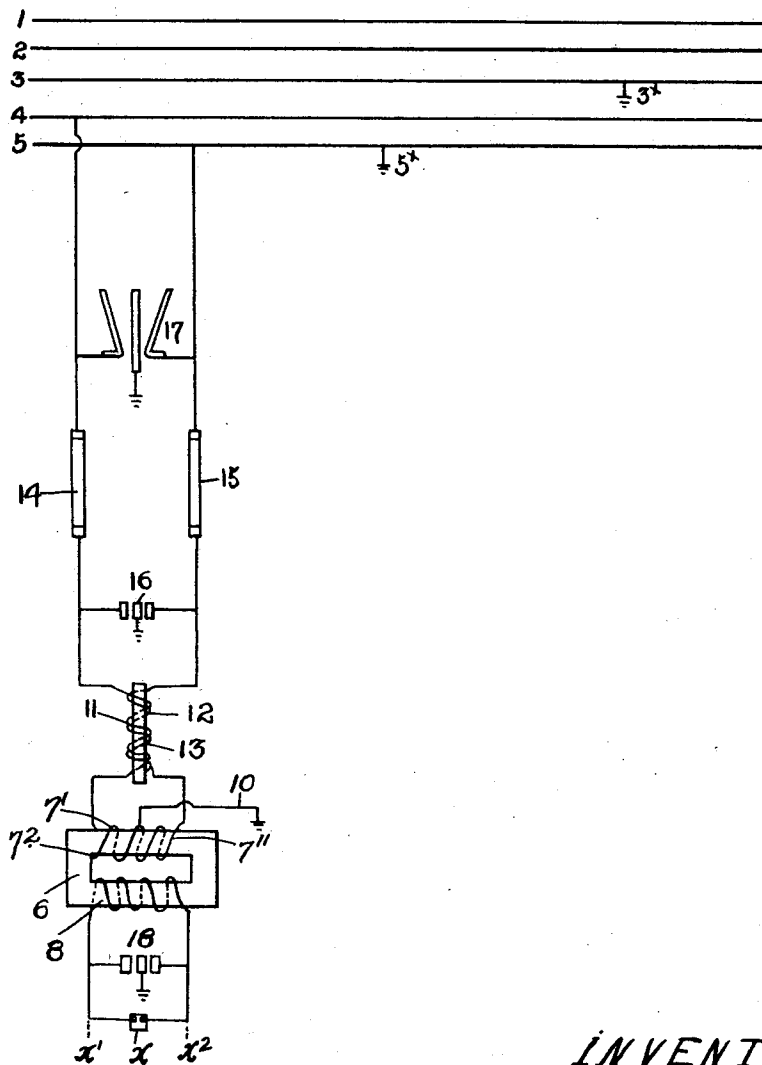


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 TELEPHONE PROTECTIVE APPARATUS FOR TELEPHONE LINES PARALLELING POWER LINES.
 APPLICATION FILED JAN. 28, 1918.

1,303,383.

Patented May 13, 1919.



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TELEPHONE PROTECTIVE APPARATUS FOR TELEPHONE-LINES PARALLELING POWER-LINES.

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Specification of Letters Patent.

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Application filed January 28, 1918. Serial No. 214,158.

To all whom it may concern:

Be it known that I, RALPH WILLOUGHBY OSBORNE, of the city of Hamilton, in the county of Wentworth, in the Province of Ontario, Canada, have invented certain new and useful Improvements in Telephone Protective Apparatus for Telephone-Lines Paralleling Power-Lines, of which the following is the specification.

My invention relates to improvements in telephone protective apparatus for protecting telephones or telephone switchboards used for communication over telephone lines paralleling electric power lines and the object of the invention is to devise a protective panel which will obviate any liability from the voltage induced in the telephone line by adjacent electric power lines from causing electrical breakdowns in the telephone apparatus.

A secondary object is to so construct the protective device that ordinary or standard telephone apparatus and interior telephone wiring may be used in connection with telephone lines paralleling electric power lines thus dispensing with the more expensive and inefficient special telephone apparatus now commonly used in connection with such lines.

Another object is to produce a standard telephone protective apparatus capable of being used in connection with all telephone lines which may by their proximity to electric power lines, be subjected to excessive or dangerous potential.

The figure represents a diagrammatic view of my protector applied to a telephone circuit.

X is the telephone connected across the wire w^1 and w^2 .

Lines 1, 2 and 3 represent the line wires of a three-phase high tension power line. The two lines 4 and 5 below represent the two wires of a telephone circuit paralleling the power line.

Voltages are induced in the telephone circuit through two phenomena—electric and magnetic induction. Both effects are always present and they combine to produce a resultant voltage between the two sides of the circuit and ground. The closer the telephone circuit is to the power circuit, other things being equal, the greater the induced voltage.

If it were possible to construct a perfectly balanced power circuit there could be theoretically no voltages induced in a parallel telephone circuit.

In practice it is impossible to obtain ideal conditions but if the power line is properly constructed and transposed so as to expose each phase of the power line equally to the telephone line through its length, there is little trouble so long as operating conditions are normal. But suppose a ground is established on the power line at 3^x by the breaking down of an insulator or other cause, the power system will be very much unbalanced and a heavy current will flow to ground at the fault and the resultant magnetic field induces in the telephone line, a voltage sufficient to break down ordinary telephone apparatus connected thereto, besides endangering the life of a person using a telephone. There are also cases of a power line breaking and falling on the telephone line which is still more dangerous.

In order to overcome this defect, I provide a protector comprising a transformer provided with primary and secondary coils, the neutral point of the primary coil being connected to ground by ground wire 10. This device protects the telephone or telephone apparatus X and the persons using the same when the above mentioned abnormal conditions develop. It affords equally as good protection against lightning during storms. It is particularly useful to power companies whose telephone lines necessarily parallel the power lines often on the same poles or towers, throughout their length. It greatly reduces the liability of telephone apparatus being inoperative after power trouble has subsided and in the case of power companies makes it immediately available for use for communication with other stations, so that the trouble may be located and power restored with little delay, thus shortening interruption to power service. It does away with the necessity of duplicate apparatus so much used by power companies and renders communication more reliable. It makes it unnecessary for the user of a telephone to stand on an insulated platform or sit on an insulated stool for safety.

These results are brought about by the ground wire connecting the neutral point

on the primary winding of the transformer to ground, preventing dangerous voltage at the secondary terminals.

The voltage induced in the telephone wires 4 and 5 raises the potential of both wires in the same direction with respect to earth. If the telephone circuit is balanced, *i. e.*, if the series impedances of the two wires and the admittances between the two wires and earth are the same at every point, the potential of both wires with respect to earth will be equal and there will be no potential between the two wires.

If my protector is connected to the telephone wires as indicated in the figure equal current will flow from each wire through fuses 14 and 15, the windings 11 and 12 of the choke coil 13, the two halves of the primary winding 7² of the transformer and ground wire 10 to earth. The two equal currents flowing through the two halves 7' and 7'' of the primary winding 7² to ground wire 10 being in opposite directions with respect to their magnetizing effects in the core of the transformer 6, the resultant magnetizing effect is zero and no voltage is induced in the secondary winding 8 to which telephone apparatus is connected by wires 16 and 17.

If an unbalanced condition develops in the power line as for instance a broken down insulator at 3^x excessive voltage will be induced in the telephone line. If at the same time an unbalanced condition develops in the telephone line an extreme case of which would be a dead ground on the line at 5^x current induced in wire 5 would flow to ground at 5^x while current induced in wire 4 would flow through fuse 14^m choke coil winding 11 one-half 7' of the primary winding 7² of the transformer and ground wire 10 to earth. Neglecting transformation losses which are small, current in one-half 7' of primary winding 7² will by its magnetizing effect on the core cause an equal current to be induced in the other half 7'' of the winding, the circuit and direction of which will be from ground wire 10, through earth to 5^x line wire 5, fuse 15, winding 12 of the choke coil through corresponding half 7'' of the primary winding 7² of the transformer to ground wire 10.

If ground 5^x is a partial ground, part of the current induced in wire 5 flows to ground at 5^x and the balance through half 7'' of the primary winding 7², via ground wire 10. The induced current from wire 4 flowing through half 7' still being equal to the total induced current flowing from wire 5, will cause a current equal to that flowing to ground at 5^x to be induced in half 7'' to make the current in half 7'' equal to the current in half 7'. The tendency therefore is for the current flowing through the two halves of the transformer to ground via

ground wire 10 to equalize. It is noted that the induced current from wire 5 flowing to ground at 5^x is opposed at 5^x by an equal current induced in half 7'' of the primary winding 7². Neglecting the losses of transformation which are negligible the resultant current flowing to ground at 5^x is therefore zero.

The voltage induced in half 7'' and required to cause the current induced in half 7'' to equalize the two currents to ground through the two halves 7' and 7'' of the primary winding 7² is equal to the equalizing current multiplied by the impedance of half 7'' of the primary winding, the choke coil winding 12, fuse 15 and line wire 5, but not including the ground 5^x, expressed mathematically $E = IZ$ when E is in volts, I the current in amperes and Z the impedance in ohms. The voltage E is a maximum with an extreme unbalanced condition and approaches zero as the line approaches a balance.

The secondary winding 8 being on the same core with the primary winding, has voltage induced in it in proportion to the voltage induced in half 7'' of the primary winding, the magnitude of the secondary voltage depending on the ratio of the number of secondary turns to the number of primary turns, which is usually 1 to 1. The ratio of the secondary turns to the turns of half the primary winding will be 2 to 1 and the voltage induced in the secondary winding will therefore be multiplied by 2.

From the foregoing explanation of the theory of the device it is evident that the voltage between wires X' and X² to which the telephone or telephone apparatus is connected would never reach a dangerous value so long as both line wires and connections thereto remain intact.

It is evident that if the ground 10 were removed current from the ungrounded wire would flow through the winding of the transformer to the ground on the other wire and a voltage would be induced in the secondary winding.

Therefore as the primary winding of the transformer has the neutral or center tap grounded it allows the induced current on the line a path or paths of low impedance to ground.

Because the tendency of the induced current is to flow to ground and because the ground connection is within the primary winding there is little or no tendency of the induced current to strain or break down the insulation between the primary and secondary winding.

It is, therefore, unnecessary to provide heavy insulation between the primary and secondary winding, and the transformer would not be large in proportion to its capacity. It is for this reason easy to design

the transformer to give efficient speech transmission.

A carbon block arrester 18 is installed across the secondary terminals to take care of any possible rise in voltage across the secondary terminals.

A choke coil 13 is wound with two heavily insulated wires 11 and 14 wound on the same core and connected non-inductive to ringing and talking current but inductive to current flowing over both wires in the same direction. This coil prevents a voltage wave of high frequency from puncturing the end turns of the transformer.

A vacuum arrester 16 is provided of such a type as will insure a minimum possibility of the carbon particles formed during discharge bridging the gaps between the line and ground electrodes.

17 is a horn gap which is used is an auxiliary arrester. It is a most effective means of discharging heavy current without bridging the gaps with particles of copper. It comes into action after the fuses blow and prevents the breaking down of wiring leading from the line to the protective apparatus. I am enabled with the use of this horn gap to use with safety ordinary twisted pair telephone wire as service wire. I mention this because power companies often find it necessary to enter the buildings with open wiring each wire entering by separate entrance. When a large number of wires enter the same building the open wire method makes an unsightly appearance besides being expensive. I find it better to make the entrance with twisted pair wires formed into a cable and supported if necessary by a steel messenger. After the blowing of the fuses the voltage on the entrance wiring would be limited to that required to rupture the air gap between the horns.

What I claim as my invention is:

1. In a telephone protective apparatus for telephone wires paralleling high tension power wires, the combination with the telephone wires, of a transformer of the closed magnetic type, interposed in the telephone circuit and having primary and secondary coils extending between the telephone wires, and a ground wire extending from the neutral point of the primary coil.

2. In a telephone protective apparatus for

telephone wires paralleling high tension power wires, the combination with the telephone wires, of a transformer interposed in the circuit and having primary and secondary coils extending between the telephone wires, a ground wire extending from the neutral point of the primary coil, and fuses located in the telephone wires leading to the primary winding of the transformer, a choke coil, and an arrester connected across the circuit between the fuses and the choke coil.

3. In a telephone protective apparatus for telephone wires paralleling high tension power wires, the combination with the telephone wires, of a transformer interposed in the circuit and having primary and secondary coils extending between the telephone wires, a ground wire extending from the neutral point of the primary coil, fuses located in the telephone wires leading to the primary winding of the transformer, and means for discharging heavy current after blowing-out of the fuses.

4. In a telephone protective apparatus for telephone wires paralleling high tension power wires, the combination with the telephone wires, of a transformer interposed in the circuit and having primary and secondary coils extending from the neutral point of the primary coil, fuses located in the telephone wires leading to the primary winding of the transformer, and a horn gap bridging the wires of the telephone and adapted to discharge heavy current after blowing-out of the fuses.

5. In a telephone protective apparatus for telephone wires paralleling high tension power wires, the combination with the telephone wires, of a transformer interposed in the circuit and having primary and secondary coils extending between the telephone wires, a ground wire extending from the neutral point of the primary coil, and a choke coil inserted in the telephone circuit and comprising a pair of windings connected respectively in series with each telephone wire and wound around a common core.

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Witnesses.

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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."