

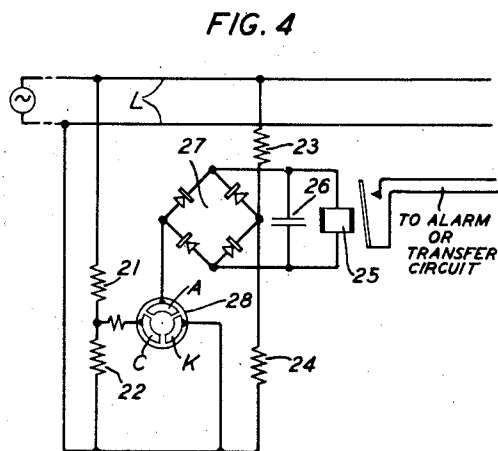
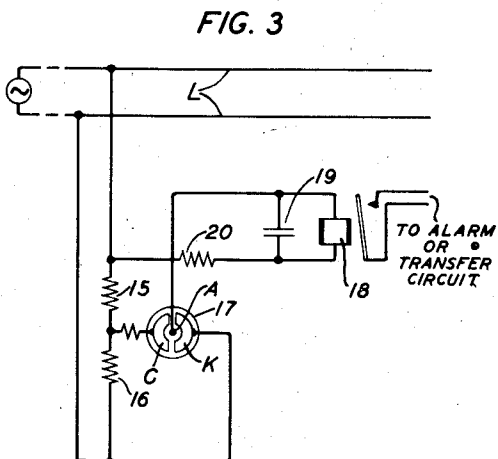
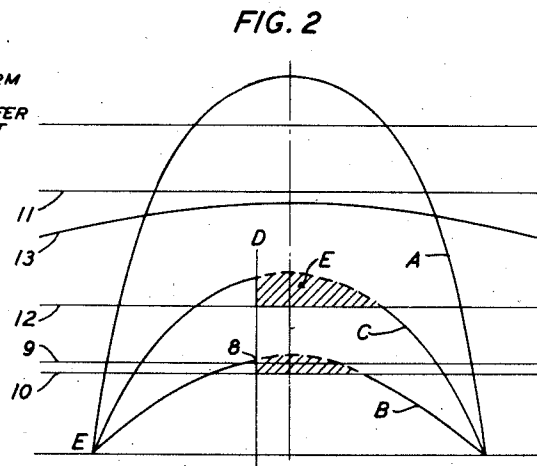
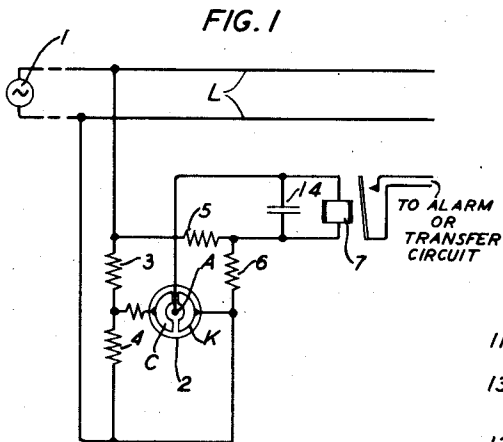
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HIGH OR LOW VOLTAGE INDICATING SYSTEM

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HIGH OR LOW VOLTAGE INDICATING
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This invention relates to an arrangement for automatically detecting either a high or low voltage condition of an alternating current source and either indicating the fact by operating some suitable signal device, or performing some other circuit function such as transferring the load circuit from the "off voltage" source to an auxiliary source.

It is old to perform the above function by means of sensitive electromagnetic devices, but such devices are not entirely satisfactory due to the fact that if such devices are constructed and adjusted to operate at a slight increase of voltage above the normal voltage of the source, they will not fully restore when the voltage again drops to the normal value, but instead will chatter for quite a substantial range to a value somewhat below the normal voltage, in other words, the margins are not close enough for certain requirements.

Other circuits are known in which vacuum tubes are employed which have better margins, but such arrangements have the objection of being relatively complicated, more costly, and requiring a constant supply of filament heating current.

An object of the invention is to provide a simple, inexpensive and efficient arrangement to indicate either a high or a low voltage condition in a source of alternating current, or to automatically perform some other function such as transferring a load circuit from the source to an auxiliary source.

A feature of the invention resides in employing a three-element gas-filled discharge device having suitable characteristics, including rectification, for the voltage to be detected, and associating the control gap thereof with the source through a potentiometer of such characteristics and adjusted that in case a high voltage is to be detected any voltage that is higher than the required minimum will cause the control gap to break down on every alternation of the voltage thereby ionizing the gas within the device and lowering the required breakdown potential of the main gap between the anode and cathode. The anode is connected to the opposite side of the circuit from that to which the cathode is connected, such anode connection serially including a current limiting resistance and a relay for performing the desired circuit function such as actuating the signal. If the voltage of the source is higher than the required breakdown potential of the main gap, a resistance of the proper value may be connected in shunt to the main gap to

reduce the applied potential to such a value that it will never be sufficient to fire the tube unless the control gap is broken down. The characteristics of gas-filled devices of the type employed are such that the device will cease discharging as soon as the voltage drops below the arcing potential of the control gap.

If the circuit is to be used as a low voltage detector, the potential supplying the control gap is so adjusted that the minimum required voltage of the source will cause voltage peaks across the control gap slightly in excess of the required break-down voltage and hence the control gap will break down with every voltage alternation and permit the anode-cathode gap to fire thereby causing current to flow through the relay and hold it operated. Consequently, as long as the voltage of the source is above the desired minimum, the relay will remain operated to perform such functions as may be desired, but as soon as the voltage drops below the predetermined minimum, the discharge will cease and the relay will release, which release may be utilized to either operate or release a signal device or perform any other desired function.

The invention will be understood from the following description and accompanying drawing in which:

Fig. 1 shows one embodiment of the invention for use on lines in which the alternating current voltage is higher than the voltage required to break down the anode-cathode gap without ionization, the tube employed having a substantially complete rectifying characteristic at a certain predetermined critical voltage applied to the anode-cathode gap;

Fig. 2 is a diagram illustrating the voltage conditions existing on the control and main gap of the tube shown in Fig. 1, with respect to the line voltage;

Fig. 3 shows a modification of the arrangement of Fig. 1 for use on lines in which the maximum or peak line voltage is below the voltage required to break down the anode-cathode gap in the absence of ionization; and

Fig. 4 shows an arrangement employing a tube which has no critical point at which it has a pronounced rectifying characteristic, in a tube whose main gap is sensitive to current of either polarity.

The invention will be first described in connection with Fig. 1, it being assumed that the arrangement is to be used to give an alarm when the line voltage drops below a predetermined critical value. 1 is a source of alternating voltage connected to and supplying line L; 2 is a three-

element cold-cathode discharge tube having an anode A, a cathode K and a control electrode C. Connected in bridge of the line L are two potentiometers one comprising resistance elements 3 and 4 and the other potentiometer comprising resistance elements 5 and 6.

The control gap between the control electrode C and cathode K is connected across resistance element 4 of the first potentiometer and the main gap, i. e., anode to cathode, is connected across resistance element 5 of the second potentiometer and in series with relay 7.

Now referring to Fig. 2 for an explanation of the operation of the circuit, curve A shows the value, at any instant, of the voltage of the line during one-half cycle; curve B shows the instantaneous voltage across resistance 4 of the first potentiometer of Fig. 1; and curve C shows the instantaneous voltage across the second potentiometer resistance element 6. At point E in the diagram the voltage across the line is zero. As the voltage shown in curve A increases towards the maximum, the voltage represented by curve B also increases in fixed proportion. At the time in the cycle represented by vertical line D it will be noted that the voltage across the control gap, i. e., the voltage drop across resistance 4, as represented by curve B has increased to a point 8 where it intersects the horizontal line 9 representing the voltage at which the control gap of tube 2 will break down whereupon the voltage across the control electrode C and cathode K drops to the sustaining voltage of this path as represented by the horizontal line 10 at which value it remains until the voltage represented by the dotted portion of curve B has decreased slightly below the sustaining voltage, i. e., horizontal line 10, at which time the control gap current will cease. It will be noted that the main gap (anode to cathode) breakdown voltage of the tube 2, when the anode is positive, as represented by horizontal line 11, is higher than the voltage represented by curve C at any time and therefore the tube will not fire across the main gap unless the tube is ionized. At the point 8 in the cycle, the control gap fires which ionizes the tube thus permitting a discharge across the main gap if the anode is positive, whereupon the voltage across the main gap, i. e., the drop in potential across resistance 6 of the second potentiometer, decreases to the main gap sustaining voltage represented by the horizontal line 12 at which point it will remain until the voltage represented by the curve C has decreased to a point just below line 12 whereupon the main gap current will cease. If the $\frac{1}{2}$ cycle had been such that the main anode was negative, at the point in the cycle represented by vertical line D, no discharge would have taken place since the sustaining voltage of the tube, due to its characteristics, as represented by line 13, was higher than curve C at any time. The shaded portions of the diagram, shown at F, represent the useful voltage applicable to actuate the relay 7. At the voltage represented by curve A, and for all higher voltages, the tube will fire every half cycle thereby operating relay 7 which will hold operated as long as the tube continues to fire, i. e., as long as the line voltage remains at or about its predetermined minimum, and therefore the alarm circuit will remain open.

If the voltage represented by curve A should decrease, the voltage represented by curve B will also decrease in fixed proportion, and as soon as the maximum voltage reached by curve B is

slightly less than the control gap breakdown voltage as represented by horizontal line 9, the control gap will not fire on the next half cycle and as no discharge across the main gap can occur unless the tube is ionized, no current will flow through relay 7 and it will therefore release and close, at its back contacts, an alarm circuit or exercise any other control desired.

Condenser 14, connected in parallel with relay 7, is for the purpose of smoothing out the current impulses through the relay thereby making its operation more stable.

By employing a discharge tube having a rectifying characteristic, the use of a conventional direct current relay in the anode-cathode circuit is made possible, otherwise, if the tube was non-rectifying, either a sluggish and more expensive direct current relay, or an alternating current relay, would be required. However, if it is desired to use a tube which is non-rectifying, in conjunction with a direct current relay of the same conventional type used in Figs. 1 and 3, the arrangement of Fig. 4, to be later described, may be employed.

Referring to Fig. 3, it will be noted that, as in the case of Fig. 1, the control gap of relay 17 is connected across resistance 16 of a potentiometer 15, 16, but the anode-cathode gap, in series with relay 18, is connected directly across the line in series with a current limiting resistance 20. This arrangement enables the use of a standard tube 17, identical with tube 2 of Fig. 1, on line voltages which are at all times below the voltage required to break down the main gap when the tube is deionized, i. e., a voltage which would be represented by a curve similar to that of curve A, Fig. 2, which curve, however, does not cross the horizontal line 11 which represents the breakdown voltage of the main gap when the anode is positive. Under this condition there is no need to limit the voltage of the anode-cathode path and hence the potentiometer is not necessary.

Other than omitting the main gap potentiometer from Fig. 3, this figure operates the same, in all respects, as that of Fig. 1 before described.

In case a high voltage alarm is required, it is only necessary to so proportion resistances 3 and 4 of Fig. 1 or 15 and 16 of Fig. 3 in order that the normal or desired maximum line voltage will not cause the control gap to fire, i. e., referring to Fig. 2, so that curve B does not intersect horizontal line 9 which represents the control gap breakdown voltage.

When, however, the line voltage increases above the desired maximum, the control gap voltage increases proportionately and when it reaches the voltage at which the control gap breaks down, the tube fires causing ionization and permitting the main gap to fire, thereby operating either relay 7 or 18, which in this case would have its contact so arranged as to close an alarm circuit when the relay operates. When the line voltage decreases, below the point where the drop across potentiometer resistance 4 or 16 is less than that required to sustain a discharge across the control gap, current ceases to flow, thereby deionizing the tube and stopping the main gap discharge, whereupon the respective relay 7 or 18 releases.

If, as previously mentioned, it is desired to employ a tube which has little or no rectifying properties, i. e., one whose main gap conducts in either direction equally well, the arrangement shown in Fig. 4 can be used. This arrangement is identical with that shown in Fig. 1, except for the in-

clusion of the rectifier arrangement 27, and functions as described for that figure. The rectifier 27 acts to rectify the alternating pulses flowing in the anode-cathode circuit in order to supply unidirectional pulses to the relay 25 which pulses, as before, are smoothed out by condenser 26.

Obviously, this figure can be made to function to give either a high or low voltage alarm by the proper proportioning of the potentiometer resistances 21 and 22, and in case the line voltage is sufficiently low so as not to break down the main gap when the tube is deionized, resistance 24 can be omitted as in the case of Fig. 3.

What is claimed is:

1. In a voltage responsive system, in combination, a line, a source of alternating current of varying potential connected thereto, a gas-filled discharge tube having an anode, a cathode and a control electrode, said potential source having a normal minimum potential value higher than the potential value necessary to break down the anode-cathode gap of said tube in the absence of ionization, a potentiometer in bridge of said line, a connection between the cathode and one side of the line, a connection between the control electrode and a point in the potentiometer so chosen that a predetermined line voltage will cause a discharge between said cathode and control electrode, a connection between said anode and the other side of the line from which the cathode is connected, and means for reducing the line potential across said cathode and anode to a value below that necessary to initiate a discharge therebetween in the absence of ionization but not below the voltage necessary to initiate such a discharge when the tube is ionized.

2. In a system responsive to a decrease from a predetermined minimum voltage, a line, a source of alternating current of varying potential connected thereto, a gas-filled discharge tube having an anode, a cathode and control electrode, said

source having a normal minimum potential value higher than the potential value necessary to break down the anode-cathode gap of said tube in the absence of ionization, a potentiometer in bridge of said line, a connection between the cathode and one side of the line, a connection between the control electrode and a point in the potentiometer so chosen that a line voltage slightly higher than a predetermined minimum will cause ionization within said tube and a decrease below said predetermined minimum will cause said tube to deionize, a connection between said anode and the other side of the line from the side to which the cathode is connected, and means for reducing the line voltage across said anode-cathode gap by such an amount that said gap will break down and conduct when the tube is ionized and cease to conduct when the tube is deionized.

3. In a system responsive to an increase from a predetermined normal voltage, a line, a source of alternating current of varying potential connected thereto, a gas-filled discharge tube having an anode, a cathode and a control electrode, said source having a normal minimum potential value higher than the potential value necessary to break down the anode-cathode gap of said tube in the absence of ionization, a potentiometer in bridge of said line, a connection between the cathode and one side of the line, a connection between the control electrode and a point in said potentiometer so chosen that a line voltage above, but not below, a predetermined normal value will cause a discharge to take place between said cathode and control electrode to ionize said tube, a connection between the anode and the other side of the line from the side to which the cathode is connected, and means for reducing the line potential across said anode-cathode gap to a value such that said gap will break down and conduct when the tube is ionized but not when the tube is deionized.

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