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Lloyd

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[54] INTEGRATED CIRCUIT SEQUENCER

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[73] Assignee: **Eastman Kodak Company,** Rochester, N.Y.

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[52] **U.S. Cl.** **355/14,** 328/37, 355/16

[51] **Int. Cl.** **G03g 15/00**

[58] **Field of Search**.....355/14, 16, 3, 53, 355/86, 96, 6; 328/37

[56] **References Cited**

UNITED STATES PATENTS

3,450,995	6/1969	Hirsch	328/37 X
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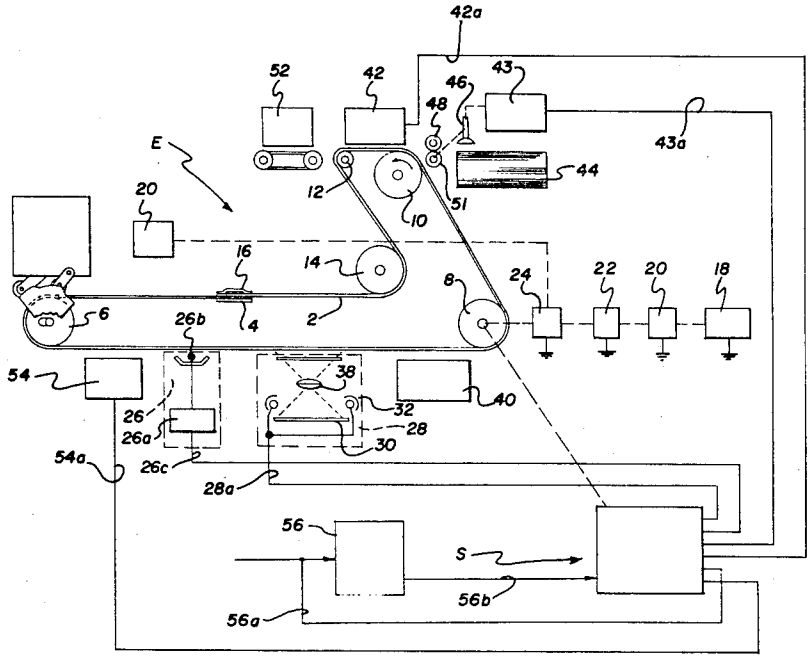
Primary Examiner—Robert P. Greiner

Attorney—W. H. J. Kline et al.

[57] **ABSTRACT**

Electrophotographic copying apparatus is disclosed having an elongated electrosensitive web defining a plurality of selectable image areas and movable along an endless path relative to a plurality of actuable work stations disposed along the path. Each work station is operative when actuated to perform a work operation on a selected image area of the web. The apparatus includes an electronic sequencer for sequentially actuating particular ones of the work stations to cause them to perform work operations on the web in timed relation to movement of selected image areas along the path respectively. The sequencer includes a shift register having a plurality of states, the state at any particular time being a function of the position of the web along the path and the number of copies to be made. The sequencer further includes means for producing a first signal having a frequency proportional to the rate of movement of the web along the path, a counter responsive to the first signal and having a plurality of states, the state at any particular time manifesting the total cumulative number of first signals, and decoding networks responsive to particular states of the shift register and particular states of the counter for sequentially actuating and de-actuating the actuable work stations in timed relation to movement of the web past predetermined positions along the endless path to effect sequential operation of such work stations with respect to selected image areas.

3 Claims, 2 Drawing Figures



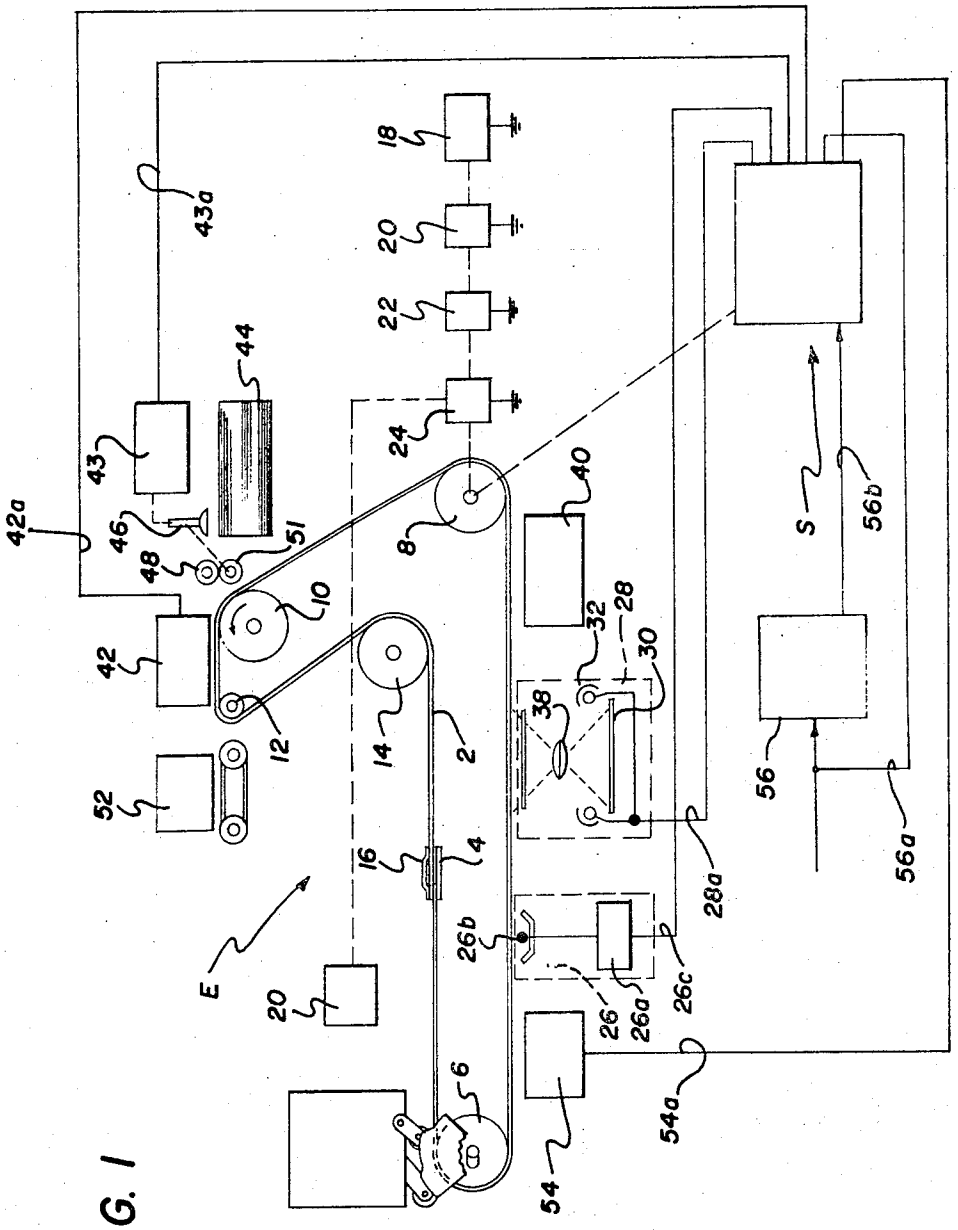

18
20
22
24
43a
44
43
42a
46
48
51
10
42
12
52
14
2
16
4
E
20
6
8
40
32
28
30
38
26b
26
26a
26c
28a
54
54a
S
56b
56
56a

FIG. 1

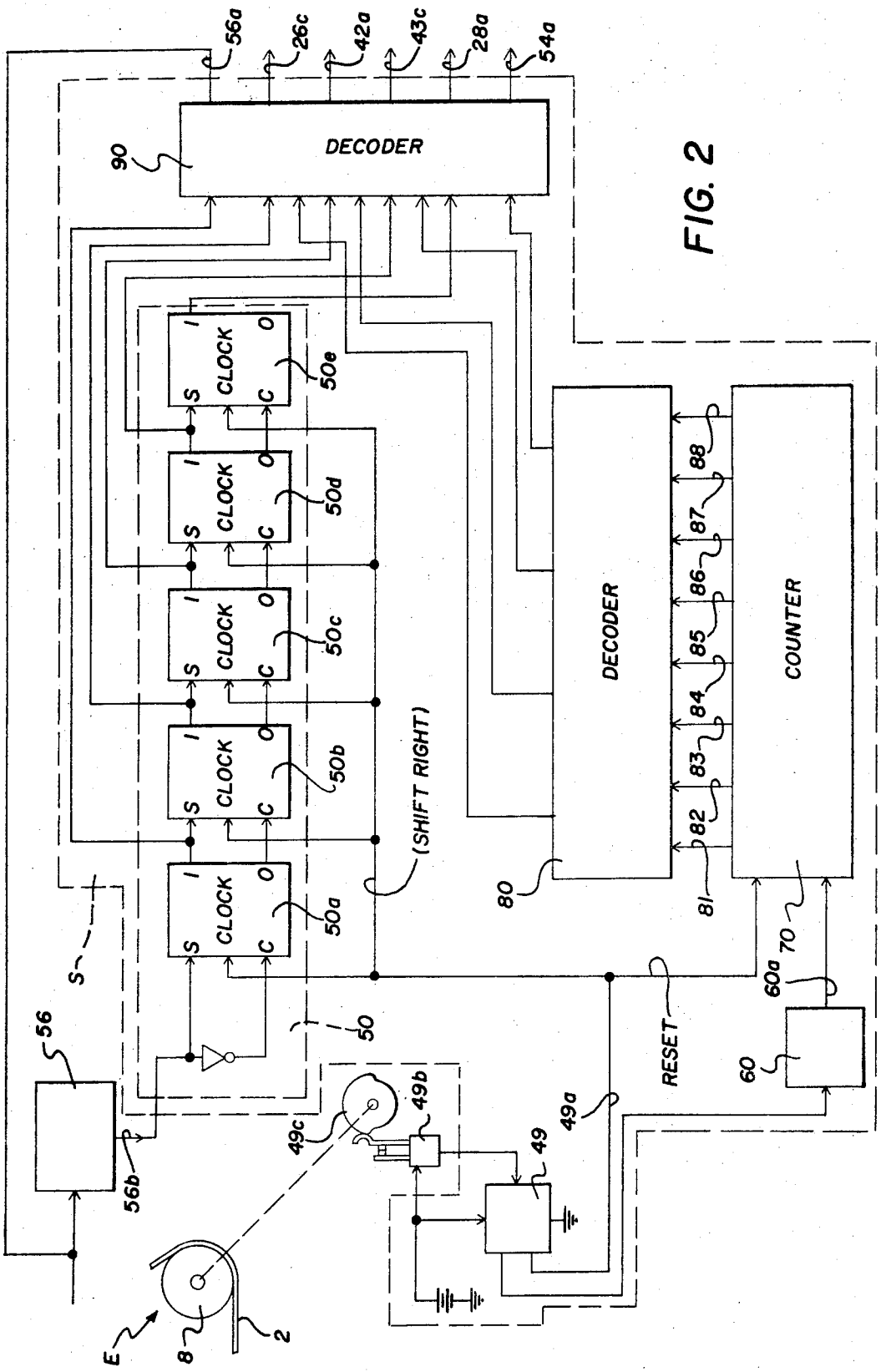

56a
26c
42a
43c
28a
54a
90
DECODER
CLOCK
50e
50d
50c
50b
50a
(SHIFT RIGHT)
DECODER
COUNTER
88
87
86
85
84
83
82
81
80
70
60a
60
RESET
S
56
50
56b
49c
49b
49a
49
E
8
2

FIG. 2

INTEGRATED CIRCUIT SEQUENCER

CROSS REFERENCE TO RELATED APPLICATIONS

Reference is made to commonly assigned U. S. Pat. application Ser. No. 19,644 entitled, MAGNETICALLY CONTROLLED PROGRAMMER and commonly assigned U. S. Patent Application Ser. No. 19,999 entitled, MACHINE PROGRAMMER filed Mar. 16, 1970, the disclosures of which are incorporated in their entirety herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to apparatus for controlling the operational work stations in apparatus such as electrophotographic copying apparatus.

2. Description of the Prior Art

In a common form of electrophotographic copying apparatus, an electrical image of an information medium such as a document is formed on an electrophotosensitive medium in response to image wise actinic radiation from the medium. The electrophotosensitive medium includes a photoconductive layer with a conductive backing, and is transported along an endless path relative to a plurality of work stations, each of which is operative when actuated to perform a work operation on the electrophotosensitive medium. 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 image-wise exposed to actinic radiation 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 adhering to the photoconductive layer in a configuration defined by the electrostatic image, a transfer station at which such 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 applications in which the electrophotosensitive medium is continually reused, it can be constructed in a form of a drum, a plate or an endless web. The endless web configuration has certain advantages and disadvantages over drums and plates. Among the advantages is the fact that 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 curved configurations at other locations to facilitate other operations such as separation of a transfer sheet therefrom. Among the disadvantages is the increased complexity of the system resulting from the need to sequentially actuate work stations in timed relation to web movement and control the number of copies to be made.

SUMMARY OF THE INVENTION

It is an object of this invention to provide for use in an electrophotographic copying apparatus improved apparatus for controlling the sequential actuation of work stations and coordinating such actuations with the number of copies to be made.

In accordance with a preferred embodiment of this invention, there is disclosed an elongated electrophotosensitive web defining a plurality of selectable image areas and movable along an endless path relative to a plurality of actuable work stations wherein each work station when actuated performs an operation in conjunction with the web. The apparatus includes sequencing means for sequentially actuating and de-actuating the work stations in timed relation to movement of the web past predetermined positions along the endless path to effect sequential operations of such work stations with respect to a selected image area during movement of said area around said endless path. The sequencing means includes means for sequentially providing a first signal with first signal being representative of copy of an original to be made, means responsive to such first signal and having a plurality of states, the state at any particular time being representative of the total cumulative number of first signals. The sequencing means further includes means for producing second signals having a frequency which is a function of the rate of speed of the web along the path, counter means responsive to the second signals and having a plurality of states, the state at any particular time being representative of the total cumulative number of second signals produced in response to movement of a selected image area relative to a predetermined position along the path and means responsive to particular states of the shift register and particular states of the counter means to effect sequential operation of the actuable stations with respect to selected image areas during movement of the web along the endless path.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing the general arrangement of a web type electrophotographic copying apparatus in accordance with the invention; and

FIG. 2 is a block diagram of the sequencer device shown in FIG. 1 for controlling the actuation of various work stations 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) & 32.14–1962.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning first to FIG. 1, there is shown an electrophotographic apparatus E that includes an electrophotosensitive member in the form of a web 2 which includes a photoconductive surface on a photoconductive backing and which defines a plurality of selectable image areas; a plurality of actuable work stations; and a sequencer S disclosed more fully in connection with FIG. 2. The web 2 has a leading end attached to a tow bar 4 by studs 16 and is movable along an endless path past rollers 6, 8, 10, 12 and 14 respectively as disclosed more fully in commonly assigned U. S. copending application Ser. No. 843,695 entitled, WEB HANDLING APPARATUS AND CARTRIDGE AND WEB USABLE THEREWITH to Thaddeus Swanke, filed June 9, 1969. Roller 8 is a drive roller for the web 2 and is driven through a drive train which includes a main

drive motor 18, an electric clutch 20, a brake 22 and a clutch 24. The clutch 24 has two selectable driving positions. When it is in the first position, the clutch 24 is effective to serve as a driving connection between the main drive motor 18 and photoconductive belt 2, and when it is moved to the second position, it serves as a driving connection between a thread-unthread motor 21.

In operation, the photoconductive belt 2 is moved along an endless path past a plurality of actuable work stations, e.g., charging station 26, imaging station, developing station 40 and and transfer station 42 all located along the path.

The charging station 26 includes a power supply 26*a* and a corona wire structure 26*b* which is operative when actuated by a signal transmitted by conductor 26*c* from the sequencer S to provide a generally uniform electrostatic charge on a selected image area of the web 2. Thereafter, such charged image area is exposed to a pattern of actinic radiation at an actuable exposure station 28 where the image of an original 30 is illuminated by a plurality of high intensity light sources 32 when they are activated by a signal transmitted by conductor 28*a* from the sequencer S and light from the document is projected upon the opening of a shutter 38. The electrostatic charge in the exposed areas is then dissipated leaving an electrostatic latent image. This latent image is developed by toner particles applied at a continuously operating developing station 40. The toner particles may have a charge opposite in polarity to that of the charge from the electrostatic image and are attracted thereto to form a toner image. The toner image is then advanced through movement of the web along its endless path to the vicinity of an actuable image transfer station 42 which in response to a signal transmitted by lead 42*a* from the synchronizer S is actuated in synchronism with the arrival of a receiver sheet feed from a paper supply 44 which is fed by means of a sheet feeder 43. The sheet feeder in turn is actuatable in response to a signal transmitted by lead 43*a* from the synchronizer S and includes a vacuum finger 46 which delivers the receiver sheet to a pair of oppositely rotating feeder rollers 48 and 51 so that the receiver sheet is brought into face-to-face contact with the toner image at the transfer station 42 whereupon the toner image is transferred from the photosensitive web to a receiver sheet. The receiver sheet is then transported to a receiver hopper or to a sheet sorter shown generally at 52. Various forms of suitable sheet feeders are known in the art; however, the sheet feeder disclosed in commonly assigned copending U. S. Pat. application Ser. No. 23,705 entitled, PAPER FEED AND EXPOSURE SYNCHRONIZER to Jorgen Reesen filed Mar. 30, 1970 is especially suitable for use with the apparatus E. The remaining station, a cleaning station 54, may include an erase lamp, actuable in response to a signal conducted by lead 54*a* from the sequencer S. It will be understood to those skilled in the art that a plurality of (in this instance, five) electrostatic and toner images may be placed sequentially on successive portions of the web as it moves along the endless path so that the above discussed work operations performed at the work stations occurs in proper timed sequence on different portions of the web which correspond to selected image areas.

Turning now to FIG. 2, the sequencer S includes a logic circuit 49 which receives signals from a shaft encoder depicted schematically to include a cam 49*c* mounted on the main drive shaft of the roller 8 and which is adapted to open and close a switch 49*b* as the shaft rotates. Logic circuit 49 is adapted to produce a signal conducted by a lead 49*a* each time one of the selectable image areas advances to a position adjacent the charging station 26 along the path. Thus, logic 49 is adapted to provide five discrete signals for each complete cycle of operation of the web, viz., each time a particular point on the web completely traverses the entire endless path. The sequencer S further includes a shift register 50 having five flip-flop memory stages (50*a–e*). The shift register 50 is responsive to signals conducted by the lead 49*a* produced by the logic 49. The contents of flip-flop 50*e* are lost each time a shift command signal is provided in lead 49*a*. As will be apparent to those skilled in the art, the flip-flops 50*a–e* are placed in a reset or "zero" state just prior to commencing operation. A logic circuit 56 will be understood to include a counter preset with the number of copies to be made and is adapted to receive a "count signal" in lead 56*a* from the sequencer S. Reference is made to commonly assigned copending application entitled, CONTROL APPARATUS FOR ELECTRPHOTOGRAPHIC APPARATUS, filed Oct. 21, 1971 in the names of Lionel Hickey and Frank Guyette which discloses logic apparatus which provides the functions of circuit 56. As shown in FIG. 1 of such disclosure the circuit 56 may include a counter 14 responsive to signals from a photocell 132, with the total cumulative number of such signals being representative of the number of copies which have been made.

Returning to FIG. 2, when the web is at rest, a clear signal is generated which resets all of the stages of the shift register 50 to a reset condition. When the motor 18 (FIG. 1) is energized and the web 2 begins to rotate, the control logic 56 is rendered effective and will produce a high level input signal to the shift register 50 for so long as the number of control signals is less than the number of copies to be made which has been entered into a preset counter. Thus, when the logic 49 produces a signal for a predetermined time duration, lead 49*g* is energized and causes a binary bit to be entered into the first stage 50*a* of the shift register 50. In a similar fashion the shift register continues to receive and enter bits upon receiving signals from logic 56 and lead 49*a*. In this manner, the state of the shift register 50 at any particular time (hereinafter called present state of the shift register 50) is a function of (a) the position of the web along the path, and (b) the number of copies to be made.

In FIG. 2, there is also provided a logic circuit block 60 coupled to the logic block 49. The logic 60 is adapted to provide a clock or signal in lead 60*a* which has a frequency proportional to the rate of speed of the web to a counter 70. In one exemplary embodiment, the clock has a frequency of 250 pulses per second, when one complete revolution of the web is accomplished in four-and-one-half seconds. If the web speed should change, the frequency of the clock will change in direct proportion thereto. The clock is continuously operated at the predetermined frequency and provides

its output directly to a counter **70** having eight flip-flops (not shown). Counter circuits in accordance with the invention are commercially available and may take various forms such as for example, Model MC93161 or MC83161p manufactured by the Motorola Semiconductive Products, Inc., as disclosed in Motorola's Handbook TTL INTEGRATED CIRCUITS DATA BOOK (1970). The counter **70** has a plurality of states, the state of the counter **70** at any particular time (hereinafter the present state of the counter **70**) is representative of the total cumulative number of pulses of the clock which are received. However, it should be noted that each time a signal is produced in lead **49***a* which corresponds in time to when a selected image area moves past a predetermined position along the path, the counter circuitry **70** will be reset to a state which represents a zero total count. Eight leads (**81–88**), couple the "1" side of each flip-flop stage in the counter **70** to decoder **80**. Decoders may take various forms well known in the art and which are adapted to provide outputs over selective lead lines corresponding to particular total cumulative counts held within the counter **70**. An example of such a decoder which may be directly used with the counter **70** is Model MC8311p manufactured by Motorola and disclosed in the aforementioned Motorola data handbook. A second decoder **90** is coupled to the shift register **80** and decodes various present states of the shift register and is adapted to provide sequential outputs which depend upon the particular ones of the present states of the counter **70** which are decoded by the decoder **80** and particular ones of the present states of the shift register **50**. The decoders are readily adjustable and so may be made to be responsive to different particular states of the counter **70** in order to compensate for operational characteristic of the various devices. In this way, sequential output control signals may be provided which correspond directly with those signals shown in the aforementioned patent applications disclosed in this section entitled, CROSS REFERENCE TO RELATED APPLICATIONS. Each of the sequential output signals of the decoder **90** are adapted to sequentially actuate particular ones of the work stations. The following simplified truth table shows the relationship between the operative counts held by the counter **70**, the present state of the shift register **50** and the output signals of the sequencer S for the count line **28***a*, in the aforementioned example where the input signal conducted by lead **60***a* is at a frequency of 250 pulses per second.

TRUTH TABLE

81	0101	0	101
82	0011	1	011
83	0000	0	111
84	0000	0	111
85	0000	1	111
86	0000	1	111
87	0000	0	111
88	0000	1	111
50*a*	0000	1	111
28*a*	0000	1	000

NOTE: Output **28***a* is logic 0 for all combinations not shown explicitly in the table.

The present invention has been described in considerable detail with particular 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.

I claim:

1. In electrophotographic apparatus having an elongated electrophotosensitive web adapted to have an electrostatic image formed thereon and means for transferring information contained in such image to a receiver sheet in image transfer relation with the web, the combination comprising:

a. a plurality of actuable work stations including an actuable charging station operative when actuated for charging a selected portion of the web, an actuable exposure station operative when actuated for forming an electrostatic image on a charged portion of the web, and an actuable sheet feeder operative when actuated for feeding the receiver sheet into image transfer relation with such electrostatic image formed on the web;

b. means for moving the web along an endless path past relative to said plurality of actuable work stations; and

c. means for sequentially actuating and de-actuating said charging, exposure and transfer stations in timed relation to movement of the web past predetermined positions along said path comprising:

i. a shift register coupled to said electrophotosensitive moving means and having a plurality of states, the present state of which is a function of the position of the web along the endless path;

ii. means coupled to said moving means and effective to produce clock signals at a frequency which is a function of the rate of speed of movement of the web along the path;

iii. counter means independent of said shift register and responsive to said clock signals and having a plurality of states, the present state of which is representative of the total cumulative number of said clock signals; and

iv. decoder means coupled to said counter means and said shift register and responsive to particular ones of the present states of said shift register and particular ones of the present states of said counter means to effect sequential operation of said charging, exposure and transfer stations with respect to said selected portion during movement of the web along the endless path respectively.

2. In electrophotographic apparatus having an elongated electrophotosensitive web adapted to have an electrostatic image formed thereon and means for transferring information contained in such image to a receiver sheet in image transfer relation with the web, the combination comprising:

a. a plurality of actuable work stations including an actuable charging station operative when actuated for charging a selected portion of the photosensitive web, an actuable exposure station operative when actuated for forming an electrostatic image on a charged portion of the web, and an actuable sheet feeder operative when actuated for feeding the receiver sheet into image transfer relation with such electrostatic image formed on the web;

b. means for moving electrophotosensitive web along an endless path past relative to said plurality of actuable work stations; and

c. means for sequentially actuating and de-actuating said charging, exposure and transfer stations in timed relation to movement of the web past predetermined positions along said path comprising:

i. means coupled to said web moving means for producing a first signal each time a selected image area moves past a predetermined position along the web;

ii. a shift register responsive to said first signals and having a plurality of states, the present state of which is solely a function of the total cumulative number of said first signals;

iii. means coupled to said web moving means and effective to produce clock signals at a frequency which is a function of the rate of speed of the web along the path;

iv. counter means independent of said shift register responsive to said clock signals and having a plurality of states, the present state of which is representative of the total cumulative number of said clock signals; and

v. at least one decoder coupled to said counter and said shift register and simultaneously responsive to particular ones of the present states of said shift register and particular ones of the present states of said counter means to effect sequential operation of said charging, exposure and transfer stations with respect to said selected portion during movement of the web along the endless path respectively.

3. The invention as set forth in claim 2 wherein said decoder means is adjustable to be responsive to different ones of particular states of said counter means.

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