REPRODUCTION SYSTEM AND METHOD WITH SIMPLEX AND DUPLEX MODES OF OPERATION

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ABSTRACT
This invention is for a reproduction system and method capable of producing collated copy sets for both simplex and duplex modes of operation. For simplex operation copies from the processor are inverted by an inverting apparatus which includes a horizontal vacuum transport which positively positions a sheet onto a vertical vacuum transport upon activation of deflector fingers. The vertical transport reverses in response to signals to deliver the sheets onto the horizontal transport with trailing edge becoming leading edge. The horizontal transport delivers copies to an array of tray members which are moved past a sheet discharge zone in timed relation to receive the copy sheets and collate them. For duplex operating inverting is omitted with the sheets moving from horizontal transport directly to the trays.

9 Claims, 14 Drawing Figures
FIG. 1
REPRODUCTION SYSTEM AND METHOD WITH SIMPLEX AND DUPLEX MODES OF OPERATION

This invention relates to a reproduction system for producing collated sets of document information for both simplex and duplex modes of operation.

With the advent of high speed sophisticated copier/duplicator systems there has been a growing concern for the rapid and reliable distribution and handling of the copy sheets in both simplex and duplex sorting modes of operation. In the past, sheet inverting devices principally have been used in the handling of documents for recording both sides as described, for example, in U.S. Pat. Nos. 3,408,140, 3,561,865, 3,227,444. Also it is known to turn cards, plates and the like as described for example, in U.S. Pat. Nos. 2,549,772 and 2,901,246. The present devices are not entirely satisfactory for high speed sophisticated reproduction machines capable of operating in simplex and duplex sorting mode of operation.

The present invention is for a reproduction system for producing collated sets of document information on one or both sides of copy sheets at the option of a machine operator. Generally speaking, this is accomplished by copying document information and producing either simplex or duplex copies distributing the copies to a conveyor face up or face down depending on the particular mode of operation, and then sorting the copy sheets into trays in collated sets.

It is therefore a general object of this invention to improve reproduction systems.

It is another object of this invention to produce collated sets of document information on one or both sides of the copy sheets.

It is a further object of the invention to enhance the delivery of copy sheets in both simplex and duplex modes of sorting operation.

It is a further object of the invention to achieve sheet inversion in a manner which minimizes the effect of sheet characteristics, such as, curl and stiffness to effect additional sheet handling.

The above and added advantages of the present invention will be more apparent after reading the following detailed description which refers to accompanying drawings in which:

FIG. 1 is a perspective view of a high speed reproduction system according to the present invention;
FIG. 2 is a schematic view illustrating the xerographic components of the copier/duplicator system;
FIG. 3 is a side view of the inverter apparatus;
FIG. 4 (a)-(c) show different views of the inverter apparatus illustrating different sequential operation during sheet inverting;
FIG. 5 is an isometric view of the inverter apparatus;
FIG. 6 is an elevation view of tray assemblies according to the present invention;
FIG. 7 is a plan view of the tray assemblies;
FIG. 8 (a)-(c) are exploded views of the tray assemblies illustrating details of the opening tray operation;
FIG. 9 is an isometric view of the drive assembly for the sorter/collator apparatus; and
FIG. 10 is an exploded view of the tray illustrating set separation upon unloading.

FIG. 1 shows a reproduction system generally designated 2 including a copier machine 3, which is a high speed copier/duplicator capable of producing simplex or duplex copies at the option of a machine operator. The copier machine 3 has a platen 4 for receiving documents to be reproduced, and a control panel 5 which includes various control knobs, buttons, and switches for selecting various modes of operation such as simplex and duplex sorting of copies and the number of copies to be reproduced. In accordance with the invention, the reproduction system includes a sheet inverter apparatus 8 which directs the copies into a sorter apparatus generally designated 6, having tray assemblies 7.

As best shown in FIG. 2, the reproduction system includes an automatic xerographic copying apparatus which includes a photosensitive plate including a photosensitive layer 10 that is placed over a conductive backing. The plate is formed in the shape of a drum 11 and the drum mounted upon a shaft 12 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 drive system (not shown) and the operation thereof coordinated in order to produce proper cooperation of the various processing mechanisms.

The original to be reproduced, is placed upon a transparent horizontally supported platen 4 and the original scanned by means of a moving optical scanning system and to produce a flowing light image of the original. The scanning system includes an elongated horizontal extended aperture lamp 15 and a movable lens element 18. The lamp and lens element moves in coordination across the object supported upon the platen to focus successive incremental bars 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, the drum is first uniformly charged by means of a corona generator 13 positioned in charging station A. Under the influence of the flowing light image, the uniformly charged photoconductive surface is selectively dissipated in the non-image 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 in to the developing station C. The developing station primarily is comprised of a developer housing 22 adapted to support a supply of two component developer material 21 therein. The developer material is transported by means of a bucket system 23 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, the backside of the copy sheet is sprayed with an ion discharge from a transfer corotron 25 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 28 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 and the copy sheet is directed along a predetermined path of travel into contact with a stationary vacuum transport 29.

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. The residual toner is transported on the drum surface into a cleaning station E where it is brought under the influence of cleaning corotron 30 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 31. A conveyor moving in an endless loop through tubes 32 transports 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 29 into fusing station F. The fuser 33 is basically made up of an upper fuser roll 34 and a lower fuser roll 35 mounted in operative relation to each other and arranged to coat so as to support a sheet of material in pressure driving contact therebetween. The lower roll is heated. 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 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 39, into cooperating advancing rolls 43 and 44. At this point, depending on the mode of operation selected, the copy sheet is either moved directly to the sorter or into the upper supply tray 52 by means of a movable sheet guide 45 before entering the sorter. For simplex copying the copy sheet is advanced directly to the sorter apparatus which serves to invert the sheet before delivery to one of the tray assemblies of the sorter apparatus.

It is believed that the foregoing description is sufficient for purposes of the present application to show the general operation of a xerographic reproducing machine. For a more detailed explanation of the copier/duplicator xerographic components reference is made to U.S. Pat. No. 3,645,615 entitled "Copying Apparatus."

INVERTER APPARATUS (FIGS. 3-5)

The inverter apparatus 8 includes a horizontal transport assembly 103 which receives copy sheets from the copier/duplicator and either inverts copy sheets before advancing to the tray assemblies or advance them directly to the tray assemblies according to the mode of operation. Transport assembly 103 includes a series of belts 105 which are formed with holes about one-fourth inch in diameter through which a vacuum is exerted through a manifold 107 extending along the length of the transport belt 105 as provided by blower 108. Belts 105 are mounted on rolls 109 and 110. Roll 110 is driven by a drive motor 111 through belts 113 and 114 and associated pulleys. Positioned above the horizontal transport assembly 103 is a vertical transport assembly having belts 117 formed with openings to exert a vacuum force overlying a manifold 119 for transporting the copy sheets as in the case of the horizontal transport assembly. Vacuum is provided by blower 108. Belts 117 are mounted on rolls 120 and 121. Roll 120 is driven by motor 123 through belts 125 and 127 and associated pulleys.

At the entrance to the vertical transport assembly 115 is a deflector assembly 130 which includes a plurality of deflector members 131 pivotally supported on a pin member 135. It will be noted that deflector members 131 each have an upwardly curved side portion 137 and a downwardly curved side portion 139 for a purpose to be described. Deflector members 131 are pivoted on the axis of pin member 135 by moving lever member 140 which is activated by a plunger 145 of a solenoid 145 in response to electrical signals supplied from machine control upon selection of simplex sorting on control panel 5. By this arrangement, copy sheets traveling along the horizontal transport 103 are directed upwardly by the upwardly curved surface 137 of the deflector fingers 131 or allowed to pass on to the vertical transport 115, as will become more apparent.

Vertical transport 115 is bi-directional and moves in a counterclockwise direction except when in the simplex sorting mode of operation. When in the simplex mode of operation as the copy sheet passes a lamp and photocell sensing unit 147 and reflector 149 the presence of the sheet causes a signal to be supplied to machine control which reverses the direction of transport 115 to a clockwise direction. The deflector fingers direct the leading edge of the copy sheet onto the transport 115 (FIG. 4a). Due to the force exerted by the vacuum, the trailing edge of the copy sheet is positively positioned against the belts 117. By this structure the trailing edge of the copy sheet is controlled in its movement from transport 103 past the deflector fingers onto transport 115. Moreover, the effect of copy sheet characteristics, such as, curl, stiffness, static charge, etc., are minimized.

Vertical transport 115 continues to move the copy sheets upwardly until such time as the trailing edge of a sheet passes the end of the deflector fingers 131, as can be detected by a lamp and photocell sensing unit with reflector 152 or a signal from machine control after a predetermined time to reverse belts 117. Upon reversal of the belts the copy sheet is guided downwardly over curved surface 139 of the deflector fingers 131 and returned to the horizontal transport assembly 103. It will now be appreciated that the copy sheets being fed onto the horizontal assembly 103 may be inverted at the end of the transport assembly if they are acted upon by the deflector fingers and vertical transport assembly 115 according to the mode of operation as to whether simplex or duplex copies are desired.

SORTER APPARATUS

Sorter apparatus 6 receives copy sheets from hori-
zontal transport assembly 103 either face up or face down depending on the mode of operation and advances them to a plurality of tray assemblies 7. A drive apparatus moves the tray assemblies vertically for receiving copy sheets advanced along the transport path as will be explained hereinafter.

The tray assemblies 7 are arranged in groups of approximately five trays each for the purpose of multiple bin unloading as will become more apparent. Each of the tray assemblies has a tray portion 205 which is inclined to the horizontal plane for receiving the sides of the copy sheets. The angle of inclination may range from about 50° to about 60° preferably is about 20° to minimize sheet scatter and still accomplish multiple bin unloading. An end portion 207 is substantially perpendicular to the tray portion 205. The tray assembly extends in a horizontal direction at tail portion 209. Tray portion 205 and tail portion 209 are mounted on cam followers which engage the spiral slot formed in the cylindrical surface of cam members to be described.

Tail portion 209 has a cam follower mounted 213 which includes a spring member 215 for enabling movement of the cam followers 213 relative to the tray assembly 203. Tray portion 205 has a pair of cam followers 211 pivotally mounted on link members 212 adjacent the leading corners of the tray assembly. Cam followers 211 are received in spiral grooves 221 of camming members 223 and 224 positioned at opposite sides of the entrance to the tray assembly. A third cam member 225 which has spiral portions 227 for receiving cam follower 213. By this arrangement, a three point suspension is provided by the tray assemblies.

Each of the cam members 223 and 224 at the entrance of the tray assemblies and cam member 225 at the rear of the tray assemblies have the same path. The path has a series of fine closely spaced or low pitch surfaces 231 separated by a high pitch surface 233 providing separation of the tray assemblies into groups to enable multiple bin unloading. It will be noted that by this arrangement that multiple bin unloading results in copy sets adjacent tray assemblies being offset about one-fourth inch such that set separation of sets or books is effected upon simultaneous unloading of a group of the tray assemblies. Also by the above arrangement, the drive motor 250, is energized intermittently by electrical signals supplied by machine control when sheets on transport assembly 105 are detected by a lamp and photocell sensing unit 253 with the aid of a reflector 255 (FIG. 9).

In operation a plurality of switches 258 serve to determine the location of the tray assemblies relative to the sheet discharge zone by contacting tray tab portions 259 (FIG. 7) which serve as a tray coding device. Switches 258 supply a signal to machine control to indicate tray assemblies are in a ready condition to receive sheets and also to indicate when drive motor 250 should reverse. Another function of the switches is to prevent the tray assemblies from over indexing beyond the normal range by supplying a signal to machine control.

One or more switches 256 are mounted near cam member 223 to control deenergization of motor 250 upon a single revolution of the cam member. In this manner the tray assemblies advance together with each tray assembly receiving a sheet in the discharge zones. Limit switches 257 are provided as a backup to detect the upper and lower limits of the path of the tray assemblies to deenergize the motor 250 to prevent damage in the event of component failure.

By the above described reproduction system, collated sets of document information are produced on one or both sides of copy sheets at the option of a machine operator. Further, the collated sets are separately identifiable. It will be appreciated that this system facilitates the reproduction and distribution of document information.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. A reproduction system for producing collated sets of document information in both simplex and duplex form comprising:
   - processing means for producing simplex and duplex copies from document information according to a desired mode of operation,
   - transport means for receiving copy sheets from the processing means and transporting them to a discharge zone,
   - sheet inverting means positioned in the sheet path of the transport means operative to move sheets away from said transport means and return the sheets thereto with trailing edge becoming leading edge in response to signals,
   - an array of tray members operative to move past said sheet discharge zone to receive sheets in said tray members, and
   - control means to actuate said sheet inverting means to invert sheets according to whether copies are produced in simplex or duplex mode of operation and to move said trays past said sheet discharge zone in timed relation to receive simplex and duplex copies to produce collated sets thereof.

2. A system according to claim 1 wherein said sheet inverting means includes a gate member to direct sheets onto conveyor means which operate to reverse direction at a predetermined time.

3. A system according to claim 1 wherein said tray members are driven by camming means adapted to be energized to advance the tray members towards the discharge zone and de-energized for a time sufficient to receive a sheet into a selected tray member.

4. A system according to claim 3 wherein at least a portion of said tray members are arranged in a nest until positioned in the sheet discharge zone.

5. A system according to claim 4 wherein said tray members are arranged in groups, each group being separated by a spacing larger than the spacing between individual tray members.

6. A method of producing collated sets of simplex and duplex copies from document information comprising the steps of copying document information to produce simplex and duplex copies thereof, immediately after producing simplex copies distributing the copies to a conveyor face down, and immediately after producing duplex copies distributing the copies to a conveyor face up.
sorting the copies advanced by the conveyor into trays continuously until the document information is reproduced into collated sets.

7. A method according to claim 6 wherein said copying step is by electrostatic recording on plain paper.

8. A method according to claim 6 wherein said trays are moved relative to the sheet path in reciprocating fashion.

9. In a reproduction system for producing both simplex and duplex copy sheets through copying processing stations according to a desired mode of operation, an improved copy sheet handling apparatus for producing collated sets of both simplex and duplex copy sheets comprising,

conveyor means for advancing copy sheets received from copy processing stations towards sorting means,
sheet inverting means positioned in the sheet path of said conveyor means operative to move sheets away from said conveyor means and return the sheets thereto with trailing edge becoming leading edge in response to signals,
sorting means positioned to receive copy sheets advanced from said conveyor means and operative to sort the sheets into collated sets in response to signals, and
control means to energize said sheet inverting means to invert copy sheets selectively according to whether copy sheets are produced in a duplex or simplex mode of operation and to energize said sorting means to sort the sheets into sets thereby producing collated sets in both simplex and duplex modes of operation.