No. 824,637. PATENTED JUNE 26, 1906.

L. DE FOREST.

OSCILLATION RESPONSIVE DEVICE.

APPLICATION FILED JAN. 18, 1906.

2 SHEETS—SHEET 1.

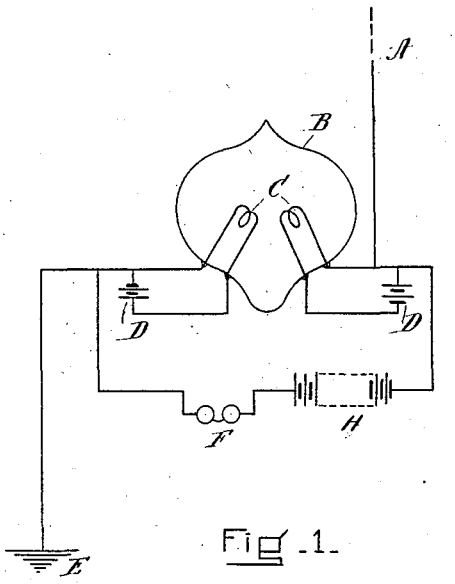

Fig. 1.

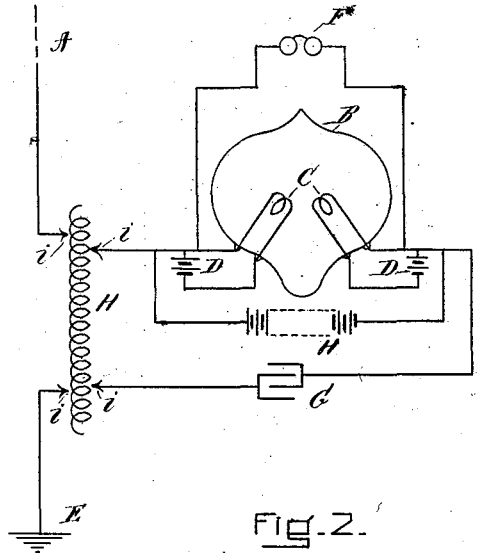

Fig. 2.

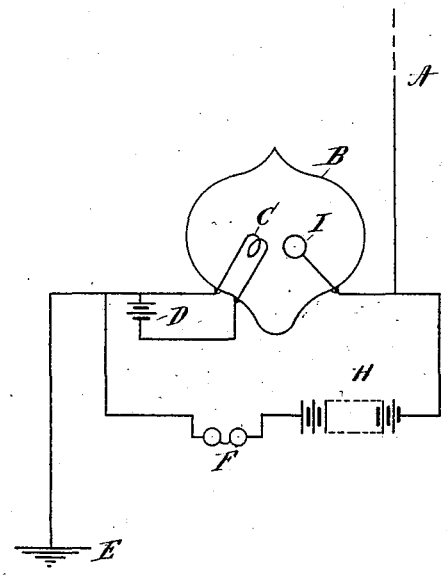

Fig. 3.

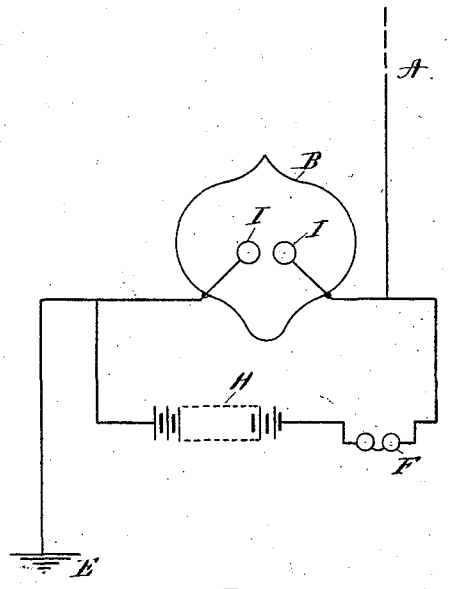

Fig. 4.

WITNESSES:
John Buckler,
Adolph C. Kaiser

INVENTOR:
Lee de Forest
by Geo. K. Woodworth
Atty.

No. 824,637. PATENTED JUNE 26, 1906.

L. DE FOREST.

OSCILLATION RESPONSIVE DEVICE.

APPLICATION FILED JAN. 18, 1906.

2 SHEETS—SHEET 2

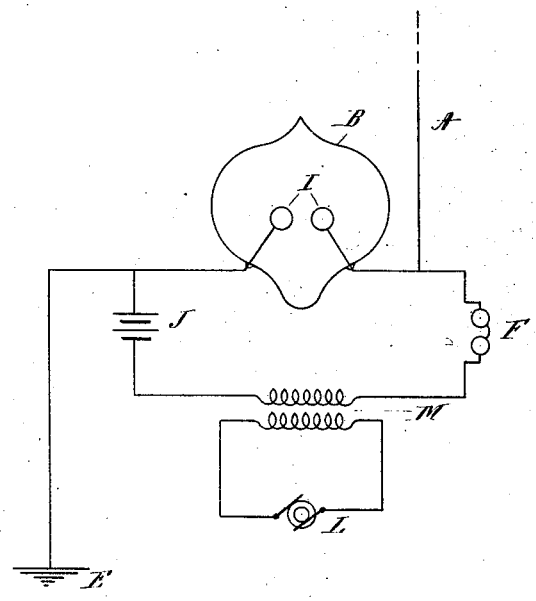

Fig. 5.

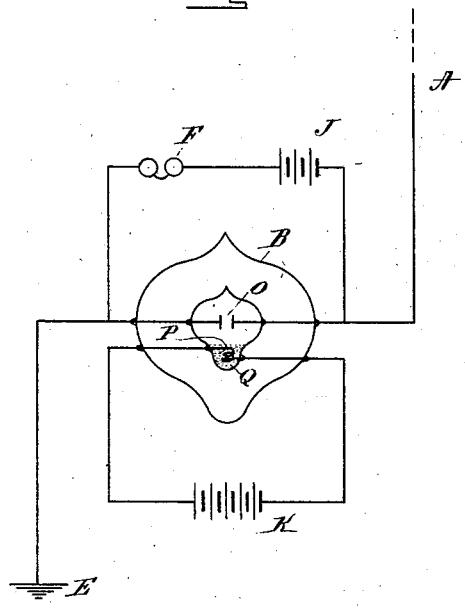

Fig. 6.

WITNESSES=
John Buckler,
Adolph C Kaiser.

INVENTOR=
Lee de Forest
by Geo. H. Woodworth
Atty.

UNITED STATES PATENT OFFICE.

LEE DE FOREST, OF NEW YORK, N. Y.

OSCILLATION-RESPONSIVE DEVICE.

No. 824,637. Specification of Letters Patent. Patented June 26, 1906.

Application filed January 18, 1906. Serial No. 296,615.

To all whom it may concern:

Be it known that I, LEE DE FOREST, a citizen of the United States, and a resident of New York, in the county of New York and State of New York, have invented a new and useful Improvement in Oscillation-Responsive Devices, of which the following is a specification.

My invention relates to devices for detecting feeble electrical currents or oscillations in general, and especially such currents or oscillations which are developed in wireless-telegraph receiving systems.

The object of my invention is to provide an oscillation detector or responder of great simplicity and sensitiveness and one which, inasmuch as it does not depend for its operation upon any variation of resistance of an imperfect electrical contact or any variation of the apparent resistance or counter electromotive force of a polarization-cell, requires no adjustment when employed for receiving wireless-telegraph signals.

With these objects in view my invention comprises a receptacle inclosing a sensitive gaseous conducting medium, the conductivity of which does not necessarily depend upon the heat of combustion, although such conductivity may be increased by heating said gaseous medium, and which in some cases requires practically no heating at all, a wave-intercepting means associated with said gaseous conducting medium, whereby the feeble electrical currents or oscillations resulting from the energy absorbed from electromagnetic signal waves may be impressed upon said gaseous conducting medium to alter its conductivity, and a signal-indicating device operatively connected with said gaseous conducting medium, whereby alterations in the conductivity of the latter may be made manifest.

My invention may best be understood by having reference to the drawings which accompany and form a part of this specification and which illustrate diagrammatically several simple and effective means whereby my invention may be practiced.

In the drawings, Figures 1, 2, 3, 4, 5, and 6 represent wireless-telegraph receiving systems provided with various forms of the oscillation responsive device which forms the subject-matter of the present invention.

In each figure, A represents a receiving antenna connected to earth at E and associated with the receptacle B. In Figs. 1, 3, 4, 5, and 6 the sensitive gaseous conducting medium inclosed in said receptacle is shown interposed between the antennæ and their earth connections, while in Fig. 2 said medium is shown interposed between the terminals of the tuned receiving-circuit *i* C G *i* H, which is inductively associated, by means of the autotransformer H, with the antenna A. By means of the four adjustable contacts *i* said tuned receiving-circuit and antenna may each be attuned to the frequency of the waves to be received. My invention, however, is not limited to any particular wireless-telegraph system, nor is it limited to wireless telegraphy, for it may be employed as a detector of feeble electrical impulses however produced.

I have discovered that the gaseous medium intervening between two separated electrodes if put into a condition of molecular activity will become highly sensitive to electrical oscillations, so that the passage across such medium of said oscillations will alter the conductivity thereof, and thereby create current variations in a circuit including said electrodes. The means which may be employed for putting said gaseous medium into a condition of molecular activity may consist of means whereby the medium is heated either by radiation, conduction, or by the actual combustion of gases. An electric current from any suitable source may be employed to heat two highly-resistant electrodes, and thereby to heat the gas intervening between said electrodes without having recourse to the heat of combustion. Said gas may be air, or the electrodes may be inclosed and surrounded by any suitable gas. The heating of the gas may also be affected by radiation from said electrodes. In fact, in the invention disclosed in the present application any suitable means for producing a heated gas with properly dissociated and conducting ions may be employed.

In all the embodiments of the present invention the electrodes are inclosed and are surrounded by suitable gas, and they may be inclosed in a receptacle which may be partially exhausted. Said gas may be rendered sensitive to electrical oscillations by slightly heating the same, preferably by electrical means, or by any other suitable means; but in those embodiments of my invention shown in Figs. 4, 5, and 6 practically no heating at all is required, while if in place of the potassium or other salt hereinafter described as

suitable for use in Fig. 6 some radio-active substance, such as radium bromid, be employed absolutely no heating is necessary.

In Fig. 1 two filaments C, which may be ordinary incandescent-lamp carbon filaments, are sealed into the receptacle B, and each is connected to a separate battery D. The local-circuit battery H and telephone F connect said filaments C. One filament is connected with the antenna A and the other is connected to earth E, although the said filaments may be associated with the antenna in any manner in which existing wireless-telegraph receivers are associated with their receiving antennæ. In lieu of connecting the telephone F in series with the local-circuit battery H said telephone may be connected in shunt to the circuit including the filaments C, which form the electrodes of the oscillation responsive device, and local battery H, as shown in Fig. 2, and such arrangement of telephone-receiver may be employed, if desired, in those embodiments of the present invention which are shown in Figs. 3 to 6, inclusive.

The potential to be impressed upon the electrodes C by the battery H depends upon the nature of the gas intervening between said electrodes and upon the degree of exhaustion maintained within the receptacle B. I have found that from twenty-five to one hundred and ten volts is sufficient, and by employing a higher degree of exhaustion a much smaller voltage may be used. The conductivity of the gas, which may be air or a gas containing compounds of the halogens or halogen salts or which may be mercury vapor, is increased by the heat resulting from the passage of the current from the batteries D through the filaments C, and a leak-current of relatively small value continually flows in the circuit containing the battery H and the electrodes C across the gap intervening between said electrodes. The passage of electrical oscillations across said gap alters the conductivity of the gas in said gap, probably by changing the speed of the ions in said gas, and thereby current variations are produced in the circuit containing the battery H, the electrodes C, and the telephone F, causing said telephone to respond. When the telephone is in series with the battery H and electrodes C, the passage of oscillations across the gap between the electrodes causes an increase of current through the telephone, and when the telephone is in shunt to said electrodes, as shown in Fig. 2, the passage of oscillations across the gap causes a diminution of current through the telephone.

It is not necessary to employ two heated electrodes in carrying out my invention, for, as shown in Fig. 3, one electrode may be replaced by a conductor I, herein shown as a disk, of platinum or other suitable material. In this case the conductivity of the gaseous medium between the two electrodes I and C is sufficiently increased to render the same sensitive to the electrical oscillations by the radiation of heat from the electrode C.

In that embodiment of my invention shown in Fig. 4 I dispense with both heated electrodes C and substitute therefor two electrodes I, of platinum or other material, and connect the same in circuit with the battery H and telephone F. In Fig. 4 the telephone F may be connected in shunt to the battery-circuit in the manner shown in Fig. 2 of the present case.

In Fig. 5, L represents a source of alternating electromotive force of a frequency so high that a high-pitch note is constantly heard in the telephone F or else so high as to exceed the limit of response of the telephone-diaphragm. The advantage in using the source of alternating electromotive force is that the voltage may be stepped up by a transformer M to any desired amount—for example, from fifty to one thousand volts—and impressed upon the electrodes I. In lieu of an alternating-current generator such as shown in Fig. 5 any source of vibratory electromotive force may be employed. The telephone F may be included in series with the circuit containing the secondary of the transformer M and electrodes I, or it may be connected in shunt to said circuit, as above stated in connection with Fig. 2, and the effect of the passage of high-frequency oscillations across the gap between the electrodes I may be increased in the telephone by including a battery J in series with the telephone. In such case the conductivity of the gas in said gap effected by the high-potential alternating current will allow the relatively low potential direct current from the battery J to flow in the circuit containing the telephone and the electrodes, and the passage of electrical oscillations across the gap between the electrodes will produce sudden changes in the conductivity of said gas, and therefore in the amplitude of the current flowing in the telephone-circuit.

A convenient way of producing a gaseous medium containing compounds of suitable salts is shown in Fig. 6, in which a globule of a solution of some such salt is placed in the bottom of a vessel O, as shown at Q, and a heating-coil P is associated with said globule in such a way that the current from the battery K will heat said coil and create a heated gas of said salt in the globe O. I prefer to employ potassium hydrate as the salt to be heated, and better effects may be obtained by inclosing the globe O inside the evacuated globe B to prevent the radiation of heat from the inner globe. The heated gas from the potassium or other salt fills the globe O, which may be exhausted to any desired degree, and completes the circuit of the battery J

and telephone F, which is connected to two electrodes, of platinum or other suitable material, in the globe O. The passage of electrical oscillations across the gap between said electrodes will alter the conductivity of the aforesaid heated gas, and thereby create current variations in the circuit of the telephone F.

All the foregoing apparatus comprises means for sensitizing the interelectrode medium, as suitable salts impregnating the said medium, as before noted, or means for producing and maintaining the medium in a state of molecular activity, as by heating, or both means for sensitizing may be concurrently employed.

I do not wish to be limited to the particular embodiments of my invention which I have herein disclosed, inasmuch as many modifications may be made therein by those skilled in the art without departing from the spirit of my invention.

I claim—

1. An oscillation-responsive device comprising a receptacle inclosing a sensitive gaseous conducting medium containing a halogen salt.

2. An oscillation-responsive device comprising a receptacle inclosing a sensitive gaseous conducting medium containing a halogen salt and means for heating said medium.

3. An oscillation-responsive device comprising a receptacle inclosing a sensitive gaseous conducting medium containing a potassium salt.

4. An oscillation-responsive device comprising a receptacle inclosing a sensitive gaseous conducting medium containing a potassium salt and means for heating said medium.

5. An oscillation-responsive device comprising a receptacle inclosing a sensitive gaseous conducting medium containing a halogen salt and means for putting said medium in a condition of molecular activity.

6. An oscillation-responsive device comprising a receptacle inclosing a sensitive gaseous conducting medium containing a potassium salt and means for putting said medium in a condition of molecular activity.

7. An oscillation-responsive device comprising a partially-exhausted receptacle, two separated electrodes sealed in said receptacle and each forming part of a separate electric circuit, a separate source of electric current for each said circuit, and means whereby electrical oscillations may be impressed upon the gaseous medium intervening between said electrodes.

8. An oscillation-responsive device comprising a partially-exhausted receptacle containing two separated electrodes, a source of electromotive force associated with said electrodes, and means whereby a relatively small electric current is caused to flow normally in the circuit including said source of electromotive force, said electrodes and the gaseous medium intervening between the latter.

9. An oscillation-responsive device comprising a partially-exhausted receptacle containing two separated electrodes, a source of electromotive force associated with said electrodes, and electrical means for heating said electrodes whereby a relatively small electric current is caused to flow normally in the circuit including said source of electromotive force, said electrodes and the gaseous medium intervening between the latter.

10. An oscillation-responsive device comprising a receptacle, two separated electrodes inclosed within said receptacle and each forming part of a separate electric circuit, a source of electric current associated with each said circuit, and means whereby electrical oscillations may be impressed upon the gaseous medium intervening between said electrodes.

11. An oscillation-responsive device comprising a receptacle inclosing a gaseous medium containing a substance the vapor of which is conducting, and electrical means for heating said medium.

12. An oscillation-responsive device comprising a receptacle inclosing a gaseous medium containing a halogen salt, two separated electrodes inclosed within said receptacle, and a source of electric current so associated with said electrodes as to render said gaseous medium sensitive to electrical oscillations.

In testimony whereof I have hereunto subscribed my name this 13th day of January, 1906.

LEE DE FOREST.

Witnesses:
LESTER TESTUT,
PHILIP FARNSWORTH.