Aug. 13, 1929. L. H GARAUX 1,724,014

ELECTRIC CIRCUIT AND FUSE TESTER

Filed Sept. 21, 1925

Fig. 1.

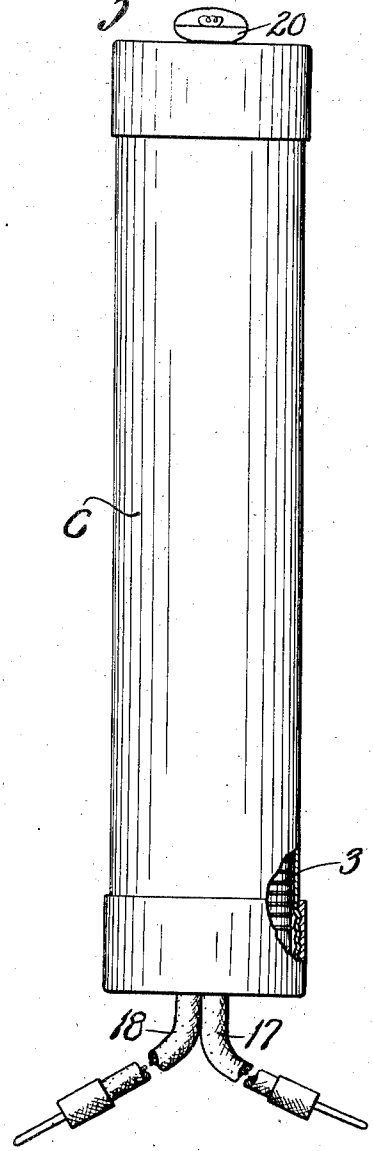


Fig. 2.

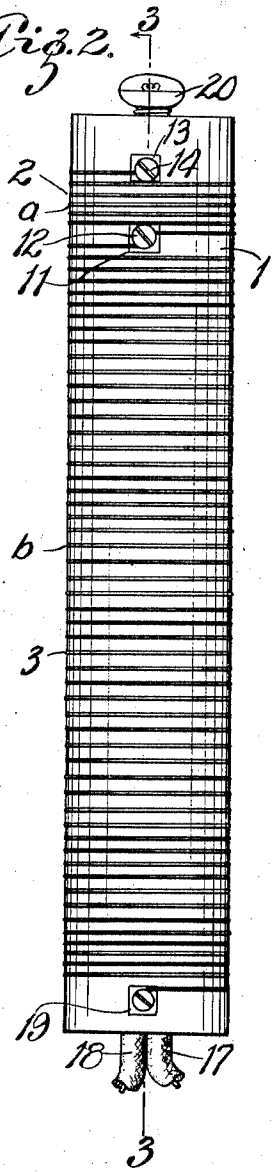


Fig. 3.

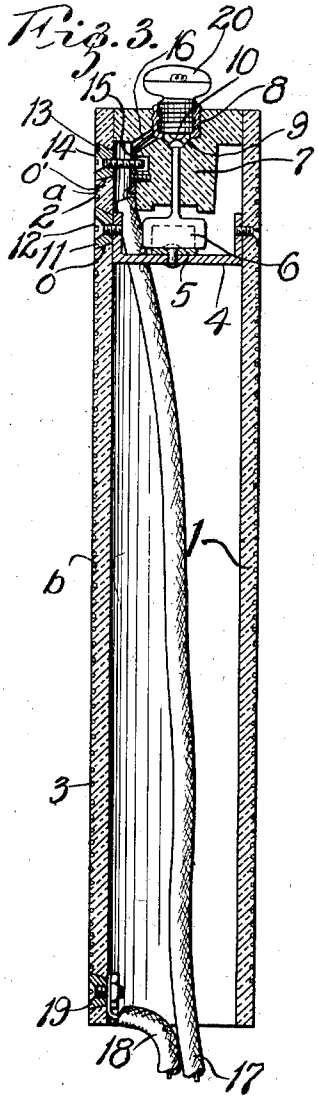
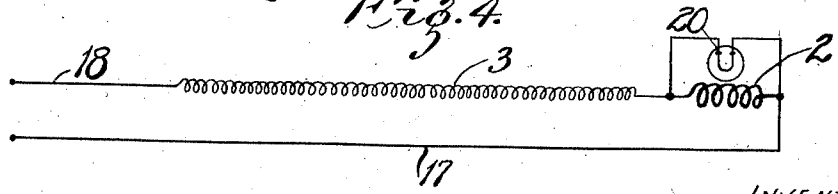


Fig. 4.



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Patented Aug. 13, 1929. 1,724,014

UNITED STATES PATENT OFFICE.

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ELECTRIC CIRCUIT AND FUSE TESTER.

Application filed September 21, 1925. Serial No. 57,713.

My invention has relation to improvements in electric circuit and fuse testers and consists in the novel features of construction more fully set forth in the specification and pointed out in the claims.

Briefly, the invention consists in a series resistor and a lamp and shunt resistor in parallel, the shunt resistor having about twice the current carrying capacity of the series resistor, by virtue of which arrangement the tester has a wide working range of impressed voltages as will be explained in detail hereinafter.

The objects of the invention are to provide a tester that may be operated on a wide range of voltages either A. C. or D. C.; one in which static cannot be mistaken for line current as the lamp, which indicates the flow of current, will not burn under the influence of static; one in which a spark is produced when the line connection is broken sharply, whereby the device is operable even though the lamp may become broken while in service; one wherein there are no parts to wear or burn out, except the lamp which may be readily replaced; and one that is small and compact, fitting conveniently into the pocket with the troubleman's usual tools. Further and other advantages will be better apparent from a detailed description of the invention in connection with the accompanying drawings, in which—

Figure 1 is an elevational view of my improved tester; Figure 2 is an elevational view of the same with the outer enclosing tube removed; Figure 3 is a vertical longitudinal section taken on the line 3—3 of Figure 2; and Figure 4 is a diagrammatical view of the tester.

Referring to the drawings, 1 represents an insulating tube which is threaded at *a* and *b* for the windings comprising the shunt resistor 2 and series resistor 3, said resistors in the present instance consisting of nichrome wire (although other resistor material such as ribbon, tubes, or sheets, may be used). The material used should give the greatest possible resistance in the smallest space and should be indestructible under the temperature attained by the tester in operation.

A connection bar 4 is secured within the tube 1 (as shown in fig. 3) and has attached to it a spring clamp 5 adapted to receive a contact 6 provided at the end of a porcelain lamp socket 7. There is a metallic threaded shell 8 in the upper part of the lamp socket 7 provided with an opening 9 through which a conductor 10 projects, said conductor being connected at its lower end to the contact 6. Opposite to the connection bar 4, an opening *o* is provided in the tube 1 into which a metallic insert 11 is passed by means of which one end of the series resistor 3 and one end of the series resistor 2 are connected together, the insert 11 being held in place by a screw 12. A second opening *o'* is provided above opening *o* and a metallic insert 13 is secured therein by means of a screw 14, said screw being threaded into a contact 15 secured to the porcelain socket 7, said contact being connected by a conductor 16 to the shell 8. One end of the resistor 2, and, also, the terminal 17 (as shown in the diagrammatic view of fig. 4) are connected to the lamp socket by means of the insert 13. The terminal 18 is connected to one end of the resistor 3 by means of an insert 19.

The operation of the invention may now be described as follows:

We will assume that resistance of the resistor 2 is 4 ohms and the resistance of the resistor 3 is 412 ohms, the ratio of these resistances being 1 to 103 which is the most desirable working ratio although it is obvious that this can be varied at will according to the results desired. The resistance of the lamp 20, which is an ordinary 4 volt flashlight bulb having a tungsten filament, is about 2 ohms at normal room temperature. Therefore, when a voltage (about 100 volts) is impressed on the terminals 17 and 18, the lamp 20 will receive sufficient current (.18 amperes) to burn dimly, the current passing through the lamp being about two-thirds of the total current flow and the balance flowing through the resistor 2. Now if an increased voltage is impressed on the aforesaid terminals, the resistor 3 rises in temperature and the lamp 20 will burn more brightly, also, greatly rising in temperature. The increase in the temperature in the resistor 3 and the lamp 20 causes an increase in the resistance of these elements so that the current flow is first cut down through the resistor 3 and again cut down by the lamp 20 so that the larger part of the current flowing through the tester will pass through the resistor 2 which is constructed so as to carry the in-

creased current without heating, hence its resistance remains constant. On impressing a voltage of about 650 volts, the current flow through the lamp 20 and resistor 2 is at a ratio of about 1 to 2; thus, it will be seen that the greater the impressed voltage, the greater the resistance through the resistor 3 and the lamp 20, and the greater will be the flow of current through the resistor 2. This action may be illustrated as follows:

Voltage	Temperature	Resistance
1	30 degrees C. (room temp.)	2 ohms
100	700 degrees C. (room temp.)	6.834 ohms
600	2630 degrees C. (room temp.)	26.52 ohms

and so on, up to 3600 degrees C. the fusing point of tungsten. The temperature of resistor 2 remains constant, as the resistor is built to carry any current necessary without heating. Therefore, the ratios for the various impressed voltages are as follows:

At 100 volts resistor 2, 4 ohms, lamp 20, 6.83 ohms.
At 600 volts resistor 2, 4 ohms, lamp 20, 26.52 ohms.

The resistor 3 increases in temperature about 300 degrees centigrade and being constructed of nichrome resistance wire with a temperature coefficient of electrical resistivity of .000432, and a normal resistance cold of 400 ohms will have a resistance of 451+ ohms at 300 degrees centigrade. Thus:—

$$300\times.000432=.1296\times400+400=451+\text{ohms.}$$

The larger the temperature coefficient of resistivity of the resistance material used in the resistor 3 and the lamp filament, and the smaller the temperature coefficient of resistivity in the material used in the resistor 2, the greater will be the efficiency of the tester; and the smaller the difference in the variation of the current flowing through the lamp 20, the greater the range of voltage over which it may be used. And the greater the change of temperature in the resistor 3, and the filament of the lamp 20 while the temperature of the resistor 2 remains constant, the greater the efficiency of the tester. Thus the temperature coefficients of the materials used and the varying temperature of these materials under different impressed voltages allows a four volt lamp to be used over a range of about five hundred and fifty volts.

The resistor 2 has approximately double the carrying capacity of the resistor 3 so that in the operation of the device, the resistor 2 will not heat and its resistance remains at a constant value while the resistance of the resistor 3 and the lamp 20 is increased by the heating of these elements.

Owing to the fact that the windings constituting the resistance coils 2 and 3 are inductive, sharp breaking of the circuit at the terminals when the tester is in use will create a spark in accordance with the operation of Lenz' law by virtue of which fact the tester may be used effectively even though the lamp may be broken.

The windings and other elements of the tester are protected by an outer tube or casing C which may be secured thereover in any suitable manner.

Having described my invention, I claim:

1. A circuit and fuse tester comprising an inductively wound series resistor, and inductively wound shunt resistor, each having a positive temperature coefficient, and a lamp having a high positive temperature coefficient, said shunt resistor and lamp being connected in parallel and the series resistor being in series therewith, the shunt resistor having a current-carrying capacity in excess of that of the series resistor.

2. A circuit and fuse tester comprising a series resistor, a shunt resistor, and a lamp, said resistors and lamp each having a positive temperature coefficient that of the lamp being greater than that of the resistors, said series resistor having a resistance many times that of the shunt resistor, and said shunt resistor and lamp being connected in parallel and the series resistor being in series therewith whereby a wide range of voltages may be determined automatically by virtue of the increase in resistance through temperature rise in the series resistor.

3. A circuit and fuse tester comprising a cartridge having within it an inductively wound series resistor and an inductively wound shunt resistor, the shunt resistor having a current carrying capacity greatly in excess of the series resistor, a lamp mounted in one end of the cartridge and connected in parallel with the shunt resistor, the series resistor being in series with lamp and shunt resistor and suitable terminals leading from said cartridge.

4. A circuit and fuse tester for use on comparatively low voltages comprising a series resistor, a shunt resistor, and a lamp, said series and shunt resistors having relatively low and high conductivity and each having a positive temperature coefficient, the series resistor being in series with the lamp and shunt resistor the shunt resistor being connected in parallel with the lamp and having a temperature coefficient of low value relative to the lamp whereby current in excess of that necessary to light the lamp will flow through the shunt resistor.

In testimony whereof I hereunto affix my signature.

LAWRENCE H. GARAUX.