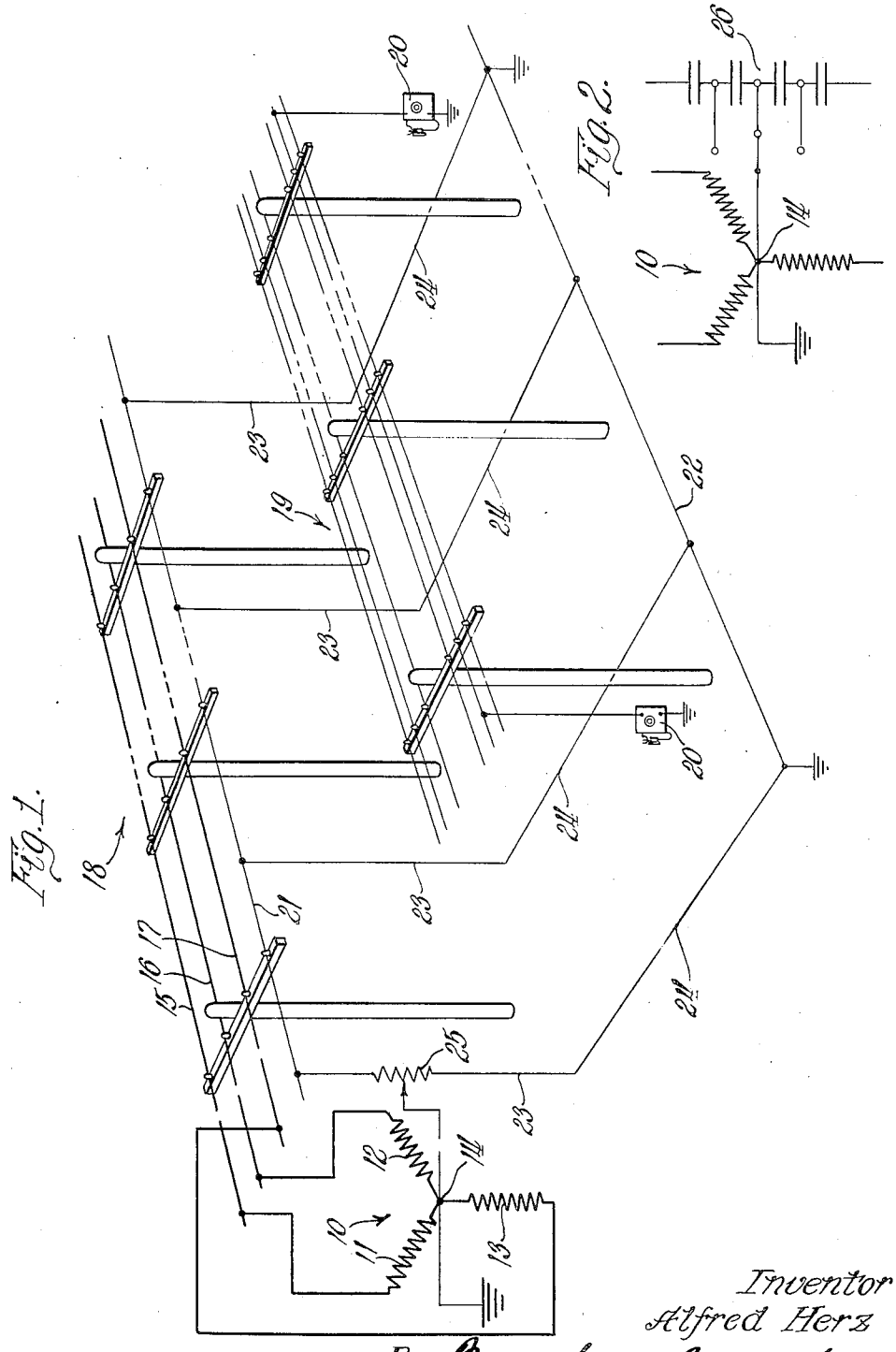
Sept. 10, 1940. A. HERZ 2,214,134

ELECTRIC SHIELDING SYSTEM

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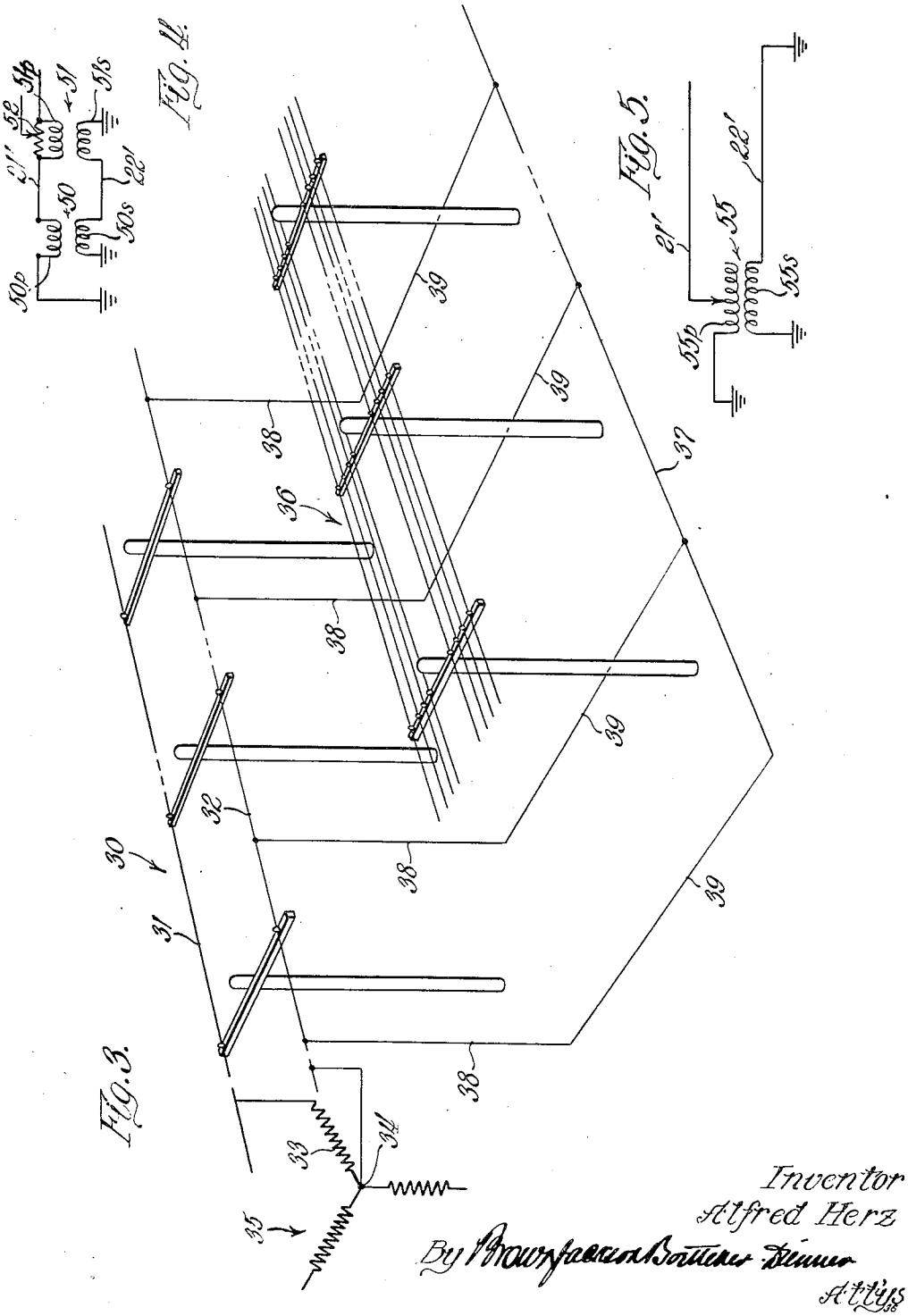


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ELECTRIC SHIELDING SYSTEM

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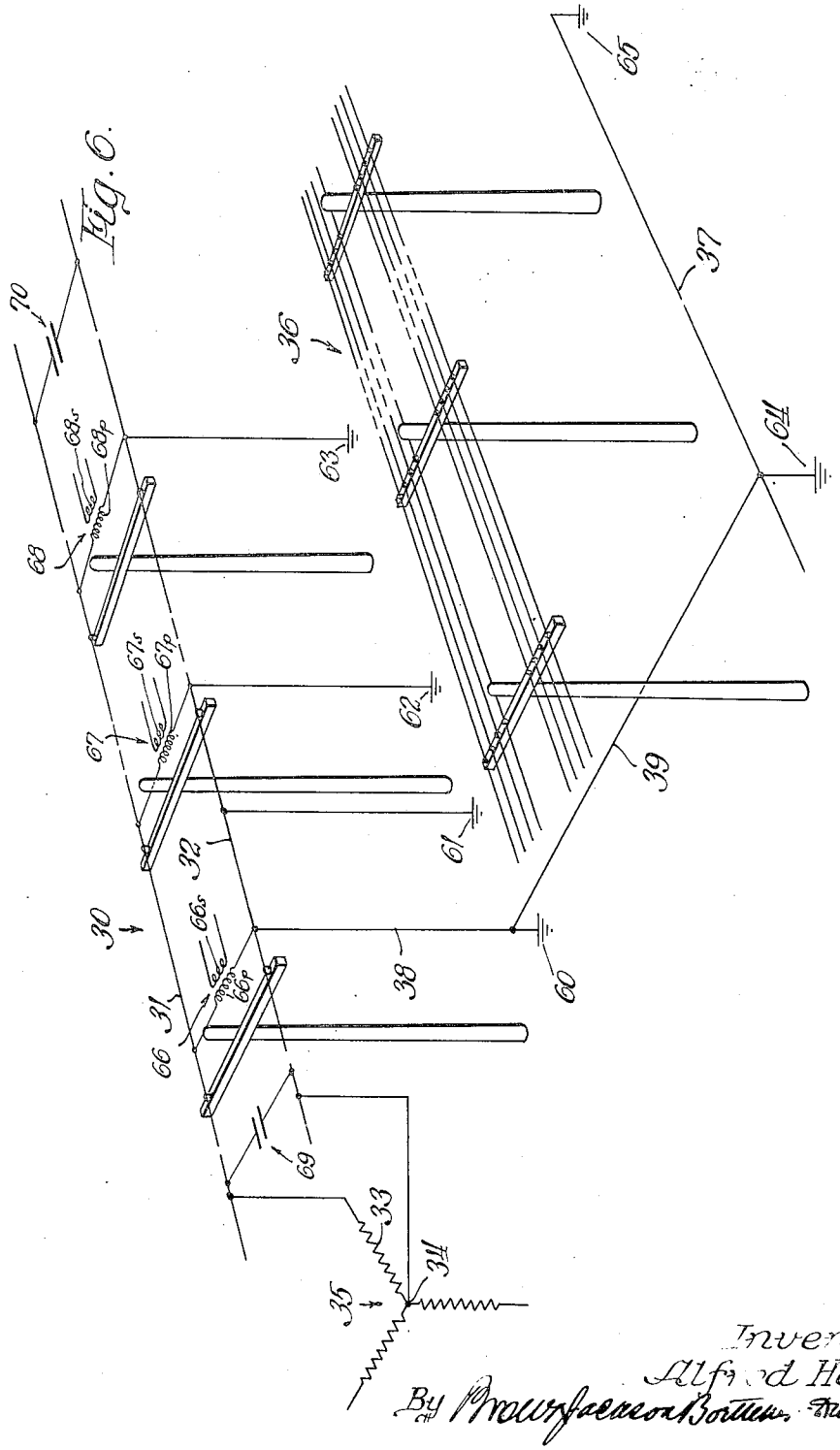


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ELECTRIC SHIELDING SYSTEM

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Fig. 6.



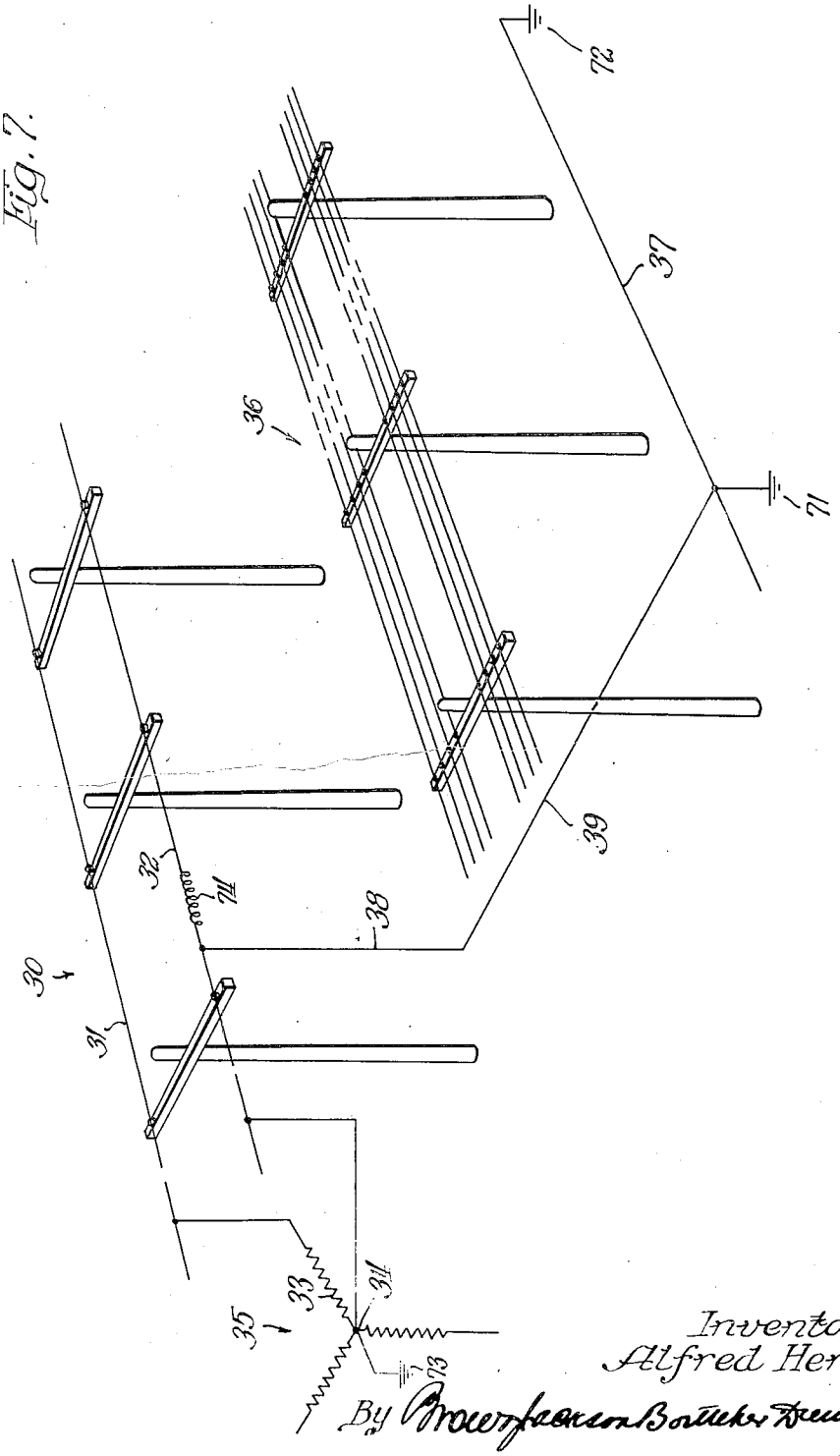
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Fig. 7.



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UNITED STATES PATENT OFFICE

2,214,134

ELECTRIC SHIELDING SYSTEM

Alfred Herz, Chicago, Ill.

Application September 22, 1938, Serial No. 231,191

20 Claims. (Cl. 171—97)

My invention relates, generally, to electric shielding systems and it has particular relation to electric shielding systems used to prevent interference or interaction between parallel power and communication lines.

It frequently is necessary for power transmission and communication lines to closely parallel each other for stretches of considerable distance. As a result, the induction effect of the power line on the communication line, and conduction of stray currents, produce serious noise and interference. This is especially true where the communication line is grounded and/or the neutral of the power line is multi-grounded.

I use the term "communication lines" to include telephone, telegraph, railway signal and other signal lines which are not primarily for transmitting power. Telephone or communication circuits may be metallic, i. e., complete metal wire circuits, or phantom circuits over the same wires, and my shielding system is especially effective when the communication circuits are ground return circuits, i. e., one metallic wire between sending and receiving ends and the circuit closed through the earth between these ends. Because the circuits in most of these communication lines are complex and delicately balanced, any external effect on them, such as induction from a power transmission line or conduction of power current therein, will upset the balance and produce noise and interference.

The most serious interference arises when a polyphase power circuit with a grounded neutral has an unbalanced load, causing current to flow in the grounded neutral of the power line, and when a single phase power line is used, one conductor of which is grounded.

This interference problem has been a source of trouble in the past, and many solutions have been offered and practiced in efforts to solve it. By employing my present invention I have found that it is possible to reduce the interference due to these effects to a minimum. In cases where power transmission lines have been installed parallel to already existing telephone lines, I have been able, by employing my present invention, to keep the noise level on the telephone line to approximatly that at which it was before the installation of the power line.

An important object of my invention, therefore, is to provide for reducing interference between an electric power line and a communication circuit or line.

Another object of my invention is to provide for adjusting the connections between the grounded conductors of parallel power and communication lines whereby interference therebetween can be reduced to a minimum.

Another object of my invention is to provide means for reducing interference between an electric power line and a communication circuit or line which does not necessitate any changes or special provisions in the already existing communication circuit or line constructions on subsequent paralleling by an alternating current power transmission line.

Another object of my invention is to provide means for reducing interference between an electric power line and a communication circuit or line which does not necessitate carrying a grounded shield wire with the communication circuit or line.

Still another important object of my invention is to provide for reducing interference between power transmission and communication lines in such manner that there is no resultant liability of danger to service men working on either the communication or power lines.

Other objects of my invention will, in part, be obvious and in part appear hereinafter.

Accordingly, my invention is disclosed in the embodiments thereof shown in the accompanying drawings, and it comprises the features of construction, combination of elements, and arrangement of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the application of which will be indicated in the appended claims.

For a more complete understanding of the nature and scope of my invention, reference may be had to the following detailed description, taken in conjunction with the accompanying drawings, in which:

Figure 1 illustrates, diagrammatically, my shielding system applied to parallel sections of a polyphase power transmission line and a communication circuit;

Figure 2 shows an adjustable impedance control which may be used in place of the one shown in Figure 1;

Figure 3 illustrates, diagrammatically, my shielding system applied to parallel sections of a single phase power transmission line and a communication circuit;

Figures 4 and 5 illustrate, diagrammatically, two circuit modifications of my shielding system; and

Figures 6 and 7 illustrate, diagrammatically, still other applications of a shield or compensating wire to parallel communication and power lines.

Referring now to Figure 1, it will be observed that the reference character 10 designates, generally, a source of three-phase alternating current. The phase windings 11, 12 and 13 are star-connected with the neutral point at 14. The terminals of the phase windings 11, 12 and 13 are each connected to the three conductors 15, 16 and 17 of a power transmission line, shown, generally, at 18. By way of example, the power

line 18 is shown carried overhead on poles with single cross arms. However, the conductors 15, 16 and 17 may be transposed or otherwise arranged and may be carried on towers if so desired.

A section of a telephone line, shown, generally, at 19 runs substantially parallel to the power line 18. For example, the power line 18 and the telephone line 19 may be on opposite sides of a highway. The telephone line 19 may be taken as illustrative of any communication line or circuit that might be encountered.

The reference characters 20 designate two telephone instruments that may be connected to one conductor of the telephone line 19 and grounded to complete the circuit. It will be understood, however, that the telephone instruments 20 are illustrative of telegraph instruments, signalling devices, and remote controls, such as relays.

A neutral conductor 21 is carried on the cross arms on which the power line 18 is carried, and is electrically connected to the neutral point 14 of the current source 10. It will be observed that the neutral conductor 21 may not only be grounded by the grounded neutral point 14, but that it may also be multi-grounded at intermediate points along the line if desired. When the load on the power line 18 becomes unbalanced, current will flow through the neutral conductor 21 in proportion to the degree of unbalance.

With a view to reducing interference on the telephone line 19, caused by the effects of the current flowing in the neutral 21, I provide a compensating wire 22. The compensating wire 22 is interconnected to the neutral 21 by the substantially vertical conductors 23 and the substantially horizontal conductors 24. The power line 18 and the telephone line 19 will be interconnected at the ends of parallel sections and may also be interconnected at intermediate points. The number of interconnections will vary from one case to another as convenience or requirements dictate.

The compensating wire 22 is preferably placed underground beneath the telephone line 19. It may be either an insulated wire or a bare wire, and may or may not be grounded, as desired.

By so disposing the compensating wire 22 it is unnecessary to go to the expense of supporting it with the telephone line 19. If the telephone line has already been built, it will usually not be strong enough to support the additional weight of the compensating wire 22 and so would have to be rebuilt if it were to support it.

There is another very important advantage to having the compensating wire 22 buried beneath the telephone line 19. It is seen that the compensating wire 22 and the neutral wire 21 are in parallel, which gives rise to the possibility of a large current flowing through the compensating wire 22 in case the power line 18 is greatly unbalanced or there is a phase to ground short. Usually the communication or telephone service men are not accustomed or expecting to encounter high voltages, as may be the case if a large current should be flowing through the compensating wire 22. Also, even when no current is flowing in it, the compensating wire 22, if carried with the telephone line, would constitute a "true ground" for service men to encounter. Thus, whether current is or is not flowing in the compensating wire 22, if carried on the same poles with the telephone line it would present the possibility for service men to receive annoying shocks. Therefore, by having it buried and out of the way, this hazard is eliminated.

I have found in developing my new shielding system that it is often desirable to include adjustable impedance between the neutral wire 21 and the compensating wire 22 and to have this impedance adjustably connected to the neutral point 14. Thus an inductor 25 is provided in one of the vertical conductors 23 with adjustable tap connection to the neutral point 14, as shown. It will be understood that the inductor 25 may be near the current source 10 or that it may be connected to it at the neutral point 14 at a distance of a few miles. By adjusting the tap connection to the inductor 25 the phase relationship and proportional division of the current between the neutral wire 21 and the compensating wire 22 can be adjusted so that the intereference effect due to conduction and induction is reduced to a minimum.

In Figure 2 there is shown a series of capacitors 26 which may be used instead of the inductor 25. The capacitors 26 will be connected in the circuit correspondingly as the inductor 25, Figure 1, is connected, and they will also have adjustable tap connection to the neutral point 14. Cases may also arise or exist in which it will be desirable to provide either capacitors, inductors or resistors, or the necessary combinations of these to bring about the desired effect. For convenience, these control means will hereafter be termed "impedance".

The impedance control may be located at either end of the line or at some intermediate point. A test will first be required to adjust the impedance so that interference is reduced to a minimum. After the impedance has once been adjusted it should be checked from time to time, to see that the best operation is being obtained.

Referring now to Figure 3 there is shown generally, at 30, a single phase power line comprising the conductor 31 and the neutral 32, which are connected, respectively, to the terminal of the phase winding 33 and the neutral point 34 of a source of three-phase alternating current, shown generally at 35. Running substantially parallel to the power line 30 is a communication circuit or line, shown generally at 36. A compensating wire 37 is disposed underground beneath the communication line 36 and is interconnected to the neutral 32 by conductors 38 and 39, similarly to the arrangement shown in Figure 1. It will be understood that the compensating wire 37 may be at or near the surface of the ground and does not necessarily have to be completely buried. The neutral wire is shown as being directly connected to the neutral point 34, but adjustable impedances may be utilized, as illustrated in connection with Figures 1 and 2.

Referring now to Figure 4, there is shown a method of inductively interconnecting the neutrol conductor of a power line, represented by conductor 21' corresponding to the neutral conductor 21 of Figure 1, and a compensating or shield wire, represented by the conductor 22', corresponding to the compensating wire 22 of Figure 1. As illustrated, the neutral conductor 21' and the compensating wire 22' are inductively interconnected through transformers 50 and 51, consisting of primaries 50*p* and 51*p* and secondaries 50*s* and 51*s*. The transformers 50 and 51 are essentially ampere-to-ampere transformers. An adjustable resistance 52 may be included between the terminals of the primary 51*p* if desired.

In Figure 5 I have illustrated another method

of inductively interconnecting a neutral conductor 21' and a compensating or shield wire 22'. The neutral conductor 21' and the compensating wire 22' are inductively interconnected through a transformer 55 consisting of a primary 55p and a secondary 55s. As illustrated, the neutral conductor 21' may have adjustable tap connection to the primary 55p of the transformer 55.

With a view of illustrating another embodiment of my invention, I have shown in Figure 6 an alternate method of interconnecting a compensating wire and the neutral wire of a power line whereby shielding of a communication line may be secured. The system shown in Figure 6 is like that of Figure 3 except that the neutral 32 and the compensating wire 37 are interconnected at one place only by conductors 38 and 39 and the neutral 32 is multi-grounded as shown at 60, 61, 62 and 63. The compensating wire 37 may be grounded as shown at 64 and 65. The loads on the power line 30 may be represented by transformers, shown generally at 66, 67 and 68, comprising primary windings 66p, 67p and 68p, and secondary windings 66s, 67s, and 68s. The line loads, such as for example residences, may be connected across the secondaries 66s, 67s and 68s, as is well understood. In electric distribution lines such as 30 for power and/or lighting loads it is often the practice to connect static condensors or capacitors, shown generally at 69 and 70, at some one or several places in the distribution line in order to compensate in whole or in part or even to over compensate for the low power factor producing tendency due to certain types of line loads.

With a view of illustrating still another embodiment of my invention, reference may be had to Figure 7 of the drawings which for the most part correspond to Figure 3. However, the neutral 32 and compensating wire 37 are interconnected at only one place by conductors 38 and 39; the compensating wire 37 is grounded as indicated at 71 and 72; the neutral point 34 of the power source 37 is grounded as indicated at 73; and, a series impedance 74 is included in the neutral 32. The series impedance 74 acts to further decrease the interference or interaction between the power line 30 and communication circuit 36. In this embodiment of my invention, the interconnection between the neutral 32 and the compensating wire 37 by conductors 38 and 39 may under certain circumstances be omitted.

It will be understood that the neutral conductor of a power line does not have to be the closest to a paralleling communication circuit in the application of my electric shield system. For there are cases in which a phase conductor of a power line is the closest to a paralleling communication circuit.

Since certain further changes may be made in the foregoing construction, and different embodiments of the invention may be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative, and not in a limiting sense.

I claim as my invention:

1. Means for roducing interaction between an electric power line and a communication circuit in the vicinity thereof, comprising, in combination, a first metallic conductor throughout its length adjacent the electric power line, a second metallic conductor throughout its length adjacent the communication circuit, and metallic conductor means interconnecting said first and second metallic conductors.

2. Means for reducing interaction between an electric power line and a communication circuit in the vicinity thereof, comprising, in combination, a first metallic conductor throughout its length adjacent the electric power line, a second metallic conductor throughout its length adjacent the communication circuit, and metallic conductors interconnecting the ends of said first and second conductors.

3. Means for reducing interaction between an electric power line and a communication circuit in the vicinity thereof, comprising, in combination, a first metallic conductor throughout its length adjacent the electric power line, a second metallic conductor throughout its length adjacent the communication circuit, and metallic conductors interconnecting said first and second conductors at spaced positions therealong.

4. Means for reducing interaction between an electric power line carried overhead on poles or towers and a communication circuit parallel thereto and also carried overhead on poles, comprising, in combination, first metallic conducting means throughout its length paralleling said power line and adjacent thereto, second metallic conducting means throughout its length paralleling said communication circuit and disposed underground therealong, and conductor means for interconnecting said first and second metallic conducting means.

5. Means for reducing interaction between an electric power line energized with alternating current and carried overhead on poles or towers and a communication circuit parallel thereto and also carried overhead on poles, comprising, in combination, a first metallic conductor throughout its length paralleling the power line and carried on its poles or towers, a second metallic conductor throughout its length paralleling the communication circuit and disposed underground therealong, and conductor means interconnecting said first and second metallic conductors.

6. Means for reducing interaction between a polyphase alternating current power line having a neutral connection and carried overhead on poles or towers and a communication circuit parallel thereto and also carried overhead on poles, comprising, in combination, a first metallic conductor connected to said neutral connection and throughout its length paralleling the power line and carried on its poles or towers, a second metallic conductor throughout its length paralleling the communication circuit and disposed underground therealong, and conductor means interconnecting said first and second metallic conductors.

7. Means for reducing interaction between a polyphase alternating current power line having a grounded neutral connection and carried overhead on poles or towers and a communication circuit parallel thereto and also carried overhead on poles, comprising, in combination, a first metallic conductor connected to said grounded neutral connection and throughout its length paralleling the power line and carried on its poles or towers, a second metallic conductor throughout its length paralleling the communication circuit and disposed underground therealong, and conductor means interconnecting said first and second metallic conductors.

8. Means for reducing interaction between a polyphase alternating current power line having a neutral connection and carried overhead on

poles or towers and a communication circuit parallel thereto and also carried overhead on poles, comprising, in combination, a first metallic conductor throughout its length paralleling the power line and carried on its poles or towers, a second metallic conductor throughout its length paralleling the communication circuit and disposed underground therealong, impedance means interconnecting said first and second metallic conductors, and means connecting said impedance means and said neutral connection.

9. Means for reducing interaction between a polyphase alternating current power line having a neutral connection and carried overhead on poles or towers and a communication circuit parallel thereto and also carried overhead on poles, comprising, in combination, a first metallic conductor throughout its length paralleling the power line and carried on its poles or towers, a second metallic conductor throughout its length paralleling the communication circuit and disposed underground therealong, circuit means including inductor means interconnecting said first and second metallic conductors, and circuit means variably connecting said inductor means and said neutral connection.

10. Means for reducing interaction between a polyphase alternating current power line having a neutral connection and carried overhead on poles or towers, and a communication circuit parallel thereto and also carried overhead on poles, comprising, in combination, a first metallic conductor throughout its length paralleling the power line and carried on its poles or towers, a second metallic conductor throughout its length paralleling the communication circuit and disposed underground therealong, circuit means including capacitor means interconnecting said first and second metallic conductors, and circuit means variably connecting said capacitor means and said neutral connection.

11. Method of reducing interaction between alternating current power and communication lines in the vicinity of each other, which comprises metallically interconnecting metallic conductors individually paralleling the lines throughout their lengths.

12. Method of reducing interaction between overhead alternating current power and communication lines in the vicinity of each other, which comprises positioning a first metallic conductor throughout its length along the power line and overhead, positioning a second metallic conductor throughout its length along the communication line and underground, and metallically interconnecting said first and second metallic conductors.

13. Method of reducing interaction between a polyphase alternating current power line having a neutral connection and a communication circuit in the vicinity thereof, the power line and communication circuit each having metallic conductors individual thereto in the vicinity thereof, which comprises interconnecting the metallic conductors through impedance means, connecting the impedance means to said neutral connection, and varying the connection to said impedance means until the interference is reduced to a minimum.

14. Method of reducing interaction between a polyphase alternating current power line having a neutral connection and a communication circuit in the vicinity thereof, which comprises positioning a first metallic conductor along the power line and overhead, positioning a second metallic conductor along the communication line and underground, interconnecting the first and second metallic conductors through impedance means connecting the impedance means to said neutral connection, and varying the connection to said impedance means until the interference is reduced to a minimum.

15. Means for reducing interaction between an electric power line and a communication circuit in the vicinity thereof, comprising, in combination, a metallic conductor of the power line, a metallic conductor paralleling said communication circuit, and metallic conductor means for interconnecting said metallic conductor of the power line and said metallic conductor paralleling the communication circuit.

16. Means for reducing interaction between an electric power line carried overhead on poles or towers and a communication circuit parallel thereto and also carried overhead on poles, comprising, in combination, a metallic conductor of the power line, a metallic conductor paralleling the communication circuit, and metallic conductors interconnecting said metallic conductor of the power line and said metallic conductor paralleling the communication circuit at spaced positions therealong.

17. Method of reducing effective coupling between overhead alternating current power and communication lines in the vicinity of each other, which comprises positioning a metallic conductor along the communication line and underground, and inductively interconnecting said metallic conductor with the neutral conductor of said alternating current power line.

18. Means for reducing interaction between parallel sections of an electric power line with a source of electric current therefor and a communication circuit in the vicinity of said power line comprising, in combination, a neutral conductor for said power line, a compensating wire throughout its length placed and grounded under said communication circuit, metallic conductor means interconnecting said neutral conductor and said compensating wire, and impedance means connected in series in said neutral conductor.

19. Means for reducing interaction between parallel sections of an electric power line with a source of electric current therefor and a communication circuit in the vicinity thereof comprising, in combination, a neutral conductor for said power line grounded at intervals therealong, and a compensating wire throughout its length placed and grounded under said communication circuit.

20. Method of reducing interaction between an alternating current power circuit energized from a source one terminal of which is grounded and a communication circuit in the vicinity of the power circuit, there being metallic conductors individual to and in the vicinity of said circuits, which comprises interconnecting the metallic conductors through impedance means, connecting the impedance means to the grounded terminal of the source, and varying the connection to said impedance means until the interaction between the circuits is reduced to a minimum.

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