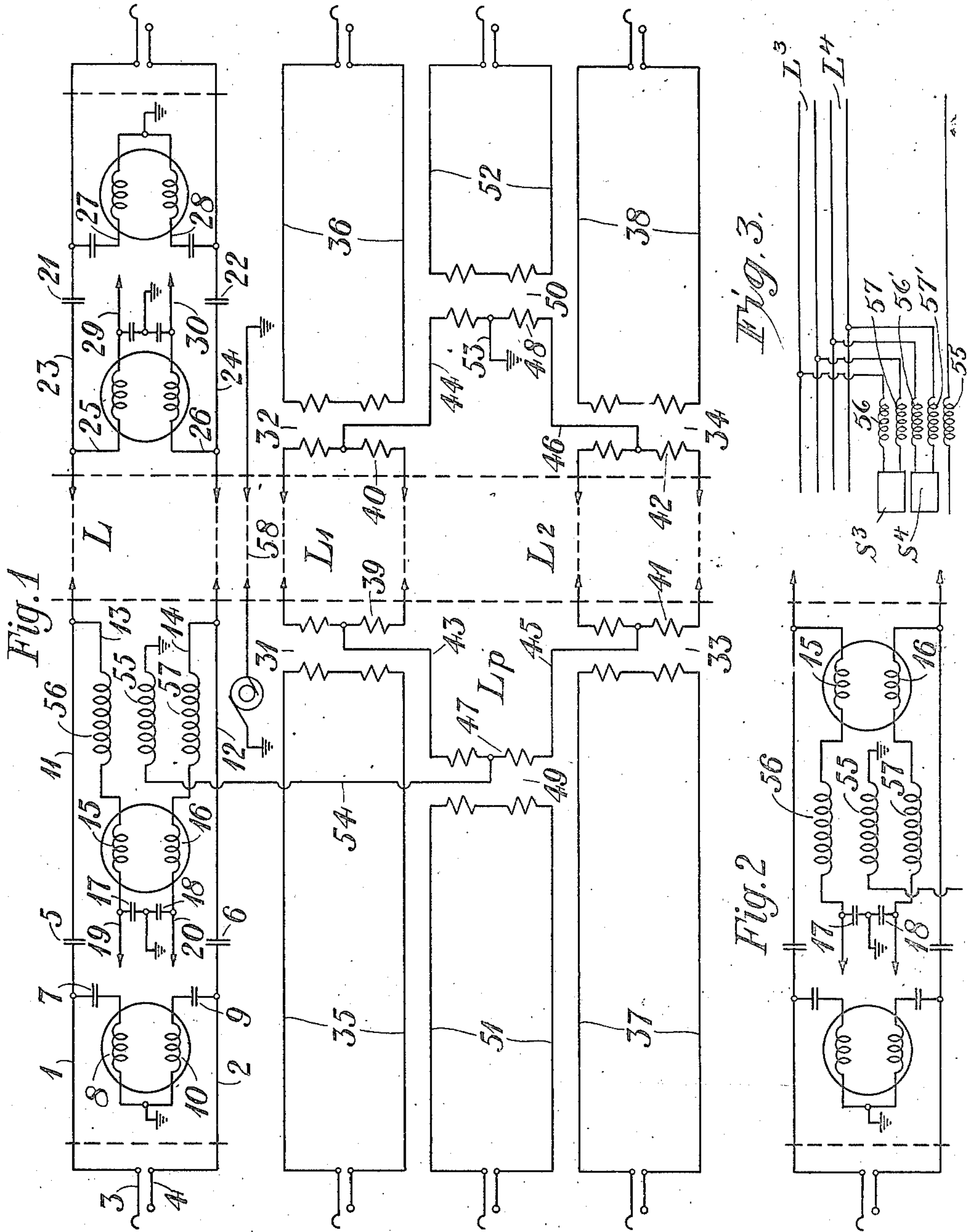


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 PROTECTIVE SYSTEM FOR COMPOSITE CIRCUITS.
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1,222,810.

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PROTECTIVE SYSTEM FOR COMPOSITE CIRCUITS.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, THOMAS SHAW, residing at Hackensack, in the county of Bergen and State of New Jersey, have invented certain Improvements in Protective Systems for Composite Circuits, of which the following is a specification.

This invention relates to composite signaling circuits and has for its primary object the protection of signaling circuits from inductive disturbances due to power or other circuits in the vicinity thereof.

More specifically, the invention has for its object the protection of composite circuits, in which telegraph circuits are superposed upon telephone circuits, from inductive interference due to power or other circuits which parallel the composite circuits.

When a signaling circuit such as a telegraph circuit parallels a power circuit, such, for instance, as that of a single phase railway system, low frequency currents are induced in the signaling circuit, which in some instances are of such magnitude as to interfere with signaling currents. It has been proposed to neutralize such disturbances by means of neutralizing transformers, the usual arrangement being to provide a primary circuit inductively related to the disturbing circuit in a manner similar to that of the circuit to be protected, the primary of the neutralizing transformer being included in the primary circuit, while the secondary is included in the protected circuit, so that an electromotive force is induced therein, substantially equal and opposite to that induced by the disturbing circuit. This scheme may be applied to composite telephone circuits, for the protection of the superposed telegraph circuits, in cases where the disturbing currents, being of low frequency, do not interfere with voice currents and only become a source of annoyance with regard to the telephone installation when they attain such magnitude as to be a source of danger to employees working about the circuits.

Heretofore it has been customary to insert the secondary windings of the neutralizing transformer serially in the line of the com-

posite telephone circuit, and the primary in another telephone circuit which thus functions as the primary circuit of the compensating system. This arrangement is objectionable in that it entails a serious transmission loss in the telephone circuits due to the inclusion of the transformer. Furthermore, when a telephone repeater is applied to such a line, the neutralizing transformer causes an irregularity in the distribution of inductance and capacity along the line, which must be compensated in the artificial line used in connection with the repeater, thereby causing additional expense in the construction of the artificial line. Accordingly it is proposed by this invention to overcome these objections by means of the organization in which the primary windings of the transformer, instead of being included in the telephone line, are included in a simplex ground connection from neutral points of the telephone circuits which are used as primary wires for the compensating system, while the secondary windings are included in the Morse legs of the standard terminal composite set if the telephone circuits are composited, or in the telegraph tap of the simplex repeating coils when the telephone circuits are simplexed.

The inventions will be more fully understood by reference to the accompanying drawing in which Figure 1 is a diagram of a circuit arrangement used in one form of the invention, Figs. 2 and 3 being diagrams of modifications.

In Fig. 1, L is a telephone line which terminates at each end in a standard terminal composite set. Said composite set comprises conductors 1 and 2 leading from terminals 3 and 4 to condensers 5 and 6 which are designed to permit the passage of high frequency telephone currents but offer a high impedance to low frequency telegraph currents. A ground tap including condenser 7 and retardation coil 8 leads from conductor 1, while a similar tap including condenser 9 and retardation coil 10 leads from conductor 2, the capacity and inductance in each case being so proportioned as to offer a high impedance to telephonic frequencies, but at the

same time readily permit the passage of telegraphic frequencies. Consequently telegraphic currents coming in over the conductors of line L and leaking through condensers 5 or 6 will pass to ground through these ground taps and will not pass over conductors 1 and 2 to affect the telephone apparatus.

Extending from condensers 5 and 6 to the line L are conductors 11 and 12, having similar ground taps 13 and 14 including retardation coils 15 and 16 and condensers 17 and 18. Extensions 19 and 20 lead to Morse sets.

The terminal composite set at the other end is arranged in the same manner as that just described, condensers 21 and 22 being provided in the two sides 23 and 24 of the line to permit passage of voice currents but offering high impedance to Morse currents, and ground taps 25, 26, 27 and 28 leading from the two sides of the line as shown. Ground taps 25 and 26 are provided with extensions 29 and 30 leading to Morse sending sets.

The apparatus so far described is the standard composite set now in general use and operates as follows: Telephone currents flow serially over the two sides of the line and pass through condensers 5, 6, 21 and 22 without entering the ground taps. On the other hand Morse currents applied to extensions 19 or 20 flow over the respective sides of the line L to ground through ground taps 25 or 26. Likewise Morse currents applied to extensions 29 and 30 flow over the two sides of the line to ground over ground taps 13 and 14. Condensers 5, 6, 21 and 22 substantially prevent such currents from affecting the telephone apparatus applied to the line beyond the condensers. Any telegraph currents which might leak through condensers 5 or 6 are shunted to ground through the filters 7-8 or 9-10, while telegraph currents leaking through condensers 21 and 22 are shunted to ground through the similar filters in ground taps 27 and 28.

Suppose now a power circuit such as a single phase railway system is located so that its power conductor 58 parallels the line L. Currents will be induced in the conductors of line L which may be of sufficient magnitude to interfere with the operation of the telegraph apparatus. The means whereby such induced currents are neutralized will now be described.

L_1 and L_2 are metallic telephone circuits connecting the same points as line L, said lines terminating at each end in repeating coils 31, 32, 33 and 34 by which telephonic signals are repeated into terminal conductors 35, 36, 37 and 38. An additional phantom circuit L_p is provided by joining the mid-points of windings 39, 40, 41 and 42 in which lines L_1 and L_2 terminate through

wires 43, 44, 45 and 46 to the windings 47 and 48 of induction coils 49 and 50 by which telephonic signals are repeated into terminal circuits 51 and 52. A ground tap 53 is connected to the mid-point of winding 48 while a second tap 54 is connected to the mid-point of winding 47 and leads to ground through the primary coil 55 of the neutralizing transformer. The secondaries 56 and 57 of the transformer are inserted in the ground taps 13 and 14 leading to the Morse sets. As a result of this arrangement, at the same time that electromotive forces are induced in the conductors of line L by the disturbing power circuit 58, similar electromotive forces are induced in the conductors of lines L_1 and L_2 causing currents to flow over the circuit including ground taps 53 and 54, thereby inducing through the windings of the neutralizing transformer counter electromotive forces in the conductors of the line L so that the currents which would otherwise flow over the telegraph circuits imposed on the line L are substantially neutralized. Should it be found that the introduction of windings 56 and 57 in the ground taps 13 and 14 results in too great a drop of potential through the ground taps 13 and 14, the drop may be reduced one-half by inserting a second transformer in ground taps 29, 30 and 53 in exactly the same manner as is illustrated in connection with ground taps 13, 14 and 54 the two transformers being of substantially one-half of the impedance of transformer 55-56-57.

It will be understood, of course, that the primary circuit comprising the lines L_1 and L_2 and the ground taps 53 and 54, may have primary windings inductively related to the secondaries inserted in the ground taps of telegraph circuits imposed upon a plurality of telephone circuits such as L, or if desired a plurality of primary circuits such as just described may be provided to protect any desired number of circuits. Thus in Fig. 3, lines L_3 and L_4 are shown, line L_3 being provided with ground taps which are led from each conductor thereof through windings 56 and 57 to a composite set, S_3 , in all respects similar to the composite sets described in connection with Fig. 1. Similarly, ground taps are led from the conductors of line L_4 through windings 56' and 57' to a composite set S_4 . A primary winding 55 is inductively associated with all of the windings 56, 57, 56' and 57'. By arranging the windings of the compensating transformer in the ground taps of the primary and protected circuits, instead of including them serially in the conductors of the lines as has been the practice heretofore, the loss of transmission caused by their introduction in the telephone conductors is practically eliminated, without any

increase in transmission loss in the telegraph circuits. Moreover, by the present construction if the line L is to be used in connection with a telephone repeater, the capacity and inductance of the line are evenly distributed so that the line may be balanced in the repeater by an artificial line of simple construction, whereas the introduction of the capacity reactance of the windings 56 and 57 in the conductors of the line may cause an objectionable irregularity of distribution which may have to be duplicated in the artificial line at considerable expense.

As shown in Fig. 1 the coils 56 and 57 are inserted between the retardation coils 15 and 16 and the line. This connection has a slight disadvantage due to the mutual capacity of the coils of the transformer, which results in a tendency to shunt the retardation coils. This defect may be overcome by the construction illustrated in Fig. 2, in which the coils are located between the condensers 17—18 and the retardation coils 15—16.

It will be understood that while for purposes of illustration the primary circuit is shown as a simplex telephone circuit, it may in fact be any circuit which is available for the purpose. Likewise, while the protected circuit is shown as a composite signaling circuit in which telegraph circuits are superposed on a telephone circuit, it will be understood that circuits of many and varied forms may be protected in a like manner, regardless of whether the circuit be used for signaling or for other purposes.

Therefore, while the invention has been specifically illustrated and described as embodied in a given form, it is capable of many and varied embodiments which render it applicable to a large number of types of circuits, and consequently the invention is not to be limited to the particular form and use herein disclosed.

What is claimed is:

1. In a protective system, a circuit to be protected and a primary circuit similarly related to a source of electrical disturbance, inductive means interconnecting said circuits, said inductive means being bridged across the protected circuit.

2. In a protective system, a circuit to be protected and a primary circuit similarly related to a source of electrical disturbance, ground taps leading from a conductor of the protected circuit, inductive means interconnecting said circuits, said inductive means being included in said ground taps.

3. In a protective system, a composite circuit, comprising a series circuit and ground taps leading from the conductors thereof, a primary circuit, and a neutralizing transformer interconnecting said circuits having

its secondary winding located in said ground taps.

4. In a protective system, a composite circuit comprising a series circuit, and ground taps leading from the conductors thereof, a primary circuit, a source of electrical disturbances tending to produce electromotive forces in both circuits, and a neutralizing transformer having one winding in the primary circuit, and another winding in a ground tap of the composite circuit, whereby the electromotive force in the primary circuit induces a counter electromotive force in the composite circuit to neutralize the disturbing electromotive force therein.

5. In a protective system, a circuit to be protected, and a primary circuit similarly related to a source of electrical disturbances, said primary circuit comprising a series circuit and ground leads connected to the conductors of the series circuit so that the circuit of the ground leads shall continue over said conductors in parallel, said protected circuit and said primary circuit being interconnected by a transformer having a winding connected in a ground lead of the primary circuit.

6. In a protective system, a circuit to be protected having ground taps leading therefrom and a primary circuit said circuits being similarly related to a source of electrical disturbances, said primary circuit comprising a pair of series metallic circuits, a phantom circuit extending over the conductors of said metallic circuits, and ground taps connected to neutral points of the phantom circuit, said protected circuit and said primary circuit being interconnected by a transformer having windings in ground taps of the primary circuit and circuit to be protected.

7. In a protective system, a composite circuit comprising a series telephone circuit, ground taps connected to the line conductors of the telephone circuit, said ground taps including capacity and inductances so proportioned as to offer high impedance to telephone currents, but low impedance to telegraph currents, whereby the line conductors may be used for telegraph circuits, a primary circuit, a source of electrical disturbances tending to produce disturbing electromotive forces in said primary circuit and said telegraph circuits, and a neutralizing transformer having one winding in the primary circuit, and a winding in a ground tap connected to each of the line conductors of the telephone circuit whereby the disturbing electromotive force in the primary circuit induces a counter electromotive force in the composite circuit to neutralize the disturbing electromotive force therein.

8. In a protective system, a plurality of composite circuits, each comprising a series

circuit with bridges across the conductors thereof, said bridges being grounded at an intermediate point, and a primary circuit inductively related to the bridges across a plurality of composite circuits.

In testimony whereof, I have signed my name to this specification in the presence of

two subscribing witnesses, this ninth day of October 1916.

THOMAS SHAW.

Witnesses:

DOUGLAS W. WHITNEY,
CLEMENT J. KOUKOL.