

[54] CONTROL APPARATUS FOR ELECTROPHOTOGRAPHIC APPARATUS

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[58] Field of Search ..... 355/14, 16, 17, 3; 328/72, 328/75

[56] References Cited

UNITED STATES PATENTS

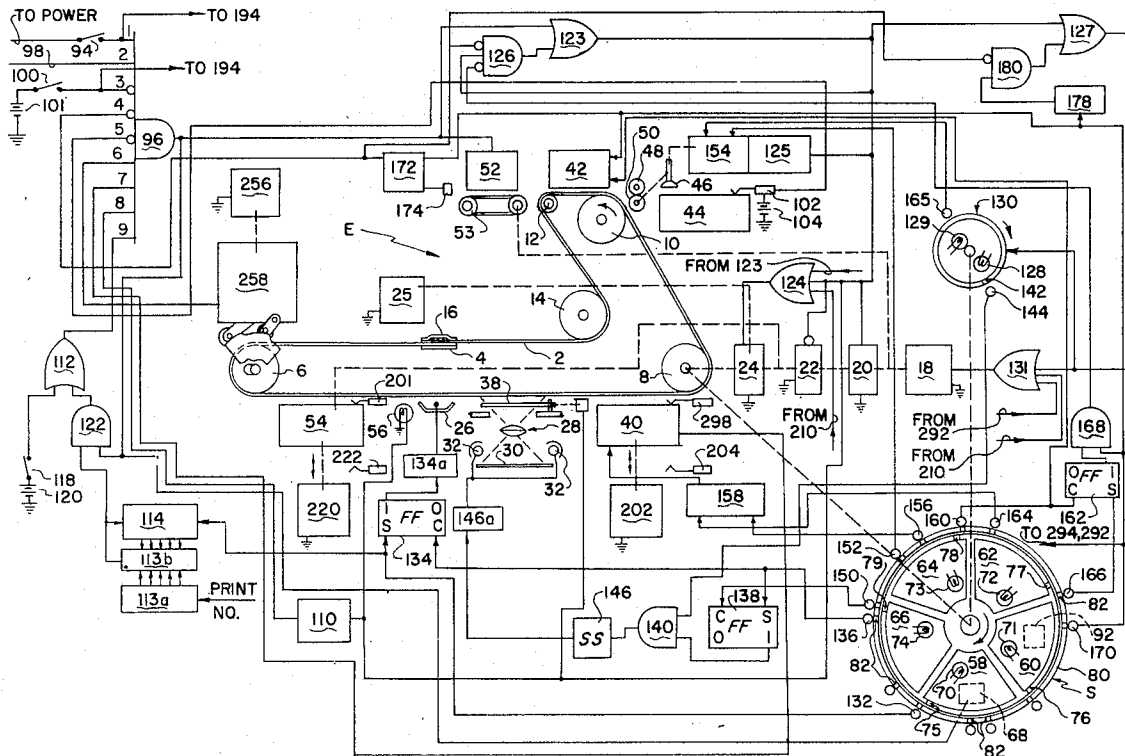
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[57] ABSTRACT

An electrophotographic copying apparatus having an electrophotographic web movable along an endless path relative to a plurality of actuatable work stations disposed along the path and wherein each of the work stations is operative when actuated to perform a work operation on the web. The apparatus includes a sequencer for sequentially producing, (a) a plurality of control signals, each such control signals for causing particular ones of the electrophotographic stations to perform work operations on the web in timed relation to web movement respectively, and (b) a count signal each time a selected station performs its operation. The apparatus further includes counter means responsive to each count signal and having a state which manifests the cumulative total number of count signals, and means responsive to a particular state of the counter means corresponding to a predetermined cumulative total number of count signals to prevent the further actuation of each work station after each station has performed a predetermined number of work operations.

8 Claims, 2 Drawing Figures



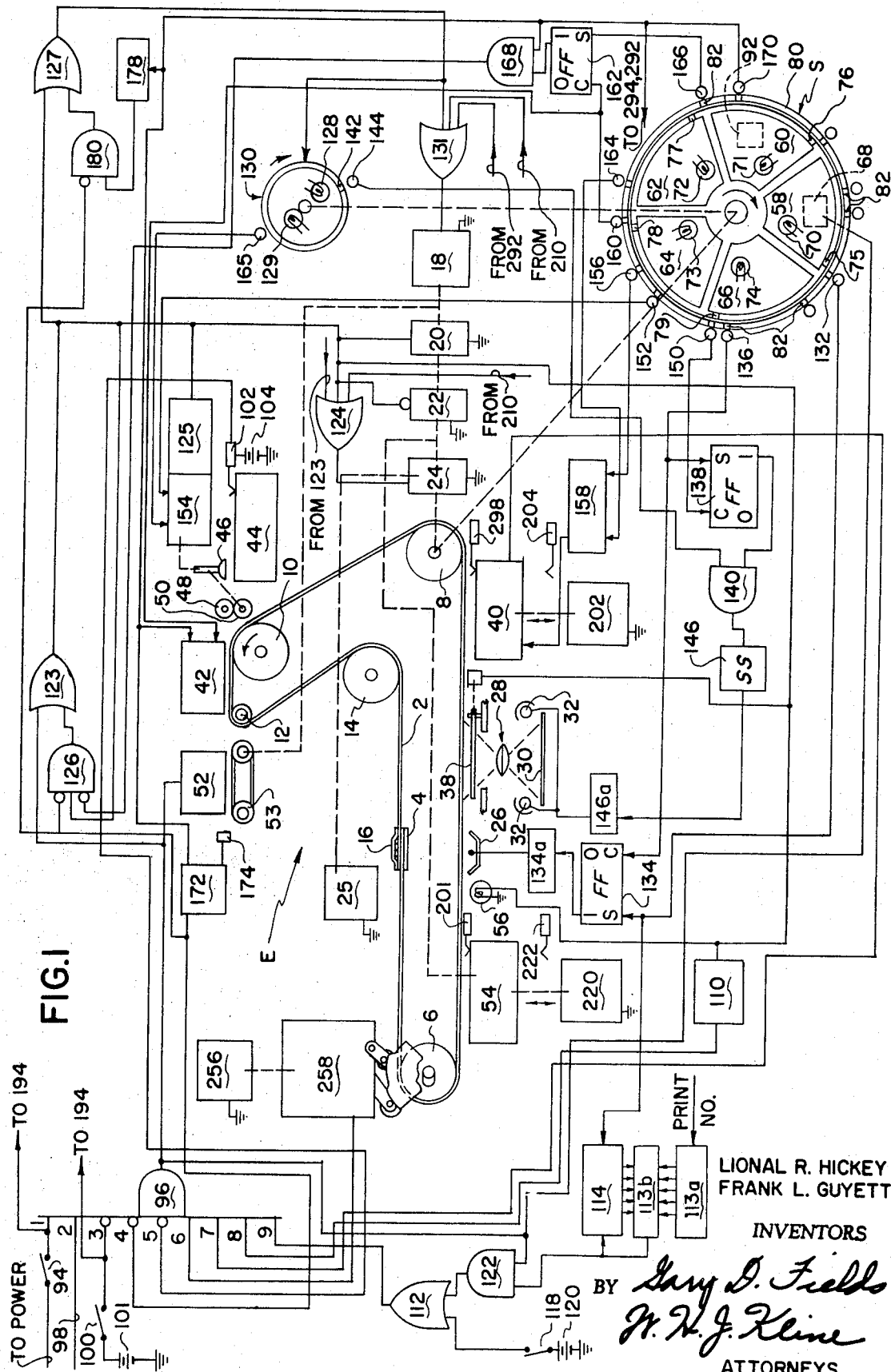


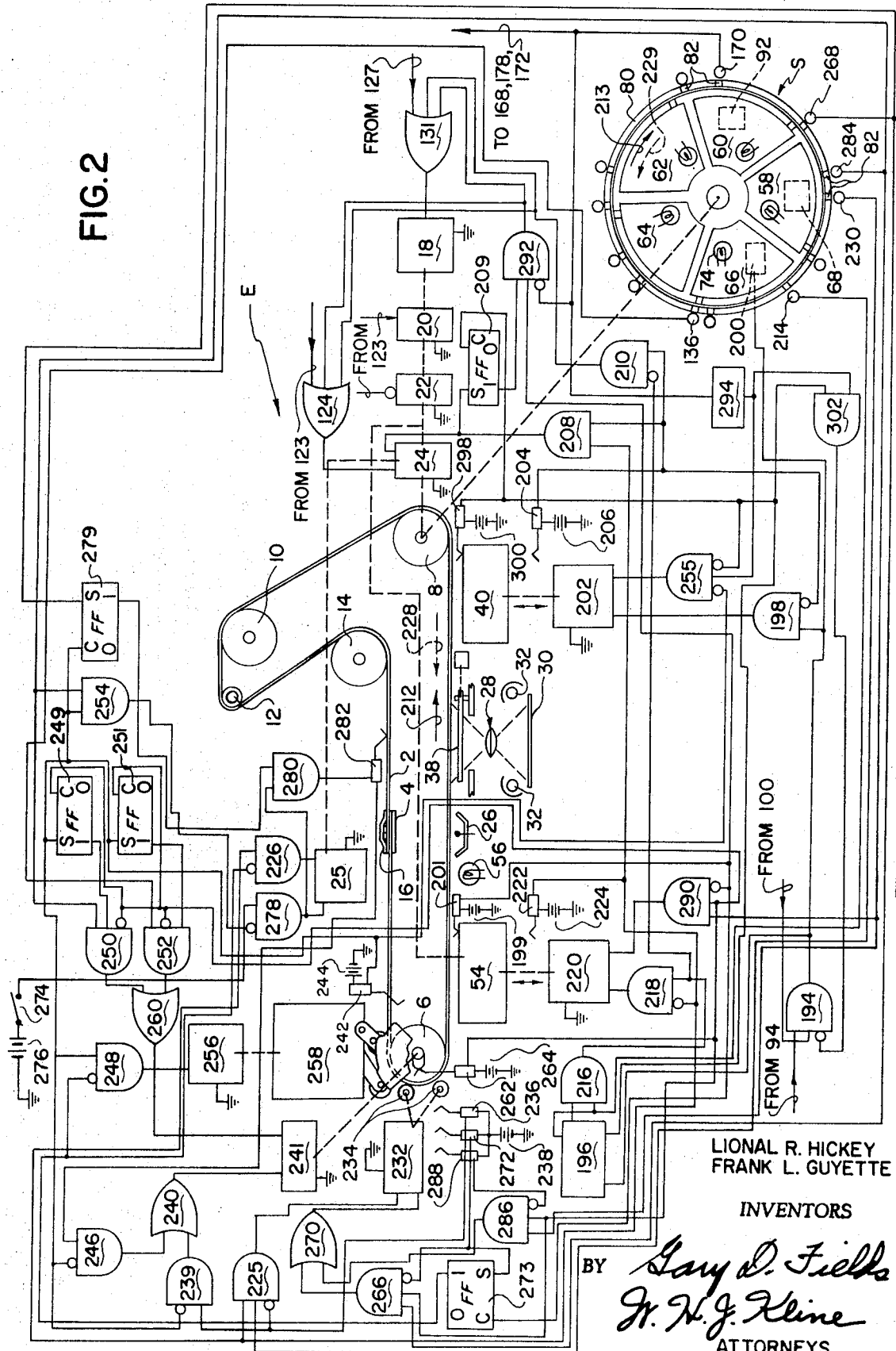
FIG. 1

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FIG. 2



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## CONTROL APPARATUS FOR ELECTROPHOTOGRAPHIC APPARATUS

### CROSS REFERENCE TO RELATED APPLICATIONS

Reference is made to commonly assigned U. S. Pat. application Ser. No. 19,644, now abandoned, entitled, **MAGNETICALLY CONTROLLED PROGRAMMER** and commonly assigned U. S. Pat. application Ser. No. 19,999, entitled, **MACHINE PROGRAMMER** both filed Mar. 16, 1970 and commonly assigned U. S. Pat. application Ser. No. 834,695, now U. S. Pat. No. 3,619,050 entitled, **WEB HANDLING APPARATUS AND CARTRIDGE AND WEB** filed June 19, 1969, the disclosures of which are incorporated in their entirety herein.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

This invention relates to the fields of electrophotography and web handling. More specifically, this invention relates to electrophotographic apparatus having electrophotosensitive members in the form of an endless web and including means for facilitating the supply, removal and/or replacement of such electrophotosensitive webs.

#### 2. Description of the Prior Art

In a common form of electrophotography, an electrical image of an information medium such as a document is formed in an electrophotosensitive member in response to imagewise actinic radiation reflected from the medium. The electrophotosensitive member includes a photoconductive layer with a conductive backing. In accordance with this known form of electrophotography, such an electrophotosensitive member is transported relative to a plurality of work stations, each of which when actuated performs a work operation. Such stations include a charging station at which a uniform charge is placed on the photoconductive layer, an exposure station at which the charged photoconductive layer is imagewise exposed to actinic radiation reflected from the medium to create an electrostatic image of the medium in the photoconductive layer, a developing station at which the electrostatic image is contacted with finely divided charged toner particles that adhere to the photoconductive layer in a configuration defined by the electrostatic image, a transfer station at which toner particles are transferred in the image configuration to a receiving surface, and a cleaning station at which residual toner is removed from the photoconductive layer so that it can be reused. In certain known modifications of this same system one or more of these stations are eliminated.

In applications in which the electrophotosensitive member is continually reused, the electrophotosensitive member can be constructed in the form of a drum, a plate or an endless web. The endless web configuration has certain advantages over drums and plates. Among these advantages is flexibility of machine design for such a web can be disposed in flat configuration at one location in the apparatus to facilitate some operations such as, e.g., exposure and in a curved configuration at other locations to facilitate such other operations as the separation of a transfer sheet therefrom.

However, some of the advantages of endless web type electrophotosensitive apparatus pointed out above may be offset by the difficulty of providing efficient apparatus for properly actuating work stations and controlling the number of copies to be made.

### SUMMARY OF THE INVENTION

It is an object of this invention to provide for use in endless web type electrophotographic copy apparatus, improved means for controlling the actuation of work stations in such copy apparatus and coordinating such actuation with the controlling of the number of copies to be made.

In accordance with a disclosed embodiment of this invention, apparatus includes an electrophotographic web movable relative to a plurality of actuable work stations along an endless path wherein a work operation is performed at each station when it is actuated. The apparatus includes means for moving the web along the endless path relative to the work stations, means for (a) sequentially producing a plurality of output control signals, each of said control signals being adapted to cause the actuating of particular ones of the work stations to perform work operations on the web respectively, and (b) a count signal each time a particular work station has performed a work operation on the web. The apparatus further includes a counter responsive to the count signals and having a state which manifests the cumulative total number of count signals, and means responsive to a state of the counter means corresponding to a selected predetermined cumulative total number of count signals to cause the signal producing means to prevent further actuation of each station of the apparatus after each work station has performed a predetermined number of work operations.

More particularly, the invention includes an electrophotographic apparatus wherein the count signal is provided by the control signal for turning on the charging station and the apparatus includes a transfer station and a fusing station through which a receiver sheet is fed to transfer a toner image from an endless electrophotographic web to the receiver sheet which toner image is then fused in the fusing station. After a predetermined number of copies have been made, means coupled to the counter causes the apparatus to shut down sequentially so that the photoconductive member first discontinues operation while the fusing station and the drive means therefore continues operating until the final print has been discharged from the fusing station after which the entire apparatus is shut down.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing the arrangement of apparatus for actuating various work stations in web type electrophotographic apparatus; and

FIG. 2 is a block diagram showing the arrangement of apparatus for controlling web replacement and various machine operations during web replacement in the electrophotographic apparatus shown in FIG. 1.

The symbols for the logic components shown in the drawings are in accordance with American Standard Graphical Symbols for Logical Diagrams (ASA&32.14-1962e).

### DESCRIPTION OF THE PREFERRED EMBODIMENT

In accordance with this invention, control logic, as illustrated in FIG. 1, is provided for an electrophotographic device E that includes an electrophotosensitive web or belt 2, which comprises at least a photoconductive surface on a conductive backing. The web has a leading end attached to a tow bar 4 by which it is moved along an endless path past rollers 6, 8, 10, 12 and 14 respectively, as shown, and is attached to a trailing end by a plurality of studs 16 as disclosed in commonly assigned copending U. S. application Ser. No. 834,695, now U. S. Pat. No. 3,619,050, entitled, WEB HANDLING APPARATUS AND CARTRIDGE AND WEB USABLE THEREWITH to Thaddeus Swanke, filed June 19, 1969. Belt 2 is driven through a drive train which includes a main drive motor 28, an electric clutch 20, a brake 22 and a second clutch 24. Clutch 24 includes a motor and is movable to either of two driving positions. When energized, it is moved to a first position to serve as a driving connection between main drive motor 18 and photoconductive belt 2. When de-energized, it moves under the urging of a spring (not shown) to a second position to serve as a driving connection between thread-unthread motor 25, as discussed below in connection with FIG. 2.

The general operation of the device E will now be described. As the photoconductive belt 2 is driven, a portion thereof moving past a charging device 26, such as a corona charger, receives a generally uniform electrostatic charge. Thereafter, the charged portion is exposed to a pattern of actinic radiation at an exposure station 28 whereat the image of an original 30 is illuminated by a plurality of high intensity light sources 32 and is projected upon the opening of shutter 38, as described below. The electrostatic charge in the exposed areas is dissipated leaving an electrostatic latent image. This latent image is developed by toner particles at a developing station 40. The toner particles may have a charge opposite that of the electrostatic image are attracted thereto to form a toner image. The toner image is advanced by the belt along the endless path to the vicinity of transfer charger station 42 so that it arrives at the transfer station in synchronism with the arrival of a receiver sheet fed from a paper supply 44 which is fed by means of a sheet feeder. The sheet feeder includes a vacuum finger 46, 48 and 50 which delivers a receiver sheet to a pair of opposed feed rollers so that the receiver sheet is brought into face-to-face contact with the toner image at transfer station 42 whereupon the toner image is transferred from the photoconductive belt to a receiver sheet. Although sheet feeders may take various forms known in the art, the sheet feeder disclosed in commonly assigned copending application, U. S. Ser. No. 23,705, now abandoned entitled, PAPER FEED AND EXPOSURE SYNCHRONIZER to Jorgen Reesen, filed Mar. 30, 1970 is especially suitable for use with the device E. The receiver sheet is separated from the photoconductive belt at small radius roller 12 and is moved through a fusing station 52 by a transport mechanism 53 where the toner image thereon is fused to the receiver to make a permanent copy which then is fed to a suitable receiving means (not shown). Any residual toner particles remaining on the photoconductive belt 2 are

removed at cleaning station 54 and the remaining electrostatic charge on the belt is discharged by erase lamp 56 after which the cycle can be repeated. It will be understood that a plurality of electrostatic and toner images may be placed sequentially on successive portions of the web as it moves along its endless path so that each of the above-described work operations performed at each work station occurs simultaneously and in proper sequence on different portions of the web.

Advantageously, the sequential operation of the various stations are controlled by a sequencer or shift register S. The sequencer S may take various forms known in the art such as an electronic shift register wherein the input to each stage is provided by the output of a previous stage, with data being transferred during application of a pulse-type shift command signal. Alternatively, and as shown, a mechanical sequencer may be provided which performs the same machine control functions as would a shift register. The sequencer S disclosed in commonly assigned copending application, U. S. Ser. No. 19,644, now abandoned entitled, MAGNETICALLY CONTROLLED MACHINE PROGRAMMER, filed Mar. 16, 1970 is especially suitable for use with the device E. The shift register S comprises a rotatable cylinder which is divided into a plurality of light-tight sectors 58, 60, 62, 64 and 66. As the shift register is rotated, an initiator coil 68 enables a signal circuit (not shown) in each sector which includes an output signal lamp, such as lamps 70, 71, 72, 73 and 74, respectively, in sector 58 which shines through slots 75, 76, 77, 78 and 79, respectively in the periphery of the respective sectors to sequentially energize a plurality of photocells spaced around a stationary sleeve 80 which has a slot 82 adjacent each photocell to permit passage of light therethrough.

For each copy that is to be made, a sector is illuminated by initiator coil 68 which sector then provides signals to cause various electrophotographic operations to be performed on corresponding segments of the photoconductive belt 2. At the end of the cycle, the signal circuit for the sector is disabled as by a permanent magnet 92 which opens a read switch (not shown) as discussed more fully in my above-mentioned copending application.

To operate the apparatus the operator first closes main power supply switch 94 which provides one input to AND gate 96. It will be understood that by closing this switch power is also supplied to other portions of the apparatus. For example, power can be supplied to preheat the fusing station 52 so that it will be at the proper temperature when the first print is made. Also, power is being provided to the various motors and controls which will be energized at appropriate times during operation of the machine by the logic circuit to be described. However, the means for supplying power to these portions of the apparatus have been omitted from both FIGS. 1 and 2 for clarity of illustration. A second input to AND gate 96 is provided by input line 98 from circuitry connected to various interlocks (not shown) which sense that all doors and compartments of the apparatus are closed before it can be energized and that developing station 40 and cleaning station 54 are in their raised position. A third inverted input is provided when normally open threading cycle switch 100, has not been closed to furnish a signal from potential

source 101. The threading mode of operation will be described below in connection with FIG. 2. A fourth inverted input indicates that there is no paper jam, as described more fully below. A fifth input signal is supplied through switch 102 from potential source 104 at paper supply station 44 to indicate that the paper supply is adequate for operation of the apparatus. A sixth input signal indicates that a photoconductive magazine containing a web is in position in a magazine receiving chamber 258. A seventh input signal to AND gate 96 is provided from developing station 40 indicating that a proper supply of toner is present. An eighth input signal to AND gate 96 is provided from timer 110 as long as the photoconductor has not been operated beyond its useful life, as more fully discussed below. It will be understood that other inputs can be provided to AND gate 96 to indicate that other operational parts of the structure are in proper operating position or condition. The final input to AND gate 96 which has been illustrated, is provided by OR gate 112. OR gate 112 has two inputs. The first is momentarily energized when a print button 118 is depressed which couples the OR gate 112 to a source of potential 120. When the button 118 is depressed, the AND gate 96 is energized and provides an input signal to an AND gate 122. A second normally energized signal is provided to the AND gate 122 so that when the button 118 is released, the AND gate 122 provides the second high level signal to the OR gate 112 which causes the AND gate 96 to remain energized. The AND gate 96 will only be de-energized when the AND gate 122 is inhibited.

To make a print the operator first selects a predetermined number of prints desired in a storage device 113a which provides a set of digital signals to the coincidence detector 113b which also receives inputs from the various stages of a digital counter 114. When a coincidence condition is detected, (viz. at the time, the state of the counter manifests that the cumulative total number has reached such a predetermined number) the coincidence detector switches its signal to the AND gate 122 and the counter 114 to a low level. The AND gate 122 is thus de-energized which causes the AND gate 96 to turn off. The fall edge of the signal to the counter 114 causes it to reset to a "zero" storage condition.

The output from AND gate 96 also enables initiator coil 68 to light successive sectors of shift register S as each one moves past the initiator coil upon rotation of the shift register as described in my above-mentioned copending application. In addition, the output signal from AND gate 96 enables OR gate 123.

The output signal from OR gate 123 performs several functions. It engages clutch 20, releases brake 22 and enables OR gate 124 to move clutch 24 into a position in which it is in driving engagement with main drive motor 18. In addition, the same signal provides an input signal to timer 110, energizes erase lamp 56 and energizes solenoid 121 to open shutter 38. The timer will run whenever the apparatus is operating. When the time period for the useful life of photoconductive belt 2 has expired, the output signal from timer 110 is terminated thereby disabling the output of the AND gate 96 which causes a shutdown of the operation of the machine, as described hereinafter. The timer also provides a signal to a control panel (not shown) to tell the

operator that the photoconductive web is to be replaced.

The output from OR gate 123 also activates vacuum supply 125 for vacuum fingers 46 and enables AND gate 126 which will keep OR gate 123 in an enabled state for a predetermined time after AND gate 96 is de-energized during a normal shutdown of the apparatus after the desired number of copies have been made as will be discussed more fully hereinafter. The output from OR gate 123 will also enable OR gate 127 whose output enables lamps 128 and 129 of synchronizer 130 and OR gate 131 which in turn enables main drive motor 18. This synchronizer is mechanically coupled to the fingers 46 of the sheet feeder and the sequencer 130 is disclosed in above-mentioned commonly assigned U. S. application Ser. No. 23,705. OR gate 127 enables OR gate 131 which in turn enables main drive motor 18 to drive photoconductive web 2 along its endless path and cause shift register S and synchronizer 130 to be rotated in the directions indicated.

As shift register S begins to turn the signal circuit of the first sector, such as sector 58 is enabled by initiator coil 68 so that lamp 70 is illuminated. When it reaches the position where slot 75 is aligned with slot 82 adjacent photocell 132, the photocell will be illuminated to provide a signal to set flip-flop 134 which now provides a signal from its "one" output to energize a high voltage supply 134a which in turn energizes a corona charger 26 and thereby place a generally uniform charge on a segment of photoconductive belt 2. The signal from photocell 132 also provides a count signal to counter 114 to permit it to change state. As the shift register continues to turn in synchronism with the movement of the charged segment of belt 2, the light from the lamp will energize photocell 136 when slot 75 is aligned with slot 82 adjacent photocell 136 to clear flip-flop 134 and hence de-energized the supply 134a and turn off charger 26 and to also set flip-flop 138 which then provides a signal from its "one" output to one input of AND gate 140 to arm exposure station 28. The second input signal to AND gate 140 is provided by synchronizer 130 when slot 142 thereof is positioned so that light 128 illuminates photocell 144. This occurs when vacuum fingers 46 are in proper position to feed a receiver sheet in proper timed relation to the segment of belt 2 from which a toner image is to be transferred. The signal from photocell 144 enables AND gate 140 which enables single shot 146 to provide a pulse signal to a high voltage power supply say, for example, in the order of 3KV for a predetermined time duration illuminating the flashlamps 32. In this manner charged photoconductive belt 2 is exposed to an image of original 30 thereby dissipating the charge in the exposed areas to form an electrostatic latent image thereon. It will be understood that the power supply 146a may include means for varying the exposure time as desired.

Further rotation of shift register S illuminates photocell 150 to provide a signal to reset flip-flop 138 so that AND gate 140 can later be armed for exposure of the next charged portion of photoconductive belt 2. Next, photocell 152 is illuminated to provide a signal to vacuum control circuit 154 which may be embodied by a flip-flop adapted to energize a valve (not shown) to supply a vacuum from vacuum supply 125 to vacuum fingers 46.

The enabled sector of shift register S will illuminate photocell 156 next to provide a signal to turn on automatic bias control circuit 158 to adjust the potential on a development electrode (not shown) which forms a part of developer station 40. Next, photocell 160 will be illuminated to provide a signal to turn on transfer charger 42 and to clear flip-flop 162, whose function is explained below. Photocell 164 is then illuminated to turn off bias control circuit 158 as a developed toner image leaves developing station 40.

At the appropriate time, slot 142 of synchronizer 130 will become aligned with photocell 165 so that it is illuminated by light 129. This will cause the photocell to provide a signal to turn off vacuum control circuit 154 when a copy sheet has been fed between feed rollers 48 and 50.

Subsequently, the synchronizer S causes illumination of photocell 166 by the enabled sector of shift register S. The photocell 166 produces an input signal to the set side of a flip-flop 162 which provides an output signal to one input of AND gate 168 to arm a circuit for shutting down the machine if no additional prints are to be made, i.e., if no more sectors are illuminated. If another sector is illuminated, photocell 160 will again be energized to clear flip-flop 162 and thereby terminate the input signal to AND gate 168. Finally, photocell 170 is illuminated, but only after the next sector has passed by photocell 160, to provide a second and final input signal to AND gate 168. If the next sector is enabled flip-flop 162 has been cleared, so AND gate 168 will not be enabled. On the other hand, if the next sector is disabled, as described in the above-mentioned U. S. Pat. application, Ser. No. 19,644, flip-flop 162 is still set and AND gate 168 is enabled to shut down the apparatus, as described below.

The signal from photocell 170 turns off transfer charger 42 and provides one input to a paper jam time delay circuit 172 which has another input connected to a paper sensor 174. If a receiving sheet does not come out of fusing station 52 within the required time so that it is sensed by sensor 174, time delay circuit 172 provides a signal which disables AND gate 96 to shut down operation of the apparatus immediately. Any suitable time delay circuit may be used, such as one in which a capacitor (not shown) is charged to a predetermined level over a given time period after which the signal is generated. The signal from time delay circuit 172 will also disable AND gates 126 and 180 which in turn disable OR gates 123 and 127, respectively, and thereby shut down all operations of the apparatus. After the paper jam is cleared, the operator closes print button 118 again and operation resumes.

Assuming no paper jam occurs, the lighted sector will be disabled or turned off by permanent magnet 92 which will open a reed switch in the output circuit of the sector (not shown) as described more fully in my copending U. S. application Ser. No. 19,644. The sector can be enabled again by initiator coil 68 and the cycle repeated so long as counter 114 has not counted down to zero.

When a signal from photocell 132, representing the last print to be made, occurs the detector 113b reaches coincidence and terminates the signal from the "one" output thereof thereby disabling AND gate 122 and OR gate 112 which in turn disables AND gate 96. The disablement of AND gate 96 disables initiator coil 68 so

that no more sectors are illuminated and it also terminates one input signal to OR gate 123 but OR gate 123 remains enabled by AND gate 126 and the apparatus continues to run, printing out the remaining images which are in various stages of formation at different sections of belt 2. However, when photocell 170 is illuminated by the last lighted sector, AND gate 168 is enabled since no lighted sectors remain to clear flip-flop 162. The resulting output signal from AND gate 168 disables AND gate 126, which disables OR gate 123 so that clutch 20 is disengaged, brake 22 is engaged, OR gate 124 is disabled to disengage clutch 24 and vacuum supply 125 is turned off. This stops operation of endless belt 20, developing station 40, cleaning station 54 and shift register S which will coast just far enough so that the last lighted sector will be turned off by permanent magnet 92. However, main drive motor 18 continues running for a predetermined time, so that fusing station 52 and transport mechanism 53 operate until the last print exists therefrom. This time period is determined by time delay circuit 178 which is activated by a signal from photocell 170 to keep AND gate 180 and OR gate 127 enabled for the predetermined period.

When photoconductive web 2 is to be replaced, the used web may be removed from the apparatus and a new web threaded thereon by the automatic threading apparatus and logic circuitry shown in FIG. 2. To begin the rewind operation, the operator closes normally open switch 100 which provides an input from power source 101 to AND gate 194 whose first input is provided from main power switch 94 (see FIG. 1). AND gate 194 establishes an output signal and provides it to counter 196, to one input of AND gate 198, and to an enabling circuit 200 which energizes lamp 74 of sector 66 of sequencer S. No other sectors are enabled during the unthreading or threading operation. AND gate 198 is now enabled and energizes a developer station motor 202 which moves developing station 40 away from belt 2 from the position shown so as to close normally open switch 204 which provides a signal from potential source 206 to one input of AND gate 208 and to one input of AND gate 210. This signal enables AND gate 210 which then provides an output signal to OR gate 124 to enable it. OR gate 124 energizes clutch 24 which moves to a position wherein it connects the roller 8 to main drive motor 18. The output signal from AND gate 210 also provides an input signal to OR gate 131 which energizes drive motor 18. The motor 18 is now coupled to the photoconductive web 2 and causes it to be moved at relatively high speed in a generally counterclockwise direction of travel as indicated by arrow 212 and sequencer S is rotated in a clockwise direction as indicated by arrow 213. The signal from potential source 206 also provides an input which is inverted, to AND gate 198 when the developing station is in a position spaced from photoconductive web 2 to disable AND gate 198 and hence motor 202.

During a predetermined number of cycles as determined by counter 196 any residual toner powder remaining on photoconductive web 2 is removed by cleaning station 54. Each time web 2 makes a complete revolution, sequencer S also makes a complete revolution and provides an output signal from lighted sector 66 to photocell 214 which provides a countdown pulse

to counter 196, and also an input pulse to one input of AND gate 216. The counter block 196 will also be understood to include an AND gate which is coupled to selected output lines of the stages of the counter so that when photoconductive web has made a desired number of revolutions, such as 5 or 6, as preset by the AND gate, the AND gate provides an output signal which is delivered to AND gate 216. AND gate 216 is now enabled and provides an output signal to one input terminal of AND gate 218 and to the second inverted input terminal of AND gate 210. AND gate 210 is now disabled and de-energizes OR gate 131, which in turn disables drive motor 18 stopping movement of photoconductive web 2. The disabling of AND gate 210 also disables OR gate 124 and deenergizes clutch 24. Meanwhile, AND gate 218 has been enabled to cause cleaning station positioning motor 220 to lower cleaning station 54 from the position shown to the position where it closes normally open switch 222 to provide a signal from potential source 224 to an inverted second input of AND gate 218 to disable AND gate 218 and stop motor 220. The signal from potential source 222 also provides the signal to the second and final input of AND gate 208 which is enabled to move clutch 24 to a position to bring thread-unthread motor 25 into driving engagement with photoconductive web 2 and to set flip-flop 209 for a purpose to be described. Furthermore, the signal from potential source 224 is provided to one input of AND gate 225 and to one input of AND gate 226 which is enabled and in turn enables motor 25 to drive photoconductive web 2 in the unthread direction as indicated by dashed arrow 228. Photoconductive web 2 is driven at a much slower speed by thread-unthread motor 25 than by main drive motor 18 during which various functions of the unthreading and threading cycles are initiated by lighted sector 66 of sequencer S.

During movement in the unthreading direction of arrow 228, sequencer S rotates in the direction of dashed arrow 229 so that lighted sector 66 moves from a position wherein light 74 shines through a slot 82 to illuminate photocell 214 to a position in which light passes through a slot 82 to illuminate photocell 230 and provide a second input signal to AND gate 225 which causes guide roller drive 232 to move guide rollers 234 from a retracted position to an extended position adjacent web 2 to close switch 236 which causes a signal to be provided from potential source 238 to a third inverted input to AND gate 225 to disable the AND gate and stop guide roller drive 232. This same signal, provided by potential source 238, is also applied to one input of AND gate 239 which enables the AND gate to in turn enable OR gate 240 which causes photoconductor tension motor 241 to be energized to move roller 6 to the right, as viewed in FIG. 2, to release tension on photoconductive web 2 so that lugs 16 can be unhooked from tow bar 4. When roller 6 has been moved to a position in which the tension is released, normally open switch 242 provides a signal from potential source 244 to an inverted input to AND gate 239 to disable it and to disable OR gate 240 and tension motor 241. This same signal from potential source 244 is provided to an inverted input to AND gate 246, to an input of AND gate 248, flip-flop 249 which provides an input to AND gate 250, flip-flop 251 which provides an input to

AND gate 252, AND gate 254 to an inverted input of AND gate 255 and to clear flip-flop 279 as described.

The signal to the input of AND gate 248 enables this AND gate to cause takeup motor 256 to be energized so that photoconductive web 2 is fed into magazine 258 in a manner described more specifically in above-mentioned commonly assigned U. S. Ser. No. 834,695, filed June 19, 1969. Thus, as thread and unthread motor 25 continues to move the belt in the unthread direction of arrow 228, takeup motor 256 continues to wind the end of web 2, which has been unhooked from lugs 16, onto magazine 258. When illuminated sector 66 reaches a position wherein light 74 shines through slot 82 to illuminate photocell 136, a signal is provided to a second input of AND gate 252 which is now enabled thereby causing OR gate 260 to apply a potential to tension motor 241 to run it in the reverse direction to move roller 6 toward the left, as viewed in FIG. 2 to restore tension and close normally open switch 262 to provide a signal from potential source 264 to an inverted input of both AND gates 250 and 252 and to clear flip-flops 249 and 251. The signal to AND gate 252 disables this AND gate and also disables OR gate 260 so that tension motor 241 is de-energized. The signal from potential source 264 is also provided to one input of AND gate 266. The photoconductive web 2 continues to be wound onto magazine 258 until sector 66 of the sequencer reaches a position wherein photocell 268 is illuminated and provides a second input signal to AND gate 266 which is enabled and in turn enables OR gate 270 which causes guide roller drive 232 to move guide rollers 234 from the extended position in which switch 236 was closed toward a retracted position so that the guide rollers close an intermediate position switch 272 to provide a signal from potential source 238 to an inverted input to AND gate 268 thereby disabling that AND gate 266 and OR gate 270 to de-energized guide roller drive 232. In addition, the signal from potential source 238 is applied to the set input of a flip-flop 273 which changes state and applies a signal to an inverted input to AND gates 226 and 248 respectively which are then disabled and de-energize thread-unthread motor 25 and takeup motor 256, respectively. At this point, the entire apparatus is disabled and used photoconductive web 2 is completely stored within magazine 258 for removal by the operator.

The operator now opens a compartment door in the apparatus and removes the magazine containing the old photoconductive web and replaces it with a magazine containing a new photoconductive web in a manner more fully described in the above-identified copending application. When a new magazine has been placed in the machine and the door closed, the operator closes normally open switch 274 which provides a signal from potential source 276 to AND gate 278 which is then enabled causing thread-unthread motor 25 to be driven in the thread direction so that the end of the new photoconductive web is attached to the tow bar and pulled along the path in the direction of arrow 212. Of course, sequencer S will be rotated in a clockwise direction as indicated by arrow 213 during this portion of the threading operation. Since the sequencer had previously stopped in a position in which photocell 268 was energized, and provided a signal which set flip-flop



279 which in turn provided a first input to an AND gate 280, when the AND gate 28 receives a second and final input from the output of AND gate 78 it provides a signal to normally open switch 282 which is closed when the photoconductive web reaches the position of the switch to provide a signal indicating that the new photoconductive web 2 is being properly fed along its endless path. This latter signal is provided to one input of AND gate 246 which is enabled and in turn enables OR gate 240 and drives photoconductive tension motor 241 in a direction to release tension by moving roller 6 to the right as viewed in FIG. 2. When tension roller 6 reaches a position wherein it closes tension-release switch 242, a signal will be provided from potential source 244 to an inverted input to AND gate 246 thereby disabling the AND gate 246 and OR gate 240 to de-energize motor 241. This same signal from potential source 244 also clears flip-flop 279 and sets flip-flops 249 and 251.

Photoconductive web 2 continues to be threaded around its endless path until tow bar 4 is overlapped by the trailing end of the web which is now completely removed from magazine 258 and is engaged with lugs 16. At this point, illuminated sector 66 reaches a position to illuminate photocell 284 which provides a signal to a second and final input to AND gate 254 whose first input is provided from potential source 244 by switch 242. The output signal from AND gate 254 to an inverted input to AND gate 278 disables the AND gate and de-energizes motor 25.

The signal from photocell 284 also provides an input to AND gate 250 whose second input is provided by flip-flop 249 thereby enabling AND gate 250 and also enabling OR gate 260 to energize tension motor 241 to move tension roller 6 to the left as viewed in FIG. 2 to interlock the overlapping end of new photoconductive web 2 with lugs 16. This movement continues until tension restoring switch 262 is closed, thereby providing a signal from potential source 264 to an inverted input to AND gate 250 thereby disabling it as well as OR gate 260 to de-energize motor 241. This signal from potential source 264 also clears flip-flop 249 and 251.

The signal from photocell 284 as well as the signal from potential source 264 are provided to first and second inputs to AND gate 286 which is enabled thereby enabling OR gate 270 to cause guide roller drive 232 to move guide rollers 234 from their intermediate position to a retracted position whereupon switch 288 is closed to provide a signal from potential source 238 to an inverted input of AND gate 286 thereby disabling the AND gate and also disabling OR gate 270 to de-energize guide roller drive 232.

Simultaneously, AND gate 290 is enabled by receiving input signals from photocell 284 and from potential source 264 thereby causing cleaning station positioning motor 220 to drive the cleaning station from a lowered position to the raised position shown until switch 201 is closed whereupon a signal is provided from a potential source 199 to an inverted input of AND gate 290 disabling the AND gate and de-energizing motor 220. The same signal clears flip-flop 273 and also provides a signal to the second input of AND gate 292, which receives an input signal from previously set flip-flop 209, and therefore is now enabled. The output signal from AND gate 292 enables OR gate 131 to cause main

drive motor 18 to be driven through clutch 24 which has been moved to its main drive position by the same output signal from AND gate 292 which also enables OR gate 124. Thus, photoconductive web 2 and sequencer S continue moving in the same direction they have been moving but now they are driven at a higher speed by main drive motor 18 rather than at a slower speed by motor 25. When lighted sector 66 illuminates photocell 170, the output signal from the photocell provides a signal to an inverted input to AND gate 292 thereby disabling the AND gate and disabling OR gate 131 to de-energize main drive motor 18 and stop movement of photoconductive web 2. In addition, the signal from photocell 170 provides an input signal to single shot 294 which provides an output signal to one input of AND gate 255 for a sufficient length of time to cause motor 202 to move developing station 40 from a lowered position to the raised position shown in FIG. 2. Upon reaching the raised position, a normally open switch 298 is closed to provide a signal from potential source 300 to clear flip-flop 209 and to an inverted input to AND gate 255 thereby disabling the AND gate and de-energizing motor 202. In addition, this signal resets counter 196 and provides a signal to one input of AND gate 302 whose second input is provided by single shot 294 thereby enabling AND gate 302 which provides an inverted signal to a third input to AND gate 194 thereby disabling the AND gate and terminating the signal to circuit 200 to disable sector 66. At this point, the threading operation has been completed.

From the foregoing, the advantages of this invention are readily apparent. An apparatus has been provided wherein a count signal to an arbitrary number counter is provided from one of the signals for controlling the apparatus from a sequencer. In addition, the apparatus shuts down in a sequential manner so that the photoconductive member stops movement as soon as the last print is made whereas the fusing station continues operating until a receiver sheet bearing the last toner image is transferred therethrough.

The invention has been described in detail with reference to a preferred embodiment thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

We claim:

1. In electrophotographic apparatus having an electro-photosensitive web, means for moving the electro-photosensitive web along an endless path relative to a plurality of actuable work stations wherein each of the work stations is operative when actuated to perform a work operation on the web, the combination comprising:

- a. a plurality of actuable work station actuating means;
- b. means for sequentially actuating particular ones of the work station actuating means in timed relation to movement of the web past predetermined positions along the path for sequentially actuating corresponding work stations to cause them to perform work operations on the web respectively, and producing at least one signal indicative of each time at least one particular work station has performed a work operation on the web;

- c. counter means responsive to said signals and having a state representative of the total cumulative number of said signals; and
- d. means responsive to a particular state of said counter means corresponding to a selected cumulative number of said signals for preventing actuation of each of said work station actuating means after its corresponding work station has performed a predetermined number of work operations.

2. In electrophotographic apparatus having means for repetitively moving an electrophotosensitive web along a first endless path relative to a plurality of actuable work stations, wherein each work station is operative when actuated to perform a work operation on the web, the combination comprising:

- a. means defining a second predetermined path;
- b. a plurality of signal actuable work station actuating means, each of said actuating means being disposed at a predetermined position along the second predetermined path;
- c. means movable along said second predetermined path for sequentially actuating particular ones of said plurality of work station actuating means in timed relation to movement of the web past predetermined positions along the first path for sequentially actuating the work stations to perform work operations on the web, respectively;
- d. counter means responsive to said count signals and having a state representative of the total cumulative number of count signals; and
- e. means responsive to a particular state of said counter means corresponding to a selected cumulative number of said count signals for sequentially preventing actuation of each said work station after it has performed a predetermined number of work operations.

3. The invention as set forth in claim 2 wherein said sequential actuating means includes an element movable along the second predetermined path, a source of energy on said element, and wherein said plurality of actuable work station actuating means comprises a plurality of energy sensing means disposed at predetermined positions on the second path and responsive to said energy source upon movement of said element along said second path to actuate particular ones of the work stations to perform a work operation on the web, respectively.

4. The apparatus as set forth in claim 2 wherein said sequential actuating means includes drive means effective in a first condition for moving the web along the endless path relative to the work stations and in a second condition for stopping movement of the web and wherein said selected counter state responsive means is responsive to said selected cumulative number to be effective to cause said drive means to be in said second condition.

5. In electrophotographic apparatus including a photoconductive member movable along an endless path past a plurality of electrophotographic stations to make one or more toner images from an original, said apparatus including:

- drive means for moving the photoconductive member along said endless path through said electrophotographic stations;
- Sequencer means responsive to movement of the photoconductive member to provide (a) output control signals sequentially to control said electrophotographic stations and (b) at least one count signal indicating that a print has been made;
- circuit means to enable said drive means and said sequencer means;
- means to energize said circuit means to initiate operation of said apparatus;
- counter means responsive to said count signals to manifest a cumulative total number of count signals; and
- means adjustable to be responsive to a selected cumulative predetermined number of count signals to de-energize said circuit means and disable said drive means and said sequencer means in a timed sequence to permit the predetermined number of toner images to be made from the original.

6. The invention as set forth in claim 5 wherein said sequencer means includes a device movable along a second predetermined path by said drive means to produce said output control signals.

7. Apparatus, as claimed in claim 6, wherein one of said electrophotographic stations is a transfer station for transferring the toner images sequentially to receiver sheets fed through said transfer station, said apparatus further including:

- means for feeding the receiver sheets through said transfer station to receive the toner images; and
- a fusing station spaced from said endless path including feed means connected to said drive means for feeding the image-bearing receivers through the fusing station to fuse the respective images thereto;

said circuit means including:  
 a clutch for connecting said drive means to the photoconductive member; and  
 means to disable said clutch in response to an output signal from said sequencer means to stop the photoconductive member and to sequentially disable said drive means after a predetermined length of time sufficient to feed the last image-bearing receiver through said fusing station.

8. Apparatus, as claimed in claim 7 wherein one of said plurality of electrophotographic stations is a charging station and said one of said control signals for turning on said charging station is said count signal.

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