United States Patent [19]

Reehil

[11] **3,806,242**

[45] **Apr. 23, 1974**

[54] **APPARATUS FOR REGULATING THE OPERATION OF A DEVICE IN ACCORDANCE WITH THE SUPPLY OF MATERIAL UPON WHICH THE DEVICE OPERATES**

[75] Inventor: **Edward G. Reehil,** Henrietta, N.Y.

[73] Assignee: **Xerox Corporation,** Stamford, Conn.

[22] Filed: **Feb. 26, 1973**

[21] Appl. No.: **335,601**

Related U.S. Application Data

[63] Continuation of Ser. No. 214,297, Dec. 30, 1971, abandoned.

[52] **U.S. Cl.** **355/14,** 271/57, 340/259

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

[58] **Field of Search** 355/14, 97, 99, 103, 104, 355/108; 271/57; 340/259

[56] **References Cited**

UNITED STATES PATENTS

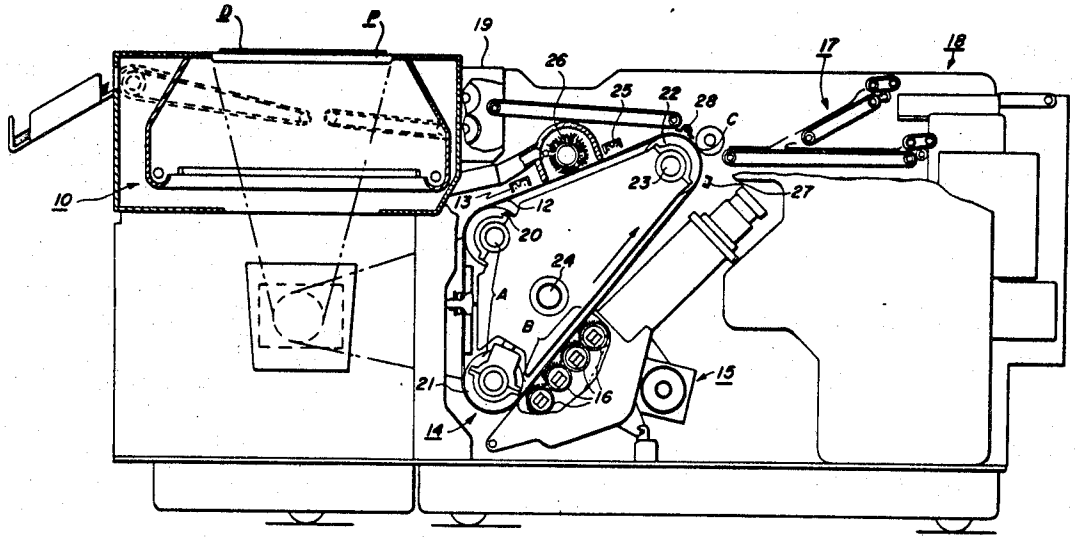
3,355,983	12/1967	Bogert et al.	355/14
3,512,885	5/1970	Osborne et al.	355/14
3,416,860	12/1968	Mihojevich et al.	355/14
3,462,217	8/1969	Tregay et al.	355/14

Primary Examiner—Richard L. Moses

[57] **ABSTRACT**

Apparatus for regulating the operation of a device in accordance with the condition of a supply of sheets of material, wherein the device operates upon said sheets of material, is disclosed in accordance with the teachings of the present invention. Control means is provided to produce an enable signal in response to action initiated by an operator, the enable signal being adapted to activate the device. Production of the enable signal is inhibited when a predetermined number of sheets remains in the supply. If, after the enable signal is produced, the last sheet of the supply is operated upon by the device, the enable signal is terminated, resulting in the de-activation of the device. Further operation of the device is, therefore, restrained. Indicating means is provided to furnish an indication of the condition of said supply of sheets.

12 Claims, 2 Drawing Figures



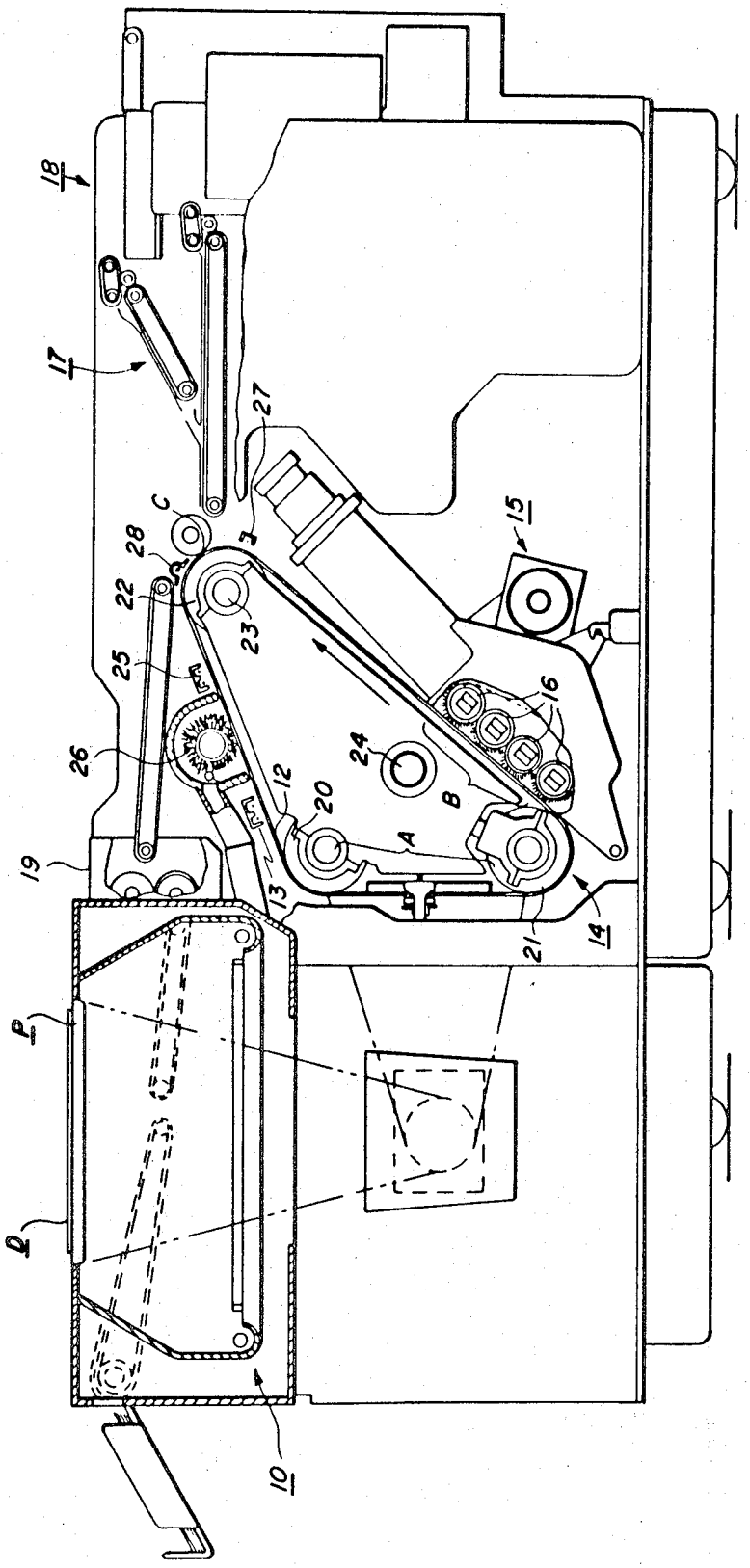


Fig. 1.

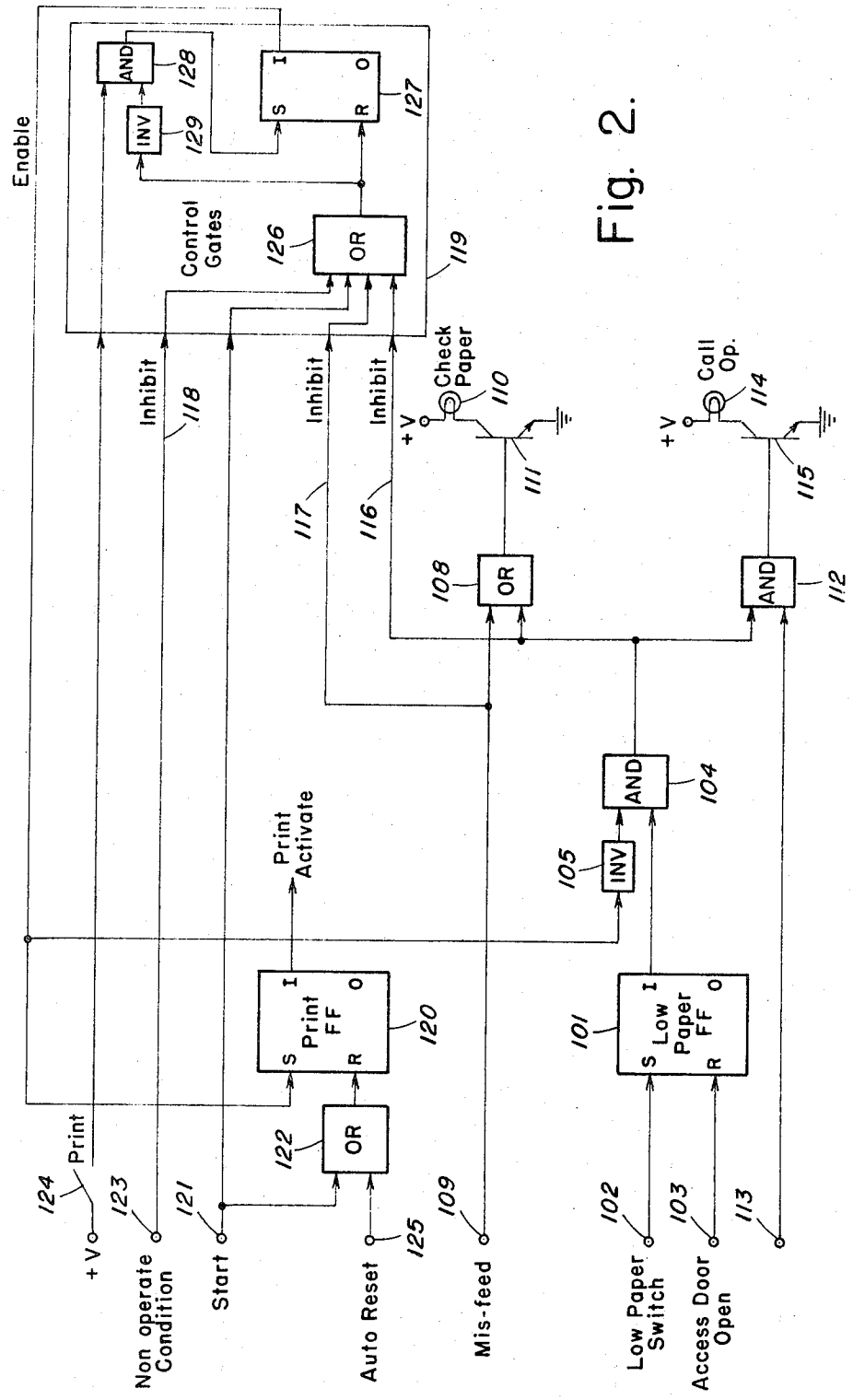

Enable
AND
128
INV
129
S
I
R
O
127
Control Gates
126
OR
119
Inhibit
118
Inhibit
117
Inhibit
116
Check Paper
110
+V
111
Call Op.
114
+V
115
108
OR
AND
112
AND
104
105
INV
Print Activate
Print FF
120
S
I
R
O
Low Paper FF
101
122
OR
124
Print
123
121
125
109
102
103
113
+V
Non operate Condition
Start
Auto Reset
Mis-feed
Low Paper Switch
Access Door Open

Fig. 2.

APPARATUS FOR REGULATING THE OPERATION OF A DEVICE IN ACCORDANCE WITH THE SUPPLY OF MATERIAL UPON WHICH THE DEVICE OPERATES

This is a continuation, division, of application Ser. No. 214,297, filed 12/30/71, now abandoned.

This invention relates to apparatus for regulating the operation of a device in accordance with the condition of a supply of sheets of material upon which the device operates and, more particularly, to such apparatus wherein the operation of the device is regulated when said supply of sheets is diminished below a predetermined minimum.

In the practice of xerography as described in U.S. Pat. No. 2,297,691 to Chester F. Carlson, a xerographic surface comprising a layer of photoconductive insulating material affixed to a conductive backing is used to supply electrostatic images. In the usual method of carrying out the process, the xerographic plate is electrostatically charged uniformly over its surface and then exposed to a light pattern of the image being reproduced to selectively dissipate the charge in the areas where light strikes the layer. The undischarged areas of the layer thus form an electrostatic charge pattern in conformity with the configuration of the original light pattern.

The electrostatic latent image may then be developed by contacting it with a finely divided electrostatically attractable material, such as a resinous powder. The powder is held in the image areas by the electrostatic fields on the layer. Where the field is greatest, the greatest amount of material is deposited; and where the field is least, little or no material is deposited. Thus, a viewable powder image is produced in conformity with the light image of the copy being reproduced. The powder is subsequently transferred to a sheet of paper or other support surface and suitably fused to thereby form a permanent print.

It is contemplated that the sheets of material to which the powder image is transferred be fed through the electrostatic reproduction machine in timed relation to the movement of the xerographic plate. Typical sheet feeding apparatus may be supplied with sheets of material that are supported in a stack-like configuration on a movable platform. The platform is preferably driven in first and second directions by suitable drive means such that a first extreme position may be assumed and a proper sheet feeding position may be assumed. In the latter position, the sheets stacked on the platform may be fed in a successive manner to the sheet transport mechanism. The platform is adapted to be driven through positions intermediate the first extreme position and the proper sheet feeding position. A complete explanation of suggested apparatus that may be employed to regulate the position of the platform is set forth in U.S. Application Ser. No. 214,299 filed on Dec. 30, 1971 and assigned to the assignee of the present invention.

In the electrostatic reproduction machine with which the aforementioned platform finds ready application, the platform is periodically indexed in a direction such that the topmost sheets stacked thereon admit of a proper position to be fed to the sheet transport mechanism. It is recognized that as sheets are removed therefrom, a condition is obtained wherein the number of sheets stacked upon the platform eventually is diminished below a predetermined minimum. Since further operation of the machine will exhaust the supply of sheets, it is preferable to restrain the initiation by an operator of a subsequent cycle of operations wherein one copy or a multiple of copies are to be produced until the supply is replenished. However, if an operating cycle requiring multiple copies has not been completed at the time the stack of sheets exhibits the predetermined minimum, the premature termination of the operation of the machine should be avoided. On the other hand, continued operation of the electrostatic reproduction machine in the absence of a supply of material upon which copies are to be formed is objectionable.

Therefore, it is an object of the present invention to provide apparatus for regulating the operation of a device in accordance with the condition of a supply of sheets of material upon which the device operates.

It is another object of this invention to provide apparatus for inhibiting the commencement of operation of a device when the supply of sheets of material upon which said device operates is less than a predetermined minimum.

A further object of this invention is to provide apparatus for interrupting the continued operation of a device when the supply of sheets of material upon which said device operates has been exhausted.

An additional object of the present invention is to provide apparatus for enabling the continued operation of a device notwithstanding the diminishing of the supply of sheets of material upon which said device operates below a predetermined minimum, provided said operation terminates prior to the exhaustion of said supply.

Yet another object of this invention is to provide apparatus for use in an electrostatic reproduction machine for inhibiting the commencement of operation of said machine in response to an operator-initiated function when the supply of paper for said machine admits of a predetermined minimum and for terminating the operation of said machine prior to the completion of a reproducing operation when said supply is exhausted.

Various other objects and advantages of the invention will become clear from the following detailed description of an exemplary embodiment thereof, and the novel features will be particularly pointed out in connection with the appended claims.

In accordance with this invention, there is disclosed apparatus for regulating the operation of a device in accordance with the condition of a supply of sheets of material therefor, said apparatus including control means adapted to produce an enable signal in response to an operator-initiated function for activating said device; inhibit means for inhibiting the production of said enable signal when said supply admits of a predetermined number of sheets and for terminating said enable signal when said supply has been exhausted; and indicating means for providing indications of the condition of said supply of sheets of material.

The invention will be more clearly understood by reference to the following detailed description of an exemplary embodiment thereof in conjunction with the accompanying drawings in which:

FIG. 1 is a schematic sectional view of an electrostatic reproduction machine embodying the principles of the invention; and

FIG. 2 is an illustration in schematic form of the apparatus of the present invention.

For a general understanding of the illustrated copier/reproduction machine in which the invention may be incorporated, reference is had to FIG. 1 in which the various system components for the machine are schematically illustrated. As in all electrostatic systems, such as a xerographic machine of the type illustrated, a light image of a document to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged developing material to form a xerographic powder image, corresponding to the latent image on the plate surface. The powder image is then electrostatically transferred to a support surface and fixed by a fusing device to cause the powder image to adhere permanently to the support surface.

In the illustrated machine, a document D to be copied is placed upon a transparent support platen P fixedly arranged in an illumination assembly, generally indicated by the reference numeral **10**, positioned at the left end of the machine. Light rays from an illumination system are flashed upon the document to produce image rays corresponding to the informational areas. The image rays are projected by means of an optical system onto the photosensitive surface of a xerographic plate in the form of a flexible photoconductive belt **12** arranged on a belt assembly, generally indicated by the reference numeral **14.**

The belt **12** comprises a photoconductive layer of selenium which is the light receiving surface and imaging medium for the apparatus, on a conductive backing. The surface of the photoconductive belt is made photosensitive by a previous step of uniformly charging the same by means of a corona generating device or corotron **13.**

The belt is journaled for continuous movement upon three rollers **20, 21** and **22** positioned with their axes in parallel. The photoconductive belt assembly **14** is slidably mounted upon two support shafts **23** and **24** with the roller **22** rotatably supported on the shaft **23** which is secured to the frame of the apparatus and is rotatably driven by a suitable motor and drive assembly (not shown) in the direction of the arrow at a constant rate. During exposure of the belt **12,** the portion exposed is that portion of the belt running between rollers **20** and **21.** During such movement of the belt **12,** the reflected light image of such original document positioned on the platen is flashed on the surface of the belt to produce an electrostatic latent image thereon at exposure station A.

As the belt surface continues its movement, the electrostatic image passes through a developing station B in which there is positioned a developer assembly generally indicated by the reference numeral **15,** and which provides development of the electrostatic image by means of multiple brushes **16** as the same moves through the development zone.

The developed electrostatic image is transported by the belt to a transfer station C whereat a sheet of copy paper is moved between a transfer roller and the belt at a speed in synchronism with the moving belt in order to accomplish transfer of the developed image by an electrical bias on the transfer roller. There is provided at this station a sheet transport mechanism generally indicated at **17** adapted to transport sheets of paper from a movable platform included in a paper handling mechanism generally indicated by the reference numeral **18** to the developed image on the belt at the station C.

After the sheet is stripped from the belt **12,** it is conveyed into a fuser assembly, generally indicated by the reference numeral **19,** wherein the developed and transferred xerographic powder image on the sheet material is permanently affixed thereto. After fusing, the finished copy is discharged from the apparatus at a suitable point for collection externally of the apparatus.

Further details regarding the structure of the belt assembly **14** and its relationship with the machine and support therefor may be found in the copending Application Serial No. 102,312 assigned to Xerox Corporation, the assignee of the present invention.

Referring now to FIG. **2,** there is illustrated, in partial schematic and partial block form, the subject matter of the present invention which is effective to regulate the operation of the aforedescribed electrostatic reproduction machine in accordance with the condition of the supply of sheets of material therefor. The apparatus depicted herein finds ready application with sheets of material stacked upon a movable platform, such as that disclosed in copending Application Ser. No. 214,299, filed on Dec. 30, 1971 and assigned to Xerox Corporation, the assignee of the present invention. It should, however, be clearly understood that the exemplary embodiment of the instant invention, as disclosed herein, may be utilized with any suitable supply of sheets of material. As illustrated, the apparatus comprising the subject matter of this invention is comprised of control means **119,** flip-flop means **101,** coincidence means **104** and flip-flop means **120.** Control means **119** is adapted to produce an enable signal for activating the aforedescribed electrostatic reproduction machine, or other operating device with which the present invention may be employed, to operate upon sheets of material supplied thereto from a suitable supply. Control means **119** serves to monitor the operating condition of the electrostatic reproduction machine and is capable of receiving various signals representative of such condition. In the absence of a signal applied thereto indicating that said machine is not capable of proper operation, control means **119** is responsive to an operator-initiated function to produce the enable signal. Accordingly, control means **119** may comprise conventional gate means, such as plural input AND gates and OR gates, well known to those of ordinary skill in the art. An exemplary embodiment of such gate means is illustrated herein and described hereinbelow.

The control means **119** includes an energizing input terminal coupled to manually operable switch means **124.** The control means further includes a first inhibit input terminal coupled to conducting means **116,** a second inhibit input terminal coupled to conducting means **118** and a third inhibit input terminal coupled to conducting means **117.** It is to be appreciated that control means **119** is effective to produce the enable signal in response to the application of a signal to the energizing input terminal thereof, provided a signal is not applied to the first or second input terminals thereof. Moreover, once the enable signal is produced, the application of a signal to the third inhibit input terminal of control means **119** serves to terminate the enable signal. The control means is further adapted to assume an initial condition in response to a signal applied to a

preestablished input terminal thereof. Hence, such preestablished input terminal of control means **119** is coupled to terminal **121** whereat an initializing signal is provided when power is first supplied to the electrostatic reproduction machine. In view of the foregoing, one of ordinary skill in the art may readily implement the particular circuitry contemplated in the construction of the control means. A typical embodiment thereof as illustrated herein will soon be described.

Flip-flop means **101** comprises a conventional bistable device having a set input terminal and a reset input terminal. The flip-flop means may be, typically, as R-S flip-flop, a J-K flip-flop, or the like, wherein a first, or set, state is assumed in response to a binary "1" supplied to a set input terminal and a second, or reset, state, is assumed in response to a binary "1" supplied to a reset input terminal. Alternatively, the flip-flop means may comprise cross-coupled NOR gates or NAND gates, as is well known to those of ordinary skill in the art. For the purpose of the present discussion, it will be assumed that a binary "1" is represented by a positive d.c. potential and a binary "0" is represented by ground potential. It is, of course, understood that the foregoing binary signals may be represented by any suitable voltage potentials.

The set input terminal of flip-flop means **101** is coupled to terminal **102** and is adapted to be supplied with a signal representing that the supply of sheets of material has been reduced such that only a predetermined number of sheets remains in said supply. The reset input terminal of flip-flop means **101** is coupled to terminal **103** and is adapted to be supplied with a signal representing that said supply has been replenished with sheets of material. The low supply signal may be applied to terminal **102** by suitable actuating means, not shown, responsive to the number of sheets of material included in said supply. If sheets of material are stacked in an elevator assembly, such as that described in aforementioned copending Application Ser. No. 214,299, it is recognized that a conventional switch means may be fixedly disposed and adapted to be contacted by the movable platform when said platform is indexed up to a predetermined position. This position will be attained after a suitable number of sheets of material that are stacked on the platform have been withdrawn, leaving a predetermined number of sheets remaining thereon. Alternatively, the generation of the low supply signal may be a function of the weight of the stack of sheets of material such that when a predetermined number of sheets remain in the stack, the weight thereof is sufficient to open (or close) a switching device, resulting in the application of the low supply signal to terminal **102.** A further alternative in the production of the low supply signal may employ a source of light in communication with a photoelectric device. The stack of sheets may be interposed in the light communication path such that a reduction in the size of the stack to a predetermined number of sheets results in the completion of the light communication path. In this manner, the photoelectric device may be energized to produce the low supply signal.

If the supply of sheets of material are stacked in the aforementioned elevator assembly, the signal representing that said supply has been replenished may be produced in response to the opening of the elevator access door by the operator. Accordingly, a conventional switching device may be disposed in a fixed location relative to the access door whereby opening of the door by an opeator to load further paper onto the elevator assembly is effective to apply a representative signal to terminal **103.**

Flip-flop means **101** includes an output terminal coupled to a first input terminal of coincidence means **104.** The coincidence means includes a second input terminal coupled to control means **119** via conventional inverter means **105** and is adapted to produce an output signal in response to the application of a predetermined signal at each input terminal thereof. Accordingly, coincidence means **104** may comprise a conventional AND gate whereby a binary "1" is produced at the output terminal thereof when a binary "1" is supplied to each input terminal thereof. Similarly, the coincidence means may comprise a conventional NAND gate wherein a binary "0" is produced at the output terminal thereof when a binary "1" is supplied to each input terminal thereof. The output terminal of coincidence means **104** is supplied via conducting means **116,** to the first inhibit input terminal of control means **119.** It may be appreciated that flip-flop means **101** and coincidence means **104** cooperate to produce a first inhibit signal to be applied to control means **119.** More particularly, and as will soon become apparent, coincidence means **104** serves to couple an inhibit signal produced by flip-flop means **101** to control means **119** in the absence of an enable signal.

The output terminal of coincidence means **104** is additionally coupled to indicating means whereat the condition of the supply of sheets if represented by suitable indications. As illustrated herein, the indicating means is comprised of "Check Paper" lamp **110** and "Call Op" lamp **114.** Each lamp is connected in series with a corresponding lamp driving means and is included in a series circuit between a source of suitable energizing potential +V and ground. Thus, "Check Paper" lamp **110** is connected to transistor means **111** and "Call Op" lamp **114** is connected to transistor means **115.** It is appreciated that each of the transistor means is adapted to assume a saturation state in response to a suitable voltage potential applied to the base electrode thereof, whereupon current may flow from the source +V, through the corresponding lamp, through the collector-emitter junction of the saturated transistor means to ground. If desired, alternative lamp driving means may be employed to effect the energization of the corresponding lamp connected thereto in response to the application of a suitable voltage. Hence, conventional relay switch means may be provided, triac devices may be provided, or the like. In the exemplary embodiment, the base electrode of transistor means **111** is coupled to the output terminal of coincidence means **104** via OR circuit **108** and the base electrode of transistor means **115** is coupled to the output terminal of coincidence means **104** via coincidence means **112.** The latter coincidence means includes another input terminal coupled to terminal **113** and is adapted to produce a pulsating energization of "Call Op" lamp **114** when the first inhibit signal is applied to control means **119.** Terminal **113** may, therefore, be supplied with a slowly pulsating signal.

OR circuit **108** includes another input terminal coupled to terminal **109** and is adapted to produce a binary "1" when at least one input terminal thereof is provided with a binary "1". Alternatively, OR circuit **108** may comprise a conventional NAND gate wherein a

binary "1" is produced when at least one input terminal thereof is provided with a binary "0". The signal to be supplied to OR circuit **108** by terminal **109** is derived from conventional means, not shown, included in the electrostatic reproduction machine and reponsive to the operation of the machine in the absence of paper. In other words, if the electrostatic reproduction machine is engaged in a normal operation wherein a developed image is to be transferred to copy paper, but copy paper is not transported by the sheet transport mechanism, a binary "1" is provided at terminal **109.** It may be recognized that such signal may be produced by conventional sensing means disposed at a fixed location in the sheet transport mechanism and adapted to sense the leading edge of a transported sheet. The sensing means may comprise a conventional switch having a depending member interposed in the path of the transported sheets. Alternatively, the sensing means may include a photoelectric device wherein a light beam is interrupted by the transported sheet. In either event, the failure of the switch to be closed or the light beam to be interrupted is indicative of the absence of a transported sheet, thereby supplying a binary "1" to terminal **109.** It may be observed that terminal **109** is additionally coupled to the third inhibit input terminal of control means **119** by conducting means **117.**

Flip-flop means **120** is similar to flip-flop means **101** and is adapted to produce an activating signal upon assuming a first, or set, state. The activating signal is coupled to suitable means, not shown, to effect the commencement of a reproducing operation by the electrostatic reproduction machine. The set input terminal of flip-flop means **120** is coupled to control means **119** and is capable of receiving the enable signal. The reset input terminal of the flip-flop means is coupled via OR circuit **122** to terminal **125.** Terminal **125** is adapted to be supplied by means, not shown herein, capable of producing a binary "1" at a predetermined time subsequent to the termination of the enable signal. OR circuit **122** is additionally coupled to terminal **121** to receive the aforementioned initializing signal when power is first supplied to the electrostatic reproduction machine. Hence, flip-flop means **120** is assured of assuming an initial state to restrain the commencement of a reproducing operation by the machine until control means **119** produces the enable signal.

Turning now to control means **119,** it may be observed that the control means is comprised of OR circuit **126,** flip-flop means **127** and coincidence means **128.** OR circuit **126,** which may be similar to OR circuit **108,** includes a first input terminal coupled to conducting means **116,** a second input terminal coupled to conducting means **118,** a third input terminal coupled to conducting means **117** and a fourth input terminal coupled to terminal **121.** The OR circuit is adapted to monitor the operating condition of the electrostatic reproduction machine, as represented by an inhibit signal applied to conducting means **118** and to sense a low supply condition or a last sheet condition, as represented by inhibit signals applied to conducting means **116** and **117,** respectively. The output terminal of OR circuit **126** is coupled to the reset input terminal of flip-flop means **127** and to an input terminal of coincidence means **128** via inverter means **129.**

The flip-flop means **127** is similar to aforedescribed flip-flop means **101** and is adapted to produce the enable signal at the output terminal thereof in response to the activation of switch means **124** provided that an inhibit signal is not supplied to OR circuit **126.** Accordingly, the set input terminal of the flip-flop means is coupled to switch means **124** via coincidence means **128.** The coincidence means is similar to aforedescribed coincidence means **104.** It is apparent that flip-flop means **127** is capable of being set to its first state when switch means **124** is activated and OR circuit **126** produces a binary "0". Conversely, the flip-flop means is reset to or maintained in its second state when OR circuit **126** produces a binary "1".

The operation of the apparatus illustrated in FIG. **2** will now be described. It will be assumed, for purposes of explanation, that the present apparatus is employed in an electrostatic reproduction machine. When power is initially supplied to the electrostatic reproduction machine, the binary "1" initializing signal is provided at terminal **121.** This binary "1" is supplied to the aforedescribed pre-established input terminal of control means **119,** and through OR circuit **126** to the reset input terminal of flip-flop means **127.** The binary "1" is additionally supplied by OR circuit **122,** to the reset input terminal of flip-flop means **120.** Accordingly, flip-flop means **127** is reset to its second state and control means **119** assumes an initial condition. Similarly, flip-flop means **120** assumes its initial condition by being reset to its second state.

OR circuit **126** of control means **119** serves to monitor the operating condition of the electrostatic reproduction machine by being responsive to signals applied to the first input terminal thereof and signals applied to the second input terminal thereof. It will be assumed that the supply of sheets of material has previously been replenished and, therefore, flip-flop means **101** has been reset to its second state in response to a binary "1" applied to terminal **103.** Hence, flip-flop means **101** does not provide an inhibit signal to conducting means **116.** Let it be further assumed that none of the remaining monitored conditions of the machine is sensed as being unfavorable and, therefore, a binary "0" is applied to terminal **123.** Conducting means **118** is thus not provided with an inhibit signal. Since the electrostatic reproduction machine has not commenced operation, the absence of transported paper is not sensed and a binary "0" is applied to terminal **109.** An inhibit signal is thus not provided on conducting means **117.** Accordingly, OR circuit **126** produces a binary "0" and control means **119** is adapted to respond to a signal applied to the energizing input terminal thereof to produce the enable signal. If an operator now wishes to commence a reproducing operation, switch means **124** is manually operated to provide a channel from the source of energizing potential +V to the energizing input terminal of control means **119** to supply a binary "1" thereat. Coincidence means **128** is thus provided with a binary "1" at one input terminal thereof and the binary "0" produced by OR circuit **126** is applied as a binary "1" to the other input terminal by inverter means **129.** A binary "1" is, therefore, applied to the set input terminal of flip-flop means **127** to set the flip-flop means to its first state. The enable signal is therefore produced and applied to the set input terminal of flip-flop means **120.** The flip-flop means thus assumes its first, or set, state to produce the activating signal. A reproducing operation is then commenced.

If the reproducing operation executed by the electrostatic reproduction machine requires multiple copies,

the operation will continue until the required number of copies is produced. At that time, the enable signal is terminated by means not shown and, at a predetermined time thereafter, a binary "1" is applied to terminal **125** to reset flip-flop means **120** to its second state. An explanation of the manner in which the enable signal is terminated is not necessary for a complete understanding of the present invention and, therefore, is not described herein. Should the number of copies produced by the machine be such that the supply of sheets of material is diminished to a predetermined number prior to the termination of the enable signal, the aforenoted suitable actuating means supplies a low supply signal to terminal **102.** Flip-flop means **101** is therefore set to its first state and a binary "1" inhibit signal is applied to the first input terminal of coincidence means **104.** It is recognized that, although the supply of sheets has been reduced to a predetermined number, the remaining sheets may be transported through the electrostatic reproduction machine to form copies. Hence, operation of the machine need not be prematurely terminated if the supply has not been exhausted. The enable signal produced by control means **119** is subject to a logic negation by inverter means **105** to apply a binary "0" to the second input terminal of coincidence means **104.** Consequently, the inhibit signal is not coupled over conducting means **116** to the first inhibit input terminal of the control means or to the indicating means. The electrostatic reproduction machine may, therefore, continue in operation to complete the requisite number of copies, and the operator is not apprised of the reduction in sheets to a predetermined number.

In the event of exhausting the supply of sheets of material prior to producing the requisite number of copies, a binary "1" is applied to terminal **109** by the aforementioned conventional sensing means. This binary "1" is utilized as an inhibit signal and is applied by conducting means **117** to the third inhibit input terminal of control means **119.** The binary "1" on conducting means **117** is coupled to the reset input terminal of flip-flop means **127** by OR circuit **126.** In addition, coincidence means **128** is disabled. Thus, it is seen that flip-flop means **127** is reset to its second state to terminate the enable signal produced thereby. At a predetermined time subsequent to the termination of the enable signal, terminal **125** is provided with a binary "1" and flip-flop means **120** is reset to its second state to terminate the activating signal produced thereby. The electrostatic reproduction machine thus halts its operation.

The binary "1" applied to terminal **109** is additionally applied by OR circuit **108** to the base electrode of transistor means **111.** It is understood that the binary "1" may be applied to any other conventional lamp driver. As a result thereof, "Check Paper" lamp **110** is illuminated to direct the operator's attention to the supply of sheets.

After exhausting the supply of sheets, or after reducing the supply below the predetermined minimum number, during a previous reproducing operation, a further reproducing operation cannot be initiated by an operator unless the supply is replenished. This obtains because flip-flop means **101** remains in its first state after receiving the low supply signal produced when the supply had been diminished to the predetermined number. Even if an operator loads the supply with an insufficient number of sheets of material such that the supply does not exceed the predetermined number, a binary "1" remains at terminal **102.** Hence, a low supply signal is applied to the set input terminal of flip-flop means **101** until the supply admits of a proper number of sheets. Consequently, the flip-flop means remains in its set state to produce an inhibit signal.

It is recalled that the enable signal is terminated when the electrostatic reproduction machine ceases its reproducing operation. Hence, the binary "0" produced by flip-flop means **127** of control means **119** is inverted by inverter means **105** to enable coincidence means **104** to couple the inhibit signal produced by flip-flop means **101** to the first inhibit input terminal of control means **119.** More particularly, this inhibit signal is coupled to the reset input terminal of flip-flop means **127** and, after being subjected to a logic negation by inverter means **129,** inhibits the operation of coincidence means **128.** Consequently, flip-flop means **127** is maintained in its second state. Thus, an attempt by an operator to initiate a subsequent reproducing operation by manually operating switch means **124** is not effective to produce the enable signal. This obtains because coincidence means **128** cannot couple the energizing signal produced in response to the activation of switch means **124** to the set input terminal of flip-flop means **127.** In addition, the inhibit signal coupled through coincidence means **104** is applied to OR circuit **108** and to coincidence means **112.** Consequently, "Check Paper" lamp **110** is illuminated, thus apprising an operator of a condition in the supply of sheets tending to inhibit the operation of the electrostatic reproduction machine. Furthermore, the inhibit signal applied to coincidence means **112** enables the slowly pulsating signal applied to terminal **113** to be applied to transistor means **115,** resulting in the pulsating illumination of "Call Op" lamp **114.** The inhibit signal may be terminated by opening the elevator access door and replenishing the supply of sheets to thereby reset flip-flop means **101** to its second state. If the supply is properly loaded, a low supply signal will not be applied to terminal **102.**

In view of the foregoing description, it is now readily apparent that the enable signal produced by control means **119** in response to the operation of switch means **124** is maintained even though the supply of sheets of material is reduced to a predetermined number sufficient to generate a first inhibit signal. However, should the supply be exhausted, the enable signal is terminated in response to the application of a second inhibit signal to OR circuit **126** of control means **119.** Furthermore, subsequent operation of switch means **124** is not effective to produce the enable signal if the supply had previously been diminished such that the first inhibit signal is provided. Hence, the electrostatic reproduction machine with which the present invention may be utilized will continue its reproducing operation until the requisite number of copies are produced unless the supply of sheets of material therefor is exhausted. In addition, the commencement of a reproducing operation is inhibited if the supply had previously been diminished to a predetermined number.

The logic circuit illustrated in schematic form herein is merely exemplary and is not to be construed as unnecessarily limiting the inventive concept depicted in FIG. **2.** One of ordinary skill in the art will appreciate that flip-flop means **127** may be omitted, if desired, without impairing the functions performed by the gate

means comprising the control means **119**. Moreover, it is contemplated that other configurations of conventional gating circuits may be adopted in practicing the present invention.

While the invention has been particularly described with reference to an electrostatic reproduction machine, it will be obvious that this invention may be utilized with any device adapted to operate upon sheets of material supplied thereto. Consequently, it is apparent that the foregoing and various other changes and modifications in form and details may be made without departing from the spirit and scope of the invention. It is therefore intended that the appended claims be interpreted as including all such changes and modifications.

What is claimed is:

1. In combination with an operating device adapted to operate upon sheets of material supplied thereto, apparatus for regulating the operation of operating device in accordance with the condition of the supply of said sheets of material, comprising:

control means adapted to produce an enable signal for activating said operating device to operate upon said sheets of material;

inhibit means coupled to said control means for inhibiting the production of said enable signal when a predetermined number of sheets of material remains in said supply and for terminating a produced enable signal after the last sheet of said supply of sheets of material has been operated upon by said operating device.

2. The combination of claim **1** wherein said inhibit means comprises:

first means for supplying a first inhibit signal to said control means representing that said predetermined number of sheets of material remain in said supply; and

second means for supplying a second inhibit signal to said control means representing that said operating device has operated on said last sheet of said supply.

3. The combination of claim **2** wherein said first means comprises:

flip-flop means adapted to be set to a first state in response to a low supply signal applied thereto for producing said first inhibit signal; said flip-flop means being further adapted to be reset to a second state when said supply is replenished with sheets of material; and

coupling means for coupling said first inhibit signal to said control means; said coupling means being inactivated in response to said enable signal.

4. The combination of claim **3** wherein said coupling means comprises coincidence means having a first input coupled to said flip-flop means, a second input coupled to said control means for receiving said enable signal and an output coupled to an inhibit input terminal of said control means.

5. The combination of claim **4** wherein said control means comprises gate means including a first inhibit input terminal coupled to said coincidence means, a second inhibit input terminal adapted to be supplied with signals representing a non-operable condition of said operating device, a third inhibit input terminal coupled to said second means and an energizing input terminal; said gate means being effective to generate said enable signal in response to a signal applied to said energizing input terminal provided a signal is not applied to said first or second inhibit input terminal and to terminate said enable signal in response to a signal applied to said third inhibit input terminal.

6. The combinationof claim **4**, further including indicating means coupled to said inhibit means for providing an indication of the condition of said supply of sheets of material, said indicating means comprising;

a first visual indicator coupled to said coincidence means and responsive to said first inhibit signal for providing a visual indication thereof; and

a second visual indicator coupled to said coincidence means and said second means and selectively responsive to said first and second inhibit signals for providing visual indications thereof.

7. In an electrostatic reproduction machine wherein a viewable image is formed on sheets of material supplied from a stack of sheets, apparatus for regulating the operation of said machine in accordance with the number of sheets in said stack, comprising:

gate means adapted to produce an enable signal in response to an operator-initiated function for activating said machine;

inhibit means coupled to said gate means for inhibiting the production of said enable signal when said stack is comprised of a predetermined number of sheets and for terminating said enable signal after a viewable image is formed on the last sheet of said stack.

8. The apparatus of claim **7** wherein said inhibit means comprises:

flip-flop means adapted to be set to a first state in response to a signal applied thereto for producing a first inhibit signal, said applied signal representing that said stack is comprised of said predetermined number of sheets; said flip-flop means being further adapted to be reset to a second state when said stack is resupplied with sheets of material;

coupling means for coupling said first inhibit signal to said gate means, said coupling means being inactivated in response to said enable signal; and

means for supplying to said gate means a second inhibit signal representing that said last sheet of said stack has been supplied to said machine.

9. The apparatus of claim **8** wherein said gate means includes a first inhibit input terminal coupled to said coupling means, a second inhibit input terminal adapted to be supplied with signals indicative of the operating condition of said electrostatic reproduction machine, a third inhibit input terminal coupled to said means for supplying and an energizing input terminal adapted to be supplied with a signal when said machine is to commence operation, for generating said enable signal in response to a signal applied to said energizing input terminal provided a signal is not applied to said first or second inhibit input terminals, and for terminating said enable signal in response to a signal applied to said third inhibit input terminal.

10. The apparatus of claim **9** further including bistable means having a first input adapted to be supplied with said enable signal to assume a first state and a second input adapted to be supplied with a reset signal at a determined period of time subsequent to the termination of said enable signal to assume a second state, said bistable means providing an activating signal to said electrostatic reproduction machine when said first state is assumed.

11. In combination with an operating device adapted to operate upon sheets of material supplied thereto, apparatus for regulating the operation of said operating device in accordance with a condition of the supply of said sheets of material comprising:

control means adapted for energizing said operating device to operate upon said sheets of material; and

means associated with said control means to prevent initial energization of said device when a predetermined number of sheets of material remains in said supply and for terminating operation of said device after the last sheet of said supply of sheets of material has been operated upon by said operating device.

12. In a reproduction machine adapted to produce copies of an original on copy material provided from a copy material supply, apparatus for regulating the operation of the machine in accordance with the supply of copy material comprising:

control means adapted to energize the machine to produce copies of the original; and

means associated with said control means to prevent initial energization of the reproduction machine when a predetermined quantity of copy material remains in the copy material supply and for terminating operation of the machine when the supply of copy material is exhausted.

* * * * *