United States Patent

Turner et al.

[15] **3,682,328**

[45] **Aug. 8, 1972**

[54] TRAY APPARATUS

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

[21] Appl. No.: **70,734**

[52] **U.S. Cl.** ..... **214/6 H**, 271/88

[51] **Int. Cl.** **B65g 57/03**

[58] **Field of Search** ...214/6 DS, 6 H, 6 DK, 6 P, 6 N, 214/6 D; 271/88, 86

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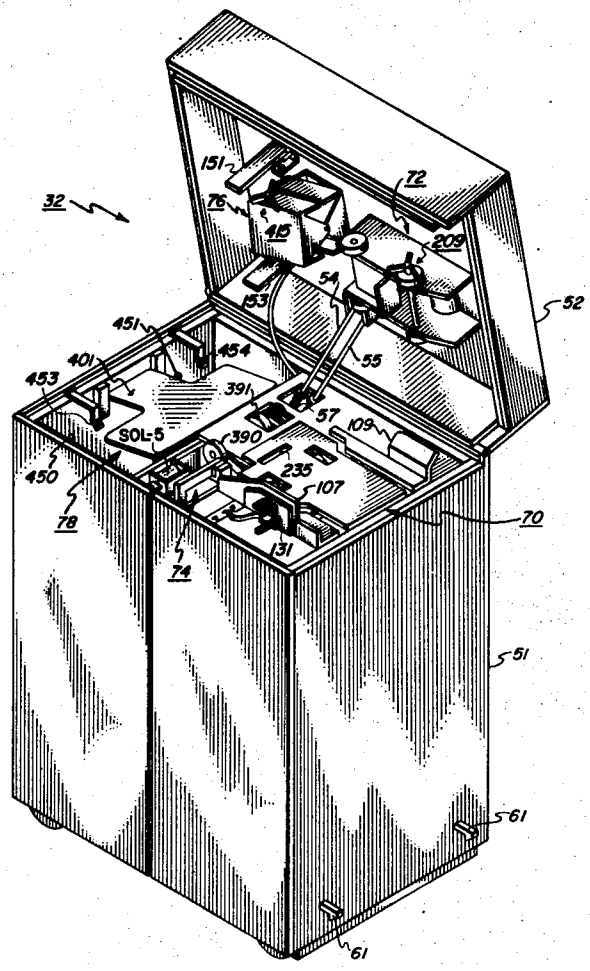
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[57] **ABSTRACT**

Tray apparatus for receiving sheet material along a predetermined path and which lowers incrementally in response to a sensing circuit including a motor which lowers a tray member to maintain a constant level of the top sheet received with the sheet path. Two lamp and photodetector pairs serve to sense the level of sheet material received on the tray member and signifies when the tray member is to be lowered. The motor is reversible to return the tray member to its starting position for unloading the sheet material when full.

5 Claims, 13 Drawing Figures



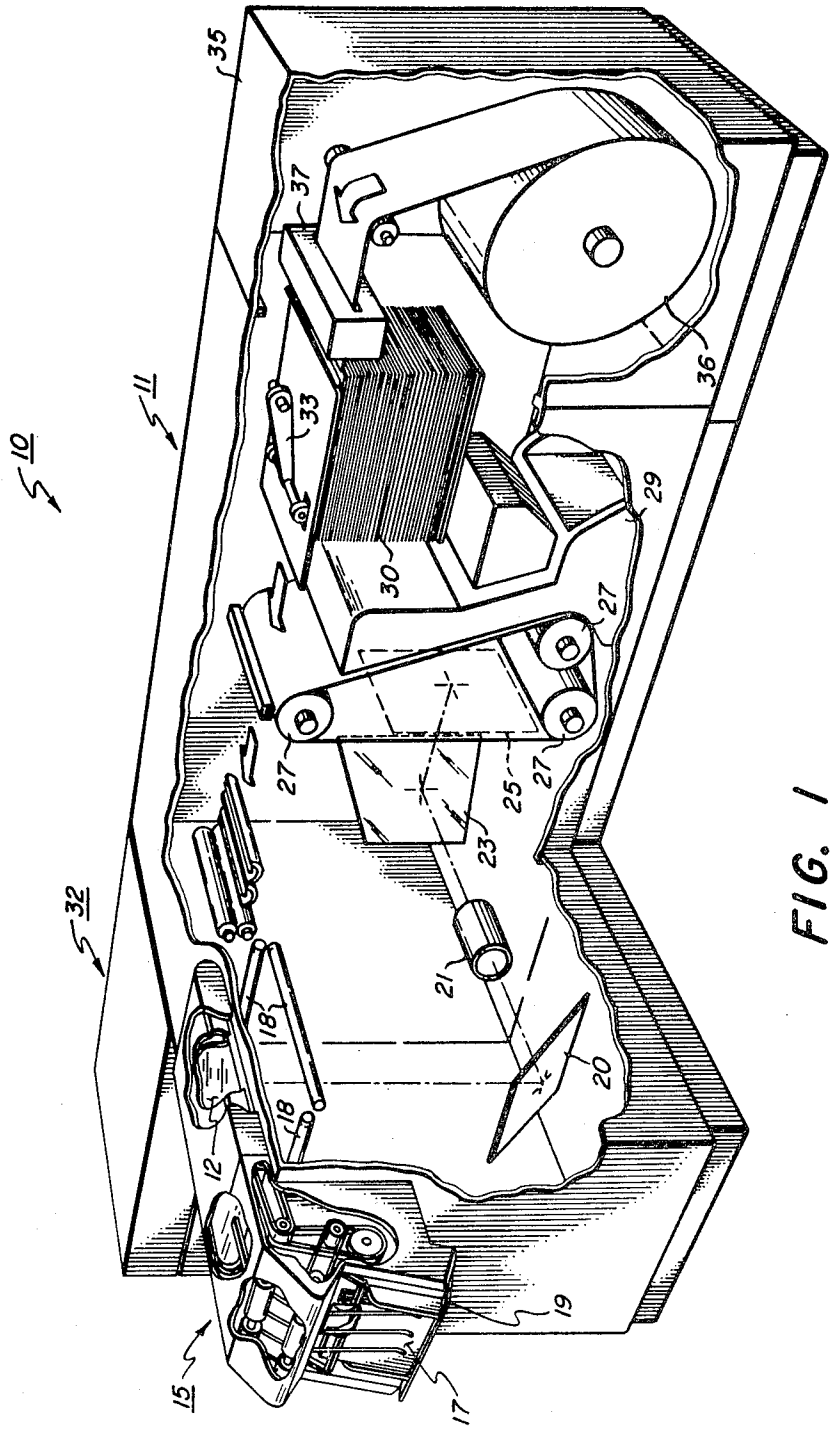


FIG. 1

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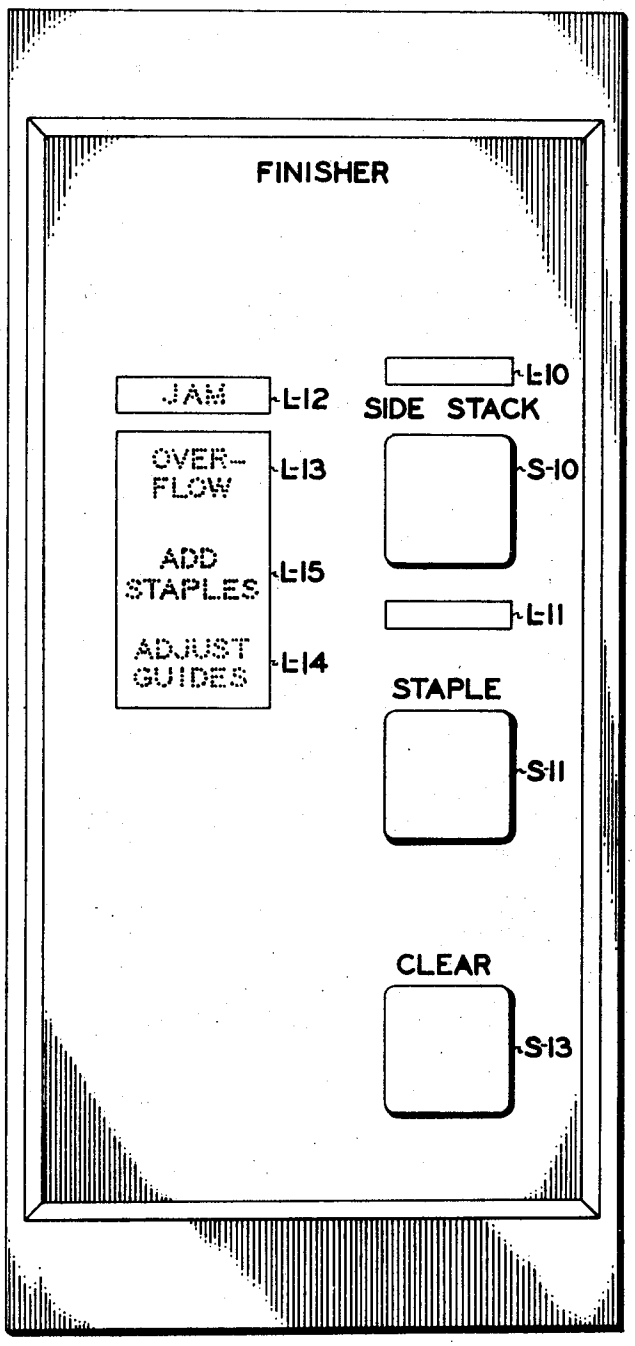

FINISHER
JAM
L-12
OVER-FLOW
L-13
ADD STAPLES
L-15
ADJUST GUIDES
L-14
L-10
SIDE STACK
S-10
L-11
STAPLE
S-11
CLEAR
S-13

FIG. 1a

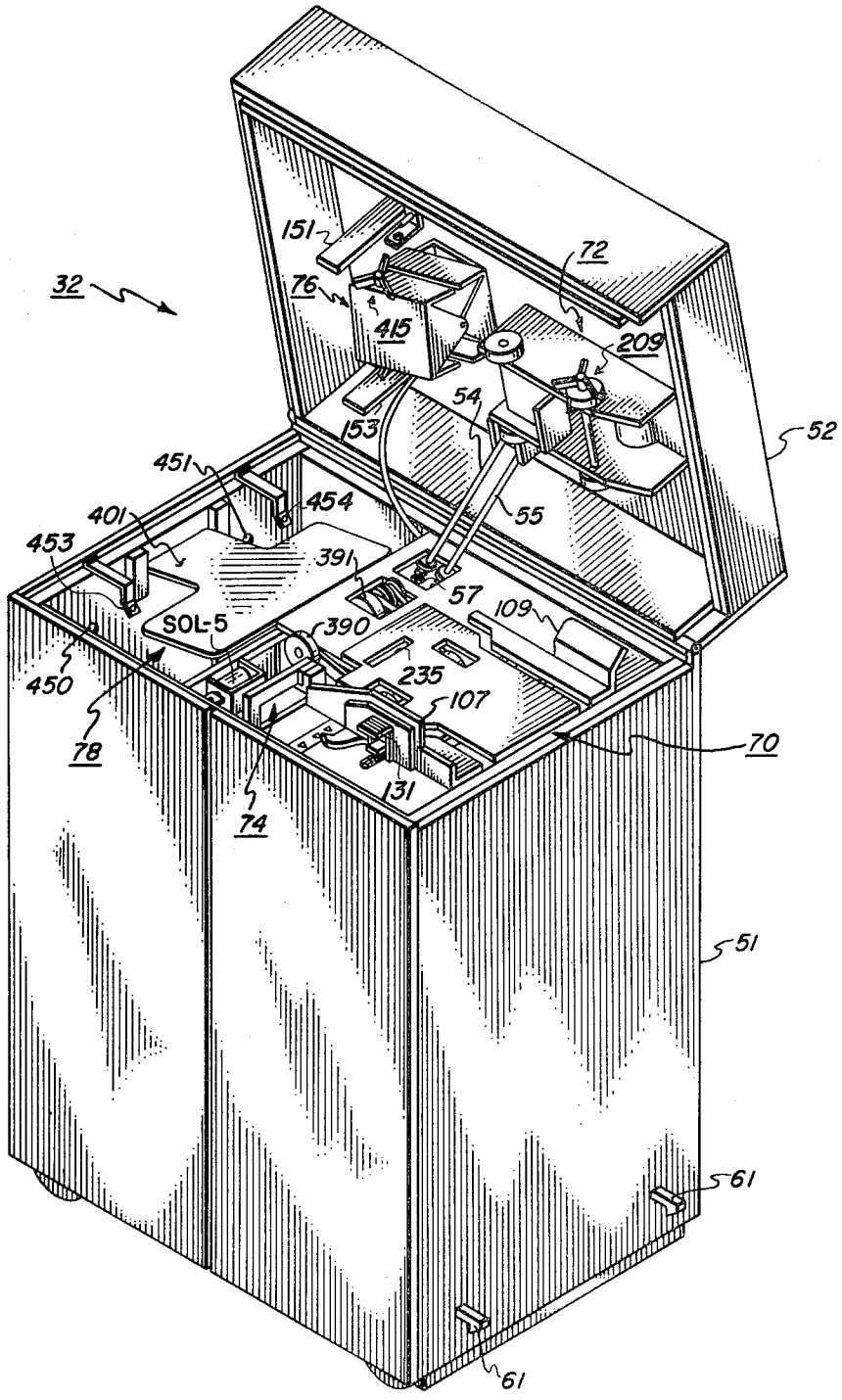

32
151
76
72
415
209
54
153
52
451
454
55
401
453
391
57
109
SOL-5
390
450
235
107
78
70
74
131
51
61
61

FIG. 2

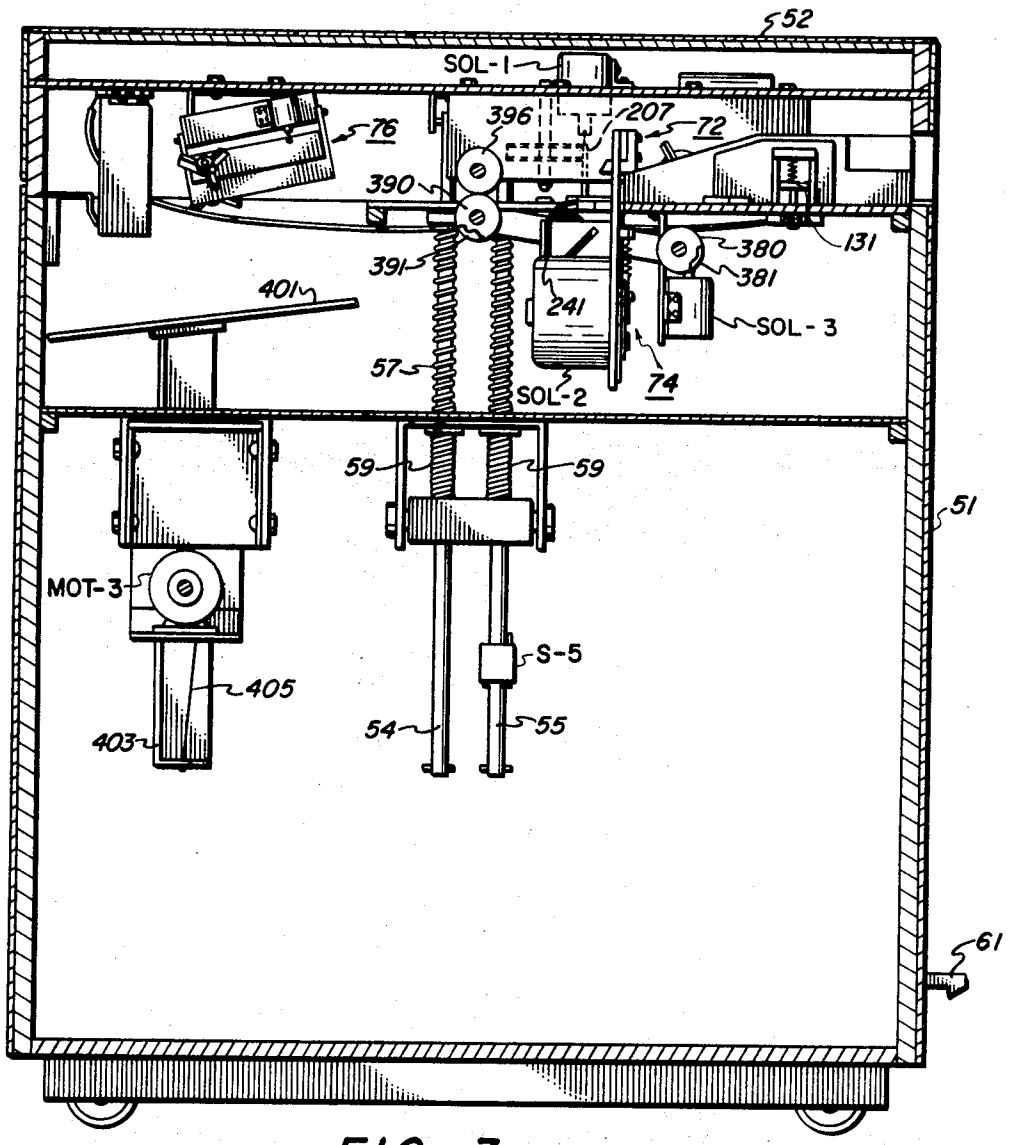

52
SOL-1
76
396
207
72
390
131
380
391
381
401
241
SOL-3
57
SOL-2
74
59
59
51
MOT-3
S-5
405
403
54
55
61

FIG. 3

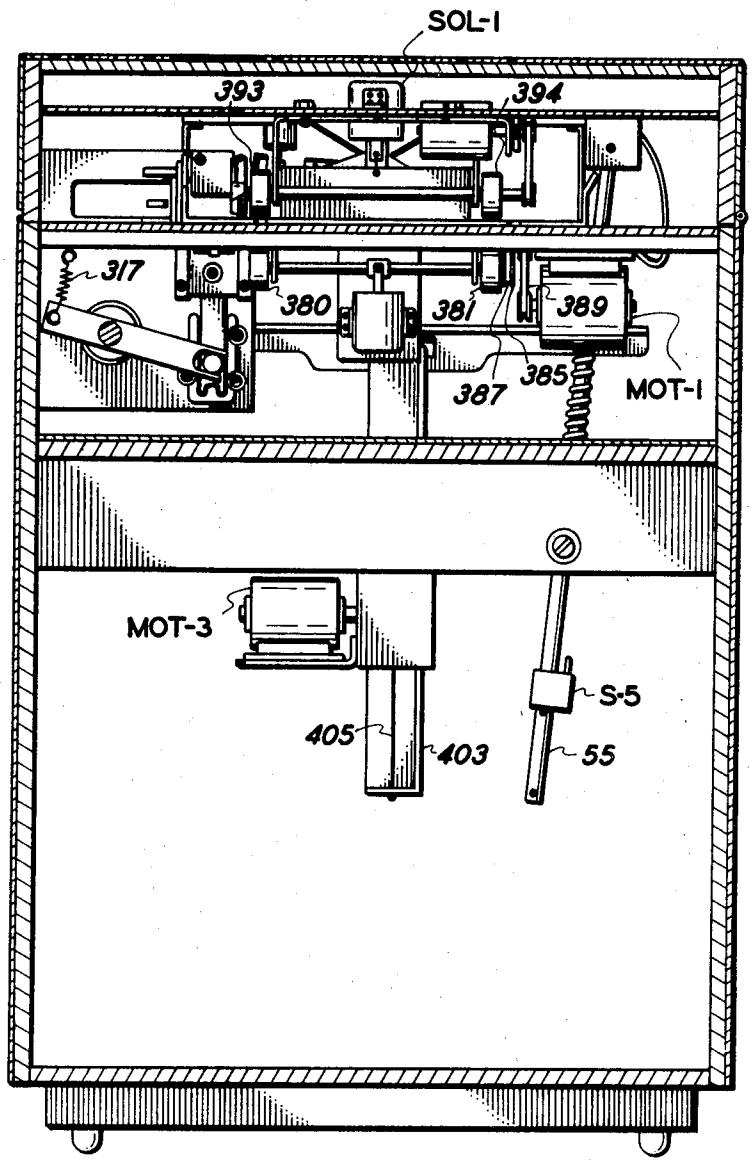


FIG. 4

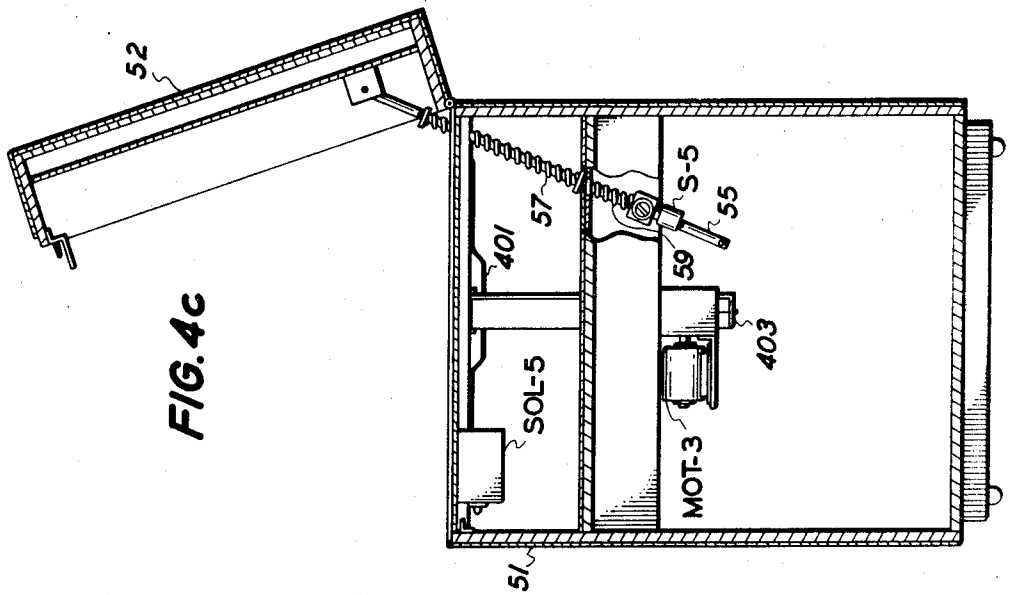


FIG. 4c

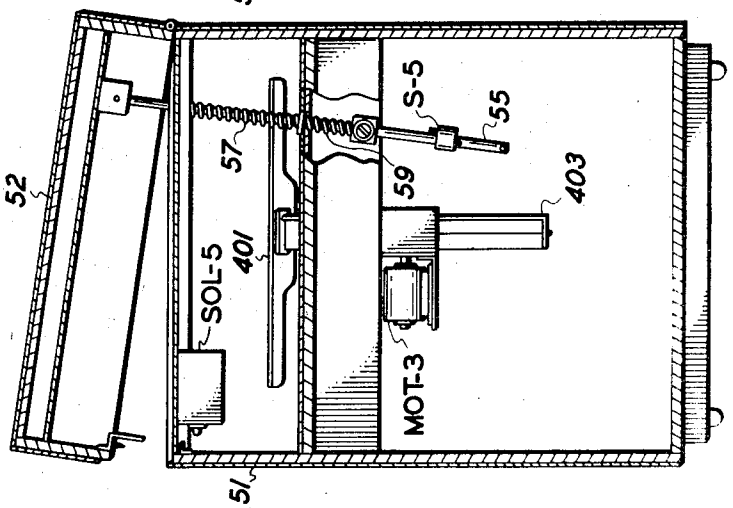


FIG. 4b

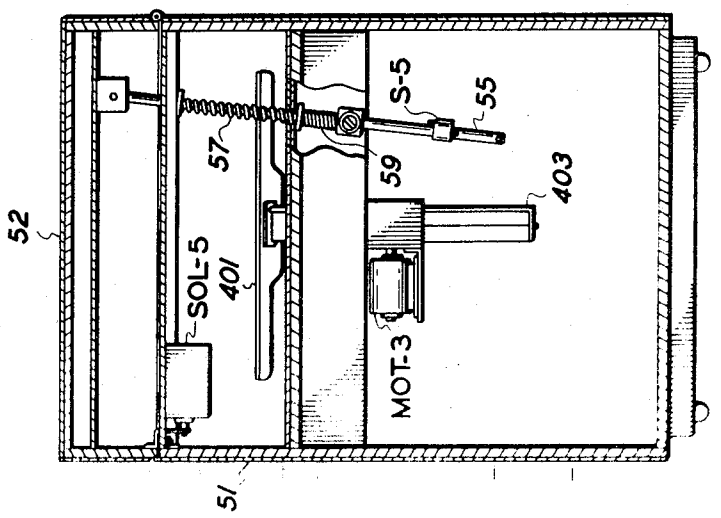


FIG. 4a

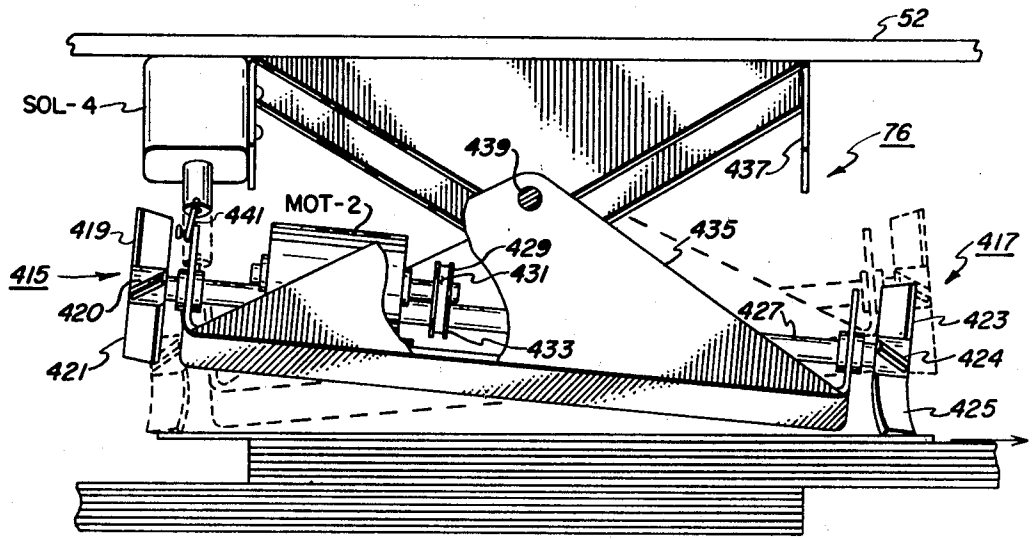

52
SOL-4
439
76
437
441
MOT-2
419
435
417
415
429
431
420
427
423
433
424
421
425

FIG. 5

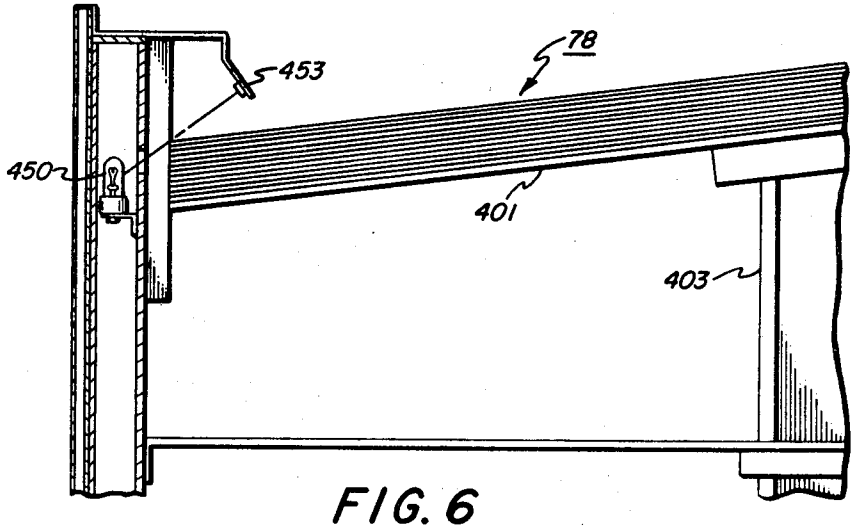

78
453
450
401
403

FIG. 6

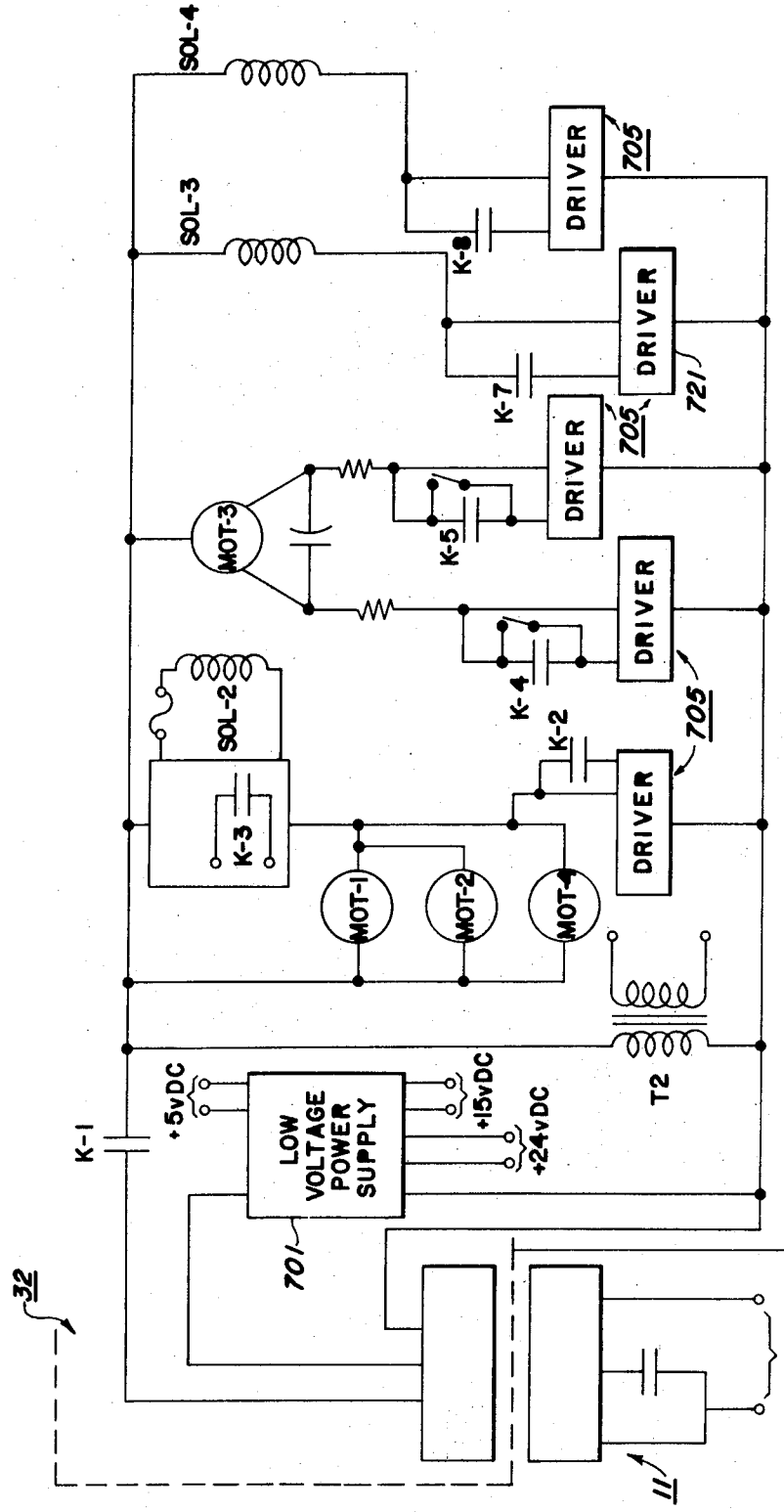

SOL-4
SOL-3
SOL-2
K-8
K-7
K-5
K-4
K-2
K-3
K-1
MOT-3
MOT-1
MOT-2
MOT-4
DRIVER
705
721
T2
+5vDC
+15vDC
+24vDC
LOW VOLTAGE POWER SUPPLY
701
32
11
115vAC

FIG. 7

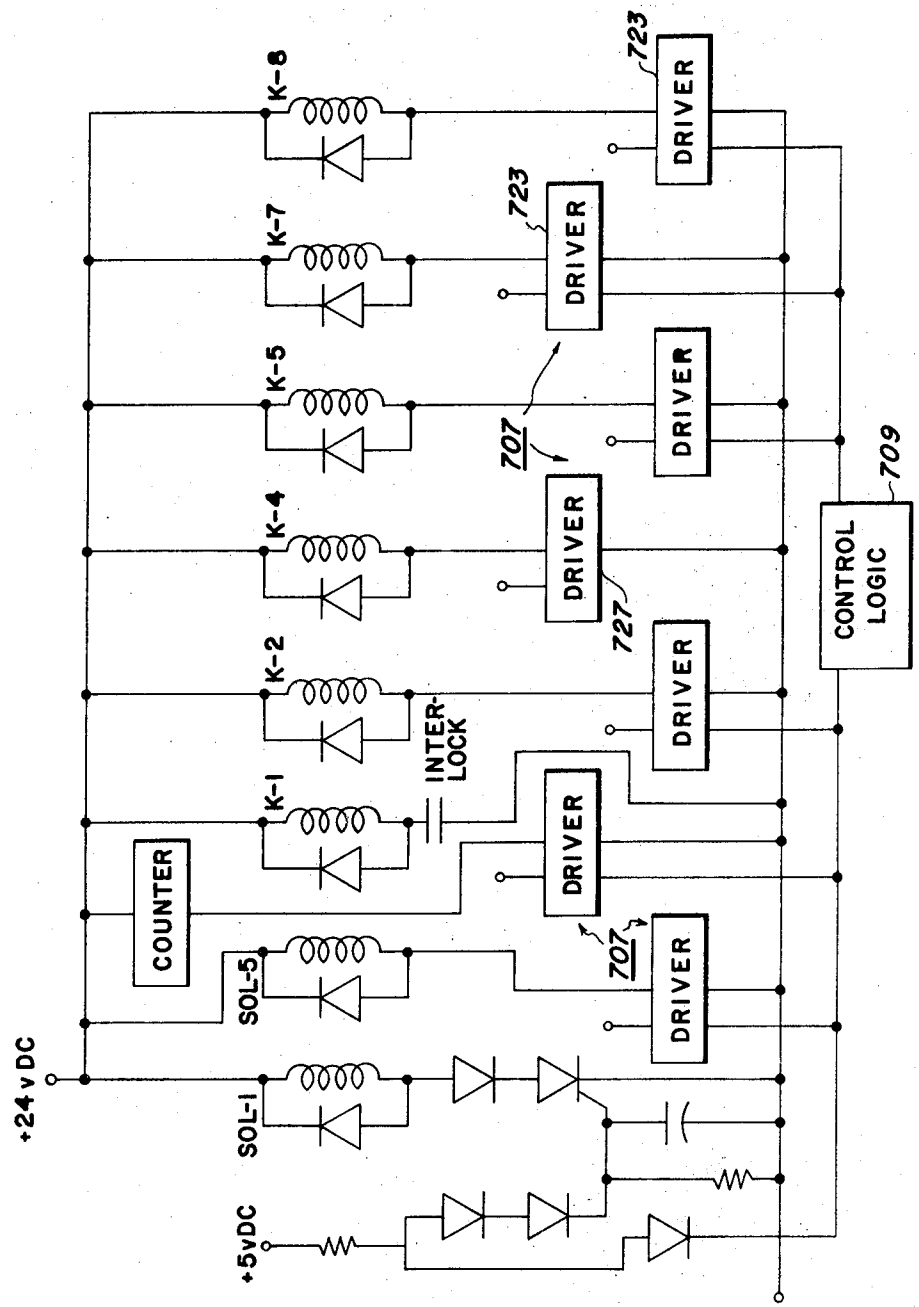

K-8
K-7
K-5
K-4
K-2
K-1
SOL-5
SOL-1
+24 v DC
+5vDC
COUNTER
INTER-LOCK
DRIVER
723
707
727
709
CONTROL LOGIC

FIG. 8

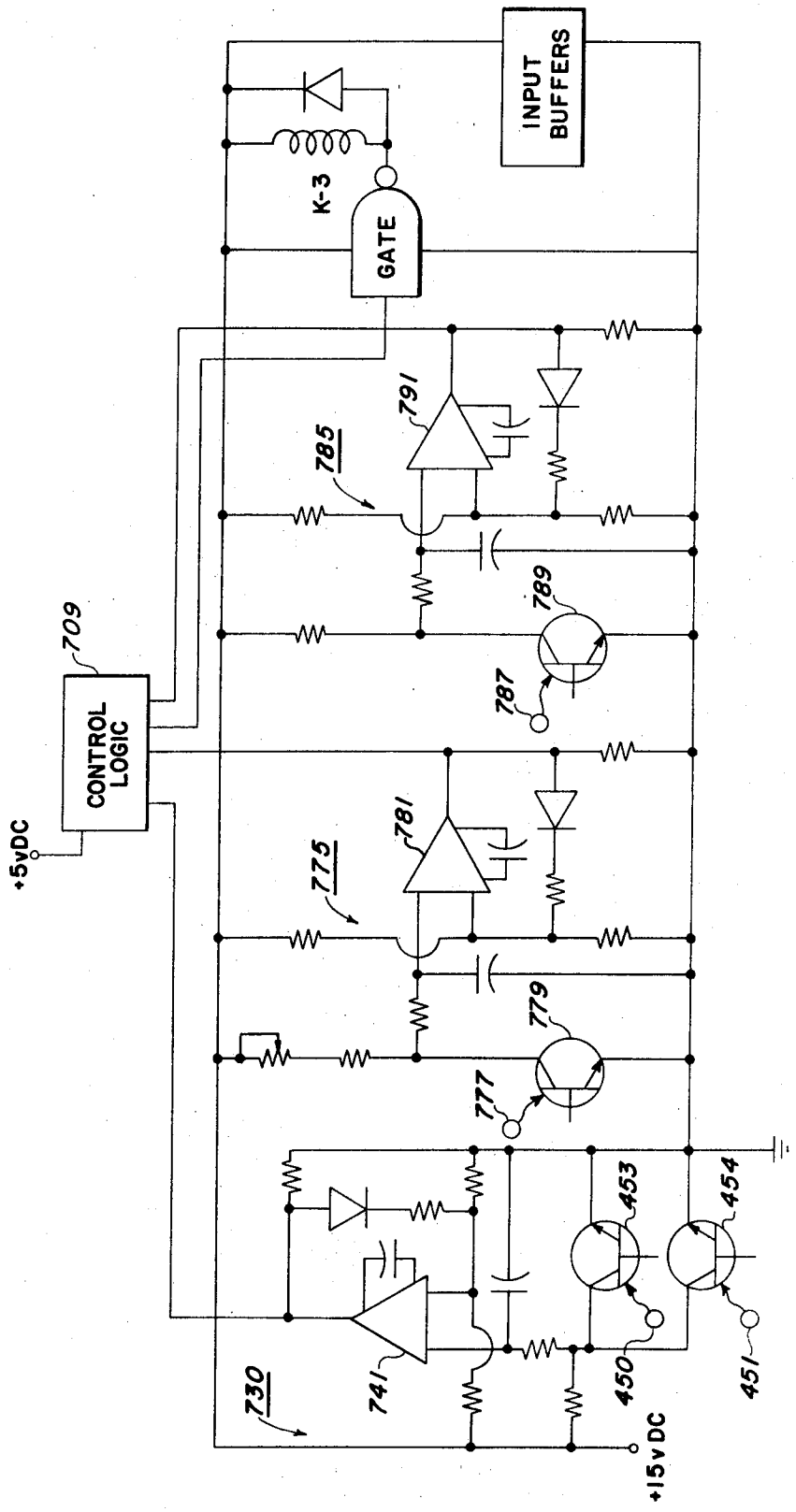

INPUT BUFFERS
K-3
GATE
791
785
789
787
709
CONTROL LOGIC
+5vDC
781
775
779
777
453
454
741
730
450
451
+15v DC

FIG. 9

TRAY APPARATUS

This invention relates to tray apparatus for receiving sheet material in booklet form or stacks and which lowers to maintain a level with the sheet path and raises to unload the sheet material.

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 assembling sheets into booklets usually requires several steps, the last of which is taking one sheet from each of the stacks and putting these sheets together in the order desired.

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

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

The present invention enables automatic assembling of sheet material into separate identifiable stacks or booklets which may be fastened into a finished form. To accomplish this, a tray apparatus accepts copy sheets from a processor in separated bundles and lowers in response to a level sensing circuit until full and then raises to unload the sheets.

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

It is another object of the present invention to stack collated sets of copy sheets from a processor in a manner more simple and cheaper than heretofore.

It is another object of the present invention to collect copy sheets from a processor into a tray capable of lowering to maintain a constant level with a sheet path in response to a level sensing circuit.

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

It is another object of the present invention to provide an elevating tray 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 an end sectional view of the finishing apparatus;

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

FIG. 5 is a side view of the side stacking assembly;

FIG. 6 is a side view of the output receiving tray assembly illustrating details of the elevation control thereof; and

FIGS. 7, 8 and 9 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, a light image of an original to be reproduced is projected onto the sensitized surface of a 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 or 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, 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-type 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 imaging 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 top 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. Nos. 731,934, filed May 24, 1968, and 756,598, filed Aug. 30, 1968, 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 sizes 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 **26**. 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 **50** 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** 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, 8 ½ × 11 paper up to 9 × 14 paper.

The staple group assembly **72** comprises a registration gate **207** 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. For a detailed description of the stapling operation, reference is made to copending application 70,735, filed on even date with the instant application and commonly assigned.

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 7 ½° 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. 7 to 9 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 S12 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 drivers. 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, a 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 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 pro-

vide 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 **451** and **453** 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** are 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. Tray apparatus for stacking paper sheet material comprising

a tray member for receiving paper sheet material transported along a sheet path,

drive means including a reversible motor drivingly connected to said tray member for lowering and raising thereof, and

cover means associated with said tray member operative to move from a first position in which sheet material is received by said tray member to a second position after the sheet material is received,

circuit means coupled to the drive means and cover means operative to actuate the motor for lowering said tray member in response to discrete signals from stack height sensing means to maintain the height of the sheet material received level with the sheet path and then to raise said tray member to its original position in response to another signal to reverse the direction of said motor upon moving said cover means from its first to its second position for unloading said tray member.

2. Apparatus according to claim 1 wherein said circuit means includes a plurality of sources of illumination each having an associated sensing device and spaced to effect sensing at different locations along the edge of the sheet material, and

wherein said circuit means includes means to cause operation of only a portion of the sources of illumination to achieve sensing at a predetermined location along the edge of the sheet material.

3. Apparatus according to claim 2 wherein said motor has a brake associated therewith to effect incremental lowering of said tray member.

4. Apparatus according to claim 3 wherein said tray member is inclined from about 5° to about 10° to the horizontal plane.

5. Apparatus according to claim 2 including stacking means associated with said tray member operative to move sheet material received thereby into identifiable stacks.

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