United States Patent

[11] **3,623,058**

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[21] Appl. No. **776,649**
[22] Filed **Nov. 18, 1968**
[45] Patented **Nov. 23, 1971**
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[54] **SHEET-SENSING APPARATUS**
2 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** ..... **340/259,** 340/258 R
[51] **Int. Cl.** **G08b 21/00**
[50] **Field of Search** ..... 340/259, 258 C; 324/60, 61, 61 P, 61 TI, 71, 33, 54

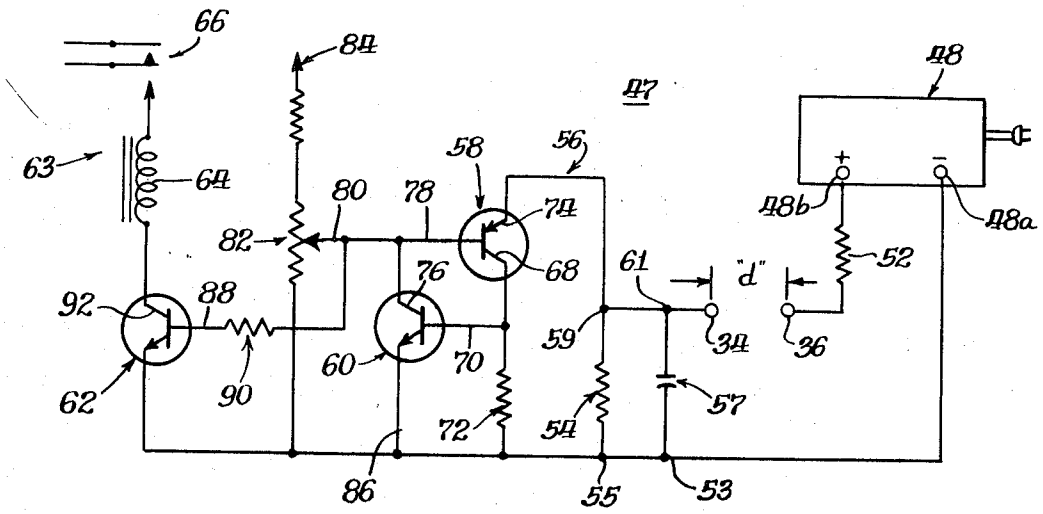
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ABSTRACT: Apparatus for sensing the presence of master sheets or the like in a copying machine, comprising a pair of spaced-apart electrodes connected to a high-voltage source, with a transistor switching circuit coupled thereto. Circuit continuity is completed through an ionized path between the spaced electrodes caused by the high voltage produced thereat. When continuity between the electrodes is maintained, the transistor switching circuit is operated to a first state, but upon passage of a master sheet between the electrodes, current flow between the latter ceases or is reduced to a point whereat the transistor switching circuit is no longer maintained in the first state, and is switched to a second state of operation.



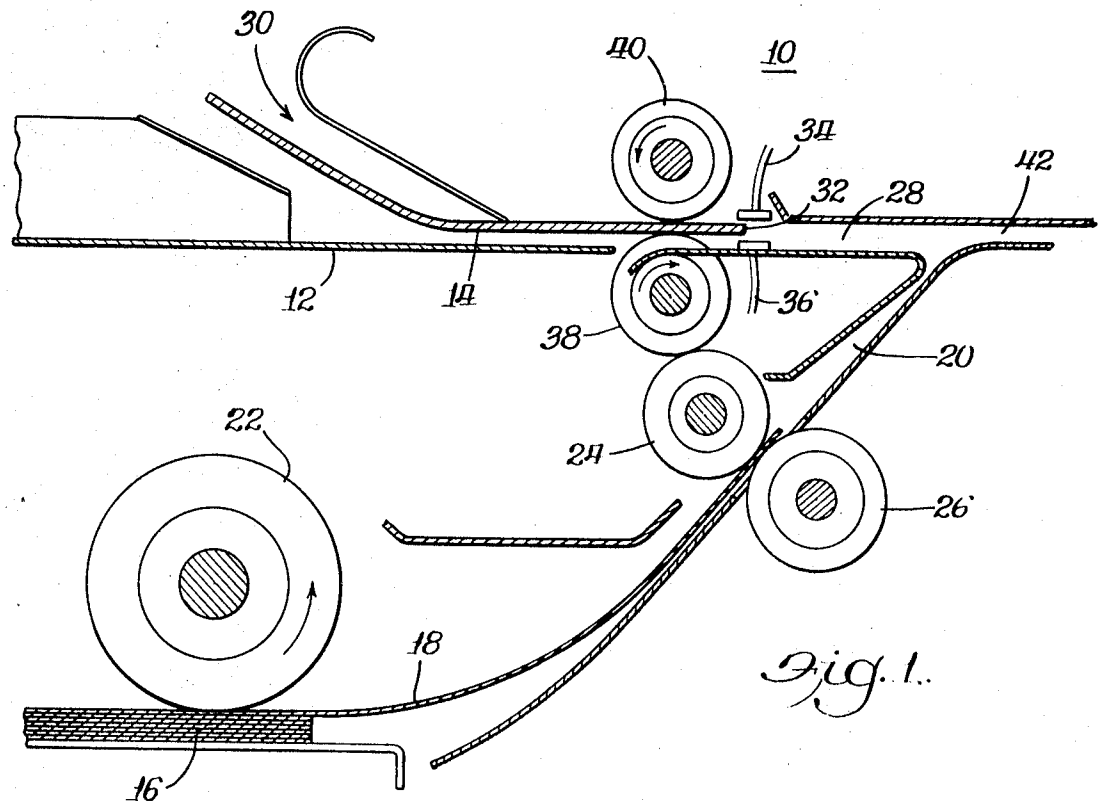
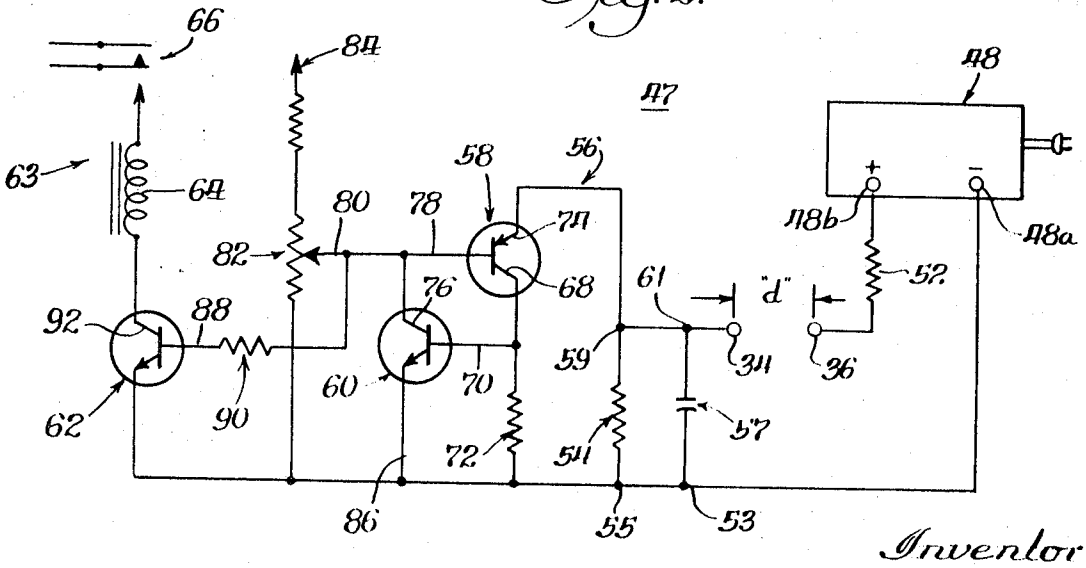


Fig. 1.

Fig. 2.



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SHEET-SENSING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates generally to sensor devices and more particularly to devices for sensing the presence of masters from which copies are made in a copying machine.

The sensing of a master or original sheet in a copying machine, either of the electrostatic or diazo type, upon insertion of the master thereinto serves in some types of copying machines, to initiate the functioning of components of the machine or the copying process itself. Most often sensing devices used for such a purpose in a copying machine are of the photocell or mechanical type.

While the last mentioned sensing devices are satisfactory in most instances, they are not well suited for sensing lightweight or transparent masters. In the case of the photocell sensor which depends upon the blocking of light therefrom by the passage of a master between the photocell and a light source, light passes through masters which are translucent without being blocked sufficiently to be detected by the photocell.

The mechanical sensor, on the other hand, is operated by the force of the incoming original thereagainst. In the event the original is lightweight or flimsy, such as in the case of vellum, onion skin, and the like, the force of the paper against the mechanical sensor arm is insufficient to activate the sensor, but instead often merely causes the crumpling or mutilation of the paper in the machine.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide a new and improved sensing device for use in a copying machine.

It is a more specific object of this invention to provide a sensing device for use in a copying machine for detecting the presence of transparent or lightweight sheets fed into the machine.

It is yet another object of this invention to provide a sensing device for use in a copying machine for sensing both transparent and nontransparent master sheets of varying weights fed thereinto, to in turn actuate a control circuit of the machine to initiate the copying process.

Briefly, a preferred embodiment of a sensing device according to the invention comprises a circuit arrangement including a pair of predeterminately spaced-apart and electrically isolated electrodes. The electrodes are connected to a high-voltage source and to an adjustable transistor switching circuit. Circuit continuity is complete through an ionized path between the electrodes caused by the high voltage produced thereat by the source. When continuity is maintained between the electrodes, the transistor switching circuit functions to prevent the actuation of the copying machine. When a master or the like sheet, either of a transparent or nontransparent type and of substantially any weight, is passed between the electrodes, current flow therebetween ceases or is reduced to a point whereat the transistor switching circuit is no longer maintained in its normal state. The change of state of operation of the transistor switching circuit in turn causes the copying machine control circuit to be activated.

DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention and its organization and construction may be had by referring to the description below in conjunction with the accompanying drawings wherein:

FIG. 1 is an enlarged sectional view of a typical assembly in a copying machine for feeding an original and a copy sheet in a synchronized relation and incorporating a sensor device according to the invention; and

FIG. 2 is a schematic representation of a sensing circuit according to the invention.

DETAILED DESCRIPTION

Referring now to the drawings in greater detail, FIG. 1 thereof shows a side sectional view of an example of an original and copy sheet feed assembly of a copying machine. The feed assembly illustrated herein is shown merely for illustrative purposes and the use of the sensor device according to the invention is not restricted thereto. Moreover, the feed assembly may be found in an electrostatic, diazo, or other type of copying machine.

Briefly, the feed assembly, designated generally by the numeral **10**, includes a table or shelf **12**, a portion of which extends outwardly of the copying machine, so as to be able to receive an original, such as **14**, from which copies are to be made.

A copy sheet stack **16** mounted below the shelf **12** is provided to deliver sheets, such as **18**, along a copy sheet path **20** of the feed assembly so as to synchronize the movement of the copy sheet and the original through the copying machine. A roller **22** mounted for rotation above the copy sheet stack serves to move a single copy sheet from the stack along path **20** to a predetermined point between a pair of feed rollers **24** and **26**. A copy sheet **18** remains in readiness between rollers **24** and **26** until the original **14** is fed into the original feed path **28** of the feed assembly.

When a copy is desired, the original **14** is fed into the throat **30** of the original feed path until the leading edge **32** thereof passes between electrodes **34** and **36** of the sensor device according to the invention. The passage of the leading edge therebetween serves to activate the sensing circuit (not shown in FIG. 1) to advise a control circuit of the machine that an original is being inserted thereinto. In response to the receipt of this information, the control circuit operates the rollers **24** and **26** to advance a partially fed copy sheet **18**. The rotation of roller **24**, which is a driven roller, causes the copy sheet to be advanced along path **20**.

Roller **38** mounted for rotation below the original feed path **28** beyond throat **30** is also a driven roller and continuously engages a resilient idler roller **40** mounted for rotation above the roller **38** and original feed path **28**. As the original passes between sensor electrodes **34** and **36**, the former also enters the nip of rollers **38** and **40** and is advanced by these rollers along feed path **28** to move into an aligned and superimposed relation with a copy sheet **18** in the single path **42** provided therebetween.

Turning now to FIG. 2 of the drawings, there is shown a schematic diagram of a sensing circuit **47** according to the invention. The electrodes **34** and **36**, corresponding to the electrodes of FIG. 1, are illustrated in FIG. 2 and are separated from each other by a gap having a predetermined distance "*d*" as shown. The distance "*d*" may be altered to suit the usage for which a specific sensing circuit is designed in accordance with changes in the values of the components of the circuit.

A high-voltage supply, which is operable by connection thereof to a common 115-volt AC household line, is provided to power the circuit. The negative output terminal **48***a* of the high-voltage supply is grounded and is connected via lead **50** to first terminals **53** and **55** of a capacitor **57** and resistor **54**, respectively. The positive output terminal **48***b* of the high-voltage supply **48** is connected through a resistor **52** to the electrode **36**. The opposite terminals **59** and **61** of resistor **54** and capacitor **57**, respectively are connected to electrode **34** to complete a first leg of the circuit. The resistors **52** and **54** and the gap between electrodes **34** and **36** serve in the capacity of a voltage-divider network, the output of which is taken across resistor **54**, and capacitor **57** is provided to remove AC components from the output.

A transistor switching circuit configuration of the Schmidt trigger variety, indicated generally by the numeral **56** and connected to the output of the voltage-divider network described above, serves as an indicating means for the sensing circuit, indicating by the functioning thereof, the passage of an article between the electrodes **34** and **36**. The invention is not limited

to the use of the particular switching circuit shown but this circuit is extremely desirable since, as will be described hereinafter, the sensitivity thereof may be adjusted for specific purposes.

The transistor switching circuit comprises a pair of transistors 58 and 60 interconnected as shown, so that transistor 60 provides a regenerative control for transistor 58. This will be explained more fully hereinafter. A third transistor serving as a driver for a relay 63, is connected to the last mentioned transistors. While relay 63, including energizing coil 64 and normally open contacts 66, serves herein to illustrate a load driven by transistor 62, in practice relay 63 could be the starting switch assembly for a copying machine or the first in a series of switches which serves to operate a control circuit of a copying machine.

Referring again to transistor 58, it can be seen that the collector 68 thereof is connected to the base electrode 70 of transistor 60, and the two are in turn connected through a limiting resistor 72 to ground via lead 50. The emitter 74 of transistor 58 is connected to the positive side of resistor 54. The collector 76 of transistor 60 and the base 78 of transistor 58 are connected to each other and in turn to the selector arm 80 of a variable resistor 82. The resistor 82 is connected at one side to a positive bias voltage supply 84 and is grounded at the other side thereof. The emitter 86 of transistor 60 is also grounded.

Transistor 62 is connected in grounded emitter fashion with the base 88 thereof coupled through a resistor 90 to selector arm 80 of the variable resistor 82. The collector or output terminal 92 of transistor 62 is connected to relay coil 64.

For purposes of affording a more complete understanding of the present invention, it is advantageous now to provide a functional description of the mode in which the circuit configuration thus far described operates.

Upon energization of the power source 48, high voltage is supplied to the circuit. A high-voltage potential in turn is applied across the gap between sensor electrodes 34 and 36, and a current is caused to flow over an ionized path produced therebetween, maintaining circuit continuity. Due to the voltage-divider action of resistor 52, 54 and the gap between the electrodes, a voltage, determined by the values of the last mentioned components, is provided across resistor 54, causing, in turn, a voltage to appear at the emitter 74 of transistor 58.

A positive bias voltage determined by the setting of selector arm 80 of variable resistor 82 and provided from voltage bias source 84, places a positive voltage at the base 78 of transistor 58. Normally the voltage at emitter 74 of transistor 58 is more positive than the voltage at base 78 thereof. Consequently, transistor 58 will be normally in a state of conduction. The conduction of transistor 58 in turn causes a voltage to appear at the base input of transistor 60 and causes the last mentioned transistor to likewise be conducting. The conduction of transistor 60 insures the maintenance of transistor 58 in a conductive state, since as was mentioned heretofore, they are regeneratively coupled. At this time, transistor 62 is turned off and the contacts 66 of relay 63 are opened as shown in FIG. 2.

Upon passing an object such as the master sheet or original 14 of a copying machine of FIG. 1, between the electrodes 34 and 36, the current flowing over the ionized path between the electrodes ceases to flow or is lessened to a point whereat the voltage supply at the emitter 74 of transistor 58 becomes less positive than the bias voltage provided at the base 78 of transistor 58, causing transistor 58 to change from its state of conduction to an "off" state (nonconduction). When this occurs, transistor 60 likewise turns "off" and the bias voltage from source 84 then serves to operate transistor 62 to a state of conduction. Relay coil 64 is energized upon the operation of transistor 62, and causes contacts 66 of the relay to close, completing an external or load circuit (not shown).

As mentioned heretofore, the sensitivity of the sensing circuit may be altered if desired. This may be accomplished by changing the voltage at base 78 of transistor 58 with respect to the voltage at emitter 74 thereof, and is easily done by an adjustment of variable resistor 82. When the voltages are chosen to be close to each other in value, the sensing circuit becomes more sensitive, since the slightest reduction of conductivity of the ionized path between electrodes 34 and 36 causes a reduction of the voltage at emitter 74 of transistor 58. Likewise, when the voltages are farther apart in value, the circuit becomes less sensitive. The distance "*d*" between electrodes may also be changed to accommodate articles passing between the electrodes to be detected by the circuit, by correspondingly changing the values of resistors 52 and 54, and/or the voltage output of high-voltage source 48.

While the sensing circuit has been used to illustrate the sensing of primarily nonconductive sheet material, such as masters or originals for copying machines, the circuit may also be used to sense conductive articles or material. In the event a conductive article is passed between electrodes 34 and 36, the high voltage from source 48 will produce an ionized path between the electrode 36 and the conductive article, causing a current flow through the metallic object from the electrode 36 to ground. The cessation of current flow through resistor 54, causes the voltage at emitter 74 of transistor 58 to cease, and in turn transistors 58 and 60 will turn "off." The turning "off" of the last mentioned transistors will, as described above, cause transistor 62 to conduct, indicating the passage of an object between electrodes 34 and 36.

Thus, the sensing circuit according to the invention provides an efficient and reliable means for detecting both nonconductive and conductive articles of all varieties; and, is especially well suited for use in copying machines to detect the passage of original or copy sheets of all types and weights.

While a preferred embodiment of a sensing circuit according to the invention has been shown, it will be obvious to those skilled in the art that the invention is not limited thereto since many modifications thereof may be made. For instance, a single transistor switch could be used as the switching means of the circuit. In this case the transistor is normally in a state of conduction, maintaining a pair of normally closed relay contacts open by the energization of a relay coil. Upon the passage of a sheet of material or the like between the electrodes, the transistor is caused to change to a state of nonconduction. The relay coil in turn is thereby deenergized and the contacts fall to their normally closed position, operating the external circuit of which they are a part. This modification however, has no sensitivity adjustment as does the preferred embodiment discussed heretofore.

In view of the above, it is contemplated to cover by the present application any and all such modifications as fall within the true spirit and scope of the appended claims.

What is claimed is:

1. An apparatus for sensing the presence of nonconductive sheet material moving along a path comprising

a pair of sensor electrodes positioned at a given point along the path and disposed opposite each other on opposite sides of the path, said electrodes being spaced from each other a distance such that the sheet material can pass between the electrodes without contacting both of the electrodes,

a voltage-dividing network connected in series with the pair of electrodes and having a tap at an intermediate point in the dividing network,

a high-voltage potential source connected across the voltage-dividing network and supplying a potential of sufficient magnitude to provide a continuous corona discharge between the electrodes so that a current continuously flows through the voltage-dividing network in the absence of sheet material between the electrodes, the interposition of sheet material between the electrodes interrupting the continuous corona discharge and interrupting the flow of current through the voltage-dividing network,

a switching means including a controlled conduction device coupled to said tap on the voltage-dividing network to

receive a given potential from the voltage-dividing network during the flow of current through the network,

biasing means coupled to the controlled conduction device for normally maintaining the controlled conduction device in one of two alternate conductive states during the persistence of said given potential, said biasing means placing said controlled conduction device in the other of its alternate conductive states when said given potential is removed by the interruption of current flow through the voltage-dividing network,

and control means coupled to and controlled by the switching means and responsive to the changes in the conductive state of the controlled conduction device.

2. An apparatus for detecting the presence of nonconductive and conductive articles moving along a given path comprising

a pair of sensor electrodes positioned along said path and disposed opposite each other spaced apart a distance sufficient to permit movement of the articles along the path, a given one of said electrodes being positioned to be engaged by an article moving along the path and to be grounded thereby when the article is conductive,

a voltage-dividing network coupled in series with the electrodes and having a tap at an intermediate point,

a high-voltage potential source connected across the voltage-dividing network and providing a voltage sufficiently high to maintain a continuous corona discharge between the electrodes in the absence of the nonconductive article so that a current flows through the network to provide a control voltage of a given value at the tap, the interposition of a nonconductive article between the electrodes interrupting the current flow to change the control voltage, the engagement of said one electrode by a conductive article also changing the control voltage,

and a control means coupled to the tap and controlled by the change in the control voltage for providing an indication of the presence of either conductive or nonconductive articles in said path.

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