Oct. 7, 1930. DE LOSS K. MARTIN 1,777,374

WAVE ANTENNA

Filed Nov. 19, 1925

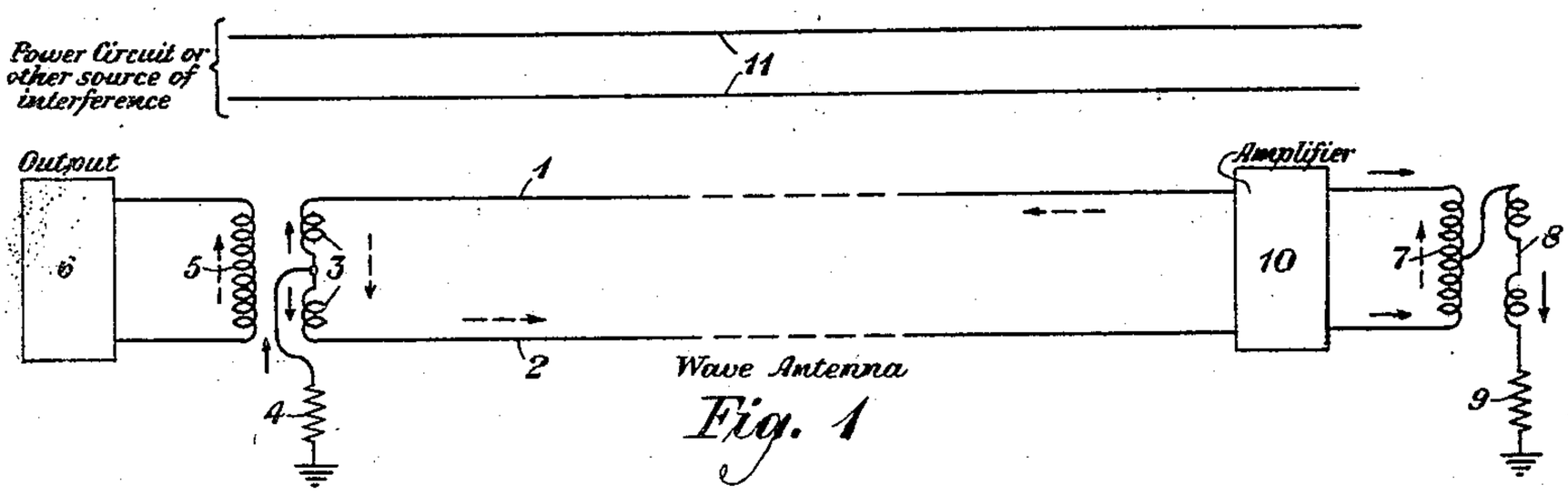


Fig. 1

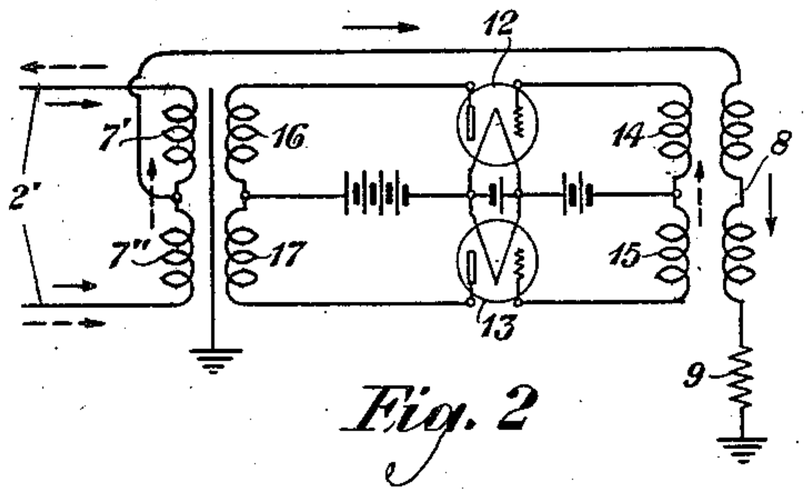


Fig. 2

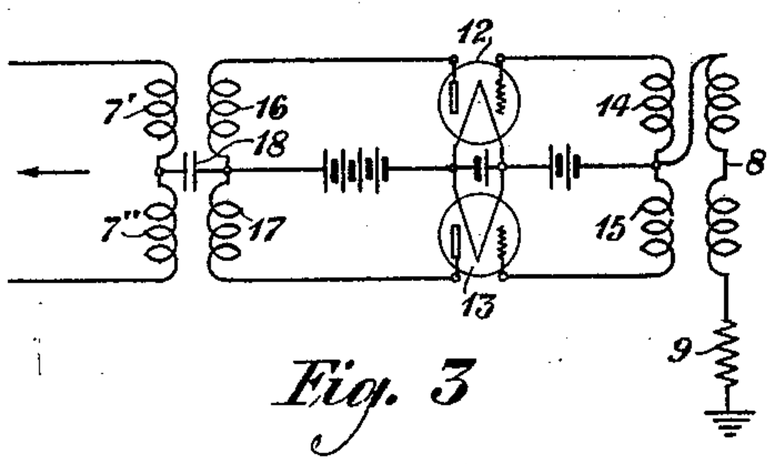


Fig. 3

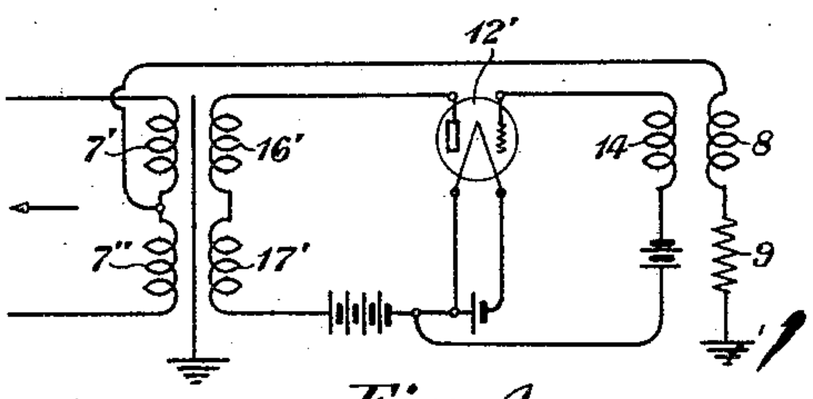


Fig. 4

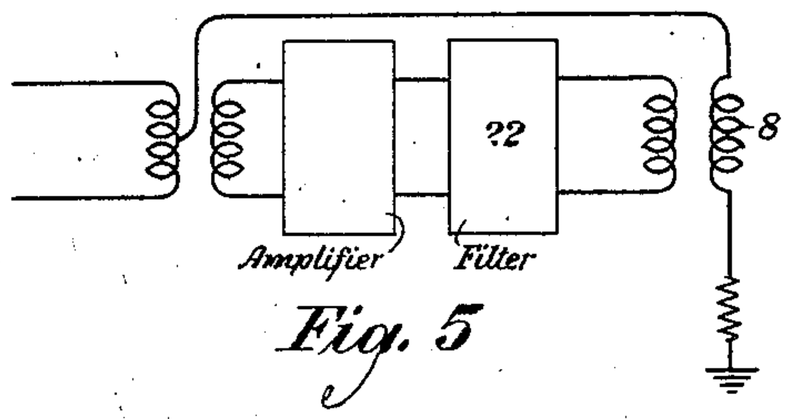


Fig. 5

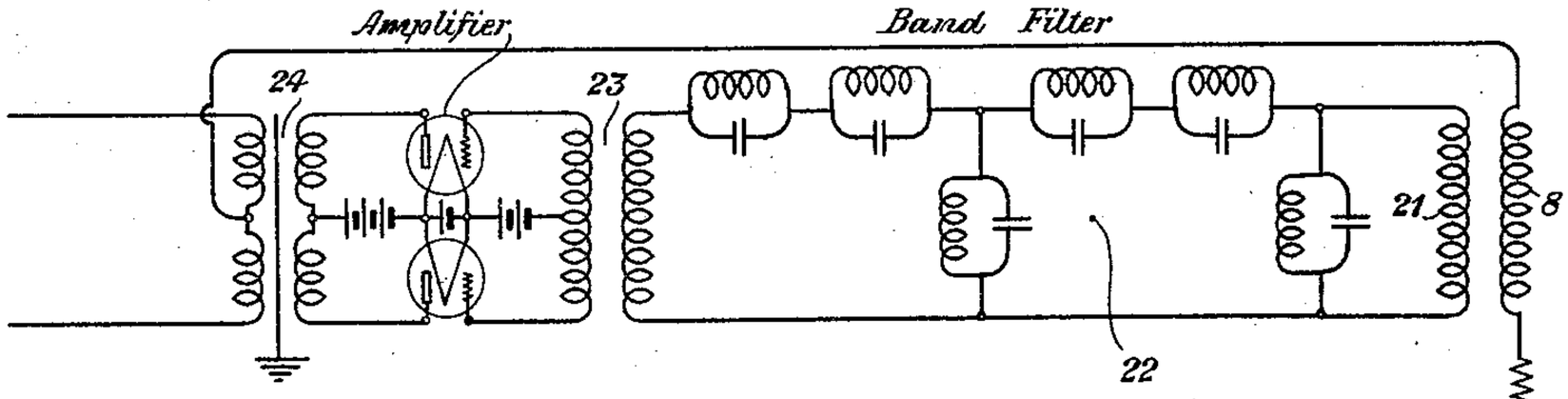


Fig. 6

INVENTOR
DeLoss K. Martin
BY
ATTORNEY

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# UNITED STATES PATENT OFFICE

DE LOSS K. MARTIN, OF WEST ORANGE, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

## WAVE ANTENNA

Application filed November 19, 1925. Serial No. 70,132.

This invention relates to wave antennæ, and particularly to an antenna of that type having an amplifier connected therewith in order to improve the ratio of the signal to the noise at the receiver end of the antenna.

In a wave antenna, such as described in the paper by Beverage, et al., which appears in the transactions of the American Institute of Electrical Engineers, Vol. XLII, pages 215 to 266, two long conductors are terminated at each end by an impedance which is connected between the ground and the midpoint of a winding of a transformer terminating the two wire circuit. The grounding connection at the far end of the antenna, viz., at the end more remote from the receiving circuit, has therein a simplexing transformer. The receiving circuit is connected with the wave antenna by means of a transformer at the near end of the antenna. The received radio waves set up currents in the same direction in each of the wires, which currents flow through the said impedances to their grounded midpoints in opposite directions. The flow of the current through the grounding connection at the distant end of the wave antenna sets up, by virtue of its simplex connection with the impedance coil at that end, a potential which causes a circulation of current around the circuit made up of the two antenna conductors and the transformer windings connecting the said conductors at each end. This circulatory current thus induces a potential in the receiving circuit, and in this manner the signal is received. As is well known, long metallic conductors are exposed to interference from external sources, as, for example, alternating current power and lighting circuits in the vicinity of the conductors. This interference produces interfering currents in the circuit made up of the conductors and their connecting transformer windings, and thus renders more difficult the reception of the signal. This difficulty may be overcome or substantially minimized by raising the level of the signaling current, viz., by improving the ratio between the signal and the noise currents set up by the sources of external interference.

This invention resides in a method and means for improving the signal-to-noise ratio in a wave antenna.

Other objects of this invention will be apparent from the following description when read in connection with the attached drawing of which Figure 1 shows schematically a general form of the invention; Figs. 2, 3 and 4 show detailed modifications by means of which the invention may be carried out; Fig. 5 shows how a filter may be used with a wave antenna to improve the discrimination of the antenna; and Fig. 6 shows in greater detail an embodiment of the idea set forth in Fig. 5.

In Fig. 1, the conductors 1 and 2 of the wave antenna are connected by means of the transformer winding 3 at the near end of the antenna, which coil has its midpoint grounded through a resistance 4. The coil 3 is inductively connected with the winding 5, which in turn is connected with the signal receiving circuit 6. The distant end of the wave antenna has one winding 7 of a simplex transformer connected across the conductors 1 and 2, the said coil having its midpoint grounded through the other winding 8 of the said transformer and the resistance 9. The winding 8 is so coupled with the winding 7 that the currents flowing through the grounding connection will set up in the wave antenna a circulatory current represented by the dotted arrows. An amplifier 10, which may be of the form shown in Figs. 2 to 4, inclusive, or which may have other forms, is connected with the wave antenna in such manner that it will raise the level of this circulatory current, so that it will be appreciably above any interfering current that may be produced in the antenna by a power line, such as 11, or other source of interference thereby improving the signal-to-noise ratio upon the circuit. This circulatory current will therefore be received by the receiving apparatus 6, and the signal will be readily detected.

Fig. 2 shows one way in which the amplifier 10 may be connected with the wave antenna. The form of the amplifier shown in Fig. 2 comprises two vacuum tubes 12 and 13 which are connected in the well known

push-pull circuit. The winding 8 in the grounding connection at the distant end of the antenna is coupled with the input windings 14 and 15 of the amplifier circuit. The windings 16 and 17 of the output side of the amplifier circuit are coupled with the windings 7′ and 7″, which are connected across the conductors 1 and 2 of the wave antenna. The junction point of the windings 7′ and 7″ is connected to ground through the winding 8 and the resistance 9. It will be seen, therefore, that when current is set up in the direction represented by the solid arrows in the conductors 1 and 2, such currents will flow through the windings 7′ and 7″ to the junction thereof, thence through the grounded connection, as shown also by the solid arrows. The flow of current through the winding 8 will set up a potential across the windings 14 and 15, which will be amplified by the tubes 12 and 13, and in that manner an amplified signal current, viz., a circulatory current will be produced in the circuit comprising the conductors 1—2 and the impedance coils 7′ and 7″ at one end and similar coils at the other end thereof, which signal current can be made of such magnitude that the level of the signal to the noise will be so high as to render the signal readily detectable.

In the arrangement shown in Fig. 3, the metallic ground circuit of the wave antenna is terminated from the junction point of the winding 7′ and 7″ which is connected through the condenser 18 with the junction point of the windings 16 and 17. This connection is carried through the battery circuit of the amplifier to the midpoint of the windings 14 and 15 and thence to ground through the connection including the winding 8 and the resistance 9.

The arrangement shown in Fig. 4 which employs a simple amplifier circuit having a single vacuum tube, is in other respects substantially similar to that shown in Fig. 2.

The arrangement shown in Fig. 5 has a filter in addition to an amplifier effectively connected between the primary and the secondary windings of the simplexing transformer, which arrangement improves the ability of the antenna to discriminate between the desired and interfering signals. This arrangement is shown in greater detail in Fig. 6, wherein the primary winding 8 of the simplexing transformer is connected with the winding 21 connected with the filter 22. This filter may be of the band-pass type as shown in Fig. 6, or it may be a low-pass filter or a simple resonant circuit or circuits, the choice depending upon the relative value of the frequency of the interfering signal to the desired signal. Filter 22 is connected with the input side of the amplifier by the transformer 23 or by any other suitable means, and the amplifier has its output circuit connected with the wave antenna circuit by means of the transformer 24.

While this filter has been shown in Fig. 6, connected with a circuit having the structural characteristics of Fig. 2, it is desirable to state that the invention is not so limited inasmuch as filters may be connected with circuits of the types shown in Figs. 3 and 4 or with other forms of circuits embodying the general principles set forth hereinbefore.

It will accordingly be seen that a wave antenna having therein an amplifier at the distant end thereof, viz., the end more remote from the receiving circuit, will be capable of raising the level of the signal to a sufficient degree before transmitting it over the conductors forming the wave antenna as to insure a high signal-to-noise ratio for the said antenna. With the circuit shown it is possible to greatly improve the impedance match between the grounded circuit and the metallic circuit over that which would be obtained without the amplifier, as the impedance matching is divided into two parts—the termination impedance of the grounded circuit and the terminal impedance of the metallic circuit. This results in an improvement in the transmission of the receiving apparatus of signals received by a wave antenna, which receiving apparatus is normally located at the near end of a wave antenna.

While this invention has been disclosed as embodied in particular forms, it is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a radio signaling system the combination with a wave antenna of a receiving circuit connected with one end thereof and an amplifier connected with the distant end thereof so as to increase the magnitude of the currents transmitted over said antenna from the distant end thereof.

2. A wave antenna comprising two conductors having a simplexing transformer connected with the distant end thereof, and an amplifier connected between the windings of the transformer to control the magnitude of the current set up in said conductors in series by the current flowing to ground over said conductors in parallel.

3. The combination with a wave antenna comprising two conductors of a simplexing transformer having its secondary winding bridged across the conductors of the said antenna and having its primary winding connected between the midpoint of the secondary winding and ground, and an amplifier having its input connected with the primary winding, and its output with said secondary winding.

4. The combination with a wave antenna comprising two conductors of a simplexing transformer connected with the distant end

of a receiving circuit coupled to the inner end of the antenna, and an amplifier interposed electrically between the windings of the said transformer to control the magnitude of the current set up in the said conductors in series by the flow of current to ground over said conductors in parallel.

5. A wave antenna having a simplexing transformer connected with one end thereof, one end of the primary of said transformer being effectively connected with the midpoint of its secondary, a filter and an amplifier effectively coupled with said primary and secondary windings.

6. In a radio signaling system, the combination with a wave antenna comprising a pair of conductors having a reflection transformer connected with one end thereof, a band filter and an amplifier effectively connected between the windings of the said transformer to select the signal band and to raise its level prior to transmission over the said pair of conductors.

7. In a radio signaling system, the combination with a wave antenna comprising a pair of horizontal conductors for collecting radiant energy, of means at each end to effectively connect the said conductors in parallel to ground, the said means connected at the distant end being arranged to impress across the said conductors a voltage corresponding to the current flowing to ground at that end, and an amplifier connected with the said antenna near the distant end to raise the said voltage applied across the conductors.

8. In a radio signaling system, the combination with a wave antenna comprising a pair of conductors having a reflection transformer connected with one end thereof, a filter effectively connected between the windings of the said transformer to select the signal band prior to its transmission over the said pair of conductors.

9. A wave antenna having a simplexing transformer connected with one end thereof, one end of the primary of the said transformer being effectively connected with the midpoint of its secondary, and a filter coupled to the said primary and secondary windings to select the frequency or band of frequencies to be impressed by the said primary upon the said secondary winding.

In testimony whereof, I have signed my name to this specification this 18th day of November, 1925.

DE LOSS K. MARTIN.