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I. G. WILSON

ELECTRICAL DISTURBANCE ELIMINATING SYSTEM

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Fig. 1.

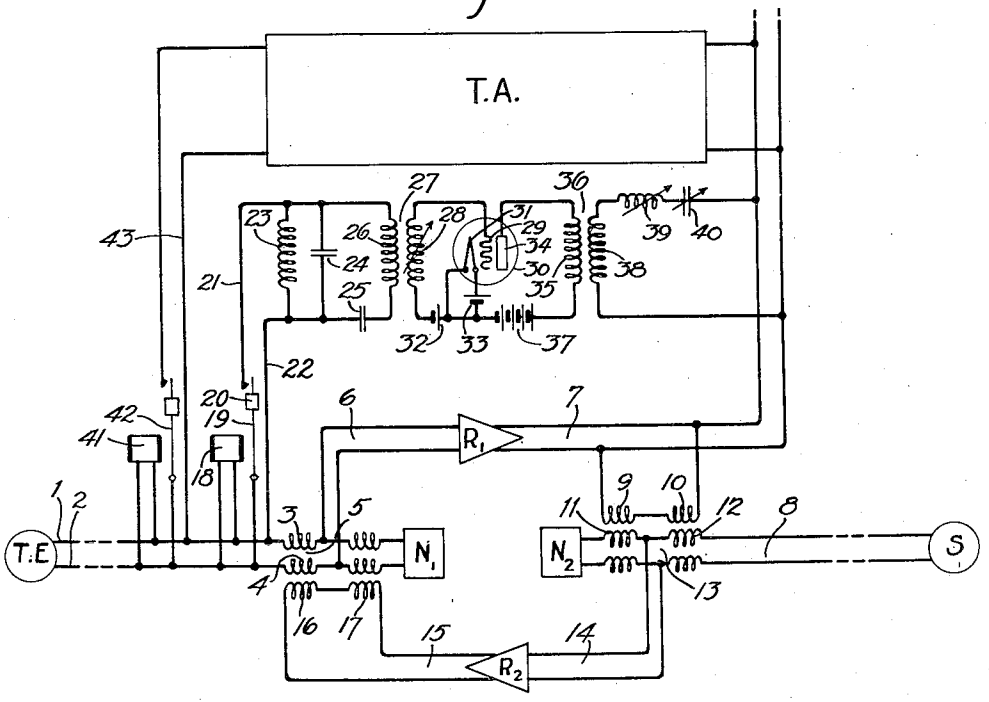
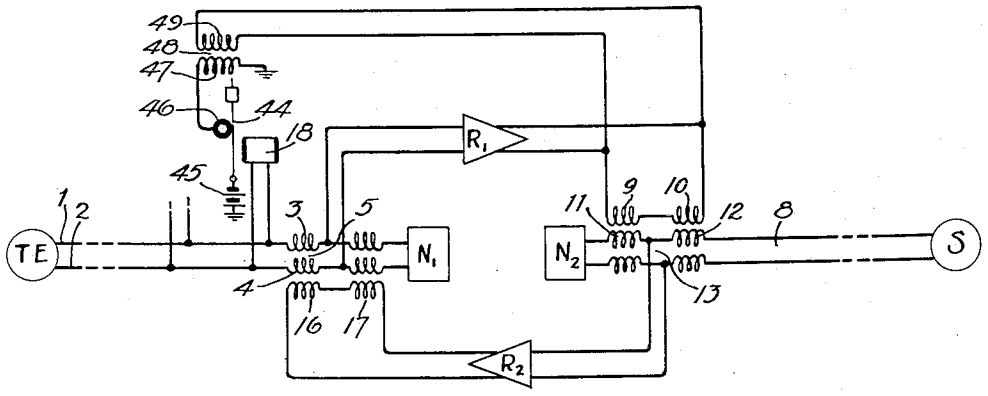


Fig. 2.



Inventor:
Ira G. Wilson
by E. W. Adams Att'y.

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IRA G. WILSON, OF BROOKLYN, NEW YORK, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ELECTRICAL-DISTURBANCE-ELIMINATING SYSTEM.

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This invention relates to electrical disturbance eliminating systems and more particularly to the elimination of noise from speech transmission systems.

One of the principal sources of external interference encountered in telephone or carrier transmission systems is inductive interference caused by induction or conduction currents from power transmission lines being picked up by the telephone lines which are in exposed locations with respect to the power lines. It has heretofore been proposed to overcome interference of this sort by permanently connecting filters or other tuned circuits in the noisy line. This has the inherent disadvantage of always removing the same frequency of the voice currents corresponding to the noise frequency present in the line. Furthermore, this arrangement removes the voice frequency even though the noise frequency is not present.

In accordance with the present invention, these disadvantages are overcome by providing tuned relays having their reeds set into vibration by the prolonged noise frequency present on the line. The vibration of the relay reed builds up until it completes a circuit for cutting in a tuned amplifier or filter to oppose or neutralize the particular noise frequency on the line. This arrangement takes advantage of the property of mechanical inertia by preventing the momentary impulses, such as speech frequencies, from affecting the operation of the relays and only in the event of the presence of a prolonged disturbing frequency or a composite noise on the line will the reeds of the relays build up sufficiently to connect in their associated neutralizing circuits.

Referring to the drawings, Fig. 1 is a diagrammatic view of a repeater system showing one embodiment of the invention, and Fig. 2 illustrates a simplified arrangement of the invention as applied to a repeater system.

In the drawings TE represents a telephone or toll exchange from which extends a transmission line consisting of conductors 1 and 2. These conductors are connected to line windings 3 and 4 of hybrid coil 5. A balancing network N_1 simulates the transmission line and the associated equipment. A uni-directional repeater R_1, preferably of the electron discharge type, has its input circuit 6 bridged across the line winding of hybrid coil 5, while the output circuit 7 is inductively connected to the subscriber's line 8 by means of windings 9 and 10 of hybrid coil 11. The hybrid coil 11 is provided with windings 12 and 13 which are included in the subscriber's line 8. This line is also balanced at one end with a network N_2 while the other end of the line is connected to the subscriber's equipment S. This description pertains to the transmission of speech from the telephone exchange T. E. through the repeter R_1 to the subscriber S. For transmission in the opposite direction a similar uni-directional repeater R_2 has its input circuit 14 bridged across the line windings of hybrid coil 11 while the output circuit 15 is inductively connected to the transmission conductors 1 and 2 through windings 16 and 17 of hybrid coil 5.

It often happens that in the geographical region through which the transmission conductors 1 and 2 extend there are high tension power lines, such as railway electrification systems, overhead trolley lines, power lighting circuits, or other high tension current carrying conductors which are in parallel relation with respect to the transmission conductors 1 and 2. These high tension systems induce interference or noise in the transmission conductors and since the range of frequencies of the noise is within the range of speech frequencies, both the noise and voice frequencies are transmitted over the line. Now, in the case of a repeater system, these noise frequencies are amplified together with the speech frequencies and the resultant amplified noise frequencies in the output of the repeater cause interference in the subscriber's circuit.

To overcome this interference, a slow-acting relay 18 is bridged across the transmission conductors 1 and 2. This relay is provided with a tuned reed 19 which may be tuned mechanically in any desirable manner, for instance, by a weight 20 being adjusted to a position on the reed to tune the reed to a desirable frequency or range of frequencies. This reed is connected to the line conductor 2 so that in its normal position it forms an open circuit for the tuned amplifier.

The mechanically tuned relay is adapted

to form an automatically operating device to connect a tuned filter or amplifier, or other correcting circuit to the transmission line in which the noise disturbance is present. As shown in the drawing it is preferable to construct the corrective circuit along the line of a uni-lateral device so that the output will not feed back into the outgoing transmission circuit. The tuned amplifier comprises an input circuit in which one line conductor 21 is normally connected in open circuit position by means of the contact adjacent to the tuned reed 19. The other input conductor 22 is connected to the conductor 1 by the transmission line. Bridged across these conductors are inductance 23 and capacity 24 having values determined by the range of frequencies corresponding to the range of frequencies to which the tuned reed 19 is responsive. A condenser 25 is also connected in series with the primary winding 26 of transformer 27 for filtering purposes. One end of the secondary winding 28 of transformer 27 is connected to the grid electrode 29 of the electron discharge device 30, while the other end is connected to one side of the filament 31 through battery 32. The secondary winding of transformer 27 is made variable or tapped to make it possible to vary the amplification. A battery 32 is connected in series with the filament and grid to impress a negative potential on the grid electrode. A battery 33 is connected in the filament circuit to render the filament 31 incandescent. The plate electrode 34 is connected to one side of primary winding 35 of transformer 36 while the other side is connected to battery 37 to impress a positive potential on the plate electrode. The secondary winding 38 of transformer 36 is bridged across the output circuit 7 of repeater R_1. Available inductance 39 and a variable capacity 40 are connected between the secondary winding 38 and one of the conductors 7. These adjustable elements are located in the output of the tuned amplifier for purposes of changing the phase and amplitude of the frequencies transmitted through the electron discharge device 30.

For the purpose of this invention, it is assumed that besides the voice frequencies being transmitted over the line conductors 1 and 2, there are also noise frequencies being transmitted together with the voice frequencies. Since the noise frequencies are well within the range of the voice frequencies, it is apparent that both types of frequencies will be transmitted over the repeatered line and the noise frequencies will cause considerable annoyance to a subscriber listening on the subscriber line 8.

While the ranges of these types of frequencies are similar, there is a marked difference in their character, since voice frequencies are generally momentary impulses, while the noise frequencies are impulses of relatively long duration. This difference is taken advantage of in accordance with this invention by providing the tuned relay arrangement above described comprising winding 18 and reed-armature 19, which will be unaffected by momentary or speech impulses and will take a considerable length of time to build up when the reed is set into vibration by the relatively long continued noise frequencies. However, when the reed is vibrated by a particular noise frequency present in the line, it will continue to vibrate while that frequency is present and in due time will vibrate to such an extent that the contact will be closed and the particular frequency will be fed into the input of the tuned amplifier. The connection of the amplifier to the transmission line causes the noise frequencies to traverse a parallel path, one through the repeater circuit R_1 and the other through the tuned amplifier. However, the adjustments in the tuned amplifier change the phase and amplitude of the frequencies so that the output of the amplifier neutralizes the noise frequencies passing through the repeater R_1 and while there is noise on the line up to the point of the output of the repeater R_1, the neutralizing effect of the tuned amplifier upon the output of the repeater R_1 substantially removes the noise frequencies from the line after this point.

The character of the noise or interference induced in the transmission line is generally composite, that is the noise is not confined to a single frequency but may comprise a wide range of frequencies. For this purpose, it is preferable to bridge a number of tuned reeds across the transmission line, adjusting the reeds mechanically to different frequencies or ranges of frequencies. As shown in the drawing, another relay 41 has the tuned reed 42 capable of being vibrated by a particular range of frequencies to which it is tuned. This reed is similarly connected to an input circuit 43 of a tuned amplifier TA having its output circuit connected to conductor 7. Since the operation of this circuit is the same as the one previously described, except for the range of frequencies to which it is tuned, it needs no further description.

Any number of relays may be bridged across the transmission line 1, 2 to take care of a wide range of noise frequencies. Then in the event of a composite noise being present on the line, only those relays which are tuned to the particular frequencies present on the line will be operated to connect in their respective correcting circuits or tuned amplifiers. In this arrangement only those frequencies which lie within the band of the noise frequencies will be eliminated from the line, and furthermore,

the corrective circuits will only be connected to the transmission line when the corresponding frequencies to which they are responsive are present.

While any number of relays may be connected to the line to associate tuned amplifiers with the line, it is apparent that other corrective circuits may be associated with the relays to accomplish the same purpose. For instance as shown in Fig. 2 the tuned reed 44 is grounded at one end to a battery 45. The tuned reed 44 also carries a carbon button 46 which is connected to the primary winding 47 of an induction coil 48. The secondary winding 49 is connected to the output circuit of repeater R_1 in the same manner as explained in connection with Fig. 1. In the operation of this circuit the noise frequencies on the line will operate the relay which in turn will vibrate the reed 44 to which the carbon button 46 is attached. The operation of the relay acting on the reed will build up its effects and cause it to vibrate. In other words, the property of inertia of the mechanical system will produce a time lag so that the actuating current may be applied for an appreciable length of time. This will be the case for a noise current which lasts for a relatively long time. On the other hand, a voice current of the same frequency will be essentially transient in character, and will neither last long enough to start vibration, nor if the reed is already in vibration long enough to change the mode of vibration. This inertia may be used therefore to distinguish between noise currents and voice currents of the same frequency. Assuming that the reed 44 is set into vibration by the continued noise frequency, this will generate a current in the carbon button 46 of the same frequency at which the reed is vibrating and proportional to the amount of vibration of the reed. The output of this system is then a current of the same frequency as the disturbing noise and of the same amplitude. This may be fed back into the circuit as was described in connection with Fig. 1. If necessary or desirable amplitude and phase shift controls may be inserted in the circuit to obtain an absolute balance so that the subscriber's circuit may be reasonably quiet. This arrangement forms a simple and economical device for the removal or neutralization of the noise frequencies present in the line. Furthermore, the relative insensitiveness of the carbon button for low energy input gives a further protection against removing the voice frequency, since the effect of these frequencies will be very small due to the inertia of the reed.

While the invention has been disclosed with respect to a repeater circuit, it is apparent that the invention can be applied to other speech transmission systems. Furthermore, the application of the property of inertia described above is not confined to purely mechanical means. Similar results may be obtained by electrical means, for instance, by replacing the tuned reed or carbon button with an amplifier having a long time constant. Such an amplifier is described by Bennett and Peters in the Journal of the American Institute of Electrical Engineers, of March, 1922, entitled "Resistance neutralization." By increasing the time constant of this type of amplifier the voice impulses would never build up and therefore could not balance themselves, but a continuous noise impulse would.

What is claimed is:

1. In a telephone transmission system, comprising a telephone line subject to interference from an external source, a normal line, interconnecting means between said lines, a neutralizing circuit connected to said normal line, and means in said telephone line operated by said interference to connect said neutralizing circuit to said telephone line.

2. In a telephone transmission system, comprising a telephone line subject to interference from an external source, a normal line, interconnecting means between said lines, a neutralizing circuit normally connected to said normal line, and a slow-acting relay in said telephone line, said relay being actuated by the interference in said line to operate contacts to connect said neutralizing circuit to said telephone line.

3. In a telephone transmisison system, comprising a telephone line subject to interference from an external source, a normal line, interconnecting means between said lines, a neutralizing circuit connected to said normal line, and a relay having a tuned reed connected across said telephone line, said relay being actuated by interference present in said telephone line to operate said reed and connect said neutralizing circuit to said line.

4. In combination, a line over which speech impulses are transmitted and subject to steady disturbing currents, a normal line connected to said disturbed line, a neutralizing circuit superimposed on said normal line, and mechanical means associated with said disturbed line acted upon by said disturbing currents to connect said neutralizing circuit to said disturbed line while still maintaining effective for the speech impulses the connection between said lines.

5. In combination, a normal line, a disturbed line, means for connecting said lines for the transmission of speech, a correcting circuit, input and output terminations for said correcting circuit, said output being connected to said normal line, and means operated by the disturbance in said dis-

turbed line to connect said input termination to said disturbed line.

6. In combination, a line over which speech and noise frequencies are transmitted, a normal line, interconnecting means between said lines, a correcting circuit, input and output terminations for said circuit, said output being operatively associated with said normal line, and tuned means in said first line operable by said noise frequencies to connect said input to said line, said means being unaffected by said speech frequencies.

7. In combination, a line for the transmission of speech, said line having induced therein interfering frequencies within the speech range, a trunk line, interconnecting means between said lines, a correcting circuit, and vibrating means operable by said interfering frequencies to build up sufficiently to interconnect said correcting circuit to said line.

8. In combination, a line for the transmission of speech, said line having induced therein interfering frequencies within the speech range, a normal line, interconnecting means between said lines, a correcting circuit, and a vibrating reed operable by said interfering frequencies, the inertia of said reed being built up by the continued interfering frequencies to interconnect said correcting circuit with said transmission line.

9. In combination, a line for the transmission of speech, said line having induced therein interfering frequencies within the speech range, a normal line, interconnecting means between said lines, a correcting circuit, and a vibrating reed operable by said interfering frequencies, the inertia of said reed introducing a time lag in the operation of said relay to connect said correcting circuit to said transmission line.

10. In combination, a line over which speech and noise impulses are transmitted, a normal line, interconnecting means between said line, a correcting circuit normally connected to said normal line, a slow-acting relay connected to said first line, said relay differentiating between short impulses of speech and continued noise impulses, a tuned reed vibrated by said continued noise impulses, and means operable by said reed to connect said correcting circuit to said line to remove said noise impulses, said reed being non-operative by said speech impulses.

11. In combination, a toll line over which speech and noise impulses are transmitted, a normal line, a repeater connecting said line, a correcting circuit permanently connected to said repeater and said normal line, and mechanical means bridged across said toll line, said means being operable by said noise impulses to interconnect said correcting circuit to said toll line to remove the noise impulses.

12. In combination, a toll line over which speech and noise frequencies are transmitted, a normal line, a repeater connecting said lines, correcting circuits permanently connected to said repeater and said normal line, each of said circuits being tuned to a particular frequency corresponding to a noise frequency present in said toll line, means for associating said correcting circuits to said toll line, and a plurality of tuned relays bridged across said toll line, each of said relays being provided with a tuned reed operated by noise frequencies present in said toll line, whereby only the tuned correcting circuits corresponding to the frequencies present in said line are connected to said line.

13. In combination, a line over which speech and noise impulses are transmitted, a normal line, a correcting circuit normally connected to said normal line, and automatic means operated by said noise impulses to associate said correcting circuits to said line to neutralize said noise impulses.

14. In combination, a line over which speech and noise impulses are transmitted, a normal line, a correcting circuit, and a mechanically tuned reed, said reed being automatically vibrated by said noise impulses to connect said correcting circuit to said line, said circuit changing the phase of said impulses and impressing said changed impulses on the output of said connecting circuit to neutralize the noise in said line.

In witness whereof, I hereunto subscribe my name this 28th day of December, A. D., 1925.

IRA G. WILSON.