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ARC DETECTOR AND SUPPRESSOR

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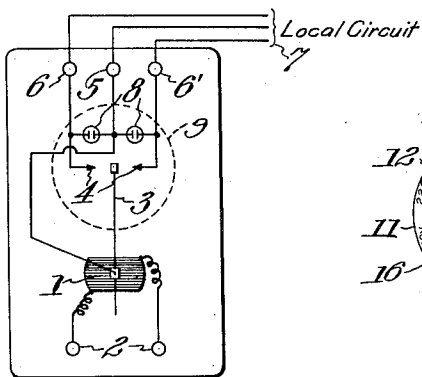


Fig. 1.

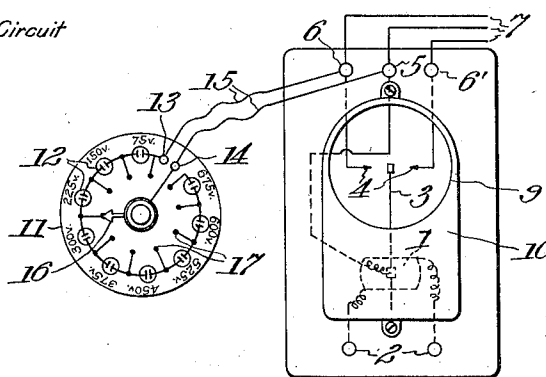


Fig. 2.

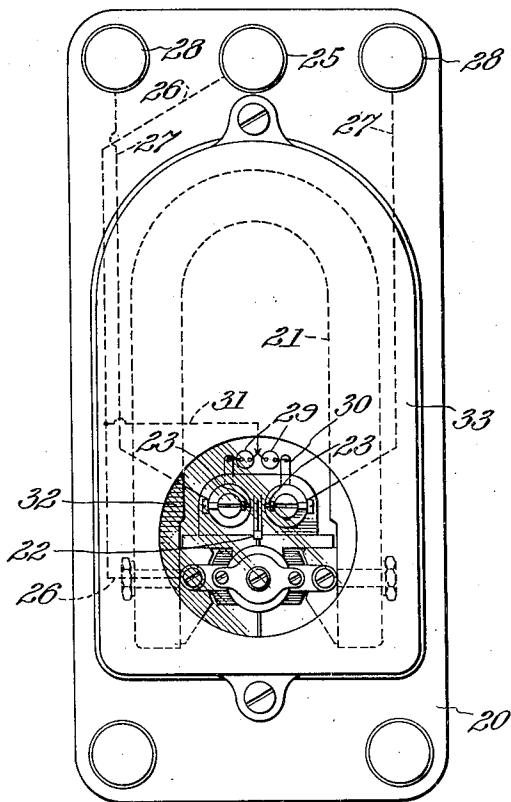


Fig. 3.

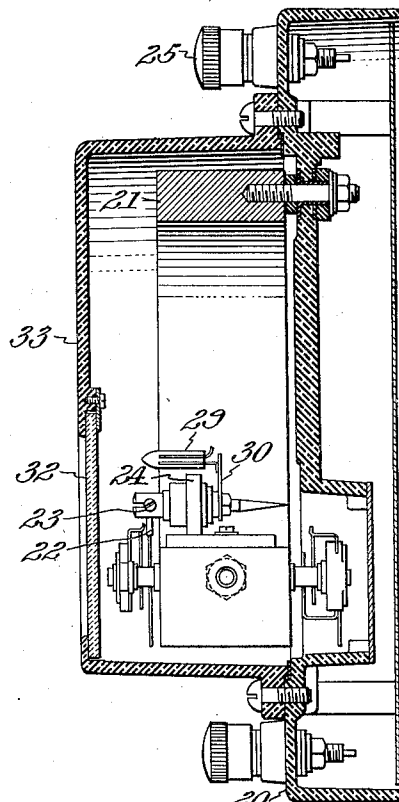


Fig. 4.

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ARC DETECTOR AND SUPPRESSOR

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4 Claims. (Cl. 175-183)

The invention relates to arc detectors and suppressors and more particularly to devices for the detection and/or the suppression of destructive arcs at the contacts of sensitive relay instruments.

It is well known that sensitive and delicate contacting mechanisms such as galvanometer relays, contacting microammeters and the like, inherently exert a very low contact pressure and consequently are subject to contact troubles. The contact troubles may be negligible when relatively low currents and voltages are encountered and when the local circuit is of a non-inductive nature but, unfortunately, in industrial practice the local circuit usually consists of an electromagnet power relay which is of a highly inductive nature.

I have tested power relays of the type including, in series circuit, a 6 volt dry battery, a sensitive relay contact and a power relay coil, and have measured arcing voltages of upward of 500 volts at the sensitive relay contacts when they were opened. Voltages of this order cause a rapid burning and pitting of the contacts which renders the sensitive relay inoperative after relatively few operations, but arc discharges of lower voltages are also damaging to the relay contacts. The arc discharges are frequently most troublesome when the voltages are in the lower ranges as the arcs may be too small to be seen by the eye but nevertheless of a destructive value. It is common practice for the manufacturers of sensitive relays to state that the relays should be so operated that there will be no arc at the contact points. The lack of a method of detecting the presence of arcing at the contact points naturally resulted in doubt as to whether or not defective contacts were due to a faulty design of the sensitive relay or to a failure to provide proper protection against arcing at the contacts.

In accordance with this invention, I employ gaseous discharge tubes for detecting arcs at the contacts of a sensitive relay, for obtaining an indication of the magnitude of the arc voltage and/or for suppressing destructive arc voltages. The tubes will be referred to as "neon tubes" since that is the term commonly applied to the gaseous discharge tubes whether or not they contain neon. Neon tubes of small size and operating on as low as 75 volts and 0.04 watt are very suitable for use with sensitive relays. The arc voltage may be measured, with exceptionally good accuracy, by connecting the neon tubes in series across the relay contacts, starting with one

tube which will ionize or break down to pass current if the arcing discharge has a potential above 75 volts and adding one tube at a time until none of the tubes glow. For example, if five tubes in series glow when the contacts are separated, but the glow is no longer present when a sixth tube is added, an arcing voltage of between 5×75 and 6×75 , i. e. between 375 and 450 volts, is indicated.

An object of this invention is to provide a simple and convenient device for detecting the existence of arcs at the contacts of a relay device. An object is to provide arc detecting devices including a plurality of small gaseous discharge tubes, commonly termed "neon tubes", for incorporation in or for use with a sensitive relay, to indicate destructive arcs and to measure the voltages thereof. A further object is to provide a voltage measuring device which includes a plurality of small gaseous discharge tubes for suppressing or for indicating the existence of destructive voltages.

These and other objects and advantages of the invention will be apparent from the following specification when taken with the accompanying drawing in which:

Fig. 1 is a diagrammatic view of a sensitive relay provided with a visible arc detector and suppressor embodying the invention;

Fig. 2 is a diagrammatic view of an arc detector and suppressor unit that may be connected to a sensitive relay to measure and/or to suppress the arc voltage across the relay contacts; and

Figs. 3 and 4 are a plan view and sectional view, respectively, of a relay which includes permanently installed arc detector and suppressor.

In the drawing, the reference numeral 1 identifies the moving coil of a sensitive instrument type relay, the coil being connected across terminals 2, 2' that are adapted to receive leads from a thermocouple, a photosensitive cell or other control device which responds to fluctuations in some factor such as temperature, light, humidity or the like. The moving coil carries a contact arm 3 cooperating with a pair of relatively stationary contacts 4 to function as the circuit-closing switches in local circuits. Contact arm 3 is connected to a terminal 5, and contacts 4 are connected to terminals 6, 6', the local circuit or circuits being connected between terminal 5 and terminals 6 and/or 6', as indicated by leads 7.

The construction, as so far described, is typical of the present sensitive relay devices which may

be associated with various types of local circuits. Such local circuits may be non-inductive but, more frequently, are highly inductive and give rise to a high voltage "inductive kick" when the relay contacts are separated. These arc discharges may be of such high voltage as to result in the destruction of relatively rugged contacts but, in general, the relays are sensitive measuring instruments which develop a very small contact pressure and, necessarily, the contacts are very delicate.

In accordance with this invention, a pair of small gas discharge or neon tubes 8 are connected across the contact arm 3 and the respective stationary contacts 4. These tubes are preferably of the miniature type similar to the customary telephone switchboard lights, without a contact base but with extended seal-in wires that serve as soldering leads and mechanical supports for the tubes. Tubes of this small type may be mounted within the usual relay casing and in position to be viewed through the sight opening, indicated by the dotted line circle 9, usually provided in the relay casing for inspection of the relay contacts.

A relay of the described construction may be operated into a load circuit of any type since the relay itself provides adequate protection for the relay contacts under all conditions of use. Under the usual condition of working into a highly inductive circuit, the neon tubes suppress the arc discharge at the relay contacts by providing a path of lower resistance when the voltage rises above the break-down voltage of the tubes. When worked into an entirely non-inductive circuit, the tubes 8 are also of value in that they afford protection against over-voltage at the contacts, which over-voltages, either accidentally or otherwise, are not uncommon. In such instances, the neon tube is lighted continuously and affords a definite indication of an abnormal condition.

The invention may be employed in the testing of any relay to detect the presence of destructive arc voltages. The relay shown in Fig. 2 is of the general type previously described, the view differing from Fig. 1 in that the casing 10 which has the sight opening 9 is illustrated, and the permanently installed neon tubes 8 are not present. Other parts of the relay are identified by the corresponding reference numerals of Fig. 1, but will not be described in detail. The relay may be of any desired construction and connected to any type of load circuit by the leads 7. The testing unit which is an embodiment of this invention comprises a base 11 carrying a plurality of neon tubes 12, preferably of the miniature type, that are serially connected. The terminals 13, 14 of the unit have flexible leads 15 that may be connected across the terminals, for example terminals 5 and 6, of the relay, the terminal 13 being connected to one side of the first neon tube 12, and the terminal 14 being connected to the switch contact arm 16 that may be set upon any one of the contacts 17 that are connected to the joined leads of adjacent tubes and to the outer lead of the last tube of the series. The base 11 is provided with numeral indications 18, such as "75V", "150V", etc., adjacent the several tubes which constitute a scale of the arc voltage existing when one or a plurality of the tubes are lighted by a discharge through the one or more tubes. These legends or voltage values may be placed on a translucent cover extending over the assembly of neon tubes.

The described unit is employed to detect the

existence of destructive voltages across the instrument contacts by connecting the leads 15 across the contacts and setting the contact arm 16 to place only the first tube in the active circuit. Freedom from destructive voltage is indicated if the first tube 12 does not light when the relay contacts are separated. A flash across the first tube indicates that the voltage across the contacts exceeds the break-down voltage of the tube, for example 75 volts. The switch arm 16 is then adjusted to include a second tube 12 in the series circuit across the relay contacts. A lighting of the first two tubes indicates that the voltage normally established across the relay contacts, i. e. before the testing unit was connected in circuit, was in excess of 150 volts. The contact arm 16 is progressively adjusted until the tubes effectively included in the series circuit do not glow when the relay contacts are opened. The value of the voltage established across the relay contacts by the opening of the load circuit lies between the total break-down voltage of the tubes which did glow and the next voltage value for which there was no discharge through the tubes. The accuracy of these voltage indications compares favorably with the accuracy of measurements made by an oscillograph as the energy required to operate the oscillograph tends to suppress the arc. Furthermore, the described testing method may be employed in the field without disturbing the connections of the relay and local circuits while the oscillograph cannot be used in the field and the entire relay system must be returned to the laboratory for testing.

I have found that, whenever the arc voltage exceeds the break-down voltage of the one or more neon tubes that are connected across the relay contacts, the arc discharge across the contacts is completely suppressed. Regardless of the actual voltage, the arc does not appear across the contacts when they are separated until one too many tubes is included in the parallel circuit, under which condition none of the tubes will glow and the arc reappears across the contacts at its full brilliancy. The purpose of the described test is, of course, to detect the existence of voltages that may damage the relay contacts. The testing unit may be left across the contacts, with switch arm 16 properly adjusted, if destructive voltages tend to be established but, a unit of this type is not intended for permanent association with a relay. Adjustments will usually be made in the load circuits, or condensers replaced or added to reduce the voltages to safe values, as indicated by the voltage measuring unit, and the unit will then be removed for future use in connection with the same or other relays.

A practical physical construction of a protected relay is shown in Figs. 3 and 4. The relay includes a base 20 upon which a permanent magnet 21 is supported. The moving system includes a contact arm 22 movable between relatively stationary contacts 23 that are carried upon an insulating bracket 24. Contact arm 22 is connected to the terminal post 25 by a lead 26, and leads 27 extend from the contacts 23 to the terminal posts 28. Small neon tubes 29 are supported adjacent the bracket 24 by soldering one lead of each tube to short strips 30 that are mounted on the posts 31 that carry the contacts 23, and soldering the other leads to each other. The joined leads of the two tubes are connected to the contact arm lead 26 by a jumper 31. Both tubes 29 are in view through the glass window 32 in the casing 33 and thus afford a continuous

indication of the operation of the relay. The glowing of one or both tubes when the corresponding contacts are separated is an indication that destructive voltages tend to exist across the contacts but, due to the described suppression action, there will be no arcing discharge across the relay contacts and the contacts cannot be damaged.

It is to be noted that the neon tubes provide general protection for relay contacts whether or not those contacts are included in an inductive load or local circuit. The relay and its contacts do not give rise to destructive voltages but the manufacturer of the relay has no control over the type of local circuit with which it may be associated. The neon tubes do not interfere with the intended operation of the relay if it is associated with a non-inductive circuit but they do afford protection against damage from over-voltage whether such voltages arise from the inductive character of the local circuit or from some fault in an inductive or non-inductive local circuit. The tubes may be used, as described, either for measuring the arcing voltage or for by-passing the arc discharge around the relay contacts and through the neon tubes.

The invention is not limited to the particular arrangements herein described as other apparatus may be employed in carrying out the disclosed inventions.

I claim:

1. The combination with an instrument type relay having contacts included in a local circuit, of means connected across said contacts to suppress arcing conduction and to measure the magnitude of the transient arc voltage, said means comprising a plurality of serially connected gaseous discharge tubes, a connection

from one of said contacts to one end terminal of said serially connected tubes, switch means having a contact arm adapted to be adjusted to include any desired number of said tubes between said contact arm and the said end terminal, and a connection from said contact arm to the other contact of said relay.

2. The invention as claimed in claim 1, wherein said means includes a base on which said tubes and said switch means are mounted, and legends on said base adjacent the respective tubes indicating the total break-down voltage of the tubes effectively included in the series circuit by the said contact arm at each adjustment thereof.

3. Apparatus for measuring the transient arcing voltage established across relay contacts when they are separated, said apparatus comprising a plurality of serially connected gaseous discharge tubes, a lead connected to one end terminal of said serially connected tubes and adapted to be electrically connected to one of the relay contacts, switch contact points connected respectively to the other end terminal and to the joined terminals of adjacent tubes, a switch contact arm adjustable to engage the desired one of said contact points to control the number of tubes effectively included in series circuit between said lead and said contact arm, and a lead connected to said switch contact arm and adapted to be connected to the cooperating contact of said relay.

4. Apparatus as claimed in claim 3, in combination with a base supporting said tubes, and legends on said base adjacent the respective tubes indicating the total break-down voltage of the tubes effectively included in the series circuit by the said contact arm at each adjustment thereof.

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