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[54] DEVICE FOR ELECTROPHOTOCOPYING MACHINES FOR DETECTING WHETHER A USABLE LENGTH OF COPY PAPER IS LEFT ON A ROLL THEREOF

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[58] **Field of Search** 340/259; 355/14

[56] **References Cited**

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[57] **ABSTRACT**

A detection device wherein the copy paper unrolled from a roll of copy paper loaded in the electrophotocopying machine is illuminated at a predetermined location so that light reflected by or transmitted through the copy paper may be incident upon a photoelectric element whose output varies depending upon whether the copy paper is present or not at the predetermined location. Switching means is provided which is actuated by the output of the photoelectric element in such a manner that when the last portion of the copy paper of the roll is sufficient in length to make one copy but not sufficient to make two copies it will be transported through the machine and discharged therefrom without being cut into a predetermined size by the cutting means which is deactivated by the switching means and then the machine may be automatically stopped. Clogging of copy paper in the machine may be prevented and photocopying operation may be greatly facilitated.

5 Claims, 2 Drawing Figures

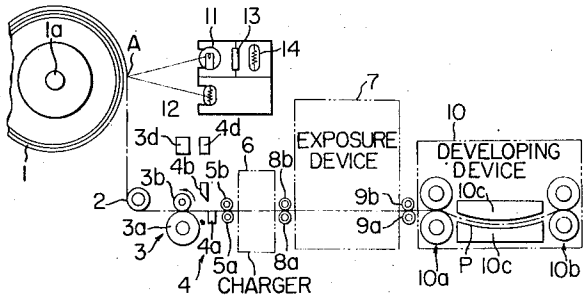


FIG. 1

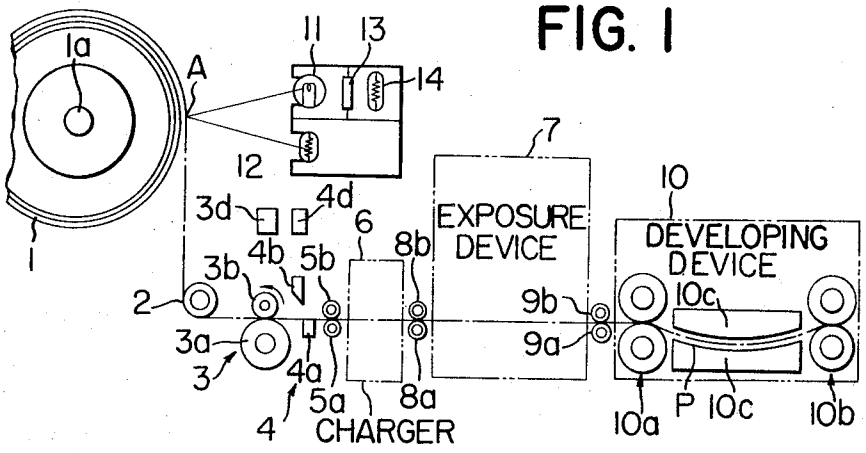
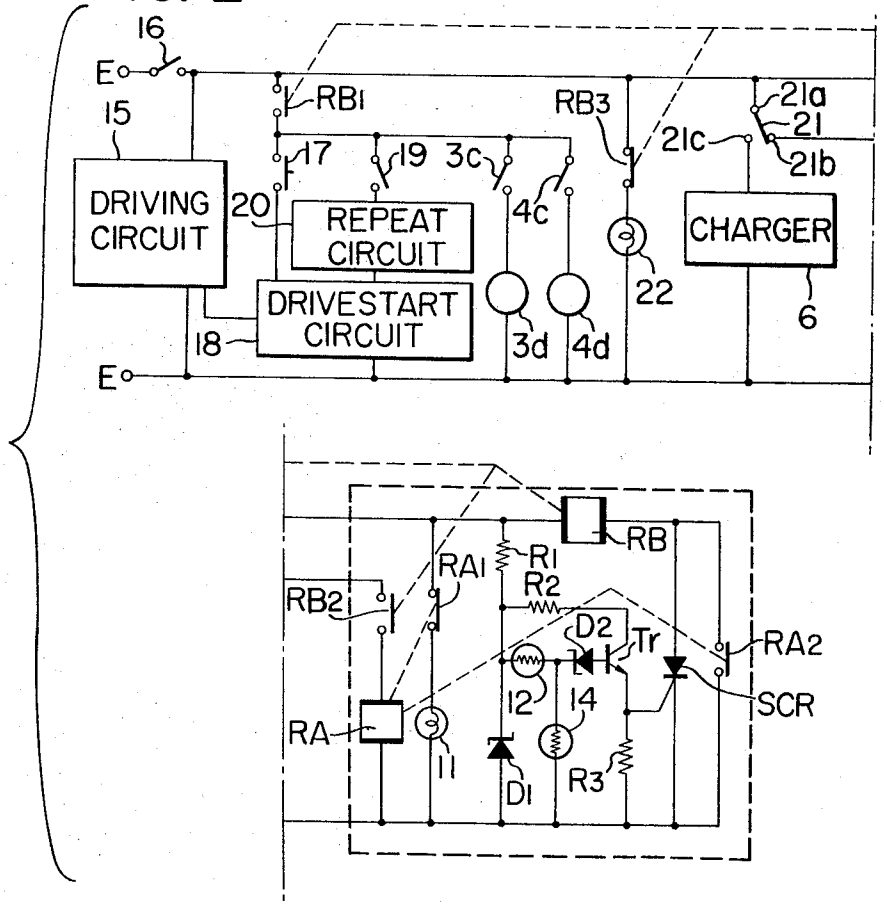


FIG. 2



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DEVICE FOR ELECTROPHOTOCOPYING MACHINES FOR DETECTING WHETHER A USABLE LENGTH OF COPY PAPER IS LEFT ON A ROLL THEREOF

BACKGROUND OF THE INVENTION

The present invention generally relates to an electrophotocopying machine and more particularly a device for use with electrophotocopying machines for detecting whether a sufficient length of copy paper is left or not on the roll in the machine.

The term "copy paper" as used in this specification and in the claims, is understood include all of the recording media employed in the conventional electrophotocopying machines.

In electrophotocopying machines of the type using a roll of copy paper, the copy paper is generally unrolled and transported a predetermined length by a copy paper feeding device into a cutting device where the copy paper is cut into a predetermined length or size to provide sheets of copy paper to be processed individually in various processing stations such as a charger, an exposure device, a developing device, a fixing device, etc. in the electrophotocopying machine. Therefore the last copy paper sheet including the trailing end of the roll of copy paper has a length shorter than a predetermined length or size, (referred to as "the copy paper of an insufficient length" hereinafter) cannot extend across the nips of the two pair of feed rollers in the path of the copy paper in the electrophotocopying machine. In consequence, the copy paper of an insufficient length is transported out of the predetermined passage, thus causing clogging or jamming. Especially when the copy paper is clogged in the developing device, a serious problem arises. To remedy the clogging of copy paper in the developing device, the device must be generally removed out of the electrophotocopying machine and sometimes disassembled because its construction is rather complicated as compared with other devices or units in the electrophotocopying machine. The removing and disassembling of the developing device are very cumbersome and require a relatively long time. In addition, the electrophotocopying machine is sometimes contaminated by the developing liquid or agent.

It is therefore very important for an operator to always check to see that the copy paper will not be cut into a length shorter than a predetermined length at the end of the roll of copy paper. In addition the copy paper near the trailing end of the roll of copy paper is generally not adapted to produce a better quality copy. Thus the operator is always bothered to check to see how long a roll of copy paper is left in the electrophotocopying machine every time the unrolled copy paper is cut into a predetermined size. Frequently he will become afraid of clogging so that he will load a new roll of copy paper too soon even while there is still left a sufficient length of copy paper, so that the copy paper is wasted.

SUMMARY OF THE INVENTION

It is therefore the primary object of the present invention to provide a device which solves the above problems encountered in the conventional electrophotocopying machine of the type using a roll of electrophotocopy paper.

Another object of the present invention is to provide a device for detecting whether a sufficiently usable length of copy paper is left or not in the electrophotocopying machine of the type described so that the portion of the roll of copy paper near its trailing end having a sufficient length to make one copy but an insufficient length to make two copies may be transported through the electrophotocopying machine and discharged therefrom without being cut into a predetermined size.

Another object of the present invention is to provide a device of the type described above which is capable of giving a warning that the roll of copy paper loaded in the electrophotocopying machine is entirely consumed, thereby facilitating the operation of the electrophotocopying machine.

Another object of the present invention is to provide a device of the type described above which may be simple in construction yet highly reliable in operation and inexpensive to manufacture.

In brief, the present invention provides an illumination lamp which illuminates the copy paper at a predetermined location in the passage of copy paper being unrolled, so that the light reflected by or transmitted through the copy paper may be incident upon a photoelectric effect element disposed in optically opposed relation with the illumination lamp. First switching means is provided which is turned on or off in response to the output variation of the photoelectric effect element caused depending upon whether the copy paper is present or not at the predetermined location to thereby turn on or off second switching means which in turn may activate or deactivate both the copy paper unrolling and feeding means and the cutting means for cutting the unrolled copy paper into a predetermined size. Therefore, when a portion of the roll of copy paper near its trailing end having a length sufficient to make one copy but not sufficient to make two copies passes the predetermined location, both the feeding and cutting means are deactivated so that this portion may be transported through the electro-photocopying machine and discharged therefrom without being cut into the predetermined size. The clogging of copy paper whose length is shorter than the predetermined size is thus positively prevented.

According to one aspect of the present invention the tape succeeding to the trailing end of the copy paper of the roll or the pasted portion near or at the trailing end of the copy paper for bonding the trailing end portion to the bobbin of the roll will not be cut in the cutting means so that its service life may be increased because the tape or the like is generally harder and more sticky than the copy paper.

According to another aspect of the present invention when the roll of copy paper is all consumed, a warning signal is generated which may be easily seen by an operator from the exterior of the machine and the electrophotocopying machine is automatically deactivated when the last portion of the roll of copy paper is discharged out of the machine. This arrangement is particularly advantageous when the electrophotocopying machine is set to a "repeat" mode, that is the condition under which the electrophotocopying cycle of the electrophotocopying machine is repeated until a desired number of copies is obtained because the electrophotocopying machine may be automatically stopped upon consumption of the roll of copy paper even though the desired number of copies has not yet been obtained.

According to another aspect of the present invention the illumination lamp is turned on for detecting whether the copy paper is present or not at the predetermined location for a very short time interval when the main switch of the electrophotocopying machine is activated and only when the copy paper is unrolled from the roll and fed into the cutting means so that the exposure of the copying paper in the exposure device is not adversely affected.

The present invention will become more apparent from the description of the preferred embodiment thereof taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic view of a electrophotocopying machine incorporating a device in accordance with the present invention for detecting whether a sufficient length of recording medium is left or not; and

FIG. 2 is an electric circuit diagram thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a electrophotocopying machine incorporating a device for detecting whether a sufficient length of copy paper 1 is left or not in accordance with the present invention generally includes a copy paper feeding device generally designated by 3, a copy paper cutting device 4, a

charger 6, an exposure device 7, a developing device 10 and the detecting device to be described in more detail hereinafter. A roll of copy paper 1 is rotatably supported by a rotary shaft 1a and the leading end of the copy paper unrolled at the point A to be referred to as "the unrolling point or end" hereinafter is normally extended through a guide roller 2 into the nip of a pair of rollers 3*a* and a pressure roller 3*b* in the copy paper feeding device 3 which further includes a switch 3*c* (see FIG. 2) and a solenoid 3*d*. When the switch 3*c* is closed, the solenoid 3*d* is energized so as to cause the pressure roller 3*b* to rotate in contact with the roller 3*a* through a clutch (not shown) thereby transporting the copy paper 1 by a predetermined length. The switch 3*c* is actuated by a control cam (not shown) which in turn is driven upon depression of a print button or switch 17 (See FIG. 2).

The copy paper 1 transported by the feeding device 3 is fed into the cutting device 4 which is shown as comprising generally a stationary cutter blade 4a, a movable cutter blade 4b for coaction with the stationary cutter blade 4a so as to cut the copy paper 1 into a predetermined length or size, a switch 4*c* (see FIG. 2) and a solenoid 4*d*. When the switch 4c is closed by a control cam (not shown), the solenoid 4d is energized to drive thereby the movable cutter blade 4*b* to cut the copy paper 1.

The copy paper cut in the cutting device 4 is fed into the charger 6 by a pair of feed rollers 5*a* and 5*b* and is uniformly imparted with the charge in a manner well known in the art. The copy paper 1 is then fed into the exposure station 7 for exposure by a pair of feed rollers 8*a* and 8*b* and therefrom into the developing device 10 by a pair of feed rollers 9*a* and 9*b*. In the developing device 10, the copy paper is developed while it is transported by two pairs of feed rollers 10*a* and 10*b* through a passage defined by a pair of upper and lower guides 10c. The developed copy paper 1 is discharged out of the electrophotocopying machine. Thus the roll of copy paper 1 is gradually consumed as the photocopying cycle described above is repeated.

The detecting device is illustrated in FIG. 1 as including an illumination lamp 11, a photoelectric effect element 12, an optical filter 13 and another photoelectric effect element 14, but the device comprises further component parts in a control circuit as will be described in more detail hereinafter with reference to FIG. 2. The illumination lamp 11 and the photoelectric effect element 12 are disposed in vertically spaced-apart relation in such a manner that the light emitted from the illumination lamp 11 illuminates the copy paper 1 at the unrolling end A and the light reflected by the copy paper 1 is then incident upon the photoelectric effect element 12. It is seen that the quantity or brightness of the reflected light is varied in response to whether the copy paper 1 is present or not at the reflecting point or unrolling end A so that the output of the photoelectric effect element 12 is varied accordingly. The control circuit is actuated in response to the output of the photoelectric effect element 12 so as to actuate the copy paper feeding and cutting devices 3 and 4 depending upon whether the copy paper 1 is present or not at the unrolling end A. To more remarkably increase the output variation of the photoelectric effect element depending upon the presence and absence of the copy paper 1 at the unrolling end A, the roll of copy paper may have a black-colored bobbin.

Light from the illumination lamp 11 is also transmitted through the optical filter 13 adapted to reduce the energy of light passing therethrough and is intercepted by the second photoelectric effect element 14 which has a function of correcting the temperature and resistance variations and another function of comparing the resistance or output of the second element 14 with that of the first photoelectric effect element 12 so as to detect the output variation thereof.

Next the control circuit and its associated circuitry will be described with reference to FIG. 2. An electrophotocopying machine driving circuit 15 connected through a main switch 16 to an electric power source E—E is connected to a drive-start circuit 18 in such a manner that the driving circuit 15 is energized through the drive-start circuit 18 and once the driving circuit 15 is energized, it remains energized independently of the drive-start circuit 18 until one electrophotocopying cycle consisting of the steps of copy paper feeding, cutting, charging, exposure and development described hereinabove is accomplished. The drive-start circuit 18 in turn is energized by a repeat circuit 20 including a repeat switch 19 connected in series thereto in such a manner that when the main switch 16 is closed and the print switch or button 17 is depressed while the repeat switch 19 is set to a desired number of copies of the same original, the repeat switch 19 is closed upon completion of each electrophotocopying cycle so as to transmit the signal to the drive-start circuit 18 through the repeat circuit 20 thereby automatically energizing again the driving circuit 15. Thus the driving circuit 15 is energized again and again automatically until the desired number of copies set by the repeat switch 19 is obtained. It is noted that the series circuit of the repeat switch 19, the repeat circuit 20 and the drive-start circuit 18, the series circuit of the switch 3c and the solenoid 3*d* in the copy paper feeding device 3 and the series circuit of the switch 4*c* and the solenoid 4d in the copy paper cutting device 4 are connected in parallel with each other to the power source E—E through a normally open contact RB_1 of a relay RB in the control circuit in the block indicated by the broken lines. Therefore it is seen that the solenoids 3*d* and 4*d* are not energized at all when the normally closed contact RB_1 is opened even when the switches 3*c* and 4*c* are closed.

The charger 6 and a change-over switch 21 are connected in series to the power source E—E and the movable contact 21*a* of the change-over switch 21 is normally in contact with the fixed contact 21*b* as viewed from FIG. 2 and is switched therefrom to the fixed contact 21c under the control of a cam (not shown) substantially when the switch 3*c* in the feeding device 3 is closed, so as to energize the charger 6. Upon completion of one electrophotocopying cycle, the movable contact 21*a* is returned to the fixed contact 21*b* which is connected in series to another relay RA in the control circuit through a normally open contact RB_2 of the relay RB. Therefore when the contact RB_2 is closed and the movable contact 21*a* of the change-over switch 21 is in contact with the fixed contact 21*b*, the relay RA is energized.

The control circuit generally comprises the relays RA and RB having contacts RA_1 and RA_2 and RB_1, and RB_2 and RB_3 respectively, the illumination lamp 11, the first and second photoelectric effect elements 12 and 14, two Zener diodes D_1 and D_2, a switching transistor Tr, a Thyristor or Silicon Controlled Rectifier SCR triggered by the transistor TR and fixed resistors R_1, R_2 and R_3. More specifically the resistor R_1 and the diode D_1 are connected in series to the power source E—E through the main switch 16 and the collector of the transistor Tr is connected to the function between them. One terminal of the first photoelectric effect element 12 is also connected to this junction while the other terminal is connected to the base of the transistor Tr through the diode D_2. The emitter of the transistor Tr is connected to the power source E—E through the resistor R_3 and to the gate of the Thyristor SCR so that it may be rendered into the conduction or non-conduction or block state depending upon the emitter potential of the transistor Tr. The anode and cathode of the Thyristor are connected to the power source E—E through the relay RB and the main switch 16 and the normally open contact RA_2 of the relay RA is connected in parallel with the Thyristor SCR so as to cut off the Thyristor SCR when it is turned on. That is when the contact RA_2 is closed, the Thyristor SCR is short-circuited and the current flowing therethrough starts to flow across the contact RA_2 thereby holding the relay RB.

The photoelectric effect element 14 is connected in parallel with the diode D_1 through the photoelectric effect element 12 for intercepting the light reflected by the copy paper 1. The series circuit of the lamp 11 and the normally closed contact RA_1 of the relay RA is connected in parallel with the series circuit of the diode D_1 and the resistor R_1.

As has been described hereinabove, the resistance of the photoelectric effect element **12** varies in response to the quantity of light from the lamp **11** reflected by the copy paper **1**. The quantity of light reflected by the copy paper **1** is large when there is copy paper present at the unrolling end A (See FIG. 1), so that the resistance of the photoelectric effect element **12** is reduced. The base potential of the transistor Tr is raised, so that it is saturated.

In addition to the above component parts in the control circuit, there is provided a pilot lamp **22**, or alternatively a buzzer for giving a warning when the copy paper is not present at the unrolling end A. More specifically, the pilot lamp **22** is connected in series with the normally closed contact RB_3 of the relay RB through the main switch **16** to the power source E—E, so that the pilot lamp **22** is turned on as the contact RB_2 is closed when the copy paper **1** is not present at the unrolling end A (See FIG. 1), thereby giving a warning that no copy paper is left upon the bobbin.

Next the mode of operation will be described. When the main switch **16** is closed, the illumination lamp **11** connected in series to the normally closed contact RA_1 of the relay RA is turned on to illuminate the copy paper **1** at the unrolling end A. When the copy paper **1** is present at the unrolling end A, the brightness of light from the lamp **11** reflected by the copy paper **1** at the unrolling end A is strong, so that the resistance of the photoelectric effect element **12** for intercepting the reflected light is reduced. On the other hand, the light from the lamp **11** is also intercepted by the photoelectric effect element **14** through the optical filter **13**. Thus the potential applied to the base of the transistor Tr is high so that it is saturated. Upon saturation of the transistor Tr, the emitter potential of the transistor Tr is applied to the gate of the Thyristor SCR as a trigger signal so that the Thyristor SCR is turned on, thereby energizing the relay RB. Thereupon, the contacts RB_1 and RB_2 are closed while the contact RB_3 is opened. When the contact RB_2 is closed, the relay RA is energized through the change-over switch **21**, so that the contact RA_1 is opened while the contact RA_2 is closed. Therefore the illumination lamp **11** is turned off since the contact RA_1 is opened. Thus the presence of the copy paper **1** at the unrolling end A (see FIG. 1) is confirmed, and this operation is accomplished within a very short time interval.

When the relay RA is energized, that is when the illumination lamp **11** is turned off, the Thyristor SCR is turned off because the normally open contact RA_2 is closed so that the Thyristor SCR is short-circuited as described above. In this case it is noted that the relay RB is kept energized because the current flows through the now closed contact RA_2.

Now upon depression of the print switch **17**, the drive-start circuit **18** is energized so that the driving circuit **15** is energized, thereby starting the electrophotocopying cycle. In this case, both of the switches **3***c* and **4***c* in the feeding and cutting devices **3** and **4** are closed by control cams (not shown) driven in response to the depression of the print switch **17** through a mechanism (not shown). In this case, the movable contact **21***a* is switched from the fixed contact **21***b* to the contact **21***c* by a cam (not shown) driven also in response to the depression of the switch **17**. Therefore, the solenoids **3***d* and **4***d* and the charger **6** are all energized so that the pressure roller **3***b* is rotated to transport thereby the copy paper **1** by a predetermined distance into the cutting device **4** where the movable cutter blade **4**b driven by the solenoid **4**d cuts the copy paper **1** into a predetermined length or size in cooperation with the stationary cutter blade **4***a*. Since the movable contact **21**a of the change-over switch **21** is switched to the fixed contact **21***c* while the normally open contact RB_2 is closed, the relay RA is de-energized so that the normally closed contact RA_1 is closed and the illumination lamp **11** is turned on again to illuminate the copy paper **1** now being unrolled. The light reflected by the copy paper **1** is again intercepted by the first photoelectric effect element **12**, so that the transistor Tr is turned on thereby triggering the Thyristor SCR again in a manner described hereinabove. Therefore, the relay RB may remain energized even when the normally open contact RA_2 is opened. Both of the copy paper feeding and cutting devices **3** and **4** are stopped after their functions are accomplished because the switches **3***c* and **4***c* are opened by the control cams. The pressure roller **3***b* may rotate freely when the copy paper **1** is being transported by the pair of feed rollers **5***a* and **5***b*. When the copy paper **1** is discharged out of the charger **6**, the movable contact **21***a* of the change-over switch **21** is also switched to the fixed contact **21**b again, so that the relay RA is energized again to open thereby the normally closed contact RA_1 to turn off the illumination lamp **11**. Since the normally open contact RA_2 is also closed, the relay RB may remain energized. The print switch **17** is adapted to be automatically opened by suitable means (not shown) when the copy paper is discharged out of the exposure device **7**. Thus one electrophotocopying cycle is now accomplished. However, when the repeat switch **19** is previously set to the desired number of copies, it is automatically closed upon completion of each electrophotocopying cycle so that the driving circuit **15** is energized again and again in a manner described hereinabove until the desired number of copies are obtained.

So far the mode of operation has been described when the copy paper **1** is present at the unrolling end A. Next the mode of operation when there is no copy paper **1** at the unrolling end A will be described. When there is no copy paper **1** at the unrolling end A the relay RB is not energized at all because the quantity or brightness of the light intercepted by the first photoelectric effect element **12** is low so that the transistor Tr is not turned on. Therefore, the Thyristor SCR is not triggered while the normally open contact RA_2 of the relay RA is opened. In this case the pilot lamp **22** is turned on giving the warning that there is no copy paper at the unrolling end A. Since the relay RB is not energized, the normally open contact RB_1 remains opened, so that even when the start switch **17** is depressed the electrophotocopying machine is not actuated at all. Thus there is no fear that a copy paper of an insufficient length will be transported though the electrophotocopying machine, causing jamming or clogging.

Next the mode of operation when the trailing end of the copy paper **1** passes the unrolling end A as it is transported by the copy paper feeding device **3** will be described. This occurs when the copy paper left in the machine has a sufficient length for making one copy but not sufficient enough to make two copies. When the trailing end of the copy paper **1** passes the unrolling point A, the light reflected by the bobbin to the first photoelectric effect element **12** is less so that the resistance of the element **12** is suddenly increased. Therefore the transistor Tr is cut off so that the Thyristor SCR is rendered into the non-conduction state. In consequence, the relay RB is de-energized to open the contacts RB_1 and RB_2 and to close the contact RB_3, so that the solenoids **3***d* and **4***d* are de-energized even though the switches **3***c* and **4***c* are closed, thereby stopping the cutting device **4**.

Consequently the copy paper **1** is transported through the electrophotocopying machine without being cut into the predetermined size or length by the cutting device **4**, directly into the charger **6** the exposure device **7** and the developing device **10**. Thus the copy paper **1** having a sufficient length to make one copy but not sufficient enough to make two copies may be discharged out of the electrophotocopying machine without causing any jamming or clogging.

Since the contact RB_2 of the relay RB is opened as the relay RB is de-energized, the relay RA is also de-energized to open the contact RA_2. In consequence, the relay RB is not energized even when the lamp **11** is turned on. In addition, since the contact RB_3 is closed the pilot lamp **22** is turned on thereby giving the operator the warning the trailing end of the copy paper has passed the unrolling end A, that is all of the copy paper **1** has been consumed. The warning signal may be readily seen from the exterior of the machine.

From the foregoing description, it is seen that in every case there remains no copy paper of an insufficient length in the electrophotocopying machine.

In the instant embodiment the light from the illumination lamp **11** is reflected by the copy paper **1** and is intercepted by the first photoelectric effect element **12**, but it is seen that a suitable light source and a photoelectric effect element may be disposed in opposed relation with each other across the copy paper when there is a sufficient space for installing them in this manner is available within the electrophotocopying machine so that the light transmitted through the copy paper may be made incident upon the photoelectric effect element to generate the signal indicating that the sufficient length of copy paper is left and when the light from the light source is directly incident upon the photoelectric effect element the signal is generated which indicates that the sufficient length of the copy paper is not left.

What is claimed is:

1. A device for detecting whether a sufficiently usable length of copy paper is left or not in a electrophotocopying machine of the type using a roll of copy paper comprising

a control circuit electrically connected to means for cutting the copy paper into a predetermined length and to means for unrolling the copy paper from said roll and feeding it to said cutting means,

said control circuit including

detecting means comprising an illumination light source for illuminating the copy paper at a predetermined location, and a photoelectric effect element disposed in optically opposed relation with said illumination light source so as to intercept the light reflected by or transmitted through the copy paper at said predetermined location so that the output of said photoelectric effect element may be varied depending upon the presence or absence of the copy paper at said predetermined location,

first switching means which is turned on and off in response to said output variation of said photoelectric effect element,

second switching means adapted to be actuated by said first switching means so as to activate or deactivate said feeding and cutting means depending upon whether the copy paper is present or not at said predetermined location, and

third switching means actuated by said second switching means so as to turn off said illumination light source which is turned on when the electrophotocopying machine is first energized and to turn on said illumination light source when the copy paper is unrolled and fed into said cutting means,

whereby when the trailing end of said roll of copy paper passes said predetermined location both of said feeding and cutting means are deactivated to thereby permit the transportation through the electrophotocopying machine and discharge therefrom the copy paper without being cut into said predetermined length.

2. A device as specified in claim **1** further comprising warning signal generating means which is actuated by said third switching means so as to give a warning that the roll of copy paper loaded in the electrophotocopying machine is all consumed.

3. A device as specified in claim **1** wherein

said first switching means is a silicon controlled rectifier including triggering means actuated in response to said output variation of said photoelectric effect element,

said second switching means is a relay connected in series to said silicon controlled rectifier and having a first normally open contact connected in series to a parallel circuit of a print switch, an automatic repeat switch, a switch in said copy paper feeding means and a switch in said copy paper cutting means, a second normally open contact connected in series to said third switching means and a third normally closed contact connected in series to said warning signal generating means, and

said third switching means is a relay having a first normally closed contact connected in series to said illumination lamp, and a second normally open contact connected in parallel with said silicon controlled rectifier.

4. A device as specified in claim **2** wherein

said warning signal generating means is a lamp.

5. A device as specified in claim **2** wherein

said warning signal generating means is a buzzer.

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