

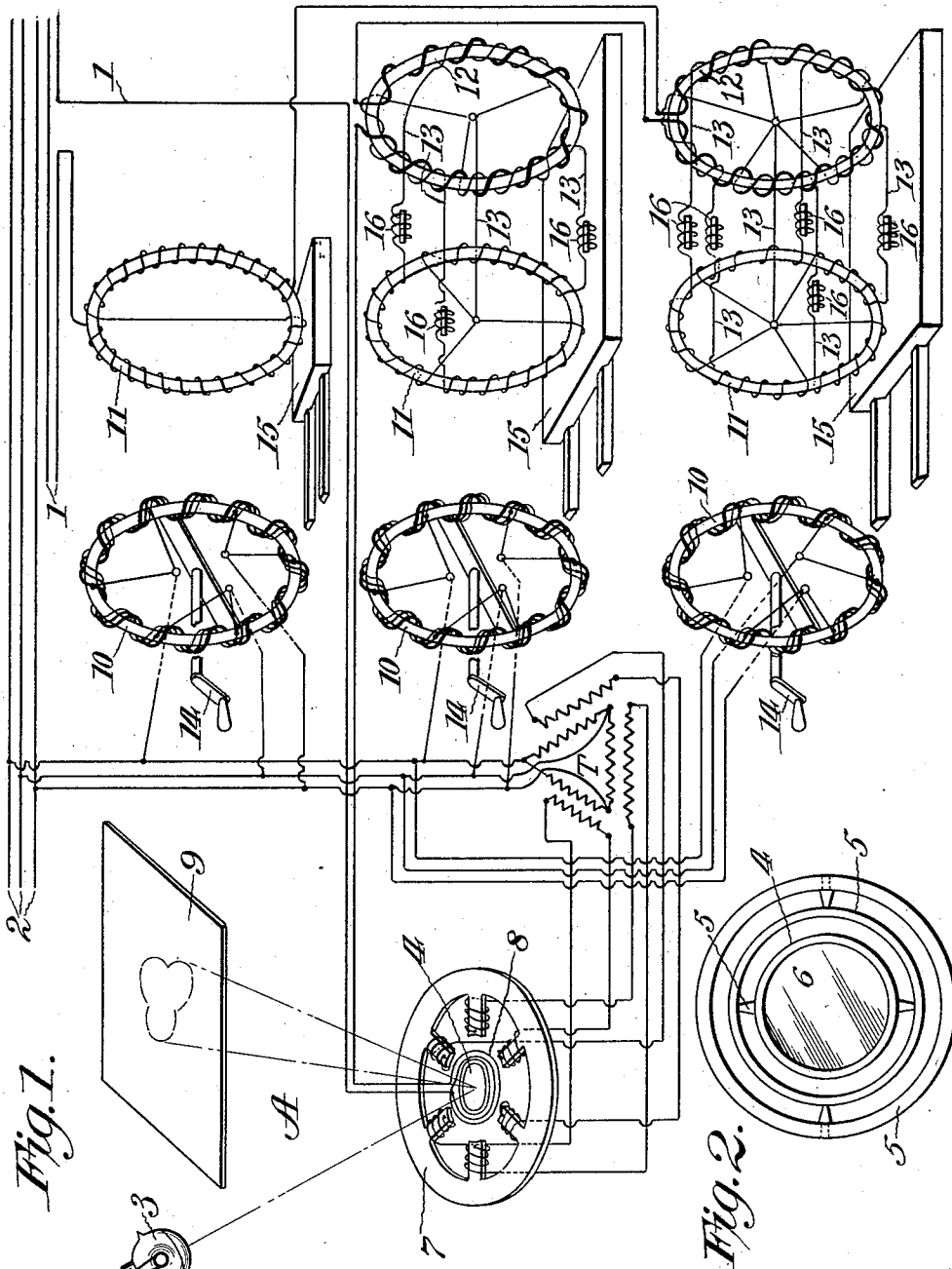
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APPARATUS FOR CORRECTING DISTURBANCES ON TELEPHONE AND OTHER LIKE WIRES.

APPLICATION FILED MAR. 3, 1914. RENEWED SEPT. 10, 1914.

1,114,409.

Patented Oct. 20, 1914.



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# UNITED STATES PATENT OFFICE.

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APPARATUS FOR CORRECTING DISTURBANCES ON TELEPHONE AND OTHER LIKE WIRES.

1,114,409.

Specification of Letters Patent.

Patented Oct. 20, 1914.

Continuation of application Serial No. 729,385, filed November 4, 1912. This application filed March 3, 1914, Serial No. 822,129. Renewed September 10, 1914. Serial No. 861,136.

*To all whom it may concern:*

Be it known that I, JAMES BUCKNER SPEED, of the city, county, and State of New York, have invented certain new and useful  
5 Improvements in Apparatus for Correcting Disturbances on Telephones and other like Wires, of which the following is a specification.

Except as to certain details of circuit arrangement in the transformers 11—12, including the impedance coils 16, this application is a continuation of my application 729,385 filed Nov. 4, 1912, and is substituted therefor.

15 My invention relates to the art of correcting disturbances on telephone and other like wires, occasioned by the proximity of electric power circuits.

My invention consists in an apparatus for  
20 this purpose, the controlling characteristic of which is that it embodies means for separately neutralizing the fundamental frequency, and harmonics, of the disturbing current, a particular embodiment of said  
25 apparatus being hereinafter described wherein, in connection with said neutralizing means, there is also employed means for producing an observable manifestation of the disturbance on the telephone line, for the  
30 purpose of facilitating the work of correction.

These means are susceptible of many refinements; for example, with regard to the production of the observable manifestation  
35 of the disturbance to be corrected, it is best that such manifestation be in the form of a visible diagram and further that said diagram be made by a beam of light projected upon a screen and caused to traverse and re-traverse a closed path synchronous with the  
40 fundamental frequency of the disturbance, and in the present case, I have illustrated these features by one form of device, though I wish it to be understood that I do not confine  
45 myself to this form, as this may be varied without altering its functions and result. Similarly with regard to the means for regulating and adjusting the second or neutralizing disturbance, I have shown one  
50 form and arrangement, but I do not confine

myself thereto, as it may be varied in many particulars to suit good practice, and still be within the meaning of my invention.

Referring to the accompanying drawings:—Figure 1 is a general view, more or  
55 less diagrammatic, of my apparatus. Fig. 2 is a plan view, enlarged, of the reflecting disk.

1 is a telephone or telegraph line in which, by reason of the proximity of an electric  
60 power line 2, disturbances or trouble occur.

A indicates, as a whole, an oscilloscope by which the disturbances in the line 1 are made visually manifest. Though this manifestation may be of any suitable observable  
65 character, I recommend in practice a form of oscilloscope which will give a closed curve or polar type of diagram, in which one revolution or 360 degrees of the diagram occupies the period of one cycle of the fundamen-  
70 tal of the disturbance. It is, further, best that the visual representation of the disturbance shall be stationary in azimuth, as this is desirable for the correction of disturbances resulting from more than one  
75 source of power not operated in parallel with the others. The oscilloscope A comprises a source of light 3, say, a small electric bulb. A minute iron disk 4 is pivoted in  
80 gimbals 5, so as to be free to turn in any direction, except in azimuth, said disk carrying a small concave mirror or a reflecting surface 6. This disk is held in the plane of its gimbals rings by a magnetic field produced by the six pole field magnet 7, the  
85 axis of said magnetic field being in the plane of the disk, and said magnetic field rotates synchronously with the fundamental of the disturbance, by reason of being energized by three 3-phase circuits, as shown.  
90

A coil of wire 8 is arranged with its axis perpendicular to the plane of rotation of the magnetic field, and this coil of wire is connected in any suitable manner, as, for example, looped in, with the line wire 1, as  
95 shown, or a repeating coil may be used in the usual manner, so that said coil is energized by the currents in said line wire. The coil of wire 8 is so disposed with reference to the iron disk 4 and the field magnet 7  
100

that its effect is to displace the plane of the iron disk angularly with respect to the plane of the rotating magnetic field which the field magnet 7 produces.

As will be seen the field magnet 7 is electrically connected with the power wire 2 through the transformer at T, that is to say it is energized from the same power system which is the cause of the disturbance on the line wire 1. It will now readily be understood that because said field magnet 7 is energized from the power wire 2, it follows that the movements of the iron disk 4 and its mirror 6 will always occur at the same position in the circular path of the spot of light, and, therefore, the same diagram will be repeated as many times a second as the frequency of the fundamental of the power circuit, and consequently the disturbance. In order to observe this diagram, the beam of light from the bulb 3 is reflected by the mirror 6 to a ground glass screen 9, and on this screen the spot of light will only re-traverse that portion of its path which is produced by the same source of disturbance as is operating the rotating field. As this is the case, it follows that the vibrations introduced by the telephone conversation, or, in case of a telegraph wire, by the application of the line battery by the operator's key, while interrupting or adding other vibrations to the disturbance vibrations, will be practically invisible on the screen 9, since they are not repeated over and over again as are those displacements produced by the disturbing current, which, as before stated, is operating the field magnet 7. Thus by means of an oscilloscope, an observable manifestation of all the electrical disturbance on the line is produced whether caused by electromagnetic or electrostatic or leakage or atmospheric conduction, said manifestation being a visual one and its diagram being a closed curve as its best type.

The means for the production of another or second disturbance on the telephone line and for regulating and adjusting the second disturbance in the light of the visible diagram above mentioned, in such manner, that it will effect the desired alterations in the diagram of the disturbance which it is wished to correct, are as follows, in so far as here illustrated, it being understood as I have before stated that said means represent one form of device which in the present case and for the purposes hereof are electrically typical rather than mechanically specified.

10 are field magnets. There is a plurality of these field magnets and though almost mechanically stationary in the sense that they do not continuously rotate, they, by the use of 3-phase currents, produce rotating magnetic fields, and these field magnets are made so as to be manually shiftable around

their axis of symmetry through a rotational angle less than 360 degrees. Corresponding to each of these field magnets are armatures 11 wound for single, three, five, seven, etc., phase circuits, only the single, three phase, and five phase armatures being shown, and these armatures are so arranged that they may be slid or pulled away in the direction of the axis of the field, so as to change the intensity of the polyphase currents developed in them by the said field.

12 indicates a plurality of small transformers. There are as many of these as there are pairs of fields 10 and armatures 11, except that the field magnet 10 and armature 11 which are arranged for the production of fundamental frequency, do not require a transformer 12. The leads 13 from the armatures 11 are carried to these transformers through the choking coils 16 as shown, so that the fundamental frequency of the various members of each polyphase set neutralize each other and nothing is left in the secondary of the transformers except the electromotive force or current which is the same multiple of the fundamental as the number of phases brought into the transformer; for example, from that armature which is wound with three coils for three-phase current, nothing will come out of the transformer into which these armature leads are taken except triple frequency.

I have stated that the field magnets 10 are shiftable around their axis of symmetry, and also that their armatures are movable parallel to themselves in the direction of the said axis. It now follows that by reason of the plurality of fields, it is possible to produce any of the said multiples of the frequency or the fundamental of the power which is operating said fields, and further that by reason of the mechanical rotative shiftable of said field magnet, each of such frequencies may be varied independently as to phase, and finally, that by reason of the adjustability of the armatures in the direction of the axis of symmetry, each of said currents may be varied independently as to intensity.

In the present illustration, the means for effecting these variations comprise a crank handle 14 by which the field magnets 10 are rotatively shifted, and sliding bases 15 on which the armatures move to and from the fields. One of these groups of field magnets and armatures, here shown as the uppermost, is connected up in that part of the complex generating set which is intended to give the variation of phase and intensity of the fundamental of the correction current to be produced. Thus this group puts in the control of the operator the means of varying the phase and intensity of the fundamental component of the complex correction wave or current to be produced. The

other successive groups of field magnets, armatures and transformers of which there may be any required number, vary the phase and intensity of the different multiples of the fundamental.

It will now be seen that means are provided by the operation of which a second disturbance may be created on the line and said second disturbance may be manipulated and so controlled and adjusted as to attain a complexity and character adapting it to neutralize the first disturbance. This adjustment is effected by the operator through her deliberate selection and manipulation of the several adjusting devices of the groups of field magnets 10 and armatures 11 to the end that in producing the complex correction current, she shall so manufacture it that, as will be indicated by its effect upon the visual diagram of the disturbance to be corrected, it is equal to and opposite at every instant to said disturbance, thereby neutralizing it.

The operation of the apparatus as a whole will be better understood by a brief recital of the manner of practically carrying out said operation in a telephone exchange. In any telephone exchange of moderate size there will be found a chief operator's desk and a trouble clerk's desk, etc., in addition to the numerous panels of the large switchboard which are attended on by the operators. I propose to put in another desk, similar in general appearance to the chief operator's desk, to be called the "correction desk," with a girl operator in charge. This desk may keep a hundred lines or more corrected. Its operation is similar to the chief operator's desk, in that the main switchboard girls or operators may all speak to the correction desk and plug any one of their noisy lines in connection with the correction desk. The correction operator on receiving a disturbed line from the main switchboard operator will plug it into a hole of her board, which communicates with one of the correction units, of which there are about a hundred in her desk. This correction unit contains, in some form, all of the apparatus heretofore described, or its equivalents—that is, the oscilloscope and the complex frequency generating groups or sets. As soon as she has plugged the line to the correction unit, there will appear on the ground-glass screen 9, a clover-leaf shaped figure, that is, one having three principal lobes and cusps, because usually the principal disturbance on telephone lines is of triple the frequency of the fundamental of the power lines. If instead of a clover-leaf figure a heart-shaped figure, with one cusp, is seen, this will indicate that the trouble is principally of the fundamental frequency. As a matter of fact, neither of these two figures in its simplest form would ever oc-

cur, the outline of the figure being decidedly wavy. Suppose, however, the figure contains one principal dent, indicating the presence of some of the fundamnetal in the disturbance. Thereupon the operator reaches for that group of field magnets 10 and armatures 11 which concerns the production of the fundamental of the correction current, and by moving the field rotatively by the crank handle 10, she will cause the region of the principal dent in the diagram to be shifted around angularly or in azimuth, while by moving the sliding armature she will change the magnitude of the dent in the diagram as measured radially from its geometrical center. This manipulation will result in the obliteration of any clearly distinguishable onesidedness in the diagram. What remains in the diagram will then be very much more noticeably three-sided or clover-leaf like. She now selects another group of the complex correction current set and by operating either the field or the armature, (it makes no difference on which she begins) she will either shift rotationally the three-sided cusps of the oscilloscope figure, or else she will change the magnitude of the three-sided part, as measured radially from the center. Between the two shiftings she then obliterates the three-parted irregularity in her diagram. Frequently, this will be quite enough to bring the diagram of the oscilloscope to indicate practical silence, but in cases where the circuit is of more importance and greater silence is required, it may be desirable to correct in a similar manner the higher harmonics, a result attained by operating other groups of the correction current sent.

I claim:—

1. An apparatus for the described purpose comprising means operated by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, for producing an observable manifestation which is indicative of the disturbance on said telephone line; means for producing a second disturbance on said telephone line, synthetically out of a plurality of alternating currents whose frequencies are respectively equal to the fundamental of the disturbance and its harmonics; and means for regulating and adjusting said alternating currents in their phases and intensities, to effect such alterations in said observable manifestation as will indicate a condition on the telephone line free from disturbance.

2. An apparatus for the described purpose comprising means operated by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, for producing a visible diagram which is indicative of the disturbance

on said telephone line; means for producing a second disturbance on said telephone line, synthetically out of a plurality of alternating currents whose frequencies are respectively equal to the fundamental of the disturbance and its harmonics; and means for regulating and adjusting said alternating currents in their phases and intensities, to effect such alteration in said visible diagram as will indicate a condition on the telephone line free from disturbance.

3. An apparatus for the described purpose comprising means operated by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, for projecting a beam of light upon a screen and causing it to traverse a path thereon and so produce a visible diagram indicative of the disturbance on said telephone line; means for producing a second disturbance on said telephone line; and means for regulating and adjusting said second disturbance to effect such alteration in the visible diagram as will indicate a condition on the telephone line free from disturbance.

4. An apparatus for the described purpose comprising means operated by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, for projecting a beam of light upon a screen and causing it to traverse a path thereon and so produce a visible diagram indicative of the disturbance on said telephone line; means for producing a second disturbance on said telephone line; and means capable of selective and several operation for regulating and adjusting said second disturbance to effect such alteration in the visible diagram as will indicate a condition on the telephone line free from disturbance.

5. An apparatus for the described purpose comprising means operated by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, for projecting a beam of light upon a screen and causing it to traverse and retrace a closed path synchronous with the fundamental frequency of the disturbance on said telephone line whereby a visible diagram is produced indicative of said disturbance but not of the sound producing currents on said telephone line; means for producing a second disturbance on said telephone line; and means for regulating and adjusting said second disturbance to effect such alteration in the visible diagram as will indicate a condition on the telephone line free from disturbance.

6. An apparatus for the described purpose comprising means operated by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, for projecting a beam

of light upon a screen and causing it to traverse and retrace a closed path synchronous with the fundamental frequency of the disturbance on said telephone line whereby a visible diagram is produced indicative of said disturbance but not of the sound producing currents on said telephone line; means for producing a second disturbance on said telephone line; and means capable of selective and several operation for regulating and adjusting said second disturbance to effect such alteration in the visible diagram as will indicate a condition on the telephone line free from disturbance.

7. An apparatus for the described purpose comprising a source of light; a movable reflector for projecting a beam of said light; a screen upon which said beam is projected; means affected by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, to operate the reflector to cause the projected beam to traverse a visible path on the screen, which path is consequently indicative of the disturbance on said telephone line; means for producing a second disturbance on said telephone line; and means for regulating and adjusting said second disturbance to effect such alteration in the visible path of the beam on the screen as will indicate a condition on the telephone line free from disturbance.

8. An apparatus for the described purpose comprising a source of light; a movable reflector for projecting a beam of said light; a screen upon which said beam is projected; means affected by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, to operate the reflector to cause the projected beam to traverse a visible path on the screen, which path is consequently indicative of the disturbance on said telephone line; means for producing a second disturbance on said telephone line; and means capable of selective and several operation for regulating and adjusting said second disturbance to effect such alteration in the visible path of the beam on the screen as will indicate a condition on the telephone line free from disturbance.

9. An apparatus for the described purpose comprising a source of light; a movable reflector for projecting a beam of said light; a screen upon which said beam is projected; means affected by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, to operate the reflector to cause the projected beam to traverse and retrace a closed path on the screen synchronous with the fundamental frequency of the disturbance on said telephone line, which path is consequently indicative of the said disturbance but not of the sound producing currents on

said telephone line; means for producing a second disturbance on said telephone line; and means for regulating and adjusting said second disturbance to effect such alteration in the visible path of the beam on the screen as will indicate a condition on the telephone line free from disturbance.

10. An apparatus for the described purpose comprising a source of light; a movable reflector for projecting a beam of said light; a screen upon which said beam is projected; means affected by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, to operate the reflector to cause the projected beam to traverse and retrace a closed path on the screen synchronous with the fundamental frequency of the disturbance on said telephone line, which path is consequently indicative of the said disturbance but not of the sound producing currents on said telephone line; means for producing a second disturbance on said telephone line; and means capable of selective and several operation for regulating and adjusting said second disturbance to effect such alteration in the visible path of the beam on the screen as will indicate a condition on the telephone line free from disturbance.

11. An apparatus for the described purpose comprising means operated by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, for producing a visible diagram indicative of the disturbance on said telephone line; means for producing a second disturbance on said telephone line; and means for regulating and adjusting the phase and intensity of said second disturbance to effect such alteration in the visible diagram as will indicate a condition on the telephone line free from disturbance, said regulating and adjusting means comprising field magnets rotatively shiftable around their axis of symmetry, armatures movable toward and from said magnets, transformers, and suitable circuit connections.

12. An apparatus for the described purpose comprising means operated by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, for producing a visible diagram indicative of the disturbance of said telephone line; means for producing a second disturbance on said telephone line; and means for regulating and adjusting the phase and intensity of said second disturbance to effect such alteration in the visible diagram as will indicate a condition on the telephone line free from disturbance, said regulating and adjusting means comprising selectively and severally operatable groups of field magnets rotatively shiftable around their axis of symmetry, armatures movable

toward and from said magnets, transformers, and suitable circuit connections.

13. An apparatus for the described purpose comprising means operated by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, for producing a visible diagram indicative of the disturbance on said telephone line; means for producing a second disturbance on said telephone line; and means for regulating and adjusting the phase and intensity of said second disturbance to effect such alteration in the visible diagram as will indicate a condition on the telephone line free from disturbance, said regulating and adjusting means comprising independent groups of field magnets and armatures, the magnets being rotatively shiftable around their axis of symmetry and the armatures being movable to and from the magnets, the armature of one group being wound for a single phase circuit, another for three 3-phase circuits, another for five 5-phase circuits, and so on, a transformer in electrical connection with the armature of each group other than that for the single phase circuit, and suitable circuit connections for said groups.

14. An apparatus for the described purpose, comprising a source of light; a movable reflector for projecting a beam of said light; a screen upon which said beam is projected; means affected by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, to operate the reflector to cause the projected beam to traverse and retrace a closed path on the screen synchronous with the fundamental frequency of the disturbance on said telephone line which path is consequently indicative of the said disturbance but not of the sound producing currents on said telephone line; means for producing a second disturbance on said telephone line; and means for regulating and adjusting the phase and intensity of said second disturbance to effect such alteration in the visible diagram as will indicate a condition on the telephone line free from disturbance, said regulating and adjusting means comprising independent groups of field magnets and armatures, the magnets being rotatively shiftable around their axis of symmetry and the armatures being movable to and from the magnets, the armature of one group being wound for a single phase circuit, another for three 3-phase circuits, another for five 5-phase circuits, and so on, a transformer in electrical connection with the armature of each group other than that for the single phase circuit, and suitable circuit connections for said groups.

15. An apparatus for the described purpose comprising means operated by the cur-



rent in the power line, the proximity of which is the cause of the disturbance on the telephone line, for producing a visible diagram indicative of the disturbance on said telephone line; means for producing a second disturbance on said telephone line; and means for regulating and adjusting the phase and intensity of said second disturbance to effect such alteration in the visible diagram as will indicate a condition on the telephone line free from disturbance, said regulating and adjusting means comprising independent groups of field magnets and armatures, the magnets being rotatively shiftable around their axis of symmetry and the armatures being movable to and from the magnets, the armature of one group being wound for a single phase circuit, another for three 3-phase circuits, another for five 5-phase circuits, and so on, a transformer in electrical connection with the armature of each group other than that for the single phase circuit, and suitable circuit connections for said groups, each of said transformers being characterized by its primary being of as many circuits as the phases of the armature to which it is connected so that the resultant magnetic flux in its iron core is of as many times the fundamental periodicity as the number of phases for which its primary is wound, and a single secondary circuit in which is developed the said multiple of the fundamental frequency.

16. An apparatus for the described purpose, comprising a source of light; a movable reflector for projecting a beam of said light; a screen upon which said beam is projected; means affected by the current in the power line, the proximity of which is the cause of the disturbance on the telephone line, to operate the reflector to cause the projected beam to traverse and retrace a closed path on the screen synchronous with the fundamental frequency of the disturbance on said telephone line which path is consequently indicative of the said disturbance but not of the sound producing currents on said telephone line; means for producing a second disturbance on said telephone line; and means for regulating and adjusting the phase and intensity of said second disturbance to effect such alteration in the visible diagram as will indicate a condition on the telephone line free from disturbance, said regulating and adjusting means comprising independent groups of field magnets and armatures, the magnets being rotatively shiftable around their axis of symmetry and the armatures being movable to and from the magnets, the armature of one group being wound for a single phase circuit, another for three 3-phase circuits, another for five 5-phase circuits, and so on, a transformer in electrical connection with the

armature of each group other than that for the single phase circuit, and suitable circuit connections for said groups, each of said transformers being characterized by its primary being of as many circuits as the phases of the armature to which it is connected so that the resultant magnetic flux in its iron core is of as many times the fundamental periodicity as the number of phases for which its primary is wound, and a single secondary circuit in which is developed the said multiple of the fundamental frequency.

17. An apparatus for the described purpose comprising means for producing a plurality of alternating electromotive forces of the frequencies of the fundamental and the harmonics of the disturbance note of the disturbance current in a telephone line exposed to an alternating power circuit influence; means for regulating and adjusting said alternating electromotive forces individually in both phase and intensity; and means for superimposing said electromotive forces on the disturbed telephone line and performing said regulation and adjustment under the guidance of an observable manifestation of the condition of disturbance on the said telephone line to the end that the disturbance is nullified.

18. An apparatus for eliminating an undesirable periodic harmonic alternating current element existing in an electric current carrying wire, which consists in means for producing an observable manifestation of the alternating current in said wire; means for producing the fundamental and several harmonics of the undesirable periodic harmonic alternating current; and means for regulating and adjusting said fundamental in intensity and phase with respect to said undesirable current, and similar means for each of the harmonics of said current, so that a part by part alteration of the observable manifestation of the current in the said wire may be made, to the end that said undesirable current element may be eliminated.

19. An apparatus for correcting alternating current disturbances on telephone and other like wires comprising means for producing a second disturbance on said telephone line synthetically out of a plurality of alternating currents whose several frequencies are respectively equal to the fundamental frequency and harmonics of the disturbing current, and means for separately regulating and adjusting said alternating currents in their phases and intensities, whereby the fundamental frequency and harmonics of the disturbing current are separately neutralized.

20. An apparatus for eliminating an undesirable periodic harmonic alternating current element existing in an electric current carrying wire which consists in means for

producing the several harmonics of the undesirable periodic harmonic alternating current, and means for separately regulating and adjusting each of the harmonics of the said current, so that a part by part alteration of the current in the said wire may be made to the end that the said undesirable current element may be eliminated.

In testimony whereof I affix my signature in presence of two witnesses.

JAMES BUCKNER SPEED.

Witnesses:

MARCELLUS BAILEY,  
H. B. MARSTON.

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