United States Patent

Conner, Jr.

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[54] EDGE CONTOUR GUIDANCE CONTROL FOR PIECES OF MATERIAL

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[73] Assignee: **Kellwood Company**, St. Louis, Mo.

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[21] Appl. No.: **738,036**

[52] **U.S. Cl.** **112/203**, 112/214, 112/DIG. 2

[51] **Int. Cl.** **D05b 27/00**

[58] **Field of Search**.....112/2, 2 A, 2 D, 10, 102, 203, 112/204, 153, 136, 205; 137/81.5, 83; 91/3

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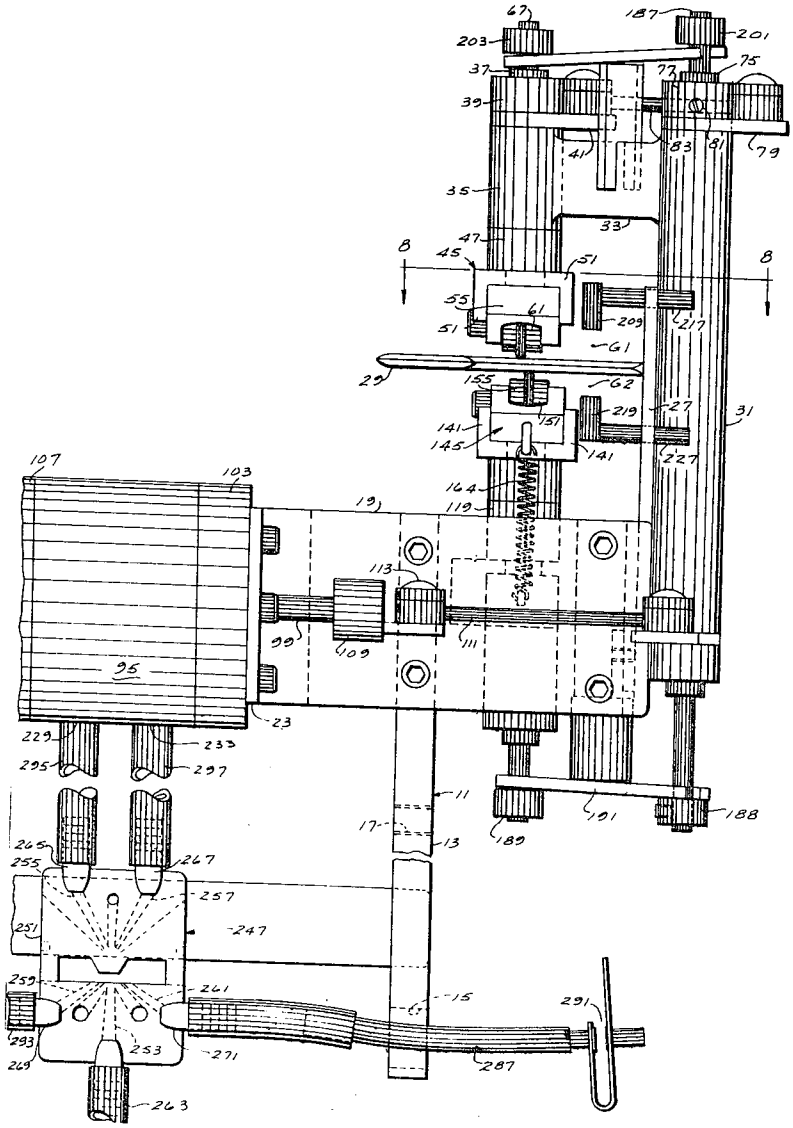
[57] **ABSTRACT**

Apparatus for automatically guiding material being fed through a sewing machine to effect contour stitching of the material, whatever its edge contour. The material is automatically shifted laterally to effect contour stitching in response to pneumatic sensing of the position of the edge of the material at any instant relative to the needle of the sewing machine. A first embodiment of the apparatus is for contour seaming of two pieces of material, which may have different edge contours, in which two pneumatic sensors are provided, one for each piece of material, and in which each piece of material is automatically shifted laterally in accordance with its edge contour. A second embodiment of the invention is for overstitching an edge of one piece of material, having a single pneumatic sensor.

25 Claims, 14 Drawing Figures



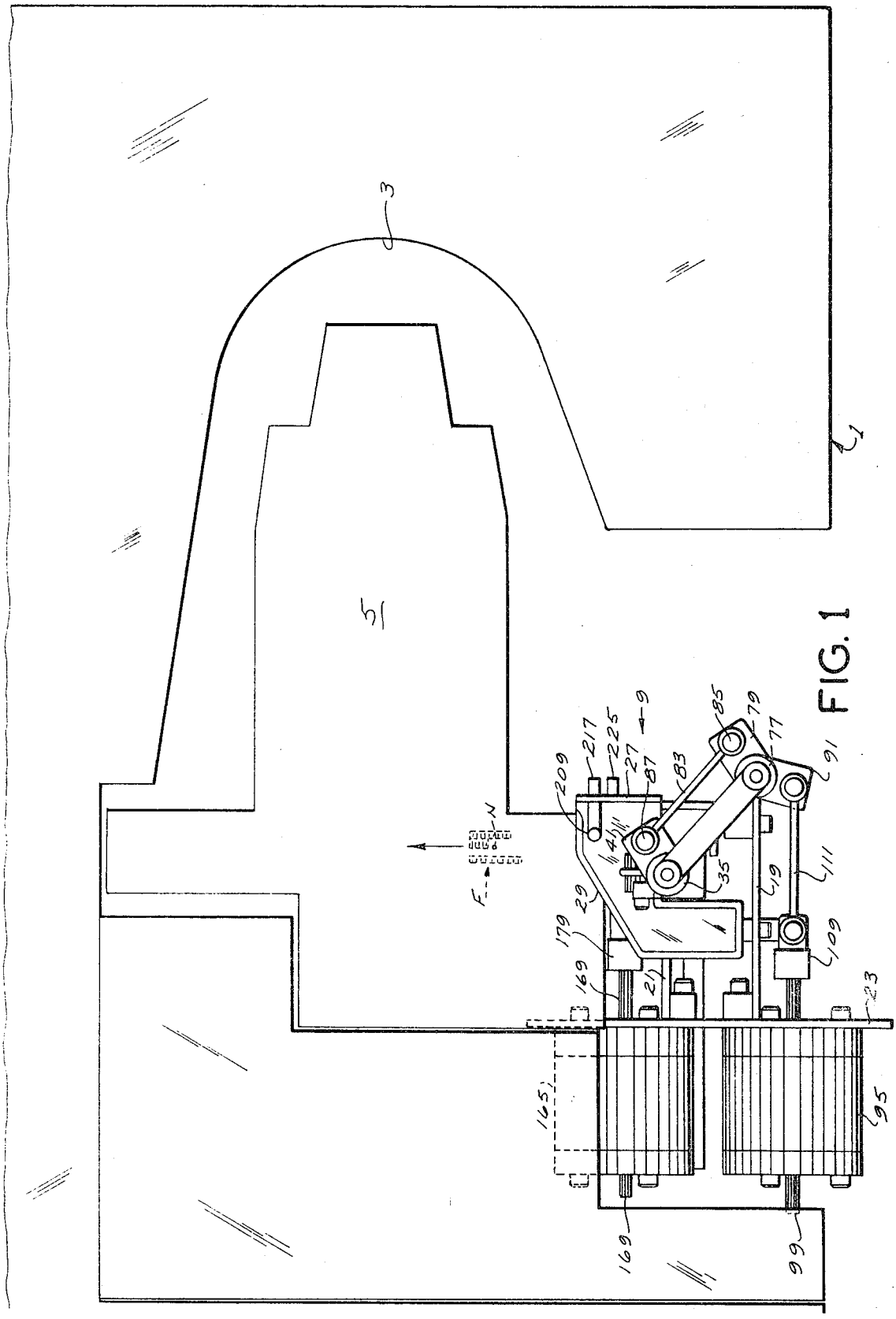

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FIG. 1

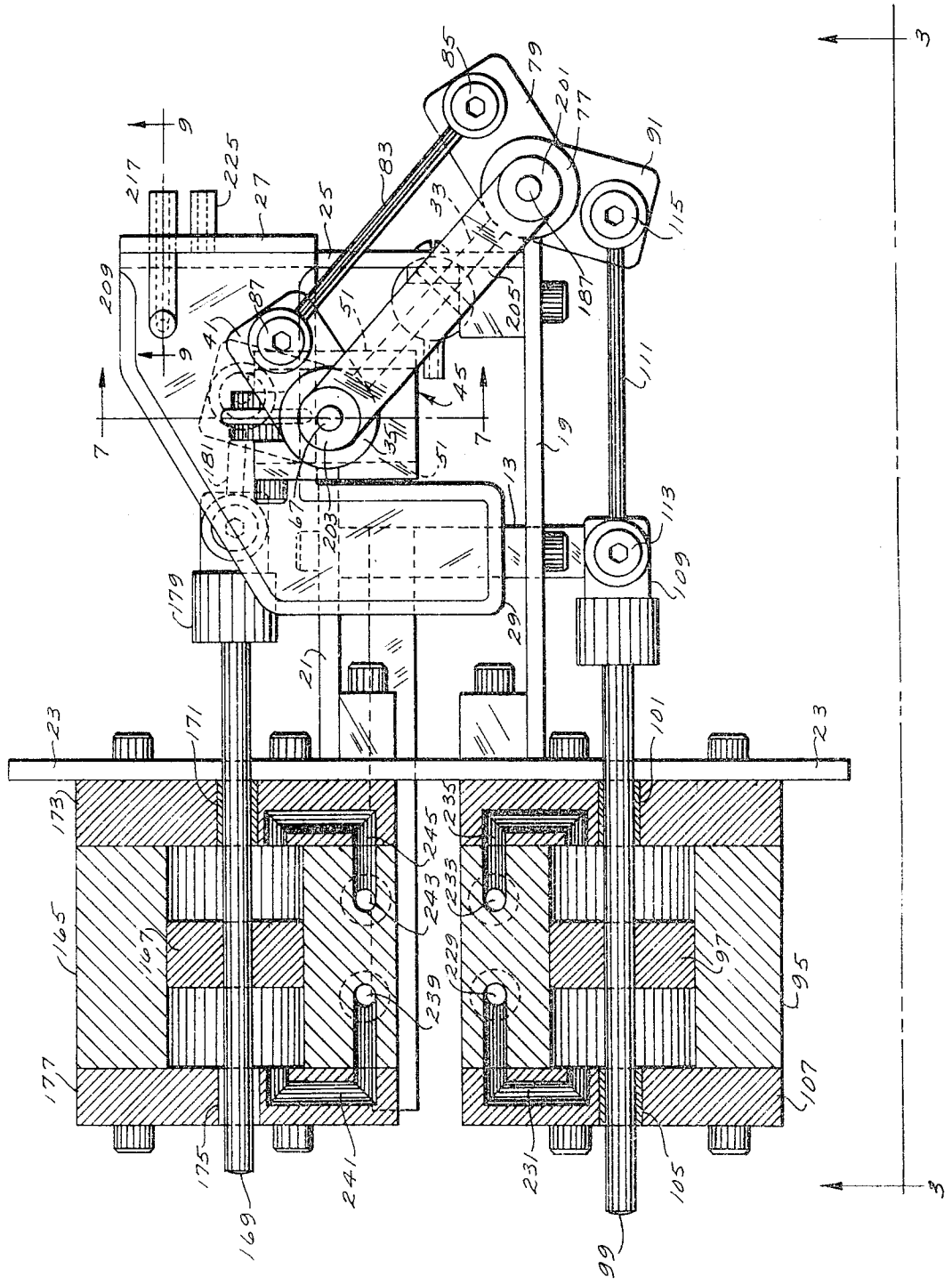

FIG. 2

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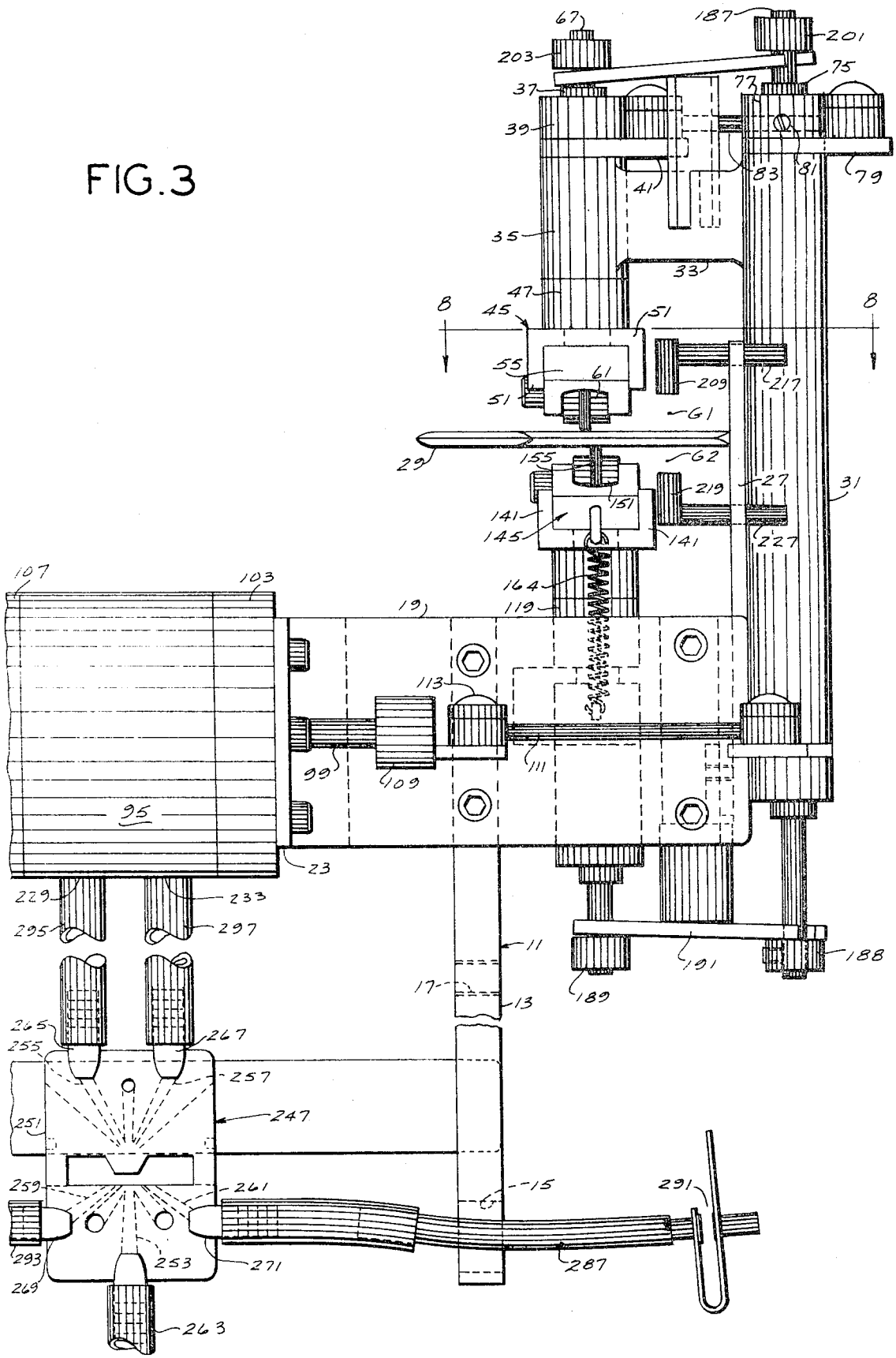
Attorneys.

FIG. 3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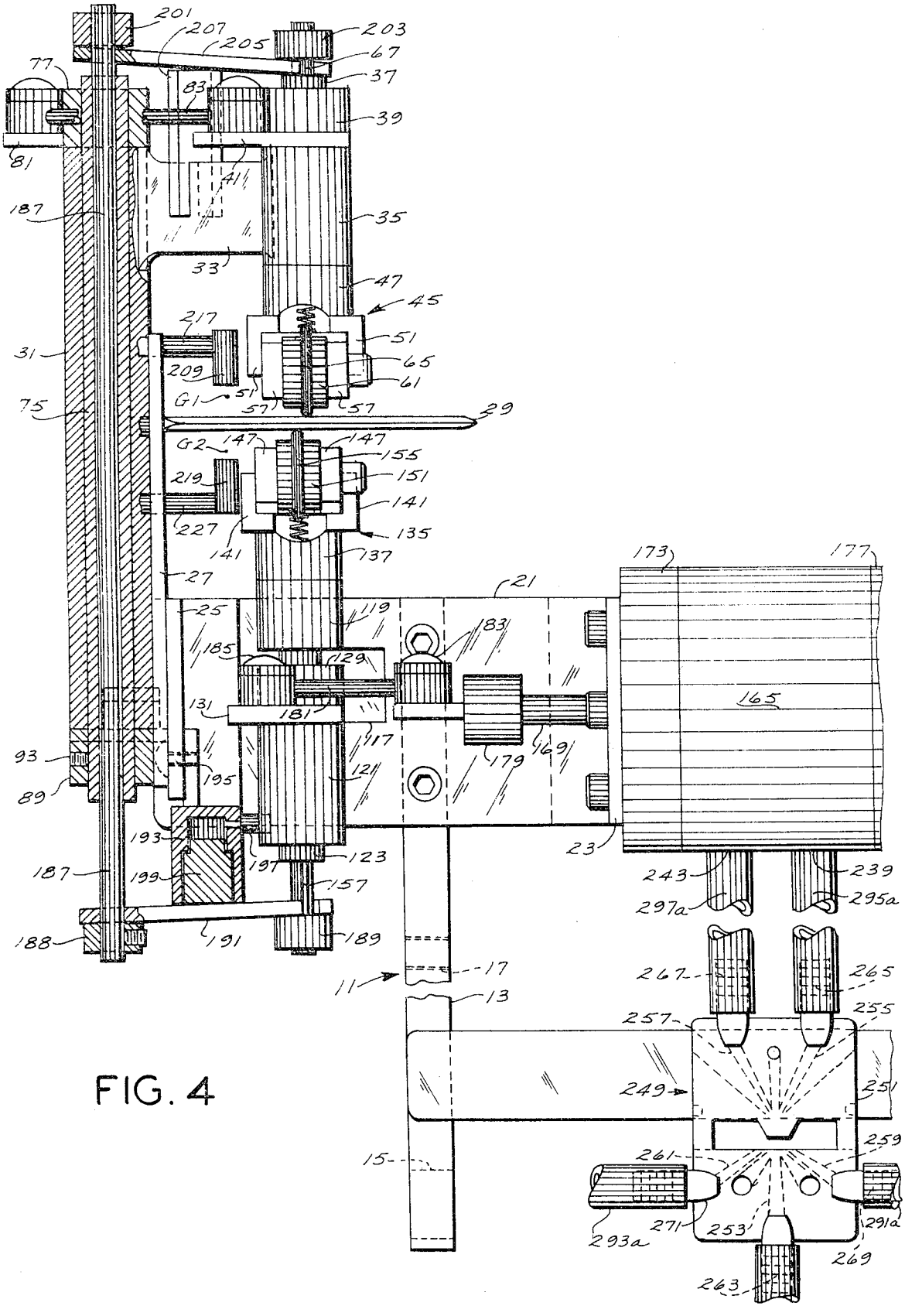
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FIG. 4

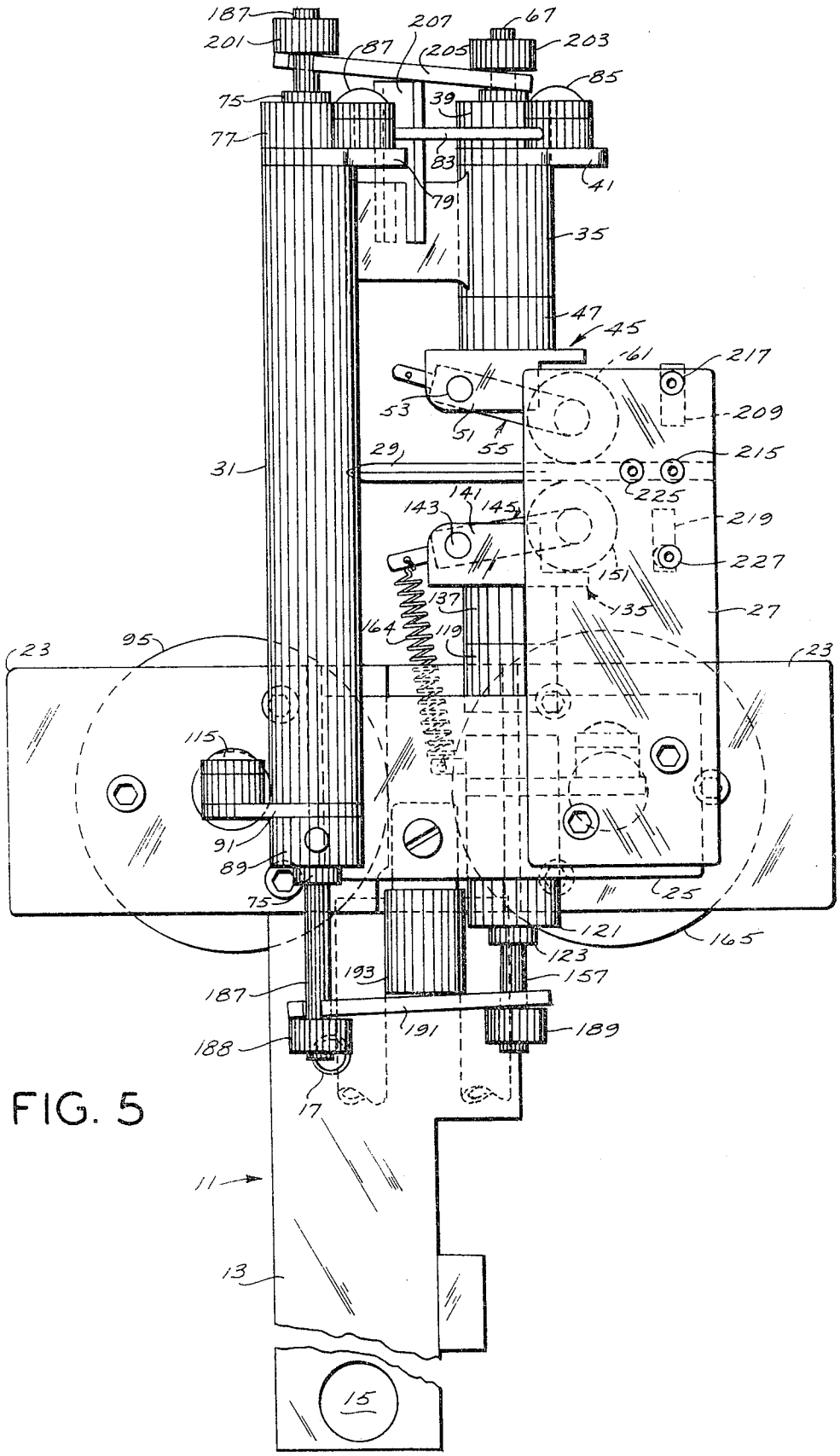
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FIG. 5

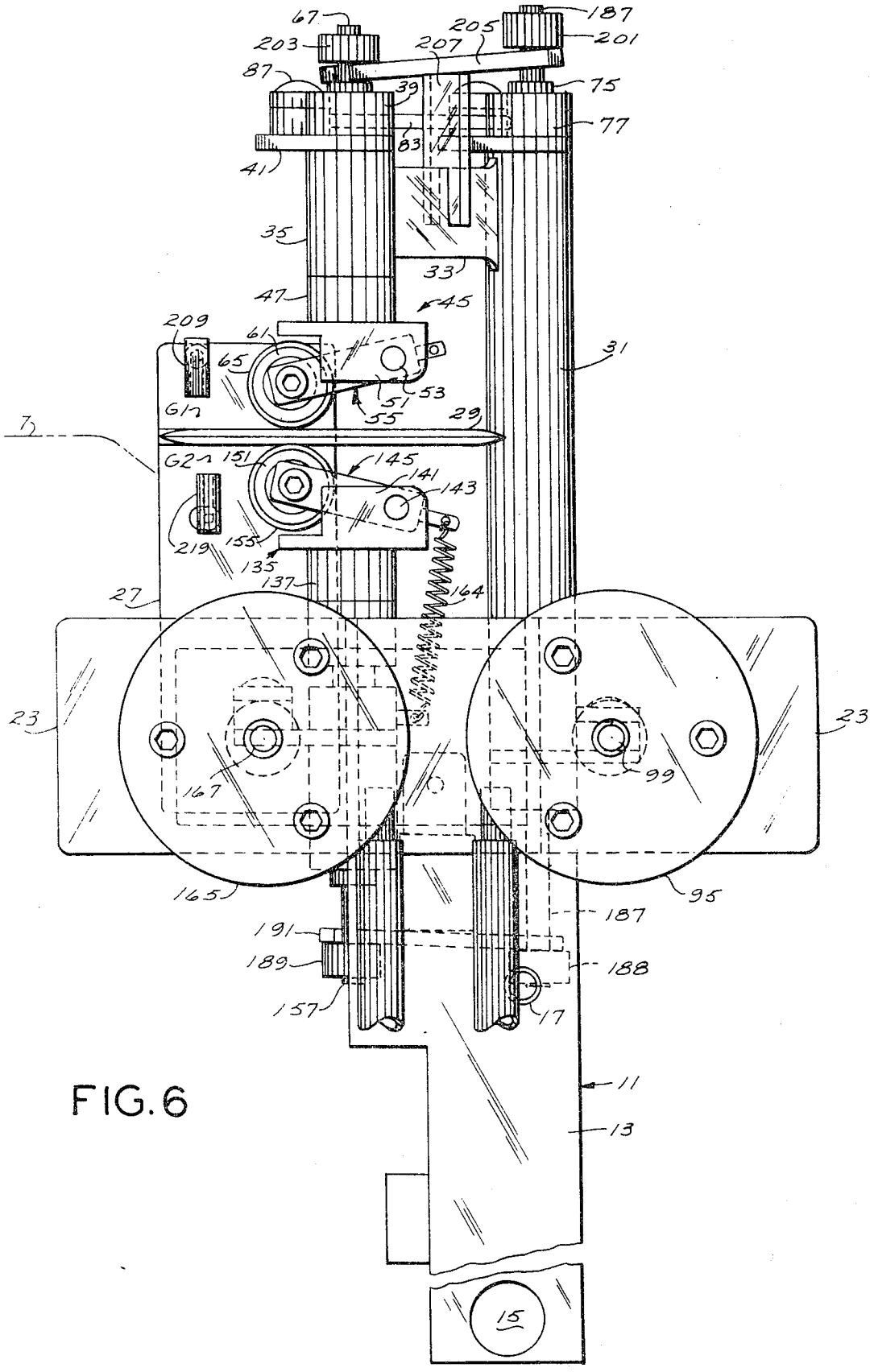
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FIG. 6

FIG. 7

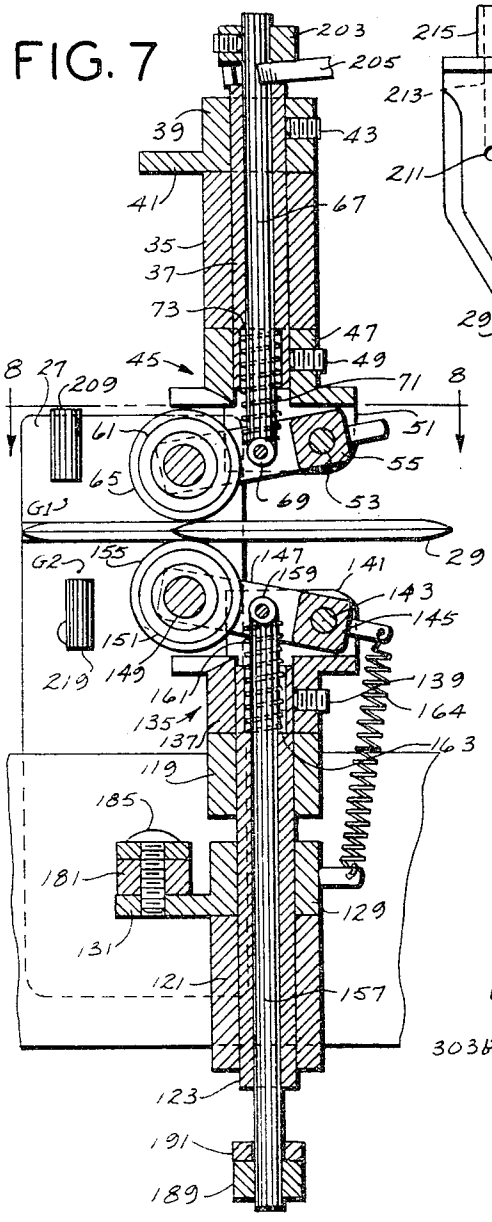
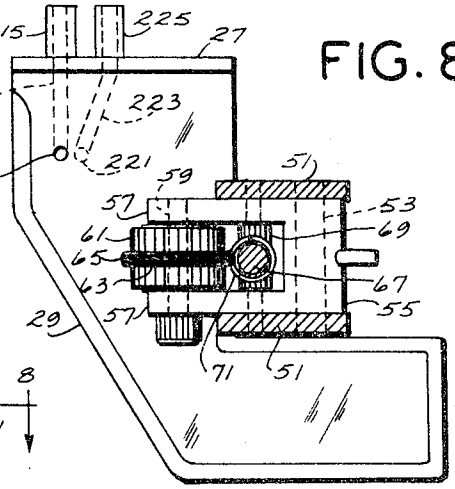


FIG. 8



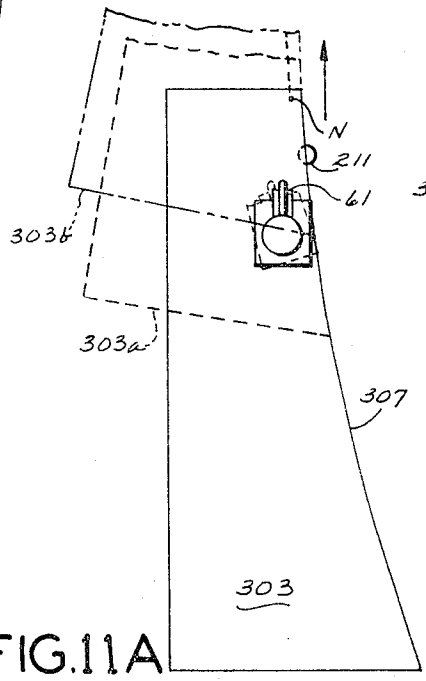


FIG. 11A

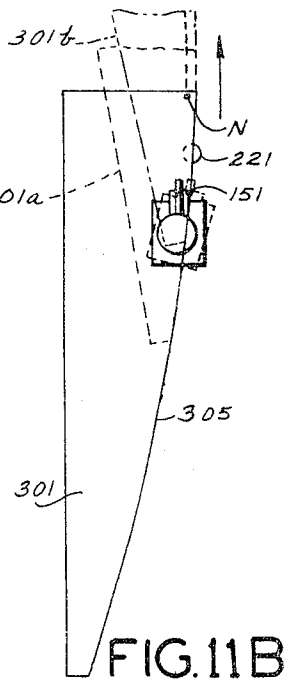


FIG. 11B

FIG. 9

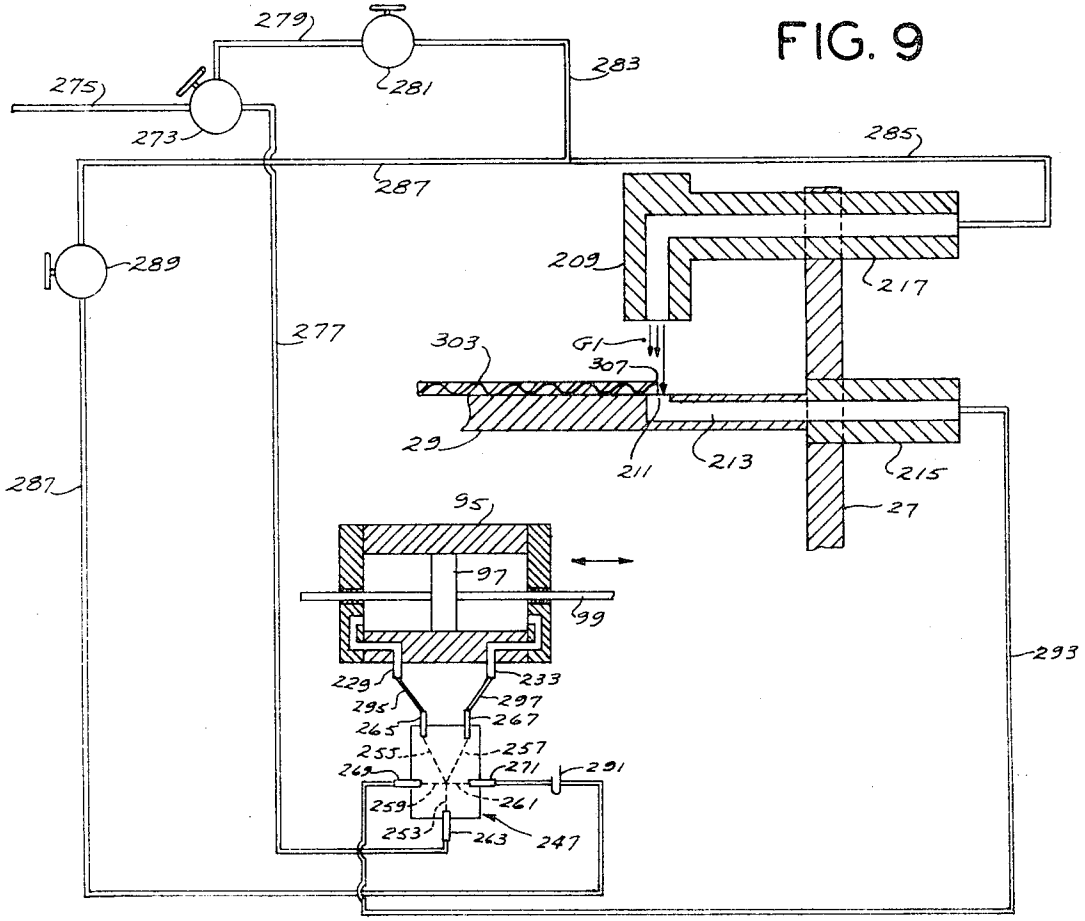

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FIG. 10

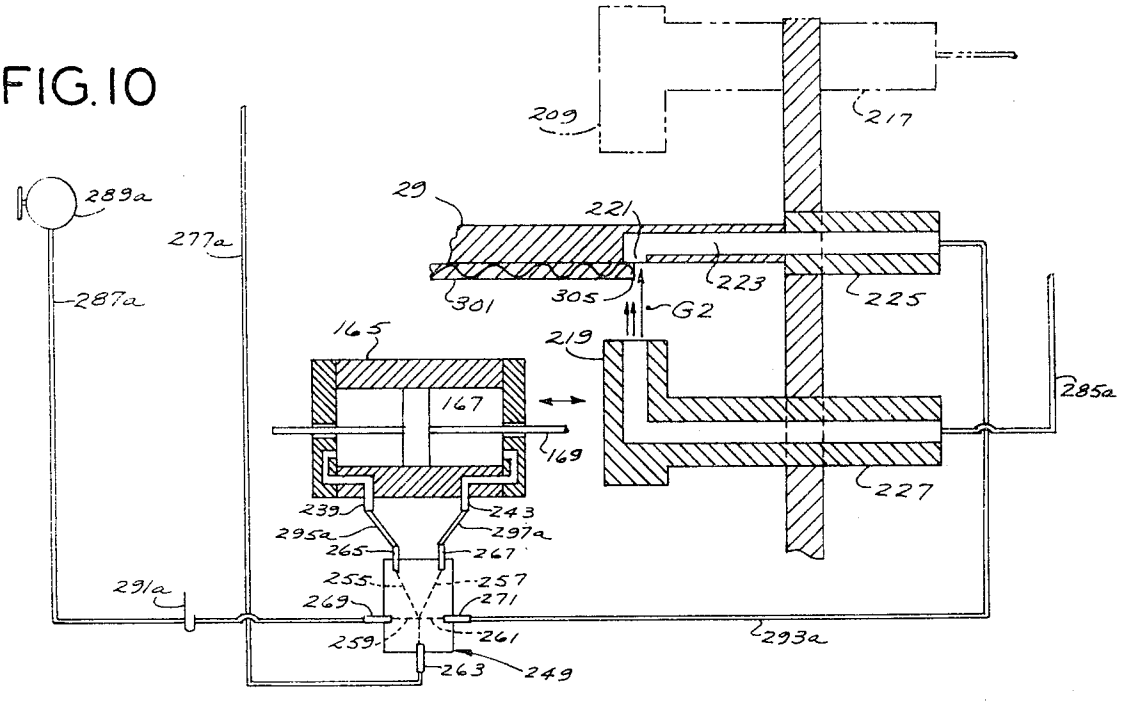
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FIG. 13

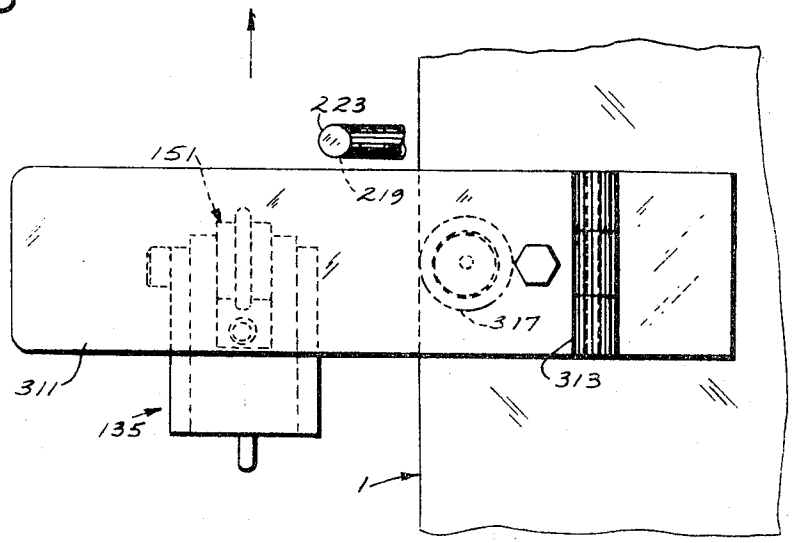
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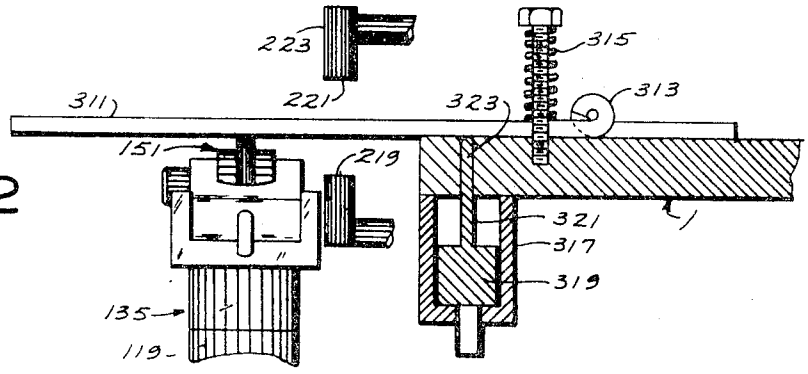
FIG. 12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EDGE CONTOUR GUIDANCE CONTROL FOR PIECES OF MATERIAL

BACKGROUND OF THE INVENTION

This invention relates to edge contour guidance controls for pieces of material, and more particularly to such controls as are especially useful in apparel manufacture for automatically guiding a piece or pieces of material through a path of travel in accordance with the contour of an edge of the piece or pieces of material. The invention is particularly useful as embodied in contour sewing apparatus for guiding a piece or pieces of material through a sewing machine for contour stitching of material, i.e., stitching along a line generally parallel to an edge of the material, and especially useful in this regard for contour stitching along an edge other than a straight edge, i.e., a curved edge, and including a reversely curved edge, and with contour seaming of two pieces of material along edges thereof which may have different edge contour. It will be understood, however, that the guidance control of this invention is adaptable for use in apparatus other than contour sewing apparatus; for example, it is adaptable for use in apparatus for combining pieces of material otherwise than be sewing, such as by any of suitable modes of securement, including adhesive securement and heat sealing. One approach to contour sewing apparatus, shown in U.S. Pat. No. 3,322,081, issued May 30, 1967, entitled Material Stitching and Guiding Machine, has been to provide a clamp movable along a flexible guide rail, the rail being adapted to be bent to different contours in accordance with the edge contours of different pieces of material to be stitched, the material being clamped at its trailing end in the clamp, the latter moving forward along the rail to shift the material for contour stitching. This, however, has the disadvantages, among others, of requiring recontouring of the rail each time a piece of material of different edge contour from a preceding piece is to be stitched, of requiring manual clamping of each piece of material in the clamp, and of being incapable of effecting contour seaming of two pieces of material having different edge contours.

SUMMARY OF THE INVENTION

the piece or pieces of the several objects of this invention may be noted the provision of an improved edge contour guidance control, for automatically guiding a piece or pieces of material through a path of travel in accordance with the contour of an edge of the piece or pieces of material; the provision of contour sewing apparatus which is adapted automatically to effect contour stitching of material without any necessity for preliminary setup, which is capable of handling material of widely varying edge contour, which does not require any operations preliminary to stitching other than introduction of the leading end of the material into the sewing machine, and which is adapted for handling contour seaming of two pieces of material, which may have different edge contours, as well as handling stitching (e.g., overstitching) of a single piece of material. In general, a control of this invention is used in conjunction with apparatus having means for feeding forward a piece of material, and means (e.g., the needle of a sewing machine) for operating on the material at a point spaced inward from an edge of the material as it is fed forward. It includes means engageable with the piece of material mounted for movement for laterally shifting the piece of material as it is fed forward to maintain said edge in predetermined spaced relation to said operating means. A pneumatic edge sensor located adjacent said operating means senses the position of the edge of the material relative to said operating means, and signals a pneumatic means for actuating the shifting means in response to deviation of the edge of the material relative to the sensor to effect lateral shifting of the material for maintaining said edge in predetermined spaced relation to said operating means. Apparatus of this invention for contour seaming of two pieces of material involves two such shifting means, one for an upper piece of material and one for a lower piece, a pneumatic edge sensor for each piece, and pneumatic

means controlled by each sensor for actuating the respective shifting means. Other objects and features will be in part apparent and in part pointed out hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view showing a table having a cutout in which is mounted a sewing machine and a guide means of this invention for guiding material through the machine, the table being broken away;

FIG. 2 is an enlarged top plan view of the guide means, with parts broken away and shown in section;

FIG. 3 is a front elevation of the guide means (as viewed on line 3—3 of FIG. 2);

FIG. 4 is a rear elevation of the guide means, with parts broken away and shown in section;

FIG. 5 is a right side elevation of the guide means;

FIG. 6 is a left side elevation of the guide means;

FIG. 7 is a vertical section on line 7—7 of FIG. 2;

FIG. 8 is a horizontal section on line 8—8 of FIG. 7;

FIG. 9 is a diagrammatic view showing the pneumatic circuit associated with an upper pneumatic edge sensor of the guide means;

FIG. 10 is a diagrammatic view showing the pneumatic circuit associated with a lower pneumatic edge sensor of the guide means;

FIG. 11A is a diagrammatic view showing how an upper piece of material is guided through the sewing machine;

FIG. 11B is a similar diagrammatic view showing how a lower piece of material, with an edge contour different from that of the upper piece, is guided through the sewing machine;

FIG. 12 is a view showing a modification for stitching (e.g., overstitching) of a single piece of material; and

FIG. 13 is a plan of FIG. 12.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, first more particularly to FIG. 1, there is indicated at 1 a table having a cutout 3 therein in which is mounted a sewing machine 5. The top of bed 7 of the sewing machine (which is indicated in phantom in FIG. 6) is generally flush with the top of the table. The needle of the sewing machine is indicated at N and the feed device of the sewing machine is indicated at F. It will be understood that, on operation of the sewing machine, the feed device F functions to feed material forward through the machine for seaming thereof by the needle. This feed is in the direction indicated by the arrow in each of FIGS. 1, 11A and 11B. At 9 is generally indicated guide means of this invention for automatically guiding two pieces of material through the sewing machine for stitching the two pieces together along one edge thereof, with each piece automatically guided in accordance with the contour of its said edge for contour seaming. The feed of the material is entirely by the feed mechanism of the sewing machine, and the guide means functions automatically to shift each piece of material laterally toward one side or the other as it is being fed through the sewing machine, in accordance with the edge contour of the material, for contour seaming of the two pieces of material.

The guide means 9 is shown in detail in FIGS. 2–8 to comprise a frame, designated in its entirety by the reference numeral 11, including a leg 13 having a hole 15 adjacent its lower end for receiving a pin on supporting structure under the top of the sewing machine table and an upper tapped hole 17 for receiving a screw for securing it in place. At the upper end of the leg are two vertical parallel plates 19 and 21, extending on opposite sides of the leg in transverse direction with regard to the direction in which the material is fed to the sewing machine. At the left end of plates 19 and 21 is a cylinder-supporting plate 23, which extends at right angles thereto parallel to the direction of feed. Plate 19 is longer than plate 21. A vertical plate 25 extends at right angles from plate

19 adjacent its end opposite plate 23, projecting in forward direction beyond the plane of plate 21. Extending up from plate 25 is a vertical plate 27 on which is mounted a horizontal backup and separator plate 29 for two pieces of material being fed to the sewing machine. This separator plate extends horizontally as a cantilever toward the left (as viewed in forward direction, and as viewed in FIGS. 1 and 2) from the plate 27. It is located generally at the level of the top of the bed of the sewing machine. The arrangement is such that a first piece of material may be inserted under the separator plate 29 from the left side of plate 27 for feeding of this piece of material to the sewing machine in contact with the bottom surface of the separator plate, and a second piece of material to be seamed to the first piece may be fed over the separator plate in contact with the top surface of the backup plate.

Extending upward from the free end of plate 19 is a tubular post 31. An arm 33 extends radially outward from this post adjacent its upper end. At the free end of this arm is a vertical sleeve 35, located above the backup plate 29. Journaled in the sleeve 35 is a tubular shaft 37 (see FIG. 7). A collar 39 having a radial arm 41 is attached by means of a setscrew 43 on the upper end of the shaft, the collar bearing on the upper end of the sleeve. A wheel carrier 45 is secured on the lower end of the shaft below the sleeve. This carrier comprises a collar 47 attached by means of a setscrew 49 on the lower end of the shaft, this collar being formed at its lower end with downwardly depending parallel side flanges 51. Extending between these side flanges offset from the vertical axis of the sleeve and the shaft is a horizontal pivot pin 53. Pivoted on this pin is a U-shaped yoke 55, the sidearms of which are designated 57 (see FIG. 8). Extending between these arms adjacent their free ends is a shaft 59 carrying a wheel 61. This wheel comprises a roller having an annular peripheral groove at 63 in which is snap-fitted a rubber O-ring 65. A wheel lifter rod 67 extends through the tubular shaft 37, being vertically slidable therein, and having a cross-pin 69 at its lower end pivoted in the yoke 55. A coil compression spring 71 surrounding the rod 67 reacts from a shoulder 73 at the upper end of a counterbore in the tubular shaft 37 against the cross-pin 69 to bias the yoke to swing downward for engagement of the rubber ring of the wheel with the upper piece of material being fed over the separator plate 29.

A tubular shaft 75 is journaled in the post 31 (see FIG. 4). A collar 77 having a radial arm 79 is attached by means of a setscrew 81 on the upper end of this shaft, the collar bearing on the upper end of the post. A link 83 interconnects arm 79 on collar 77 with arm 41 on collar 39, being pin-connected at 85 to arm 79 and at 87 to arm 41. A collar 89 having a radial arm 91 is attached by means of a setscrew 93 on the lower end of shaft 75. An air cylinder 95 is mounted in horizontal position on the outside of plate 23. Working in this cylinder is a piston 97 on a piston rod 99. This rod extends through a hole 101 in the inner end head 103 of the cylinder and a registering hole in plate 23, and through a hole 105 in the outer end head 107 of the cylinder. The axis of the cylinder is located outward of plate 19. Accordingly, the piston rod extends on the outside of plate 19. At its right end as viewed in FIGS. 2 and 3 the piston rod has a coupler 109. A link 111 interconnects this coupler and arm 91 of collar 89, being pin-connected at 113 to the coupler and at 115 to arm 91. The arrangement is such that on movement of the piston and piston rod in one direction, the tubular shaft 37 carrying the wheel carrier 45 is swung in one direction via the linkage comprising link 111, arm 91, shaft 75, arm 79, link 83 and arm 41, and on movement of the piston and piston rod in the opposite direction, the wheel carrier 45 is swung in the opposite direction.

Plate 21 has a notch 117 extending inward at its free end. At the free end of the portion of the plate above this notch is a short vertical sleeve 119 and at the free end of the portion of the plate below the notch is a somewhat longer vertical sleeve 121 which is coaxial with sleeve 119. The sleeves 119 and 121 are located below the separator plate 29 and their vertical axis is offset somewhat to the right as viewed in forward direction (and as viewed in FIG. 3) from the axis of sleeve 35. Journaled in the sleeves is a tubular shaft 123. A collar 129 having a radial arm 131 is secured by means of a setscrew (not shown) on shaft 123 in the notch 117 between the sleeves 121 and 119. A wheel carrier 135 is secured on the upper end of the shaft 123 above the upper sleeve 119. The wheel carrier 135 is identical in construction to the wheel carrier 45, but inverted in relation thereto. Thus, it comprises a collar 137 attached by means of a setscrew 139 on the upper end of shaft 123, this collar having at its upper end a pair of upwardly extending parallel side flanges 141. Pivoted on a pin 143 extending between these flanges offset from the vertical axis of the sleeves 119 and 121 is a U-shaped yoke 145, the sidearms of which are designated 147. Extending between these arms adjacent their free ends is a shaft 149 carrying a lower guide wheel 151, comprising a roller having a rubber ring 155 (corresponding to ring 65). A pulldown rod 157 extends through the tubular shaft 123, being vertically slidable therein, and having a cross-pin 159 at its upper end pivoted in the yoke 145. A coil compression spring 161 surrounding the rod 157 reacts from a shoulder 163 at the lower end of a counterbore in shaft 123 against the cross-pin to bias the yoke to swing upward for engagement of the rubber ring of the wheel with the lower piece of material being fed under the separator plate 29. An additional biasing spring 164 may be provided (and a similar spring may be used for additional bias on the upper wheel 51, if desired).

An air cylinder 165 is mounted in horizontal position alongside cylinder 95 on the outside of plate 23. This cylinder, which is identical to cylinder 75, has a piston 167 working therein, the piston being on a piston rod 169. The latter extends through a hole 171 in the inner end head 173 of the cylinder and a registering hole in plate 23, and through a hole 175 in the outer end head 177 of the cylinder. The axis of the cylinder 165 is located outward of plate 21. Accordingly, the piston rod 169 extends on the outside of plate 21. At its right end as viewed in FIG. 2, the piston rod 169 has a coupler 179. A link 181 interconnects this coupler and the radial arm 131 of collar 129, being pin-connected at 183 to the coupler and at 185 to arm 131. The arrangement is such that on movement of the piston 167 and piston rod 169 in one direction, the tubular shaft 123 carrying the lower wheel carrier 135 is swung in one direction, and on movement of the piston 167 and piston rod 169 in the opposite direction, the lower wheel carrier 135 is swung in the opposite direction.

A rod 187 is vertically slidable in the tubular shaft 75 in post 31 (see particularly FIG. 4). This rod 187 and the pulldown rod 157 have collars 188 and 189 at their lower ends. Spanning these collars is a yoke 191. At 193 is indicated an air cylinder, attached as indicated at 195 to the plate 25 and extending downward therefrom. This cylinder is open at its lower end and has an air inlet 197 adjacent its upper end. A piston 199 is slidable in and out of the cylinder through its open lower end. The lower end of this piston bears on the top of the yoke 191. The arrangement is such that, on admission of air under pressure to the upper end of the cylinder, the piston is forced downward to move the yoke and hence the rods 187 and 157 downward. The rod 187 and the lifter rod 67 have collars 201 and 203 at their upper ends. A lever 205 adapted to rock on a fulcrum 207 extending up from arm 33 has its ends engaged under the collars 201 and 203, the arrangement being such that when rod 187 is moved down on operation of air cylinder 193, lever 205 is rocked to lift the lifter rod 67. Thus, on operation of air cylinder 193 to lift rod 67 and pulldown rod 157, the upper guide wheel 61 is swung up away from the separator plate 29 and the lower guide wheel 151 is swung down away from the separator plate 29.

For operating the guide wheels for automatic shifting of the pieces of material being fed through the sewing machine in accordance with the contour of their edges which are to be seamed together, there is provided a pneumatic edge sensor for the upper piece of material and a pneumatic edge sensor for the lower piece of material. The edge sensor for the upper piece of material comprises an air nozzle 209 positioned to

direct a continuous stream of air downward toward an air inlet hole 211 in the separator plate 29 (see particularly FIGS. 8 and 9). This inlet extends downward from the top of the plate 29 toward but terminating short of the bottom of the plate 29, being in communication via a horizontal passage 213 drilled in the plate 29 with a nipple 215 pressed in a hole in the plate 27. The nozzle 209 is positioned vertically at the inner end of a pipe 217 extending through a hole in the plate 27, the outer end of the pipe extending outward beyond plate 27 for connection of an air supply line thereto. The inlet 211 is vertically aligned with the nozzle, there being a gap G1 between the lower end of the nozzle 209 and the upper surface of the of the separator plate 29, this gap being dimensioned for passage of relatively thick pieces of material therethrough. The edge sensor for the lower piece of material comprises an air nozzle 219 positioned to direct a continuous stream of air upward toward an air inlet hole 221 in the separator plate which extends upward from the bottom of the plate 29 toward but terminating short of the top of the plate 29 (see FIGS. 8 and 10). Hole 221 is in communication via an angled horizontal passage 223 drilled in the backup plate with a nipple 225 pressed in a hole in the plate 27. The holes 211 and 221 are offset from one another as appears in FIG. 8. The nozzle 219 is positioned vertically at the inner end of a pipe 227 extending through a hole in the plate 27, the outer end of the pipe extending outward beyond plate 27 for connection thereto of an air supply line. The hole 221 is vertically aligned with the nozzle 219, there being a gap G2 between the upper end of nozzle 219 and the bottom face of the separator plate 29 of sufficient extent for passage of relatively thick pieces of material therethrough.

Air cylinder 95 operates in response to the edge sensor for the upper piece of material to control the upper guide wheel 61, and air cylinder 165 operates in response to the edge sensor for the lower piece of material to control the lower guide wheel 151. As shown in FIG. 2, air cylinder 95 has a port 229 connected by passaging 235 to its inner end. Similarly, air cylinder 165 has a port 239 connected by passaging 241 to its outer end and a port 243 connected by passaging 245 to its inner end. Supply of air to ports 227 and 233 of cylinder 65 is controlled by an air-proportioning device 247 which is in turn under control of the edge sensor 209, 211 for the upper piece of material, and supply of air to ports 239 and 243 of cylinder 165 is controlled by an air-proportioning device 249 which is in turn under control of the edge sensor 219,221 for the lower piece of material. The air-proportioning devices 247 and 249, which are identical, are of a type available from Corning Glass Works, of Corning, New York, essentially comprising a relatively thin generally rectangular body 251 having an air inlet passage 253, two air outlet passages 255 and 257, and two control passages 259 and 261. A nipple 263 is provided for connection of an air line to the inlet passage 253, nipples 265 and 267 are provided for connection of air lines to the outlet passages 255 and 257, and nipples 269 and 271 are provided for connection of air lines to the control passages 259 and 261. The passaging in the body is such that, with air under pressure supplied through the inlet passage 253, and with air at equal pressure supplied through the control passages 259 and 261, the air input is equally proportioned between outlet passages 255 and 257, so that the air output of each of the outlet passages 255 and 257 is equal. If pressure of air supplied through control passage 259 becomes higher than pressure through air supplied through control passage 261, then the device automatically functions to proportion the output according to the control pressures, i.e., to increase the pressure of air delivered through outlet passage 257 and decrease the pressure of air delivered through outlet passage 255. Conversely, if pressure of air supplied through control passage 261 becomes higher than pressure of air supplied through control passage 259, then the device functions automatically to increase the pressure of air supplied through outlet passage 255 and decrease the pressure of air supplied through outlet passage 257.

Referring to FIG. 9, there is indicated at 273 a pressure regulator to an inlet of which is connected an air line 275 leading from a source of compressed air (e.g., at 40 p.s.i.). Regulator 273 is adapted to drop the supply pressure to 5 p.s.i., for example. An air supply line 277 extends from an outlet of regulator 273 to the inlet 263 of the air-proportioning device 247. An air line 279 is shown as extending from another outlet of regulator to the inlet of another pressure regulator 281, which is adapted further to drop the pressure (e.g., to 2¼ p.s.i.). An air line 283 extends from the outlet of regulator 281, and has branch air line connections 285 and 287, respectively, with pipe 227 for nozzle 209 and with nipple 271 for control passage 261 of the air-proportioning device 247. Line 285 supplies air to nozzle 209. Line 287 has a flow regulator 289 and an airgap 291 therein. An air line 293 interconnects inlet 211 via nipple 215 with nipple 269 for control passage 259 of the air-proportioning device 247. Line 287 maintains a control pressure (e.g., 1½ p.s.i.) in control passage 261 of device 247, the airgap 291 reducing surging in line 287. Pressure in control passage 259 varies in accordance with the extent of the opening or closing of the inlet 211 by the edge of the upper piece of material, via line 293. Nipples 265 and 267 of air outlet passages 255 and 257 of device 247 are connected to ports 229 and 233 of cylinder 95 as indicated at 295 and 297.

Referring to FIG. 10, there is indicated an air line 277*a* supplied with air from line 277 and connected to the nipple 263 of air inlet 253 of the second air-proportioning device 249. An air line 285*a* supplied with air from line 285 is connected to pipe 227 for supplying air to nozzle 219. An air line 287*a* supplied with air from line 287, and having a flow control 289*a* and an airgap 291*a* therein is connected to nipple 269 of control passage 259 of device 249. An air line 293*a* interconnects inlet 221 via nipple 225 to nipple 271 of control passage 261 of device 249. Line 287*a* maintains a control pressure (e.g., 1½ p.s.i.) in control passage 259 of device 249, and airgap 291*a* reduces surging in line 287*a*. Pressure in control passage 261 of device 249 varies in accordance with the opening or closing of the inlet 221 by the edge of the lower piece of material, via line 293*a*. Nipples 265 and 267 of air outlet passages 255 and 257 of device 249 are connected to ports 239 and 243 of cylinder 165 as indicated at 295*a* and 297*a*.

Operation is as follows:

By operation of cylinder 193 (under control of a suitable valve, not shown), the upper guide wheel 61 is lifted to a raised retracted position clear of plate 29, and the lower guide wheel 151 is pulled down to a lowered retracted position clear of plate 29. This enables easy insertion of a lower piece of material 301 between the lower wheel 151 and the bottom of plate 29 and of an upper piece of material 303 between the upper wheel and the top of plate 29 and positioning these pieces for being fed through the sewing machine 5 for seaming them together along edges 305 and 307 thereof. FIGS. 9 and 10 show how the upper piece 303 lies on the top of plate 29 and how the lower piece lies under plate 29, and FIGS. 11A and 11B show the position of the pieces as they start to travel through the sewing machine. For purposes of illustration, the upper piece 303 is shown in FIG. 11A as having a concavely curved edge 307 and the lower piece 301 is shown in FIG. 11B as having a convexly curved edge 305, these edges to be contour seamed (i.e., sewn together along a line uniformly spaced inward from edge 307 and also uniformly spaced inward from edge 305.

After the pieces have been initially positioned, the cylinder 193 is deactivated to lower the upper wheel 61 into engagement with the upper piece of material 303 and to raise the lower wheel 151 into engagement with the lower piece of material 301. The upper wheel presses the material down against the top of plate 29, and the lower wheel presses the material up against the bottom of plate 29. The sewing machine is then operated to feed the pieces of material through the machine and stitch them together.

As the upper piece of material **303** is fed through the sewing machine, the upper pneumatic edge sensor constituted by nozzle **209** and the associated air inlet **211** continuously senses the position of the edge **307** of this piece of material at each instant relative to the needle N of the sewing machine. The normal position of the edge **307** of the material may be considered as the position in which the edge portion of the material halfway closes off the inlet **211**, as illustrated in FIGS. **9** and **11A**. As the piece of material **303**, having a concavely curved edge **307** as illustrated, is fed straight forward by the feed device F, its edge (due to its concave contour) will further close the inlet **211**, and thus decrease the admission of air to the inlet **211**. Upon decrease in admission of air to the inlet **211**, the pressure in control passage **259** of the air-proportioning device **247** decreases, and hence the pressure of air delivered through outlet passage **255** and line **295** to the left end of cylinder **95** increases, and the pressure of air delivered through outlet passage **257** and line **297** to the right end of cylinder **95** decreases. As a result, piston **97** in cylinder **95** moves to the right, which results in the upper wheel **61** swinging to the left as viewed in FIGS. **2** and **11A** about the vertical axis of sleeve **35** and tubular shaft **37** (this vertical axis being offset upstream from the horizontal axis of the wheel, i.e., on the side thereof away from the needle of the sewing machine). The wheel **61** acts as a shifting means to shift the upper piece of material to the left, as indicated by position **303***a* of the upper piece of material shown in dotted lines in FIG. **11A**, to bring the edge **307** of the upper piece of material over to the left at the needle N to the appropriate position in relation to the needle N for contour stitching along the edge **307**. Any overshift of the piece of material **303** to the left results in edge **307** opening up the inlet **211** more than halfway, with the result that admission of air to inlet **211** is increased. The pressure in control passage **259** is thereby increased, the pressure of air delivered through outlet passage **255** and line **295** to the left end of cylinder **95** decreased, and the pressure of air delivered through outlet passage **257** and line **297** to the right end of cylinder **95** increased. Piston **97** moves to the left to swing upper wheel **61** to the right thereby shifting the upper piece of material to the right for appropriate correction. Thus, deviation of the edge **307** of the upper piece of material **303** relative to the upper edge sensor **209**, **211** actuates the upper wheel **61** to effect lateral shifting of the upper piece of material for contour stitching thereof along edge **307**.

The lower piece of material **301** is fed through the sewing machine simultaneously with the upper piece **303**. As the lower piece is fed forward, the lower pneumatic edge sensor constituted by the nozzle **219** and the associated air inlet **221** continuously senses the position of the edge **305** of the lower piece at each instant relative to the needle N. The normal position of edge **305** may be regarded as the position in which the edge portion of the lower piece of material halfway closes off the inlet **221**, as illustrated in FIGS. **10** and **11B**. As the lower piece of material **301**, having a convexly curved edge **305**, as illustrated, is fed straight forward by the feed device F, the inlet **221** will be further opened due to the convex contour of edge **305**, thus increasing the admission of air to inlet **221**. The pressure in control passage **261** of the air-proportioning device **249** increases, and hence the pressure of air delivered through outlet passage **255** of device **249** and line **295***a* to the left (outer) end of cylinder **165** increases and the pressure of air delivered through outlet passage **257** of device **249** and line **297***a* to the right (inner) end of cylinder **165** decreases. Accordingly, piston **167** moves to the right, which results in the lower wheel **151** swinging to the right as viewed in FIG. **11B** about the vertical axis of sleeves **119** and **121** and tubular shaft **123** (this vertical axis being offset upstream from the horizontal axis of wheel **151**, i.e., on the side thereof away from the needle). The wheel **151** acts as a shifting means to shift the lower piece of material to the right, as indicated by position **301***a* of the lower piece of material shown in dotted lines in FIG. **11B**, to bring the edge **305** of the lower piece of material over to the right at the needle N to the appropriate position in relation to the needle for contour stitching along the edge **305**. Any overshift of the piece of material **301** to the right results in edge **305** closing the inlet **221** more than halfway, with the result that admission of air to inlet **221** is decreased. The pressure in control passage **261** of device **249** is thereby decreased, hence the pressure of air delivered through outlet passage **257** of device **249** and line **297***a* to the right (inner) end of cylinder **165** increases and the pressure of air delivered through outlet passage **255** of device **249** and line **295***a* to the left (outer) end of cylinder **165** decreases. Accordingly, piston **167** moves to the left to swing wheel **151** to the left to shift the lower piece of material to the left for appropriate correction. Thus, deviation of the edge **305** of the lower piece of material **301** relative to the lower edge sensor **219**, **221** actuates the lower wheel **151** to effect lateral shifting of the lower piece of material for contour stitching thereof along edge **305** (and hence contour seaming of pieces **301** and **303** along their edges **305** and **307**).

In FIGS. **11A** and **11B**, further shifted positions of the pieces **303** and **301** effected by the guide means for contour sewing are indicated at **303***b* and **301***b*.

Arrangement of each of the wheels **61** and **151** to swing about a vertical axis offset upstream or rearward from the horizontal axis of the wheel is advantageous in establishing feedback effects, so as to provide for extremely rapid and accurate shifting of the material (which, as will be understood, may be fed relatively rapidly through the sewing machine) with a minimum of hunting. It is also to be noted that the feeding means F (and needle N) is downstream from the guide or shift means **9**. The terms "upstream" and "downstream" are used herein in relation to the direction of feed or flow of the material.

It will be observed that the guide means **9** above described is readily adaptable for automatically guiding two pieces of material through a device wherein the two pieces are seamed otherwise than by stitching. For example, instead of feeding the pieces of material to the needle of a sewing machine, they may be fed to a heat-sealing instrumentality, or a device for applying adhesive, or the like.

FIGS. **12** and **13** illustrate a modification for contour stitching of one piece of material (i.e., contour overstitching or "serging" of the piece of material along one edge thereof). In this modification, only a lower wheel **151** is provided, on a wheel mount **135** journaled in a vertical sleeve **119**, actuated as before by cylinder **165**. Instead of using plate **29** as a backup member for the wheel, there is provided a backup plate **311** hinged at **313** on the top of the sewing machine table **1**. This plate is biased downward toward a horizontal backup position by a spring **315**, and is adapted to be swung up to a retracted position to facilitate entry of a piece of material between the plate and the wheel by an air cylinder **317** having a piston **319** therein and a rod **321** extending upward from the piston through a hole **323** in the table. The nozzle **219** is located downstream from the plate, and the inlet **221** is provided by means of another nozzle **223** with a gap between the two nozzles for passage of the material.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In apparatus having means for feeding forward pieces of material having a curved edge, including pieces having a reversely curved edge, and means for operating on the piece of material at a point spaced inward from said curved edge thereof as it is fed forward, means engageable with the piece of material mounted for movement for laterally shifting the piece of material as it is fed forward to maintain said curved edge in predetermined spaced relation to said operating

means, a pneumatic edge sensor located adjacent said operating means for sensing the position of the edge of the material relative to said operating means, and pneumatic means responsive to deviation of the edge of the material relative to the sensor for actuating the shifting means to effect lateral shifting of the material for maintaining said edge in predetermined spaced relation to said operating means, said shifting means and said sensor being located upstream from and closely adjacent said operating means, said feeding means being downstream from said shifting means, a horizontal backup member for the material, the shifting means comprising a wheel opposed to said backup member, the material being fed between the wheel and the backup member, and means mounting the wheel for rotation on a horizontal axis and for movement by said pneumatic means to effect lateral shift of the material, the wheel-mounting means mounting the wheel for swinging movement about a generally vertical axis offset from the wheel axis on the upstream side thereof in respect to the direction of feed of the material, said pneumatic edge sensor having an air inlet adapted for passage thereacross of the edge of the material, the material acting to control the admission of air to the inlet in accordance with the position of the edge of the material relative to the inlet, and said pneumatic means comprising an air cylinder having a piston thereon, the piston being connected to said wheel-mounting means for swinging the wheel, and means for directing air to opposite ends of the cylinder and proportioning the supply of air to opposite ends of the cylinder in accordance with variation in the admission of air to said inlet.

2. In apparatus as set forth in claim 1, the edge sensor including a nozzle for directing air toward the inlet with a gap between the outlet end of the nozzle and the inlet, the edge of the material passing through the gap.

3. In apparatus as set forth in claim 2, means for effecting separation of the wheel and the backup member for insertion of material therebetween.

4. In apparatus having means for feeding forward first and second pieces of material and means for operating on the two pieces of material at a point spaced inward from an edge thereof as they are fed forward to seam them together, a first means engageable with said first piece of material mounted for movement for laterally shifting said first piece of material as it is fed forward to maintain said edge of said first piece of material in predetermined spaced relation to said operating means, a first pneumatic edge sensor located adjacent said operating means for sensing the position of said edge of said first piece of material relative to said operating means, a first pneumatic means responsive to deviation of the edge of said first piece of material relative to the sensor for actuating said first shifting means to effect lateral shifting of said first piece of material for maintaining its said edge in predetermined spaced relation to said operating means, a second shifting means engageable with said second piece of material being fed forward mounted for movement for laterally shifting the second piece of material as it is fed forward to effect contour edge seaming of the first and the second pieces of material, a second pneumatic sensor located adjacent said operating means for sensing the position of the edge of the second piece of material relative to said operating means, and second pneumatic means responsive to deviation of the edge of the second piece of material relative to said second sensor for actuating said second shifting means to effect lateral shifting of the second piece of material for contour edge seaming of the first and second pieces of material.

5. In apparatus as set forth in claim 4, the first and second shifting means and the first and second sensors being located in trailing relation to and closely adjacent said operating means.

6. In apparatus as set forth in claim 5, a horizontal plate located closely adjacent the operating means, one piece of material travelling over said plate and the other travelling under said plate, one of said shifting means comprising a wheel engageable with the piece of material travelling over said plate, and the other shifting means comprising a wheel engageable with the piece of material travelling under said plate, and means mounting each wheel for rotation on a horizontal axis and for movement by the respective pneumatic means to effect lateral shift of the respective piece of material.

7. In apparatus as set forth in claim 6, each wheel-mounting means mounting its wheel for swinging movement about a generally vertical axis offset from the wheel axis on the trailing side thereof in respect to the direction of feed of the material.

8. In apparatus as set forth in claim 7, each pneumatic edge sensor having an air inlet adapted for passage thereacross of the edge of the respective piece of material, the material acting to control the admission of air to the inlet in accordance with the position of the edge of the material relative to the inlet, and each pneumatic means comprising an air cylinder having a piston therein, the piston being connected to the respective wheel-mounting means for swinging the respective wheel, and means for directing air to opposite ends of the cylinder and proportioning the supply of air to opposite ends of the cylinder in accordance with variation in the admission of air to the respective inlet.

9. In apparatus as set forth in claim 8, the inlets being in said plate, one extending down from the top of the plate and the other extending up from the bottom of the plate, and each edge sensor including a nozzle for directing air toward the respective inlet with gaps between its outlet ends of the nozzles and the inlets, the edges of the two pieces of material passing through the gaps.

10. In apparatus as set forth in claim 9, means biasing the wheels toward the plate.

11. In apparatus as set forth in claim 10, means for retracting the wheels from the plate for insertion of a piece of material between one wheel and the top of the plate and the other piece of material between the other wheel and the bottom of the plate.

12. Apparatus for guiding pieces of material having a curved edge, including pieces having a reversely curved edge, in accordance with the contour of said curved edge of each piece of material and in relation to a fixed point of reference as the piece of material is being fed forward, comprising means for feeding the material forward, means engageable with the material as it is being fed forward mounted for movement for laterally shifting the material to maintain its said curved edge in a predetermined relation to said fixed point of reference, an air cylinder having a piston therein connected to said shifting means, a pneumatic edge sensor for sensing the position of the edge of the material relative to said fixed point of reference, said shifting means and said sensor being located upstream from and closely adjacent said fixed point of reference, said feeding means being downstream from said shifting means, said sensor comprising an air inlet adapted for passage thereacross of the edge of the material and a nozzle for directing air toward the inlet with a gap between the outlet end of the nozzle and the inlet, the edge of the material passing through the gap and the material acting to control the admission of air to the inlet in accordance with the position of the edge of the material relative to the inlet, an air-proportioning device having an air inlet, a first air outlet connected to one end of the cylinder and a second air outlet connected to the other end of the cylinder and first and second air control passages adapted to proportion the supply of air through the outlets in accordance with the supply of air to said control passages, a line interconnecting said sensor inlet and one control passage, and a reference air supply line connected to the other control passage, a horizontal backup member for the material, the shifting means comprising a wheel opposed to the backup member, the material being fed between the wheel and the backup member, and means mounting the wheel for rotation on a horizontal axis and for movement by said air cylinder and piston to effect lateral shift of the material, the wheel-mounting means mounting the wheels for swinging movement about a generally vertical axis offset from the wheel axis on the upstream side thereof in respect to the direction of feed of the material.

13. Apparatus for guiding each of two pieces of material each in accordance with the contour of an edge thereof and in relation to a fixed point of reference as the piece of material is being fed forward for combining of the two pieces with an edge of the first piece generally registering with an edge of the second piece, comprising a first means engageable with said first piece of material as it is being fed forward mounted for movement for laterally shifting said first piece of material to maintain its said edge in a predetermined relation to said fixed point of reference, a first air cylinder having a piston therein connected to said first shifting means, a first pneumatic edge sensor for sensing the position of said edge of said first piece of material relative to said fixed point of reference, said first sensor comprising a first air inlet adapted for passage thereacross of said edge of said first piece of material and a first nozzle for directing air toward the first inlet with a first gap between the outlet end of the first nozzle and the first inlet, said edge of said first piece of material passing through the first gap and the material acting to control the admission of air to the first inlet in accordance with the position of said edge of said first piece of material relative to the first inlet, a first air-proportioning device having an air inlet, a first air outlet connected to one end of said first cylinder and a second air outlet connected to the other end of said first cylinder and first and second air control passages adapted to proportion the supply of air through the outlets in accordance with the supply of air to said control passages, a line interconnecting said inlet of said first sensor and one control passage, and a reference air supply line connected to the other control passage, a second shifting means engageable with said second piece of material as it is fed forward mounted for movement for laterally shifting the second piece of material to effect combination of the first and second pieces with their edges generally in register, a second air cylinder having a piston therein connected to said second shifting means, a second pneumatic edge sensor for sensing the position of the edge of the second piece of material relative to said fixed point of reference, said second sensor comprising a second air inlet adapted for passage thereacross of the edge of the second piece of material and a second nozzle for directing air toward said second inlet with a second gap between the outlet end of the second nozzle and the second inlet, the edge of the second piece of material passing through the second gap and acting to control the admission of air to the second inlet in accordance with the position of the edge of the second piece of material relative to the second inlet, a second air-proportioning device having an air inlet, a first air outlet corrected to one end of the second cylinder and a second air outlet connected to the other end of the second cylinder, and first and second air control passages adapted to proportion the supply of air through the outlets in accordance with the supply of air to said control passages, a line interconnecting said second sensor air inlet to one of the control passages of said second proportioning device, and a reference air supply line connected to the other control passage of said second proportioning device.

14. Apparatus as set forth in claim 13 having a horizontal plate, one piece of material travelling over said plate and the other travelling under said plate, one of said shifting means comprising a wheel engageable with the piece of material travelling over said plate, and the other shifting means comprising a wheel engageable with the piece of material travelling under said plate, and means mounting each wheel for rotation on a horizontal axis and for movement by the respective cylinder and piston to effect lateral shift of the respective piece of material, and wherein each wheel-mounting means mounts its wheel for swinging movement about a generally vertical axis offset from the wheel axis on the trailing side thereof in respect to the direction of feed of the material.

15. Contour sewing apparatus comprising a sewing machine and means associated therewith for feeding therethrough pieces of material having a curved edge, including pieces having a reversely curved edge, means engageable with a piece of material being fed through the machine mounted for movement for laterally shifting the piece of material as it travels past the shifting means to effect contour stitching of the piece of material along said curved edge thereof, said feeding means being downstream from said shifting means, a pneumatic edge sensor located adjacent the sewing machine for sensing the position of said edge of the material relative to the needle of the sewing machine, and pneumatic means responsive to deviation of said edge of the material relative to the sensor for actuating the shifting means to effect lateral shifting of the material for contour stitching thereof along said edge, said shifting means and said sensor being located on the entry side of the sewing machine upstream from and closely adjacent the needle of the machine, a horizontal backup member for the material, said shifting means comprising a wheel opposed to said backup member, the material being fed between the wheel and the backup member, and means mounting the wheel for rotation on a horizontal axis and for movement by said pneumatic means to effect lateral shift of the material, the wheel-mounting means mounting the wheel for swinging movement about a generally vertical axis offset from the wheel axis on the upstream side thereof away from the needle, said pneumatic edge sensor having an air inlet adapted for passage thereacross of the edge of the material, the material acting to control the admission of air to the inlet in accordance with the position of the edge of the material relative to the inlet, and said pneumatic means comprising an air cylinder having a piston therein, the piston being connected to said wheel-mounting means for swinging the wheel, and means for directing air to opposite ends of the cylinder and proportioning the supply of air to opposite ends of the cylinder in accordance with variation in the admission of air to said inlet.

16. Contour sewing apparatus as set forth in claim 15 wherein the edge sensor includes a nozzle for directing air toward the inlet with a gap between the outlet end of the nozzle and the inlet, the edge of the material passing through the gap.

17. Contour sewing apparatus as set forth in claim 16 having means for effecting separation of the wheel and the backup member for insertion of material therebetween.

18. Contour sewing apparatus for contour edge seaming of two pieces of material comprising a sewing machine and means associated therewith for feeding first and second pieces of material therethrough, first means engageable with the first piece of material being fed through the machine mounted for movement for laterally shifting the first piece of material as it travels past the first shifting means to effect contour stitching of the first piece of material along an edge thereof, a first pneumatic edge sensor located adjacent the sewing machine for sensing the position of the edge of the first piece of material relative to the needle of the sewing machine, and first pneumatic means responsive to deviation of the edge of the first piece of material relative to the first sensor for actuating the first shifting means to effect lateral shifting of the first piece of material for contour stitching thereof along its said edge, a second shifting means engageable with the second piece of material being fed through the machine mounted for movement for laterally shifting the second piece of material as it travels past said second shifting means to effect contour edge seaming of the first and the second pieces of material, a second pneumatic sensor located adjacent the sewing machine for sensing the position of the edge of the second piece of material relative to the needle, and second pneumatic means responsive to deviation of the edge of the second piece of material relative to said second sensor for actuating said second shifting means to effect lateral shifting of the second piece of material for contour edge seaming of the first and second pieces of material.

19. Contour sewing apparatus as set forth in claim 18 wherein the first and second shifting means and the first and second sensors are located on the entry side of the sewing machine closely adjacent the needle of the machine.

20. Contour sewing apparatus as set forth in claim 19 having a horizontal plate located closely adjacent the sewing machine on the entry side thereof generally at the level of the top of the

bed of the sewing machine, one piece of material travelling over said plate and the other travelling under said plate, one of said shifting means comprising a wheel engageable with the piece of material travelling over said plate, and the other shifting means comprising a wheel engageable with the piece of material travelling under said plate, and means mounting each wheel for rotation on a horizontal axis and for movement by the respective pneumatic means to effect lateral shift of the respective piece of material.

21. Contour sewing apparatus as set forth in claim 20 wherein each wheel-mounting means mounts its wheel for swinging movement about a generally vertical axis offset from the wheel axis on the side thereof away from the needle.

22. Contour sewing apparatus as set forth in claim 21 wherein each pneumatic edge sensor has an air inlet adapted for passage thereacross of the edge of the respective piece of material, the material acting to control the admission of air to the inlet in accordance with the position of the edge of the material relative to the inlet, and wherein each pneumatic means comprises an air cylinder having a piston therein, the piston being connected to the respective wheel-mounting means for swinging the respective wheel, and means for directing air to opposite ends of the cylinder and proportioning the supply of air to opposite ends of the cylinder in accordance with variation in the admission of air to the respective inlet.

23. Contour sewing apparatus as set forth in claim 22 wherein the inlets are in said plate, one extending down from the top of the plate and the other extending up from the bottom of the plate, and wherein each edge sensor includes a nozzle for directing air toward the respective inlet with gaps between its outlet ends of the nozzles and the inlets, the edges of the two pieces of material passing through the gaps.

24. Contour sewing apparatus as set forth in claim 23 having means biasing the wheels toward the plate.

25. Contour sewing apparatus as set forth in claim 24 having means for retracting the wheels from the plate for insertion of a piece of material between one wheel and the top of the plate and the other piece of material between the other wheel and the bottom of the plate.

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