United States Patent

Turner et al.

[15] **3,685,712**

[45] **Aug. 22, 1972**

[54] STAPLING APPARATUS

[72] Inventors: **Lyman H. Turner**, Pittsford; **William P. Kukucka**, Henrietta; **James E. Summers**, Fairport, all of N.Y.

[73] Assignee: **Xerox Corporation**, Stamford, Conn.

[22] Filed: **Sept. 9, 1970**

[21] Appl. No.: **70,737**

[52] **U.S. Cl.** **227/3**, 227/7, 227/45, 227/100

[51] **Int. Cl.** **B27f 7/06**

[58] **Field of Search**.....227/2, 3, 4, 5, 6, 7, 28, 30, 227/39, 40, 45, 99, 100, 101

[56] **References Cited**

UNITED STATES PATENTS

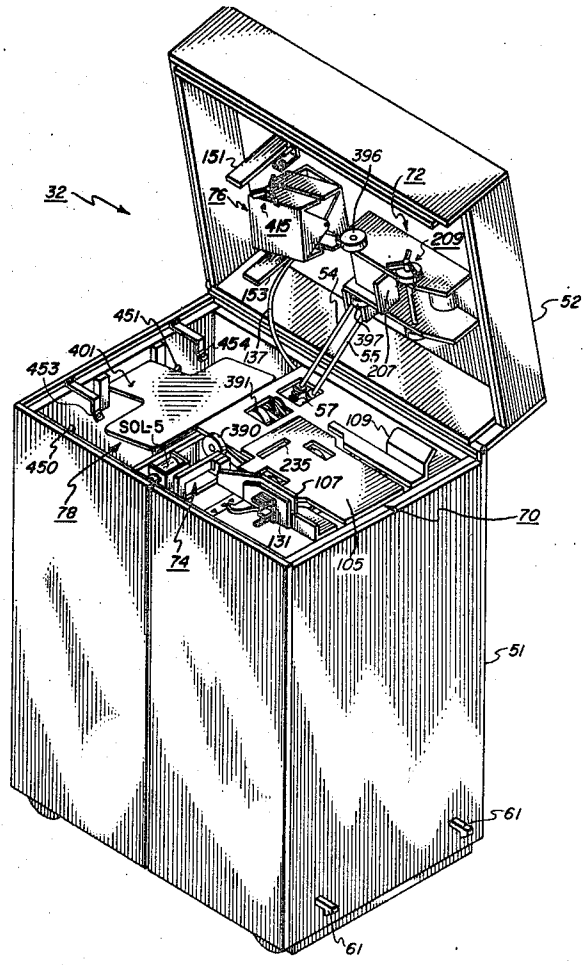
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Primary Examiner—Granville Y. Custer, Jr.
Attorney—James J. Ralabate, Norman E. Schrader and Melvin A. Klein

[57] **ABSTRACT**

Stapling apparatus used for stapling copy sheets into booklets produced from documents copied in repeated cycles which includes a tray mechanism having movable side guide members capable of receiving different size sheet material fed along a predetermined path from a processor. The sheet material is stopped by a gate mechanism which is positioned adjacent to the tray mechanism and is operative to move from one position in the sheet path to a second position out of the sheet path in response to discrete electrical signals. The stapling assembly is operative to drive staples one staple at a time into each pile of sheets collected and held in registration by the tray mechanism and gate mechanism in response to electrical signals. A solenoid actuated eject roll mechanism is used to eject the stapled pile of sheets after the gate mechanism has been lifted out of the gate path and move the staple pile to the receiving tray. A control circuit supplies the signals necessary to carry out the program logic of the various components of the stapling apparatus in timed relation.

6 Claims, 28 Drawing Figures



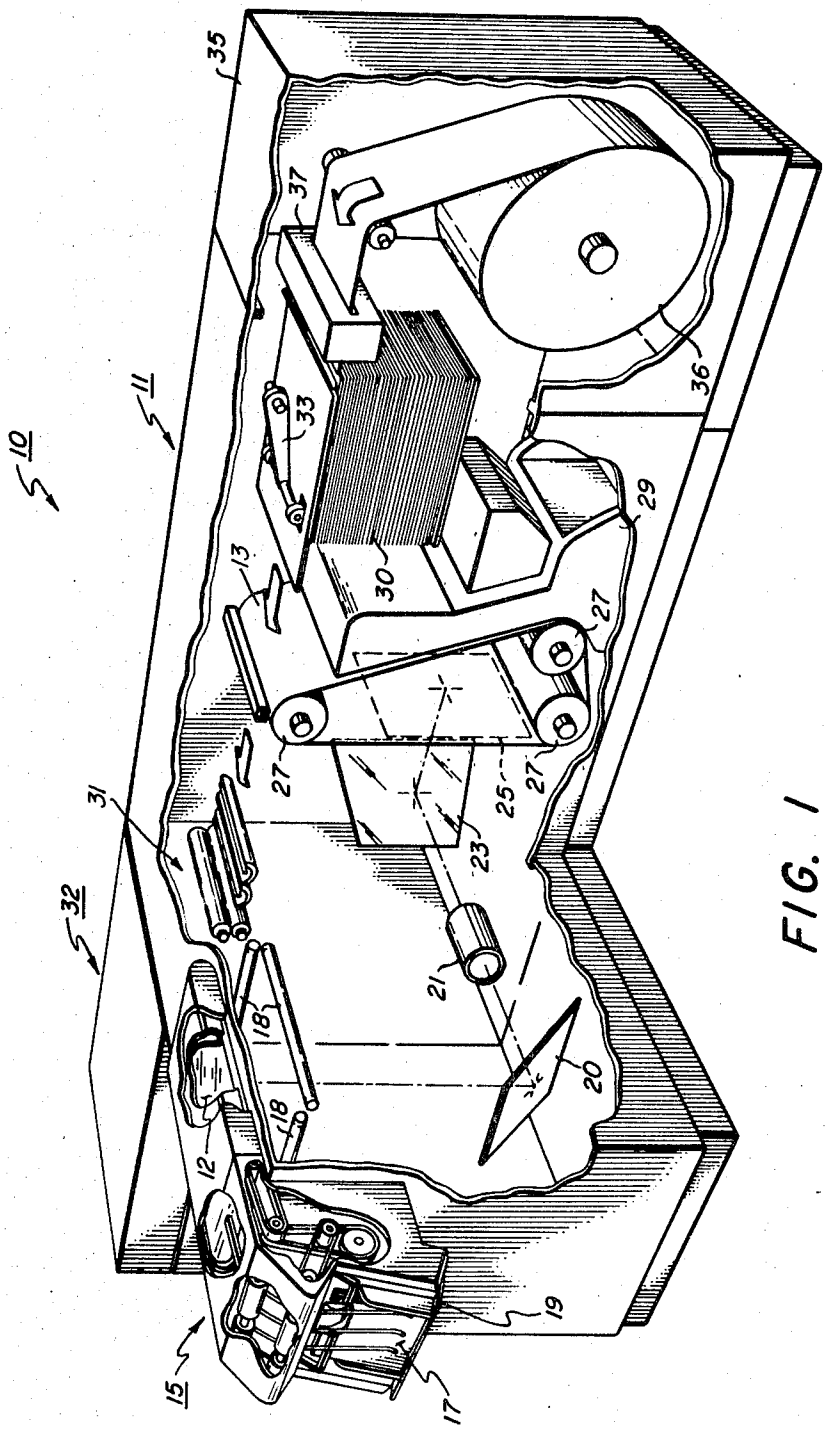


FIG. 1

INVENTORS.
LYMAN H. TURNER
WILLIAM P. KUKUCKA
BY JAMES E. SUMMERS
Melvin A. Klein
ATTORNEY

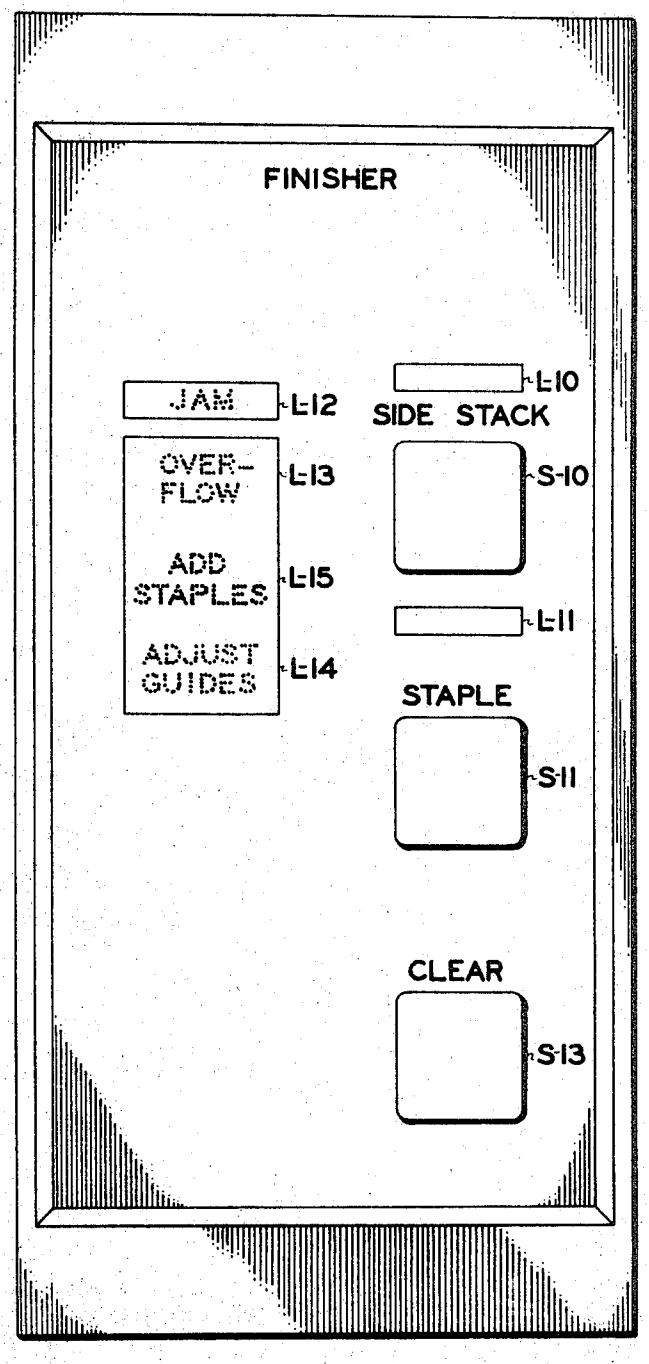

FINISHER
L-10
JAM
L-12
SIDE STACK
OVER-FLOW
L-13
S-10
ADD STAPLES
L-15
L-11
ADJUST GUIDES
L-14
STAPLE
S-11
CLEAR
S-13

FIG. 1a

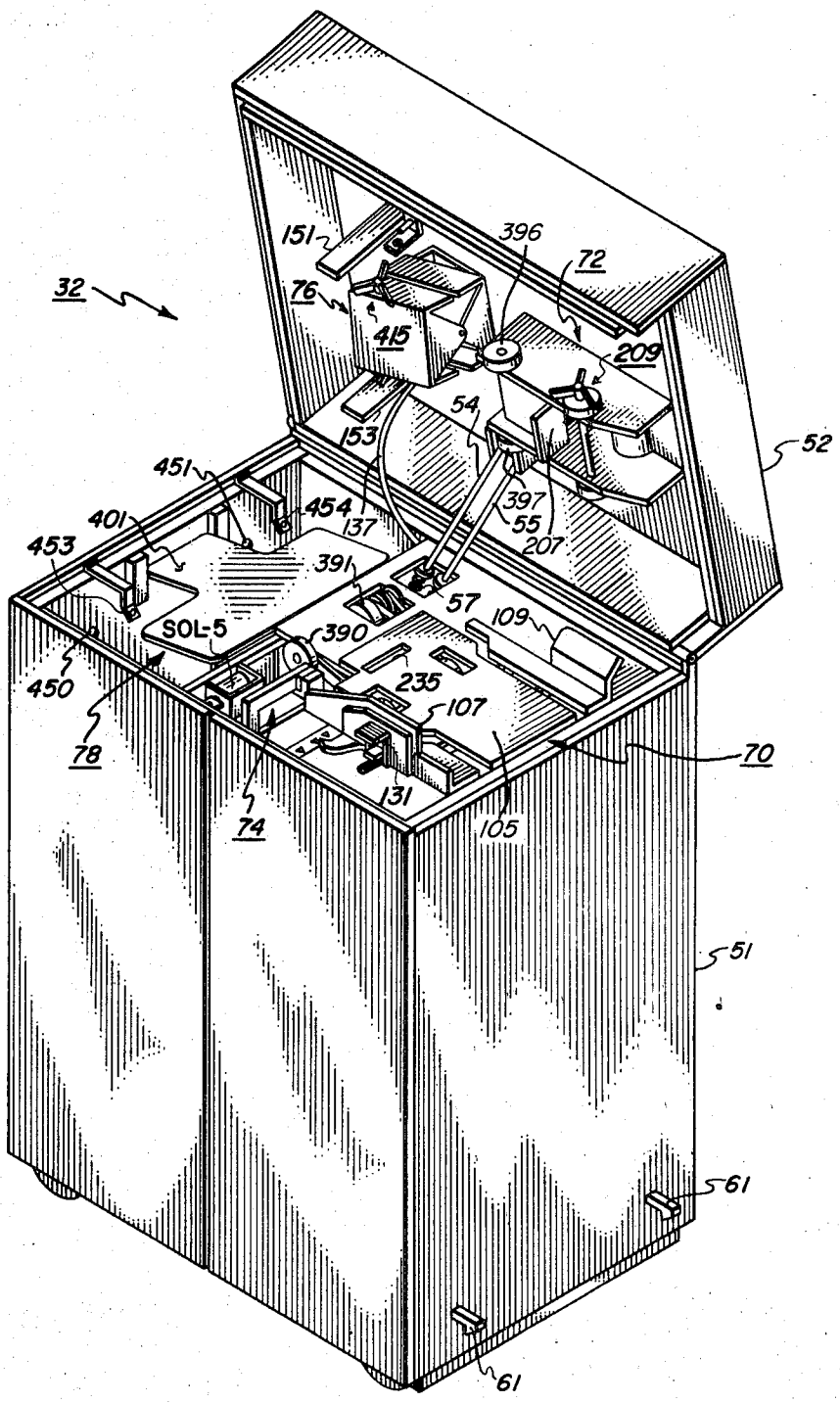

32
151
396
72
76
415
209
54
153
52
451
454
137
397
55
207
401
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109
SOL-5
390
450
235
107
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78
74
131
105
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61
61

FIG. 2

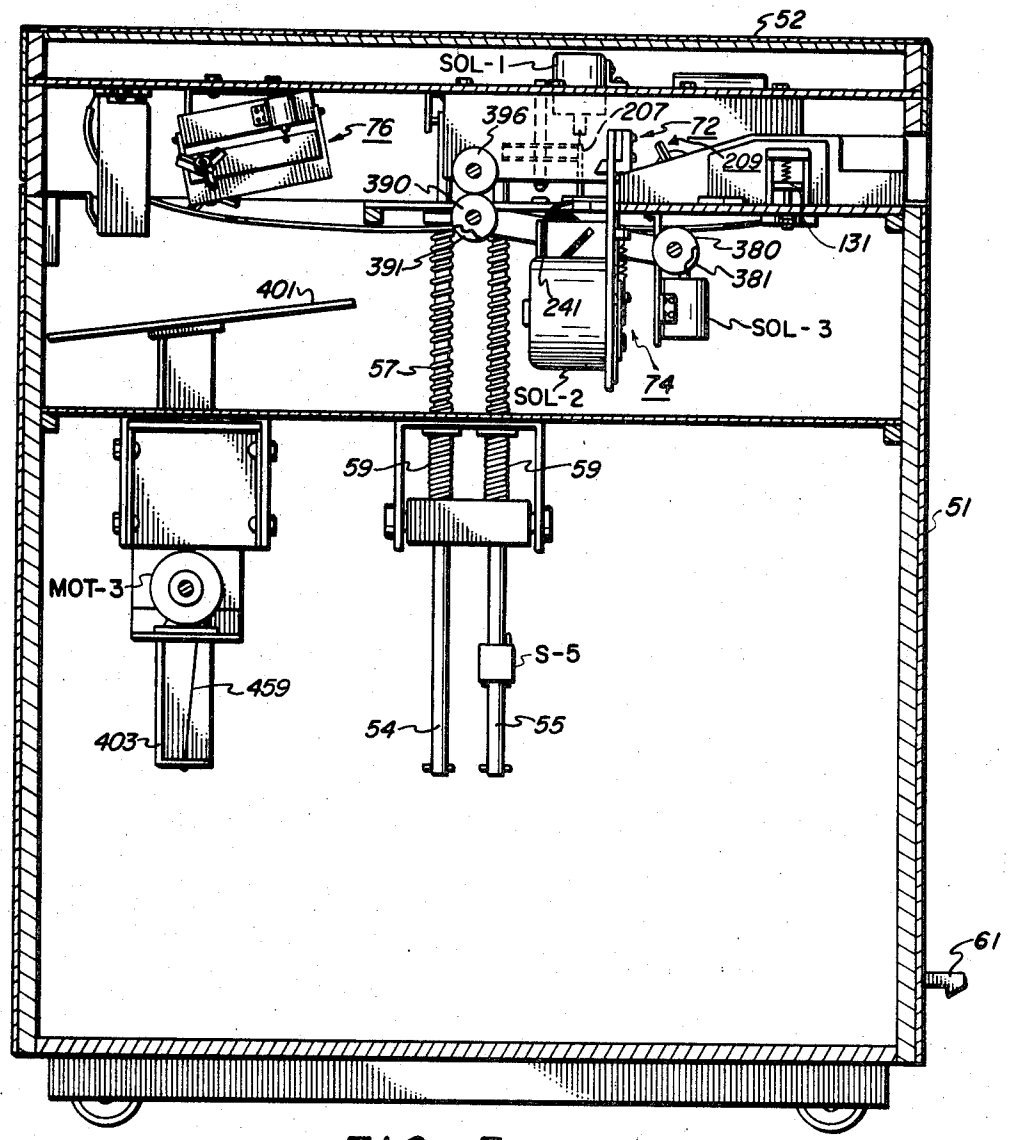

52
SOL-1
76
396
207
72
209
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131
380
391
381
401
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SOL-3
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SOL-2
74
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59
51
MOT-3
S-5
459
403
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55
61

FIG. 3

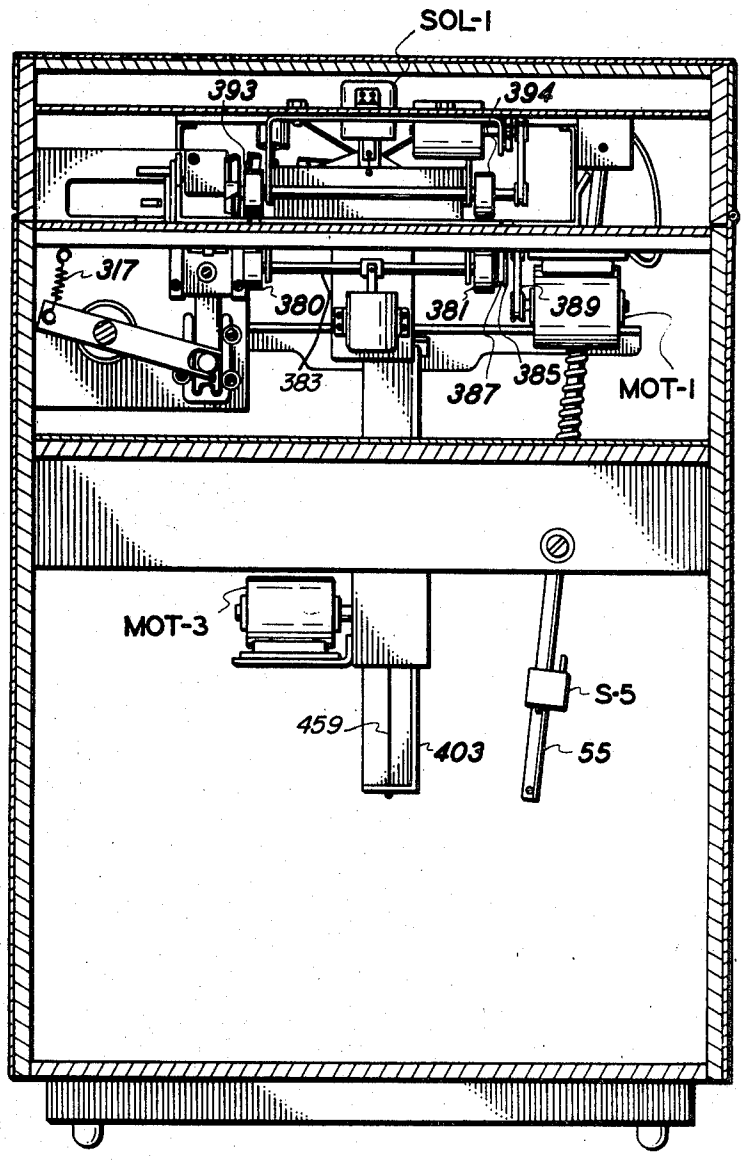


FIG. 4

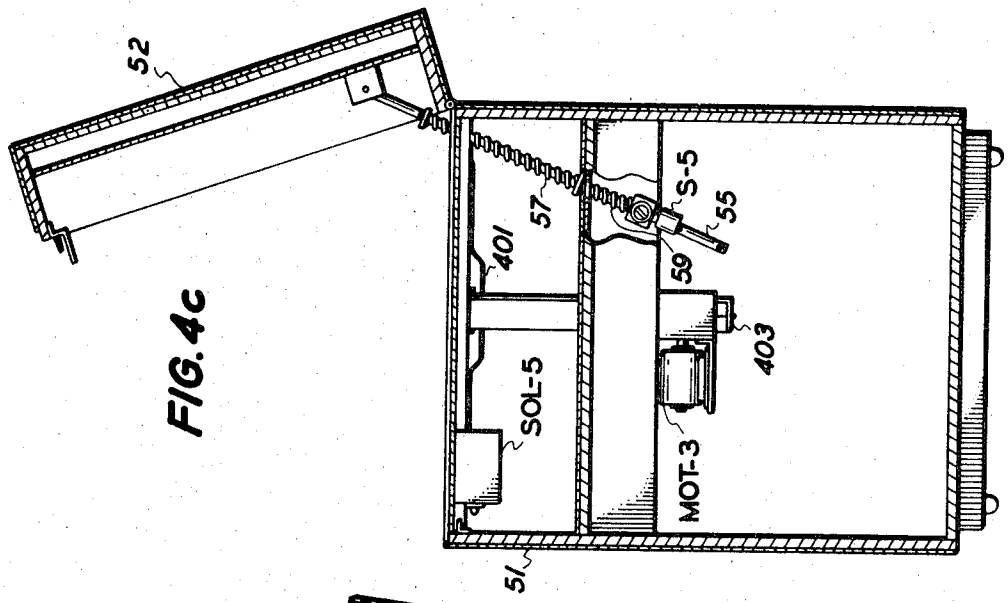


FIG. 4c

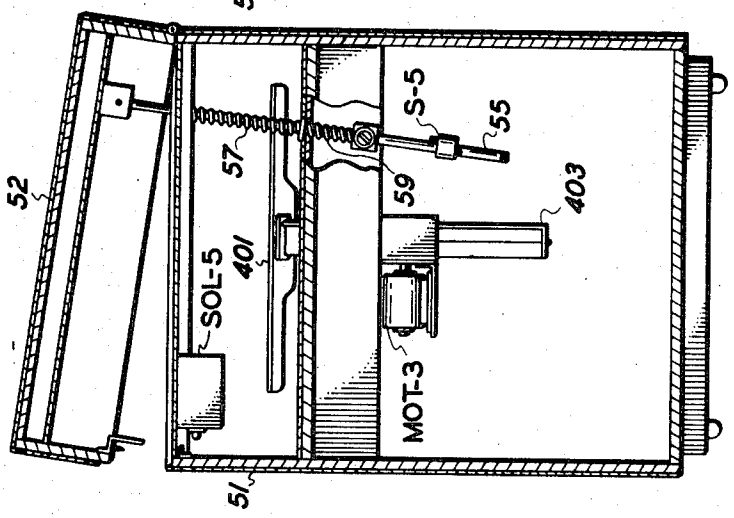


FIG. 4b

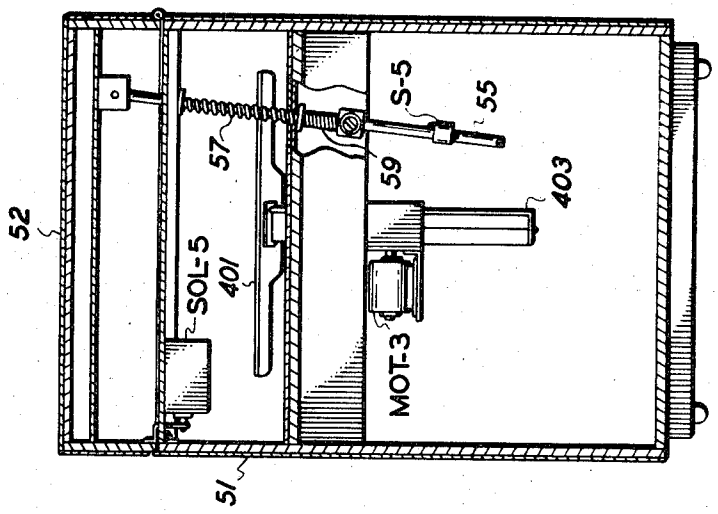


FIG. 4a

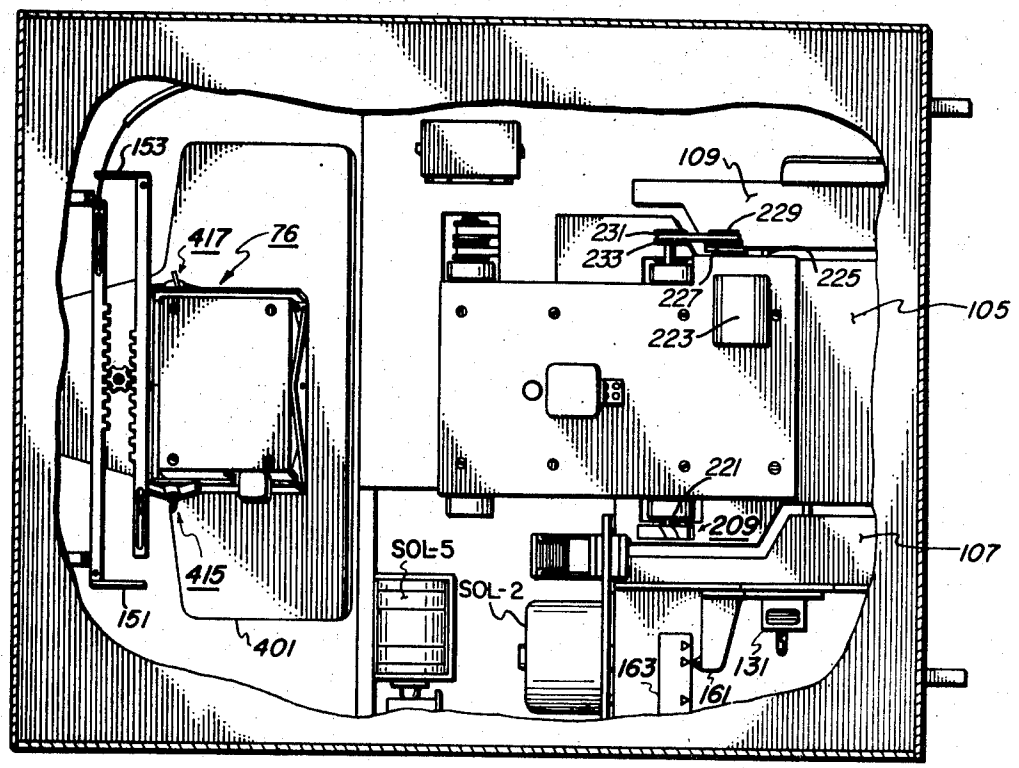

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SOL-5
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FIG. 5

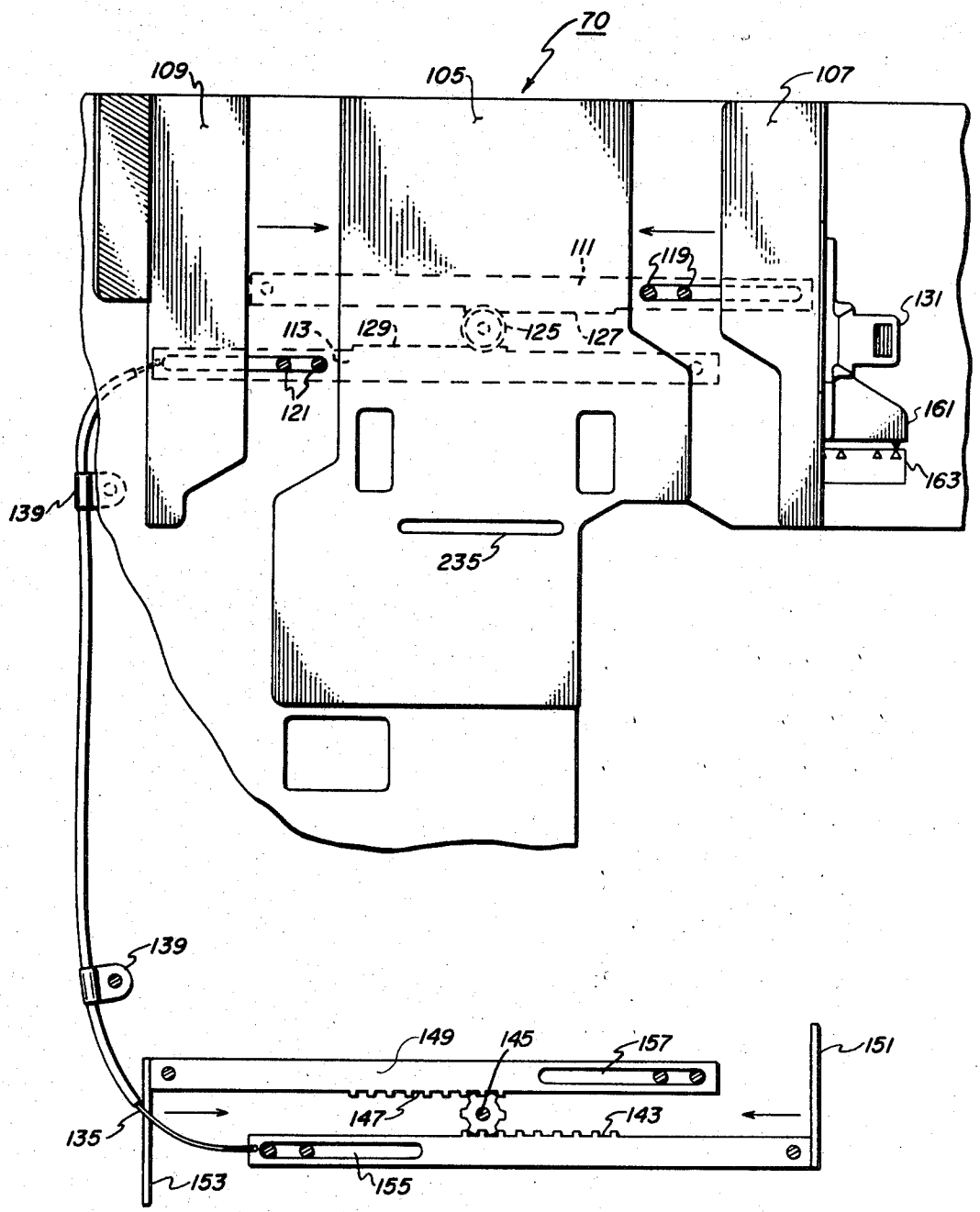

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FIG. 6

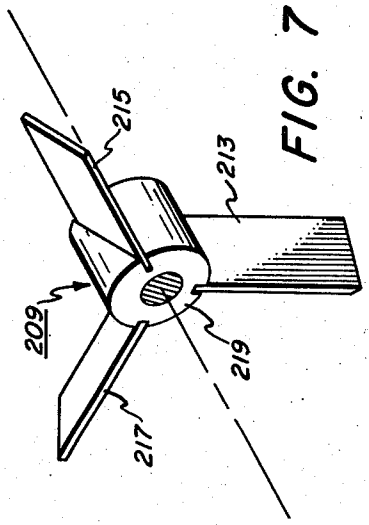


FIG. 7

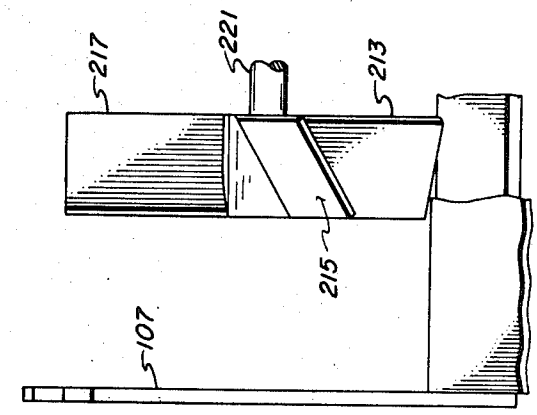


FIG. 7c

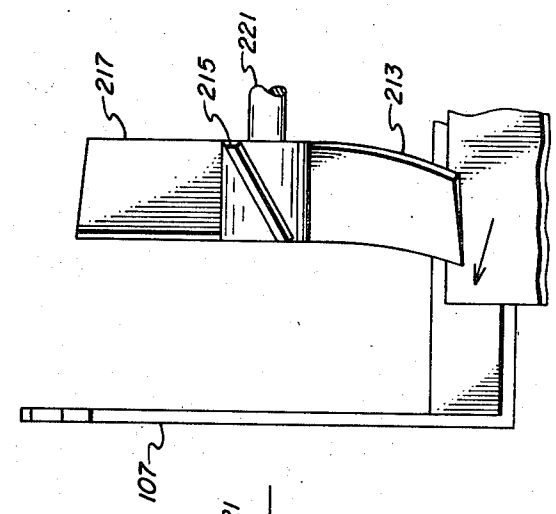


FIG. 7b

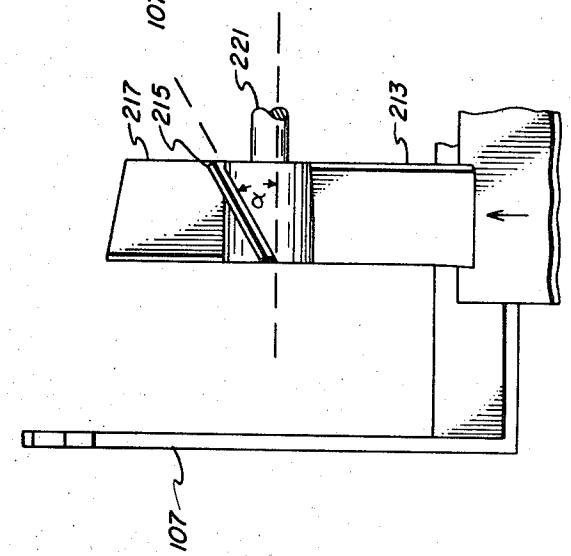


FIG. 7a

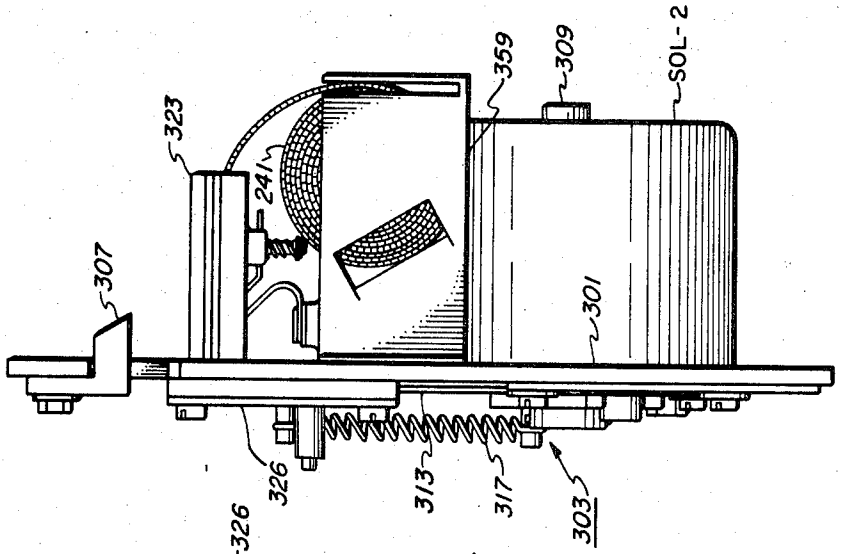

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SOL-2
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FIG. 9

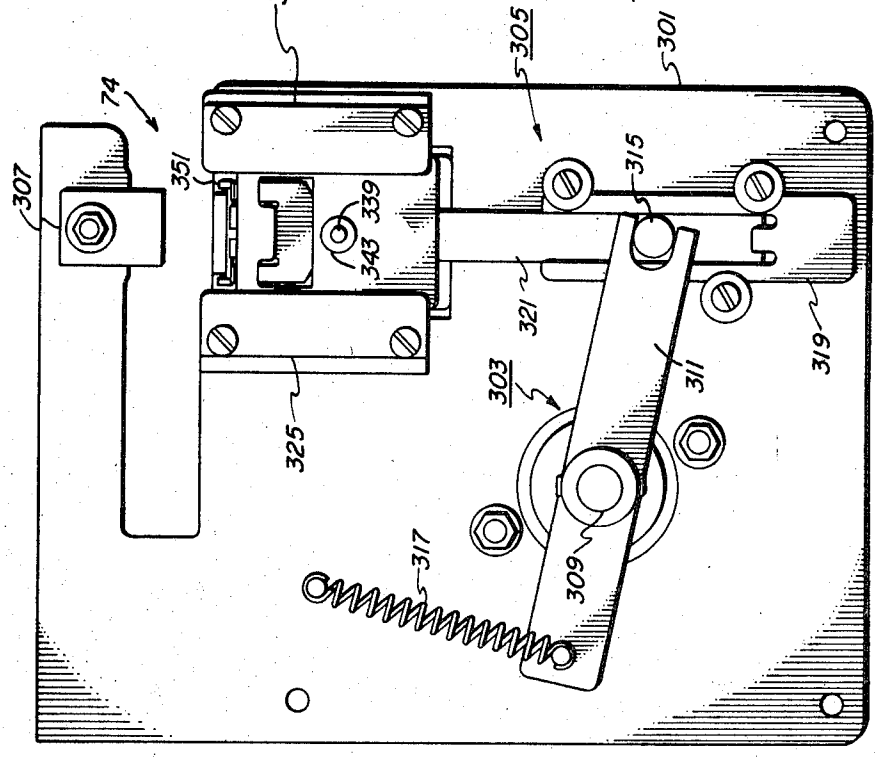

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FIG. 8

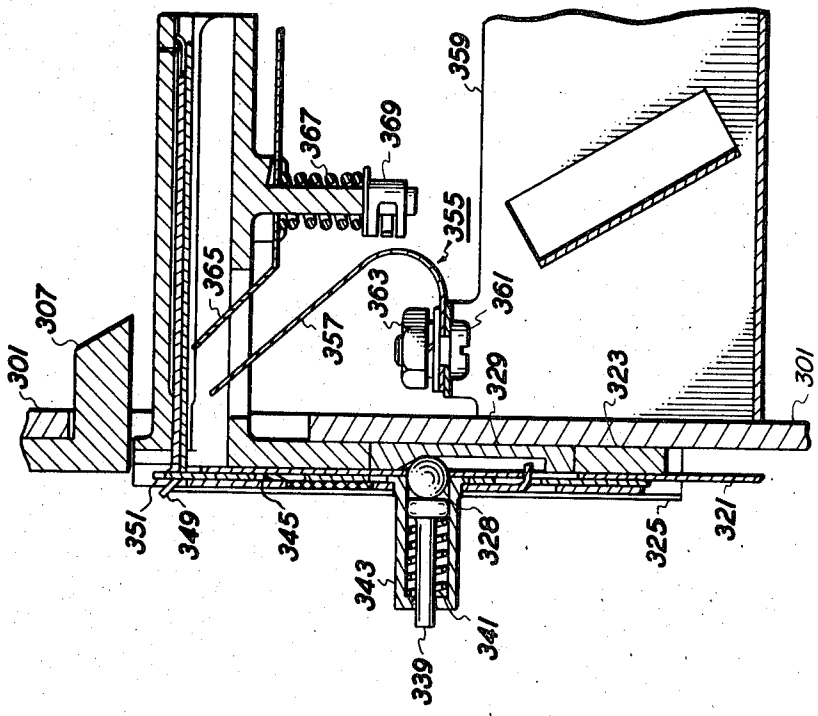

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FIG. 11

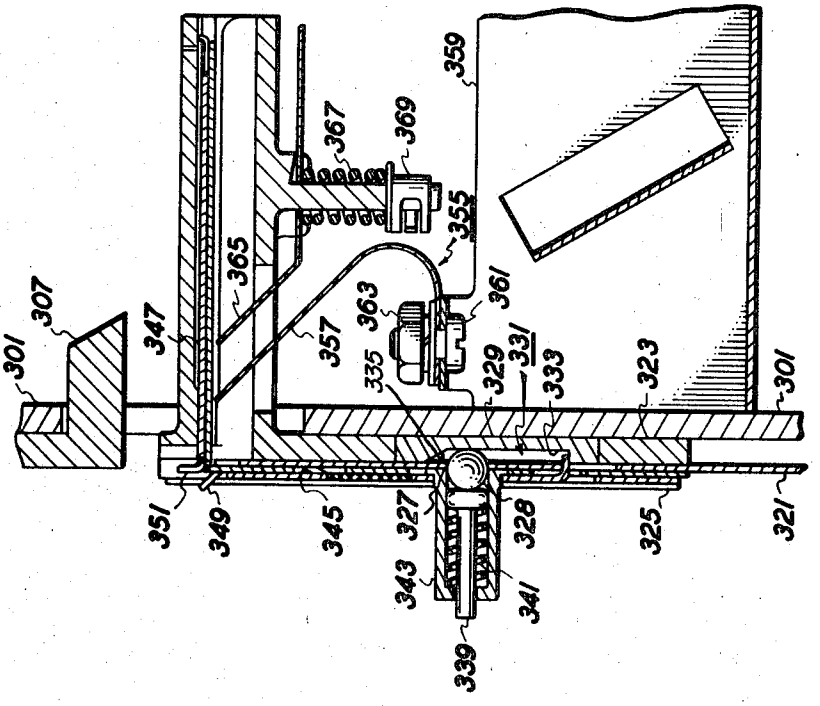

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FIG. 10

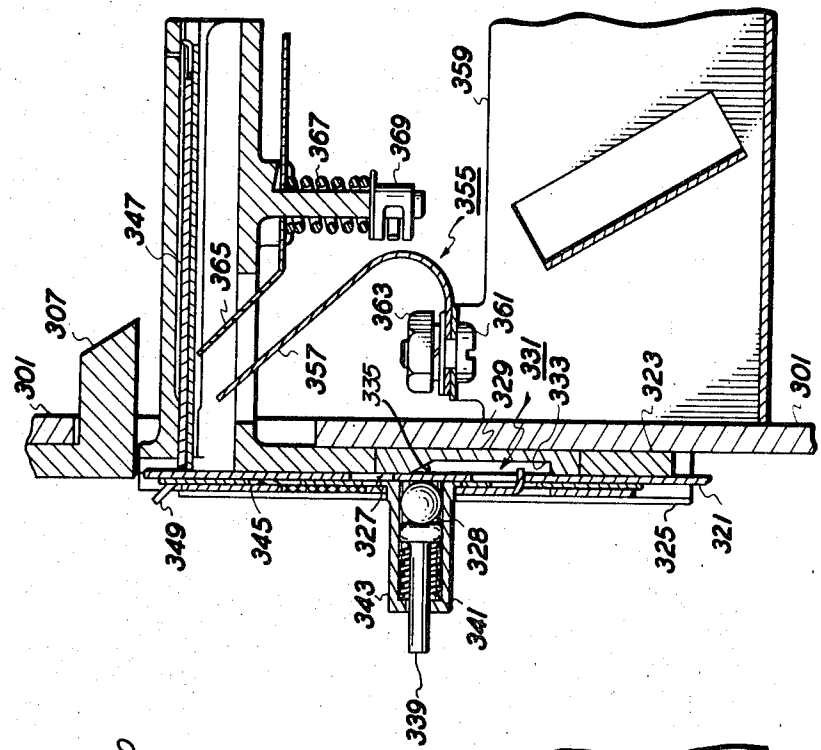

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FIG. 13

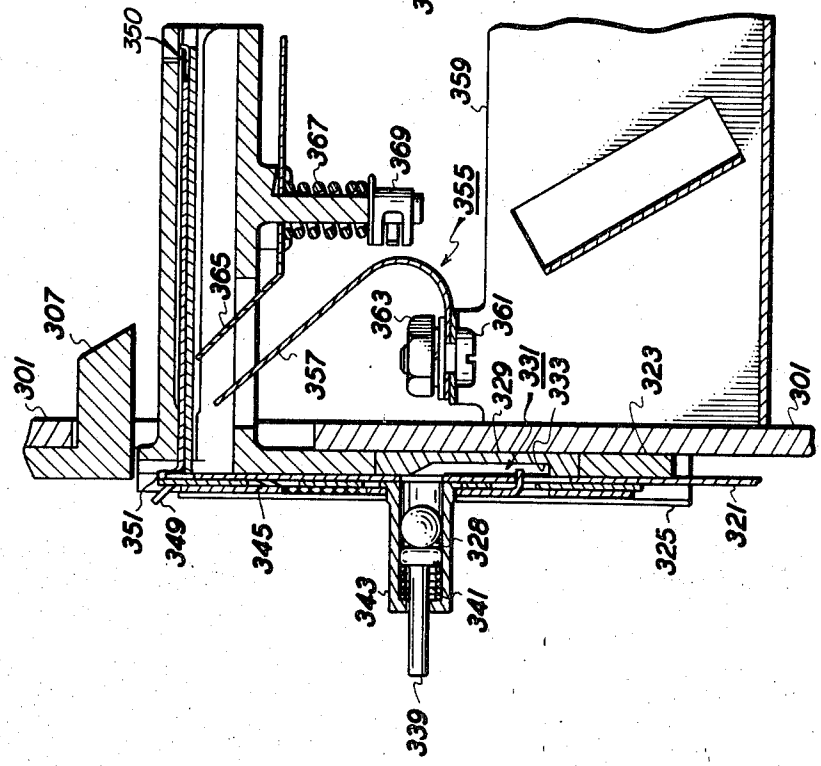

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FIG. 12

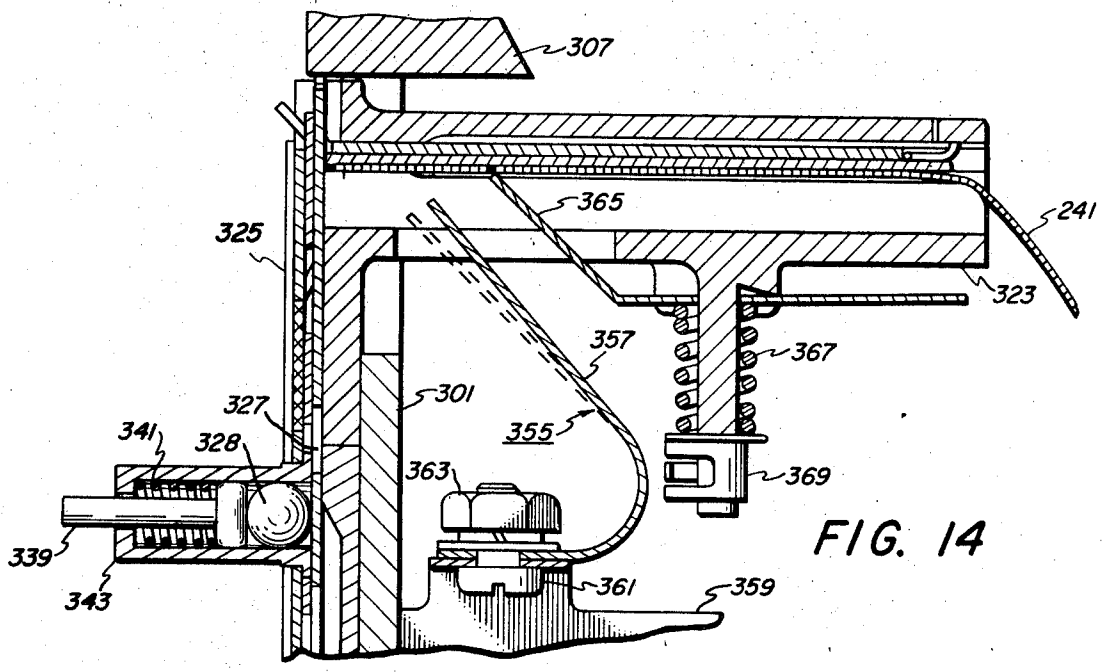

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FIG. 14

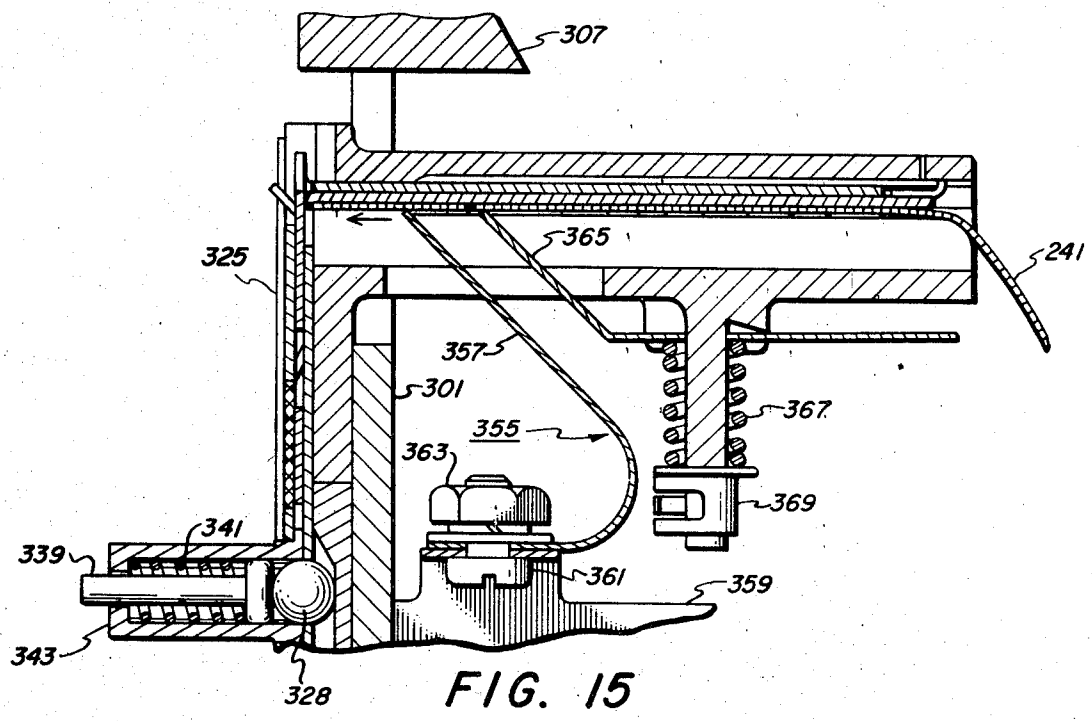

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359
343
328

FIG. 15

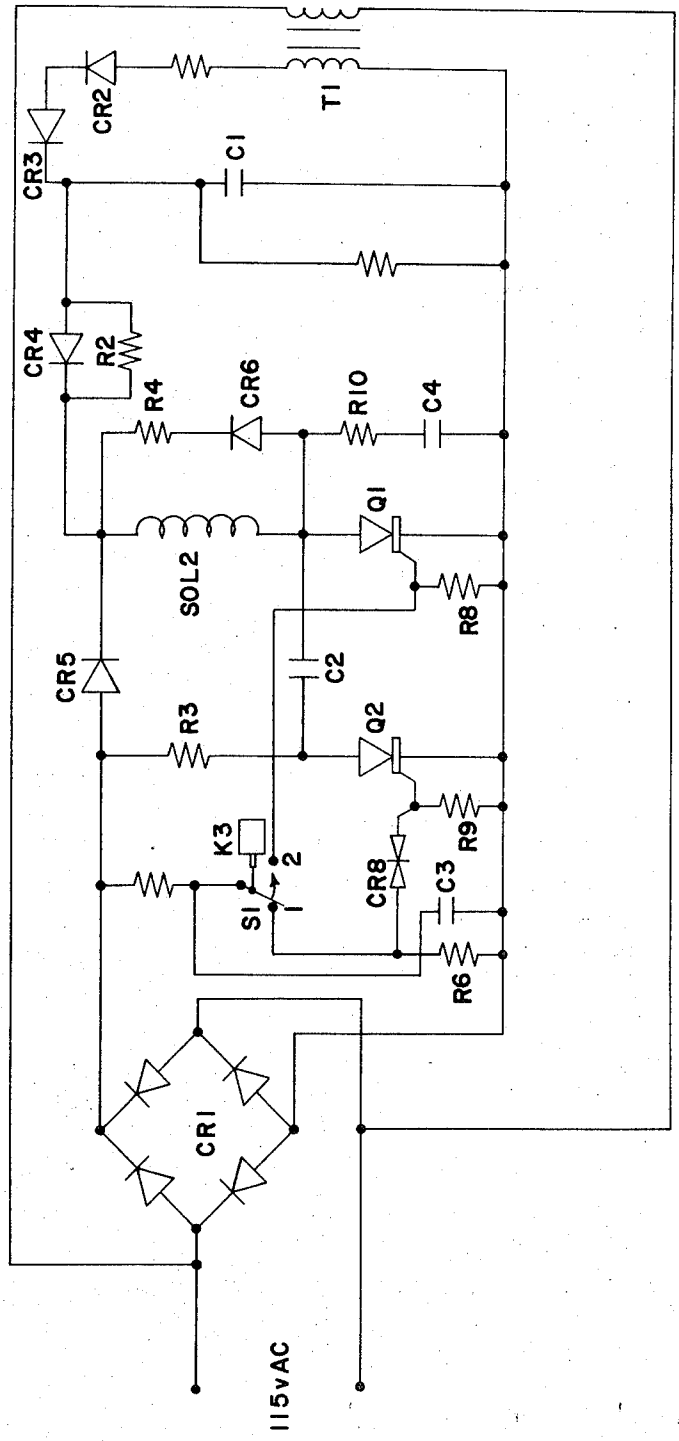

T1
CR2
CR3
C1
CR4
R2
R4
CR6
R10
C4
Q1
SOL2
R8
CR5
C2
R3
Q2
K3
2
R9
CR8
C3
S1
1
R6
CR1
115vAC

FIG. 16

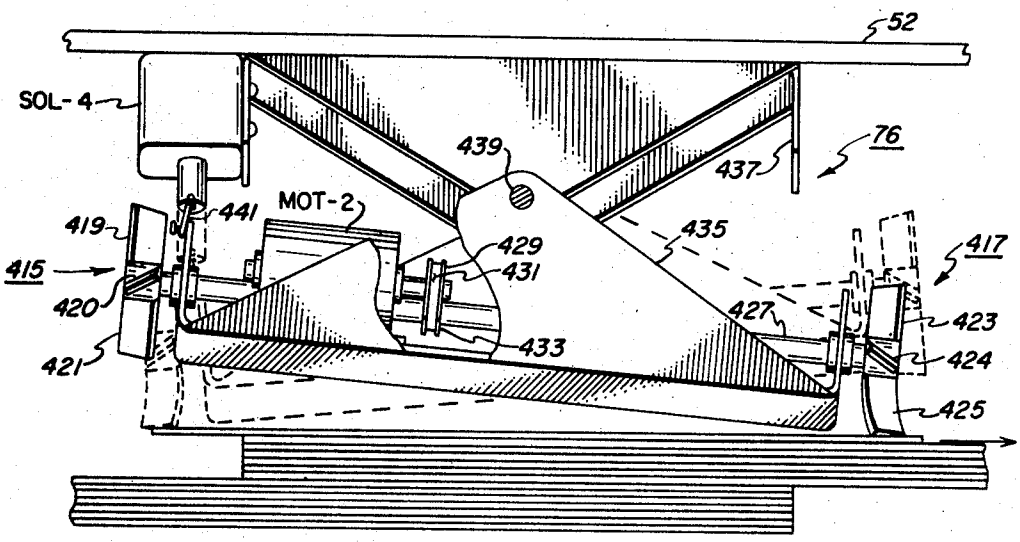

52
SOL-4
439
76
437
441
MOT-2
419
435
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424
425

FIG. 17

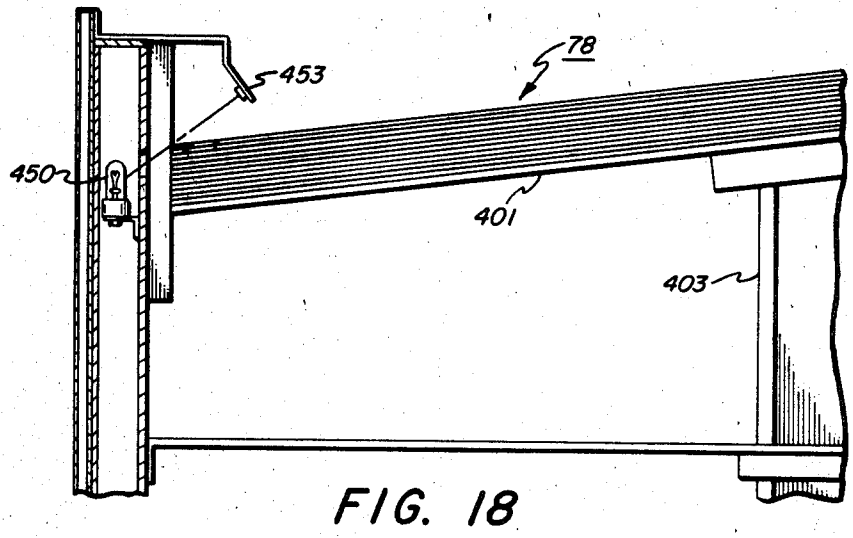

78
453
450
401
403

FIG. 18

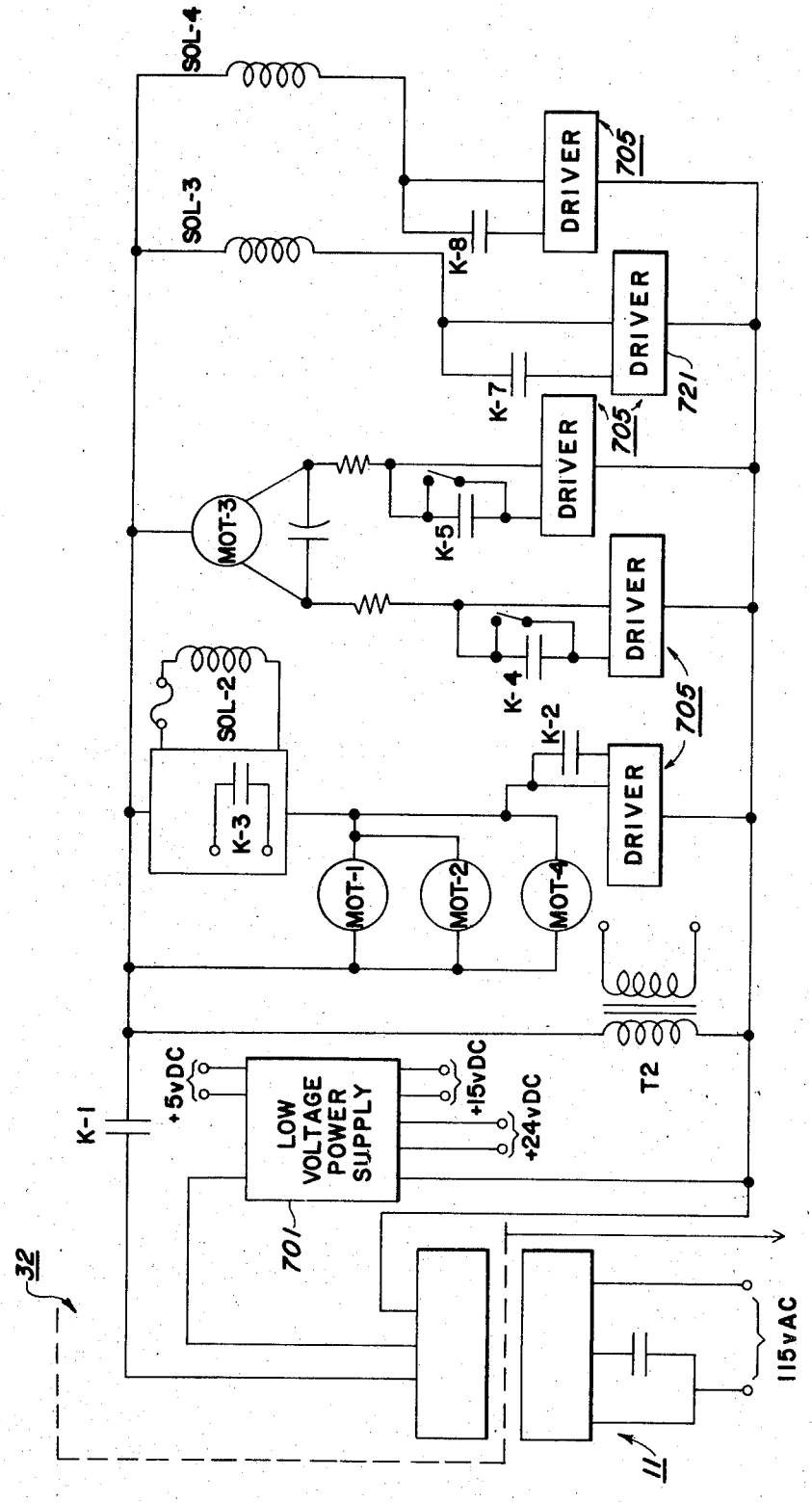

SOL-4
SOL-3
SOL-2
K-8
K-7
K-5
K-4
K-2
K-3
K-1
DRIVER
705
721
MOT-1
MOT-2
MOT-3
MOT-4
T2
+5vDC
+15vDC
+24vDC
LOW VOLTAGE POWER SUPPLY
701
32
11
115vAC

FIG. 19

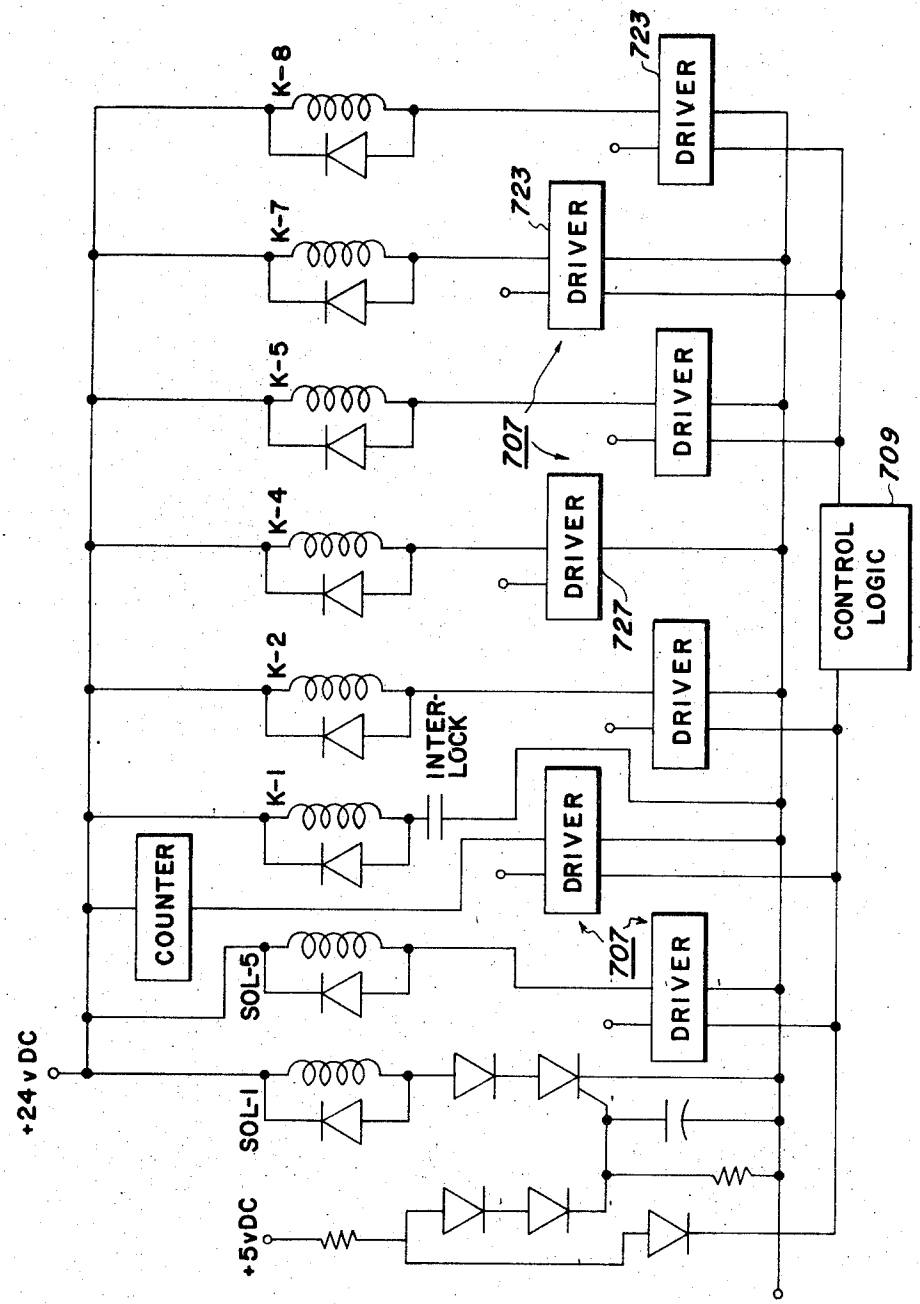

K-8
K-7
K-5
K-4
K-2
K-1
SOL-5
SOL-1
+24 v DC
+5vDC
COUNTER
INTER-LOCK
DRIVER
723
707
727
709
CONTROL LOGIC

FIG. 20

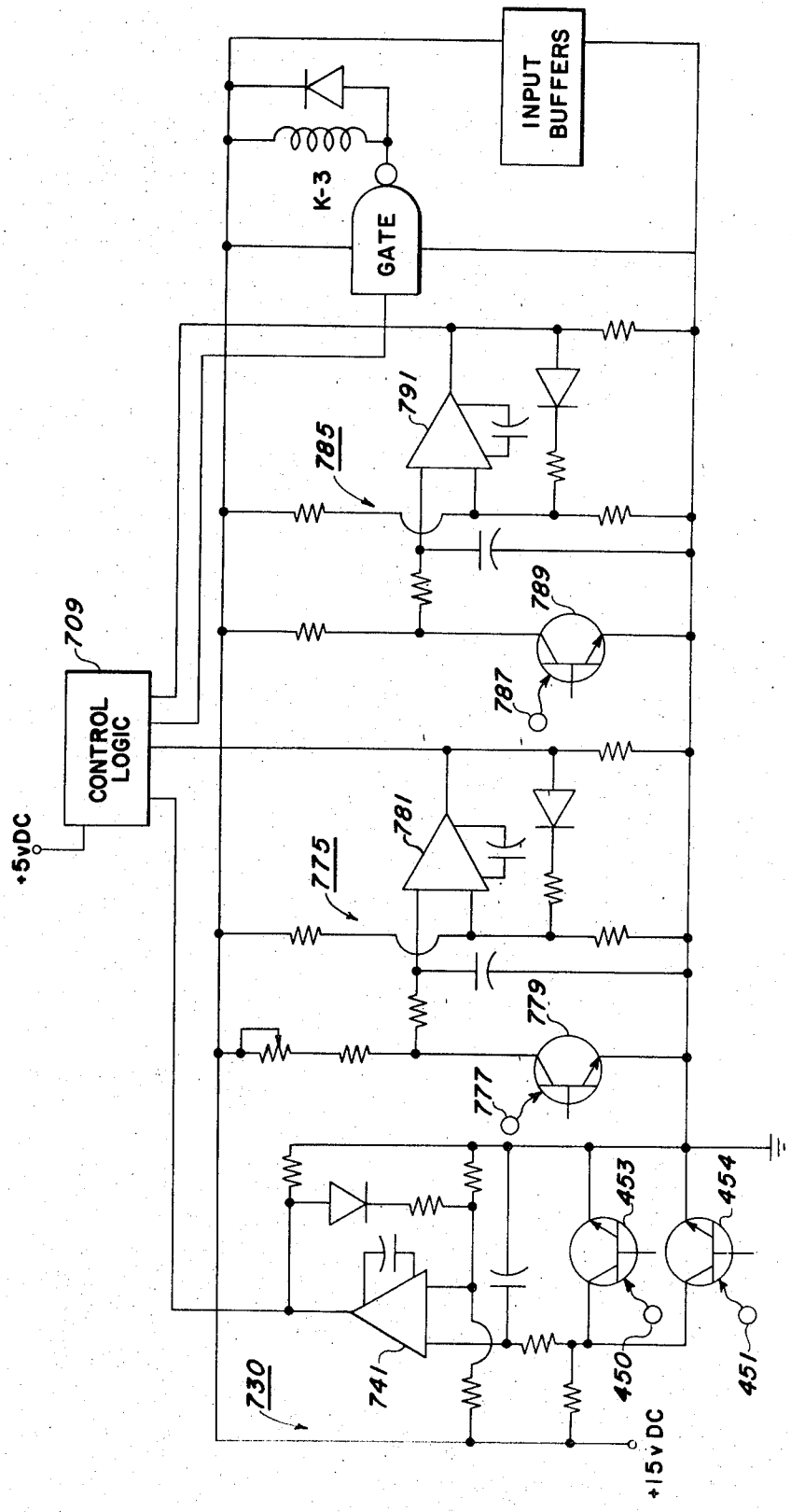

INPUT BUFFERS
K-3
GATE
791
785
789
787
709
CONTROL LOGIC
+5VDC
781
775
779
777
453
454
741
730
450
451
+15 v DC

FIG. 21

STAPLING APPARATUS

This invention relates to apparatus for automatcally printing and stapling sheets into booklets.

As is well known in the art of bookmaking, it is generally necessary to first print or copy sheets and then gather groups of different sheets in a definite order referred to as collating. The operation of printing and then collating sheets into booklets usually requires several steps, the last of which is taking one sheet from each of a number of printed stacks and putting these sheets together in the order desired.

Normally the collating of the sheets into booklets by hand is slow an cumbersome. Also, the number of people necessary is considerable and the likelihood of making a mistake great.

Present devices for mechanically collating sheets into booklet form have the disadvantage of being prolix and costly and have not been entirely satisfactory.

The present invention enables automatic collating and stapling of sheet material into booklets. To accomplish this, a stapling apparatus accepts copy sheets from a processor and registers them in a pile, and then drives staples one at a time in sequence to form finished booklets.

It is therefore an object of the present invention to improve the printing of booklets.

It is another object of the present invention to enable copy sheets from a processor to be stapled into packs in a manner more simple and cheaper than heretofore.

It is another object of the present invention to provide a system for producing collated sets of copies from precollated document material to be reproduced.

It is another object of the present invention to provide method and apparatus for stapling sheet material in a manner more expeditious than heretofore.

It is another object of the present invention to provide a staple finishing apparatus which is simple and compact in design.

These objects as well as others will become more apparent upon considering the following description which is to be read in conjunction with the accompanying drawings in which:

FIG. **1** is a perspective view of a copying machine incorporating a finishing apparatus according to the present invention;

FIG. **1***a* is a view of the machine control panel section for the finishing apparatus;

FIG. **2** is an isometric view of the exterior of the finishing apparatus;

FIG. **3** is a side sectional view of the finishing apparatus;

FIG. **4** is a end sectional view of the finishing apparatus;

FIGS. **4***a–c* are end sectional views illustrating the various positions for the the cover of the finishing apparatus;

FIG. **5** is a plan view of the finishing apparatus with parts in section to illustrate certain details thereof;

FIG. **6** is a plan view of the sheet receiving tray assembly;

FIG. **7** is an isometric view of a paddle wheel;

FIGS. **7***a–c* illustrate in sequence the action of a rotating paddle wheel on moving sheet material;

FIGS. **8** and **9** are side and end views, respectively, of the staple head assembly;

FIGS. **10**, **11**, **12** and **13** are sectional views illustrating sequentially the details of operation of the stapling head assembly;

FIGS. **14** and **15** are sectional views illustrating details of the feed of the staple roll;

FIG. **16** is a diagrammatic showing of the staple drive circuit;

FIG. **17** is a side view of the side stacking assembly;

FIG. **18** is a side view of the output receiving tray assembly illustrating details of the elevation control thereof; and

FIGS. **19**, **20** and **21** are diagrams of the control circuits of the finishing apparatus.

GENERAL

For a general understanding of reproduction apparatus with which the present invention may be incorporated, reference is made to FIG. **1** wherein various components of a typical electrostatic printer system are illustrated. The printer system is of the xerographic type and is generally designated with the reference numeral **10**. As in all xerographic systems, reference light image of an original to be reproduced is projected onto the sensitized surface of xerographic plate to form an electrostatic latent image. Thereafter, the latent image is developed with toner material to form a xerographic powder image corresponding to the latent image on the plate surface. The powder image is then electrostatically transferred to a record material such as a sheet or web of paper or the like to which it may be fused by a fusing device whereby the powder image is caused permanently to adhere to the surface of the record material.

The xerographic processor indicated by the reference numeral **11** is arranged as a self-contained unit having all of its processing stations located in a unitary enclosure or cabinet. The printer system includes an exposure station at which a light radiation pattern of a document to be reproduced is positioned on a glass platen **12** for projection onto a photoconductive surface in the form of a xerographic belt **13**. The document is transported by a recirculating document feed apparatus **15** from the bottom of a stack **17** on a supply tray **19** to the platen for exposure and then returned to the top of the supply tray on completion of the exposure until the entire stack has been copied at which time the cycle may be repeated as described in copending U.S. application Ser. No. 781,287, filed on Dec. 4, 1968, now U.S. Pat. No. 3,556,512, issued Jan. 19, 1971 entitled Document Feed Apparatus and commonly assigned with the present invention.

Imaging light rays from the document as flash illuminated by lamps **18** are projected by a first mirror **20** and a projection lens **21** and another mirror **23** onto the belt **13** at the focal plane for the lens **21** at a position indicated by the dotted line **25**.

As an interface structure and for unobstructive optical projections, the side of the cabinet is formed with an enlarged rectangular opening to permit the projection of image light rays from the lens **21** to the mirror **23**. Similarly, the cabinet supporting the document plane is formed with a corresponding rectangular opening that mates with the opening in the printer cabinet when the two cabinets are operatively joined together for copy/duplicating purposes. Suitable light-tight

gaskets may be utilized adjacent the exterior of each opening in the cabinets in order to minimize the leakage of unwanted extraneous light.

The xerographic belt **13** is mounted for movement around three parallel arranged rollers **27** suitably mounted in the frame of processor **11**. The belt may be continuously driven by a suitable motor (not shown) and at an appropriate speed corresponding to the discharge responsive the photoconductive material that comprises the belt and the intensity of the imaging light rays from the document. The exposure of the belt to the imaging light rays from the document discharges the photoconductive layer in the area struck by light whereby there remains on the belt an electrostatic latent image of figuration corresponding to the light image projected from the document. As the belt continues its movement, the electrostatic latent image passes a developing station at which there is positioned a developer apparatus **29** for developing the electrostatic latent image. After development, the powdered image is moved to an image transfer station whereat record material or sheet of paper just previously separated from a stack of sheets **30** is held against the surface of the belt to receive the developed powder image therefrom. The sheet is moved in synchronism with the movement of the belt during transfer of the developed image. After transfer, the sheet of paper is conveyed to a fusing station where a fuser device **31** is positioned to receive the sheet of paper for fusing the powder thereon. After fusing of the powder image, the sheet is conveyed through an opening in the cabinet to a finishing apparatus **32** for stapling or side stacking in a manner as will be described more fully hereinafter. The sheets are separated from the stack and fed from the tap of the stack by means of a separator roll device **33** and timed sequence of the movement of the developed latent images on the belt **13**.

Further details of the processing devices and stations in the printer system are not necessary to understand the principals of the present invention. However, a detailed description of these processing stations and components along with the other structures of the machine printer are disclosed and copending application Ser. No. 731,934, filed May 24, 1968, and Ser. No. 756,598, filed Aug. 30, 1968, now U.S. Pat. No. 3,597,071, issued Aug. 3, 1971, which are commonly assigned with the present invention.

It will be appreciated that the printer system may be operated in conjunction with a roll converter unit indicated by the reference numeral **35**. The roll converter unit **35** is adapted to convert a relatively large roll of paper **36** into various sized of sheets of paper by means of a cutter device **37** and a suitable control system (not shown) arranged to control cutting and feeding of the individual sheets into operative cooperation with the separator roller **33**. It will be appreciated that operative cooperation is assured between the various units operating with the printer system by the physical association of the cabinets for the units and the matching openings which enable full cooperation of the imaging light rays and sheet transport path between the units. In this regard, locking clamps may be provided on all the units for preventing the inadvertent movement of such units during use and interlocks which is an alignment device may be utilized on each unit for ensuring upper alignment and to terminate or suspend operation in the event mis-alignment or separation of the units occur. For facility and needs of operation, each of the units provided with caster wheels and locking brakes thereby aiding in the movement of the units into and out of cooperative engagement.

FINISHING APPARATUS

The finishing apparatus **32** comprises a frame having a main body housing **51** and cover **52** which is connected to the frame by rods **54** and **55** against the action of spring sets **57** and **59** (FIG. 3) encircling the rods to enable a pop open position of the cover as well as a fully raised position to permit access into housing **51** as will become more apparent. Housing **51** has hook members **61** extending from the lower portion to secure the frame to the processor **11** as previously mentioned.

Finishing apparatus **32** includes an input receiving tray assembly **70**, a stapler group **72**, a stapler head assembly **74**, a side stacking assembly **76** and an output receiving tray assembly **78**. Input receiving tray assembly **70** comprises an adjustable input receiving tray **105** which serves to guide the sheet material along a path from the processor into the finishing apparatus. The tray is adjustable for varying paper width which may accept, as for example, 8½ × 11 paper up to 9 ×14 paper. Tray assembly **70** has a left hand guide **107** and right hand guide **109** which are connected by a pair of bar or rod members **111** and **113**. Bar or rod members **111** and **113** are formed with elongated slots **115** and **117**, respectively, to enable sliding movement of the bar members relative to the machine frame. Pin members **119** and **121** serve to guide the bar members **111** and **113**, respectively, in their movement at right angles to the sheet path. In order to ensure that the bar members **111** and **113** are moved equal and opposite distances from the centerline of the sheet path, a sprocket gear **125** secured to the frame meshes with teeth **127**, **129** formed on the bar members **111**, **113**, respectively. To position the tray assembly, the machine operator depresses a tray release handle **131** which when engaged enables guide **107** to be moved relative to the machine frame which, in turn, moves bar **111** which, in turn, drives the gear sprocket **125** which then drives bar **113** and in equal and opposite direction from movement imparted through bar **111** thereby moving guide **109** to an equal and opposite position relative to the center line of the sheet path. It will be noted that a wire **135** received in a sleeve **137** which is clamped to the frame by clamps **139** which serve to impart movement to a bar **141** associated with the side stacking assembly **76** as will be described hereinafter. Bar **141** has teeth **143** formed therein which mesh with a sprocket gear **145** which, in turn, also meshes with teeth **147** on a bar **149** in similar fashion to bars **111** and **113**. Bars **141** and **149** have guide plates **151** and **153** secured thereto and have elongated slots **155** and **157** formed therein, respectively. It will be further noted that release mechanism **131** has an indicator portion **161** which may be aligned with marks **163** on the frame to facilitate the positioning of guides **107**, **109**, **151** and **153** to the various widths. By this arrangement when release handle **131** is actuated, the guides **107**

and 109 are moved in equal and opposite directions simultaneously. Guides 151 and 153 are moved in equal and opposite directions which are equal to the movement imparted to the guides 107 and 109 to establish the desired paper path for a desired paper width.

STAPLE GROUP ASSEMBLY

The staple group assembly 72 comprises a registration gate 207 (FIG. 3) which stops the forward motion of the sheet material, a paddle wheel 209 which moves the sheet to the forward left-hand corner of the input receiving tray for stapling by stapling head assembly 74 which drives staples into the sheet material positioned on the receiving tray to produce finished booklets. Paper guides 107 and 109 which have been previously described assist in positioning the sheet material coming from the processor and received on the input receiving tray. As the sheet material is received by the receiving tray by virtue of the exit speed of the sheets from the processor, the sheets come into contact with paddle wheel 209. Paddle wheel 209 comprises three blade members 213, 215 and 217 which are connected to a hub portion 219 which is received on a shaft member 221. The blade members are made out of flexible material such as polyurethane and are formed at a helix angle α ranging between about 20° to about 50° and preferably from 25° to 35° along the axis of shaft 221 for a purpose that will become more apparent. The blade members have length to width ratio ranging from about 2:1 to 3:1 and preferably are about one-half inch wide and about 1¼to 1½inches long and have a thickness ranging from about 0.050 inch to about 0.100 inch and preferably from about 0.065 inch to about 0.075 inch to obtain proper blade flexing when contact is made with the sheet material at the blade tips. Shaft 221 (FIG. 5) is driven by a motor 223 through gears and and 227 with gear 227 driving a pulley 229 which transmits motion to a pulley 231 mounted on the shaft 221 through an "O"-ring 233.

Referring now to FIGS. 7*a*, *b*, and *c*, there is shown in sequence the movement imparted to a sheet by the paddle member 209. The sheet moves initially to the left against paper guide 107 and then forwardly as the paddle member continues to rotate on shaft 221. The sheet is contacted by the outer tip of the blade 213. Due to the helix angle of the blade with the shaft axis and the unique shape and thickness of the blade, the blade is caused to flex to the outside or to the left looking at the figures which imparts a force on the sheet to the left carrying the sheet against the paper guide 107. As the blade member 213 continues to rotate, the outside tip moves out of contact with the sheet and the inner part of the blade is placed in contact with the sheet causing a forward force to be imparted to the sheet in the direction at which the paddle member is being rotated moving the sheet up against a gate member 207. The inner portion of the paddle member 213 does not flex to the same degree as the outer portion by virtue of the fact that the outer portion commences to return to its original shape after being flexed against the sheet thereby tending to impart a force against further flexing of the blade member in a sideways direction or to the left. As a result, the trailing portion or right-hand portion of the blade member serves to carry the sheet in a forward direction against the gate 207. Since the blade members 213, 215 and 217 are continuously acting on sheets, there is a continuous action piling sheets to the left against guide 107 and gate 207 thereby ensuring that sheets received onto the tray are collected in registration for stapling as will be described hereinafter.

Gate 207 stops the forward motion of the sheet material and is received in a slot 235 formed in the input receiving tray. Gate 207 is maintained in a rest position in slot 235 by the action of a spring and can be actuated to a raised position above the sheet path by the energization of a solenoid SOL–1 as will be described hereinafter. The stapling head assembly 74 places staples into the sheets collected on the input receiving tray having been positioned in corner registration against paper guide 107 and gate 207. For this purpose, staple blanks are in the form of a roll and are held together by a suitable coating which roll is commercially available under the trade name Swingline, manufactured by Swingline, Inc., Long Island City, New York. Typically, the staple blank length is about 1 inch such that a staple blank having a crown of about one-half inch can be formed from the staple and inserted into the sheets forming booklets. The staple length, of course, can be varied depending upon the number of pages or sheets which are to be stapled to form a booklet. Staple blanks are fed from the roll 241 by the action of the driving elements of the stapling head assembly which will be described.

STAPLE HEAD ASSEMBLY

The staple head assembly 74 comprises a frame 301 on which is mounted a solenoid drive assembly 303 which drives a staple forming and punch assembly 305 which severs a staple from staple roll 241 and forms the staple blank into a generally U-shape which is then driven against an anvil 307 which serves to clinch the staple into the sheets forming a finished booklet. Solenoid drive assembly 303 includes a rotary solenoid SOL–2 which rotates a shaft 309 about 25° when energized. Shaft 309 drives arm member 311 which is connected to a punch member 321 of the staple forming and punch assembly 305 by means of a lug 315. Arm 311 is connected to frame 301 by means of a spring 317 for returning arm member 311 to its rest position when solenoid SOL–2 de-energizes. The solenoid drive assembly 303 causes a reciprocating movement to be imparted to punch member 321 which is received in a guide 319 mounted on frame 301. Punch member 321 is mounted on a frame member 323 which is received in guides 325, 326 mounted on frame 301. It will be noted that punch member 321 is formed with an opening 327 in which is received a ball member 328. Thus, moving in conjunction with punch member 321 and frame member 323 is a wedge member 329 which is formed with a cavity 331 having a vertical wall 333 and a tapered wall 335 which acts on ball member 328. As wedge member 329 moves upwardly, ball member 328 is urged against a plunger member 339 acted on by a spring 341 received in a housing 343.

Included with the staple forming and punch assembly is a staple forming finger member 345 which forms the staple blank into a generally U-shaped around a mandrel member 347. At the same time, a lever member

349 moving with the staple forming and punch assembly contacts a mandrel finger 351 as best shown in FIG. 11. On further movement of the staple forming and punch assembly in an upward direction, lever 349 causes mandrel finger 351 to be displaced against a spring 350 which, in turn, retracts mandrel member 347 out of the path of the staple as shown in FIG. 12. At the same time, ball member 328 is contacted by tapered wall 335 of wedge 329 causing the ball member to be driven into housing 343 against plunger 339 and the action of spring 341. When ball member 337 moves into housing 343, punch member 321 is free to move independent of the staple forming and punch assembly 305. Upon continued movement punch member 321 is moved to sever a staple from roll 241 and carry the staple out of contact with staple forming fingers 345 and against anvil 307 and serves to drive the U-shaped staple into its fastening position against the sheets. Upon de-energization of the solenoid SOL–2 spring 317 serves to retract punch member 321, staple forming and punch frame member 323, wedge 329, staple forming fingers 345, mandrel member 347, lever member 349 and mandrel fingers 351 to their rest position by imparting a downward force on punch member 321 through lug 315 and arm 311. At this time, ball member 337 is urged back into the opening 327 formed in punch member 321 due to the action of spring 341 on plunger 339. As the staple forming and punch assembly 305 is being pulled downwardly into a rest position, the next staple from the roll 241 is fed into a stapling position in the path of punch member 321 for the next stapling cycle by a staple feed assembly 355.

Staple feed assembly 355 comprises a staple feed finger 357 which is secured at one end to the staple roll housing 359 by a screw 361 and nut 363 in such a manner as to enable the finger 357 to be able to be flexed. By this arrangement, staple feed finger 357 is displaced to the right on the upward stroke of the staple forming and punch assembly out of contact with the staple roll 241 but as the staple forming and punch assembly returns to its downward position, the staple feed finger 357 contacts the staple roll and due to its spring action causes an individual staple to be fed incrementally along its path to the left to a position in registry with punch member 321. In this manner, staples are incrementally fed into a feeding position in the staple path continuously with the reciprocating action of the staple forming and punch assembly. In order to ensure that a positive traction is maintained on the staple roll along its staple feed path, there is provided an anti-backup finger 365 which is mounted on the staple forming and punch frame 323 by a compression spring 367 which, in turn, is held in place by a clip 369 mounted on the frame. By this structure on the upward stroke of staple forming and punch assembly, the anti-backup finger 365 is maintained in contact with the staple roll preventing the roll from slipping to the right. During the feed of the individual staples of the staple roll the anti-backup finger 365 by virtue of the angle formed with the path of the staple roll enables the roll to be fed or advanced along its path to the left without restricting the movement thereof.

After a stapling cycle has been completed, the finished booklet is then ready to be ejected by eject rolls 380, 381. Eject rolls 380, 381 are mounted on a shaft 383 which is driven by a belt 385 mounted on pulley 387. Belt 385 is continuously driven by a motor MOT–1 through another belt 389 which, in turn, drives exit rolls 390, 391. It will be noted that eject rolls 380, 381 are connected to a solenoid SOL–3 which upon receiving a signal as will be explained hereinafter causes the eject rolls to be raised into contact with the stapled booklet against a pair of idler rolls 393, 394. By this arrangement, the stapled booklet is ejected from the stapling head assembly toward the exit rolls 390, 391 which together with idler rolls 396, 397 provide a further driving force on the booklet toward receiving tray assembly 78.

STAPLE CONTROL CIRCUIT

In order to achieve a reliable operation, a control circuit is associated with the stapling head assembly to provide a predetermined pulse of sufficient duration to maintain the driving stroke and staple forming operation of the stapling head assembly. As shown in FIG. 16, the staple driving circuit comprises a full wave bridge rectifier CR1 which provides a signal input to SCR Q2 and also an input to the coil of solenoid SOL–2 through a diode CR5. It will be noted that one side of the coil of solenoid SOL–2 is connected to another SCR Q1. The other side of the coil is connected to a terminal of the full wave bridge rectifier CR1. The same side of the coil which is connected to CR1 is also connected to a capacitor C1 which is coupled through a diode CR4. A transformer T1 is coupled to capacitor C1 through diodes CR2 and CR3. Transformer T1 serves to charge up the capacitor C1 continuously. At the same time, a charging current is also provided by the bridge CR1 through the diode CR5 and resistor R2. It will be noted that capacitor C2 also couples the SCR's Q1 and Q2.

In operation, a reed switch S1 which is coupled to the coil of a relay K3 upon actuation of the relay turns on SCR Q1. At the same time, the relay serves to shut off SCR Q2. It will be noted that Q2 is coupled to the bridge CR1 and will be shut off with each half cycle. It will be further noted that SCR Q1 which receives its power input from the transformer T1 in the form of a DC signal after passing through diodes CR2 and CR3 will allow a power input supplied continuously to SOL2 unless Q1 is otherwise turned off. In order to maintain an input pulse of a predetermined duration sufficient to accomplish the stapling operation, the coil of solenoid SOL–2 receives its input signal from SCR Q1 which will remain on until shut off by Q2. In order to shut off Q1, reed relay switch S1 is de-activated by de-energizing relay K3 thereby moving the reed switch from a terminal 2 to a terminal 1. At this time, a power input from the bridge CR1 is then coupled with diac CR8 which will not turn on Q2 until a sufficient voltage has been built up on capacitor C3 to turn off SCR Q1. A capacitor C4 and a resistor R10 ensure that Q1 will not turn on immediately after being turned off. The resistance of a resistor R3 is sufficient to enable the voltage build up on capacitor C2 to be completed before diac CR8 is ready to fire. By this arrangement, when Q2 turns on, Q1 will be turned off and coil of the solenoid SOL–2 will be de-energized ensuring that the stapling head assembly is returned to its rest position ready to commence another cycle. To discharge the

transient from the inductance of the solenoid coil when SCR Q1 is turned off, a resistor R4 and a diode CR6 are provided.

SIDE STACKING AND OUTPUT RECEIVING TRAY ASSEMBLIES

Side stacking assembly **76** cooperates with output receiving tray assembly **78** to stack sheets in separately identifiable bundles instead of in stapled booklets at the option of a machine operator. Tray assembly **78** includes a tray **401** positioned at about a 7½° angle to the horizontal to facilitate receiving sheets fed along the transport path. Tray **401** is mounted in the frame for sliding movement in a vertical plane on slide shaft **403**. The tray is lowered as the sheets are received to maintain a uniform level with the transport path by an elevator control system **404** as will be described hereinafter.

The level of tray **401** is controlled by elevator control system **404**. Elevator control system **404** includes a pair of lamps **450** and **451** and corresponding phototransistors **453** and **454**, respectively, and an associated control circuit to be described including a reversible motor MOT–3. To move the tray the motor MOT–3 is energized to rotate a pulley **457** which carries a cable **459** connected to slide shaft **403**. On the down movement during the side stacking operation, motor MOT–3 is only energized in brief intervals to effect incrementally lowering the tray due to a braking action on the motor when power is shut off. Level control is effected by signals received from phototransistors **453** and **454** which provide signals to the control circuit when darkened. It will be noted that lamps **450** and **451** direct a beam of illumination across the top leading edge of the sheets toward their corresponding phototransistors. By this arrangement, the tray is caused to be lowered until such time as light is received by the phototransistors at which time power to motor MOT–3 will turn off.

Side stacking assembly **76** serves to stack the sheets into shingled or offset bundles on tray **401**. The side stacking assembly comprises a pair of pivotable paddle wheels **415** and **417** which are similar in construction to paddle wheel **209**. Paddle wheel **415** has blade members **419**, **420**, and **421** and paddle wheel **417** comprises blade members **423**, **424** and **425**. Paddle wheels **415** and **417** are mounted on a shaft **427** which is driven by a motor MOT–2 through the pulley **429** which receives a belt **431** which is wrapped around another pulley **433** mounted on the shaft **427**. In this manner, the paddle wheels **415** and **417** are continuously rotated so that the blade members are advanced into contact with the topmost sheet received on tray **401** such that a sideways and ahead movement is imparted to the sheet as previously described in the case of paddle wheel **209**.

Each of the paddle wheels **415** and **417** may be alternately positioned to contact with the sheets advanced onto the tray depending upon whether the sheets of the topmost bundle are to be stacked on the left of the tray. To accomplish this, the shaft **427** is supported in a frame **435** which is suspended from a similar frame **437** on a pivot pin **439**. Secured on one end of the frame **435** is actuating arm **441** which is connected to a solenoid SOL–4. Upon receiving a signal as will be described hereinafter, solenoid SOL-4 actuates arm **441** to cause the frame **435** to pivot on pivot pin **439** so that paddle wheel **417** is in contact with the sheets received onto the tray causing them to be stacked to one side. At the proper interval, solenoid SOL-4 is de-energized which causes frame **435** to pivot due to the weight of motor MOT–2 and paddle wheel **415** to be placed into contact with the oncoming sheets resulting in stacking towards the opposite side. By repeating this sequence, offset stacks or bundles are formed of the sheet material received onto the tray.

MACHINE OPERATION

An understanding of the machine operation of the finishing apparatus may best be understood in connection with the circuit diagrams in FIGS. **19** to **21** and the finishing apparatus control panel in FIG. **1***a*. The processor has a control section for the finishing apparatus for selecting the mode of operation of the finishing apparatus in either the stapling mode or the side stacking mode. On the control panel are switches **S10** and **S11** for machine operator to select one of the two modes of operation. Also included in the control panel are indicator lamps **L10** and **L11** to indicate when the finishing apparatus is in either of these modes of operation. A clear switch **S13** is provided to enable the finishing apparatus selection to be dropped if the processor is in a standby mode or if it is in a hold mode such as in the case of a jam. Also included on the control panel is a lamp **L12** to indicate a jam has occurred at the finishing apparatus and a lamp **L13** to indicate that either of the input or output receiving trays is in a overflow condition with too much sheet material received therein. Another lamp on the control panel **L14** indicates that there is a misregistration between the paper size of the processor and the finishing apparatus and also a lamp **L15** to indicate a low staple condition in the stapling head assembly. When the processor is turned on the finishing apparatus receives power through a relay K1. To actuate relay K1 power is received from a low voltage power supply **701** which serves to energize a coil to pull in a contact K1 of the relay K1 which allows power to be received by A/C drivers **705**. The low voltage power supply **701** also provides power to D/C drivers **707** and a control logic **709** coupled to the D/C received by A/C drivers **705**. When the contact K1 of relay K1 is closed, power is available to the eject motor MOT–1, paddle wheel motor MOT–4, the elevator motor MOT–3, the side stack paddle wheel motor MOT–2, the eject solenoid SOL–3, the side stack solenoid SOL–4, the lamp drive transformer T2, and the transformer T1 and bridge rectifier CR1 of the staple drive circuit.

In the stapling mode of operation, the staple switch **S10** of the control console is depressed. When the processor commences printing, control logic **709** supplies a signal to a driver **705** which energizes a relay K2. Relay K2 energizes contact K2 which turns on motors MOT–1, MOT–2, MOT–4, and transformer T1 and bridge rectifier CR1. When this occurs the copies from the processor entering the finishing apparatus are received on the input receiving tray **105** and each copy contacted by the paddle wheel **209** which then urges the copy sheet forward and to the left against the guide **107** and the registration gate **207**. Succeeding copies are fed on top of the preceding sheets by the paddle

wheel 209 which is driven by the motor MOT–4. When the last sheet of a stack is received in the tray, the control of the processor indicates that this condition exists to the control logic 709 which then actuates a relay K3. When relay K3 is actuated, Q1 of the staple driving circuit is turned on and the coil of the solenoid SOL-3 energized which causes the stapling head assembly to be actuated into a stapling operation. When this occurs, a staple from the staple roll is severed and fastened to the sheets. Relay K3 is then de-energized turning on SCR Q2 which, in turn, turns off SCR Q1 to de-energize the coil of the solenoid SOL–3 which returns the stapling head assembly to its rest position and at the same time advances the feed of the staple roll to position the next staple for the next stapling operation due to the action of staple feed finger 357. When the staple head assembly starts to return to its rest position, the control logic 709 provides a signal to a driver 711 which is coupled to the gate solenoid SOL–1. When SOL–1 is energized, gate 207 is retracted in an upward position out of the path of the sheets. At the same time, a signal is provided to the coil of solenoid SOL–3 which is energized by a driver 721 which is energized by driver 723. When this occurs, eject rolls 380 and 381 are actuated against the idler rolls 393, 394 to eject the stapled stack of sheets in a direction toward the output receiving tray 401. Exit rolls 390, 391 and idler rolls 396 and 397 cooperate to maintain control of the sheets along its transport path into the receiving tray as they leave the eject rolls 380 and 381. As the stacks of sheets which are now stapled booklets are received by the receiving tray 401, the tray is lowered incrementally to maintain the level of the topmost sheet on the tray at a predetermined height with the transport path. Paddle wheel 415 contacts the stapled stacks to help guide the sheets into the output receiving tray.

In order to ensure that the receiving tray 401 is lowered at the proper time intervals, there is a control circuit coupled to elevator motor MOT–3 which is energized when a coil of relay K4 is energized to pull in a contact K4. In order for the control logic 709 to provide a signal to a driver 727 for energizing relay K4 a signal is received from a sheet stacking sensing circuit 730 which includes phototransistors 453 and 454 which receive illumination from lamps 450 and 451, respectively. Illumination from the lamps 450 and 451 is such as to impinge on the phototransistors 453 and 454 when the tray 401 is at the proper elevation. Thus, the sheets start to collect, the path of illumination is blocked and the resistance of the phototransistors increased. When this occurs, an output signal is generated to operational amplifier 741 which is set at a voltage level to provide an output signal to the control logic 709. It will be noted that for this condition to occur, both of the phototransistors 731 and 733 must be blocked for a resistance increase to occur in both before and output signal is sent to control logic 709. Desirably, lamp 451 is turned off during the stapling mode since the thickness of the staples on the same side assures reliable operation with lamp 450 only. Motor MOT-3 has a brake which normally engages when power is not received as known by those skilled in the art. In this manner, the movement of the tray is incremental to provide a smooth reliable operation in a downward direction.

For a side stacking mode of operation, side stack switch S11 on the control panel is pressed. When this occurs, the eject roll motor MOT–1, is energized to rotate eject rolls 380 and 381 and the side stack motor MOT–2 energized to rotate paddle wheels 415 and 417 through a closing of a contact K2 which is caused when a relay K2 is energized from control logic 709. At the same time, a signal is received by the gate solenoid SOL–1 to pull the gate into an upward position out of the path of the sheets. At the same time, a signal is received by a relay K7 to close a contact K7 to energize eject solenoid SOL–3. As sheets are received in the receiving tray 205, the sheets are advanced by the eject rolls 380, 381 and the exit rolls 390 and 391 to feed the sheets directly to the output receiving tray 399. As the sheets are fed through the exit rolls, the sheets are driven sideways to the right by the side stack paddle wheel 417. A signal is received from the processor to control logic 709 to cause a signal to be sent to a relay K8 which when energized closes a contact K8 to energize solenoid SOL–4 which, in turn, causes the side stack paddle wheel 417 to be lowered into contact with the sheets and side stacked bundle commences. At the completion of the run, solenoid SOL–4 is de-energized and the side stack paddle wheel 415 lowered due to its weight into contact with the sheets causing the side stack paddle wheel 417 to be raised.

By continued actuation and de-actuation of the solenoid SOL–18 in accordance with the control logic, the sheets received onto the output receiving tray are stacked to the left or to the right to form offset bundles or stacks corresponding to the input information received by the processor. Tray 401 is incrementally depressed downwardly in the same manner as described in connection with the stapling mode of operation except when stacking with paddle wheel 415, both lamps 450 and 451 0425 energized. When stacking with paddle wheel 417, lamp 450 is energized only as in the case of the stapling operation for a more reliable operation. Upon completion of a run in either the stapling mode or the side stacking mode, control logic 709 de-activates relay K2 which, in turn, opens a contact K2 to de-energize eject roll motor MOT–1, paddle wheel motor MOT–4 and the side stack motor MOT–2. At the same time, if in the side stack mode of operation, relay K7 is de-energized to open a contact K7 to de-energize the solenoid SOL–1 for eject rolls and solenoid SOL–3 for returning the gate to a rest position.

A signal is then supplied to a solenoid SOL–5 which serves to release the cover 52 from its locked condition against the action of springs 57. It should be noted that when the cover solenoid SOL–5 is energized, the cover is released to a position slightly above the level of its normally closed position which then causes the solenoid SOL–5 to be de-energized by control logic 709. The machine operator then raises the cover 52 to its fully open position closing a switch S5 causing a relay K5 to be energized which closes a contact K5. When contact K5 closes, this energizes motor MOT–3 to reverse its drive and raise the tray 401 to its fully elevated position in which the sheet material is brought directly upward to facilitate the removal thereof from the finishing apparatus. When the tray 401 reaches its original starting position, the relay K5 is de-energized by the control logic 709 to open contact K5 thereby de-energizing motor MOT–3.

JAM DETECTION

Jam detection is provided for in the control circuit by a level detecting circuit **775** which serves to signal control logic **709** when sheets are present in the vicinity of the gate **207**. To accomplish this, a lamp **777** is positioned in the sheet path to provide illumination toward a phototransistor **779** which is coupled to an operational amplifier **781**. When sheets are present in the sheet path, illumination from lamp **777** is blocked and the resistance of phototransistor **779** increased which causes the operational amplifier **781** to increase in voltage resulting in a change in state on the output side of the operational amplifier. When this happens, control logic **709** times out to indicate that a jam has occurred in the finishing apparatus and supplies a signal to the processor to turn it off. Also, the control circuit includes a low staple detect circuit **785** which serves to indicate to the control logic **709** when a low staple condition has occurred in the staple head assembly. To accomplish this, a lamp **787** is positioned to provide illumination to a phototransistor **789** when the staple roll shows no staples are present which causes the resistance of the phototransistor **789** to increase and the output condition of an operational amplifier **791** to change which condition is indicated to the control logic **709**.

Control logic **709** includes a counter for counting the sheets transported along the sheet path into the finishing apparatus so that an overflow condition can be detected. When this occurs, a signal is supplied to the processor apparatus to indicate that an overflow condition exists to turn the processor off.

What is claimed is:

1. Stapling apparatus comprising

tray means including side guide members for receiving sheet material along a predetermined path,

gate means positioned adjacent said tray means operative to move from one position in the sheet path to block the movement of sheet material therealong to a second position out of the sheet path in response to discrete electrical signals,

stapling means operative for driving staples one at a time into sheet material collected and held in registration by said gate means and said tray means in response to discrete electrical signals,

eject means to eject a stapled pile of sheet material upon actuation of said gate means to a position out of the sheet path, and

circuit means to control the operation of said gate means, stapling means and eject means in a predetermined sequence.

2. Stapling apparatus comprising

tray means including side guide members for receiving sheet material along a predetermined path,

gate means positioned adjacent said tray means operative to move from one position in the sheet path to block the movement of sheet material therealong to a second position out of the sheet path in response to discrete electrical signals,

stapling means operative for driving staples one at a time into sheet material collected and held in registration by said gate means and said tray means in response to discrete electrical signals,

eject means to eject a stapled pile of sheet material upon actuation of said gate means to a position out of the sheet path,

circuit means to control the operation of said gate means, stapling means and eject means in a predetermined sequence, and

a rotating paddle member positioned in the sheet path in front of said gate means for imparting a force on said sheet material at right angles to the path against a one of said guide members.

3. Apparatus according to claim **1** where said side guide members are adjustable to accommodate different size sheet material transported along the sheet path.

4. Apparatus according to claim **3** including an output receiving tray means positioned to receive stapled piles of sheet material from said eject means and operative to lower continually to maintain a constant level with the sheet path as the sheet material is collected thereon.

5. Apparatus according to claim **4** wherein output receiving tray means includes adjustable side guide members operatively connected to said side guide members of said tray means for movement in conjunction therewith.

6. In a copying apparatus for producing stapled piles of copies from documents advanced from a supply source to a copier platen and then returned to the supply source in repeated cycles, and improved stapling apparatus for stapling the copies in sets corresponding to the documents being copied comprising

tray means including slide guide members for receiving sheet material along a predetermined path,

gate means adjacent said tray means operative to move from one position in the sheet path to a second position out of the sheet path in response to the discrete electrical signals,

stapling means operative to drive staples one at a time into a pile of sheets collected in registration by said gate means and tray means in response to discrete electrical signals,

eject means to eject a stapled pile of sheets upon said gate means being moved to a position out of the sheet path,

circuit means to control said gate means, stapling means and eject means in timed sequence with the operation of said copier machine, and

a rotating paddle member positioned in the sheet path in front of said gate means for imparting a force on said sheet material at right angles to the path against a one of said guide members.

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