

[54] SORTING APPARATUS

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[52] U.S. Cl. .... 271/64

[51] Int. Cl. .... B65h 29/58

[58] Field of Search ..... 271/64; 270/58, 85

[56] References Cited

UNITED STATES PATENTS

3,618,936 11/1971 Ziehm ..... 271/64

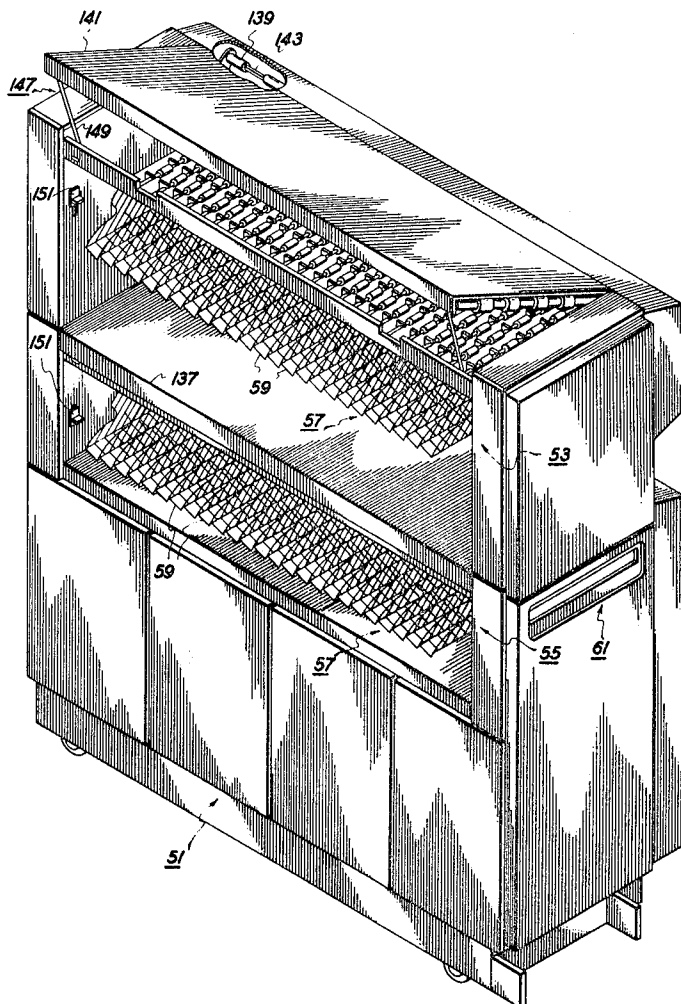
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[57] ABSTRACT

Apparatus for receiving and distributing sheets in substantially vertically extending trays including first and second modular assemblies positioned in overlying relationship. Each modular assembly includes a frame supporting a wire framework forming vertically extending trays and a horizontal sheet conveyor in the form of endless belts extending in a path along the inlet side of the trays. At the inlet side of each of the trays is a movable sheet deflection gate which is pivotally supported and solenoid actuated in response to a control signal to route sheet material carried by the horizontal conveyor downwardly into a selected one of the trays. A separate drive is associated with each of the horizontal conveyors and a double acting clutch mechanism is associated with conveyors so that each of the modular assemblies may be operative to drive pinch rolls at the inlet of the sorting apparatus in the event that a drive becomes inoperative. The horizontal conveyors are supported in a pivotable cover to facilitate the clearance of paper jams along the sheet path.

8 Claims, 14 Drawing Figures



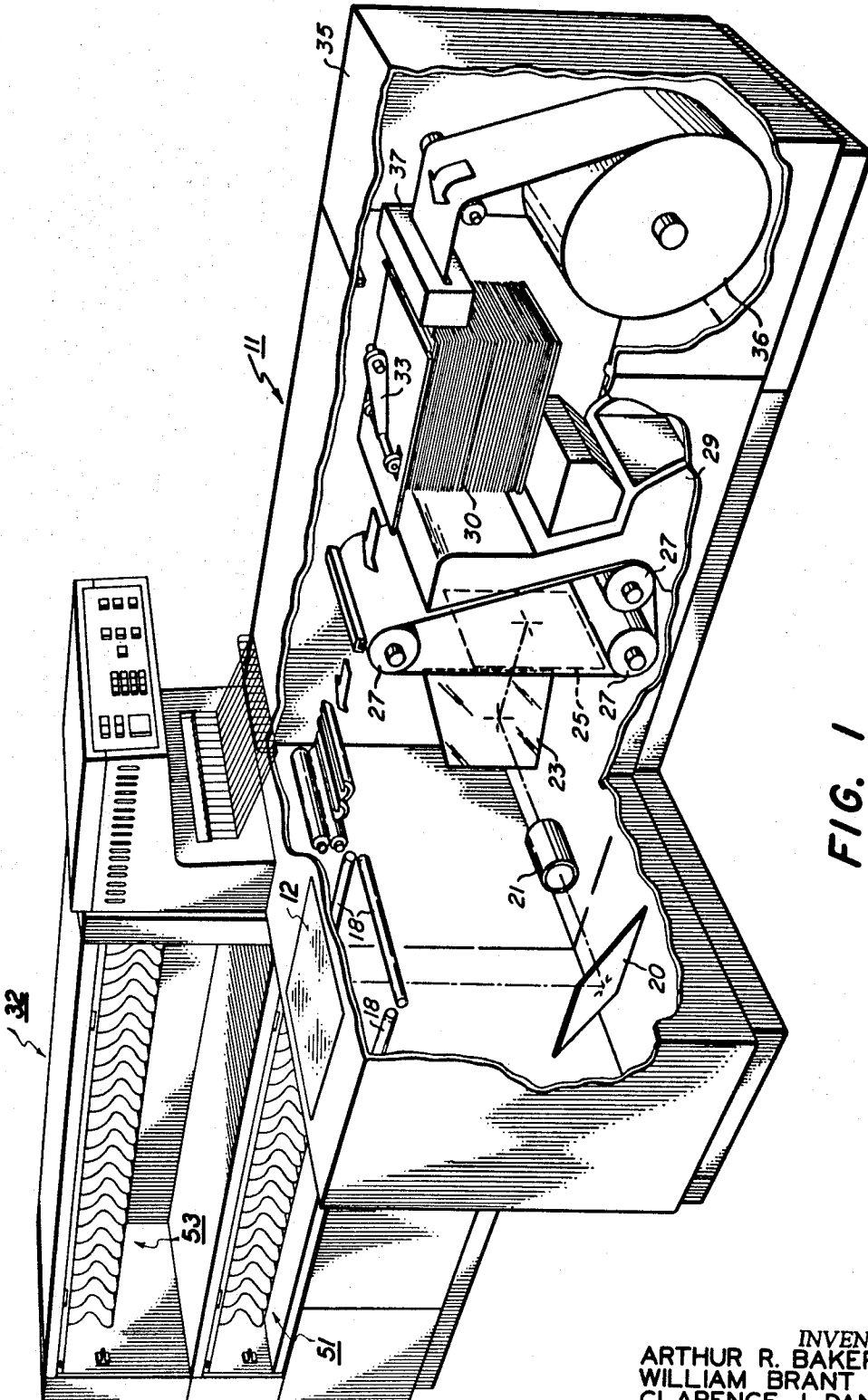
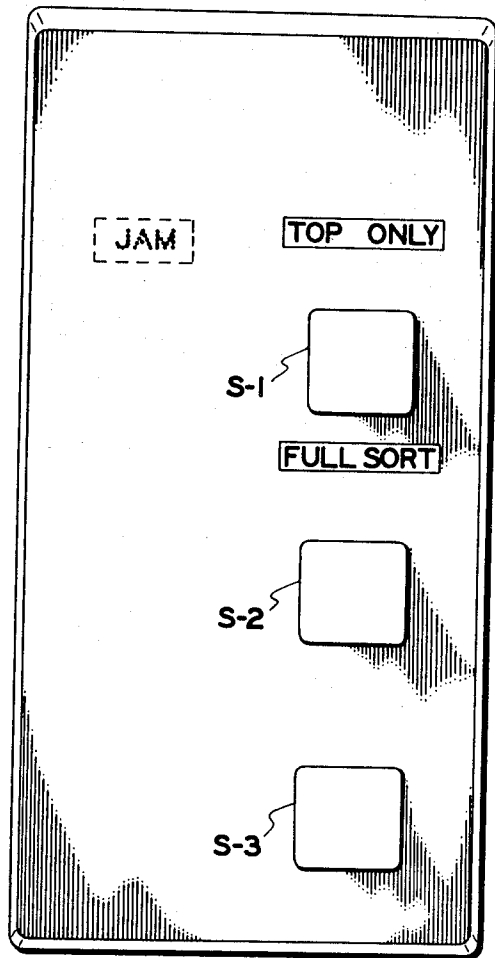


FIG. 1

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**FIG. 1(a)**



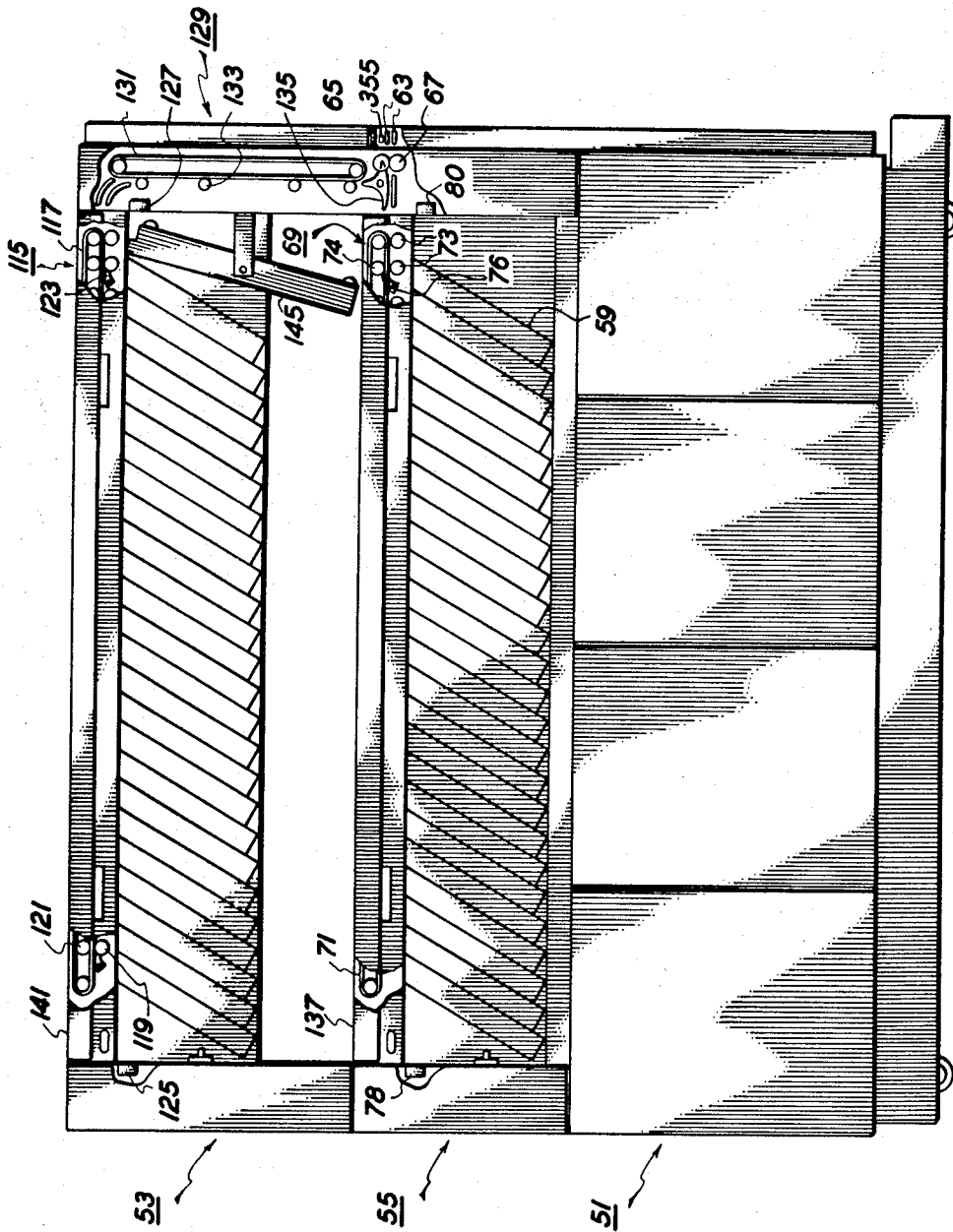


FIG. 3

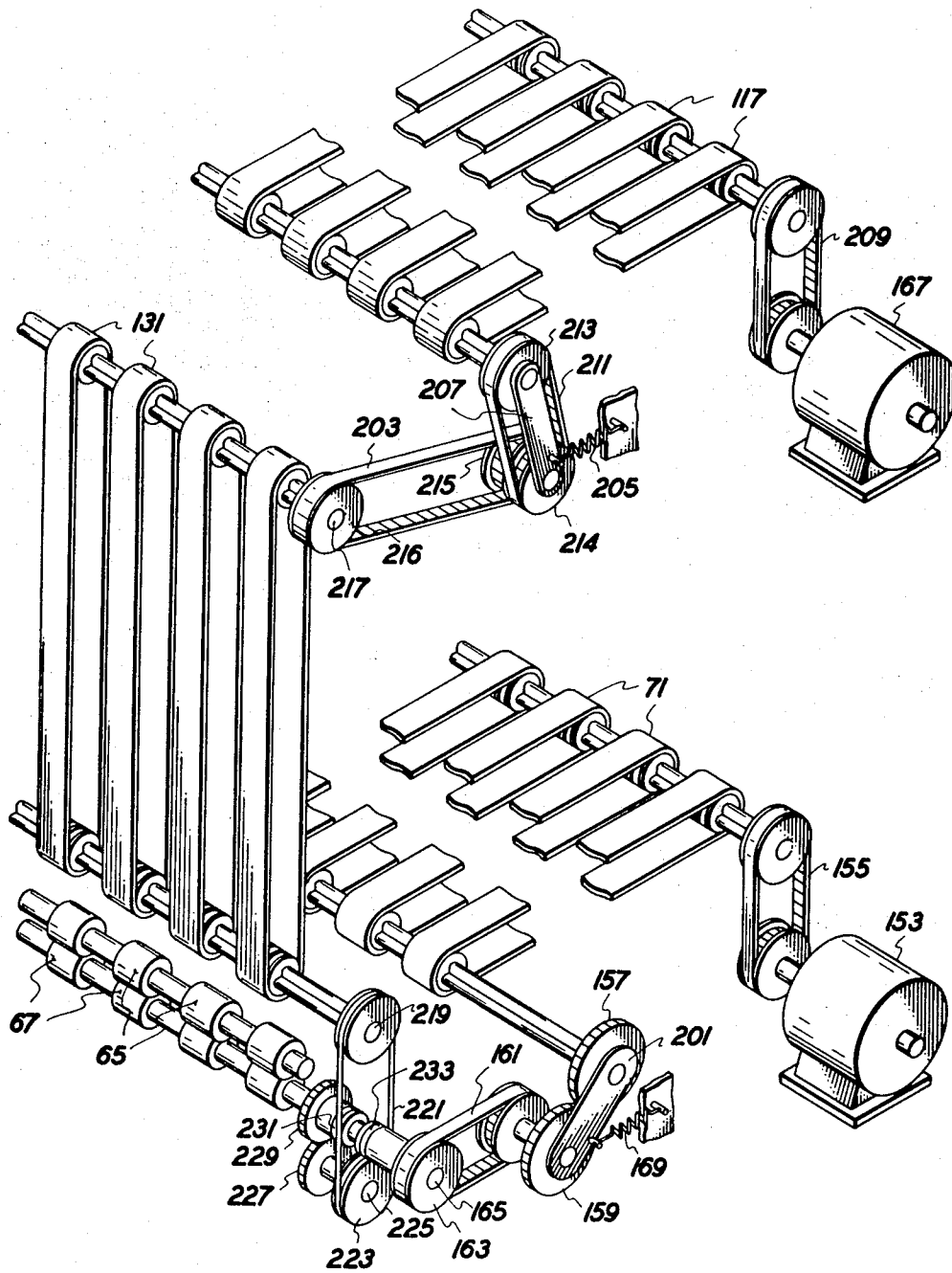
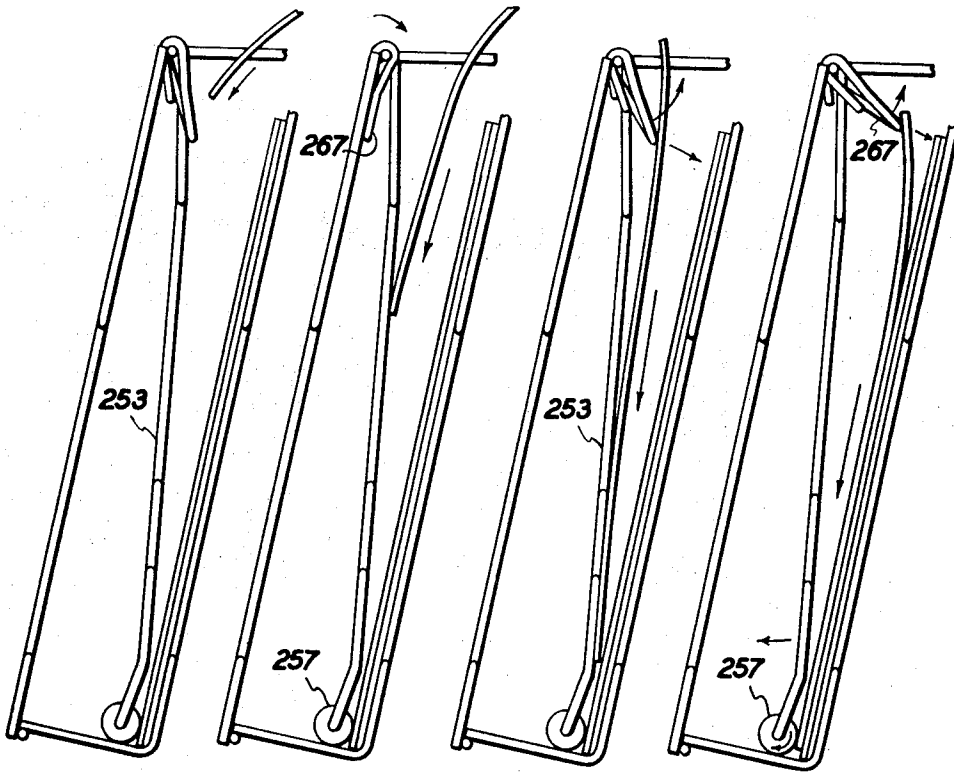
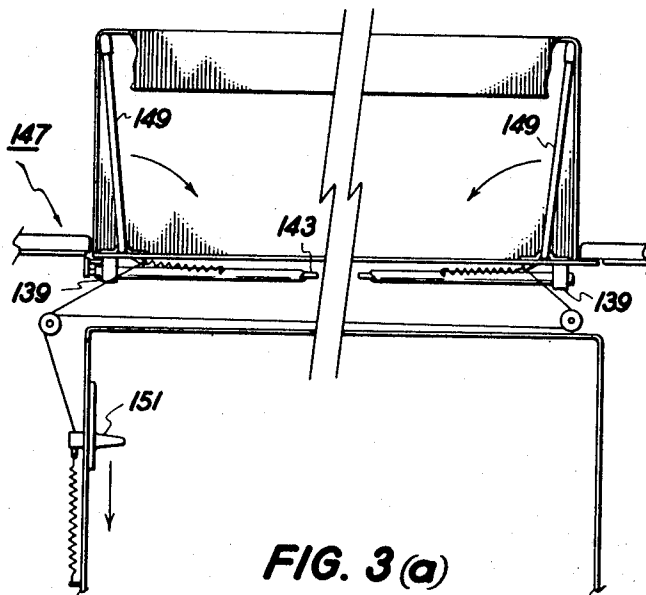


FIG. 4



**FIG. 7(a) FIG. 7(b) FIG. 7(c) FIG. 7(d)**



**FIG. 3(a)**

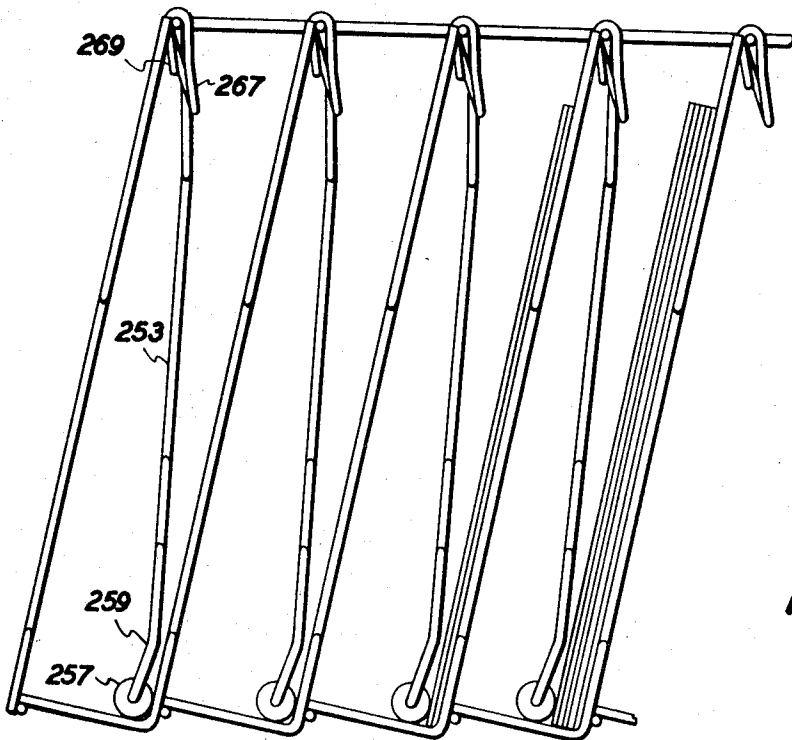
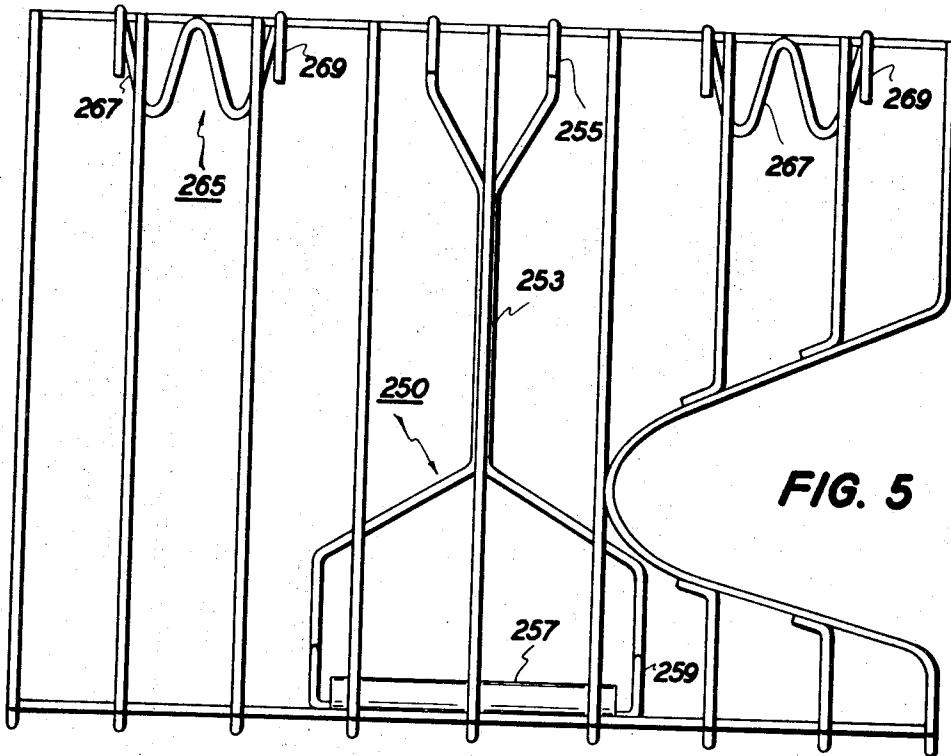


FIG. 6



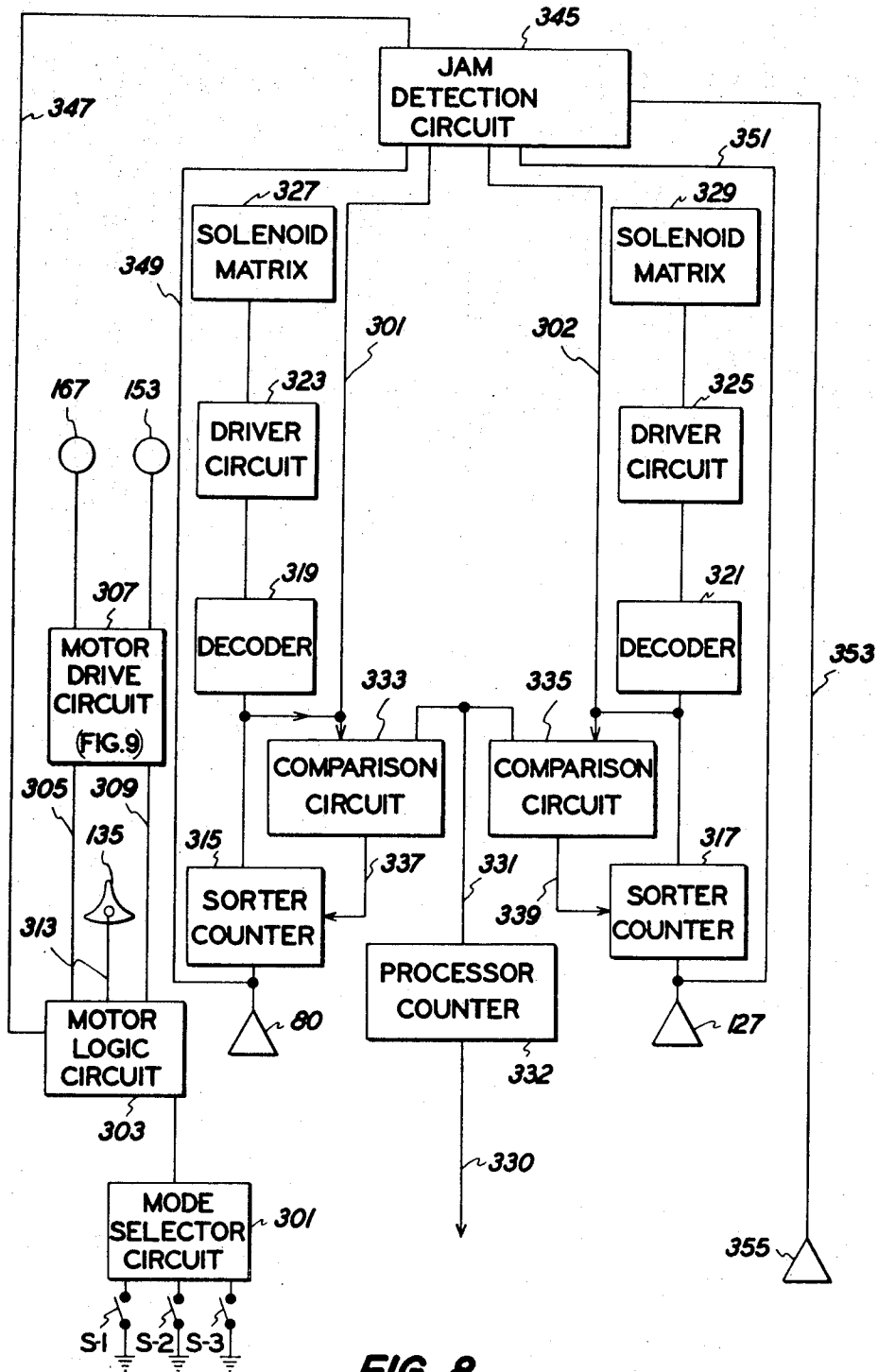


FIG. 8

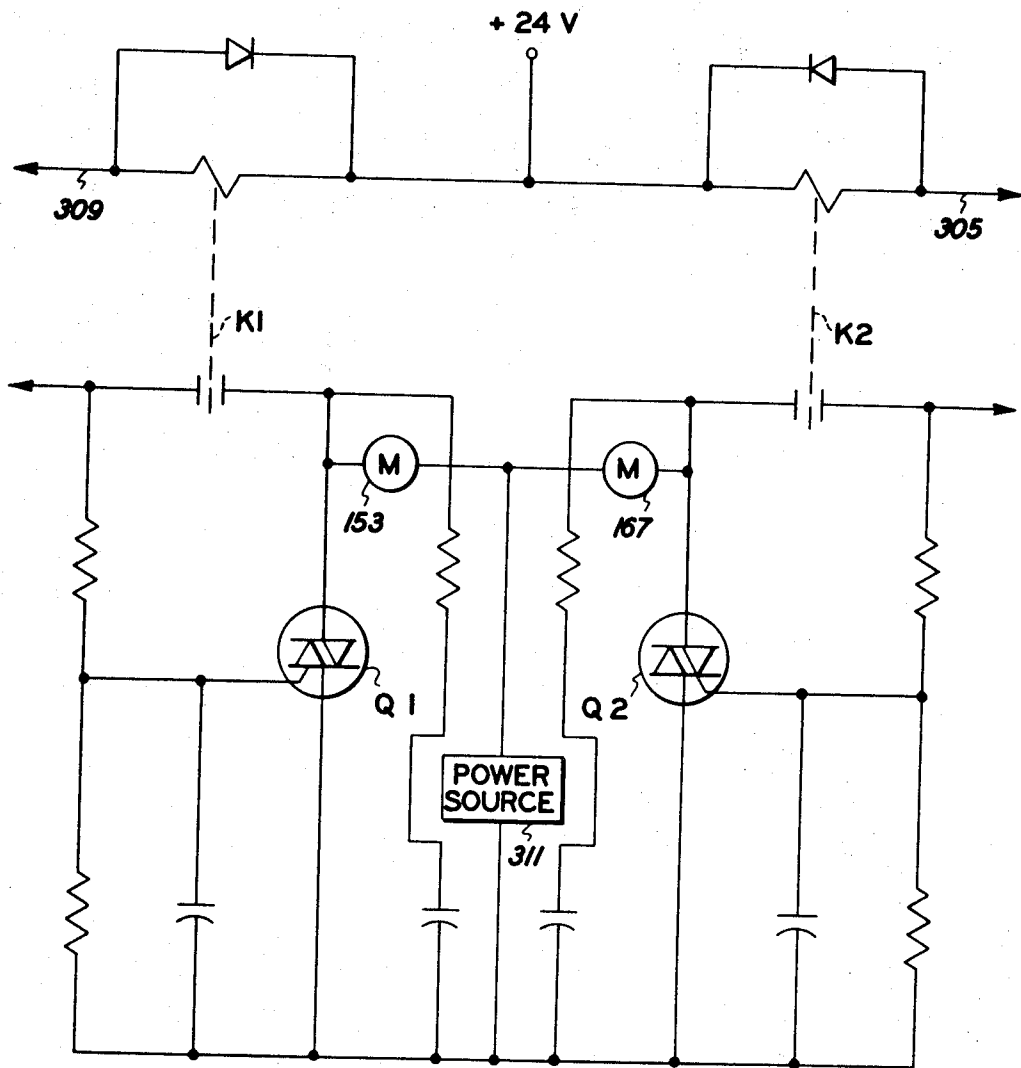


FIG. 9

## SORTING APPARATUS

This invention relates to apparatus for sorting documents and more particularly to a high speed modular type apparatus capable of sorting documents along alternate routes in a greatly improved fashion.

Sorters for copying machines are of several types. One type shifts copy receiving trays arranged in columns relative to a fixed sheet feed path as described, for example, in U.S. Pat. No. 3,372,922. Another type feeds copy sheets to a plurality of modular assemblies in a serial fashion as described, for example, in U.S. Pat. No. 3,484,101. With the advent of high speed copier machines where paper jams become more frequent, it is desirable to simplify the routing of the copy sheet material and to facilitate the transport thereof to minimize the occurrence of paper jams. However, in the event that a jam does occur, it is desirable that jams be cleared as expeditiously as possible so that machine down time is minimized.

It is therefore an object of the present invention to improve the sorting of sheet material.

It is another object of the present invention to provide alternate paths for the feeding of sheet material to copy receiving trays.

It is a further object of the present invention to facilitate the clearing of paper jams occurring in sorting apparatus.

It is a further object of the present invention to improve the construction of modular sorting apparatus.

It is a further object of the present invention to enhance the flexibility in which sheet material is handled by high speed sorting apparatus.

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 sorting apparatus according to the present invention;

FIG. 1a is a view of the control panel of the sorting apparatus;

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

FIG. 3 is a front sectional view of the sorting apparatus;

FIG. 3a is a front view of the sorting apparatus with cover open illustrating certain details of the latch assembly;

FIG. 4 is an isometric view of the drive mechanism of the sorting apparatus;

FIGS. 5 and 6 are end and front sectional views of the trays and stacking control apparatus;

FIGS. 7a through 7d are front views illustrating sequential operation of the stacking control apparatus;

FIG. 8 is a block diagram of the control circuitry for the sorting apparatus; and

FIG. 9 is a circuit diagram of the motor circuit of the control circuitry.

## 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. It should be understood, however, that any

type of printer system could be used with the present invention and not necessarily the printer system described herein. 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 of paper or the like to which it may be fused by a fusing device whereby the powder image is caused permanently to adhere to the surface of the record material.

The xerographic processor indicated by the reference numeral 11 is arranged as a self-contained unit having all of its processing stations located in a unitary enclosure or cabinet. The printer system includes an exposure station at which a light radiation pattern of a document to be reproduced is positioned on a glass platen 12 for projection onto a photoconductive surface in the form of a xerographic belt 13.

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 sta-

tion 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 sorting apparatus 32 for distributing into trays or bins 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 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 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 misalignment 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.

### SORTING APPARATUS

Referring now to FIGS. 2-6, sorting apparatus 32 comprises a base frame 51 which supports upper and lower sorting assemblies 53, 55, respectively. Lower sorting assembly 55 includes a unitary framework 57 defining a series of bins or trays 59 which receive copy sheets in a downward direction. Similarly, upper sorting assembly 53 has a unitary framework 57 which defines a series of trays or bins 59 for receiving copy sheets.

Sheets enter the sorting apparatus through an opening 61 formed in the frame of the lower sorting assembly 55. The sheets pass through guides 63 to a pair of pinch rolls 65 and 67 which direct their travel to a horizontal transport 69 which is made up of a plurality of horizontal driving belts 71 which are above the sheet path and free wheeling rollers 37 positioned below the sheet path. Above rollers 73 are rollers 74 which are positioned within belts 71 and are spring loaded downward to ensure proper traction between the belts and sheets being transported. The sheets traveling on the horizontal belts are deflected downward into an ap-

propriate tray by fingers or gates 76 actuated into the sheet path by an associated solenoid in accordance with the control logic. The control logic is triggered by the passage of a sheet from the horizontal transport into a tray which causes the breaking of the light beam between a light source 78 and a photo-transistor 80. The breaking and then re-establishment of the light beam results in the open gate closing and the next gate opening which continues until the last copy is received in the appropriate sorting assembly.

The upper sorting assembly 53 includes a transport 115 made up of horizontal belts 117 which moves above the sheet path and free wheeling rollers 119 positioned below the sheet path. Above rollers 119 are rollers 121 which are positioned in belts 117 to ensure proper traction as in the case of rollers 74. Fingers or gate members 123 serve to deflect the copy sheets into the bins or trays when actuated by the control logic which includes a light source 125 and phototransistor 127.

To transport the copy sheets into the upper sorting assembly, there is provided a vertical transport 129 made up of vertical belts 131 which moves against rollers 133. The vertical transport 129 receives the sheets when solenoid actuated sheet deflector 135 is positioned so as to direct the sheet upwardly in accordance with control logic as will be described hereinafter.

Horizontal belts 71 are received and supported in a pivotable cover 137 connected to the frame by one or more hinges 139. Similarly, horizontal belts 117 are received in and supported by a pivotable cover 141 connected to the frame by one or more hinges 139. By this arrangement, if a jam occurs within the transport path, the belts 71 and 117 may be raised clear from the transport path by pivotable movement of the covers 137 and 141, respectively. Torsion springs 143 extend along the length of covers 137 and 141 and serve to facilitate raising of the covers. In the event that a jam occurs in the vertical transport 129, a hinged cover 145 is provided for easy access to the transport path. It will now be appreciated that if a jam occurs anywhere along the sheet path, the sheet may be cleared expeditiously by opening of the covers 137, 141 or 145 to a displaced position away from the sheet path sufficiently so that an operator's hand may be inserted and the jammed sheet removed from the sheet path. A latch assembly 147 including spring biased pins 149 serves to maintain each of the covers 137 and 141 in a raised position to prevent inadvertent closing on the hand of an operator. Handle 151 operates to retract the spring biased pins for closing of the covers.

Sheets may be sorted by either the lower sorting assembly 55 or the upper sorting assembly 53 or both together for long runs. The lower sorting assembly includes a drive motor 153 which drives transport belts 71 through a timing belt 155 (FIG. 4). Transport belts 71 drive gears 157, 159 which, in turn, drive pinch rolls 67 through a timing belt 161 which is mounted on a pulley 163 driving shaft 165 carrying the pinch rolls 67. It will be appreciated that by virtue of the flexibility of belt 161, that transport belts 71 which are housed in cover 137 may be pivoted away from and into the sheet path. A spring 169 connected to the frame and a link member 201 maintains proper belt tensioning during operating conditions. The pinch rolls 67 desirably are

driven at a speed or rate slightly lower than the speed at which the belts 71 are moving so that the paper is pulled smoothly along its transport path rather than being pushed or jerked.

Upper sorting assembly 53 includes a drive motor 167 which drives the transport belts 117 through a timing belt 209. Transport belts 117, in turn, drive transport belts 131 through a timing belt 211 mounted on pulleys 213 and 214 and a belt 203 which is mounted on pulleys 215 and 216 which serve to drive shaft 217 drivingly connected to the belts 131. It will be appreciated that belt 203 is able to flex when belts 117 and cover 141 are raised above the sheet path. A spring 205 connected to link 207 maintains proper belt tension for accomplishing the desired drive operation. It will be noted that a shaft 219 which is at the lower extent of the transport belts 131 is drivingly connected to a pinch roll 67 through an "O" ring 221 which is received on a pulley 223 mounted on a shaft 225 which carries gear 227 which meshes with a gear 229 mounted on a shaft 165.

The driving mechanism described above enables the vertical transport to be driven by motor 167, and pinch rolls 67 to be driven through the upper or lower sorting assemblies by motors 153 and 167, respectively. To accomplish this operation, a pair of overrunning clutches 231 and 233 are mounted on shaft 165. The shaft 165 may then be driven through either the upper sorting assembly drive motor or the lower sorting assembly drive motor. It will now be appreciated that when clutch 231 is in driving relation that clutch 233 overruns and vice versa. By virtue of this driving arrangement, the pinch rolls 65 and 67 may be operated to provide alternate sorting paths into the two sorting assemblies. Thus in the event that drive motor 153 becomes inoperative, the pinch rolls are driven by drive motor 167 through clutch 233. Furthermore, by virtue of the flexibility of belts 161 and 203, the transport belts may be moved out of the sheet path to remove sheet jams expeditiously.

#### STACKING CONTROL APPARATUS

Associated with each of the trays 59 is a stacking control apparatus 250 which serves to ensure that the sheets when received in a tray do not bounce to interrupt the light beam and assures proper stacking alignment of the sheets. The stacking control apparatus comprises a roller assembly 251 which includes an X-shaped frame 253 with loop portions 255 engaging wire framework 57. Suspended from X-shaped frame 253 is a roller member 257. It will be noted that the configuration of frame 253 is such that a crimped or offset portion 259 is located in the vicinity of roller member 257 to enable sheets to enter tangentially to the roller. By this structure the sheet acceleration is controlled to prevent bouncing of the sheets off the tray bottom back into the light beam.

The sheets are aligned in the trays to form desirable stacks. Associated with roller assembly 251 is a plurality of hanging wire devices 265 which serve to retard the velocity of an incoming sheet and further compress the top of the stack being formed in its tray. It will be noted that pairs of hanging wire devices are suspended from framework 57 symmetrically on each side of the sheet centerline. It will be further noted that each of the

hanging wire devices has generally W-shaped portions 267 and loop portions 269 for free pivoting on the framework as then are impacted by incoming sheets. By this structure, the top of a stack formed is compacted to assure clearance in the sheet path for the next incoming sheet. The hanging wire devices are easily mounted on the framework by virtue of loop portions 269 with the framework. It has been found that the hanging wire devices which are made of a conductive metal contribute to the dissipation of static electricity normally imparted to the sheets being transported along their path.

#### SORTING APPARATUS CONTROL CIRCUIT

A description of the control circuitry for the sorting apparatus may best be understood in connection with the control panel of FIG. 1a, the block diagram of FIG. 8, and the motor drive circuit of FIG. 9. The mode of operation for the sorting apparatus is determined by pressing a one of switches S1, S2, or S3 on the control panel which then set a mode selector circuit 301 for upper sorting assembly 53, lower sorting assembly 55 or off condition, respectively. If S1 is closed an output from mode selector circuitry 301 is supplied to a motor logic circuit 303 which, in turn, supplies a signal 305 to a motor drive circuit 307 for energizing motor 167. By closing switch S2, motor logic circuit 303 supplies a signal 309 to motor drive circuit 307 which operates to energize motor 153. FIG. 9 illustrates the motor drive circuit in detail. It will be noted that motor 153 has a triac Q1 and a power source 311 connected across its terminals and that motor 167 also has a triac Q2 and power source 311 connected across its terminals. It will be appreciated that signal 309 serves to energize a relay K1 causing Q1 to conduct which then provides a conductive path for power source 311 to cross motor 153. In similar fashion, signal 305 serves to energize relay K2 which causes Q2 to conduct thereby enabling power to be placed across the terminals of motor 167. It will be further noted that motor logic circuit 303 provides a signal 313 to sheet deflector 135 at the entrance of the sorting apparatus to assure a sheet path consistent with the motor drive circuit.

The sheets are transported along their selected path and enter a first tray of the selected sorting assembly. Phototransistors 80 and 127 detect each sheet being deflected into its tray by fingers 76 and 123, respectively, and signal counters 315 and 317, respectively. Counters 315 and 317 supply an input to decoders 319 and 321, respectively. Decoders 319 and 321 serve to energize the selected solenoid driver of solenoid driver circuits 323 and 325, respectively, which, in turn, energize the proper solenoid of the solenoid matrix 327 and 329, respectively.

At the same time, signals 330 from the processor which are taken from the pulsing of flash lamps 18 or any other suitable processor reference count are received by a counter 332 and signals 331 supplied to comparison circuits 333 and 335, respectively. Comparison circuits 333 and 335 also receive signals from counters 315 and 317, respectively. If the counts of the processor and sorting assemblies agree, then reset signals 337 and 339 are supplied to counters 315 and 317, respectively.

A jam detection system of the control circuitry of the sorting apparatus enables detecting different types of jams which may occur while the sheet is on a belt transport or upon entering a particular tray. A jam detection circuit 345 serves to detect jams in the vicinity of the trays by timing the duration of signals 349 and 351 supplied by phototransistors 80 and 127, respectively. Jam detection circuit 345 supplies a signal 347 to motor logic circuit 303 to de-energize whichever motor is in operation at the time. If a jam occurs while the sheet is on the transport belts, then a timing signal 353 supplied from a sensor 355 (FIG. 3) located at the entrance of the sorting apparatus is received by the jam detection circuit 345 and compared with signals 349 and 351. In this manner, jams are detected both during the transport of the sheets on the belts as well as in the vicinity of the trays as they are deflected by the fingers associated therewith.

As a special jam detection feature for the sorting apparatus, counters 315 and 317 are interrogated by jam detection circuit 345 at the completion of the run to ascertain if all sheets were actually received in the trays. By this arrangement if a last sheet has not been received a count will remain and as a result a jam signal 347 supplied to motor logic circuit 303 for de-energizing the appropriate sorting assembly.

What is claimed is:

1. Sorting apparatus comprising:

- a base frame,
- first and second sorting assemblies including sheet conveyor means positioned in overlying relationship to the base frame,
- said first and second sorting assemblies each including a frame work defining substantially vertical trays connected in series along a horizontal path and sheet deflecting gate means positioned at the inlet side of an associated tray to direct sheets transported downwardly into said tray,
- transport means positioned at the inlet of said sorting assemblies in driving relationship with each of said sheet conveyor means, and
- clutch means associated with said sheet conveyor means to drive said transport means and deliver sheets to a predetermined one of said sorting assemblies.

2. Apparatus according to claim 1 wherein the sheet conveyor means of a one of said sorting assemblies includes a horizontal conveyor section and a vertical conveyor section.

3. Apparatus according to claim 1 wherein said sheet conveyor means includes drive motor which operate alternately and consecutively depending upon the length of a sorting run.

4. Sorting apparatus comprising:

- a base frame,
- first and second sorting assemblies including horizontal sheet conveyor means positioned in overlying relationship to the base frame,
- said first and second sorting assemblies each including the framework defining substantially vertical trays connected in series along a horizontal path in overlying relationship to said horizontal sheet conveyor means and sheet deflection gates positioned at the inlet side of an associated tray and operative to direct sheets into said tray,
- vertical sheet conveyor means extending between said horizontal sheet conveyor means and connected in driving relationship to a one of them,
- transport rolls positioned at the inlet side of one of said sorting assemblies and in driving relationship to said sheet conveyor means, and
- clutch means associated with said sheet conveyor means to drive said transport rolls to deliver copy sheets to a selective one of said sorting assemblies.

5. Apparatus according to claim 4 wherein said horizontal transport means is mounted in a cover pivoted for displacement toward and away from the sheet path.

6. Apparatus according to claim 5 wherein said pivotable cover is arranged with a torsion spring member to facilitate the lifting thereof.

7. Apparatus according to claim 6 wherein said pivotable cover has associated therewith a latching mechanism which is retractable to enable lowering of said cover back into the sheet path.

8. Apparatus according to claim 5 wherein said vertical sheet conveyor means has pivotable cover associated therewith for movement toward and away from the sheet path.

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