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(54) RECORDING APPARATUS

(71) We, CANON KABUSHIKI KAISHA, a Japanese Company of 30-2, 3-chome, Shimomaruko, Ohtaku, 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 a recording apparatus which is particularly but not exclusively applicable as a print out device for use with data processing apparatus such as an electronic computer.

Heretofore, mechanical impact printers have often been used as the output devices for electronic computers. Recent developments in electronics have often been used as the output devices for electronic computers. Recent developments in electronics have led to a general improvement in operational and storage capacity in computers, and this has in turn led to the desire for output printers which will excel the known mechanical impact printers in performance. Accordingly, various non-impact printers have been proposed and among these, the so-called transfer type electrostatic recording or electrophotographic recording system is preferred because of its high printing speed, high printing quality and low running cost. In such a system, the output information from an electronic computer is used to form an electrostatic latent image on an image carrier, such as a photosensitive medium, the electrostatic latent image is developed into a visible image using a toner developer, the visible image is transferred onto plain paper and then fixed, and the paper is discharged from the apparatus as the computer output. The operation of this system is satisfactory provided the output information is continuous, but when the output of information, and/or the printing of the information is intermittent the output paper would have unprinted portions corresponding to the intermissions if the feed of the transfer paper is continuous.

Also, if the feed of the transfer paper is stopped when the output of information to be printed is interrupted and a transfer charger is maintained operative while the paper feed is at a halt, the transfer paper may be stained or the image thereon may be disturbed.

Further, when the fixation of the image on the transfer paper is carried out by heat-fixing means (a heat roller, a radiant heating lamp, a heat plate or the like), the transfer paper may be broken or burnt if it passes intermittently through continuously operating fixing means.

Furthermore, if the paper conveyance and the image transfer operation take place intermittently but the run-up, or run down response times of the conveyance means are long, the images may suffer from misregistration. Furthermore, if the response of the transfer corona or of a contact roller at the transfer position is sluggish, unsatisfactory image transfer will occur. Figure 1 of the accompanying drawings illustrates one effect of unsatisfactory image transfer onto the transfer paper P1. It will be seen from this figure that image transfer cannot take place in the trailing portion *a* of an image area, or in the leading end portion *b* of the next image area. The presence of such unrecorded or unclearly recorded areas as the leading and the trailing ends of images is particularly inconvenient if the transfer paper is fan-folded to receive developed images in a page-by-page manner.

According to the present invention there is provided a recording apparatus comprising:

a moveable image carrier;

image forming means for forming successive images on said image carrier;

feed means for intermittently feeding a continuous transfer medium through a transfer station;

transfer means operative at said transfer station for transferring said successive images from said image carrier onto successive portions of the transfer medium, said transfer means being operable to effect said transfer while an image-bearing portion of the image carrier and the transfer medium move at the same speed through said transfer station; and

control means for controlling the operation of said feed means and of said transfer means in response to the operation of the image forming means so that the mutual spacing of the images on the transfer medium is independent of the time intervals between successive operations of the image forming means;

wherein said feed means and said transfer means have different inherent actuating response times as hereinafter defined, and wherein the control means are operative to cause initiation of activation of the said feed means and transfer means after respective different delay periods following initiation of image formation in order to provide a predetermined time relationship between the attainment by said feed means and said transfer means of their respective fully active conditions.

As used herein the actuating response time of an actuable device is the time which elapses between the initiation of activation of the device and the time when the device attains its fully active condition.

The spaces between the successive images may accordingly be minimised by proper control of the feed and transfer means so as to reduce paper wastage and improve the characteristics of image transfer.

Where the feed means and transfer means also have different inherent deactuating response times the initiation of deactivation of the feed means and the transfer means is preferably effected by the control means also after respective different delay periods following termination of image formation in order to provide a predetermined time relationship between the attainment by said feed means and said transfer means of their respective fully inactive conditions.

As used herein, the deactuating response time of a device is the time which elapses between the initiation of deactivation of the device and the time when the device attains its fully inactive condition. Both the actuating and deactuating response times may differ significantly between the feed means and the transfer means.

An image fixing means for heat fixing the transferred images on the transfer medium may also be controlled by the control means in this manner in accordance with its own inherent delay characteristics.

In the described embodiment the image carrier is a rotatable photosensitive drum upon which an electrostatic latent image is formed by the image forming means and developed prior to the transfer operation. The timing of the delay periods prior to initiating actuation of the various aforesaid means may be achieved by counting pulses generated in accordance with the rotation of the drum, to provide predetermined synchronisation.

The image forming means may be a laser oscillator providing a modulated beam which scans the image carrier to form the images thereon.

Further reduction of wastage of the transfer medium may be achieved by reverse driving the medium a predetermined amount after completion of a transfer operation.

According to the present invention there is also provided a recording apparatus comprising:

a movable image carrier;

image forming means for forming successive images on said image carrier;

feed means for intermittently feeding a continuous transfer medium through a transfer station;

transfer means operative at said transfer station for transferring said successive images from said image carrier onto successive portions of the transfer medium, said transfer means being operable to effect said transfer while an image-bearing portion of the image carrier and the transfer medium move at the same speed through said transfer station; and

control means for controlling the operation of said feed means and of said transfer means in response to the operation of the image forming means so that the mutual spacing of the images on the transfer medium is independent of the time intervals between successive operations of the image forming means;

wherein said feed means and said transfer means have different inherent deactuating response times, as hereinbefore defined, and wherein the control means are operative to cause initiation of deactivation of the said feed means and transfer means after respective different delay periods following termination of image formation in order to provide a predetermined time relationship between the attainment by said feed means and said transfer means of their respective fully inactive conditions.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which:–

Figure 1 is a plan view of a recording medium showing images recorded thereon using apparatus according to the prior art;

Figure 2 is a schematic diagram illustrating a recording apparatus according to the present invention;

Figure 3 is a cross-sectional view of an image transfer station of the apparatus of Figure 2;

Figure 4 is a schematic diagram illustrating a feed mechanism for transfer medium;

Figure 5 is a cross-sectional view of a fixing device for fixing transferred images on

the transfer medium;

Figure 6 is a time chart illustrating the sequential operation of different elements of apparatus according to the present invention;

Figures 7 and 8 illustrate the inherent delay characteristics and the relative timing of the operation of feed, and image transfer elements at the start and end of an image transfer operation;

Figures 9 and 10 illustrate the inherent delay characteristics and the relative timing of the operation of the fixing elements at the start and end of an image transfer operation, and

Figures 11, 12, 13 and 14 diagrammatically show the electrical circuitry for producing control signals for controlling the operation of the elements in a recording apparatus according to the invention.

With reference to Figure 2, a laser beam 2 produced by a laser oscillator 1 is modulated by a modulator 3 which receives an input signal from an information output device 56. The modulated laser beam is scanned by a rotating polygonal mirror 4 and focused on a drum-shaped photosensitive medium 7 rotating clockwise (in Figure 2). Other means such as a cathode ray tube, plasma display, may be employed to effect exposure of the photosensitive medium to the image to be recorded.

Any of a variety of electrophotographic processes may be employed to record and develop the image. The present embodiments will be described with reference to a process disclosed in our Japanese Patent Publication No. 23910/1967.

The photosensitive medium 7, which basically comprises an electrically conductive back-up member, a photoconductive layer and an insulating surface layer, is uniformly precharged by a primary corona charger 8 and then exposed to the light image defined by the modulated laser beam while, at the same time, it is subjected to AC corona discharge by an AC corona discharger 9. The whole surface of the photosensitive medium 7 is then uniformly exposed to light from a whole surface exposure lamp 10, with the result that an electrostatic latent image corresponding to the aforementioned light image is formed on the surface of the photosensitive medium 7.

This electrostatic latent image is developed into a visible image by the use of a developer in a developing device 11 which developer is composed chiefly of electrically charged coloring particles (toner). The developed image is transferred to fan-folded paper 15 by the use of image transfer rollers 19, 21 and the electric field produced by an image transfer corona discharger 20, the fan-folded paper being a transfer medium conveyed by a tractor 16 having sprocket pins engageable with perforations formed in the transfer medium and by a first intermediate conveyor device 22 having a suction fan 32 and a porous belt 31. (The fan-folded paper 15 will hereinafter be referred to as transfer paper or simply as paper.)

Upon completion of transfer of the image from the photosensitive medium 7, that is, when the last part of the recorded image is transferred to the transfer paper, the image transfer rollers 19 and 21 are released and the corona discharge for image transfer is stopped. As soon as the transfer paper 15 is disengaged from the photosensitive medium 7, the tractor 16 starts reverse rotation. Thus, the transfer paper on the conveyor belt 31 is attracted by the suction fan 32 while a tension for advancing the transfer paper is imparted to the paper, whereby the transfer paper 15 is separated from the surface of the photosensitive medium. Since the backward tension imparted to the transfer paper by the reverse rotation of the tractor 16 is stronger, the transfer paper 15 is reverse driven by a sufficient amount to prevent any misregistration or any blur during the restart of copying operation, and stopped at that position. Thereafter, when another image recording cycle is effected on the photosensitive medium 7, the image transfer rollers 19 and 21 again urge the transfer paper 15 against the developed image on the photosensitive medium 7 and a voltage is applied to the image transfer corona discharger 20, whereby the newly developed image on the photosensitive medium 7 is transferred to the transfer paper 15 with the leading end of the new image continuous to the trailing end of the previously transferred image on the transfer paper 15, that is, the newly developed image on the photosensitive medium 7 is transferred to the transfer paper 15 as an image which is free of any misregistration at the region adjacent the previously transferred image or free of any blur.

Figure 3 is an enlarged view of the image transfer station. A first transfer roller 19 and a second transfer roller 21, both of which have their surfaces covered with insulative rubber, are positioned in proximity to the image transfer charger 20, and these rollers serve to prevent the image from being disturbed by the expanse of the corona charge. More particularly, they prevent toner scattering, and resultant image blurring which would be caused if the transfer field of the corona charge is applied before the paper is brought into contact with the photosensitive medium or after the paper is separated from the latter. Moreover by urging the transfer paper against the photosensitive medium, the transfer rollers 19 and 21 serve to eliminate the floating of the paper which would result in an unsatis-

factory image transfer effect, especially, in a case where the transfer paper is fan-folded paper having perforated portions which tend to float with respect to the photosensitive medium to induce such unsatisfactory image transfer effect, and thus serve to ensure that stable and uniform image transfer is accomplished.

On the other hand, during non-transfer time, the first 19 and the second transfer roller 21 are retracted to the phantom-line position by a first 29 and a second plunger 30 to release the pressure contact of the transfer paper 15 with the photosensitive medium 7. At the same time, an upper guide plate 28 incorporated in the same base plate, not shown, on which the first transfer roller 19 is mounted, is moved in a direction to separate the transfer paper 15 from the photosensitive medium 7, upon release of the first plunger 29, thereby ensuring the separation of the transfer paper 15 from the photosensitive medium.

Figure 4 illustrates the mechanism for conveying and reverse driving the transfer paper. In Figure 4, the photosensitive drum 7 is driven from a drive motor 33 through pulleys 40, 41, timing belt (or chain) 44 and gears 46, 47. The drive motor 33 also cooperates with pulleys 42, 43, timing belt 45, transfer paper conveyance clutch (such as micropowder clutch) 37 and tractor 16 to convey the transfer paper 15. The transfer paper 15 is conveyed in synchronism with the photosensitive drum 7 by the operation of the clutch 37 controlled in accordance with a pulse signal generated by a rotary encoder 35, which will later be described. On the other hand, upon completion of image transfer, the conveyance clutch 37 is released and a reversing clutch 38 is electrically energized to permit the drive of a paper returning motor 34 to be transmitted through gears 50, 51, 52, 53 to reverse the movement of the tractor 16, thus returning the transfer paper 15. When a predetermined amount of return of the transfer paper 15 is counted by a rotary encoder 36, a stopping clutch 39 is operated to stop the transfer paper 15. When information is again recorded on the photosensitive medium, the conveyance clutch 37 is operated by the signal from the rotary encoder 35 to resume synchronized conveyance of the transfer paper.

In Figure 4, the conveyance and return of the transfer paper 15 by the tractor 16 has been described with respect to the case that the transfer paper 15 is fan-folded paper, whereas the tractor may be replaced by a pair of rollers and this would especially be effective where the transfer paper is rolled paper or the like.

On the other hand, after completion of the image transfer, any residual coloring particles (toner) on the photosensitive drum are removed by a cleaning device 12, thus rendering the photosensitive drum ready for another electrostatic latent image formation process.

After having passed through the image transfer step, the transfer paper is conveyed to a heat roller type fixing device 25 by a first intermediate conveyor device 22, a buffer device 23 and a second intermediate conveyor device 24. The velocity of the transfer paper before reaching the first intermediate conveyor device 22 is completely synchronized with the movement of the photosensitive medium by the operation of the paper feed tractor 16. On the other hand, the velocity at which the transfer paper passes through the fixing device slightly differs from the paper feed speed of the paper feed tractor 16, because the diameter of the fixing roller varies with temperature and the meandering movement of the transfer paper being corrected at the second intermediate conveyor device 24. Since the transfer paper is a long footage of continuous paper, such slight errors may be progressively accumulated to cause the transfer paper to be broken or to be stagnant in the course of the conveyor system. These inconveniences may be overcome by detecting any slack in the transfer paper at the buffer device 23 to control the rotational velocity of the fixing roller such that it is increased when the slack is greater than a prescribed value and decreased when the slack is less than the prescribed value. At the fixing device, the transfer roller is conveyed while being subjected to heat and pressure by two rollers. At that time, the transfer paper may tend to move slightly obliquely due to such factors as the slight imbalance of the pressure in the direction of the rotational axis, the variation in roller diameter in the direction of the rotational direction, imbalance of the lateral expansion of the transfer paper. In the case of a long footage of continuous paper, such slight oblique movement may accumulate into a significant amount. At the second intermediate conveyor device 24, accumulation of such oblique movement is prevented by detecting any oblique movement of the transfer paper and varying the suction force of the suction device so as to correct the oblique movement, thereby controlling the lateral balance of the back tension in the transfer paper.

Figure 5 shows details of the fixing device. The transfer paper 15 bearing toner images transferred thereto is fixed and conveyed while being subjected to heat and pressure by a fixing roller 61 and a pressure roller 64. Paper discharge rollers 77, 78 impart a tension to the transfer paper by a normally constant torque. Heating rollers 62, 63 are

rotated in contact with the fixing roller 61, thus imparting heat to the latter. The rotative drive is imparted only to the fixing roller 61 by a drive motor, not shown. The heating rollers 62, 63 and the pressure roller 64 follow the fixing roller. The fixing roller 61 may be formed by adhesively attaching heat-resistant, thick, parting rubber (such as silicone rubber valcanizable at room temperatures) to the surface of a metallic cylinder. The pressure roller 64 may be formed by adhesively attaching a heat-resistant, thin, elastomeric material to the surface of a metallic cylinder. The heating rollers 62, 63 each comprise an aluminum cylinder having its surface plated with chromium and include infrared ray lamps 79 and 80 disposed therewithin. In the waiting position wherein the transfer paper 15 is not in motion, the pressure roller 64 is spaced apart from the fixing roller 61 and the transfer paper is also spaced apart from the fixing roller 61. The auxiliary heating roller 63 is also spaced apart from the fixing roller 61. The heating roller 62 uniformly imparts heat to the surface of the fixing roller 61 while keeping contact and rotating with the latter. The surface temperature of the heating roller 62 is detected by a thermistor 72 and the electrical energy applied to the heater 79 is controlled to maintain the surface temperature constant, so that the surface temperature of the fixing roller 61 is maintained constant. Likewise, the surface temperature of the auxiliary heating roller 63 which is then not in contact with the fixing roller 61 is also maintained at a predetermined level. These temperature controls are effected by a temperature control circuit 74 in a well-known manner.

The fixing operation is started in the manner which will hereinafter be described. First, rotation of the fixing roller 61 is stopped, and then the pressure roller 64 is urged against the fixing roller 61 by the operation of an air cylinder 68 through an arm 69. Thus, the transfer paper 15 is also urged against the fixing roller. When the pressing operation becomes completed, the fixing roller starts rotating. At the same time, the auxiliary heating roller 63 is urged against the fixing roller 61 by the action of an air cylinder 66 through an arm 65. This performs the function of supplying heat to the surface of the fixing roller 61 and maintaining the surface temperature constant, the supplied heat being carried away by the transfer paper 15 during the fixation.

The fixing operation is terminated in the following sequence. After the rotation of the fixing roller 61 has been stopped, the auxiliary heating roller 63 is brought out of contact with the surface of the fixing roller 61 by the operation of the air cylinder 66 and the pressure roller 64 is brought out of contact with the fixing roller 61 by the air cylinder 68. At the same time, a separating piece 75 is operated by a solenoid 76 to beat down the transfer paper 15 from the surface of the fixing roller 61. The transfer paper comes to a position indicated by a dot-and-dash line, due to the back tension imparted from the second intermediate conveyor means and the tension imparted from the discharge rollers 77 and 78. When the transfer paper is separated from the fixing roller surface, the fixing roller 61 resumes rotation. Thus, the waiting position is restored.

The operational timing between the fixing roller 61 and the auxiliary heating roller 63 and the pressure roller 64 is illustrated in Figure 6. By the above-described sequence of operation, when the transfer paper is intermittently moved, perfect fixation is performed without inducing any of such inconveniences as unfixed image portions, image registration, burnt transfer paper, etc. It will be noted that air is introduced from a compressor 71 into the air cylinders 66 and 68 through electromagnetic valves 69 and 70. Control of the operation of the air cylinders 66 and 68 is performed by changing over the electromagnetic valves 69 and 70 between a position for introducing the air into the respective air cylinders and a position for letting out the air in the air cylinders.

The above-described sequence of latent image formation, transfer and fixation and the timing control of the driving portion necessary therefor is effected by a control circuit 57 (Figure 11).

Figure 6 is a timing chart for illustrating the relations in operation between main print signals and the driving portion. First, the main switch of the apparatus is closed to make and complete such preparations as preheating of the fixing device, placement of the transfer paper at a predetermined position, etc. Here, the information output device 56 of Figure 1 is that if a computer and when information to be recorded is prepared, this device sends PRINT signal to the control circuit 57 on the recording apparatus side. By the PRINT signal, the control circuit 57 electrically energizes the motor for rotatively driving the photosensitive drum. At the same time, all the chargers except the transfer charger 20, the developing device, the cleaning device and the lamps start operating to make preparations for latent image formation (pre-rotation).

When the pre-rotation is completed (dA), DATA READY signal is sent back from the control circuit 57 to the information output device 56. If the DATA READY signal is "1", the information output device 56 starts transferring the data. During the transfer of data, DATA signal is "1" and at the same time, necessary modulating signal is sent to the modulator 3.

Simultaneously with the rising of the DATA signal, the beginning of the information to be recorded is projected upon the photosensitive drum 7 at the exposure station of Figure 1 (the station whereat the AC charger 7 is located). This produces an electrostatic latent image with high contrast by whole surface exposure and developed into a visible image and when it reaches the image transfer station, the transfer paper comes into contact with the photosensitive medium and starts moving at the same velocity as the peripheral velocity of the photosensitive drum while, at the same time, a voltage is applied to the transfer charger. If the actuating response times of the paper drive, the displacement assembly for the transfer rollers and the transfer corona were sufficiently short and sufficiently similar the following relation would suffice: dB=dC=dD=T (T is the time required for the photosensitive drum 7 to rotate from the exposure station to the transfer station). However, considering the actual values of these response times (of the order of several milliseconds to 100 milliseconds), dB, dC and dD are determined with these response times taken into account in order to improve image transfer. These relations will now be described by reference to Figure 7. For image transfer to be completely performed, it is necessary during image transfer, as already described, that the velocity of the photosensitive drum and the velocity of the transfer paper be equal to each other, that contact be maintained between the transfer paper and the photosensitive drum and that the intensity of the transfer corona be sufficient, and to prevent scattering of the toner image, the transfer corona should not be imparted before the transfer paper comes into contact with the photosensitive drum. To satisfy these conditions, the velocity of the transfer paper (i.e. of the tractor) should first be made constant, and then the transfer paper should be brought into contact with the photosensitive drum, whereafter transfer corona should be imparted.

Due to such series of operations, there may occur on the transfer paper blank portions having no transferred image or portions having unsatisfactorily transferred images. To reduce these portions, dB, dC and dD are determined as shown in Figure 6. In this manner, the blank portions or the unsatisfactorily transferred image portions may be reduced by taking into account the rising times of the transfer paper feed means, transfer paper urge means and transfer field imparting means and providing optimal timings for energizing these means.

Likewise, at the end of image transfer, the timings dH, dI and dJ for deenergization are determined taking into account the deactuating response times of said various means (Figure 7). Where the rising and the falling times of the tractor, the transfer roller and the transfer corona were 7-10 milliseconds, 30-40 milliseconds and 80-100 milliseconds, respectively, the blank portions formed on the transfer paper at the beginning and the end of the transfer under the condition that the peripheral velocity of the photosensitive drum is 2000 inches per minute could be reduced to 1/2 inch or less.

Also, to further reduce or null the blank portions, the transfer paper may be moved back at the end of transfer by an amount corresponding to the blank portion.

Also, in the fixing device, when the transfer paper is intermittently fed, the above-described sequence of operation takes place to completely perform fixation, but unless the actuating and deactuating response times of the drive for the fixing roller and of the operation of the pressure roller are taken into account, the difference between the amount of the transfer paper fed by the tractor and the amount of the transfer paper conveyed by the fixing device will exceed the tolerance which can be absorbed by the buffer device 23, so that the transfer paper may be broken. Preferred movements of the various elements in the fixing device at the start of image transfer are illustrated in Figure 9, and those at the end of image transfer are illustrated in Figure 10.

The developing device is also controllable to effect intermittent operation.

In this manner, the series of recording operation is completed and the PRINT signal from the information output device becomes "0". However, the control circuit maintains a print-ready condition for some time (dO) and keeps DATA READY signal to be "1". If PRINT signal again becomes "1" during this period, the information can be immediately written without requiring the pre-rotation time (dA). Even if the period of dO is exceeded but unless PRINT signal becomes "1", the sequence for stopping the photosensitive drum takes place (dP), whereafter the photosensitive drum stops rotating, thus restoring its initial waiting position.

The dB, dC, dD, dE, dF and dG shown in Figure 6 may be provided with high accuracy by counting, with the rising of DATA signal from "0" to "1" as the reference, a predetermined number of pulses from the rotary encoder 35 which generates a pulse number proportional to the amount of rotation of the photosensitive drum connected to its rotary shaft. Likewise, dH, dI, dJ, dM and dN may also be provided by counting a predetermined number of pulses from the rotary encoder 35 with the falling of DATA signal from "1" to "0" as the reference.

Figure 11 shows an embodiment of the counting circuit for these pulses and Figure

12 shows an embodiment of the circuit for generating driving signals for said various means.

The rotary encoder 35 generates a series of pulses by photoelectrically detecting a number of apertures formed in a disc provided on the rotary shaft of the photosensitive drum.

Through a rotary encoder 101 and by the rotation of the photosensitive drum, pulse is repetitively generated and applied to a gate circuit 102. From the gate 102, the pulse is further applied to and counted by a counter 104. The photosensitive medium, which is in an endless form, never effects gating depending on the drum position. Designated by 105 is an OR circuit for resetting the counter 104 by signals TRA and TRB and opening the gate 102. Coincidence between setting means 107 and 109 for setting the count number and the driver timing is discriminated by comparators 106 and 108. When the coincidence is found, there are generated coincidence pulses, for example, dBC and dHC.

Designated by 103 is a circuit which serves to discharge the pulse to the gate 102 to close it when a maximum count number is reached. The necessity of the circuit 103 comes from the purpose of preventing the possibility that if the counter is of the two-digit count type, coincidence pulse may appear again and again during the same mode because the drum pulse reaches 99 and then returns to 0, whereupon count is again started. Designated by 110 is a print mode generating circuit for generating print mode signals CM0, CM1, CM2, data rising signal TRA and data falling signal TRB, as shown in Figure 6, in response to "PRINT" and "DATA" signals sent from the information output device 56. If the time required from the rising of DATA READY signal till the DATA signal is sent is substantially equal, this circuit may also be represented by Figure 13. Figure 14 shows an example of the ON-delay OFF-delay pulse generator 120 in Figure 13.

In Figure 13, an inverter 121 is connected to an AND gate 123 to generate mode signal CM2 when there is no data and when data ready, and an inverter 122 is for generating signal CM0 when no data ready. Denoted by 124 and 125 are one-shot multivibrators for generating pulse signals TRA and TRB during the rising and falling of each data signal.

In Figure 14, a setting means 136 is provided to set the time dA from print instruction to data ready. A counter 134 counts the pulse from the rotary encoder 35. A comparator 135 compares the count value with the set value and when they are coincident, sets a flip-flop 140 and puts out DATA ready signal. A setting means 139 is for setting the time dO from disappearance of the print instruction to disappearance of DATA READY signal.

The operational sequence of the tractor for the feeding of paper (forward) will now be explained by reference to Figure 11. When the drum starts rotating in response to PRINT signal as already described, drum pulse is sent from the rotary encoder. After DATA READY is turned on, DATA signal is sent, whereupon TRA pulse is sent from the mode generator 110 to clear the counter 104 and open the gate 102, thereby generating mode signal CM1. When the count by the counter 104 becomes coincident with the dB value of the setting means 107, dBC pulse is sent from the comparator 106. By the coincidence between dBC and CM1, JK flip-flop 113 is set. By this, a signal for driving the tractor is put out from Q terminal to energize a tractor driving clutch. Designated by OSC is an oscillator for operating the JK flip-flop. When the counter 104 reaches a maximum count, coincidence pulse is put out from 103 to close the gate 102, thereby stopping the advance of the counter 104. This state is held until DATA signal disappears and, when DATA signal disappears, TRB signal is put out to reset the counter 104 and open the gate 102. On the other hand, mode signal CM2 is put out from the mode generator 110. The counter 104 effects advance and when the count becomes coincident with the set value dH of the setting means 109, coincidence output dHC is put out. By this, coincidence is brought about between dHC and CM2, whereby JK flip-flop 113 is reset and the tractor (forward) drive signal disappears to stop the feeding. Likewise, thereafter, when DATA signal is again generated, tractor drive signal is generated with a delay corresponding to dB to start the feeding and the tractor drive signal disappears with a delay corresponding to dH. ON-OFF signals for the various driving portions (transfer charger, transfer roller, fixing roller) other than the tractor may be explained in the same manner as described above.

Accordingly, as described above, the driving portions are individually controlled in a specific time relation with the start or the end of recording and this prevents unsatisfactory recording which would tend to occur at the start or the stop of the recording, and thereby reduces the unusable blank portions.

WHAT WE CLAIM IS:–

1. A recording apparatus comprising:

a movable image carrier;

image forming means for forming successive images on said image carrier;

feed means for intermittently feeding a continuous transfer medium through a transfer station;

transfer means operative at said transfer station for transferring said successive images from said image carrier onto successive portions of the transfer medium, said transfer means being operable to effect said transfer while an image-bearing portion of the image carrier and the transfer medium move at the same speed through said transfer station; and

control means for controlling the operation of said feed means and of said transfer means in response to the operation of the image forming means so that the mutual spacing of the images on the transfer medium is independent of the time intervals between successive operations of the image forming means;

wherein said feed means and said transfer means have different inherent actuating response times as hereinbefore defined, and where the control means are operative to cause initiation of activation of the said feed means and transfer means after respective different delay periods following initiation of image formation in order to provide a predetermined time relationship between the attainment of said feed means and said transfer means of their respective fully active conditions.

2. A recording apparatus according to claim 1 wherein the feed means and transfer means also have different inherent deactuating response times, as herein defined, and wherein the control means are operative also to cause initiation of deactivation of the feed means and the transfer means after respective different delay periods following termination of image formation in order to provide a predetermined time relationship between the attainment by said feed means and said transfer means of their respective fully inactive conditions.

3. A recording apparatus according to any preceding claim, wherein said transfer means includes a transfer charger and contacting means operable to bring said transfer medium into contact with said image carrier.

4. A recording apparatus according to claim 3, wherein said control means are operative to cause said contacting means to attain its fully active condition prior to the attainment by said transfer charger of its fully active condition.

5. A recording apparatus according to any preceding claim including fixing means for fixing said images on said transfer medium.

6. A recording apparatus according to claim 5, wherein the fixing means has a different inherent response time, as herein defined, from at least one of the drive means and the transfer means and wherein the control means are operable to cause initiation of activation of said fixing means after a delay period, following initiation of image formation, which is different from at least one of the delay periods associated with the drive means and the transfer means.

7. A recording apparatus according to claim 5 or claim 6 wherein said fixing means include a pair of rollers with said transfer medium interposed therebetween, and said control means control the pressure contact between said rollers.

8. A recording apparatus according to claim 7, wherein at least one of said rollers is a heat applying roller for apply heat to the transfer medium.

9. A recording apparatus according to claim 8, further comprising a heating roller, having a heater, for applying heat to said heat applying roller.

10. A recording apparatus according to claim 8 or claim 9 wherein said rollers of said pair are separable and wherein means are provided for forcing the transfer medium to disengage from said heat applying roller when the said rollers are separated.

11. A recording apparatus according to any preceding claim, wherein said image forming means include means for forming electrostatic latent images on said image carrier and means for developing said electrostatic latent images.

12. A recording apparatus according to any preceding claim, wherein said image forming means are operable to form the images on the image carrier in accordance with image defining signals carrying data defining said images.

13. A recording apparatus according claim 12, wherein said image forming means comprise a beam oscillator for generating a beam for executing recording on said image carrier bearing member and wherein said image defining signals control the beam.

14. A recording apparatus according to claim 13, wherein said beam oscillator is a laser beam oscillator.

15. A recording apparatus according to any preceding claim, further comprising reversing means for causing said transfer medium to be reverse driven, under the control of said control means between the performance by said transfer means of successive transfer operations.

16. A recording apparatus according to any preceding claim wherein said image carrier is a rotatable member, and said image forming means and said transfer means are provided adjacent the surface of said rotatable member at circumferentially spaced locations.

17. A recording apparatus according to claim 16, further comprising means for generating a pulsed signal in response to the rotation of said rotatable member, said delay periods being predetermined so as to be timed by counting the pulses from said

pulsed signal generating means.

18. A recording apparatus according to claim 16 or claim 17, wherein the image carrier is controlled so as to rotate prior to the initiation of image formation by said image forming means.

19. A recording apparatus according to any of claims 16 to 18 wherein the image carrier is controlled to continue rotating after the completion of an image transfer so as to maintain the apparatus prepared for operation.

20. A recording apparatus according to any preceding claim, wherein said continuous transfer medium is a fan-folded web and said feed means include a tractor drive.

21. A recording apparatus comprising:

a movable image carrier;

image forming means for forming successive images on said image carrier;

feed means for intermittently feeding a continuous transfer medium through a transfer station;

transfer means operative at said transfer station for transferring said successive images from said image carrier onto successive portions of the transfer medium, said transfer means being operable to effect said transfer while an image-bearing portion of the image carrier and the transfer medium move at the same speed through said transfer station; and control means for controlling the operation of said feed means and of said transfer means in response to the operation of the image forming means so that the mutual spacing of the images on the transfer medium is independent of the time intervals between successive operations of the image forming means;

wherein said feed means and said transfer means have different inherent deactuating response times, as hereinbefore defined, and wherein the controls means are operative to cause initiation of deactivation of the said feed means and transfer means after respective different delay periods following termination of image formation in order to provide a predetermined time relationship between the attainment by said feed means and said transfer means of their respective fully inactive conditions.

22. Recording apparatus substantially as herein described with reference to the accompanying drawings.

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1590845 COMPLETE SPECIFICATION
9 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

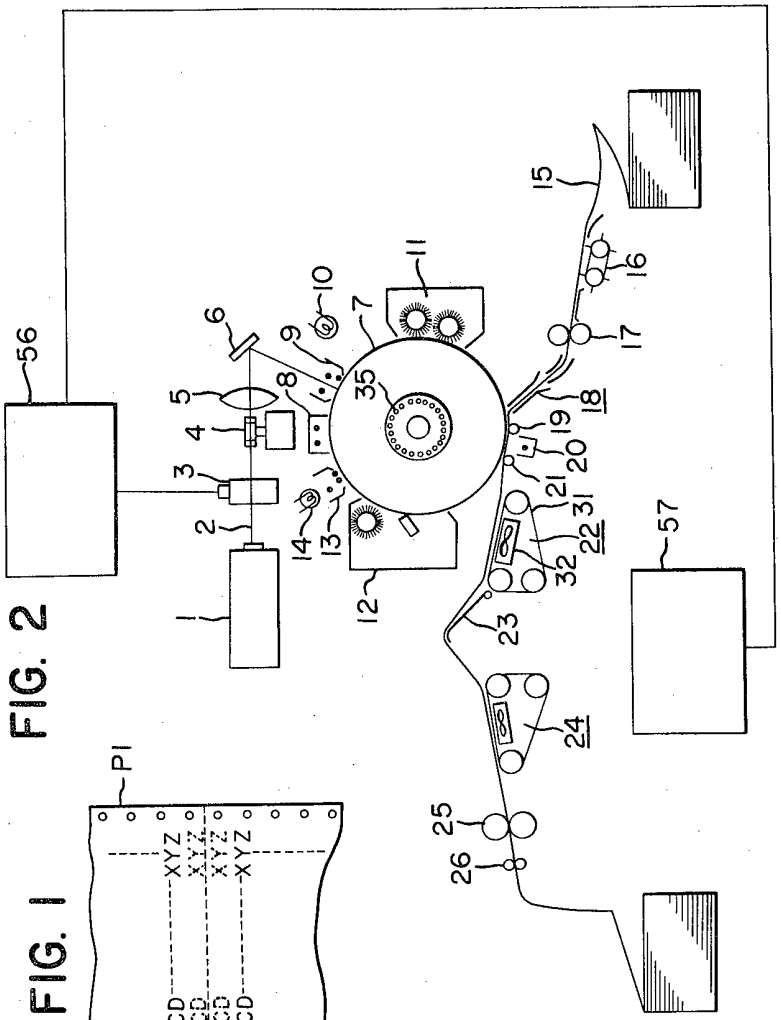


FIG. 2

FIG. 1

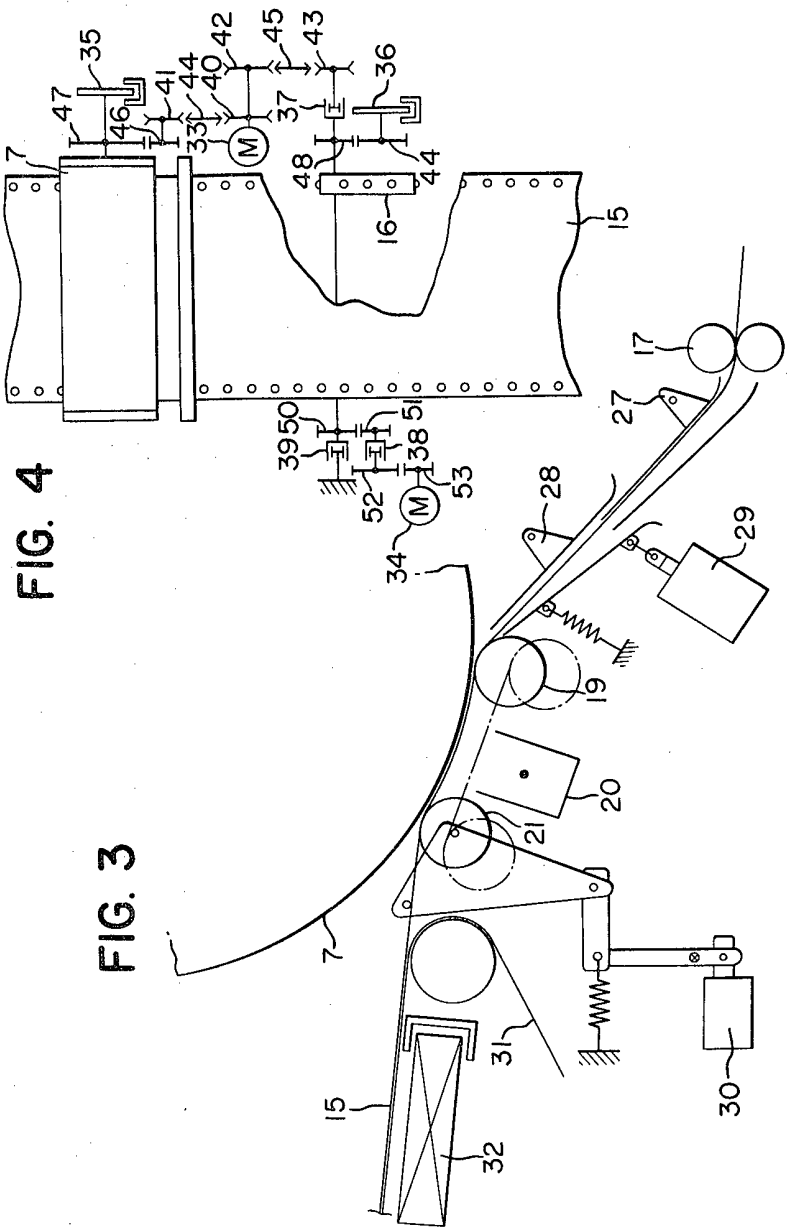

35
42
45
43
47
41
44
40
36
46
33
37
M
48
44
7
16
15
17
27
39
50
51
38
52
53
M
28
29
34
19
20
21
7
31
15
32
30

FIG. 4

FIG. 3

1590845 COMPLETE SPECIFICATION
9 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 3

FIG. 5

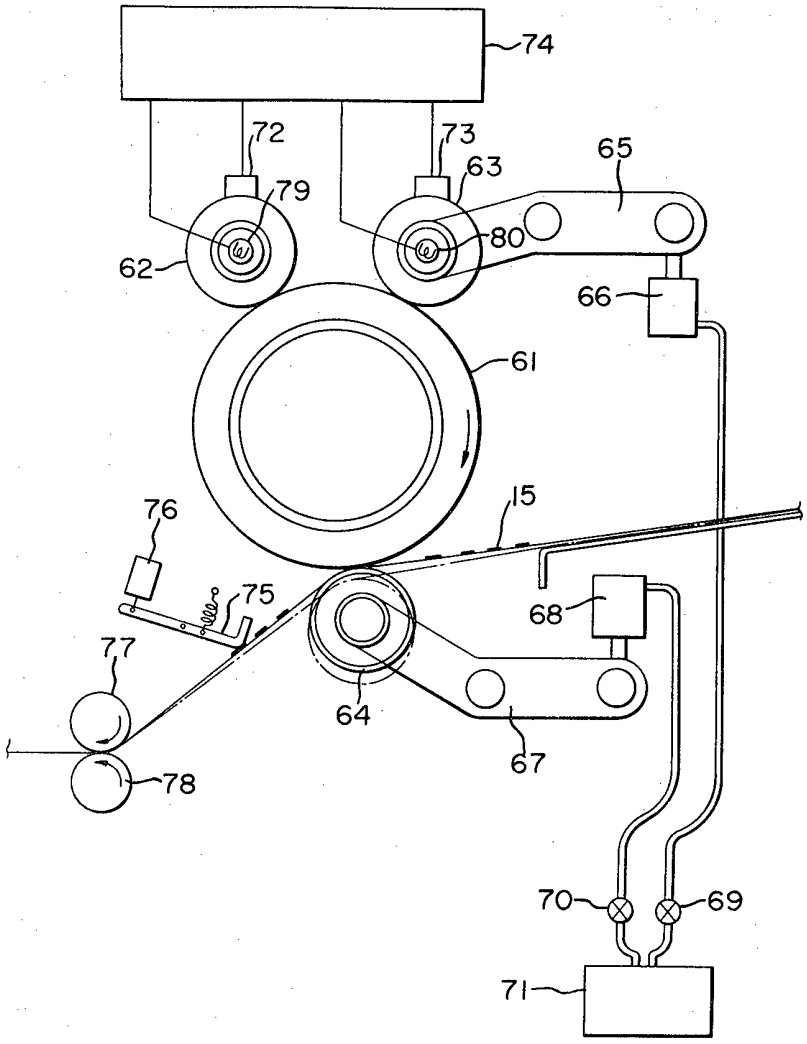


FIG. 6A

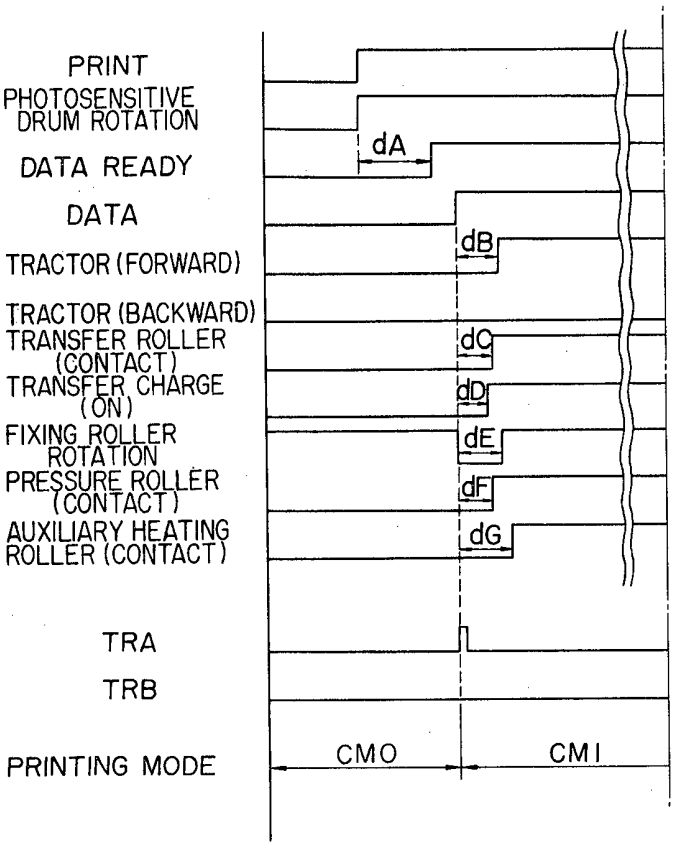

PRINT
PHOTOSENSITIVE DRUM ROTATION
DATA READY
DATA
TRACTOR (FORWARD)
TRACTOR (BACKWARD)
TRANSFER ROLLER (CONTACT)
TRANSFER CHARGE (ON)
FIXING ROLLER ROTATION
PRESSURE ROLLER (CONTACT)
AUXILIARY HEATING ROLLER (CONTACT)
TRA
TRB
PRINTING MODE
dA
dB
dC
dD
dE
dF
dG
CMO
CMI

FIG. 6B

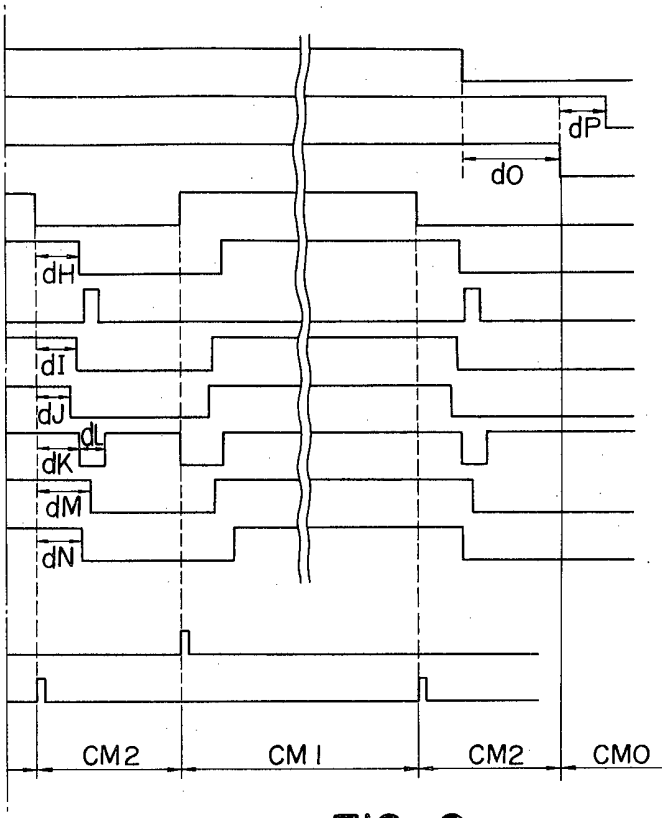


FIG. 6

FIG. 6A	FIG. 6B

FIG. 7

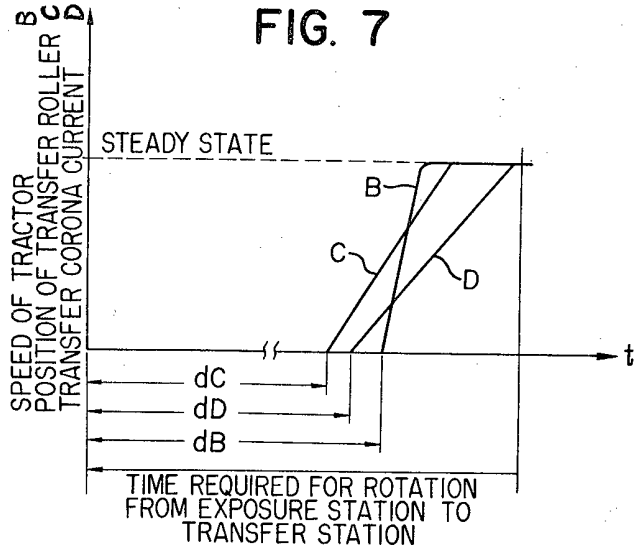

B C D
SPEED OF TRACTOR
POSITION OF TRANSFER ROLLER
TRANSFER CORONA CURRENT
STEADY STATE
B
C
D
t
dC
dD
dB
TIME REQUIRED FOR ROTATION
FROM EXPOSURE STATION TO
TRANSFER STATION

FIG. 8

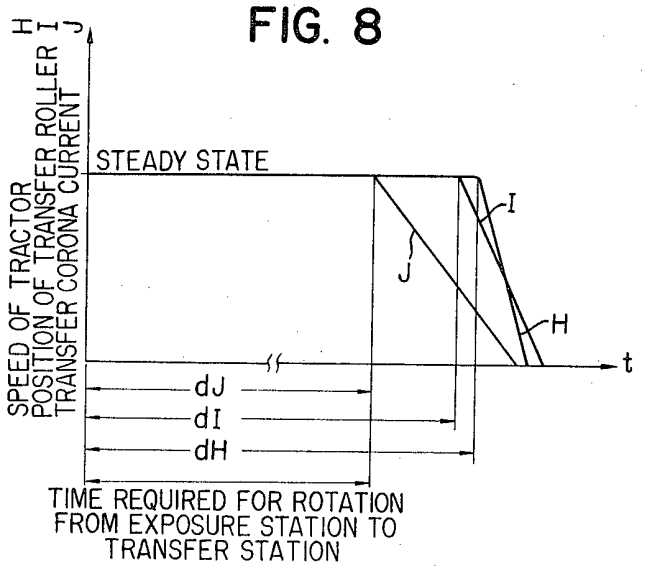

H I J
SPEED OF TRACTOR
POSITION OF TRANSFER ROLLER
TRANSFER CORONA CURRENT
STEADY STATE
I
J
H
t
dJ
dI
dH
TIME REQUIRED FOR ROTATION
FROM EXPOSURE STATION TO
TRANSFER STATION

FIG. 9

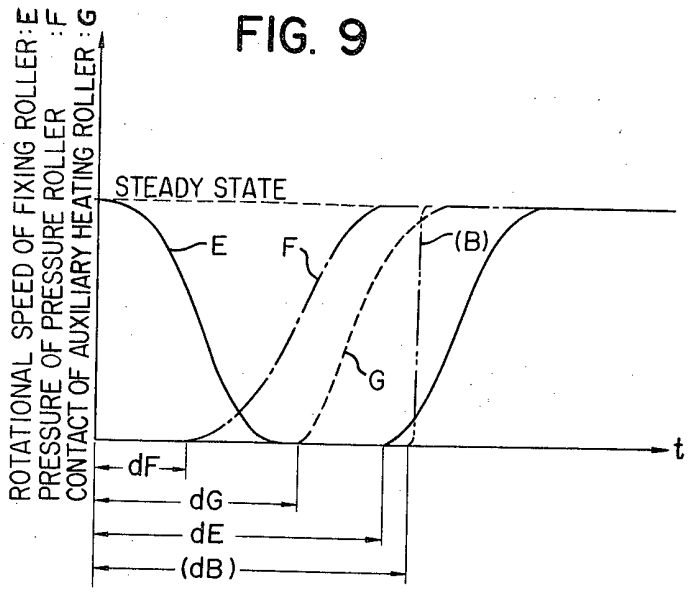

ROTATIONAL SPEED OF FIXING ROLLER : E
PRESSURE OF PRESSURE ROLLER : F
CONTACT OF AUXILIARY HEATING ROLLER : G
STEADY STATE
E
F
G
(B)
t
dF
dG
dE
(dB)

FIG. 10

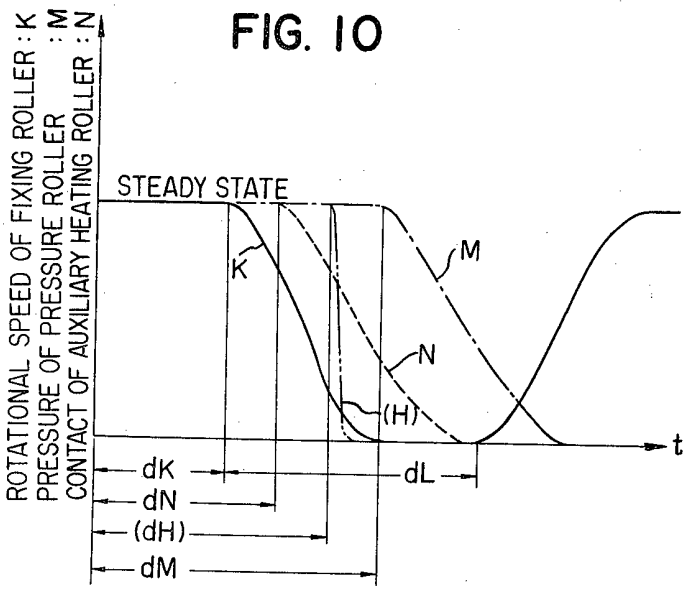

ROTATIONAL SPEED OF FIXING ROLLER : K
PRESSURE OF PRESSURE ROLLER : M
CONTACT OF AUXILIARY HEATING ROLLER : N
STEADY STATE
K
M
N
(H)
t
dK
dL
dN
(dH)
dM

FIG. 11

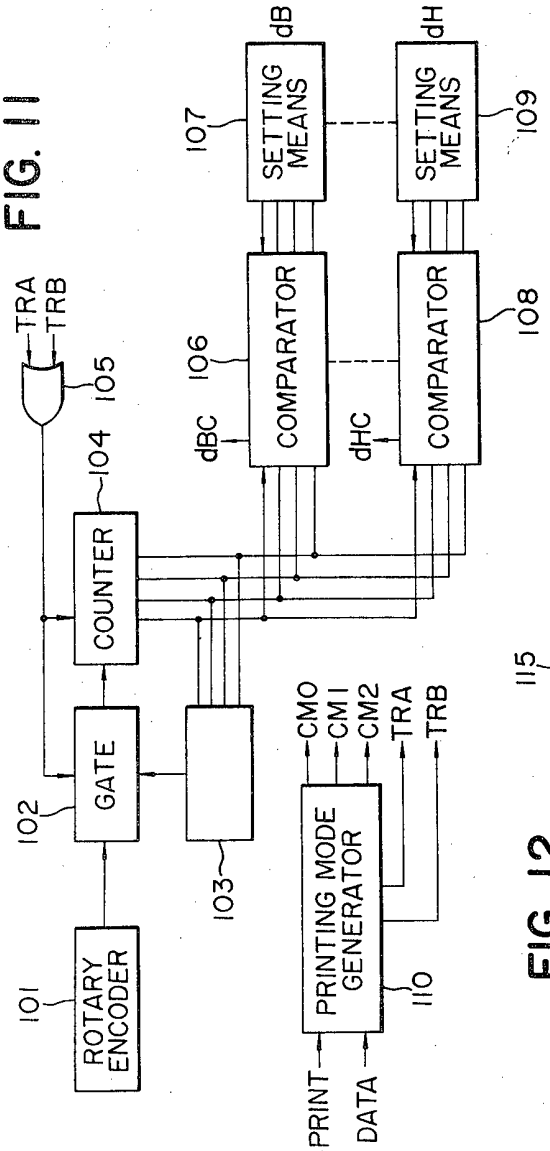
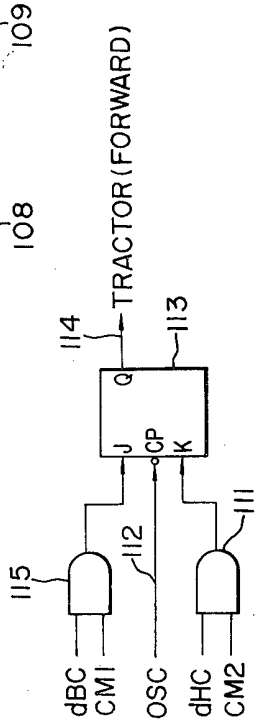

ROTARY ENCODER
101
GATE
102
103
COUNTER
104
TRA
TRB
105
dBC
106
COMPARATOR
dB
SETTING MEANS
107
dHC
108
COMPARATOR
dH
SETTING MEANS
109
PRINTING MODE GENERATOR
110
CM0
CM1
CM2
TRA
TRB
PRINT
DATA

FIG. 12


TRACTOR (FORWARD)
114
113
Q
J
CP
K
111
112
115
dBC
CM1
OSC
dHC
CM2

1590845 COMPLETE SPECIFICATION
9 SHEETS

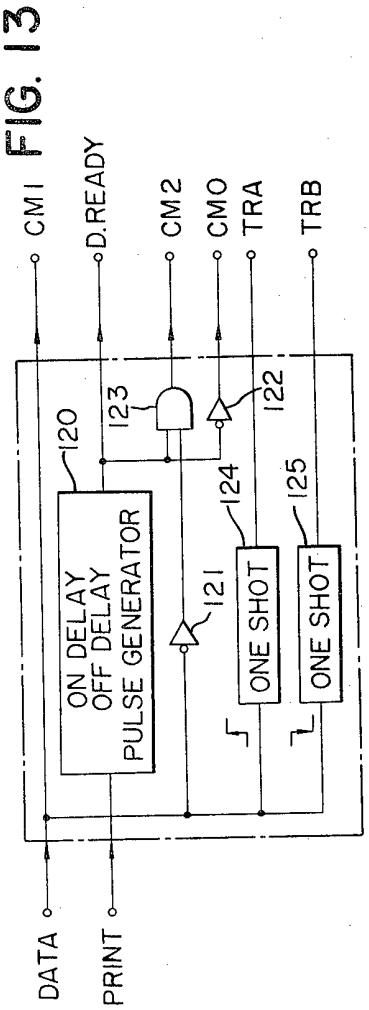


FIG. 13

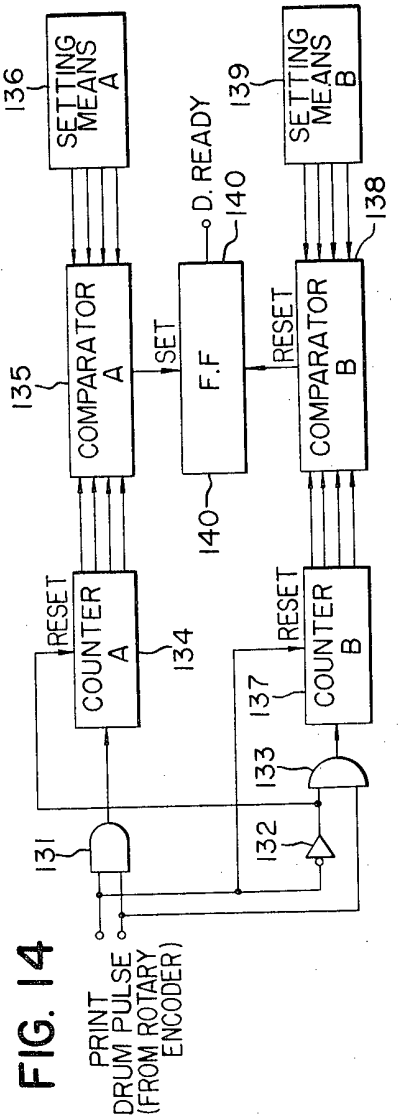


FIG. 14