United States Patent

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[54] **SET SEPARATION COPIER SYSTEM**
7 Claims, 15 Drawing Figs.

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[51] **Int. Cl.** G03g 15/00, B65h 39/00, B65h 31/34
[50] **Field of Search** 355/3, 6, 8, 14, 17; 270/52; 271/89, 48

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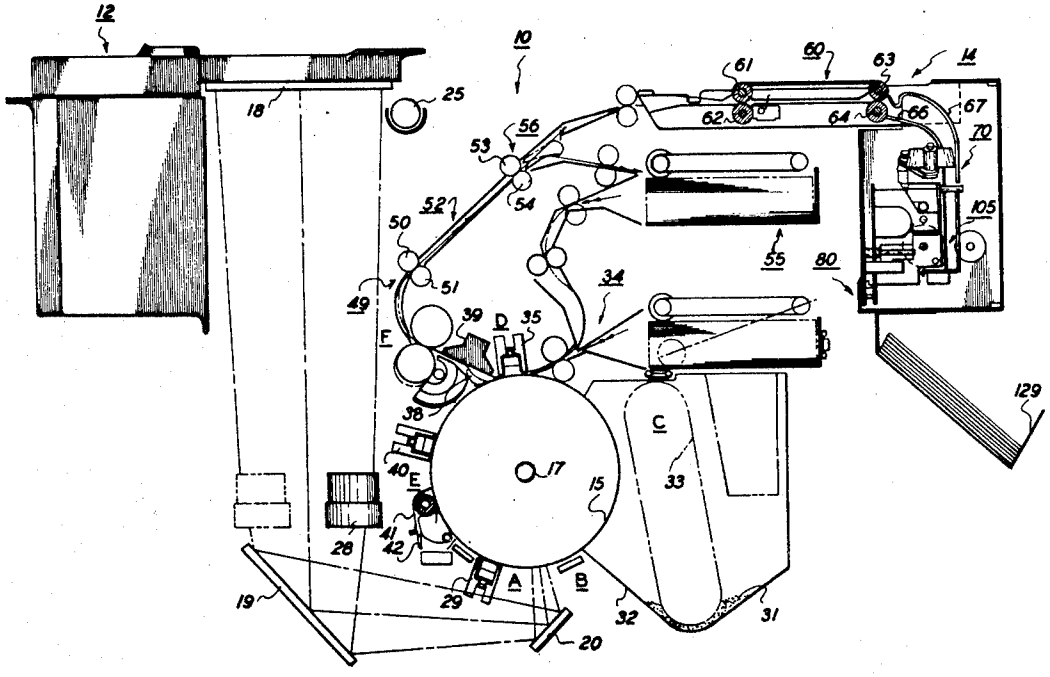
ABSTRACT: A system for producing sets of copies from documents that are copied in repeated cycles. A transport delivers copies to an intermediate tray which collects them in a set and then separates each set from a previous set in offset fashion. A control logic provides for different modes of operation in which there is a book mode of operation and a normal copying operation and also provides appropriate signals for the offsetting of the sets as well as ejection of the sets into an output tray.



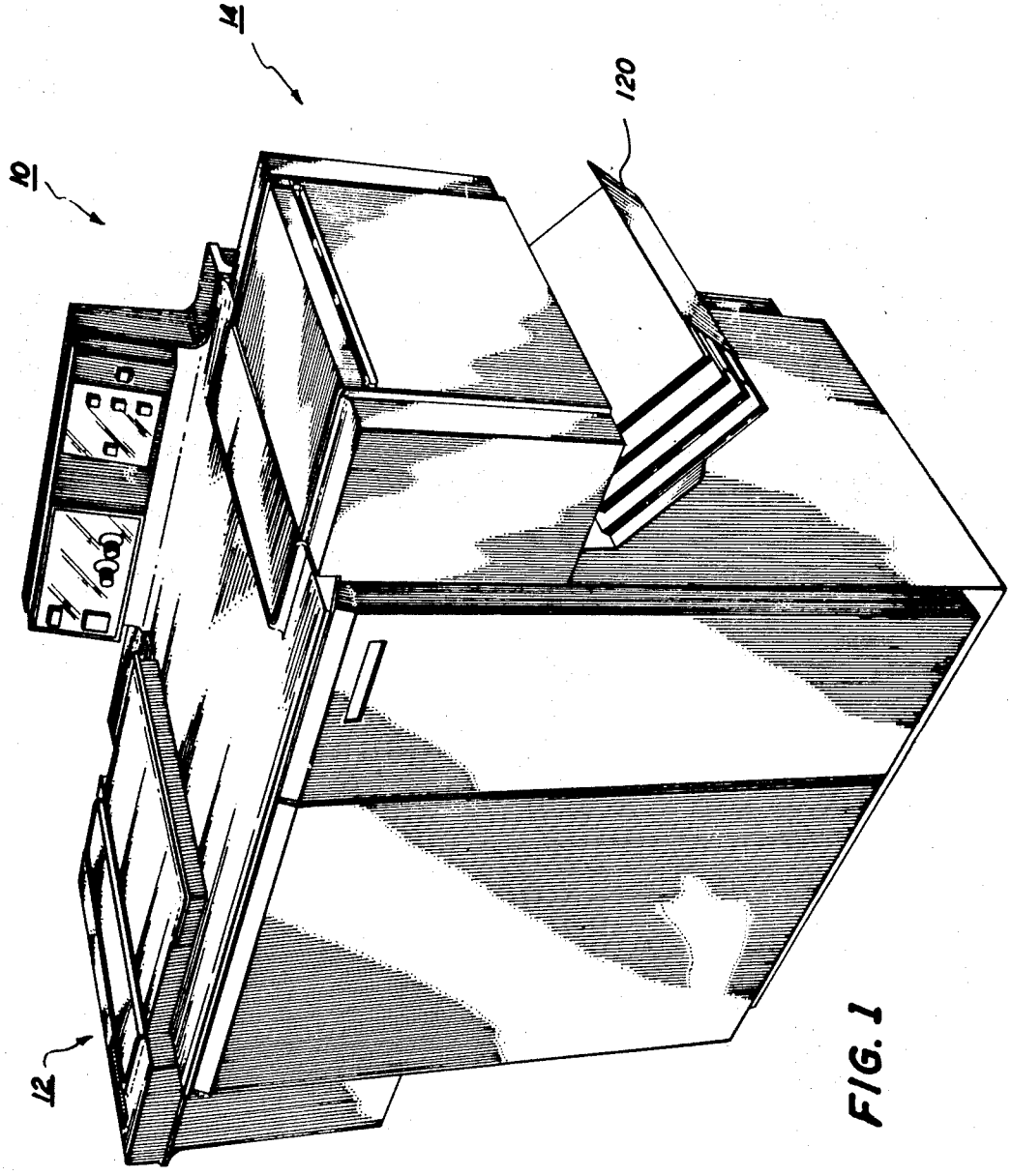


FIG. 1

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BY DENIS J. STEMMLE
Melvin A. Klein
ATTORNEY

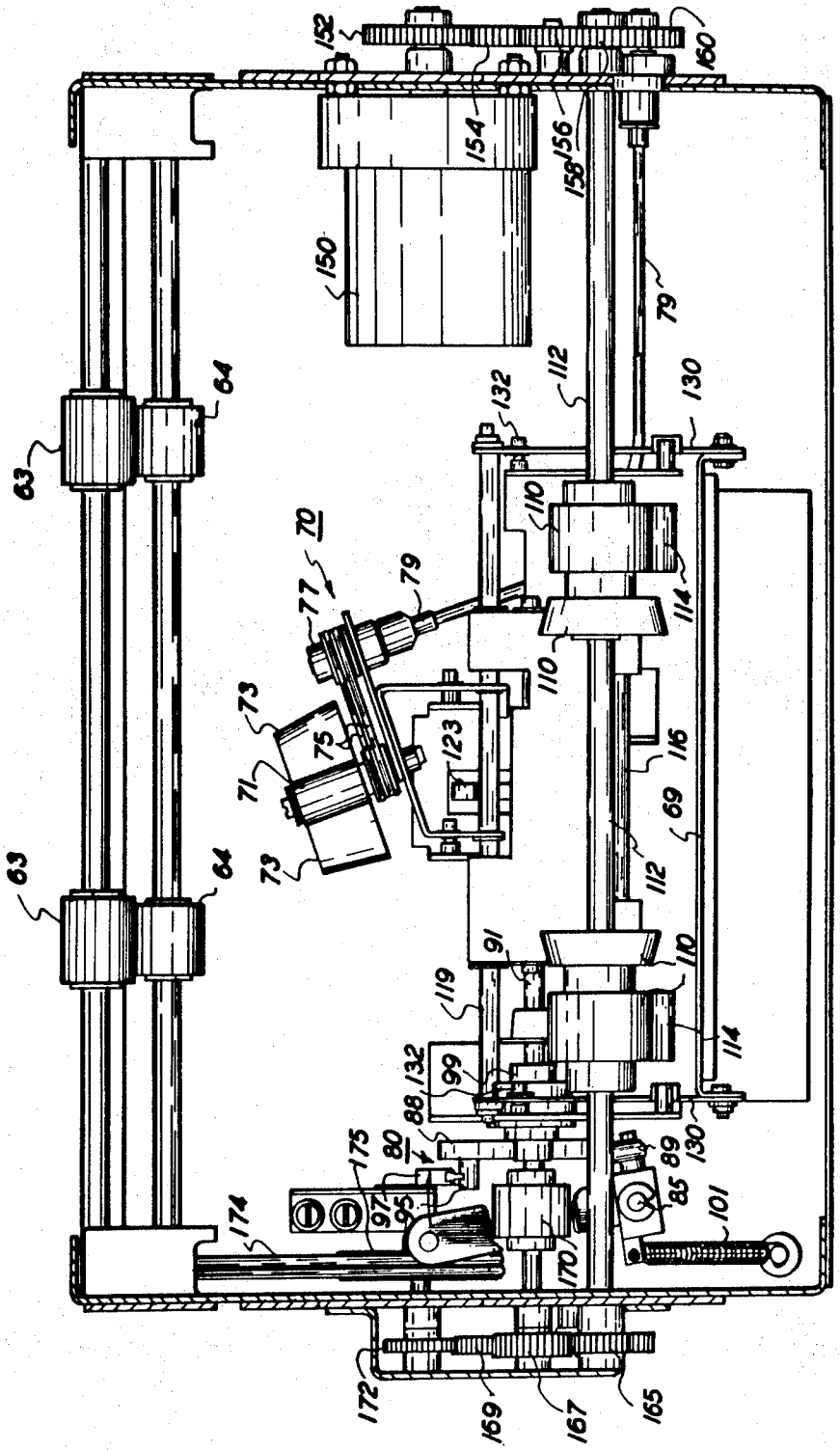
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FIG. 3

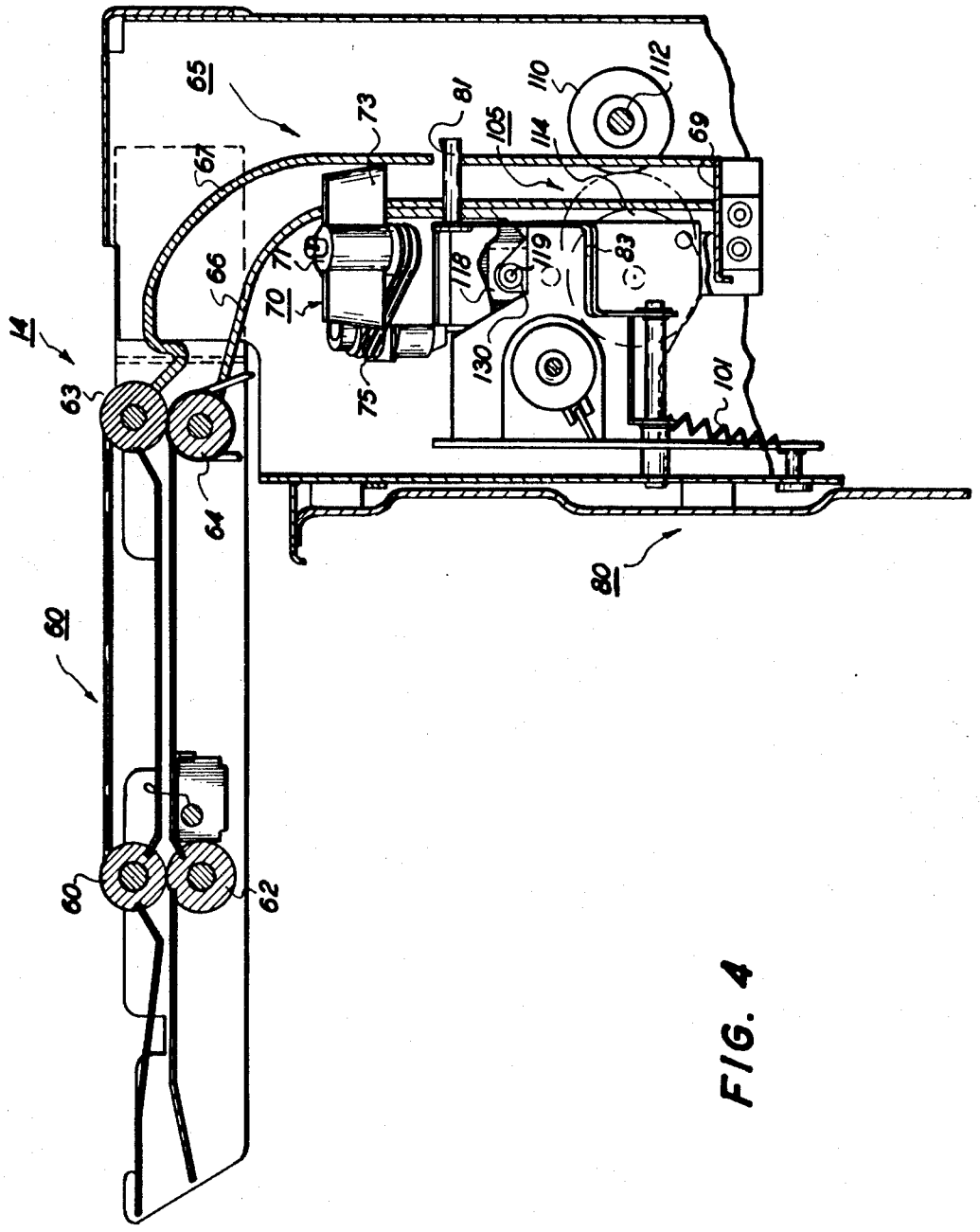
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FIG. 4

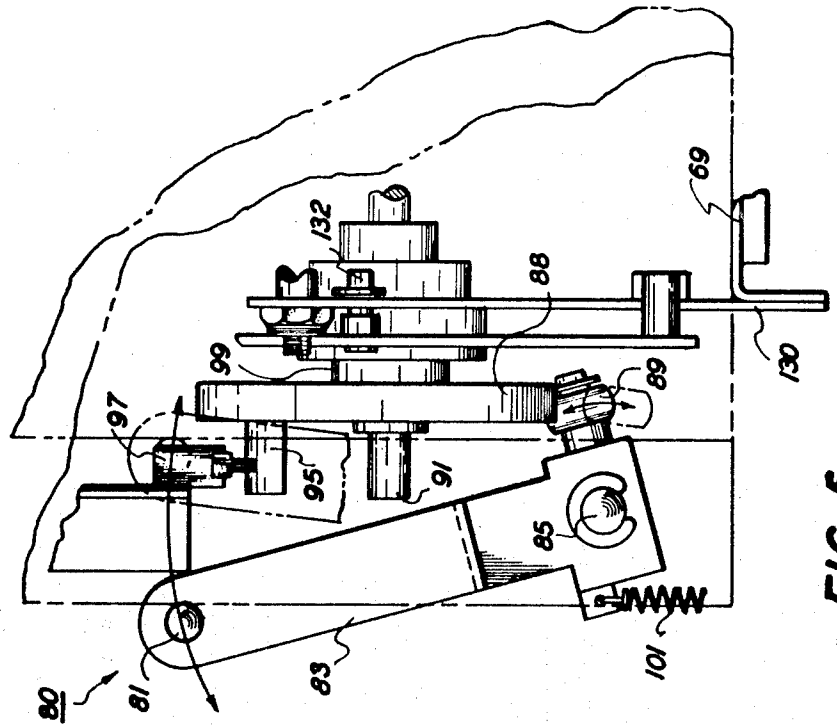
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FIG. 5

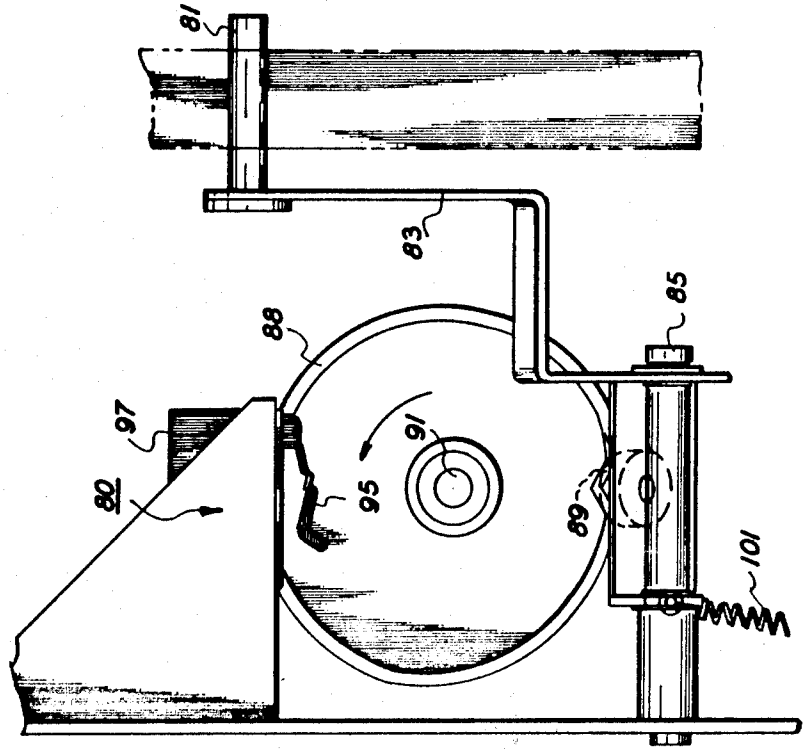
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FIG. 6

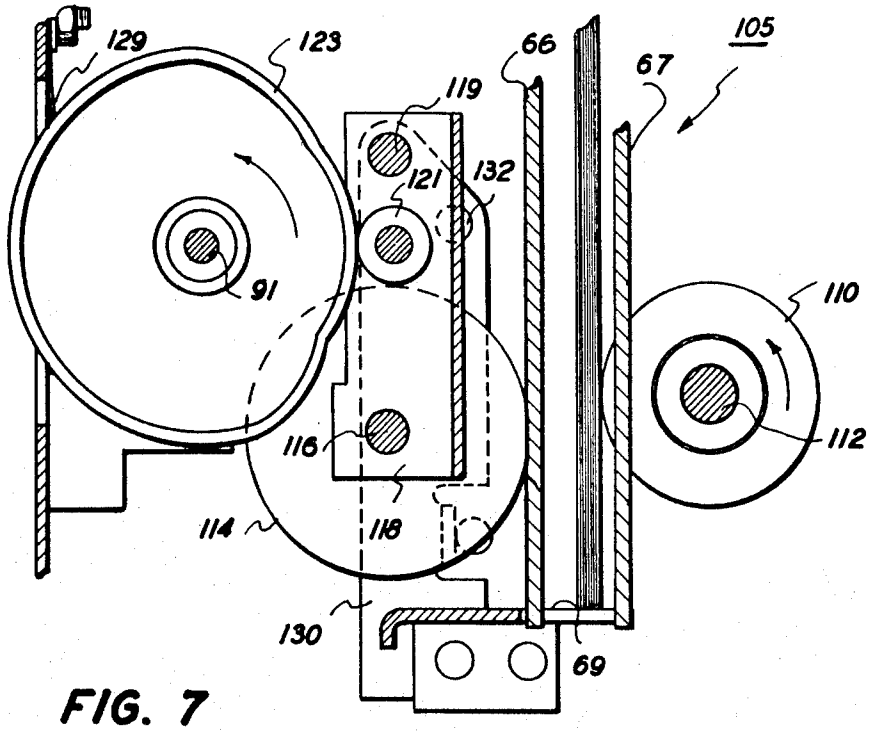
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FIG. 7

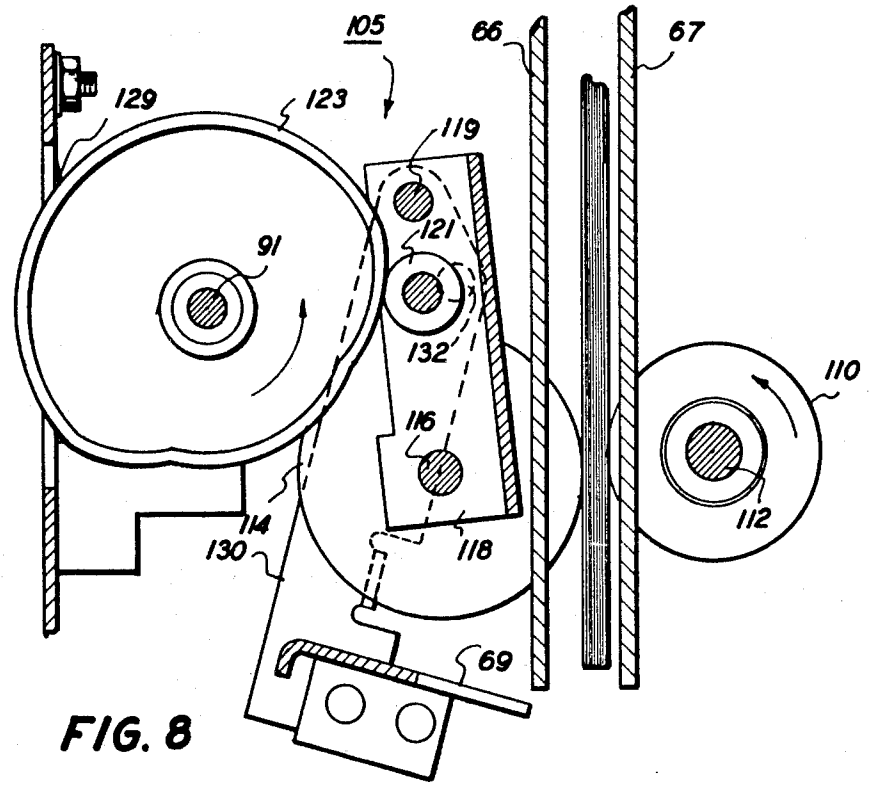
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FIG. 8

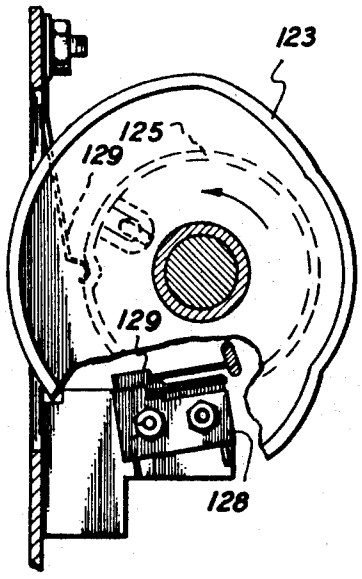

FIG. 9

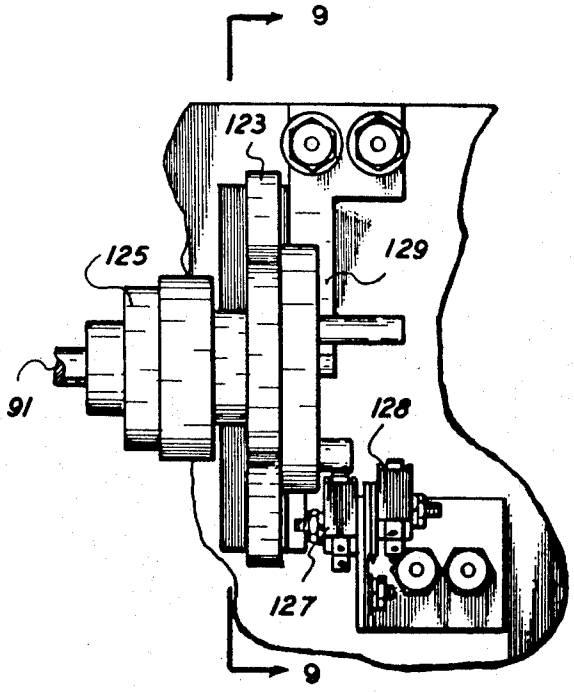

FIG. 10

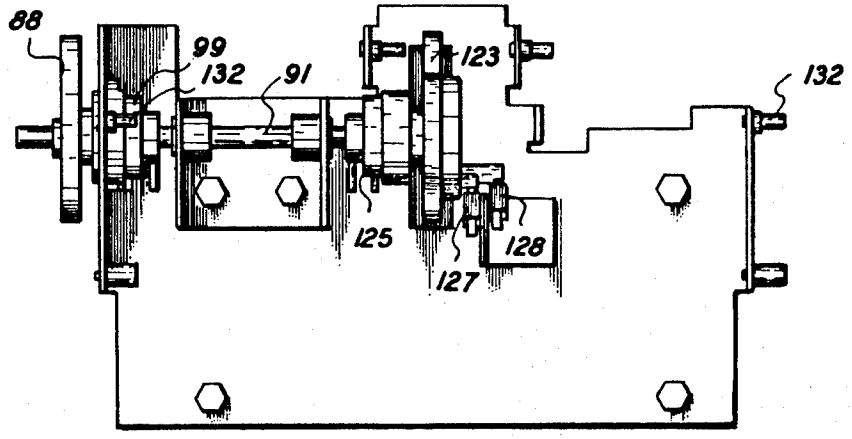

FIG. 11

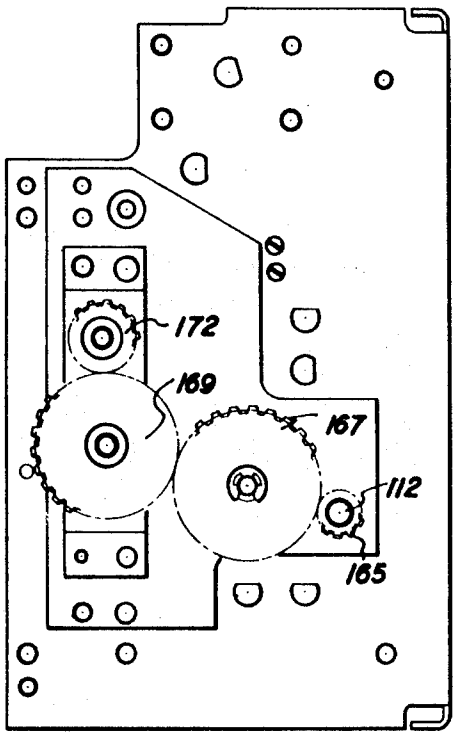

FIG. 12

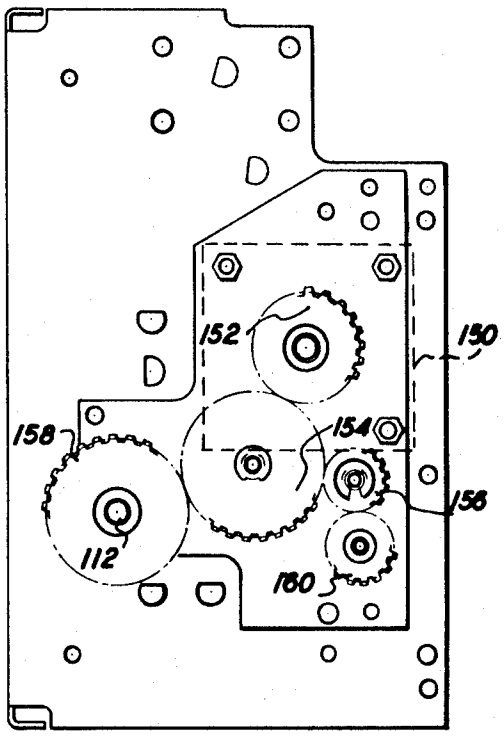

FIG. 13

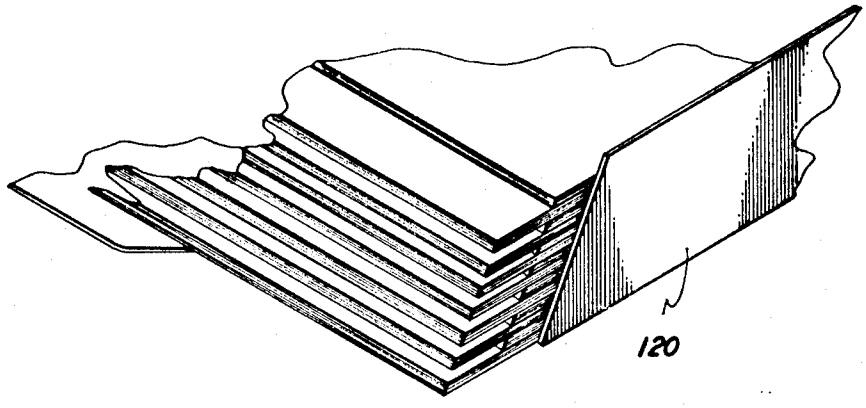

FIG. 14

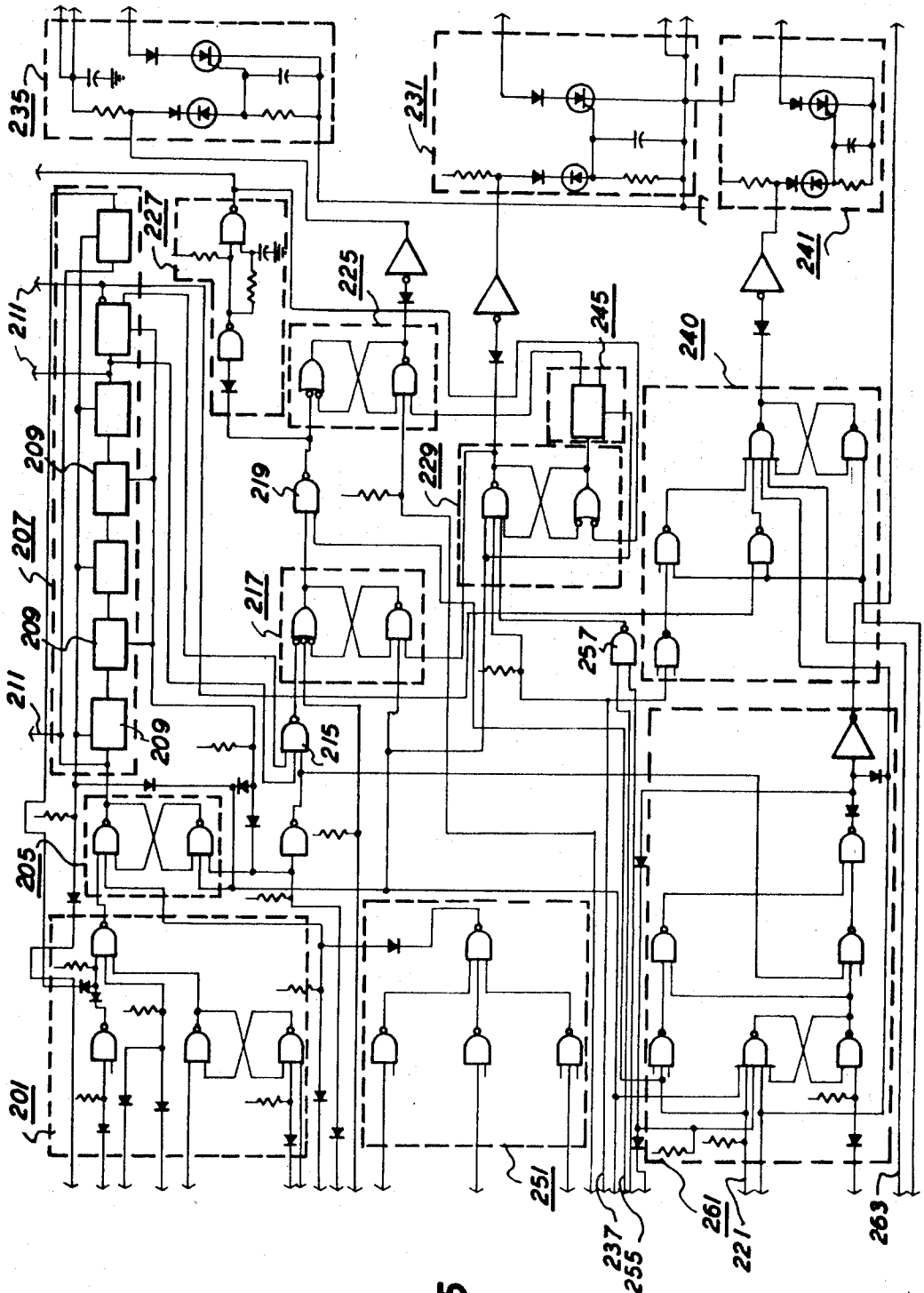
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FIG. 15

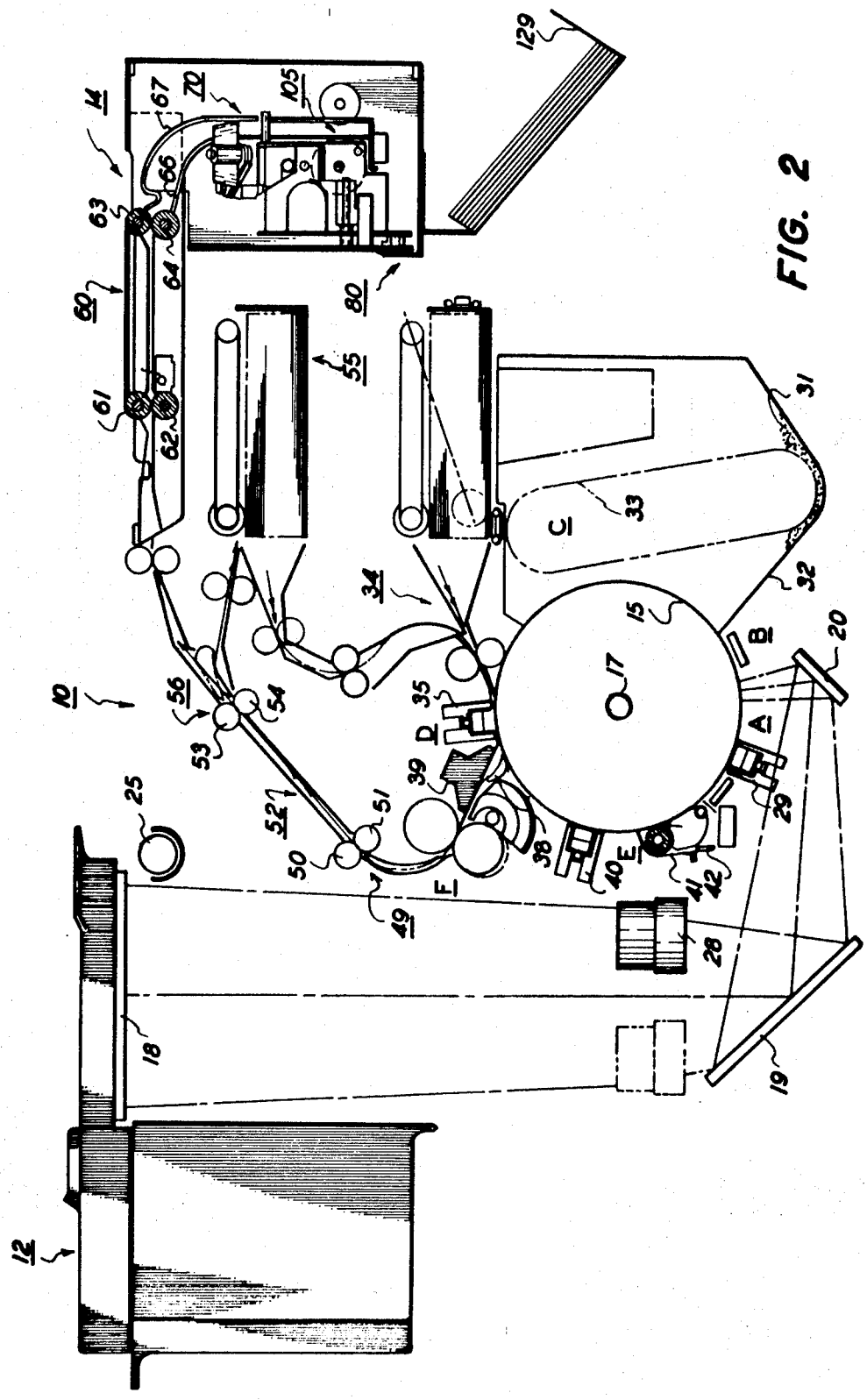
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FIG. 2

SET SEPARATION COPIER SYSTEM

This invention relates to a system for automatically separating copies into sets corresponding to documents copied in repeated cycles to produce separately identifiable sets or bundles.

As is well known in the art of bookmaking, it is generally necessary to gather groups of different sheets placed in a definite order referred to as collating. The operation of assembling the sheets into sets or booklets normally consists of taking one sheet from each of a group of stacks and putting the sheets together in the order desired.

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

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

The present invention enables automatically delivering the copy sheets in set form and then separating the sets from each other into separately identifiable bundles. To accomplish this, a transport advances the copy sheets into an intermediate tray which collects them into set form. A set separation mechanism serves to separate each set from a previous set by offsetting and a set eject mechanism then ejects each set into an output tray.

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

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

It is another object of the present invention to collect copy sheets from a processor into separately identifiable sets or stacks.

It is another object of the present invention to provide a system for producing collated sets of copies produced from a processor according to a document input cyclically reproduced.

It is another object of the present invention to provide method and apparatus for separating copy sheet material into offset identifiable books.

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 finishing apparatus according to the present invention;

FIG. 2 is a schematic side elevation of the various components of the copying machine employing the apparatus of the present invention;

FIG. 3 is an end view of the finishing apparatus according to the present invention;

FIG. 4 is a side sectional view of the finishing apparatus;

FIGS. 5 and 6 are end and side views, respectively, of the set separation assembly of the finishing apparatus;

FIGS. 7 and 8 are side views of the set ejection assembly illustrating different sequences in the operation thereof;

FIGS. 9 and 10 are end and side views of the clutch mechanism for the set ejection assembly;

FIG. 11 is a side view of the drive mechanism of the finishing apparatus;

FIGS. 12 and 13 are left- and right-hand end views of the drive mechanism;

FIG. 14 is a partial exploded isometric view illustrating the separated sets of copies in the output tray; and

FIG. 15 is a schematic wiring diagram of the control circuit for the finishing apparatus.

GENERAL

Illustrated in FIG. 1 is an exterior of an automatic xerographic reproducing machine 10 capable of producing either simplexed or duplexed copies in sets from a wide variety of

originals which may be advanced in recirculating fashion by recirculating document apparatus 12 described in copending application Ser. No. 781,287, filed on Dec. 4, 1968, entitled Document Feed Apparatus and commonly assigned with the present invention. Although the present invention is particularly well suited for use in automatic xerography, the finishing apparatus generally designated 14 is equally well adapted for use in any number of devices in which cut sheets of material are delivered in a set or stack and the set then separated from a previous set and forwarded to an output tray. It should become apparent from the discussion below that this apparatus is not necessarily limited to its application to the particular embodiment shown herein.

For a general understanding of the automatic xerographic machine with which the present invention is utilized, reference is made to FIG. 2 which shows the various components of a typical xerographic processor. The processor includes a photosensitive plate including a photoconductive layer that is placed over a conductive backing. The plate is formed in the shape of a drum 15 and the drum mounted on a shaft 17 that is journaled for rotation in the machine frame. Basically, the xerographic drum is rotated in the direction indicated so as to pass sequentially through a series of xerographic processing stations. The photosensitive drum and the xerographic processing apparatus are driven at predetermined speeds relative to each other from a single drive system (not shown) and the operations thereof coordinated in order to produce proper cooperation of the various processing mechanisms.

The document to be reproduced is transported by document-handling apparatus 12 from the bottom of a stack to a transparent horizontally supported platen 18 and scanned by means of a moving optical scanning system to produce a flowing light image. After scan the document is returned and the next advanced and scanned and so on until the entire document stack has been copied at which time the cycle may be repeated as described in the above copending application. The scanning system includes an elongated horizontal extended aperture lamp 25 and a movable lens element 28. The lamp and lens element moves in coordination across the object supported upon the platen to focus successive incremental bans of illumination reflected from the object onto the moving drum surface at synchronous speeds therewith. The optical path is folded by means of a pair of image mirrors 19 and 20 interposed between the lens and the drum surface and arranged to place the image on the drum at exposure station B. Prior to the imaging of the drum surface, the drum is first uniformly charged by means of a corona generator 29 positioned in charging station A. Under the influence of the flowing light image, the uniformly charged photoconductive surface is selectively dissipated in the nonimaged areas to form what is commonly known as a "latent electrostatic image."

The latent electrostatic image is carried on the drum surface from the exposure station into the developing station C. The developing station primarily is comprised of a developer housing 32 adapted to support a supply of two-component developer material 31 therein. The developer material is transported by means of a bucket system 33 from the bottom of the developer housing to an elevated position where the material is delivered into the active development zone. The developer material is caused to flow downwardly in contact with the upwardly moving drum surface under closely controlled conditions wherein charged toner particles are attracted from the developer mix into the image areas on the plate surface, thus, making the image visible.

The moving drum surface next transports the developed xerographic image to a transfer station D. Cut sheets of final support material are also moved into the transfer station from sheet-registering apparatus 34 in synchronous relation with the image on the drum surface. In the transfer station, the back side of the copy sheet is sprayed with an ion discharge from a transfer corotron 35 inducing on the sheet a charge having a polarity and magnitude sufficient to attract the toner

material from the drum surface to the final support material. This induced charge also electrostatically tacks the final support material to the drum surface. In order to remove the copy sheet from the drum surface, a stripper finger **38** is positioned downstream from the transfer corotron. The finger is arranged to move between the drum surface and the copy sheet and lifts the sheet from the drum surface. The stripped sheet is directed along a predetermined path of travel into contact with a stationary vacuum transport **39**.

Although a preponderance of the toner material is transferred from the drum surface to the copy sheet during the transfer process, invariably some residual toner remains behind on the drum surface after transfer. This residual toner is transported on the drum surface into a cleaning station E where it is brought under the influence of cleaning corotron **40** adapted to neutralize the electrostatic charge tending to hold the residual toner to the drum surface. The neutralized toner is mechanically cleaned from the drum surface by means of a brush or the like and the toner collected within a housing **41**. A conveyor moving in an endless loop through tubes **42** transport the collected residual toner back to the developer housing where it is deposited within the developer mix so that it can be once again reused in the xerographic developing process.

The copy sheet, which has been removed from the drum surface after the transfer operation, is moved along stationary transport **39** into fusing station F. The fuser **43** is basically made up of an upper fuser roll **44** and a lower fuser roll **45** mounted in operative relation to each other and arranged to coact so as to support a sheet of material in pressure driving contact therebetween. The outer surface of the lower roll is heated by means of a horizontally supported radiant heat source **48** positioned in close proximity to the roll surface adjacent to the point at which the roll contacts the image-bearing support material. As the heated roll is rotated in the direction indicated, the heated surface of the lower roll is pressed into intimate contact with the image face of the support sheet. Mechanical and heat energy is transported from the roll surface to the support sheet to permanently bond the toner particles to the support material.

Upon leaving the fuser, the fixed copy sheet is passed through a curvilinear sheet guide system, generally referred to as **49**, into cooperating advancing rolls **50** and **51**. The advancing rolls forward the sheets through a linear sheet guide system **52** into a second pair of advancing rolls **53** and **54**. At this point, depending on whether simplex or duplex copies are desired, the simplexed copy sheet is either forwarded directly into finishing apparatus **14** or into upper supply tray **55** by means of a movable sheet guide **56** before the finishing apparatus for the duplexed copy. Movable sheet guide **56**, and associated advancing rolls are prepositioned by appropriate machine logic system to direct the individual sheets into the desired path.

It is believed that the foregoing description is sufficient for purposes of the present application to show the general operation of a simplex or duplex xerographic reproducing machine embodying the teachings of the present invention. For a more detailed explanation of the processing stations, reference is made to copending application Ser. No. 838,791, filed on July 3, 1969, and commonly assigned with the instant application.

FINISHING APPARATUS

The transport assembly **60** receives copy sheet material from the processing station and includes two sets of pinch rolls **61, 62, 63** and **64** which advances the sheet material to an intermediate tray assembly **65**. Intermediate tray assembly **65** comprises inner and outer baffle members **66** and **67** which serve to guide the sheet material which is arrested at the lowermost portion of the intermediate tray assembly by a gate **69**. It will be noted that baffle members **66** and **67** are arranged to receive the sheet material with the topmost sheet on the outside and the subsequent sheets in an order which maintains a proper sequence with the document input.

In order to provide side registration of the sheet edges and registration of the lead edges of the sheet material, a jogger assembly **70** is provided to contact the sheet material received by the intermediate assembly. Jogger assembly **70** comprises a hub **71** on which are mounted a plurality of blades **73** made of flexible elastomeric material, such as rubber. The hub is rotated on a shaft inclined at an acute angle to the sheet path with the blades propelling at right angles to the sheet path to affect a thrust in a sideways direction to sheets moving in the direction along a sheet path. Hub **71** is driven through belts **75** which are driven by pulleys **77** which are mounted on a flexible shaft **79** which is driven through the main drive as will be described hereinafter.

To accomplish the offsetting of the sheet material into separately identifiable sets or booklets, there is provided a set separation assembly **80**. Set separation assembly **80** includes a set separation finger **81** which is connected at one end of the pivot arm **83** and pivots on an axis through a stud **85**. To move arm **83** there is a cam actuating mechanism **87** which includes cam element **88** and cam follower **89** which cam follower is connected to arm **83**. Cam element **88** is carried on a cam shaft **91** which is driven through the main drive as will be described hereinafter. Cam element **88** is a single lob cam having a recessed portion **93** which serves as a detent against cam follower **89**. To ensure that the cam element **88** stops rotation after a single rotation, a cam portion **95** contacts a switch **97** which deenergizes a clutch mechanism **99** used to drive the cam element through the main drive. A spring **101** serves to maintain cam follower **89** into contact with cam element **88**.

After the set-indexing operation is completed, the set of sheet material is ejected by the set ejection assembly **105** comprising rollers **110** which are continuously driven on a shaft **112** and pivotal rollers **114** which serve as idler rollers mounted on a shaft **116** which shaft is mounted on support brackets **118** which pivot on the axis of a shaft **119**. Mounted on support brackets **118** is a cam follower **121** which is driven by a cam element **123** which cam element is driven on the same shaft with the set separation assembly. Cam element **123** is driven through an electrical clutch **125** which is deenergized by switch **127** upon one revolution of the cam element which is then arrested by the detent **129** to prevent further movement thereof. It will be noted that another switch **128** is positioned in the path of cam element **123** to deenergize electrical clutch **125** such that the copy gate is positioned open and remains open as will be explained hereinafter.

When clutch **125** is energized by a signal from machine control as will be explained hereinafter, the clutch turns cam element **123** which engages cam follower **121** which causes support brackets **118** to pivot on axis **119** until rollers **114** pinches the set against rollers **110**. As cam element **123** continues to rotate, support brackets **118** are caused to pivot at the nip of rollers **110, 114** thereby enabling pivot axis **119** to float. When support brackets move on floating axis **119**, the gate **69** is caused to pivot on supports **130** on a pivot **132**. When this occurs, gate **69** is pivoted away from the sheet path enabling rollers **110** and **114** to drive the set into the receiving tray **120**. It will be noted that the jogger assembly abuts with shaft **119** and is caused to move away from the sheet path during the time the set is being ejected. To facilitate the positioning of rollers **114** relative to rollers **110**, support brackets are adjustable as by a screw (not shown).

The drive for the finishing apparatus is powered by a motor **150** which drives a main drive gear **152** which drives idler gear **154** which drives idler gear **156** and a gear **158** mounted on shaft **112**. Gear **156** meshes with a gear **160** which drives a flexible shaft **79**. Drivingly connected to shaft **112** is a gear **165** which drives an idler gear **167** which, in turn, drives a gear **169** to drive shaft **91** to actuate the set separation assembly and the ejection assembly through flexible coupling **170**. Gear **169** drives gear **172** which, in turn, drives transport roll **64** through a belt **174** and pulley **175**. Transport roll **64** is drivingly connected to roll **62**.

MACHINE OPERATION

The operation of copying machine with finishing apparatus according to the invention is best understood in connection with the wiring diagram of FIG. 16. The machine has different modes of operation wherein sets or books are produced in collation with the document input. Alternatively, if the document-handling apparatus is dispensed with and documents are manually fed, copies are transported to the output tray with or without set separation.

For the set mode of operation, the copy sheets are advanced by transport 60 past jogger member 70 to copy gate 69 which stacks them in registration. Signals are supplied from the set mode logic 201 to a flip-flop 205 when a set is completed. When a stop print operation is desired, a logic group 251 serves to supply a signal to flip-flop 205. When either of these situations occur, a signal is supplied to a shift register 207 comprising flip-flops 209 which are arranged in three pairs. Shift register 207 receives input signals 211 from the processor logic and provides an output signal to gate 215. The output from gate 215 is stored in a flip-flop 217 which is coupled to a gate 219 which also receives a signal 221 from copy sheets along the sheet path as they are advanced to the copy gate. Gate 219 supplies an output signal to a flip-flop 225 for effecting set separation and also to a time delay 227 which after an appropriate time delay, supplies a signal to flip-flop 229. Flip-flop 229 provides an output to electrical clutch 125 through an amplifier 231 to actuate copy gate 69 after a complete set has been stacked. Time delay 227 ensures that electrical clutch 99 has been energized through flip-flop 225 and amplifier 235 to effect a set separation before the set is ejected into the output tray. It will be noted that switch 127 serves to supply a signal 237 to motor logic 240 which serves to deenergize the drive motor through an amplifier 241 if the processor has cycled out. Further, it will be noted that flip-flop 225 provides an output signal on alternate sequence only due to the insertion of a flip-flop 245 coupled between flip-flop 225 and flip-flop 229.

It will now be appreciated that the set separation assembly is actuated laterally for every other set. Thus, set separation from a previous set is achieved by side staggering alternate sets. Following set separation, the set is pinched by the rollers 110 and 114 as the copy gate 69 is pivoted away upon actuation of the set ejection assembly. The collected set is lowered into the output tray where each set is staggered to distinguish between sets. The copy gate then closes and the rollers 114 return to its starting position ready to commence another set separation and collection cycle.

It will be appreciated that the finishing apparatus is also capable of transporting copies directly into the receiving tray without collection and set separation. In this case a signal 255 is received by flip-flop 229 in a switch 128 and a gate 257 such that the copy gate is positioned open and remains open while the rollers 110 and 114 are positioned together which serve to advance the copy sheets directly into the output tray one at a time.

A jam logic 261 with detection sensors in the sheet path is coupled to the processor jam logic to supply a signal to the processor which supplies a signal 263 to motor logic 240 which serves to deenergize the drive motor in case of a jam occurring in the finishing apparatus.

What is claimed is:

1. In a copying machine in which documents are advanced from a supply source to a platen and then returned to the supply source in repeated cycles, apparatus for producing identifiable collated sets of copies comprising

gate means including a displaceable member for receiving copy sheets advanced along a predetermined path and movable from a first position in the sheet path to a second position out of the sheet path in response to discrete electrical signals,

set separation means disposed adjacent to said gate means operative to move laterally to the sheet path in response to discrete electrical signals,

set eject means associated with said gate means operative to pinch a set of sheets and advance them to a receiving tray in synchronization with the movement of said gate means, and

logic means to supply discrete signals to said gate means, set separation means, and set eject means at predetermined intervals to effect staggered sets of sheets in the tray.

2. Apparatus according to claim 1 wherein said gate means, set separation means, and set eject means is drivingly connected with a common drive mechanism including at least one electrical clutch mechanism which remains energized for a predetermined interval.

3. Apparatus according to claim 2 wherein said drive mechanism is rotatable in a path to actuate signal means operative to deenergize said electrical clutch mechanism and means to reposition said drive mechanism for subsequent cycles.

4. Apparatus according to claim 3 wherein said set separation means and said set eject means each have an electrical clutch mechanism associated therewith and the former is energized every other time of which the latter is energized.

5. Apparatus according to claim 1 including jogging means positioned in the sheet path before said gate means.

6. Apparatus according to claim 5 wherein said jogging means comprises a plurality of paddle members mounted on a hub rotated on a shaft inclined at an acute angle to the plane of the sheet path.

7. A method of producing collated sets of copy sheets printed in a copying machine from precollated documents copied in repeated cycles comprising the steps of feeding documents to an exposure station of a copying machine for copying thereof and then returning the documents to their original position in seriatim, collecting copies in a stack in an intermediate tray corresponding to the documents being copied, ejecting the stack to a final output tray, and separating each stack from a previous stack by imparting lateral movement to every other stack collected in the intermediate tray before ejection thereof.

* * * * *