

[54] **AUTOMATIC FEEDER FOR WORKPIECES OF FABRIC OR THE LIKE**

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[51] Int. Cl. D05b 33/00
[58] Field of Search 112/121.29, 121.11, 121.12,
112/121.15, 102, 203, 212, 211, 214, 47; 271/26, 1,
27, 28, 33, 36, 39, 43, 60, 68, 86, 74, 82, 85

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[57]

ABSTRACT

Apparatus for automatically feeding workpieces of fabric or similar limp material one after another from a stack of workpieces and delivering each workpiece to a sewing machine for a sewing operation along an edge of the workpiece. The top workpiece of the stack is picked off by means of a roller which rolls up the top workpiece of the stack, advances it to a position spaced from the stack, and then retracts to unroll the workpiece, whereupon a feed device takes over to feed the workpiece into a sewing machine to start the sewing operation. The sewing machine then takes over, and the workpiece is fed through the sewing machine by the feed device of the sewing machine and stitched. In being fed through the sewing machine, the workpiece is automatically guided for contour stitching along an edge thereof. A stacker is provided on the exit side of the sewing machine for automatically stacking completed workpieces exiting from the sewing machine.

9 Claims, 26 Drawing Figures

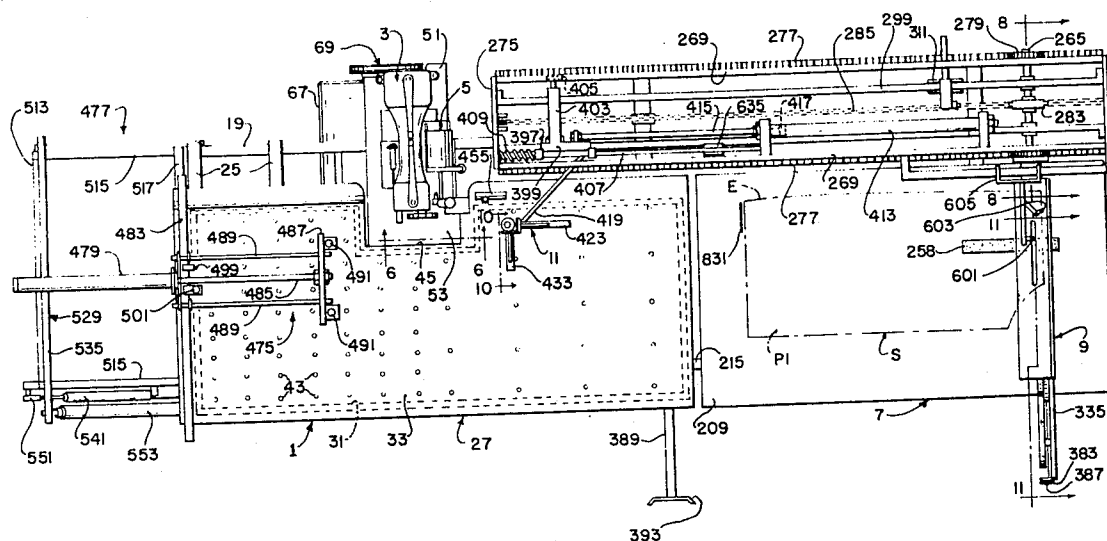


FIG.1

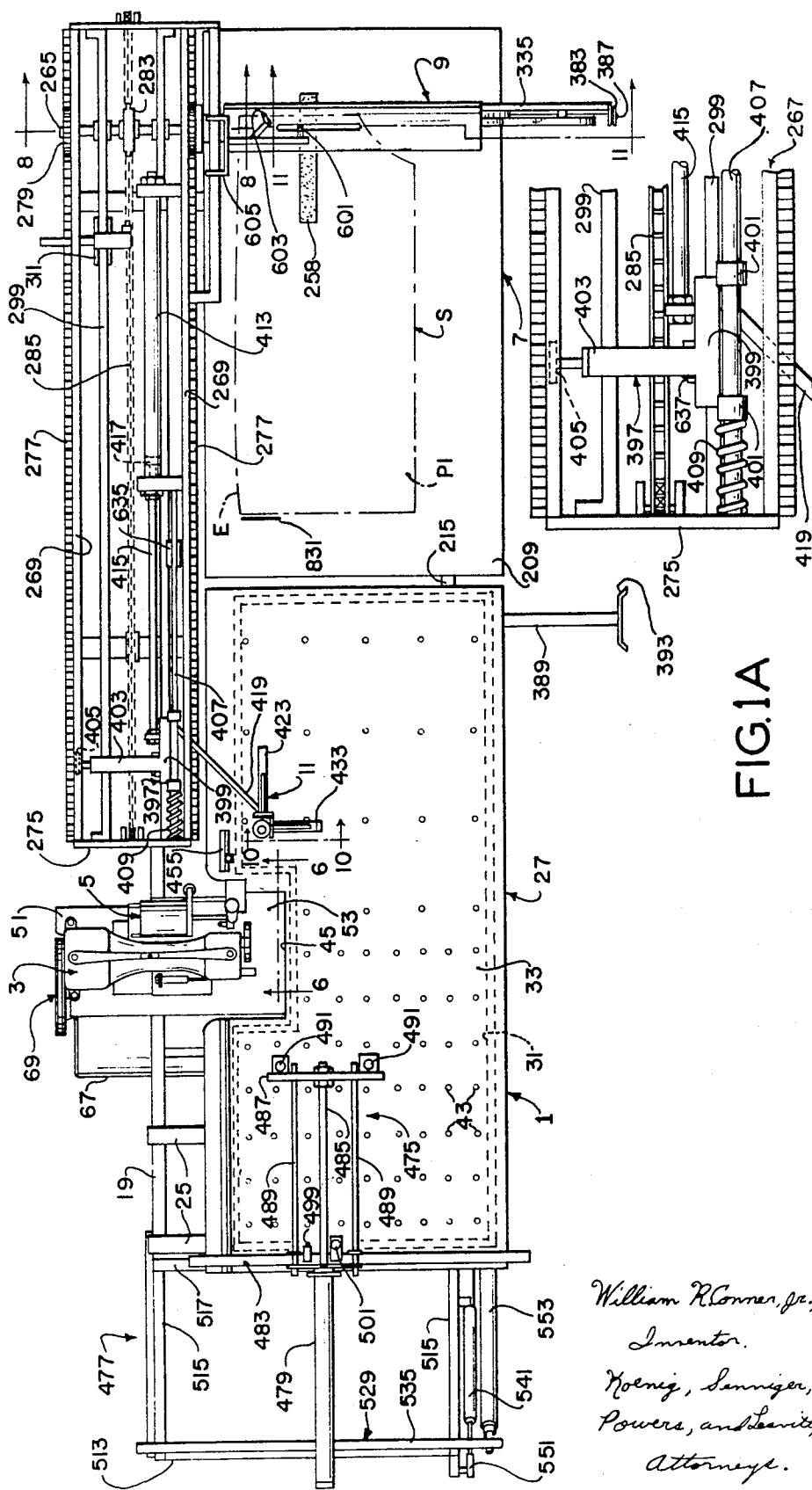


FIG.1A

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Attorneys.

FIG.2

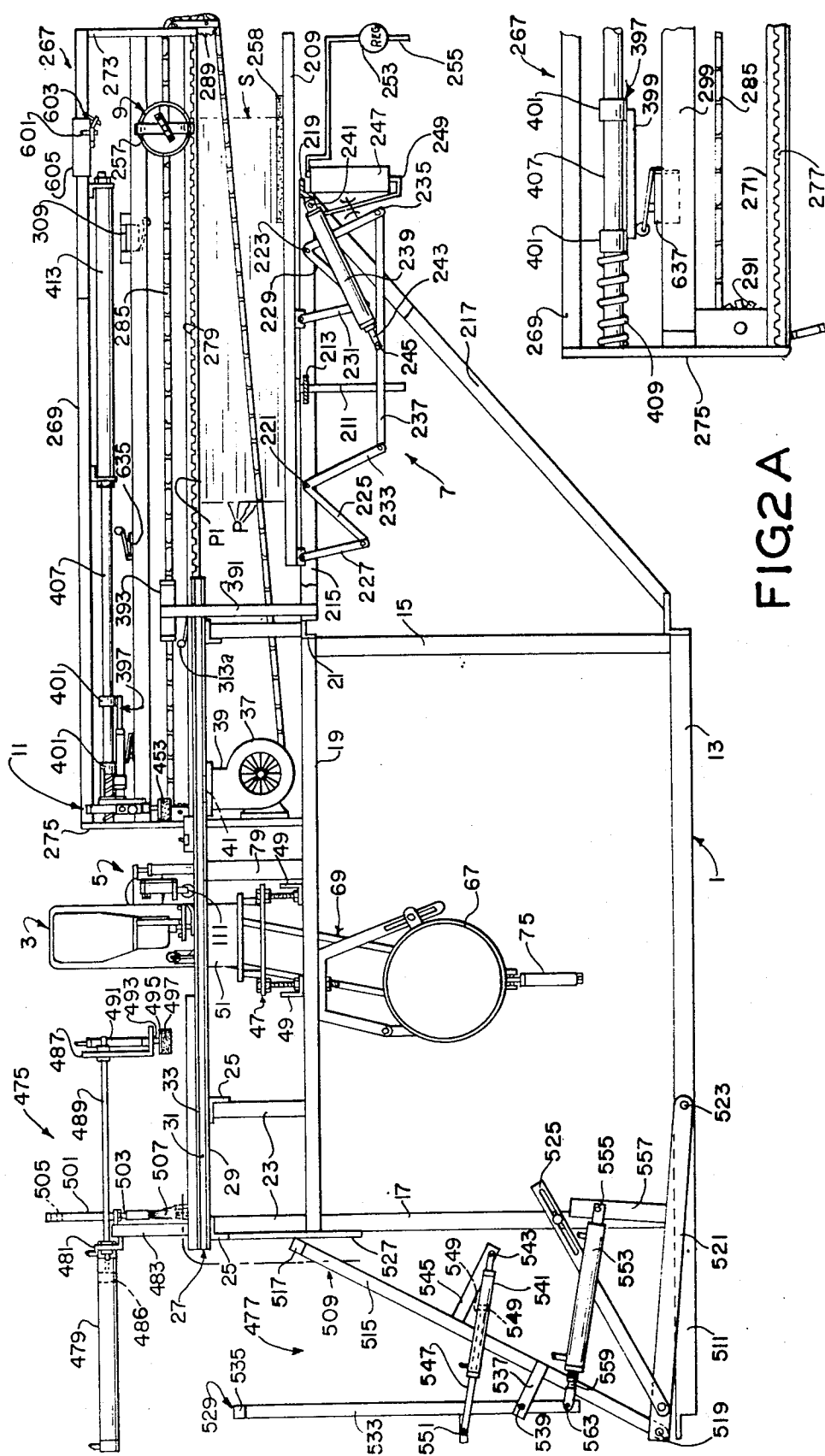


FIG.2A

F/G.3

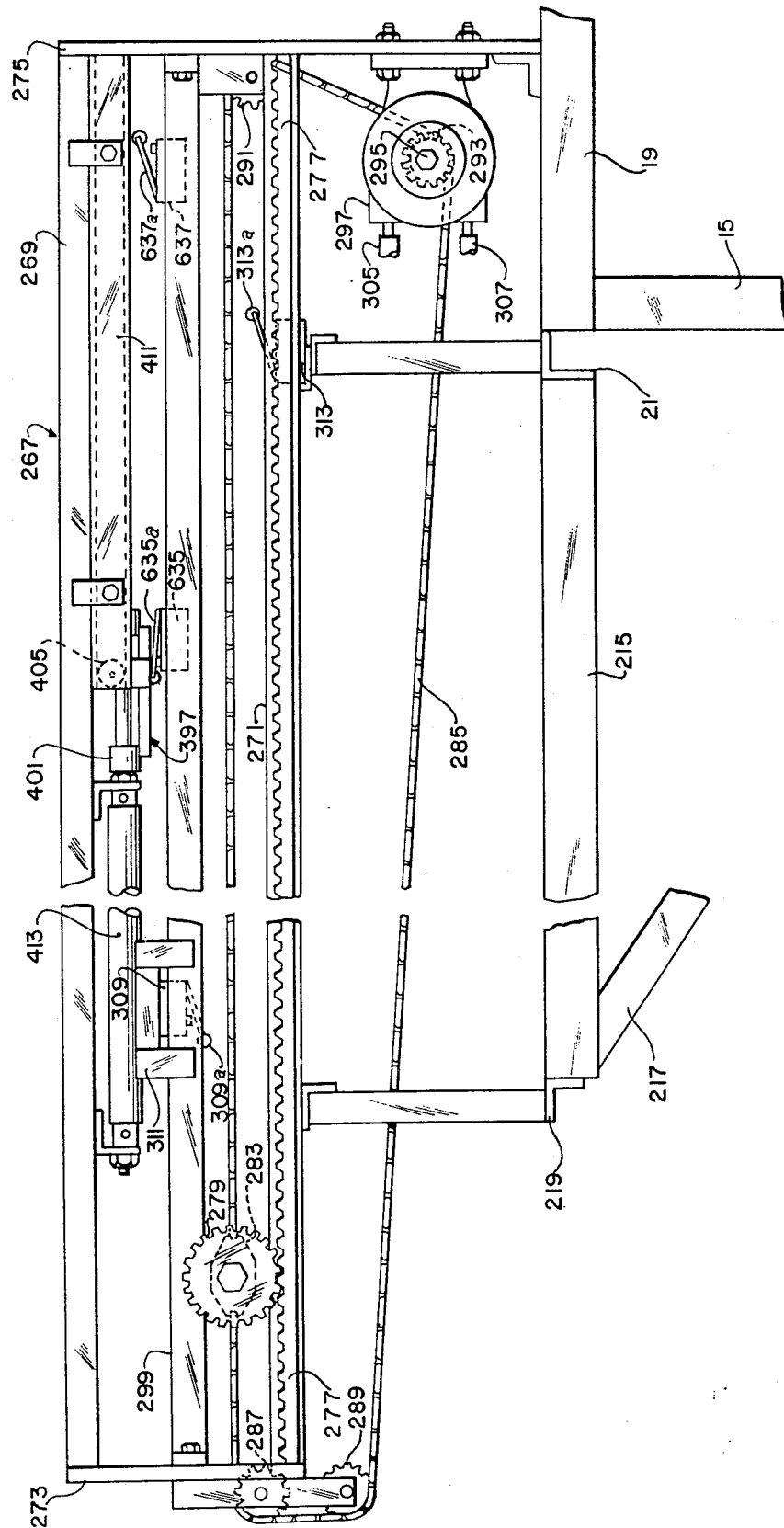


FIG. 4

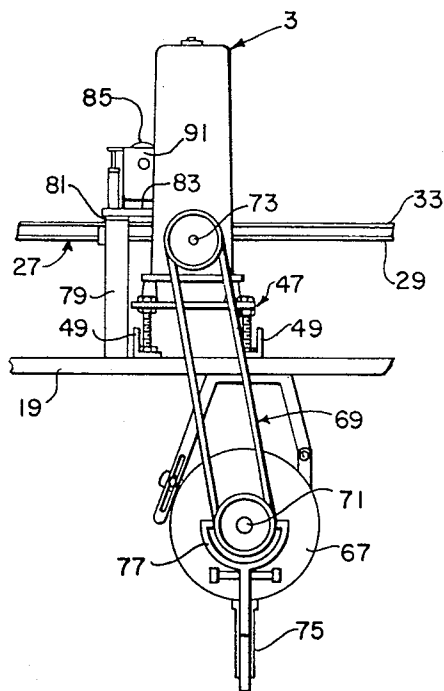


FIG. 5

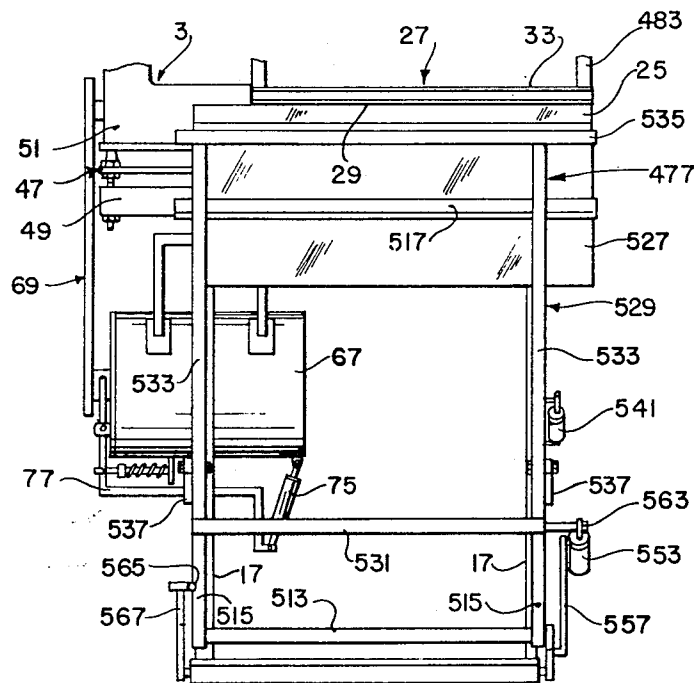


FIG. 6

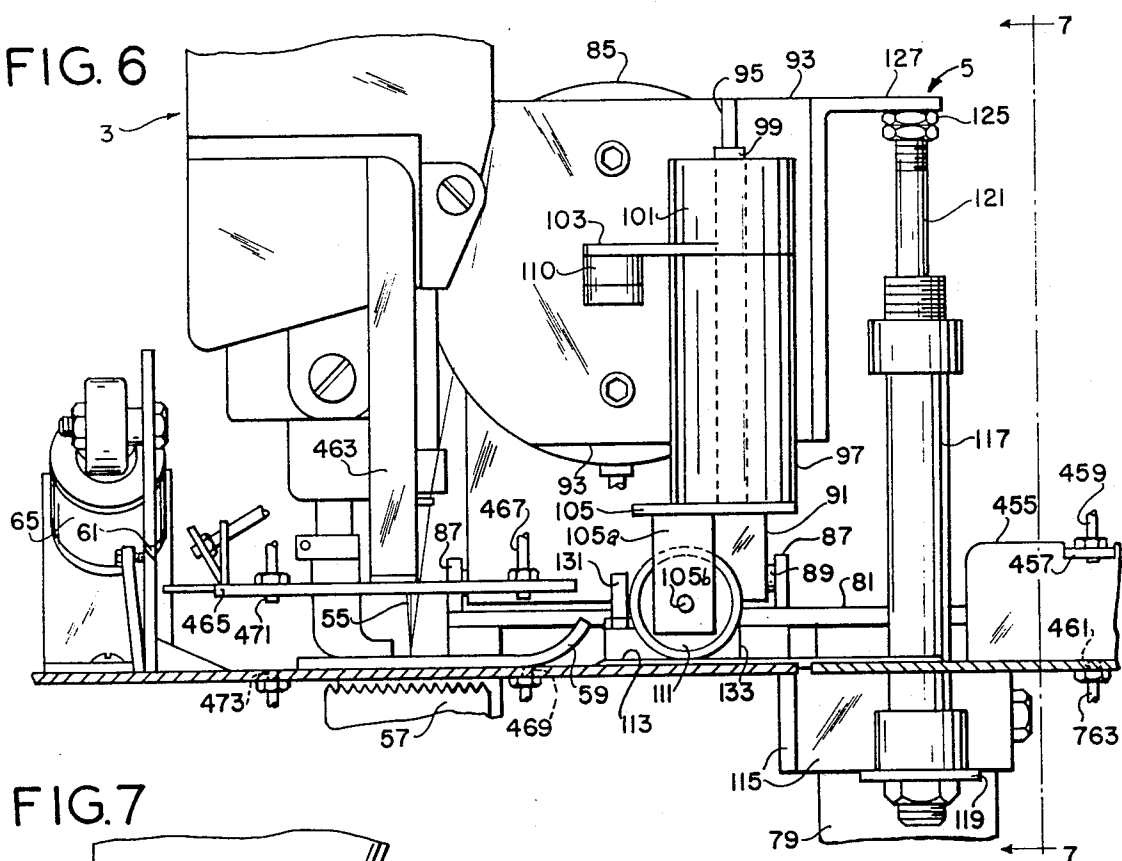


FIG. 7

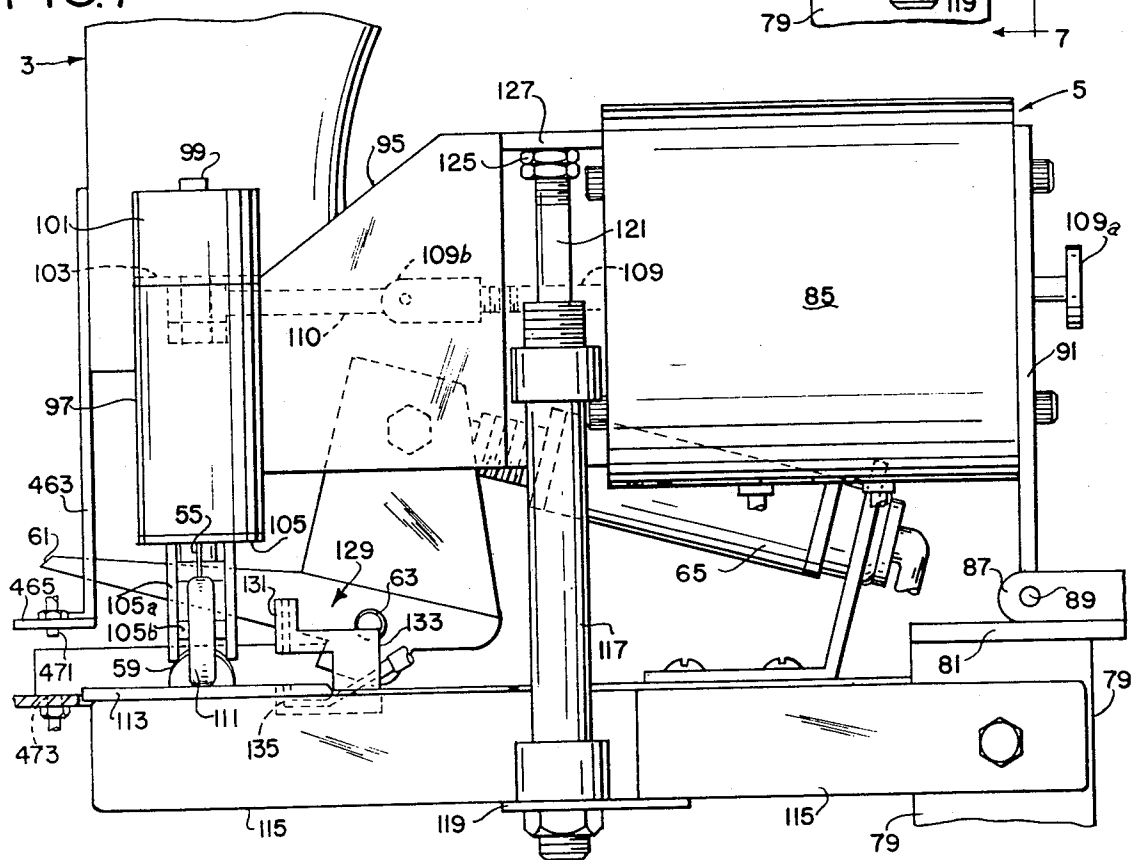


FIG.8

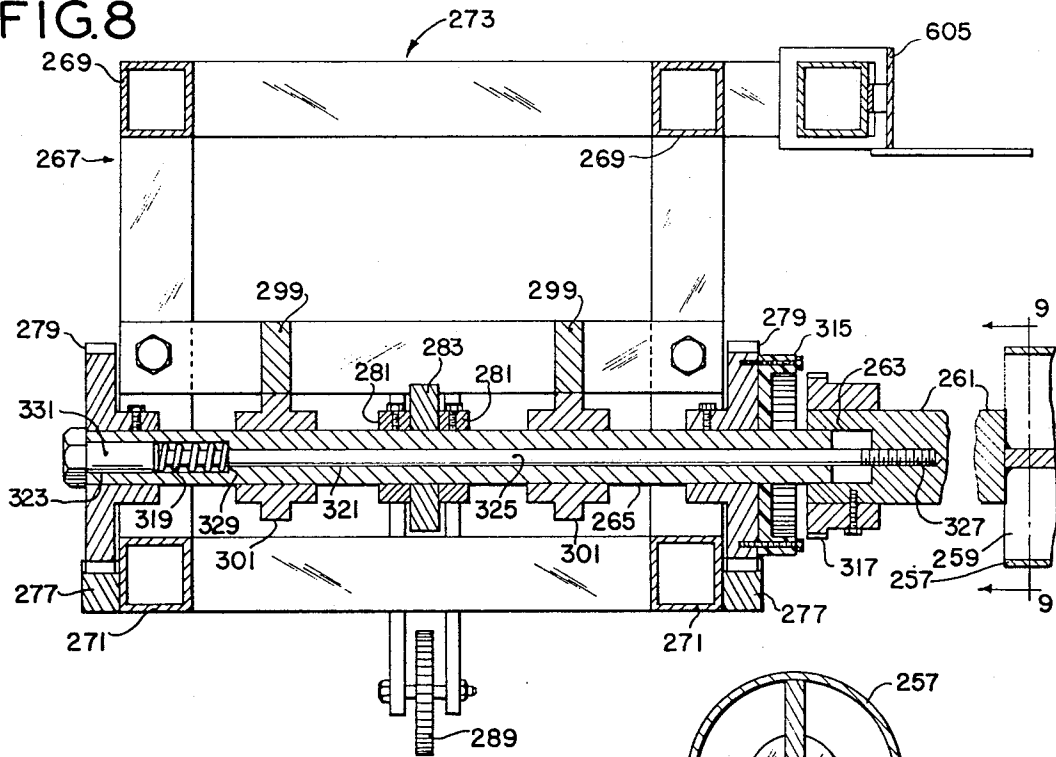


FIG. 9

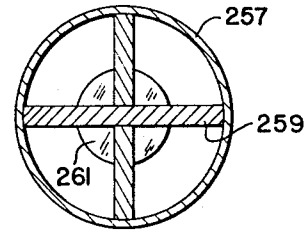


FIG.10

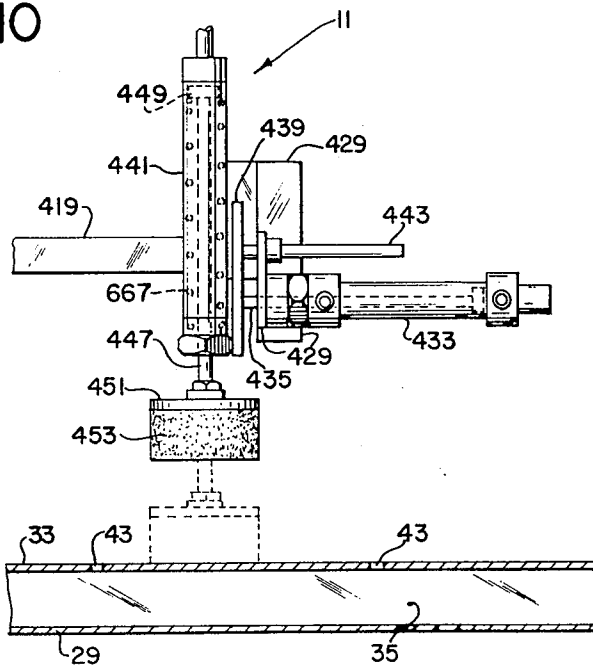


FIG.14

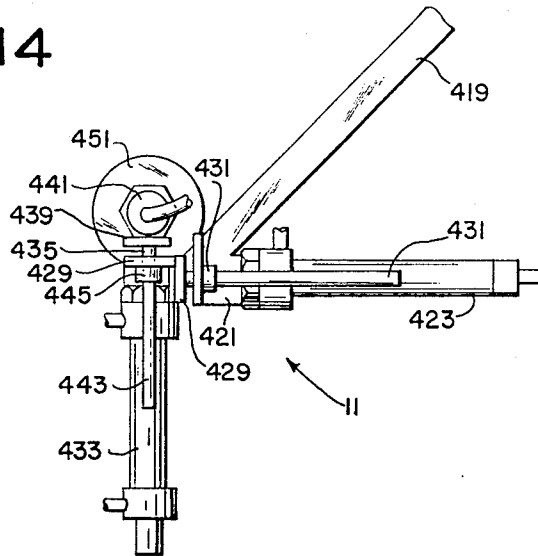
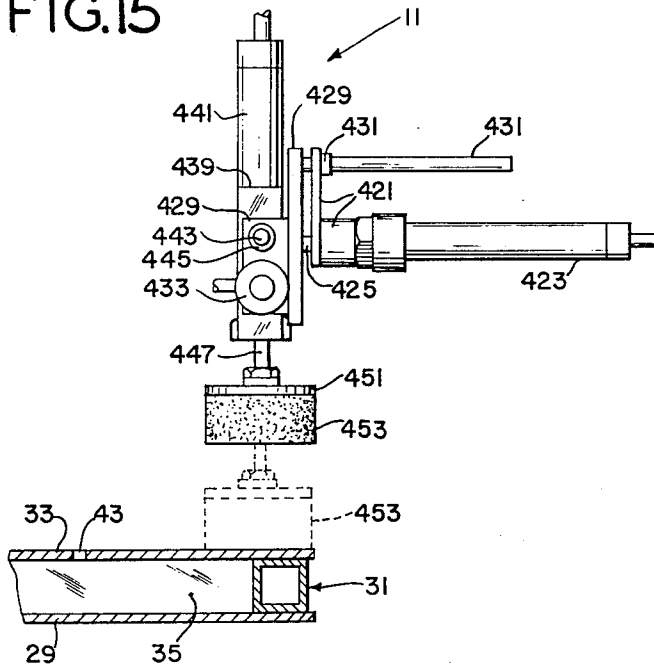


FIG.15



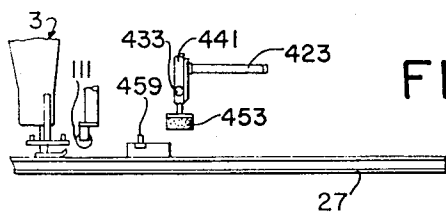
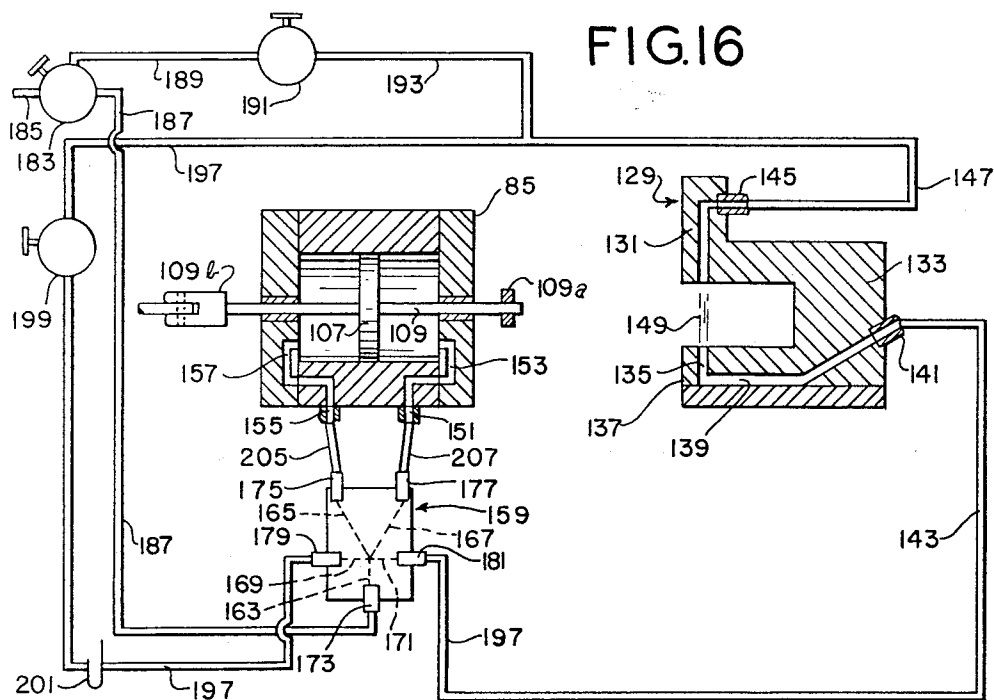


FIG.17

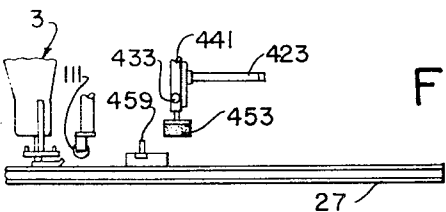
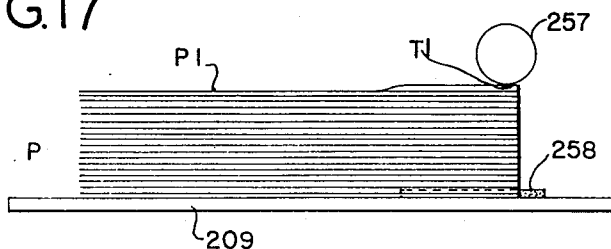


FIG.18

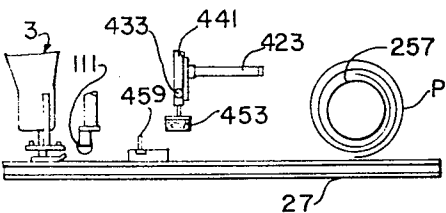
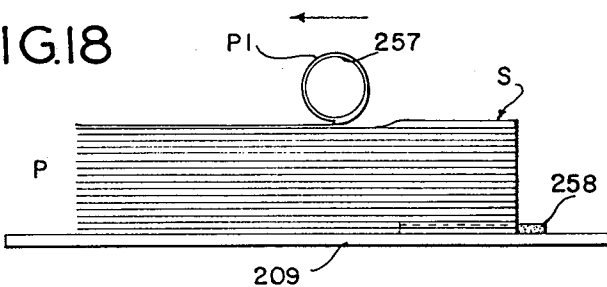


FIG.19

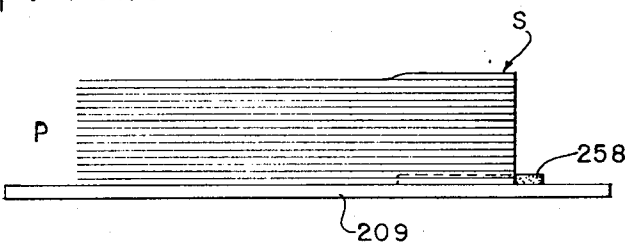


FIG.20

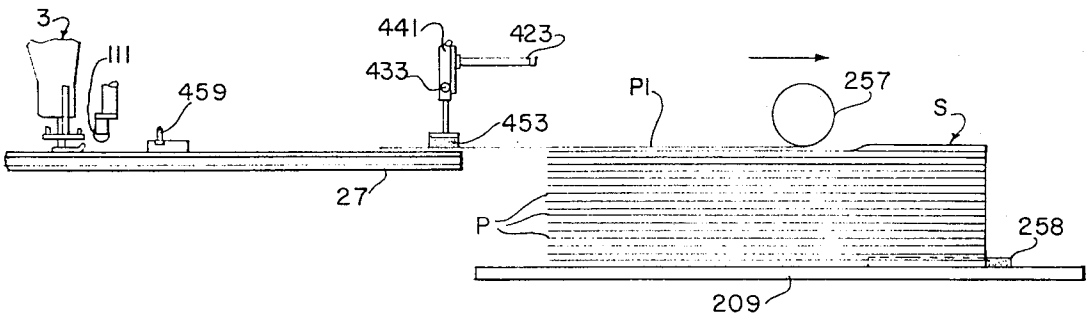


FIG.21

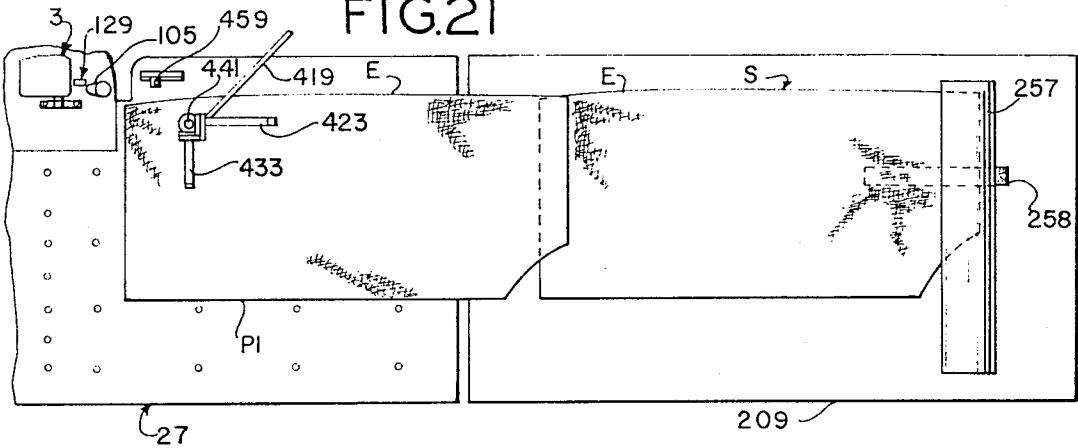


FIG.22

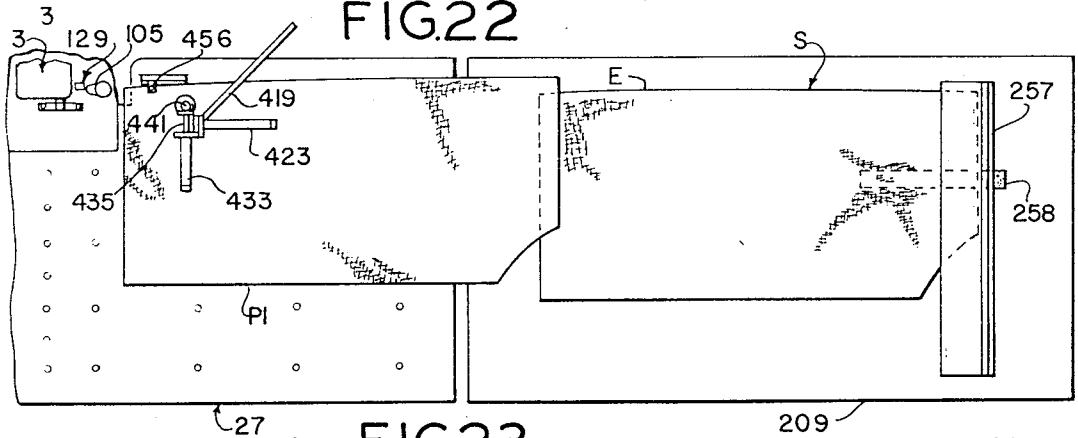
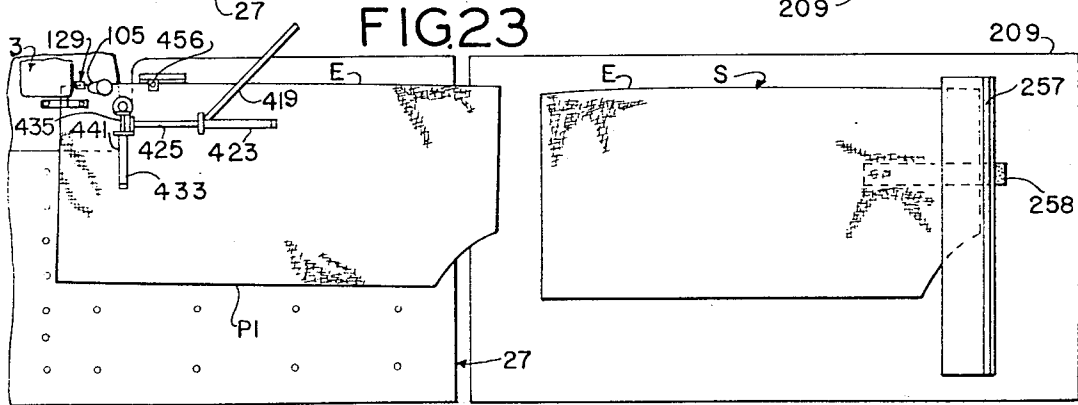
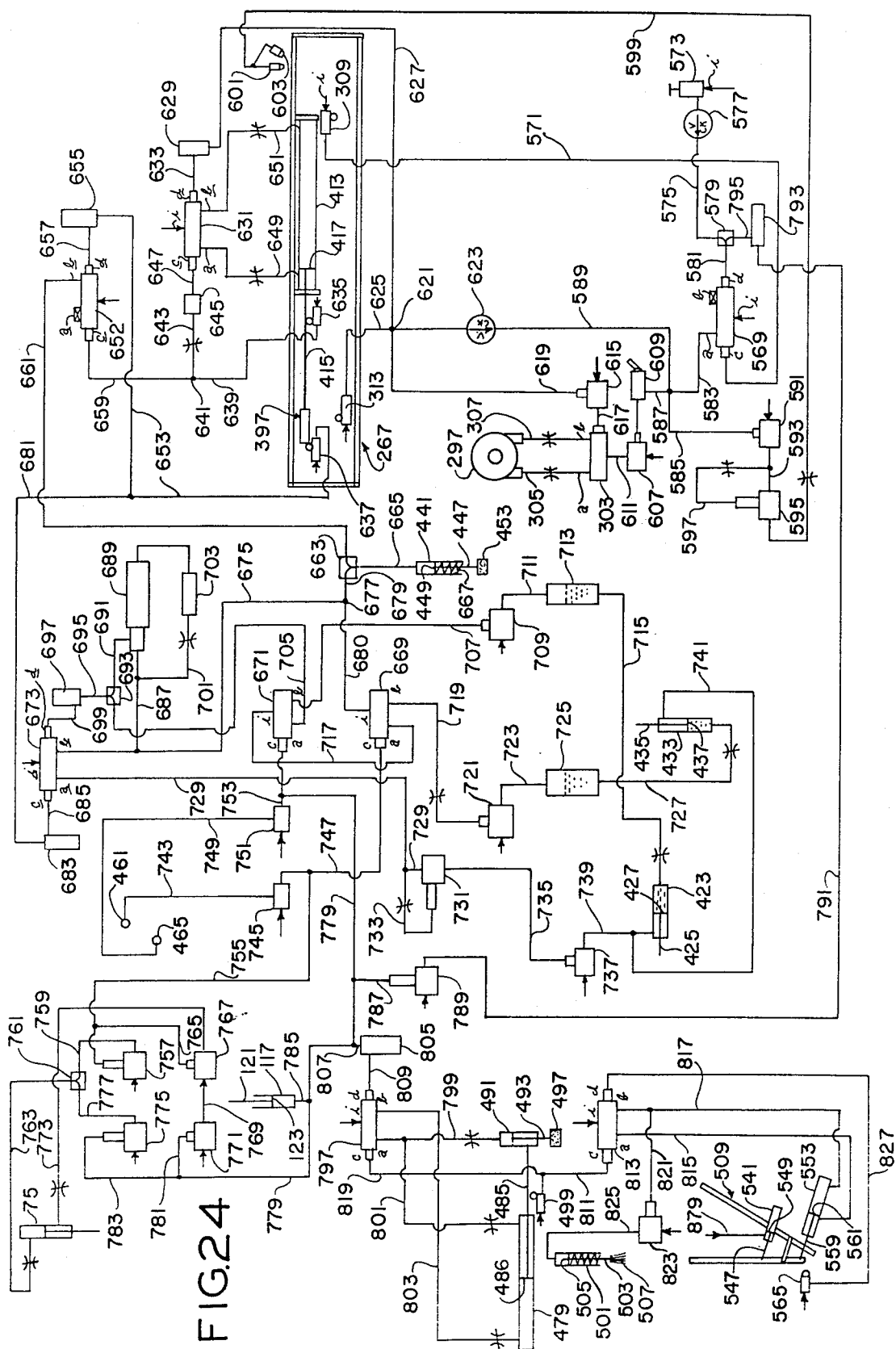


FIG.23





AUTOMATIC FEEDER FOR WORKPIECES OF FABRIC OR THE LIKE

BACKGROUND OF THE INVENTION

This invention relates to automatic feeders for workpieces of fabric or the like, and more particularly to apparatus for automatically feeding such workpieces one after another from a stack thereof to and through a sewing machine for a sewing operation along an edge of each workpiece.

This invention is particularly directed toward automating the sewing of workpieces of fabric or the like. Automation of sewing operations has involved problems in the separation and pick-up of a single fabric workpiece, referred to as a ply, from a stack of fabric plies, in the introduction of the ply into the sewing machine, in the control of the ply as it is fed through the sewing machine for contour stitching along an edge being sewn, and in the handling of the plies exiting from the sewing machine. Reference may be made to such U.S. Pat. Nos. as 2,985,122, 3,083,961, 3,099,970, 3,168,307 and 3,168,308 for prior art of interest. Reference is also made to my prior copending U.S. Pat. application Ser. No. 738,036, filed June 18, 1968, relating to an Edge Contour Guidance Control for Pieces of Material, which shows a control for contour stitching along an edge of the material being sewn utilized in conjunction with the present invention.

SUMMARY OF THE INVENTION

Among the several objects of this invention may be noted the provision of an automatic feeder for feeding workpieces of fabric or other limp material one after another from a stack thereof to and through a machine for carrying out an operation on each workpiece; the provision of such apparatus having improved means for separating and picking up the top ply of the stack (the top workpiece); the provision of such apparatus having means operable on the workpiece picked up from the stack to feed it forward to the machine in position for starting the operation of the machine on the workpiece; the provision of apparatus such as described wherein the machine is a sewing machine for carrying out the operation of stitching along an edge of the workpiece and having means for guiding the workpiece through the machine for contour stitching along said edge; and the provision of means for efficiently stacking workpieces exiting from the sewing machine.

In general, apparatus of this invention for automatically feeding workpieces of limp material one after another from a stack thereof to and through a machine, e.g., a sewing machine, for operating on the workpieces comprises a table over which workpieces may be fed to and through the machine. Means is provided adjacent the entrance end of the table for holding a stack of workpieces, and means is provided for separating and picking up the top workpiece of the stack and delivering it to the table. Further means is provided for feeding the workpiece over the table to the machine and entering it in the machine with the workpiece in position for being fed through the machine for operation thereon by the machine. The means for separating and picking up the top workpiece of the stack comprises a roller for rolling up the top workpiece, this roller being mounted for rotation on its axis and also for translation at right angles to its axis to roll over the top workpiece, and having means for initial attachment thereto of the top workpiece so that it may be rolled up on the roller. Other objects and features will be in part apparent and in part pointed out hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan of an automatic feeder constructed in accordance with this invention;
FIG. 1A is an enlarged fragment of FIG. 1;
FIG. 2 is a front elevation of the feeder;
FIG. 2A is an enlarged fragment of FIG. 2;
FIG. 3 is a rear elevation of part of the feeder, on a larger scale than FIGS. 1 and 2, with parts broken away to reduce the length of the view, and showing a moved position of parts;

FIG. 4 is a rear elevation of another part of the feeder, on a larger scale than FIGS. 1 and 2;
FIG. 5 is a view in elevation of the left end of FIG. 1;
FIG. 6 is an enlarged vertical section on line 6—6 of FIG. 1;
FIG. 7 is an enlarged vertical section on line 7—7 of FIG. 6;
FIG. 8 is an enlarged vertical section on line 8—8 of FIG. 1;
FIG. 9 is a vertical section on line 9—9 of FIG. 8;
FIG. 10 is an enlarged view in elevation on line 10—10 of FIG. 1;

FIG. 11 is an enlarged section on line 11—11 of FIG. 1;

FIG. 12 is a view on line 12—12 of FIG. 11;

FIG. 13 is a section on line 13—13 of FIG. 11;

FIG. 14 is a plan of FIG. 10;

FIG. 15 is a front elevation of FIG. 14;

FIG. 16 is a diagrammatic view showing certain pneumatic circuitry;

FIGS. 17—20 are views in elevation showing certain steps in the operation of the apparatus;

FIGS. 21—23 are plan views showing certain steps in the operation of the apparatus; and

FIG. 24 is a pneumatic circuit diagram.

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 FIGS. 1 and 2, apparatus made in accordance with this invention is shown to comprise a sewing machine table 1 over which a workpiece of fabric material P, which is sometimes referred to as a "ply," is to be fed to a sewing machine 3 and thence through the machine for contour stitching (e.g., over stitching or "serging") of the workpiece of ply P along one edge thereof, herein indicated as the long curved edge E of the piece of material. At 5 is generally indicated means for guiding a workpiece of ply P through the sewing machine in accordance with its edge contour to effect contour stitching of the edge, i.e., stitching along a line generally parallel to the edge. Adjacent one end of the sewing machine table 1, which may be referred to as its entry end (its right end as viewed in FIGS. 1 and 2), is means generally designated 7 for holding a pile or stack S of workpieces or plies P of fabric each of which is to be individually contour-stitched along its edge E, this means being adapted to maintain the top ply of the stack (this top ply being specially designated P1) generally in a predetermined plane as plies are separated from and picked up off the top of the stack, one-by-one. This plane is generally the plane of the top of the sewing machine table 1. At 9 is generally indicated means for separating and picking up the top ply P1 off the stack S and delivering it to the sewing machine table, and at 11 is generally indicated means for feeding the ply of material which has been delivered to the table 1 by means 9 over the table and entering its leading end at edge E into the sewing machine in position for contour stitching of said edge. Once entered into the sewing machine, the piece of material is fed forward through the machine by the conventional feed mechanism of the machine under the guidance control of means 5 for contour stitching of edge E.

The sewing machine table 1 comprises a base 13, legs such as indicated at 15 extending up from the base at one end thereof constituting what may be referred to as its entrance end, and legs such as indicated at 17 extending up from the base adjacent its other end, which may be referred to as its exit end. Side rails such as indicated at 19 and end rails such as indicated at 21 extend between the upper ends of the legs. Extending up from the side rails 19 are additional short legs 23 spanned by transversely extending angle irons such as indicated at 25 supporting the table top, which is generally designated 27. The table top is of hollow construction, comprising a generally rectangular bottom plate 29, an open generally rectangular frame 31 extending around the margin of the bottom plate on the top thereof, and a generally rectangular top plate 33 on the frame spaced from the bottom plate so as to

provide a plenum chamber 35 (see FIG. 10) between the plates. A blower 37 is mounted below the table top, having its outlet 39 secured to the bottom plate 29 around an opening 41 in the bottom plate, so that it is adapted to blow air into the plenum 35. The top plate 33 has a plurality of perforations, such as indicated at 43, for exit of air from the plenum. In the operation of the apparatus, the blower 37 is continuously operated for blowing air upward through the perforations 43 to cause a workpiece or ply P being fed over the table top 27 in effect to "float" on the table top for easy low-friction movement over the table top.

The table top 27 has a generally rectangular cutout 45 in one side thereof which may be referred to as its rearward side. The sewing machine 3 is mounted as indicated at 47 on a pair of horizontal angle irons 49 which span the side rails 19 of the table 1 and which are cantilevered outward beyond the rear of the table from the rear side rail 19 with the front end of the bed 51 of the sewing machine received in the cutout 45 of the table and with the horizontal top surface of the bed 51 of the sewing machine generally flush with the top surface of the table top 27 (i.e., the table top plate 33). The work plate of the sewing machine is indicated at 53; the needle of the sewing machine is indicated at 55; the feed device of the sewing machine is indicated at 57; and the presser foot of the sewing machine is indicated at 59. On the exit side of the needle is a cutter 61 (see FIG. 7) pivoted at 63 on the bed of the machine and operable by an air cylinder 65.

At 67 is indicated an electric motor for driving the sewing machine via a conventional clutch and brake mechanism (not shown) and a belt and pulley drive 69 between the output shaft 71 of the clutch and brake mechanism and the input shaft 73 of the sewing machine. In the operation of the apparatus, the electric motor operates continuously, and the clutch is engaged with attendant release of the brake to start the sewing machine for a sewing operation on a piece of fabric entered into the sewing machine, and the clutch is disengaged with attendant engagement of the brake to stop the sewing machine when the sewing operation has been completed. Actuation of the clutch and brake mechanism is via an air cylinder 75 operating a shifter fork 77.

The means 5 for guiding a workpiece through the machine for contour stitching of the edge of the workpiece is similar to the edge contour guide system shown in my aforesaid copending U.S. application Ser. No. 738,036. It is located at the entrance side of the sewing machine 3 and comprises a post 79 extending up from the back side rail 19 of the table 1. Extending back from the top of this post is a platform 81 on the rearward end of which is mounted a bracket 83 for pivotally supporting an air cylinder 85.

The bracket includes a pair of arms 87 extending horizontally in the direction toward the front of the apparatus and having a pivot pin 89 extending horizontally between the arms at their front ends, this pin being generally at right angles to and slightly above the bed 51 of the sewing machine. A hinge plate 91 is hinged at its lower end on the pin 89. The air cylinder 85 has its back end secured to the hinge plate 91 and extends therefrom in the direction toward the front of the apparatus.

Mounted on the front end of the air cylinder 85 is a bracket 93 having a leg 95 extending in the direction toward the front of the apparatus and carrying at its front end a vertical sleeve 97. Rotatable in this sleeve is a shaft 99 having a collar 101 secured on its upper end at the top of the sleeve having a radial arm 103, and a radial arm 105 constituting a wheel carrier secured on its lower end at the lower end of the sleeve. The cylinder has a piston 107 slidable therein having a piston rod 109 extending out through openings in the front end head of the cylinder and the rear end head of the cylinder. On the rear end of the piston rod is a collar 109a serving as a stop with respect to forward movement of the piston rod. On the front end of the piston rod is a clevis 109b the rear end of which serves as a stop with respect to rearward movement of the piston rod, with a link 110 having a pin connection with the

clevis and a pin connection with the radial crank arm 103 on the upper end of the shaft 99. The wheel carrier arm 105 extends in the direction toward the sewing machine from the lower end of shaft 99 and has an inverted U-shaped yoke 105a extending downward therefrom adjacent its forward end with a shaft 105b extending between the lower ends of the sides of this yoke carrying a guide wheel 111.

The cylinder 85, carrying the bracket 93 and the wheel 111, is adapted to swing down by gravity on the axis of pivot pin 89 to a lowered operative position determined by engagement of the wheel 111 with a horizontal bed plate 113 on the front end of an arm 115 which extends toward the front of the apparatus from the post 79. The bed plate 113 is accommodated in the cutout 45 of the table top 27, and is generally flush with the top plate 33 of the table top. The cylinder 85 is adapted to be swung upward from its stated lowered position to lift the wheel 111 upward away from the bed plate 113 by a vertically extending air cylinder 117 having its lower end mounted as indicated at 119 on the arm 115. A piston rod 121 extends upward from a piston 123 in the cylinder and has a nut 125 adjustably threaded on its upper end engageable by an ear 127 at the top of the bracket 93, the arrangement being such that on upward movement of the piston rod 119 from its lowered retracted position of FIG. 7, the cylinder 85 is swung upward to lift the wheel 111 off the bed plate 113.

For operating the guide wheel 111 for automatic shifting of the fabric ply being fed through the sewing machine 3 in accordance with the contour of its edge E which is to be stitched, there is provided a pneumatic edge sensor for the ply, indicated generally at 129, and comprising an air nozzle 131 on a C-shaped bracket 133 on the work plate 53 of the sewing machine positioned to direct a continuous stream of air downward toward a vertical air inlet hole 135 in the base 137 of the C-shaped bracket. This hole intersects a hole 139 in the base and a nipple 141 is provided on the back of the base in communication with hole 139 for attachment of an air line 143. Nozzle 131 has a lateral nipple 145 for attachment of an air supply line 147. The lower end of the nozzle is spaced from the top surface of the base 137 of the bracket 133, the gap therebetween being indicated at 149. This gap is dimensioned for free passage therethrough of a piece of material being stitched by the sewing machine. The nozzle 131 (and the air inlet hole 135 aligned with the nozzle) are located closely adjacent the guide wheel 111 and in the region between the guide wheel and the needle of the sewing machine, and laterally offset toward the rear of the apparatus from the vertical longitudinal plane of the apparatus through the needle of the sewing machine a distance corresponding to the desired spacing for the stitching from edge E of the ply of material.

Air cylinder 85 operates in response to the edge sensor 129 to control the guide wheel 111 for guiding the ply of material being fed through the sewing machine by its feed means 57 in accordance with the contour of the edge E of the ply of material. Air cylinder 85 has a port 151 connected by passageway 153 to its rear end and a port 155 connected by passageway 157 to its front end. Supply of air to these ports is controlled by an air proportioning device 159 which is in turn under control of the edge sensor 129 (see FIG. 16). The air proportioning device 159 is of a type available from Corning Glass Works, of Corning, New York, essentially comprising a relatively thin generally rectangular body 161 having an air inlet passage 163, two air outlet passages 165 and 167, and two control passages 169 and 171. A nipple 173 is provided for connection of an air line to the inlet passage 163, nipples 175 and 177 are provided for connection of air lines to the outlet passages 165 and 167, and nipples 179 and 181 are provided for connection of air lines to the control passages 169 and 171. The passaging in the body is such that, with air under pressure supplied through the inlet passage 163, and with air at equal pressure supplied through the control passages 169 and 171, the air input is equally proportioned between outlet passages 165 and 167, so that the air output of each of the outlet passages 165 and 167 is equal. If pressure of air supplied

through control passage 169 becomes higher than pressure of air supplied through control passage 171, 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 167 and decrease the pressure of air delivered through outlet passage 165. Conversely, if pressure of air supplied through control passage 171 becomes higher than pressure of air supplied through control passage 169, then the device functions automatically to increase the pressure of air supplied through outlet passage 165 and decrease the pressure of air supplied through outlet passage 167.

Referring to FIG. 16, there is indicated at 183 a pressure regulator to an inlet of which is connected an air line 185 leading from a source of compressed air (e.g., at 40 psi). Regulator 183 is adapted to drop the supply pressure to 5 psi, for example. An air supply line 187 extends from an outlet of regulator 183 to the inlet 173 of the air proportioning device 159. An air line 189 is shown as extending from another outlet of regulator to the inlet of another pressure regulator 191, which is adapted further to drop the pressure (e.g., to 2 1/4 psi). An air line 193 extends from the outlet of regulator 191, and has branch air line connections 147 and 197, respectively, with nozzle 131 and with nipple 179 for control passage 169 of the air proportioning device 159. Line 147 supplies air to nozzle 131. Line 197 has a flow regulator 199 and an air gap 201 therein. Air line 143 interconnects inlet 135 via nipple 141 with nipple 181 for control passage 171 of the air proportioning device 159. Line 197 maintains a control pressure (e.g., 1 1/2 psi) in control passage 169 of device 159, the air gap 201 reducing surging in line 197. Pressure in control passage 171 varies in accordance with the extent of the opening or closing of the inlet 135 by the edge E of the ply of material, via line 143. Nipples 175 and 177 of air outlet passages 165 and 167 of device 159 are connected to ports 155 and 151 of cylinder 85 as indicated at 205 and 207. The means 7 for holding the pile or stack S of plies P of material at the rearward end of the sewing machine table 1 comprises a vertically movable elevator platform 209 adapted to hold the stack, and biased to move relatively slowly upward as plies are picked up off the stack to maintain the top ply P1 of the stack generally in the plane of the top 27 of the sewing machine table 1. This elevator platform 209 is guided for vertical movement by means of a pair of guide rods such as indicated at 211 extending downward from the platform through guide holes in a crossbar 213 spanning a pair of fixed horizontal side rails 215 which extend rearward from the rearward end rail 21 of the sewing machine table 1. The rails 215 are supported at their outer ends by a pair of inclined braces 217 joined at their rearward upper ends to a crossbar 219. Shafts 221 and 223 are journaled at their ends in the side rails 215. Shaft 221 has a pair of arms 225 extending radially therefrom having their outer ends connected by links 227 to the platform 209. Shaft 223 has a single arm 229 extending radially therefrom connected by a link 231 to the platform. Crank arms 233 and 235 extending from shafts 221 and 223, respectively, have their outer ends connected together by a link 237. A cylinder 239 is pivotally connected at its rearward end as indicated at 241 to the crossbar 219. A piston rod 243 extends from a piston in the cylinder through the forward end of the cylinder to a pin connection at 245 with the link 237. An oil reservoir 247 is mounted on the crossbar 219, the lower end of this reservoir being in communication with the rearward end of cylinder 239 via an oil line 249 having a flow control therein for controlling the rate of flow of oil from the reservoir to the cylinder for controlling the rate of speed of rise of the platform. The upper end of the reservoir is supplied with compressed air from a suitable source (not shown) via a pressure regulator 253 and an air line 255. Compressed air under regulated pressure is maintained in the reservoir 247 on top of the oil therein to maintain the oil in the cylinder 239 under pressure for a constant upward bias of the platform 209 via the piston rod 243, link 237, crank arms 233 and 225, 235, and 229, and links 227

and 231. Upward movement of the platform is limited, as will appear, by engagement of the top of the stack S of plies of material on the platform with the bottom of a roller or reel 257 of the means 9 for separating and picking up the top ply P1 of material from the stack S. Extending lengthwise on top of the platform is a strip of foam rubber 258, forming a ridge for humping up the stack S at its trailing end.

The roller or reel 257 comprises an elongate hollow cylinder having one end thereof (its back end) secured on a spider 259 at the front end of a roller-supporting quill 261. The quill has an axial bore 263 extending frontward from its back end receiving the front end of a quill-supporting shaft 265 with a sliding fit therebetween so that the quill 261 is axially slidable on the front end portion of shaft 265.

An auxiliary frame generally designated 267 (see FIGS. 1-3 and 8) extends longitudinally of the apparatus in back of the elevator platform 209 and partly in back of the sewing machine table 1 at level just above the top of table 1. This frame includes a pair of upper longitudinal bars each designated 269 and a pair of lower longitudinal bars 271 extending between frame ends indicated at 273 and 275. The lower bars 271 are located approximately in the same horizontal plane as the table top 27, and each has secured on its outside face a rack 277. These racks extend generally the full length of the bars 269 with their teeth in a plane slightly above the plane of the top surface of the table top 27.

The shaft 265 (which supports the roller 257) has a pair of pinions each designated 279 keyed thereon meshing with and rolling on the racks 277. Shaft 265 has a pair of collars 281 secured thereon on opposite sides of a chain fastener member 283 mounted on the shaft 265, the shaft extending through and being rotatable in a central hole in this member. A roller chain 285 has its ends connected to member 283 at opposite sides of the shaft 265 and extends around a pair of idler sprockets 287 and 289 at the outboard end 273 of the frame 267, an idler sprocket 291 at the inboard end 275 of the frame 267, and a drive sprocket 293 on the output shaft 295 of a reversible air-operated rotary motor 297. The arrangement is such that, on operation of the air motor to rotate the shaft 295 in one direction which may be referred to as the forward or advance direction the chain 285 is moved in the direction for moving the shaft 265 forward, pinions 279 then rolling in counterclockwise direction as viewed from the front on the racks 277 and rotating the shaft 265, as it translates forward, in counterclockwise direction as viewed from the front. On operation of the air motor 297 to rotate the shaft 295 in reverse direction, the chain 285 is moved in reverse direction thereby to move the shaft 265 back toward the outboard end 273 of the frame 267 with accompanying rotation of the pinions 279 and the shaft 265 in reverse direction (clockwise as viewed from the front of the apparatus). The pinions 279 are held down in mesh with the racks by means of a pair of rails 299 extending longitudinally of the frame 267 above the shaft 265 on opposite sides of the chain fastener member 283, these rails engaging rollers 301 on the shaft 265.

An air-operated reversing valve for the air motor 297 is indicated at 303 (see FIG. 24). This is adapted to supply compressed air to motor 297 either via line 305 for operation of the motor in forward direction or via line 307 for operation of the motor in reverse direction. The valve is under control of a rearward pilot valve 309 carried by a bracket 311 adjustably mounted on the back rail 299 and a forward pilot valve 313 mounted in fixed position between the lower bars 271. These pilot valves have trip arms indicated at 309a and 313a engageable by the chain fastener member 283, with the arrangement such that when shaft 265 is moved forward by the chain 285 (i.e., in the direction toward the table 1), member 283 ultimately engages the trip arm 313a of pilot valve 313 to actuate this valve and hence to actuate reversing valve 303 to reverse the air motor 297 to cause the chain to reverse and return the shaft 265 rearward, and, as it returns, member 283 engages the trip arm 309a of pilot valve 309 to actuate this valve to stop the motor 297 with an overrun so that roller 257 reaches

its retracted position. Valve 309 is of a type which is tripped only on the rearward stroke of member 283, not on its forward stroke.

As previously mentioned, the quill 261 is axially slidable on the front end portion of shaft 265 which projects frontward beyond the front pinion 279. Secured on the front face of the front pinion 279 concentric therewith is an internal ring gear 315. The quill has a spur gear 317 on its back end, and the assembly of the quill and roller is biased in the direction toward the back of the apparatus to an operative position wherein the spur gear 317 is within and in mesh with the ring gear 315 by a compression spring 319. The shaft 265 has an axial bore 321 with an enlarged-diameter back end section 323. A rod 325 has its front end threaded axially in the back end of the quill as indicated at 327 and extends back through the bore 321 in the shaft with a sliding fit therein. Spring 319 surrounds the rod 325 in the enlarged section 323 of the bore in the shaft 265 and reacts from the shoulder 329 at the inner end of section 323 against a head 331 on the back end of rod 325 to bias the quill/roller assembly in the direction toward the back of the apparatus.

Associated with the roller 257 is a pressure-sensitive tape system generally designated 333 providing for removable attachment of the top ply of material P1 to the roller as the roller moves forward in translation and simultaneously rotates in wind-up direction (counterclockwise as viewed from the front of the apparatus) to cause the top ply of material to become rolled up on the roller. This pressure-sensitive tape system comprises a bar 335 extending out of the front end of the roller 257, having its inner end 335a secured to the inside of the annular wall of the roller. Mounted on this bar between the front end of the roller and the front end of the bar is a holder 337 for a roll R of pressure-sensitive adhesive tape T. The holder comprises a plate 339 rotatable on a pin 341 extending from the bar 335 having four pins 343 extending from the face of the plate for mounting the roll R thereon. A tape take-up roller 345 is rotatable on a pin 347 extending from the bar 335 between the front end of the roller 257 and the holder 337. The tape T extends from the supply roll R around the take-up roller 345 and into the roller 257, thence out and around a guide roll 349 and back over a shoe 351 which projects out slightly from the roller 257 through a slot 353 therein, thence in and around a guide roll 355 to the take-up roller. The shoe 351 is adjustable axially of the roller along a diametrical partition 357 in the roller 257, this partition having an axial slot 359 receiving screws 361 extending through the slot 359 and threaded in tapped holes in the base of the shoe 351. The screws 361 are accessible via a slot 363 in the roller 257 diametrically opposite slot 353.

A pawl and ratchet mechanism for rotating the take-up roller is indicated generally at 365. This comprises a ratchet 367 on the end of the take-up roller 345 adjacent the bar 335 and a driving pawl 369 for this ratchet. Pawl 369 is a leaf spring member extending from a block 371 secured on a rod 373 mounted for sliding movement parallel to the bar 335 in inboard and outboard apertured guides 375 and 377 on the bar. A spring 379 reacting from the inboard guide 375 against the block 371 biases the rod 373 to slide outwardly to a retracted position determined by engagement of a cotter pin 381 in the rod with the outboard guide 377. A yoke 383 secured on the outer end of the rod has a guide pin 385 parallel to the rod extending through guide 377 at the end of bar 335. The yoke has a follower button 387 constituted by the head of a screw for cam actuation of the yoke and pawl-carrying rod 373. An arm 389 extending forward from the table structure 1 has a post 391 extending up from its outer end carrying a fixed cam 393 for actuating the button 387 on the yoke 383 to drive the rod 373 and the drive pawl 369 inward on forward movement of the roller 257 thereby to ratchet the take-up roller 345 one step forward to take up an increment of the tape T so as to advance a fresh part of the tape into position over the shoe 351. A holding pawl for the ratchet 367 is indicated at 395.

The means 11 for feeding the ply of material delivered to the table by the means 9 (which includes roller 257) comprises a carriage generally designated 397 slidable longitudinally in the frame 267. This carriage comprises a bar 399 extending longitudinally of the frame 267 having a pair of guide eyes 401 thereon at its ends and a bar 403 extending transversely back from bar 399 having a guide roller 405 at its back end. The guide eyes 401 receive and are slidable on a rod 407 extending longitudinally of the frame 267 under the upper front bar 269 of the frame. A coil compression spring 409 serving as a bumper is mounted on rod 407 at its forward end. Roller 405 rides in a channel track 411 on the bottom of an upper back bar 269 of the frame 267. The carriage 397 is adapted for reciprocation longitudinally of the frame 267 between the advanced position in which it appears in FIG. 1 and the rear retracted position in which it appears in FIG. 3 by a relatively long air cylinder 413 mounted in the frame having a piston rod 415 extending through the forward end of the cylinder from a piston 417 therein to a connection with the carriage 397.

An arm 419 extends forward from the carriage over the sewing machine table top 27 at an acute angle to the axis of the guide rod 407 for the carriage. At the free end (the forward end) of this arm is a bracket 421. An air cylinder 423 has one end (its forward end) secured to this bracket and extends horizontally rearward therefrom. A piston rod 425 extends forward from a piston 427 in this cylinder through the bracket 421 and has a vertical crosshead 429 on its forward end. A guide rod 431 extends rearward from the crosshead 429 through a guide 431 in the bracket 421 having a sliding fit therein. An air cylinder 433 has one end (its back end) secured to the crosshead 429 adjacent the lower end of the crosshead and extends horizontally toward the front of the apparatus therefrom. A piston rod 435 extends toward the back of the apparatus from a piston 437 in cylinder 433 and has a vertical crosshead 439 on its back end carrying a vertical air cylinder 441. A guide pin 443 extends toward the front from crosshead 439 through a guide 445 in crosshead 429, having a sliding fit therein. A piston rod 447 extends down from a piston 449 in cylinder 441 through the lower end of this cylinder and has a disk 451 on its lower end carrying a circular pad 453 of soft sponge material (e.g., sponge rubber) constituting a gripper. Cylinder 441 is a spring return cylinder.

On top of the sewing machine table 1 immediately rearward of the cutout 45 and adjacent the back side of the table is a bracket 455 having an upper ear 457 extending toward the front over the table, and mounted in this ear is a jet sensor nozzle 459 adapted to blow air downwardly toward an air inlet hole 461 in the top plate 33 of the table top 27 aligned with the nozzle. This nozzle 459 and the air inlet hole 461 constitute a sensor for sensing lateral movement of a ply of fabric over the table top in the direction toward the back of the apparatus to a position from which the ply is adapted to be fed forward into the sewing machine, and for effecting actuation of cylinder 75 to engage the clutch (and disengage the brake) of the sewing machine drive to start the sewing machine, also for effecting actuation of cylinder 413 as will appear.

A bracket 463 mounted at the front end of the sewing machine 3 has a horizontal flange 465 extending in the direction toward the front of the apparatus above the work plate 53 of the sewing machine. A jet sensor nozzle 467 is mounted in this flange adjacent its trailing end adapted to blow air downwardly toward an air inlet hole 469 in the work plate 53. This nozzle 467 and the air inlet hole 469 constitute a sensor for effecting deactuation of cylinder 117 to lower the guide wheel 111, deactuation of cylinders 423, 433 and 441 to retract the pad 453 (in three directions), deactuation of cylinder 75 to stop the sewing machine when a ply of fabric has been fed through the machine and stitched, and also controlling operation of a stacker, to be described. Another jet sensor nozzle 471 is mounted in flange 465 adjacent its leading end adapted to blow air downwardly toward another air inlet hole 473 in plate 53. This nozzle 471 and inlet hole 473

constitute a sensor for controlling operation of the cylinder 65 for operating the cutter 61. This operation is by means of a conventional pneumatic circuit adapted to operate the cylinder to drive the cutter through a cutting stroke when the trailing edge of a ply of fabric fed through the sewing machine exits from the machine, and then to retract the cutter.

Means indicated generally at 475 is provided at the exit end of the apparatus for feeding a ply of material which has been stitched by the sewing machine forward over the exit end of the top 27 of the sewing machine table 1 to present it to a stacking means indicated generally at 477. This feeding means 475 comprises an elongate horizontal air cylinder 479 having one end secured to a bracket 481 on a bridge 483 spanning the exit end of the table top 27, and extending forward from the bracket away from the exit end of the table top in the longitudinal direction of the apparatus. A piston rod 485 extends rearward from the cylinder from a piston 486 therein through the bracket 481 and has a horizontal crosshead 487 secured to its rearward end. Guide rods 489 extend back from the bridge through holes in the crosshead. The crosshead carries a pair of vertically positioned air cylinders 491. The piston rod 493 of each of these cylinders extends downwardly through the lower and of the cylinder and has a disk 495 at its lower end having a pad 497 of resilient sponge material (e.g., sponge rubber) on its bottom. At 499 is indicated a pilot valve mounted on the guide rod 489 toward the back of the table top in position for engagement by the crosshead 487 on retraction of the piston rod 485 into the cylinder 479 to move the crosshead forward. An air cylinder 501 is mounted in vertical position on the bridge 483 and has a piston rod 503 extending down from the piston 505 therein through the lower end of the cylinder with a brush 507 on the lower end of the piston rod which acts as a clamp for clamping a ply of material fed forward by pads 497 against the table top as will appear.

The stacking means 477 comprises a stacker frame generally designated 509 pivoted for swinging movement about a horizontal axis at the forward end of a forward end extension 511 of the base 13 of the sewing machine table 1. More particularly this stacker frame is of open rectangular form comprising a tubular bottom member 513, side members 515 and a top rail 517. A pivot rod 519 extends through the tubular bottom member 513 between a pair of arms 521 pivoted at 523 on the base 13 and held in adjusted position by bars as indicated at 525. The stacker frame 509 normally occupies a position inclined back toward the sewing machine table 1 with its upper end bearing against a sheet metal panel 527 on the forward end of the sewing machine table. Associated with the stacker frame is a clamp frame 529 adapted to clamp pieces of material to the stacker frame as will appear. The clamp frame is of open rectangular form having a bottom member 531, side members 533, and a top bar 535. It is pivoted for swinging movement on a horizontal axis extending parallel to and above but adjacent its bottom member 531 between a pair of arms 537 extending forward from the side members 515 of the stacker frame 509, the pivot point being indicated at 539. An air cylinder 541 is pivoted at one end as indicated at 543 on arms 545 on the stacker frame, with a piston rod 547 extending from a piston 549 therein through the forward end of the cylinder pin-connected as indicated at 551 to the clamp frame. An air cylinder 553 has one end pivoted at 555 on a post 557 extending up from the front arm 521 with a piston rod 559 extending from a piston 561 therein through the forward end of the cylinder to a pin connection at 563 with the clamp frame 529. A pilot valve 565 is mounted as indicated at 567 for actuation by the stacker frame 509 when it swings forward away from the exit end of the table 1.

Referring to FIG. 24, there is indicated at 569 a valve having an inlet *i* supplied with compressed air from a suitable source as indicated by the arrow and having two ports *a* and *b* and two air-operated actuators *c* and *d*. Port *b* is blocked. When actuator *c* is actuated by air, it shifts the valve to direct air from inlet *i* to port *b*, which is blocked. When actuator *d* is actuated by air, it shifts the valve to direct air from inlet *i*

through port *a*. Pilot valve 309 is a normally closed valve having an inlet *i* supplied with compressed air, from the source as indicated by the arrow, with a line 571 interconnecting its outlet and actuator *c* of valve 569. A normally closed manual on-off start valve 573 has its inlet *i* supplied with compressed air from the source and its outlet connected by a line 575 including a check valve 577 to one inlet of a shuttle valve 579. A line 581 connects the outlet of the shuttle valve to actuator *d* of valve 569. A line 583 interconnects outlet *a* of valve 569 with lines 585, 587 and 589. Line 585 is connected to the air-operated actuator of a normally closed air-operated valve 591. The inlet of this valve 591 is supplied with compressed air from the source as indicated by the arrow, and its outlet is connected by line 593 to the inlet of a normally open air-operated valve 595. A line 597 including a flow control interconnects line 593 and the air-operated actuator of valve 595. A line 599 including a flow control extends from the outlet of valve 595 and supplies air to two jets 601 and 603 carried by a bracket 605 adjustable along the front bar 269. Jet 601 is positioned to direct air down on top of roller 257 when the latter is in its retracted (rearward) position, and jet 603 is positioned to direct air down at an angle behind the roller 257 when the latter is in its retracted position.

Line 587 is interconnected with the air-operated actuator of a normally closed air-operated valve 607 and includes an on-off toggle valve 609 which is maintained on for full automatic operation. The inlet of valve 607 is supplied with compressed air from the source as indicated by the arrow and its outlet is connected by a line 611 to the inlet of the aforesaid air-operated reversing valve 303 for the air motor 297. The valve 303 has ports *a* and *b* connected by the lines 305 and 307 (each including a flow control) to the motor 297. At 615 is indicated a normally closed air-operated valve having its inlet supplied with compressed air from the source as indicated by the arrow and its outlet connected by line 617 to the air-operated actuator of valve 303. The arrangement is such that when valve 615 is closed (as in normal), valve 303 is set to operate motor 297 in forward direction, and when valve 615 is open, valve 303 is set to operate motor 297 in reverse direction. A line 619 is interconnected between the air-operated actuator of valve 615 and a junction 621. Line 589, which includes a check valve 623, extends to this junction. Pilot valve 313 has an inlet supplied with compressed air from the source as indicated by the arrow, and has its outlet connected to junction 621 by a line 625.

A line 627 is interconnected between junction 621 and the inlet of a pulse valve 629 (i.e., a valve which delivers a pulse of air on being actuated by air, and then shuts off). At 631 is indicated a valve having an inlet *i* supplied with compressed air from the source as indicated by the arrow, two ports *a* and *b*, and two air-operated actuators *c* and *d*. When *c* is actuated, air is delivered through *b* and *a* is vented, and when *d* is actuated air is delivered through *a* and *b* is vented. A line 633 connects the pulse outlet of valve 629 and actuator *d* of valve 631. At 635 is indicated a pilot valve having an operating arm 635a engageable by the rear end of carriage 397 upon retraction thereof, and at 637 is indicated a pilot valve having an operating arm engageable by carriage 397 at the forward end of its stroke (see FIGS. 2 and 3 as well as FIG. 24). Valve 635 has an inlet supplied with compressed air from the source as indicated by the arrow in FIG. 24 and has its outlet connected by a line 639 to a junction at 641. A line 643 including a flow control extends from this junction to the inlet of a delay device 645 (e.g., a chamber) and a line 647 connects the outlet of this delay device and the actuator *c* of valve 631. A line 649 including a flow control connects port *a* of valve 631 to the forward end of cylinder 413 and a line 651 including a flow control connects port *b* of valve 631 to the rear end of cylinder 413.

At 652 is indicated a valve having an inlet *i* supplied with compressed air from the source as indicated by the arrow, two ports *a* and *b*, and two air-operated actuators *c* and *d*. Port *a* is blocked. When *d* is actuated, *b* is vented. When *c* is actuated,

air is delivered through *b*. A line 653 connects the outlet of pilot valve 637 to the inlet of a pulse valve 655. A line 657 connects the outlet of this pulse valve to actuator *d* of valve 652. A line 659 extends from junction 641 to actuator *c* of valve 652. A line 661 extends from port *b* of valve 652 to one inlet of a shuttle valve 663. A line 665 extends from the outlet of this shuttle valve to the upper end of cylinder 441, which is a spring-return cylinder having a spring 667 biasing its piston 449 upward.

At 669 and 671 are indicated valves each having an inlet *i*, two outlets *a* and *b*, and a single air-operated actuator *c*. At 673 is indicated a valve having an inlet *i* supplied with compressed air from the source as indicated by the arrow, two ports *a* and *b* and two air-operated actuators *c* and *d*. As to each of valves 669 and 671, when *c* is deactuated, air is supplied from *i* to *a*. When *c* is actuated air is supplied from *i* to *b*. As to valve 673, when *c* is actuated, air is supplied from *i* to *b* and *a* is vented, and when *d* is actuated air is supplied from *i* to *a* and *b* is vented. A line 675 extends from outlet *b* of valve 673 to a junction 677, and a line 679 extends from this junction to the other inlet of shuttle valve 663. A line 680 extends from junction 677 to the inlet *i* of valve 669. A line 681 extends from line 653 to the inlet of a pulse valve 683 and a line 685 extends from the outlet of this pulse valve to the actuator *c* of valve 673. A line 687 extends from line 675 to the inlet of an air-actuated snap-acting valve 689, and a line 691 extends from the outlet of valve 689 to one inlet of a shuttle valve 693. Valve 689 is adapted to snap open when pressure builds up therein to a predetermined value and supply air through 691. The outlet of shuttle valve 693 is connected by a line 695 to the inlet of a pulse valve 697, the outlet of which is connected by line 699 to actuator *d* of valve 673. A line 701 around valve 689 includes a flow control and a tank 703.

A line 705 connects outlet *a* of valve 671 and the other inlet of shuttle valve 693. A line 707 connects outlet *b* of valve 671 to the air actuator of a normally closed air-operated valve 709. The latter has an inlet supplied with compressed air from the source as indicated by the arrow and has its outlet connected by a line 711 to the top of an oil reservoir 713. An oil line 715 including a flow control extends from the bottom of this reservoir to the rear end of cylinder 423. A line 717 extends from outlet *a* of valve 669 to inlet *i* of valve 671. A pilot line 719 including a flow control extends from outlet *b* of valve 669 to the actuator of a normally closed air-operated valve 721, the inlet of which is supplied with compressed air from the source as indicated by the arrow. A line 723 extends from the outlet of valve 721 to the top of an oil reservoir 725. An oil line 727 including a flow control extends from the bottom of this reservoir to the lower end of cylinder 433. A line 729 extends from outlet *a* of valve 673 to the inlet of a normally open air-operated valve 731 and is connected by line 733 including a flow control to the actuator of this valve 731. A line 735 extends from the outlet of valve 731 to the actuator of a normally closed air-operated valve 737, the inlet of which is supplied with compressed air from the source as indicated by the arrow. A line 739 extends from the outlet of valve 737 to the forward end of cylinder 423, and a line 741 interconnects line 739 and the upper end of cylinder 433.

A line 743 connects the sensor inlet hole 461 to the control of an interface valve 745 (an amplifier) the inlet of which is supplied with compressed air from the source as indicated by the arrow. A line 747 connects the outlet of this valve to the actuator *c* of valve 669. A line 749 connects the sensor inlet hole 465 to the control of an interface valve 751 similar to 745 the inlet of which is supplied with compressed air from the source as indicated by the arrow. A line 753 connects the outlet of this valve to actuator *c* of valve 671. A line 755 extends from line 747 to the actuator of a normally open air-operated valve 757, the inlet of which is supplied with compressed air from the source as indicated by the arrow. A line 759 extends from the outlet of valve 757 to one inlet of a shuttle valve 761. The outlet of this shuttle valve is connected by a line 763 including a flow control to the upper end of cylinder 75. A line

765 extends from line 755 to the actuator of a normally closed air-operated valve 767. The inlet of this valve is adapted to be supplied with air via a line 769 from the outlet of a normally closed air-operated valve 771, the inlet of which is supplied with compressed air from the source as indicated by the arrow. The outlet of valve 767 is connected by a line 773 including a flow control to the lower end of cylinder 75. A normally open air-operated valve 775 having its inlet supplied with compressed air from the source as indicated by the arrow has its outlet connected by a line 777 to the other inlet of the shuttle valve 761. A line 779 extending from line 753 has branch connections 781 and 783 to the actuators of valves 771 and 775. The lower end of cylinder 117 is connected to line 779 as indicated at 785. A line 787 connects line 779 to the actuator of a normally open air-operated valve 789 the inlet of which is supplied with compressed air as indicated by the arrow. The outlet of valve 789 is connected by a line 791 to the inlet of a pulse valve 793, with a line 795 connecting the outlet of this pulse valve and the other inlet of shuttle valve 579 from line 575.

At 797 is indicated a valve having an inlet *i*, two ports *a* and *b* and two air-operated actuators *c* and *d*. Inlet *i* is supplied with compressed air from the source as indicated by the arrow. When *c* is actuated air is supplied from *i* to *a* and *b* is vented and when *d* is actuated air is supplied from *i* to *b* and *a* is vented. Port *a* of valve 797 is connected by lines 799 and 801 each having a flow control therein to the upper ends of cylinders 491 and the inboard end of cylinder 479. Outlet *b* of valve 797 is connected by a line 803 including a flow control to the outboard end of cylinder 479. A pulse valve 805 has its inlet connected to line 779 as indicated at 807 and its outlet connected by line 809 to actuator *d* of valve 797. Valve 499, which is normally closed, has its inlet supplied with compressed air from the source as indicated by the arrow and its outlet connected by a line 811 to the actuator *c* of a valve 813 having an inlet *i*, two ports *a* and *b*, and two actuators *c* and *d*. The inlet *i* of this valve is supplied with compressed air from the source as indicated by the arrow. When *c* is actuated, air is supplied from *i* to *a* and *b* is vented, and when *d* is actuated air is supplied from *i* to *b* and *a* is vented. A line 815 connects outlet *a* of valve 813 to the forward end of cylinder 553 and a line 817 connects outlet *b* of this valve to the rearward end of cylinder 553. A line 819 connects line 811 to actuator *c* of valve 797. A line 821 connects line 817 to the actuator of a normally closed air-operated valve 823, the inlet of which is supplied with compressed air from the source as indicated by the arrow. The outlet of valve 823 is connected by a line 825 to the upper end of the cylinder 501 for actuating the brush 507. Valve 565, which is normally closed, has its inlet supplied with compressed air from the source and its outlet connected by a line 827 to actuator *d* of valve 813. The head end of cylinder 541 is continuously supplied with compressed air from the source as indicated at 829.

Operation is as follows:

The apparatus as described above and shown in the drawings is adapted to operate automatically to process each ply or workpiece *P* through a cycle, with each successive cycle starting before the previous cycle is completed for rapid processing of the workpieces, involving separating and picking up of a workpiece (the top ply *P1*) from the stack *S* and delivering it to the table top 27, feeding the workpiece over the table top 27 by means 11 for entry of the leading end of its edge *E* into the sewing machine 3, feeding the workpiece through the sewing machine (by the feed device 57 of the sewing machine) and stitching along its edge *E*, with the workpiece guided for contour stitching along edge *E* by the edge contour guide means 5, feeding the stitched workpiece exiting from the sewing machine by means 475 to the stacking means 477, and, finally, stacking the workpiece by means 477.

At the start of the cycle on each workpiece, the roller 257 is back in its retracted position of FIGS. 1-3 and 17 over and engaged by the trailing end portion of stack *S*, and the roller is in the angular position of rotation around its horizontal axis

wherein the exposed reach T1 of the pressure-sensitive tape T is facing downward, contacted by the humped-up trailing end portion of the top ply P1 of the stack. The retracted position of the roller 257 is determined by the position of the pilot valve 309, which, as above noted, is adjustable longitudinally along the frame 267 to make the retracted position of the roller to correspond to the position of the trailing end portion of the stack S on the elevator platform 209. Generally, the platform 209 will have a mark such as indicated at 831 thereon indicating the position for placement of the stack on the platform, and valve 309 is adjusted in accordance with the length of plies P in the stack so that the roller 257 retracts to a position above the trailing end portion of the stack. To place the roller 257 in its stated angular position wherein the exposed reach T1 of the tape T faces downward when the roller is in its retracted position, the roller is pulled axially toward the front of the apparatus (against the return bias of spring 319) to disengage the spur gear 317 from the internal ring gear 315, then the roller may be rotated on its axis to bring it into its stated angular position with the exposed reach T1 of the tape T facing downward, and finally the roller is returned axially toward the back of the apparatus for reengagement of gears 319 and 317. The carriage 397 and cylinders 423, 433 and 441 carried thereby (constituting the feeding means 11) are in the advanced or forward position of FIGS. 1, 2 and 17 with the piston rods of all three of these cylinders retracted, hence with pad 453 raised above table top 27. Platform 209 is biased upward by the air-pressurized oil in cylinder 239 so that the humped-up trailing end portion of the top ply P1 of the stack S is in contact with (and adhered to) the exposed reach T1 of tape T on the roller 257.

A cycle may be regarded as starting when the leading end of a workpiece (i.e., top ply P1) being fed forward by means 11 during the preceding cycle passes between the jet 467 and the inlet 465 and interrupts the flow of air through lines 749, 753, 779 and 787. When this occurs, valve 789 is returned to its normally open position, and supplies air via line 791 to pulse valve 793 which delivers a pulse of air via line 795, shuttle valve 579 and line 581 to actuator d of valve 569, thereby setting this valve to deliver air through its port a to lines 583, 585, 587 and 589. This results in valve 303 being set to operate the air motor 297 in forward direction, and in air being delivered via line 599 to the jets 601 and 603.

Upon operation of the air motor 297 in forward direction, chain 285 is driven in forward direction to pull member 283 forward, and this moves roller 257 forward in translation in direction normal to its axis. As roller 257 moves forward, it is caused to rotate by the rolling of pinions 279 on the racks 277 in counterclockwise direction as viewed from the front of the apparatus. The top ply P1 of the stack S is in effect attached to the roller by its adherence to the exposed portion T1 of the pressure-sensitive adhesive tape T, and hence is rolled up around the roller as the roller moves forward as illustrated in FIGS. 18 and 19. The humping up of the trailing or rearward end of the stack by the strip 258 of sponge rubber acts to minimize the tendency of the second ply of the stack S to cling to the top ply P1, and the top ply is efficiently and cleanly peeled off the stack away from the second ply of the stack. The jet 601 directs air down on the top of the roller 257 as the roller moves forward, and the jet 603 directs air at an angle down behind the roller 257 to peel the second ply away from the first ply if it should tend to cling to the top ply.

The roller 257 moves forward in translatory motion and rotates on its axis as it moves forward to continue winding up the top ply P1. It continues its forward motion and its rotation on its axis until it has rotated one complete revolution after leaving the leading (forward) end of the stack, as determined by the position of valve 313. FIG. 19 shows the roller 257 with the wound-up ply P1 thereon as it completes this one-revolution motion; it will be observed that at this point the roller 257 has moved forward some distance over the table top 27. The outer end of the ply P1 on the roller (which had been the leading end of the ply as it reposed at the top of stack S) is

disposed on the table. Chain fastener member 283 engages arm 313a of valve 313 and actuates valve 313 at this point. Valve 313 thereupon delivers air via lines 625 and 619 to the actuator of valve 615 to set it to deliver air via line 617 to the actuator of valve 303, thereby setting the latter to drive the air motor 297 in reverse direction. Chain 285 is thereupon driven in reverse direction to pull member 283 back, and this moves roller 257 back toward its retracted starting position. As roller 257 moves back, it is caused to rotate in unwinding direction (clockwise as viewed from the front of the apparatus) by rolling of pinions 279 on the racks 277, and this results in unwinding of the ply P1 from the roller.

On being actuated by member 283, valve 313 also delivers air via lines 625 and 627 to pulse valve 629 which delivers a pulse of air to actuator d of valve 631 to set this valve to deliver air via its outlet a and line 649 to the forward end of cylinder 413 (its left end as viewed in FIG. 24) and to vent the rearward end of this cylinder via line 651 and port b of valve 631. As a result, piston rod 415 is retracted to retract the carriage 397 rearward and this moves the cluster of cylinders 423, 433 and 441 rearward to the retracted position in which they appear in FIG. 20, the cluster closely following the retreating roller 257. The carriage 397 moves rearward until it engages the operating arm of valve 635 and actuates this valve to supply air via lines 639, 643, delay means 645 and line 647 to actuator c of valve 631. After a delay due to 645, valve 631 is reversed to deliver air via line 651 to the rearward end of cylinder 413 and to vent the forward end of cylinder 413 via line 649 to return the carriage forward to its starting position. However, before the return of the carriage forward (i.e., during the delay imposed by 645), valve 635 also supplies air via lines 639 and 659 to actuator c of valve 652, setting it to deliver air via its port b and line 661, shuttle valve 663 and line 665 to the top of cylinder 441 to drive the pad or gripper 453 downward (see the dotted line position shown for 453 in FIG. 10, and also see FIG. 20) to clamp the leading end of the workpiece (ply P1) down on the table top 27. This keeps the workpiece from being pulled back by the retreating roller 257, so that the workpiece remains in the position in which it has been delivered to the table by the roller 257, as shown in FIG. 20. The pad 453 holds its FIG. 20 position until the roller 257 has been completely retracted and portion T1 of tape T has disengaged from the workpiece.

When the roller 257, in moving forward, passes off the forward end of the stack S, the platform 209 and stack are released for upward movement under the bias of the air-pressurized oil in cylinder 239. However, the arrangement is such that the platform and stack move upward relatively slowly, and as the roller 257 moves back from its FIG. 19 advanced position it rolls over the top of the stack and, if necessary, pushes the stack and platform down.

As the roller 257 is moving forward and near the end of its forward stroke, the button 387 on the yoke 383 engages the cam 393, and the yoke 383, rod 373 and pawl 369 are driven inward with respect to roller 257 against the return bias of spring 379 to ratchet the take-up roller 345 one step forward and thereby take up an increment of tape T to effect bringing a fresh portion of tape into position T1 for the ensuing cycle.

As the carriage 397 is moved forward back to its starting position, the pad 453, which is in its lowered position pressing the leading end of the workpiece down against table top 27 to grip the workpiece, feeds the workpiece forward over the table top 27 from the FIG. 20 position to the FIG. 21 advanced position wherein the leading end of the ply is somewhat forward of the sensor jet 459. The carriage 397, at the end of its forward stroke, actuates valve 637, opening the latter to deliver air via line 653 to pulse valve 655 which delivers a pulse of air to actuator d of valve 652. This sets valve 652 to vent port b, and line 661, but cylinder 441 remains pressurized and pad 453 remains down due to valve 637 also supplying air via lines 653 and 681 to pulse valve 683 to deliver a pulse of air via line 685 to actuator c of valve 673 thereby to deliver air through port b of 685, and lines 675 and

679, and shuttle valve 663 and line 665 to the upper end of cylinder 441. It also provides for delivery of air via line 680 to inlet *i* of valve 669, which is set at this time to deliver air via its port *b* and line 719 to the actuator of valve 721. The latter opens and delivers air via line 723 to the oil reservoir 725 to pressurize oil in this reservoir and in line 727 and the cylinder 433 to extend the piston rod 435 of cylinder 433 so as to move the pad 453 (which is down and still gripping the workpiece) laterally with respect to the table top 27 in the direction toward the sensor jet 459 and the related air inlet 461. The pad 453, still clamped down on the workpiece and gripping it moves it laterally of the table top 27 back in the direction toward the jet 459 (compare FIGS. 21 and 22).

Piston rod 435 of cylinder 433 continues its movement, with continuing movement of the workpiece laterally with respect to the table top 27, until the margin of the workpiece at its edge E intersects the sensor inlet port 461 and blocks the flow of air through line 743. The result of this is to cut off flow of air through valve 745 and line 747 to actuator *c* of valve 669, with the result that valve 669 is deactuated to deliver air via its port *a* and line 717 to inlet *i* of valve 671. Valve 721 is thereby deactuated to vent the upper end of the oil reservoir 725, and piston rod 435 stops, with the workpiece in a position of alignment with respect to the needle of the sewing machine, as determined by the location of jet 459 and air inlet 461 for entry of the workpiece into the sewing machine 3. Valve 671 is set at this time to deliver air from its inlet *i* to its port *b*, hence air is delivered via line 707 to actuate valve 709 to deliver air to the top of oil reservoir 713. The pressurized oil acts via line 715 to extend piston rod 425 of cylinder 423, thereby moving cylinders 433 and 441 and pad 453 (which is still down and still gripping the workpiece) forward to feed the workpiece P1 further forward over the table top 27 to enter the workpiece into the sewing machine (see FIG. 23).

The forward movement of piston rod 425 and pad 453 continues until the leading end of the workpiece P1 intersects the sensor inlet port 465. This blocks the flow of air through line 749, with the result that valve 751 shuts off the flow of air through line 753 to actuator *c* of valve 671. Accordingly, valve 671 is shifted back to its deactuated position in which it vents its port *b*, and hence it vents line 707, deactuates valve 709, and vents line 711 and oil reservoir 713. This stops the forward movement of piston rod 425 of cylinder 423. Valve 671, being deactuated, provides for delivery of air via line 705, shuttle valve 693 and line 695 to pulse valve 697 to deliver a pulse of air via line 699 to actuator *d* of valve 673, thereby shifting valve 673 back to its starting position. Valve 673 thereupon vents cylinder 441 via 679, 675 and its port *b* for retraction (raising) of the pad 453. It also delivers air via line 729 to and through valve 731 to close it and line 735 to the actuator of valve 737, actuating the latter to deliver air via lines 739 and 741 to cylinders 423 and 433 to retract the piston rods 425 and 435 of these cylinders (thus returning them to their starting position). The flow control in line 733 acts to delay actuation of valve 731 which when actuated cuts off the return air pressure for cylinders 423 and 433 so that they are not when off duty.

When flow of air through line 753 is shut off (by blocking of sensor inlet 465), air is shut off from line 779. This deactuates cylinder 117 so that the edge contour guide wheel 111, which had been held up in raised position by piston rod 121 of cylinder 117 being extended upward, comes down on the workpiece P1 which has been fed under the wheel 111 by the pad 453 as it is moved forward by cylinder 423. This downward movement is under the weight of cylinder 85, bracket 95 etc.

As above noted, the workpiece is moved laterally from its FIG. 21 to its FIG. 22 position by pad 453 until the workpiece blocks sensor inlet 461, which results in curtailing the flow of air through line 747. It also curtails the flow of air through line 755, with the result that valve 757 is deactuated and hence opened (and valve 767 is deactuated and hence closed). Valve 757 thereupon supplies air via 759, 761 and 763 to the upper

end of cylinder 75. The lower end of this cylinder is vented via line 773 and valve 767 (deactuated on account of curtailment of air flow in 755 and 765). Accordingly, the piston rod of cylinder 75 is extended to start the sewing machine 3. Thus, the sewing machine is running when the workpiece is fed forward by the forward movement of the piston rod 425 of cylinder 423 (FIG. 23) and its leading end is entered in the sewing machine. The pad 453 is raised when the leading end of the workpiece enters the sewing machine, and the feeding device 57 of the sewing machine then takes over and feeds the workpiece through the machine for stitching of the workpiece along its edge E. As the workpiece is fed through the sewing machine, it is guided for contour stitching of its edge E by the wheel 111 under control of cylinder 85, the air proportioning device 161 and jet sensor 129.

During the time the workpiece is being fed through the sewing machine, sensor port 469 remains covered by the workpiece. When the workpiece has been almost completely fed through the machine, its trailing end passes by port 469, which then again receives air from jet 467. Air thereupon flows through line 753 to reset valve 671. Air flows from line 753 through lines 779 and 785 to extend piston rod 121 of cylinder 117 (i.e., move it upward) so as to lift up the guide wheel 111 for entry of the next workpiece, air flow through 779 and 781 actuates valve 771 and air flow through line 783 actuates (closes) valve 775. Valve 771 supplies air through line 769 to valve 767, which is open, and thence through line 773 to the lower end of cylinder 75. The upper end of the cylinder 75 is vented via line 763, shuttle valve 761, line 777 and valve 775. Thus, the piston rod of cylinder 75 is retracted (moved upward) to stop the sewing machine. This is after a delay due to the flow control in line 763, enabling the sewing machine to complete the feeding and stitching of the workpiece along its edge E.

Also, line 779 supplies air to pulse valve 805 which delivers a pulse of air to actuator *d* of valve 797, shifting this valve so that it delivers air via lines 799 and 801 and vents air from line 803 to lower the pads 497 and retract the piston rod 485 of cylinder 479 to move the pads 497 forward (toward the left as viewed in FIGS. 1 and 2) to feed the stitched workpiece forward over the forward end edge of the table top 27. As the piston rod 485 completes its forward stroke, the crosshead 487 on the end of the rod actuates the valve 499. This delivers air via lines 811 and 819 to the actuator *c* of valves 797 and 813. This reverses valve 797 to cause pads 497 to be raised and piston rod 485 to be extended to return cylinders 491 to their starting position. It shifts valve 813 to deliver air via line 817 to line 821 and to the rear end of cylinder 553 and to vent its head end via line 815. As a result, brush 507 is driven downward to engage the workpiece P1 adjacent its trailing end, the workpiece hanging over the forward (left) end of the table top 27 on the outside of the top rail 517 of the stacker frame 509. Clamp frame 529 is swung rearward by extension of piston rod 551 of cylinder 553 so that its upper rail 535 clamps the workpiece against rail 517, then further extension of the piston rod 551 causes both frames to swing forward in unison away from panel 527. The trailing portion of the workpiece is pulled out from under the brush 507 and falls behind (to the right of) the rail 517. Thus, the workpiece is stacked by being draped over the rail 517. Ultimately, frame 509 actuates valve 565 to supply air via line 827 to actuator *d* of valve 813, shifting it to deliver air via line 815 and vent line 817. This results in upward return of the brush 507, and return of frames 509 and 529 to their FIG. 2 starting position.

Previous reference has been made to the return movement of the roller 257. As it is moved in the return (rearward) direction by the chain 285, the chain fastener member engages the operating arm 309a of valve 309 and thereby trips this valve to deliver air via line 571 to actuator *c* of valve 569. Valve 569 thereupon is set to deliver air from its inlet *i* to port *b*, which is blocked, and to vent its port *a*, thus venting line 583 and lines 585, 587 and 589. Valve 591 thereupon shuts off to stop flow of air to the jets 601 and 603. Valve 607 also

shuts off to stop the air motor 297. Roller 257 continues to move rearward after motor 297 for about one-half a turn and comes to a stop in its retracted position above the trailing end of the stack ready for the next cycle, which starts when, during the instant cycle, the leading end of the workpiece intersects the jet sensor inlet 465. It will thus be observed that successive cycles overlap, providing for rapid operation.

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 a machine for operating on workpieces of limp material, means for automatically feeding such workpieces one after another from a stack thereof to and through said machine, comprising a table over which workpieces may be fed to and through said machine, means adjacent one end of the table for holding a stack of workpieces, means for separating and picking up the top workpiece of the stack and delivering it to said table, and means for feeding the workpiece over the table to said machine and entering it in said machine with the workpiece in position for being fed through the machine for operation thereon by the machine comprising a gripper engageable with the top of a workpiece on the table, and means for moving the gripper downwardly from a raised retracted position into engagement with the top of a workpiece delivered to the table and then moving it forwardly and laterally over the table from a rearward retracted position to slide the workpiece forwardly and laterally over the table, said machine being a sewing machine for stitching along one edge of the workpiece, and said gripper sliding the workpiece forward and laterally into position for its entry into the sewing machine for stitching of the workpiece along its said one edge, then sliding it farther forward into the sewing machine, and then retracting.

2. Apparatus as set forth in claim 1 having means for starting the sewing machine in response to the positioning by the gripper of the workpiece for its entry into the sewing machine and stopping the sewing machine on completion of stitching of the workpiece.

3. Apparatus as set forth in claim 2 wherein the means for moving the gripper over the table to the sewing machine is operable first to move the gripper and workpiece forward over the table from its position of delivery to the table to an advanced position, then laterally over the table to a position of alignment with respect to the needle of the sewing machine, and then again forward over the table for entry into the sewing machine.

4. Apparatus as set forth in claim 2 having means for guiding the workpiece as it is fed through the sewing machine for contour stitching of the said one edge thereof, said guiding means comprising a guide wheel mounted to be lowered down on the workpiece and raised for passage of the workpiece thereunder as it is being fed forward by the gripper for entry into the sewing machine, and means for lowering the wheel in response to forward feed of the workpiece under and past the

wheel, and for raising it in response to passage of the workpiece out of the sewing machine.

5. Apparatus as set forth in claim 4 wherein the means for moving the gripper over the table to the sewing machine is operable first to feed the workpiece forward over the table from its position of delivery to the table to an advanced position, then laterally to a position of alignment with respect to the needle of the sewing machine, and then again forward for entry into the sewing machine, and wherein the means for lowering the guide wheel is responsive to the lateral feed of the workpiece by the gripper to said position of alignment with respect to the needle.

6. Apparatus as set forth in claim 5 having means for starting the sewing machine in response to the positioning by the gripper of the workpiece for its entry into the sewing machine and stopping the sewing machine on completion of stitching of the workpiece, and wherein the means for starting the sewing machine is responsive to the lateral feed of the workpiece by the gripper to said position of alignment with the needle.

7. Apparatus as set forth in claim 6 wherein said gripper moving means, the means for lowering and raising the wheel, and the means for starting and stopping the sewing machine are air-operated, and wherein the operation of said gripper moving means to feed the workpiece laterally, the operation of the means for starting the sewing machine and the operation of the gripper moving means to feed the workpiece forward for its entry into the sewing machine are controlled by a first air jet sensor for sensing the edge of the workpiece, and wherein the operation of the means for lowering the wheel is controlled by a second air jet sensor for sensing the end of the workpiece.

8. Apparatus as set forth in claim 7 wherein the stopping of the sewing machine is controlled by the trailing end of the workpiece passing by the second air jet sensor.

9. In apparatus comprising a machine for operating on workpieces of limp material, said machine having means for feeding workpieces therethrough, means for automatically feeding such workpieces one after another from a stack thereof to said machine, comprising a table, means adjacent one end of the table for holding a stack of workpieces, means for separating and picking up the top workpiece of the stack and delivering it to the table, pneumatically operated means for feeding the workpiece forward over the table to a first position wherein it is located longitudinally for entry into the machine but offset laterally from a second position for entry into the machine, then feeding the workpiece laterally to its said second position, and then feeding the workpiece forward from its said second position for entry into the machine and subsequent feeding of the workpiece through the machine by the feeding means of the machine, said pneumatically operated means including an air jet sensor for sensing the arrival of the workpiece at its said second position, the leading end of said workpiece, when it is fed to its said first position, being forward of said sensor, said machine being a sewing machine for stitching along one edge of the workpiece, and said apparatus having means for starting the sewing machine in response to said air jet sensor sensing the arrival of the workpiece at its said second position, and means for stopping the machine on completion of stitching of the workpiece.

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