No. 802,981. PATENTED OCT. 31, 1905.

L. DE FOREST.

WIRELESS SIGNALING APPARATUS.

APPLICATION FILED DEC. 10, 1902.

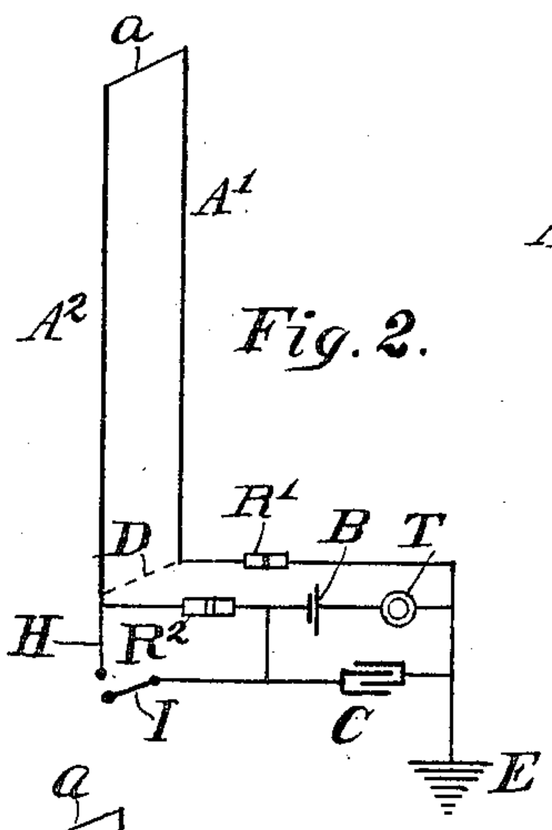

Fig. 2.

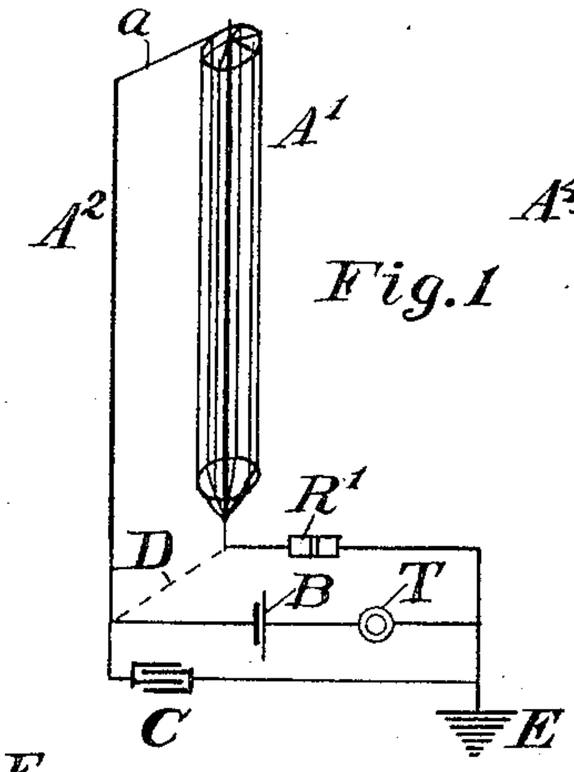

Fig. 1

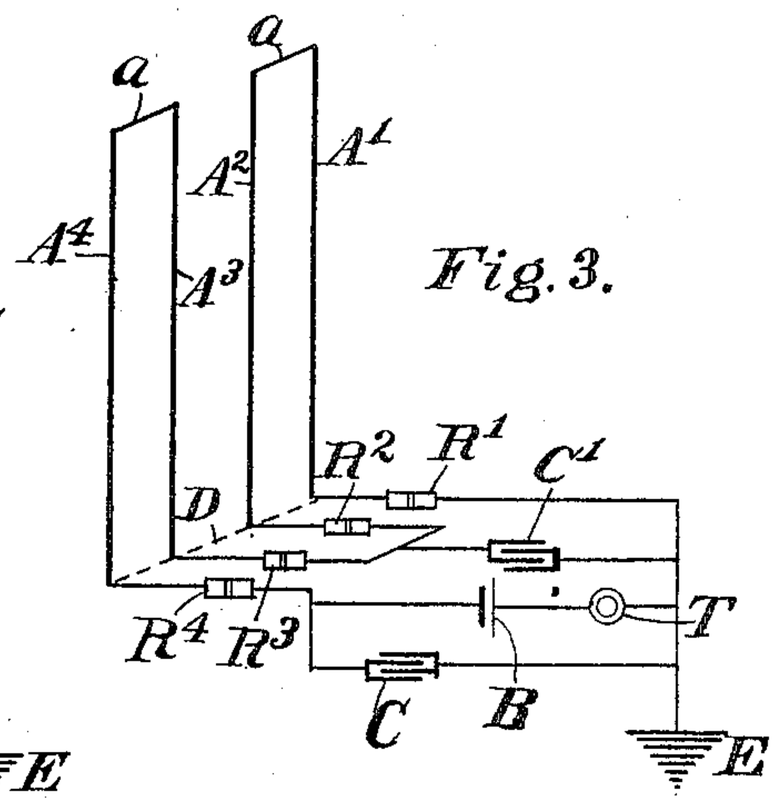

Fig. 3.

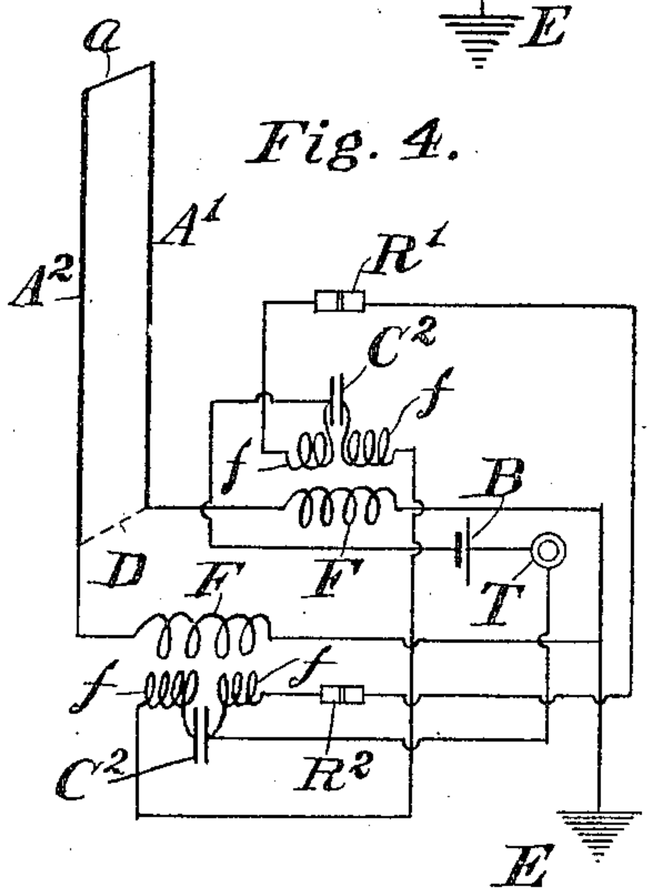

Fig. 4.

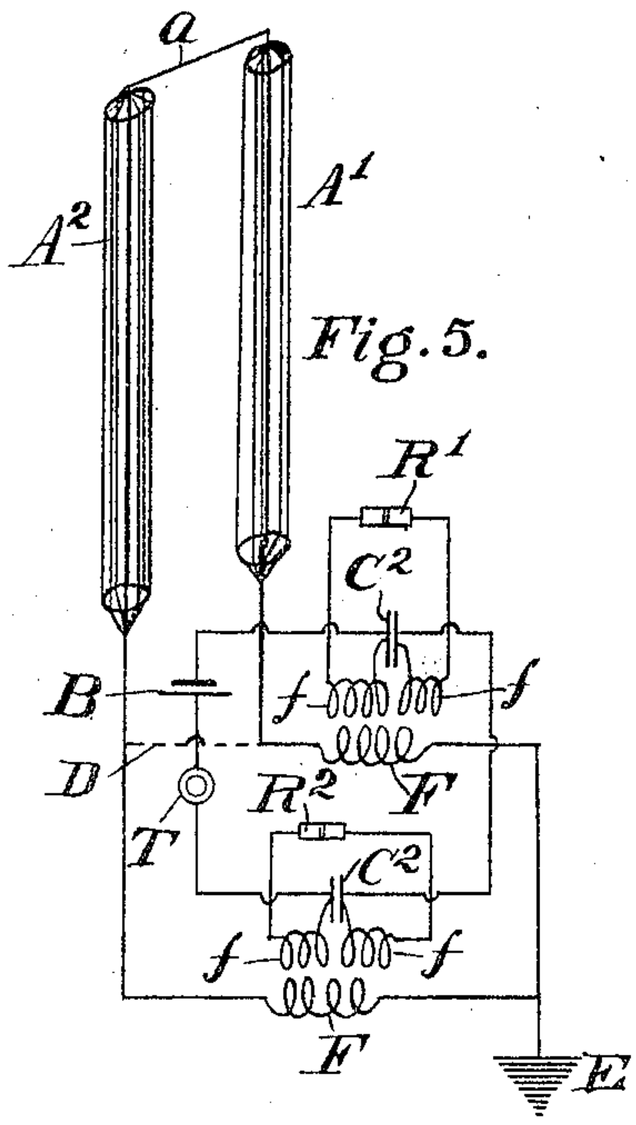

Fig. 5.

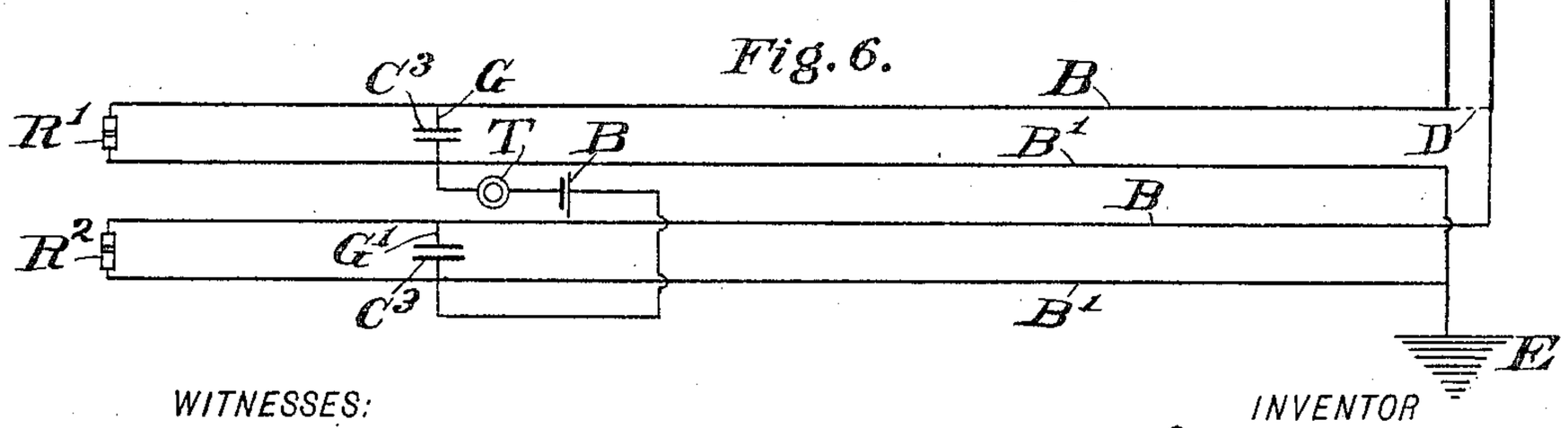

Fig. 6.

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WIRELESS SIGNALING APPARATUS.

No. 802,981. Specification of Letters Patent. Patented Oct. 31, 1905.

Application filed December 10, 1902. Serial No. 134,598.

To all whom it may concern:

Be it known that I, LEE DE FOREST, a citizen of the United States, and a resident of the city of New York, borough of Manhattan, in the county and State of New York, have invented certain new and useful Improvements in Wireless Signaling Apparatus, of which the following is a specification.

This invention relates to improvements in wireless signaling, including the novel construction and arrangement of various parts of the apparatus, whereby with a given amount of power, messages may be reliably sent to greater distances than has hitherto been possible with the same amount of power. Also the connection of the antennæ in pairs in a circuit which is in effect a closed circuit as to the signal-produced waves, forms a good resonator capable of more perfectly picking up faint aerial impulses and of responding more strongly thereto than if ordinary open-ended antennæ. It is evident that such a result would enable a receiving apparatus to be operated to successfully receive signals when the intensity of the signal-waves is too weak to give any indication in an ordinary apparatus. From this it follows that the range of the apparatus is greatly increased.

My invention comprises a form of apparatus adapted to secure the above-mentioned results; and it consists of the novel features, parts, and combinations thereof, which will be hereinafter described and particularly pointed out in the claims. The accompanying drawings illustrate certain forms of apparatus adapted to secure these results and embodying my invention. These drawings are given merely as illustrations of practical methods of utilizing my invention and not as an exhaustive exhibit of devices which may be used.

Figures 1 and 2 show apparatus using two wave-sensitive members, but differing in the manner of using them. Fig. 3 shows an apparatus using four wave-sensitive members. Figs. 4 and 5 show duplex apparatus inductively acting upon the local circuit, but differing in their arrangement, and Fig. 6 shows a duplex apparatus using the Lecher system of resonant conductors.

In wireless telegraphy the available portion of the expanding field of force is in the form of a torus or cylinder having the sending-antennæ as its axis. Any one of a number of receiving-antennæ, if sufficiently separated from each other, is in an independent field, that is absorbs a certain amount of this radiated energy regardless of that absorbed by the others. I have found a separation of ten feet to give satisfactory results with wires one hundred and fifty feet long. If properly utilized this fact enables us to take advantage of an amount of the radiated energy proportional to the number of antennæ employed, which can thus be made as great as desired within the limits which practical construction and erection of antennæ will permit. The use of multiple antennæ also makes unnecessary the use of choke-coils in the local battery-circuit at the receiving-station. These coils are designed to prevent the shunting of the Hertzian waves from the aerial circuit to earth by way of the local circuit, instead of passing through the wave-sensitive member, that is, the coherer, responder or whatever equivalent device is employed. These coils at best are inefficient and do not, as ordinarily employed, completely suppress this shunting tendency. They also represent a dead or useless resistance in the local circuit which it is desirable to suppress. This I have succeeded in doing by my present invention. By so doing I have increased slightly the action of the aerially-received wave upon the wave-sensitive member, and in connection therewith am enabled to employ a plurality of such wave-sensitive members and to cumulate their effects upon the wave-indicating member, such for instance as a telephone-receiver. In other words the power to influence the indicating member is, at least approximately, directly proportioned to the number of wave-sensitive members employed.

In Fig. 1 is shown a double antennæ arrangement designed to cut into the advancing wave, A′ representing the main antenna, which consists preferably of a number of wires or a harp, to better attain this end. The second antenna A^2 is shown as consisting of a single wire, which is insulated and separated from the other antenna A′ except for a connection A at their upper ends. It is intended that the plane of the antennæ corresponds with the plane of the advancing wave, that is, be perpendicular to the direction of propagation. In this and all the other figures, B is the local battery, T a telephone-receiver or other indicating device, and E the earth connection, and R′, R^2, R^3 and R^4 the wave-sensitive mem-

bers employed such as a responder, coherer or other like device. It will be seen that the local circuit is completed through the antennæ and the conductor *a*, connecting their upper end. No choke-coils are used as there is no shunt-circuit about the wave-responsive device and the reason for their use does not exist. It is true that a small portion of the advancing wave is intercepted by the antenna A^2 and led to earth through the battery B, and telephone T, but this does not affect the energy received by the main antenna A′, if the two are sufficiently separated. If A′ is in the form of a "bird-cage," as shown, the wire A^2 may be a single wire placed in the axis of the other antenna, and thus be shielded from the waves.

When the antennæ herein shown are employed for transmission, or as radiating antennæ, they are connected at their bases as indicated in the various figures by a conductor represented by the dotted line D, so that they act as a single radiating antenna and there is no loss as there would be if one or more wires were retained connected to earth as shown.

In Fig. 2 is shown a double antennæ arrangement with a separate wave-sensitive device for each placed between its base and the earth and influenced only by the impulse received therefrom. The wave-sensitive members are thus in parallel as regards the aerial waves, but in series as regards the local circuit. If each be acted on but feebly the effect upon the indicating member in the local circuit is the combination or sum of the effects upon all the wave-sensitive members. The result is a clear and positive indication of the signal impulse when it is so feeble that with a single wave-sensitive member it would be inappreciable or very uncertain. The condenser C in the shunt-circuit permits free passage to earth of the signal-transmitting oscillations developed in the antenna A^2.

In Fig. 3 is shown an arrangement which is substantially the same as that shown in Fig. 2, four antennæ A′, A^2, A^3 and A^4 with four separate wave-sensitive members R′, R^2, R^3 and R^4, one for each antenna, being employed. Condensers C and C′ permit free passage of the high-potential signal-transmitting waves to earth, but interpose an effective barrier to the low-potential current from the battery B of the local circuit. The antennæ are connected at their upper ends in pairs and successive pairs are connected at their lower ends. The local circuit is in turn up and down successive antennæ, including in turn all the wave-sensitive members R′, R^2, R^3 and R^4. These are in parallel as to the aerial circuits, but in series as to the local circuit so that the effects upon all are added to produce an intensified effect upon the wave-indicating member. The number of antennæ may be made any even number within practical limits of construction; and if sufficiently separated the effect upon the indicating device will be approximately proportional to the number of antennæ and wave-sensitive members used.

Figs. 4 and 5 show the principle of my invention applied to transformer devices, the primaries F being in the aerial circuits and the secondaries *f* in whole or in part in the local circuit. Condensers C^2 enable a shunt-circuit to be provided for the aerially-induced waves, while interposing an effective barrier to the passage of the local current.

In Fig. 6 I have shown my invention as applied to a syntonic system consisting of Lecher conductors B, B′. The wave-sensitive members R′, R^2 are placed between the parallel conductors at a point corresponding with a loop of the electromagnetic waves, and bridges G, G′ connect the conductors of each system at points corresponding to nodes of the waves. These bridges contain condensers, and the indicating member T, and battery B are placed in a conductor connecting nodal points of the two systems. The local circuit is completed through the outer portions of conductors B′, the wave-sensitive members R′, R^2, the conductors B, the antennæ A′, A^2 and the connection *a* at their top. I have found a further additional advantage to follow from the use of a plurality of antennæ connected at the top, namely that if one antenna is freely connected with the earth, that is if its connection with the earth be other than through a wave-responsive device, or in such manner that the resistance between the other antenna and the earth is less by this connection than through the wave-responsive device, it acts as a path for the free discharge of the atmospheric electricity which otherwise is apt at times to cause much disturbance in the receiving apparatus and false signals due to its passage through the wave-responsive devices. Such a connection may consist of a wire supplied for this purpose alone and without any intention of using it as an antenna.

In Fig. 1 I have shown a shunt connection about the battery B, and telephone T, said shunt containing a condenser C which prevents short-circuiting the battery without interfering with the free passage of the atmospheric electricity. This would be necessary in such a construction as is shown in Fig. 1 only when it was desired to be able to cut out the resistance of the battery and telephone. In Fig. 2 I have shown a shunt H extending about the wave-responsive device and containing a switch I so that it may be used or not as desired.

My invention may be applied to substantially any form of wireless signaling system. I have, however, not attempted to herein illustrate it except in a few arrangements sufficient to make clear the principle involved and the manner of applying it. I do not, however, wish to be understood as limiting my in-

vention to the forms of construction shown, but to claim it as embodied in any practicable construction. The scope of my invention is to be determined by an inspection of the claims hereunto attached, in considering which the omission of any feature or element or the failure to qualify any element is to be taken as a positive statement that such feature or element or qualification thereof is not essential to the invention as therein claimed.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. A wireless signal-receiving system comprising a plurality of wave-collectors, a wave-responsive device between each collector and the earth, conductors connecting the upper ends of the wave-collectors in pairs, a shunt connection between the earth connections of said wave-collectors, and an indicating mechanism in said shunt connection.

2. A wireless signal-receiving system comprising a plurality of wave-collectors connected at their upper ends in pairs, a wave-responsive device in the circuit of each collector, an indicating mechanism and a local circuit containing the wave-responsive devices and the indicating mechanism in series.

3. A wireless signal-receiving system comprising two wave-collectors connected at their upper ends, a single earth connection therefor, and wave-responsive devices in series with said collectors.

4. A wireless signal-receiving device having a pair of collecting-antennæ connected at their upper ends, a common ground therefor, wave-responsive devices adapted to each be affected by waves from its respective collector, an indicating device, and a local circuit containing said indicating device and the wave-responsive devices.

5. A wireless signal-receiving system comprising a plurality of collecting-antennæ connected at their upper ends in pairs, a syntonic system for each antenna consisting of a pair of conductors constituting a Lecher system, wave-responsive devices connecting the conductors of each pair at a point substantially corresponding with a loop of the waves created therein and a local circuit containing an indicating instrument connecting the conductors of different pairs substantially at nodal points of the said waves.

6. A wireless signal-receiving system comprising a plurality of collecting-antennæ connected at their upper ends in pairs, a syntonic system for each antenna consisting of a pair of uniformly-spaced conductors one of which is connected with its antenna, a common ground for the other conductors of all the pairs, a wave-responsive device connecting the conductors of each pair at a point corresponding substantially with a loop of the waves created therein, and a local circuit containing an indicating device connecting the conductors of different pairs substantially at nodal points of the said waves.

7. A wireless signal-receiving system comprising a plurality of wave-collecting antennæ connected at their upper ends in pairs, a system of syntonic conductors for each antenna consisting of a pair of conductors which are a multiple of a quarter wave length and are uniformly spaced between nodal points of the waves therein, wave-responsive devices connecting each pair of conductors, and a local circuit containing an indicating device connecting each pair of conductors substantially at nodal points and including therein the wave-collectors.

8. In a receiving apparatus for wireless signaling, the combination with a collecting-antenna of a leakage-conductor for atmospheric electricity connecting the upper portion of the antenna with the earth.

9. In a receiving apparatus for wireless signaling, the combination with a collecting-antenna, a wave-responsive device and an earth connection therefor, of means for independently connecting the upper part of the antenna with the earth.

10. In a receiving apparatus for wireless signaling, the combination with a collecting-antenna and a wave-responsive device in series therewith, of a ground connection from the upper part of the antenna to the earth of less resistance than through the wave-responsive device.

11. In a receiving apparatus for wireless signaling, the combination with a plurality of collecting-antennæ, a wave-responsive device connected with each antenna, and a shunt connection adapted to cut out one of said wave-responsive devices.

12. In a receiving apparatus for wireless signaling, the combination with a pair of collecting-antennæ connected at their upper ends, and wave-indicating mechanisms between said antennæ and the earth, of a shunt connection for one of said antennæ adapted to cut out the wave-indicating mechanism from the earth connection thereof.

13. A double antennæ for wireless telegraphy, which consists of a plurality of wires in each side.

14. A wireless-telegraphy system, which comprises a double antennæ having an earth connection through a condenser, and a local circuit in shunt to the condenser and including the double antennæ.

15. In a wireless-telegraph system, the combination with a receiving-antenna, of a shunt connection to earth therefrom, of less resistance than the antenna, to permit the shunt discharge of atmospheric electricity.

16. In a wireless-telegraph system, the combination with a receiving-circuit, comprising a double antennæ connected together at their upper ends but insulated from each other otherwise and at their bases; of a local

signal-indicating circuit in operative relation with said receiving-circuit and including a source of electromotive force; and a condenser arranged to prevent the short-circuiting of the local electromotive force.

17. In a wireless-telegraph system, the combination with double antennæ connected together at their upper ends but insulated from each other otherwise and at their bases; of a transformer having its primary connected in one of the antennæ; and a local signal-indicating circuit including the secondary of said transformer.

18. In a wireless-telegraph system, the combination with a receiving-circuit comprising a double antennæ, of a local signal-indicating circuit operatively associated with said receiving-circuit, and a plurality of wave-responsive devices connected together in parallel with each other in said receiving-circuit, and in series with each other in said local circuit.

In testimony whereof I have hereunto affixed my signature, this 4th day of December, 1902, in the presence of two witnesses.

LEE DE FOREST.

Witnesses:
H. L. REYNOLDS,
HUGO LOUIS BEIL.