

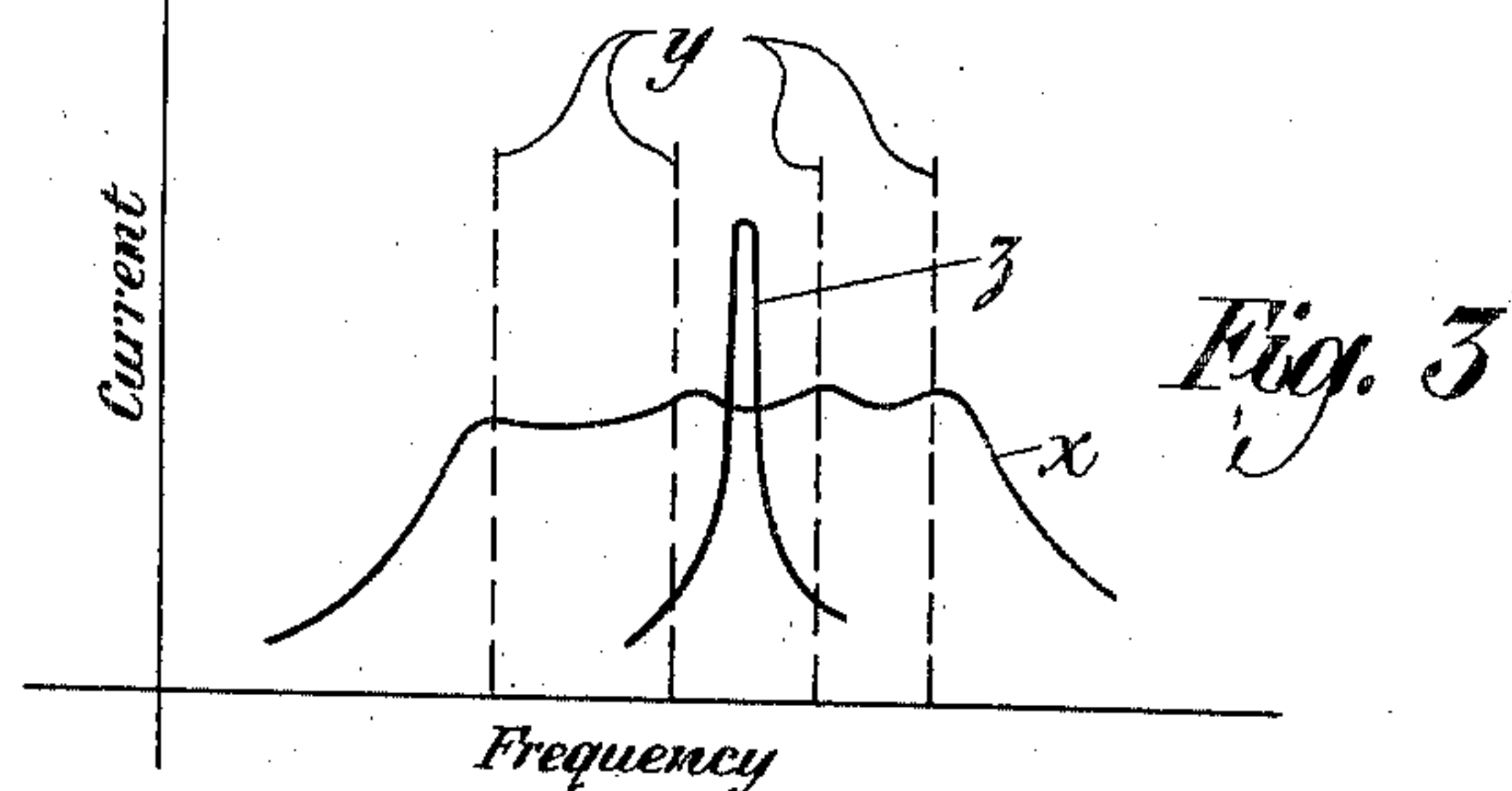
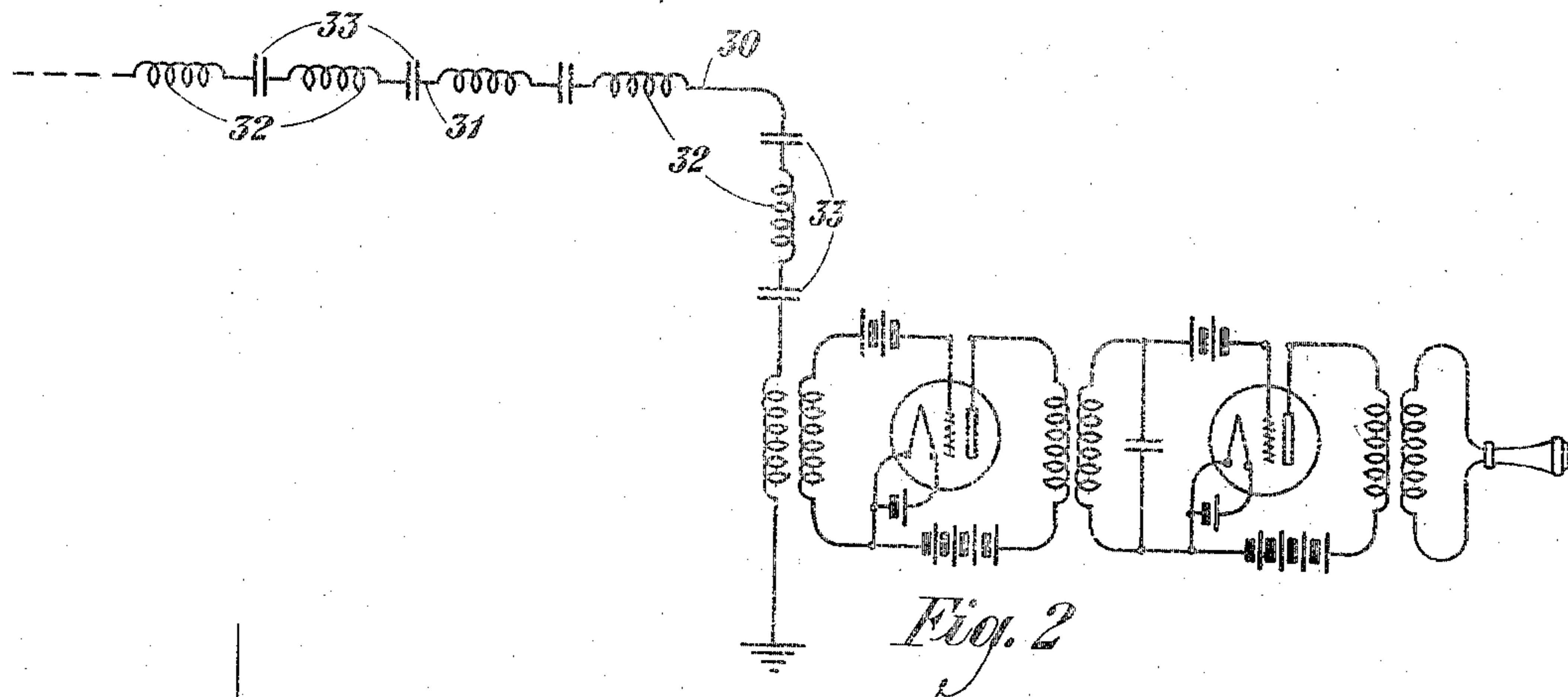
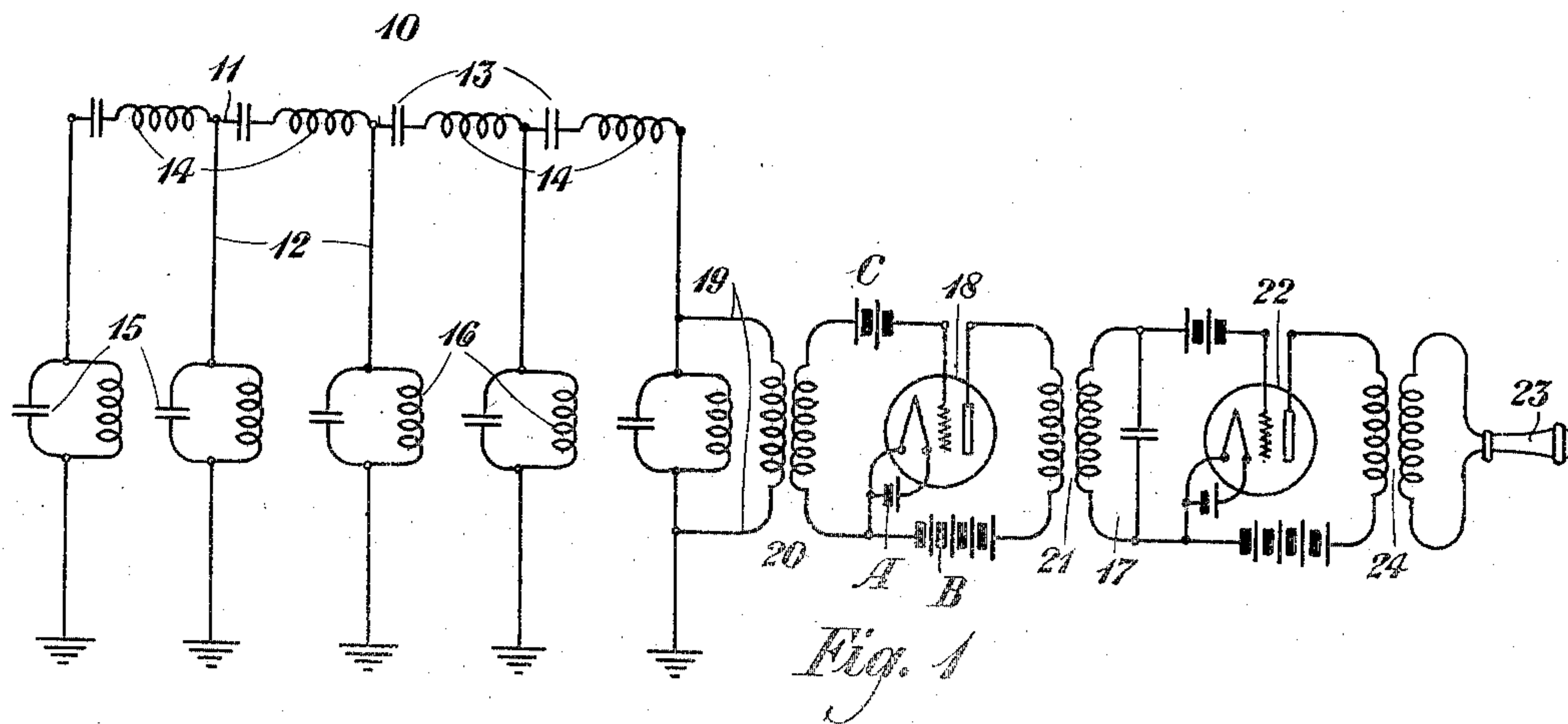
Feb. 11, 1930.

L. ESPENSCHIED

1,746,305

RADIO SIGNALING SYSTEM

Original Filed Jan. 17, 1923



INVENTOR
L. Espenschied
 BY *gr 402*
 ATTORNEY

UNITED STATES PATENT OFFICE

LLOYD ESPENSCHIED, OF HOLLIS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE
AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

RADIO SIGNALING SYSTEM

Original application filed January 17, 1923, Serial No. 613,226, which, in turn, is a division of my Patent
No. 1,446,890, dated February 27, 1923. Again divided and this application filed December 10, 1924.
Serial No. 755,076.

This invention relates generally to systems for transmitting energy and particularly to the protection of such systems against disturbance. Its object is to provide a method
5 of and apparatus for eliminating or minimizing the effects of disturbances in such systems, whether in power circuits or signaling systems, and in either wire or wireless systems of communication. The invention finds one
10 very important application in the radio transmission of intelligence as a protection against the electrical disturbances commonly known as "static"; and the invention will be here described as applied to such a system, but, as
15 will clearly appear hereinafter, the invention is of much broader applicability.

This application is a division of my co-
pending application. Serial No. 613,226, filed
January 17, 1923, which in turn, is a division
20 of an application of mine which issued on February 27, 1923 as Patent No. 1,446,890.

In radio signaling systems the usual antenna is sharply tuned to increase its responsiveness to waves of the particular frequency to be
25 received and to reduce the liability of interference from signals of other frequencies. The effect of static disturbances upon an antenna thus sharply tuned seems to be analogous to that of a blow upon a tuning fork, that
30 is the energy of the impact is converted largely into oscillations of the frequency to which the device is tuned. In a wireless receiving system this means that the disturbance will
35 appear in the receiver to the confusion of the signals it is desired to observe. In other words the receiving systems, instead of excluding the static disturbances by reason of existing differences between them and the
40 signaling impulses, or instead of accentuating or producing differences between them, tends to effectually extinguish the differences that do exist, so that the disturbance is in a sense manufactured by the system for its own receiver. Like phenomena may occur in al-
45 most any energy transmission system where some or all of the transmitting medium has a natural period or is capable of responding sympathetically to foreign disturbances.

This invention proposes to avoid such dis-
50 turbance by changing or diverting the dis-

turbing energy into a plurality of frequencies other than that of the energy to be transmitted or into a band of frequencies of considerable extent so that, even though the frequency being transmitted falls within its
55 scope, only a small proportion of the disturbance reaches the translating or indicating devices of the system.

The invention will be more fully understood by reference to the following description and the accompanying drawing in which:

Figure 1 is a diagrammatic illustration of the receiving end of a radio signaling system embodying the invention and in which a wave filter form of antenna is employed.

Fig. 2 is a variant of the arrangement shown in Fig. 1.

Fig. 3 is a curve indicating generally the operation of the system.

In Fig. 1, 10 represents the antenna of the receiving circuit arranged in the form of
70 wave filter, consisting of a horizontal conductor 11 grounded at intervals, as shown, by vertical conductors 12. Impedance, here shown as capacities 13 and inductances 14, is
75 located in each section of the horizontal conductor, that is, between each two grounded conductors. Each grounded conductor is also provided with impedance, shown in this instance as a capacity 15 and an inductance
80 16, arranged in parallel.

The wave filter per se is the invention of G. A. Campbell, and, as disclosed in his Patent 1,227,113, May 22, 1917, may assume any one of several forms. Thus, for the purposes of
85 tuning to respond to different frequencies, any set of inductances or capacities above indicated, may be omitted, or their values adjusted.

A circuit of this character has a plurality of
90 natural frequencies and at the same time is capable of responding to forced or sustained alternating current excitation over a considerable range or band of frequencies.

17 represents the usual tuned receiving circuit, which is in this case tuned sharply to
95 the frequency of the signal to be received. Between this and the antenna is placed a device 18 for the purpose of preventing reaction, between the sharply tuned circuit 17
100

and the filter circuit. In the present instance, this is illustrated as an audion having the usual filament, grid and plate, and the batteries A, B and C for controlling its action. When the audion is used for this purpose, it is adjusted to amplify to a large degree in transmitting energy from the filter circuit to the tuned circuit 17, in which case its effect when transmitting in the opposite direction is negligible. This prevents the circuit 17 from becoming in effect one section of the antenna circuit and partaking in forming the natural oscillations of various frequencies present in that circuit. The device 18 may conveniently be called a one-way device by reason of the characteristic just pointed out. It is possible to omit it entirely if the coupling between the tuned circuit 17 and the antenna is made sufficiently loose to prevent the undesired reaction mentioned.

The device 18 is connected to the antenna circuit by conductors 19, which are here shown as terminating at the end vertical conductor, though it will be understood that this connection may be otherwise located. Transformers 20 and 21 are interposed, as usual, in the circuit at either side of the one-way device to localize the battery currents and to give any desired ratio of transformation.

22 is a detector for the signaling current, here shown as of the audion type and operating in a well known manner. It is coupled with the receiver 23 by transformer 24 in the usual way.

In Fig. 2 a different form of antenna is illustrated. It is composed of a conductor having a vertical component 30 and a horizontal component 31 in each of which are located inductances and capacities 32 and 33 in much the same manner as in the horizontal conductor the modification shown in Fig. 1. As is well known, an antenna, especially one with a horizontal component, as illustrated in this figure, has a natural capacity to ground which may be regarded as distributed along the antenna something after the fashion of the capacities 15 in Fig. 1. The antenna here shown will, therefore, when properly tuned and coupled with the other elements of the receiving circuit above described, operate as a wave filter having a plurality of natural frequencies. Here, the one-way device, the tuned circuit, the detector and the receiver, correspond to those described in connection with Fig. 1.

Fig. 3 is a curve illustrating the operation of the receiving circuit, in which the ordinates represent current and the abscissae frequency. The line α indicates the band of frequencies to which the filter circuit will respond for sustained or forced alternating current. Lines γ indicate the natural frequency periods to which the filter circuit is adjusted. Four such frequencies are indicated in this instance corresponding to the four natural

periods of the four section filter circuit shown. In general, for the simple form of antenna in Fig. 2, the number of natural periods corresponds to the number of sections of the filter circuit. For the more general form of filter circuit in which both the series and the shunt-branches contain both inductance and capacity, as in Fig. 1, each section exhibits two degrees of freedom, the number of natural periods being then twice the number of sections. The curve α indicates the resonance characteristic of the sharply tuned circuit 17. The frequencies to which this circuit will respond are located, it will be observed, in a very narrow band between the natural frequencies of the filter circuit. It will be understood that this circuit might be tuned to a frequency lying beyond the natural frequencies of the filter circuit in either direction if the responsiveness of the filter to forced alternating current impulses were made sufficiently broad to allow of such an adjustment.

The operation of the receiving circuit will now be readily understood. Static disturbances falling upon the filter circuit are largely converted into oscillations of a plurality of definite frequencies, or bands of frequencies of limited extent, which corresponds to the natural frequencies of the circuit. These oscillations, being relatively persistent and for the most part at least, different from the signaling frequency, are discriminated against by the sharply selective circuit 17. The signaling impulses are of a frequency differing from the natural frequencies of the circuit and are received through the filter circuit by reason of its responsiveness to forced alternating current impulses, as indicated by the curve α in Fig. 3. These pass through the one-way device 18 which, in this case, also amplifies them, into the tuned circuit 17 to the detector 22, and thus to the receiver, in the usual manner. Inasmuch as the static disturbance is for the most part dissipated into frequencies other than the signaling frequency, no appreciable interference with the signals will result.

If the filter circuit is adjusted so that the natural frequencies thereof are each represented by a band of more or less extent, it is possible that these may, in some cases, lap over the signaling frequency. If the bands were conceived as extending toward each other until they merge this would be true in all cases, but even under these conditions the energy of the static disturbance is spread out, so to speak, over a large number of frequencies, while the signaling frequency is sharply limited, and the resulting disturbance in the receiver would be proportionately reduced.

Since this method of differentiation is based upon the difference which exists between the disturbance and the signaling cur-

rent as regards persistency, it is obviously desirable that this difference be preserved to the point at which the currents enter the frequency-concentrating filter. This desirable condition is fulfilled in the organization of Fig. 1, by incorporating the filter action in the antenna itself so that immediately upon the transference of the energy of the free electric waves into current form, the filter action becomes effective. This is likewise the case in the system of Fig. 2.

It will now be evident that the broad method herein employed for differentiating between impulses and steady state forces, or between oscillations of different degrees of persistency, is a general method and is not limited to the application herein described in detail, but is applicable irrespective of the type of transmission system (i. e. whether using natural media or wires) or of the form of the energy involved, whether electrical or mechanical, or of the absolute values of the frequencies concerned. In the sphere of wireless transmission, for instance, the method is not limited to electric wave transmission which is usually conducted at ultra-audible frequencies, but may be invoked as well in audible sound-wave transmission, as in submarine signaling.

In this latter art the transmission waves of compression and rarefaction are generated by forces applied mechanically to the water. In the case of ordinary submarine signaling, continuously generated sound waves producing in the receiver a musical note are usually employed; and these waves are generated at the transmitter by the rhythmic motion of a diaphragm in the water. Detection of vessels by underwater sound transmission may be accomplished by reason of the waves which are set up in the water by the propelling machinery of the vessel, the driving engines or motors, or the propellers themselves. The receiving of such submarine signals as these is, however, frequently interfered with by the presence in the water of extraneous pressure waves, caused by surface waves, etc., which act upon the receiving diaphragm and attendant receiving circuits in much the same way as does static upon a radio receiving system, and this may be eliminated by the invention here described.

It will be understood that the method described may also be used in the art of wire electric transmission systems of all kinds. While free transmission systems such as radio and submarine signaling systems are peculiarly subject to the interference of transient disturbances, confined transmission systems such as employ wire circuits are nevertheless not entirely free from this difficulty. Such disturbances may arise in wire systems from external sources, such as lightning or foreign electric systems, or may arise from sources within the wire system itself as from alter-

nations in the energy transmitted. In the case of power supply circuits, these alternations may be caused by sudden changes of switching, circuit-breaker operation, etc., while in signaling circuits they may be even those characteristic of the signaling itself. Manifestly the method and means described herein are applicable to the protection of wire systems against such disturbances.

What is claimed is:

1. In a radio signaling system, the combination with a detecting circuit tuned to a particular frequency or band of frequencies, of a filter structure functioning not only as a filter but also as a collector of radiant energy, the said structure having series impedance elements and shunt impedance elements proportioned to readily transmit a selected frequency or band of frequencies.

2. In a radio signaling system, the combination with a detecting circuit tuned to a particular frequency or band of frequencies, of a filter structure functioning not only as a filter but also as a collector of radiant energy, the said structure comprising a plurality of similar recurrent electrical networks arranged to readily transmit a selected frequency or band of frequencies, and a unidirectional translating device connected between the said tuned detecting circuit and the said filter structure.

3. In a radio signaling system, the combination with a filter structure functioning not only as a filter but also as a collector of radiant energy, the said structure being tuned to respond to a plurality of frequencies by means of series impedances and shunt impedances to ground, of a sharply tuned receiving circuit and a unidirectional translating device inserted between the said filter structure and the said receiving circuit.

4. In a radio signaling system, the combination with a filter structure functioning not only as a filter but also as a collector of radiant energy, the said structure comprising a plurality of sections tuned to respond to a plurality of frequencies, of a receiving circuit sharply tuned to a frequency or to a band of frequencies.

5. In a radio signaling system, the combination with a filter structure functioning not only as a filter but also as a collector of radiant energy, the said structure comprising a plurality of sections tuned to respond to a plurality of frequencies, of a sharply tuned receiving circuit, and a unidirectional translating device connected between the said filter structure and the said receiving circuit.

In testimony whereof, I have signed my name to this specification this 8th day of December 1924.

LLOYD ESPENSCHIED.