PATENT SPECIFICATION

(11) 1 577 217

1 577 217

(21) Application No. 28976/79 (22) Filed 28 Nov. 1976
(62) Divided out of No. 1577215
(31) Convention Application No. 50/143179
(32) Filed 28 Nov. 1975
(31) Convention Application No. 50/143180
(32) Filed 28 Nov. 1975
(31) Convention Application No. 50/143178
(32) Filed 28 Nov. 1975
(31) Convention Application No. 50/144158
(32) Filed 2 Dec. 1975 in
(33) Japan (JP)
(44) Complete Specification published 22 Oct. 1980
(51) INT CL³ B41L 39/00//G03G 21/00
(52) Index at acceptance
G3N 275 381 382 385 402 404 BA2X
B6C 104 1200 1210 1211 1232 1241 1249 1250 1260 VK

(19)

(54) COPYING OR PRINTING APPARATUS

(71) We, CANON KABUSHIKI KAISHA, a Japanese company of 30—2, 3-chome, Shimomaruko, Ohta-ku, Tokyo, Japan, 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 copying or printing apparatus operable for carrying a multiple copying or printing operation in which a plurality of identical copies are produced.

The present invention provides copying or printing apparatus operable for carrying out a multiple copying or printing operation in which a plurality of identical copies are produced, including means for setting the number of copies to be produced in a said multiple copying or printing operation; display means for displaying during said multiple copying operation a number related to said operation; signal generating means for generating a signal for interrupting said multiple copying or printing operation; and means for causing said display means to provide a display different from said number upon interruption of said operation in response to said signal.

Said signal generating means may be provided for generating a said interrupting signal in response to a fault in the apparatus, such as a copy material jam arising or such as a circuit failure. When such arises, the display means may be arranged to provide a display which indicates both the type of fault and its location. Thus, the provision of separation display devices for indicating a number related to the multiple copying operation, such as the number of copies to be made or the number of copies made, and for indicating faults is unnecessary.

An embodiment of the invention in an electrophotographic copying apparatus will now be described in detail with reference to the accompanying drawings. In this apparatus, primary electrostatic latent images are formed on a rotatable photosensitive screen and a plurality of secondary electrostatic latent images may be formed from each primary image on a rotatable insulating drum by modulating a corona ion flow with the primary image on the screen. The secondary images are developed on the drum and then transferred to copy sheets. This process of forming a number of copies from each primary image is known as "retention copying". In the accompanying drawings:—

Figure 1 is a schematic cross-sectional view of an example of the copying apparatus;

Figure 2 diagrammatically shows the driving circuit for the display device;

Figure 3 is a time chart illustrating the operations of various devices in the copying apparatus;

Figure 4 is a block diagram of the control section;

Figure 5 is a flow chart showing a sequence of judgements taking place in connection with primary image formation;

Figure 6 diagrammatically shows the circuit realizing the sequence judgement of Figure 5.

Figure 7 diagrammatically illustrates the driving circuits for various devices, of the copying apparatus;

Figures 8(a) and 8(b) are a time chart and a circuit diagram, respectively, illustrating jam detecting operations;

Figure 9 is a time chart illustrating the operations of various devices after the jam detection;

Figures 10 and 10(a) to 10(e) are more detailed flow charts showing the sequence judgements during retention copying;

Figure 11 diagrammatically shows an example of the circuit realizing the sequence judgements of Figure 10;

Figures 12 and 13 are a graph and a circuit diagram, respectively, illustrating the correction of the variation in image quality taking place during retention copying;

Figure 14 is a time chart of the operations of the elements in Figure 13;

Figure 15 diagrammatically shows an example of the driving circuit for Figure 13;

Figure 16 shows an example of the driving circuit for the devices shown in Figure 3;

Figure 17 is a cross-sectional view of the photosensitive screen;

Figure 18 diagrammatically shows an example of the circuit for generating prohibition time signals when jam occurs;

Figure 19 schematically illustrates the accounting system;

Figure 20 shows an example of the control circuit for the output side of one of the corona dischargers;

Figure 21 shows an example of the signal generating circuit using the circuit of Figure 18 and corresponding to Figure 16;

Figure 22 shows some examples of the display effected by the display device of the apparatus;

Figure 23 shows an example of the driving circuit for effecting the displays shown in Figure 22.

Description of the Preferred Embodiments

The embodiment illustrated in the drawings employs a photosensitive screen of three-layer construction comprising an insulating layer, a photoconductive layer and an electrically conductive layer to produce copies with high contrast at high speed (see UK Patent Specification No. 1,480,841), wherein the photosensitive medium is subjected to first charging, exposure to light from image original and discharging simultaneous with said exposure (although the discharge could be arranged to take place subsequent to exposure) to thereby form a primary latent image on the photosensitive medium, whereafter corona ion flow is modulated by the primary latent image to form a secondary latent image on an insulative member adjacent to the photosensitive medium and the secondary latent image is developed into a visible image by well-known developing means while the insulative member is moved, and then the visible image is transferred onto a sheet of plain paper, which is in turn separated from the insulative member to provide a copy.

Figure 1 is a cross-sectional view of such a copying apparatus, the mechanical construction of which will now be described. The aforementioned three-layer photosensitive screen (see Figure 17) is extended over and adhesively or otherwise secured to a metallic screen drum substrate having annular opposite ends integrally connected together by a connecting band, thus forming a screen drum 1, and this screen drum is mounted on a tubular screen drum shaft 2. With the application of a bias voltage taken into account, a screen drum flange of insulating material is secured to each end of the screen drum 1 as by screws, and the forward portion of the screen drum flange has an opening through which a modulating charger 11 (second modulating charger) and a pre-modulating charger (first modulating charger) 13 may be mounted within the screen drum 1. The screen drum flange is installed on the tubular screen drum shaft 2 which is fixed by means of ball bearings. The screen drum 1 is rotatable about the fixed screen drum shaft 2.

The screen drum 1 is formed by an electrically conductive member 70 having a number of fine apertures and a photoconductive member 71 and an insulating member 72 successively layered over the conductive member 70 so that one surface of the conductive layer is exposed. The conductive member may be prepared by knitting thin wire of metal such as stainless metal or nickel into the form of netting.

The mesh value of the conductive member may suitably be 100 to 400 meshes in terms of the resolving power for copying, and may preferably secure a numerical aperture of 50% or more. The photoconductive member may be prepared by evaporating Se-alloy or the like, or by spray-coating of dispersed insulative resin carrying particles of CdS, PbO or like substance, or by etching. The insulating member may be prepared by either spraying or vacuum-evaporating a solvent type organic insulative material such as epoxyresin, acrylic resin or silicone resin. Exposing one surface of the conductive member may be accomplished by applying the coating or the spray to the conductive member with one surface thereof covered by suitable means, or by grinding the portion of the coating material which has come round to cover said one surface of the conductive member.

The following devices necessary for the formation of electrostatic latent image on the photosensitive screen are disposed around the screen drum 1. A pre-exposure lamp 3 is provided to erase undesirable ghost or the like on the photosensitive screen, and a primary charger 4 serves to impart uniform electrostatic charge onto the photosensitive screen. Since the diameter of the screen drum is relatively small, the leading end portion of the formed image may sometimes be recharged during the formation of electrostatic latent image on the photosensitive screen, in spite of an electrostatic latent image having already been formed thereon. Therefore, the primary charger 4 is divided into two, and the same voltage or the same current may be applied to the two chargers at a time interval. An AC discharger 6 is provided to remove the charge from the photosensitive medium in accordance with the light image 5 of the original illuminated by an original illumination lamp 52. The AC discharger may be replaced by a DC discharger opposite in polarity to the primary charger. A whole surface exposure lamp 7 is used to enhance the contrast of the primary latent image formed on the photosensitive screen. An insulating drum 8 comprising an electrically conductive member coated with an insulating layer in the form of thin film is juxtaposed closely adjacent to the screen drum 1. The screen drum 1 and the insulating drum 8 are rotatable in synchronism with each other but in the directions of arrows A and B, respectively.

Within the screen drum 1, a modulating charger 11 is mounted on a rail 10 supported by an insulating block 9 at the nearest position with respect to the insulating drum 8 and a pre-modulating charger 13 is mounted on a rail 12 also supported by the insulating block 9. In order to prevent dust from sticking to the screen drum 1 to hinder the formation of primary and secondary latent images, a blower 14 and a discharger 15 within the duct of the blower are provided to cause any suspending dust to stick to the back plate of the discharger and to cause clean air to be blown against the screen drum through a dust-removing nozzle 17. When the photosensitive screen is adversely affected by low temperature and high humidity, the air being blown may also be heated by a heat source 18. The pre-modulating charger 13 serves to apply a voltage opposite in polarity to that of the modulating charger 11 so as to ensure the potential of primary latent image on the screen drum 1 to be constant at all times when a number of secondary latent images are to be obtained from that primary latent image.

The secondary latent image on the insulating drum 8 may be developed by a developing device 20. The developing device 20 includes toner supply means 22 which is separated from a developing section 24 by a partition plate 23. Developing toner 25 may be supplied into the developing device 20 by rotation of a toner distribution roller 26. The developing toner 25 may be sufficiently agitated by rotation of an agitating roller 27 to develop the electrostatic latent image on the insulating drum 8 with the aid of a sleeve 29 containing magnet 28 therewithin.

A paper feed table 30 is capable of carrying thereon a great quantity of copy paper (2,000 to 4,000 sheets), and the uppermost level of the copy paper stock may be detected so that the uppermost level 31 may always assume a predetermined position and the paper feed table may be lifted along a guide rail 32 by the drive of a lift motor in accordance with the decrease in quantity of the copy paper.

A sheet of copy paper may be fed from the uppermost level of the copy paper stock by a pick-up roller 33 substantially in synchronism with the visible image on the insulating drum 8 and further made coincident with that visible image by timing rollers 34, and then passed between conveying rollers 35 so that the visible image on the insulating drum 8 may be transferred to the copy paper by an image transfer charger 36. A separating charger 37 is provided to weaken the attraction between the insulating drum 8 and the copy paper, and a conveyor belt 38 containing a suction device 39 therewithin is provided to separate the copy paper from the insulating drum 8 and convey the same. The conveyor belt 38 is extended over a belt driving roller 40 and rollers 41, 42 and movable round with the rotation of these rollers to convey the copy paper while attracting it thereto. A further conveyor belt is extended over rollers 43 and 45 to convey the copy paper to a set of fixing rollers 45. Then, the toner image on the copy paper may be fused and fixed, whereafter the copy paper may be passed along a guide 46 and onto a tray 47.

Operation of the Key Operating Board

The running of the copy apparatus of the present invention is started by an order from an operating board 61 shown in Figure 1. The operation board 61 comprises two display devices 62, 63, two pilot lamps 65, 66 and a keyboard 64. A key "O" (Original) on the keyboard 64 is used to set the number of electrostatic latent images to be formed on the screen drum 1. If numeric keys "0" to "9" are depressed in subsequence to the depression of the "O" key, the contents of these keys may be successively entered into the display device 62. If a key "∞" is depressed after the entry of the numeric keys, the contents of the display device 62 will be cleared to turn on the "∞" pilot lamp 65. If, conversely, the numeric keys are depressed after the "∞" pilot lamp is turned on, this pilot lamp will be turned off and the figures will be entered into the display device 62. Thus, the numeric data and the "∞" order may be automatically changed over. It is to be noted here that "∞" means an operation to be infinitely continued until there comes a "Stop" order which will later bc described.

A key "R" (Retention) is used to set the number of copies to be produced from a single electrostatic latent image formed on the screen drum. Entry of the numeric keys or the "∞" key may be done in the same manner as described above in connection with the "O" key, and the contents of these keys may be displayed by the display device 63 or the pilot lamp 66. For example, when ≪123≫ and ≪456≫ are to be entered into the display devices 62 and 63, respectively, the key depressions may take place in the sequence of "O"→"1"→"2"→"3"→"R"→"4"→"5"→"6". Thus, the "0" to "9" numeric keys and the "∞" key may be arbitrarily entered into the two display devices 62, 63 or the two pilot lamps 65, 66 by changing over the two function keys "O" and "R". Of course, the depressions of the "O" key and the "R" key may be interchanged in order. A key "CO" (Clear Original) serves to clear the display device 62 or the pilot lamp 65, and may be used to correct any numeric data erroneously entered. For example, when ≪123≫ entered into the display device 62 is to be corrected to ≪456≫, keys may be depressed in the sequence of "CO"→"0"→"4"→"5"→"6". A key "CR" (Clear Retention) is provided to serve a similar purpose and may be used to clear the display device 63 or the pilot lamp 66.

A "Start" key is used to start the copying operation. Once the "Start" key is operated to start the copying apparatus, the other keys than the "Stop" key are prohibited from operating by a prohibition circuit which will later be described. Further, when ≪002≫ and ≪003≫ are entered into the display devices 62 and 63, respectively, a primary latent image will be formed on the screen drum, and then modulation, development and transfer will take place three times each, whereafter this cycle will be repeated once again, whereby six copies will be produced. In this case, the two display devices will display ≪000≫ upon operation of the "Start" key, and will come to display ≪001≫, ≪002≫ and so on as the copying operation progresses.

Operating Board Circuit

Figure 2 is a block diagram of the operating board circuit in the present invention. A memory 202 and a counter 201 correspond to the display device 62 and respectively serve to store and count the number of times an electrostatic latent image is formed on the screen drum. A memory 203 and a counter 204 correspond to the display device 63 and respectively serve to store and count the number of copies produced from a single primary latent image.

Operation of the circuit will now be described. Signals from a group of keys 217—221 on the operating board are gated by the output signal 214 from a prohibition circuit 216, and this signal line 214 is normally at the "1" level, but whenever the prohibition circuit 216 is operated, the signal line 214 assumes the "0" level so that no output is produced even if the key group is operated. The prohibition circuit 216 comprises flip-flops 209, 210, 211 and two OR gates 222, 223. The flip-flops respectively store the depression of the "Start" key, the depression of the "Stop" key, and the jam of paper such as excess of paper, feeding of two sheets at a time, unsatisfactory separation of paper or the like. The flip-flops 209 and 210 are such that they are not set at the same time but one of them is set while the other is reset. That is, the "Start" order and the "Stop" order are never present at the same time. Also, whenever the flip-flop 211 is set, the flip-flops 209 and 210 are reset by all means and interrupt every operation when paper jam happens. The outputs of the OR gates 222 and 223 are normally at the "1" and the "0" level, respectively, but these are reversed to the "0" and the "1" level when any one of the flip-flops 209, 210 and 211 is set. That is, when one of the "Start" key, the "Stop" key and the jam detector is being operated, the signal line 214 assumes the "0" level and the signal line 215 assumes the "1" level. Thus, the group of keys 217, 218, 220 and 221 on the operating board are disabled while, at the same time, the gates 225 and 226 are closed and the gates 224 and 227 are opened so that, in the display devices 62 and 63, the contents of the memories 202 and 203 are replaced by the contents of the counters 201 and 204, which are thus displayed. During the copying operation, the other keys than the "Stop" key are inoperable. Therefore, at the moment the "Start" key is actuated, the contents of the counters are still zero and thus, the display device 62 changes from ≪002≫ to ≪000≫ while the display device 63 changes from ≪003≫ to ≪000≫. However, as the copying operation progresses, these figures are counted up until the figures of the corresponding memories and the figures of the corresponding counters become equal, whereupon the copying operation is terminated. Upon termination of the copying operation, each of the counters is cleared to zero in preparation for another cycle of operation and the display devices 62 and 63 again display the figures of the memories.

The "Stop" key, when depressed at any desired point of time during the copying operation, brings the copying operation to an end at an operationally good point apart from said point of time.

Flip-flops 205 and 206 store the depressions of the "O" and the "R" key, respectively, and they are such that they are not set at the same time but one of them is set while the other is always reset. When the "O" key is depressed, the flip-flop 205 is set while the gates 228 and 229 are opened. Subsequently, when one of the numeric keys 217 is depressed, the signal from the depressed key is passed through the gate 228 and, if the pilot lamp 234 is turned on by a flip-flop 209, the pilot lamp is reset and turned off by a signal line 232. When the "∞" key 221 is depressed instead of one of the numeric keys 217, the signal from the key 221 is passed through the gate 229 to set the flip-flop 207 and turn on the pilot lamp 234 while, at the same time, the memory 202 is cleared by a signal line 233 if some figure has already been entered into the memory. Thus, entry of a figure into the memory and the "∞" order can never come into existence at the same time but, when one of them exists, the other is always in no existence.

When the "R" key is depressed, the flip-flop 205 is reset while the flip-flop 206 is set and the gates 230 and 231 are opened. Thereafter, as already described in connection with the depression of the "O" key, the figure of one of the keys 217 is passed through a gate 231 to the memory 203 and the signal of the "∞" key is passed through a gate 230 to set a flip-flop 208 and turn on a pilot lamp 235. Again in this case, if some figure is entered into the memory 203, the flip-flop 208 is reset and conversely, if the flip-flop 208 is set, the memory 203 is cleared. Thus, entry of numeric data into the memory and the "∞" order are automatically changed over therebetween. It is also possible to enter inputs into the two types of memories 202 and 203 by means of keys 217 and 221 of one type.

It should be understood that the infinity key is not normally used. As will become apparent, particularly with reference to Figure 5, if the infinity key is depressed after the "O" key so as to light the pilot lamp 65, repeated primary image formation takes place without any copies ever being formed. This facility may therefore merely be provided for use in testing the apparatus. It will also be understood that an infinite number of secondary images and copies cannot be obtained from a single primary image so that depression of the infinity key subsequent to depressing the "R" key thus to illuminate the pilot lamp 66, does not provide for practical operation of the machine and this facility also, therefore, may be provided for testing purposes.

Relation Between Sequence and Mechanical Operation

Figure 3 is a time chart showing the operational sequence of the copying apparatus of Figure 1 with respect to a case where the orders from the operating board are Original ≪002≫ and Retention ≪002≫. First, upon closing of the main switch, a cleaning motor 320 for collecting the residual toner removed from the insulating drum and for driving the conveyor belt, a dust collector 15 for screen

(Figure 1), a fan 14 for screen dust-proof (Figure 1), two screen heaters 18 (Figure 1) and a dust collecting fan 325 for sucking the toner suspended within the developing device are started and driven until the main switch is opened, with the only exception that one of the two screen heaters is deenergized at a point of time whereat formation of a first electrostatic latent image is completed.

Subsequently, when the "Start" key for starting the copying operation is depressed, the motor 301 for screen drum is rotated. Thereupon, the reciprocating clutch for optical system is operated to thereby drive the optical system in synchronism with the screen drum. Describing the mechanism of the optical system by reference to Figure 1, an original on the original supporting glass is illuminated by the original illumination lamp 52 while this lamp 52 and a first mirror 53 integrally formed with the reflector of the lamp are being moved at a velocity v synchronous with the peripheral velocity of the screen drum 1. As long as the motor for screen drum is driven during the illumination by the original illumination lamp, the screen drum is rotated at the peripheral velocity thereof but when this motor is deenergized while the motor for insulating drum is energized, both the two drums instantaneously increase their velocities to about twice.

During the rotation of the motor 301 for screen drum, a cooling fan 326 for optical system is driven to prevent the build up of heat in the optical system caused by the turn-on of the pre-exposure lamp 3, the whole surface illumination lamp 7 and the original illumination lamp 52.

Also, closing of the "Start" key energizes the charger 36 for toner image transfer, the charger 37 for paper separation, the discharger 50 for the insulating drum and the suction fan 319 for paper separation (Figure 3) and these are deenergized upon completion of the copying operation. However, the potentials of the above-mentioned chargers 36, 37 and 50 are reduced so that no excess charge may be imparted to the insulating drum which is being slowly rotated at the peripheral velocity of the motor for screen drum (317, 318 and 321 in Figure 3).

Next, after the formation of a primary latent image, the motor for screen drum is deenergized and the motor for insulating drum is energized, whereupon the copying processes such as modulation, development, image transfer, paper separation, etc. are started. The first copy is finished after three complete rotations of the screen drum following the start of secondary image formation but thereafter, a copy is finished for each complete rotation of the screen drum.

Describing this by reference to Figure 3, the rotation of the drum is first changed over to the motor 328 for insulating drum and simultaneously therewith, the first modulating charger 310 and the clutch 316 for conveying roller for transmitting the drive of the cleaning motor 320 to the conveyor belt 38 (Figure 1) are energized. As the screen drum progressively rotates through 80° from its home position, the second modulating charger 311 for transferring the electrostatic latent image from the screen drum to the insulating drum is energized; when the screen drum rotates to an angular position of 310°, the clutch 314 for paper feed roller for feeding a sheet of copy paper from the paper feed table is energized; and when the screen drum rotates to an angular position of 350°, the motor 312 for developer and the reversible toner bridge prevention motor 313 for agitating the toner staying in the developing device are energized. After the modulation is started, the screen drum enters a second cycle of rotation and when it comes to the position of 30°, the clutch 314 for paper feed roller is deenergized, whereby the clutch 315 for timing roller is energized to bring the leading edge of fed paper into coincidence with the leading edge of the developed visible image on the insulating drum. If the number of copies desired is one, the first 310 and the second modulating charger 311 are deenergized when the screen drum is at the position of 80°, but in the present case, these chargers are not deenergized because the number of copies desired is two. As the screen drum further rotates to the position of 310°, the clutch 314 for paper feed roller is energized to feed a second sheet of copy paper. At the position of 360°, the clutch 315 for timing roller for the first sheet of copy paper is deenergized. A third cycle of rotation is entered and when the screen drum comes to the position of 30°, the clutch 314 for paper feed roller is deenergized and the clutch 315 for timing roller for the second sheet of copy paper is energized. At the position of 80°, the first 310 and the second modulating charger 311 are deenergized. If the number of copies desired is one, the motor 312 and the toner bridge prevention motor 313 are deenergized at this point. At the position of 360°, the clutch for timing roller is deenergized. A further cycle of rotation is entered and when the screen drum comes to the position of 80°, the motor 312 for developer and the toner bridge prevention motor 313 are deenergized. At the position of 360°, the motor 328 for insulating drum and the clutch 316 for conveying roller are deenergized, thus completing the retention cycle.

A separating pawl solenoid 329 for separating paper from the insulating drum (indicated by 73 in Figure 1) becomes operative at the position shown in Figure 3, by the pulses being counted from the point of time whereat the leading edge of the paper passes between the lamp 69 and the light receiving element 70 (Figure 1).

When all the copying operation has been completed, an electromagnetic brake 327 is temporally operative to brake the drum against overrunning.

Arrangement of the Sequence Control Circuit

Figure 4 is a block diagram of the control section. There are applied from outside to the central control 401 signals from the keyboard 402 giving operational orders, detection signal 403 for the home position of the screen drum which forms the reference for the sequence, a series of clock pulses 404 from a clock pulse generator synchronous with the rotation of the insulating drum, and six microswitch signals 405 determining the timing of primary latent image formation. In accordance with these input signals, the central control drives two memories and three counters to effect storage and judgment and put out proper signals to an interface 406.

The screen drum home position is obtained in the form of detection pulse 330 (Figure 3) by the magnet 68 and magnetoelectric conversion element 67 (Figure 1) on the screen drum for each complete rotation of the screen drum. Discriminating pulses (1) 331 are provided following the formation of each electrostatic latent image on the screen drum. The leading edge of each discriminating pulse (1) 331 is created by MS1 when the optical system comes back to its home position and the trailing edge by the trailing edge of the screen drum home position signal DHP. During each discriminating pulse (1) 331, judgement is effected as to whether the contents of the memory (1) 202 and the screen drum counter 409 are equal or not and whether the "Stop" order has been given or not, whereby either the motor for insulating drum is started in order to initiate the process of secondary latent image formation, or the primary latent image formation is restarted or the motor for the screen drum is stopped, thereby determining whether or not to terminate the sequence.

Such determinations may be expressed in a flow chart as shown in Figure 5. As seen there, the actions taken in response to these determinations are respectively indicated by Y, Z and X. The operations of this flow chart are carried out by means of a semiconductor read-only memory circuit as shown in Figure 6. Define the vertical bus bars as columns and the lateral bus bars as lines. The control orders indicated by <> are connected to columns 601—604, respectively. Also, these signals are inverted by inverters 605—608 and connected to columns 609—612. Lines 613—617 are connected to the power source through resistors. This power source must be at a level equal to the logic level "1".

For example, the condition © in Figure 5 is that "there is no Stop order given, the pilot lamp 1 is not turned on and a figure is in the memory 2" and therefore. this may be expressed by a logic equation "©=$\overline{\text{FSTOP}}$. $\overline{\text{FS}\infty}$. $\overline{\text{IL}}$=0". Thus, if diodes are inserted in columns 609, 610, 611 and line $\overline{615}$ in the senses as shown, there is formed an AND gate in which line 615 is at the "1" level only when columns 609—611 are at the "1" level. In other words, line 615 assumes the "1" level when the condition © is established. Likewise, conditions Ⓐ to Ⓔ are put out onto lines 613—617. Further, these lines 613—617 are inverted by inverters 618—622 and connected to lines 623—627. If columns 628—630 intersecting these lines 623—627 are connected through resistors to the power source E to form a diode matrix again, line 630 assumes the "0" level only when the condition "Ⓐ or Ⓔ" is established, and the output 644 of inverter 633 becomes as expressed by a logic equation "Ⓐ+Ⓔ" and assumes the "1" level only when the aforementioned condition is established. Accordingly, if this is passed to gate 638 with control pulse (1) FJ1 331 and screen drum home position pulse DHP330 which represents the break point of operation, the operation order "X" representing the termination of the sequence may be given to latch the memory circuit. Other signals Y and Z may likewise be given. In the case of signal Z, the outputs of the aforementioned chargers 36, 37 and 50 are reduced in the manner as shown in Figure 20.

When the condition © is established and signal Y is obtained, the motor for screen drum is deenergized while the motor for insulating drum is started and the velocity of the drum is changed to high level and the disc 59 is rotated by gearing in synchronism with the drum. Signals generated by apertures formed circumferentially of the disc 59 traversing the clearance between a pair of light emitting element and light receiving element 60 are taken out as clock pulses 332 (Figure 3). These clock pulses are generated in such a manner that a pulse is generated per 1° rotation of the screen drum and 360 pulses are generated per 360° rotation of the screen drum. Since it is difficult to form an aperture per 1° in a disc having the same diameter as that of the screen drum, there is provided another disc whose number of revolutions is made as great as *n* times that of the screen drum by gearing and which is formed with 1/n apertures.

In the present apparatus, during the processes subsequent to the primary image formation, these clock pulses are processed for reading from a further semiconductor read-only memory circuit instruction or control signals for driving various devices. During such processes, as shown in Figure 3, the first copy sheet is finished for one complete and half turn of the insulating drum and the second and subsequent copy sheets are finished for each half of one complete turn of the insulating drum and therefore, with one-half turn of the insulating drum or one complete turn of the screen drum as the reference for the sequence control, a binary coded 360-counter is operated by the clock pulses 332 to put out the control pulses 333—345 shown in Figure 3.

The further semiconductor read-only memory circuit is shown in Figure 7. Ten flip-flops are connected together to constitute a 360-counter which may count clock pulses from 0 to 359. The first four flip-flops constitute a decimal counter which represents the place having the weight of 1 and repeats counting from 0 to 9, the next four flip-flops constitute a decimal counter which represents the place having the weight of 10 and repeats counting from 0 to 9, and the last two flip-flops constitute a trinary counter which represents the place having the weight of 100. However, when the count advanced from 0 changes from 359 to 360, a set signal is put out from a decoder to reset all the flip-flops. Thus, these flip-flops provide a 360-counter which repeats counting from 0 to 359 for each complete turn of the screen drum from its home position. The control pulses 333—345 in Figure 3 are generated by the output of the above-mentioned counter being decoded by the matrix memory circuit of Figure 7. Where it is desired to alter the timing of the sequence of 310 to 316 in Figure 3, this may be accomplished by changing the locations of the diodes in the circuit as desired. For example, delicate adjustment such as the timing of the paper feed or the registration between the leading edge of the paper and the developed visible image on the drum which could not be accomplished by a microswitch-cam combination may be readily accomplished.

The other control pulses are put out in a similar manner.

In Figure 3, selection of the control pulses is necessary in order that the first modulating charger 310 may be energized at count 1 in the first cycle and if the number of copies desired is one, may be deenergized at count 80 in the second cycle and if the number of copies desired is two, may be deenergized at count 80 in the third cycle.

The present embodiment, as shown in Figure 4, uses two insulating drum counters IC and IC′ to count the discriminating pulses (2), which are generated by the circuit of Figure 7, and compare the counter number with the memory (2).

The counters IC and IC′ are used to control the paper feed roller and the timing roller. More specifically, if the insulating drum counter IC 347, which effects a count of "1" in each cycle after the first, contains a number which is less than that in the memory (2) which stores the desired number of copies to be taken during retention copying, the copy paper feed roller is actuated in each cycle to feed a copy sheet. However, once the number in counter IC is equal to that in memory (2), indicating that sufficient copy sheets have been fed, the paper feed roller clutch ON signal 342 during that cycle is inhibited. After that, this counter is stopped. It will be understood, therefore, that the paper feed roller is not actuated in either of the last two cycles.

The clutch for the timing roller should not be operated in the first cycle i.e. it should be operated for the first sheet of paper for the first time in the second cycle. Further, the timing roller should not be actuated in the last cycle so that in the example in Figure 3 the timing roller is only actuated during the second and third cycles. To achieve this, the second insulating drum counter IC′ is provided and counts up with a delay of one count with respect to the counter IC. The timing roller is actuated only in those cycles in which the number in the counter IC is not 0 and the number in the counter IC′ is not equal to the number in memory (2).

In the case of Figure 3, the insulating drum counter IC coincides with the memory (2) in the third cycle and stops counting, whereas the insulating drum counter IC′ coincides with the memory (2) in the fourth cycle. Thus, the insulating drum counters (1) and (2) coincide with each other in the fourth cycle. The coincidence between these two counters means the last cycle of copying, and during the last time of that cycle, namely, during the time of discriminating pulse (2), the two counters are cleared and again a decision is taken as to whether or not the screen drum counter is coincident with the memory (1) storing the number of times primary latent image formation is to be carried out. If they are coincident, a copy terminating order is put out to stop the drum from rotating. If not coincident, the motor for insulating drum is deenergized and the motor for screen drum is energized and the exposure of the original and the primary latent image formation are repeated.

Figure 16 shows examples of the drive controls for various devices. In this Figure, 310, 312, 314 and 315 respectively correspond to the clutch for paper feed roller, the first modulating charger, the motor for developer and the clutch for timing roller shown in Figure 3. Designated by 160 is an amplifier for operating these. There are further seen the gates 167 and 170 of flip-flops, inverters 161, 164, 166 and 168, NAND gate 162, NOR gate 163 and AND gates 165 and 167. When the coincidences between the aforementioned counters IC, IC′ and the copy number setting memory (2) are discriminated by the respective coincidence circuits, ON pulses are interrupted and the devices are stopped by OFF pulses. Thus, the devices can be controlled with a predetermined timing.

It is further to be noted that if the process concerned is the sequence of steps of latent image formation or the like and control pulse is generated for each process, the necessary control pulse corresponding to each process may be selected according to the above-described method.

Also, if the developing device is of the liquid developing type, the step of idle rotation cleaning of the insulating drum before the formation of secondary latent image and the step of idle rotation cleaning of the same drum after the image transfer may be provided to ensure the next image formation to be good. More particularly, it will become possible to prevent the difficulties which would otherwise be encountered in the cleaning of the insulating drum during the next cycle as the result of the liquid on the surface of the drum or the toner on the cleaning blade 48 (Figure 1) being dried up. Exposure of the rotating insulating drum to AC corona discharge would result in a better cleaning effect. The pre-rotation of the drum may provide the rotation of primary latent image formation. It will also become possible to form the control pulse according to the above-described method so that the post-rotation may be substantially one complete rotation.

If copy paper clogs in its path of conveyance or if copy paper after image transfer is not successfully separated from the insulating drum but moved therewith, or if two sheets of copy paper have been fed at a time, the jam resulting therefrom may be detected with the aid of a pair of light source 69 and light receiving element 70 and a pair of light source 71 and light receiving element 72 provided as shown in Figure 1. Since the paper will not intercept the light from one or other of the light sources 69, 71 at the time that it would have in the absence of a jam. Description will be given with reference to Figure 8 of detection of a jam arises from unsuccessful separation of the paper from the drum. When the leading edge of the copy paper passes by the light source 69 (SGI), a signal from the light receiving element 70 causes the jam counter to start counting the clock pulses and, when the leading edge of the copy paper passes by the light source 71 (SGO), the light receiving element 72 puts out separation confirmation detection pulses SDP comprising the decoded output of the jam counter. The counted number of the detection pulses corresponds to the conveyance distance from the light source 69 to the light source 71. Therefore, if copy paper fails to be separated from the insulating drum, the copy paper does not intercept the light source 71 in spite of the separation detection pulses being put out. Accordingly, a jam detection signal JP is put out along a circuit as shown in Figure 8(b). It is also possible to utilize this counter to cause output of a pulse signal for creating a timing with which the separation pawl 73 (Figure 1) may be operated.

Reference will now be had to Figure 9 to discuss the sequence control which takes place after jam detection.

As soon as a jam is detected, the electromagnetic brake is used to suddenly stop the motor for insulating drum and thereby stop the sequence of operations, thus enabling repair to be done without the main switch being opened. During the repair, the counter remains stationary while storing the number counted as of the point of time whereat the jam occured. If the "Start" key is again depressed upon completion of the repair, the motor for screen drum is energized to rotate the screen drum to its home position and in this home position, the motor for screen drum is deenergized while the motor for insulating drum is energized. Since the electrostatic latent image on the screen is retained even during the repair, the sequence of copy formation is resumed. This sequence requires the insulating drum to effect one and a half rotations (three complete rotations of the screen drum) in order to provide the first copy. This applies to the first copy of a retention copying operation as well as to the first copy after a jam has been cleared. Therefore, in the case of the restart after the jam, it is necessary to create the appropriate sequence of operations for providing the first copy but while the insulating drum counters IC1 and IC2 remain stationary. For this reason, prohibition time 1 and prohibition time 2 are provided for in the first and the second cycle of the sequence, as shown in Figure 9. The insulating drum counters (1) and (2) effect count-up from the beginning of the third cycle and the sequence control thereafter is effected in the same manner as the ordinary control.

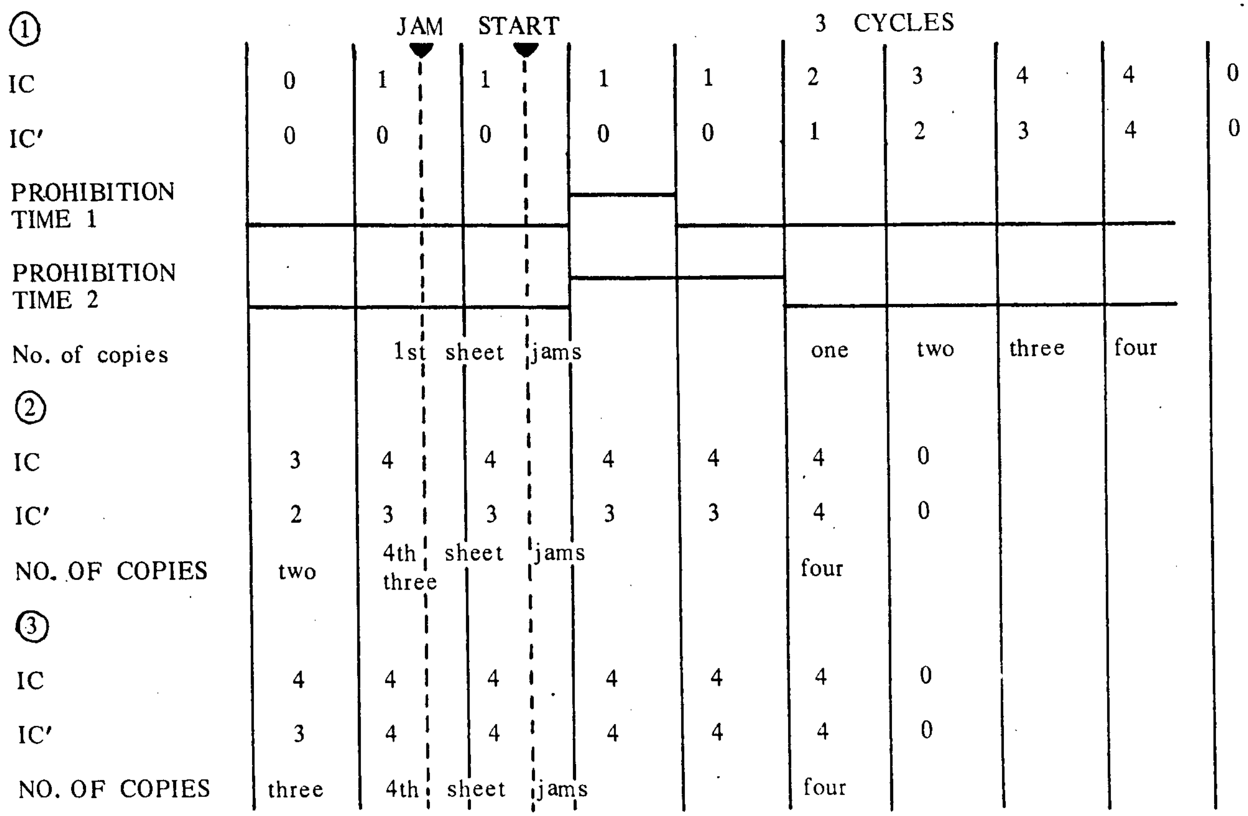
A copy sheet may be jammed at any of a number of places in its path of movement and such a jam may arise at any time during a retention copying operation. The following cases will be considered:

① when the first sheet jams at a time, when the insulating drum counters (1) IC and (2) IC′ are not equal to the memory (2);

② when the insulating drum counter IC is equal to the memory (2); and

③ when the insulating drum counter IC′ is equal to the memory (2).

The movements of the counters in the case of the restart after jam are illustrated below, it being understood that memory (2)=4.


①
JAM
START
3 CYCLES
IC 0 1 1 1 1 2 3 4 4 0
IC′ 0 0 0 0 0 1 2 3 4 0
PROHIBITION TIME 1
PROHIBITION TIME 2
No. of copies
1st sheet jams
one two three four
②
IC 3 4 4 4 4 4 0
IC′ 2 3 3 3 3 4 0
NO. OF COPIES two
4th three sheet jams
four
③
IC 4 4 4 4 4 4 0
IC′ 3 4 4 4 4 4 0
NO. OF COPIES three
4th sheet jams
four

In case ①, jamming is detected at a time when the counter IC contains 1 and the counter IC′ contains 0. Thus, it will be recognized, particularly from consideration of Figure 3B, that jamming has been detected in the second cycle after primary latent image formation. During this cycle, the timing roller is actuated to feed the sheet towards the transfer station, but it is not until the next cycle that the sheet should have reached a position in its path where its leading edge should have been separated from the drum. Thus, case ① assumes that jamming has been detected at some stage in the path of movement of the paper before its leading edge should be separated from the drum e.g. such jamming may be detected by failure of the leading edge of the copy sheet to intercept the light from the light source 69 during the second cycle.

In case ②, it is assumed that two copies have been discharged from the machine, that there is no problem with the third copy, that the fourth copy has jammed. Since detection of this jam takes place at a time when the counter IC contains 4 and the counter IC′ contains 3, it will be understood from consideration of the above discussion of case ① that the fourth sheet must have jammed at a similar stage in its path to that in which the first sheet jammed in case ①.

In case ③, however, detection of a jam arises when both counters IC and IC′ contain 4 indicating that the jam is detected in the last cycle. During this cycle, the fourth copy sheet should become separated from the drum and thus in case ③ it is assumed that the jam arises from unsuccessful separation.

After the jam has been cleared in the case ①, both the counters IC and IC′ effect count-up from the third cycle. In the case ②, only the counter IC′ effects count-up in the third cycle until IC=IC′, this terminating the retention copying operation at the end of the third cycle. In the case ③, count-up is not effected even when the third cycle is entered, and IC=IC′ is confirmed at the end of the third cycle, thus terminating the retention copying operation. The retention copying operations in cases ② and ③ come to an end in the same cycle because the difference between the cases ② and ③ results from the time difference between the point of time whereat jam occurs near the paper leading edge detector, e.g. due to two sheets having been fed at a time, and the point of time whereat jam occurs due to unsuccessful separation of the paper.

Description will now be made of the sequence control method using the prohibition time (INH1) and the prohibition time 2 (INH2). In the sequence restarted after jam, the first sheet must be printed anyhow and therefore, in the prohibition time 1, the elements 310—314 in Figure 3 must be energized with a proper timing. The element 315 must also be energized with a proper timing of $\overline{\text{INH1}}$. INH2 ($\overline{\text{INH1}}$ is the inverted signal of INH). Subsequently, during the time of $\overline{\text{INH1}}$. INH2, the elements 310 and 311 are deenergized if the contents of the counter IC has already become equal to the contents of the memory (2), and the element 314 is also deenergized in such case. In the cycle after INH2, the counters IC and IC′ are controlled in the manner as already described and therefore, control is effected by the comparison between the memory (2) and these two counters as in normal operation.

The circuit for generating the prohibition time signal INH1 and INH2 is shown in Figure 18, where there are seen flip-flops 181, 182, gates 183, 184, start signal FRS TRT concerned with starting of the insulating drum, and discriminating pulse (2) FJ2. The gates 183 and 184 put out INH1 and INH2 with the timing as shown in Figure 9. The driving of the devices and the stoppage of the counters during these prohibition times are controlled by a circuit as shown in Figure 21. In this Figure, the ON and the OFF pulses are the same as the sequence pulses in Figure 3.

As is apparent from what has already been described, each cycle after the primary image formation corresponds to one cycle of the 360-counter which counts clock pulses. The pulses shown in Figure 3 are generated at the proper count in each cycle, although not all of them are used i.e. they are used only in those cycles in which it is desired to turn on or off the flip-flops for latching the associated devices (for example see the above description of the operation of the paper feed and timing rollers). Thus, it is possible to form a flow chart in which the sequence is based on the 0 to 359 count of the 360-counter. Such a flow chart is shown in Figure 10, and is embodied in a semiconductor read-only memory circuit as shown in Figure 11 in which the programmed series of sequences of the flow chart are incorporated in a diode matrix, thereby enabling the sequence control to be accomplished without using any kind of switches.

The following list of symbols used in Figure 10 will make it possible to understand the flow chart thereof without the necessity for a detailed description:

SL required number of primary images stored in memory 1;
SC number in screen drum counter equal to the number of primary images which have been formed;
IL required number of copies from each primary, stored in memory 2;
IC number in insulating drum counter (1) representing number of copies taken from given primary;
IC′ number stored in insulating drum counter 2;
FC∞ signal indicating infinite repetition of primary image formation;
FI∞ signal indicating infinite repetition of retention copying;
FSTOP stop signal;
DHP screen drum home position;
CP clock pulses;
FJ1 discriminating pulses 1 produced at end of primary image formation;
FJ2 discriminating pulses 2 produced at end of each rotation of screen drum during secondary image formation;
CO clear memory 1;
CR clear memory 2;
SGI start of synchronized paper feeding movement (light source 69);
SGO leading edge of paper separated (light source 71);
SDP separation confirmation pulse;
JP jam detection signal;
INH1 prohibition time 1;
INH2 prohibition time 2;
FRSTRT start signal after paper jam;
FHVT5 first modulating corona discharger;
FHVT7 second modulating corona discharger;
EHV10 transfer charger;
FCL3 paper feed roller;
FCL4 timing roller;
FM2 motor for insulating drum;
FM3 motor for developing device;
FMB brake for insulating drum;
FRC IC=999;
FRC′ IC′=999.

Thus, by way of example, the instruction "set FHVT5" turns on the first modulating charger, the instruction "reset FCL3" turns off the paper feed roller and the instruction "set FC14" turns on the timing roller. It is believed that further description is unnecessary.

Description will now be made of means for improving retention copying. As the retention copying operation progresses, the primary electrostatic latent image formed on the screen suffers from natural loss of charge and reduced potential, which affects the gradation, contrast or the like of the resulting visible image. To correct the variation in the image resulting from such reduced potential, the potential of the second modulating charger changes as the retention copying operation progresses. In the present apparatus, as is illustrated in Figure 12, the potential is higher for the first sheet than for the second sheet, whereafter the potential is stepwisely increased for the tenth, the thirtieth, the fiftieth, the seventieth and the ninetieth sheet.

The rise and fall of the potential may be accomplished by varying the input voltage at the primary winding of the high tension transformer. This will more specifically be described with respect to Figure 13. Six resistors are inserted in series and these resistors are successively short-circuited by relays or the like operable as the retention copying operation progresses, thereby increasing the potential. These resistors may be inserted in series as shown, or alternatively different resistance values may be parallel-connected and they may be changed over therebetween.

The timing with which the above-mentioned relays or switches are operated is shown in Figure 14. Such timing may be formed by a combination of the insulating drum counter (1) and the modulating charger ON pulse. For example, in the present apparatus wherein the potential is varied for the second, the tenth, the thirtieth, the fiftieth, the seventieth and the ninetieth sheet, the timing is provided by the modulating charger ON pulse gated by decoded output of the insulating drum counter (1). Accordingly, the operating pulse for relays K1—K6 is put out at count 80 of clock pulse when IC=1 for the second sheet, when IC=9 for the tenth sheet, when IC=29 for the thirtieth sheet, when IC=49 for the fiftieth sheet, when IC=69 for the seventieth sheet, and when IC=89 for the ninetieth sheet, respectively, whereby latches 1—6 are set to operate the coils of the relays K1—K6.

Description will now be made of a rational method of accounting the copying fees in the copying apparatus of the present embodiment. The light source for illuminating the image original is used only during the step of primary latent image formation and the deterioration of the photosensitive medium is usually induced by the passage of current through the photosensitive medium and thus, the deterioration of the light source and of the photosensitive screen occurs mostly during the step of primary latent image formation and has little or nothing to do with the subsequent steps. Such a copying apparatus, therefore, requires not only a method of accounting the fees by the size and quality of the copying paper used but also a method of accounting the fees by taking into consideration the difference between the step of forming a primary latent image on the photosensitive screen and the subsequent steps up to the step of transferring the image to the copying paper. An example of the latter method will be explained by reference to Figure 19. In this Figure, there is seen a total counter 191 for counting the number of times the formation of electrostatic latent image on the photosensitive screen occurs, and a total counter 192 for counting the number of times the steps of forming a secondary latent image on the insulating drum from the primary latent image on the screen drum, developing the secondary latent image and transferring the developed image to copying paper occur (which number agrees with the integrated number of copy sheets). The other reference numerals correspond to the reference numerals in Figure 2 (block diagram of the operating board). Operation will now be explained. Each time an electrostatic latent image is formed on the screen drum by the image original being illuminated, the count-up switch 241 repeats ON and OFF and correspondingly, the numbers in the counter 201 and the total counter 191 are each increased by 1. The apparatus repeats a series of copying operations and, when the number in the counter 201 comes to agree with the preset number of copies stored in the memory 202, the counter 201 is cleared. On the other hand, the total counter 191 is not cleared but still continues to count even for the ensuing copying operations. That is, when the image original copied is removed and replaced by another image original and a new number of copies is set, the counter 201 again begins to count up from 1 to 2, 3 and so on, but the total counter 191 begins to count up from the previous count plus 1. Also, each time the count-up switch 242 for the steps of secondary latent image formation, development and transfer to copy paper repeats ON and OFF, the counter 204 and the total counter 192 perform their respective functions corresponding to those of the counter 201 and the total counter 191, and the total counter 201 is not cleared but continues to count the total number of copies produced. In this manner, the number of times the electrostatic latent image formation occurs on the screen drum and the subsequent steps up to the transfer of visible image to copying paper are individually counted, whereby the counts by the respective total counts are individually totalled at discrete rates at the time of accounting. By so accounting the copying fees, there is provided an accounting system whereby the unit price of copy is gradually decreased with increase in the number of copies in a case where a number of copies are desired from the same image original, and such an accounting system may be said to have made the best use of the features of the present invention.

Whenever paper jams in its passageway during copying, the apparatus may be restored to its normal condition if the jamming paper is removed by the operator and thus, removal of jam may be readily done by the operator if he is only informed of where in the apparatus the jam has occured. In the present embodiment, a display device for displaying the number of copies is used also for that purpose and this display device is a numerical display device which effects two-digit display by the use of seven segments. When paper jams at a second point of detection among numerous possible points of jam detection, the jam will be displayed as J2, as shown in Figure 22(a).

Also, in preparation for a failure occuring to any of the control circuits for the optical system, the developing device, the image transfer, etc. which are necessary to the copying apparatus, numbers corresponding to the respective control circuits may be predetermined so that, when for example, the control circuit for the optical system (corresponding number is No. 8) fails, F8 may be displayed by taking the initial of "Failure", as shown in Figure 22(b). At sight of this, the user may know the presence of a failure in the apparatus and may also report the failure number to the service department of the manufacturer so that a serviceman can quickly take proper measures. This will lead to a shorter time required for the service.

The same display device may also be used to indicate the presence or absence of copy paper. More specifically, the absence of paper may be displayed as PE which comprises the initials of "Papers End" and if the apparatus is equipped with a number of cassettes for containing copy paper, the number of the cassette which has become empty may be additionally indicated after PE, for example, like PE3 as shown in Figure 22(c), which means that cassette No. 3 has become empty. This may also be displayed by two digits, as P3.

Further, exhaustion of the developer used for the image development may be displayed as DE (Figure 22(d)), and exhaustion of Isopar (Registered Trade Mark) may be displayed as IE (Figure 22(e)). The initial letters used to represent the various states are not restricted to the shown examples.

Reference will now be had to Figure 23 to describe a circuit serving as the change-over means for effecting the above-described displays. In Figure 23, the counter for displaying the counted number of the copies is diverted to display the jam (as "J", for example) and display the jammed point by figures (as "1" or "2", for example). Thus, a single display device can simply serve both the display of count and the display of jam.

In Figure 23, there is seen counter means 701 for counting the number of copies produced, a gate 702 for controlling the count output thereof, a gate 703 for output-controlling a jammed point, a gate 704 for putting out a count signal or a jam signal, a decoder 705 for converting the output of the gate 704 into transmission signals for the segments of a display device 711, flip-flops 706 for putting out a binary signal indicative of the jammed point, a detector 707 for detecting the jammed point, an encoder 708 for converting the detection signal into a binary coded decimal output, and a flip-flop 709 for putting out a jam signal.

Several jam detectors 707 (substantially represented by switches) are pre-numbered (for example, 01 for the neighborhood of the timing roller, 02 for the neighborhood of the paper separator, 03 for the neighborhood of the fixing device, ...), and any of these numbers is converted into a binary number by the encoder 708, the output of which is in turn applied to a group of flip-flops corresponding to the weight of the binary number. The encoder 708 also puts out a jam detection signal 710 to set the flip-flop 709, the output of which is used to change over the counter 701 to the jam display. By this change-over, the contents of the counter 701 are passed through the gate 702 and the binary coded output of the flip-flops 706 is passed through the gate 703, and binary-decimalized by the decoder 705 and displayed by the display device.

Description will be made of, for example, a case where jam detector No. 2 is operated to display "J02" on the three-digit display device.

When jam detector No. 2 is operated, the flip-flop F2 of weight 2 and the flip-flop 709 are set by the encoder 708 and the counter 701 is stopped from counting, whereupon the gate 702 is closed and the gate 703 is opened. The contents of the flip-flop group 706 are passed through the gate 703 and through the gate 704 to the decoder 705, whereby they are displayed in the two least significant digit places of the display device. The output of the flip-flop 709 is directly applied to the decoder 705 and coded into character "J", which is in turn displayed in the most significant digit places of the display device.

While the present invention has been described with respect to a copying apparatus in which visible image is transferred to plain paper, the invention will be very effectively applicable to an apparatus utilizing the so-called TESI system in which a latent image formed on a photosensitive medium by exposure and other steps is directly transferred to plain paper to thereby produce a copy or an apparatus in which a secondary latent image on an insulating drum is directly transferred to plain paper and the transfer image is developed to produce a copy.

Reference is directed to our co-pending Application No. 48811/76 (Serial No. 1,577,215), from which the present application is divided and also to our co-pending Application Nos. 28975/79 (Serial No. 1,577,216), 29032/79 (Serial No. 1,577,218) and 29091/79 (Serial No. 1,577,219).

WHAT WE CLAIM IS:—

1. Copying or printing apparatus operable for carrying out a multiple copying or printing operation in which a plurality of identical copies are produced, including:

means for setting the number of copies to be produced in a said multiple copying or printing operation;

display means for displaying during said multiple copying or printing operation a number related to said operation;

signal generating means for generating a signal for interrupting said multiple copying or printing operation and;

means for causing said display means to provide a display different from said number upon interruption of said operation in response to said signal.

2. Apparatus according to claim 1, wherein said signal generating means is operative to generate a said signal in response to a fault in said apparatus.

3. Apparatus according to claim 2, wherein said signal generating means is operative to respond to any of a plurality of different kinds of fault in said apparatus.

4. Apparatus according to claim 2 or 3, wherein the or one of the faults is a copy material jam.

5. Apparatus according to claim 4 operable to produce copies on separate copy sheets and arranged so that said copy sheets are movable along a predetermined path during said image forming and wherein said signal generating means is operable to detect failure of a copy sheet to arrive at a predetermined point in said path at a predetermined time.

6. Apparatus according to any of claims 2 to 5, wherein the or at least one of the faults is a circuit failure.

7. Apparatus according to any of claims 2 to 6, wherein said different display contains an indication of the type of fault.

8. Apparatus according to claim 7, wherein said indication of the type of fault is provided by displaying a letter.

9. Apparatus according to claim 7 or 8, wherein said different display provides an indication of the location of said fault.

10. Apparatus according to claim 9, wherein said indication of location is provided by a number.

11. Apparatus according to claim 8, or claim 9 or 10 as dependent upon claim 8, wherein said display means comprises a row of multiple segment display members at least one of which is arranged for displaying a number in response to said setting means and for displaying said letter in response to said interrupting signal.

12. Apparatus according to any preceding claim, including means for disabling said setting means automatically upon start of a said copying or printing operation until completion thereof.

13. Apparatus according to any preceding claim, including an electrophotographic photosensitive member, means for forming a primary electrostatic latent image on said member, means for forming a secondary electrostatic latent image from said primary image, and means for forming a copy from said secondary electrostatic latent image.

14. Apparatus according to claim 13, operable for carrying out a said multiple copying or printing operation by forming a plurality of said primary images and a plurality of secondary images and copies from each primary image.

15. Apparatus according to claim 14, wherein said setting means comprises means for setting a first number determining the number of primary electrostatic latent images to be formed and means for setting a second number determining the number of copies to be made from each said primary electrostatic latent image.

16. Apparatus according to claim 15, wherein said setting means comprises a first memory for storing said first number and a second memory for storing said second number, said apparatus further including a first counter for storing the number of primary images formed and a second counter for storing the number of secondary images formed.

17. Apparatus according to claim 16, wherein said display means includes first and second indicators for indicating respectively, in response to operation of said setting means, said first number and said second number and arranged, during copying, to indicate respectively the number in the first counter and the number in the second counter.

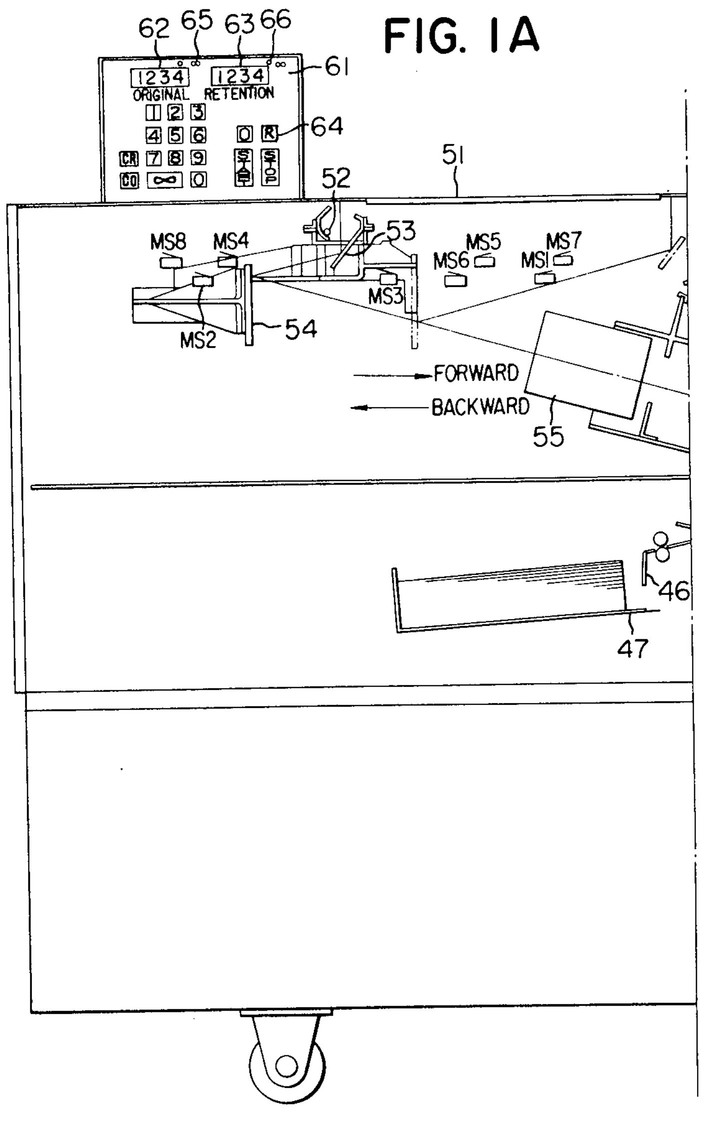
18. Apparatus according to any of claims 13 to 17, including an insulating member arranged to receive said secondary electrostatic latent images thereon, means for developing said electrostatic latent images on said insulating member and means for transferring said developed images to copy material.

19. Apparatus according to claim 18, wherein said photosensitive member is in the form of a screen, said photosensitive member and said insulating member are movable in synchronism around respective endless paths, and said secondary electrostatic latent image forming means is operative for creating a flow of ions through said screen for modulation by said primary electrostatic latent image thereby to form said secondary electrostatic latent images on said insulating member.

R. G. C. JENKINS & CO.,
Chartered Patent Agents,
Chancery House,
53/64 Chancery Lane,
London, WC2A 1QU.
Agents for the Applicants.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1980
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

FIG. 1A


62
65
63
66
61
1234
1234
ORIGINAL
RETENTION
1
2
3
4
5
6
7
8
9
0
CR
CO
∞
0
R
START
STOP
64
51
52
53
MS8
MS4
MS2
MS3
54
MS5
MS6
MS7
MS1
FORWARD
BACKWARD
55
46
47

1577217 COMPLETE SPECIFICATION

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

Sheet 2

FIG. 1

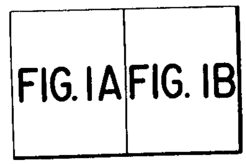
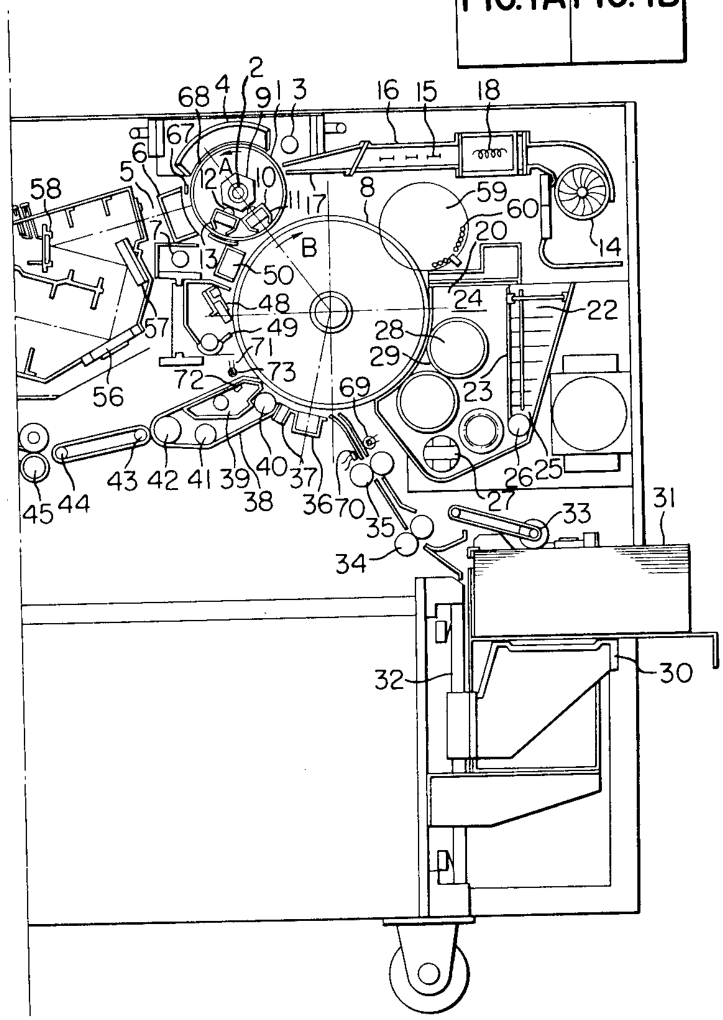


FIG. 1B



1577217 COMPLETE SPECIFICATION
31 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 3

FIG. 2

FIG. 2A	FIG. 2B

FIG. 2A

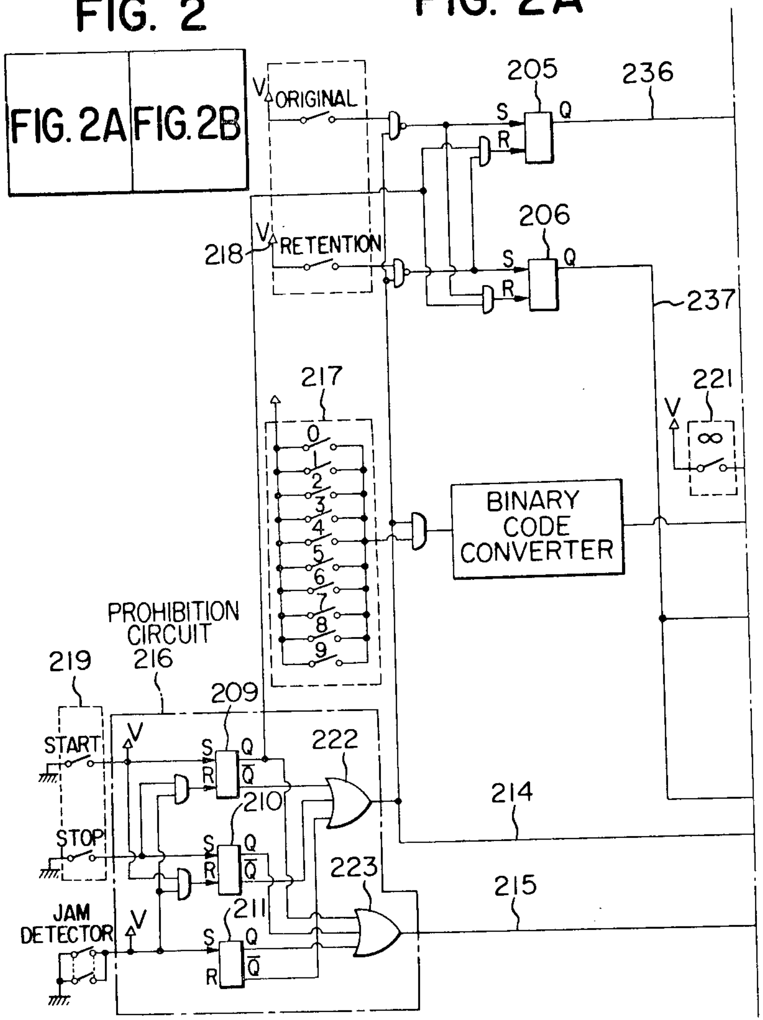
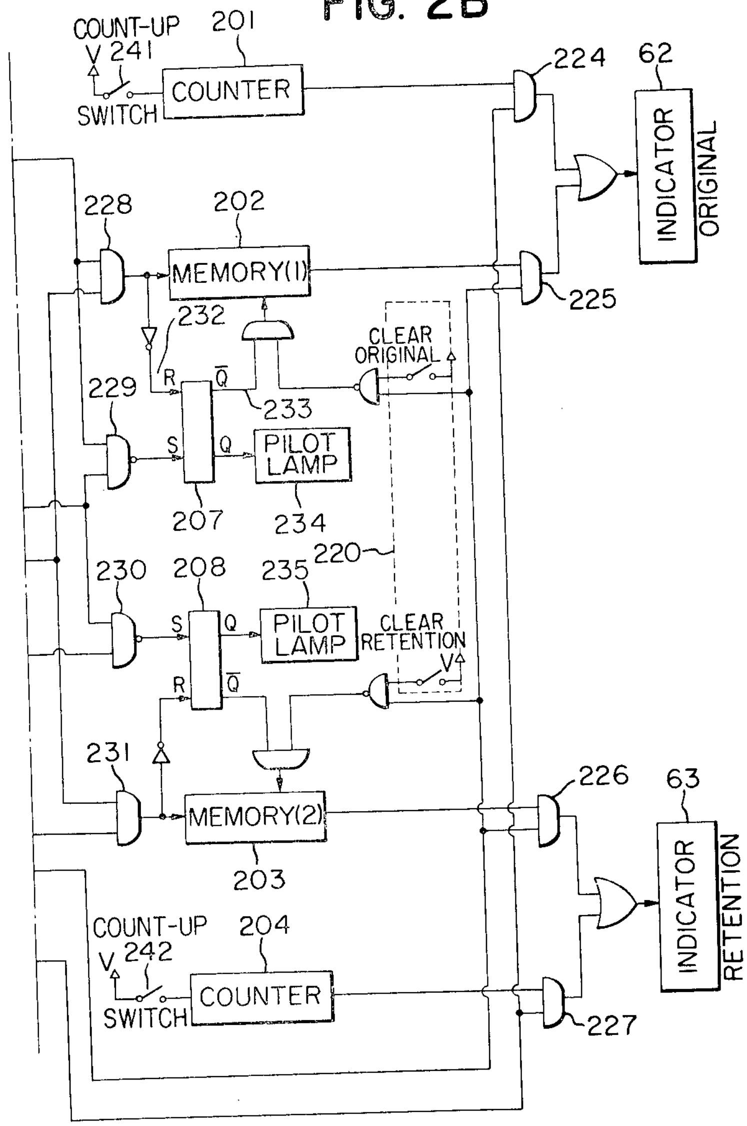


FIG. 2B


COUNT-UP
V 241
SWITCH
201
COUNTER
224
62
INDICATOR
ORIGINAL
228
202
MEMORY(1)
225
232
CLEAR
ORIGINAL
R
Q̄
233
229
S
Q
PILOT
LAMP
207
234
220
230
208
235
S
Q
PILOT
LAMP
CLEAR
RETENTION
V
R
Q̄
231
MEMORY(2)
226
63
203
INDICATOR
RETENTION
COUNT-UP
204
V 242
COUNTER
SWITCH
227

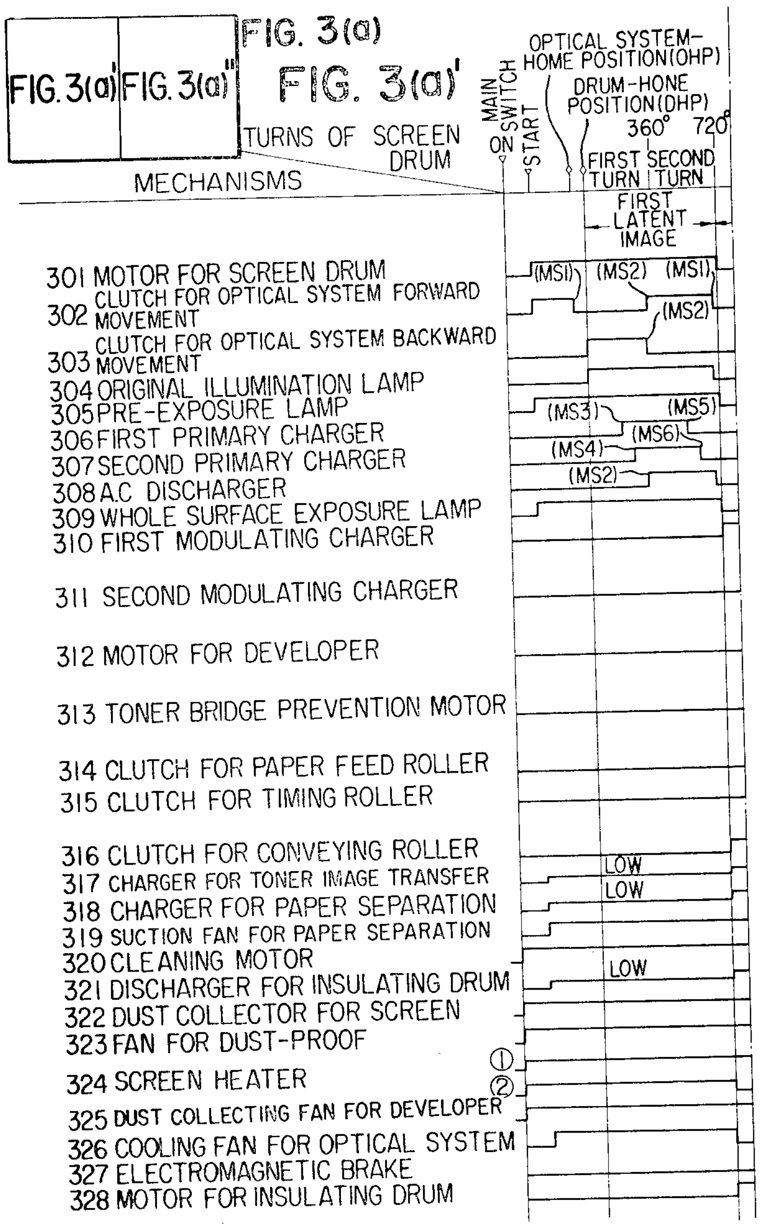


FIG. 3(a)'
FIG. 3(a)''
FIG. 3(a)
FIG. 3(a)'
TURNS OF SCREEN DRUM
MECHANISMS
MAIN SWITCH ON
START
OPTICAL SYSTEM-HOME POSITION(OHP)
DRUM-HONE POSITION(DHP)
360°
720°
FIRST TURN
SECOND TURN
FIRST LATENT IMAGE
301 MOTOR FOR SCREEN DRUM
302 CLUTCH FOR OPTICAL SYSTEM FORWARD MOVEMENT
303 CLUTCH FOR OPTICAL SYSTEM BACKWARD MOVEMENT
304 ORIGINAL ILLUMINATION LAMP
305 PRE-EXPOSURE LAMP
306 FIRST PRIMARY CHARGER
307 SECOND PRIMARY CHARGER
308 A.C DISCHARGER
309 WHOLE SURFACE EXPOSURE LAMP
310 FIRST MODULATING CHARGER
311 SECOND MODULATING CHARGER
312 MOTOR FOR DEVELOPER
313 TONER BRIDGE PREVENTION MOTOR
314 CLUTCH FOR PAPER FEED ROLLER
315 CLUTCH FOR TIMING ROLLER
316 CLUTCH FOR CONVEYING ROLLER
317 CHARGER FOR TONER IMAGE TRANSFER
318 CHARGER FOR PAPER SEPARATION
319 SUCTION FAN FOR PAPER SEPARATION
320 CLEANING MOTOR
321 DISCHARGER FOR INSULATING DRUM
322 DUST COLLECTOR FOR SCREEN
323 FAN FOR DUST-PROOF
324 SCREEN HEATER
325 DUST COLLECTING FAN FOR DEVELOPER
326 COOLING FAN FOR OPTICAL SYSTEM
327 ELECTROMAGNETIC BRAKE
328 MOTOR FOR INSULATING DRUM
(MS1)
(MS2)
(MS1)
(MS2)
(MS3)
(MS5)
(MS4)
(MS6)
(MS2)
LOW
LOW
LOW
①
②

FIG. 3(a)"

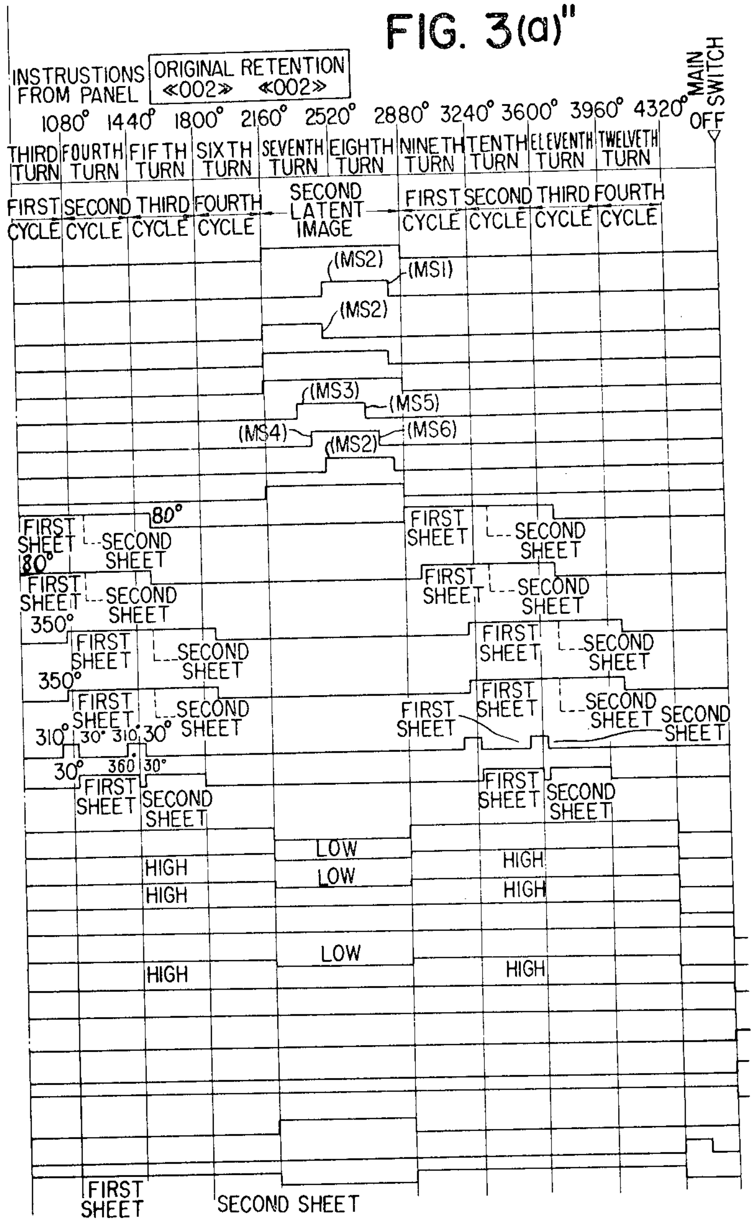

INSTRUSTIONS FROM PANEL
ORIGINAL RETENTION «002» «002»
1080° 1440° 1800° 2160° 2520° 2880° 3240° 3600° 3960° 4320°
MAIN SWITCH OFF
THIRD TURN
FOURTH TURN
FIFTH TURN
SIXTH TURN
SEVENTH TURN
EIGHTH TURN
NINETH TURN
TENTH TURN
ELEVENTH TURN
TWELVETH TURN
FIRST CYCLE
SECOND CYCLE
THIRD CYCLE
FOURTH CYCLE
SECOND LATENT IMAGE
FIRST CYCLE
SECOND CYCLE
THIRD CYCLE
FOURTH CYCLE
(MS2)
(MS1)
(MS2)
(MS3)
(MS5)
(MS4)
(MS2)
(MS6)
FIRST SHEET
SECOND SHEET
80°
FIRST SHEET
SECOND SHEET
FIRST SHEET
SECOND SHEET
FIRST SHEET
SECOND SHEET
350°
FIRST SHEET
SECOND SHEET
FIRST SHEET
SECOND SHEET
350°
FIRST SHEET
SECOND SHEET
FIRST SHEET
FIRST SHEET
SECOND SHEET
SECOND SHEET
310° 30° 310° 30°
30° 360 30°
FIRST SHEET
SECOND SHEET
FIRST SHEET
SECOND SHEET
LOW
HIGH
LOW
HIGH
HIGH
HIGH
LOW
HIGH
HIGH
FIRST SHEET
SECOND SHEET

FIG. 3(b)'

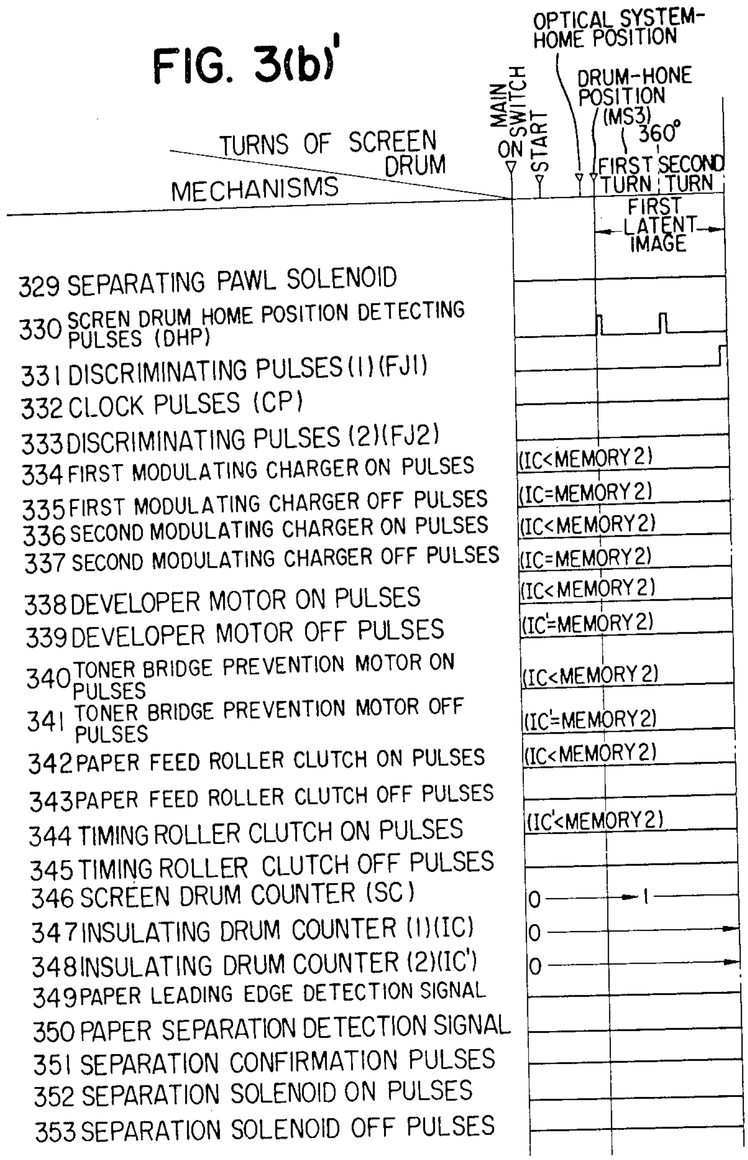

OPTICAL SYSTEM-HOME POSITION
MAIN SWITCH ON
START
DRUM-HONE POSITION (MS3)
360°
FIRST TURN
SECOND TURN
FIRST LATENT IMAGE
TURNS OF SCREEN DRUM
MECHANISMS
329 SEPARATING PAWL SOLENOID
330 SCREN DRUM HOME POSITION DETECTING PULSES (DHP)
331 DISCRIMINATING PULSES (1) (FJ1)
332 CLOCK PULSES (CP)
333 DISCRIMINATING PULSES (2)(FJ2)
334 FIRST MODULATING CHARGER ON PULSES
335 FIRST MODULATING CHARGER OFF PULSES
336 SECOND MODULATING CHARGER ON PULSES
337 SECOND MODULATING CHARGER OFF PULSES
338 DEVELOPER MOTOR ON PULSES
339 DEVELOPER MOTOR OFF PULSES
340 TONER BRIDGE PREVENTION MOTOR ON PULSES
341 TONER BRIDGE PREVENTION MOTOR OFF PULSES
342 PAPER FEED ROLLER CLUTCH ON PULSES
343 PAPER FEED ROLLER CLUTCH OFF PULSES
344 TIMING ROLLER CLUTCH ON PULSES
345 TIMING ROLLER CLUTCH OFF PULSES
346 SCREEN DRUM COUNTER (SC)
347 INSULATING DRUM COUNTER (1)(IC)
348 INSULATING DRUM COUNTER (2)(IC')
349 PAPER LEADING EDGE DETECTION SIGNAL
350 PAPER SEPARATION DETECTION SIGNAL
351 SEPARATION CONFIRMATION PULSES
352 SEPARATION SOLENOID ON PULSES
353 SEPARATION SOLENOID OFF PULSES
(IC<MEMORY 2)
(IC=MEMORY 2)
(IC<MEMORY 2)
(IC=MEMORY 2)
(IC<MEMORY 2)
(IC'=MEMORY 2)
(IC<MEMORY 2)
(IC'=MEMORY 2)
(IC<MEMORY 2)
(IC'<MEMORY 2)
0
1
0
0

FIG. 3(b)

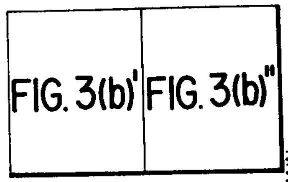


FIG. 3(b)'
FIG. 3(b)"

FIG. 3(b)"

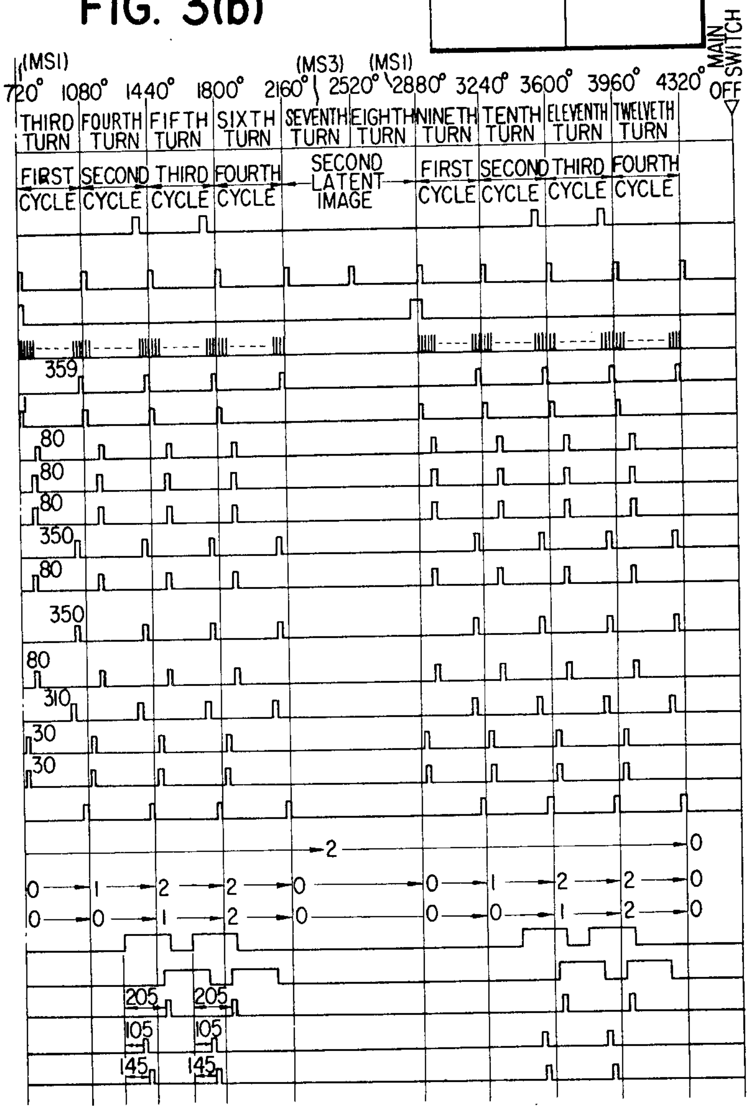

(MS1)
(MS3)
(MS1)
720° 1080° 1440° 1800° 2160° 2520° 2880° 3240° 3600° 3960° 4320°
MAIN SWITCH OFF
THIRD TURN
FOURTH TURN
FIFTH TURN
SIXTH TURN
SEVENTH TURN
EIGHTH TURN
NINETH TURN
TENTH TURN
ELEVENTH TURN
TWELVETH TURN
FIRST CYCLE
SECOND CYCLE
THIRD CYCLE
FOURTH CYCLE
SECOND LATENT IMAGE
FIRST CYCLE
SECOND CYCLE
THIRD CYCLE
FOURTH CYCLE
359
80
80
80
350
80
350
80
310
30
30
2
0
0 1 2 2 0 0 1 2 2 0
0 0 1 2 0 0 0 1 2 0
205
205
105
105
145
145

FIG. 4A

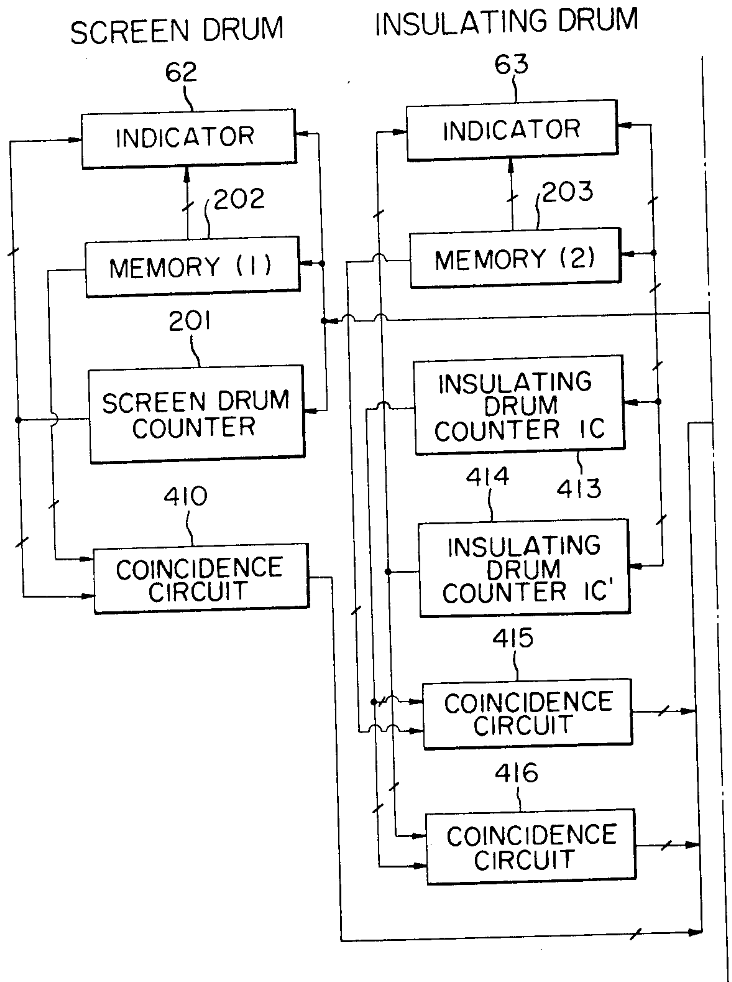

SCREEN DRUM
INSULATING DRUM
62
INDICATOR
202
MEMORY (1)
201
SCREEN DRUM COUNTER
410
COINCIDENCE CIRCUIT
63
INDICATOR
203
MEMORY (2)
INSULATING DRUM COUNTER IC
414
413
INSULATING DRUM COUNTER IC'
415
COINCIDENCE CIRCUIT
416
COINCIDENCE CIRCUIT

FIG. 4B

CONTROL BLOCK DIAGRAM

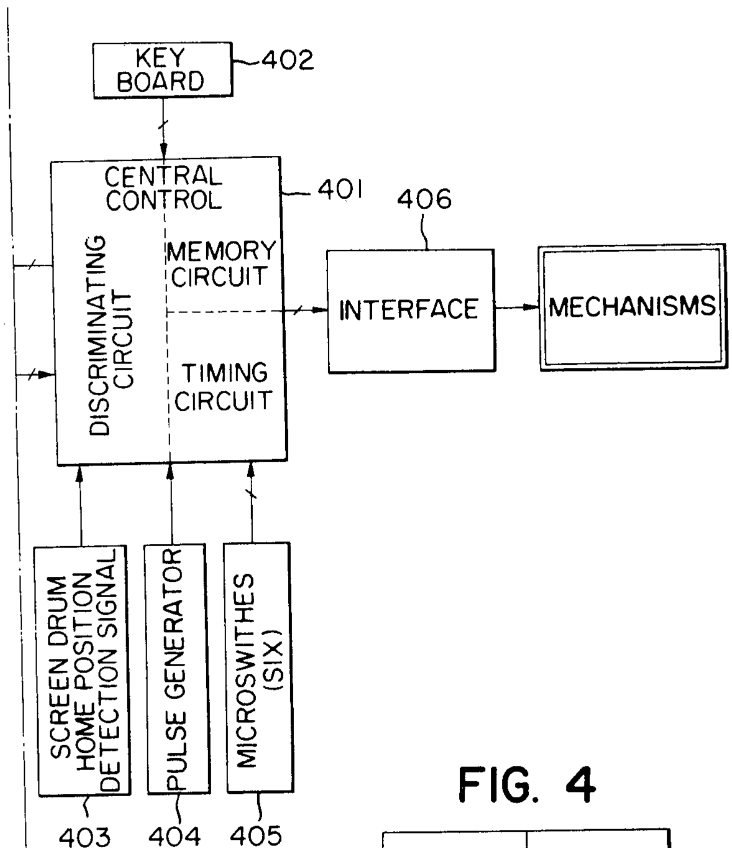


FIG. 4

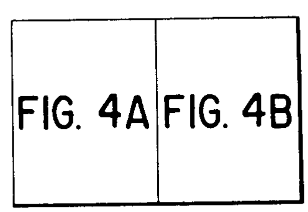


FIG. 5

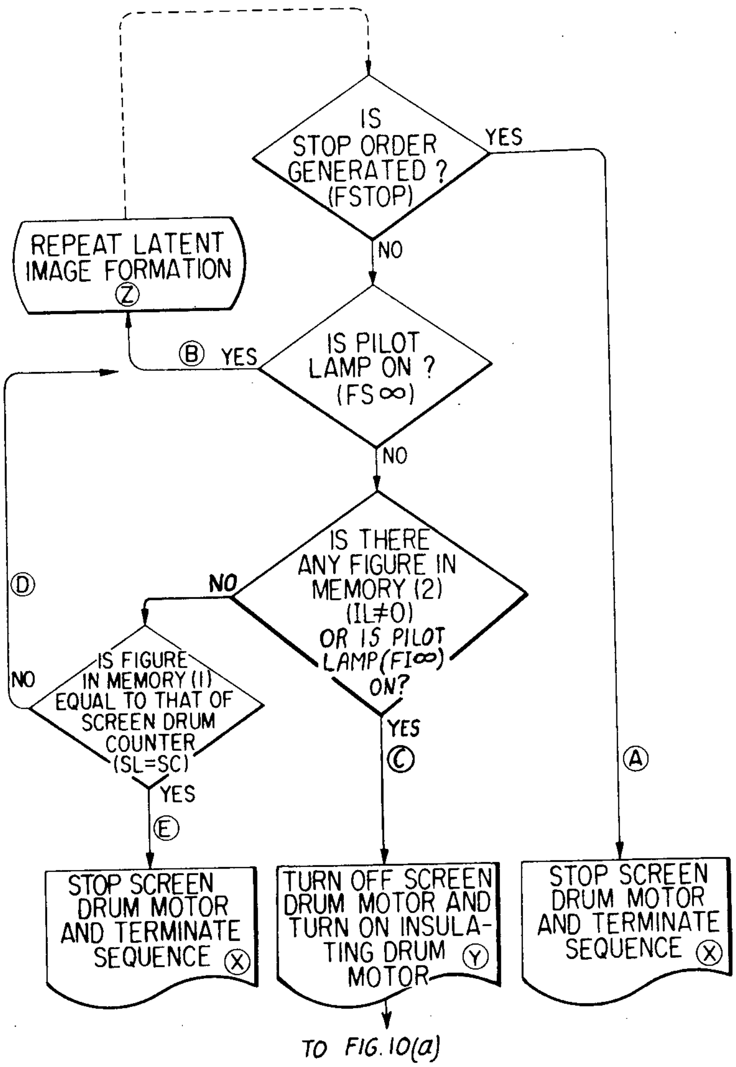
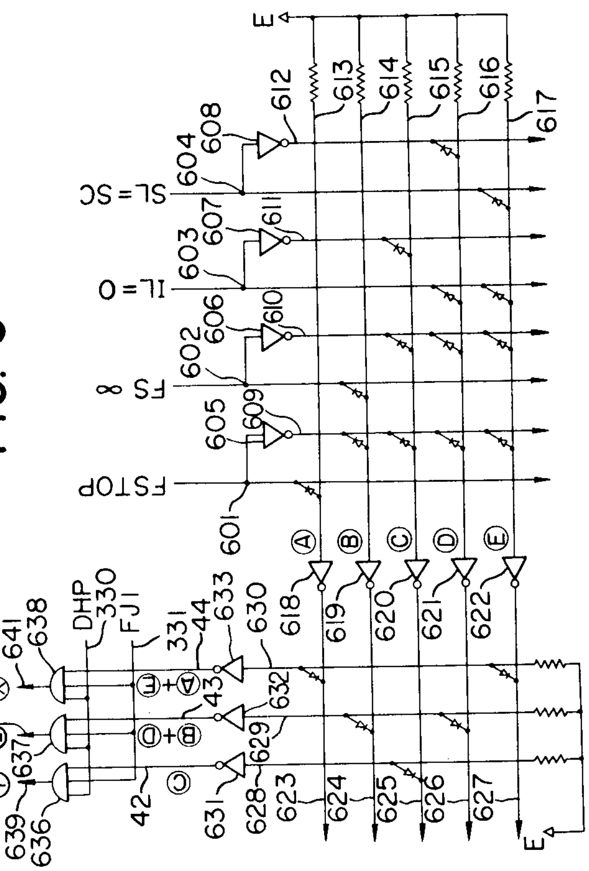

IS STOP ORDER GENERATED ? (FSTOP)
YES
NO
REPEAT LATENT IMAGE FORMATION Ⓩ
Ⓑ YES
IS PILOT LAMP ON ? (FS∞)
NO
IS THERE ANY FIGURE IN MEMORY (2) (IL≠0) OR IS PILOT LAMP(FI∞) ON?
NO
Ⓓ
NO
IS FIGURE IN MEMORY (1) EQUAL TO THAT OF SCREEN DRUM COUNTER (SL=SC)
YES
Ⓔ
YES
Ⓒ
Ⓐ
STOP SCREEN DRUM MOTOR AND TERMINATE SEQUENCE Ⓧ
TURN OFF SCREEN DRUM MOTOR AND TURN ON INSULATING DRUM MOTOR Ⓨ
STOP SCREEN DRUM MOTOR AND TERMINATE SEQUENCE Ⓧ
TO FIG. 10(a)

FIG. 6



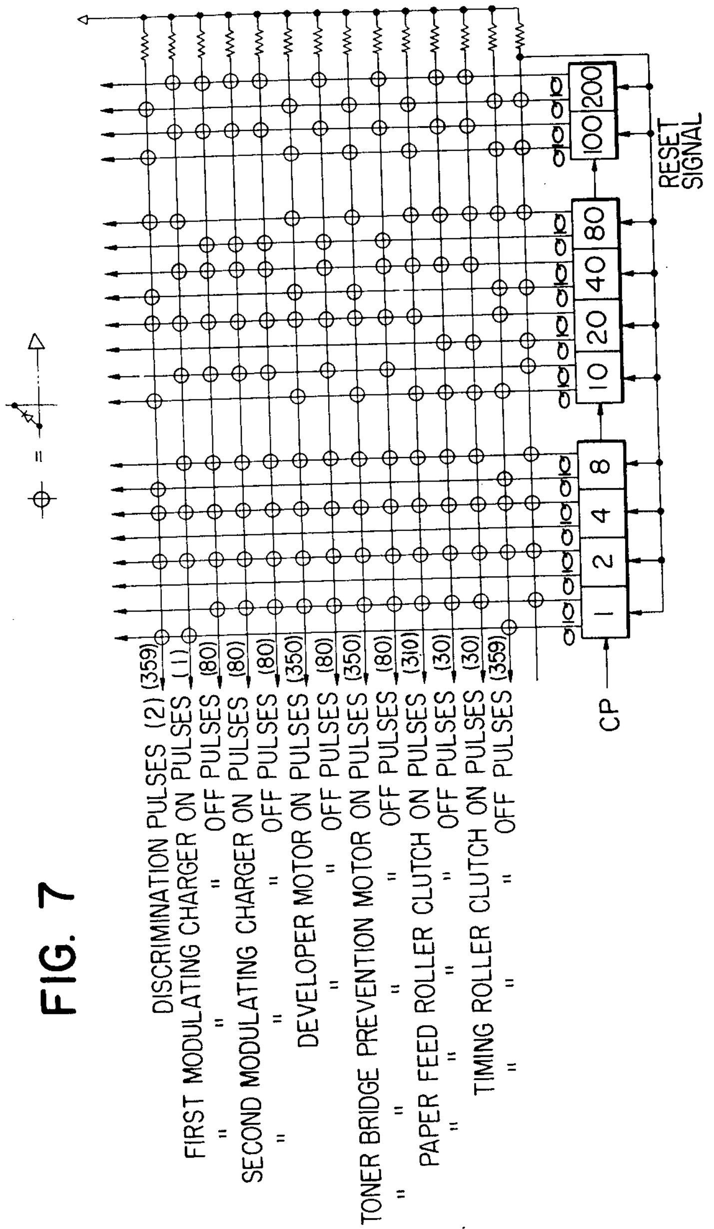

DISCRIMINATION PULSES (2) (359)
FIRST MODULATING CHARGER ON PULSES (1)
" " OFF PULSES (80)
SECOND MODULATING CHARGER ON PULSES (80)
" " OFF PULSES (80)
DEVELOPER MOTOR ON PULSES (350)
" OFF PULSES (80)
TONER BRIDGE PREVENTION MOTOR ON PULSES (350)
" " OFF PULSES (80)
PAPER FEED ROLLER CLUTCH ON PULSES (310)
" " OFF PULSES (30)
TIMING ROLLER CLUTCH ON PULSES (30)
" " OFF PULSES (359)
CP
1
2
4
8
10
20
40
80
100
200
RESET SIGNAL

FIG. 7

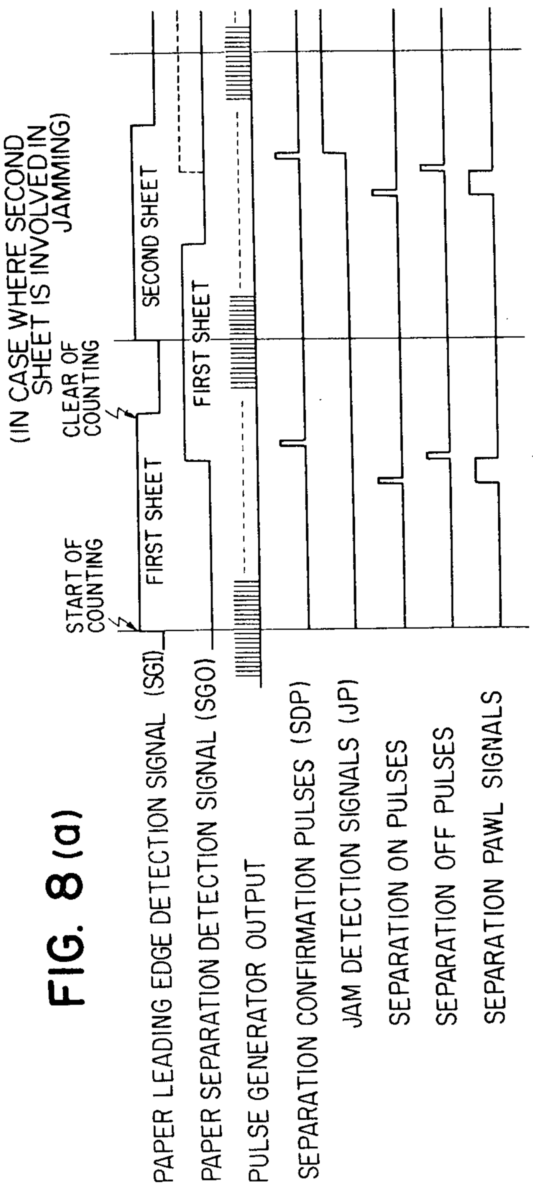

(IN CASE WHERE SECOND SHEET IS INVOLVED IN JAMMING)
START OF COUNTING
CLEAR OF COUNTING
FIRST SHEET
SECOND SHEET
FIRST SHEET
PAPER LEADING EDGE DETECTION SIGNAL (SGI)
PAPER SEPARATION DETECTION SIGNAL (SGO)
PULSE GENERATOR OUTPUT
SEPARATION CONFIRMATION PULSES (SDP)
JAM DETECTION SIGNALS (JP)
SEPARATION ON PULSES
SEPARATION OFF PULSES
SEPARATION PAWL SIGNALS

FIG. 8 (a)

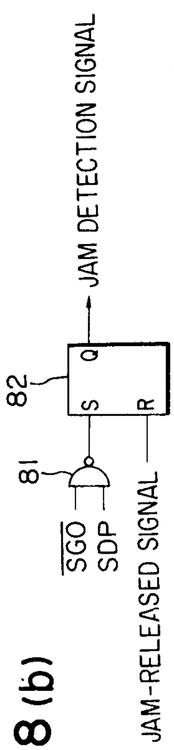

$\overline{SGO}$
SDP
81
82
S
Q
R
JAM DETECTION SIGNAL
JAM-RELEASED SIGNAL

FIG. 8 (b)

FIG. 9

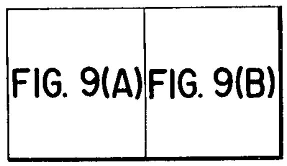


FIG. 9(A)
FIG. 9(B)

FIG. 9(A)

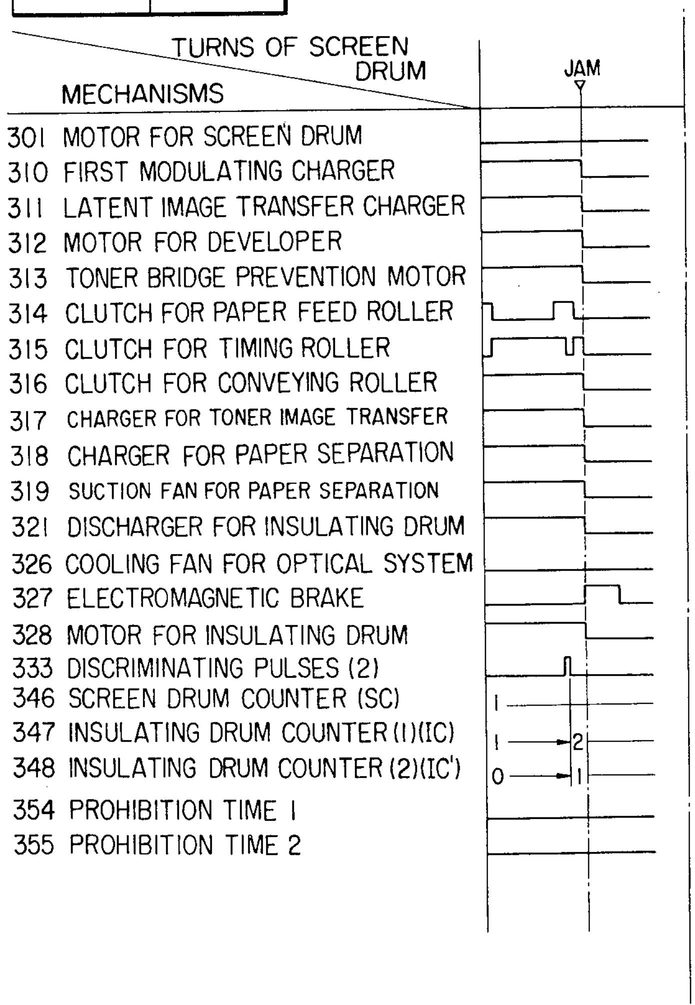
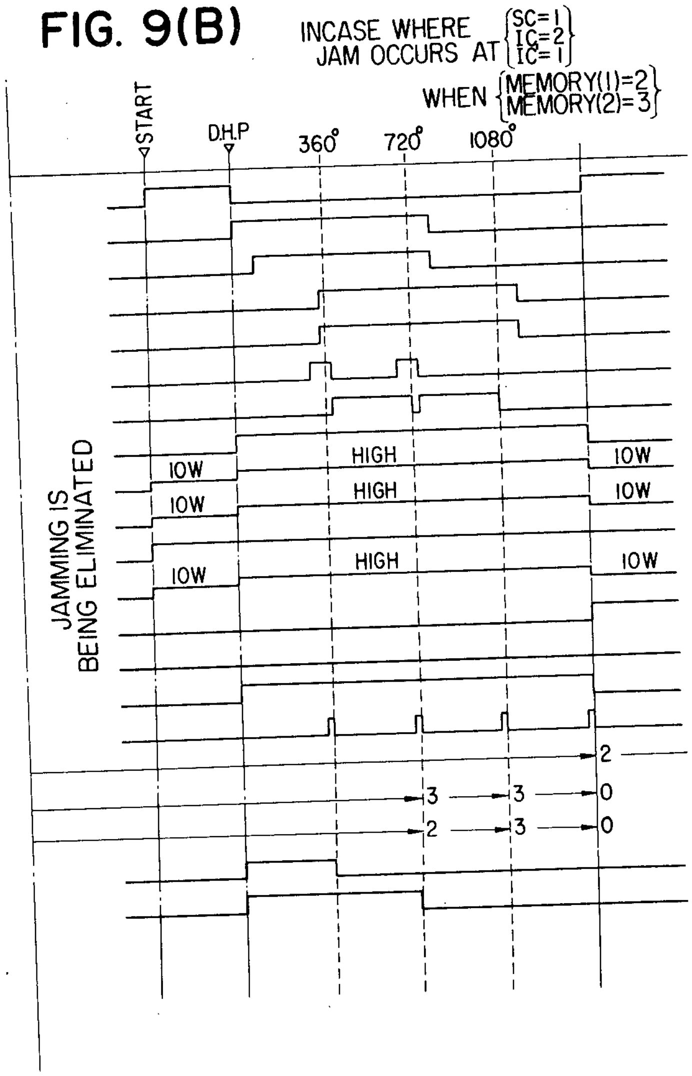

TURNS OF SCREEN DRUM
MECHANISMS
JAM
301 MOTOR FOR SCREEN DRUM
310 FIRST MODULATING CHARGER
311 LATENT IMAGE TRANSFER CHARGER
312 MOTOR FOR DEVELOPER
313 TONER BRIDGE PREVENTION MOTOR
314 CLUTCH FOR PAPER FEED ROLLER
315 CLUTCH FOR TIMING ROLLER
316 CLUTCH FOR CONVEYING ROLLER
317 CHARGER FOR TONER IMAGE TRANSFER
318 CHARGER FOR PAPER SEPARATION
319 SUCTION FAN FOR PAPER SEPARATION
321 DISCHARGER FOR INSULATING DRUM
326 COOLING FAN FOR OPTICAL SYSTEM
327 ELECTROMAGNETIC BRAKE
328 MOTOR FOR INSULATING DRUM
333 DISCRIMINATING PULSES (2)
346 SCREEN DRUM COUNTER (SC)
347 INSULATING DRUM COUNTER (1)(IC)
348 INSULATING DRUM COUNTER (2)(IC')
354 PROHIBITION TIME 1
355 PROHIBITION TIME 2
1
1
2
0
1

FIG. 9(B)


INCASE WHERE JAM OCCURS AT {SC=1, IC=2, IC=1}
WHEN {MEMORY(1)=2, MEMORY(2)=3}
START
D.H.P
360°
720°
1080°
JAMMING IS BEING ELIMINATED
IOW
HIGH
IOW
IOW
HIGH
IOW
IOW
HIGH
IOW
2
3
3
0
2
3
0

1577217 COMPLETE SPECIFICATION

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

Sheet 17

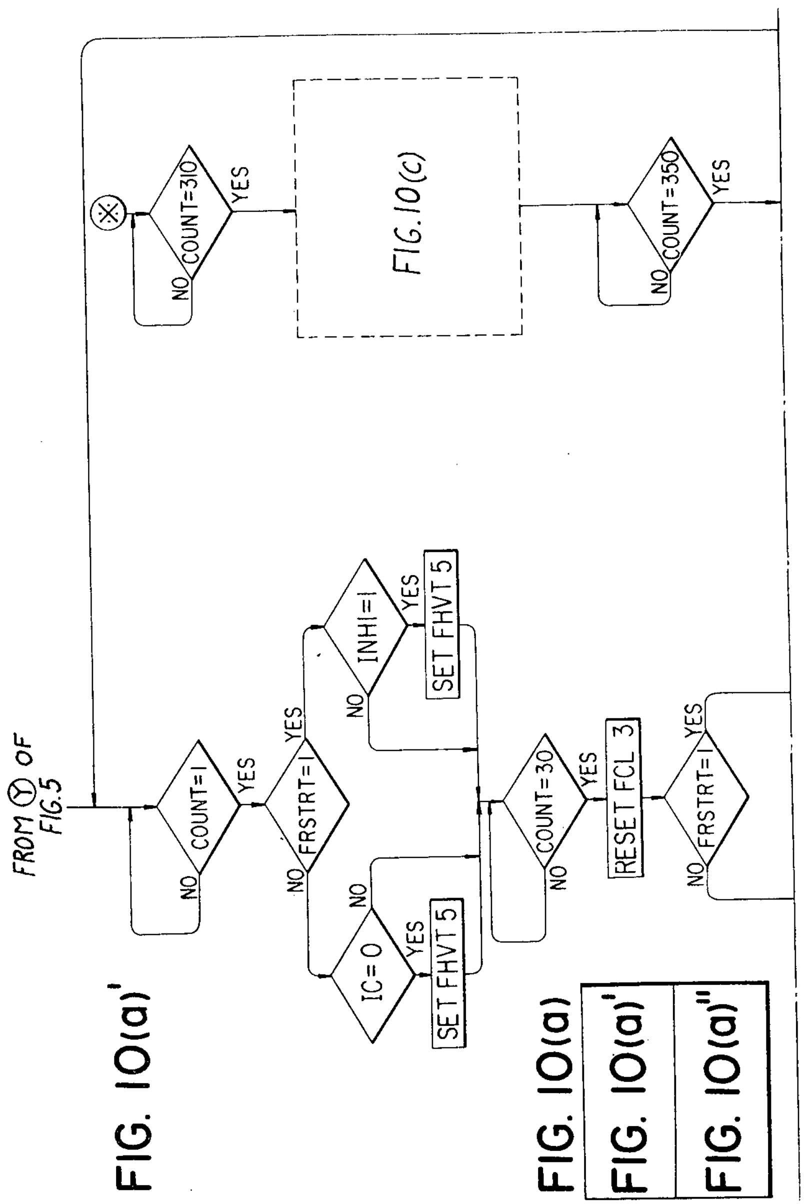


FIG. 10(a)'

FIG. 10(a)

FIG. 10(a)'
FIG. 10(a)''

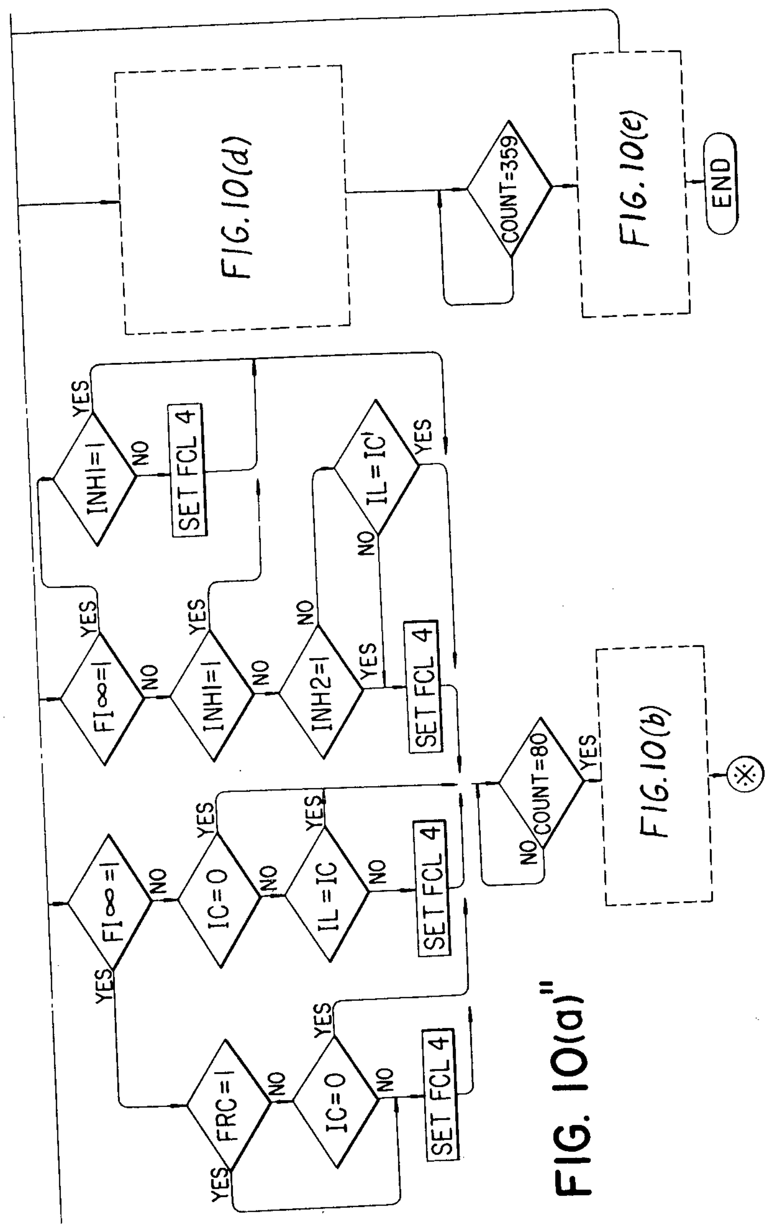


FIG. 10(d)
COUNT=359
FIG. 10(e)
END
INH1=1
YES
NO
SET FCL 4
IL=IC'
YES
NO
FI∞=1
YES
NO
INH1=1
YES
NO
INH2=1
NO
YES
SET FCL 4
COUNT=80
YES
NO
FIG. 10(b)
※
FI∞=1
NO
YES
IC=0
YES
NO
IL=IC
YES
NO
SET FCL 4
FRC=1
YES
NO
IC=0
YES
NO
SET FCL 4

FIG. 10(a)"

FIG. 10(b)

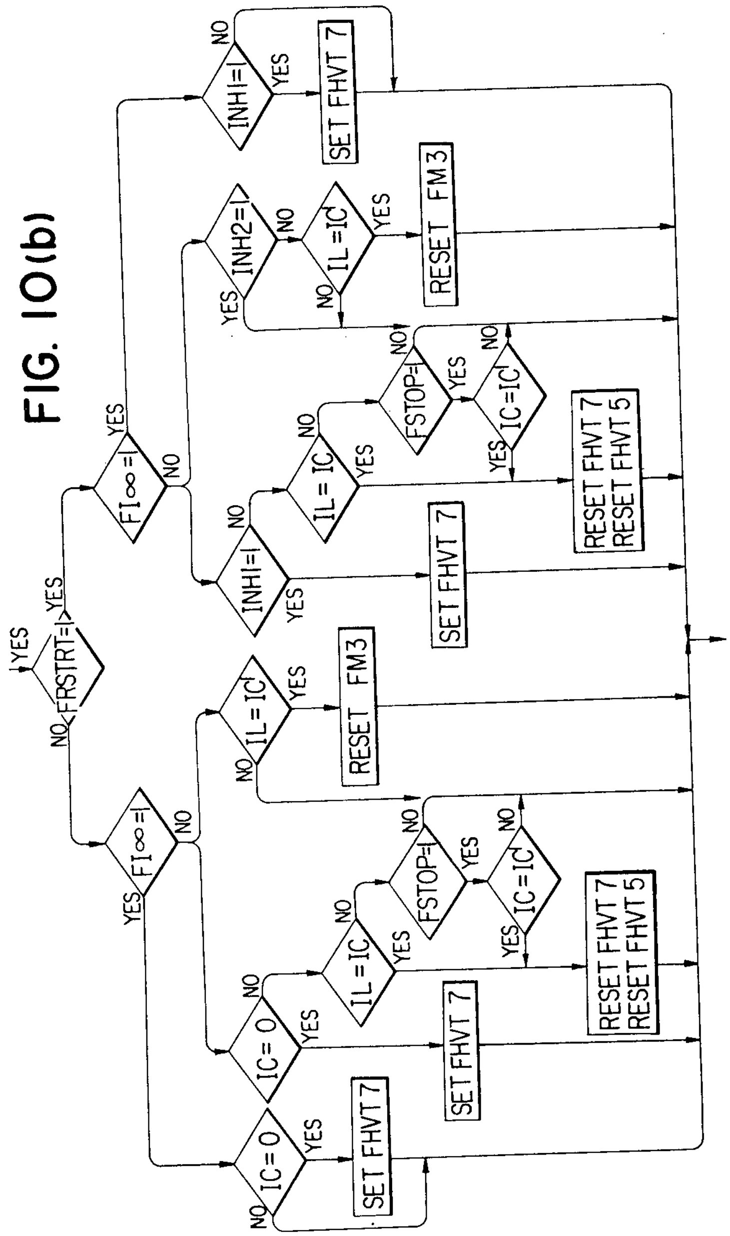

FRSTRT=1
FI∞=1
INH1=1
SET FHVT 7
INH2=1
IL=IC
RESET FM3
FSTOP=1
IC=IC
RESET FHVT 7
RESET FHVT 5
IC=0
YES
NO

FIG. 10(c)

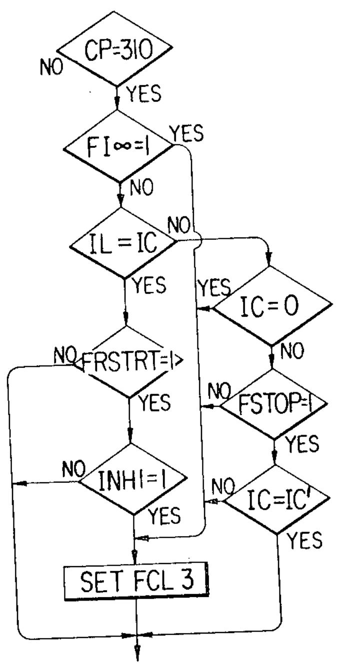


FIG. 10(d)

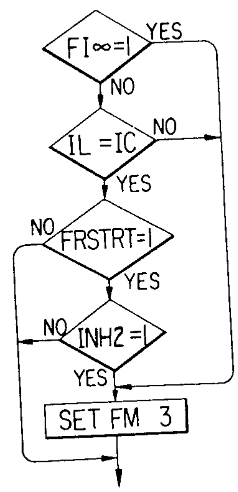
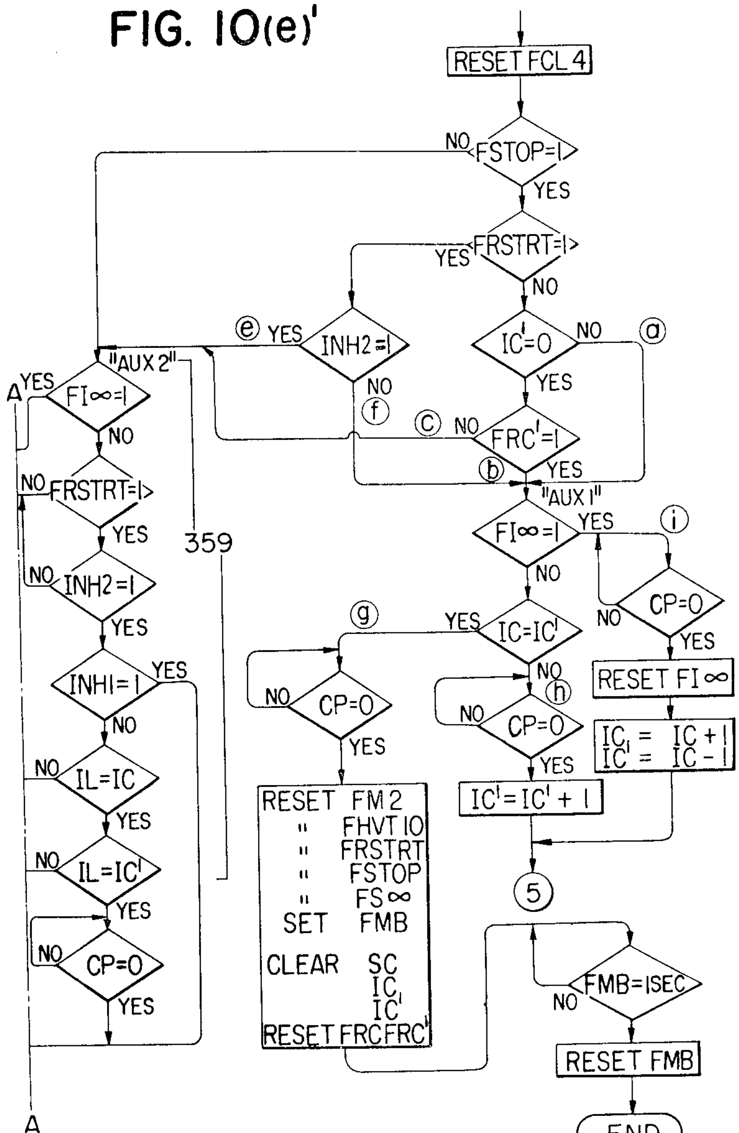


FIG. 10(e)'


RESET FCL 4
FSTOP=1
NO
YES
FRSTRT=1
YES
NO
INH2=1
IC'=0
"AUX 2"
FI∞=1
FRC'=1
"AUX 1"
FRSTRT=1
INH2=1
INH1=1
IL=IC
IL=IC'
CP=0
359
IC=IC'
CP=0
RESET FM 2
FHVT 10
FRSTRT
FSTOP
FS∞
SET FMB
CLEAR SC
IC,
IC'
RESET FRC FRC'
IC'=IC'+1
RESET FI∞
IC, = IC+1
IC' = IC-1
5
FMB=1SEC
RESET FMB
END
A

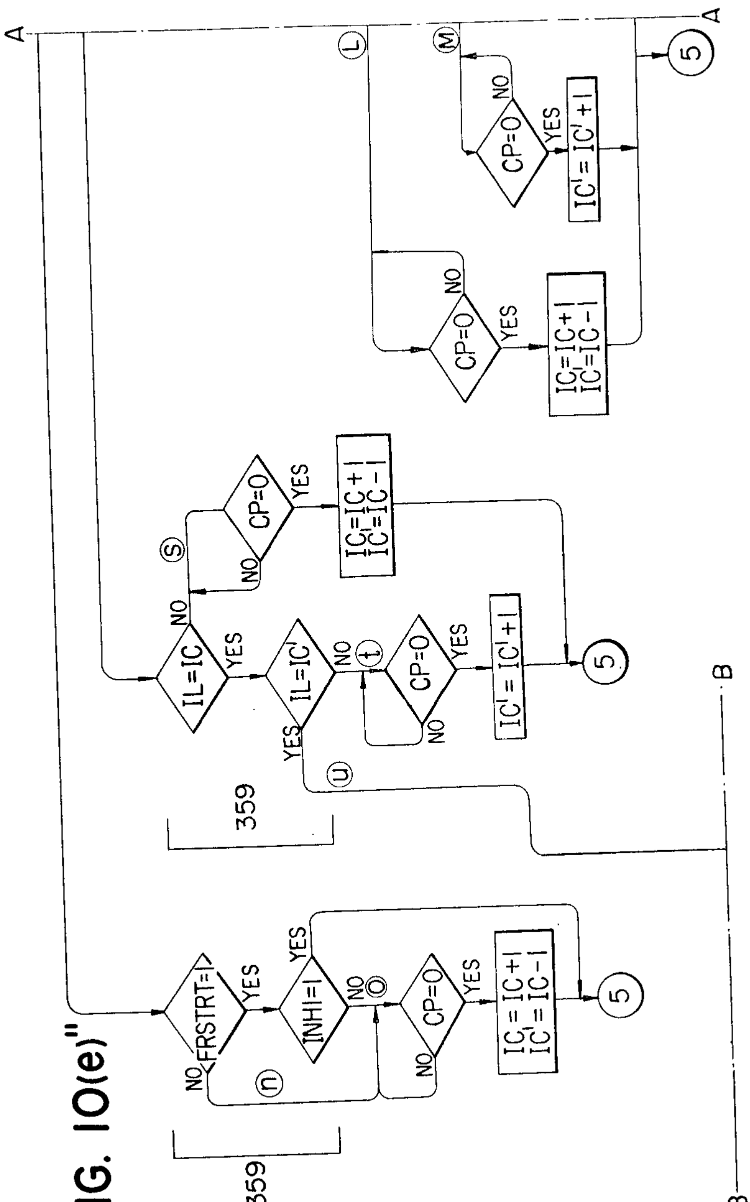
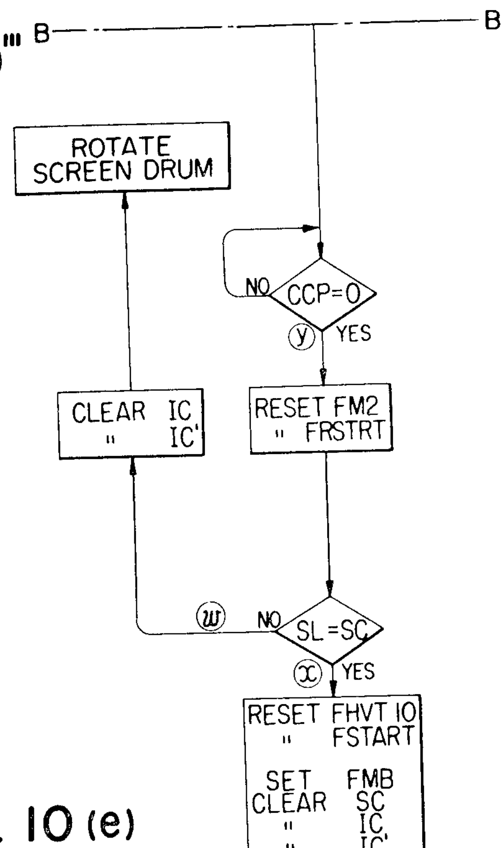

A
A
B
B
FRSTRT=1
YES
NO
INHI=1
YES
NO
CP=0
YES
NO
IC = IC+1
IC' = IC-1
5
359
359
n
o
IL=IC
YES
NO
IL=IC'
YES
NO
S
t
u
CP=0
YES
NO
IC=IC+1
IC'=IC-1
CP=0
YES
NO
IC' = IC'+1
5
L
M
CP=0
YES
NO
IC=IC+1
IC'=IC-1
CP=0
YES
NO
IC' = IC'+1
5

FIG. 10(e)"

FIG. 10(e)'''



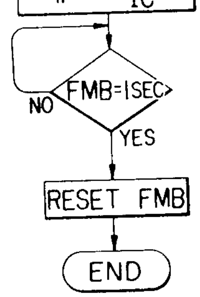


FIG. 10 (e)

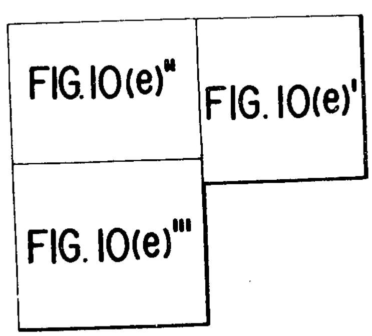


FIG. 11

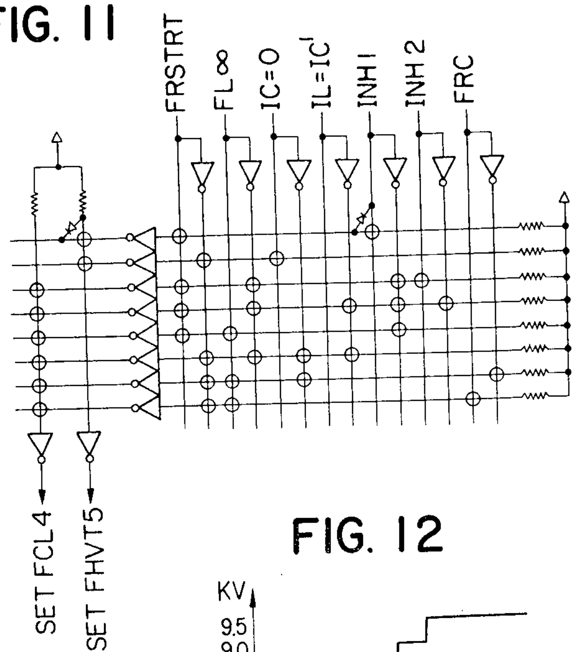


FIG. 12

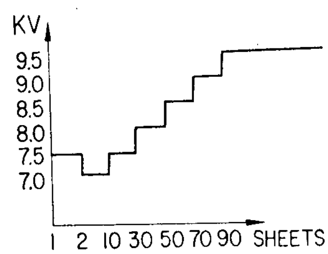


FIG. 13

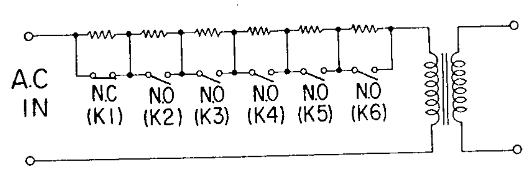


FIG. 14

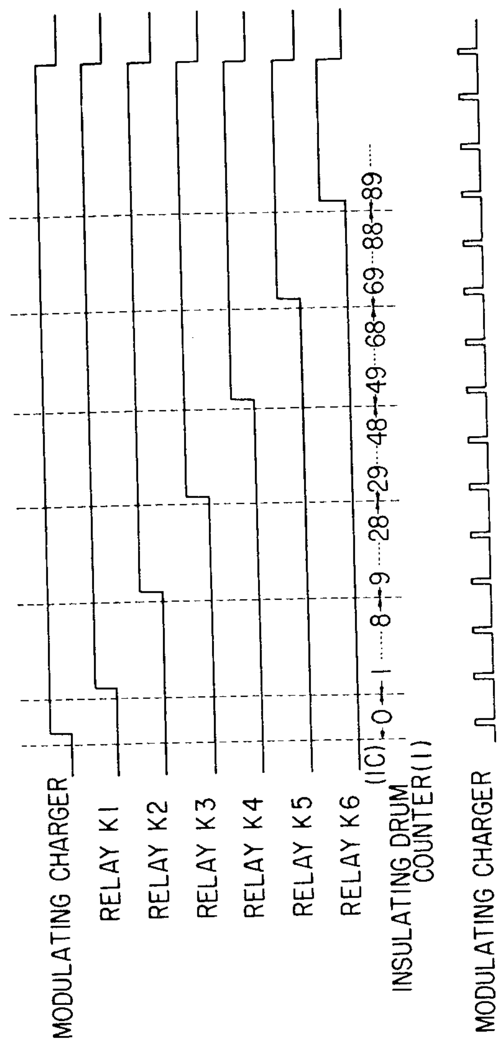
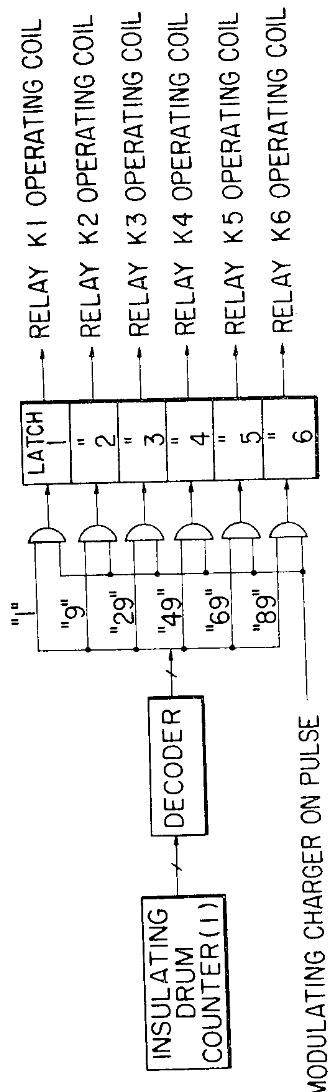

MODULATING CHARGER
RELAY K1
RELAY K2
RELAY K3
RELAY K4
RELAY K5
RELAY K6
INSULATING DRUM COUNTER(1)
(IC) 0 1 8 9 28 29 48 49 68 69 88 89
MODULATING CHARGER

FIG. 15


INSULATING DRUM COUNTER (1)
DECODER
"1"
"9"
"29"
"49"
"69"
"89"
MODULATING CHARGER ON PULSE
LATCH 1
" 2
" 3
" 4
" 5
" 6
RELAY K1 OPERATING COIL
RELAY K2 OPERATING COIL
RELAY K3 OPERATING COIL
RELAY K4 OPERATING COIL
RELAY K5 OPERATING COIL
RELAY K6 OPERATING COIL

1577217 COMPLETE SPECIFICATION

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

Sheet 27

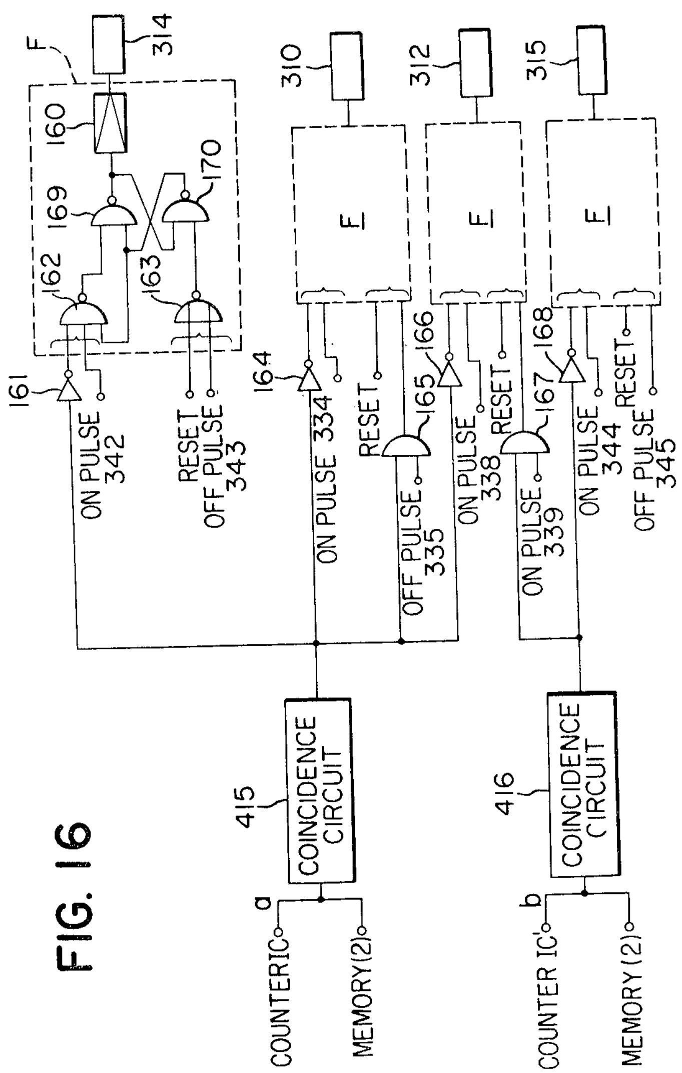


FIG. 16

1577217 COMPLETE SPECIFICATION

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

Sheet 28

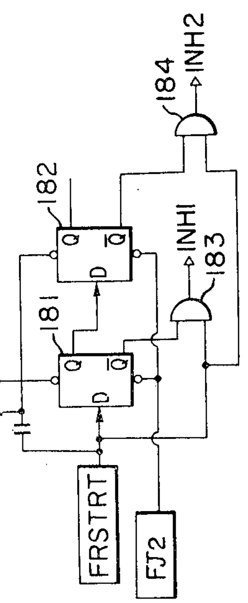
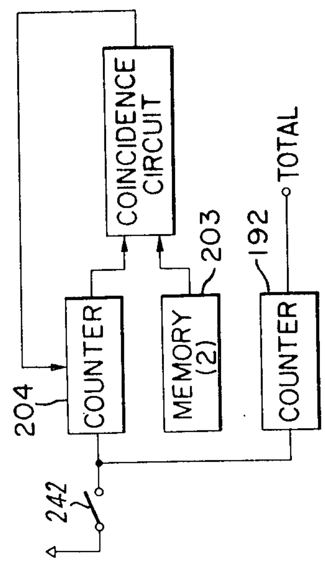


FIG. 18



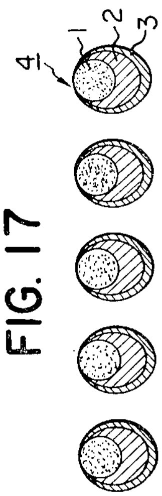


FIG. 17

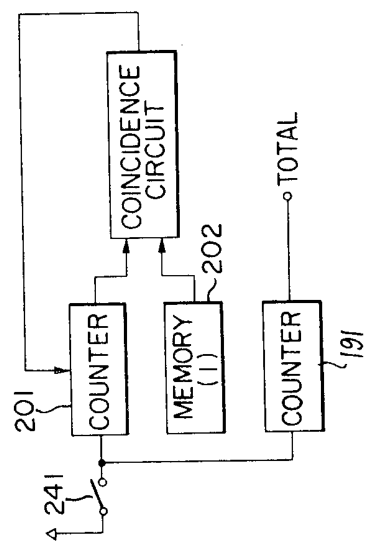


FIG. 19

FIG. 20

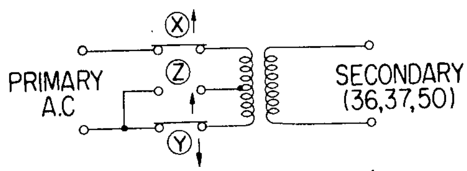

PRIMARY
A.C
SECONDARY
(36,37,50)

FIG. 21

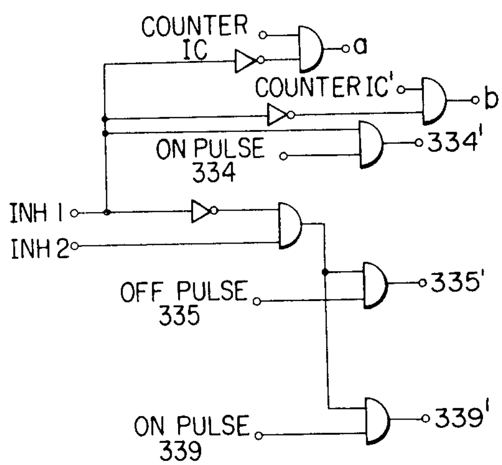

COUNTER
IC
a
COUNTER IC'
b
ON PULSE
334
334'
INH 1
INH 2
OFF PULSE
335
335'
ON PULSE
339
339'

FIG. 22(a)

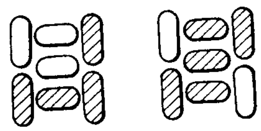


FIG. 22(b)

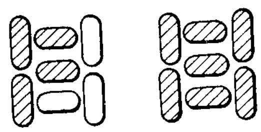


FIG. 22(c)

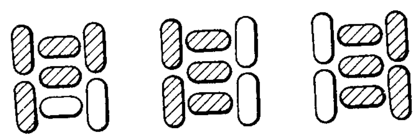


FIG. 22(d)

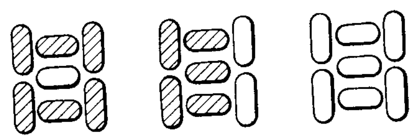


FIG. 22(e)

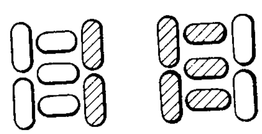
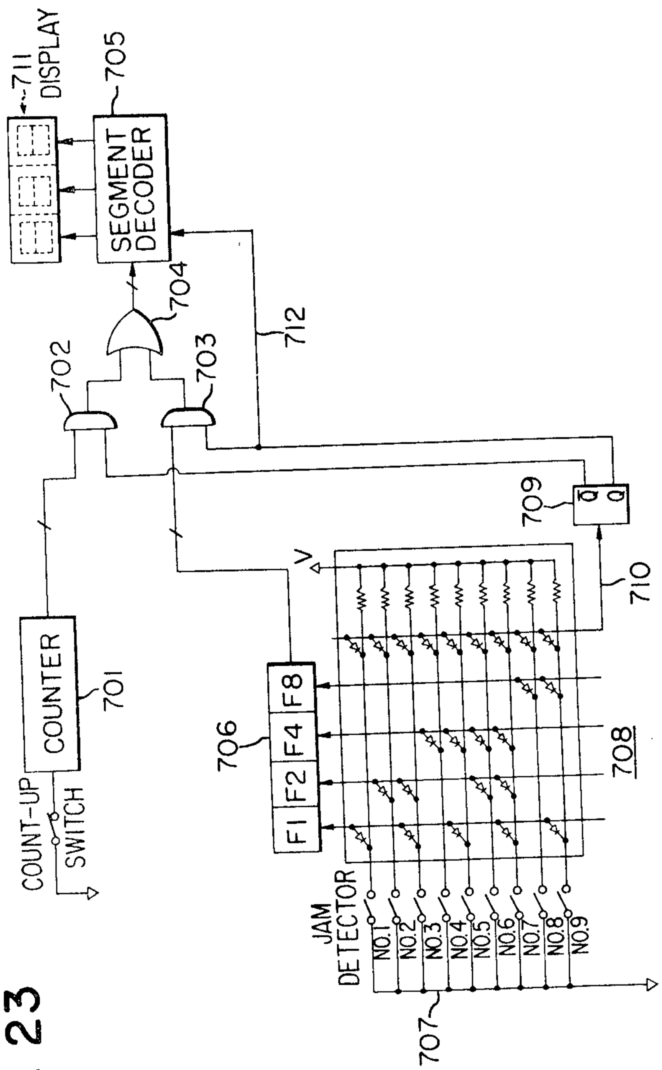


FIG. 23


711
DISPLAY
705
SEGMENT DECODER
704
702
703
712
COUNT-UP SWITCH
COUNTER
701
709
710
V
706
F1
F2
F4
F8
708
JAM DETECTOR
NO.1
NO.2
NO.3
NO.4
NO.5
NO.6
NO.7
NO.8
NO.9
707