

May 31, 1927.

M. LATOUR

1,630,346

AMPLIFIER FOR ELECTRICALLY DISTURBED TELEPHONE LINES

Filed Aug. 29, 1921

3 Sheets-Sheet 1

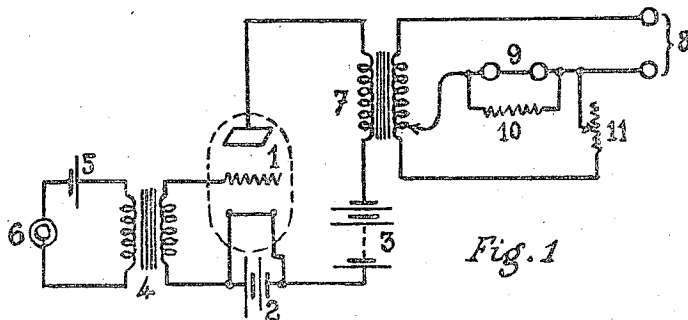


Fig. 1

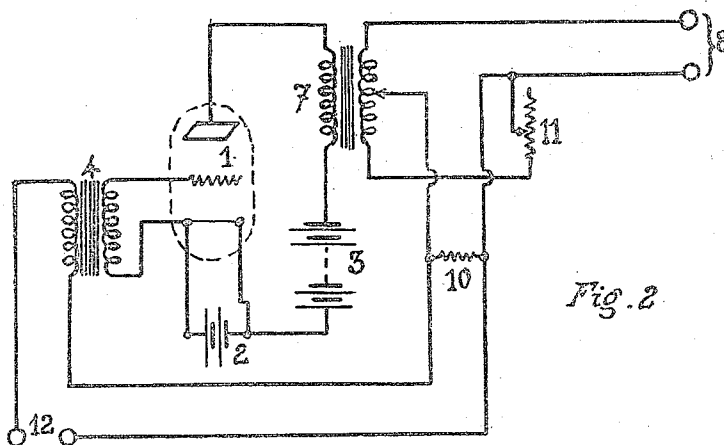


Fig. 2

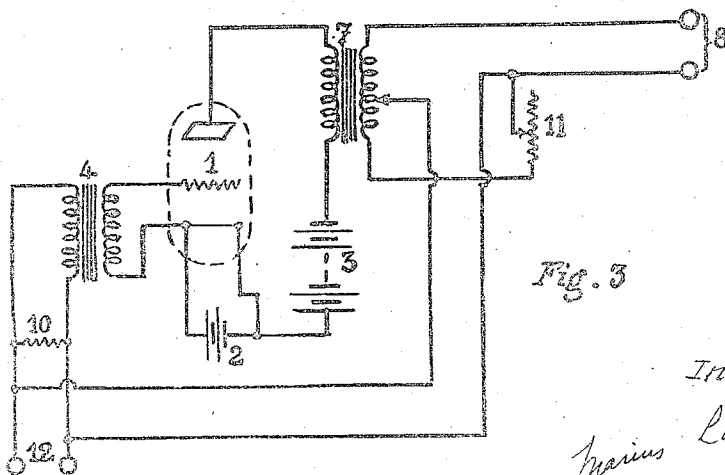


Fig. 3

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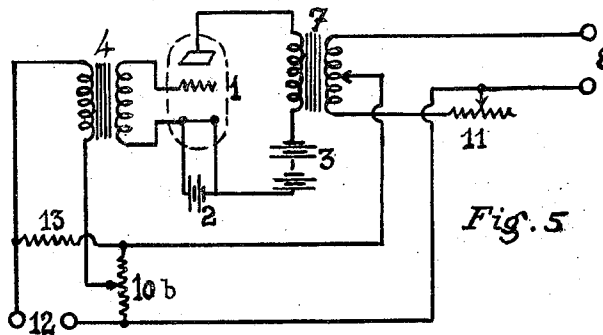
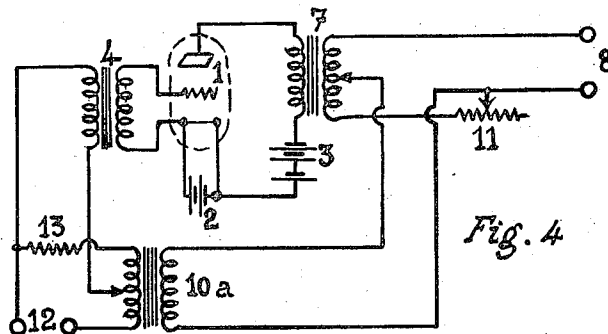
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3 Sheets-Sheet 3

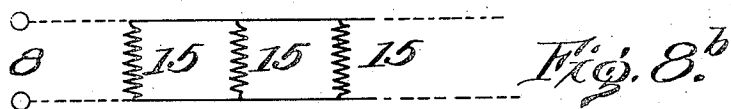
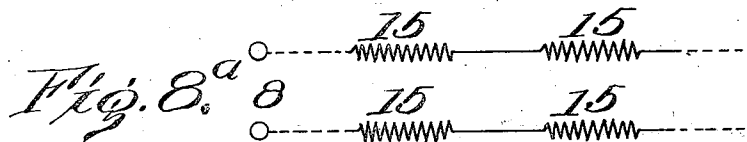
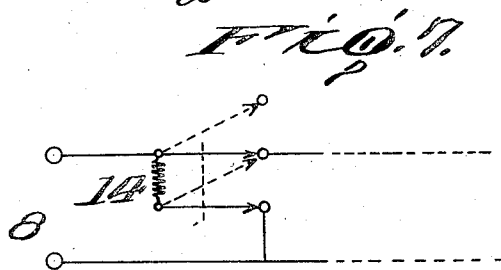
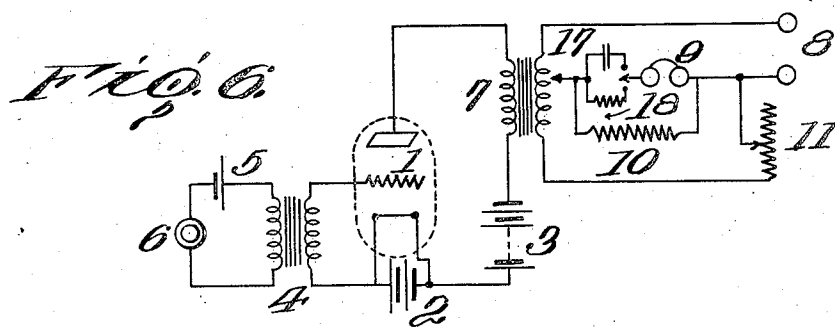


FIG. 9.

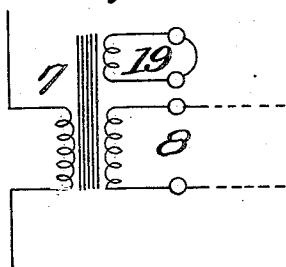
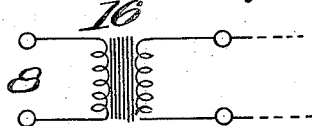


FIG. 10.



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Patented May 31, 1927.

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UNITED STATES PATENT OFFICE.

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AMPLIFIER FOR ELECTRICALLY-DISTURBED TELEPHONE LINES.

Application filed August 29, 1921, Serial No. 496,649, and in France June 25, 1915.

(GRANTED UNDER THE PROVISIONS OF THE ACT OF MARCH 3, 1921, 41 STAT. L., 1313.)

The present invention relates to improvements in telephone systems, and in particular telephone lines suffering from disturbances consequent upon the induction therein of parasitic currents as in highly attenuated lines. It is more particularly described with reference to the accompanying diagrammatic drawings, Figs. 1 to 10, inclusive.

Figure 1 illustrates the invention as applied directly to the terminals of an interurban line;

Figs. 2, 3, 4, 5 and 6 illustrate various modes of applying the invention to a two-wire interurban line having a two-wire subscriber's line connected to its extremity;

Figs. 7, 8^a, 8^b, 9 and 10 illustrate various means of adapting the interurban line to efficient working with the main part of the invention.

Several types of amplifiers have been devised with a view to compensating for the attenuation of the speech signals during their propagation along the line. These repeaters, as they are commonly called, are introduced in the telephone line, usually midway between the terminal stations, and are so arranged as to permit of amplifying the speech signals emanating from either end of the line; hence the name "two-way two-repeater" by which they are designated. They all suffer from the same defect that, inasmuch as they are situated at a point of the line where the speech signals have already undergone attenuation, they amplify not only the signal currents, but also the parasitic currents which prevail in the telephone line.

The present invention aims at overcoming this by providing a super-amplification of the speech signals previous to their departure from the terminal stations, such that the intensity of the amplified speech will be sufficient to eclipse the parasitic noises in the receivers at the distant station.

Fig. 1 illustrates a means of amplifying the microphonic current by a thermionic tube amplifier 1, the filament of which is brought to incandescence by the supply 2, the anode circuit being energized by the supply 3. The grid-filament circuit is influenced by the secondary winding of an input transformer 4 the primary winding of which is included in a circuit comprising a cell 5 and a microphone 6. The secondary winding of

the output transformer 7 feeds the telephone line at terminals 8 as well as the artificial line 11 which is connected in series with the real line.

The receiver 9, which is shunted by an impedance 10, is connected between the junction point of the real and artificial lines on one side and a point intermediate the extremities of the secondary winding of the output transformer on the other side. The object of the latter arrangement is to avoid the so-called howling or Larsen effect caused by the reaction of the receiver 9 upon the microphone 6.

As far as the amplified microphone current is concerned, the receiver 9 may thus be connected to equipotential points. In this manner the amplified current does not affect the receiver 9 which would be apt to react on the microphone 6 and thereby set up howling.

The artificial line 11 is variable as well as the tapping point on the secondary winding of the output transformer 7.

The object of the receiver shunting resistance 10 is to restore the audibility of the amplified speech of the corresponding party to a normal value and, at the same time, attenuate the effects of the disturbances induced in the line.

Instead of shunting the receiver 9 only, either another resistance 18 or a capacity 17 may be inserted in series with the receiver 9, and the shunting impedance 10 may or may not be made to shunt the receiver-resistance or receiver-capacity system thus formed. This is shown in Fig. 6.

With the same object in view, it is possible to use a receiver which is not suited to the circuit by having a too high or too low impedance.

Another method consists in the systematic use of a high resistance telephone line that could be made up, for example, of small copper wire or of a more electrically resistive conductor, such as iron, so as to reduce the value of the induced disturbances. The use of transmitting amplifiers at the ends of the line will always insure telephone currents, properly speaking, of a sufficient value.

As illustrated in Fig. 7, an appropriate impedance 14 can be put in series or in shunt with the real line so as to dampen the currents circulating therein. The increase of

the line impedance can also be realized artificially by inserting concentrated impedances 15 at different points along the line as shown in Fig. 8^a. Instead of inserting series impedances as shown in Fig. 8^a it is possible to connect shunt impedances as shown in Fig. 8^b and thereby cause leakages.

In any case, the object remains the same, i. e. to so arranged the elements of the system as to cause all induced currents irrespective of their nature, even those arising from neighboring telephone lines using amplifiers, to reach the two extreme stations under very attenuated intensity. The object being attained, terminal transmitting amplifiers are then used to allow of telephonic communication being carried on over the inefficient telephone line thus realized.

The invention has so far been described in combination with a circuit arrangement suitable to eliminate the so-called howling or Larsen effect. Failing the adoption of this particular arrangement, however, the receiver 9 can be branched in shunt to the transformer 7 or, as shown in Fig. 9, it can be actuated by a special winding 19 of the output transformer having a sufficiently small number of turns to prevent the induced currents from disturbing the reception of speech.

Instead of being fed directly, the telephone line 8 can be fed through a so-called combination transformer 16 as shown in Fig. 10 and having a ratio such that the induced disturbing currents are very attenuated in the receiver circuit.

The subscriber can be connected with the terminal amplifying station by two wires only, instead of by four wires, as would be required with the arrangement illustrated in Fig. 1. Figs. 2 and 3 illustrate two practical methods of realizing this. The reference numbers in the latter figures are used to designate the same organs as in Fig. 1.

In Figs. 2 and 3, the thermionic tube amplifier 1 is energized by the batteries 2 and 3. The amplifier further includes an input transformer 4 and an output transformer 7. The interurban telephone line is connected to the terminals 8 and a variable artificial line is connected at 11. The subscriber's line is connected at 12.

Fig. 2 illustrates the series arrangement which may include an impedance 10 whose function is to shunt the received current just as in Fig. 1.

Fig. 3 illustrates the shunt arrangement and is shown to include the shunting impedance 10.

Instead of obtaining a balance by means of the artificial line 11 only, that is, by balancing the output circuit only, an additional balance may be also obtained by adjusting the input circuit. Figs. 4 and 5 illustrate two methods of realizing this. The ref-

erence figures therein have the same meaning as in the preceding figures.

In the case of Fig. 4, the interurban telephone line is connected with the subscriber's line through a transformer 10^a, the primary of which is connected between two equipotential points from the amplified current point of view. In series with the subscriber's line there is a balancing impedance 13 adjusted to a value equal to that of the subscriber's line. The primary of the input transformer 4 is then connected between two equipotential points from the point of view of telephone currents received from the interurban line and sent on to the subscriber via transformer 10^a.

In practice, it is possible to use either an autotransformer or an impedance with a middle-point in place and stead of transformer 10^a as shown in Fig. 5.

Fig. 5 represents the more usual way of using the invention and includes a simple resistance 10^b. This resistance also contributes to attenuate the parasitic currents inasmuch as it decreases the audibility.

It is to be remarked that, in the case of Fig. 4 as well as in that of Fig. 5 by adding the balancing effects of the two artificial lines 11 and 13, it is possible to more closely approach the condition of minimum value of the amplified current apt to traverse the primary of the transformer 4.

It is not intended to restrict the degree of amplification to a single thermionic tube as shown in the accompanying figures merely by way of example, but any number of such tubes may be used to obtain the speech amplitude required to produce a normal audibility at the far end of the line.

According to the invention, the amplifying systems are placed at the extremities of the interurban line. In the case of a telephone system which undergoes disturbing effects over only a portion of its circuit, however, the amplifying systems would then be placed at the input and output ends of the disturbed portion of the system.

What I claim is:—

1. In combination, a telephone line, a thermionic tube transmitting amplifier at each end thereof, and means for reducing the audibility of the parasitic currents and speech in said line.

2. A method of reducing the effect of electrical disturbances on telephone lines characterized by the initial amplification of speech currents simultaneously with a reduction of the received currents.

3. In a long distance telephone communication system, a two-wire interurban line, a two-wire subscriber's line at each end of said interurban line, an outgoing transmitting amplifier interposed between each of said subscriber's lines and the interurban line, an incoming receiving transformer in-

terposed between each of said subscriber's lines and the interurban line in circuits forming a shunt around said outgoing amplifier, means at each extremity including an artificial line to balance the interurban line, and means at each extremity including an artificial line to balance said subscriber's line.

4. In a long distance telephone communication system having a two-wire interurban line, a two-wire subscriber's line at each extremity of said interurban line, an outgoing transmitting amplifier between the interurban line and each of said subscriber's lines, an incoming receiving circuit shunted around each of said amplifiers, and artificial lines at each extremity of said interurban line to balance said interurban and subscriber's lines, the method which comprises employing both of said artificial lines to balance out the effect of the plate circuit of each amplifier upon its grid circuit.

5. The method of reducing the relative effect of induced current to voice current in telephone circuits, which consists in amplifying the voice currents to an abnormal value before they enter the region of induction and reducing them to a normal value and simultaneously reducing the induced currents after they leave the said region to such an extent that the disturbing current becomes inappreciable in magnitude.

6. In combination, a plurality of transmission lines, one being subject to the inductive influence of the other, transmitting and receiving devices associated with the terminals of the said one line, an amplifying device associated with said line substantially between the transmitting device and the region of inductive influence, and an attenuating device associated with said line substantially between the said region and the receiving device, said attenuating device simultaneously attenuating both currents to such an extent that the disturbing current becomes inappreciable.

7. In a telephone transmission line having terminal apparatus associated thereto, the method of reducing the interference in the telephone circuits of said line, which consists in amplifying voice currents flowing from the terminal apparatus to an intermediate point on said line to such an extent that the interference currents encountered are negligibly small as compared with said voice currents, and in attenuating the voice and the interference currents flowing from an intermediate point on said line to

the terminal apparatus to normal value for the voice currents.

8. The method of reducing interference in transmission systems, which consists in amplifying only such energy as flows in a circuit towards the region of disturbance and in simultaneously attenuating all the energy which flows in said circuit in the opposite direction as to the disturbances to such an extent that the interfering energy becomes small.

9. The method of reducing disturbance in a signal transmission system having a source of disturbing energy associated therewith, which consists in amplifying the signaling energy above normal transmission level before the same reaches the source of disturbing energy and subsequently attenuating said signal and disturbing energy to such an extent that said signal energy reaches normal transmission level.

10. The method of reducing interference in transmission systems, which consists in modifying the energy flowing in a medium toward the region of disturbance by a different factor than for the energy flowing in the opposite direction in said medium.

11. The method of reducing interference in transmission systems, which consists in modifying the energy flowing in a medium toward the region of disturbance by a higher factor than for that flowing in the opposite direction in said medium.

12. In a two-way telephone transmission line, the method of reducing interference, which consists in amplifying signal currents flowing from either end to the line above normal transmission level and attenuating said signal currents flowing from the line to either end back to normal transmission level.

13. A telephone transmission line, substations associated therewith at its ends, a repeater between each substation set and the line, said repeaters comprising means to amplify currents flowing to the line and to attenuate currents flowing from the line toward the substations.

14. A telephone transmission line, substations associated therewith at its ends, a repeater between each substation set and the line, one side of said repeater comprising an amplifying element for the current flowing to the line and the other side comprising an attenuating element for current flowing from the line.

In testimony whereof I affix my signature.

MARIUS LATOUR.