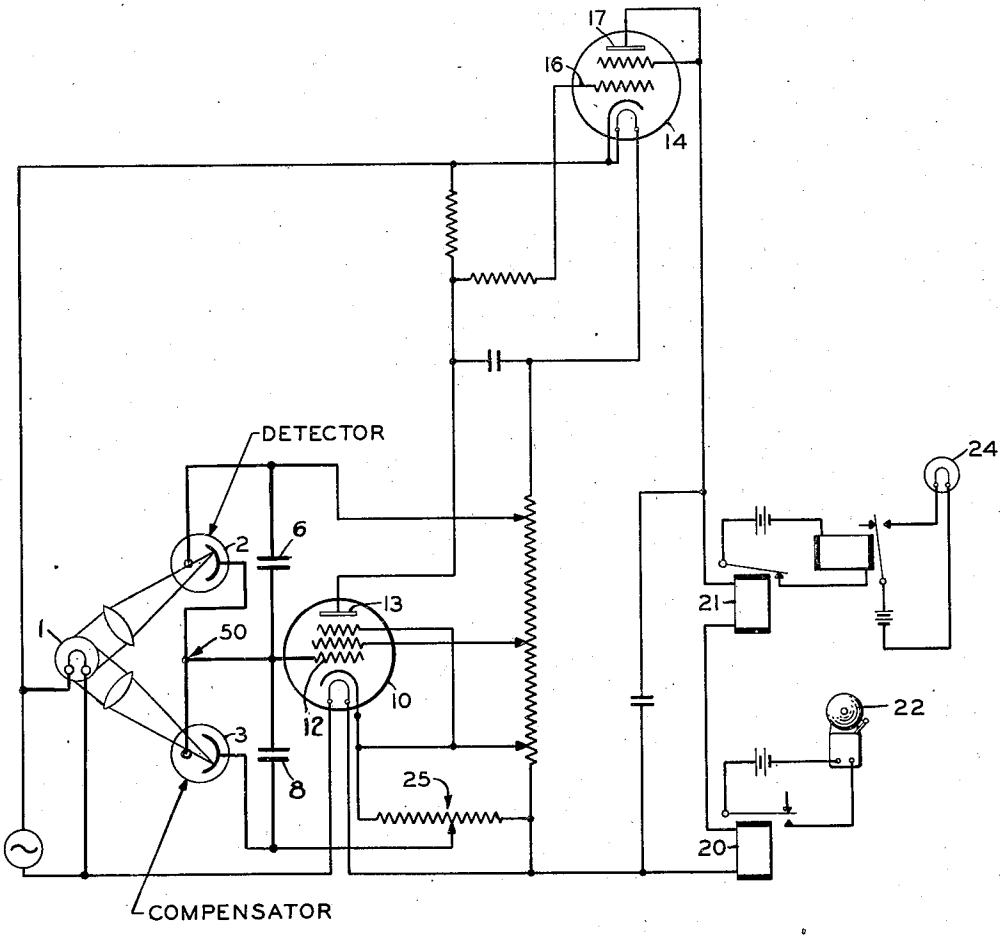
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PHOTOELECTRIC SMOKE DETECTION SYSTEM

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PHOTOELECTRIC SMOKE DETECTION SYSTEM

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This invention relates generally to light-sensitive detecting or control systems adapted primarily for purposes of operating alarm devices or electrical release devices of various types. The invention is particularly adapted for use as a fire detection system for closing dampers and stopping fans in air conditioning or ventilating systems wherein it is necessary to detect fire conditions when existing either in the air conditioning system or in or near the premises served by such system.

Smoke detecting systems used for fire detection must be unusually sensitive and also reliable to the extent that ordinary fluctuations in the commercial supply voltage will not cause false alarms or undesired control of the air conditioning system. The smoke detector must also be under constant supervision from a central control point whereby trouble conditions may be discovered promptly to prevent accidental periods of inoperativeness which might allow fires to occur without causing an alarm. In prior smoke detectors of the photoelectric type, it has been necessary to utilize complicated and expensive apparatus for the purpose of compensating for variations in supply voltages. This invention provides an extremely sensitive and simple circuit wherein the above mentioned requirements are met.

The primary object of this invention is to provide a photoelectric smoke detecting system of high sensitivity wherein the sensitivity is maintained over a high range of voltage fluctuations in the electrical supply circuit and wherein constant trouble supervision is maintained.

Another object of this invention is to provide a photoelectric smoke detecting circuit which prevents false alarms or false operations of load circuits due to voltage fluctuations.

Still another object of this invention is to provide a light-sensitive circuit wherein trouble conditions may be supervised from a remote point.

A further object of this invention is to provide indications of trouble in the amplifier associated with the photoelectric smoke detecting circuit.

A still further object of this invention is to provide indications of trouble in the photoelectric cell branch of the smoke detecting system.

Still another object of this invention is to provide a supervisory circuit for indicating trouble conditions within the light source which is used in connection with a smoke detecting device or failure of the circuit of said light source.

A further object of this invention is to provide a supervisory circuit comprising a single trouble responsive element for detecting troubles in certain component parts of a smoke detecting system.

Another object of this invention is to provide an amplifier and associated photoelectric cell circuit which is suitable for supervision by a single trouble responsive unit.

Still a further object of this invention is to provide a smoke detection circuit which can be supervised by a single trouble responsive element.

Still another object of this invention is to provide a new and improved sensitive smoke detecting circuit wherein fluctuations in supply voltage may be compensated, alarm conditions and trouble conditions are distinguished from one another and which is simple in arrangement.

Further objects and advantages of this invention will be evident from consideration of the following description of the preferred embodiment shown in the accompanying drawing wherein:

The figure of the drawing shows a circuit diagram of the smoke detector system embodying this invention.

In order to utilize photoelectric smoke detecting systems for alarm purposes they must be highly sensitive or responsive to small variations of received light radiation over a wide range of voltage fluctuations in the electrical supply circuit and they must also be arranged for constant supervision whereby indications of trouble may be transmitted to a central control point. The circuit embodying this invention and meeting the above requirements consists of a bridge circuit containing the photoelectric cells 2 and 3 which are adapted to receive light from a light source 1. In the preferred application of this circuit it is used for smoke detection but it is adapted for use in any application where changes in light may be used for signalling or control purposes. The cell 2 acts as a detector for detecting smoke as it passes before the light source 1, while the cell 3 is arranged to receive unintercepted light from source 1, or light unaffected by smoke or other factors affecting the cell 2, and acts as a compensator for compensating fluctuations in supply voltage. The cells are connected in a bridge circuit with the condensers 6 and 8 as shown in the drawing. The bridge comprising the cells 2 and 3 and condensers 6 and 8 is normally in a balanced condition whereby changes in supply voltage affecting the amount of light emitted by the light source 1 do not disturb the balanced condition and consequently no change in output occurs.

The bridge circuit is connected to an amplifier tube 10 which is in turn connected to an amplifier 14. The normal preset output of this amplifier 14 controls the alarm relay 20 and the trouble relay 21 whereby changes in amplifier output result either in alarm signals or trouble signals.

Since under normal conditions light from the source 1 falls on both the cells 2 and 3, they are conductive and the potentials occurring across each cell will be determined by the light radiations received by each. Consequently the grid 12 of the amplifier 10 will be forced to assume the potential occurring at junction point 50 of the two photocells. The bias voltage on grid 12 is provided by means of potentiometer 25 and is so adjusted as to maintain the circuit in its most sensitive condition. Should smoke or any other suspended matter reduce the amount of light falling on cell 2, the conductivity of the detecting photocell 2 will be decreased thus increasing the impedance of that photocell and driving the grid 12 to a more negative bias with a consequent reduction in the plate output of tube 10. Inspection of the circuit diagram will show that the second stage 14 of the amplifier is operated back-to-back with respect to the first stage 10 and that the output from amplifier 10 is used directly for controlling the control grid 16 of tube 14. Hence the decrease in the plate output in the tube 10 due to an interruption of the light beam from source 1 causes the grid 16 to be driven to a more positive bias on the next half cycle and increases the current output from plate 17 very sharply. Alarm relay 20 is adjusted to become energized on plate currents above the normal preset output of plate 17 whereby the increase in output resulting from interception of the light beam from source 1 causes relay 20 to energize and close its contacts to transmit an alarm signal to alarm 22.

As mentioned above, the voltage fluctuations in the electrical supply circuit are balanced out in the bridge circuit since both the compensator cell 3 and the detector cell 2 receive light from the same lamp filament whereby any variation in line voltage affecting the light source 1 will affect both the compensator and the detector cells in the same direction and in proportion, thereby keeping the bridge circuit which is connected to the grid 12 of amplifier 10 in a balanced condition. When both photocells are dark, the condensers 6 and 8 connected in parallel with the photocells 2 and 3 maintain the grid 12 of the tube 10 at a preset bias or potential which is slightly positive with respect to the normal bias or potential which exists when both the photocells are illuminated. These condensers are necessary due to the fact that the impedance of the photocells in their dark condition approaches infinity and hence if the grid were not stabilized at a given potential as described above it might assume such a potential that unstable operation of the amplifier would result. The importance of this bias adjustment will appear later in connection with trouble supervision. As a result of the bridge arrangement, the smoke detector circuit is highly sensitive over a wide range of voltage fluctuations. The fluctuation of supply voltage may actually vary as much as 20% without any perceptible change in the sensitivity of the system.

The relay 21 is provided for transmitting trouble indications and is normally energized by a preset value of current during normal conditions or alarm conditions within the detector circuit. If for any reason the light source 1 should fail, the bias of grid 12 becomes more positive, resulting in a more negative bias in tube 14 and a decrease in the output from plate 17 whereby relay 21 becomes deenergized to transmit a trouble alarm. Obviously if either of the tubes 10 or 14 should fail due to filament burnout, the energizing current of relay 21 would cease and a trouble condition would result in energization of trouble indicator 24. This operation results from the fact that the filaments of tubes 10 and 14 are connected in series with the voltage source whereby failure of the filament in tube 10 opens the series circuit and extinguishes the filament of tube 14 whereby electron emission therein will cease. The same is true when the filament of tube 14 fails.

From the above description it is evident that this invention provides a highly sensitive smoke detecting arrangement which maintains its sensitivity over a wide range of voltage fluctuation in the supply circuit. It is further evident that a single trouble relay is enabled to supervise component parts of the smoke detector circuit whereby trouble alarms will result upon a failure or trouble condition in the circuit.

Various modifications may be made in the system embodying this invention without departing from the spirit and scope thereof and we desire therefore that only such limitations shall be placed thereon as are imposed by the prior art and as set forth in the appended claims.

We claim:

1. In a photoelectric circuit, a source of light, a balanced photoelectric circuit responsive to variations of light from said source comprising a compensator cell arranged to receive uninterrupted light from said source, a detector cell connected in series with the compensator cell and arranged to receive light from said source and detect the passage of foreign matter across a supervised area between said source and cell, a pair of condensers connected in series across said cells for limiting the impedance increase in said balanced circuit when the light source fails, and a connection from a common point between said condensers to a common point between said cells whereby each condenser shunts a cell, resistance means connected across said balanced circuit, a source of alternating potential connected across said light source and said resistance means whereby the potential at said common points is normally constant regardless of fluctuations in the voltage of said source, or said potential assumes a certain value when the impedance of said detector cell changes or said potential assumes an opposite value when said light source fails, a vacuum tube switching device connected in series with said source of potential, a connection from said common points to the input of said switching tube for biasing it to decrease its output upon a decrease in light received by said detector cell or for biasing said tube to increase its output when said light source fails and for maintaining normal bias and output in said tube when the light is uninterrupted but fluctuating, a control vacuum tube connected directly to the output of said switching tube and in series with said source of potential whereby said control tube is biased for increasing its output in response to decreased output in said switching tube and for decreasing its output in response to increased output in said switching tube, alarm means and trouble indication means connected in series to

the output of said control tube, said alarm means responding to increases of said control tube output resulting from detector cell actuation, and said trouble means responding to decreases in said control tube output resulting from failure of the light source or vacuum tube circuit.

2. In a photoelectric circuit, a source of light, a photoelectric circuit responsive to variations of light from said source comprising a compensator cell arranged to receive uninterrupted light from said source, a detector cell connected in series relation to balance the compensator cell and arranged to receive light from said source and detect the passage of foreign matter across a supervised area between said source and cell, a pair of high impedances connected across said cells, and a connection from a common point between said impedances to a common point between said cells whereby each impedance shunts a cell for limiting the impedance increase in said balanced circuit when the light source fails, a source of potential connected across said light source and said photoelectric circuit whereby the potential at said common points is normally constant regardless of fluctuations in the voltage of said source, or said potential assumes a certain value when the impedance of said detector cell changes or said potential assumes an opposite value when said light source fails, a vacuum tube control device connected in series with said source of potential, a connection from said common points to the input of said control device for biasing it to increase its output upon a decrease in light received by said detector cell or for biasing said control device to decrease its output when said light source fails and for maintaining normal bias and output in said control device when the light is uninterrupted but fluctuating, alarm means and trouble indication means connected in series to the output of said control device, said alarm means responding to increases of said control device output and said trouble means responding to decreases in said control device output.

3. In a photoelectric circuit, a source of light, a balanced photoelectric circuit responsive to variations of light from said source comprising a compensator cell arranged to receive uninterrupted light from said source, a detector cell connected in series with the compensator cell and arranged to receive light from said source and detect the passage of foreign matter across a supervised area between said source and cell, high impedance means connected across said cells, and a common connection between each of said impedance means and said cells, a source of potential connected to said light source and said balanced circuit whereby the potential at said common connection is normally constant regardless of fluctuations in the voltage of said source, or said potential assumes a certain value when the impedance of said detector cell changes or said potential assumes an opposite value when said light source fails, alarm means and trouble indication means controlled by the potential of said common connection, said alarm means responding when change of received light changes the impedance of the detector cell and said trouble means responding to voltage changes when the light source fails.

4. In a photoelectric circuit, a source of light, a plurality of photoelectric cells connected in series balanced relation, one of said cells arranged to receive uninterrupted light from said source and act as a compensator cell, the other of said cells arranged to detect variations in light received from said source across a supervised area whereby normal fluctuation of the light source has no effect, a source of potential connected to the balanced circuit, high impedance means in parallel with each cell for limiting the impedance increase in said balanced circuit when said light source fails, alarm means responsive to said balanced circuit when light to said detector cell is obstructed and trouble indicating means responsive to voltage changes caused by the limited impedance increase when said source fails.

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