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(54) REPRODUCTION MACHINE HAVING DUPLEX JOB RECOVERY CAPABILITIES

(71) We, XEROX CORPORATION of Xerox Square, Rochester, New York, United States of America, a corporation organised under the laws of the State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a reproduction machine capable of making duplex copies from a set of original documents. More particularly, it involves a control system for automatically adjusting the reproduction process of such a machine in the event of a fault condition so that the selected number of copies are ultimately produced even though some copies may have been lost due to the fault occurring during the middle of a copy run.

As processing speeds of modern day reproduction machines become increasingly faster, and machine accessories such as sorters, collators, binders, document handlers, etc. become more prevelant, the problem of recouping or saving a specific job in the event of a machine malfunction or fault condition, such as, for example, a paper jam, becomes almost impossible. It will be understood that protection against fault conditions like paper jams is provided through safety controls designed to stop the machine, as well as any accessories used therewith. The jammed papers, which are usually damaged or mutilated, are then removed and the machine restarted. However, loss of these partially processed copies upsets the copy run, since, if the system is merely restarted, the number of copies made will not equal the number of copies selected. This, of course, is due to loss of some copies in clearing the machine.

Thus, to ultimately produce the number of copies selected, some provision for making up the copies lost as a result of clearing the jam must be made. Unfortunately, this is an extremely difficult task in modern high speed reproduction machines, particularly those employing accessories such as document handler, since it is difficult to determine exactly how many copies are actually lost and to identify those copies lost with the correct original. Rather than go through a complicated evaluation, many users may tend to simply start the entire copy run anew, discarding even those copies which have been successfully completed. This, of course, can be quite wasteful and expensive, particularly where the job is large and almost completed at the time of the jam.

As described in United States Patent No. 3,944,794 the Xerox 9200 (Trade Mark) copier/duplicator system incorporates a jam recovery technique that has proven to be extremely satisfactory. However, the machine does not include provision for automatically making two sided or duplexed copies. Instead, it merely provides the capability of producing one sided or simplex copies automatically. It is realized that some of the more recent commercially available machines provide the capability of automatically producing duplex copies. However, due to the extreme complexity of such machines, they have not included provision for automatically remaking lost copies in the event of fault conditions.

According to the invention there is provided a method of controlling a reproduction machine to produce duplex copies from a set of original documents and for automatically adjusting the reproduction process in the event of a fault condition so that the selected number of copies are produced, said method comprising:

a) storing the quantity to be exposed and the quantity to be delivered to a receptacle for each original in the set for proper completion of the copy run;

b) exposing a side 1 original to form at least one image thereof on a photoreceptor;

c) forming finished copies from each image thus formed;

d) delivering said side 1 copies to a temporary receptacle;

e) counting in an exposures made counter the actual number of exposures made for each original;

f) counting in a copies delivered counter the number of finished copies successfully delivered to a receptacle;

g) comparing the quantity to be exposed and the quantity to be delivered with the contents of the exposures made counter and the copies delivered counter for the side 1 copies, respectively;

h) presenting a side 2 original to the machine only if there is both side 1 exposure and delivery coincidence;

i) exposing the side 2 original to form at least one image thereof on the photoreceptor;

j) comparing the quantity to be exposed with the contents of the exposures made counter for the side 2 original;

k) feeding said side 1 copies from the temporary receptacle;

l) forming finished copies of the side 2 original on the opposite side of the side 1 copies thereby forming duplex copies;

m) delivering said duplex copies to an output receptacle;

n) comparing the quantity to be delivered with the contents of the copies delivered counter for the side 2 originals; and

o) repeating steps b—n in the event of a fault condition until side 1 and side 2 exposure and delivery coincidences are met thereby remaking any lost copies due to the fault.

The side 1 original may be presented to the machine for forming finished copies thereof, with the side 1 copies being delivered to a temporary receptacle. The actual number of exposures made for each original is counted, as is the number of copies actually delivered. The side 2 original is presented to the machine only if there is both exposure and delivery coincidence for the side 1 copies. If so, duplex copies are formed by forming finished copies of the side 2 original on the opposite side of the side 1 copies which are fed from the temporary receptacle. In order to optimize the machine speed, the next side 1 original may be placed on the platen and exposed as soon as there is side 2 exposure coincidence. However, the number of duplex copies subsequently delivered to an output receptacle is also detected and compared with the stored quantity of copies to be delivered for necessary completion. The above procedure is repeated in the event of a fault condition until side 1 and side 2 exposure and delivery coincidences are both met thereby making any lost copies due to a fault condition.

A reproduction apparatus incorporating a control system according to the present invention will now be described by way of example with reference to the accompanying drawings in which:—

A reproduction apparatus according to the invention will now be described by way of example with reference to the accompanying drawings in which:—

Fig. 1 is a schematic representation of the reproduction apparatus incorporating a control system;

Fig. 2 is a schematic view showing a paper path and sensors of the apparatus shown in Fig. 1;

Fig. 3 is an enlarged view showing details of a copy sorter for the apparatus shown in Fig. 1;

Fig. 4 is a schematic view showing details of a document handler for the apparatus shown in Fig. 1;

Fig. 5 is a block diagram of a controller for the apparatus shown in Fig. 1;

Fig. 6 is a view of a control console for inputting copy run instructions to the apparatus shown in Fig. 1;

Fig. 7 is a flow chart illustrating a typical machine state,

Fig. 8 is a flow chart of the machine state routine;

Fig. 9 is a view showing an event table layout;

Fig. 10 is a chart illustrating the relative timing sequences of the clock interrupt pulses;

Figs. 11a, 11b, 11c comprise timing charts of the principal operating components of the host machine in an exemplary copy run; and

Fig. 12—16 are flow charts which illustrate the duplex job recovery sequence.

Referring particularly to Figures 1—4 of the drawings, there is shown, in schematic outline, an electrostatic reproduction system or host machine, identified by numeral 10, incorporating the control arrangement. To facilitate description, the reproduction system 10 is divided into a main electrostatic xerographic processor 12, sorter 14, document handler 16, and controller 18. Other processor, sorter and/or document handler types and constructions, and different combinations thereof may instead by envisioned.

Processor

Processor 12 utilizes a photoreceptor in the form of an endless photoconductive belt 20 supported in generally triangular configuration by rolls 21, 22, 23. Belt supporting rolls 21, 22, 23 are in turn rotatably journaled on subframe 24.

In the exemplary processor illustrated, belt 20 comprises a photoconductive layer of selenium, which is the light receiving surface and imaging medium, on a

conductive substrate. Other photoreceptor types and forms, such as comprising organic materials, or of multi-layers or a drum may instead be envisioned.

Suitable biasing means (not shown) are provided on subframe 24 to tension the photoreceptor belt 20 and insure movement of belt 20 along a prescribed operating path. Belt 20 is supported so as to provide a trio of substantially flat belt runs opposite exposure, developing, and cleaning stations 27, 28, 29 respectively. To enhance belt flatness at these stations, vacuum platens 30 are provided under belt 20 at each belt run. Conduits 31 communicate vacuum platens 30 with a vacuum pump 32. Photoconductive belt 20 moves in the direction indicated by the solid line arrow, drive thereto being affected through roll 21, which in turn is driven by main drive motor 34.

Processor 12 includes a generally rectangular, horizontal transparent platen 35 on which each original 2 to be copied is disposed. A two or four sided illumination assembly is provided for illuminating the original 2 on platen 35.

The light image generated by the illumination system is projected via mirrors 39, 40 onto the photoreceptive belt 20 at the exposure station 27. Exposure of the previously charged belt 20 selectively discharges the photoconductive belt to produce on belt 20 an electrostatic latent image of the original 2. To prepare belt 20 for imaging, belt 20 is uniformly charged to a preselected level by charge corotron 42 upstream of the exposure station 27.

To prevent development of charged but unwanted image areas, erase lamps 44, 45 are provided. Lamp 44, which is referred to herein as the pitch fadeout lamp, is supported in transverse relationship to belt 20, lamp 44 extending across substantially the entire width of belt 20 to erase (i.e. discharge) areas of belt 20 before the first image, between successive images, and after the last image. Lamps 45, which are referred to herein as edge fadeout lamps, serve to erase areas bordering each side of the images. Edge fadeout lamps 45, which extend transversely to belt 20, are disposed within a housing having a pair of transversely extending openings of differing length adjacent each edge of belt 20. By selectively actuating one or the other of the lamps 45, the width of the area bordering the sides of the image that is erased can be controlled.

Magnetic brush rolls are provided in a developer housing 51 at developing station 28. The bottom of housing 51 forms a sump within which a supply of developing material is contained. A rotatable auger 54 in the sump area serves to mix the developing material and bring the material into operative relationship with the lowermost of the magnetic brush rolls.

As will be understood by those skilled in the art, the electrostatically attractable developing material commonly used in magnetic brush developing apparatus of the type shown comprises a pigmented resinous powder, referred to as toner, and larger granular beads referred to as carrier. To provide the necessary magnetic properties, the carrier is comprised of a magnetizable material such as steel. By virtue of the magnetic fields established by developing rolls and the interrelationship therebetween, a blanket of developing material is formed along the surfaces of developing rolls adjacent the belt 20 and extending from one roll to another. Toner is attracted to the electrostatic latent image from the carrier bristles to produce a visible powder image on the surface of belt 20.

A magnetic pick-off roll 72 is rotatably supported opposite belt 20 downstream of pre-transfer lamp 71, roll 72 serving to scavenge leftover carrier from belt 20 preparatory to transfer of the developed image to the copy sheet 3. Motor 73 turns roll 72 in the same direction and at substantially the same speed as belt 20 to prevent scoring or scratching of belt 20.

Referring to Fig. 2, to transfer developed images from belt 20 to the copy sheets 3, a transfer roll 75 is provided. Transfer roll 75, which forms part of the copy sheet feed path, is rotatably supported within a transfer roll housing opposite belt support roll 21.

To facilitate separation of the copy sheets 3 from belt 20 following transfer of developed images, a detack corotron is provided. The corotron generates a charge designed to neutralize or reduce the charges tending to retain the copy sheet on belt 20. The corotron 82 is supported opposite belt 20 and downstream of transfer roll 75.

Referring particularly to Figures 1 and 2, copy sheets 3 comprise precut paper sheets supplied from either main or auxiliary paper trays 100, 102. Each paper tray has a platform or base 103 for supporting in stack-like fashion a quantity of sheets. The tray platforms 103 are supported for vertical up and down movement by motors 105, 106. Side guide pairs 107, in each tray 100, 102 delimit the tray side boundaries, the guide pairs being adjustable toward and away from one another in accommodation of different size sheets. Sensors 108, 109 respond to the position of each side guide pair 107, the output of sensors 108, 109 serving to regulate operation of edge fadeout lamps 45 and a fuser cooling valve. Lower limit switches 110 on each tray prevent overtravel of the tray platform in a downward direction.

A heater 112 is provided below the platform 103 of main tray 100 to warm the tray area and enhance feeding of sheets therefrom. Humidstat 113 and thermostat 114 control operation of heater 112 in response to the temperature/humidity conditions of main tray 100. Fan 115 is provided to circulate air within tray 100.

To advance the sheets 3 from either main or auxiliary tray 100, 102, main and auxiliary sheet feeders 120, 121 are provided. Feeders 120, 121 each include a nudger roll 123 to engage and advance the topmost sheet in the paper tray forward into the nip formed by a feed belt 124 and retard roll 125. Retard rolls 125, which are driven at extremely low speed by motor 126, cooperate with feed belts 124 to restrict feeding of sheets from trays 100, 102 to one sheet at a time.

Feed belts 124 are driven by main and auxiliary sheet feed motors 127, 128 respectively. Nudger rolls 123 are supported for pivotal movement about the axis of feed belt drive shaft 129 with drive to the nudger rolls taken from drive shaft 129. Stack height sensors 133, 134 are provided for the main and auxiliary trays, the pivoting nudger rolls 123 serving to operate sensors 133, 134 in response to the sheet stack height. Main and auxiliary tray misfeed sensors 135, 136 are provided at the tray outlets.

Main transport 140 extends from main paper tray 100 to a point slightly upstream of the nip formed by photoconductive belt 20 and transfer roll 75. Transport 140 is driven from main motor 34. To register sheets 3 with the images developed on belt 20, sheet register fingers 141 are provided, fingers 141 being arranged to move into and out of the path of the sheets on transport 140 once each revolution. Registration fingers 141 are driven from main motor 34 through electromagnetic clutch 145. A timing or reset switch 146 is set once on each revolution of sheet register fingers 141. Sensor 139 monitors transport 140 for jams. Further amplification of sheet register system may be found in U.S. Patent No. 3,781,004,

Pinch roll pair 142 is interspaced between transport belts that comprise main transport 140 on the downstream side of register fingers 141. Pinch roll pair 142 are driven from main motor 34.

Auxiliary transport 147 extends from auxiliary tray 102 to main transport 140 at a point upstream of sheet register fingers 141. Transport 147 is driven from motor 34.

To maintain the sheets in driving contact with the belts of transports 140, 147, suitable guides or retainers (not shown) may be provided along the belt runs.

The image bearing sheets leaving the nip formed by photoconductive belt 20 and transfer roll 75 are picked off by belts 155 of the leading edge of vacuum transport 149. Belts 155, which are perforated for the admission of vacuum therethrough, ride on forward roller pair 148 and rear roll 153. A pair of internal vacuum plenums 151, 154 are provided, the leading plenum 154 cooperating with belts 155 to pick up the sheets leaving the belt/transfer roll nip. Transport 149 conveys the image bearing sheets to fuser 150. Vacuum conduits 147, 156 communicate plenums 151, 154 with vacuum pumps 152, 152'. A pressure sensor 157 monitors operation of vacuum pump 152. Sensor 144 monitors transport 149 for jams.

To prevent the sheet on transport 149 from being carried into fuser 150 in the event of a jam or malfunction, a trap solenoid 158 is provided below transport 149. Energization of solenoid 158 raises the armature thereof into contact with the lower face of plenum 154 to intercept and stop the sheet moving therepast.

Referring particularly to Figure 2, fuser 150 comprises a lower heated fusing roll 160 and upper pressure roll 161. The core of fusing roll 160 is hollow for receipt of a heating rod therewithin.

Fuser roll 160 is driven from main motor 34. Pressure roll 161 is drivingly coupled to fuser roll 160 for rotation therewith.

Thermostat 175 (Fig. 12) in the fuser housing controls operation of the heating rod in response to temperature. Sensor 175 protects against fuser over-temperature. To protect against trapping of a sheet in fuser 150 in the event of a jam, sensor 176 is provided.

Following fuser 150, the sheet is carried by post fuser transport 180 to either discharge transport 181 or, where duplex or two sided copies are desired, to return transport 182. Sheet sensor 183 monitors passage of the sheets from fuser 150. Transports 180, 181 are driven from main motor 34. Sensor 181' monitors transport 181 for jams. Suitable retaining means may be provided to retain the sheets on transports 180, 181.

A deflector 184, when extended, directs sheets on transport 180 onto conveyor roll 185 and into chute 186 leading to return transport 182. Solenoid 179, when energized raises deflector 184 into the sheet path. Return transport 182 carries the sheets back to auxiliary tray 102. The forward stop 187 of tray 102 is supported for oscillating movement. Motor 188 drives stop 187 back and forth tap sheets returned to auxiliary tray 102 into alignment for refeeding.

To invert duplex copy sheets following fusing of the second or duplex image, a displaceable sheet stop 190 is provided

adjacent the discharge end of chute 186. Stop 190 is pivotally supported for swinging movement into and out of chute 186. Solenoid 191 is provided to move stop 190 selectively into or out of chute 186. Pinch roll pairs 192, 193 serve to draw the sheet trapped in chute 186 by stop 190 and carry the sheet forward onto discharge transport 181. Further description of the inverter mechanism may be found in U.S. Patent No. 3,856,295,

Output tray 195 receives unsorted copies. Transport 196 a portion of which is wrapped around a turn around roll 197, serves to carry the finished copies to tray 195. Sensor 194 monitors transport 196 for jams. To route copies into output tray 195, a deflector 198 is provided. Deflector solenoid 199, when energized, turns deflector 198 to intercept sheets on conveyor 181 and route the sheets onto conveyor 196.

When output tray 195 is not used, the sheets are carried by conveyor 181 to sorter 14.

Sorter

Referring particularly to Fig. 3, sorter 14 comprises upper and lower bin arrays 210, 211. Each bin array 210, 211 consists of series of spaced downwardly inclined trays 212, forming a series of individual bins 213 for receipt of finished copies 3'. Conveyors 214 along the top of each bin array, cooperate with idler rolls 215 adjacent the inlet to each bin to transport the copies into juxtaposition with the bins. Individual deflectors 216 at each bin cooperate, when depressed, with the adjoining idler roll 215 to turn the copies into the bin associated therewith. An operating solenoid 217 is provided for each deflector.

A driven roll pair 218 is provided at the inlet to sorter 14. A generally vertical conveyor 219 serves to bring copies 3' to the upper bin array 210. Entrance deflector 220 routes the copies selectively to either the upper or lower bin array 210, 211 respectively. Solenoid 221 operates deflector 220.

Motor 222 is provided for each bin array to drive the conveyors 214 and 219 of upper bin array 210 and conveyor 214 of lower bin array 211. Roll pair 218 is drivingly coupled to both motors.

To detect entry of copies 3' in the individual bins 213, a photoelectric type sensor 225, 226 is provided at one end of each bin array 210, 211 respectively. Sensor lamps 225', 226' are disposed adjacent the other end of the bin array. To detect the presence of copies in the bins 213, a second set of photoelectric type sensors 227, 228 is provided for each bin array, on a level with a tray cutout (not shown). Reference lamps 227', 228' are disposed opposite sensors 227, 228.

Document Handler

Referring particularly to Figure 4, document handler 16 includes a tray 233 into which originals or documents 2 to be copied are placed by the operator following which a cover (not shown) is closed. A movable bail or separator 235, driven in an oscillatory path from motor 236 through a solenoid operated one revolution clutch 238, is provided to maintain document separation.

A document feed belt 239 is supported on drive and idler rolls 240, 241 and kicker roll 242 under tray 233, tray 233 being suitably apertured to permit the belt surface to project therewithin. Feedbelt 239 is driven by a notor through an electromagnetic clutch. Guide 245, disposed near the discharge end off feed belt 239, cooperates with belt 239 to form a nip between which the documents pass.

A photoelectric type sensor 246 is disposed adjacent the discharge end of belt 239. Sensor 246 responds on failure of a document to feed within a predetermined interval to actuate solenoid operated clutch 248 which raises kicker roll 242 and increases the surface area of feed belt 239 in contact with the documents. Another sensor 259 located underneath tray 233 provides an output signal when the last document 2 of each set has left the tray 233.

Document guides 250 route the document fed from tray 233 via roll pair 251, 252 to platen 35. Roll 251 is also drivingly coupled to a motor through an electromagnetic clutch. Contact of roll 251 with roll 252 turns roll 252.

Roll pair 260, 261 at the entrance to platen 35 advance the document onto platen 35, roll 260 being driven in the forward direction. Contact of roll 260 with roll 261 turns roll 261 in the document feeding direction. Roll 260 is selectively coupled through a gearset with the motor through an electromagnetic clutch so that roll 260 and roll 261 therewith turn in the reverse direction to carry the document back to tray 233 via return chute 276.

The document leaving roll pair 260, 261 is carried by platen feed belt 270 into platen 35, belt 270 being comprised of a suitable flexible material having an exterior surface of xerographic white.

To locate the document in predetermined position on platen 35, a register 273 is provided at the platen inlet for engagement with the document trailing edge. For this purpose, control of platen belt 270 is such that following transporting of the document onto plate 35 and beyond register 273, belt 270 is reversed to carry the document backwards against register 273.

To remove the document from platen 35 following copying, register 273 is retracted to an inoperative position. Solenoid 274 is provided for moving register 273.

A document deflector 275, is provided to route the document leaving platen 35 into return chute 276. Discharge roll pair 278 carry the returning document into tray 233.

To monitor movement of the documents in document handler 16 and detect jams and other malfunctions, photoelectric type sensors 246 and 280, 281 and 282 are disposed along the document routes.

To align documents 2 returned to tray 233, a document patter 284 is provided adjacent one end of tray 233. Patter 284 is oscillated by motor 285.

Timing

To provide the requisite operational synchronization between host machine 10 and controller 18 as will appear, processor or machine clock 202 is provided. Referring particularly to Fig. 1, clock 202 comprises a toothed disc 203 drivingly supported on the output shaft of main drive motor 34. A photoelectric type signal generator 204 is disposed astride the path followed by the toothed rim of disc 203, generator 204 producing, whenever drive motor 34 is energized, a pulse like signal output at a frequency correlated with the speed of motor 34.

As described, a second machine clock, termed a pitch reset clock 138 herein, and comprising timing switch 146 is provided. Switch 146 cooperates with sheet register fingers 141 to generate an output pulse once each revolution of fingers 141. As will appear, the pulse like output of the pitch reset clock is used to reset or resynchronize controller 18 with host machine 10.

A real time clock is utilized to control internal operations of the controller 18 as is known in the art. The real time clock is also utilized to time the operation of some of the machine components as will be described.

Controller

Referring to Fig. 5, controller 18 includes a Central Processor Unit (CPU) Module 500, Input/Output (I/O) Module 502, and Interface 504. Address, Data and Control Buses 507, 508, 509 respectively operatively couple CPU Module 500 and I/O Module 502. CPU Module 500 I/O Module 502 are disposed within a shield 518 to prevent noise interference.

Interface 504 couples I/O Module 502 with special circuits module 522, input matrix module 524, and main panel interface module 526. Module 504 also couples I/O Module 502 to operating sections of the machine, namely, document handler section 530, input section 532, sorter section 534 and processor sections 536, 538. A spare section 540, which may be used for monitoring operation of the host machine, or which may be later utilized to control other devices, is provided.

CPU module 500 comprises a processor such as an Intel 8080 microprocessor manufactured by Intel Corporation, Santa Clara, California, and includes conventional memories, such as a 16K Read Only Memory (herein ROM) and 2K Random Access Memory (herein RAM), as well as a nonvolatile memory.

Machine Operation

As will appear, host machine 10 is conveniently divided into a number of operational states. The copy control program is divided into background routines and foreground routines with operational control normally residing in the background routine or routines appropriate to the particular machine state then in effect. The output buffer of the RAM memory section is used to transfer/refresh control data to the various remote locations in host machine 10.

Foreground routine control data which includes a Run Event Table built in response to the particular copy run or runs programmed, is transferred to the remote locations by means of a multiple prioritized interrupt system wherein the background routine in process is temporarily interrupted while fresh foreground routine control data is inputted following which the interrupted background routine is resumed.

The copy control program for host machine 10 is divided into a collection of foreground tasks, some of which are driven by the several interrupt routines, and others by the background or non-interrupt routines. Foreground tasks are tasks that generally require frequent servicing, high speed response, or synchronization with the host machine 10, different background routines being performed with different machine states. The copy control program includes a single background software routine (STCK) composed of specific subroutines associated with the principal operating states of host machine 10 is provided. A byte called STATE contains a number indicative of the current operating state of host machine 10. The machine STATES are as follows:

State No.	Machine State	Control
0	Software Initialize	Subr
1	System Not Ready	INIT
2	System Ready	NRDY
3	Print	RDY
4	System Running	PRINT
5	Not Print	RUNNPRT
	Service	TECHREP

Referring to Figure 7, each STATE is normally divided into PROLOGUE, LOOP and EPILOGUE sections. As will be evident from the exemplary background program STCK entry into a given STATE (PROLOGUE) normally causes a group of operations to be performed, these consisting of operations that are performed once only at the entry into the STATE. For complex operations, a CALL is made to an applications subroutine therefor. Relatively simpler operations (i.e. turning devices on or off,clearing memory, presetting memory, etc.) are done directly.

Once the STATE PROLOGUE is completed, the main body (LOOP) is entered. The routine remains in this LOOP until a change of STATE request is received and honored. On a change of STATE request, the state epilogue is entered wherein a group of operations are performed, following which the STATE moves into the PROLOGUE of the next state to be entered.

Referring to Fig. 8, on actuation of the machine POWER-ON button 804, the software Initialize STATE(INIT) is entered. In this STATE, the controller is initialized and a software controlled self test subroutine is entered. If the self test of the controller is successfully passed, the System Not Ready STATE (NRDY) is entered. If not, a fault condition is signaled.

In the System Not Ready STATE (NRDY), background subroutines are entered. These include setting of Ready flags, control registers, timers, and the like; turning on power supplies, the fuser, etc., initializing the Fault Handler, checking for paper jams (left over from a previous run), door and cover interlocks, fuser temperature etc. During this period, the WAIT lamp on console 800 is lit and operation of host machine 10 precluded.

When all ready conditions have been checked and found acceptable, the controller moves to the System Ready State (RDY). The READY lamp on console 800 is lit and final ready checks made. Host Machine 10 is now ready for operation upon completion of the conditioning of the machine for the desired copy run, loading of one or more originals 2 into document handler 16 (if selected by the operator), and actuation of STAR PRINT button 805. As will appear hereinafter, the next state is PRINT wherein the particular copy run selected is carried out.

While the machine is completing a copy run, the controller normally enters the Run Not Print State (RUNNPRT) where the controller calculates the number of copies delivered, resets various flags, stores certain machine event information in the memory, as well as generally conditioning the machine for another copy run, if desired. The controller then returns to the System Not Ready State (NRDY) to recheck for ready conditions prepatory for another copy run, with the same state sequence being repeated until the machine is turned off by actuation of POWER OFF button 804 or a malfunction inspired shutdown is triggered. Hence, the copy control program comprises the routines in states 0—4. In contrast, the last state (TECHREP—5) is a machine servicing state wherein different operating programs can be accessed as will later be described.

Referring particularly to Fig. 6, the machine operator uses control console 800 to condition the machine for the copy run desired. Conditioning may be done during either the System Not Ready (NRDY) or System Ready (RDY) states, although the machine will not operate during the System Not Ready state should START PRINT button 805 be pushed. The copy run conditioning includes selecting (using keyboard 808) the number of copies to be made, and such other ancillary features as may be desired, i.e. use of auxiliary paper tray 102, (push button 810), image size selection (push buttons 818, 819, 820), document handler/sorter selection (push buttons 822, 823, 825, 826), copy density (push buttons 814, 815), duplex or two sided copy button 811, etc. On completion of the copy run START PRINT button 805 is actuated to start the copy run selected (presuming the READY lamp is on and an original or originals 2 have been placed in tray 233 of document handler 16 if the document handler has been selected).

On entering PRINT STATE, a Run Event Table (Fig. 9) comprised of foreground tasks is built for operating in cooperation with the background tasks the various components of host machine 10 in an integrated manner to produce the copies desired. The run Event Table is formed by controller 18 through merger of a Fixed Pitch Event Table and a Variable Pitch Event Table in a fashion appropriate to the parameters of the job selected.

The Fixed Pitch Event Table is comprised of machine events whose operational timing is fixed during each pitch cycle such as the timing of bias to transfer roll 75, (TRN 2 CURR), actuating toner concentration sensor 65 (ADC ACT), loading roll 161 of fuser 150 (FUS*LOAD), and so forth, irrespective of the particular copy run selected. The Variable Pitch Table is comprised of machine events whose operational timing varies with the individual copy run, i.e. timing of pitch fadeout lamp 44 (FO*ONBSE) and timing of flash illumination lamps 37 (FLSHBSE). The variable Pitch Table is built by the Pitch

Table Builder from the copy run conditioning information coupled with event address information from ROM memory, sorted by absolute clock count, and stored in a RAM memory section. The Fixed Pitch Event Table and Variable Pitch Table are merged with the relative clock count differences between Pitch events calculated to form the Run Event Table shown in Figure 9.

Referring particularly to Fig. 9, the Run Event Table consists of successive groups of individual events 851. Each event 851 is comprised of four data blocks, data block 852 containing the number of clock pulses (from machine clock 202) to the next scheduled pitch event (RELDIFF), data block 853 containing the shift register position associated with the event (REL SR), and data blocks 854, 855 (EVENT LO) (EVENT HI) containing the address of the event subroutine.

The data in the Run Event Table is utilized to control the machine components in a properly fixed sequence initiated by signals from the pitch reset clock 138, machine clock 202, and the real time clock 670 shown in Fig. 10.

Referring particularly to the timing chart shown in Figures 11a—11c, an exemplary copy run wherein three copies of each of two simplex or one-sided originals in duplex mode is made. Referring to Fig. 6, the appropriate button of copy selector 808 is set for the number of copies desired, i.e. 3 and document handler button 822, sorter select button 825 and two sided (duplex) button 811 depressed. The originals, in this case, two simplex or one-sided originals are loaded into tray 233 of document handler 16 (Fig. 4) and the Print button 805 depressed. On depression of button 805, the host machine 10 enters the PRINT state and the Run Event Table for the exemplary copy run selected is built by controller 18 and stored. As described, the Run Event Table together with Background routines serve, via the multiple interrupt system and output refresh (through D.M.A.) to operate the various components of host machine 10 in integrated timed relationship to produce the copies programmed.

During the run, the first original is advanced onto platen 35 by document handler 16 where three exposures (1ST FLASH SIDE1) are made producing three latent electrostatic images on belt 20 in succession. As described earlier, the images are developed at developing station 28 and transferred to individual copy sheets fed forward (1ST FEED SIDE 1) from main paper tray 100. The sheets bearing the images are carried from the transfer roll/belt nip by vacuum transport 155 to fuser 150, where the images are fixed. Following fusing, the copy sheets are routed by deflector 184 (referred to as an inverter gate in the tables) to return transport 182 and carried to auxiliary tray 102. The image bearing sheets entering tray 102 are aligned by edge pattern 187 in preparation for refeeding thereof.

Following delivery of the last copy sheet to auxiliary tray 102, the document handler 16 is activated to remove the first original from platen 35 and being the second original into registered position on platen 35. The second original is exposed three times (FLASH SIDE 2), the resulting images being developed on belt 20 at developing station 28 and transferred to the opposite or second side of the previously processed copy sheets which are now advanced (FEED SIDE 2) in timed relationship from auxiliary tray 102. Following transfer, the two side images are fused by fuser 150 and routed, by gate 184 toward stop 190, the latter being raised for this purpose. Abutment of chute 186, effectively inverting the sheet, now bearing images on both sides. The inverted sheet is fed onto transport 181 and into an output receptacle such as sorter 14 where, in this example, the sheets are placed in successive ones of the first three trays 212 of either the upper of lower arrays 210, 211 respectively depending on the disposition of deflector 220.

Job Recovery

Referring now to Figures 12—16, there will be described in more detail the method of controlling machine 10 to produce duplex copies from a set of original documents and for automatically adjusting the reproduction process in the event of a fault condition so that the selected number of copies are ultimately produced even though some copies may have been lost due to the fault.

Referring especially to Figure 12, it will be remembered that the controller 18 is normally being instructed by the state checker or master program. Before the beginning of a copy run, the controller 18 fetches the input data for the particular copy run, such as the quantity of copies selected (QTY@SEL), whether the document handler 16 has been selected (ADH@MSEL), the condition of the sorter 14, e.g. whether both bin arrays 210 and 211 are empty (TWO@AVAL), whether duplex copies are desired (2SD@FLAG), etc. As is well known in the art, controller 18 has previously set the appropriate flags (as set out in the parentheses above) when the user has selected the various machine features by pressing the corresponding console buttons on console 800, or, as in the case of the sorter 14, by the condition of sensors (e.g. 225, 226) detecting the condition of the machine.

Before the copy run is initiated, controller 18 is instructed to utilize this copy run data to calculate the set quantity (QTY@SET). The set quantity is the number of copies that can be made without exceeding the capacity of the machine. For example, if one of the bin arrays 210, 211 is empty, the capacity of the sorter 14 is 25 collated books. If the quantity selected is greater than 25, the job must be broken down into sets of 25 copies or less. This is accomplished by the set preduction routine (MODE@) which is called by the State Checker routine. This routine also calculates and stores the quantity to be flashed (QTY@TBF) and quantity to be delivered (QTY@TBD) for each original. In this embodiment, these stored quantities are placed in the RAM memory by means well known in the art. For purposes of illustration, assume that 100 collated duplex copies have been selected and that one of the sorter bin arrays is empty. This routine fetches the stored capacity of sorter 14 for making collated books with one bin array empty. This capacity is compared with the quantity selected. Since the quantity selected exceeds the capacity of the machine for this copy run, controller 18 will divide it into a plurality of sets of 25 each. Consequently, the quantity to be flashed (QTY@TBF) and delivered (QTY@TBD) would likewise be 25 and would be stored in a memory location. In comparison, if 100 noncollated copies (STACKS) are selected, the sorter's capacity would not be exceeded and the copy run can proceed with the set quantity, quantity to be flashed, and quantity to be delivered all being 100. It should be noted that while the subject invention is described in connection with a machine utilizing flash exposure, other types of exposure techniques can also be utilized, such as known scanning techniques including laser beam exposure. It should also be realized that while the quantity to be delivered for each original will be the same, the copies of the originals may be delivered to different places within the machine. For example, side 1 copies will be delivered to auxiliary tray 102, while the finished side 2 or duplex copies will be delivered to sorter 14.

The set prediction routine also clears the necessary counters etc. prior to the copy run. When the machine parameters indicates that the machine is ready to make copies, it enters the PRINT state as described earlier herein.

Referring now especially to Figure 13, the document handler 16 is cycled to place the side 1 original on platen 35. For purposes of this invention, a side 1 original means an original document 2 or representations thereof from which images are formed to produce copies on the front side or side 1 of copy sheets 3. Similarly, a side 2 original means an original document 2 or representations thereof from which images are made to form copies on the back side or side 2 of copy sheets 3 bearing side 1 copies on their opposite sides. The machine includes a provision for indicating whether it is making side 1 or side 2 copies. For example, controller 18 sets a flag SD1@DEL when it is making copies from side 1 originals. This flag is then cleared as soon as all of the side 1 copies are delivered. The flag is reset when all of the side 2 or duplex copies have been successfully delivered. In the event of a fault condition, controller 18 checks the status of this flag to determine what copies must be remade. For example, if the flag is set at the time of the fault, only side 1 copies must be recovered or remade. On the other hand, both side 1 and side 2 copies must be remade if the flag is not set at the time of the fault. The procedure for automatically remaking the necessary lost copies due to the fault will now be explained.

The side 1 original is exposed by activating the flash lamps of the illumination assembly 40 thereby forming images thereof on photoreceptor belt 20. A quantity flashed counter (QTY@FLH) maintains a running count of the number of flashes made for each original. The quantity flashed counter is a software counter, as are the remaining counters referred to in this description. A software counter is well known in the art and as such forms no part of this invention. Typically, such counters are memory locations which are incremented by appropriate signals, for example, in the case of the quantity flashed counter, by a signal generated everytime the flash lamps are activated. In the absence of a fault condition, flashing of the side 1 original continues until there is flash coincidence. Flash coincidence is met when the stored quantity to be flashed (QTY@TBF) is the same as the contents of the quantity flashed counter (QTY@FLH). In this embodiment, this is accomplished by the instructions provided by the flash increment routine (FLASHINC). As soon as there flash coincidence the flash lamps are deactivated. However, the side 1 original remains on the platen until there is delivery coincidence as well. As previously described, side 1 copies are inverted and routed back into a temporary receptacle or auxiliary tray 102. Appropriate sensors, such as sensor 189 detects the entry of successfully completed side 1 copies into auxiliary tray 102 as can be seen most clearly in Figure 2. The output of sensor is 189 coupled to a copies delivered counter (QTY@DLV) which maintains a running count of the number of

successfully delivered copies, be it side 1 copies to auxiliary 102 or side 2 copies to sorter 14 as similarly detected by sensors 225 or 226 for sorter bin arrays 210, 211, respectfully. A delivery increment routine (OUT@INC) increments and compares the contents of the copies delivered counter (QTY@DLV) with the predicted quantity to be delivered (QTY@TBD) necessary for proper completion of the copy run.

After side 1 flash and delivery coincidences are both met, the side 1 original is removed from platen 35 and returned to paper tray 233 on top of bail bar 235 (see Figure 4). Every time an original document is removed from platen 35, an originals flashed counter (ORIG@FLH) is incremented by routines REVERSE and INC@ORFH, respectively. Similarly, whenever there is delivery coincidence, an originals delivered counter (ORIG@DLV) is incremented thereby keeping a running count of the number of originals from which all the necessary copies have been made.

Controller 18 then checks to determine if there are any more originals to be placed on the platen 35. This may be accomplished by the input empty routine (LEDGIEMP). Briefly, when the last original leaves tray 235, bail bar or separator 235 contacts switch 259 thereby signalling that the last original has left the tray 233. After the last original has been placed on platen 35 and exposed, the controller compares the stored quantity of selected copies (QTY@SEL) with the quantity of flashes made (QTY@FLH). If, for example, the number of copies selected is greater than the number of flashes made document handler 16 is recycled to refeed the originals to platen 35 beginning with the first original, with the machine completing the job by making the necessary copies. As noted before, this will occur when the job has been split up into multi-set copy runs since the quantity flashed (QTY@FLH) will be less than the quantity selected when the set quantity is less than the quantity selected (QTY@SEL).

Assuming that the side 1 original was not the last original, the next original, here, the side 2 original is placed on platen 35. The flash lamps are then activated until there is exposure coincidence, i.e. the number of flashes actually made as indicated by the quantity flashed counter (QTY@FLH) is the same as the quantity to be flashed (QTY@TBF). Unlike the side 1 original, the side 2 original is removed from platen 35 and the succeeding document, here the next side 1 original (e.g. page 3), is placed on platen 35 as soon as there is side 2 exposure coincidence. It should be realized that there is a significant delay between the time of exposure and the time of delivery of the copies made from the exposed original. For example, the necessary number of side 2 exposures may be completed before the side 2 or duplex copies have been delivered to sorter 14. As described earlier, the side 2 copies are formed on the opposite sides of the side 1 copies are fed from auxiliary tray 102. Hence, by activating the document handler 16 to place the next side 1 original on platen 35 in preparation for making copies therefrom, the throughput of the machine is thereby optimized. In fact, exposure of the next side 1 original can be begun before the last duplex copy has been delivered to sorter 14. After there is side 2 delivery coincidence, the originals delivered counter (ORIG@DLV) is incremented and the above described sequence is repeated until the necessary copies are made.

It is a feature of the invention that none of the side 2 originals are presented to the machine processor 12 until there is both side 1 flash and delivery coincidences. This permits controller 18 to readily keep track of the number of copies made and their location with only a minimal number of counting devices, sensors, etc. On the other hand, the machine is conditioned to receive images from the next side 1 original as soon as there is flash coincidence for the side 2 original thereby optimizing the speed of the machine. Moreover, this sequence of events permits controller 18 to initiate the necessary recovery steps to remake lost copies in the event of a fault condition. The recovery steps will differ depending upon the event currently in process at the time of the fault condition. These fault conditions represent a wide variety of machine malfunctions and include such things as paper jams which are detected by sensors disposed along the machine paper path as is well known in the art. When a fault condition is detected, the sensors send appropriate signals to controller 18 which enters the Run Not Print STATE and ceases further machine operation. In this STATE, controller 18 is instructed by the Delivery Check (DEL@CK) routine. This routine determines whether there has been side 1 or side 2 delivery coincidence at the time of the fault. If not, it initiates the recovery steps for remaking any copies lost due to the fault as described below.

Since the side 1 original is not removed from platen 35 until there is both flash and delivery coincidence, controller 18 realizes that the correct original for remaking any lost copies is still on the platen when there is a fault before side 1 flash or delivery coincidence. Turning to Figure 14, in the event of a side 1 fault the operator is instructed to remove the side 1 copies from the paper path. In other words, all of the copies sheets 3 in transit to the auxiliary tray

102 are considered lost. However, some of the side 1 copies may have been successfully delivered to the auxiliary tray 102. This would be indicated by the contents of the copies delivered counter (QTY@DLV). Under instruction of the flash increment routine (FLASHINC), the quantity flashed counter (QTY@FLH) is reset with the contents of the copies delivered counter (QTY@DLV). For purposes of illustration assume that 10 copies were selected, but that only 3 copies were actually delivered to auxiliary tray 102 before the fault occurred. Then, even though there may have been side 1 flash coincidence, the quantity flash counter (QTY@FLH) would be reset with the number 3. The side 1 original, which is already on the platen, would be exposed 7 additional times to remake the lost copies. As soon as there is delivery coincidence, the side 2 original would be placed on the platen and the normal sequence of events shown in Figure 13 would take place in order to finish the copy run.

Assume now that the fault, instead, occurs after side 1 delivery coincidence but before there is side 2 delivery coincidence. Again, due to the preset sequence of operation, the correct original for recovering lost copies will still be on platen 35 since side 2 flash coincidence has not been met. As described earlier herein, the side 2 original is not removed from platen 35 until there is flash coincidence. Consequently, the contents of the originals flashed (ORIG@FLH) counter is the same as the originals delivered (ORIG@DLV) counter. The Delivery Check routine calls a routine (RECOV@CK) which senses this coincidence thereby signalling that the correct ORIGINAL IS STILL ON THE PLATEN. However, since it is a side 2 fault some of the side 1 copies must be remade even though they were successfully delivered to auxiliary tray 102. Referring to Figure 15, the operator is instructed to remove the copy sheets in transit from auxiliary tray 102 to sorter 14. It can be envisioned that some of the duplex copies have already been made and delivered to sorter 14, while others are in transit from auxiliary tray 102, with some of the side 1 copies still remaining in tray 102. Instead of discarding the remaining side 1 copies in tray 102, it is another feature of this invention that they are further utilized to make duplex copies even though more side 1 copies may be necessary to ultimately recover for those lost in clearing the jam.

The contents of the quantity flashed counter (QTY@FLH) then is reset with the contents of copies delivered counter (QTY@DLV), such counter now indicating the number of duplex copies successfully delivered to sorter 14. For purposes of illustration, assume that after clearing the jam, there are three side 1 copies remaining in auxiliary tray 102, and that two completed duplex copies have reached sorter 14 successfully. Hence, the quantity flashed counter is set to the number 2 and the flash lamps are then activated. However, the lamps are deactivated as soon as the auxiliary tray 102 becomes empty as indicated by an appropriate signal from switch 110. Accordingly, only 5 duplex copies are successfully delivered to sorter 14. Consequently, the contents of the copies delivered (QTY@DLV) counter would now be 5. This number is stored and is utilized to twice reset the quantity flashed and delivered counters for the next 2 originals, i.e. the side 1 and side 2 recovery originals from which copies are needed to properly complete the copy run. It should be noted that this can be accomplished by a variety of methods depending upon the number of counters, etc. utilized. For example, in this embodiment, the same counter QTY@DLV is utilized to first count the side 1 copies delivered, and then, after delivery coincidence is used to count the side 2 or duplex copies delivered. Consequently, when there is a fault before side 2 delivery coincidence, the necessary information for resetting the quantity flashed and copies delivered counters for the recovery originals must be temporarily stored until the proper original is presented to the machine as discussed below. In this embodiment, this is accomplished by the instructions of the flash increment routine (FLASHINC).

Under the instructions of the side two jam recovery routine (PROG2SJM), document handler 16 is recycled to bring the old side 1 original back onto platen 35. This is accomplished by comparing the contents of the originals flashed counter (ORIG@FLH) with that of the originals delivered counter (ORIG@DLV). It should be noted that an appropriate provision can be made to deactivate the flash lamps until the correct original is on the platen 35. When the contents of these two counters coincide, the correct original for remaking the side 1 copies is in place on platen 35. Thus, the old side 1 original is on the platen and the contents of the quantity flashed counter (QTY@FLH) is at 5, this counter having been reset to the number of side 2's delivered. The flash lamps are then activated until coincidence (5 times) to produce 5 side 1 copies, which are placed in auxiliary tray 102. The side 2 original is then placed on platen 35, with the contents of the quantity flashed (QTY@FLH) and delivered QTY@DLV) counters being set to 5. The flash lamps are then flashed till coincidence to thus form 5 duplex on the backside of side 1 copies fed from auxiliary tray 102,

with these copies being placed in sorter 14. Accordingly, the 8 duplex copies required to recover from the fault have been produced.

Referring back to Figure 13, the remaining possibility is for the fault condition to occur after side 2 flash coincidence but before side 2 delivery coincidence. In such case, the contents of the originals flashed counter (ORIG@FLH) would not be equal to the contents of the originals delivered counter (ORIG@DLV), such comparison being made by the instructions included in the routine RECOV@CK. Such noncoincidence is due to the fact that the side 2 original is removed from platen 35 as soon as there is flash coincidence, but before all the copies therefrom are delivered. Accordingly, the routine RECOVER sets a flag indicating that the document handler 16 needs to be recycled.

Turning now to Figure 16, the operator is instructed to remove copies not only from the paper path, but also from auxiliary tray 102. For purposes of illustration, assume that after clearing the jam, there have been two successfully delivered duplex copies to sorter 14. Hence, the contents of the copies delivered counter (QTY@DLV) would be 2. Again, assume that 10 copies are desired. Hence, 8 duplex copies must be remade for proper completion of the copy run. With the auxiliary tray empty, the side 2 jam recovery routine (PROG2SJM) instructs the document handler 16 to recycle the originals 2 until the originals flashed counter (ORIG@FLH) equals the original delivered counter (ORIG@DLV). (It will be remembered that the contents of the originals flashed counter is incremented whenever an original is removed from platen 35, even though they may not be exposed as is the case here.) In such manner, the old side 1 original is automatically placed on platen 35. In the same manner as described above, the contents of the quantity flashed counter (QTY@FLH) and quantity delivered counter are reset, for the next two originals, to the stored contents of the copies delivered counter (QTY@DLV), such counter indicating the number of duplex copies that were successfully delivered, here 2 in number. The flash lamps are then activated to form 8 copies of side 1, with such copies being placed in auxiliary tray 102. After side 1 delivery coincidence, the quantity flashed (QTY@FLH) and delivered (QTY@DLV) counters are reset to 2, and the side 2 original is placed on platen 35 whereat eight copies therefrom are produced on the backsides of the side 1 copies fed from auxiliary tray 102. After side 2 flash coincidence, the contents of the counters are cleared to zero and the normal operating sequence shown in Figure 13 is repeated until the end of the copy run.

In view of the foregoing, it can now be realized that the present invention provides a method of controlling a reproduction machine to produce duplex copies automatically. Moreover, provision is made for automatically remaking lost copies due to a fault condition during the middle of a copy run. More importantly, this is accomplished by the use of a minimal number of sensors and counters, while at the same time optimizing the throughput of the machine.

WHAT WE CLAIM IS:

1. A method of controlling a reproduction machine to produce duplex copies from a set of original documents and for automatically adjusting the reproduction process in the event of a fault condition so that the selected number of copies are produced, said method comprising:

a. storing the quantity to be exposed and the quantity to be delivered to a receptacle for each original in the set for proper completion of the copy run;

b. exposing a side 1 original to form at least one image thereof on a photoreceptor;

c. forming finished copies from each image thus formed;

d. delivering said side 1 copies to a temporary receptacle;

e. counting in an exposures made counter the actual number of exposures made for each original;

f. counting in a copies delivered counter the number of finished copies successfully delivered to a receptacle;

g. comparing the quantity to be exposed and the quantity to be delivered with the contents of the exposures made counter and the copies delivered counter for the side 1 copies, respectively;

h. presenting a side 2 original to the machine only if there is both side 1 exposure and delivery coincidence;

i. exposing the side 2 original to form at least one image thereof on the photoreceptor;

j. comparing the quantity to be exposed with the contents of the exposures made counter for the side 2 original;

k. feeding said side 1 copies from the temporary receptacle;

l. forming finished copies of the side 2 original on the opposite side of the side 1 copies thereby forming duplex copies;

m. delivering said duplex copies to an output receptacle;

n. comparing the quantity to be delivered with the contents of the copies delivered counter for the side 2 originals; and

o. repeating steps b—n in the event of a fault condition until side 1 and side 2 exposure and delivery coincidences are met thereby remaking any lost copies due to the fault.

2. The method of claim 1 which further includes the steps of:

using a document handler device to automatically feed the originals to an exposure platen from which the originals are presented to the machine for forming images therefrom;

storing in an originals exposed counter a running count of the originals presented to the machine; and

storing in an originals delivered counter a running count of the number of originals from which all the necessary copies thereof have been successfully completely delivered.

3. The method of claim 2 which further includes the following step prior to step o when side 1 exposure and flash coincidences are not met:

resetting the exposures made counter with the contents of the copies delivered counter.

4. The method of claim 2 which further includes the following steps prior to step o when side 2 exposure coincidence is not met:

removing copies in transit between the temporary receptacle and the output receptacle;

resetting the exposures made counter for the side 2 original to the contents of the copies delivered counter;

feeding the remaining side 1 copies from the temporary receptacle;

forming side 2 copies on the opposite sides of the side 1 copies until the temporary receptacle becomes empty;

delivering the duplex copies to the output receptacle;

storing the contents of the copies delivered counter whose contents indicates the number of duplex copies successfully delivered to the output receptacle;

resetting the exposures made counter and the copies delivered counter for the next two originals with the stored contents of the copies delivered counter for the duplex copies; and

recycling the document handler to replace the previous original on the platen.

5. The method of claim 4 wherein the document handler is recycled until there is coincidence between the originals exposed and originals delivered counters thereby automatically replacing the necessary side 1 original on the platen to remake the lost copies.

6. The method of claim 2 which further includes the following steps prior to step o when side 2 delivery coincidence is not met:

removing copies from the temporary receptacle and those copies in transit to the output receptacle;

storing the contents of the copies delivered counter whose contents indicates the number of duplex copies successfully delivered to the output receptacle;

resetting the exposures made counter and copies delivered counter for the next two originals with the stored contents of the copies delivered counter for the duplex copies delivered to the output receptacle; and

recycling the document handler to replace on the platen the last original from which all of the necessary copies have been successfully delivered.

7. The method of claim 6 wherein the document handler is recycled until there is coincidence between the originals delivered counters thereby automatically replacing the necessary side 1 original on the platen to remake the lost copies.

8. A reproduction machine for making duplex copies from side 1 and side 2 originals comprising means for automatically adjusting the reproduction process in the event of a fault condition so that the selected number of copies are produced, said means including:

a first counter means for maintaining a running count of the number of successfully delivered copies of each original;

a first flag means for signaling that copies of the side 1 original are being made;

a second flag means for signaling that copies of the side 2 original are being made;

detector means for checking the condition of the first and second flag means in the event of a fault;

means for storing the contents of the second counter when the second flag signal is present at the time of the fault;

means for twice resetting the first and second counters with the stored contents of the second counter as the next two originals are presented to the machine;

means for successively representing the previous side 1 and side 2 originals to the machine; and

means for successfully making a sufficient number of copies from said side 1 and side 2 originals to bring the count of said first and

second counters equal to the number of copies selected thereby remaking the copies lost due to the fault.

9. Reproduction methods and machines substantially as herein described with reference to Figures 1—16 of the accompanying drawings.

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Chartered Patent Agent

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1560780 COMPLETE SPECIFICATION

18 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

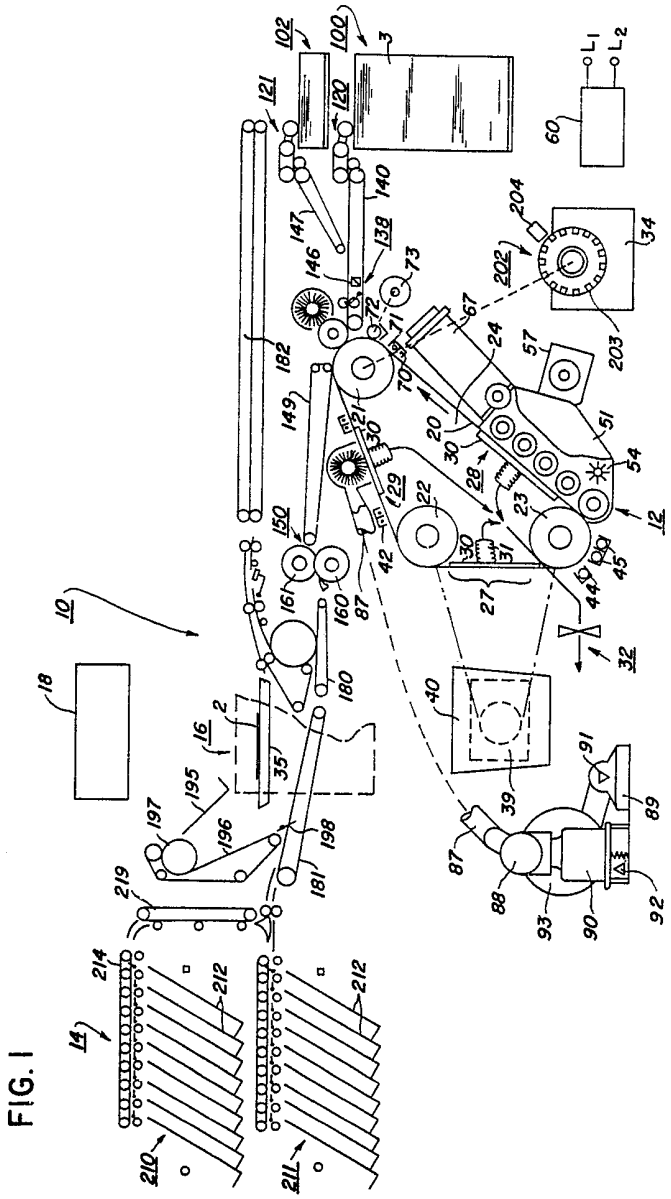


FIG. 1

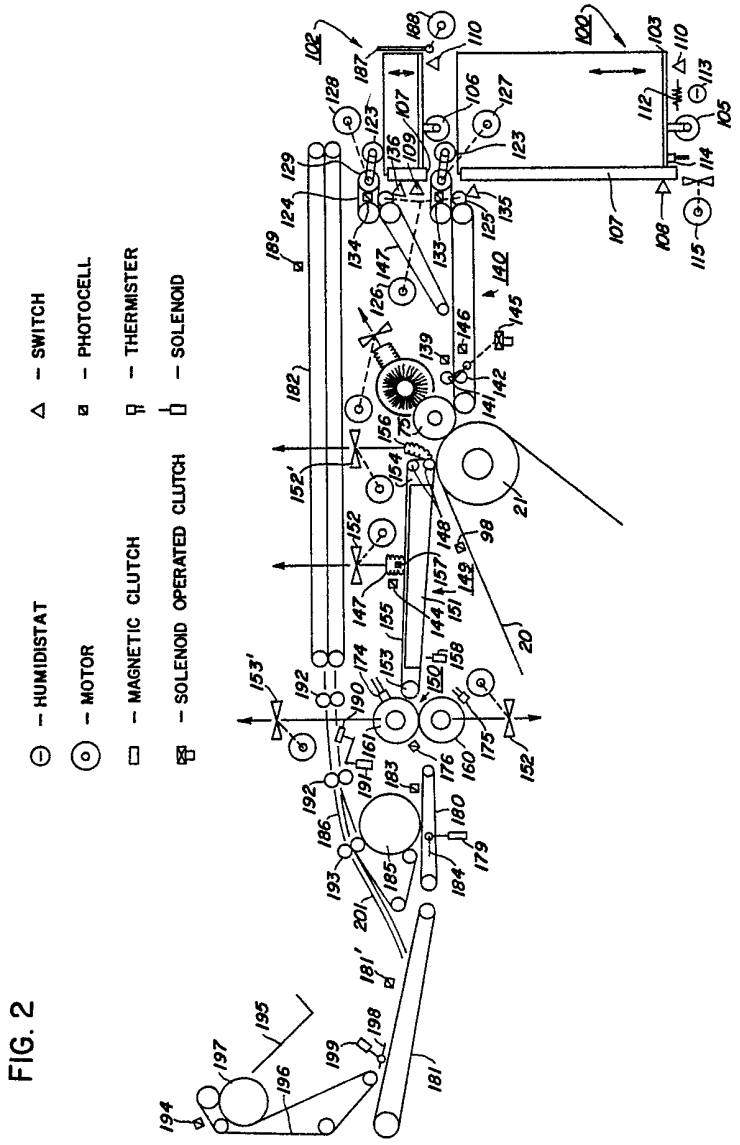

⊖ – HUMIDISTAT
△ – SWITCH
⊙ – MOTOR
◙ – PHOTOCELL
□ – MAGNETIC CLUTCH
– THERMISTER
– SOLENOID OPERATED CLUTCH
– SOLENOID

FIG. 2

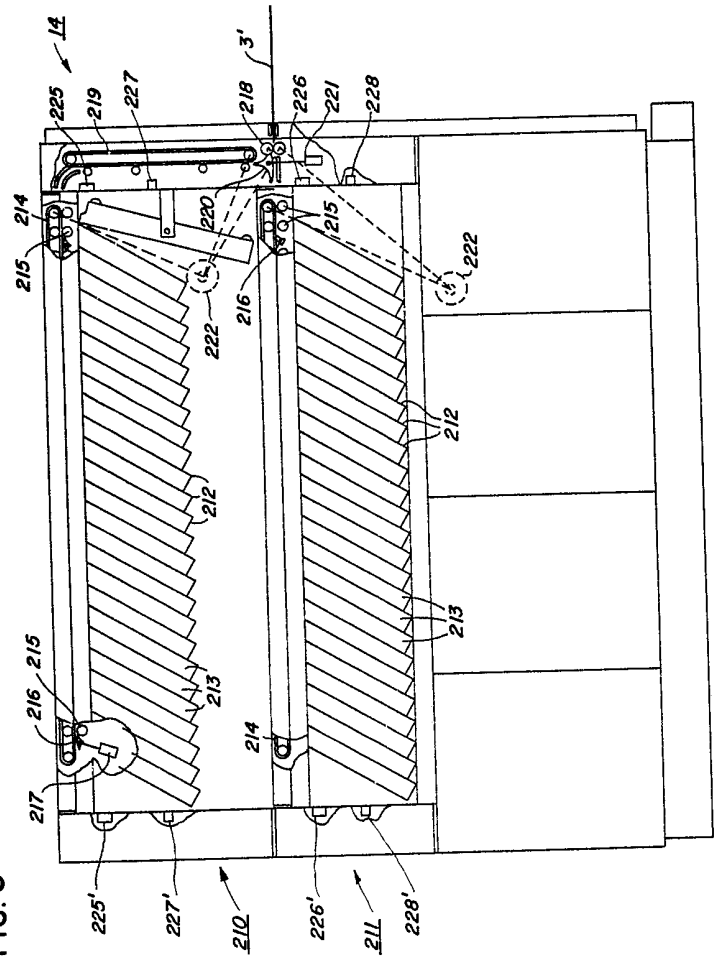
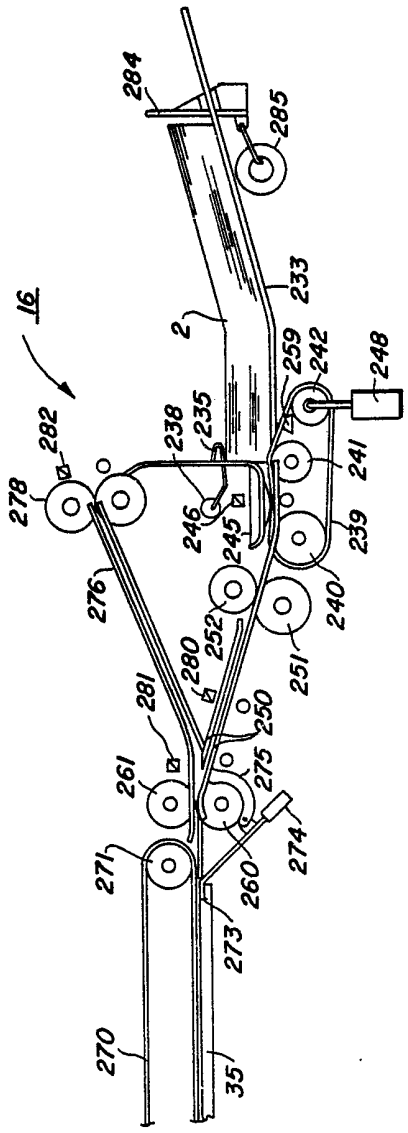

14
3'
225
219
227
218
226
221
228
214
215
220
215
222
216
222
212
212
213
213
215
216
214
217
225'
227'
210
226'
211
228'

FIG. 3


16
2
233
284
285
259
242
248
282
238
235
241
278
246
245
239
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252
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261
275
271
260
274
273
270
35

FIG. 4

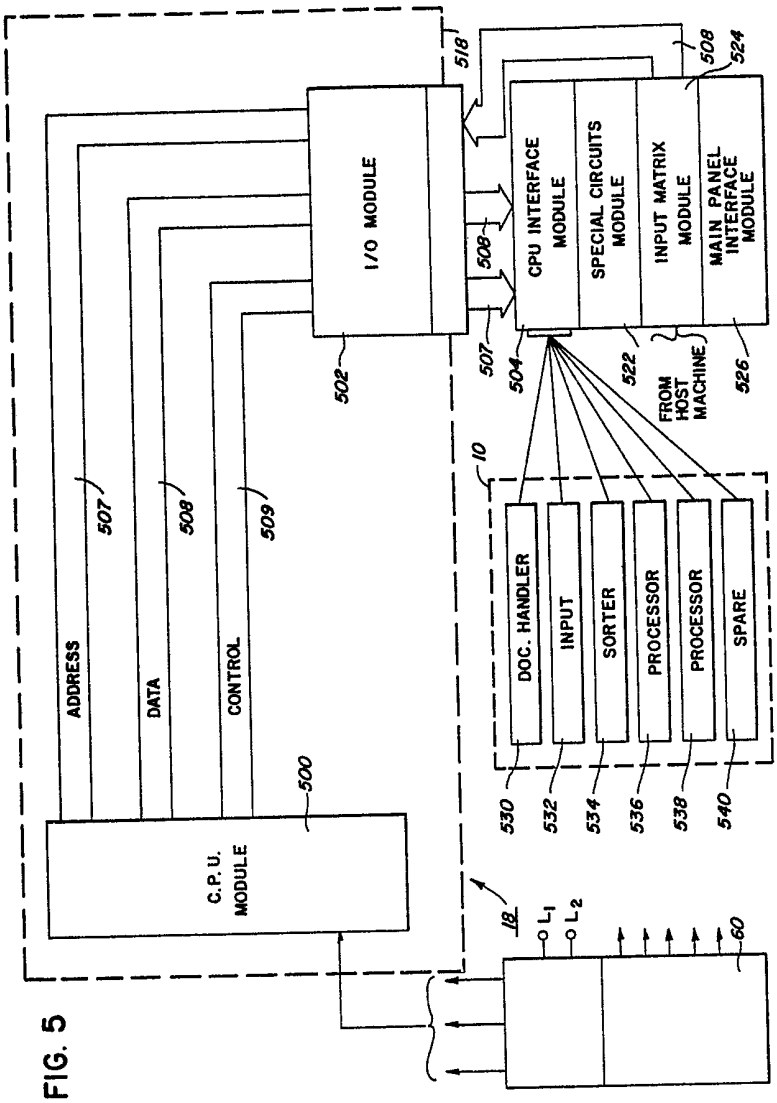
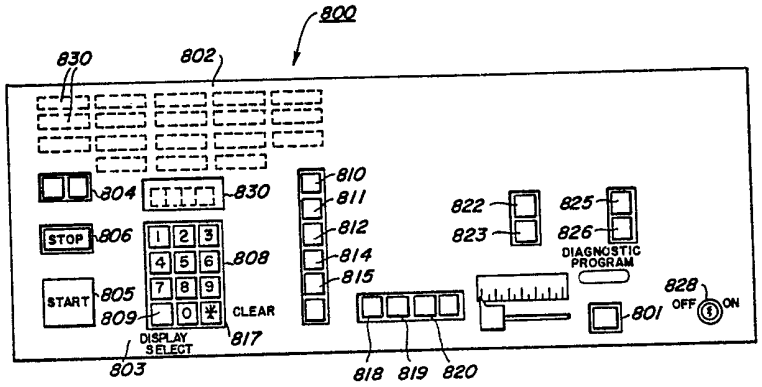

518
508
524
I/O MODULE
CPU INTERFACE MODULE
SPECIAL CIRCUITS MODULE
INPUT MATRIX MODULE
MAIN PANEL INTERFACE MODULE
506
507
504
522
526
FROM HOST MACHINE
502
10
ADDRESS
DATA
CONTROL
507
508
509
500
DOC. HANDLER
INPUT
SORTER
PROCESSOR
PROCESSOR
SPARE
530
532
534
536
538
540
C.P.U. MODULE
18
L1
L2
60

FIG. 5

FIG. 6


800
830
802
304
830
STOP
806
1 2 3
4 5 6
7 8 9
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808
START
805
809
CLEAR
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DISPLAY SELECT
803
810
811
812
814
815
818
819
820
822
823
825
826
DIAGNOSTIC PROGRAM
828
OFF
ON
801

FIG. 7

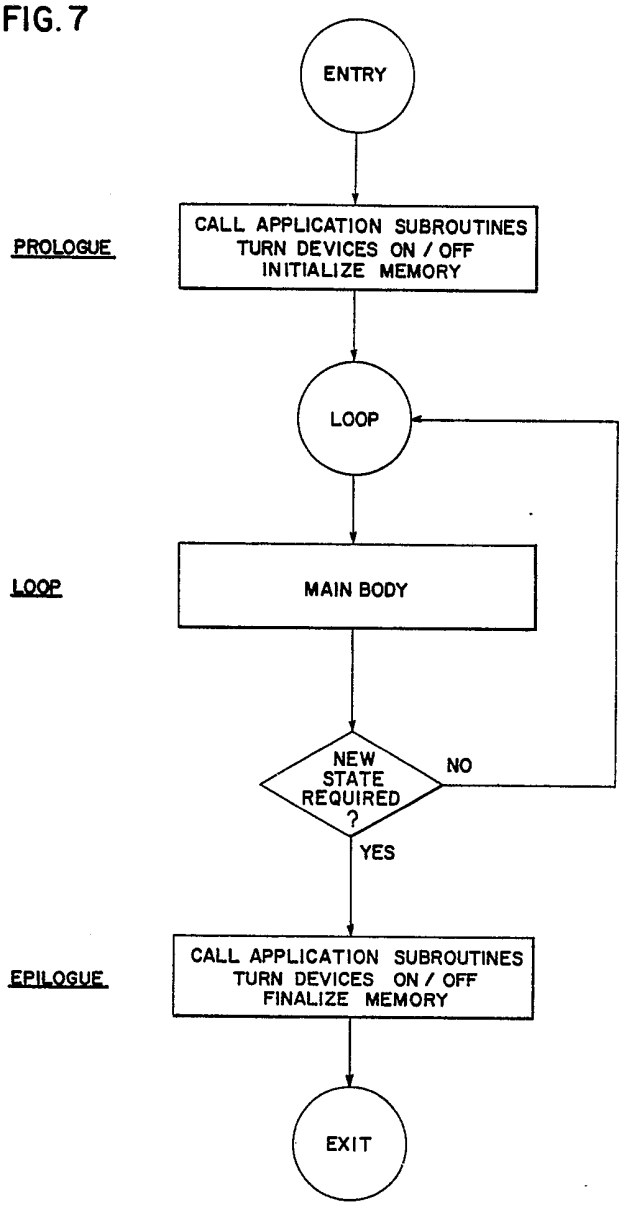

ENTRY
PROLOGUE
CALL APPLICATION SUBROUTINES
TURN DEVICES ON / OFF
INITIALIZE MEMORY
LOOP
LOOP
MAIN BODY
NEW STATE REQUIRED ?
NO
YES
EPILOGUE
CALL APPLICATION SUBROUTINES
TURN DEVICES ON / OFF
FINALIZE MEMORY
EXIT

FIG. 8

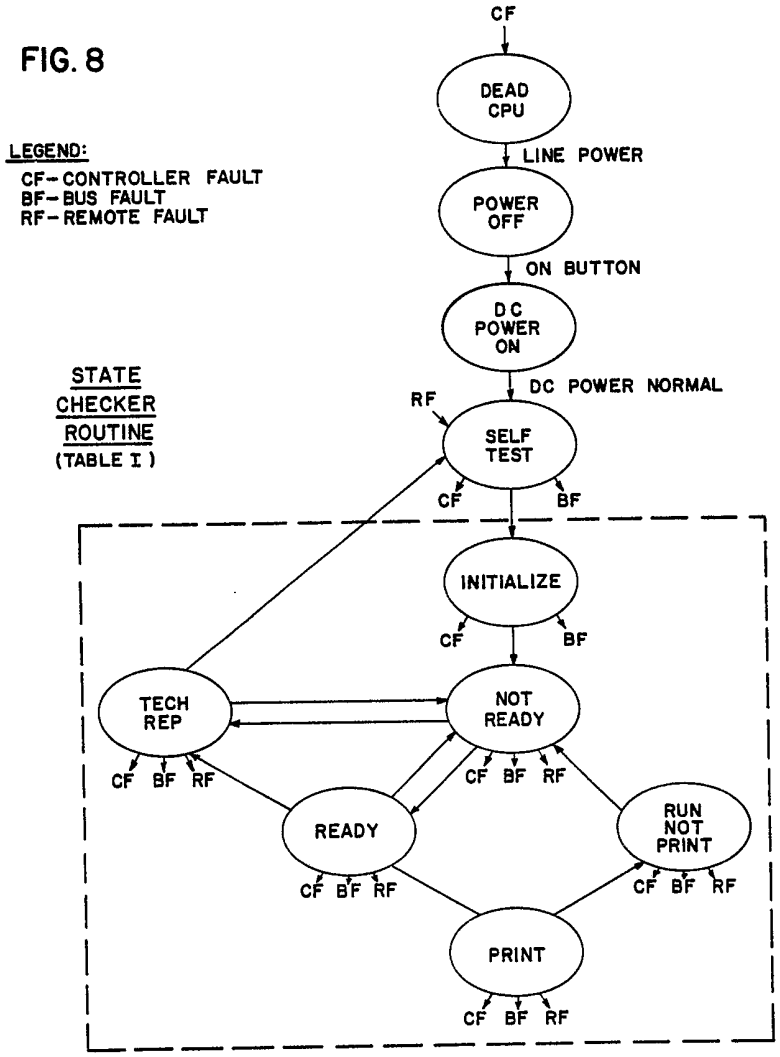
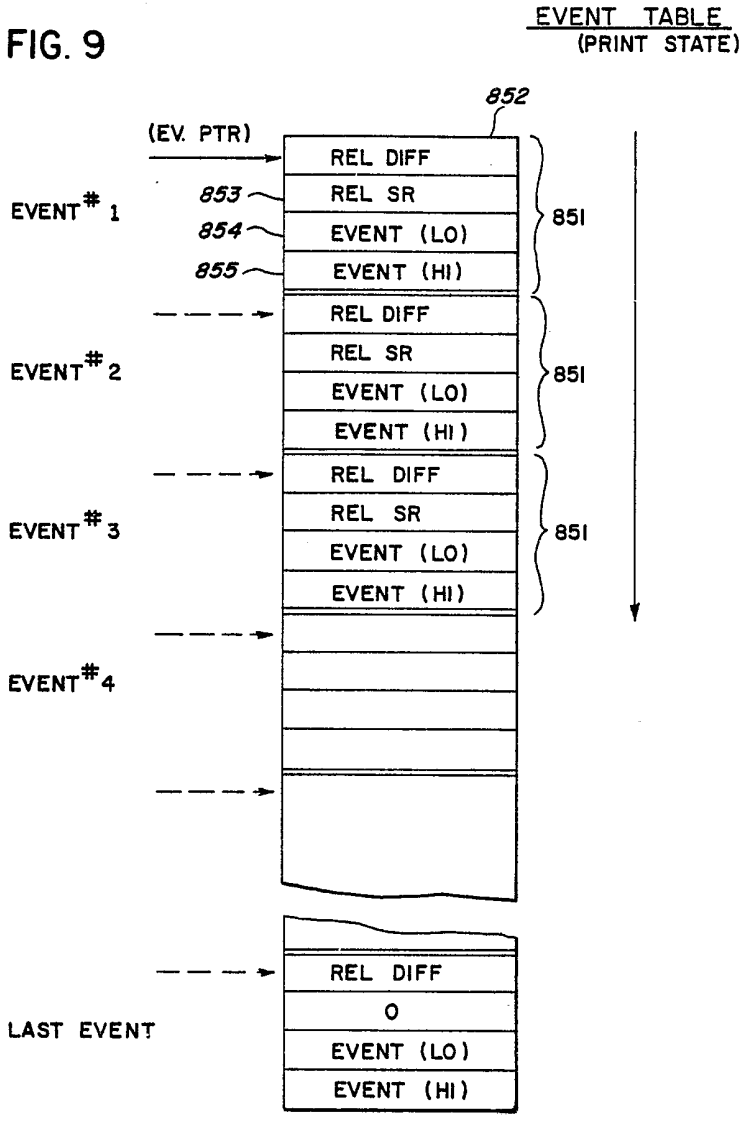

LEGEND:
CF-CONTROLLER FAULT
BF-BUS FAULT
RF-REMOTE FAULT
STATE CHECKER ROUTINE (TABLE I)
CF
DEAD CPU
LINE POWER
POWER OFF
ON BUTTON
DC POWER ON
DC POWER NORMAL
RF
SELF TEST
CF
BF
INITIALIZE
CF
BF
TECH REP
NOT READY
CF BF RF
CF BF RF
READY
RUN NOT PRINT
CF BF RF
CF BF RF
PRINT
CF BF RF

FIG. 9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(PRINT STATE)
852
(EV. PTR)
REL DIFF
853
REL SR
854
EVENT (LO)
855
EVENT (HI)
851
EVENT# 1
EVENT# 2
EVENT# 3
EVENT# 4
LAST EVENT
0

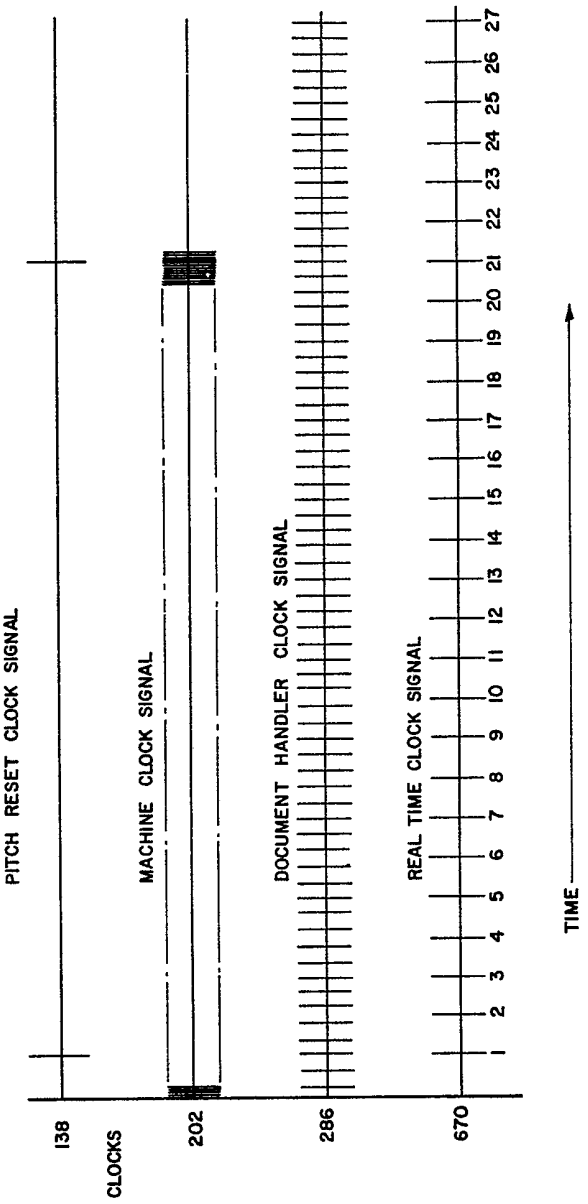

PITCH RESET CLOCK SIGNAL
MACHINE CLOCK SIGNAL
DOCUMENT HANDLER CLOCK SIGNAL
REAL TIME CLOCK SIGNAL
TIME
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
138
CLOCKS
202
286
670

FIG. 10

FIG. 11a

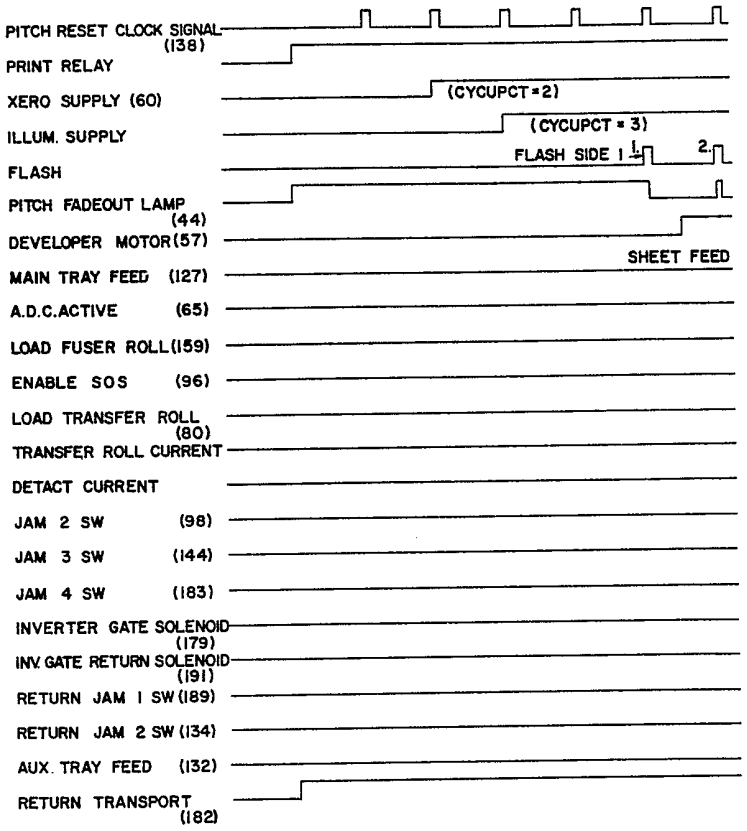

PITCH RESET CLOCK SIGNAL (138)
PRINT RELAY
XERO SUPPLY (60)
(CYCUPCT=2)
ILLUM. SUPPLY
(CYCUPCT = 3)
FLASH
FLASH SIDE 1
1
2
PITCH FADEOUT LAMP (44)
DEVELOPER MOTOR (57)
SHEET FEED
MAIN TRAY FEED (127)
A.D.C. ACTIVE (65)
LOAD FUSER ROLL (159)
ENABLE SOS (96)
LOAD TRANSFER ROLL (80)
TRANSFER ROLL CURRENT
DETACT CURRENT
JAM 2 SW (98)
JAM 3 SW (144)
JAM 4 SW (183)
INVERTER GATE SOLENOID (179)
INV. GATE RETURN SOLENOID (191)
RETURN JAM 1 SW (189)
RETURN JAM 2 SW (134)
AUX. TRAY FEED (132)
RETURN TRANSPORT (182)

FIG. 11*b*

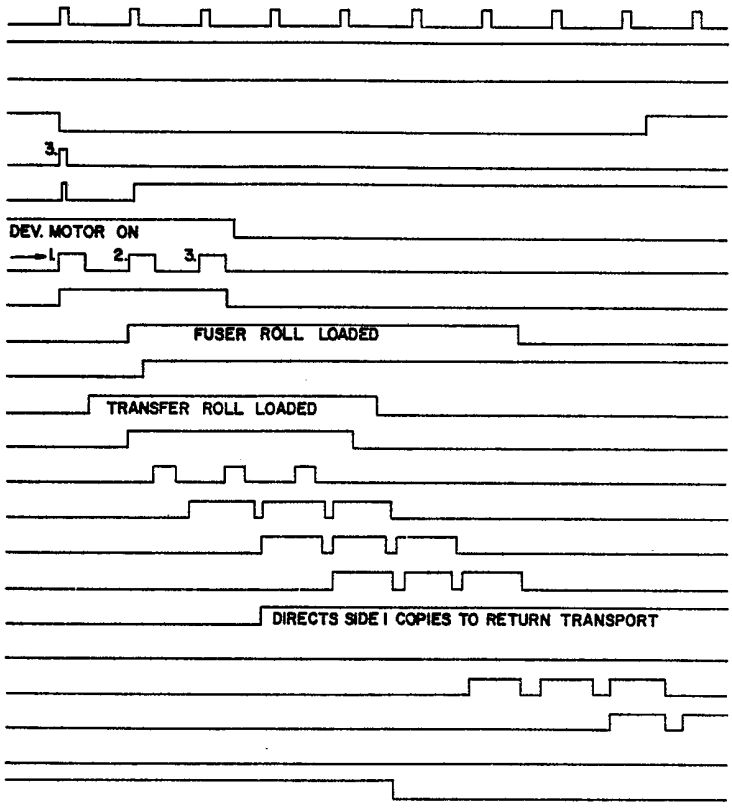

3.
DEV. MOTOR ON
1.
2.
3.
FUSER ROLL LOADED
TRANSFER ROLL LOADED
DIRECTS SIDE I COPIES TO RETURN TRANSPORT

FIG. 11*c*

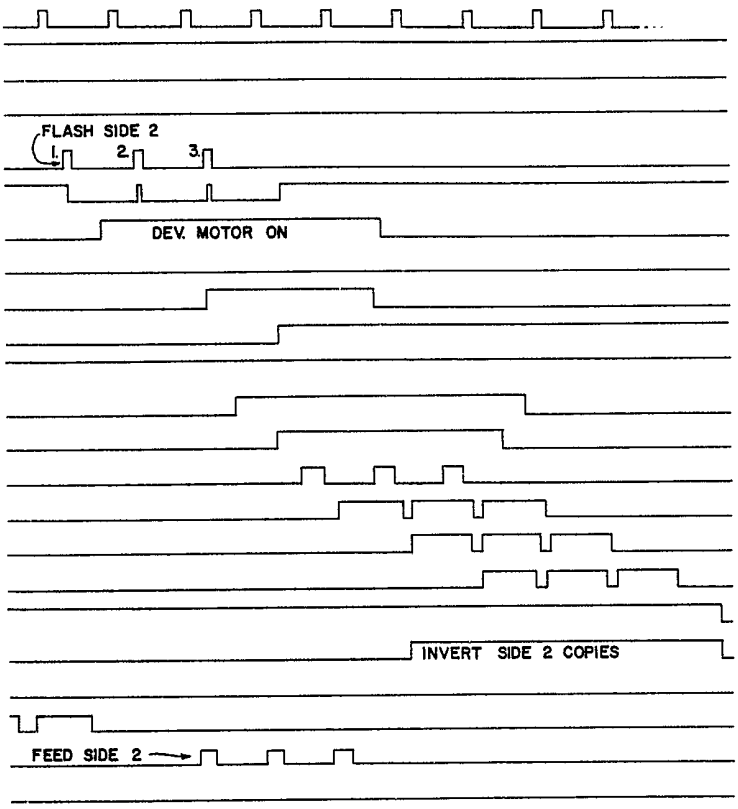


FIG. 12

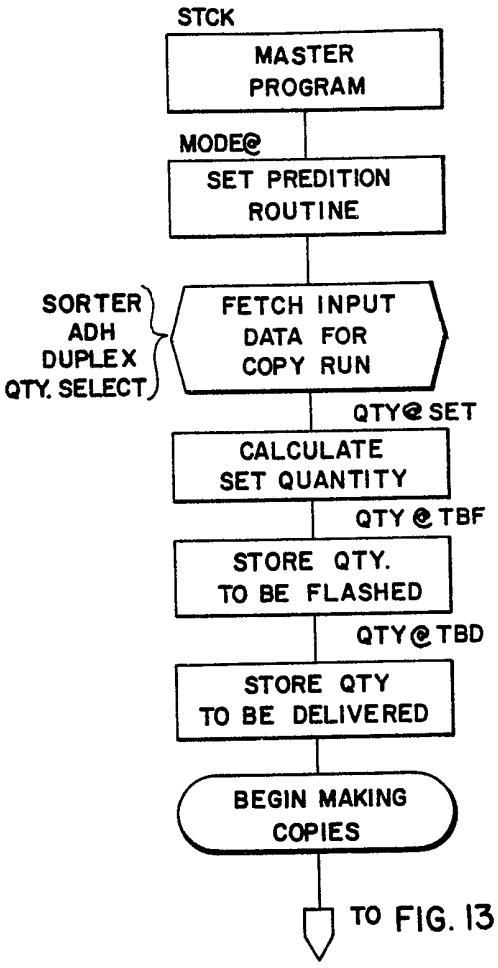

STCK
MASTER PROGRAM
MODE@
SET PREDITION ROUTINE
SORTER
ADH
DUPLEX
QTY. SELECT
FETCH INPUT DATA FOR COPY RUN
QTY@ SET
CALCULATE SET QUANTITY
QTY @ TBF
STORE QTY. TO BE FLASHED
QTY@ TBD
STORE QTY TO BE DELIVERED
BEGIN MAKING COPIES
TO FIG. 13

FIG. 13a

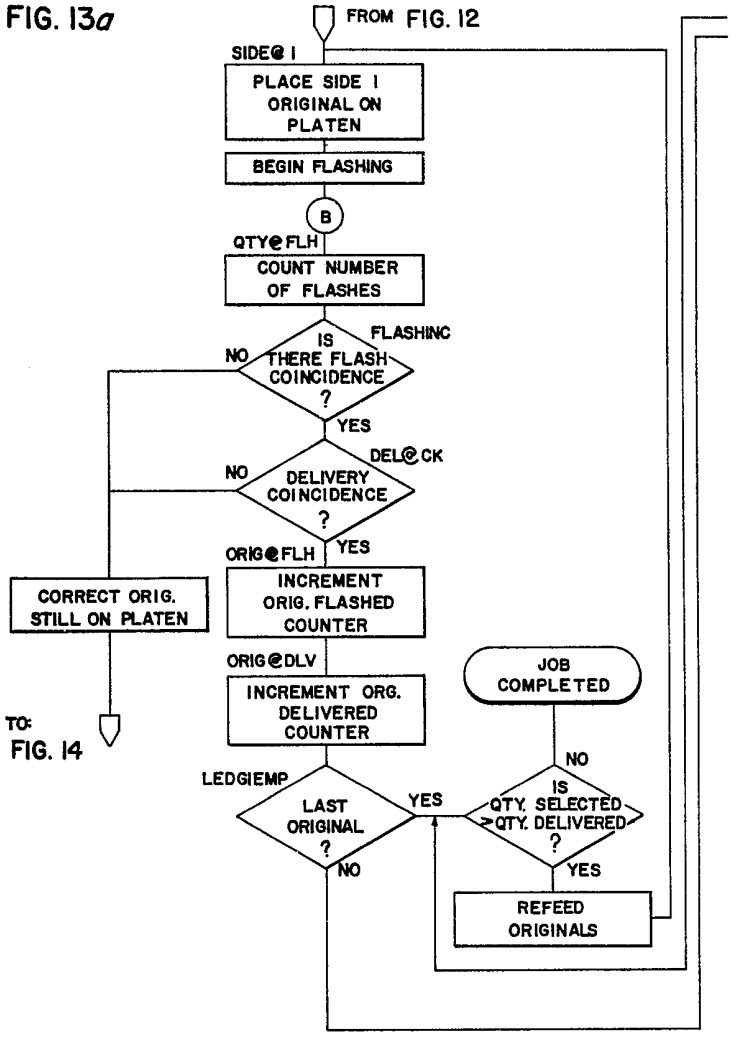

FROM FIG. 12
SIDE@ 1
PLACE SIDE 1 ORIGINAL ON PLATEN
BEGIN FLASHING
B
QTY@FLH
COUNT NUMBER OF FLASHES
FLASHINC
IS THERE FLASH COINCIDENCE ?
NO
YES
DEL@CK
DELIVERY COINCIDENCE ?
NO
YES
ORIG@FLH
INCREMENT ORIG. FLASHED COUNTER
CORRECT ORIG. STILL ON PLATEN
ORIG@DLV
INCREMENT ORG. DELIVERED COUNTER
TO: FIG. 14
LEDGIEMP
LAST ORIGINAL ?
YES
NO
JOB COMPLETED
IS QTY. SELECTED >QTY. DELIVERED ?
NO
YES
REFEED ORIGINALS

FIG. 13*b*

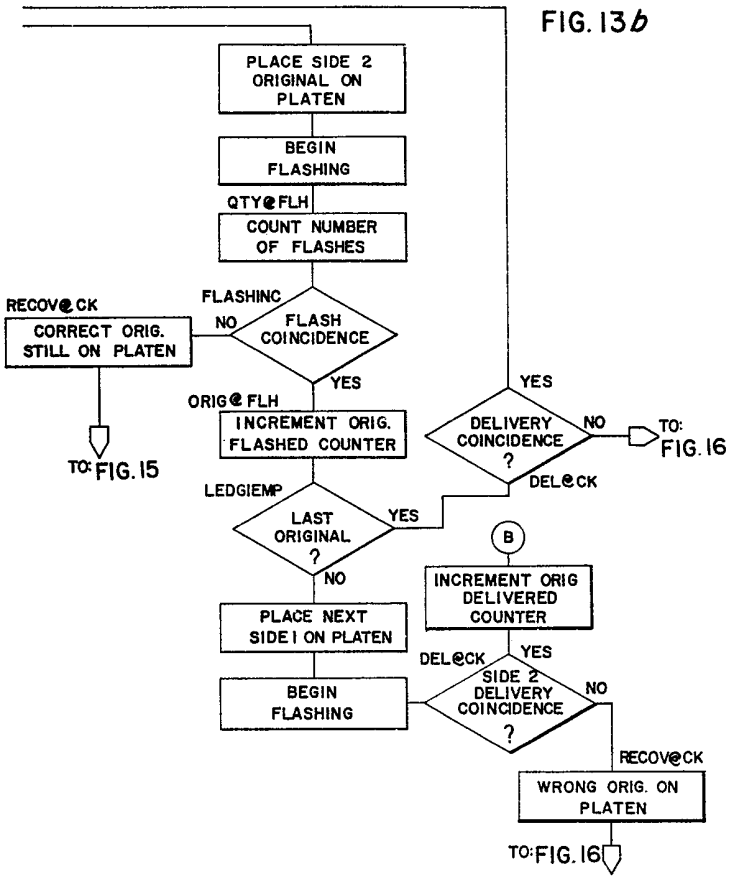

PLACE SIDE 2 ORIGINAL ON PLATEN
BEGIN FLASHING
QTY@FLH
COUNT NUMBER OF FLASHES
FLASHINC
FLASH COINCIDENCE
NO
YES
RECOV@CK
CORRECT ORIG. STILL ON PLATEN
TO: FIG. 15
ORIG@FLH
INCREMENT ORIG. FLASHED COUNTER
LEDGIEMP
LAST ORIGINAL ?
YES
NO
PLACE NEXT SIDE1 ON PLATEN
BEGIN FLASHING
YES
DELIVERY COINCIDENCE ?
NO
TO: FIG. 16
DEL@CK
B
INCREMENT ORIG DELIVERED COUNTER
DEL@CK
YES
SIDE 2 DELIVERY COINCIDENCE ?
NO
RECOV@CK
WRONG ORIG. ON PLATEN
TO: FIG. 16

FIG. 14

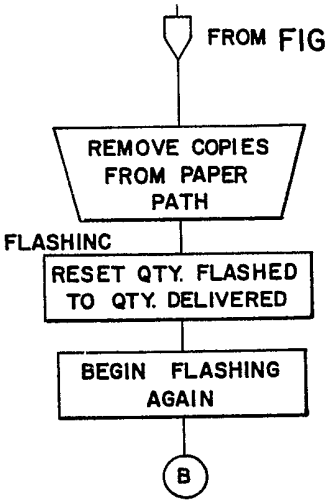

FROM FIG. 13
REMOVE COPIES FROM PAPER PATH
FLASHINC
RESET QTY. FLASHED TO QTY. DELIVERED
BEGIN FLASHING AGAIN
B

FIG. 16

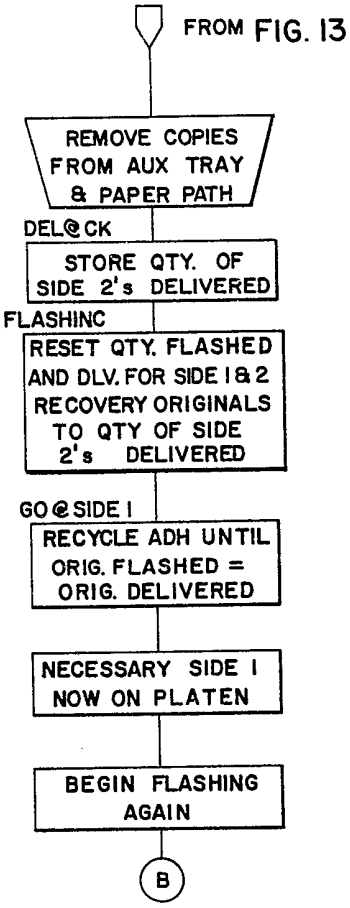
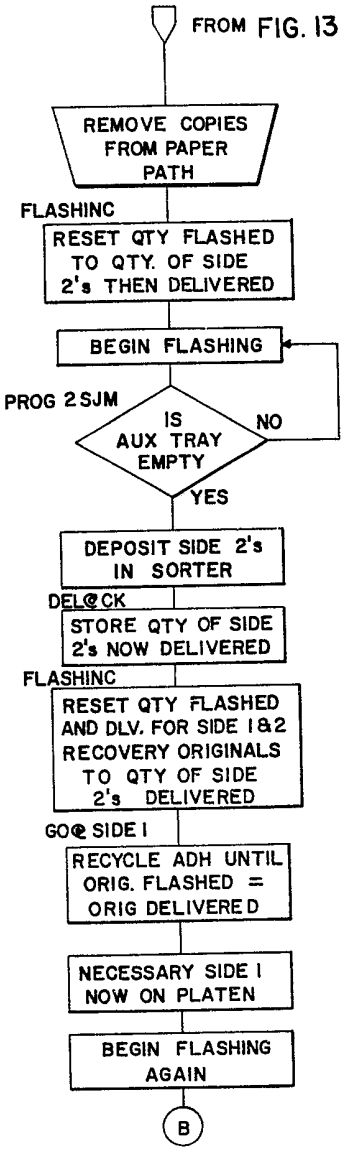

FROM FIG. 13
REMOVE COPIES FROM AUX TRAY & PAPER PATH
DEL@CK
STORE QTY. OF SIDE 2's DELIVERED
FLASHINC
RESET QTY. FLASHED AND DLV. FOR SIDE 1&2 RECOVERY ORIGINALS TO QTY OF SIDE 2's DELIVERED
GO@SIDE 1
RECYCLE ADH UNTIL ORIG. FLASHED = ORIG. DELIVERED
NECESSARY SIDE 1 NOW ON PLATEN
BEGIN FLASHING AGAIN
B

FIG. 15


FROM FIG. 13
REMOVE COPIES FROM PAPER PATH
FLASHINC
RESET QTY FLASHED TO QTY. OF SIDE 2's THEN DELIVERED
BEGIN FLASHING
PROG 2SJM
IS AUX TRAY EMPTY
NO
YES
DEPOSIT SIDE 2's IN SORTER
DEL@CK
STORE QTY OF SIDE 2's NOW DELIVERED
FLASHINC
RESET QTY FLASHED AND DLV. FOR SIDE 1&2 RECOVERY ORIGINALS TO QTY OF SIDE 2's DELIVERED
GO@ SIDE 1
RECYCLE ADH UNTIL ORIG. FLASHED = ORIG DELIVERED
NECESSARY SIDE 1 NOW ON PLATEN
BEGIN FLASHING AGAIN
B