Sept. 24, 1968 T. P. REDDING 3,402,928

SHEET HANDLING APPARATUS

Filed Oct. 11, 1966 8 Sheets-Sheet 1

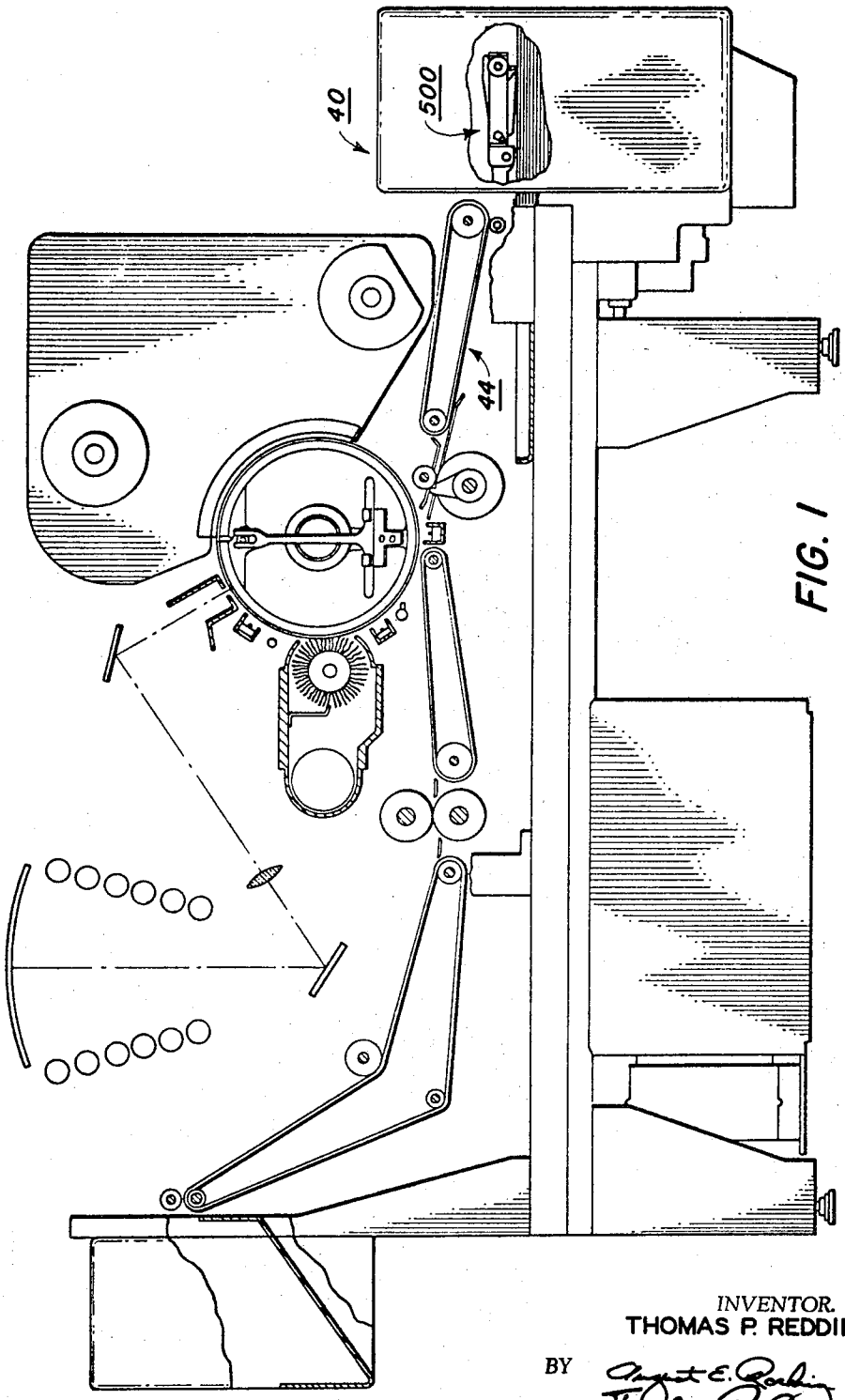


FIG. 1

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BY

ATTORNEYS

Sept. 24, 1968 T. P. REDDING 3,402,928

SHEET HANDLING APPARATUS

Filed Oct. 11, 1966 8 Sheets-Sheet 2

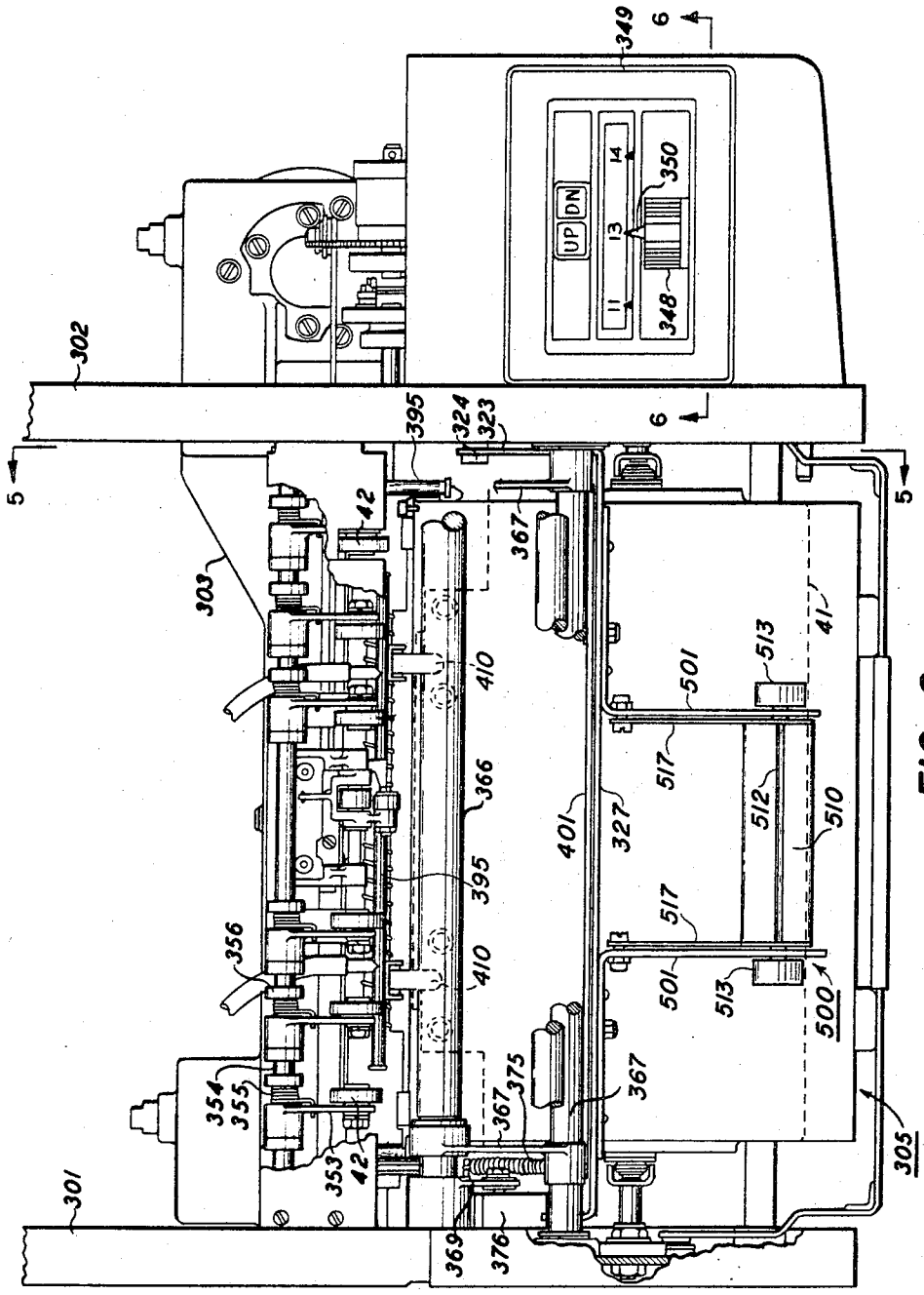


FIG. 2

INVENTOR
THOMAS P. REDDING

BY August E. Redding Jr.
Stanley Block

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Sept. 24, 1968 T. P. REDDING 3,402,928

SHEET HANDLING APPARATUS

Filed Oct. 11, 1966 8 Sheets-Sheet 3

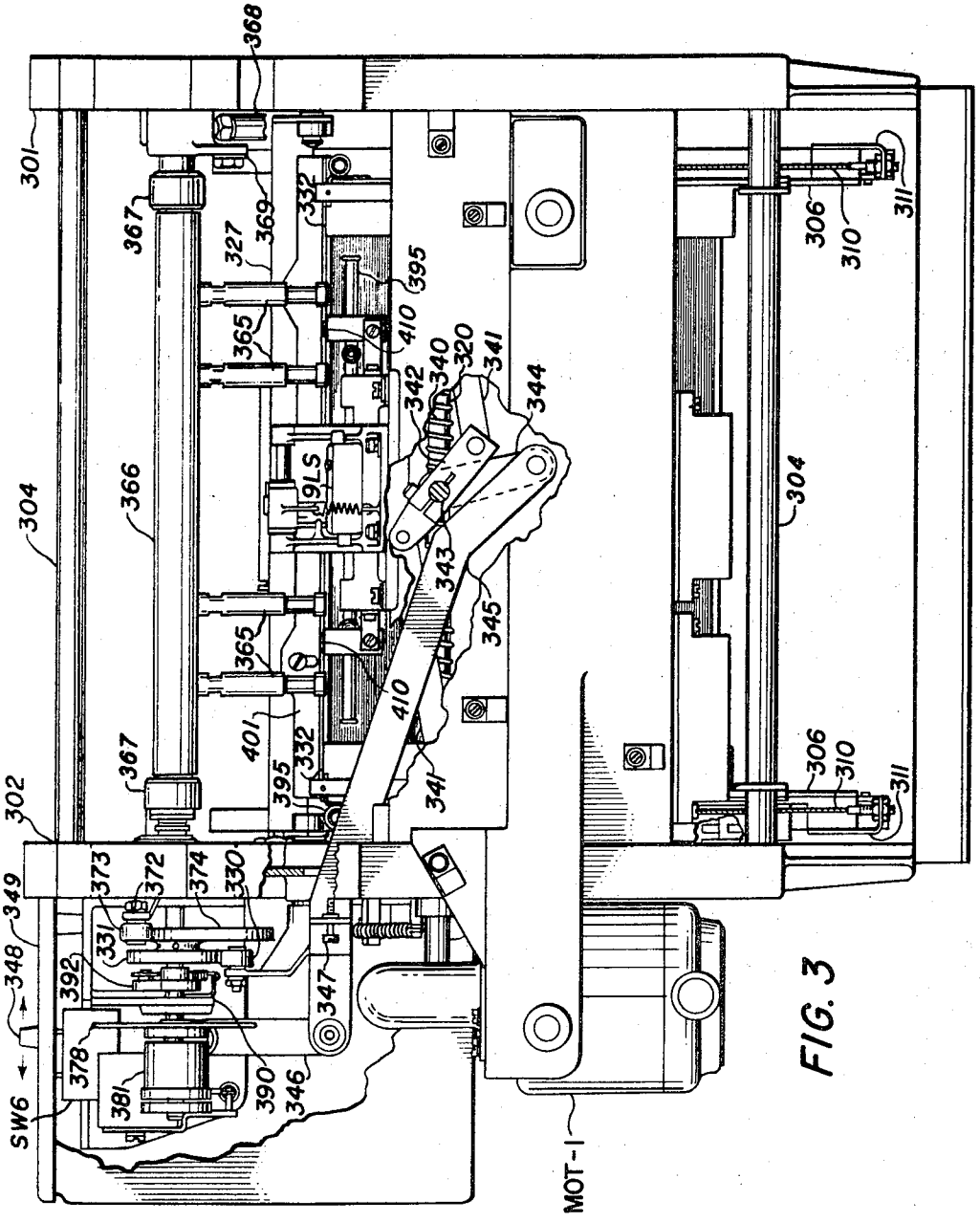


FIG. 3

INVENTOR
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BY August E. Gorling Jr.
Stanley Z. Cole

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Sept. 24, 1968 T. P. REDDING 3,402,928

SHEET HANDLING APPARATUS

Filed Oct. 11, 1966 8 Sheets-Sheet 4

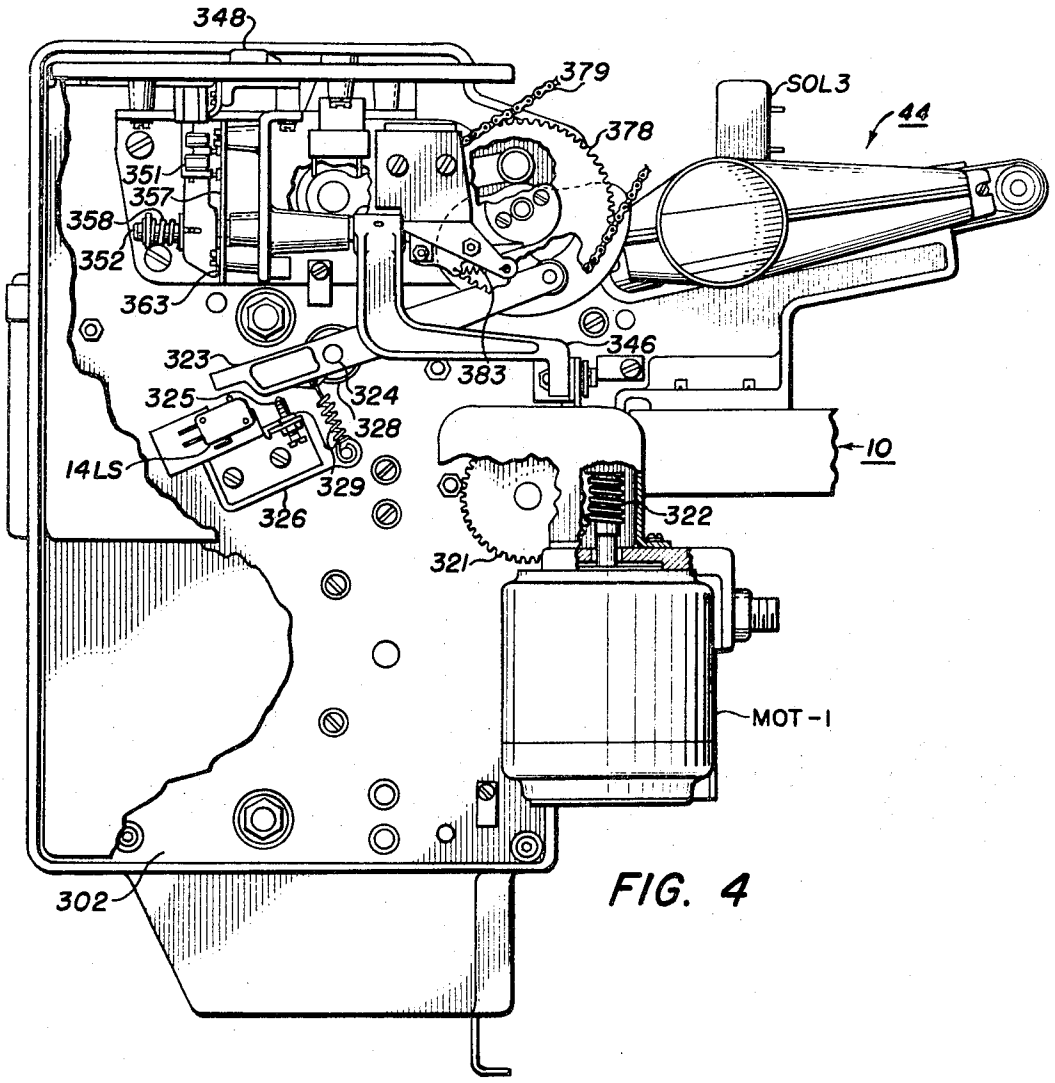


FIG. 4

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Sept. 24, 1968 T. P. REDDING 3,402,928

SHEET HANDLING APPARATUS

Filed Oct. 11, 1966 8 Sheets-Sheet 5

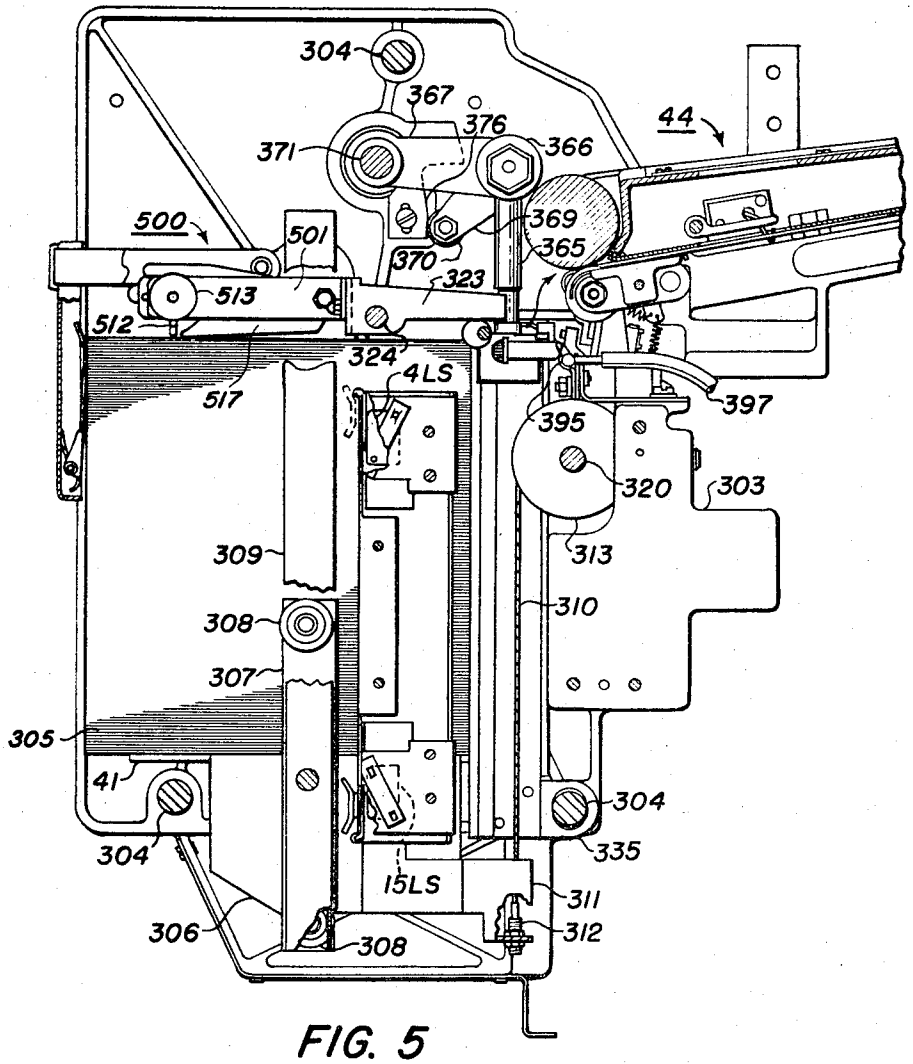


FIG. 5

INVENTOR
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BY
ATTORNEYS

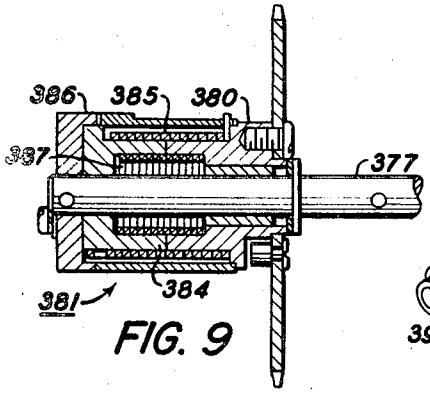


FIG. 9

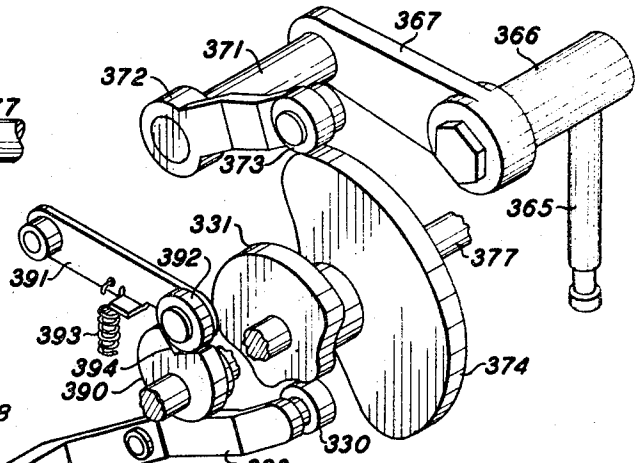
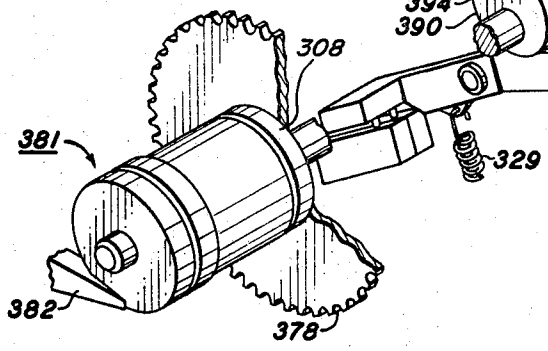


FIG. 8



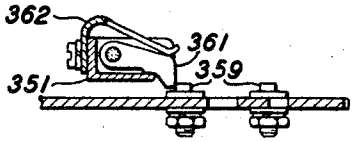


FIG. 7

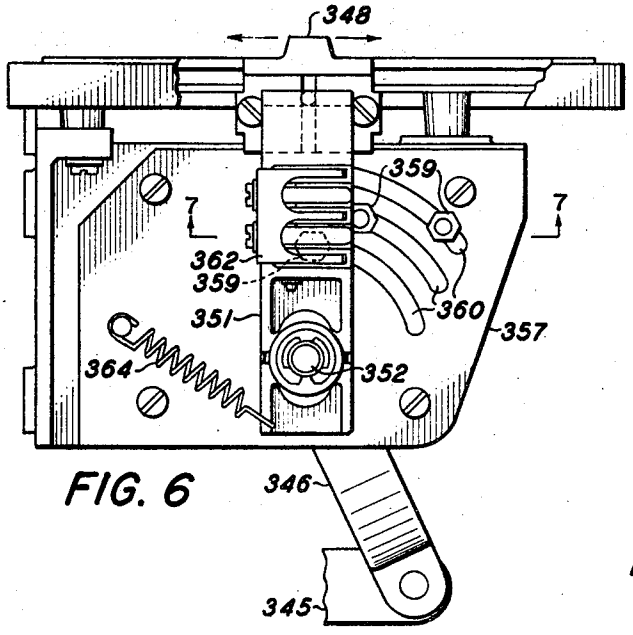


FIG. 6

INVENTOR
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BY August E. Hoffman Jr.
Stanley Zobl
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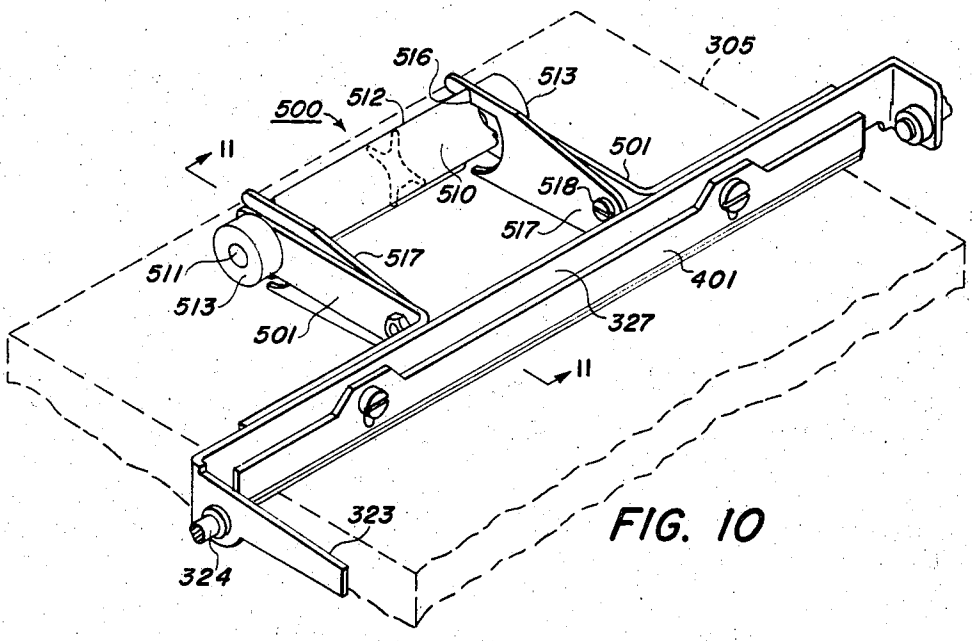


FIG. 10

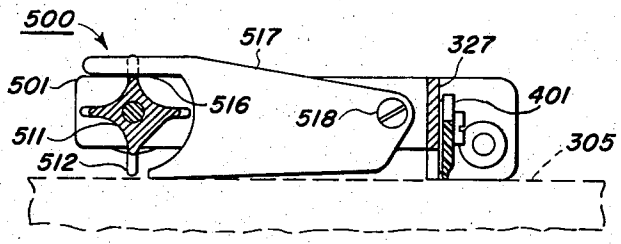


FIG. 11

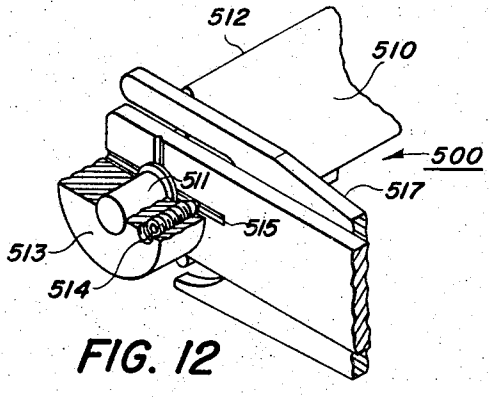


FIG. 12

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Sept. 24, 1968 T. P. REDDING 3,402,928

SHEET HANDLING APPARATUS

Filed Oct. 11, 1966 8 Sheets-Sheet 8

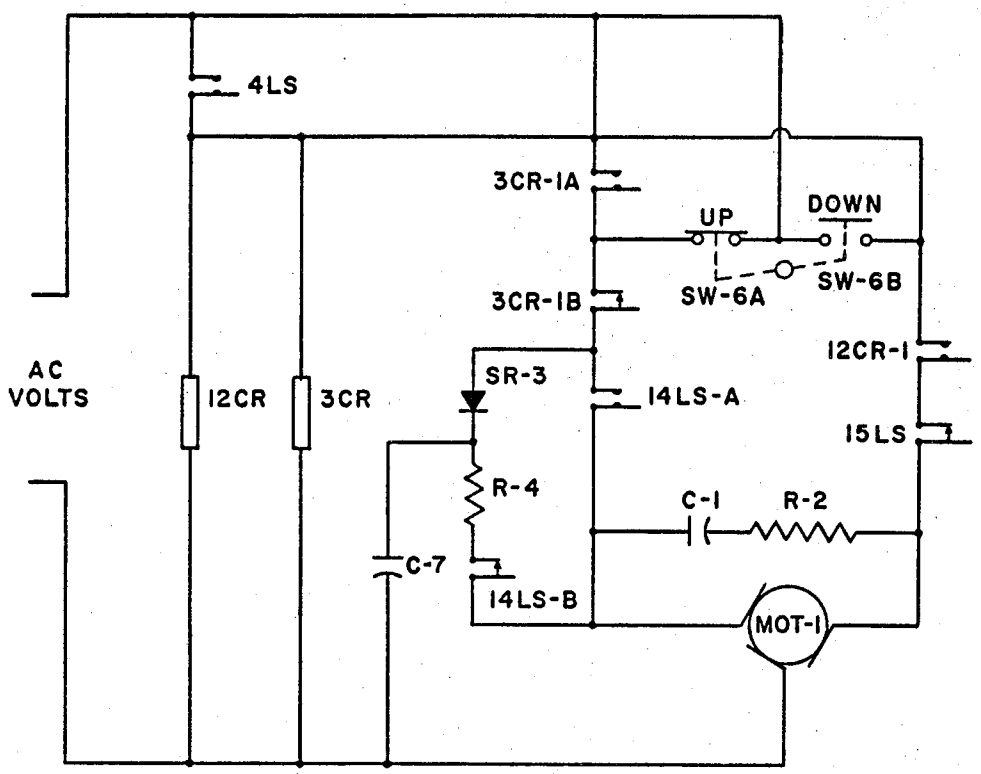


FIG. 13

INVENTOR.
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BY
ATTORNEYS

United States Patent Office 3,402,928 Patented Sept. 24, 1968

3,402,928

SHEET HANDLING APPARATUS

Thomas P. Redding, Penfield, N.Y., assignor to Xerox Corporation, Rochester, N.Y., a corporation of New York

Filed Oct. 11, 1966, Ser. No. 585,886
4 Claims. (Cl. 271—62)

ABSTRACT OF THE DISCLOSURE

Apparatus for raising a stack of sheet material so that it may be retained at a predetermined height for being sequentially transported by sheet feeding means. The apparatus includes a sheet sensor member to control a sheet elevator. The sheet sensor member oscillates into and out of contact with the topmost sheet of the stack and includes arms which support a rotatable member. The rotatable member has radial vanes of different lengths so that the height of the stack, relative to the sheet feeding means, may be controlled as a function of the vane selected to contact the topmost sheet of the stack.

This invention relates in general to paper handling apparatus and, in particular, to a sheet feed mechanism for seriatim feeding quantities of sheet material wherein the thickness of individual sheets comprising a substantially homogeneous quantity of sheet material varies with respect to separate quantities.

More specifically, this invention relates to a sheet feed mechanism having an improved sensor bail for controlling the operation of a pack advancer and enabling various thicknesses of sheet material to be fed by the sheet feed mechanism throughout extreme ambient environmental conditions. The invention of this application is particularly well adapted to be used in cooperation with a xerographic reproducing machine such as that disclosed in copending application Ser. No. 400,542, filed Sept. 30, 1964, now Patent No. 3,301,126, in the name of R. F. Osborne et al. and for convenience of illustration will be described with reference to its use therein, but it is not intended to be limited thereto.

In xerographic reproducing machines of the type disclosed in the above-reference copending application, it is necessary that the mechanism be operable throughout an extremely wide range of ambient environmental conditions, and be capable of handling various quantities of sheet material wherein the separate quantities may comprise sheets of diverse thicknesses. In prior xerographic reproducing machines, sheet handling mechanisms has been of the type wherein a substantially single thickness of sheet material is utilized with the machine. However, as the science of xerography has progressed faster machines have been developed necessitating a substantially greater quantity of sheet material to be utilized with the machine and fed thereto at a speed much greater than that of previous devices. It is desired that these large volume-high speed xerographic reproducing machines be capable of handling various types of sheet material of thicknesses ranging from, for example, onion skin to card stock. The present invention comprises a sheet handling mechanism capable of retaining a large quantity of sheet material, wherein each sheet has a substantially uniform thickness, regardless of the diverse thicknesses of the sheets comprising the separate quantities.

It is, therefore, an object of this invention to improve sheet handling mechanisms for automatically advancing sheet material to a predetermined height upon response to slight variations in the height of the stack.

Another object of this invention is to improve sheet handling mechanisms whereby the stack cannot be advanced above a predetermined height.

A further object of this invention is to improve sheet handling mechanisms whereby the topmost sheet is constrained in a predetermined manner as determined by its thickness to enable the sheet to be fed from the top of the stack into a sheet conveying mechanism.

Another object of this invention is to improve sheet handling mechanisms whereby the topmost sheet is released from any constraining force at the time the sheet is fed from the top of the stack into a sheet conveying mechanism.

Still another object of this invention is to improve sheet handling mechanisms by separating the topmost sheet from the stack by introducing aeriform fluid into the stack in an amount determined by the thickness of the sheet material being forwarded into the sheet conveying mechanism.

These and other objects are attained in accordance with the present invention wherein there is provided a pack advancer having a sensor bail mechanism traversing the top of the stack of sheet material to constrain the topmost sheet in a predetermined configuration, the sensor being oscillated into and out from contact with the topmost sheet during the sheet feeding cycle to constrain the sheet in a predetermined configuration and to release the topmost sheet from the constraining force at the time of feeding to a sheet conveying mechanism, and wherein the portion of the sensor bail contacting the topmost sheet of the stack of sheet material is adapted to be varied in accordance with the thickness of the sheet material.

Further objects of this invention, together with additional features contributing thereto and advantages accruing therefrom will be apparent from the following description of an embodiment of the invention when read in conjunction with the accompanying drawings wherein:

FIG. 1 illustrates schematically a preferred embodiment of a xerographic reproducing machine having a sheet handling apparatus constructed in accordance with the invention;

FIG. 2 is a top view of a sheet handling mechanism with portions broken away to show internal operation of the apparatus;

FIG. 3 is a left side elevation of the sheet handling mechanism shown in FIG. 2 with portions broken away to show the internal structure of the apparatus;

FIG. 4 is a rear view of a sheet handling mechanism with the cover panel broken away to show the internal elements of the mechanism;

FIG. 5 is a sectional view of the sheet handling mechanism taken along lines 7—7 of FIG. 2;

FIG. 6 is an enlarged view of the apparatus for adjusting the sheet handling mechanism for various lengths of sheet material;

FIG. 7 is a partial section view of FIG. 6 taken along line 7—7;

FIG. 8 is a perspective view of the drive system of the sheet feed mechanism;

FIG. 9 is a sectional view of the clutch mechanism utilized in the drive system of the sheet feed mechanism taken along line 9—9 of FIG. 8;

FIG. 10 is a perspective view of the sensor bail of the sheet handling apparatus;

FIG. 11 is a section view of FIG. 10 taken along lines 10—10;

FIG. 12 is an enlarged portion of the sensor bail mechanism with parts broken away to better show the structure thereof; and

FIG. 13 is a schematic electrical wiring diagram of the sheet mechanism index motor circuit.

As shown in FIG. 1 the sheet feed mechanism 40 used to separate the topmost sheets one at a time from

the top of the stack or pile of sheet material and to feed the sheets to the paper transport **44** may be formed as an integral unit of a separate unit connected to the frame of the reproducing apparatus wherein a front frame plate **301** and a rear frame plate **302** are connected together and maintained in spaced relation to each other by cross members **303** and tie rod **304**. A stack or pile of sheets, indicated as **305**, is supported on a movable table or tray **41** between the frame plates **301** and **302**. The tray **41** has a depending side **306** extending downward to which are secured a pair of extension arms **307** carrying a pair of rollers **308**. The rollers **308** are adapted to ride in guide channels **309** secured to frame plates **301** and **302**. Thus, the tray **41** is movable in a vertical direction between the two frame plates **301** and **302**, and is guided in its vertical movement by rollers **308** and the guide channels **309**.

The tray **41** is supported from a pair of cables **310** by means of brackets **311** secured to the tray side **306**. Each of the cables **310** has one end secured to the brackets **311** by means of connectors **312**, as seen in FIG. 5, and the other end secured to the pulley **313**.

The pulleys **313** are fixed to a shaft **320** on opposite sides of the tray between plates **301** and **302**. Shaft **320**, journaled in suitable bearings mounted in the plates **301** and **302**, is driven to raise or lower the table by means of a gear **321** mounted on a portion of the shaft **320** which extends through the frame plate **302**. Driving power is supplied to the gear **321** to rotate shaft **320** to raise and lower table **41** by worm gear **322** on the drive shaft of an index motor MOT–1.

The index motor MOT–1 is connected to a source of electrical power and its operation controlled by index limit switch **14LS**, down limit switch **15LS** and index switch SW6 shown schematically in the wiring diagrams and described hereinafter. Down limit switch **15LS** is secured to plate **302** and positioned to be actuated by the tray as it reaches its lower or bottom position. The index limit switch **14LS** and a tray up interlock switch **31LS**, are mounted in side-by-side relation on the outside of side frame **302**, to be actuated by a switch actuating lever **323**, pivoted at pin **324**. An adjustable stop **325**, mounted on the same bracket **326** as the switches **14LS** and **31LS**, limits the movement of the lever **323** so that these switches are not damaged when the paper supply is excessively low or the table is at the bottom of its downward movement.

The lever **323** is secured to the pin **324**, and the pin **324** extends through the side frame plate **302**. The opposite end of the pin **324** has the paper level sensing bail cross bar **327** secured thereto. The pin **324** is rotatably mounted in the frame plate **302** by means of a bearing **328** so that movement of the sensing bail **500** rotates the pin **324** and the lever **323**. The opposite end of the sensing bail cross bar **327** is pivotally secured on a stub shaft, not shown, mounted in the side frame **301**. The sensing bail is biased downward towards the top of the stack of sheets by tension spring **329**, mounted between the lever **323** and the switch bracket **326**. Sensing bail **500** is formed in a U-shaped configuration traversing the top of the stack of sheet material **305**. Pin **324** and the stub shaft, not shown, support the sensing bail in a position whereby only the sensing portion or contact member **510** of the bail contacts the sheet material. A floating guide bar **401** is slidably supported from the cross bar **327** of the sensing bail **500** by bolts secured to the cross bar and passing through slots in the guide bar **401** so that the bar slides in a vertical plane relative to the cross bar **327** and, therefore, contacts the stack of sheet material **305** to perform a function hereinafter described in detail. Cross bar **327** has L-shaped brackets **501** secured thereto as by spot welding to form the leg portions of the U, or sensing portion **510** of the sensor bail **500**, comprises a contact member, secured to a shaft **511** rotatably supported in a bearing surface secured in the brackets **501**, and having a cross section similar to a paddle wheel as best seen in FIGS. 10 and 11.

The contact member sensing portion **510** is secured on shaft **511** for rotational movement to permit one of the vanes **512** to contact the stack of sheet material **305**. The vanes **512** of the contact member **510** are of various radii with reference to the axis of rotation, shaft **511**, to control the height of the paper stack **305** with reference to the manifold conduits **395**. The shaft **511** extends through brackets **501** at both ends and has an adjusting knob **513** secured to each extended portion as by a press fit. A spring biased pin **514** is secured in each adjusting knob to engage one of the detents **515** in the brackets **501** to maintain the contact member **510** in its proper location with one of the vanes **512** contacting the stack of sheet material **305**.

Each vane **512** of the contact member **510** has a stepped or shoulder portion **516** at each end to engage the upper arm of bifurcated guides **517**. A guide is secured to each leg portion of the sensor bail, or L-shaped bracket **501**, and rotatably secured thereto by means of a shoulder screw **518** whereby the upper bifurcated portion of the guides **517** depend upon the shoulder portions of the vanes **512**.

Each of the stepped or shoulder portions **516** is a different radius with reference to the axis of rotation, shaft **511**, to complement the vane in contact with the stack of sheet material. With the guides depending on the complementary shoulder portion **516**, the rotational position of the guide bracket **517**, with respect to the L-shaped brackets **501** or leg portions of the sensor bail, is maintained such that the bottom portion of the guide bracket **517** is in a substantially straight line with the contact point of the vane engaging the stack of sheet material.

As the topmost sheet is fed from the top of the stack of sheet material **305**, the sensor bail **500** is oscillated out from contact with the topmost sheet to prevent constraining the sheet during the sheet feed cycle.

The end of the lever **323** opposite the pin **324** contains a cam follower **330** which is urged by the spring **329** against a cam **331**. Rotation of the cam **331** raises and lowers the sheet sensing bail **500** by means of the lever **323** and pin **324**. The movement of the cam **331** is timed with the movement of the sheet feeder so that the sensing bail **500** is raised from the sheet stack at the time the top sheet is fed; thus, the sensing portion or contact member **510** of the sensing bail does not constrain the individual sheet feeding.

During operation of the sheet feeding mechanism, the sensor bail drops downward a distance sufficient to actuate switch **14LS**, by means of arm **323**, after a predetermined number of sheets have been fed. The switch **14LS** effects operation of the drive system described above to raise the entire sheet stack to the proper feeding level and to raise sensing bail **500**, thus, releasing switch **14LS**. During continued operation of the sheet feeder, the sheet stack is periodically indexed or raised to the feeding level so that the top of the stack is continuously in a position to feed sheets to the transport system.

Since the termination of the operation of the pack advancer drive motor MOT–1 is dependent upon the raising of the sensor bail **500** by the top of the stack of sheet material to deactivate switch **14LS**, the radii variation of vanes **512** allows the stack to be raised to various heights as determined by the vane contacting the topmost sheet. The manifold conduits **395** are positioned at a fixed height and, therefore, the position of the stack of sheet material relative to the manifold conduits controls the amount of aeriform fluid passing into the topmost sheets. When the shortest vane contacts the top of the stack of sheet material, the stack will be advanced to its highest position relative to the manifold conduits **395**, and, therefore, the maximum amount of aeriform fluid will penetrate the stack. In the event the longest radius vane contacts the top of the stack of sheet material, the

opposite situation will occur with the stack being advanced to its lowest feeding position and a lesser amount of aeriform fluid will penetrate the stack. The controlling of the feeding height in relation to the manifold conduits **395** permits a greater amount of stack aerification as desired when feeding thick sheet material such as index card stock, and a lesser amount of stack aerification as desired when feeding thinner sheet material.

In this particular apparatus, the sheet material is fed edgewise to the xerographic reproducing machine. Therefore, the stack of sheets is arranged on the tray **41** with its longer dimension being transverse to the direction of movement of sheet material. The stack is aligned on the tray by means of an adjustable guide mechanism disclosed in J. W. Wagner Patent No. 3,251,594, and will not be herein described in detail since it forms no part of the subject invention.

The sheet separating mechanism for separating the top sheet from the stack includes a number of suction feet **365** which pick up the topmost sheet and advance the sheet into the pinch of the idler rollers **42** and the belts of the paper transport system **44**. The idler rollers **42** are canted in the path of sheet feed at an angle in a horizontal plane. The slight canting from a position parallel to the path of sheet travel causes the leading edge of the paper to be pulled taut by the equal but opposite forces exerted through the idler rollers **42** sandwiching the sheet between these rollers **42** and the belts of the paper transport **44**. The forces exerted on the sheet at an angle from the paper path prevent the sheet material from sagging and insures proper delivery to the sheet transport **44**.

The suction foot **365** comprises a hollow tube secured at one end to hollow manifold tube **366** journaled at opposite ends in pivots arms **367**. One end of the tube **366** is sealed and has a suitable adjustable limiting valve **316** to control the suction pressure, and the opposite end of the tube is connected by a flexible conduit **368** to the inlet of a vacuum pump, not shown, driven by a suitable motor. A cam follower arm **369**, carrying cam follower **370** is also secured to the manifold tube **366**. The opposite ends of pivot arm **367** are secured to the rock shaft **371** journaled in plates **301** and **302**. For more details concerning the specific construction of a vacuum sheet feeder such as described, reference is made to J. W. Wagner Patent No. 3,241,830.

To insure the separation of single sheets from the stack of sheet materials by the vacuum feeder, the pressure side of the vacuum pump is connected by conduits **397** to manifold conduits **395** positioned near the leading edge and the leading corners of the stack of sheet material **305**. Apertures **396**, in the manifold conduits direct air under pressure toward the leading edges of the topmost sheets of the stack whereby these sheets are loosened from each other and lifted to the proper height for removal by the suction feet, the amount of air passing into the stack being controlled as heretofore described. When the suction feet are in contact with the sheet, air is drawn into the pump through adjustable valve **316**.

To insure seratim feeding of single sheets and to prevent the removal of those superposed, flexible snubber tabs **410** are provided at the leading edge of the stack of sheet material and located between the suction feed extending a predetermined amount over the stack. The snubber tabs **410** are of a resilient material and formed with one end extending above and parallel to the leading edge of the stack of sheets and the other end fastened to a block support secured to the paper feeder by means of brackets **411**. The tabs **410** extend above and parallel to the topmost sheet of the stack of paper between the vacuum suction feet **365** and over the leading edge of the paper so that the forward edges of the snubber tabs **410** are in line with the center line of the suction feet **365** which extends at right angles to the path of sheet travel. As the paper is aerated by the discharge from the manifold conduits **395** lifting the topmost sheets on the air cushion created thereby, the vertical height of the sheets is limited by the snubber tabs **410**. When the suction feet **365** engage the topmost sheet, flexing the tabs **410** out of interference with the topmost sheet for forwarding to the sheet conveyor **44**, the upward force due to the suction feet **365** and the restraining force caused by the snubber tabs **410** create a deformation or kink in the paper which in the event of superposed sheet strips the bottom sheet or sheets from the sheet being fed.

In operation, as air is emitted through the manifold conduit **395** against the leading edge and corners of the stack material, a plurality of the topmost sheets float up from the stack engaging the snubber tabs **410** which limit the vertical movement of the sheet material. Floating guide bar **401** constrains the center section of sheets in a manner such that the forward portion of the sheets float in the trapped air cushion by the air from the manifold conduits, while the rearward portion of the sheets remains in contact with the stack. The guides **517** constrain the sheets in a manner to taper the air cushion from the forward portion of the sheets to the contact point of the vane **512**. Since the guides **517** depend upon the complementary shoulder portion **516** of the contact member **510** to form a smooth straight guide surface from the point of contact forward toward the cross bar **327**, the air cushion between the contact point of the vanes **512** forward toward the floating guide bar is uniformly tapered to prevent a kink from forming in the aerated sheets causing misfeeding of the sheet material by the vacuum sheet feeders **40**.

To operate the pack advancer, FIG. 13 shows a schematic illustration of the paper feeder elevator or index motor circuit, the circuit being connected to a suitable source of power. The circuit includes the index motor MOT–1 controlled by paper feeder up index limit switch **14**LS actuated by the sheet sensor bail **500**, previously described. With "up" contact SW6A of index switch closed, a circuit is partly completed through normally closed contact 3CR1B of relay 3CR, the only break in this circuit being the contact **14**LSA of index limit switch **14**LS. However, as sheets are fed from the stack of sheets, the sheet sensor bail **500** will drop sufficiently to actuate the switch **14**LS closing its contact **14**LSA to energize the index motor MOT–1 to raise the stack until the sheet sensor bail is disengaged from the index limit switch **14**LS, which due to the varying radii of the vanes of the sensing portion **510** will be at differing portions relative to the manifold conduits **395**. This cycle of operation continues during normal operation of the machine.

If the supply of paper is nearly exhausted the "low" paper limit switch 4LS is actuated closing its contact which completes a circuit to energize relays 3CR and 12CR.

As this occurs, contact 3CR1A closes and contact 3CR1B opens to establish a holding circuit to relays 12CR and 3CR through the closed "up" contact SW6A and contact 3CR1A. Contact 12CR1 closes and provides power to the "down" portion of the elevator motor through the down limit switch **15**LS, normally closed. Now the motor operates to lower the paper tray **41** until the down limit switch **15**LS is acuated to break this circuit.

The operator will load additional paper in the paper tray **41** and then press the "up" button of switch SW6, to momentarily open the contact SW6A, normally biased into a closed position, to break the circuit to relays 3CR and 12CR, the low paper limit switch 4LS opening as soon as the paper tray was lowered. The up index limit switch **14**LS again takes over control of this motor until the sensing bail is again lifted out of contact with this switch **14**LS to open its contact stopping the upward progress of the paper tray as determined by the height of the stack of paper positioned on the tray and the vane **512** of the contact portion **510** of the sensing bail. Lifting of the sensor bail will also open switch **31**LS breaking the circuit to relay 27CR, allowing its contact 27CR2 to again

close to complete the circuit to print switch SW4A and the ready lamps.

The operator can also lower the paper tray to add paper by depressing the down button for index switch SW6 to close the contact SW6B which completes a circuit to relays 12CR and 3CR, the index motor then being energized through the circuits previously described.

The purpose of rectifiers SR3, normally closed contact 4LSB and capacitor C7 is to provide a holding torque on motor MOT–1 when it is not operating. The capacitor C–1 and Resistor R–2 are part of the circuit for the motor itself. The motor MOT–1 is preferably a Slo-Syn synchronous motor adapted to be electrically connectable for reversible rotation, for example, a Number SS–150–1077 electric motor manufactured by the Superior Electric Company, Bristol, Conn.

It is apparent that the circuit shown in FIG. 12 can be incorporated into a circuit for the entire xerographic apparatus and that relays 3CR and 12CR can have more contacts than shown for use in such as overall circuit, which may be a circuit as disclosed in the above referenced application Ser. No. 400,363.

While the invention has been described with reference to the structure disclosed herein, it is not confined to the details set forth, and this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.

What is claimed is:

1. A pack advancer for use in cooperation with a sheet feeding mechanism including

retaining means for supporting a stack of sheet material for vertical movement,

elevating means connected to said retaining means for raising and lowering said stack of sheet material,

switch means operatively connected to said elevating means to actuate said elevating means to raise said stack of sheet material,

sensor means operable to a plurality of predetermined positions adapted to coact with the topmost sheet of said stack of sheet material to control the height thereof,

said sensor means comprising a bail having a U-shaped portion with the center section of said U-shaped portion being a rotatable member having a plurality of diverse radii vanes extending outwardly therefrom, and

said sensor means also including actuator means to actuate said switch to effect the vertical movement of said retaining means when the height of the stack of sheet material falls below a predetermined height.

2. The apparatus of claim 1 wherein said bail is pivotally secured at both ends for oscillation above said stack with said center section of said U-shaped portion oscillatable into and out from contact with the topmost sheet of said stack in timed relation to the operation of a sheet feed mechanism.

3. A pack advancer for use in cooperation with a sheet feeding mechanism including

retaining means for supporting a stack of sheet material,

elevating means coupled to said retaining means for raising and lowering said stack of sheet material,

switch means operatively connected to said elevating means to actuate said elevating means to raise said stack of sheet material,

sensor means including a reciprocatory member supporting a sheet contacting surface, said surface being adjustable with respect to said reciprocatory member so as to cooperate with the topmost sheet of said stack of sheet material to thereby control the height of the stack as a function of the adjustment of said sheet contacting surface, and

said sensor means also including actuator means to actuate said switch to effect the raising movement of said retaining means when the height of said stack of sheet material falls below a predetermined height.

4. The apparatus as set forth in claim 3 wherein said sheet contacting surface is pivotable with respect to said reciprocatory member and the adjustment therebetween is effected by rotation of said surface.

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