United States Patent [19]

Baker et al.

[11] **3,709,492**

[45] **Jan. 9, 1973**

[54] SORTING APPARATUS

[75] Inventors: **Arthur R. Baker,** Pittsford; **William Brant,** Rochester; **Clarence J. Danielson,** Fairport, all of N.Y.

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

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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
3,372,922	3/1968	Snellman	270/58

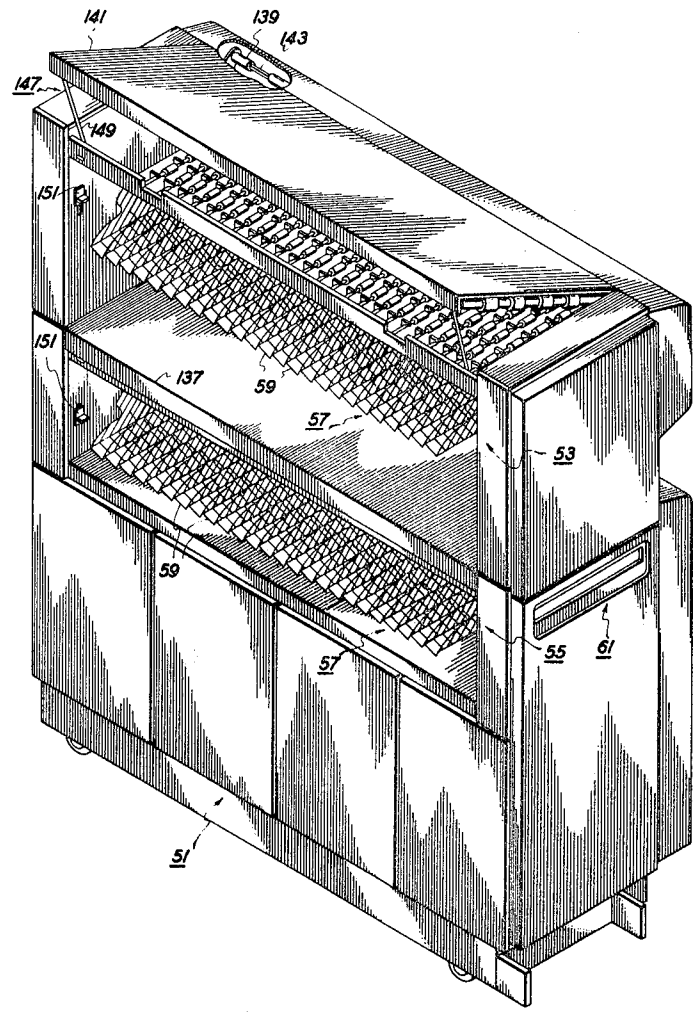
Primary Examiner—Richard E. Aegerter

Attorney—James J. Ralabate, Donald F. Daley and Melvin A. Klein

[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



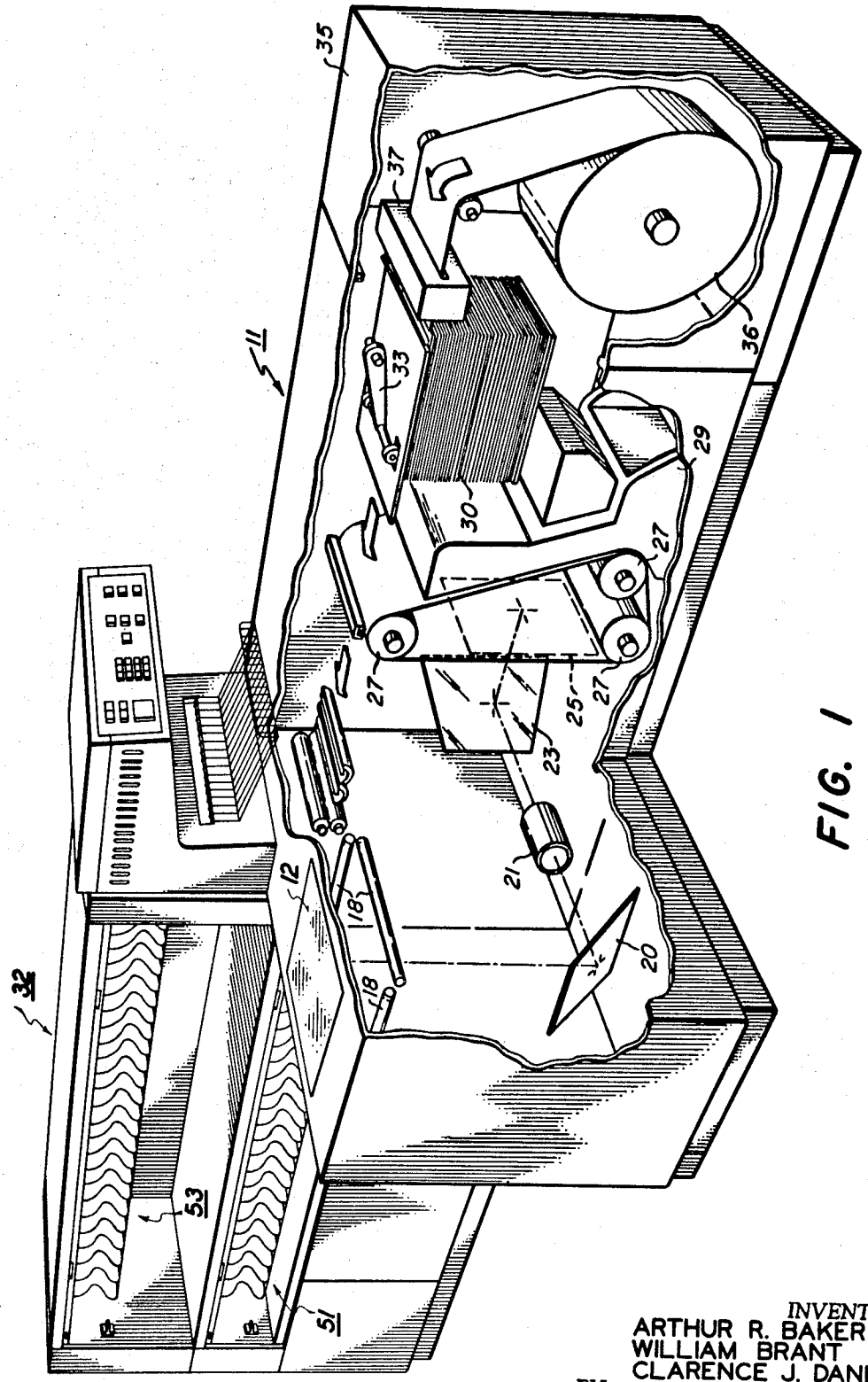


FIG. 1

INVENTORS.
ARTHUR R. BAKER
WILLIAM BRANT
CLARENCE J. DANIELSON

BY Melvin A. Klein

ATTORNEY

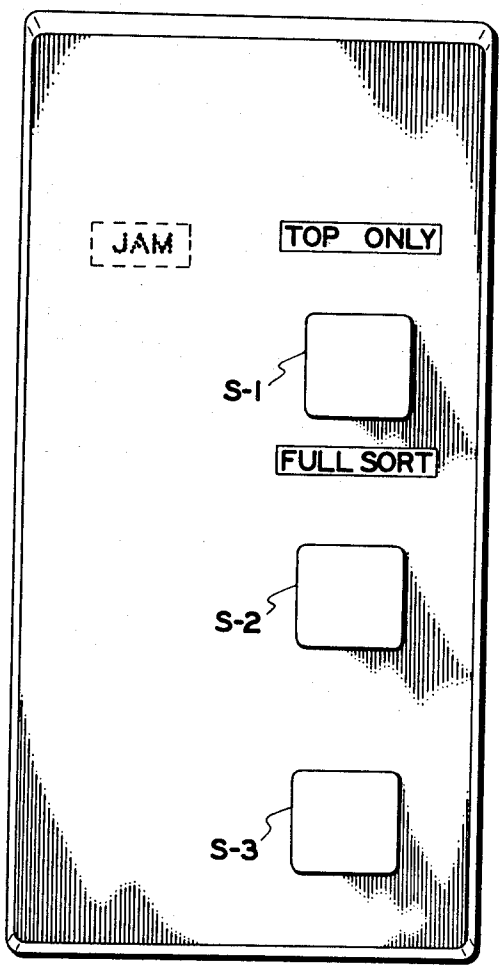


FIG. 1(a)

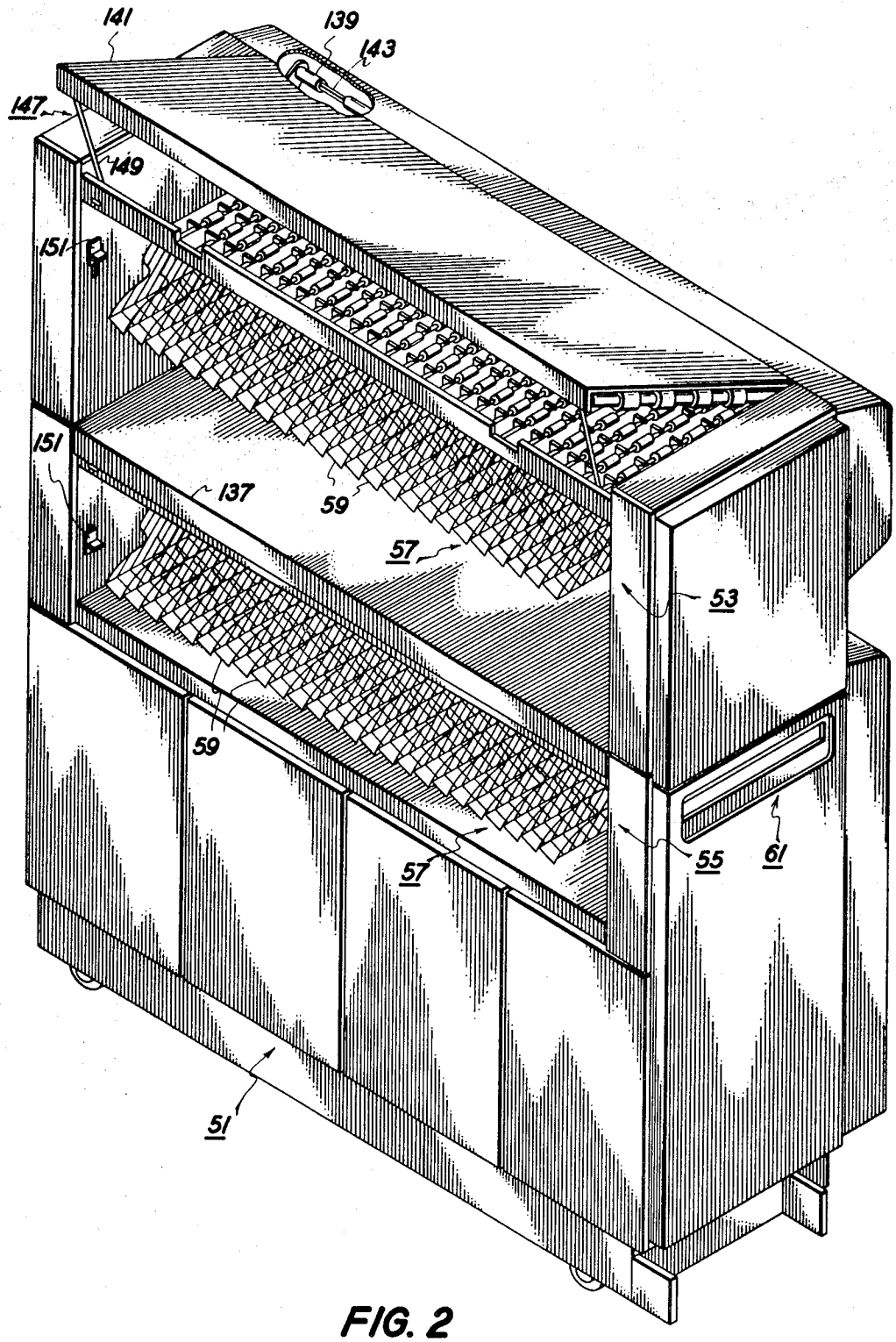


FIG. 2

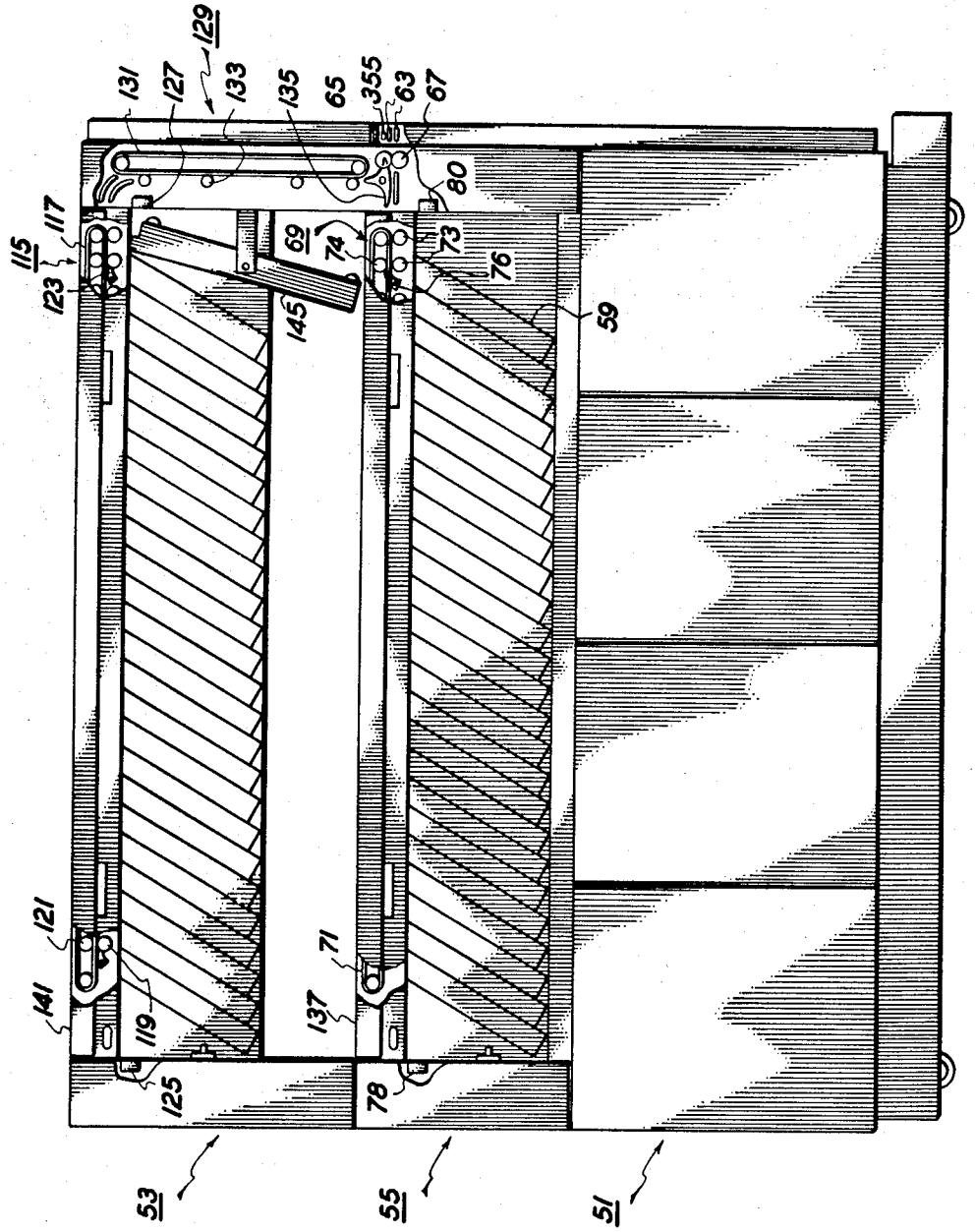

129
131
127
133
135
65
355
63
67
80
117
115
123
69
74
73
76
145
59
121
141
119
71
137
125
78
53
55
51

FIG. 3

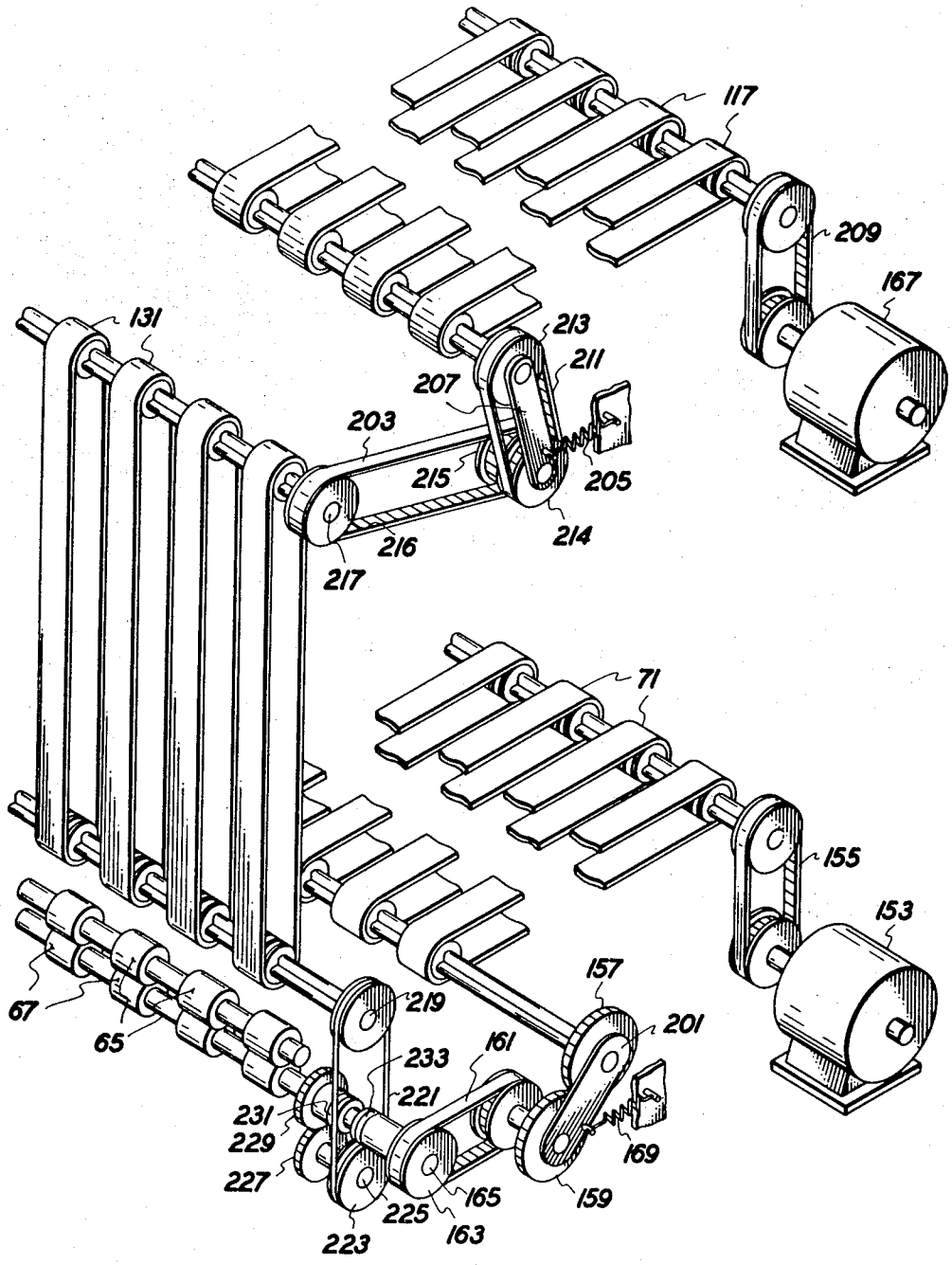

117
209
167
131
213
211
207
203
205
215
214
216
217
71
155
153
157
201
67
65
219
233
161
221
231
229
227
169
159
165
225
163
223

FIG. 4

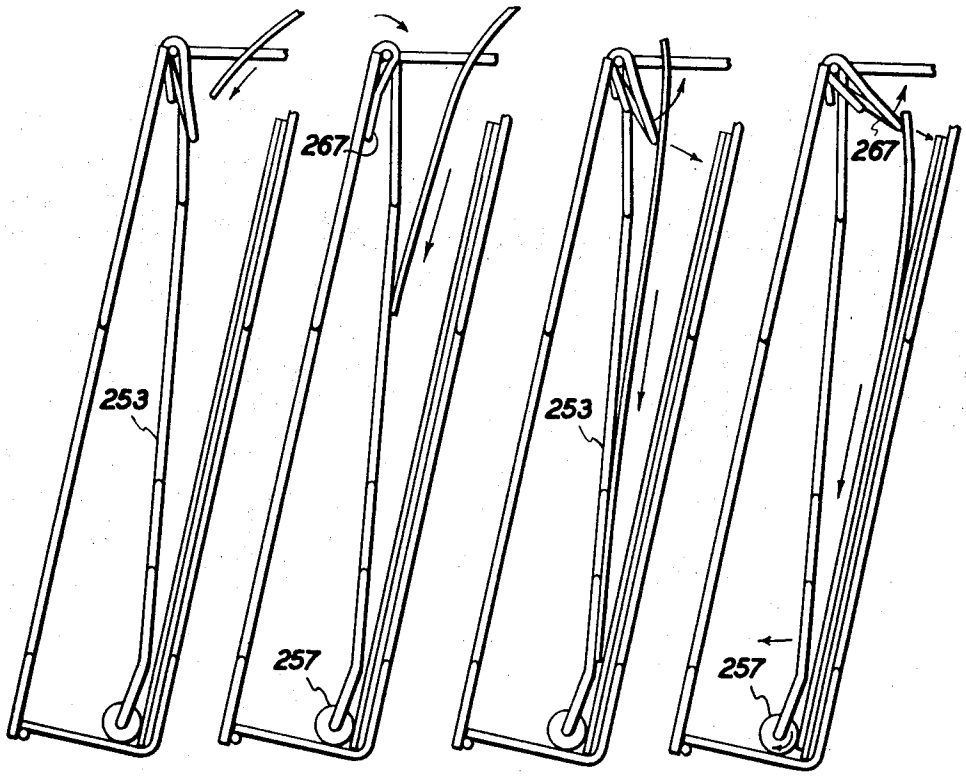


FIG. 7(a) FIG. 7(b) FIG. 7(c) FIG. 7(d)

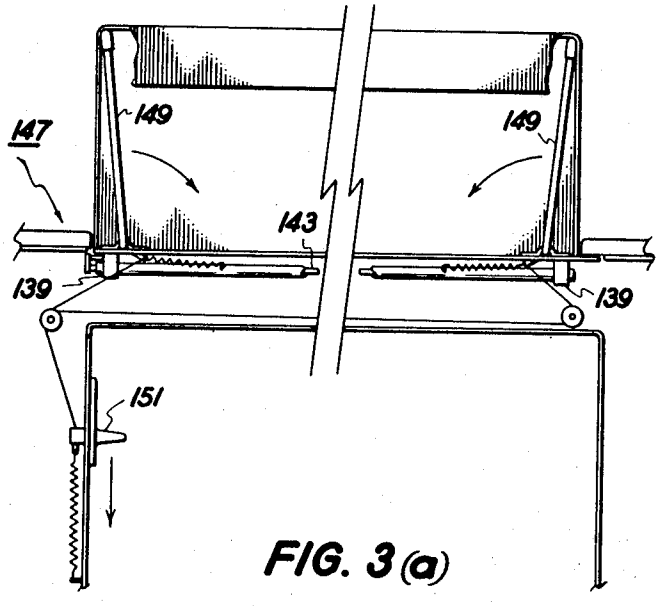


FIG. 3(a)

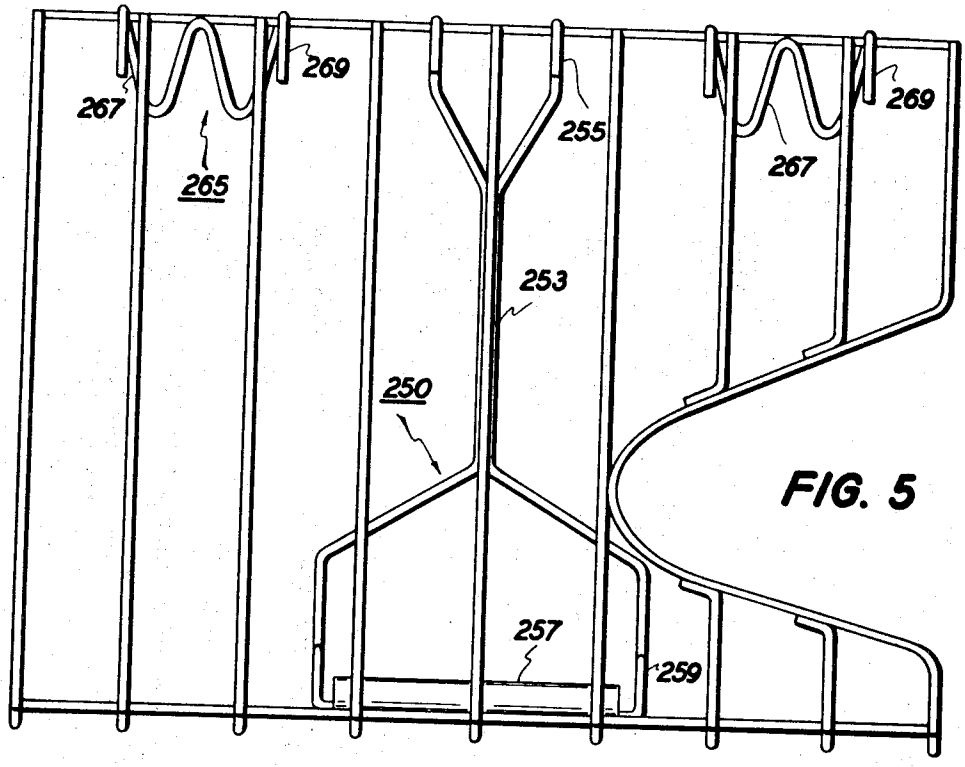


FIG. 5

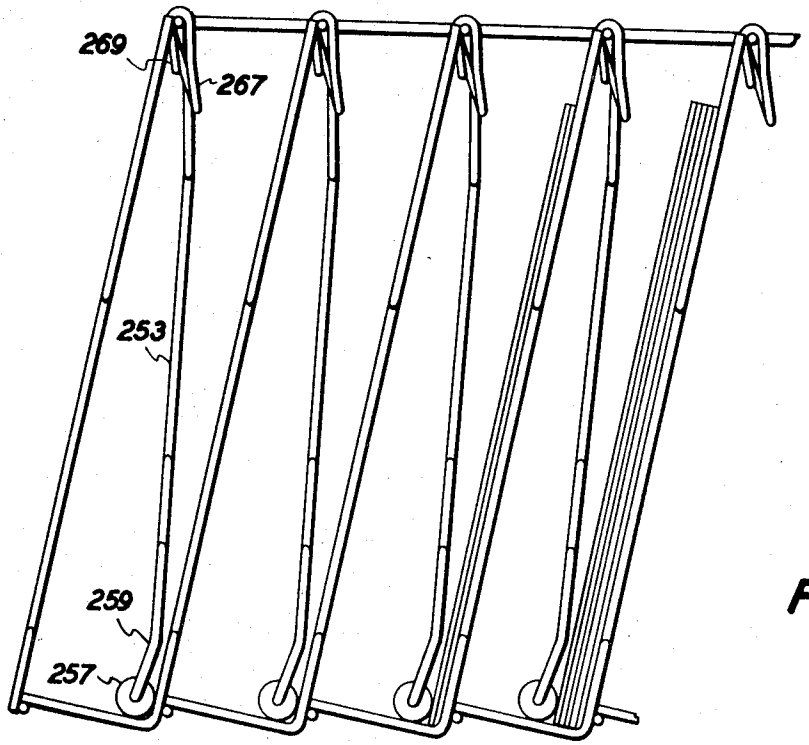


FIG. 6

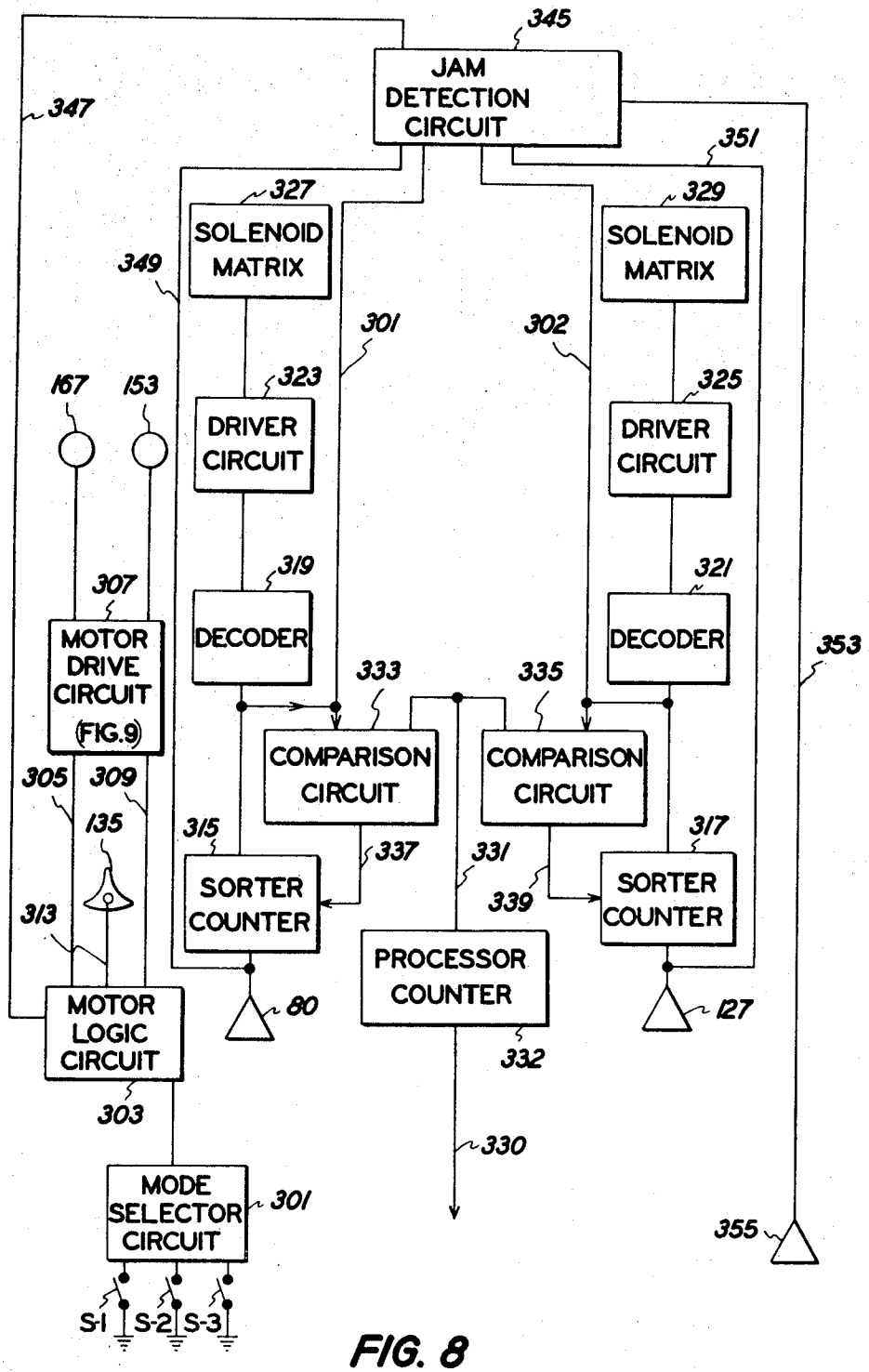

345
JAM DETECTION CIRCUIT
347
351
327
SOLENOID MATRIX
329
SOLENOID MATRIX
349
301
302
167
153
323
DRIVER CIRCUIT
325
DRIVER CIRCUIT
319
DECODER
321
DECODER
307
MOTOR DRIVE CIRCUIT (FIG.9)
333
335
353
COMPARISON CIRCUIT
COMPARISON CIRCUIT
305
309
135
315
337
331
317
SORTER COUNTER
339
SORTER COUNTER
313
PROCESSOR COUNTER
80
127
MOTOR LOGIC CIRCUIT
332
303
330
MODE SELECTOR CIRCUIT
301
355
S-1
S-2
S-3

FIG. 8

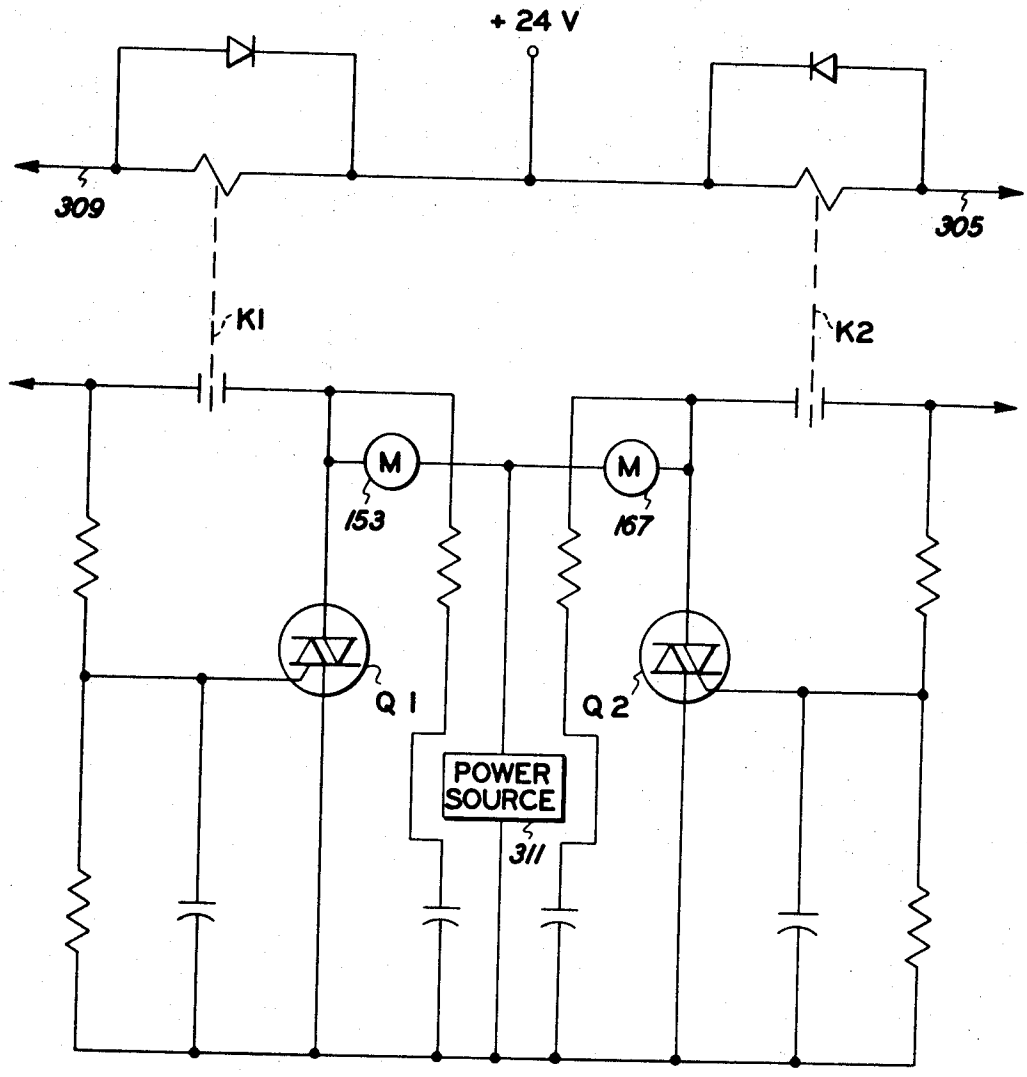


FIG. 9

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. **1***a* 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. **3***a* 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. **7***a* 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 appropriate 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 flexiblity 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. **1***a*, 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 traic **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 alternatively 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.

* * * * *