ABSTRACT

An improved copying system where documents are fed to the copier input station, copied a number of times equal to the number of bins in each section of the collator or the number of collated sets required, whichever is smaller, fed from the copier to one section of the collator and upon copying of all documents in the document tray repeating the copying of each document and switching the transporting of documents from the copier to a different section of the collator.

14 Claims, 5 Drawing Figures
FIG. 5
SORTER APPARATUS OF PRINTER SYSTEM

This is a continuation of application Ser. No. 198,725 filed Nov. 15, 1971 now abandoned. This invention relates generally to a collating system and particularly to a system for the production of an unlimited number of collated copy sets from a set of documents arranged in a predetermined order.

Prior to the advent of copying machines of the type wherein an original document could be reproduced on demand without the use of intermediate masters or special handling of the document in contact with specially treated copy sheets, the production of large numbers of collated sets of documents required offline operation or separate collating equipment. Whether collated documents were produced automatically or manually, it was necessary to produce all copies of each page to be collated prior to collation of the first documents. If it was desired to produce 25 booklets or sets of collated documents and each booklet or set had 10 pages, then 25 copies of 10 individual pages were first produced. If the collation was manual then the 25 copies of Page 1 were spread out into 25 individual piles. The 25 copies of Page 2 were placed individually on top of each copy of Page 1. This process was repeated for all 10 pages thus producing 25 collated sets of a 20 page document. If collating equipment were available, it took either of two forms. All of the 25 copies of Page 1 were placed in a sheet feeder which individually fed each copy into a separate bin of a collator. The copies of Page 2 were then placed in the sheet feeder and each copy of Page 2 was placed into the same bins as Page 1. This sequence of operation would be repeated for all 10 pages thus producing 25 collated sets of the 10 page document. An alternate mode of operation was to place all 25 copies of Page 1 into one bin and all 25 copies of Pages 2 through 10 each in its own individual bin. Each bin would be equipped with its own sheet feeding device whereby each bin could be actuated individually to feed out one copy from each bin thus producing one collated set of a 10 page document. Repeating the operation 25 times produced 25 sets of collated copies.

Copying machines capable of producing an unlimited number of copies from a single original upon demand eliminated the need for the production of all copies prior to collating. Thus, Page 1 could be placed in a copy machine set to produce 25 copies. When used in conjunction with sorting or collating apparatus the copies could be placed in individual bins. The sequential copying of Pages 2 through 10 by the copier and the subsequent insertion of each copy into the collator bins would produce collated sets of documents. Alternatively, devices were developed whereby individual collated sets of documents could be produced by pre-collating the documents to be copied and sequentially feeding the originals to the copier with the copier producing one copy of each original in turn and repetitively feeding the set of originals to the copier. Thus, each time a full set of collated originals was sent to the copier the output would be a complete collated copy of the document.

Both methods of production of collated copies has disadvantages. The production of large numbers of collated sets using collators with or without copying machines requires many bins, large complicated and expensive means to move the bins or to direct the copies to individual bins. Using precollated input with an office copier requires automatic handling of the original document with each collated output document. Thus, if there is a large number of collated documents required, the handling of the collated documents becomes excessive and increases the possibility of damage or destruction or reduction in quality of the original documents.

The present invention utilizes a combination of techniques employed by both output collators and precollation to produce a limitless sorter which, with a given number of bins together with limited use of precollection, will produce any number of collated sets of documents. By providing control logic relating to the operation of a copier capable of producing unlimited numbers of copies of an original document upon demand with an automatic document handling device which can feed original documents sequentially to the copier as required by the control logic and an output collator having at least two separate sections of bins each capable of receiving and collating documents received from the copier, a limitless number of collated sets of documents can be produced without interrupting the production and collation of documents.

By feeding the individual documents to the copier, producing copies equal to the number of bins in one section of the collator, feeding these copies into the bins of that section of the collator and then feeding the next original document to the copier and repeating the operation, a set of collated documents can be produced in the first section of the collator. As the original documents are returned from the copier to the document handling device in the same order as they were originally presented to the copier and in a position to be refed to the copier, the entire sequence can be repeated except that the output copies from the copier would be directed into a second section of the collator. While collated documents are being produced in the second section of the collator, the collated sets of copies in the first section of the collator can be removed manually or automatically making that section available for use when the collated sets in the second section are completed. By removing the sets of the collated documents from the second section of the collator while collated sets are being produced in the first section, the second section then becomes available for use when the collated sets in the first section are completed. By repeating this operation between sections of a collator, an unlimited number of collated sets of documents may be produced in a given size collator while efficiently maintaining the maximum copying rate of the copier.

The control logic relating to the copier, the document handling device and the collator, controls the feeding of originals to the copier in a precollated manner, controls the number of copies produced from each document fed to the copier, and controls the number of times the entire set of documents is fed to the copier and in addition controls the section of the collator into which the copies from the copier are fed and each run of originals fed by the document handler to the copier.

It is an object of the present invention to produce an unlimited number of collated sets of documents in a fixed size copy collator.

It is a further object of this invention to combine an office copier, a document handling device and a colla-
As an interface structure and for unobstructed 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 copying purposes. Suitable light-tight 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. 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 image 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 station 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 limitless sorting apparatus 32 as will be described hereinafter. The sheets are separated from the stack and fed from the top of the stack by means of a separator roll device 33 in timed sequence with the movement of the developed latent images on the belt 13.

Further details of the processing devices and stations in the printer system are not necessary to understand the principles 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 in copending applications Ser. Nos. 731,934 filed May 24, 1968; and 756,598, filed Aug. 30, 1968, now U.S. Pat. Nos. 3,661,452 and 3,597,071 respectively, 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 with the separator roller 33. It will be appreciated that 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 incorporating an alignment device may be utilized on each unit for ensuring upper alignment and to terminate or suspend operation in the event mis-alignment or separation of the units occur. For facility and needs of operation, each of the units may be provided with caster wheels and locking brakes thereby aiding in the movement of the units into and out of cooperative engagement.

LIMITLESS SORTING APPARATUS

Referring now to Fig. 2, limitless 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 which defines a series of bins or trays 59 which receive copy sheets in a downward direction. Similarly, upper sorting assembly 53 has a unitary framework which defines a series of trays or bins 59 for receiving copy sheets.

Sheets enter the sorting apparatus through an opening 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 belts 71 driven by a motor drive MOT-1 (Fig. 4). Belts 71 are above the sheet path and free wheeling rollers 73 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 solenoid control logic (Fig. 5). The solenoid 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 phototransistor 80. The breaking and 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 driven by a motor MOT-2 (Fig. 4) 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 solenoid 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 move 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 as will be described hereinafter.

Horizontal belts 71 are received and supported in a pivotal cover 137 connected to the frame by one or more hinges. Similarly, horizontal belts 117 are received in and supported by a pivotal cover 141 connected to the frame by one or more hinges.

The above brief description is deemed sufficient for a proper understanding of the sorting apparatus sections or modules. For a more detailed description reference is made to copending application Ser. No. 146,330, filed on May 24, 1971 entitled "Sorting Apparatus", now U.S. Pat. No. 3,709,492 commonly assigned with the instant application.

In accordance with the present invention the sorting apparatus is capable of limitless operation in producing collated sets of copy sheets from pre-collated documents. More specifically the sorting operation enables collating copy sets continuously by alternating sorting between the upper and lower sorting assemblies in such a manner that while one of the sorting assemblies is being emptied the other sorting assembly is being filled. Hence the printing machine is capable of producing collated copy sets from pre-collated documents without operator intervention.

A better appreciation of the invention may be had in connection with the control circuitry of Figs. 3-5. The machine operator selects the sorter or collated sets mode of operation by depressing the switch S1 (Fig. 1) on the control panel. By depressing switch buttons S3 (Fig. 1) the number of copies desired of each document is selected. When switch S1 is closed, a sorter logic 301 (Fig. 3) interrogates sensors 303 and 305 which are phototransistors similar to 80 and 127 mentioned above and also located on the lower and upper sorting assemblies 55 and 53, respectively (Fig. 2). It will be noted that the light sources or lamps 306 and 307 are aligned with sensors 303 and 305, respectively. Illumination from the lamps 306 and 307 will be sensed by sensors 303 and 305 which are coupled to sorter logic 301 if no sheet material is present in the trays. If either or both of the sorting assemblies are empty the sorter logic 301 is already to commence operation. Upon depressing a print switch S2 an exposure counter 309 counts flashes of flash lamps 18 up to the number of trays in each of the sorting assemblies or the number of copies of a document selected by pressing switch buttons S3 whichever is smaller. It should be understood that the exposure counter could be used with a scan type exposure system as well. When this occurs sorter logic 301 signals the processor logic 311 to wait while the document accessory logic 313 associated with document feed apparatus 15 signals the document feed apparatus to supply another document to the platen for copying. After this document is in place document accessory logic 313 signals processor logic 311 to enable the flashing of lamps 18. This exposure operation continues until the document feed apparatus 15 has removed the last document of stack 17 from the platen at which time the sorter logic 301 again interrogates sensors 303 and 305 to determine if there is an available or empty sorting assembly. If a sorting assembly is available the aforementioned operation is completed. If at any time during the printing operation a sorting assembly is not available to sort, i.e., sets have not been removed from the trays, the sorter logic 301 signals processor logic 311 and document accessory logic 313 to wait until a sorting assembly is available. When a sorting assembly is available a signal is received from sensors 303 or 305 and the operation continues in automatic fashion as before.

It will be appreciated that signals from phototransistors 80 and 127 count the copies entering the trays thereby establishing control of motors MOT-2 and MOT-1 and also deflector 135 which are controlled by signals 405, 409 and 413, respectively, supplied from
sorter logic 301. FIG. 4 illustrates the motor drive circuit in detail. It will be noted that motor 153 has a triac Q1 and a power source 411 connected across its terminals and that motor MOT-2 also has a triac Q2 and power source 411 connected across its terminals. It will be appreciated that signal 409 serves to energize a relay K1 causing Q1 to conduct which then provides a conductive path for power source 411 to energize motor MOT-1. In similar fashion, signal 405 serves to energize relay K2 which causes Q2 to conduct thereby enabling power to be placed across the terminals of motor MOT-2. It will be further noted that logic 301 provides a signal 413 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, of lower and upper sorting assemblies 55 and 53, respectively, and signal counters 415 and 417, respectively. Counters 415 and 417 (FIG. 5) supply an input to decoders 419 and 421, respectively, which, in turn, energize the proper solenoid of the solenoid matrix 427 and 429, respectively through drive circuits 423 and 425.

At the same time, signals 350 and 351 from the sorter logic 301 are supplied to comparison circuits 433 and 435, respectively. Comparison circuits 433 and 435 also receive signals from counters 415 and 417, respectively. If the counts agree, then reset signals 437 and 439 are supplied to counters 415 and 417, respectively. The counts agree when the number of copies sorted equal the number of copies made of a particular original.

By the above described invention an entirely new concept producing collating sets of copies from precollated documents is made possible without operator aid except for the emptying of trays of a particular module. Heretofore, the number of sheets of collated copies was limited to the number of modular assemblies and trays that could be positioned adjacent to the processor of a printing machine. When documents are being recycled automatically with the present invention, only two sorting assemblies are utilized for receiving collated sets of copies in alternate fashion such that when one is receiving copy sets, copy sets may be removed from the other. It will be appreciated that with the advent of high speed printing machines utilizing automatic document handling accessories that the coordination of recirculating original feeder with the sorting assemblies herein greatly enhance the overall capabilities of the printing machine.

While the invention has been described with reference to the structure disclosed herein, it is not confined to the details set forth; and this application is intended to cover such modifications or changes as may come within the scope of the following claims.

What is claimed is:

1. Apparatus for the production of an unlimited number of sets of collated copies of documents from a single set of precollated originals including:
document copier including an input station for documents to be copied, means to create multiple copies of each document at the input station and means to transport the copies produced in sequence out of the copier;
document handling means including a document tray to hold a stack of documents in a prearranged order, means to feed documents individually in the prearranged order from the document tray to the input station of the copier, means to return documents from the input station of the copier back into the document tray in the prearranged order;
copy collator means comprising at least two sections with each section having a plurality of copy bins and collector transport means to feed individual copies sequentially into each bin in either section, said collector transport means positioned to receive copies from the copier for insertion into the collector bins; and
control means to correlate the operation of the document handling means, the copier and the collector means including means to preset the number of sets of collated copies to be produced, means to count the number of copies made from each original and upon coincidence of the number of copies made with the number of bins in a predetermined section of the collector to initiate operation of the document handling means to feed a document from the document tray to the copier input station and to return any document at the input station to the document tray, means to indicate when each document in the document tray has been copied and to switch the collector transport means to feed copies into a different section of the collator means, means to determine the number of collated sets produced and to reinitiate operation of the document handling means when the number of preset sets does not compare and to terminate operation of the copier and document handling means when the numbers do compare.

2. In an apparatus for printing comprising an exposure station, document handling means for feeding documents in seriatim towards the exposure station for copying thereof, said printing apparatus including means for producing copies of the documents and transporting them along a copy feed path, an improved apparatus for sorting collated sets of copies of the document continuously comprising
a first sorting assembly including a first copy transport means positioned to deliver copies into a first array of trays in predetermined sequence
a second sorting assembly including second copy transport means positioned to deliver copies into a second array of trays in predetermined sequence
deflector means positioned in the copy path to direct a copy towards the first or second sorting assemblies in response to electrical signals,
sensing means associated with each of the sorting assemblies for detecting the presence of copies therein and emitting electrical signals in the absence thereof,
logic means coupled to said sensing means for energizing an appropriate one of the first and second transport means in alternating fashion and for energizing said deflector means to control the production of copies in response to electrical signals from the sensing means until the copying operation is completed.

3. Apparatus according to claim 2 wherein the exposure station includes at least one lamp responsive to control signals from said logic means.
4. Apparatus according to claim 2 wherein said logic means includes sensing means associated with each of the sorting assemblies for establishing a count of copies received thereby.

5. Apparatus according to claim 3 wherein said lamp is coupled to an exposure counter for controlling the number of exposures in a predetermined period.

6. A method of automatically printing collated sets of copies continuously from precollated documents from a stack comprising:
advancing documents to a copying position for copying and returning each document in the same order to the stack and then recirculating the documents as before until the desired number of copies is made,
sorting a predetermined number of copy sheets in a first array of trays,
sorting a predetermined number of copy sheets in a second array of trays, and
alternating sorting between said first and second array of trays upon filling one array and sensing an empty condition in the other until the printing operation is complete.

7. In a reproduction system for producing and collating copies from a set of documents including a processor and a sorter, the sorter having at least one copy storage section with a predetermined number of copying receiving trays, the improvement comprising:
program means for presetting the number of copies of the set of documents to be made by the processor in a reproduction operation; and
control means responsive to said program means when preset for a number of copies greater than said predetermined number of trays to limit the number of copies made of the set of documents by the processor to no more than said predetermined number of trays before further copies of said set are made.

8. The reproduction system according to claim 7 in which said control means includes means responsive to the presence of copies in said sorter section to prevent placement of subsequent copies therein, said means being adapted on clearing of copies from that section to override the control means and enable subsequent copies to be placed in said section.

9. The reproduction system according to claim 7 further including a document handler for presenting one document at a time from the set of documents for reproduction by said processor,
said control means being adapted to actuate said document handler to present the next document in the set for reproduction each time said predetermined number of trays is reached during the document set reproduction.

10. The reproduction system according to claim 9 in which said control means is adapted to actuate said document handler until all the documents in the set have been produced and collated, and to recirculate the set of documents until the total number of document set copies programmed are made.

11. The reproduction system according to claim 10 further including a second sorter section having a predetermined number of copy receiving trays,
said control means being adapted to direct copies of the recirculated document set into said second sorter section.

12. The reproduction system according to claim 10 further including at least one additional sorter section having a predetermined number of copy receiving trays,
said control means adapted to direct copies of each recirculated document set alternately to one or the other of said tray sections until the total number of document set copies programmed are made.

13. The reproduction system according to claim 12 in which said control means includes means responsive to the presence of copies in either of said sorter sections to direct subsequent copies to the other sorter section, said means being adapted on clearing of copies from that section to condition the same for receipt of subsequent copies.

14. In a reproduction system for producing and collating copies of a set of documents including a processor, a document handler, and a sorter, the sorter having at least two copy storage sections each with a predetermined number of copy trays, the combination of:
counter means for presetting the number of copies to be made,
control means in response to said presetting arranged to actuate the document handler to present one document at a time to the processor for copying the document, and to actuate the sorter to place each copy produced in a different one of said trays,
means responsive to setting of said counter means to a number of copies exceeding said predetermined number of trays to operate said processor to make copies of each document in groups equal to or less than said predetermined number, said last named means being adapted to operate the document handler to recirculate the set of documents the number of times required to produce the preset number of copies and means for directing the copies to one sorter section or the other as each of said groups are completed.

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