April 7, 1931. D. P. LOYE 1,799,174

PROTECTIVE DEVICE

Filed April 24, 1928

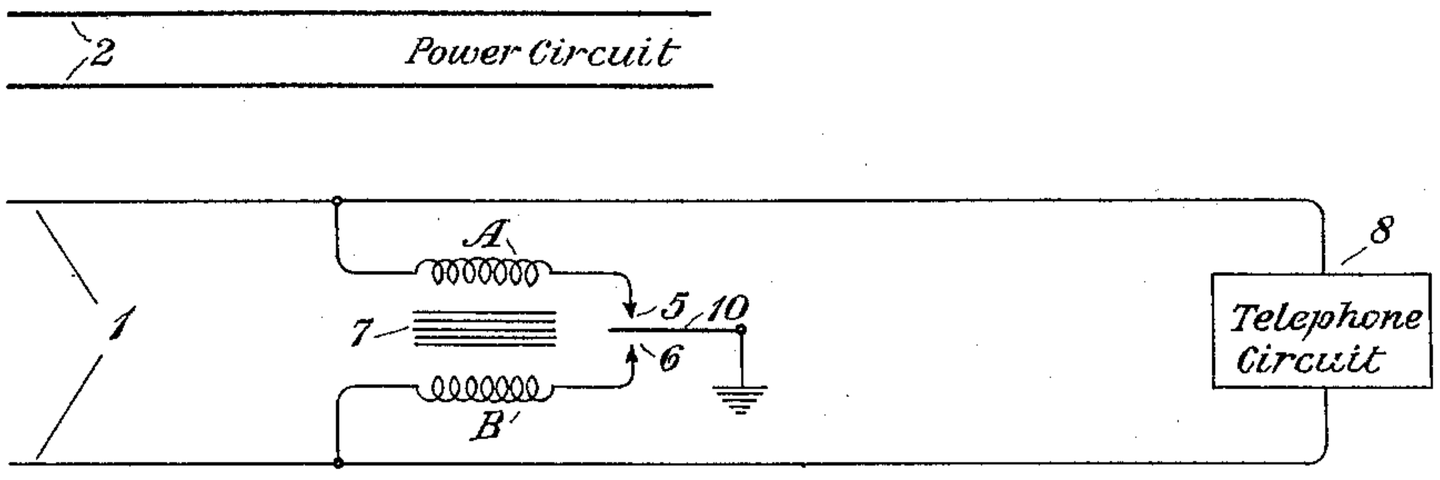

Fig. 1

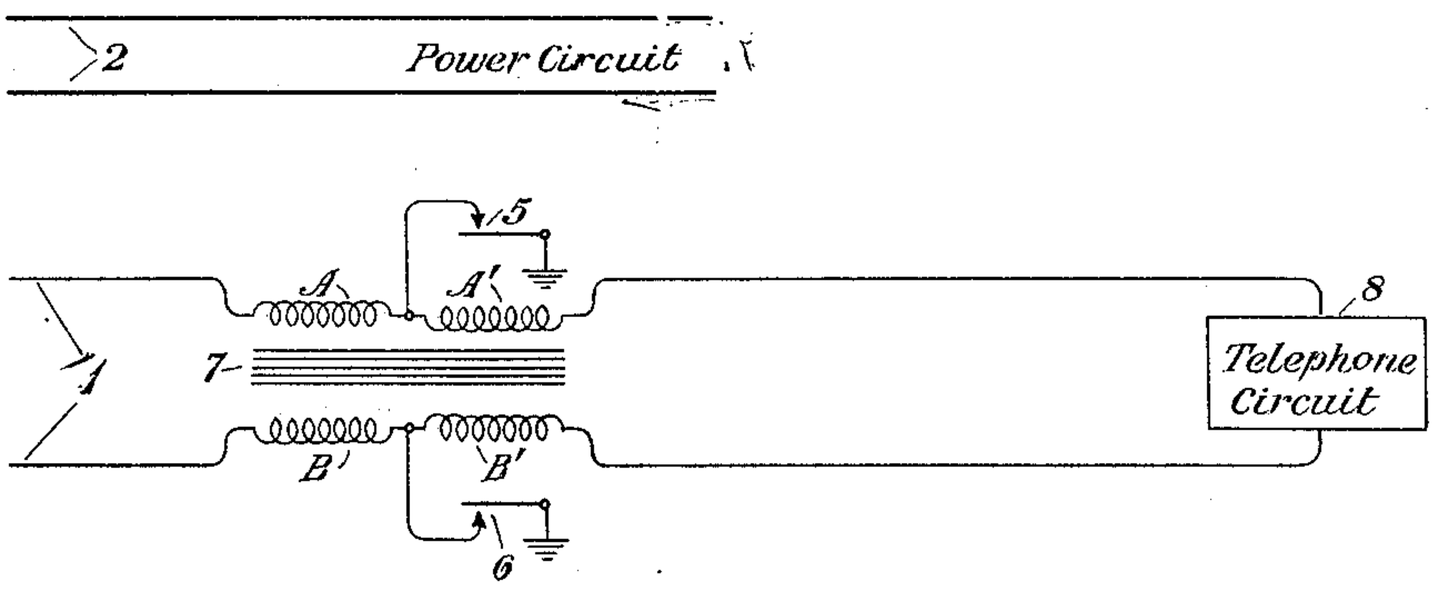

Fig. 2

INVENTOR
D. P. Loye

BY

ATTORNEY

Patented Apr. 7, 1931 1,799,174

UNITED STATES PATENT OFFICE

DONALD P. LOYE, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

PROTECTIVE DEVICE

Application filed April 24, 1928. Serial No. 272,367.

This invention relates to voltage limiting devices, and more particularly to arrangements designed to limit the magnitude of the potential that may be applied to a selected section of a circuit.

In the operation of transmission circuits such, for example, as long telephone or carrier telegraph circuits which are exposed to atmospheric disturbances or to inductive interference from neighboring power circuits, trouble known as acoustic shock is often experienced or, in the case of telegraph circuits, interference may result and cause faulty operation. This trouble is caused when a high potential surge is set up in the exposed transmission line, due, for example, to the accidental grounding of a neighboring power circuit, or from atmospheric disturbances such as lightning or from any other extraneous cause. The abnormal potential induced in the transmission line will produce an abnormal click in the telephone head receiver connected to such a line or will interfere with the proper operation of other apparatus connected to the line, such as carrier telegraph apparatus. The result of such acoustic shock or interference disrupts 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 transmission line upon a circuit to be protected, such, for example, as an operator's telephone circuit so that the current in the operator's receiver or other apparatus can never exceed a predetermined value regardless of the potential applied across the transmission line thereby preventing what is known as acoustic shock. While the arrangements of the invention will be illustrated in connection with the prevention of acoustic shock in a telephone receiver, it is pointed out that the invention may be utilized in many other circuits, such for example, as a means for preventing interference in telegraph circuits.

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

In Figure 1 is shown a transmission line 1 which is exposed to inductive interference from the adjacent power circuit 2. The transmission line 1 might furthermore be exposed to atmospheric disturbance. The transmission line 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 interfering disturbances, such as acoustic shock might be substituted therefor. However, for purposes of simplicity, the invention has been described in connection with an operator's telephone set.

Bridged across the line 1 in Figure 1 is a discharge balance coil. It consists of a transformer having two windings A and B 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 or to set up opposite fluxes in the core 7 when current flows through each to ground. Winding A is connected to one side of the line 1 and to a protector gap comprising the electrode 5 and the grounded plate electrode 10. Winding B is connected to the other side of line 1 and to a protector gap comprising the electrode 6 and the grounded plate electrode 10. With such arrangement, when the protector gaps are broken down or operated by high voltage, the protector gap discharge currents flow through the two windings A and B 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 are unequal, we would then have an unbalance which would cause acoustic shock in the operator's circuit 8. However, the wind-

ings A and B 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 windings of the type referred to, the current through the operator's circuit which produces 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 found to assist in reducing the intensity of acoustic shock, 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, and particularly in the case where the protector gap on one side of the line fails to break down initially, 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. As this high impedance winding is connected in parallel with the side of the line, 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 A and B were not included in the circuit. The voltage induced in the coil connected to the other side of the line will tend eventually to break down the discharge gap connected thereto and thus ultimately reduce the impedance presented to the current by the coils. However, before this effect takes place, the impedance presented by the coil connected to the side of the line to which the greater initial potential, or which contains a slightly lower breakdown protector, is applied, will be very high and there will be a most undesirable tendency to increase the acoustic shock. It is the purpose of the arrangements of this invention to provide a protective device which will have all of the advantages of the discharge coil of the prior art and which will not have the undesirable feature of tending to increase the acoustic shock when potentials of large difference are applied to the sides of the line and particularly when one of the discharge gaps is not initially broken down by such applied potentials.

In Fig. 2 is shown a transmission line 1 exposed to inductive interference from a neighboring power circuit. The transmission line 1 will be connected to an operator's telephone circuit 8. Included in series in each side of the line 1 will be the windings A and B. These windings will be mounted on a common core 7. The impedances of these two windings are carefully balanced. These windings will contain the same number of turns and are arranged to oppose each other or to set up opposite fluxes in the core 7 when current flows through them both to ground. Winding A will be connected to the discharge gap 5 and winding B will be connected to the discharge gap 6. These windings will function in substantially a similar manner to the arrangement of the prior art illustrated in Fig. 1. In other words, if unequal discharges are taking place across the gaps 5 and 6, the current induced by one winding in the other winding will tend to equalize the discharge across the two protector gaps. If currents having large differences in potential are applied to the sides of the line, such that the protector gap 5 will break down and the protector gap 6 will not break down, it will be seen that the high magnetizing impedance of the winding A will be presented in series in the side of the line 1 rather than in parallel with the side of said line. Accordingly, this high impedance will be directly presented to the incoming high potential and will prevent said potential from affecting the telephone circuit 8. In a similar manner, if the discharge gap 6 should break down while the gap 5 failed to break down, the high magnetizing impedance of the winding B would be presented serially in the line to the incoming high potential and would thus prevent it from affecting the telephone circuit 8. In other words, by arranging the windings A and B in series in the sides of the line instead of in parallel therewith, the arrangements of this invention utilize the high magnetizing impedance of such windings existing when one of the protector gaps fails to break down as a means for preventing the high potential currents from reaching the telephone circuit 8 rather than as a cause for increasing the tendency for such currents to reach the apparatus 8 as in the prior art. Connected in series with winding A would be provided the winding A′, having its windings arranged to oppose those of winding A. Similarly, there would be provided a winding B′ in series with winding B having its windings arranged to oppose those of winding B. With such an arrangement, the windings A and A′ and B and B′ will offer no impedance to the normal operating currents of the system.

While the arrangements of the invention have been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that they are capable of embodiment in many and other 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 interference, a circuit to be protected associated therewith, and a protective device comprising a trans-

former having two equal turn windings differentially arranged on a common core, said windings being included in series in opposite sides of said line circuit and in series with said circuit to be protected, and protector gaps connected to each of said windings.

2. A line circuit exposed to interference, a circut to be protected associated therewith, a protective device comprising a transformer having a set of two equal turn windings differentially arranged with respect to each other in series in one side of said line, a second set of two equal turn windings differentially arranged with respect to each other in series in the other side of said line, the windings of one set being differentially arranged with respect to the windings of the other set, and protector gaps connected to the midpoints of each set of windings.

In testimony whereof, I have signed my name to this specification this 23rd day of April, 1928.

DONALD P. LOYE.