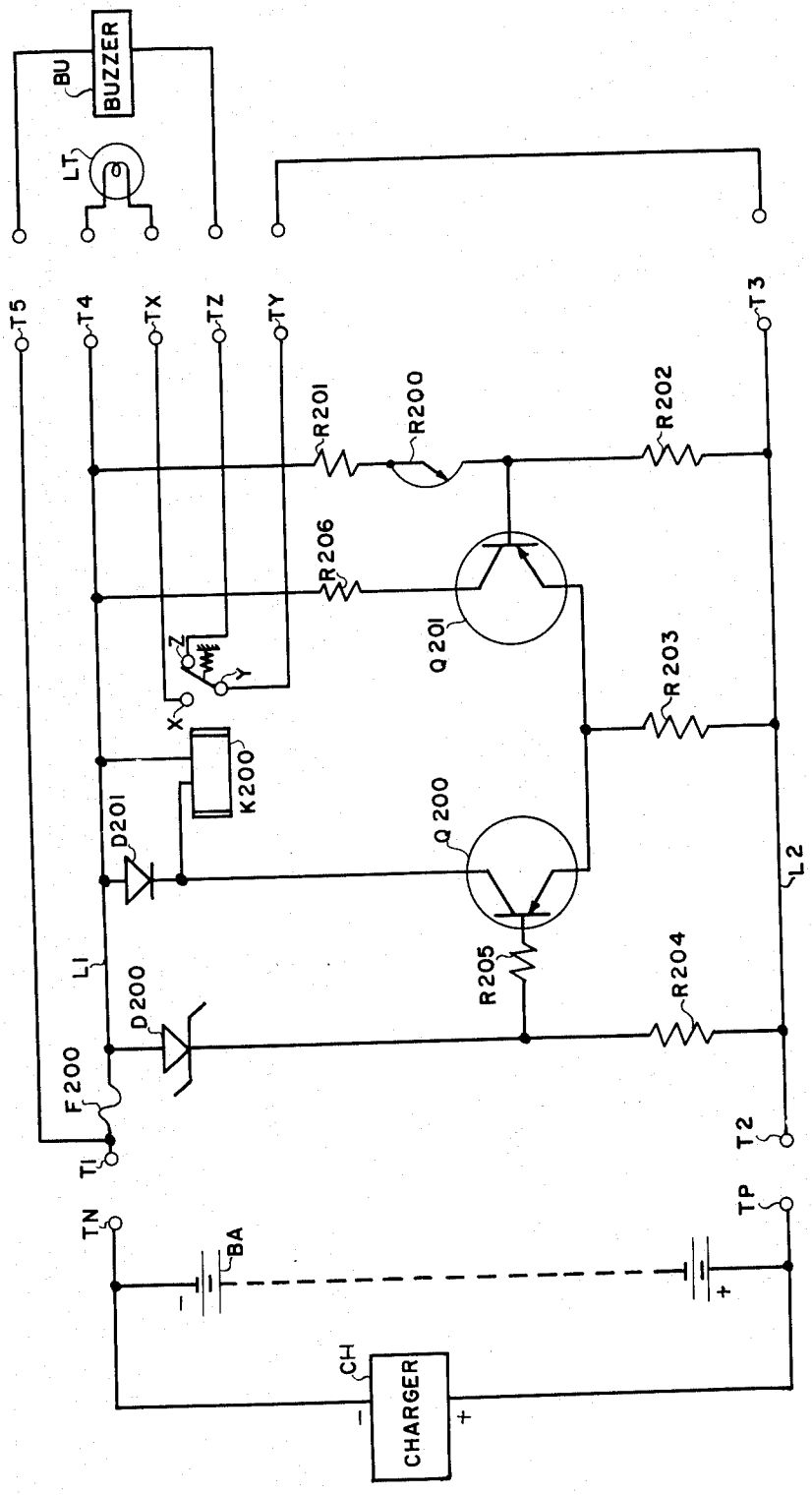
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TRANSISTORIZED LOW-VOLTAGE RESPONSIVE ALARM

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TRANSISTORIZED LOW-VOLTAGE RESPONSIVE ALARM

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My invention relates to voltage sensitive monitor devices for monitoring a varying direct voltage by engaging a switch when the varying voltage passes through a predetermined or preselected value, and particularly to alarm devices for monitoring voltages across a bank of batteries which energize a telephone exchange system by effecting a visual or audible alarm or indication when the battery voltage decreases below or increases above a predetermined value.

A principal object of this invention is to provide a continuously monitoring device capable of withstanding high voltages, which at the same time exhibits considerable sensitivity and is adjustable to actuate a visual or audible alarm over a wide range of voltages.

Another object of the invention is to provide such a device which is applicable for providing a high-voltage as well as a low-voltage alarm.

According to a feature of my invention, I provide the alarm device with terminals adapted to be connected across the voltage to be monitored, and I connect across the terminals a transistor differential amplifier having a standard input and a test input. I further apply a constant potential device from one terminal to the standard input while at the same time applying a potential corresponding to the voltage to be monitored at the test input and I couple a current-responsive switch device to one of the branches so that when the voltage at the test input corresponding to the voltage to be monitored is more than the voltage at the standard input, the switch device is energized.

According to another feature of my invention, I connect the differential amplifier between a pair of lines respectively leading to the terminals, and I connect the constant potential device from the line coupled to the collectors of the transistors in the transistor differential amplifier to the standard input.

These features and other objects of the invention will become more apparent from the following specification when read in light of the accompanying drawing showing a schematic circuit diagram of a voltage alarm relay according to the invention.

According to the drawing, the voltage alarm relay device comprises two Cleavite 1349 PNP transistors Q200 and Q201 in balanced circuit connection between a negative line L1 leading through a ½ ampere fuse F200 to a negative terminal T1 and a positive line L2 leading to a positive terminal T2. The terminals T1, T2 are adpated to be connected respectively to the negative and positive terminals output TN, TP of a telephone battery bank BA receiving charge from a charger CH. The bank BA and charger CH are adapted to energize a telephone-exchange system through the output terminals TN, TP, and represent the voltage to be monitored. When the relay device is used the terminals T1, T2 connect to the terminals TN, TP.

Connecting the emitters of transistors Q200 and Q201 to the positive lead L2 is a single 2000-ohm 5-watt common-emitter resistor R203. A 250-ohm, 3 watt, collector resistor R206 connects the collector of transistor Q201 to the negative lead L1, thereby completing a current path from line L1 to L2 through resistors R206 and R203 as well as through the emitter-collector circuit of

transistor Q201. The transistor Q200 controls current flow through a 2.5 volt D.C. 5 milliampere relay K200 connecting the collector of transistor Q200 to the negative line L1. A bypass diode D201, poled as shown, counteracts the reactive and current-storage effect of the coil in relay K200. The relay K200 includes an armature Y and two contacts X and Z.

Biasing the base of transistor Q201 is a voltage divider sensing the voltage between leads L1 and L2 and comprising a 200-ohm 3-watt resistor R201 connected to the line L1, a 250-ohm 25-watt rheostat R200 connecting the resistor R201 to the base of transistor Q201, and a 750-ohm 5-watt resistor R202 connecting the base of transistor Q201 to the line L2. Biasing the base of transistor Q200 to a fixed reference voltage relative to the negative lead L1 is an International Rectifier Co. 1N935 Zener diode D200 poled as shown and receiving current through a 2000-ohm 5-watt resistor R204 connected in series therewith to the positive lead L2. A 200-ohm 5-watt resistor R205 connects the base of transistor Q200 to the junction of the resistor R204 and diode D200. Six output terminals T3, TZ, TY, TX, T4, T5 connect respectively to positive line L2, the contact Z, the armature Y, contact X, negative line L1 and terminal T1.

The armature Y of relay K200 is normally biased in the unenergized condition of relay K200 toward the unconnected contact Z of relay K200. The invention contemplates connecting between the terminals T5 and TZ an alarm buzzer BU for example, connecting between terminals T4 and TX an indicator light LT, and connecting terminals TY and T3 to each other. Other connections, for example the lamp LT between terminals TZ and T5 and the buzzer between TX and T4, with TY and T3 connected to each other, are also contemplated. The invention also contemplates connecting the armature Y directly to the line L2 so that the exterior connection from TY to T3 would be superfluous.

In operation the terminals T1, T2 are connected to respective terminals TN, TP. The voltage divider circuit, consisting of resistors R201 and R202 and rheostat 200, then continuously senses the voltage applied from the battery BA and charger CH across terminals T1 and T2 and between the leads L1 and L2 and compares the portion of the voltage across members R200 and R201 to the fixed reference voltage across the Zener diode D200. As is well known, a Zener diode such as D200, when backwardly biased by a voltage such as appears across terminals T1 and T2, through a resistor, such as R204, exhibits a constant voltage over a wide range of currents. When the voltage applied between leads L1 and L2 by the battery BA and charger CH exceeds a preset minimum, the voltage across resistor R201 proportional to the now-increased voltage across the leads L1, L2, exceeds the constant voltage across the Zener diode D200. This lowers the base-to-emitter voltage of transistor Q201 relative to the base-to-emitter voltage at transistor Q200. This effect turns transistor Q201 off, and turns on transistor Q200. Turning on transistor Q200 completes the circuit from the line L2 through the resistor R203 through the emitter-collector circuit of transistor Q200 and through the coil of relay K200, thereby energizing relay K200. Energizing relay K200 closes the armature Y with the contact X. This completes, when the buzzer BU connects the terminal TZ to T5 and the light LT connects the terminal T4 to TX and the terminals TY and T3 are connected together, a circuit from positive line L2 through armature Y to contact X through failure lamp LT, and line L1. Contacts Y–Z are held open during this time. The light LT thus indicates that the voltage is above the predetermined level. Should the voltage applied by the battery BA and charger CH

across the leads L1 and L2 decrease below the preset minimum voltage, transistor Q201 turns on and transistor Q200 turns off, thereby depriving the relay coil K200 of operating current and causing it to drop out. This allows the armature Y to revert to its normal position against the contact Z, so as to turn off light LT and energize the buzzer BU by current flow through members TP, T2, L2, T3, TY, TZ, BU, T5, T1, to TN.

With the buzzer BU and light LT connected between terminals T5 and TZ, and T4 and TX, respectively, the device according to my invention operates as a fail-safe low voltage alarm. When the voltage at terminals TN and TP decreases below a predetermined value the light LT extinguishes and the buzzer BU sounds the alarm. Changing the connection of buzzer BU and light LT, that is by connecting LT between T4, TZ and connecting BU between TX, T5 utilizes the alarm device as a high voltage fail-safe alarm relay. The low voltage alarm configuration affords for example an indication whether the charger CH is failing to charge the battery BA. The high voltage alarm configuration affords a means of indicating whether the charger CH for example is overcharging the battery BA.

The voltage alarm relay circuit itself may be adjusted to function at any predetermined voltage between 42 volts D.C. and 56 volts D.C. by means of the rheostat R200. Thus the voltage at which the relay K200 trips is selected with the rheostate R200 which varies the voltage at the base of transistor Q201 relative to the voltage between the leads L1 and L2. This variation tends to vary the relationship between the source voltage fluctuations and the constant voltage across the Zener diode. The voltage across the Zener diode remains constant regardless of the voltage across the terminals T1, T2 within an extensive range, because the applied voltage from the battery BA is capable of supplying sufficient current through the resistor R204 to maintain constant the voltage across the diode 200 by operating the diode within the significant current range for constant voltage.

Adjustment of the voltage alarm relay for low voltage indication at a predetermined voltage is accomplished as follows when the terminals T1 to T5 and TX to TZ connect to their nearest counterparts on the drawing. A voltage at least 1 volt less than the normal system operating voltage for the battery BA is chosen below which the alarm system is to become effective. Temporarily, the voltage of the battery B is reduced by a voltage divider or a resistor or the like to the desired voltage at which the alarm is to become effective. The rheostat 200 is turned to a full clockwise position in the illustrated diagram thus illuminating indicator light LT by raising the voltage between the base of transistor Q201 and the line L1 relative to the voltage across the Zener diode, thereby energizing the relay coil K200. The rheostat R200 is then turned in a counterclockwise direction, thereby decreasing its effective resistance, and rendering the voltage at the base of transistor Q201 more negative, while the battery BA voltage remains constant until the voltage at the bases of the transistors balance and the indicator light LT suddenly extinguishes with the dropping out of the relay K200. To check the adjustment, the battery BA voltage is allowed to return to its normal operating condition. At this point the indicator light should switch on. Reducing the system voltage should cause the indicator light to go out. This should occur at the voltage chosen above. Slight readjustment of relay assembly may be needed for a desired response.

The invention as stated contemplates that the sense of the indication may be reversed for high voltage alarm by changing the connection of ilght LT from between T4 and TX to between T4 and TZ while similarly changing the connection of buzzer BU from between T5 and TZ to between T5 and TX. The lamp then lights for normal and goes out for a fault or when a fuse blows.

The rheostat R200 is capable of selecting the voltage at which the relay drops out through a range of about 80% to 120% of normal voltage.

Of particular advantage in the disclosed embodiment according to the invention is the connection of the Zener diode D200 between the negative line L1 energizing the collectors of transistors Q200, Q201 and the base of transistor Q200. This contrasts with possibly connecting the reference voltage diode D200 from the emitter-energizing lead L2 to the base of transistor Q200. Because of the illustrated configuration the monitor device according to the invention is capable of withstanding extensive voltage surges without harming the transistors Q200 or Q201. A voltage surge appearing between the lines L1 and L2 will render the collector voltage of transistor Q200 and Q201 as well as the base of transistor Q200 far more negative relative to the line L2. However, because the base of transistor Q200 has been raised negatively to a negative value almost as great as line L1, the transistor Q200 will conduct heavily so that the current through emitter resistor R203 raises the negative potential at the emitter of transistor Q200 to almost the value of the corresponding base. The negative potential at the emitter of transistor Q201 is also raised thereby. This increase in current can continue until the transistor Q200 is saturated. By negatively raising the respective emitter voltages of the transistors, the collector-emitter potentials thereof are reduced to a safe value corresponding to the Zener diode D200 voltage and most of the voltage associated with the surge appears across the resistor R203. This resistor can of course be designed to withstand such high voltages and high currents by assigning to it a suitable power rating. Thus a voltage surge which would otherwise appear across the transistors Q200 and Q201 is converted into a current surge through a fully turned-on transistor Q200 and a voltage surge across resistor R203. The transistor Q200 when turned fully on exhibits only a small saturation voltage and negligible dissipation. Transistor Q201 is turned fully off and need withstand only an emitter-collector voltage which cannot be much larger and is almost equal to the constant voltage across diode D200.

By contrast, if the regulating Zener diode D200 were connected between the base of transistor Q200 and the line L2 or the emitter of transistor Q200, a voltage surge would apply, between the emitter and collector as well as between the base and collector of transistors Q200 and Q201, a substantially high potential. This high potential would be maintained because the voltage differential between emitter and base established by the diode D200 would prevent the emitter or base voltage from approaching in value the collector voltage. Thus, because transistors are able to withstand only a predetermined maximum voltage applied across the various junctions, the transistor could fail by voltage punch-through at comparatively low voltage surges.

It will be obvious to those skilled in the art that the disclosed embodiments of the invention may be modified without departing from the scope of the invention, and that particularly values indicated for the individual elements are not fixed and may be varied for a particular situation.

I claim:

1. A transistor indicating relay device for connection across a source to be measured comprising:

a pair of leads connected to the source;

transistor circuit means including a pair of transistors having emitters and collectors forming respective emitter-collector circuits connected in parallel between said leads and having respective bases;

a common-emitter resistor connected in series with both of said emitter-collector circuits between said emitters and one of said leads;

relay means connected in one of said emitter-collector circuits in series with the respective collector to be controlled by current therethrough;

a diode connected across said relay means;

constant potential means connecting the other said leads to one of said bases; and

voltage divider means across said leads having a potential point between said leads, said point being connected to the other of said bases.

2. A transistor low-voltage alarm relay for connection across a source to be measured comprising:

first and second leads connected to the source;

a pair of transistors having emitters and collectors forming respective emitter-collector circuits connected in parallel between said leads and having respective bases;

a common-emitter resistor connected in series with both of said emitter-collector circuits between said emitters and the first of said leads;

switching means connected in series between one of said collectors and said second lead to be controlled by current therethrough;

a diode connected across said switching means;

constant potential means connected between the second lead to one of said bases; and

voltage divider means across said leads having a potential point between said leads, said potential point being connected to the other of said bases.

3. A transistor low-voltage alarm relay for connection across a source to be measured comprising:

first and second leads connected to the source;

a pair of transistors having emitters and collectors forming respective emitter-collector circuits connected in parallel between said leads and having respective bases;

a common-emitter resistor connected in series with both of said emitter-collector circuits between said emitters and the first of said leads;

switching means connected in series between one of said collectors and said second lead to be controlled by current therethrough;

a diode connected across said switching means;

a Zener diode connected between the second of said leads to one of said bases;

means connected to said first lead and said Zener diode to energize said Zener diode into its constant potential mode of operation; and

voltage divider means across said leads connected to the other of said bases.

4. A transistor low-voltage alarm relay for connection across a source to be measured comprising:

first and second leads connected to the source;

a pair of transistors having emitters and collectors forming respective emitter-collector circuits connected in parallel between said leads and having respective bases;

a voltage divider connected across said leads and having a mid potential point connected to one of said bases;

a common-emitter resistor connected in series with both of said emitter-collector circuits between said emitters and the first of said leads;

relay means connected in series between one of said collectors and the second of said leads to be controlled by current therethrough;

a diode connected across said relay means;

a Zener diode connected between the second lead and the other of said bases;

a resistor connected between said Zener diode and the first of said leads.

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