Sept. 25, 1928.

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MULTIWINDING DISCHARGE BALANCE COIL

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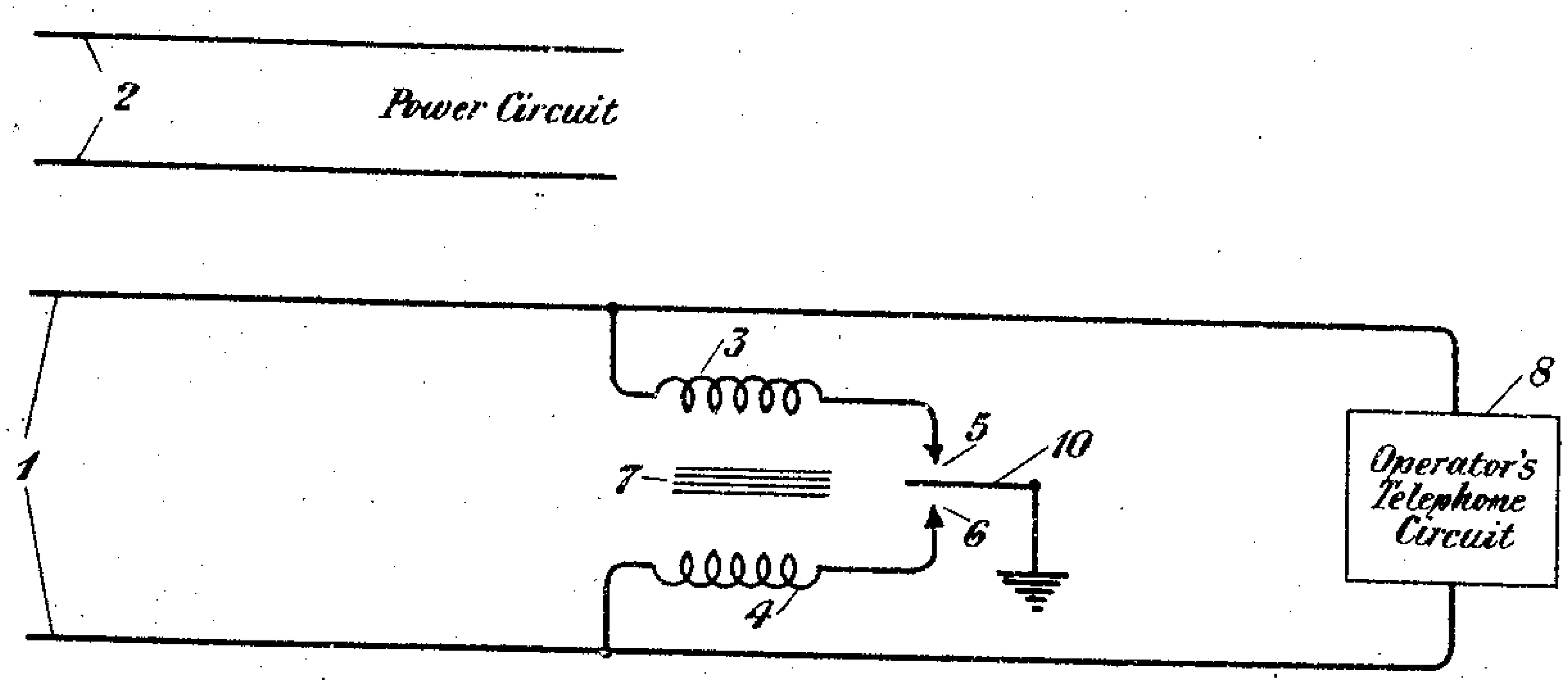

Fig. 1

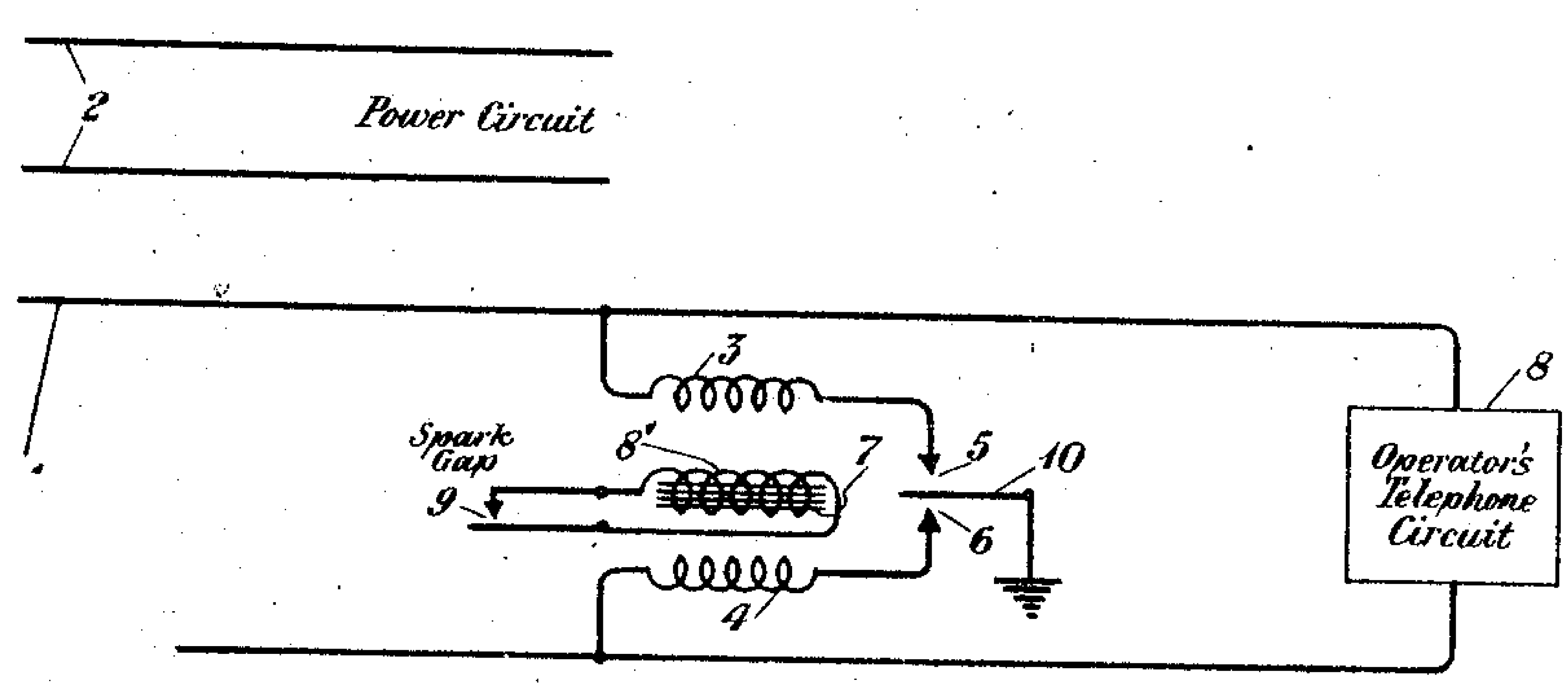

Fig. 2

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UNITED STATES PATENT OFFICE.

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MULTIWINDING DISCHARGE BALANCE COIL.

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This invention relates to voltage limiting devices, and particularly to a type of multiwinding transformer which is designed to limit the magnitude of the potential that may be applied to a selected section of a circuit.

In the operation of telephone circuits, such for example, as long circuits, which are exposed to inductive interference by neighboring power circuits, trouble known as "acoustic shock" is experienced, particularly by the telephone operators when a high potential surge is set up in the exposed circuit, due, for example, to the accidental grounding of the power circuit. The abnormal potential induced in the telephone line circuit produces an abnormal click in the telephone head receiver of the operator. The result of such acoustic shock interferes with the normal operating routine and therefore, is detrimental to the service.

It is the object of this invention to provide means for limiting the potential that may be impressed by an exposed line circuit upon a circuit to be protected, such, for example, as an operator's telephone circuit, so that the current in the operator's receiver can never exceed a predetermined value regardless of the potential applied across the line circuit, thereby preventing what is known as acoustic shock.

The invention may be more fully understood from the following description, together with the accompanying drawing, in the Figures 1 and 2 of which are illustrated arrangements of the prior art and one form of embodiment of the invention. Like reference characters have been used to denote like parts in both figures.

In Fig. 1 is shown a telephone line circuit 1 which is exposed to inductive interference from the adjacent power circuit 2. The telephone line circuit 1 is connected to an operator's telephone circuit 8, shown schematically. While the circuit 8 has been referred to as an operator's circuit, it is understood that this is for purposes of illustration only and that any other circuit which it is desired to protect from acoustic shock might be substituted therefor. However, as the effect of acoustic shock is usually most severe in an operator's telephone set, the invention has been described in connection therewith.

Bridged across the line 1 in Fig. 1 is a discharge balance coil. It consists of a transformer having two windings 3 and 4 on a common core 7. The impedances of these two windings are carefully balanced. They contain the same number of turns and are arranged to oppose each other or to set up opposite fluxes in the core 7. Winding 3 is connected to one conductor of circuit 1 and to a protector gap comprising the electrode 5 and the grounded plate electrode 10. Winding 4 is connected to the other conductor of circuit 1 and to a protector gap comprising the electrode 6 and the grounded plate electrode 10. With such an arrangement, when the protector gaps are broken down, or operated by high voltage, the protector gap discharge currents flow through the two windings 3 and 4 of the transformer. The chief function of a discharge balance coil of this type is to overcome the effect of unbalanced discharge characteristics between the two protector gaps. If we assume that potentials of equal magnitude were applied to both sides of line 1 and that the discharges across the two protector gaps were unequal, we would then have a condition of unbalance which would cause acoustic shock in the operator's circuit 8. However, the windings 3 and 4, which have equal turns and are so poled as to oppose each other, will tend to equalize the currents through the two protector gaps and hence neutralize the effect of an unequal discharge. In other words, by providing two coils of the type referred to, the current through the operator's circuit which produces the acoustic shock and is caused by unbalanced discharge characteristics across the two protector gaps will be minimized.

The operation of a discharge balance coil of this type has been shown to assist markedly in reducing the intensity of acoustic shocks when the voltages applied to the two sides of the circuit are equal or of only a small difference in their order of magnitude. However, when there is a large difference between the voltages applied to each side of the line, including the case where the protector gap on one side of the line does not break down, there will be practically no current in one of the windings of the transformer and the other winding will present its relatively high magnetizing impedance to the discharge current. This will have the effect of keeping the potential of the line wire at a high value due to the drop of the discharge current through this high magnetizing impedance. In such a case the acoustic shock experienced may be more severe than that which would result if the coils 3 and 4 were not included in circuit. In other words, the discharge balance coil presents certain advantages over a discharge gap alone when the applied voltages are equal or only of slight difference in that it compensates for unequal discharge characteristics. However, under conditions where the difference in the applied voltages is very great or where one of the protector gaps fails to break down, the discharge balance coil is a detriment and a discharge gap alone would be preferable.

In accordance with this invention, the discharge coil is constructed as shown in Fig. 2 of three windings on a common core instead of only two balanced windings as in the arrangements of the prior art shown in Fig. 1 and heretofore described. Accordingly, a third winding 8′ is provided on the common core 7. This third winding 8′ will have a larger number of turns than either of the windings 3 and 4 and its terminals will be connected to the discharge gap 9. When the voltages applied to the two sides of the line are of the same order of magnitude, the discharge currents through the opposing windings 3 and 4 will be approximately equal. As these windings oppose each other, there will be practically no flux set up in the core 7 and hence practically no voltage induced in winding 8′. Under these conditions the protective device will operate in substantially the same manner as the discharge coil of Fig. 1. If, however, the applied voltages are largely unbalanced so that the two currents are very different, and particularly in the case where no discharge takes place on one side of the line resulting in zero current in the winding on that side, there will be a considerable voltage across the other winding which will result in a flux in the core 7 and hence an induced voltage in the third winding 8′ to which the discharge gap 9 is connected. The ratio of turns to the third winding 8 would be so adjusted that the discharge gap 9 connected to it would break down at a predetermined voltage across one of the equal turn windings. When this voltage is reached, the discharge gap 9 will break down and will close the circuit of the third winding 8′. This has the effect of practically closing a short circuit around the winding carrying the discharge current. Accordingly, the impedance presented by this winding is removed or greatly reduced, thereby lowering the voltage from that side of the line to ground.

The limiting value of the voltage in one of the equal windings 3 and 4 which causes the breakdown of the gap 9 connected to the third winding 8′ should be so chosen that the gap 9 will not break down on the small difference in voltage required to balance the discharge when the applied voltages are only slightly different. For example, the two applied voltages may lie one above and the other below the breakdown voltage of the two protector discharge gaps. In this case it is desirable to permit the discharge current in the winding connected to the side of the line to which the higher voltage is applied, to induce a voltage on the opposite side sufficient to bring the applied voltage on that side to a value that will break down the second protector. If the gap 9 were operated at a very low voltage, this action would be interfered with.

While the invention has been disclosed in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many other and widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A line circuit exposed to inductive interference, a circuit to be protected associated therewith, and a protective device comprising a multiwinding transformer having two equal turn windings differentially arranged on a common core, each of said windings connecting a protector gap to different sides of said line circuit, and an auxiliary winding mounted on said common core and having a greater number of turns than either of said equal turn windings, and a spark gap across the terminals of said third winding.

2. A line circuit exposed to inductive interference, a circuit to be protected associated therewith, and a protective device comprising a multi-winding transformer having two equal turn windings differentially arranged on a common core, each of said windings connecting a protector gap to opposite sides of said line circuit, and a third winding mounted on said common core having a spark gap across the terminals of said third winding adapted to operate at a definite potential in said winding.

In testimony whereof, I have signed my name to this specification this 25th day of February, 1926.

RICHARD K. HONAMAN.