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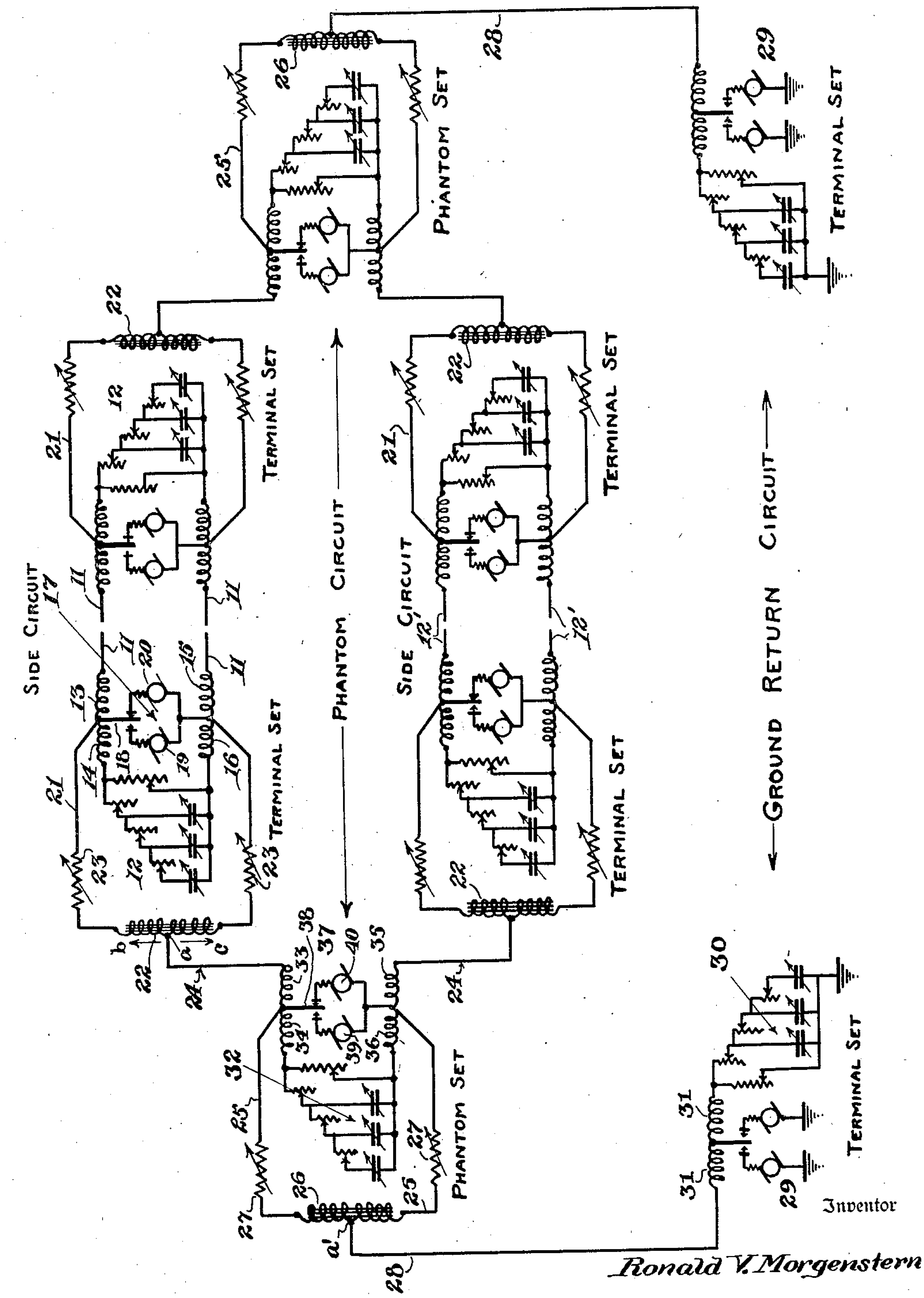

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SUPERIMPOSED TELEGRAPH CIRCUITS

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This invention relates to superimposed circuits, particularly to the method of coupling the superimposed circuit to the circuit or cir cuits on which it is superimposed.

The object of the invention is to provide a novel method of conductively coupling the superimposed circuit to the electrical center of the source of potential employed to send signaling current over the circuit on which the superimposing is done. This condition is necessary in superimposed circuits in order that the circuit on which the superimposing is done shall not interfere with the superimposed circuits.

It is also desired by this invention to provide the best possible superimposed circuits with the least possible effect on the circuits upon which they are superimposed.

The invention may be explained by reference to the accompanying drawing which shows the embodiment of the principles of the invention in a superimposed telegraph system. In the system illustrated, two metallic telegraph circuits have superimposed on them a third metallic telegraph circuit upon which in turn is superimposed a ground return telegraph circuit. In the telegraph system illustrated by the drawing, all the circuits shown are arranged for the simultaneous transmission of signals in opposite directions, but it is understood that the invention is not to be considered as limited to such a system.

On the figure the line conductors 11, 11 are used in a side circuit which is balanced for duplex operation by an artificial line 12, the relay coils 13, 14, 15, 16 being suitably connected in such a way that the transmitter 17 at the same station does not produce actuation of the relay. A similar arrangement is provided at the other terminal set of this side circuit, and at the terminal sets of the side circuit which includes line conductors 12′, 12′.

The relays at the terminal sets are preferably so arranged that the coils which are connected in the main line, e. g. coils 13 and 15, have twice the number of turns of the coils in the artificial line, e. g. coils 14 and 16. The advantage of this arrangement is found in the fact that with a given winding space on a relay it is possible by this arrangement to secure a greater number of ampere turns to operate the relay than can be secured by making the artificial and main line coils contain the same number of turns. This is explained in detail in U. S. Patent No. 1,584,682 to Albert Atherton and George W. Janson.

The transmitter 17 is schematically represented by a tongue 18 having alternate contacts which are connected to generators 19 and 20 for supplying current impulses of opposite polarities to the line through the windings of the receiving relay.

When transmitting signals over the side circuit which includes conductors 11, 11, current impulses of opposite polarities are sent to line from potential sources 19 and 20 by way of tongue 18 and one or other of its contacts. There is a tendency for current to flow through shunt 21 by reason of its connection across the two points at which battery is applied to the terminal set on the side circuit, but this tendency is minimized because of the nature of the shunt. The inductance 22 and resistance 23 of the shunt are so regulated in relation to the constants in the circuit that the shunting action of the shunt circuit at the beginning of a signal is practically suppressed. It is not thereafter permitted to obtain a substantial value before the next current reversal.

The conductors 24, 24 connect the midpoint *a* of inductive resistance coils 22, 22 to the terminal set on the phantom circuit which is like that provided at the terminals of each of the side circuits. Artificial line 32 balances for duplex operation the phantom circuit. The transmitter 37, schematically represented as comprising a tongue 38 and a pair of contacts connected to potential sources 39 and 40, is

connected to the junction point of coils 33, 34, 35, 36 of the receiving relay at the terminal set on the phantom circuit. A similar terminal set is provided at the other end of the phantom circuit. The main line coils of these relays may, like those at the terminal sets of the side circuits, comprise twice as many turns as the corresponding coils in the artificial line. In order to provide a ground return circuit over the four line conductors shown in the drawing, as well as the three metallic circuits already mentioned, a shunt 25 is connected across the two points at which transmitting potential is connected to the terminal sets on the phantom circuit. Like the shunt 21 which is connected across the two points at which potential is applied to the terminal sets on a side circuit, this shunt is provided with an inductive resistance coil 26 and resistances 27, 27 which may be variable. The inductive resistance coil 26 is not inductive to currents originating at the terminals of the ground return circuit, but is highly inductive to currents from the phantom circuit.

A conductor 28 leads from the electrical midpoint a' of coil 26 to a terminal set 29 for the ground return circuit. The terminal set includes an artificial line 30, relay coils 31, 31 and a transmitter connected between ground and the junction of the relay coils and schematically represented as before, by a tongue and two cooperating contacts connected to potential sources of opposite polarity. The operation of the system will be apparent from the following:

When transmission takes place over the side circuit comprising conductors 11, 11, current impulses of opposite polarities are transmitted to line from sources 19 and 20 by way of tongue 18 and one or the other of its contacts. The shunt 21, by reason of its connection across the terminals of the transmitter 17 tends to absorb part of the line current, but this tendency is minimized because of the nature of the shunt. The high inductance and the low resistance of the shunt are so regulated in relation to the constants of the circuit that the shunting action of the shunt circuit at the beginning of a signal is practically suppressed and is not thereafter permitted to attain a substantial value before the next current reversal.

When the transmitter 17 at the terminal set reverses the polarity of the signaling current, the impedance of the shunt is very high and allows a very small current to flow through it to the battery return. This means that at the beginning of the signal there is a very small increase in the voltage drop across the resistance placed in the connection from potential sources 19, 20 to contacts of transmitter 17, due to the shunt on the battery supply. For this reason practically the same voltage is applied to the line conductor at the beginning of a signal as would be the case if this shunt was not present.

As the length of time during which the same polarity of signaling current is impressed in the circuit increases the amount of current through the shunt increases, and the voltage across the resistance in the leads from the potential sources to the transmitter contacts also increases, lowering the potential applied to the line circuit. If the inductance of the shunt is high enough in relation to its resistance, i. e., if the time constant of the shunts is sufficiently great, the distant receiving relay is reversed in response to the reversal of signaling current before there is any appreciable decrease in signaling current strength, and the shorter the time length of signal the less final effect the shunt will have in reducing the strength of the signaling current. This is important because it is always the short signals which are the most difficult to transmit over a circuit.

The same explanation applies to the action of shunt 25 in preventing any appreciable effect of the phantom circuit transmitter upon the superimposed circuit with ground return.

The resistance of the shunt can be made as small as is compatible with the minimum voltage which must be applied to the line. The lower the shunt resistance the greater its time constant.

Since the shunt is non-inductive to the superimposed currents, the impedance which it offers to these currents is due only to its resistance, which should be made as low as is practicable. It will be further observed that the effective resistance which it offers to the superimposed current is equal to one-fourth the resistance offered by the shunt to the circuits on which the superimposing is done.

It is apparent that upon a judicious selection of the values of inductance and resistance of the shunt circuit depends the efficiency with which the desired results are attained. If the inductance of the shunt is of appropriate value compared to the rate of current reversal, the shunt circuit instead of absorbing, may even aid, by reason of the stored magnetic energy, in establishing the current reversal in the line.

The use of a single inductive resistance coil tapped at its center, rather than of two separate coils, offers the advantage of minimum inductive reactance to the currents from the superimposed circuit as well as of maximum inductive reactance to current from the circuit upon which the superimposing is done.

In the example illustrated, the adjustable resistances 23 and 27 may have a value of 400 ohms; coils 13 and 15 may have 3500 turns and coils 14 and 16, only 1750 turns. Obviously, however, these values are given merely by way of example and may be varied widely to meet varying circuit conditions.

Various adaptations of the invention will be apparent to persons skilled in the art, and the details of the specific embodiment shown are not to be taken as limiting the invention, which is capable of application to superimposed circuits generally.

I claim:

1. A superimposed telegraph circuit comprising a metallic circuit, telegraph transmitting means comprising a source of signaling potentials connected through resistance to a pair of terminals of said circuit and a shunt circuit connected to said terminals comprising an inductive resistance coil, and a conductor of a circuit having a ground return connected to the midpoint of said coil, whereby the inductance coil offers great impedance to the flow of current from the said metallic circuit and negligible impedance to flow from said ground return circuit.

2. The system according to claim 1, in which the resistance and inductance of the shunt circuit are adjusted in accordance with the voltage of said source, the characteristics of the metallic circuit, and the speed of signal transmission from said source to provide minimum shunt effect of the shunt circuit upon said source.

3. The method of operating a system according to claim 1 which comprises regulating the relation of the speed of signal transmission to the constants of the shunt circuit and of the metallic circuit so that substantially the same voltage is applied to the metallic circuit at the beginning of a signal as would be the case if the shunt were not present.

4. A superimposed telegraph system, comprising a metallic circuit, a source of potential connected to a pair of terminals thereof, a shunt circuit connected to said terminals and including an inductance and adjustable resistance, a conductor of a third circuit connected to the electrical center of said shunt circuit, and a source of signaling potential connected to said conductor, whereby the shunt circuit offers great impedance to the flow of current from said metallic circuit and negligible impedance to flow from said third circuit conductor.

5. The system according to claim 1, in which the resistance and inductance of the shunt circuit are adjusted in accordance with the voltage of said source, the characteristics of the metallic circuit and the speed of signal transmission of the metallic circuit and the speed of signal transmission from said source to provide minimum shunt effect of the shunt circuit upon said source, the resistance of the shunt circuit being made as small as is compatible with the minimum voltage which must be applied to the line.

6. In a superimposed telegraph system, a pair of metallic side circuits, a source of potential for each side circuit connected to a pair of terminals thereof, an inductive resistive shunt for each side circuit connected to a pair of terminals, a conductor of a phantom circuit connected across the electrical centers of said shunt circuits, a source of potential for the phantom circuit connected to said conductor, an inductive resistive shunt connected across the terminals of said last mentioned source, and a conductor for a transmitting circuit connected to the electrical center of said last mentioned shunt.

7. In a superimposed telegraph system, a metallic side circuit, an artificial balancing line therefor, a pair of transmitting terminals for the side circuit, a receiving relay comprising coils connected between each terminal and the line conductor and between each terminal and the artificial line, and a source of signaling currents connected to said pair of terminals whereby signal currents from said source are ineffective to operate said relay, a shunt circuit connected across said pair of terminals comprising a highly inductive resistance coil, and a conductor of a phantom circuit connected to an intermediate point of said coil, whereby signal currents from said source have negligible effect upon said phantom circuit.

8. In a superimposed telegraph system, metallic side circuit sets arranged for duplex operation, sources of signaling potentials connected to conjugate transmitting terminals of said sets, a terminal set arranged for duplex operation, and means connecting said sets to provide a phantom circuit for said terminal set comprising shunt circuits connected across the terminals of the signaling sources of said side circuit sets and including inductance coils so wound as to be non-inductive to currents from said phantom set and highly inductive to currents from said side circuit sets, whereby interference is prevented between the transmitter of each set and the receiver of its own or any other set.

9. In a telegraph system, a transmission line, a terminal set adapted for connection to said transmission line, an artificial line for balancing said line with respect to transmitted current from said terminal set, a highly inductive shunt circuit connected across the conjugate transmitting terminals of said set, duplicate apparatus at the other end of the transmission line, and means connected to the electrical centers of said shunt circuits for completing a superimposed circuit over said transmission line.

10. In a superimposed telegraph system, a pair of side circuits each comprising a source of signaling potentials connected to a pair of terminals thereof, a phantom circuit including a source of signaling potentials directly connected to said side circuits and means in said phantom circuit connection for preventing interference in said phantom circuit from

said side circuit signaling sources, said means comprising an inductance coil in shunt to the terminals of each source, a grounded circuit superimposed upon said phantom circuit and a means in the connection of said grounded circuit for preventing interference from the phantom circuit in said grounded circuit, said last mentioned means comprising an inductance coil in shunt to the phantom circuit signaling sources.

In testimony whereof I affix my signature.

RONALD V. MORGENSTERN.