United States Patent

[11] 3,556,516

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[54] **SELF-ALIGNING FEED ROLLER**
3 Claims, 17 Drawing Figs.

[52] **U.S. Cl.** **271/36**
[51] **Int. Cl.** **B65h 3/06**
[50] **Field of Search** 271/36, 37, 38

[56] **References Cited**

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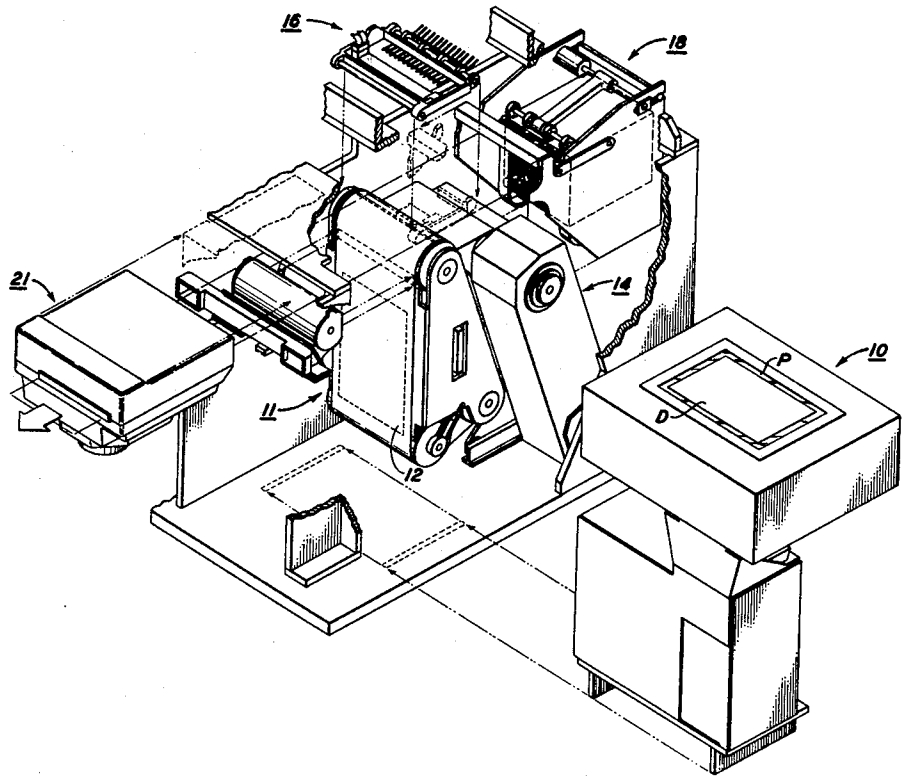
ABSTRACT: A sheet separating apparatus having a plurality of rollers supported along a common axis adapted to be placed upon the top sheet of a stack of paper. The rollers are adapted to be raised vertically from the stack and also their common axis support rocked so as to permit the outboard rollers to lift individually from the top sheet. Each of the rollers is provided with a one way clutch relative to its support structure.



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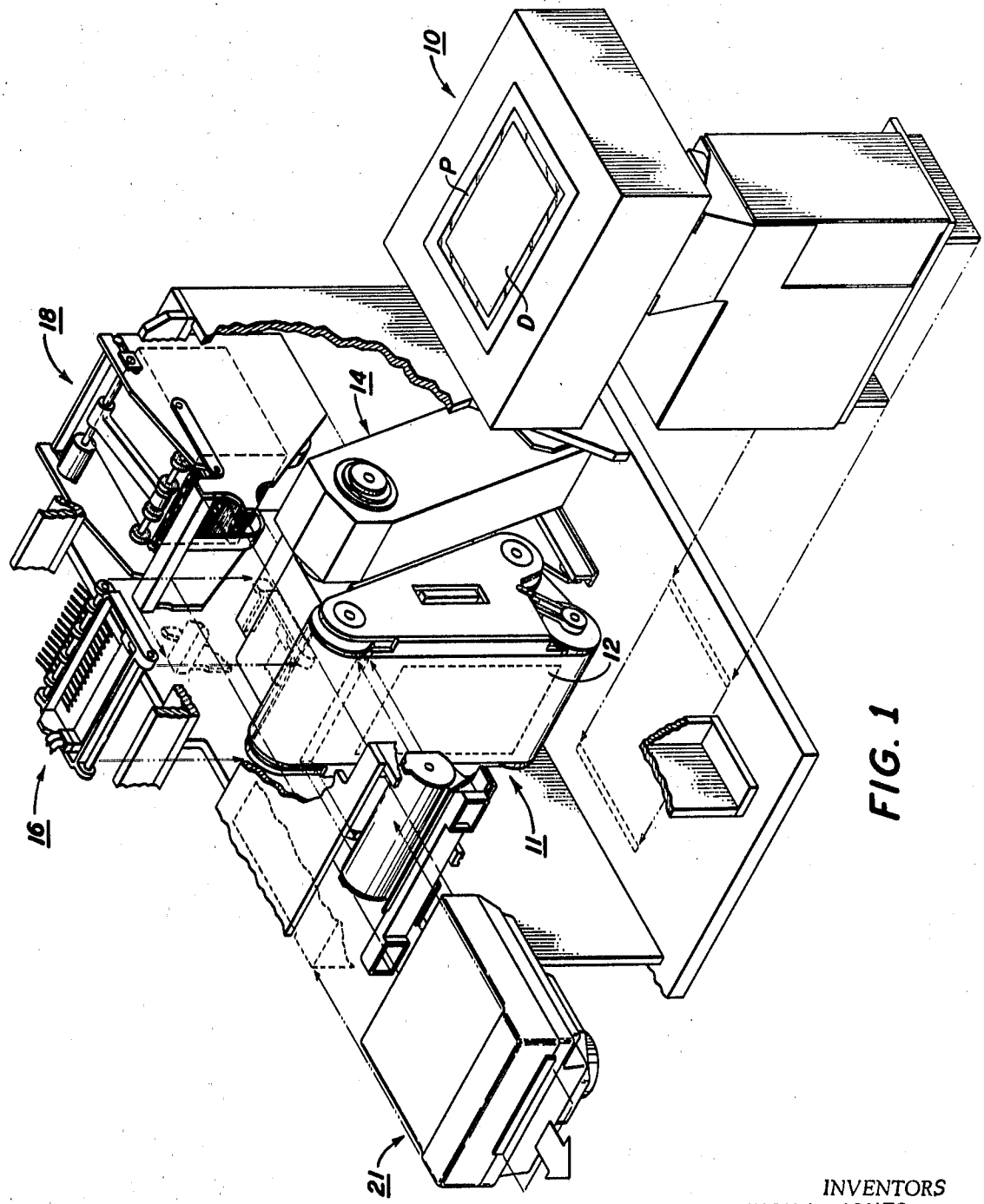

FIG. 1

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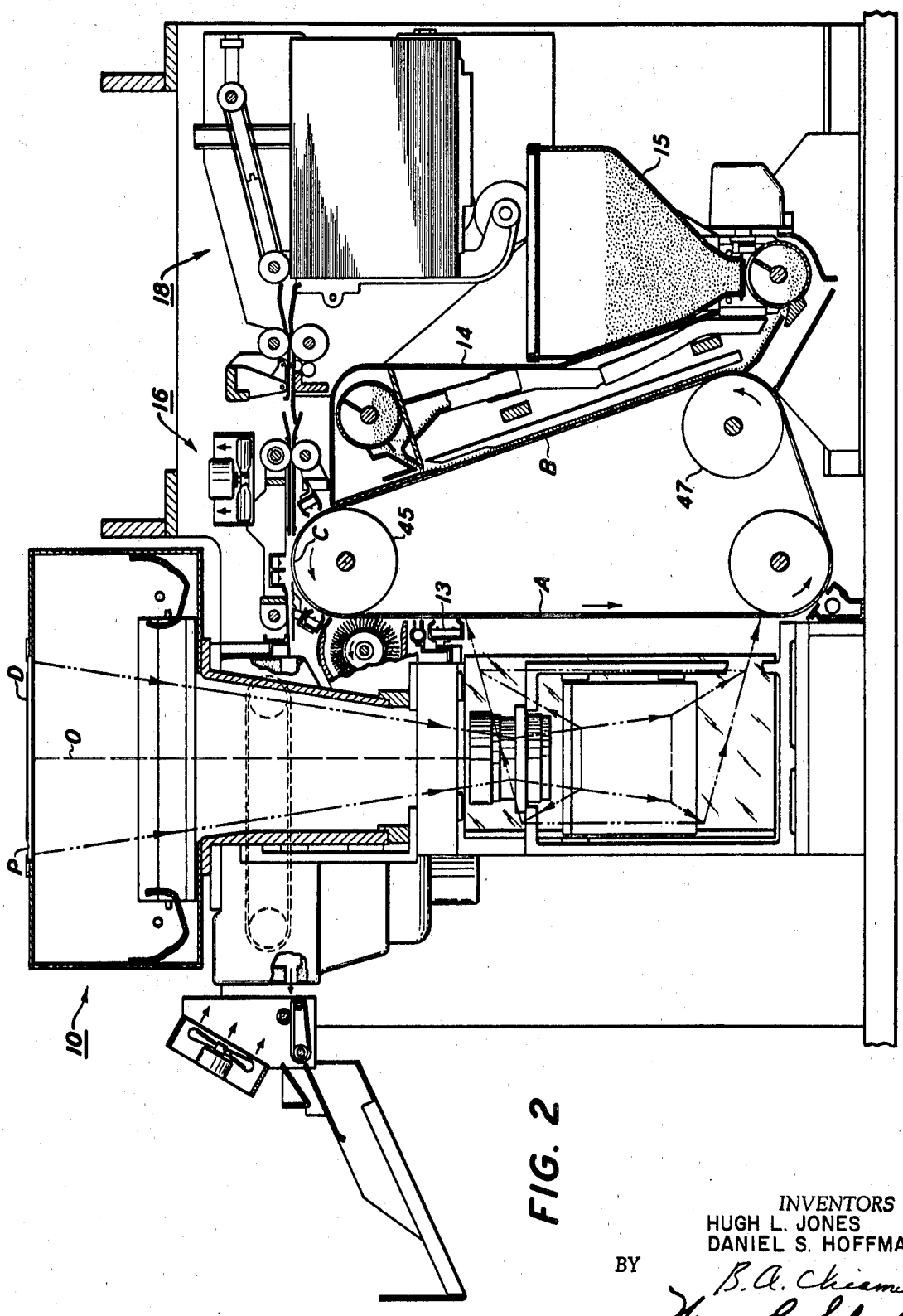

FIG. 2

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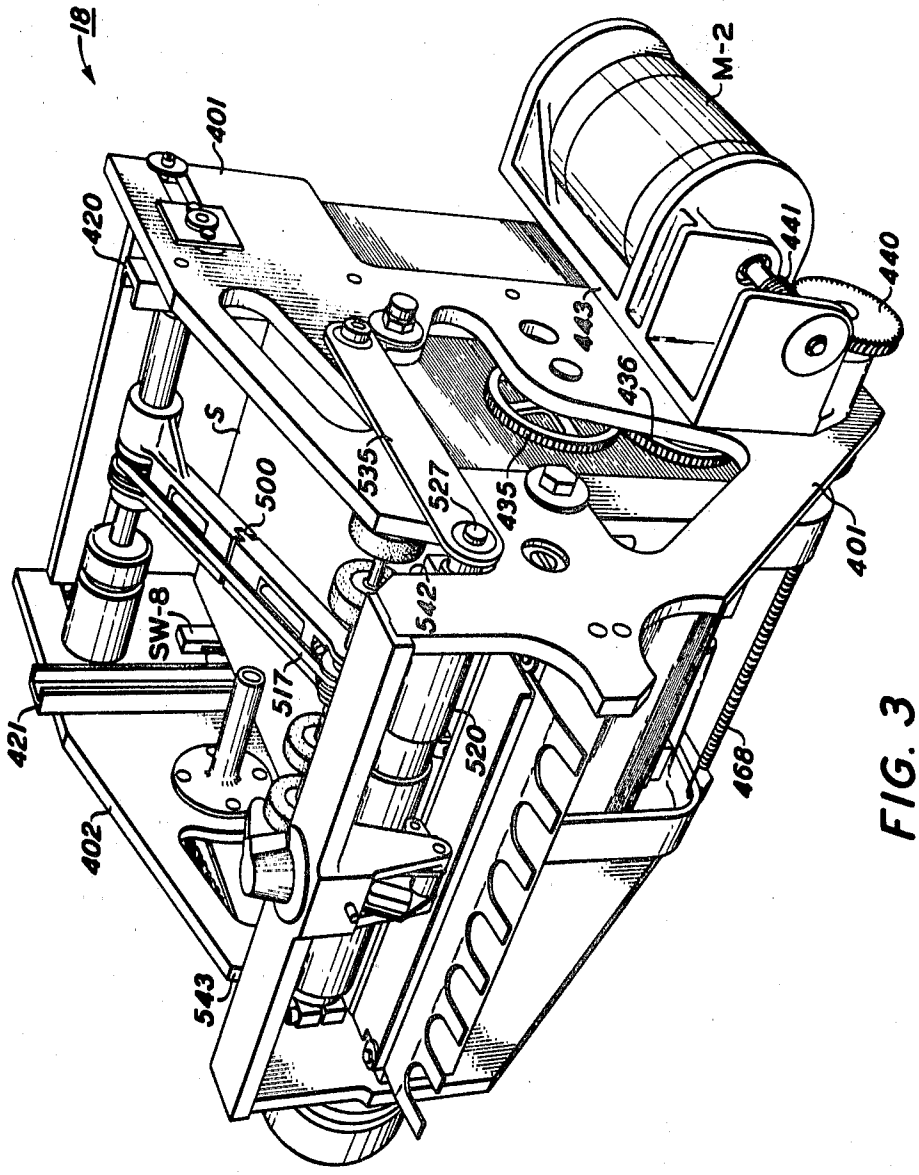

FIG. 3

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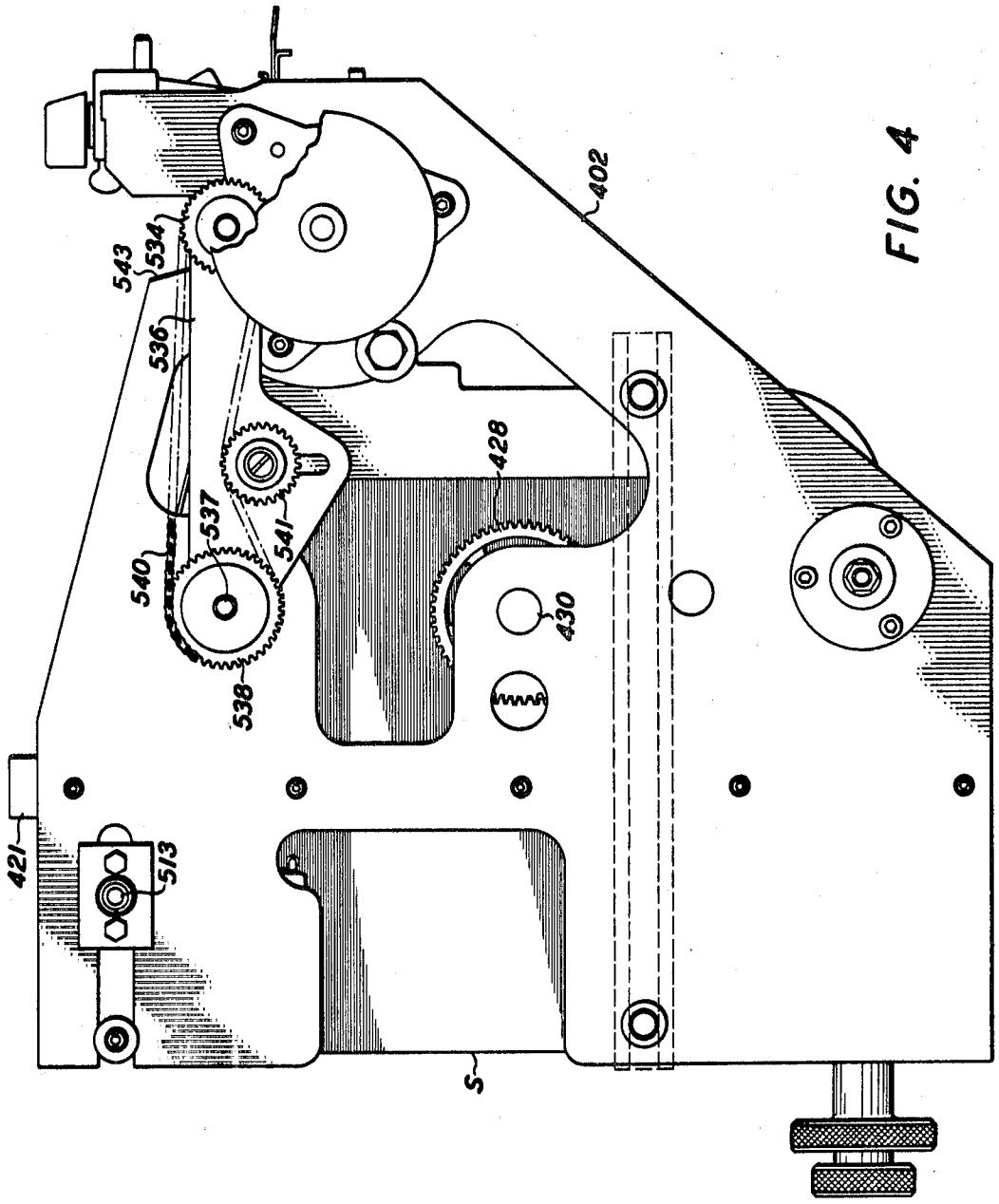

FIG. 4

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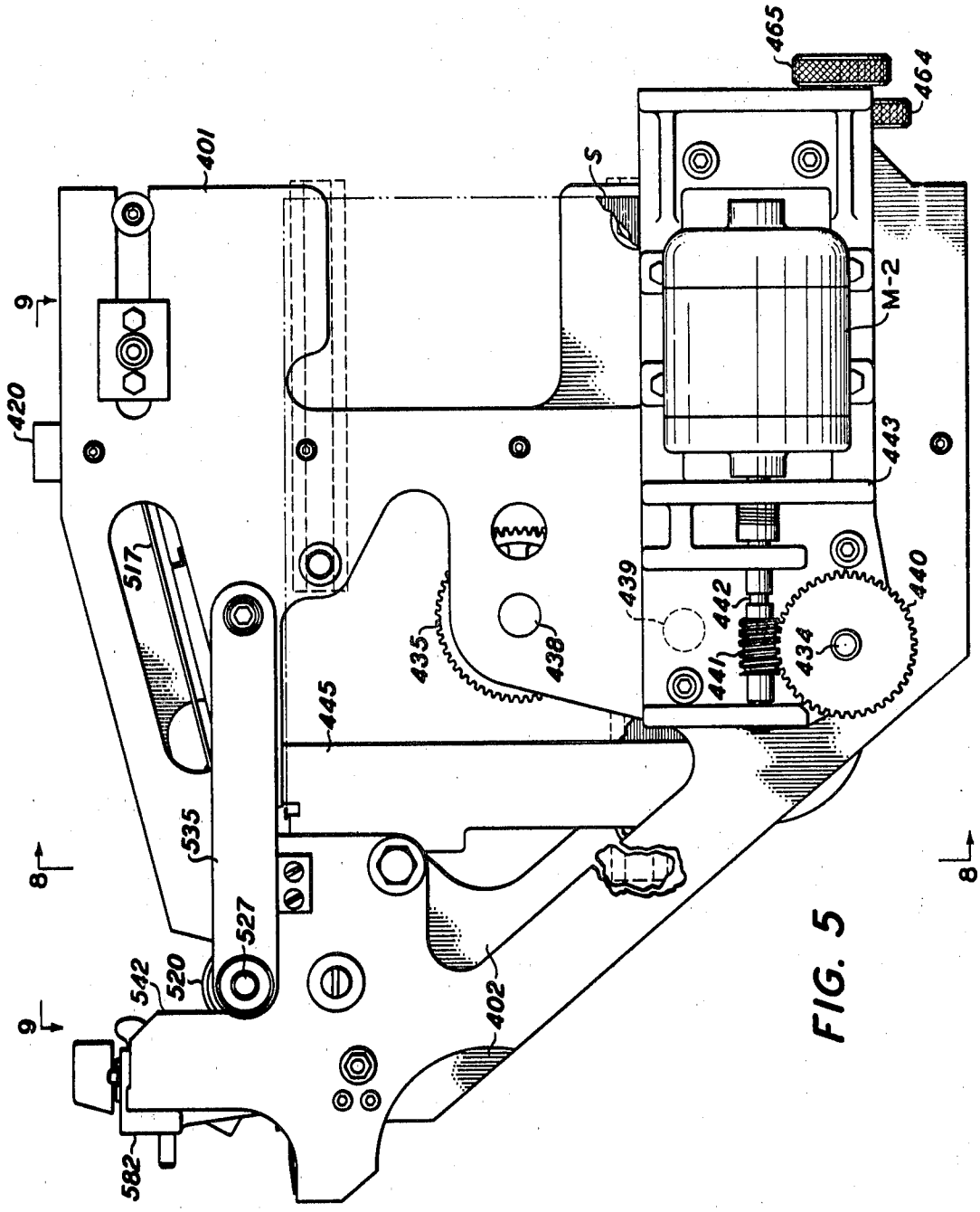

FIG. 5

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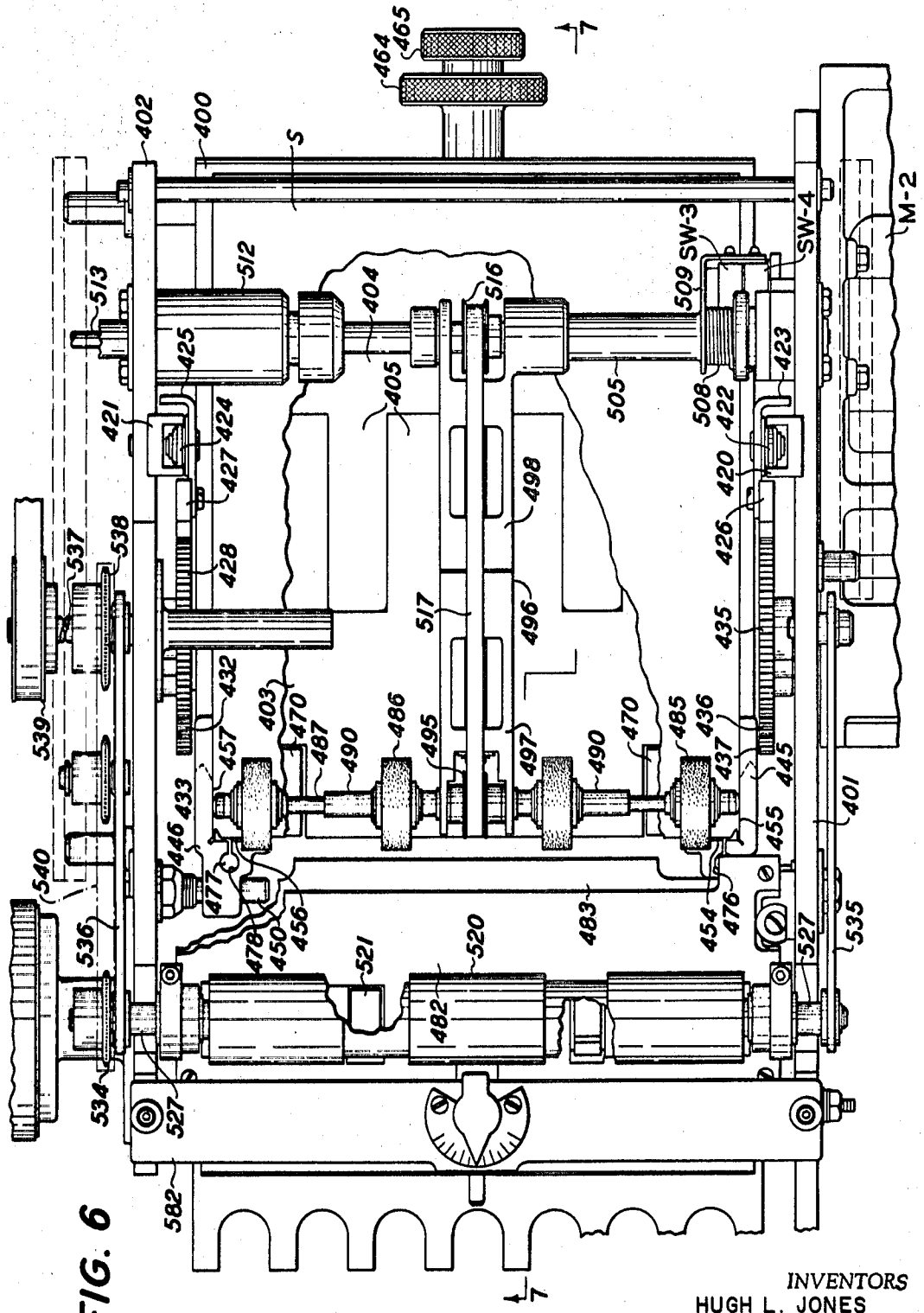

FIG. 6

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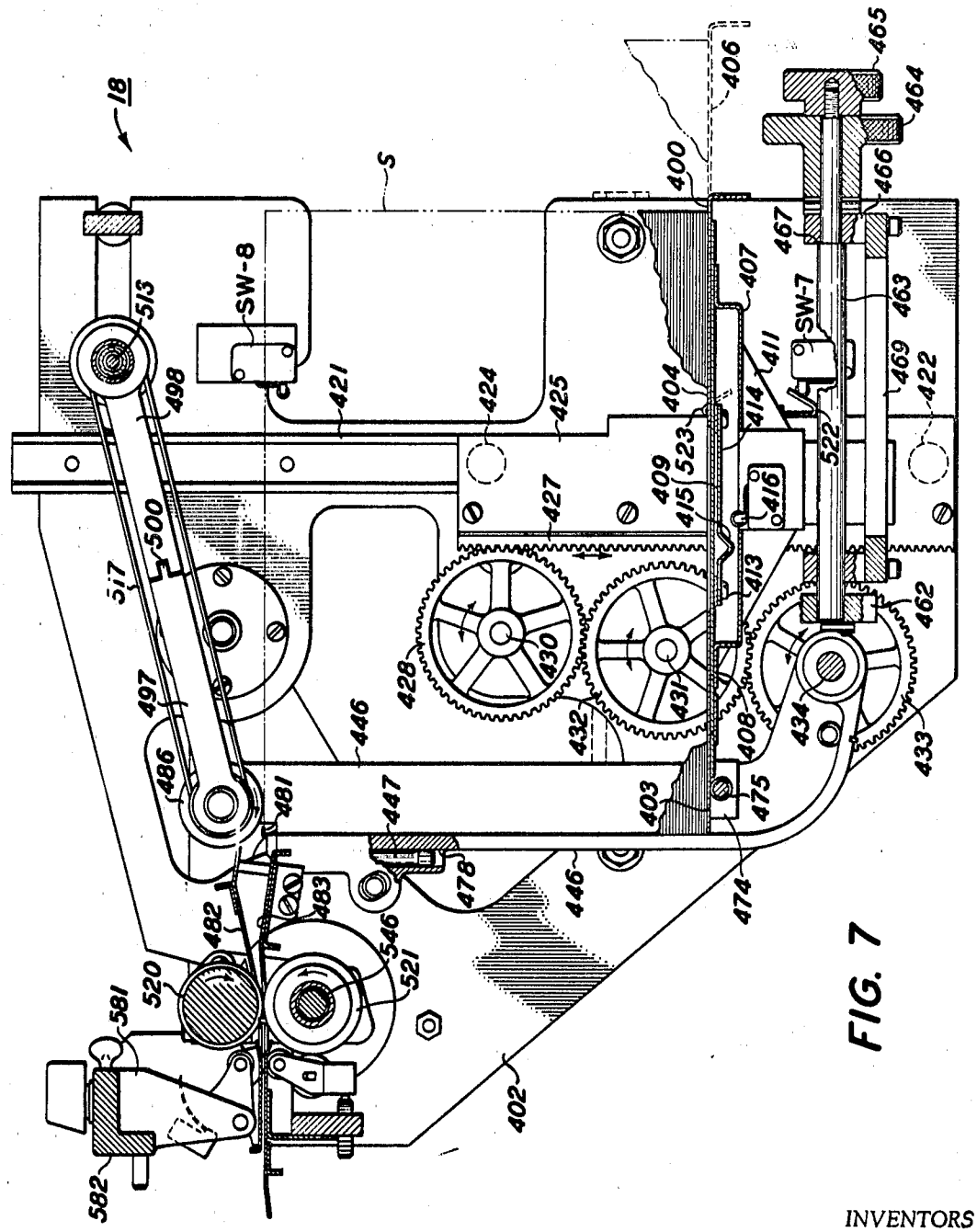

FIG. 7

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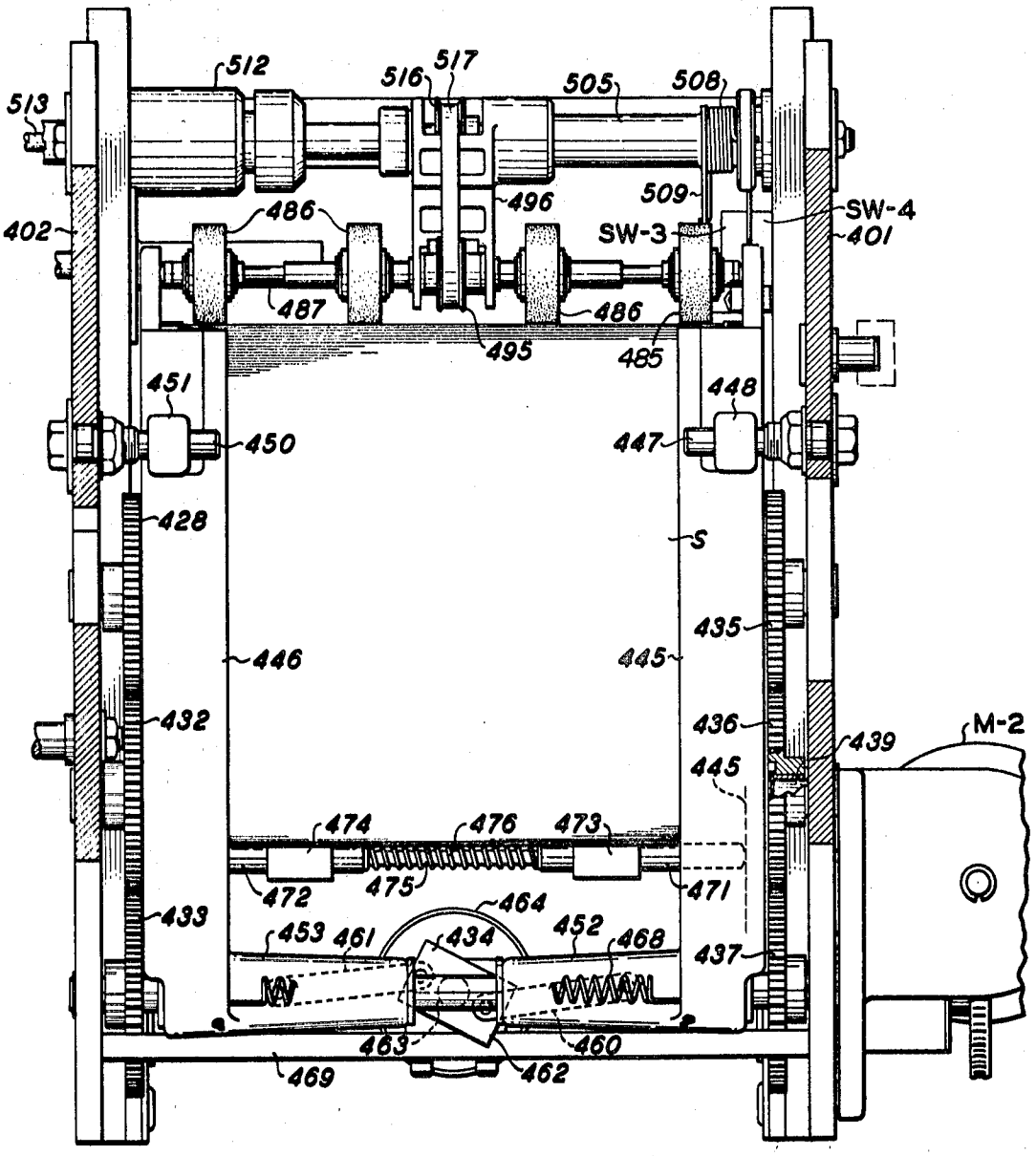

FIG. 8

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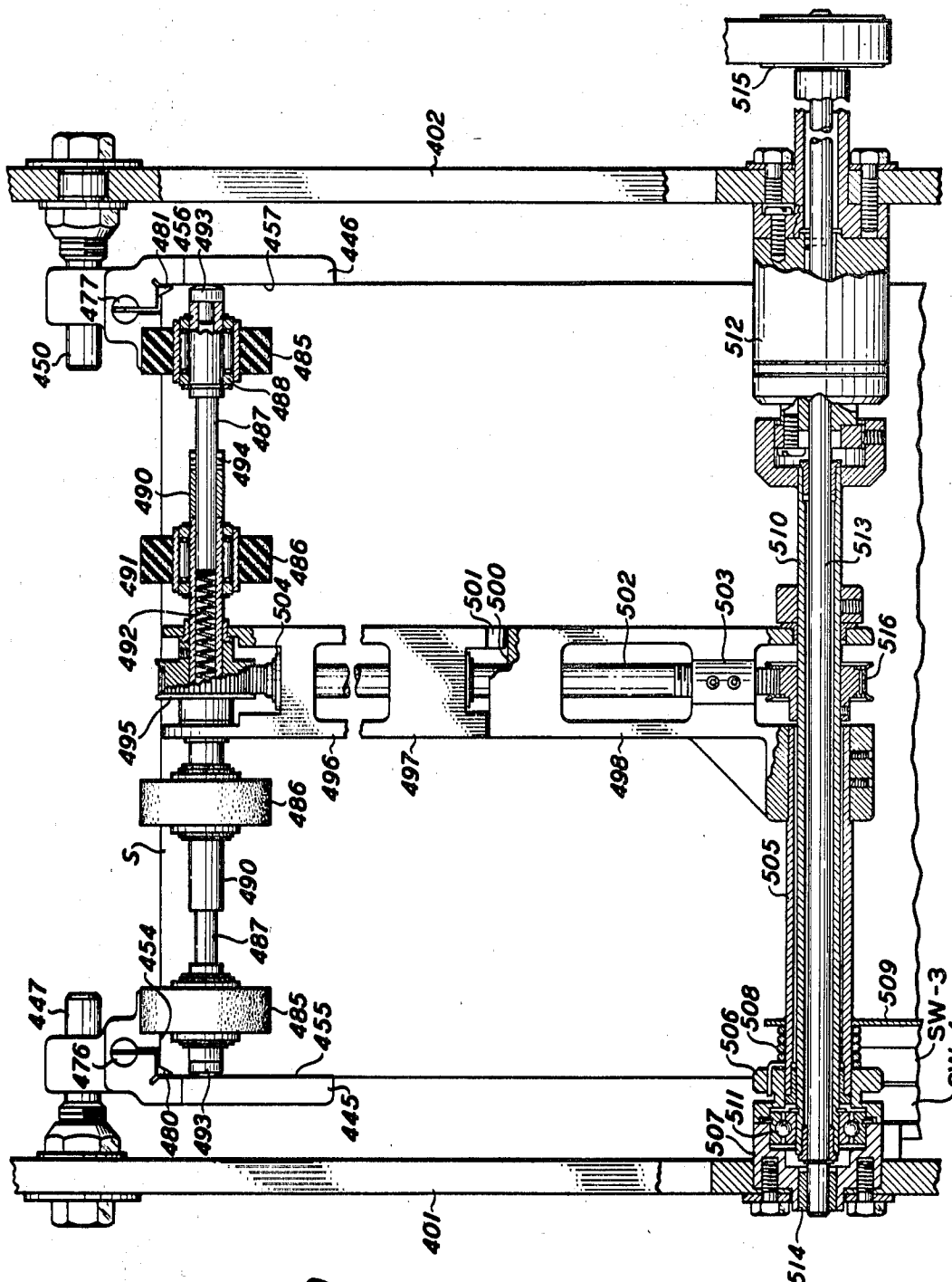

FIG. 9

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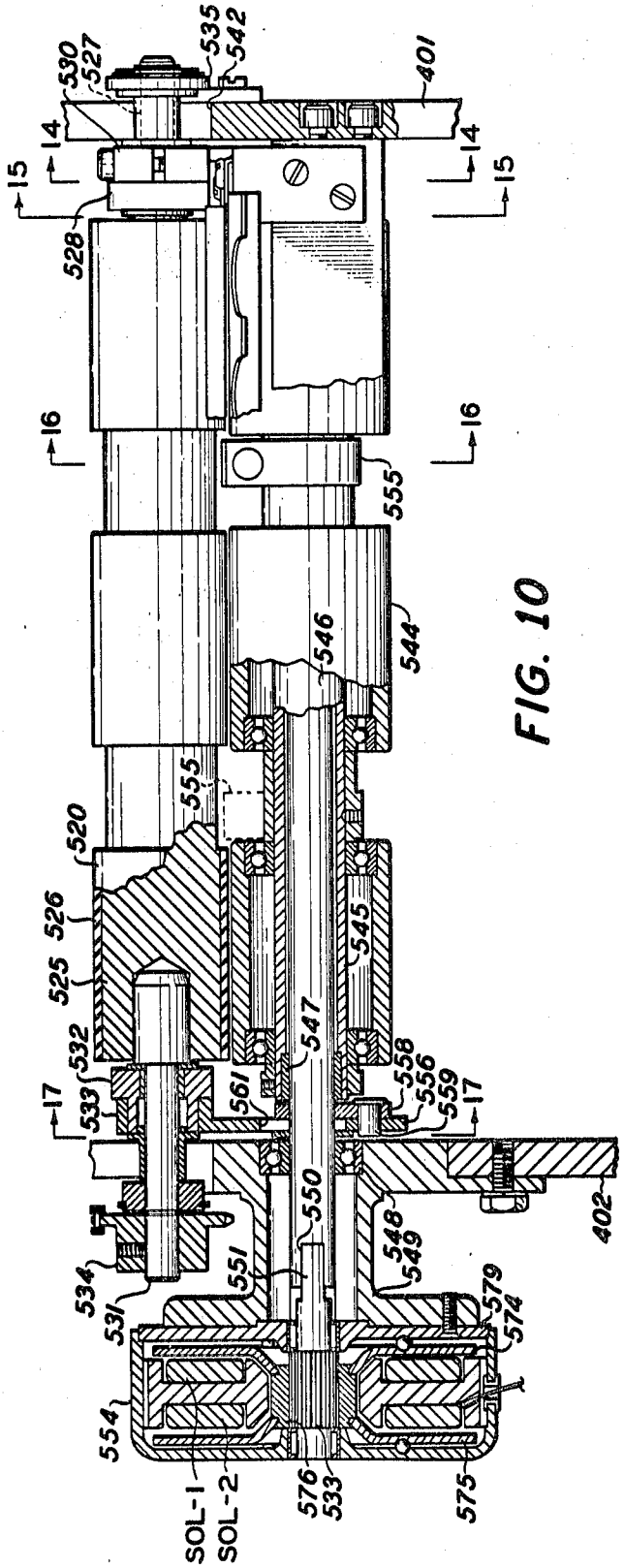

FIG. 10

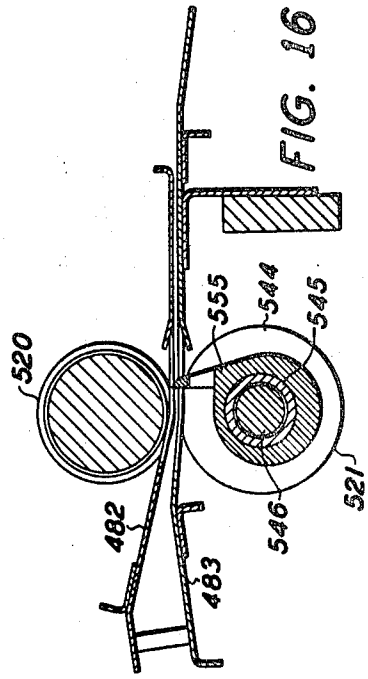

FIG. 16

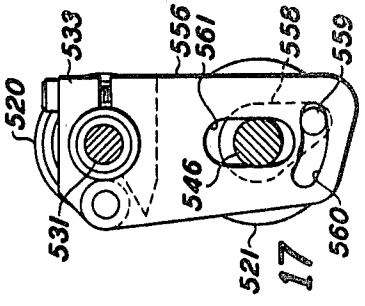

FIG. 17

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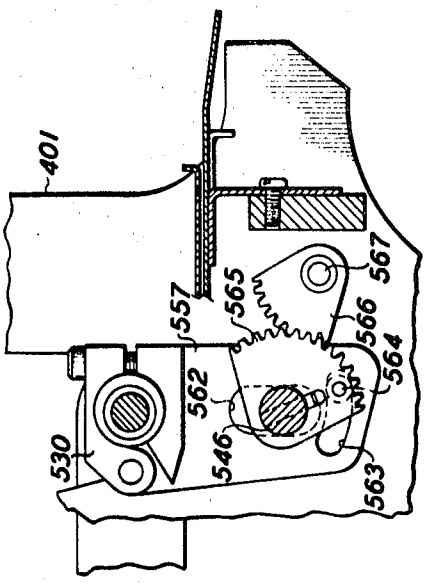

FIG. 14

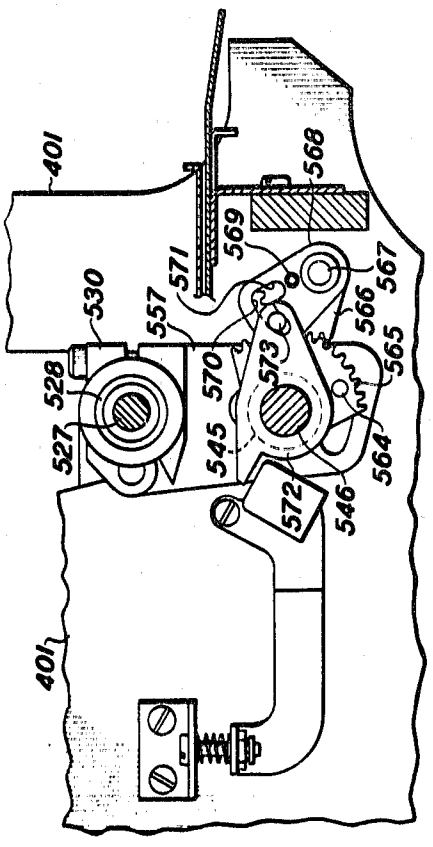

FIG. 15

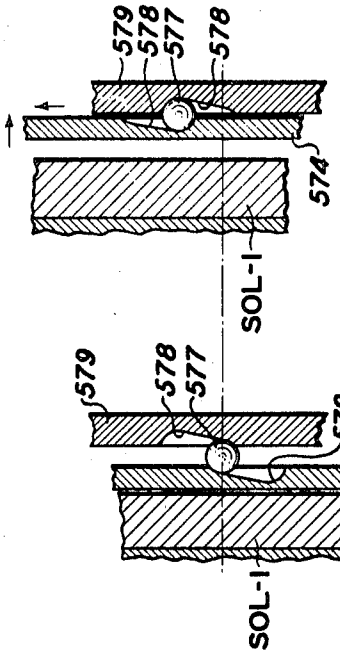

FIG. 13

FIG. 12

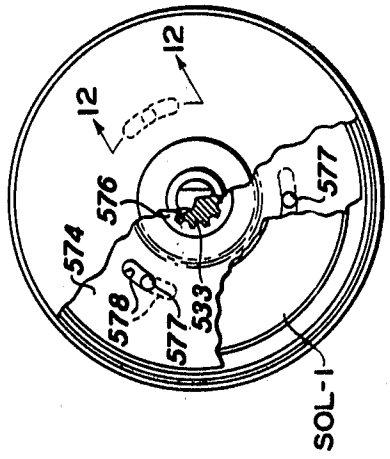

FIG. 11

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SELF-ALIGNING FEED ROLLER

This invention relates to paper feed systems, and particularly, to improvements in the arrangement of separator rollers that are capable of limited individual action and particularly adapted for use with automatic copiers/reproducers capable of high speed operation.

As is well known in recent years, the steadily increasing size of various industries has required an enormous increase in the amount of paperwork that must be accomplished, maintained and made available for wide interplant circulation. In the present day commercial automatic copiers/reproduction machines, which are adapted to produce copies of between five and 60 8 11 " sheets of copy per minute, the photoreceptor device is in the form of a drum which rotates in timed unison relative to a plurality of processing stations and the usual paper feeding system is limited as to the speed of moving sheet paper material that can be conveyed to a transfer station for the machine.

As a solution for overcoming the disadvantages for high speed copying, the latest machine concept for copiers utilizes flash exposure of a document and the arrangement of a moving photoconductor material in the form of an endless belt. However, there has been no efficient way in which to feed sheets of paper at high speed without encountering paper jams and improper registration of the leading edges of the sheets with pretransfer structure.

It is therefore the principal object of this invention to improve paper feed apparatus for effecting high speed feed of sheet material, to a transfer station of a reproduction machine.

Another object of this invention is to utilize self-aligning separator rollers in a paper feed apparatus which will minimize sheet skewing and insure proper leading edge alignment during high speed use.

These and other objects of this invention are obtained by means of a sheet separation arrangement including four feed rollers arranged for rotation on a common axis wherein the two inner rollers are mounted on a common shaft and the two outer rollers mounted on individual shafts drivingly connected to the inner rollers shaft. Each of the rollers are mounted on one-way slip clutches and all of the rollers are adapted for rocking movement on an axis normal to the common axis.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in conjunction with the accompanying drawings, wherein:

FIG. **1** is an exploded right-hand perspective view of a reproduction machine incorporating the present invention therein with the processing components separated to better illustrate the environment for the present invention;

FIG. **2** is a schematic sectional view of the reproduction machine showing the various processing stations;

FIG. **3** is an isometric view of a paper handling and feeding component of the machine to which the present invention is applied;

FIG. **4** is a side elevational view of the paper handling device as viewed from the rear of the machine;

FIG. **5** is a side elevational view of the paper handling device as viewed from the front of the machine;

FIG. **6** is a plane view of the paper handling device with parts broken away;

FIG. **7** is a sectional view taken along the line **7–7** in FIG. **6**;

FIG. **8** is a sectional view taken along line **8–8** in FIG. **5**;

FIG. **9** is a sectional view of the paper feeding mechanism taken along s line **9–9** in FIG. **5**;

FIG. **10** is a sectional view with parts broken away of the paper registration rollers utilized along with the paper feeding mechanism;

FIG. **11** is an end view of the double rotary solenoid utilized to effect sheet registration and feed out;

FIG. **12** is a fragmentary enlarged view of a rotary drive device taken along the line **12–12** in FIG. **11**;

FIG. **13** illustrates another position of operation of the rotary device of FIG. **11**;

FIG. **14** is a sectional view of a detail used with the registration rollers taken along the line **14–14** in FIG. **10**;

FIG. **15** is a sectional view of another detail taken along line **14–14** in FIG. **10**;

FIG. **16** is a sectional view showing the registration fingers and taken along line **16–16** in FIG. **10**; and

FIG **17** is a sectional view of the roller bearing support taken along line **17–17** in FIG. **10**.

For a general understanding of the illustrated copier/reproduction machine, in which the invention may be incorporated, reference is had to FIGS. **1** and **2** in which the various system components for the machine are schematically illustrated. As in all electrostatic systems such as a xerographic machine of the type illustrated, a light image of a document to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged developing 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 support surface to which it may be fused by a fusing device whereby the powder image is caused permanently to adhere to the support surface.

In the illustrated machine, an original to be copied is placed upon a transparent support platen P fixedly arranged in an illumination assembly generally indicated by the reference numeral **10**, arranged at the left end of the machine. While upon the platen, an illumination system flashes light rays upon the original thereby producing image rays corresponding to the informational areas on the original. The image rays are projected by means of an optical system for exposing the photosensitive surface of a xerographic plate in the form of a flexible photoconductive belt arranged on a belt assembly generally indicated by the reference numeral **11**.

The photoconductive belt assembly **11** is slidably mounted upon a support bracket secured to the frame of the machine and is adapted to drive a selenium belt **12** in the direction of the arrow as shown in FIG. **2** at a constant rate. During this movement of the belt, the reflected light image of an original on the platen is flashed upon the xerographic surface of the belt. The belt surface that intercepts the light rays comprises a layer of photoconductive material such as selenium on a conductive backing that is sensitized prior to exposure by means of a charging corona generator device indicated at **13**.

The flash exposure of the belt surface to the light image discharges the photoconductive layer in the areas struck by light, whereby there remains on the belt a latent electrostatic image in image configuration corresponding to the light image projected from the original on the supporting platen. As the belt surface continues its movement, the electrostatic image passes through a developing station B in which there is positioned a developer assembly generally indicated by the reference numeral **14** and where the belt is maintained in a flat condition. The developer assembly **14** comprises horizontally and vertically conveying mechanisms which carry developing material to the upper part of the belt assembly **11** whereat the material is dispensed and directed to cascade down over the upwardly moving inclined selenium belt **12** in order to provide development of the electrostatic image.

As the developing material is cascaded over the xerographic plate, toner particles in the development material are deposited on the belt surface to form powder images. As toner powder images are formed, additional toner particles are supplied to the developing material in proportion to the amount of toner deposited on the belt during xerographic processing. For this purpose, a toner dispenser generally indicated by reference numeral **15** is used to accurately meter toner to the developer material in the developer assembly **14**.

The developed electrostatic image is transported by the belt to a transfer station C whereat a sheet of copy paper is moved at a speed approximately in synchronism with the moving belt in order to accomplish transfer of the developed image. There is provided at this station a sheet transport mechanism generally indicated at **16** adapted to transport sheets of paper from a paper handling mechanism generally indicated by the reference numeral **18** to the developed image on the belt at the station C.

After the sheet is stripped from the belt **12**, it is conveyed into a fuser assembly generally indicated by the reference numeral **21** wherein the developed and transferred xerographic powder image on the sheet material is permanently affixed thereto. After fusing, the finished copy is discharged from the apparatus at a suitable point for collection externally of the apparatus.

Suitable drive means may be arranged to drive the selenium belt **12** in conjunction with timed flash exposure of an original to be copied, to effect conveying and cascade of toner material, to separate, and feed sheets of paper and to transport the same across the transfer station C and to convey the sheet to paper through the fuser assembly in timed sequence to produce copies of the original.

It is believed that the foregoing description is sufficient for the purposes of this application to show the general operation of an electrostatic copier using an illumination system constructed in accordance with the invention. For further details concerning the specific construction of the electrostatic copier, reference is made to copending application Ser. No. 731,934 filed concurrently herewith in the name of Hewes et al.

The sheet feeding mechanism **18** is illustrated in FIGS. **3 -9** for the seriatim feeding of cut sheet transfer material into contact with the xerographic belt **12** so that developed powder images on the surface of the belt may be transferred to the transfer material. The mechanism includes a tray for holding a supply of cut sheet transfer material, separator rollers and devices for separating a single sheet of transfer material on the tray, feed rollers for feeding a single sheet into the transport system **16** in order to bring the sheet into impression contact with the belt **12** and means for coordinating the operation of the separator rollers and feed rollers to thereby feed a single sheet of transfer material into contact with the belt **12** at proper registration of the powder image on the belt onto the transfer material. A tray level control device is also provided for raising the tray as sheets of transfer material are fed from the top of the material supply.

Referring now specifically to the drawings, the apparatus for feeding sheets of transfer material to the transport system **16** in timed relation to the appearance of a developed image on the belt **12** includes a paper tray **400** slidably positionable from the side of the machine between frame plates **401**, **402** and arranged to hold a stack S of various widths of sheet material such as paper.

The paper tray **400** includes a paper stack supporting base comprising two sections: a stationary base section **403**, and a movable base plate **404**, both plates being coplanar and including flat relatively wide fingers **405** (see FIG. **6**) which intermesh when both plates are joined to support a stack of paper. The fingers **405** support the stack when the rearwardly extending movable base plate **404** is pulled rearwardly to the position shown in dotted lines in FIG. **7** and indicated by the numeral **406**. The base plate may be placed in this position when loading the paper tray with long (legal size) paper which requires the machine to run in a long pitch mode.

The stationary plate **403** is held against movement within its plane by means of boxlike structure **407** having one edge **408** welded to an intermediate plate **409** which in turn is spot welded to the bottom surface of the stationary plate **403**. The sides of the intermediate plate **409** which extends in a plane parallel to and below the combined plate for the plate **403**, **404** are formed into downwardly projecting tapered side panels **411** which are held against forward or rearward movement by a slide mechanism to be described hereinafter. The intermediate plate **409** is formed with a slot **412** arranged centrally between the side panels **411** and extending for nearly the entire length of the plate **409**. Through this shot extends a pair of screws **413** secured to the bottom surface of the central finger **405** of the movable base plate **404**. These screws serve to support a ribbon **414** positioned paralleled to and below the plate **404** and is formed with a depending portion **415** which is adapted to engage an actuator **416** of a switch SW when the movable plate **404** is pulled rearwardly. The switch SW may be connected as an interlock circuit to effect change in machine pitch resulting from the use of longer sheets of transfer material. In loading the paper tray with longer sheets, the plate **404** is extended not only to accommodate longer sheets but also to condition the machine for the long pitch mode.

Each of the side panels **411** is adapted to be driven vertically in order to cause raising and lowering of the paper tray during paper feed operation. To this end, the base plate **401** has secured thereto a channel member **420** having its open side extending inwardly and arranged in a vertical position. Similarly the base plate **402** is provided with a channel member **421** secured thereon to face the channel **420**. The channel member **420** is adapted to receive a pair of guide rollers **422** mounted in space relation upon a vertically extending plate **423** secured in a vertical arrangement upon one of the side panels **411**. In like manner, the channel **421** serves to guide vertically a pair of vertically spaced rollers **424** mounted upon a plate **425** secured to the other side panel **411**. With this arrangement, the paper tray is free to move vertically and is held against horizontal movement by the confinement of the side panels **411** to the fixed channels **420**, **421**.

In order to produce control and automatic movement of the paper tray vertically the forward edges of each of the plates **423**, **425** is provided with a gear rack **426**, **427** respectively. A train of three vertically aligned gears are adapted to drive each of the gear racks in order to impart vertical motion of the paper tray. As shown in FIG. **7**, the gear rack **427** is in direct mesh with an upper gear wheel **428** mounted for rotation upon a stud shaft **430** secured to the frame plate **402**. Mounted below the gear **428** upon a stud shaft **431** is an intermediate gear **432**. Below the intermediate gear **432** is a third lower gear **433** secured to a drive shaft **434** having one end secured in a bearing to the frame plate **402** and its other end bearing mounted for rotation on the frame plate **401**.

This completes the three gear trains for the side of the paper feeder frame which supports the gear rack **427**. On the other side of the paper frame is a second gear train comprising gears **435**, **436**, **437** arranged on stud shafts **438**, **439** respectively for the gears **435** and **436** and the drive shaft **434** to which the lowermost gear **437** is secured. It will be apparent that the shaft **430** and **438** are in actual alignment as are the shafts **431** and **439**. It will also be apparent that upon rotation of the lowermost gears. **433** and **437** motion will be imparted to each of the respective upper gears which in turn produce corresponding movement of the respective gear racks **426**, **427**.

In order to produce rotation of the lowermost gears, the outer extremity of the drive shaft **434** on that side of the sheet feed mechanism having the base plate **401**, has secured thereto a drive gear **440** which is in mesh with a worm gear **441** formed on a shaft **442** mounted for rotation between flanges of a bracket **443** which also supports a paper elevation motor M–2 having its shaft connected to the shaft **442** for imparting rotation thereto. Preferably the motor M–2 is adapted to produce a low r.p.m. rotation which when coupled with the worm gear **441** and drive gear **440** impart relatively slow motion to the paper tray.

Centering of the stack S of the paper relative to the optical centerline of the copier/duplicator machine in order to insure proper registration and feeding of individual sheets of paper from the top of the stack is accomplished by a pair of vertically extending guide members **445**, **446** arranged at the forward corners of the stack when in position for separation operation. The guide member **445** is supported in an upright position by means of a horizontally extending guide pin **447** suitably secured to the frame plate **401** and extending through a boss **448** formed in the guide member **445**. Similarly the member **446** is supported in a vertical position by a guide pin **450** secured to the frame plate **402** and slidably received in a boss **451** formed in the upright. The guide members **445** and **446** are also formed at the lower ends with bosses **452**, **453** for supporting guide members **445**, **446** and to permit movement of these guide members toward and away from each other.

As shown in FIGS. 7 and 9, the guide member **445** is formed with a guide edge **454** that extends vertically along the length of the guide member and adapted to engage the leading edge of the stack of paper at one corner thereof. Engaging the side edges of the stack S along the same corner is a guiding surface **455** also formed along the length of the member **454**. The guide member **446** is similarly formed with a front guide edge **456** and a side guide edge **457** for guiding the leading and side edges of the stack of paper at that corner. The side edges **455** and **457** are adapted to be moved toward and away from each other and relative to the center line of the paper tray **400** in order to center the stack S relative to the optical axis of the xerographic machine as the axis will manifest itself during the image transfer step.

In order to drive the side edges **455, 457** toward and away from each other, the paper feeder **18** is provided with a manually operable centering drive system comprising a pair of links **460, 461** each having an end connected to one of the bosses **452, 453** and the other end connected to a block **462** mounted for rotation upon a shaft **463**. The points of connection of the links **460, 461** with the block **462** are offset relative to the axis of rotation for the block in order to cause movement of the bosses **452, 453** upon rotation of the block **462** in either direction. Rotation of the shaft **463** is accomplished by a knob **464** secured at the outer end of the shaft **463** at the rear of the paper handling mechanism **18**. A lock knob **465** secured to the extremity of the shaft **463** serves to move the knob **464** axially relative to the shaft and against a nonrotatable block **466** mounted on a spacer plate **469** and held axially thereto by a suitable shoulder **467** formed on the shaft. Rotation of the knob **465** will lock the knob **464** against rotation in order to prevent inadvertent driving movement being imparted to the guide members **445, 446**. It will be apparent that upon rotation of the knob **464**, the block **462** will be rotated for driving the links **460, 461** in either direction in order to impart corresponding movement of the bosses **452, 453** respectively. During a paper loading operation, the knob **464** is rotated to space the members **445, 446** apart to accommodate various widths of transfer material on the tray **400** and to permit the easy loading of additional sheets upon the tray. After the tray has been supplied with the sheets the knob **464** is rotated to drive the guide members toward each other in unison thereby aligning the stack relative to the optical centerline of the xerographic machine in proper position for paper feeding.

The driving action produced by the knob **464** and the shaft **463** in order to separate the members **445, 446** is against the bias of a spring **468** held in tension by being connected at its ends to each of the guide members and normally biasing them toward one another. Preferably, the spring is of such a strength that with the knob **464** left unsecured the guide members will be normally forced inwardly against the adjacent side edges of the stack of papers thereby enhancing good side-to-edge alignment.

The coacting side guide edges **455, 457** coacting with guide follower element **470** secured on the outwardly extending ends of a pair of rods **471, 472** held in axial alignment and being slidably mounted within blocks **473, 474** respectively, secured below and in spaced relation to the stationary plate **403** of the paper tray support the corners of the stack of transfer material. A rod **475** is slidably retained in the opposing ends of the rods **471, 472** and has a spring **476** encircling it in order to maintain the rods **471, 472** outwardly to force the follower elements **470** against the guide members **445, 446**. The guide elements **470** fill the corner gaps and support paper of all widths.

Generally, the upper ends of the guide edges **454, 456** are held at a point slightly below the top sheet of the stack S. As individual sheets of paper are fed from the stack, each is adapted to slide or to be driven over the top ends of the members. Means are provided for separating only the top sheet from the stack during a paper feed operation. In order to insure separation of the topmost sheet only from the stack, there is provided at opposite corners of the stack, separating devices which apply a light restraining force on the forward corners of the topmost sheet and the leading edge of the paper stack. Each of the separating devices comprise a vertically movable plunger **476, 477** freely movable in a vertical passageway **478** formed in each of the forward portions of the guide members **445, 446**. Each of the plungers has a snubber **480, 481** secured thereto at a plane slightly above the upper ends of the plungers and to be movable therewith.

The weight of each of the plungers **476, 477** is imposed on the upper forward corners of the paper stack. Normally the weight on each corner is such that the plungers will follow the level of the stack downwardly as the stack level is lowered by continuous feeding of paper. Their weights also provides a restraining force which will assist on the feeding of a single sheet of paper when the stack is acted upon by separator rollers to be described hereinafter. It is preferred that the limits of downward movement for the plungers **474, 476** are short in order to limit the downward movement of the corresponding snubbers. This is to limit the lowering of the snubbers when the level of the stack is lowered prior to a tray loading procedure and to guarantee that the snubbers are atop the corners of a freshly loaded stock without manual manipulation. As it is raised assuming proper centering by guide member **445, 446** the adjacent corners of the stack will engage the snubbers and carry them upwardly until the top of the stack is at its proper predetermined position for feeding of the top sheet.

To feed sheets of paper one at a time from the stack S and into the narrow slot formed between two closely spaced guide chutes **482, 483** arranged just forward of the top few sheets of the stack S, there is provided a paper separating means comprising a first pair of intermittently driven rollers **485** mounted rotation adjacent the side edges of the stack and a second paid of driven rollers **486** mounted inwardly of the rollers **485**. All of the rollers are engageable with the top of the paper stack. Each of the outboard rollers **485** is mounted for rotation on and by a driven shaft **487** associated with each of the rollers by means of a one way clutch **488** which permits each roller **485** to rotate freely in that direction that the topmost sheet moves when it is pulled out from the stack at a greater rate than the roller is capable of moving the sheet.

The inboard rollers **486** are mounted for rotation upon a drive sheet sleeve **490** which is drivingly connected to each roller by means of a one-way roller clutch **491** similar to the clutch **488**. The shafts **487** are mounted each within an end of the drive sleeve **490** which also contains within its interior a coil spring **492** which serves to force the two shafts shifts **487** outwardly for positioning the outboard rollers **485** to a predetermined position relative to the edge of the stack. This outward movement is limited by suitable buttons **493** which engage the edge guides **455, 457**. As the guide member **445, and 446** are moved outwardly the shafts **487** will follow the same in order to insure that the roller **485** maintain their set relation to the edges of the stack regardless of stack width.

Rotation is imparted to each of the shafts **487** by a pin **494** connected between each shaft and the end of the drive sleeve **490**. The sleeve **490** at each end is formed with a slot into which each pin is adapted to be inserted for connecting the shaft and for permitting limited axial movement of each outer roller **485**.

Driving rotation is imparted to the drive sleeve **490** by way of a timing pulley **495** secured axially of and at the center of the sleeve held between the flanges of a channel support arm **496** which supports the sleeve **490** and the rollers **485, 486**. The channel arm **496** is formed in two parts: a forward part **497** the end of which supports the sleeve **490** as previously stated and a supporting section **498** which conforms with the shape and direction of the portion **497**. These sections are connected in end-to-end relation by means of an opposing slot **500** formed in the portion **498** and coacting tongue **501** on the section **497** loosely insertable in the slot **500** to permit disconnection of the parts **497,498**. The loose connection between

the slot 500 and tongue 501 also permit limited rotation of the portion 497 about its longitudinal axis in order to allow all four rollers to contact the material surface regardless of stack deformation due to humidity. The purpose of this limited rocking movement will be described hereinafter.

The portions 497 and 498 are detachably held one to another by means of an adjusting screw 502 positioned within the channel shape of the arm 496 which positioned threadedly received at one end in a tapped portion 503 formed in the section 498 and at its other end that it received in a boss 504 formed in the portion 497. A suitable retaining ring is employed relative to the boss 504 for permitting rotary action of the screw 502 but preventing axial motion relative to the boss screw 502 need only be rotated until it becomes disengaged with either the block 503 or the boss 504 thereby permitting removal of the portion 497. The screw 502 serves as adjustment means between the portions 497 and 498 to control tension on the timing belt utilized to rotate the rollers 485, 486.

The support arm 496 is secured between the frame plate 401, 402 by means of a sleeve 505 which is mounted at one end through a knurled thimble 506 which is rotatably adjustable and supported upon a support sleeve 507 secured by suitable screws to the frame plate 401. Normally the arm 496 is under the influence of gravity in a direction to maintain the two pairs of rollers 485, 486 into engagement with the topmost sheets of the paper stack. However, additional force must be added in order to increase the force of the rollers upon the stack. This is accomplished by means of a torsion spring 508 having one end secured to the thimble 506 and its other end connected to a retaining plate 509 through which the sleeve 505 extends and is secured. The spring 508 may be adjusted in tension between its two supporting structures in such a manner as to impart rotation to the support sleeve 505 in addition to that rotation produced by gravity for more reliable feeding of heavier weight transfer material. When the stack is removed, the retaining plate 509 also serves to limit the downward movement or rotation of the arm 496 and prevent the undue stress on the structural parts. The retaining plate 509 also serves actuate the "up" elevator switch SW–3 and the "down" elevator switch SW–4 in a manner to be described hereinafter.

Held within the support sleeve 505 and extending across almost the distance between the plates 401, 402 is a drive sleeve 510 mounted for rotation at one end by a bearing 511 having its outer race secured to the inner recess of the support sleeve 507 and, a clutch mechanism 512 supported by suitable screws upon the frame plate 402. Axially rotatable within the drive sleeve 510 is a drive shaft 513 supported at one end in a bearing 514 mounted within the support sleeve 507 and at the other end extending beyond the frame plate 402 and terminating in a drive pulley 515 for a suitable drive system. The clutch is adapted, when energized, to operatively connect the drive shaft 513 with the drive sleeve 510 in order to produce rotation of a timing pulley 516 positioned between the flanges of the arm 496 and which is associated with a timing belt 517 also wrapped around the timing pulley 495 in order to impart rotation thereto. During operation when the clutch 512 is energized rotative motion is imparted to the pulley 516 which correspondingly imparts rotation to the timing pulley 495 for rotating the inboard paper feed rollers 486 and consequently the outboard rollers 485.

In operation, as the topmost sheet is frictionally advanced by the rollers 485, 486 the leading edge corners of the sheet engage the snubbers 480, 481 which are formed so as to present a continuation of the vertical front guide edges 454, 456 and hence a vertical barrier to the passage of sheets, but one limited to the outer extremes of the leading edge of the forward moving topmost sheet. As the rollers 485, 486 apply a forward force to the topmost sheet, the two forward corners of the sheet thus restricted by the snubbers, create a lag in the forward movement of the corners as the sheet is continually advanced. This lag will produce slight inward sliding movement of the corners of the sheet of paper with consequent buckling of the sheet. This buckling action of the topmost sheet insures its separation from the underlying sheets in the stack.

During feeding of the topmost sheet into the space between the guide baffles 482, 483, both pairs of feed rollers 485, 486 are positively driven to affect this movement. As the sheet advances its leading edge moves into the gate of the slightly separated registration rollers 520, 521 which eventually engage the sheet and pulls the same their remaining distance in order to clear the stack S. This second movement of the sheet is slightly faster than the initial driving action produced by the feed rollers 485, 486 and thereby results in the feed rollers rotated individually and freely in view of the individual one-way clutches associated with each of the rollers. Actually at this point, when the registration rollers 520, 521 take over control of the feeding of the sheet, energization of clutch 512 is terminated thereby stopping the positive drive action by the drive sleeve 490. In the event the topmost sheet becomes slightly askew as it is advanced across the remaining portion of the paper stack perpetuation of this unwanted skew condition is prevented in view of the fact that the feed rollers 485 and 486 will stop individually and sequentially as the topmost sheet trailing edge is pulled from under them. Without individual one-way clutches, the next sheet the stack will skew is each successive roller drops off the trailing edge of the previous sheet being skewed. Since these rollers would be secured to a common shaft, some nonstop turning until all have cleared the trailing edge. Rollers still on a skewed top sheet will continue to drive those rollers that have cleared the trailing edge, thereby urging that portion of the next sheet forward, perpetuating the skew.

The paper tray 400 is limited in its downward motion by means of a limit switch SW–7 mounted upon the frame plate 401 and electrically connected to the paper elevation motor M–2 through a suitable logic circuit for deenergizing M–2 upon activation of the switch when the tray reaches a predetermined low position. This is accomplished by means of a projection 522 secured to the plate 425 and which actuates the switch SW–7 at the predetermined low point. Another switch SW–8 mounted on the frame plate 401 controls the upper limit of travel of the paper tray 400 by means of a projection 523 mounted on the plate 425. In the event the tray 400 attains a predetermined high point, the switch SW–8 is actuated though a suitable logic circuit in order to terminate energization of the paper elevation motor M–2.

In the sheet registration mechanism illustrated in FIGS. 10 and 14—17, the registration rollers 520, 521 are adapted to cooperate with a pair of registering fingers interposed in the path of movement of a sheet being fed by the separator rollers 485, 486 in order to align the leading edge of each sheet to a precise position before the sheet is permitted to continue on to the paper transport mechanism 16 whereat the developed electrostatic image on the belt 12 will be transferred. As shown in FIG. 10, the top registration roll 520 comprises a central metallic core 525 having a plurality of soft rubber layers 526 therearound adapted to engage frictionally a sheet of paper. The roller 520 is mounted at one end on a stub shaft 527 (see FIG. 15) supported in a bearing housing 528 held by a clamp 530 to the shaft end, at its other end on a stub shaft 531 supported in a bearing housing 532 held thereto by a clamp 533.

At the left end of the registration roller 520 as viewed in FIG. 10, a sprocket 534 is secured to the stub shaft 531. The bearing housings 528 and 532 are eccentric in nature so as to provide adjustment to the pinch between the upper register roller 520 and the lower roller 521. The end of the registration roller 520 is also supported by levers 535, 536 (see FIGS. 4 and 5) pivotally mounted at the ends by fixed stub shafts 537 secured on the frame plates 401, 402 respectively, in axial alignment. The stub shaft 537 that is fixed to the plate 402 also has secured thereto a sprocket 538 which is arranged in driving connection with the sprocket 534 by a drive chain 540 for driving the registration rollers to be described hereinafter. A

suitable idler sprocket **541** is also mounted on the lever **536** and operatively associated with the chain **540** to permit tightening of the chain **540** for removal from the operating sprockets.

The top edge of the frame plate **401** is formed with a generally vertically extending slot **542** into which the stub shaft **527** for the upper roller **520** is adapted to be placed when this roller is in operating position. Similarly, the shaft **531** at the other end of the roller is adapted to be positioned within the open ended slot **543** formed in the upper edge of the frame plate **402**. The provisions of the slots permit the pivoting moment of the driven roller **520**, away from the lower idler roller **521** and out of the path of movement of the paper and, in fact, away from the cooperating structure therefore to permit maintenance and paper jam clearing.

Located immediately below the top registration roller **520** and parallel therewith, the lower roller **521** comprises a plurality of free wheeling, short rollers **544** all of which are rotatably mounted with ball bearings upon a common sleeve **545** which is rotatably mounted on a shaft **546** by means of a roller bearing **547** provided at each end thereof. The shaft **546** is mounted at one end to the frame plate **401** by suitable bearings and at the other end by a bearing **548** secured in a solenoid mount **549**. At this end, the shaft **546** terminates in a straight slot **550** into which projects a tongue **551** formed on the end of a movable actuator **553** for a double-acting rotary solenoid **554** the details of which will be described hereinafter. The solenoid **554** comprises an "up" solenoid SOL—**1** and a "down" solenoid SOL–**2** and is adapted to impart nonaxial rotary motion to the drive shaft **546** in either direction for approximately 45° upon energization of each of the solenoid coils associated with the solenoids SOL–**1** and SOL–**2**.

Mounted upon the sleeve **545** between any two of the free wheeling rollers **544** are registration fingers **555** which are secured by suitable set screws upon the sleeve **545** to be moved therewith or held stationary when the sleeve is held against rotation.

As shown in FIG. **16**, the periphery of the roller **520** is slightly spaced from the periphery of the rollers **544**. This spacing is greater than the thickness of a sheet of paper and permits the sheet to enter within the nip between the rollers and, against the fingers **555** and to maintain this position until a feed cycle is activated. At this time in the cycle, paper is still being driven by the feed rollers **485**, **486**. This action is opposed by the fingers **555** in the paper path causing the paper to buckle momentarily squaring the front edge. With the forward edge of a sheet of paper against the fingers **555**, the upper roller **520** is continuously driven but being spaced slightly from the top surface of the sheet of paper it is incapable of driving the sheet beyond the fingers **555**. In order to permit the proper alignment of the forward edge of the sheet of paper against the registration fingers **555** and then to accomplish forward feeding movement to the sheet by means of the roller **521**, **520**, the registration system is provided with a control mechanism which controls the movement of the upper roller **520** downwardly into engagement with the sheet of paper located therebelow in order to drive the same at the same time as retracting movement of the fingers **555** in order to eliminate the impeding action by these fingers against the forward edge of the sheet.

This control mechanism includes a first link member **556** (See FIG. **17**) arranged to encircle both shafts **531**, **546** for the rollers **520**, **521** respectively adjacent the frame plate **402** and, a second link member **557** (see FIG. **15**) arranged to encircle both shafts for the upper and lower registration rollers adjacent the frame plate **401**. These link members more or less hold the two rollers in superimposed close relationship. Movement of the upper registration roller **520** toward the lower roller a slight increment is accomplished during energization of the solenoid SOL–**2**. Upon energization, the actuator **553** is rotated in angular distance of 45° which action imparts similar rotation to the drive shaft **546**. As shown in FIG. **17**, a crank **558** secured to the shaft **546** of the lower roller **521** and having a cam pin **559** arranged for movement in a cooperating arcuate internal cam **560** formed in the lower end of the link **556** is adapted to force the shaft **531** toward the shaft **546**. As previously stated, the levers **535** and **536** permit limited movement of the upper roller **520** toward and away from the lower roller **521**. As the crank **558** is rotated clockwise as viewed in FIG. **17**, the cam pin **559**, as it moves from the right-hand end of the cam **560** to approximately the center point thereof, will drive the link member **556** slightly downwardly carrying therewith the roller **520** toward the roller **521**.

In order to maintain the fixed position of the shaft **546** for the lower roller, the link **556** is formed with a vertical extending slot **561** through which the shaft **546** extends. This provides a lost motion connection between the link **556** and the shaft **546** during the slight upper and lower movement of this link. Continuing movement of the cam pin **559** from the approximate center point of the cam **560** to the left-hand end of the cam, a total angular distance equal to 45° produced by the continued rotation of the solenoid SOL–**2** armature **553**, the distance between the axes of the shafts **531** and **546** remains the same. This movement of the cam pin **559** can be considered dwell time for the operation of the motion producing mechanism to effect engagement of the rollers **520**, **521** in order to permit the remaining rotation of the shaft **546** to perform another function, that of rotating the registration fingers **555** out of engagement with the leading edge of a sheet of paper positioned in the paper guides **482**, **483**.

The mechanism to control movement of the fingers **555** is illustrated in two sequences of operation in FIGS. **14** and **15** and is effected by actuation of the link member **557**. The link member **557** is identical with the link member **556** and is formed with a vertical straight slot **562** through which the shaft **546** extends for lost motion when the link member **557** is moved and, an internal cam **563** through which a control cam pin **564** projects. The curvature and angular relationship and distance of the cam **563** relative to the axis of the shaft **546** is the same as the cam **560**. Consequently during rotation of the shaft **546** in a clockwise direction, as viewed in FIG. **14**, the positioning and movement of the pin **564** is the same as the pin **559**.

Secured to the shaft **546** adjacent the link member **557** is a sector **565** to which the cam pin **564** is attached. Meshing with the gear **564** is a second sector gear **566** mounted for rotation on a pivot pin **567** secured to the frame plate **401**. The pivot pin **567** also supports for rotation thereon a cam member **568** secured to the sector gear **566** and made adjustable therewith by means of a set screw **569** threadedly received in the member **568** (see FIG. **15**) and engageable with the sector **566** to permit angular adjustment of one with the other. It will be apparent upon rotation of the shaft **546**, the sector **565** will be rotated and the cam pin **564** will be moved in the cam **563** thereby driving the link member **557** downwardly. This motion of the link member **557** is simultaneous and equal to the motion of the downward link **556** in order to impart the smooth uniform motion of the roller **520** downwardly.

As shown in FIG. **15**, the cam member **568** is formed with an angled internal cam which is formed so as to have a first cam portion **570** with a center of curvature approximately coincident with the axis of the pivot pin **567** in a second cam portion **571** which merges with one end of the angled cams but extends radially toward the pivot pin axis. The angled cam is adapted to control movement of a rotatable actuating element **572** rotatably mounted on the shaft **546** adjacent the sector gear **565** and secured to one end of the sleeve **545**. This is accomplished by means of a control pin **573** secured to one end of the actuating element **572** and retained within the cam portions **570**, **571** to be movable therein. Upon rotation of the link **568** from the position shown in FIG. **15** wherein the pin **573** is in the arcuate cam portion **570** of the angled cam, no rotation is imparted to the actuating member **572** that is, the register fingers **555** will not be rotated. This result occurs because the control pin **573** merely slides in a arcuate cam as

the cam member 568 pivots about its axis. This initial rotation of the member 568 is produced by the initial energization of the solenoid armature SOL–2 which action also produces the short movement of the control pin 559 for the first portion of its movement in the cam 560 as previously described. The resultant action merely keeps the upper roller 520 against the lower roller 521 and the register fingers in dwell.

When the pin 573 reaches the end of the cam 570 at the apex of the cam angle, continued rotation of the link member will actuate the pin 573 in the same direction therewith to produce clockwise rotation of the link member will actuate the pin 573 in the same direction therewith to produce clockwise rotation of the actuating element 572 as viewed in FIG. 15 in order to produce slight rotation of the sleeve 545 along its axis. Since the fingers 555 are secured to the sleeve 545 this last motion of the rotation of the link member 557 causes movement of the fingers away from the leading edge of the sheet of paper between the rollers 520, 521. This rotation of the fingers will be clockwise as viewed in FIG. 16. The set screw 569 is utilized to orientate the member 568 relative to the sector gear 566 in order to insure proper rotation of the actuating member 572 at a time when the rollers 520, 521 are in engagement. When this occurs the upper roller 520 engages the short rollers 544 of the lower roller to impart rotation thereto for driving this sheet therebetween at the same time that the fingers 555 are moving in the same direction as the leading edge of the sheet but in additional downwardly motion in order to become clear of this edge.

From the foregoing the paper sheet feeding mechanism 18 is adapted to feed continuously individual sheets of paper to the sheet registration device in the form of the rollers 520, 521 and the fingers 555 located in the path of movement of the paper. The sheet registration device arrests and aligns each individual sheet of material and then in timed relation to the movement of the xerographic belt 12 advances the sheet material into contact with the belt in registration with a previously formed xerographic powder image on the belt.

As previously stated the double-acting rotary solenoid 554 comprises a pair of pancake solenoids SOL–1 and SOL–2 and, is arranged to produce rotation of the shaft 546 in either direction without the usual incidental movement in the axial direction. In accomplishing this function, the "up" solenoid SOL–1 has its armature 574 in the form of a flat disc and arranged to be rotated in one direction when the solenoid is energized and, the "down" solenoid SOL–2 has its armature 575 also in the form of a flat disc arranged to be rotated in the opposite direction when this solenoid is energized.

The disc armatures are arranged in parallel planes and have their axes in alignment. Each is formed with an axial opening through which a rotary element 576 extends and is secured to the armatures to be removable therewith as a unit. The element 576 slidably receives the actuator 553 and is provided with internal teeth that mesh with the splined exterior surface of the actuator to which is connected to the tongue 551 and groove 550 as a driving connection to the shaft 546 for the lower registration roller 521. As each of the armatures 574 and 575 is moved by its respective energized solenoid coil, it moves the element axially along the actuator and moves the other armature away therewith.

Upon energization of either of the coils for the solenoids, the respective armature will be driven in rotational movement. This rotary motion is produced by the cooperative action of a plurality of balls 577 rotatably held within a pair of coacting inclined depressions 578 formed one on the outer surfaces of each armature and the other in cover plates 579 which may surround the solenoids as a casing therefor. The depressions 578 are disposed so that their longitudinal axes and therefore, the inclined surfaces are circular having a radius of curvature on the axes for the armatures. Each of the cover plates 579 and armature associated therewith are held one parallel to the other and close enough so that the balls are retained within the inclined depressions in the armatures and their coacting inclined depression 578 in the cover plates.

In operation, when the solenoid SOL–2 is energized and the other SOL–1 is deenergized, the armature 575 is attracted to the coil for SOL–2. This causes the element 576 to slide to the right, as viewed in FIG. 10 without producing axial movement of the actuator 553. Movement of the element 576 causes the other armature 574 to be driven toward the adjacent cover plate 579, this is, from the position shown in FIG. 12 to that shown in FIG. 13. The normal magnetic action of the coil for the solenoid SOL–2 could want to force the armature to the right as viewed in FIG. 10. Since the balls 577 prevent axial motion directly, the magnetic force will cause the balls to move along the inclined planes of the depressions 578 on the plate 579. Because of the locking action between the balls and the leading edges of the inclined planes of the depressions formed in the armature 574, the same will be caused to rotate. The armature 574 will rotate in an amount determined by the length of the depressions 578 and the distance the armature is allowed to move axially. For purposes of actuating the upper registration roller 520 into a paper feeding position and to reposition the fingers 555, the amount of angular rotation desirable is approximately 45°.

In the event the "up" solenoid SOL–1 is energized, the armature 575 will be rotated in the opposite manner as the armature 574. Regardless of which of the solenoids are energized both armatures with the element 576, secured therebetween will move as a unit and will slide relative to the actuator 553. However, the actuator will be rotated, the direction being determined by which of the solenoids being energized. With the "up" solenoid SOL–1 energized, the roller 520 will be held in its uppermost position and the fingers 555 in a sheet engaging condition.

While there is in this application specifically described one form which the invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration, and that the invention may be modified and embodied in various other forms without departing from the scope of the appended claims.

We claim:

1. In a sheet handling apparatus having a frame structure and a supply tray adapted to hold a stack of sheet material to be fed seriatim off the top of the stack, the combination of:

a plurality of separator rollers arranged to be engageable with the top sheet of the stack and adapted when rotated to separate the top sheet and move the same in the plane of the sheet;

two of said separator rollers being mounted for rotation on a main shaft arranged substantially parallel to the leading edges of the sheets in the stack, others of said plurality of rollers positioned outboard of said two rollers on each side thereof and in axial alignment therewith, each of said other rollers being mounted on individual shafts arranged coaxial with said main shaft and mounted for axial movement relative thereto;

a support arm operatively connected at one end to the shaft for supporting the same for rotation;

means for pivotally supporting said support arm at its other end on the frame structure wherein the rotative movement of the arm is in a plane substantially normal to the plane of the top sheet whereby the separator rollers may be lifted therefrom; and

drive means for imparting rotation to said plurality of separator rollers.

2. The apparatus of claim 1 wherein said two rollers and said outboard rollers are provided with a one-way clutch in their mountings relative to their respective shafts preventing a drive being imparted to any one of the rollers by a driving action of another roller.

3. In a sheet handling apparatus of the type having a supply tray adapted to hold a stack of sheet material to be fed seriatim off the top of the stack, separator rollers mounted for rotation on a shaft arranged parallel to the leading edges of the stack and moving the same in the plane of the sheet, a support arm connected at one end to the shaft for supporting the rol-

lers for rotation, and drive means for imparting rotation to said separator rollers, the improvement wherein said support arm for the shaft comprises at least two portions, one of said portions being connected to the shaft as aforesaid and to said other portion for rocking movement relative to said other portion for permitting rocking movement of said shaft about an axis substantially parallel with the longitudinal axis of said arm and normal to the shaft wherein the extent of rocking will permit one of the rollers to be lifted from the top sheet while another roller remains thereon.