June 16, 1931. E. H. VEDDER 1,810,739

SMOKE INDICATOR SYSTEM

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Fig. 1.

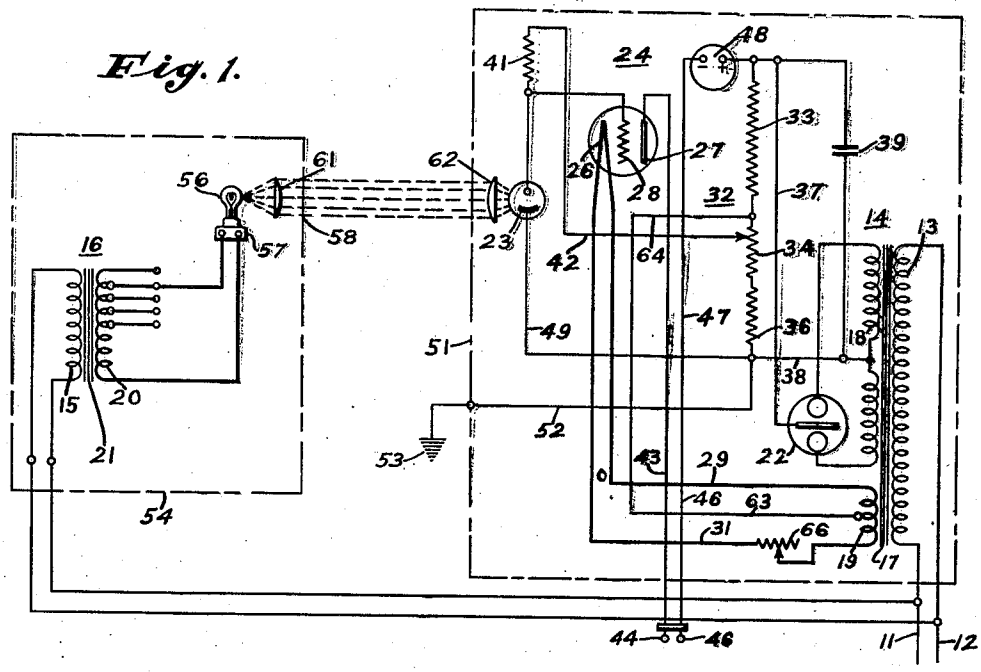
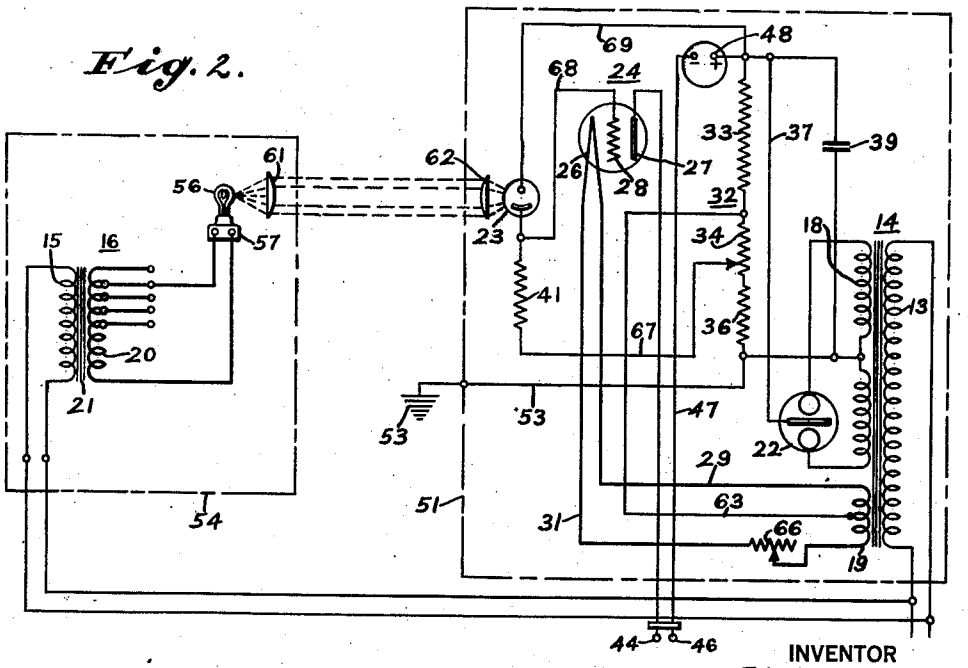


Fig. 2.



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SMOKE INDICATOR SYSTEM

Application filed November 9, 1928. Serial No. 318,298.

My invention relates to electrical systems and particularly to means for compensating for voltage variations in the electrical system of smoke indicators and recorders.

An object of my invention is to provide a relatively simple and effective means in an electric supervisory system for counteracting the effect of variations in the voltage of a source of supply of electric energy therefor.

Another object of my invention is to provide a relatively simple and effective means for compensating for minor voltage variations in the electrical system of a smoke indicator.

Another object of my invention is to provide voltage compensation means that shall require the use of a minimum number of additional elements in such a system.

In practicing my invention, I provide a light source, a photoelectric cell energized thereby, a thermionic tube controlled by the photoelectric cell, a plural section potentiometer resistor electrically connected to the cell and to the tube to energize them, a rectifier electrically connected to the resistor and energized from the main secondary winding of a transformer, and an auxiliary secondary winding on the transformer for energizing the lamp and the filament of the tube.

In the drawings, Figure 1 illustrates a diagram of connections of an electrical system of a smoke indicator embodying my invention, and

Fig. 2 illustrates a diagram of connections of a system that does not provide proper voltage compensation.

Referring to Fig. 1, a source of supply of electric energy embodies supply circuit conductors 11 and 12 which have connected thereto the primary winding 13 of a transformer 14 and also the primary winding 15 of a second transformer 16. The transformer 14 comprises in addition to the primary winding 13 a core member 17, a two-part main secondary winding 18 and an auxiliary secondary winding 19, whose uses and connection will be hereinafter set forth in detail.

The transformer 16 comprises, in addition to the primary winding 15 a secondary winding 20 and a core 21. The secondary winding 20 may be provided with a plurality of taps, for a purpose to be hereinafter described.

A rectifier 22 of any suitable or desired kind is electrically connected to the two terminals of the two-part secondary winding 18. The rectifier 22 is of the kind embodying two anodes and a single cathode in order that full wave rectification of the alternating current energy impressed thereon may be effected thereby, and impressed upon the outside circuit connected to the rectifier cathode and to the junction point of the two-part secondary winding 18.

A photoelectric cell 23 is of the usual construction embodying a suitable casing transparent to light rays and an anode and a cathode therein. As the particular construction of the photoelectric cell forms no part of my present invention, I have not deemed it necessary to illustrate or describe the same in further detail.

A thermionic triple-electrode amplifier tube 24 is provided and is of the usual construction as has already been developed for such tubes in radio work. The tube 24 comprises a filament 26, a plate electrode 27, and a grid 28. The filament 26 is electrically connected to and energized by the auxiliary secondary winding 19 of the transformer 14, the connections being made by conductors 29 and 31, respectively.

A plural section potentiometer resistor 32 is provided and comprises, in the present instance, three sections numbered respectively, 33, 34 and 36.

All of these sections are connected in series circuit relation relatively to each other and the outside terminal of section 33 is connected by a conductor 37 to the cathode of rectifier 22. The outside terminal of section 36 is connected by a conductor 38 to the junction point of the two parts of the secondary winding 18. A condenser 39 is connected in parallel circuit relation between the outer end of resistor 33 and the junction point of the windings 18 in order to aid in smoothing out the ripples in the rectified voltage waves effected by the rectifier.

A grid resistor 41 is provided and may have a resistance of about one hundred megohms. One terminal of this resistor is connected to the anode of the cell 23 while the other terminal thereof is connected by a conductor 42 to any desired point on the resistor 34. The junction point between the grid resistor 41 and the anode is connected to the control grid 28.

The plate electrode 27 is connected by a conductor 43 to a suitable terminal 44 of the device, a second terminal 46 being also provided to which the terminals of an electrical recording device may be connected, provided that it is desired to use a recording device in addition to the elements of the present system. In case no recording device is to be used, the terminals 44 and 46 will be connected by a suitable electric-conducting member.

The terminal 46 is connected by means of a conductor 47 to one terminal of an electric indicating instrument 48, the other terminal of which is connected to the outer terminal of the section 33 of the resistor 32. The cathode of cell 23 is connected by a conductor 49 to the outer terminal of section 36 and consequently to the mid-point of the two parts of the secondary winding 18, by means of the conductor 38.

All of the elements herinbefore described with the exception of the transformer 16 are mounted on a suitable base 51 which may be made of electric-conducting material. The outer terminal of section 36 of the resistor 32 is connected by means of a conductor 52 to the base 51 and is also connected by a suitable conductor to a ground 53.

The numeral 54 indicates a suitable casing within which is located not only the transformer 16 but also a light source 56, usually a small incandescent lamp, mounted in a suitable socket 57 whose terminals are connected by a pair of conductors to the terminals of the secondary winding 20 or preferably to one terminal thereof, and to a selected tap thereof. A suitable opening 58 is provided in the casing 54 to permit of light from the filament of lamp 56 leaving the casing and impinging on the photoelectric cell 23.

It is to be understood that the base 51 may be a part of a suitable housing or casing within which are located the elements operatively associated with the photoelectric cell and that the casing 54 is located at some distance from the base or housing 51.

A lens 61 is associated with the lamp 56 and a similar lens 62 is operatively associated with the photoelectric cell 23 in order to suitably collect and direct the rays of radiant energy emanating from the lamp 56 and impinging on the photoelectric cell 23.

A conductor 63 is connected to a tap connected to the mid-point of the auxiliary secondary winding 19 and a conductor 64 connects conductor 63 to the junction point of resistor sections 33 and 34.

An adjustable resistor 66 permits of varying the energization of the filament 26 of tube 24.

In systems of this kind, it is possible that voltage variations may occur on the supply circuit represented by the conductors 11 and 12 and my invention has reference more particularly to certain predetermined conditions of operation of different elements and parts of the system and their cooperation to the effect that minor voltage variations in the supply circuit shall have relatively little or at least a reduced effect upon the readings of the indicating instrument 48, or correspondingly upon the records made by a recording device whenever the same is used.

In order to distinguish the above-described system from one in which no compensation is effected for voltage variations, I have shown such a system in Fig. 2. Substantially the same apparatus is used but the connections between the light sensitive cell and the other parts of the system are different. One terminal of the resistor 41 is connected to the cathode of the cell 23 and the other is adjustably connected, by a conductor 67, to the resistor 34. The junction point of the resistor 41 and the cathode of cell 23 is connected by a conductor 68 to the grid 28 of the tube 24. The anode of cell 23 is connected by a conductor 69 to the junction point of instrument 48 and resistor section 33.

The elements of the system shown in Fig. 1 are so proportioned that a change from the normal fully illuminated or energized condition of the photoelectric cell, that is a one hundred percent energization, to a condition of entire darkness thereof, will cause a change of ten volts in the bias voltage effected by the grid resistor 41. To obtain this, the voltage drops across the plural section resistor 32 will be substantially one hundred volts across resistor 33, ten volts between the junction point of resistors 33 and 34 and the point of contact of the conductor 42, and approximately one hundred volts across the remainder of resistor 34 and resistor 36.

Let it be assumed further that the voltage between either terminal of the filament, or preferably between a point midway therebetween, represented by conductor 63 and the plate 27 is one hundred volts. Let it be assumed also that the potential between the outer terminal of the grid resistor 41 and the midpoint of the filament 26 as represented by conductor 63 is ten volts.

The total grid bias voltage between the grid 28 and the midpoint of winding 19 and hence the filament 26 will be $-10-10=-20$ volts, made up of the drop across the resistor 41 and the drop in that portion of re-

sistor 34 included between the junction point of resistors 33 and 34 and the point of contact of conductor 42.

While I have given definite values of various voltages in different parts of the circuit, I do not desire to be limited thereto as these are given for illustrative purposes and not in a limiting sense. The exact values will depend on the kind of thermionic tube and on the kind of photoelectric cell.

It has been found that the circuit illustrated in Fig. 1 will effect substantially complete compensation for minor voltage variations, that is, the reading on instrument 48 will not vary appreciably even though the voltage of the source of energy supply varies three percent.

Such compensation is effected for the following reasons. When the circuit and system has been adjusted in substantially the manner hereinbefore described, the variations in the plate voltage will have more effect than will the change in the grid bias. When the voltage drops, the intensity of illumination of the lamp 56 will decrease and the energization of the light sensitive cell will also be less. The effect of voltage change on the grid and the plate of the thermionic tube will be such as to offset the variation on the grid caused by the change in the energization of the cell because of the change in the illumination provided by the light source.

It has been found that the circuit illustrated in Fig. 2 will produce a variation of substantially twenty five percent in the reading of the instrument 48 for a change of three percent in the voltage of the supply circuit.

This lack of compensation is for the following reasons. When the circuit is adjusted in substantially the same manner as set forth in connection with Fig. 1, the net effect of voltage variation on the grid and the plate of the thermionic tube is to cause a decrease in the plate current because the effect of plate voltage variation is greater than that of grid voltage variation. The effect of variation of voltage on the candle power of the light source is in itself on the order of four times the voltage variation, each expressed in percent.

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

I claim as my invention:

1. In an electric circuit, in combination, a primary source of supply of electric energy, a photoelectric cell having an anode and a cathode, a resistor connected in series circuit with the anode thereof and the source of energy for the cell, a plural electrode thermionic amplifier tube, means for connecting the filament to the source of energy to energize the filament, means for connecting the plate circuit to the source of energy, means connecting the control electrode of the tube to the anode of the photoelectric cell to be controlled thereby, a light source for energizing the photoelectric cell energized from the primary source of supply, and an indicating instrument in the plate circuit to indicate the degree of energization of the photoelectric cell by said light source.

2. In an electric amplifier circuit, in combination, a transformer having a primary, a main and an auxiliary secondary winding, a rectifier connected to the main secondary winding, a plural section resistor energized from the rectifier, a thermionic tube having filament, plate, and control electrodes, connections between the filament and the auxiliary winding to effect energization of the filament, means for energizing the plate filament circuit from one of the resistor sections, a photoelectric cell having an anode and a cathode, means for energizing the cell from another of the resistor sections, means connecting the control electrode of the tube to the anode of the photoelectric cell to be controlled thereby, an incandescent lamp affecting the photoelectric cell, means for energizing the lamp from the source of supply of electric energy, and an indicating instrument in the plate filament circuit to indicate the degree of energization of the photoelectric cell by the incandescent lamp.

3. In an electric amplifier circuit, in combination, a source of supply of electric energy, a thermionic amplifier tube having filament, grid and plate electrodes, means for connecting the filament and plate electrodes to the source of energy supply, a photoelectric cell having an anode and a cathode, means for connecting the anode to the grid electrode of the tube and to the source of energy supply, a light source embodying a filament energizing the photoelectric cell, means connecting the filament to the source of energy, and an indicating instrument in circuit with the plate electrode to indicate the degree of energization of the photoelectric cell by the light source.

4. In an electric amplifier circuit, in combination, a source of supply of electric energy, a thermionic amplifier tube having filament, grid and plate electrodes, means for connecting the filament and plate electrode to the source of energy supply, a photoelectric cell having an anode and a cathode, means for connecting the anode of the cell to the grid electrode and for adjustably connecting it to the source of supply to permit of energizing the photoelectric cell and to permit also of varying the bias adjustment of the control electrode, a light source having a filament, means connecting the filament to the

source of energy, an indicating instrument, and means connecting it in the plate circuit of the amplifier tube whereby it will indicate the degree of energization of the photoelectric cell by the light source.

5. An amplifying system comprising a source of alternating-current electrical energy, a plural-electrode electric-discharge device including a control electrode and a plurality of principal electrodes, said electric-discharge device being energized from said source of electrical energy, a photo-sensitive device including a cathode and an anode, said anode being connected to said control electrode, and said cathode being connected to said source of electrical energy, and a source of radiation for energizing said photo-sensitive device, said source of radiation being energized from said source of electrical energy.

In testimony whereof, I have hereunto subscribed my name this 6th day of November, 1928.

EDWIN H. VEDDER.