United States Patent

Hayne et al.

[15] **3,684,890**

[45] **Aug. 15, 1972**

[54] **PHOTOSENSITIVE MISFEED DETECTOR**

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[52] **U.S. Cl.**.....**250/223,** 250/219 FR, 271/57

[51] **Int. Cl.**.....**G06m 7/00**

[58] **Field of Search**....250/223, 204, 219 DQ, 219 F; 101/284, 408–410; 271/53, 57, 60

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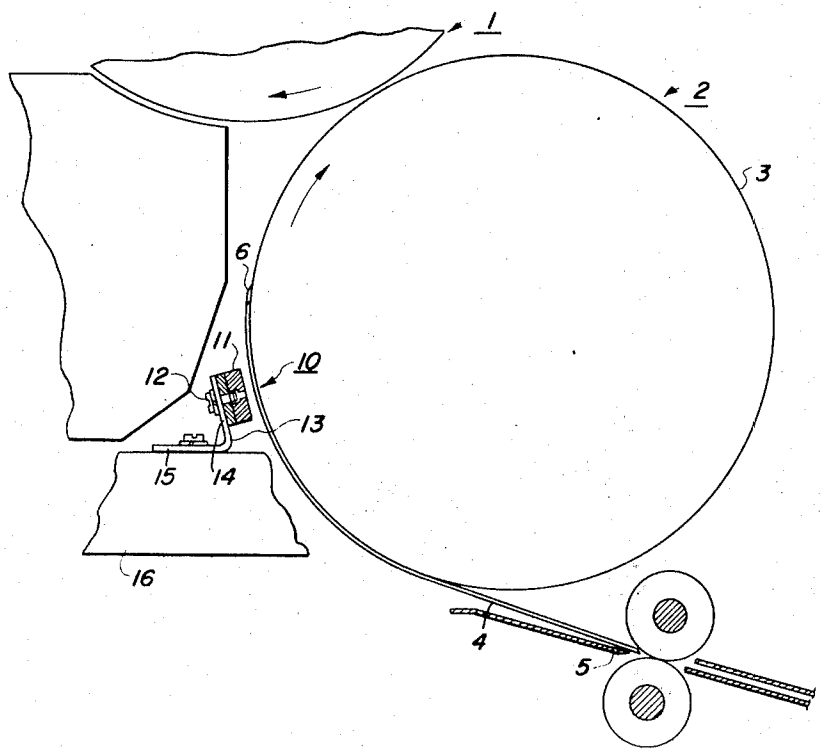
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[57] **ABSTRACT**

A misfeed detector for sensing the presence of a properly fed sheet of support material prior to the sheet being conveyed to the photoconductive surface of a xerographic machine for transfer of a developed image thereto. A photocell system utilizes two reflections from an area where both a sheet should be located and a gripper member is situated to determine whether a sheet is correctly positioned to be conveyed for an image transfer. If a misfeed of the sheet is detected by the photocells, a shutdown of the xerographic machine is effected.

9 Claims, 6 Drawing Figures



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SHEET 1 OF 2

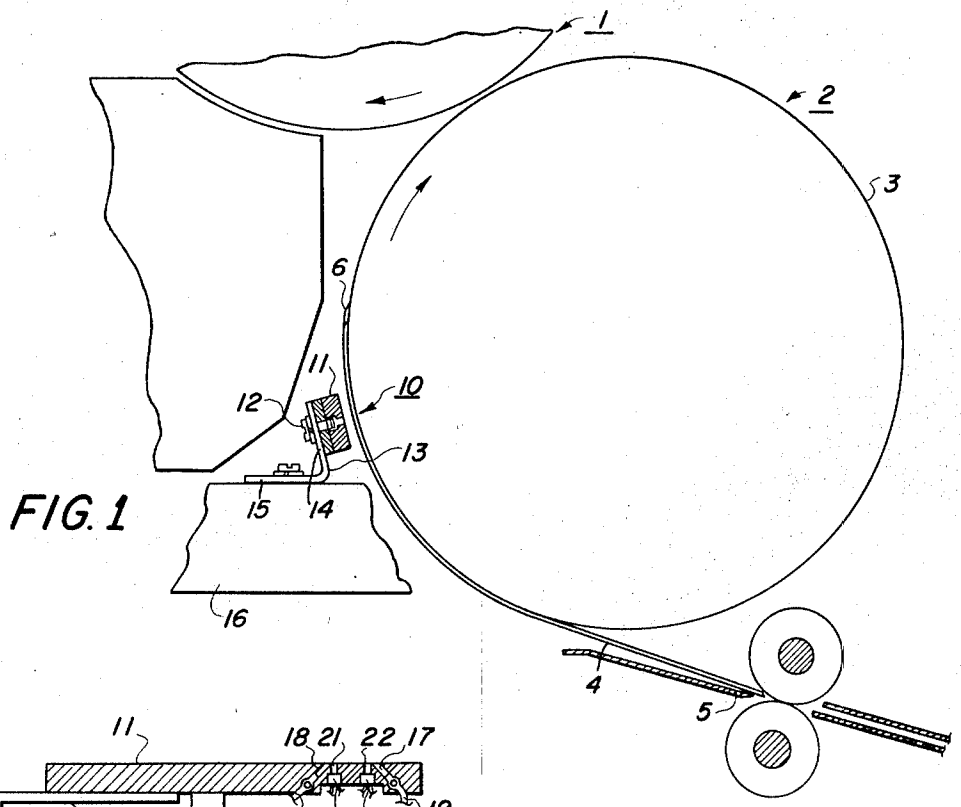


FIG. 1

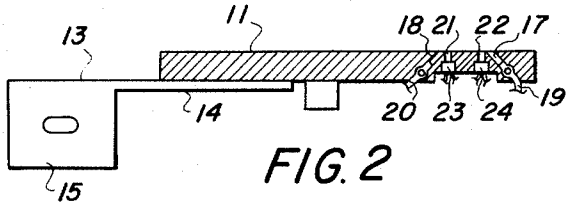


FIG. 2

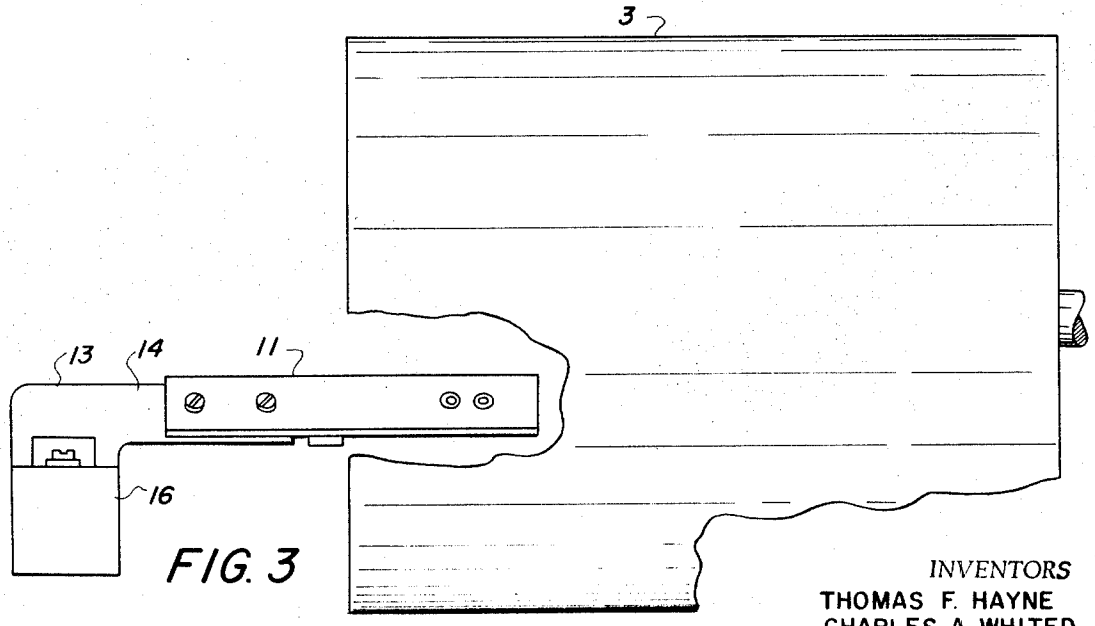


FIG. 3

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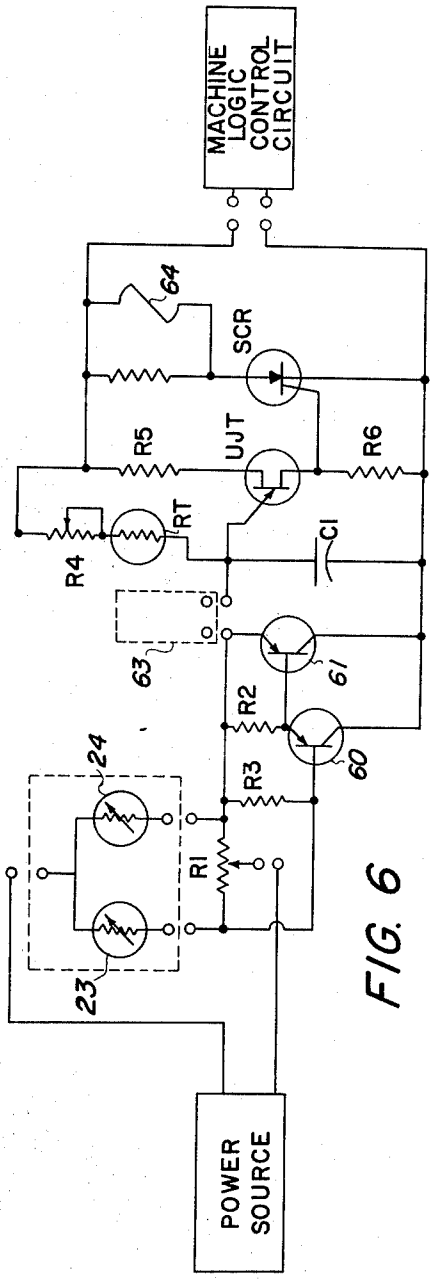


FIG. 6

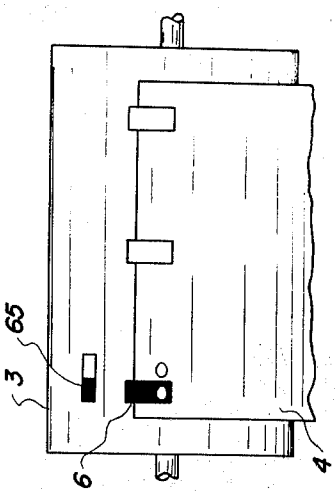


FIG. 5

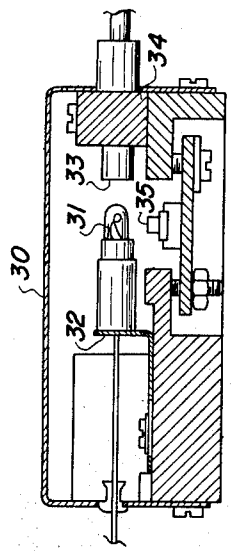


FIG. 4

PHOTOSENSITIVE MISFEED DETECTOR

BACKGROUND OF THE INVENTION

This invention relates in general to the proper handling of a sheet of material and in particular to a detecting device for sensing the proper feeding of a sheet of support material for transfer of a developed electrostatic image thereto.

More specifically, this invention relates to a misfeed detector wherein a photocell system detects whether a sheet of support material is properly positioned prior to being fed to a utilization station. A photolamp directs two beams of light through a fiber optic means to reflect off the surface supporting the sheet material and the gripper member gripping the paper being fed thereon. If a sheet of support material is properly fed to the surface supporting the sheet material, the beam of light striking the gripper finger and the beam striking the paper produce unbalanced reflective values to thereby indicate a sheet is properly fed. However, if the two beams of light are reflected in a substantially balanced condition, a misfeed of a sheet is indicated and a control signal is produced to effect a discontinuation of the operation of the particular machine utilizing the sheet. Further, to insure the accurate detection of the feeding of a sheet material, a light sensitive element is positioned within the light producing housing to sense whether a proper beam of light is present.

Although not intended to be so limited, for convenience of illustration the misfeed detector of the present invention is described for use in an automatic xerographic reproducing machine. In the process of xerography a xerographic plate comprising a layer of photoconductive material on a conductive backing is given an uniform electrostatic charge on its surface and is then exposed to the subject matter to be reproduced by various projection techniques. This exposure discharges the plate in accordance with the light intensity reaching it thereby creating a latent electrostatic image on or in the plate. Development of the image is effected by developers which may comprise, in general, a mixture of suitable, pigmented or dyed, resin base powder, hereinafter referred to as toner, which is brought into contact with the plate by various well-known development techniques. During such development of the image, the toner powder is brought into surface contact with the photoconductive coating and is held there electrostatically in a pattern corresponding to the latent electrostatic image. Thereafter, the developed xerographic image may be transferred to the support material to which it may be fixed by any suitable means such as heat fusing.

Several techniques are employed in the prior art to produce the aforementioned transfer of the developed toner image from the photoconductive surface to a support material. One well-known method utilizes the use of a web of support material such as paper which is positioned against the photoconductive drum by means of two rollers offset from the point of actual transfer of the image to the material. The transfer of the developed material to the web is effected by use of a corotron which applies an electrostatic charge to the back side of the support material to effect transfer of the toner image thereto. However, in such a system it is usually necessary to cut the web support material into sheets after the toner image has been fused thereto in order to produce convenient reproductions. Therefore, a suitable cutting system must be employed in the xerographic machine which will accurately meter the web of support material past a cutter to provide the correct correspondence of the cut sheets to the original image.

The precise indexing of the web to produce an accurately cut sheet is difficult to achieve as well as increases the complexity of the xerographic machine. In addition to the difficulties presented by the necessity of the web of support material being properly indexed, the use of a web is also economically wasteful since the support material must carry the transferred image to the fusing means thereby not utilizing material between the image at the fusing area and the subsequent image to be transferred. Therefore, it has become advantageous in many xerographic applications to utilize sheets of support material to receive developed toner images.

An example of a toner image transfer system utilizing a support material in sheet form is disclosed in the copending application, Ser. No. 830,426 by Michael Langdon filed June 4, 1969, now abandoned. Such a particular system may be, for example, utilized in a color xerographic reproducing machine and includes the use of an electrical bias potential applied to a conductive transfer roller to effect efficient transfer of the image thereto. The conductive roller is mounted adjacent the photoreceptor drum to rotate at the same surface speed. A sheet of paper from a paper feeder is moved to the conductive roller and is gripped by a gripper member so as to be carried to the transfer station adjacent the drum surface. Such a transfer system overcomes the problems of registration caused by the required cutting of sheets after transfer and fusing and further prevents the waste of support material inherent in web systems.

However, unlike a web of support material which generally does not misfeed unless the supply roll of material is depleted, the utilization of support material in individual sheets frequently encounters improper feeding situations. The sheets often physically jam in the paper feeder or in other areas and do not reach the position of transfer as required. Such a failure of a sheet of paper to be located between the transfer roller and the photoconductor drum results in the failure of a duplicate being produced by the machine. Further, an absence of a sheet between the transfer roller and the photoconductive drum causes the developed image to transfer to the surface of the roller which allows toner from the mistransferred image to be applied to subsequently fed sheets and thus damage their quality. Also, toner not properly transferred to a support material hinders the proper operation of the xerographic machine by contaminating it with excess particles which tend to interfere with the elements of the apparatus.

In order to overcome the problems of a misfed sheet of material in a xerographic machine, it becomes desirable to provide a detection device which accurately and quickly determines whether a sheet of support material has been properly fed to the transfer device. Such a detection system must be compatible with a xerographic machine to effectively cooperate in its operation and still be relatively inexpensive and have good operational reliability. Further, the sheet detec-

tion system must accurately determine whether a sheet has been properly fed by the paper feeding mechanism and desirably indicate whether the sheet of paper is properly gripped by the member carrying in on the transfer means. As a further precaution to prevent the misfeed of a sheet, it is important to utilize a misfeed detector which includes a fail safe mechanism to insure that the system is continuously operating to detect the presence of a sheet of support material. Therefore, it is advantageous to utilize in a xerographic machine employing support material in sheet form, a misfeed detection device which clearly indicates the correct positioning of a sheet of material for reception of an image from a photoconductive surface.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to improve the transfer of a developed image from a photoconductive surface to a sheet of support material.

Another object of this invention is to improve the detection of the proper feeding of a sheet of support material to a transfer device.

A further object of this invention is to detect the proper feeding of a sheet material by means of a photocell system.

Still another object of this invention is to improve the detection of whether a gripper member has properly gripped a sheet of material being conveyed by a roller.

A still further object of this invention is to detect the failure of a photolamp to operate in a detection system.

These and other objects are obtained in accordance with the present invention wherein there is provided a misfeed detector that reliably detects the presence of a sheet of paper or other support material as, for example, being fed to a photoconductor drum to receive a developed electrostatic image therefrom. The detection system includes a photolamp which directs two beams of light upon the surface supporting the sheet material and a gripper member for conveying the sheet member, and according to the detected reflective outputs of the beams, a control signal to the machine utilizing the sheet is effected. If a sheet of material is properly fed and the proper reflective signal is detected, the machine is given a go signal to continue its normal sequence of operations. However, if the reflective value of the light beams indicates that a misfeed of a sheet material has occurred or that the gripper member is not properly in position, then the detection system produces a signal to discontinue the operation of the machine to prevent further damage to the apparatus. As a further protection the detection system includes a photocell means to detect the presence of a light beam to insure that the detecting device is properly operating.

The novel misfeed detection system of the present invention produces a reliable indication of the proper feeding of a sheet of support material. Not only does the detection device disclosed herein improve the prior art detection of sheets of material, but also further gives an indication of the proper positioning of the gripper member which conveys the support material. Further, the inclusion of a fail safe light detection system makes the present detection system extremely reliable, since the light emanating from a lamp does not need to be periodically checked until the fail safe detection system detects the presence of an inoperable lamp. Also, the detection unit of this application is both compact and non-complex and readily cooperates with various types of sheet feeding mechanisms. Therefore, the present invention presents a novel and accurate misfeed detection system having high reliability not heretofore provided by the prior art.

DESCRIPTION OF THE DRAWINGS

Further objects of the invention together with additional features contributing thereto and advantages accruing therefrom will be apparent from the following description of one embodiment of the invention when read in conjunction with the accompanying drawings wherein:

FIG. **1** is a schematic illustration of a transfer device for a xerographic machine utilizing the misfeed detector of the present invention.

FIG. **2** is a side schematic illustration of the misfeed detector of the present invention.

FIG. **3** is a schematic illustration of the illuminator for the misfeed detector of the present invention.

FIG. **4** is a front schematic illustration of the misfeed detector of the present invention.

FIG. **5** is a schematic illustration of the positioning of a properly fed sheet of support material on the conductive roller of the transfer device.

FIG. **6** illustrates the electrical circuit in the detection device of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, there is shown a schematic illustration of an example of transfer device **2** mounted adjacent a photoconductive drum **1** and utilizing the misfeed detector of the present invention. The transfer device **2** comprises a conductive transfer roller **3** coupled to a suitable electrical bias potential and the roller is rotated by a suitable motor means (not shown) in a clockwise direction at the surface speed of the drum **1**. The bias potential connected to the conductive roller **3** produces an electric field which effects transfer of the developed toner image from the photoconductive drum **1** to a sheet **4** of support material which is positioned between the confronting faces of the drum and the roller. The sheet **4** of support material is fed at the proper sequence to the bottom of the conductive roller by feeder mechanism **5** at a faster speed than the speed of the surface and the sheet is then gripped by gripper member **6** mounted on the roller.

A series of gripper fingers are provided to swing down onto the properly positioned sheet of support material by suitable means (not shown) and grasp the sheet in order to carry it in the upward direction on the conductive roller to be in a transfer position. For a more detailed description of the transfer device **2** utilizing the conductive roller herein described, reference is made to the aforementioned copending application Ser. No. 830,426.

Still referring to FIG. **1**, the position of the misfeed detector according to the present invention is illustrated generally at **10**. A detector plate **11** is mounted in close vicinity to the transfer roller at the point after the sheet of support material is supplied to the transfer roller and is gripped by the gripper members **6**. The de-

tector plate is mounted by a suitable screw means **12** onto a V-shaped bracket **13**, wherein the vertical extending portion **14** of the bracket extends a greater width than the horizontal support portion **15** as best shown in FIG. **2**. Again, referring to FIG. **1**, the bracket **13** is supported on a support member **16** which rests on the housing of the xerographic machine. The plate **11** extends from the vertical portion of the bracket **13** along the conductive roller to be at least in confrontation with the first gripper member as best shown in FIG. **3**.

Referring in particular to FIG. **2**, the plate of the misfeed detector includes two angularly directed holes **17** and **18** drilled at, for example, identical complementary angles with respect to a normal direction from the plate surface, although dissimilar angles can be utilized if desired. Two fiber optical light guide members **19** and **20** are mounted respectively in holes **17** and **18** and both light guides extend to a common illuminator housing (to be explained in detail later). The fiber optics light guide comprises any suitable conventional fiber optical material as, for example, a plastic. The plate **11** further includes two holes **21** and **22** drilled in a perpendicular direction to the surface of the plate which supports two conventional photocell elements **23** and **24** capable of detecting light intensity. Alternatively, the photocells may be remotely located wherein a fiber optic light guide directs light reaching the holes **21** and **22** to a respective photocell element. The holes **21** and **22** may also be drilled at a selected angle other than normal as shown. The photocells **23** and **24** are coupled by suitable electrical connectors (not shown) to the electrical circuit of the present invention (to be illustrated later).

Referring now to FIG. **4**, there is illustrated the illuminator housing **30** which transmits light through the fiber light guide members **17** and **18**. The illuminator housing is mounted in any convenient remote location from the detector plate, and within the housing **30** a lamp **31** of any conventional type is mounted on a bracket **32**. The lamp **31** is connected by suitable electrical leads to a low voltage power supply (not shown) for illumination of the lamp. The light from the lamp is directed to the receiving end **33** of the fiber optics light guide which is mounted in suitable brackets **34** directly adjacent the light beam of the lamp **31** to receive the rays therefrom. The end **33** of the fiber optics light guide receives the light from the lamp and divides it up into two beams which are directed through the two separate fiber optics guide members **19** and **20**. The light in the two fiber optics light guide members is directed to their respective ends mounted in holes **17** and **18** in the detector plate **11** to form two beams which are directed onto the transfer roller. Also a light sensitive element **35** such as, for example, a phototransistor used as a photodiode is mounted within the illumination housing **30** and is responsive to the level of light within the illuminator housing to cause a shutdown of the xerographic machine in the event that the lamp fails to illuminate. The cooperation of the photodiode **35** within the circuit of the detector to effect a fail safe type sensing function will be explained later in conjunction with the description of FIG. **6**.

Referring now to FIG. **5**, there is illustrated a schematic view of the transfer roller **3** wherein a properly fed sheet of paper being gripped by the gripper fingers is illustrated. The roller **3** is shown with a properly inserted sheet **4** of support material which is gripped by three gripper fingers **6**. The gripper finger which is used as a reflective surface is painted black whereby when a beam of light is directed upon it, no reflection will occur. Therefore, the light emanating from the fiber optic member **19** is directed upon the location where the gripper finger should be when properly gripping a sheet of paper. The light being directed by the other fiber optic member **20** is directed to a location on the roller directly adjacent to the gripper finger which is reflective if a white support member is properly present, but the roller surface in the vicinity of the gripper is selected to be non-reflective in absence of a sheet.

Therefore, if a properly fed sheet is attached to the roller by the gripper, an unbalanced reflective value is produced by the gripper finger and the sheet surface. However, it can also be seen that if, for example, a sheet of paper is not properly fed to the gripper, light will not reflect off the transfer roller and a balanced black or very low level reflection is detected by the photocells. Similarly, if a sheet covers the black gripper finger and thereby being improperly attached to the roller, a substantially balanced reflective value is detected by the two photocells, since both beams of light are directed against the sheet.

Referring now to FIG. **6**, the electrical circuit is illustrated which cooperates with the photocell system of the misfeed detector of the present invention. The two sensing photocells **23** and **24** in the detection plate **11** form two arms of a bridge circuit which includes a resistor **R1** and a tap element and the bridge is coupled to a suitable DC power source. The bridge circuit is connected to the base of a suitable PNP transistor **60** and through a resistor R2 to the emitter of the PNP. A suitable bias resistance R3 is further coupled to the base of transistor **60**. The base of a second identical PNP transistor **61** is connected to the emitter of the transistor **60** and the collector of transistor **61** is coupled to the collector of the first PNP. The photodiode **35** shown in FIG. **4** is connected in the circuit block **63** to effect a control signal to discontinue operation of the xerographic machine in the event of a burn out of the lamp (as will be described in detail later).

The circuit of the invention further includes a timing means which comprises a capacitor C1 and resistors R4 and RT that control the firing of a unijunction transistor UJT. The transistor UJT is suitably biased by resistances RT, R4, R5, and R6 wherein RT provides thermal compensation for the unijunction due to ambient variations in the machine environment. The output of the unijunction is connected to the collector of a silicon controlled rectifier SCR which includes a relay **64** in series therewith. The logic circuit of the xerographic machine is coupled to the timing circuit to apply and subsequently remove power from the detector timing circuit to determine proper feeding of a sheet during the appropriate interval. In this manner proper feed or lack of proper feed is determined and the machine is allowed to continue or commanded to begin a shutdown sequence.

In operation, the detector circuit effects a control of the xerographic machine by the particular timing sequence of the timing means. The power source of the

detector circuit is actuated by he machine logic circuit to begin the charging of capacitor C1 of the detector to commence a timing sequence by the timing means. If the bridge becomes unbalanced before the triggering of the UJT transistor by the capacitor as in the case where the photocell **23** does not sense reflected light while the photocell **24** does sense illimination, then the two PNP transistors will both conduct to discharge the capacitor C1 whereby the capacitor has not reached a level sufficient to trigger the UJT and therefore a new timing cycle is begun by the timing circuit. In order to achieve a precise start time for the timing means and to improve photocell stability, a test pattern **65** is mounted a predetermined distance ahead of the gripper fingers on the transfer roller as best shown in FIG. **5**. At a time after the power is applied to the circuit in its proper sequence of operation, the light beams strike the black and white pattern **65** on the roller to produce the aforementioned discharge of the capacitor C1 because of the unbalance of the photocells and a new timing interval is then again commenced, since the capacitor has not reached a level sufficient to trigger the UJT.

After the new time interval has been started by the renewed charging of the capacitor C1, the gripper fingers and sheet on the conductor roller **3** are rotated past the detecting light beams produced by lamp **31**. If the photocells **23** and **24** detect a correctly fed sheet and the darkened gripper finger is in the correct position to carry the paper to the transfer station, the capacitor again is discharged to effect a new timing cycle since photocells sense an unbalanced light condition. However, if the photocells detect a balanced black condition, then a sheet of support material has been misfed and both transistors **60** and **61** will not fire to reset the timer as in the unbalanced light situation. Thereafter, the timing circuit after a balanced detection continues its normal time interval by the capacitor C1 being charged by the power source. When the capacitor is then charged to the required level, the unijunction UJT is triggered to instantaneously fire the SCR switch and the relay **64** is energized. If the relay **64** is energized the machine circuit will receive a signal to effect a shutdown sequence of the xerographic machine. Similarly, if the photocells detect the condition where a sheet of paper is present but the sheet covers the gripper finger, a balanced light condition is sensed which will likewise not discharge the capacitor to reset the timer and thus a shutdown sequence is also effected. On the other hand, if an unbalanced light pattern is sensed by the photocells due to a properly fed sheet of material as stated previously, the timer is reset and the relay is not energized whereby the machine logic circuit continues normal operation of the apparatus.

If an improper fed sheet is detected, the shutdown of the operation of the xerographic machine may involve a sequence of operations such as, for example, fusing of a prior transferred image, a movement by the transfer charged away from the photoreceptor drum, or other desirable events needed before a satisfactory shutdown should be effected. Further, the photodiode **35** mounted in the illuminator housing possesses a low resistance when lighted and upon the lamp being burned out, the diode immediately acquires a high resistance. The resulting high resistance makes it impossible for the PNP transistors to discharge the capacitor C1 to reset the timing circuit for a new sequence which is necessary for a go situation for the machine. Therefore, the UJT triggers at the next interrogation interval as the capacitor C1 becomes charges to the necessary level to energize the relay and cause the machine to discontinue operation in a manner similar as in the case of a misfed sheet of support material as previously described.

In the above description there has been disclosed an improved misfeed detection device for insuring the correct feeding of a sheet of support material to the transfer station of a xerographic apparatus. The misfeed detection device of the present invention may be utilized in conjunction with other image transfer mechanisms and xerographic machines other than the one herein disclosed. Further, the novel detection device disclosed herein was described for convenience of illustration for use in a xerographic machine, but the invention may be utilized in any system where it is desired to detect the misfeeding of sheet material. Also the sensor may be used to test the efficiency of grip (percentage of area of paper gripped) by relating the relative effectiveness of an ideal grip in the form of the test pattern to the actual grip by observation of the capacitor discharge curve.

While the invention has been described with reference to the preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the true spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teaching of the invention without departing from its essential teachings.

WHAT IS CLAIMED IS:

1. An apparatus for detecting the non-feed and misfeed of positioning of a sheet material supported on a conveying surface including

energy beaming means to direct a plurality of energy beams against a conveying surface adapted to convey a sheet material to a utilization station,

energy sensing means to sense the plurality of levels of energy produced by the plurality of energy beams directed against the conveying surface,

control means responsive to the plurality of levels of energy sensed by the energy sensing means to indicate the feed and non-feed of positioning of a sheet material on the conveying surface upon the plurality of levels of energy being substantially equal to each other, and

said control means further including a timing means to measure a pre-determined time interval beginning upon the application of power to said control means and again recommencing upon the sensing of an unequal energy level whereby the control means is conditioned prior to the beginning of each sensing cycle.

2. The apparatus of claim **1** wherein the energy beaming means directs two beams of radiant energy against the conveying surface and a non-reflective member positioned thereon.

3. The apparatus of claim **2** wherein the energy sensing means senses the reflective level of the two beams of radiant energy from the conveying surface and the non-reflective member.

4. A detector apparatus for detecting the improper positioning of a sheet member on a conveying surface having a sheet securing means comprising

a first energy means to direct a first beam of energy against the conveying surface,

a second energy means to direct a second beam of energy against the sheet securing means,

energy sensing means to sense the magnitudes of the energy produced by the first beam of energy and the second beam of energy directed against the conveying surface and the sheet securing means respectively,

control means responsive to the relative magnitudes of energy sensed by the energy sensing means to indicate the improper positioning of a sheet material on the conveying surface upon the magnitudes of energy remaining balanced for a predetermined time interval.

5. The apparatus of claim 4 wherein the first energy means and the second energy means each direct a beam of radiant energy.

6. The apparatus of claim 4 wherein the magnitude of energy produced by the second beam of energy is unequal to the magnitude of energy produced by the first beam of energy directed against the conveying surface having a properly positioned sheet material.

7. The apparatus of claim 4 wherein the time interval is measured by a timing circuit.

8. The apparatus of claim 4 wherein the conveying surface supporting a sheet member moves relative to the detector apparatus to produce unbalanced magnitudes of energy during the time interval upon the sensing of a properly positioned sheet.

9. A method of sensing the presence of a properly positioned sheet of material being conveyed by a conveying surface including a sheet securing means comprising the steps

directing a first beam of energy against a conveying surface having a first energy reflective level to produce a first magnitude of energy,

directing a second beam of energy against a sheet securing means having a second energy reflective level to produce a second magnitude of energy,

moving the surface and sheet securing means relative to the first and second energy beams, and

sensing the proper positioning of a sheet of material on the conveying surface upon at least one of the first magnitude of energy and the second magnitude of energy changing value during a predetermined time interval.

* * * * *