyor means operable to grip the formed wire section and to convey that section along a generally longitudinally extending travel path away from the primary station after the clamp means releases the wire, and with at least one end of the formed wire section presented laterally for processing thereof.

Typically, the wire deforming means includes a first deforming element, and includes apparatus at the primary station mounting the first deforming element for movement out of the path of wire travel by the conveyor means. Such apparatus may comprise a rotor having two of said first deforming

elements thereon, the rotor rotatable in 180° increments to bring the first deforming elements alternately into position to bend the advancing wire. Also, the wire deforming means may include a second deforming element, and a carrier for that second element movable to bring the second element into proximity to said first element to effect bending of the advancing wire, and to carry the second element away from the wire during initial conveying of the wire section by the conveyor means.

It is a further object of the invention to provide a de-reeling means in the form of a selection frame having carriers for multiple wires, and means to selectively displace the frame relative to said wire advancing means to bring a selected wire into position for feeding of a selected wire by said wire advancing means.

It is a still further object of the invention to deform the wire into one of several selectable shapes, including S-shape, U-shape, and a succession of U-shapes, with the aid of the rotor and deforming elements as referred to. A yet further object of the invention is to provide the conveyor means with a primary pair of endless conveyors and means to effect endless travel of the conveyors and also crawl displacement of primary conveyors to grip the wire length and convey it along the longitudinal paths of the conveyors undergoing such endless travel. A secondary pair of endless conveyors may also be provided to receive the wire lengths from said primary pairs of conveyors, for transfer to a tertiary pair of endless conveyors, the conveyors travelling at different rates to controllably space the received wire lengths.

The invention is also applicable to other flexible cords or cord-like devices such as optical fibres, plastic tubings etc./

These and other objects and advantages will become apparent from the following description, by way of example, of a preferred embodiment of the invention. Reference is made to the accompanying drawings, in which:

Figure 1 is a plan view of apparatus incorporating the invention, and depicted in views 1a and 1b;

Figure 2 is a vertical section on lines 2-2 of Figure 1;

Figure 2a is a cross-section through three wires, in a frame;

Figure 3(a) is an enlarged section taken in plane view on lines 3(a)-3(a) of Figure 2; and Figures 3(b) ---3(k) are views like Figure 3(a) but showing successive steps in wire processing;

Figure 4 is vertical section on line 4-4 of Figure 3;

Figures 5 and 6 are vertical sections taken on lines 5-5 and 6-6 respectively of Figure 3(a);

Figure 7 is an enlarged fragmentary plan view sections showing details of a right hand portion of Figure 3(a);

Figure 8 is a section, in elevation, on lines 8-8 of Figure 7;

Figure 9 is a vertical section taken on lines 9-9 of Figure 7;

Figure 10 is vertical section taken on lines 10-10 of Figure 7;

Figure 11 is a view taken on lines 11-11 of Figure 9;

Figure 12 is a view taken on lines 12-12 of Figure 9;

Figures 13(a) and 13(b) are enlarged fragmentary plan view sections corresponding to Figures 3(f) and 3(g) and showing a modified form of wire processing;

Figure 14 is an enlarged section on lines 14-14 of Figure 3(f);

Figure 15 is an enlarged section on lines 15-15 of Figure 13(a), showing cutting details, prior to cutter closure;

Figure 16 is a view like Figure 15, showing actuated cutter details;

Figure 17 is an enlarged plan view showing section lines 17-17 of Figure 18 (see also outline at left hand portion of Figure 3);

Figure 18 is a vertical section on lines 18-18 of Figure 17.

Figure 19 is a vertical section on lines 19-19 of Figure 20;

Figure 20 is a section on lines 20-20 of Figure 19;

Figure 21a is an elevation, partly in section, showing details of one side of wire section advancement means;

Figure 21b is a view like Figure 21a but showing the opposite side of the apparatus;

Figure 22 is an enlarged vertical section on lines 22-22 of Figure 21a;

Figure 22a is like Figure 22, but taken lines 22a-22a of Figure 21a;

Figure 22b', b'', b''', c', c'', d' and d'' are diagrams;

Figure 23 is an enlarged side elevation showing details of a timing belt shown in Figures 21a and 21b;

Figures 24a --24c illustrate schematically, the loading of wires onto conveyors;

Figure 25 shows wires being advanced by conveyor belt, with their ends processed, as by applying terminations;

Figure 26 is a side elevational view like Figure 3, and also Figure 13, but showing modified apparatus;

Figure 27 is a section on lines 27-27 of Figure 26;

Figure 28 is a fragmentary section on lines 28-28 of Figure 26;

Figure 29 is a plan view on lines 29-29 of Figure 26;

Figure 30 is a sectional plan view on lines 30-30 of figure 26;

Figure 31(a) --(i) and (n) are schematic showings of wire conveyors;

Figures 32 (a) --(h) are schematic showings of wire conveyors; and

Figures 33(a) ---(i) and (n) are schematic showings of wire conveyors.

Referring first to Figures 1-3(a), a first means 10 advances a selected wire 11 toward a primary station 12, the wire travelling leftwardly in Figures 3-(a) and 3(b). The wire being advanced has a forward end portion indicated at 11a in Figure 3(b); also it is typically insulation covered;

Wire deforming means at the primary station form at least one bend in the advancing wire, one such bend indicated at 11b, for example in Figure 3(g). In the example, the deforming means includes a first forming element, such as a roller 13a (see Figure 3(g) carried by a rotary or revolver apparatus 14, and a secondary roller 13b on a carrier 15 separate from apparatus 14. As will appear, the apparatus 14 and carrier 15 will function not only to hold elements 13a and 13b in wire bend forming position, but also to transport element 13a and 13b out of interfering relation with subsequent travel of the formed wire section by conveyor apparatus, in longitudinal direction 16, in Figure 3(a).

Clamp means at the primary station clamp the forward portion 11a of the wire that has approached endwise the wire deforming (bend forming) means, as at 13a and 13b. One such clamp shown at 17 in Figure 3(d), is rotatable about an axis normal to the plane of Figure 3(d) so as to bend the wire as at 11c, in Figure 3(g) to an extent causing the wire end portion 11(a) to be presented laterally for processing, during its subsequent travel longitudinally in direction 16.

A cutter means severs the wire after a selected length thereof has advanced, whereby a wire section of predetermined length is formed. The cutter means may be includes blades 18a and 18b as seen in Figures 3(a) --3(k) and also appearing in open position in Figure 15, and in wire cutting closed position in Figure 16. In those views, the cutter approaches the wires from beneath. The cutter jaws 21 and 22, are operated by the actuator 20.

Conveyor means operate to grip the formed

wire section, as at portions 11a and 11d thereof (which project transversely oppositely in Figures 2-(i) --3(k) to convey the sections along a generally longitudinally extending travel path (see arrow 16) away from the primary station 12 after the clamp means releases the wire, and with at least one end (and typically both such ends) of the formed wire section (see portion 11a and/or portion 11d) presented laterally, for processing thereof. Endless conveyor belts 22 and 23 in Figure 3, and subject to bodily displacement, as by crawling, in a direction opposite to arrow 16 so as to overlap the wire portions 11a and 11d. For example, Figure 24a - schematically shows the belts prior to rearward crawl displacement, and Figure 24b shows the belts after having bodily advanced rearwardly to envelop the wire portions 11a and 11d (above and below); and Figure 24c shows the wire being fed away from the primary station by the belts which have been bodily forwardly advanced, by crawl, in the direction of arrow 16, and also endlessly fed, to advance the wire longitudinally. See also Figures 21a and 21b. Note also the belt 23 projects rearwardly to greater extent than belt 22, to envelop wire portion 11a offset from wire portion 11a. Belt 23 is also, temporarily, endlessly fed to greater extent than belt 22, to bring the wire extents 11a and 11d into endwise alignment, as will appear at 11a' and 11d', in Figure 24c.

It will be further noted that wires of different lengths are easily handled, a longer wire having intermediate portions that dangle downward as at 11e in Figure 2. The extent of such dangling is determined by the metered or controlled advancement of the wire by means 10, to be described, prior to severing, as referred to. Figure 25 also shows dangling wires 11f, and wire ends projecting laterally from between upper and lower conveyor belts 28 and 29, 30 and 31 and supporting various terminations 32 as applied by selected termination equipment, to be referred to.

Referring now to the initial wire selection, and to Figure 2, a wire selection frame 40 is provided, with carriers 11 for multiple wires extending in parallel, spaced apart relation, and in the same plane. The wires typically differ in cross-sectional dimension, as indicated for example in Figure 2a. Thus, wire 11_x is larger in diameter than wire 11_{x-1}, which is in turn larger in diameter than wire 11_{x-2}. The wires typically have metal cores 11_y and insulations 11_z, the wires being electrical.

In the embodiment shown, the carriers comprise two upright posts 41 and 42, spaced apart in the direction of selected wire advancement. The posts have holes 43 and 44 to receive and feed the wires endwise, with guidance, and they also position the wires in parallel relation so that a selected wire may immediately be fed by the wire advance-

ment means. Endwise, (for example vertical) movement of the posts moves the frame 40 in directions indicated by arrows 43a, so as to bring the selected wire into driven position. See wire 11 in Figure 2.

Turning now to Figures 7, 9 and 10, endwise drives for the posts appear at 45 and 46. Drive 45 for post 41 includes an upright rotary screw 45a that threadably engages a nut 45b attached to post 41; a pulley 47 mounted to the lower end of the screw, and a belt 48 engaging the pulley. In similar manner, drive 46 for post 42 includes an upright rotary screw 46a that threadably engages a nut 46b attached to post 42; a pulley 49 mounted to the lower end of the screw, and the belt 48 engaging the pulley. See also screw bearings 51 and 52, and frames 53 and 53a carrying those bearings. A suitable motor drives belt 48, whereby the carrier posts 41 and 42 may be elevated and lowered in unison to position a selected wire at the location of wire 11 in Figure 2, for endwise advancement. Detector 54 (including a disc 54a on screw 46a and position sensor 54b on frame 53b) detects the position of the frame and controls the motor to exactly position a selected wire in the position of wire 11, as referred to.

Figures 7 and 10 also shows the provision of means to clamp the wires to the carrier, wire passing plungers 56 being provided for this purpose. The plungers slidably received in transverse openings 57 in the posts, and wires pass endwise through openings 58 in the plungers. Compression springs 59 urge the plungers endwise to cause jamming or clamping of the wires against the side walls of the openings 57, as in Figure 7; and an actuator 61' at the level of selected wire 11, is operable to cause extension of a plunger 61a' to urge the plunger sufficiently rightwardly (in Figure 10) to relieve such jamming, whereby the selected wire is free to advance endwise. Wires are conveniently supplied from spools to the wire positioning frame structure.

Means for advancing the wire 11 endwise, shown in Figures 1, 2, 3, 7 and 8 includes two endless drive belts 60 and 61 has stretchers 60a and 61a that clamp the wire 11 therebetween and displace it endwise, i.e. leftwardly in Figure 7. Belts 60 and 61 are typically timing belts with internal cogs 62, as shown, and engaged by sprockets 63-66. Pressure idler sprockets 67 and 68 engage the stretchers 60a and 61a to urge them toward the wire length being gripped and advanced. Drives for the sprockets 63 and 65 are shown at 70 and 71 in Figures 2, 3 and 8 to include timing belts 71' and 72 on sprockets 73 and 74. The latter drive shafts 75 and 76 suitably attached to sprockets 63 and 65.

The shafts 75 and 76 are carried by structure

77 and 78 (Figure 8) mounted so as to be advanced sidwardly toward the wire, to grip it, and to be retracted away from the wire. Linear actuators 80 and 81 are connected via shafts 82 and 83 to bearing blocks 84 and 85 that have bores 84a and 85a receiving the shafts 75 and 76. When the actuators are extended, the sprockets 63 and 65 are positioned to cause the belts 60 and 61 to grip the wire; but, when the actuators are retracted, the retracted sprockets 63 and 65 retract the belts 60 and 61 to release the wire, and to form an enlarged space therebetween to receive another selected wire. Note frames 63a and 65a for the sprockets.

The wire advancing means also shown in Figures 3 and 6 includes two drive rollers 88 and 89 and has wire gripping annular surfaces 88a and 89a to tension the wire and precisely position an advancing wire. The rollers are carried by drive shafts 90 and 91 driven by a belt 92 wrapping about spools 93 and 94, as also seen in Figure 3. An idler spool for the belt is shown at 95. Suitable mounting frame structure appears at 97 and 98. Figures 3 and 4 also show a master drive for all belts, including motor 200 driving a master drive spool 201 via belt 202. See also belts 203.

The fed wire 11 then passes through a linear guide 100 on a wire deflecting arm 102, pivoted at 103 to the frame structure. See Figures 3(f) and 13(b). Guide 100 is slidably guided on a base plate 104, and the top of the guide carries a rack 105 engaged by teeth 106 on a segment 107. The latter is pivoted at 108, and connected to linear actuator 109. When the segment is rotated by retraction of the actuator, the guide 100 is advanced leftwardly, in the direction of arrow 110. This occurs in the Figure 3(b) position of the arm, when the wire 11 is to be advanced leftwardly; however, in pivoted position of arm 102 as seen in Figure 3(f), the rack 105 is disengaged from the segment teeth 106. Actuator 112 is employed to pivot arm 102 between Figure 3 and Figure 13 positions.

Roller 13b is pivotally carried by arm 102 at 113, and is driven in rotation in Figure 3(g) arm position by belt 114. The latter is driven by roller 115 which is in turn driven by a belt 116 and master drive spool 201. Rotation of roller 13b effects wire bend formation at 11b, as referred to above.

The wire 11 in Figure 3 is fed by linear guide 100 (to the cutting zone defined by the jaws cutters 18a and 18b as previously described) in advanced position.

Referring now to Figure 18, rotary revolver apparatus 14 is shown to include pulley 120 driven by belt 121, and spindle parts 122-125 rotated by pulley 120. Rotor 126 is clutch coupled at 127 to part 125, and is also driven in rotation. When clutch 127 is engaged the rotating spindle part 125 is

coupled to rotor 126, for rotating same together with a deck 14a attached at 130 to a carrier 129. This effects a controlled 180° rotation of the deck 14a of the apparatus 14, to carry the first deforming element, i.e. roller 13a, out of the path of wire travel by the conveyor means.

Drive is transmitted to each of the two clamps 17 from part 123, via gear 134 on part 123, gear meshing with gear 124, gear 136 meshing with gear 135, and shaft 137 connected with gear 136. Support structure for these elements is indicated 140, 141 and 142.

At the end of the above described 180° rotation of deck 14a, an actuator 143 is operated to cause pin 144 to rise and enter lock recess 145 in a sleeve 146 carried by the rotary frame structure 142, to block further rotation of frame 142 and deck 14a. Actuator 143 is carried by non-rotary support structure 140. When pin 144 enters the recess 145, it also drives a pin 146 upwardly, ejecting plunger 128a from recess 130, de-coupling the deck structure 14a from the rotary drive.

The sequential steps of wire processing in Figures 3(a) --3(k) will now be described.

In Figure 3(a), step 1), a wire is selected, as described above, to be advanced leftwardly. All clamps and rolls carried by the revolver apparatus 14 are in up-position in Figure 18, and therefore not seen in the plane of Figure 3(a).

In Figure 3(b), step 2), a selected wire 11 is advanced leftwardly, to the position shown. Wire injector or guide 100 also moves forwardly (leftwardly); and belts 60 and 61 de-reel a selected length of wire. Note the wire end projecting just beyond the plane of the cutters 18a and 18b.

In Figure 3(c), step 3) the wire is cut-off near its end, by cutters 18a and 18b, to establish a precision location of the remaining wire end 11a', relative to the remainder of the wire to be advanced, and cut-off at its opposite end.

Figure 3(d), step 4) illustrates clamping of the wire by clamp 17 lowered by actuator means 190, in Figure 18. One of the two rollers 13a on the revolver apparatus is also lowered into the plane of Figure 3(d), by actuator 137. Further, the conveyors 22 and 23 are moved endwise into the position shown, without moving the revolver 14.

Figure 3(e), step 5) shows the cutters 18a and 18b retracted away from the wire end 11a', and the revolver apparatus ready to be rotated. The wire is clamped at 17.

Figure 3(f), step 6) illustrates the revolver apparatus in rotating mode, i.e. rotating about a central axis normal to the plane of Figure 3(f), the conveyor retreating in direction 16 during such rotation. The revolver is driven through engaged clutch 127 (see Figure 18). Curved end surface 14a of the revolver pushes against cam surface 102 on

arm 102, to cause the arm 102 to swing as shown, about a pivot at 103. Clamp 17 rotates with the revolver to pull wire end portion 11a forwardly and in a circular path, the roller 13a on the revolver sidewardly approaching the wire and engaging it, as shown. In so doing, the wire is pulled forwardly through and relative to injector 100. Belts 60 and 61 advance the necessary length of wire to follow clamp 17. Clamp 17 is also rotated relative to the revolver apparatus to maintain its orientation in space i.e. the wire end 11a', continues to project leftwardly in the sequence 3(e) --3(k).

Figure 3(g), step 7) illustrates the position of the parts at the completion of revolver 180° rotation, rollers 13(a) and 13(b) now engaging opposite sides of the wire curved and deflected extent at 11b.

In Figure 3(h), step 8), the clamp continues to engage the wire; and the de-reeling apparatus operates to advance wire leftwardly, rollers 13a and 13b advancing wire, to controllably metered extent, to hang loosely as "excess" wire at 11(e) (see also Figure 2).

Figure 3(i), step 9) illustrates cutting of the wire at 18a and 18b, to metered length. Thus, a precision length wire strand is now in position to conveyed by conveyors 22 and 23, which are shown advanced into position to grasp the wire opposite end extents 11a and 11d, which project in endwise opposite directions. Also, the wire extent to the right of the cutters 18a and 18b is now being clamped at 17 (employing the second clamp on the revolver), for subsequent processing of that next wire extent. Second roller 13a is also in down position.

In Figure 3(j), step 10), the revolver is again ready to rotate about its axis; cutters 18a and 18b have released the wire, and the first clamp 17 has now released the wire extent 11a and has been raised by the revolver apparatus.

In Figure 3(k), step 11), the first cut wire is now being transported by the conveyors 22 and 23, in direction 16, away from the revolver apparatus, the latter now operating as in Figure 3(f), step 6).

Accordingly, precision lengths of wire, having desired and controllable lengths, are formed in rapid succession, with their opposite end portions 11a and 11d presented and maintained in endwise opposite directions, for end terminal application to such ends.

Figures 13(a) and 13(b) correspond to Figures 3(f) and 3(g) except that the clamp 17 is not rotated relative to the revolver during rotation of the latter. As a result, on wire end 11a is reversed in direction as the revolver rotates, Figure 13(b) showing that the resultant wire is U-shaped, having its end portions 11a and 11d extending rightwardly i.e. in the same direction. Accordingly, the ends of

those wire portions, when conveyed, are presented rightwardly for application of terminals.

Figures 31(a) --31(i), and also Figure 31(n), show schematically operation of multiple conveyors to create batch groupings of multiple wire segments. Primary conveyors 22 and 23 are as described above, and secondary conveyors are indicated at 122 and 123. Conveyor 122 includes linked together belts 122a and 122b, and conveyor 123 includes linked together belts 123a and 123b.

In Figure 31(a), conveyors 22 and 23 have delivered wire sections 11a' and 11d' as in Figures 24(c), to a position for pick-up by conveyor belts 122a and 123a, the sections 11a' and 11d' extending endwise oppositely. Note axis F₃. In Figure 31(b), conveyor belts 22 and 23 have retracted by amount F₂ relative to axis F₃. In Figure 31(c) conveyors 122 and 123 have moved to the right and carried the wire to the right, by amount B₃, relative to axis F₃. In Figure 31(d) conveyors 22 and 23 have moved forward by amount B₂ to carry a second wire having end portions 111a' and 111d' into the position of axis F₃. Note that the two wires are now closely clustered and separated by shortened distance B₃, i.e. the two wires are batched.

Figures 31(e) --31(h) repeat this process to bring a third wire having end portions 211a' and 211d' into clustered relation with the first two wires. Figure 31(n) shows six wires clustered as described. This forms a cluster "harness" of wires suitable for application of terminals to clustered ends 11a', 111a'---511a', and for application of terminals to opposite clustered ends 11d', 111d' --- 511d'.

Figures 32(a) --32(h) shows a similar sequence of steps, operating the same conveyors however, blank spaces (indicated by broken lines) are now formed at certain otherwise wire occupied spaces. This is accomplished by operating secondary conveyors 122 and 123 to displace the first wire an amount B₃ (see Figure 32c) while the primary conveyor is transporting the next wire 111 into position as seen in Figure 32d. Only three (solid line) wires 11, 111 and 211 are positioned in the final cluster, there being three blanks located as shown. Control of wire position in clusters, and the number of wires in clusters is thereby achieved.

Figures 33(a) --33(i) and 33(n) show another similar sequence of steps using the same conveyors; however, wires end portions are now controllably displaced or offset by controlled operation of conveyors 122 and 123, to form a desired configuration harness, suitable for end termination. Figure 33(a) to 33(f) are similar to Figures 31(a) --31(f) but in Figure 33(g) the belt of conveyor 122a is moved to the right, while the belt of conveyor 123b is not so moved, while both conveyors 122a and 123a are bodily moved to the right, thereby offsetting wire

ends 11a' and 111a' relative to wire ends 11d' and 111d'. The next added wire ends 211a' and 211d' are not so offset, in Figure 33(h). Note the final configuration of wire ends in Figure 33(n), adjusted for termination or fitting to harness terminals at 500 and 501, at a subsequent terminal station 502, as shown. In Figures 33(g)--(i) and (n), the "stepped" portions 11f', 11f' and 311f' of the wires represent slack intermediate (for example dangling) portions of the wires, between the conveyors.

Referring now to Figures 1, 3, 21a, 21b, 22 and 23, the primary conveyor 22 comprises upper and lower endless belts 22a and 22b, and the primary conveyor 23 also comprises upper and lower endless belts 22a and 23b. Each belt is covered with spongy material such as foam polyurethane in order to yieldably grip wires of different diameters, even when such different wires are closer together. The belts of each pair include stretchers, as at 22a' and 22b', that close toward one another to grip the wire end portions 11a and 11d, just prior to release of wire portion 11a by clamp 17, which includes wire gripping arms 17a and 17b. Clamp 17 may also be upwardly withdrawn, as by actuator structure 190.

Figure 22 shows that each of conveyors 22 and 23 include two side-by-side pairs of upper and lower endless belts, as at 22a and 22b, an 23a and 23b, for gripping the wire portions 11a and 11d. Such conveyors may comprise timing belts, as shown, driven by sprockets 154a and 154b, and 155a and 155b. Axles 156a and 156b, and 157a and 157b mount the sprockets, as shown, and are driven by inter-connected gears 159a and 159b. A master timing belt 160 gauges sprocket 161 that is connected to axles 162 and 162a, the latter driving gears 164 and 165, respectively driving gears 158a and 159a. Suitable bearings are provided, as shown, and mount the gears, axles, and timing belts in a travelling frame 166. The latter is guided for travel in the direction of arrows 167 on guide rods 168-170 passing through guide openings 171-173 in the frame part 166a.

The master timing belt 160 is shown as wrapped in S-shaped configuration about sprocket 161 and also a rear sprocket 174, as well as over idler sprockets 175 and 176. Figures 21a and 21b show actuators 180 and 181 having plungers 180a and 181a engaging the travelling frame 166. When the travelling frame 166 is moved rightwardly on Figure 21, sprockets 161 and 174 turn due to the fixing of both ends of the belt 160 to the fixed frame structure 175a. the two sprockets 161 and 174 turn in opposite directions. These sprockets are mounted on shafts 162 and 162a by over-running roller clutches 163 and 163a. These two roller clutches are mounted so that when the sprocket 161 rotates the shaft 162 in clockwise direction by

means of the roller clutch 163, the sprocket 174 then does not rotate the shaft 162a (the roller clutch 163a is over-running on shaft 162a). So, when the frame 166 in Figure 21a is moving rightwardly only the shaft (162a) is then rotating. Shaft 162a rotates the gears 164b and 165b if the disc clutches 164c and 165d are activated. In that case, rotated gear 164b transmits its rotation to gear 158c and 158d. These then rotate the shafts 156a and 156d. These shafts then rotate the pulleys 1554c, 154d, 155c and 155d. Finally, all the belts (22a', 22b', 22a, 22b, 23a' 23b', 23a, 23b) are rotating during the travelling of the frame 166.

Observing the right side of Figure 21a, the result is shown in Figure 22b', i.e. before travelling of the frame 166. Figure 22b'' illustrates the positions of elements and wires during travelling the frame 166; and Figure 22b''' shows the positions at the end of rightward travelling of the frame 166. Notice that the wires already handled by the belts 22a and 22b have not been moved. The wire 11a has been taken between the two belts.

When the travelling frame 166 is moved leftwardly in Figures 21a (after being moved rightwardly), sprockets 161 and 174 turn due to the fixing of both ends of the belt 160 to the fixed frame structure 175. But, this time the shaft 162 alone is rotated by the sprocket 161 and the roller clutch 163. The belts 22a, 22b, 22a', 22b' are rotated if the disc clutch 164a is activated. The belts 23a, 23b, 23b' and 23a' are rotated if the disc-clutch 165 is activated. So, accordingly, depending upon what displacement of wire or wires is needed, during leftward travel of the frame 166 one can activate the clutches 164a or 165a, or both, or neither. The Figures 22c and 22d show what occurs in several cases. Figures 22c' and 22c'' show frame travel leftwardly without also rotating the belts 22a and 22b. The resulting leftward displacement Δ of the wire 11a is equal to the leftward displacement of the frame 166. In Figures 22d' and 22d'' the situation is the same except the displacement 2Δ equal to twice the leftward displacement of the frame 166. Figures 24a, 24b, 24c, and Figure 31, show various uses of these selected different displacements of wire tips.

Turning now to the modified structure of Figures 26-30, components which are the same as previously referred to bear the same numbers, new numbers being applied to modified components.

The means for advancing wire 11 includes two drive rollers 288 and 289 having wire gripping annular surfaces 288a and 289a to tension the wire and align it with cutters 218a and 218b. The rollers are carried by shafts 290 and 291, on which drive gears 290a and 291a are also carried. Those gears mesh with gears 250 and 251 driven by gear 252, and the latter is driven by a pulley 253 and belt

254. Belt 254 is in turn driven by a pulley 255 on drive shaft 256 of motor 257. Note also idler pulley 258 for the belt. Frame structure appears at 310 and 311.

The fed wire then passes through linear guide 270 carried by the frame part 271. Guide 270 includes a guide tube 272 into which the wire enters at taper 272a, and through which the wire passes. Means to positively advance the wire leftwardly includes a tubular plunger 274 slidable on the tube 272, in response to fluid pressure application on the plunger piston head 274a slidable in the bore of a cylinder 276. Plunger jaws 277 grip the wire so that it can be pulled leftwardly by the plunger stroking.

Note that the wire is turned about roller 13a in response to rotary and compressive force exertion on the wire bend 11b by roller 213b. The latter roller is carried by arm 280 and 281, and is driven in rotation by belt 282 engaging a pulley on roller shaft 282a, the belt also engaging a pulley or roller on idler shaft 283. Idler pulley 284 also on that shaft is driven by belt 285 engaging a pulley integral with pulley 254. Arm 280 is rotatable about the pivot axis 286 about which pulley 254 rotates, so that roller 213b is driven whatever the angular position of arm 280. Actuator 287 urges the arm counterclockwise, against the tension of a spring 288a connected to the arm at 289a, and to the frame at 290a, and operation of the actuator to retract the rotor 213b occurs each time a formed and cut wire is transported by belts 22 and 23. The wire next to be formed is then advanced leftwardly toward and past the cutters and adjacent roller 13a, at which time the arm is returned and the wire clamped by rotating roller 213b, for forming. Thus, rotation of roller 213b in the Figure 26 position shown effects wire bending formation, and temporary retraction of the arm counterclockwise allows initial wire feeding about roller 13a. Cutters 218a and 218b operate in the same manner as cutters 18a and 18b previously described, to sever the wire when a predetermined length of wire has passed the cutters, so that the severed wire having parallel sections 11a and 11d, and bends 11b and 11c may be transported by belts, including those shown at 22 and 23, and as previously described. Rotor 14 operates as previously described.

The operating steps shown in block form in Figure 34, are further described as follows:

INJECTING

As indicated in Figures 3(a) and 3(b), wire 11a is advanced leftwardly via telescopic guide 100, by the de-reeler belts 60, 61.

CUTTING

As seen in Figure 3(c), the wire end is cut by cutters 18a and 18b on the rotor 14, to determine the exact position of the free wire end. See also Figures 15 and 16. In Figure 3(d) the guide 100 is retracted.

REVOLVER (ROTOR) LOADING

Figure 3(d) shows the clamp 17 on the rotor in down position, clamping the wire 11a. See also Figure 18 showing the down position of the clamp on the revolver. The clamp actuator appears at 190. Selection of wire bend shape to be formed (U or Z) is made by moving transfer gear 135 to up or down positions. (If gear 135 is pushed to down position, as seen in Figure 18 by actuator 128, see in Figure 18, gear 135 engages fixed gear 134, whereby the wire section assumes Z shape, as seen in Figures 3(f), 3(g) and 3(h). If the gear 135 is pushed to up position by actuator 143 seen in Figure 18, gear 135 engages upper gear 134(a) which rotates as the revolver rotates, whereby the wire section assumes U-shape as seen in Figure 13(b).

Also, as seen in Figure 18, the revolver 126 is clutched to the spindle part 124, so as to be rotated by belt 121.

The cutter blades 18 and 18a retract from the wire (see Figure 3(e)).

TRANSFER

The rotor 14 is rotated by belt 121; as seen in Figure 3(f), belt 121 is moved by its connection at 121a to actuator 181 seen in Figure 21a. In this regard, just prior to rotation of the rotor, the cam or arm 200 seen in Figure 26 (corresponding to arm 102 in Figures 3(b) and 3(f) releases (unblocks) the rotor to permit its rotation by re-energizing cylinder 287 in Figure 26 (corresponding to actuator 102 in Figure 3(f). When the revolver has rotated 180°, the arm 280 returns to position as seen in Figure 26 (corresponding to arm 102 position in Figure 3-(g)), and held in that position by its actuator. Reverse rotation is blocked as indicated by mechanism 285 in Figure 17. As the rotor rotates, wire is fed from the de-reeling mechanism, as by the stepping motor 200 in Figure 3(f), and encoding of revolver motion at 300 (see Figure 18) controls the motor, via suitable logic, indicated at 301 in Figure 3(f).

Roller 213b is then pushed toward roller 18a

by spring 288 in Figure 26, gripping the wire therebetween. (See also Figure 3(g)). The revolver is unclutched from the belt 121, via clutch 127 (see Figure 18).

DE-REELING

An over-length (selected) or wire is then fed by the de-reeler mechanism. This wire is pulled forward by the rollers 13a and 213(b) (see Figure 26), corresponding to rollers 13a and 13b in Figure 3-(h). The over-length between the roller and the clamp 17 hangs downward at 11e, as a selected length loop (see also Figure 2 which is an elevation). See also the description of 11(e) formation at the beginning of the specification.

CONVEYOR LOADING

As shown in Figure 3(i) and Figure 21, conveyor belts 22 and 23 (upper and lower belts 22a, 22b, 23a and 23) move into positions to receive the wire end portion (between the upper and lower stretches of the belts) on the spongy material of the belts as described herein. The wire end portions are thus gripped by the conveyor belts.

CUTTING

Figure 3(i) shows cutting of the wire by cutters 18(a) and 18(b). Accordingly, precision length or sections of wire are formed, for transport on the conveyor belts, as in Figure 3(k).

Claims

1. In a wire processing system, the combination comprising:

a) first means to advance a wire generally endwise toward a primary station, the wire having a forward portion;

b) wire deforming means at the primary station to form at least one bend in the advancing wire;

c) clamp means at the primary station to clamp said forward portion of the wire that has passed said deforming means;

d) cutter means to sever the wire after a selected length of wire has advanced past the cutter means, whereby a wire section of predetermined length is formed;

e) and conveyor means operable to grip the formed wire section and to convey that section along a generally longitudinally extending travel

path away from the primary station after the clamp means releases the wire, and with at least one end of the formed wire section presented laterally for processing thereof.

2. The combination of claim 1 wherein said wire deforming means includes a first deforming element, and including apparatus at the primary station mounting said first deforming element for movement out of the path of wire travel by said conveyor means.

3. The combination of claim 2 wherein said apparatus comprises a rotor having two of said first deforming elements thereon, the rotor rotatable in 180° increments to bring said first deforming element alternately into position to bend the advancing wire.

4. The combination of claim 3 wherein said wire deforming means includes a second deforming element, and a carrier for said second element movable to bring the second element into proximity to said first element to effect bending of the advancing wire, and to carry the second element away from the wire during initial conveying of the wire section by the conveyor means.

5. The combination of claim 1 wherein said first means includes a wire drive and guide operable to advance the wire generally toward said primary station until a selected length of the wire has passed said cutter means for said bend forming beyond the cutter means.

6. The combination of claim 1 including said wire having one of the following shapes, after operation of said deforming means and gripping by said conveyor means:

i) C-shape

ii) S-shape.

7. The combination of claim 1, including a wire selection frame having carriers for multiple wires, and means to selectively displace the frame relative to said first means to bring a selected wire into position for feeding of a selected wire by said first means.

8. The combination of claim 2 including said wire having in plan view, after operation of said deforming means and rotation of said rotor apparatus, a shape in the form of a succession of U's.

9. The combination of claim 2 wherein said clamping means includes two clamps carried by said rotor apparatus to clamp wire end portions for supporting the wire for loading onto the conveyor means.

10. The combination of claim 2 wherein said deforming means includes a second deforming element, and including arm mounted to swing and cause the second deforming element to move toward the first deforming element to clamp the wire therebetween, thereby to form said bend or bends.

11. The combination of claim 10 wherein said first deforming element is a roller, and said arm has a retracted position in which the second deforming element is retracted away from the first deforming element during operation of said conveyor means to convey the wire section away from the primary station.

12. The combination of claim 1 wherein the wire in elevation view forms a suspended loop, as gripped by the conveyor means.

13. The combination of claim 1 wherein said conveyor means includes at least a primary pair of endless conveyors and means to effect endless travel of the conveyors, and also crawl displacement of certain conveyors to grip the wire length and convey it along said longitudinal path of the conveyors undergoing said endless travel.

14. The combination of claim 13 including at least a secondary pair of endless conveyors to receive the wire length from said primary pair of conveyors, for transfer to a tertiary pair of endless conveyors, the conveyors travelling at different rates to controllably space the received wire lengths.

15. The combination of claim 7 wherein the carriers comprise two posts with wire guide holes to orient the wires in parallel relation and in the same plane, and said means to displace the carrier posts include two rotary screws threadably coupled to the posts, and screw rotary drive means, and including detector means to detect the position of the carrier posts so that a selected wire may be exactly positioned to be advanced by said first means.

16. The combination of claim 15 including means to clamp the wires in positions relative to such posts, and to unclamp the selected wire brought into position for endwise advancement.

17. The combination of claim 1 wherein said first means to advance a wire endwise includes two endless belts having stretches that grip a wire along its length, and means driving said belts.

18. The combination of claim 17 including means mounting said belts for endless travel, for retracting the belts away from a wire reception zone to receive a selected wire therein, and for advancing the belts toward said zone to grip the selected wire along its length.

19. The combination of claim 13 wherein means to effect endless travel of the conveyor and also crawl displacement thereof includes a timing belt having fixed ends, a pair of sprockets spaced apart in the direction of conveyor crawl displacement, the belt wrapping about the sprockets in S-shaped relation, and at least one of the sprockets connected in driving relation with the conveyors.

20. The combination of claim 10 wherein the first and second deforming elements comprises first and second rollers, there being drive means carried by the arm to rotate the second roller at a speed to bend the wire about the first roller.

21. The combination of claim 20 including an actuator to pivot the arm, and a tensioning means to urge the arm in a direction to cause the second roller to compress the wire against the first roller.

22. The combination of claim 20 wherein said first means comprises a plunger intermittently driven in timed relation to pivoting of said arm, to feed a wire strand past the cutter means and to the wire deforming means.

23. In wire handling apparatus, the combination comprising:

a) means to advance wire endwise;

b) a rotor, clamp means on the rotor to locally clamp wire after a metered length of wire has been advanced toward the clamp means, and a first roller on the rotor;

c) a pivoted arm and a second roller on that arm, the arm swingable toward and away from the rotor;

d) means to rotate the rotor while the arm swings relative to the rotor axis of rotation to bring said first and second rollers into engagement with wire, and also to cause the clamp means to bend the wire around the first roller so that the wire extent proximate the roller and clamp means assumes Z-shaped configuration;

e) means to sever the wire to isolate the Z-shaped extent of the wire;

f) and conveyor means movable to engage the Z-shaped extent of the wire and to convey it away from the rotor.

24. The method of clustering wire sections, for attachment of terminations to ends of the sections, and employing multiple conveyors, that includes:

a) operating a first conveyor to sequentially travel the wire section in sequence in a longitudinal direction, with the ends of the sections presented laterally;

b) receiving the sections, sequentially on a second conveyor, for subsequent travel;

c) operating the second conveyor in such relation to the first conveyor that the wire sections are travelled with reduced spacing therebetween in the direction of said subsequent travel relative to spacing between wire sections travelled by the first conveyor.

25. The method of claim 24 wherein the second conveyor includes laterally spaced conveyor sections, and including operating said second conveyor sections to relatively offset selected opposite ends of wire sections received by the second conveyor.

26. In wire processing apparatus, the combination comprising:

a) first means to advance wire generally endwise;

b) a wire selection frame having carriers for multiple wires, and means to selectively displace the frame relative to said first means to bring a selected wire into position for feeding of a selected wire by said first means. 5

27. The combination of claim 26 wherein said carriers comprise two posts with wire guide holes to orient the wires in parallel relation and in the same plane, and said means to displace the carrier posts include two rotary screws threadably coupled to the posts, and screw rotary drive means, and including detector means to detect the position of the carrier posts so that a selected wire may be exactly positioned to be advanced by said first means. 10 15

28. The combination of claim 27 including means to clamp the wires in positions relative to such posts, and to unclamp the selected wire brought into position for endwise advancement. 20

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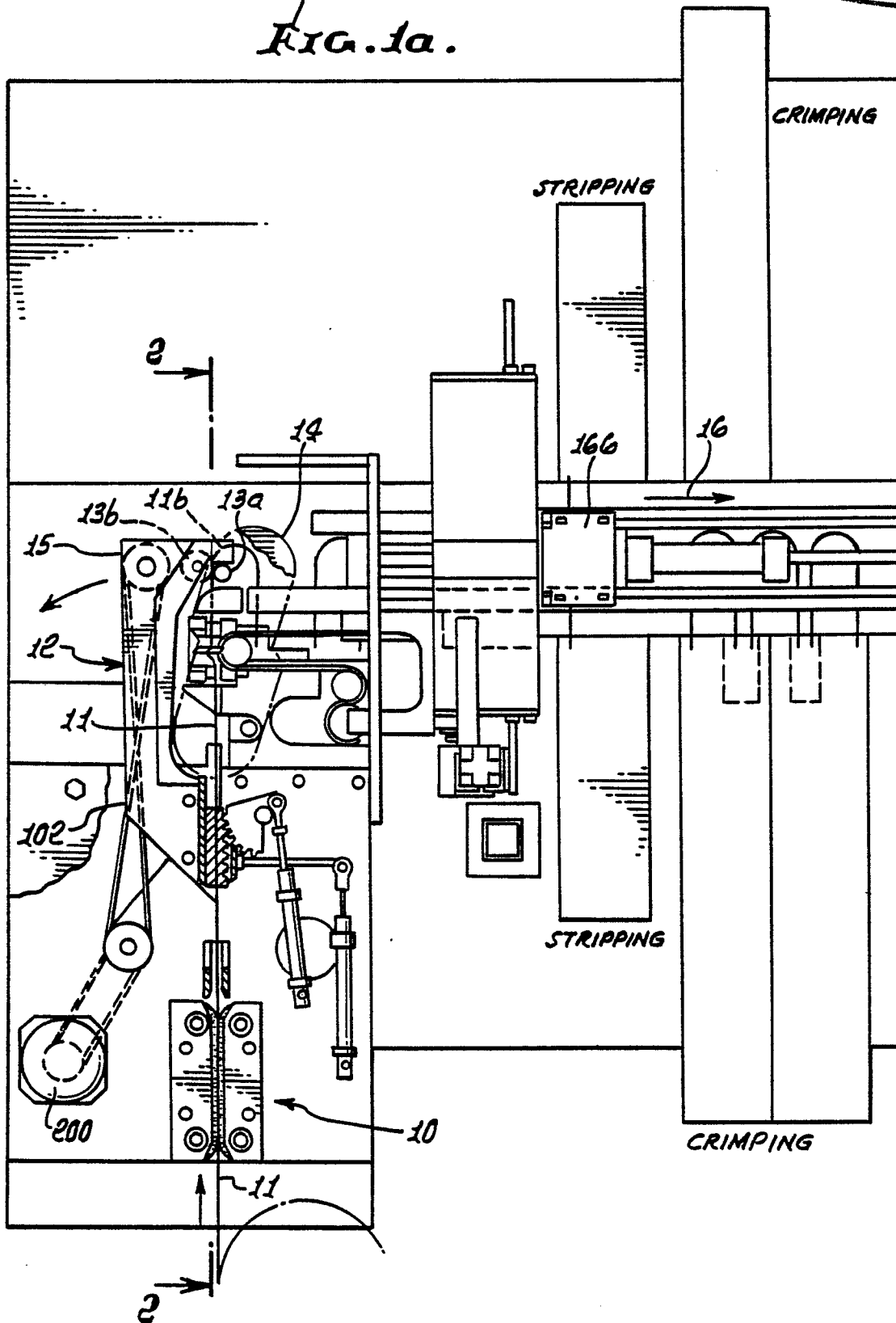
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11

11 38 80

Neu eingereicht / Newly filed
Nouvellement déposé

FIG. 1a.



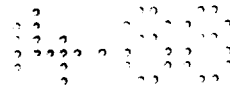


FIG. 1b.

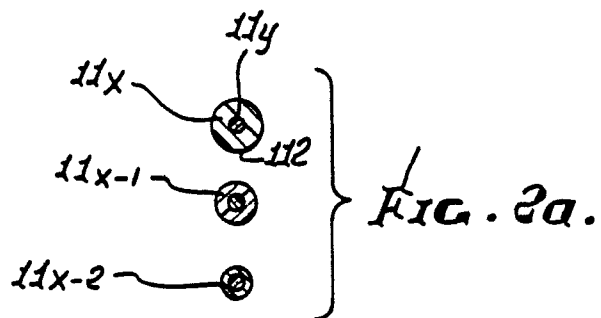
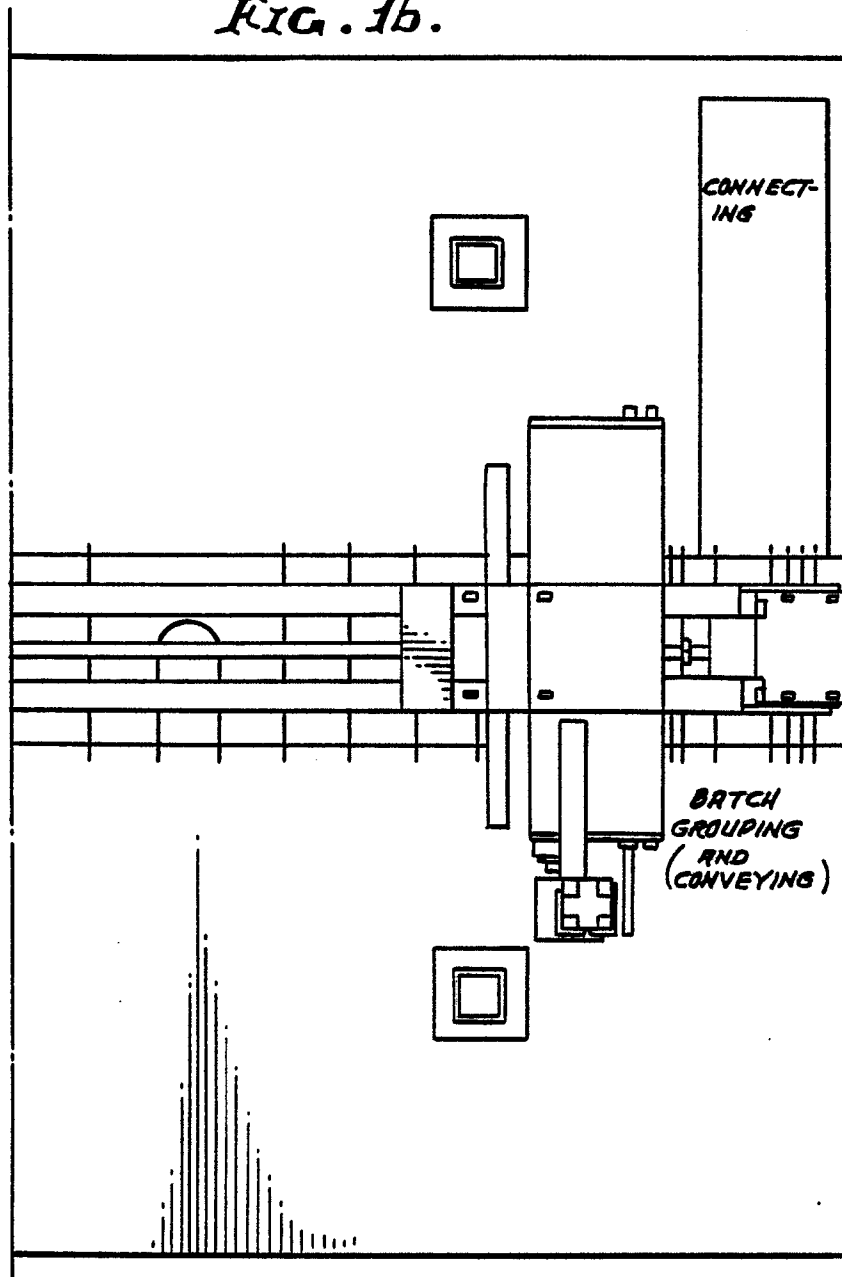
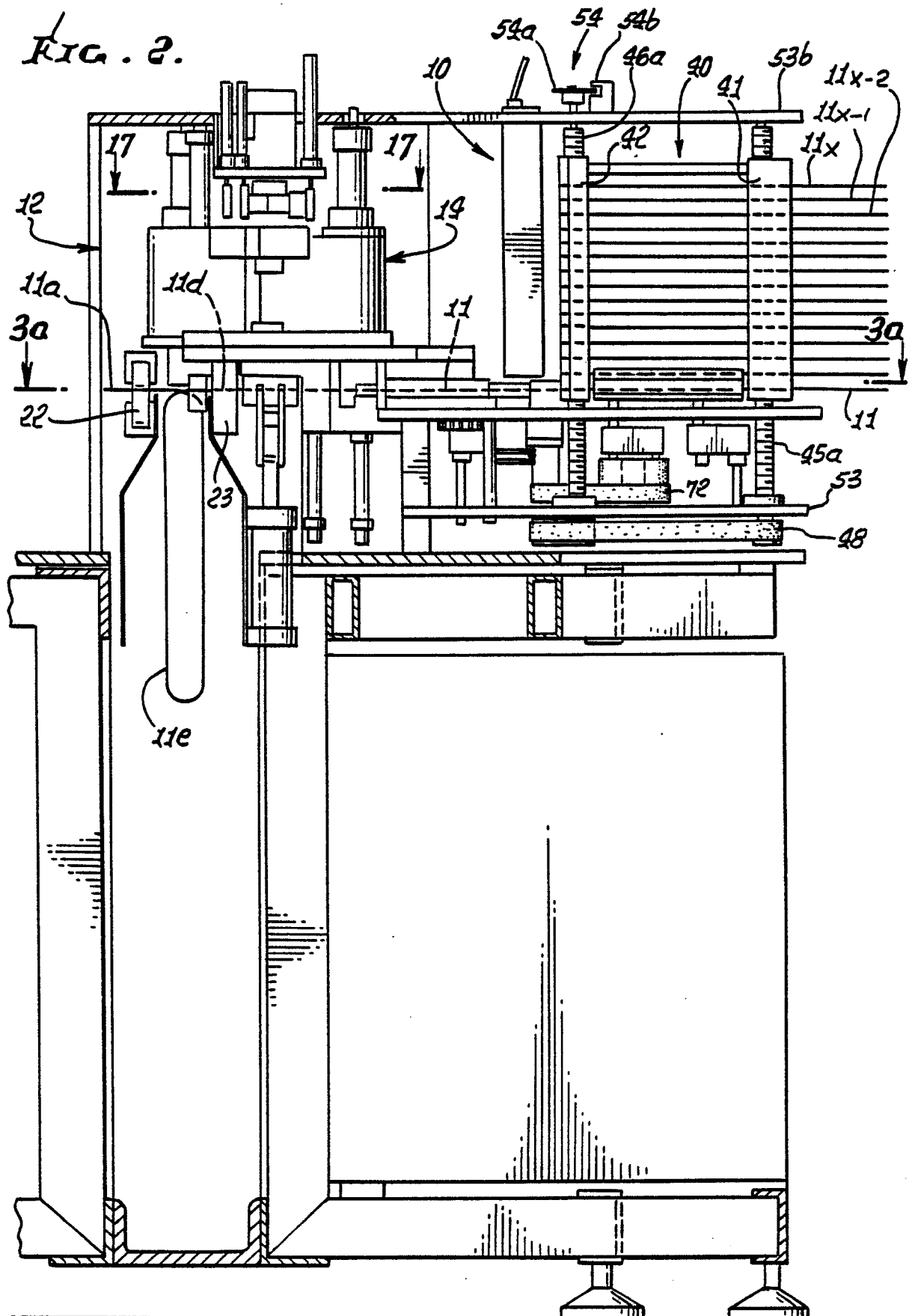
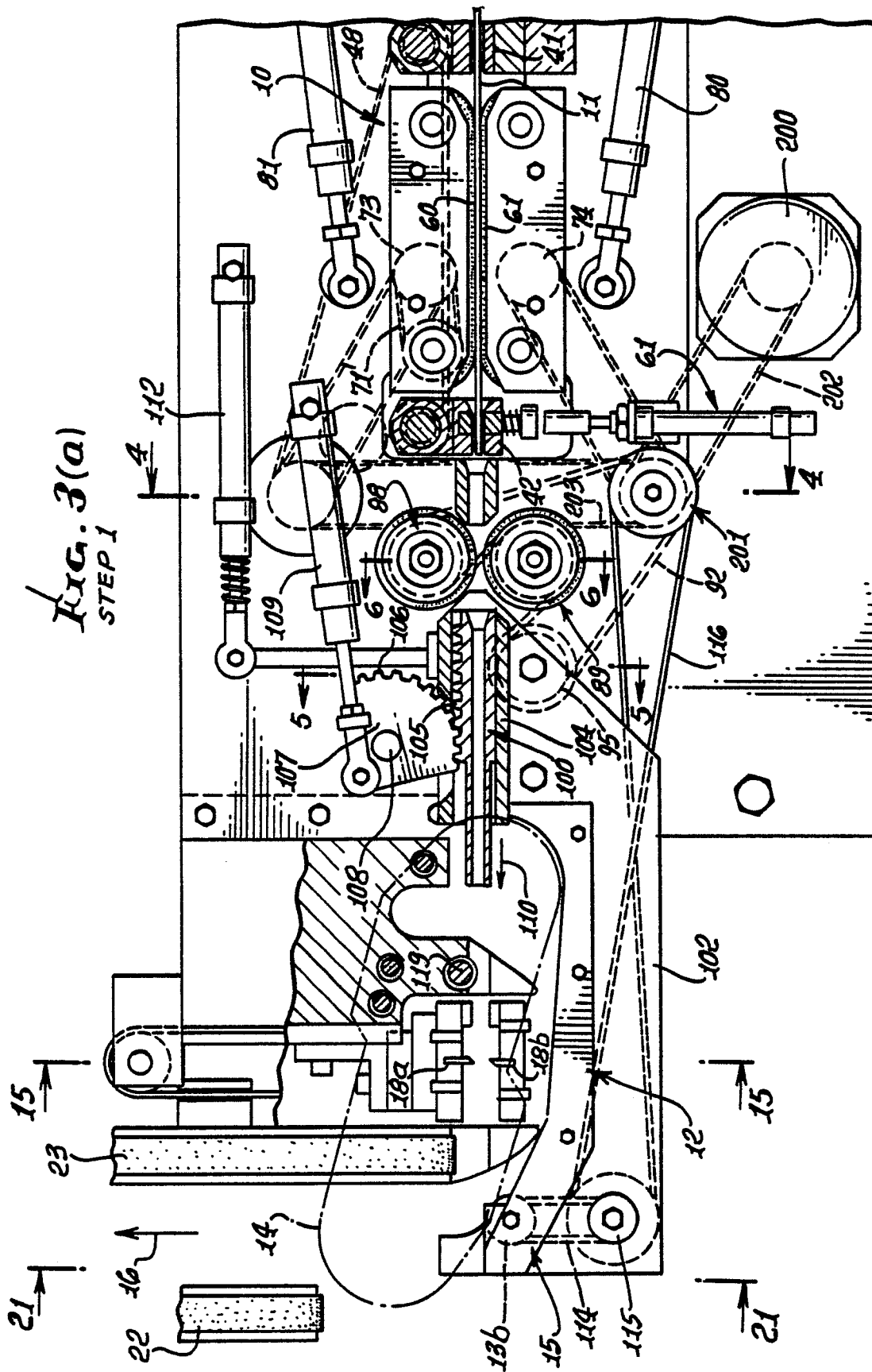


FIG. 2.





EXG. 3(b)
STEP 2

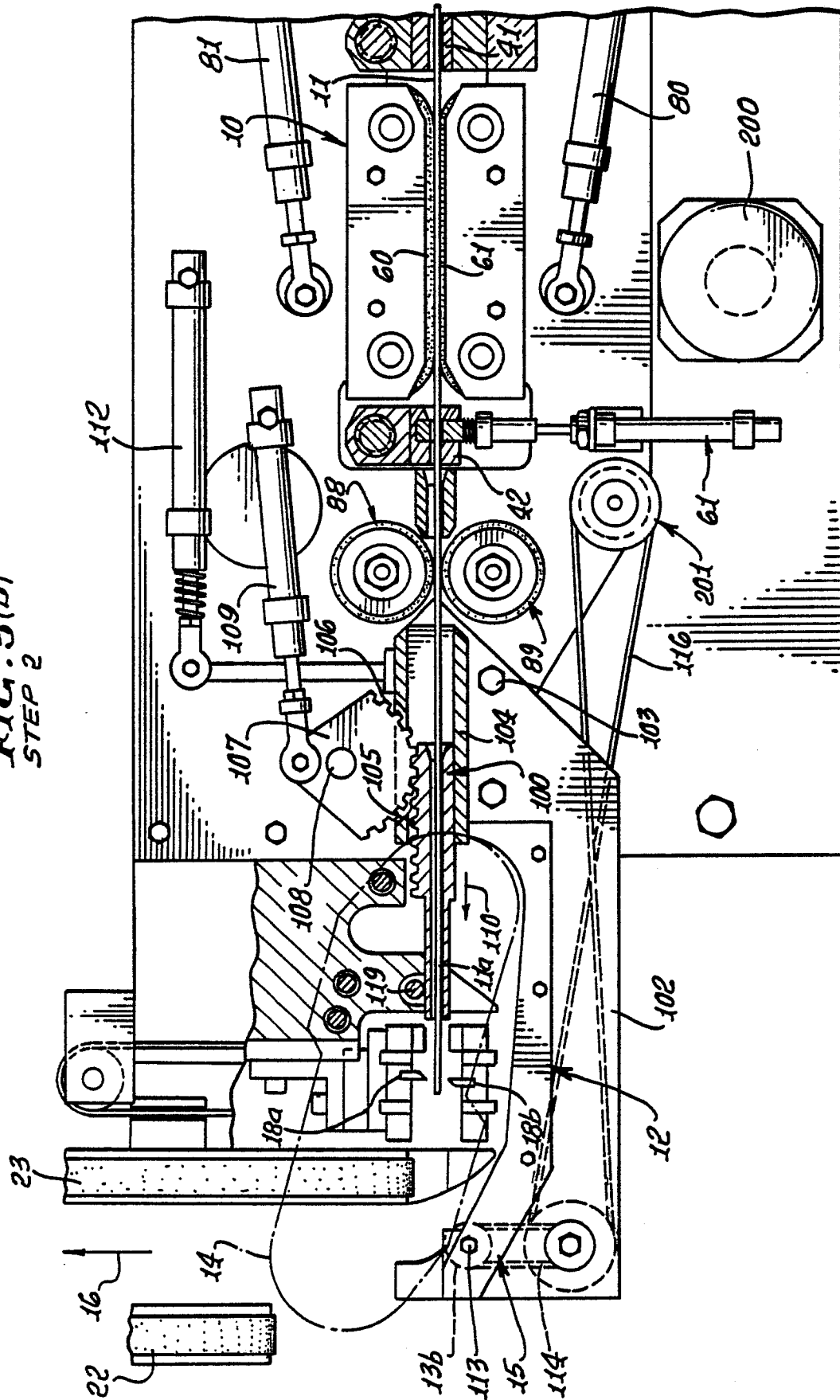


FIG. 3(c)
STEP 3

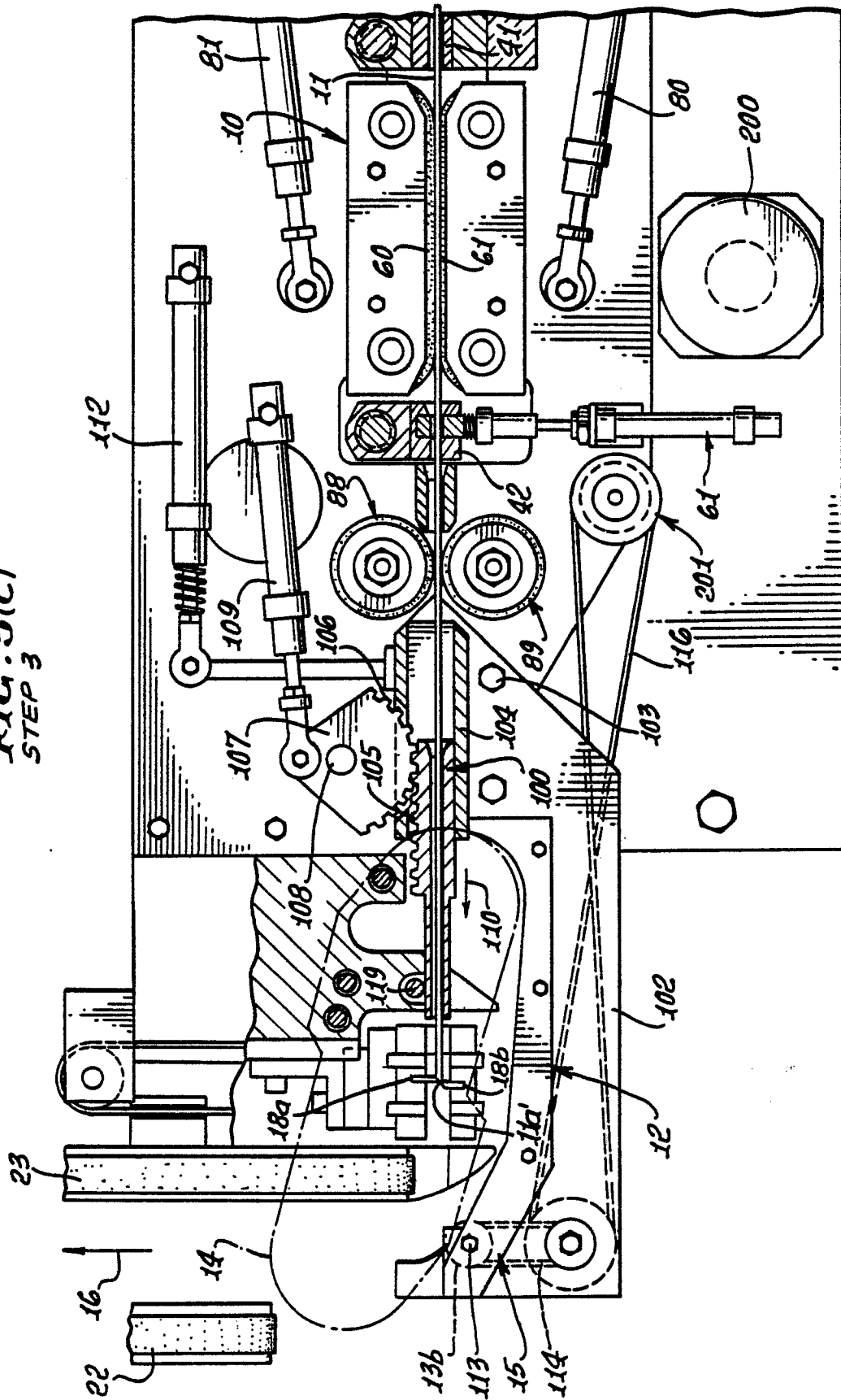


FIG. 3(d)
STEP 4

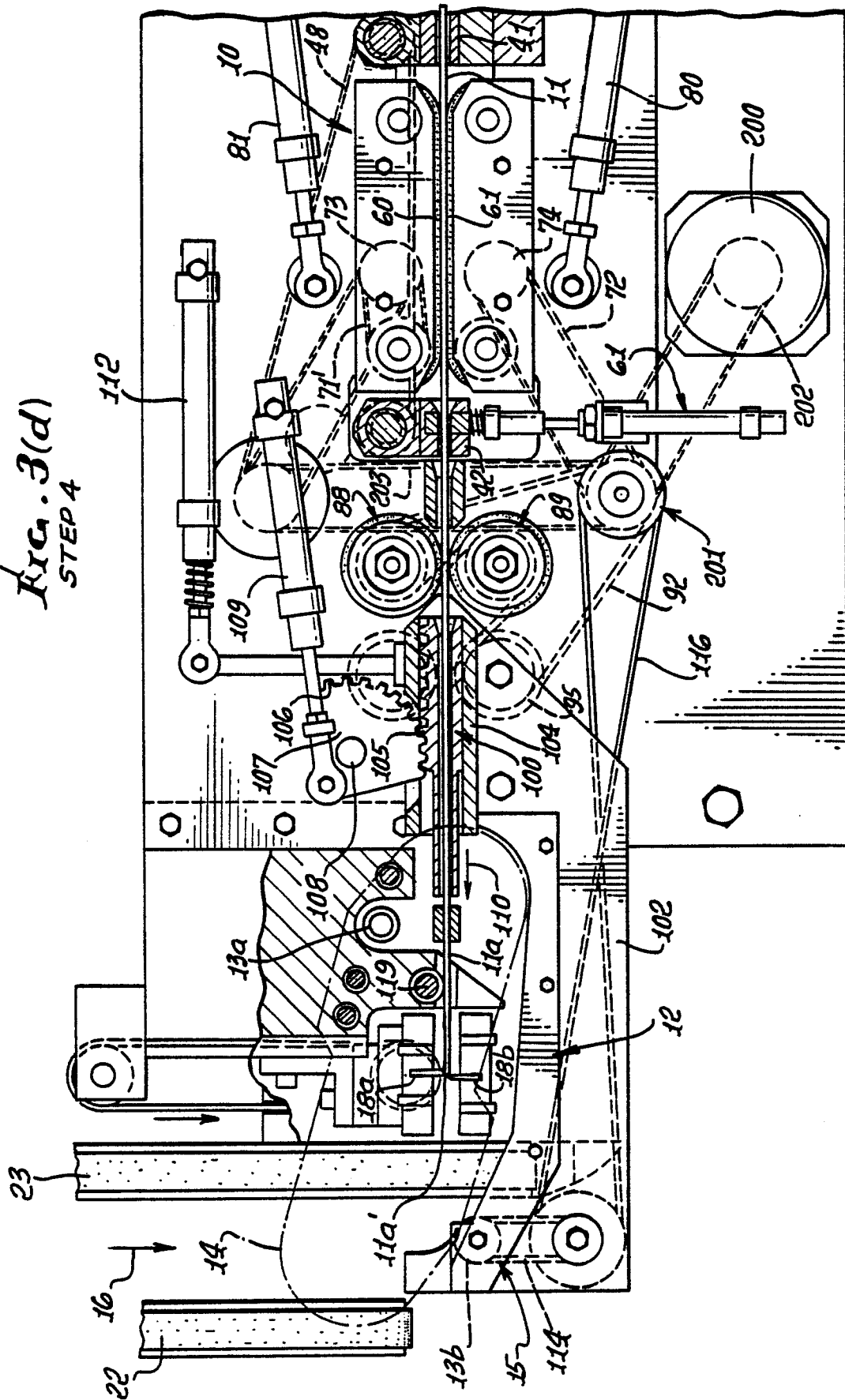
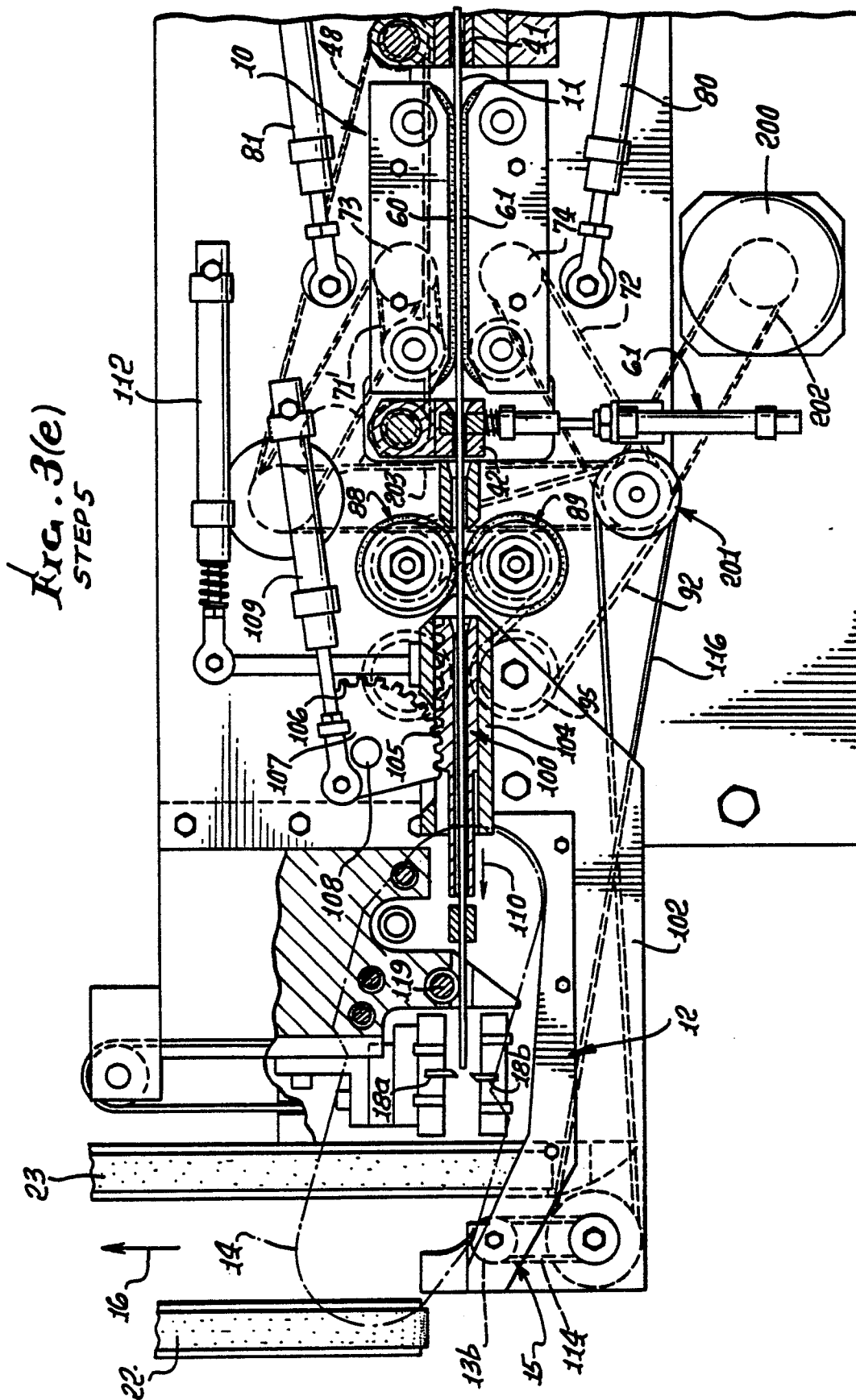
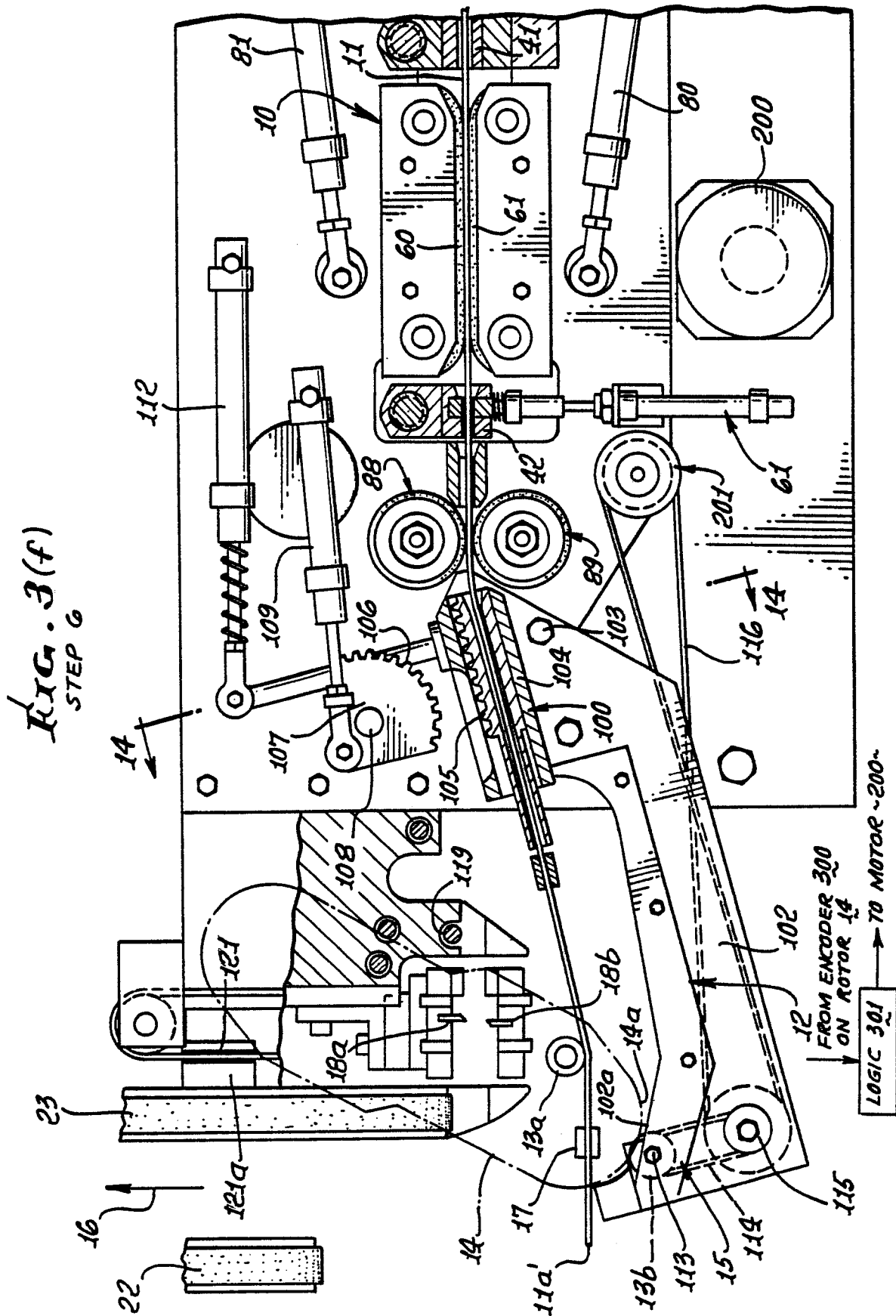
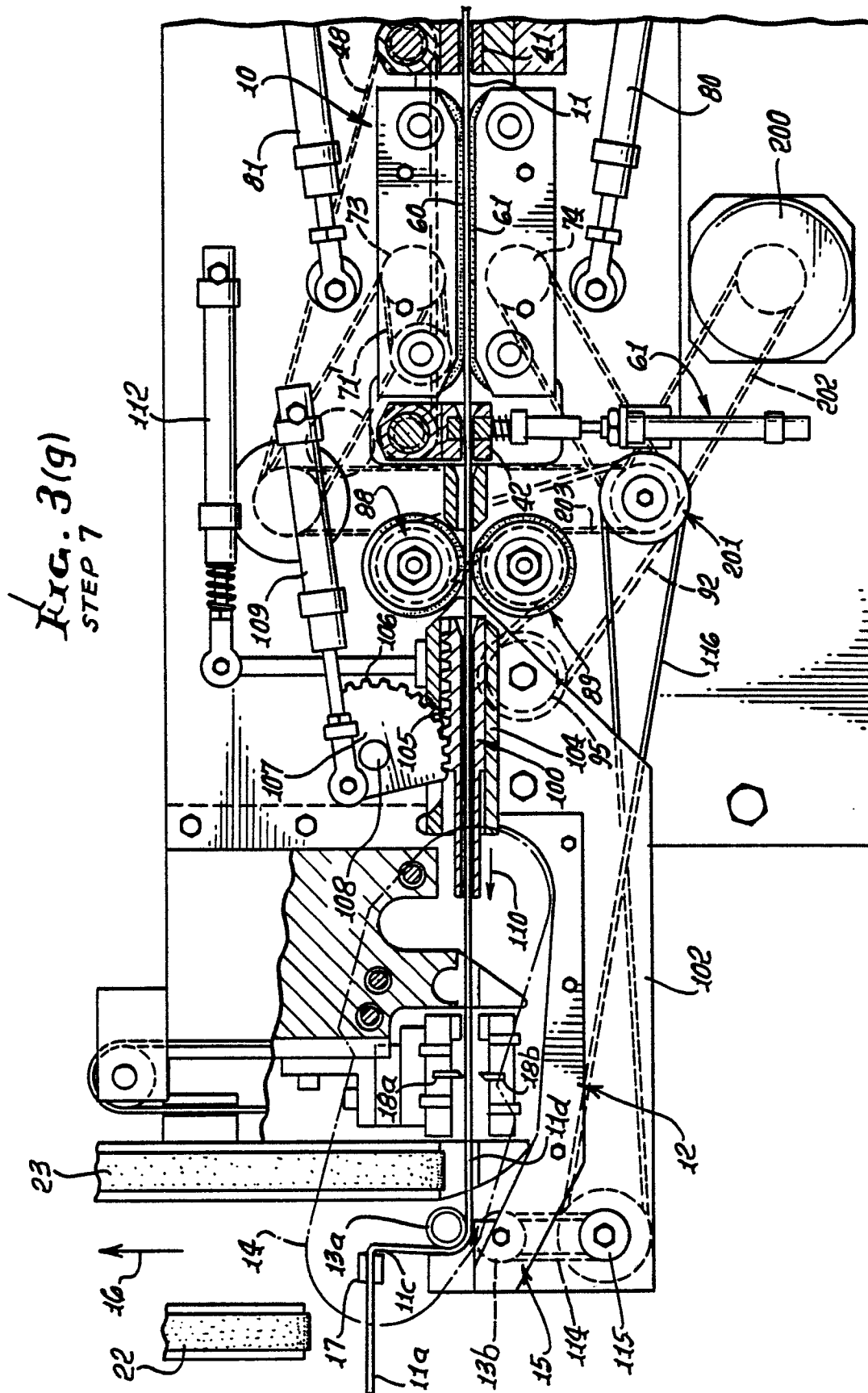
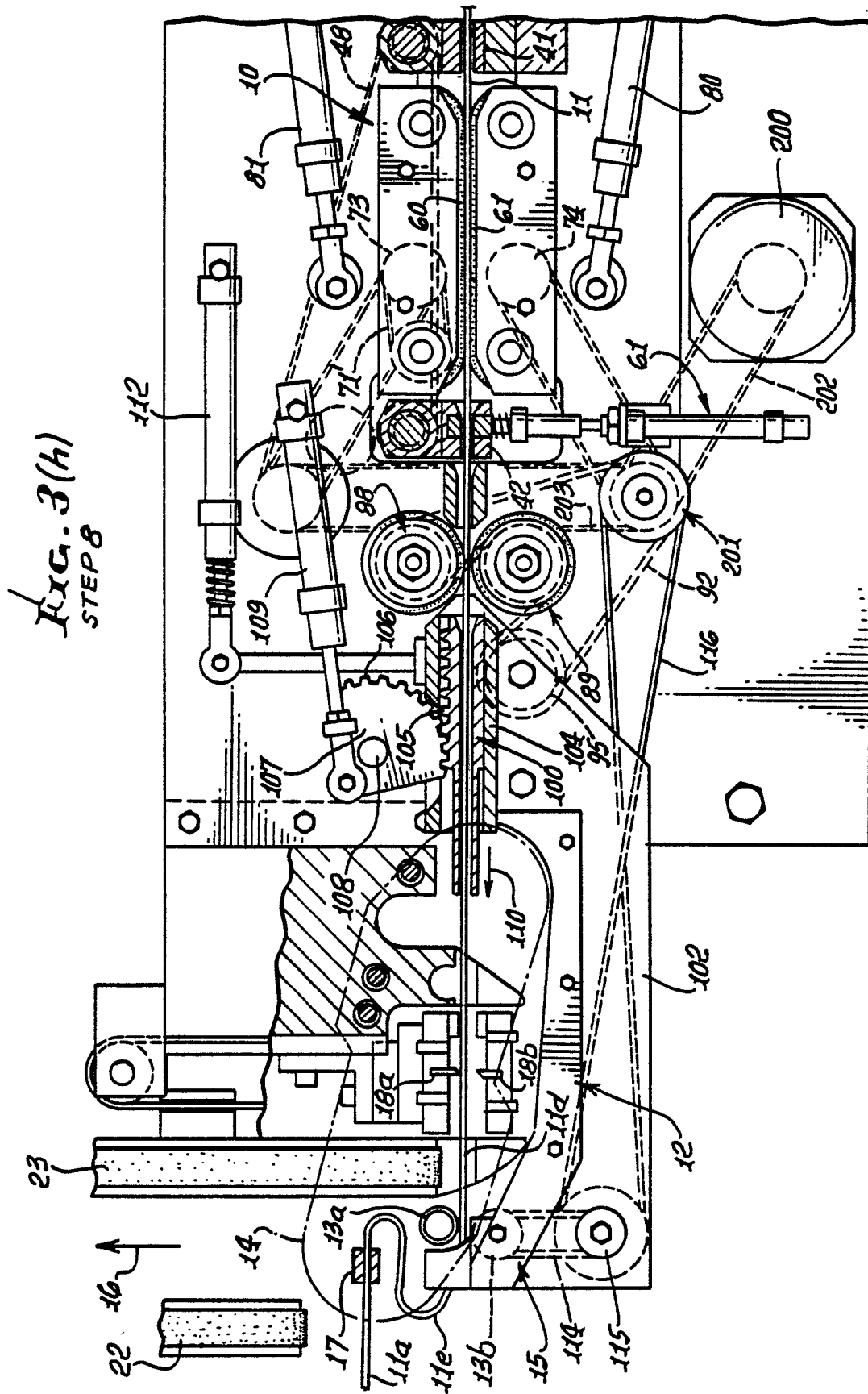


FIG. 3









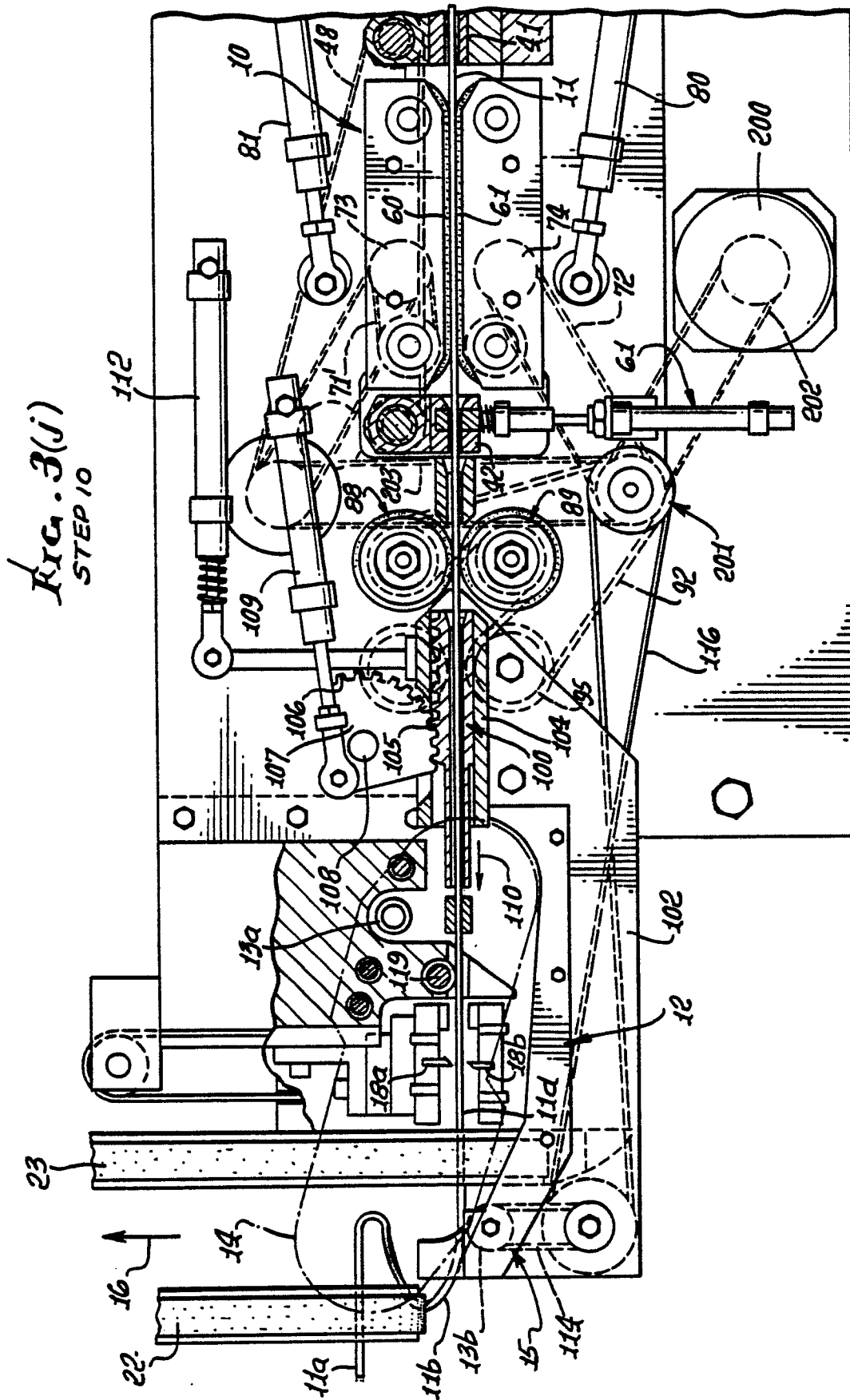


FIG. 3(K)
STEP 11

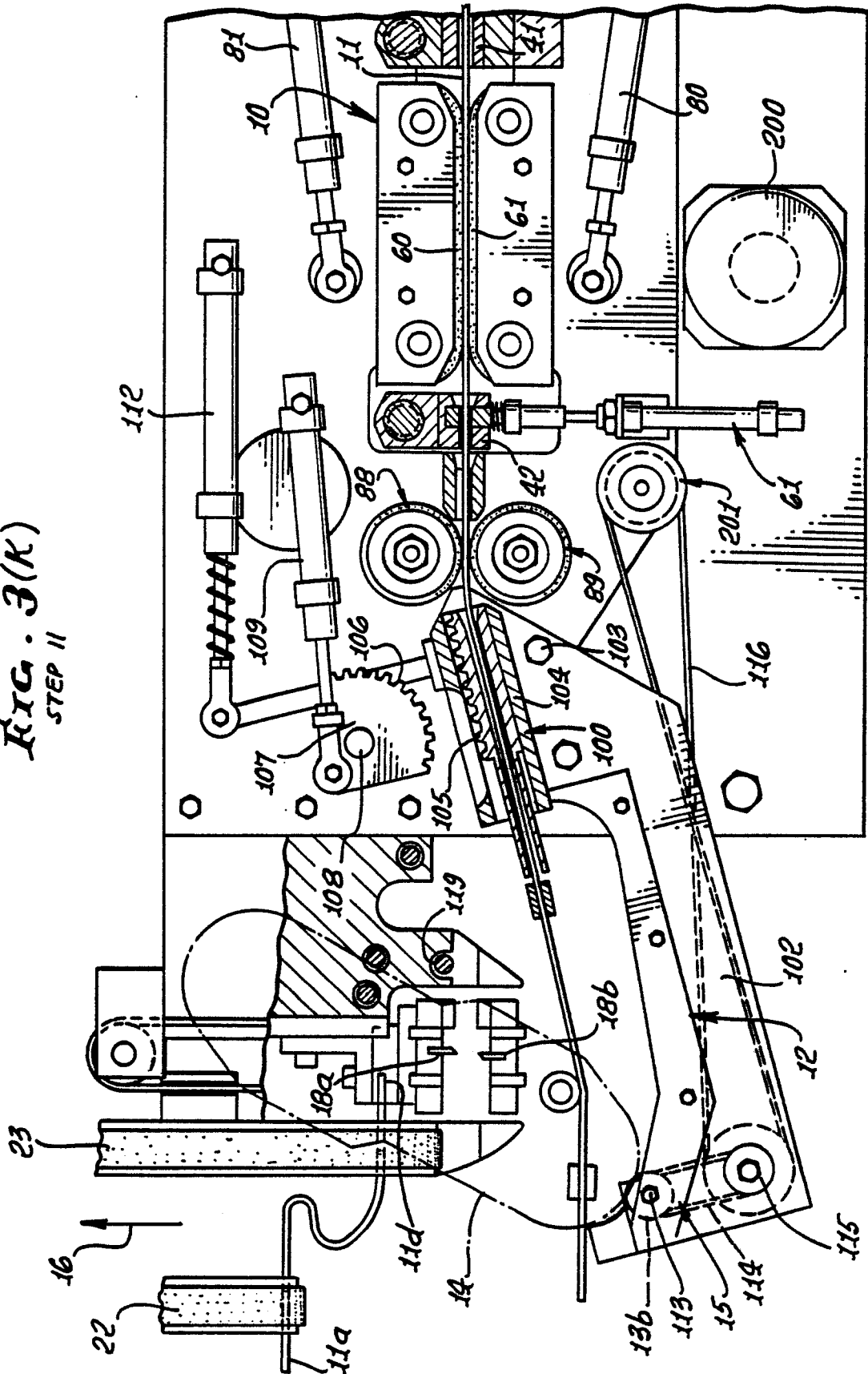


FIG. 4.

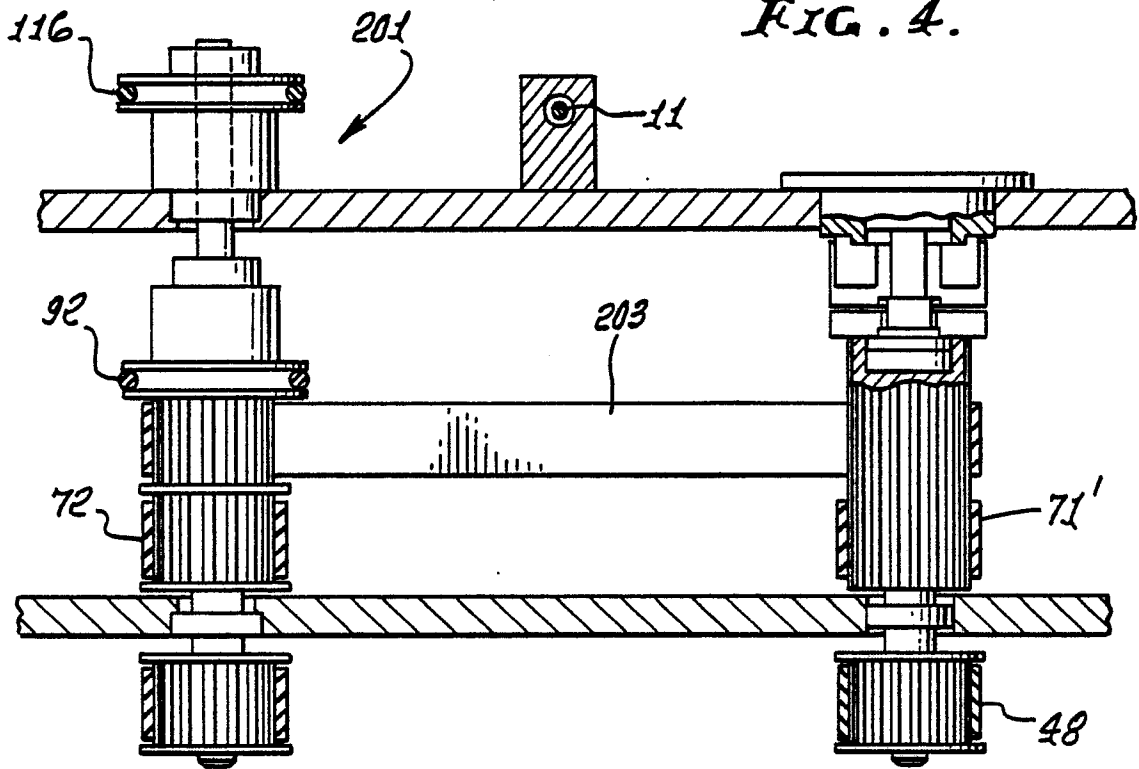


FIG. 11.

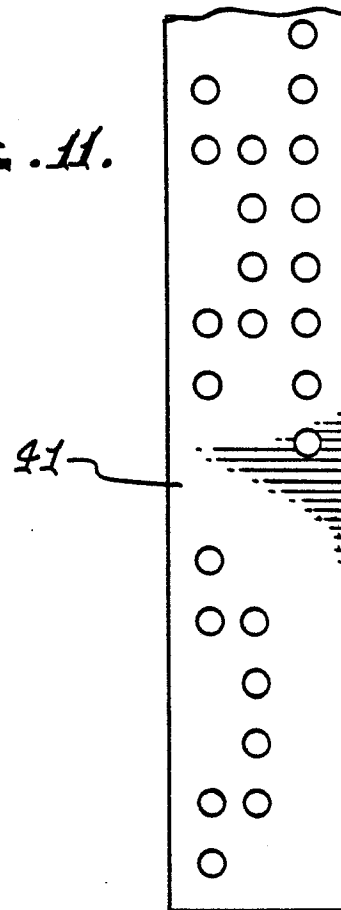


FIG. 12.

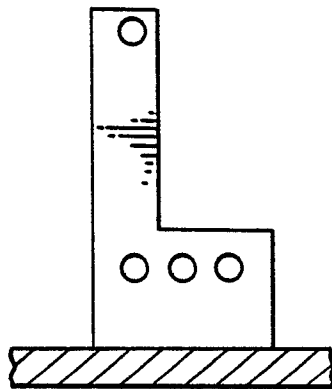


FIG. 5.

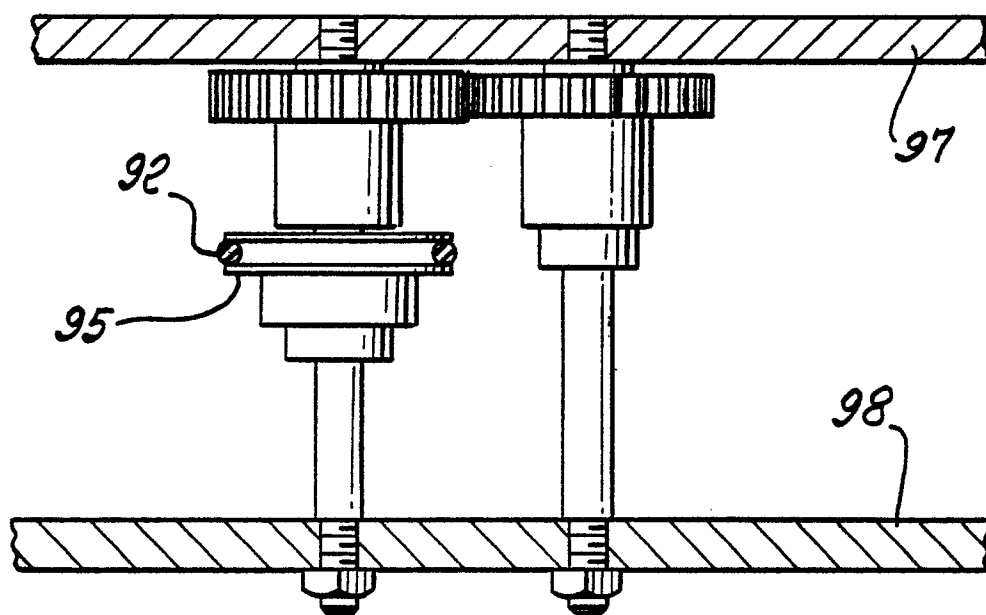
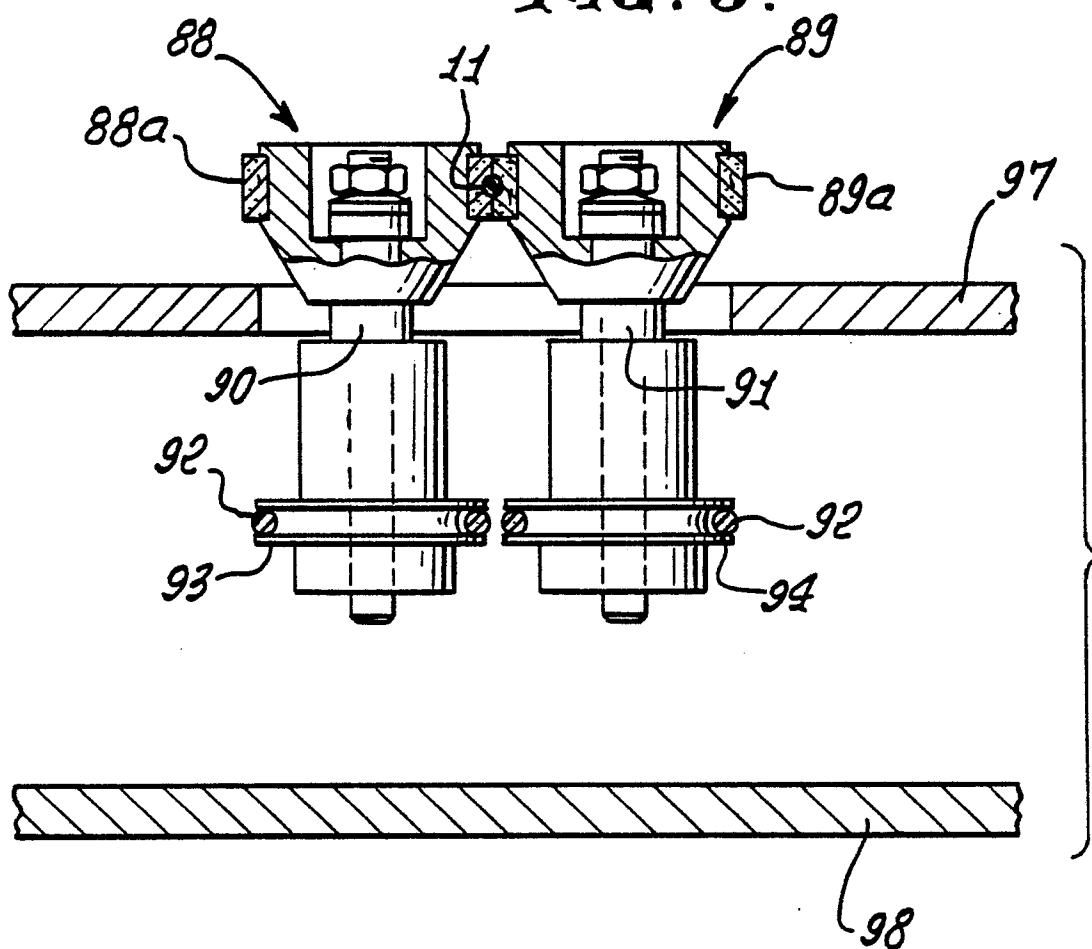
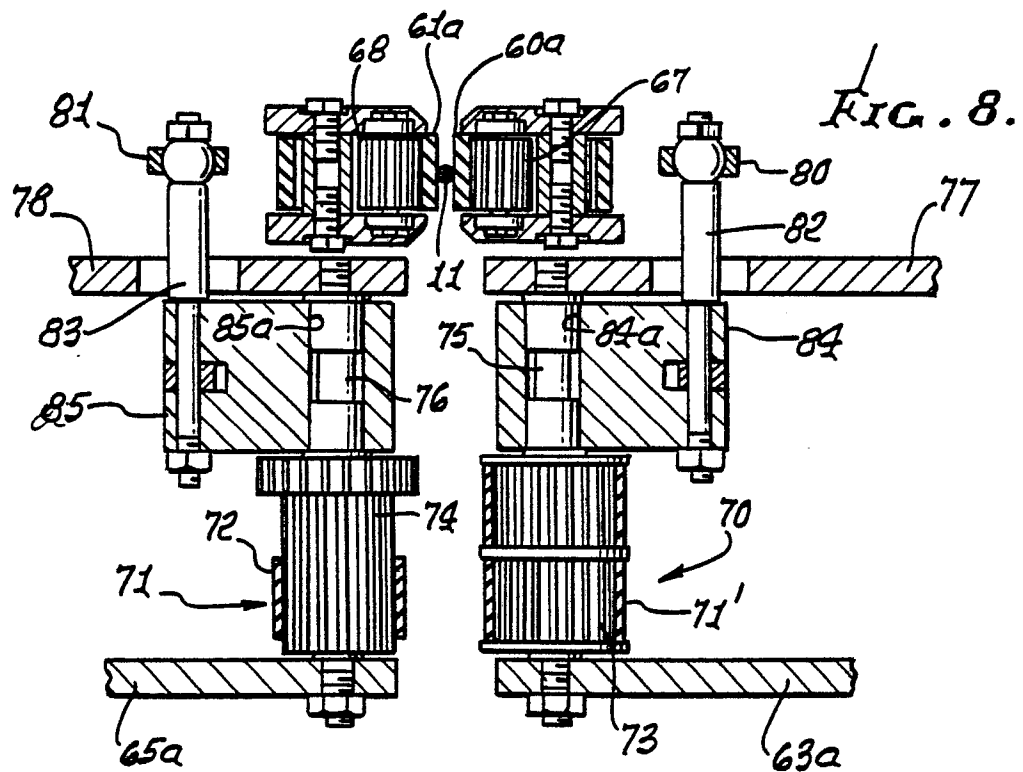
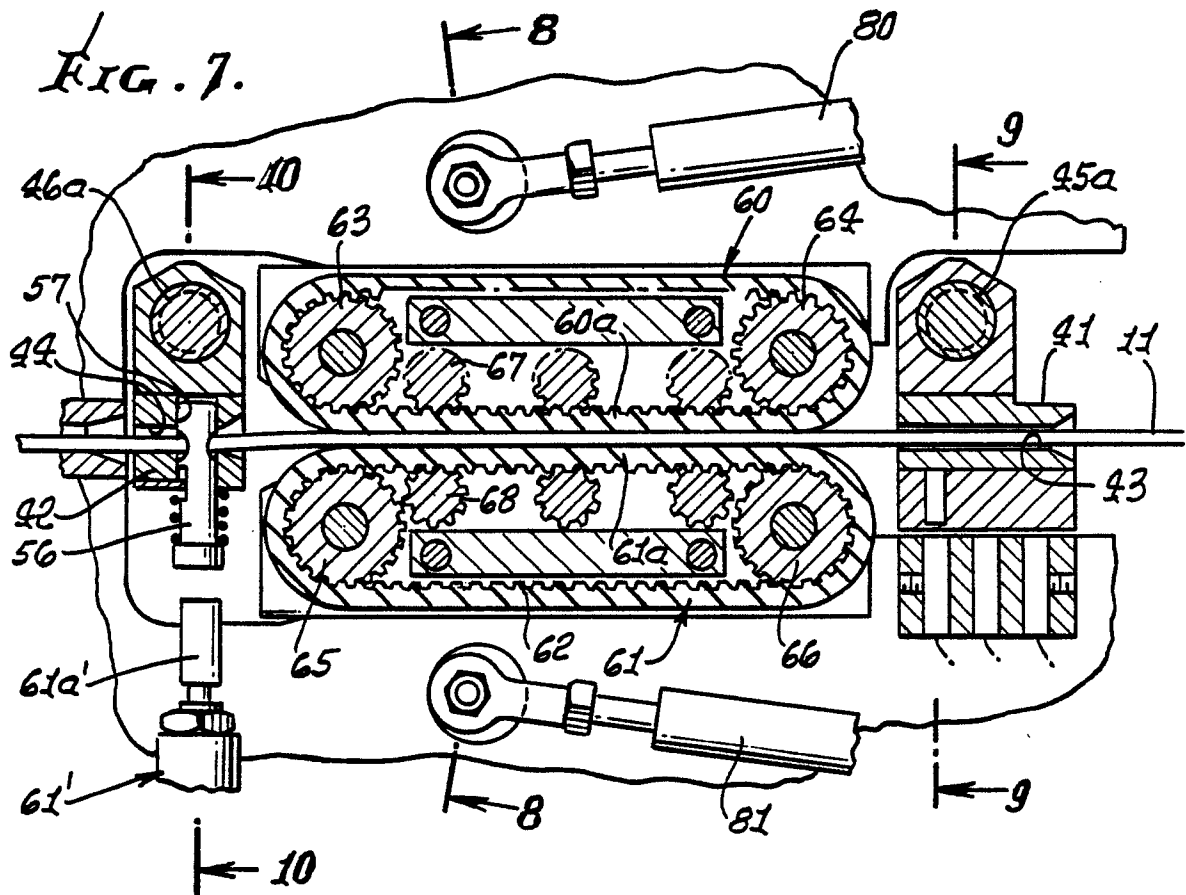


FIG. 6.





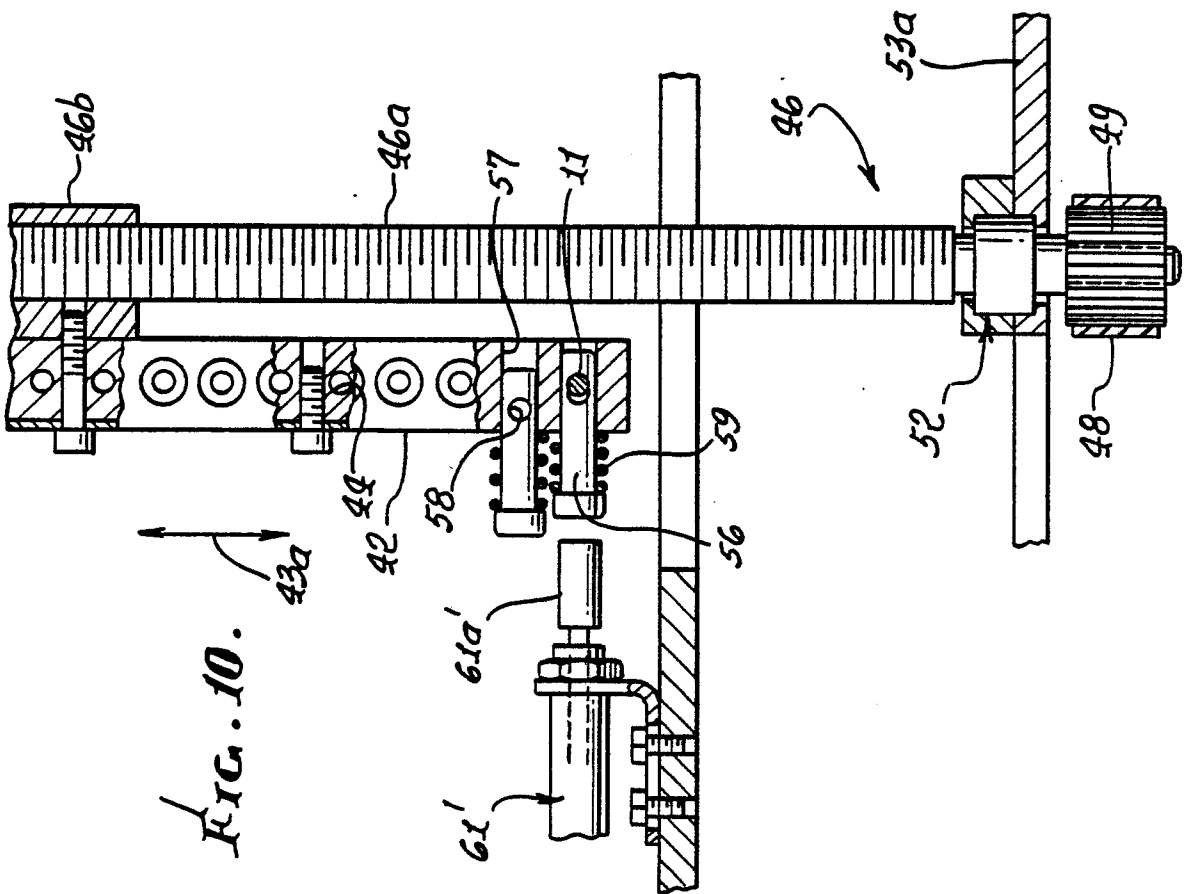
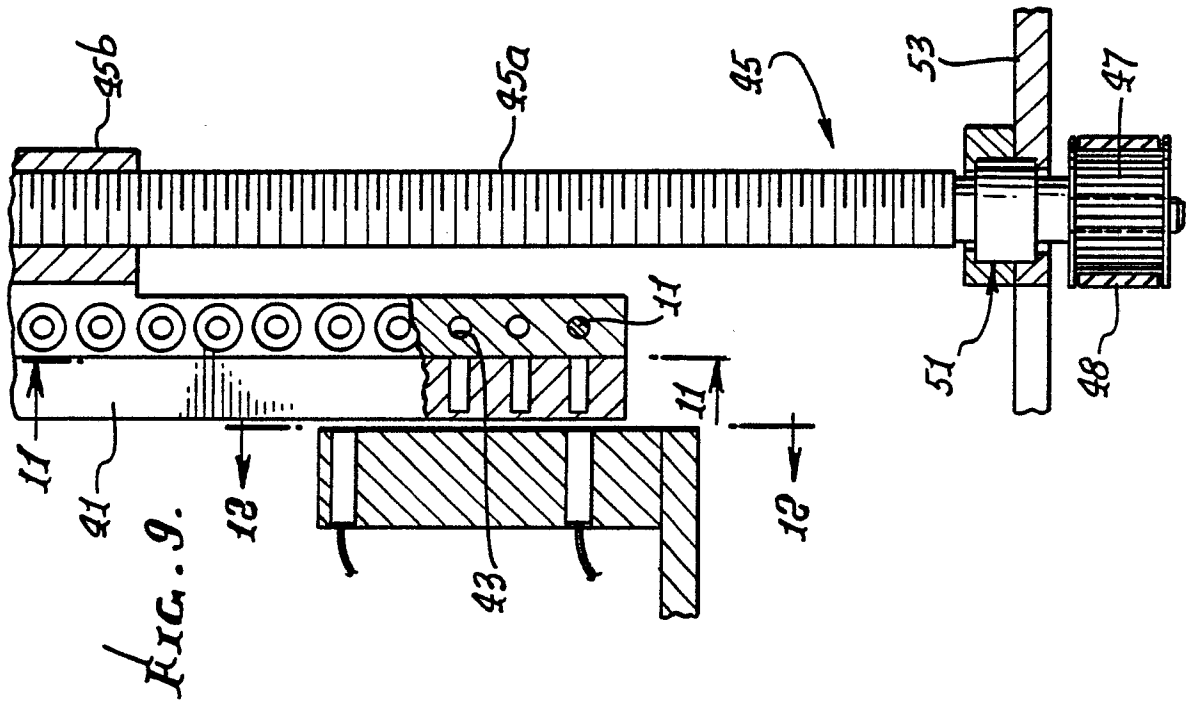


FIG. 13a.

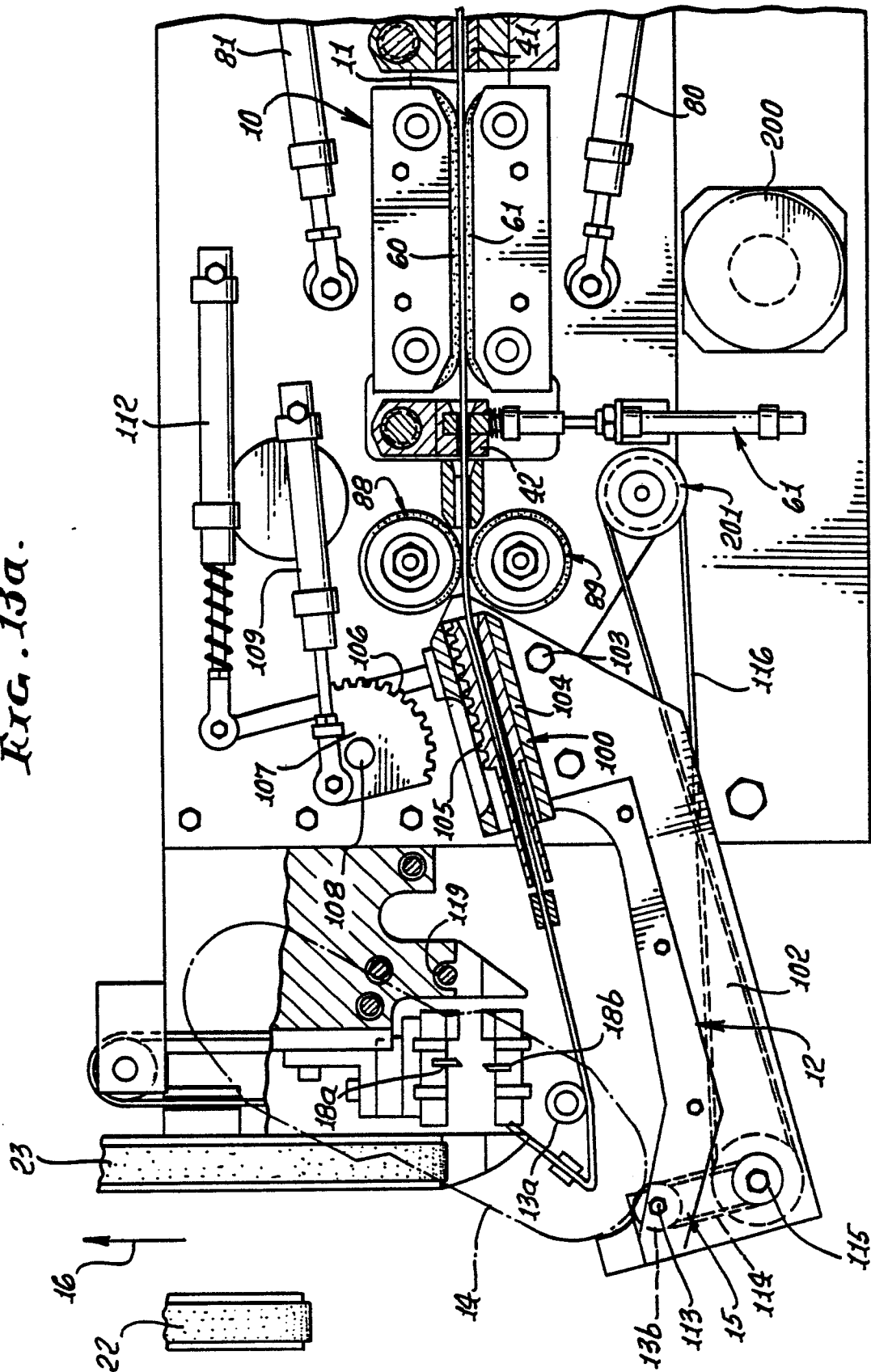


FIG. 13b.

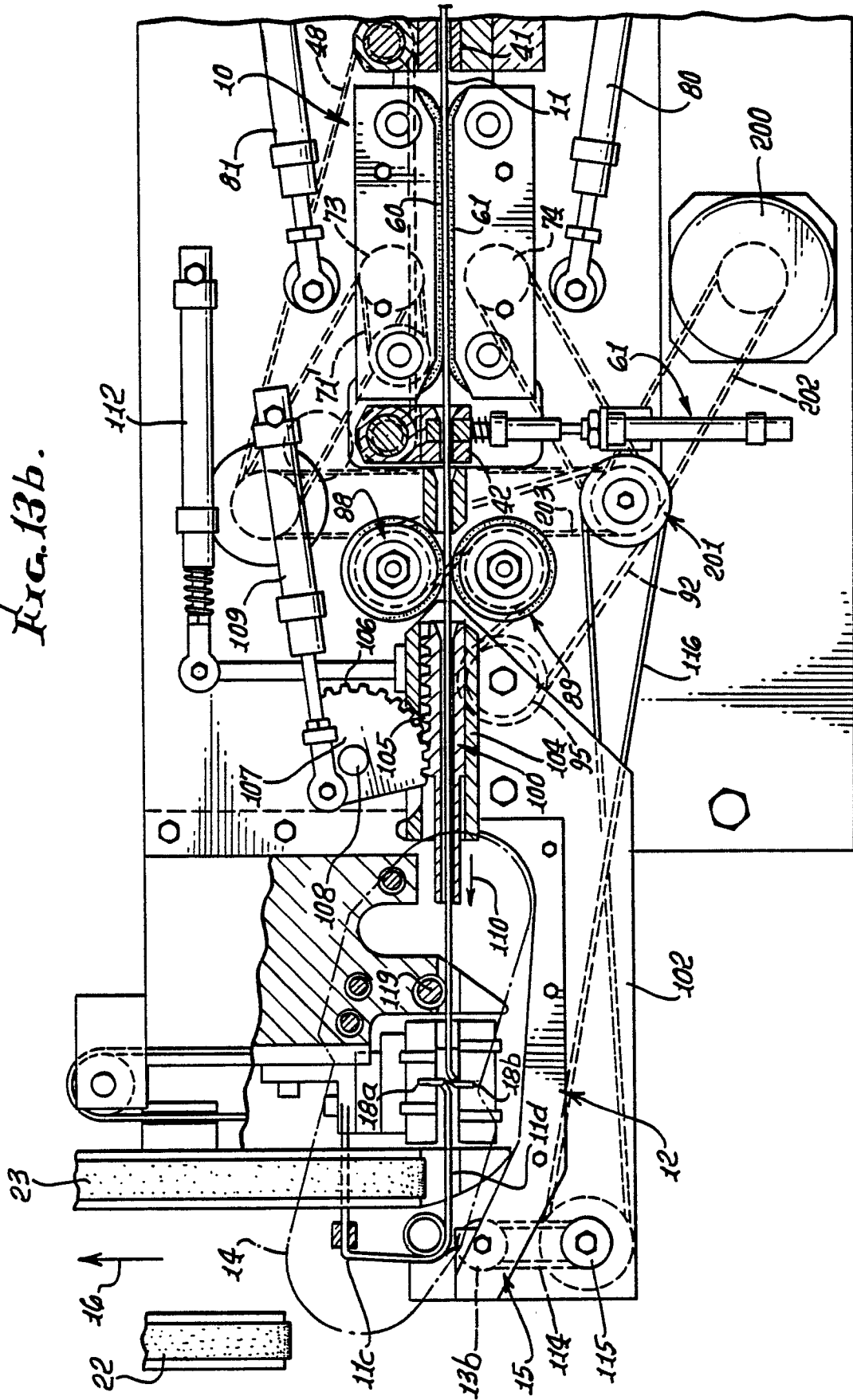


FIG. 14.

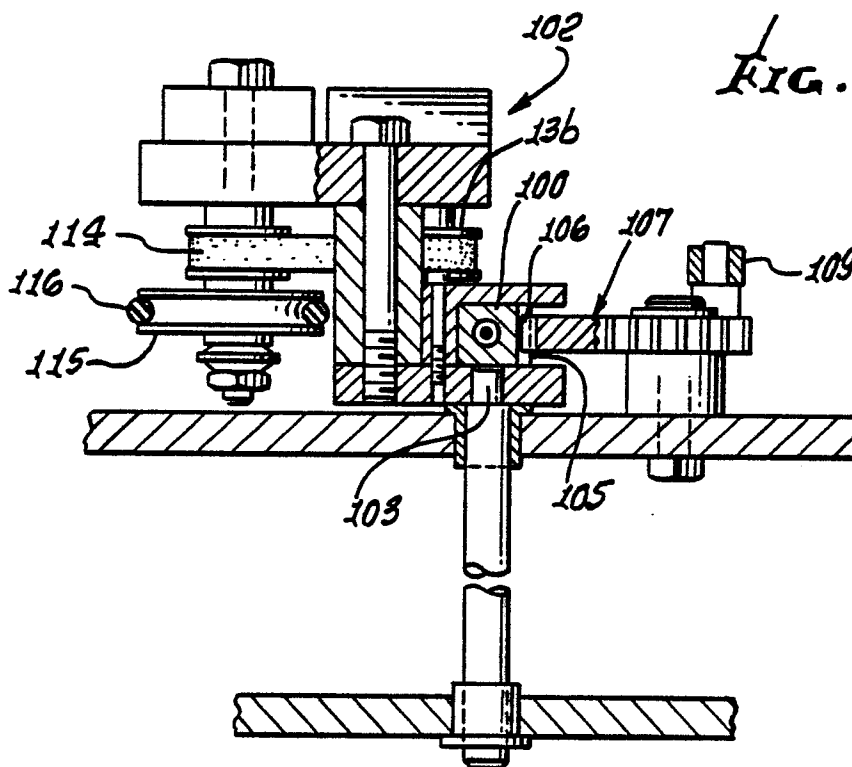


FIG. 15.

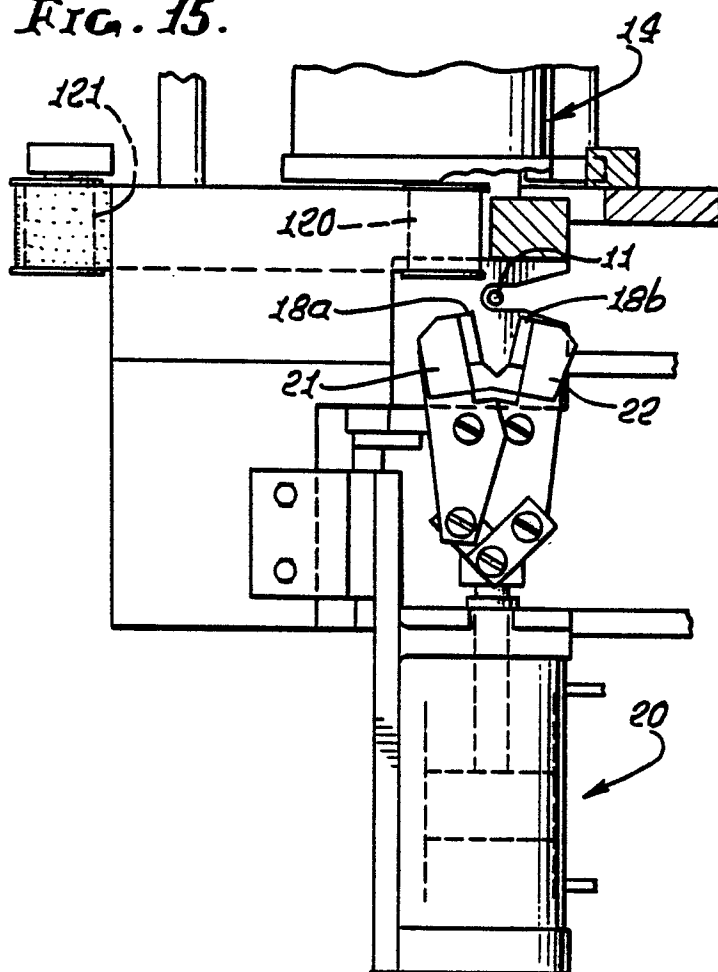
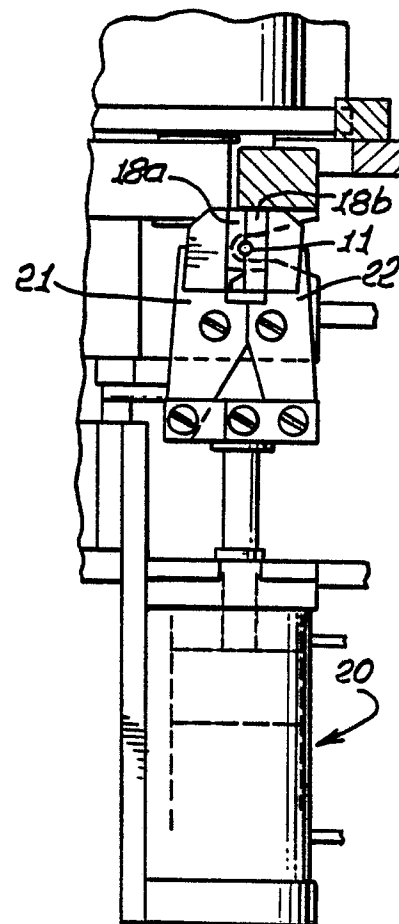


FIG. 16.



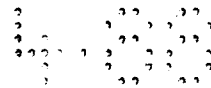


FIG. 17.

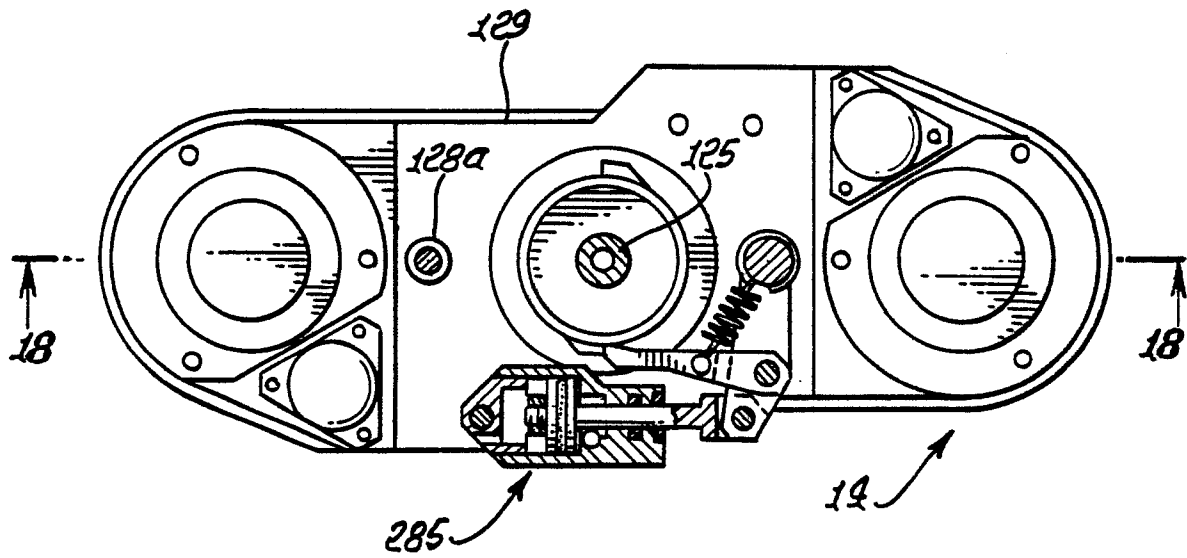
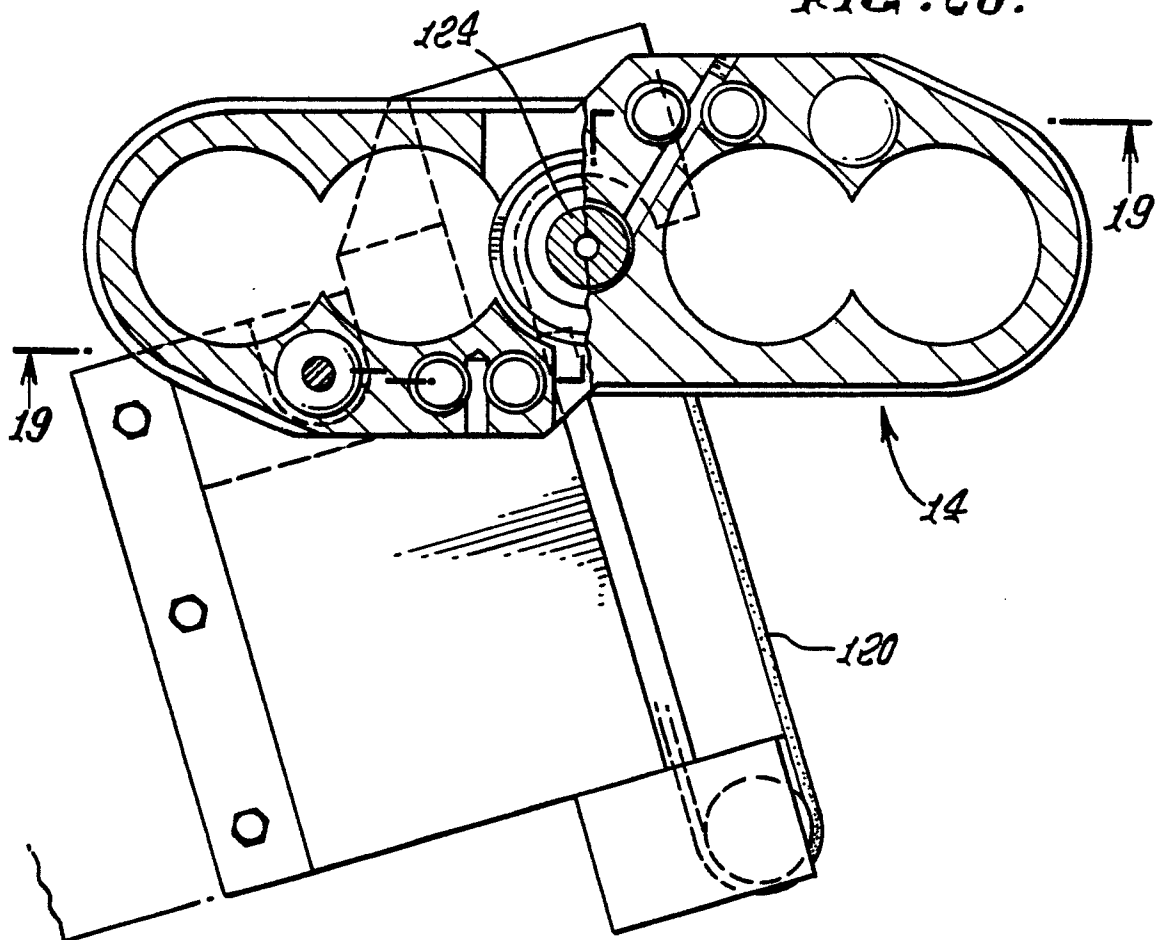


FIG. 20.



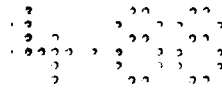
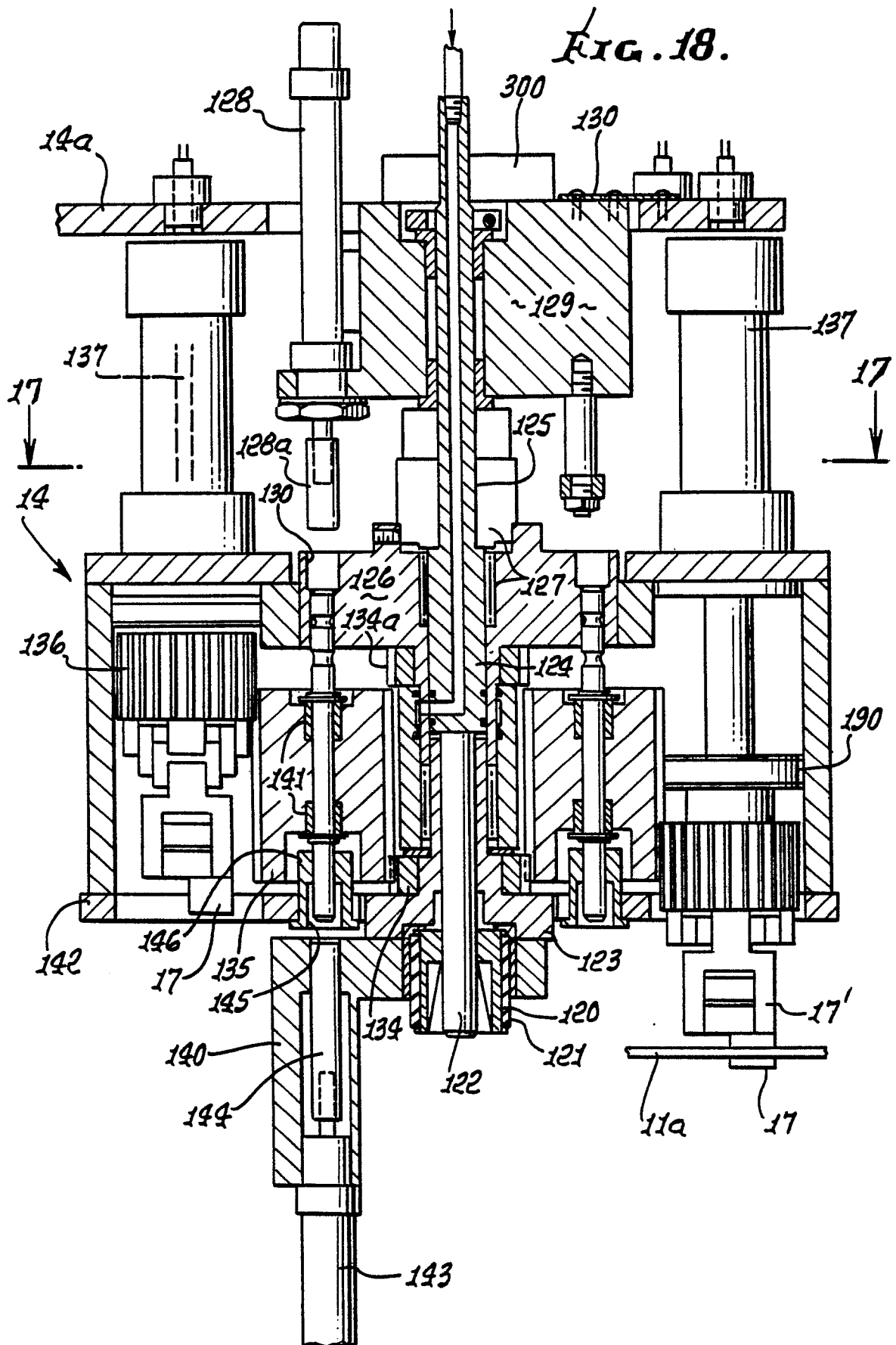


FIG. 18.



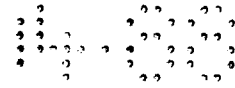


FIG. 19.

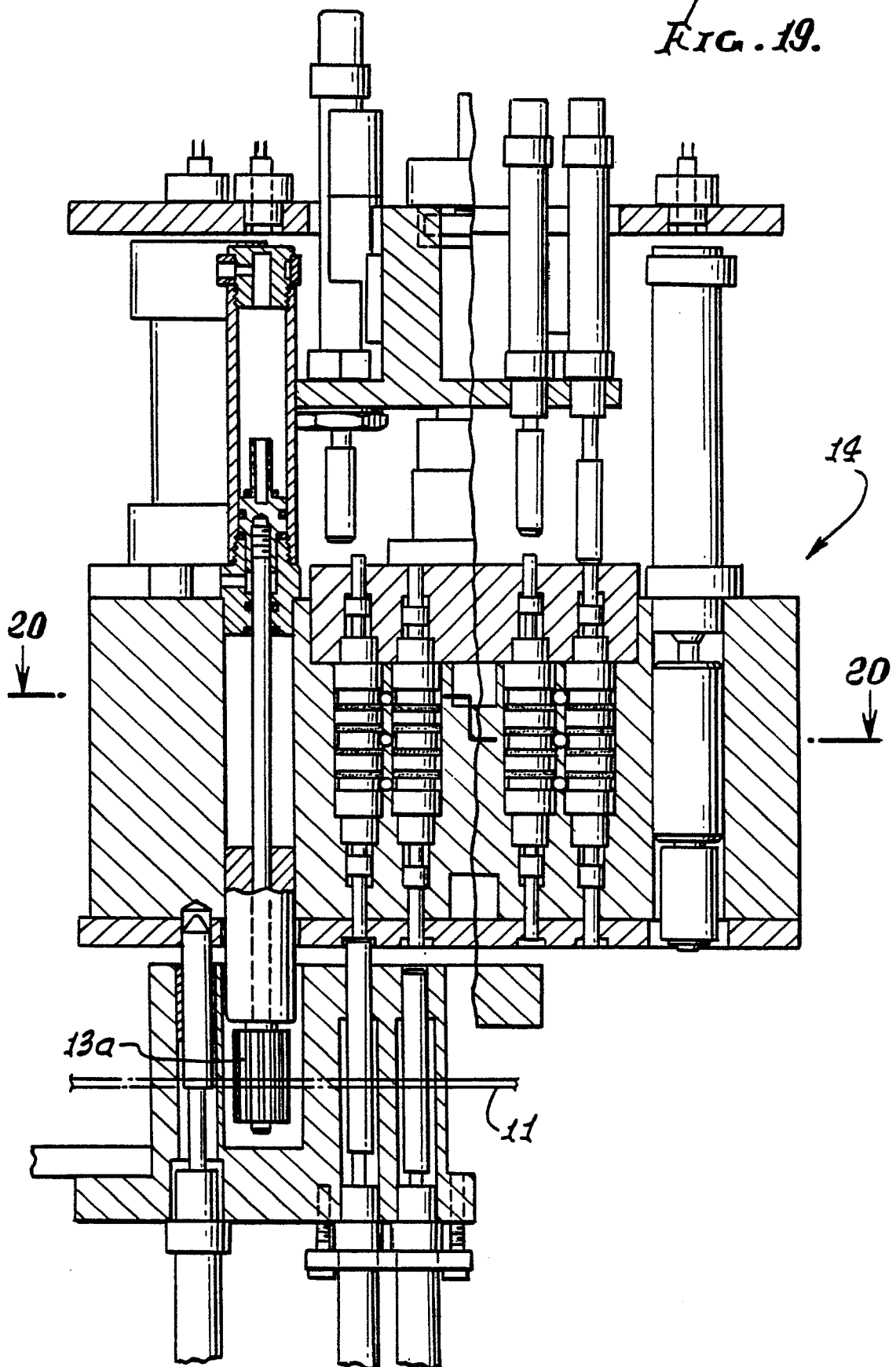


FIG. 21a.

FIG. 21a.

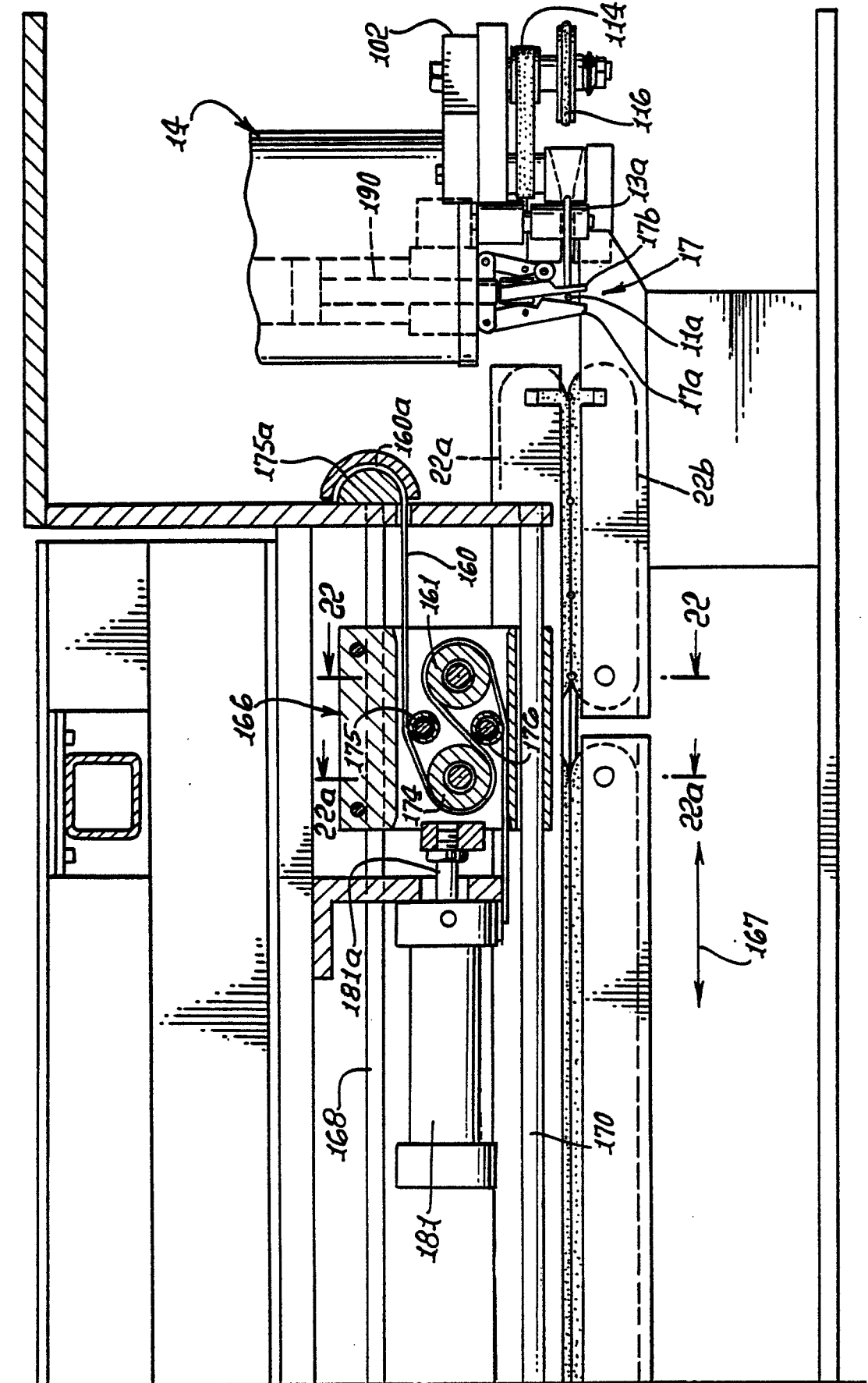
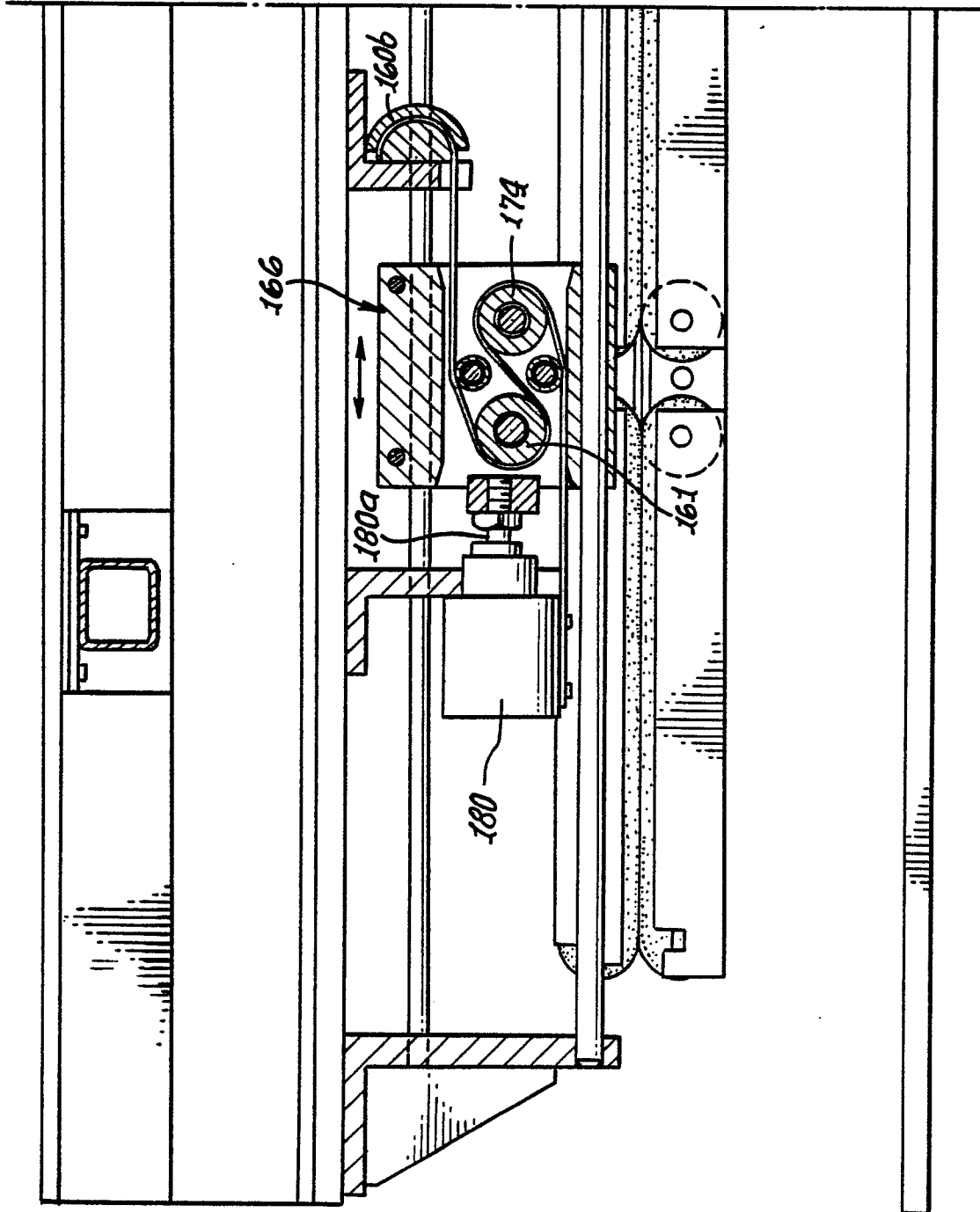
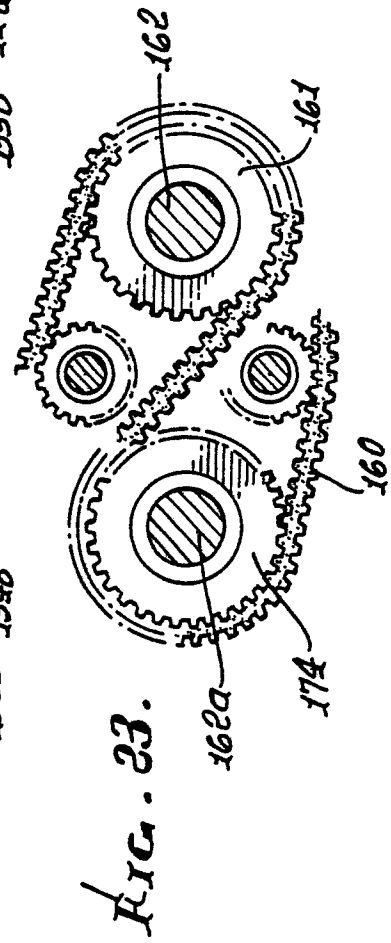
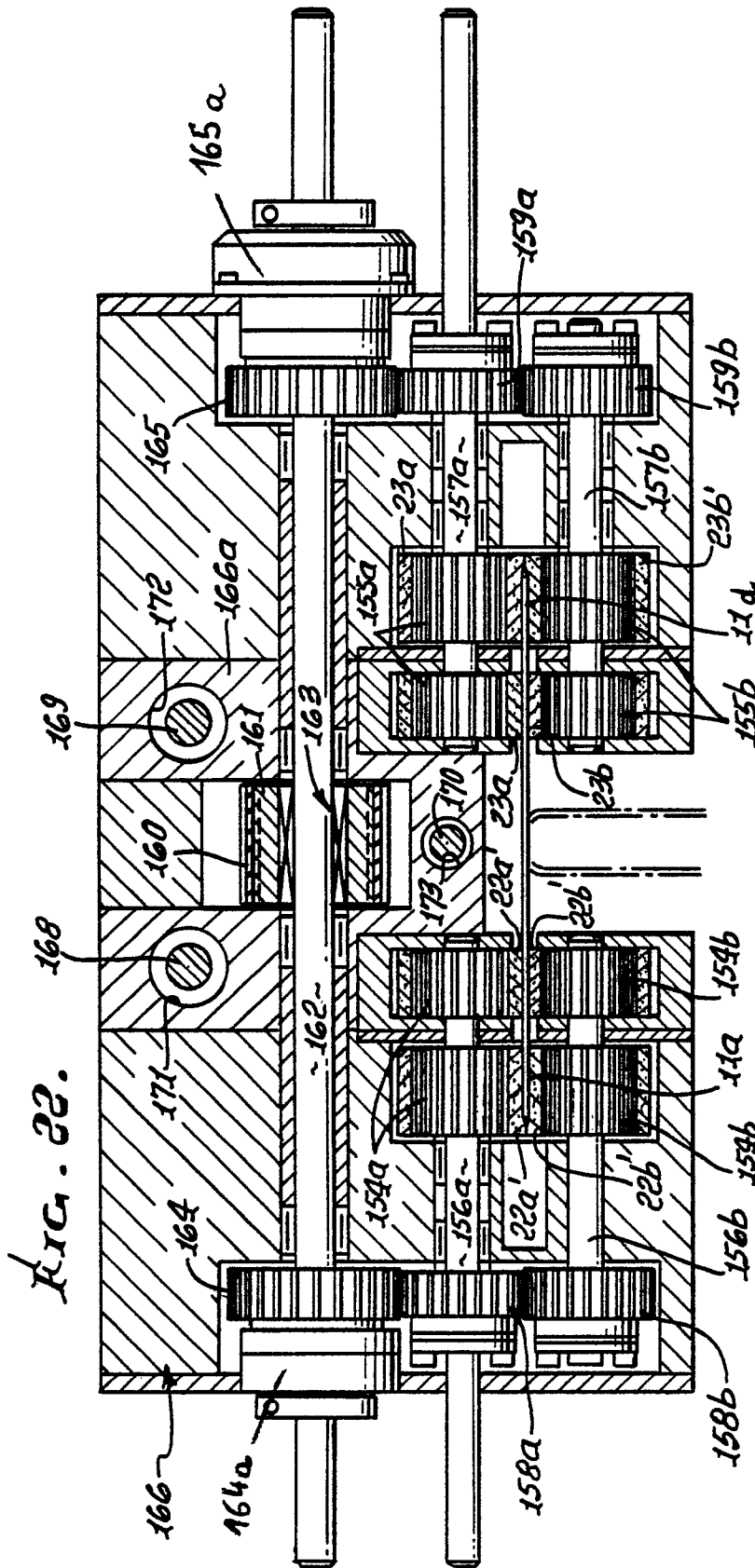
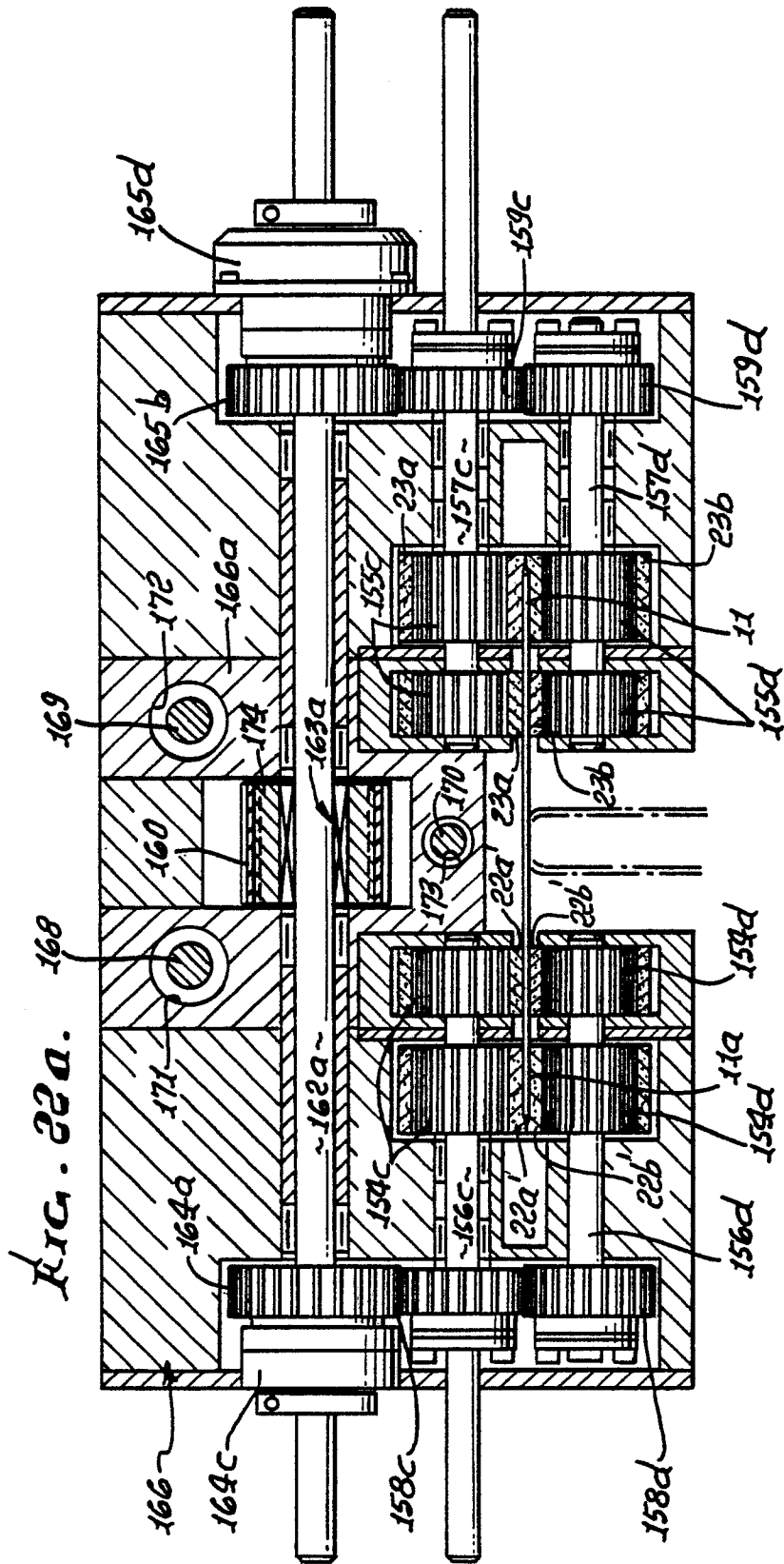


FIG. 21b.







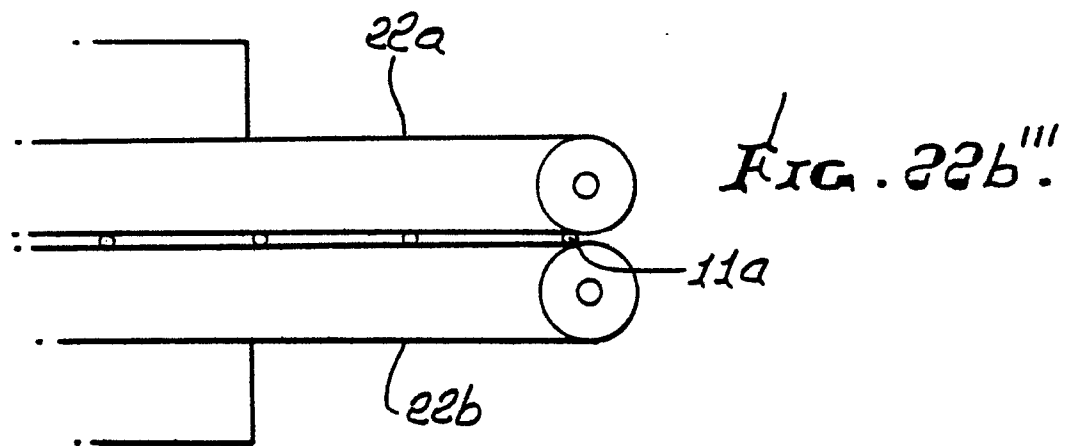
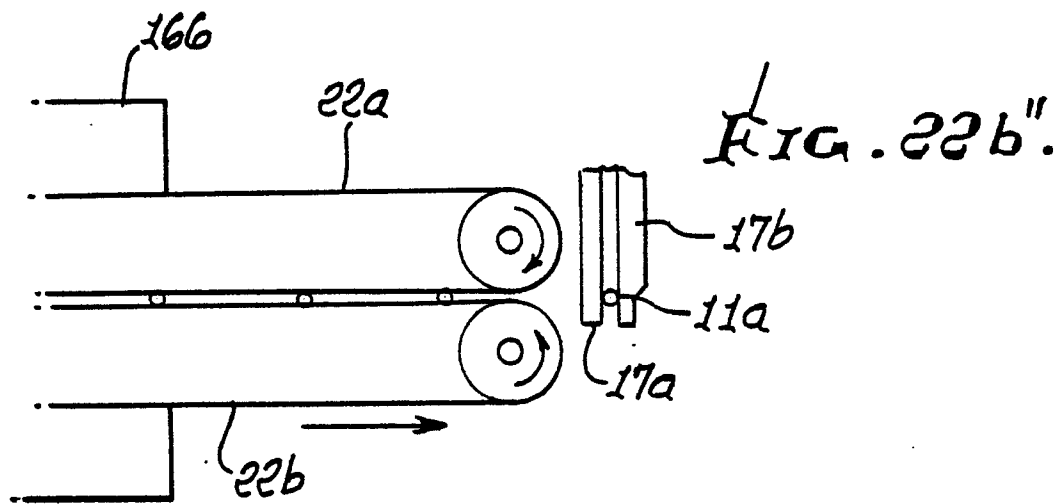
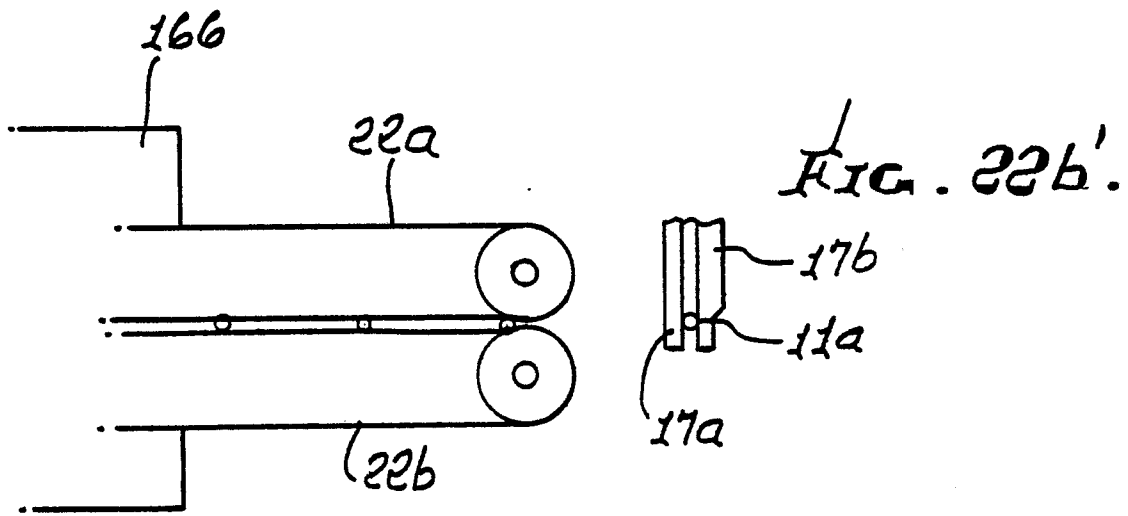


FIG. 22c'

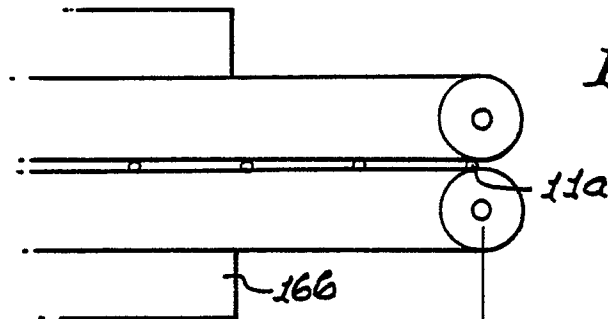


FIG. 22c''

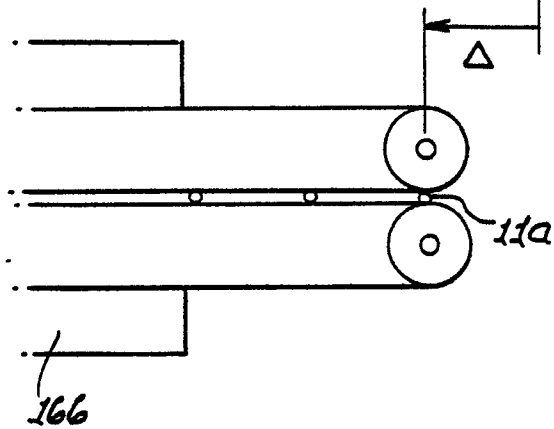


FIG. 22d'

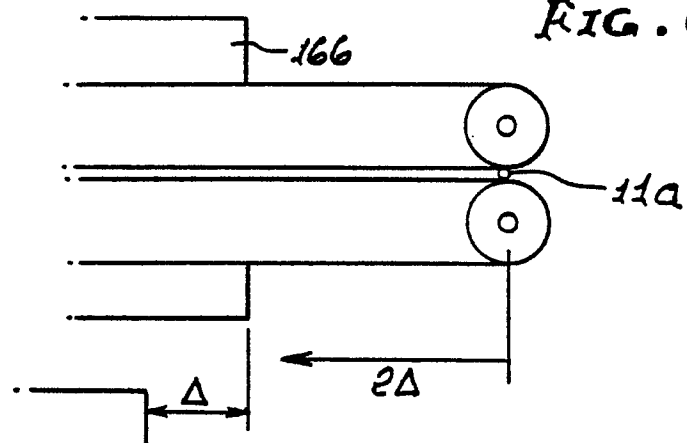


FIG. 22d''

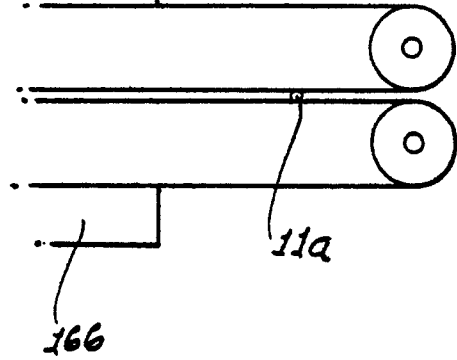


FIG. 24a.

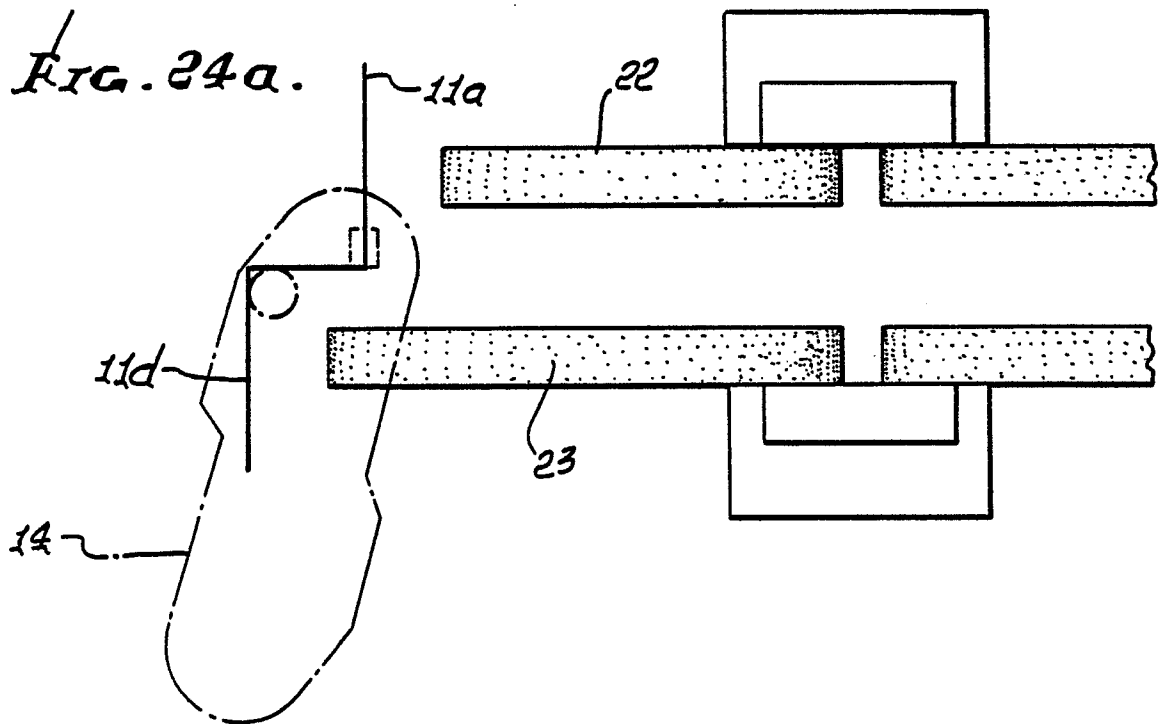
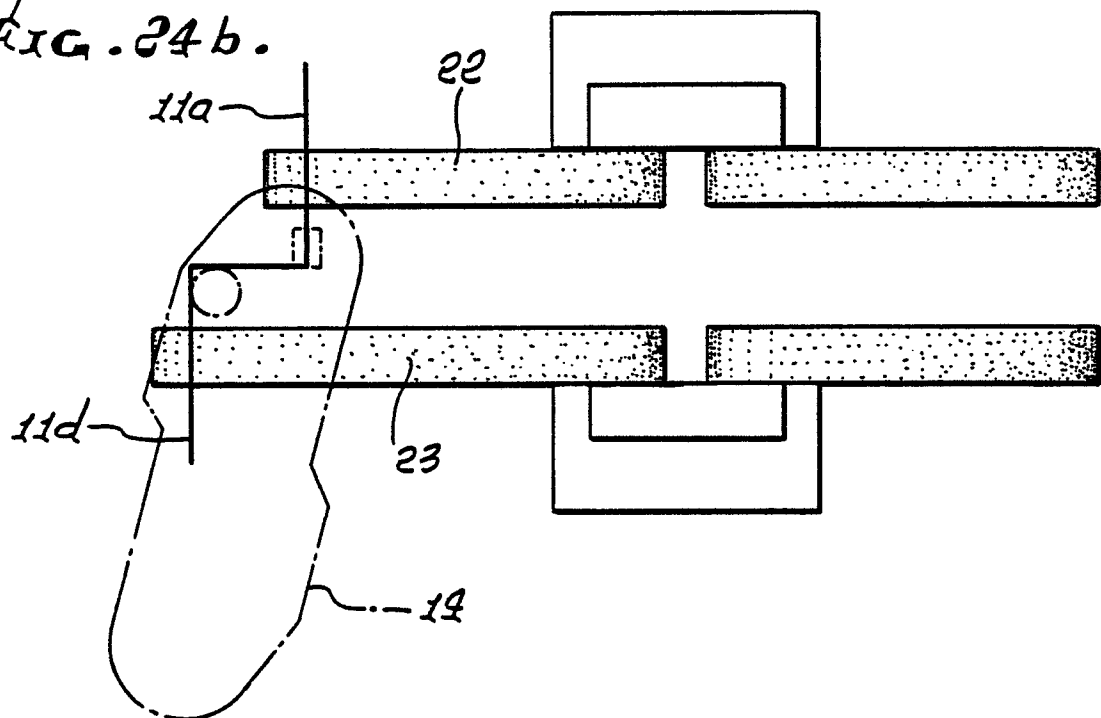


FIG. 24b.



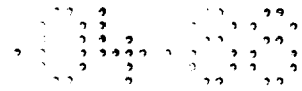


FIG. 24c.

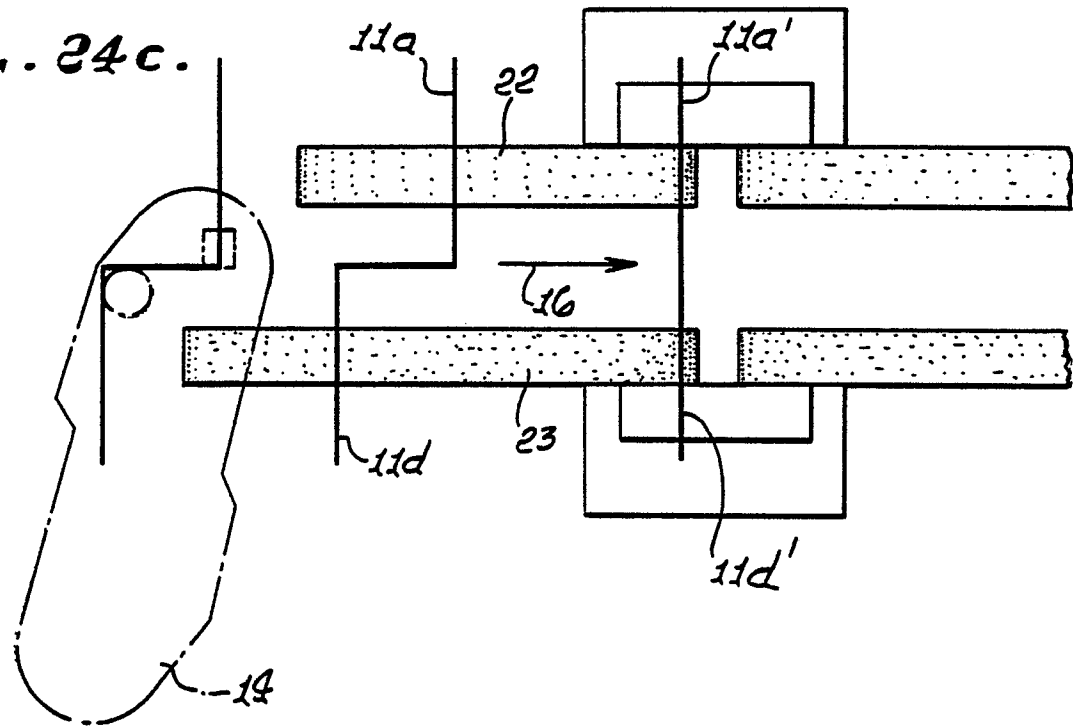
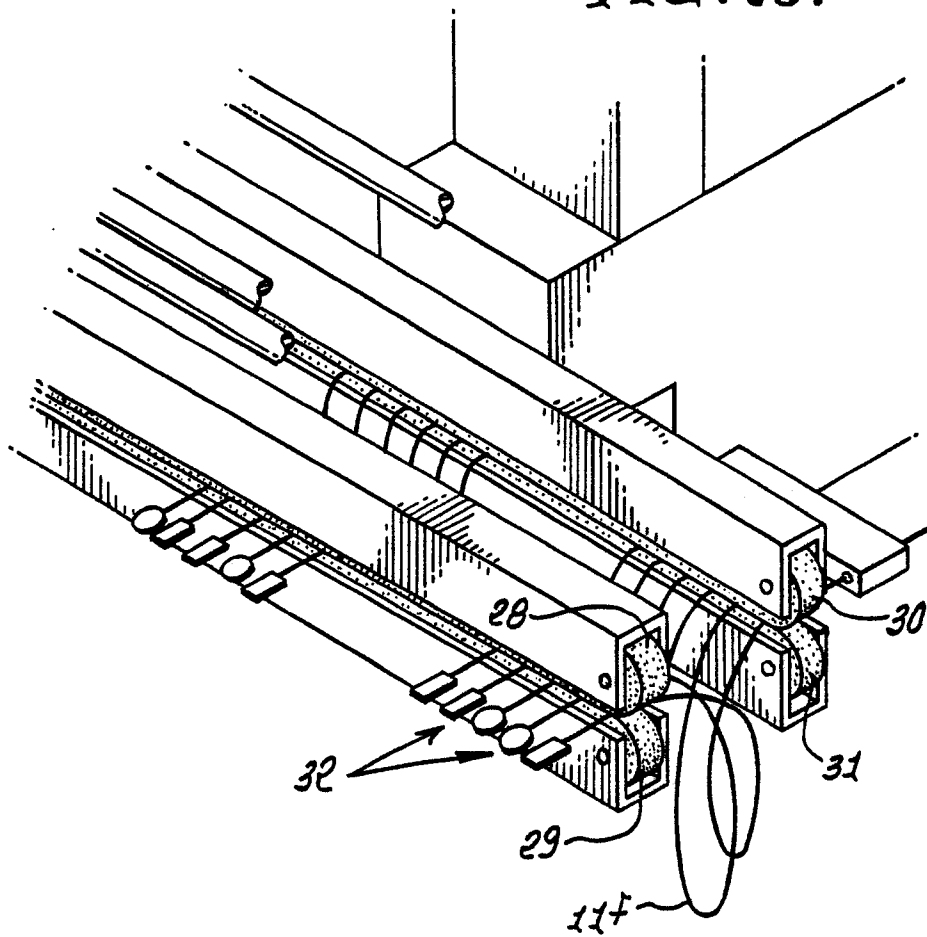
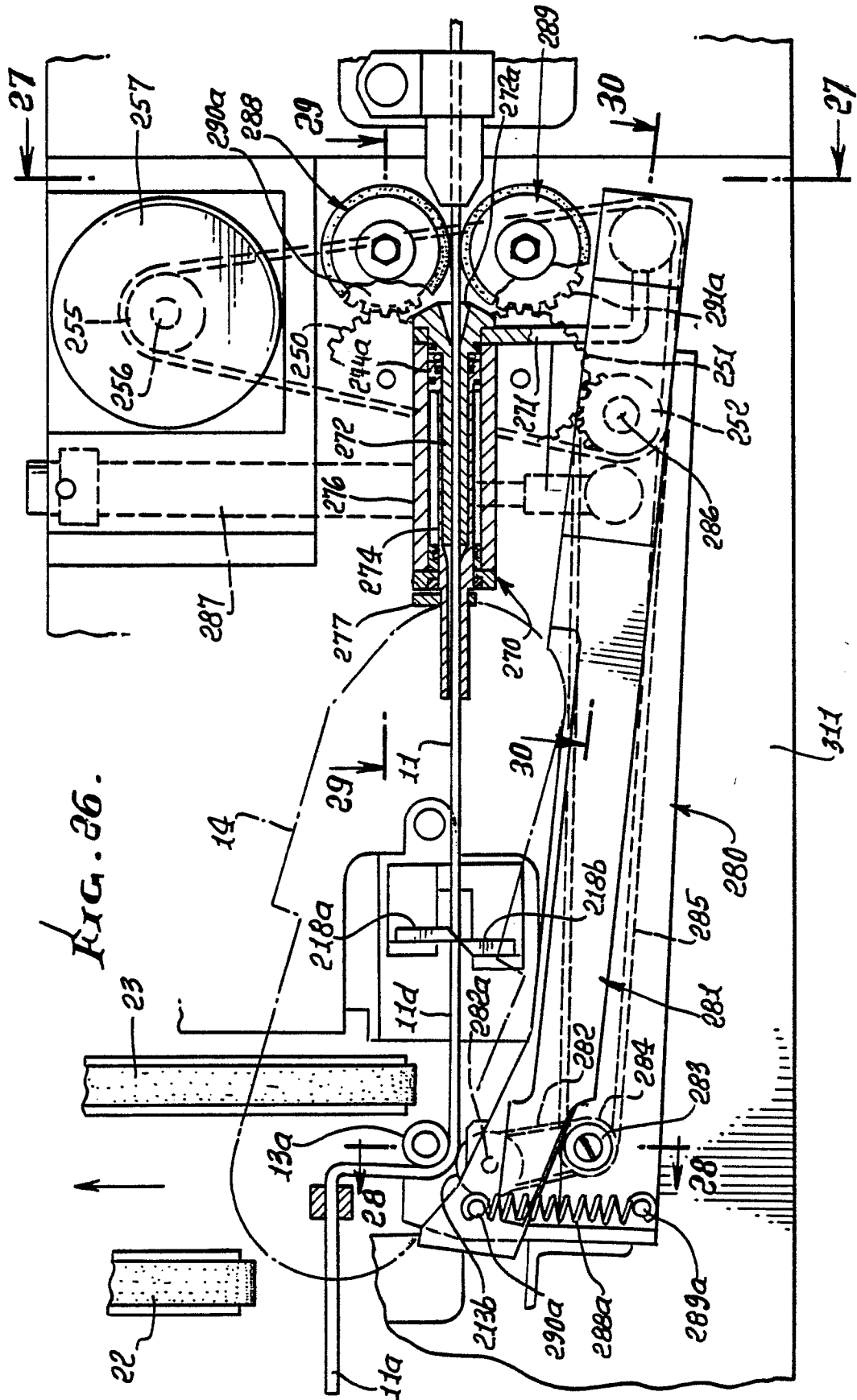
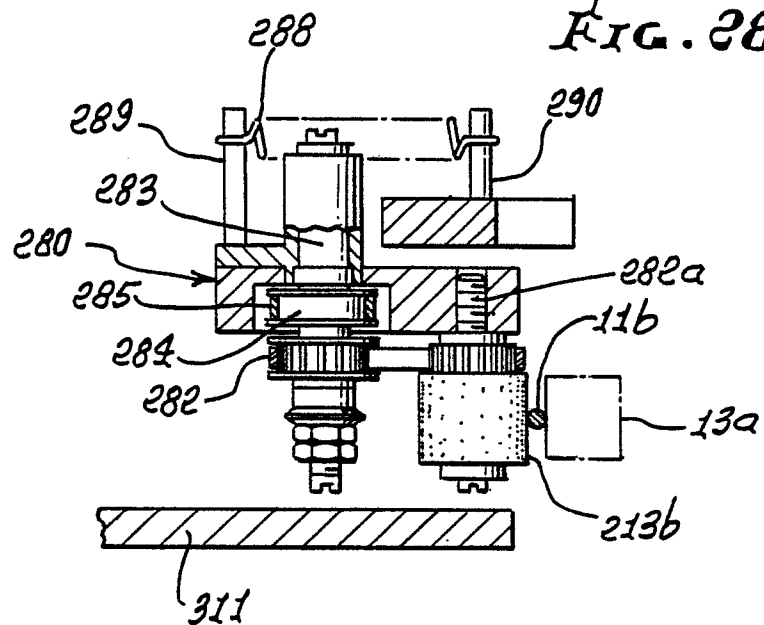
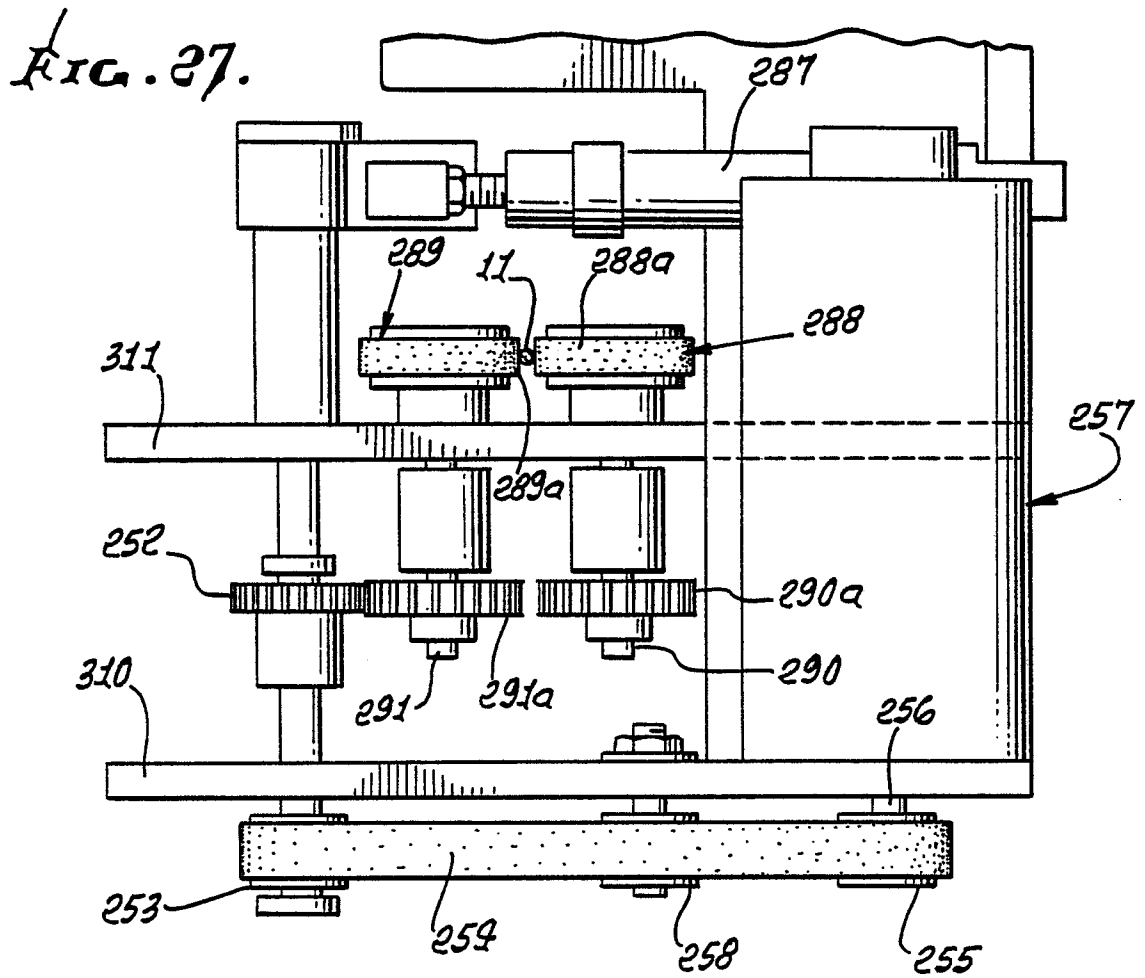
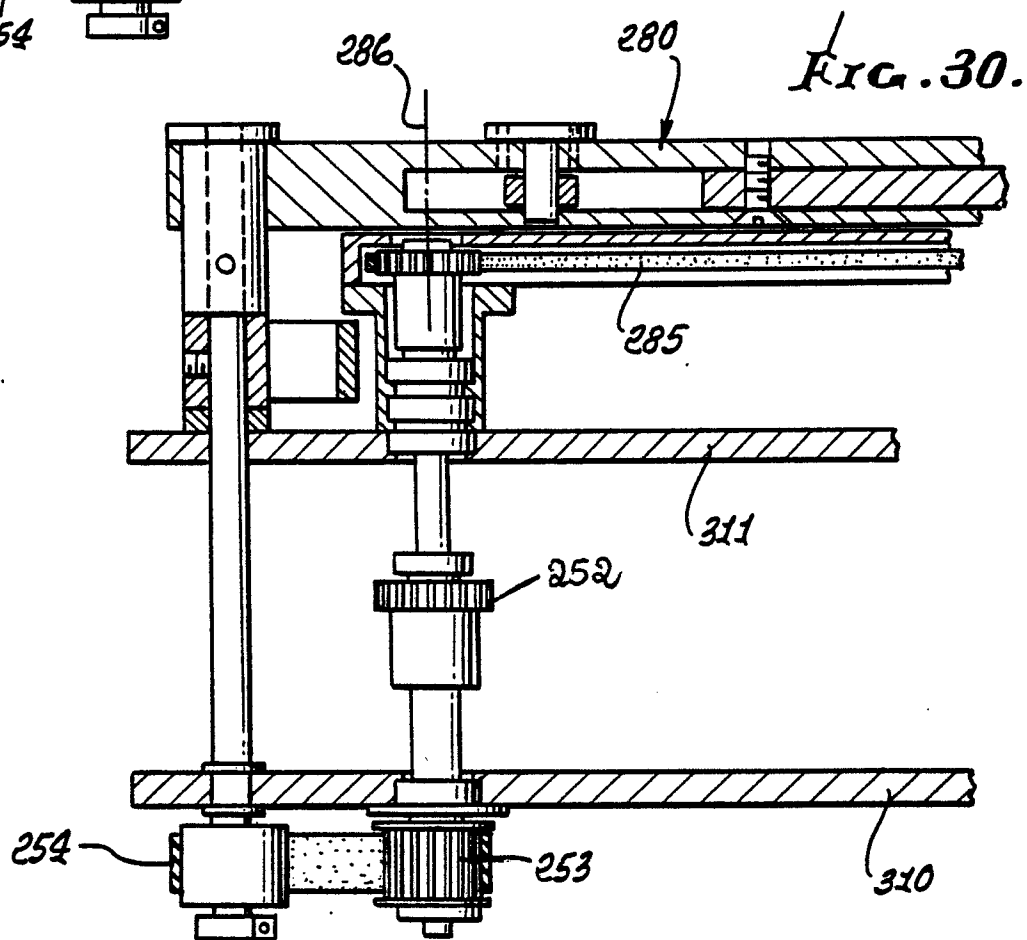
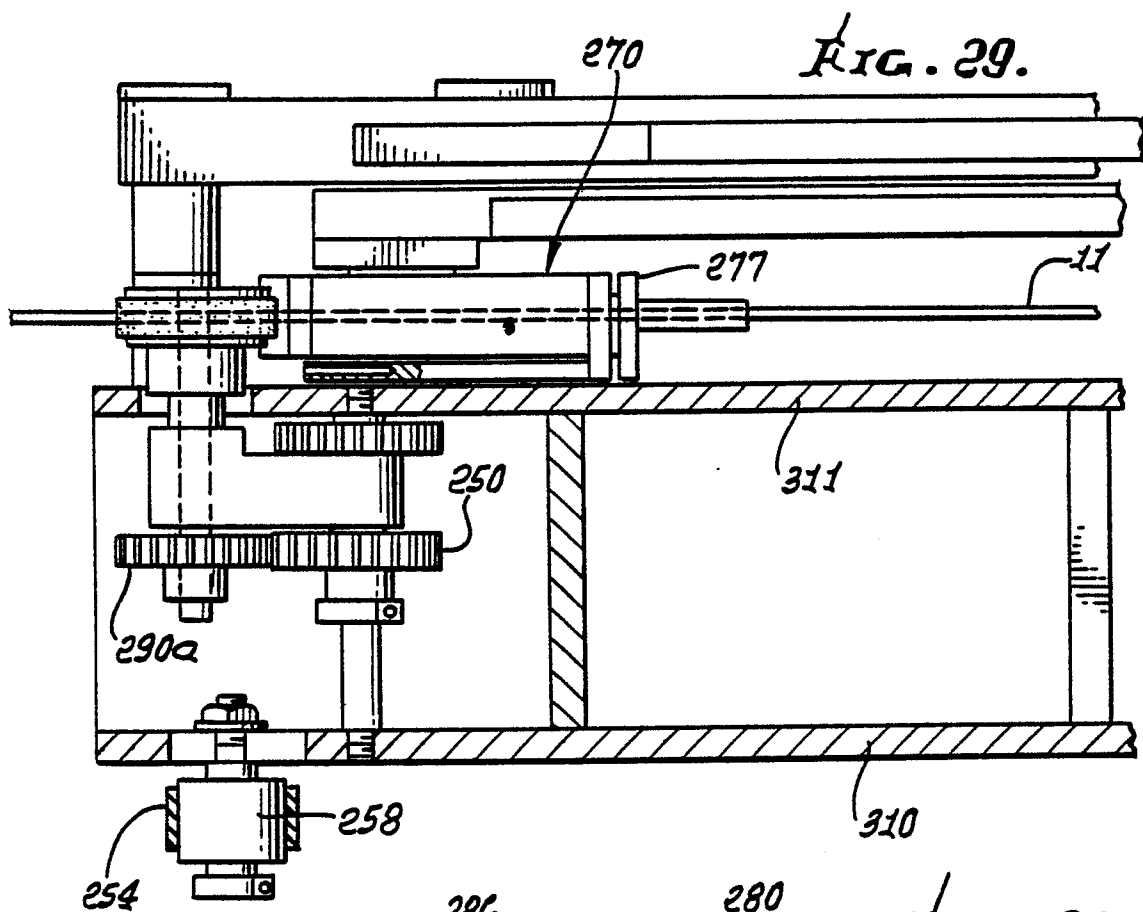


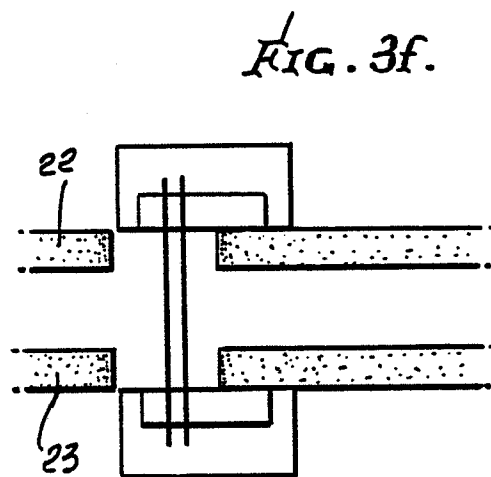
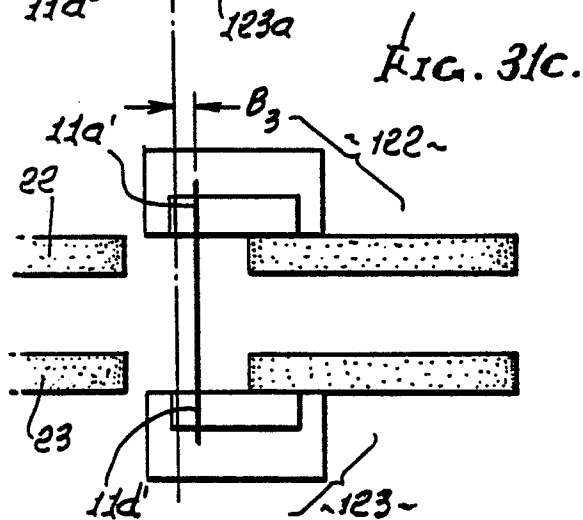
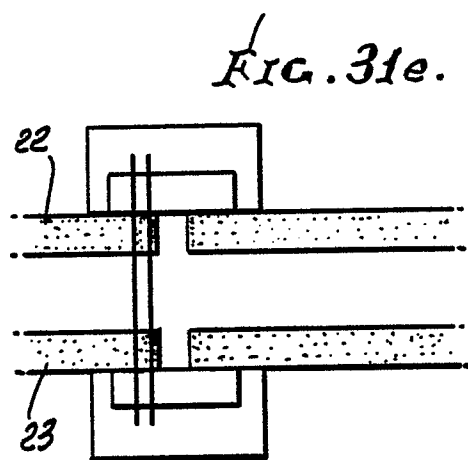
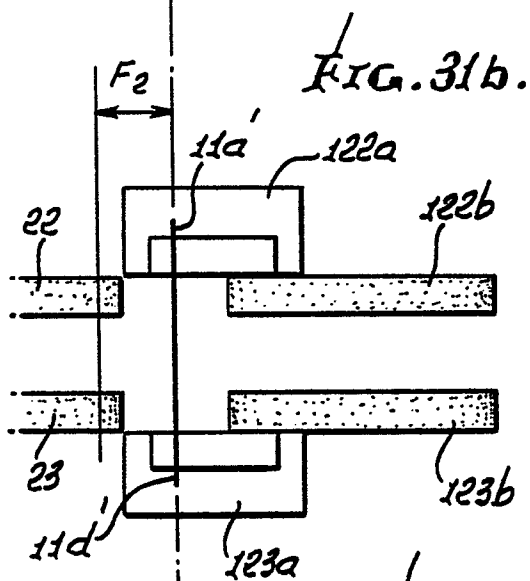
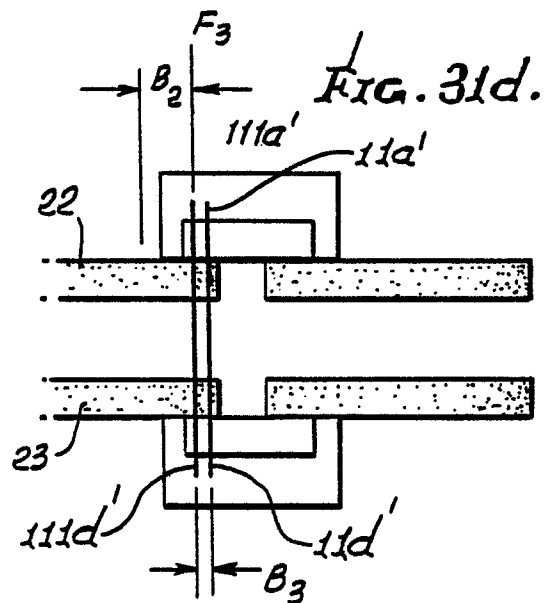
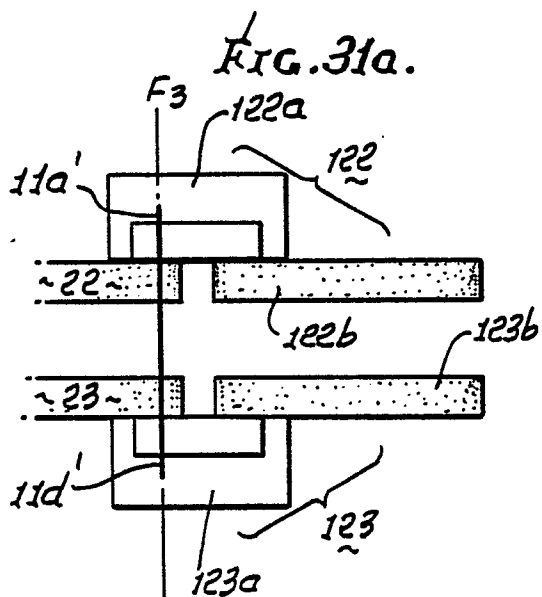
FIG. 25.











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FIG. 31g.

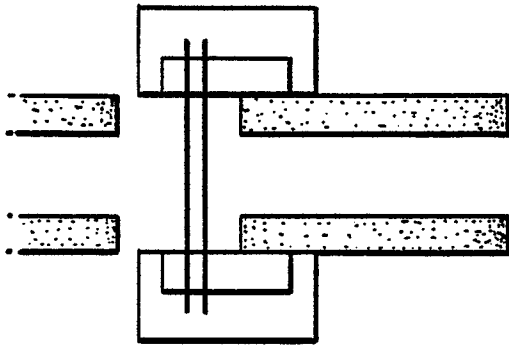


FIG. 31h.

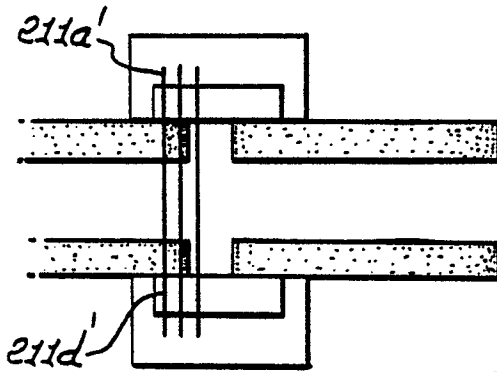


FIG. 31i.

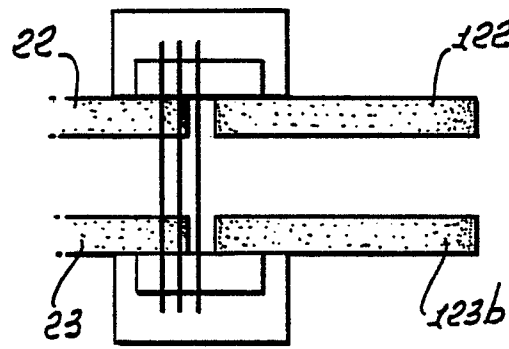


FIG. 31n.

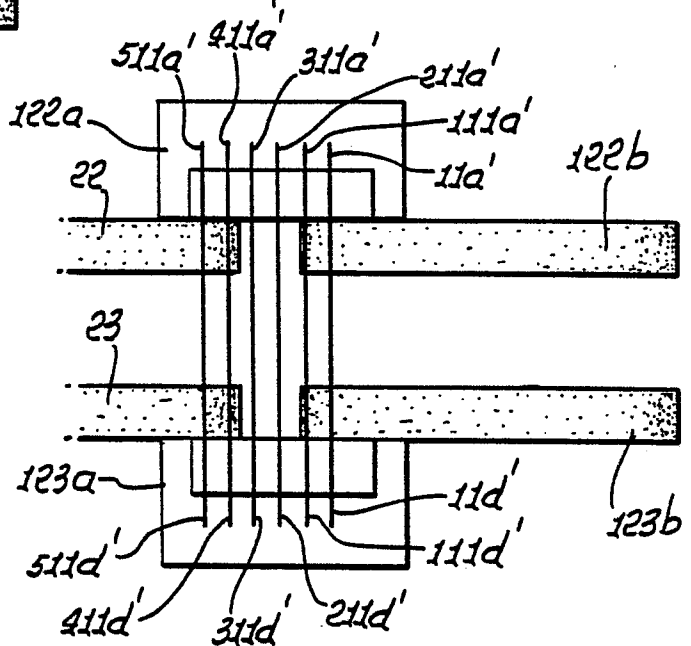


FIG. 32.

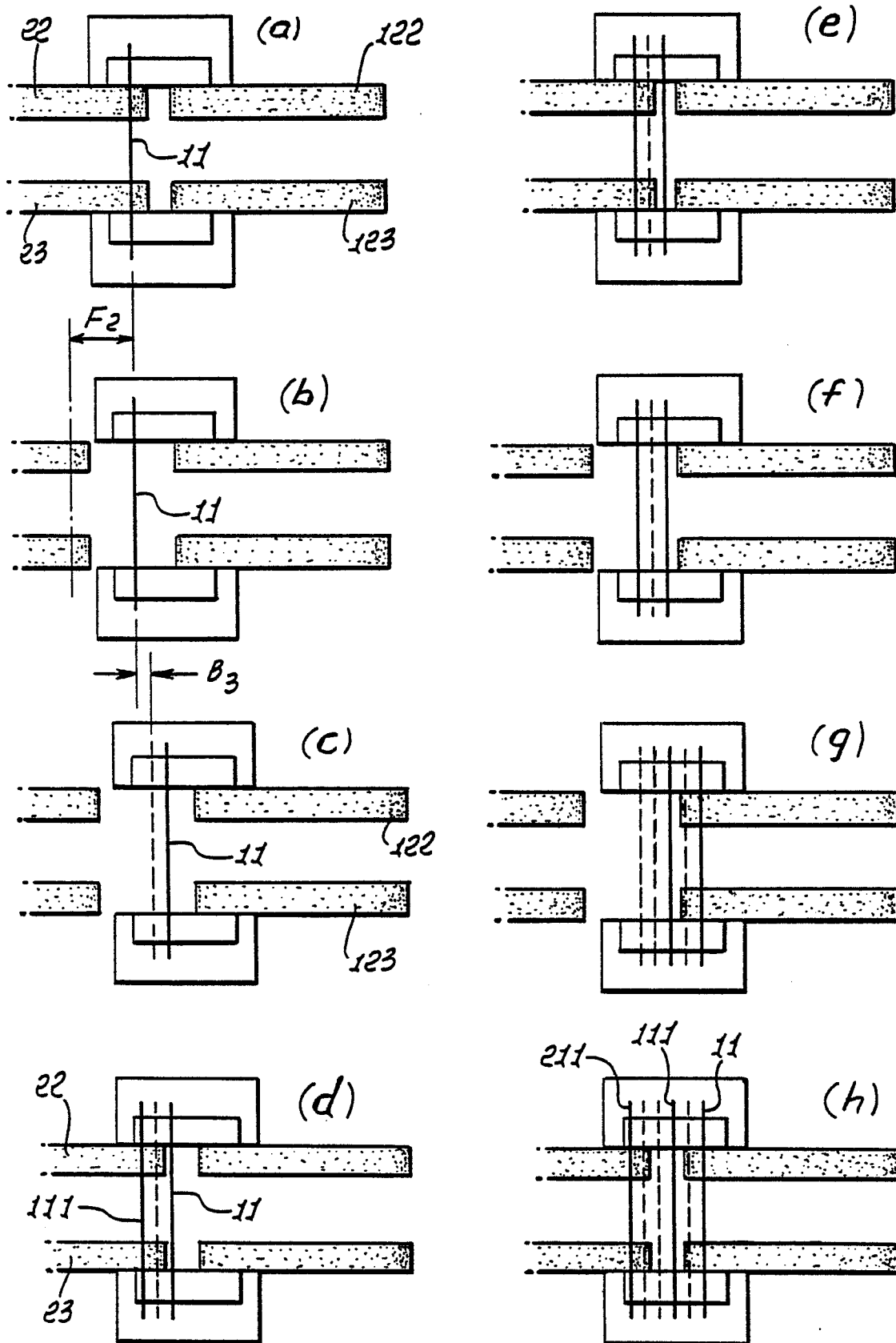


FIG. 33.

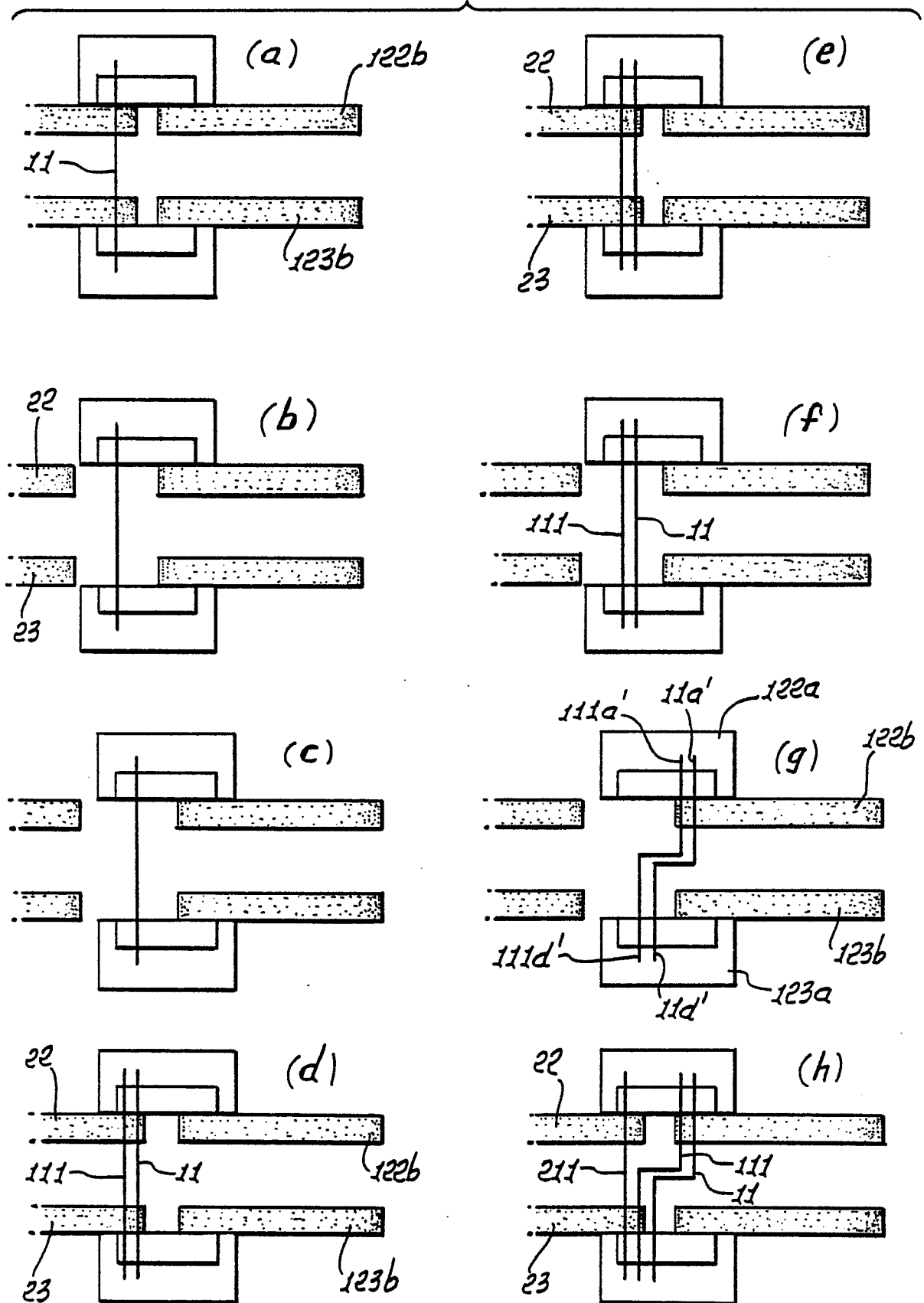


FIG. 33i.

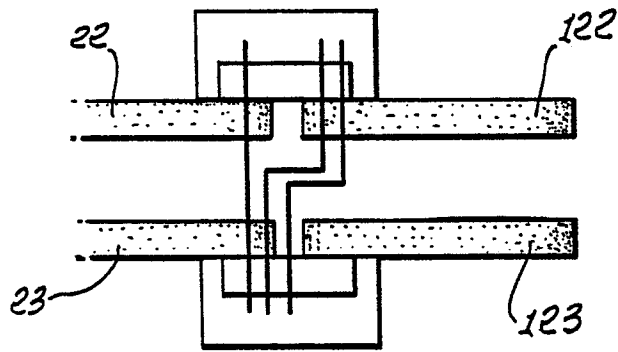


FIG. 33n.

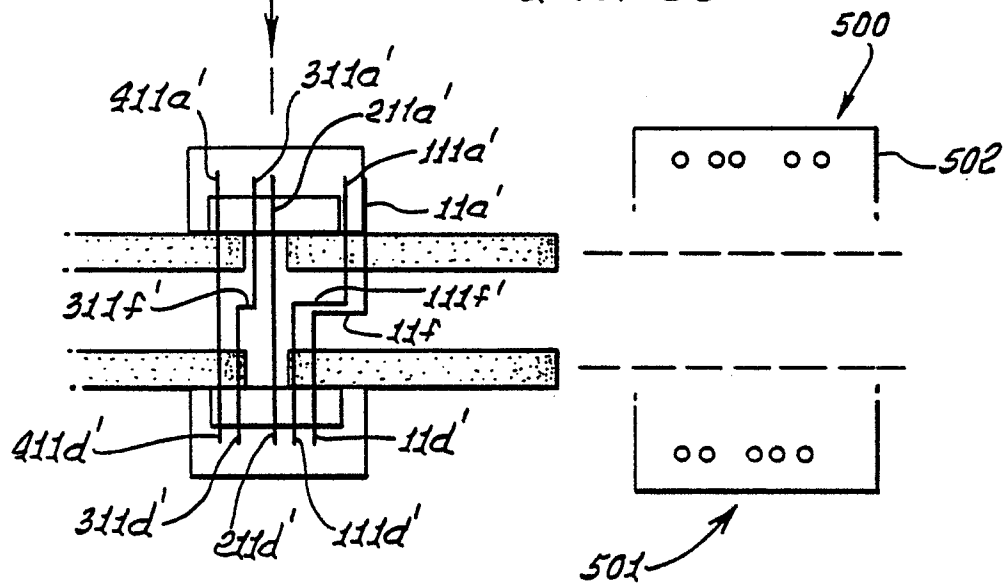


FIG. 34.

