

[54] **ELECTROSTATIC PRINTING MACHINE
WITH SELF-CLEANING CORONAL
GENERATING DEVICE**

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[22] Filed: **Sept. 24, 1973**

[21] Appl. No.: **400,077**

[52] U.S. Cl. **250/324, 317/262 A**

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

[58] Field of Search..... 250/324, 325, 326;
317/262 A

[56] **References Cited**

UNITED STATES PATENTS

2,791,949	5/1957	Simmons et al.	250/325
3,496,352	2/1970	Jugle.....	250/326

OTHER PUBLICATIONS

"Corona Unit Cleaning Device," by W. F. Voit, Jr.,

from IBM Technical Disclosure Bulletin, Vol. 11, No. 8, Jan. 1969, p. 1025.

Primary Examiner—James W. Lawrence

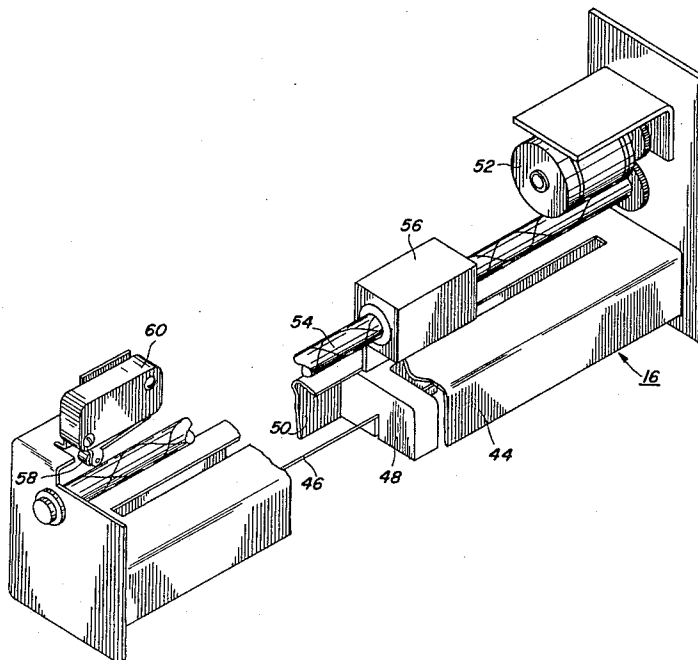
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[57] **ABSTRACT**

A printing machine corona generating device having a corona wire and a shield surrounding the wire has a cleaning pad which is moved along the corona wire and interior surfaces of the shield in response to a signal which is automatically generated after a predetermined machine event, for example, after each copy run. A mechanism is used which causes the pad to move from one end of the wire and back, and then stop.

4 Claims, 3 Drawing Figures



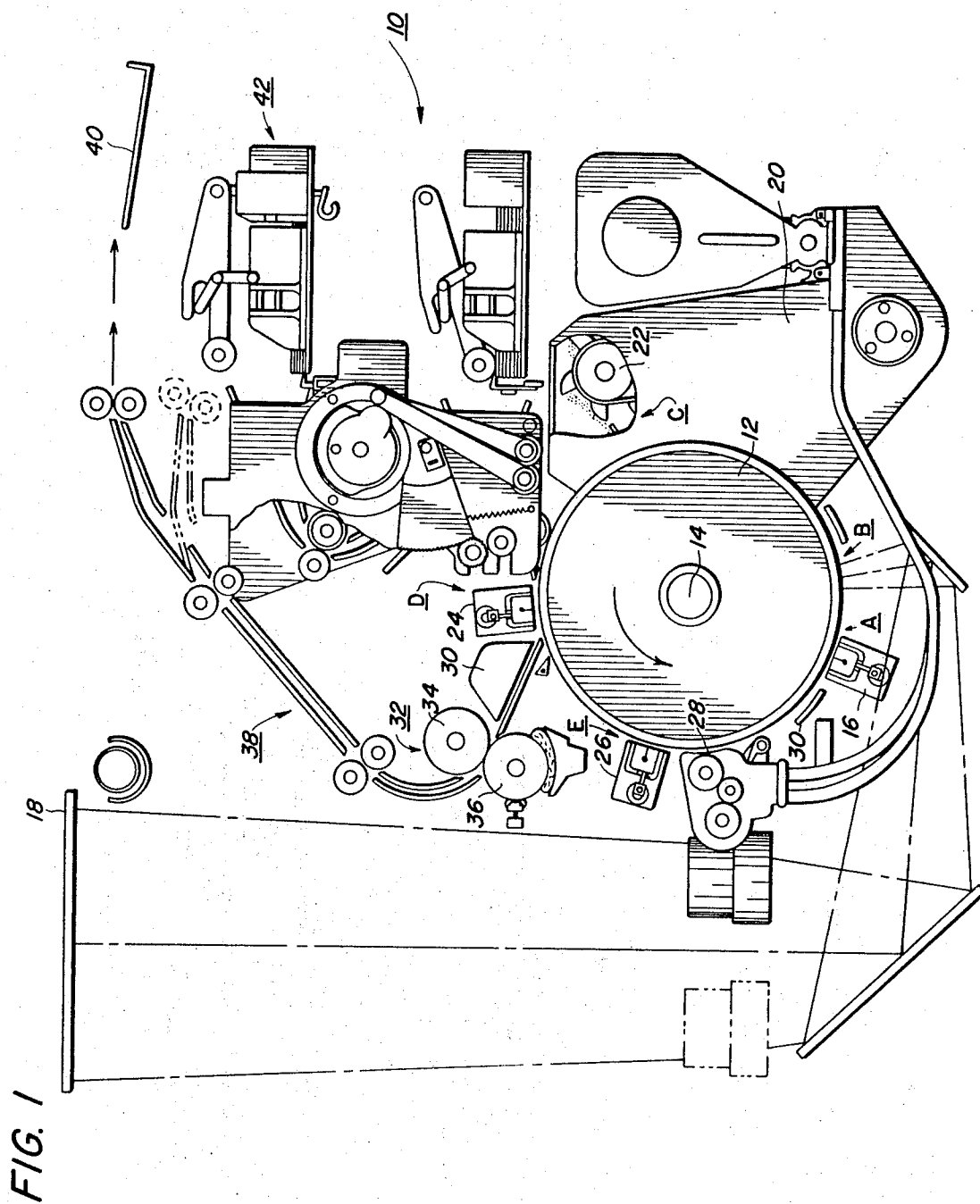


FIG. 2

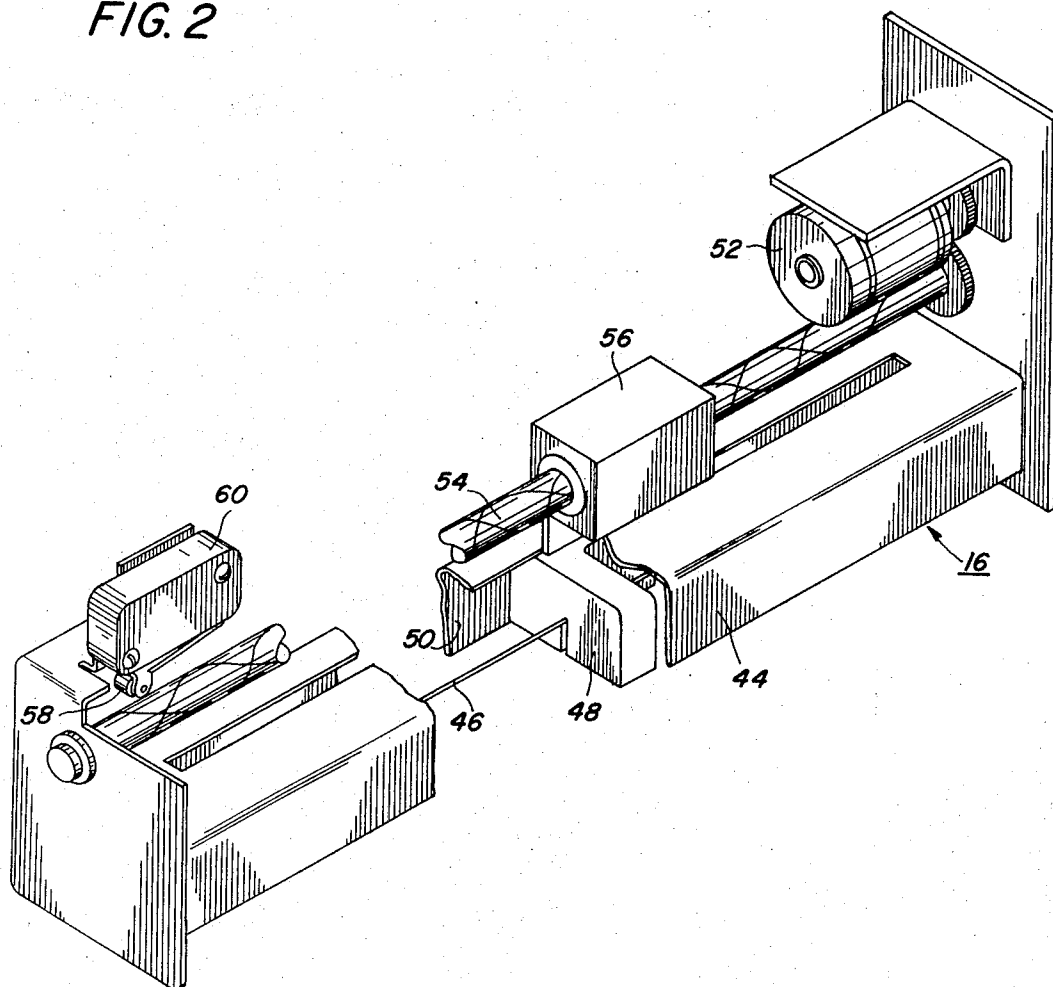
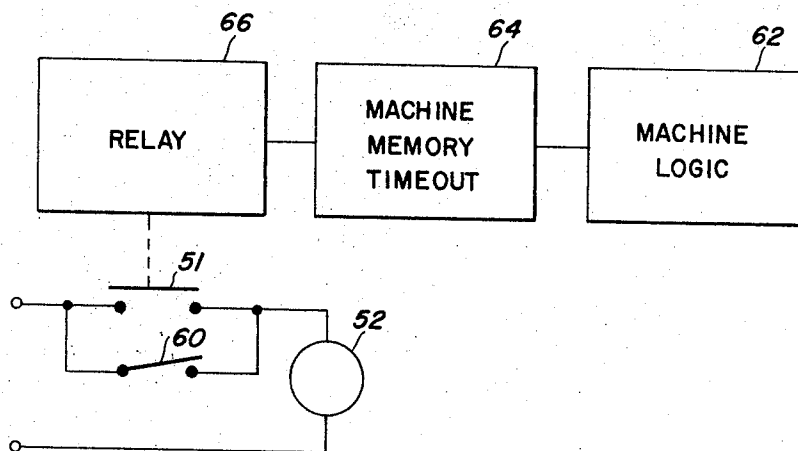


FIG. 3



ELECTROSTATIC PRINTING MACHINE WITH SELF-CLEANING CORONAL GENERATING DEVICE

BACKGROUND OF THE INVENTION

This invention relates generally to an electrostatic printing machine, but more particularly to such a machine having means for automatically cleaning a corona generating device on the machine after a predetermined machine event by moving a cleaning pad along its corona emitting wire, and its shield or ground plane through one cycle of operation, and then stopping the movement.

In the process of xerography, for example, as disclosed in Carlson U.S. Pat. No. 2,297,691, issued Oct. 6, 1942, a xerographic plate comprising a layer of photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate area in accordance with the radiation intensity that reaches them, and thereby creates an electrostatic latent image on or in the photoconductive layer. Development of the latent image is effected with an electrostatically charged, finely divided material such as an electroscopic power that is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. Thereafter, the developed xerographic powder image is usually transferred to a support surface to which it may be fixed by any suitable means.

In automatic xerographic equipment, it is common to employ a xerographic plate in the form of a cylindrical drum which is continuously rotated through a cycle of sequential operations including charging exposure, developing and transfer. During the cycle, copy is reproduced onto a support surface and after transfer, the plate is cleaned before reuse. It is usual to charge the xerographic plate with corona of positive polarity by means of a corona generating device having an electrode which when supplied with potential above the corona threshold produces ions that deposit uniformly onto the plate surface. Typical of the corona generating devices employed heretofore are those described in U.S. Pat. No. 2,777,957 to Walkup and U.S. Pat. No. 2,836,725 to Vyverberg, each constructed generally of an electrode wire or wires supported relatively close to the surface to be charged. A grounded metallic shield generally surrounds the electrode except for an opening through which charge is emitted and is adapted to attract surplus emission emanating therefrom.

Inherent in xerographic apparatus of the type described above is the continuous presence of dust generated by the operations and generally comprising particulate quantities of stray electroscopic powder. With continuous operation, dust accumulates on and about the interior of the corona generating device to such an extent that the charging efficiency thereof decreases substantially as the density of dust accumulation increases. As a result there is a sharp drop-off in the quality of prints reproduced.

To ensure a high charging efficiency the corona generating device requires frequent cleaning and maintenance. For example, in order to maintain the entire apparatus operating effectively it has been necessary to clean the corona generating device completely after

approximately several hundred reproductions and even sooner with machines operating at very high rates. Normally this necessitates removing the corona generating device from the machine and cleaning the entire assembly including wire and housing with a suitable cleaning solution. It goes without saying that this is a very time consuming operation not to mention the fact that the machine must remain idle during this period and thus can be of no benefit to the user.

Another means which is used to clean a corona generating device is to move a cleaning pad along the corona wire. Such a wire cleaning mechanism is shown in U.S. Pat. No. 2,614,901. An IBM Technical Disclosure Bulletin (Vol. 11, No. 8, p. 1025, January, 1969) shows a cleaning pad arrangement which is utilized for cleaning a corona generating device of the general type described above. A disadvantage of these mechanisms is that the cleaning must still be accomplished by manually moving the cleaning pad along the corona wire; this does not clean the shield or ground plane, thus resulting in an unstable corona generating device. If an operator forgets or neglects to clean the corona generating device at the proper time, the accumulated dirt or dust will affect the quality of prints or copies reproduced. Another means for cleaning a corona wire (U.S. Pat. 3,496,352) is by generating an electrical current in the corona wire sufficient to vaporize and therefore remove the dust from the wire. A disadvantage of this latter arrangement also, is that only the wire of the corona generating device is cleaned, not the shield. What is needed is a mechanism or arrangement which can automatically clean the corona wire, and the shield around the wire after a predetermined machine event.

SUMMARY OF THE INVENTION

The present invention is directed to an electrostatic printing machine having a corona generating device, the wire and shield of which are automatically cleaned after a predetermined machine event, e.g., when the machine logic reaches the point of coincidence after each copy run regardless of the number of copies printed, after a predetermined number of hours of machine operation has elapsed, etc. A double helix screw mechanism and an electrical circuit are incorporated to effect movement of a cleaning pad along the corona wire and the shield to clean both. In some instances, corona generating devices may be mounted side-by-side. In this event a single mechanism will drive two pads along the wires and shields, there being one pad for each of the devices. Two switches are connected in parallel to effect actuation of a motor which drives the screw. The first switch is actuated by a signal which is generated after the predetermined machine event has occurred; this initiates movement of the pad. A second switch is actuated by the initial movement of the pad to effect completion of a cycle of operation of the pad.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side elevation of an electrostatic printing machine utilizing the present invention;

FIG. 2 is a perspective view of a corona generating device having a cleaning pad and a mechanism for effecting movement of the pad along the device;

FIG. 3 is a schematic view of an electrical control system for effecting movement of the cleaning pad.

DETAILED DESCRIPTION OF THE INVENTION

The general apparatus of the instant invention is shown herein embodied in an automatic electrostatic printing machine 10 employing a drum-shaped xerographic plate 12 comprising a photoconductive layer which is placed upon a conductive backing.

Drum 12 is mounted on shaft 14 journaled in the machine frame (not shown) and is rotated in the direction indicated by the arrow by means of motor causing the drum surface to sequentially pass through a plurality of xerographic processing stations. The support member (e.g., paper) on which an image is to be fixed is fed to the drum 12 via paper feeding mechanism.

For purposes of the present invention, the several xerographic processing stations positioned in the path of movement of drum 12 as shown in FIG. 1 may be described functionally as follows:

a charging station A, at which is positioned a corona-generating device 16 for placing a uniform positive electrostatic charge on the photoconductive layer of the drum surface as the drum is driven in the direction indicated;

an exposure station B, at which a light or radiation pattern of the original document to be reproduced which is supported on platen 18, is projected onto the drum surface thereby dissipating the charge found thereon in the areas exposed so as to form a latent electrostatic image of the original document;

a developing station C, having a housing generally designated 20, in which a developed material utilizing, in this case, negatively charged toner particles is delivered to the entrance of the development zone from where it is caused to flow in opposition over an upwardly moving portion of the drum surface by means of bucket conveyors system 22, thus enabling the toner particles to contact and adhere to the electrostatic image on the drum surface to form a developed powder image in image configuration of the original document to be reproduced;

a transfer station D, at which the xerographic powder image is electrostatically transferred from the drum surface to a sheet of final support material by means of transfer corona generating device 24, and

a drum-cleaning and discharge station E, at which the drum surface is exposed to a cleaning corona generating device 26 and then contacted by means of a doctor blade 28 to remove residual toner particles which may remain thereon after the transfer operation and where the drum surface is exposed to the source of illumination 30 to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

Transfer corona generating device 24 located at station D sprays the backside of the final support material with positive ions, thus producing a charge of sufficient magnitude on the back of the paper to attract the toner from the drum surface to the final support material. However, the positive charge which is sprayed over the non-imaged background areas electrostatically tacks the support material to the moving drum surface. A plurality of arcuate-shaped stripper fingers positioned subsequent to the transfer station are arranged to lift the leading edge of the tacked support material from the drum and direct the material upwardly. As the drum continues to drive the support material forward, the finers strip the material from the drum and guide it

into contact with vacuum transport 30. The support material, a portion of which is still electrostatically tacked to the drum surface is caused to move along the vacuum transport towards fuser assembly 32.

Under the influence of the rotating drum, the support material is moved along the stationary vacuum transport 30 into the nip between the upper fuser roller 34 and the lower fuser roll 36 to fix the image. The coating fuser rolls are arranged to apply a pressure-driving force to the sheet of support material positioned therebetween and to forward the sheet at a synchronous speed with the rotating drum surface.

The copy, with the fixed image thereon, is transported through a circular path of travel, generally referred to as 38 comprising a series of pinch rolls arranged to either discharge a final support material from the apparatus into catch tray 40 or to feed the support material back into a second feed tray 42. Support material stored in feed tray 42 are once again redirected through the xerographic processing stations to form a second or duplex image on the backside thereof. To be certain that corona generating devices 16, 24, and 26 are kept free from dust and dirt, an arrangement is provided for automatically cleaning the same after each copy run. The term "automatically" cleaned, as used herein, means that the cleaning occurs without separate human intervention. In other words, normal actuation of the machine to effect copying or printing is all that is needed to effect periodic cleaning of the corona generating devices. Because each of the corona generating devices is cleaned in the same manner, only the corona generating device 16 at charging station A will be discussed.

Referring to FIG. 2, it can be seen that corona generating device 16 has a generally U-shaped shield 44 around a corona wire 46. To clean the device, a cleaning pad 48 contacts both the wire 46 and the internal surface 50 of the shield, the pad being mounted for movement along the length of the device.

To initiate movement of the cleaning pad 48 along the device 16, an electrical signal closes a first switch 51 (see FIG. 3) to drive motor 52, the latter in turn rotating a conventional double helix screw 54. As the screw 54 rotates, a follower 56 is driven via the helical grooves along the length of the screw, thus moving the cleaning pad. As viewed in FIG. 2, when the first switch closes, the follower 56 is at the left end of the screw 54 with the roller 58 of switch 60 riding on top surface of the follower to keep the latter switch open. As the follower 56 moves toward the other end of the screw 54, the roller 58 leaves the top surface of the follower 56 to thus close the switch 60 to complete a cycle of operation of the cleaning pad, which in the present instance is to the right end of screw 54 and back again. When the follower 56 returns to the left end of the screw, it once again opens the switch 60 to stop the motor 52, thus completing the cycle of operation. It is realized that to complete a cycle of operation, the pad may move only from one end to the other, or may move from one end to the other numerous times if desired.

In the present embodiment, it is preferred that the corona generating devices be cleaned after each copy run, i.e., after the number of copies which has been selected have been made on the machine. When this occurs, coincidence is reached in the machine logic 62 and consequently, the machine memory timeout 64 is actuated to effect various shutdown operations within

the machine. When the machine memory timeout mechanism is actuated to thus start the timeout cycle, a relay 66 is energized to close switch 51 to thus initiate a cleaning cycle. In addition to energize relay 66, the machine memory timeout acts as a timer to properly phase out various other machine operations in the proper sequence.

Electrostatic copying and duplicating machines conventionally have a copy select register and a copy count register. An operator will select the number of copies to be made on a copy run, and press a "start-print" button to initiate machine operation. As the copies are made, the number is registered on the copy count register. When the numbers on the copy select register and the copy count register are equal, coincidence occurs, and a signal is produced to initiate machine shutdown.

While the invention has been described with reference to the structure disclosed, it is not confined to the details set forth, but is intended to cover such modifications or changes as may come within the scope of the following claims.

What is claimed is:

1. An improved electrostatic printing machine comprising means defining a photoconductive surface which is adapted to move around a closed path, means including at least one corona generating device for making a copy of an original document, the corona generating device being disposed adjacent the photoconductive surface along the closed path, the corona generating device having a corona wire and a generally U-shaped elongated shield around the corona wire, and a cleaning pad contacting the corona wire and the inner surface of the shield such that when moved along the device, the wire and substantially the entire inner surface of the shield will be cleaned, the improvement comprising:

means for automatically moving the cleaning pad along the corona wire and shield to complete a cycle of operation upon receiving an input signal

after a predetermined machine event has occurred.

2. An improved electrostatic printing machine as set forth in claim 1, wherein the automatic moving means includes a double helix screw, a motor for rotating the screw, a follower mounted upon the screw, means defining an opening along the length of the shield, means extending through the opening and connecting the pad to the follower, first means adapted to be actuated by an input signal for initially starting the motor to begin the cycle of operation, and second means mounted so as to be actuated by the movement of the follower to complete the cycle of operation.

3. An improved electrostatic printing machine as set forth in claim 2, and further including means for delivering an input signal after each copy run to initiate movement of the cleaning pad.

4. An improved apparatus comprising means defining a photoconductive surface which is adapted to move around a closed path, a corona generating device disposed adjacent the surface along the path, the device having a corona wire and a generally U-shaped shield around the wire, and a cleaning pad in contact with the wire and the inner surface of the shield such that when moved along the device, the wire and substantially the entire inner surface of the shield will be cleaned, the improvement comprising:

- a. means for moving the pad back and forth along the wire and the shield;
- b. first activating means for causing the moving means to initiate the movement of the pad along the wire and the shield;
- c. second activating means mounted so as to be actuated by the movement of the pad for completing the movement of the pad through a cycle of operation, and
- d. means for delivering an input signal to the first activating means after each copy run.

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