Dec. 11, 1923.

L. COHEN ET AL

1,476,691

ELECTRICAL SIGNALING

Filed Jan. 26, 1921

4 Sheets-Sheet 1

Fig. 1.

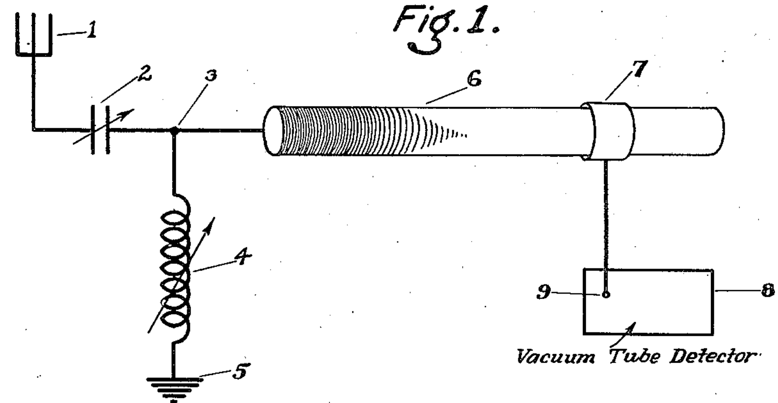

Fig. 2.

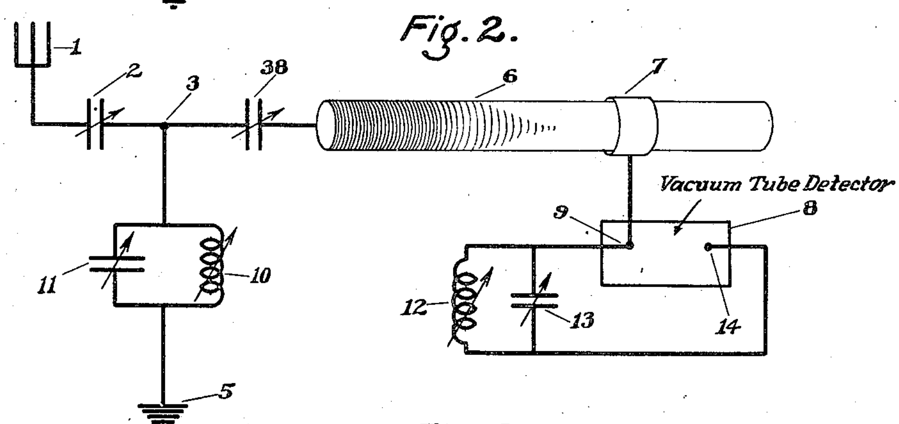

Fig. 3.

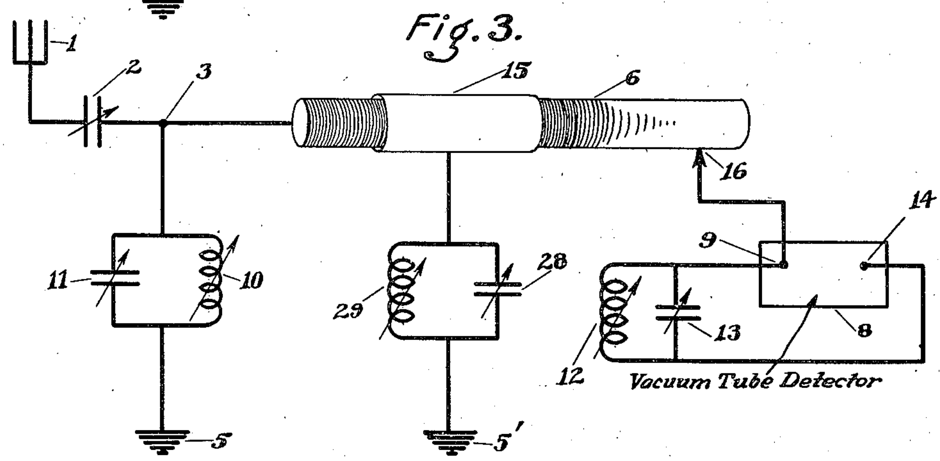

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Fig. 4.

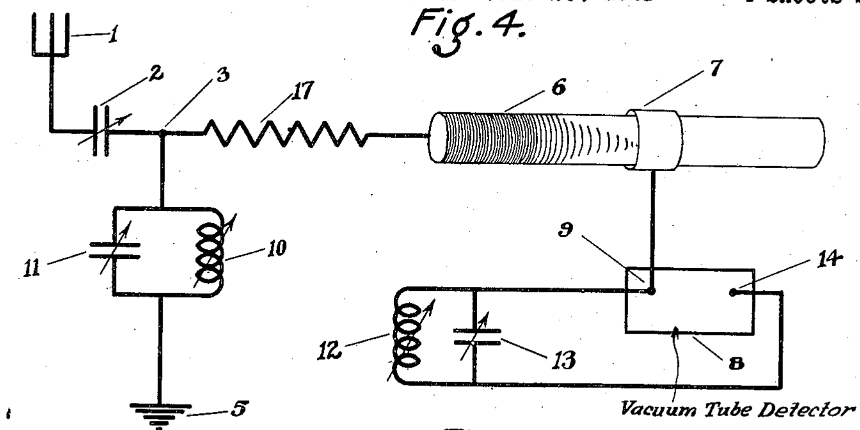

Fig. 5.

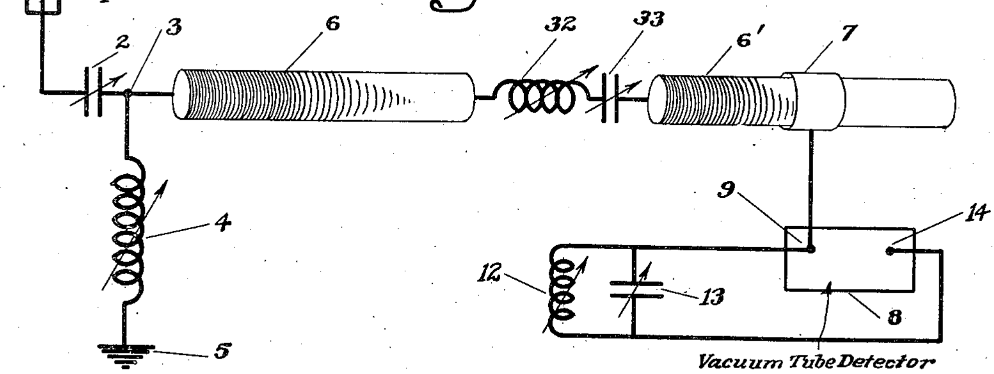

Fig. 6.

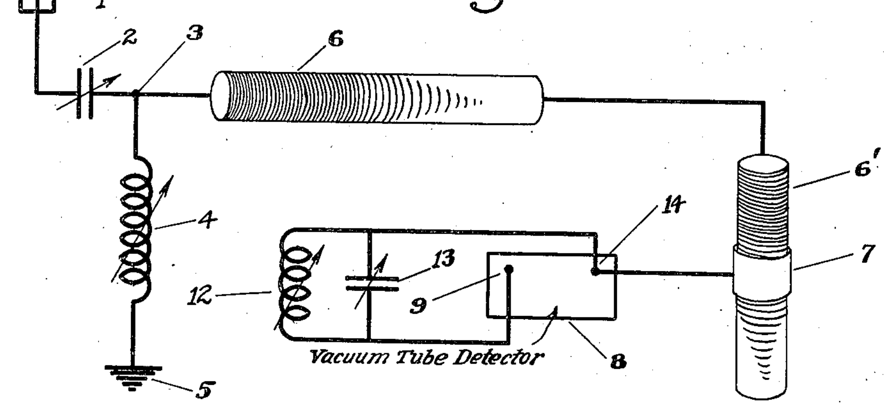

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Fig. 7.

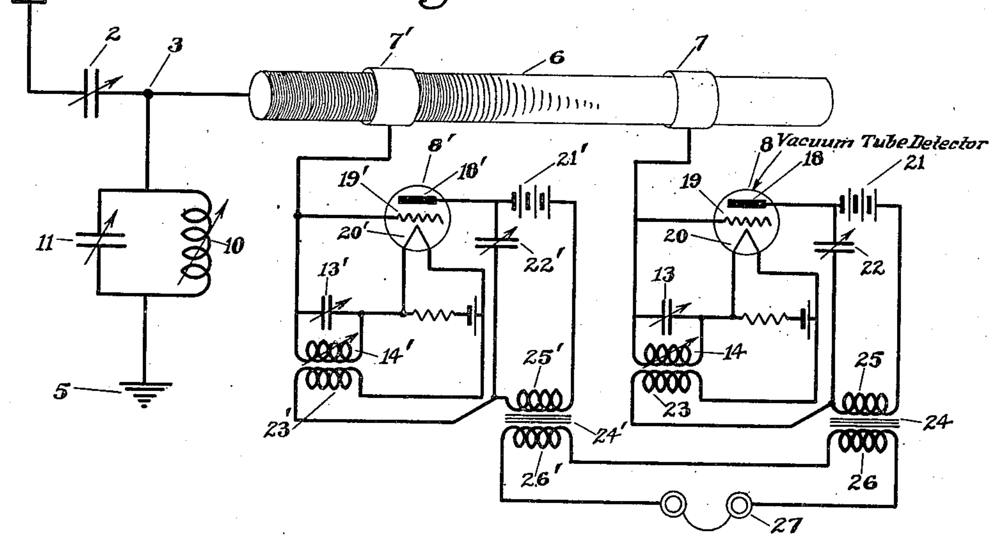

Fig. 8.

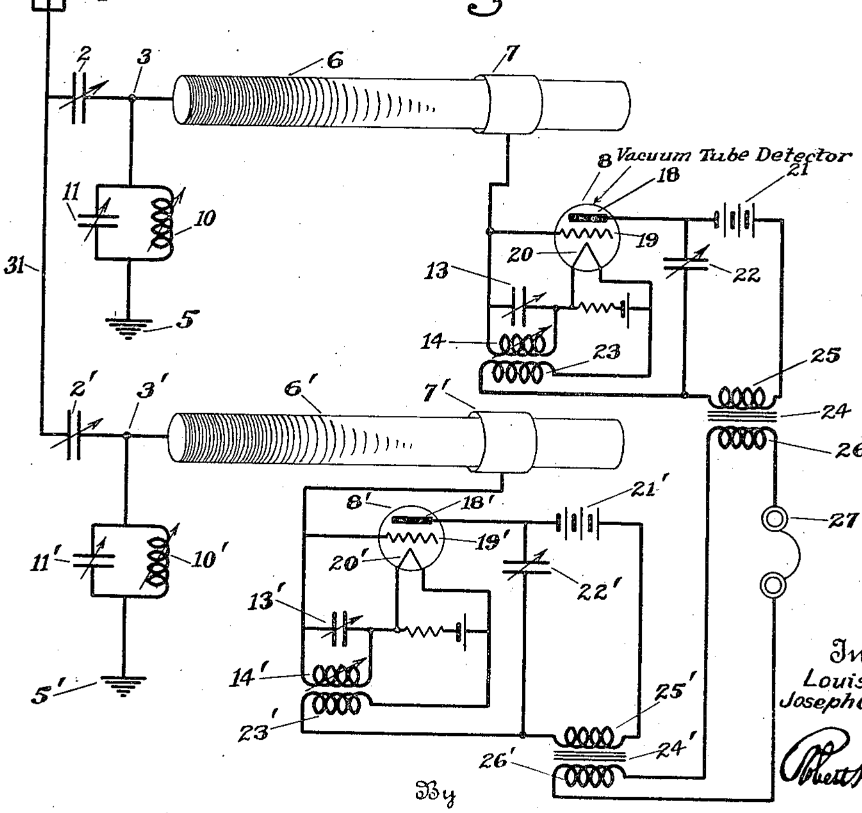

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Fig. 9.

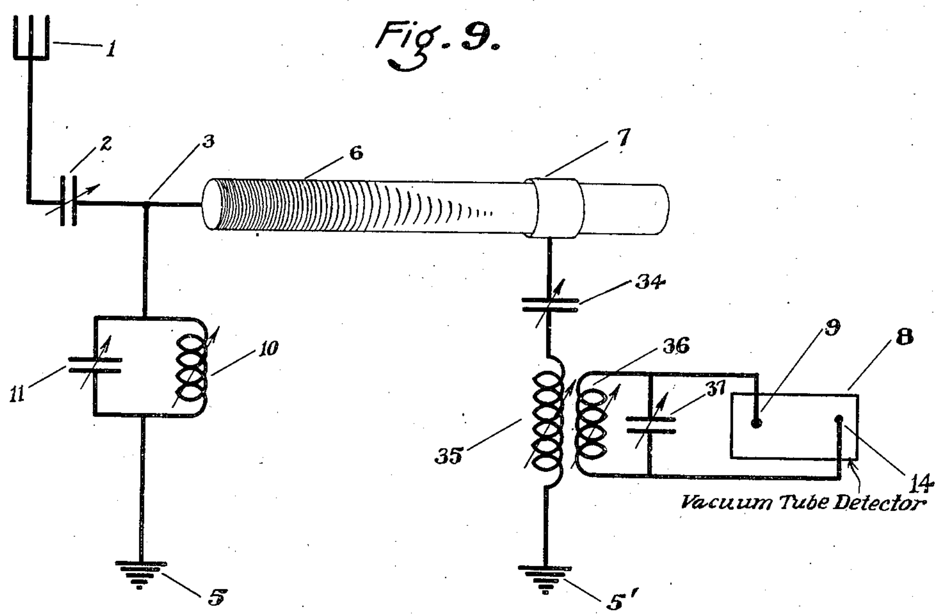
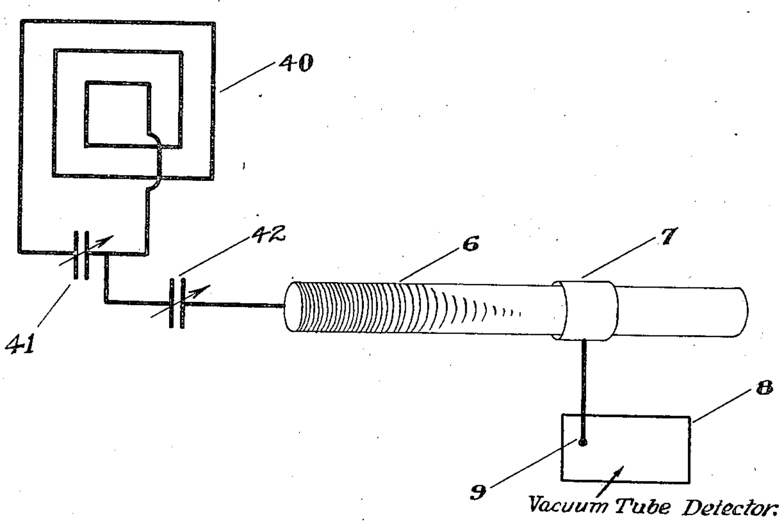


Fig. 10.



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By Robert H. Young

Attorney

Patented Dec. 11, 1923. 1,476,691

UNITED STATES PATENT OFFICE.

LOUIS COHEN AND JOSEPH O. MAUBORGNE, OF WASHINGTON, DISTRICT OF COLUMBIA.

ELECTRICAL SIGNALING.

Application filed January 26, 1921. Serial No. 440,208.

To all whom it may concern:

Be it known that we, LOUIS COHEN and JOSEPH O. MAUBORGNE, residing in Washington, District of Columbia, have invented certain new and useful Improvements in Electrical Signaling, of which the following is a specification.

This invention relates to the art of radio signaling, and particularly receiving radio signals and system for use in practicing same.

The object of the present invention is to eliminate electro-static disturbances and other interferences in the reception of radio signals and thus improve the clearness and reliability of radio communication.

In pending applications, Serial Numbers 401752 and 419383, we have described a method for receiving radio signals in which resonance wave coils are made use of and utilizing the wave development effects produced by electrical excitation acting on the antenna. The present invention is another modification of the same general idea, embodying novel features with a view of securing still greater improvements in the results desired, namely, more effective elimination of static disturbances and other interferences in the reception of radio signals.

The method consists in connecting a wave coil to a relatively high potential point of a tuned antenna circuit, transmitting the received signal energy over the wave coil and detecting the signals by connecting electrically a suitable detector to a point on the wave coil. The principle involved appears to be as follows: By tuning the antenna circuit to the frequency of the signal to be received, and suitably adjusting the capacity and the inductance reactances of the antenna circuit, the potential of the signal energy across the condenser or the inductance may be increased to many times through the resonance process so that the signal energy is transformed to high potential energy, and this high potential is impressed on the wave coil. The term "wave coil" is understood to mean a coil having a sufficient length of wire on it in relation to the wavelength of the signal to secure a wave development on the coil. The coil may be made in many forms, preferably in the form of a long helix wound uniformly with fine wire so as to obtain a coil of distributed inductance and capacity and thus the equivalent condition of a long line in the matter of wave development. If the length of the coil is properly adjusted in relation to the wavelength of the signals, one or more maximum potential points is developed on the wave coil, and by connecting the detector, preferably the grid of a three electrode tube, to a point of maximum potential on the wave coil, a large signal effect is produced in the detector. In case of any other electrical effects acting on the antenna, such as interfering signals of different frequencies or electro-static effects, the conditions for the potential building-up process through resonance which obtain in the case of signals of the frequencies for which the system is adjusted, do no longer exist, and consequently, their effect on the detector is relatively small. In this way, a much larger ratio of signal to foreign disturbances is produced on the detector than can be obtained with the usual circuit arrangements heretofore used in the reception of radio signals.

Further, this method lends itself readily to various modifications for the neutralization of any residual effects of interfering disturbances, which are described in part in the accompanying diagrams showing typical embodiments of the invention, and which form part of this specification.

In the accompanying drawings:

Figure 1 is a diagrammatic view of a system for carrying out the invention in which a wave coil is connected to a point on the antenna circuit and the detector is coupled electro-statically to the wave coil.

In Figure 2, an additional oscillating circuit is used to produce beats with the incoming signals, and the wave coil is coupled electro-statically to the antenna.

Another modification is shown in Figure 3 in which a metal tube, grounded through a loop circuit, is placed around the wave coil and the detector is connected directly to a point on the wave coil.

The modification in Figure 4 shows a resistance introduced between the antenna and the wave coil.

Another embodiment of our invention is shown in Figure 5 in which two wave coils are used, connected through an inductance and a capacity.

According to Figure 6, two wave coils are employed and so placed as not to be within each other's magnetic or static influence.

In the arrangement shown in Figure 7, two detecting instruments are employed, each separately connected to a different point on the wave coil, and the respective effects on the two detectors combined in one indicator.

The embodiment of the invention shown in Figure 8 differs from that of Figure 7 in that two independent antenna tuning elements and two independent wave coils are used, each wave coil having a separate detector and oscillating circuit associated with it, and the respective effects on the two detectors are combined in one indicator.

In the arrangement shown in Figure 9, a grounded tuned circuit is coupled electrostatically to the wave coil and another tuned circuit associated with a suitable detector is coupled magnetically to the first-mentioned tuned circuit, and

Figure 10 is a diagrammatic view of the embodiment of the invention in which a loop antenna is employed.

Having particular reference to the drawings and in connection with which like characters of reference will designate corresponding parts thereof, in Figure 1, the antenna 1 is connected in series with the variable capacity 2, a variable inductance 4, and ground 5, constituting the antenna circuit. The wave coil 6 is connected to the antenna at the point 3, and the detector 8 is connected electro-statically to the wave coil through the metal ring 7, sliding on the wave coil and insulated from it. It is preferable to use a three-electrode vacuum tube detector, and in this case 8 indicates the tube detector and 9 is the grid connection of the tube.

The operation is as follows; The antenna circuit 1, 2, 3, 4, and 5, is tuned to the frequency of the signal which it is desired to receive and if the capacity of the condenser 2 is small, the inductance 4, large, the resonance potential across the condenser 2 may be made relatively very large, many times the voltage induced in the antenna by the electro-magnetic waves of the signal.

Connecting the wave coil 6 to the point 3 on the antenna circuit, a high potential is impressed on the wave coil and part of the signal energy is transmitted over the wave coil effecting a wave development on the coil. Since the signal energy is transmitted at a high potential, the current in the wave coil is correspondingly small and the efficiency of transmission is accordingly large, comparatively little energy is lost in the transmission. By suitably adjusting the length of the coil in relation to the wavelength of the signals, one or more maximum potential points will occur on the coil. While good results may be obtained if the length of the wave coil is less than one quarter of the wavelength, it is preferable to have the coil of sufficient length to secure the development of at least a quarter wavelength. By connecting the detector 8 to a maximum potential point on the wave coil, which is accomplished by sliding the ring 7 along the coil, a further increase in the receiving efficiency of the system is thus obtained. In using a three-electrode vacuum tube detector the grid 9 is connected to the ring.

When any other electrical disturbances act on the antenna, such as interfering signals or electro-static disturbances, the effect on the detector is small, for the reason that the antenna circuit is not in resonance for the interference effects and hence the potential across the condenser 2 produced by these effects, is also relatively small. The effect is more in the nature of a rush of current flow through the antenna circuit, part of which will necessarily be transmitted over the wave coil, but because of the large resistance of the wave coil, the energy is quickly dissipated and the disturbance is very largely attenuated before it reaches the part of the wave coil which is connected to the detector, and therefore the effect on the detector is small.

In Figure 2, the tuning inductance 4 of Figure 1 is replaced by a loop circuit consisting of a variable condenser 10, and a variable inductance 11, an arrangement which sometimes is preferable for tuning, particularly in the case of long waves. The wave coil 6 is connected to the point 3 of the antenna through a variable condenser 38. Also a self-exciting, oscillating circuit 12, 13, is connected to the three-electrode vacuum tube 8 at the points 9 and 14, which are the grid and filament respectively. In this case, 8 indicates an electron tube detector including all the necessary electrical elements and connections for regeneration so as to set up oscillations in the circuit 12, 13. Any of the well-known methods of regeneration may be employed. This arrangement provides a suitable means for receiving undamped waves.

The modification in Figure 3 consists in placing a metal tube 15 around the wave coil for part of its length. The position of the metal on the coil may be varied. The metal tube is grounded at 5′ through a properly adjusted loop circuit of capacity 28 and inductance 29. By this arrangement the capacity of the coil is increased, and it is also helpful in further reducing interfering effects. Also the detector is shown connected directly to a point 16 on the wave coil.

Still another modification is shown in Figure 4 in which the wave coil 6 is connected through the resistance 17 to the point 3 on the antenna circuit. This arrangement is effective in dissipating in a much higher ratio the energy from any interference effects than the energy of the signal, thereby still further improving the selectivity of the system.

According to Figure 5, two wave coils, 6 and 6′ are employed being connected through a suitably adjusted circuit consisting of an inductance 32 and capacity 33.

In Figure 6 two wave coils 6 and 6′ are employed, electrically connected and so placed in relation to each other as to reduce the magnetic and static influences from one upon the other to a minmum. The purpose of this arrangement may be stated as follows: When an electrical impulse, such as an electro-static disturbance acts on the antenna, it sets up a current flow in the wave coil, and though the current at the end of the coil farthest from the antenna connection is very small, nevertheless, the magnetic field set up by that current in the first part of the wave coil, which may be large, reacts upon the distant part of the wave coil and may induce in it considerable current. Splitting the wave coil into two parts, as shown in Figure 6, one of which is designated by 6 and the other by 6′, removes the coil 6′ from the electrical influence of the current in the coil 6 and thus further improves the selectivity of the system.

The embodiment of the invention shown in Figure 7 consists in the use of two independent detectors 8 and 8′ connected electro-statically through the metal rings 7 and 7′ to two different points on the wave coil and the effects on the two detectors are combined in one indicator 27, through the transformers 24 and 24′. The potential amplitudes at different points on the wave coil 6 are different in the case of signals to which the system is adjusted than in the case of interfering disturbances, and as a consequence, the ratio of signal to static is different in different parts of the wave coil. In the case of static disturbances, for instance, the energy may be large at the beginning of the coil and very much attenuated at the end of the coil. Hence by properly selecting the locations of the rings 7 and 7′ on the wave coil, the effects produced on the two detectors 8 and 8′ are different. In one case the interfering effects may be much larger than in the other case. By combining these effects in indicator 27′ through transformers 24 and 24′ and suitably adjusting the transformer connections, the disturbing effects may be completely neutralized in leaving only the signal to actuate the indicator which is preferably a telephone, indicated by 27. The circuits 13, 14, 23 and 13′, 14′, 23′, are the usual circuit arrangements for producing oscillations for the purpose of beat formation.

According to Figure 8, the invention may be realized by the employment of two independent tuning elements and two independent wave coils connected to the same antenna each having associated with it a detector and an oscillating circuit, and the effects combined in one indicator. The operation is exactly the same as described in connection with Figure 7.

Still another embodiment of the invention is shown in Figure 9 in which a tuned circuit, consisting of a variable capacity 34, and a variable inductance 35, is coupled electro-statically to the wave coil 6, the circuit 34—35 being grounded at 5. Another tuned circuit 36, 37, associated with a suitable detector, is coupled electro-magnetically to the circuit 34—35.

According to Figure 10, the embodiment of the invention consists in tuning a loop antenna 40 by a condenser 41, connecting electro-statically through condenser 42, a wave coil 6 to the tuned loop antenna, and detecting the signals by connecting a detector 8 electro-statically through the metal ring 7 to the wave coil 6.

It is obvious that various modifications of the circuit arrangements may be made without departing from the spirit of the invention. For the purpose of illustration, the detector is shown in nearly all the figures electro-statically coupled to the wave coil, but obviously any other electrical method for connecting the detector to the wave coil may be used in connection with this invention. Likewise, in nearly all the figures with exception of Figure 10, an open antenna is shown but the circuit arrangements shown in connection with the open antenna can be used as advantageously with the loop antenna as indicated in Figure 10. Also the wave coil is shown in all the figures, except that of Figure 2, as being directly connected to the antenna circuit, but obviously the wave coil can be electro-statically coupled in all the figures throughout in the manner shown in Figure 2.

We claim:

1. A system for radio signaling comprising an antenna, a condenser, a loop circuit and a ground connection constituting an antenna circuit, a wave coil connected to a point on said antenna circuit, a detector associated electrically with the said wave coil and an oscillating circuit associated with the said detector.

2. A system for radio signaling comprising an antennna, tuning elements and ground connection constituting an antenna circuit, a wave coil connected to a point on said antenna circuit, an adjustable metal tube enclosing part of said wave coil, said metal tube being grounded through a loop circuit and a detector associated electrically with the said wave coil.

3. A system for radio signaling comprising an antenna, tuning elements and ground connection constituting an antenna circuit, a wave coil connected through a

resistance to a point on said antenna circuit and a detector associated electrically with the said wave coil.

4. A system for radio signaling comprising an antenna, tuning elements and ground connection constituting an antenna circuit, two wave coils connected in series through a variable inductance and a variable capacity, one end of one of said wave coils being connected to a point on the said antenna circuit and a detector electrically associated with the second of said wave coils.

5. A system for radio signaling comprising an antenna, tuning elements and a ground constituting an antenna circuit, two wave coils electrically connected and so placed as not to be within each other's magnetic or static influence, one of said wave coils being connected to a point on the antenna circuit and the other of said wave coils having a detector associated with it..

6. A system for radio signaling comprising an antenna, tuning elements and ground constituting an antenna circuit, a wave coil connected to a point on the said antenna circuit, two detectors associated with two different elements of said wave coil and a common indicator associated with the said two detectors.

7. A system for radio signaling comprising an antenna, two sets of independent tuning elements with ground connections connected to the said antenna, two wave coils separately connected to points of the two independent tuning elements of the said antenna, two separate detectors each of which is associated with one of the two said wave coils and a common indicator associated with the said two detectors.

8. A system for radio signaling comprising an antenna, tuning elements and ground connection constituting an antenna circuit, a wave coil connected to a point on said antenna circuit, another set of tuning elements being connected to a point on said wave coil, the other end of said tuning elements being grounded, another tuned circuit coupled to said tuning elements and a detector associated with said tuned circuit.

9. A system for radio signaling comprising an antenna, a condenser, a loop circuit, and a ground connection constituting the antenna circuit, a wave coil connected to a point on said antenna circuit, another set of tuning elements being connected electrically to a point on said wave coil, the other end of said tuning elements being grounded, another tuned circuit coupled to said tuning elements and a detector associated with said tuned circuit.

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