L. DE FOREST.

WIRELESS TELEGRAPHY.

APPLICATION FILED JUNE 20, 1906.

1,101,533.

Patented June 30, 1914.

4 SHEETS—SHEET 1.

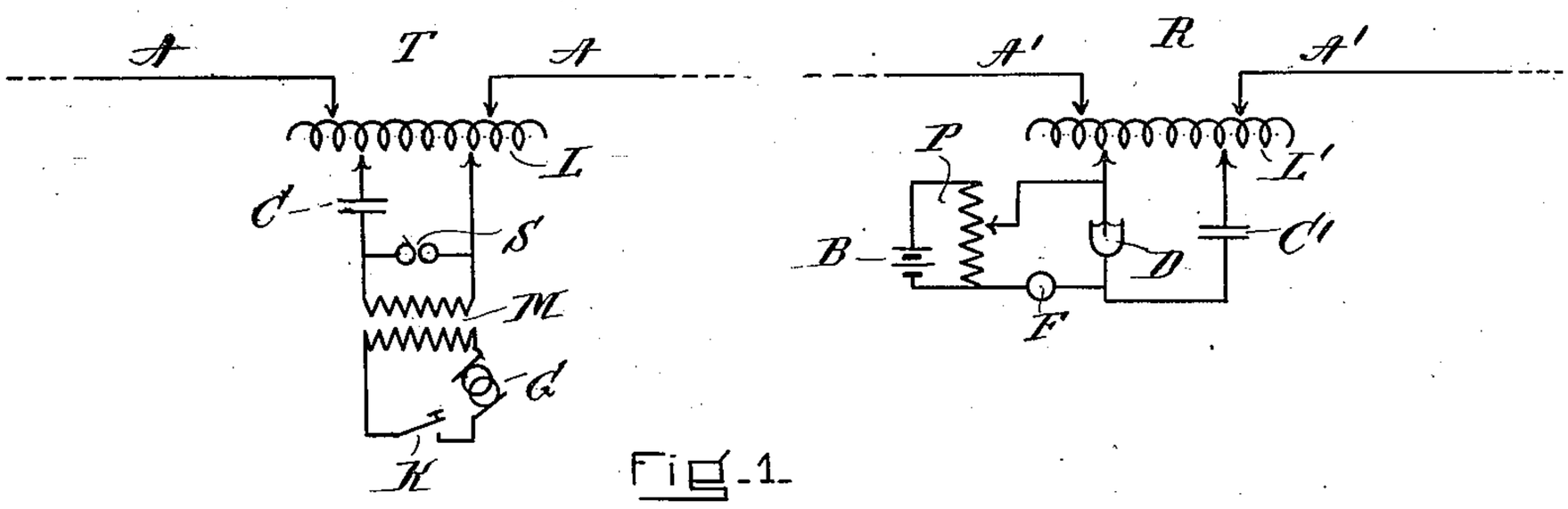

Fig. 1.

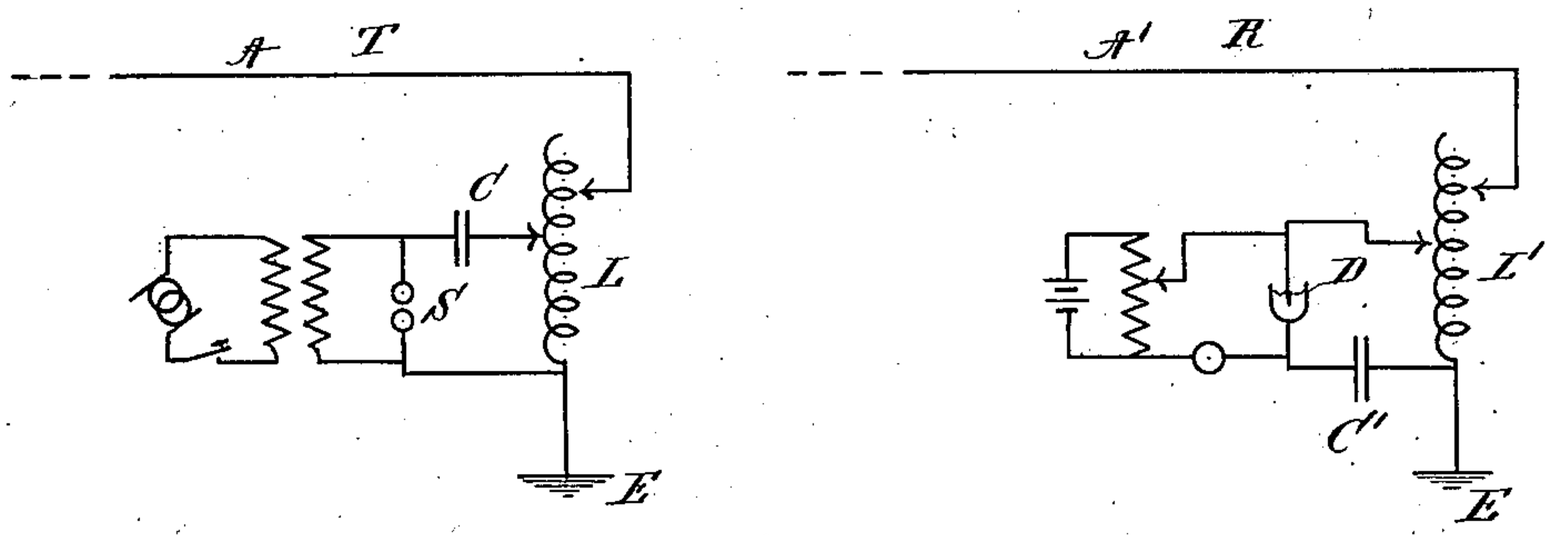

Fig. 2.

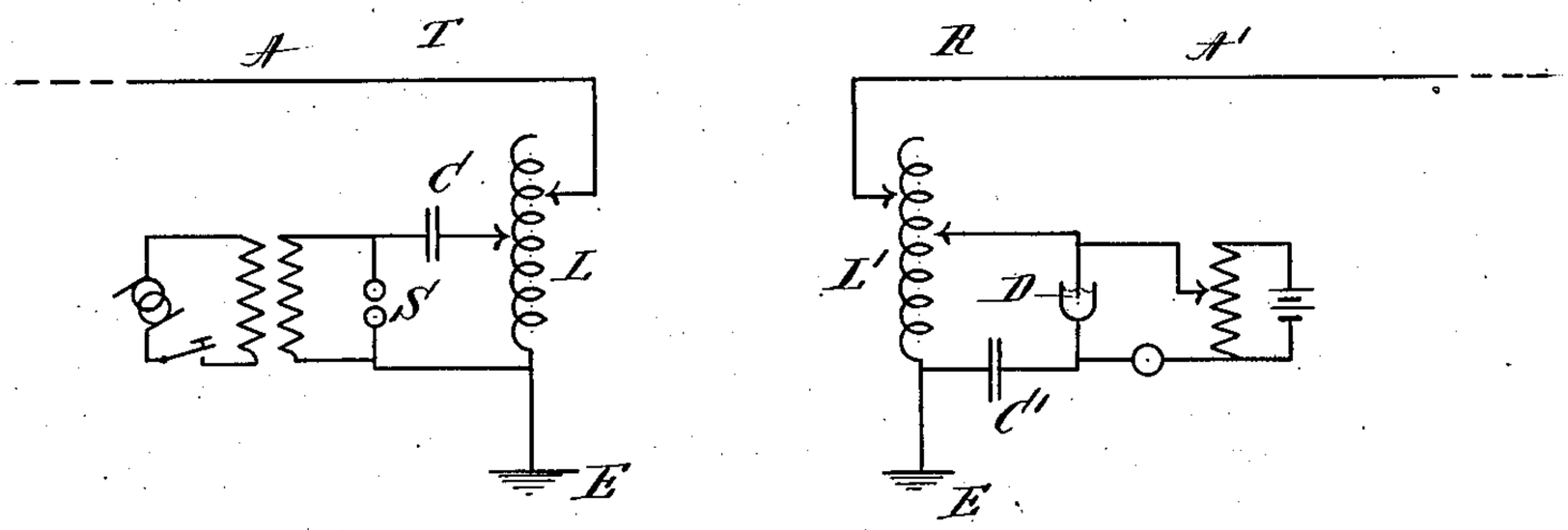

Fig. 3.

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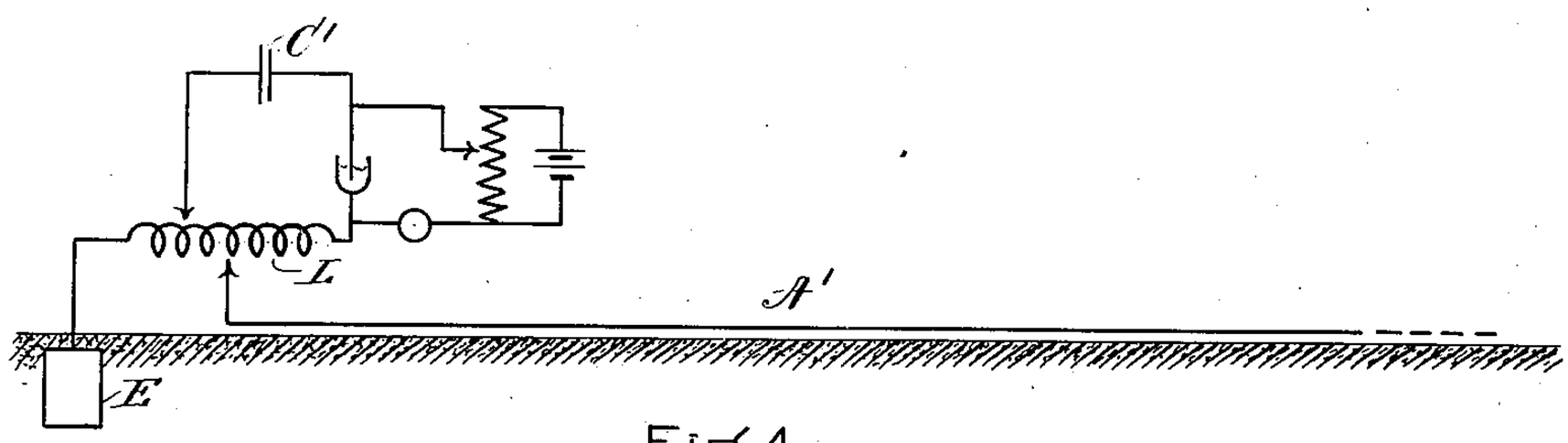

Fig. 4.

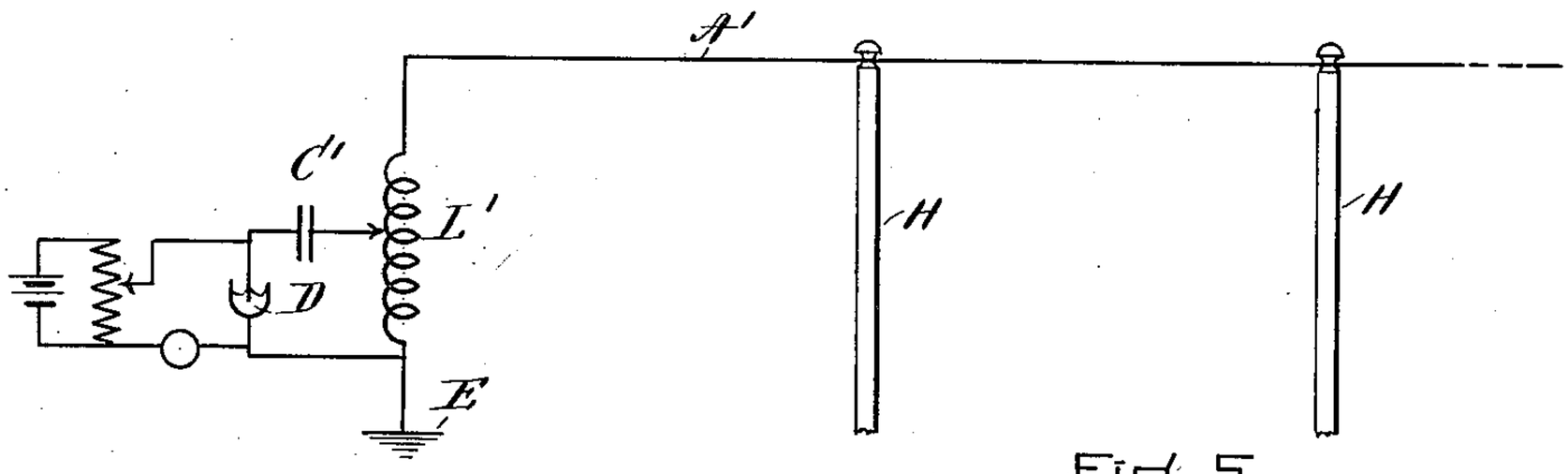

Fig. 5.

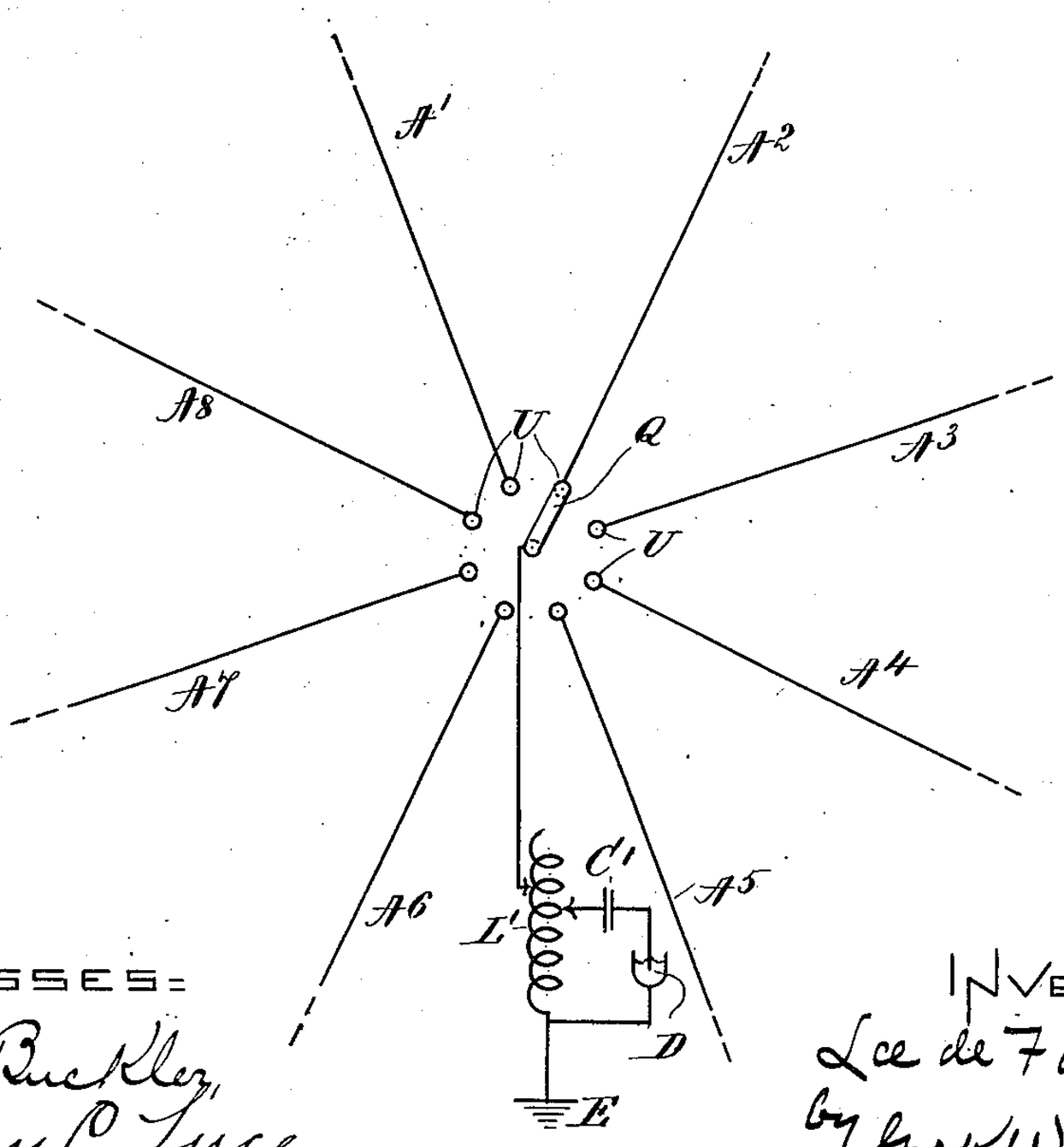

Fig. 6.

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4 SHEETS—SHEET 3.

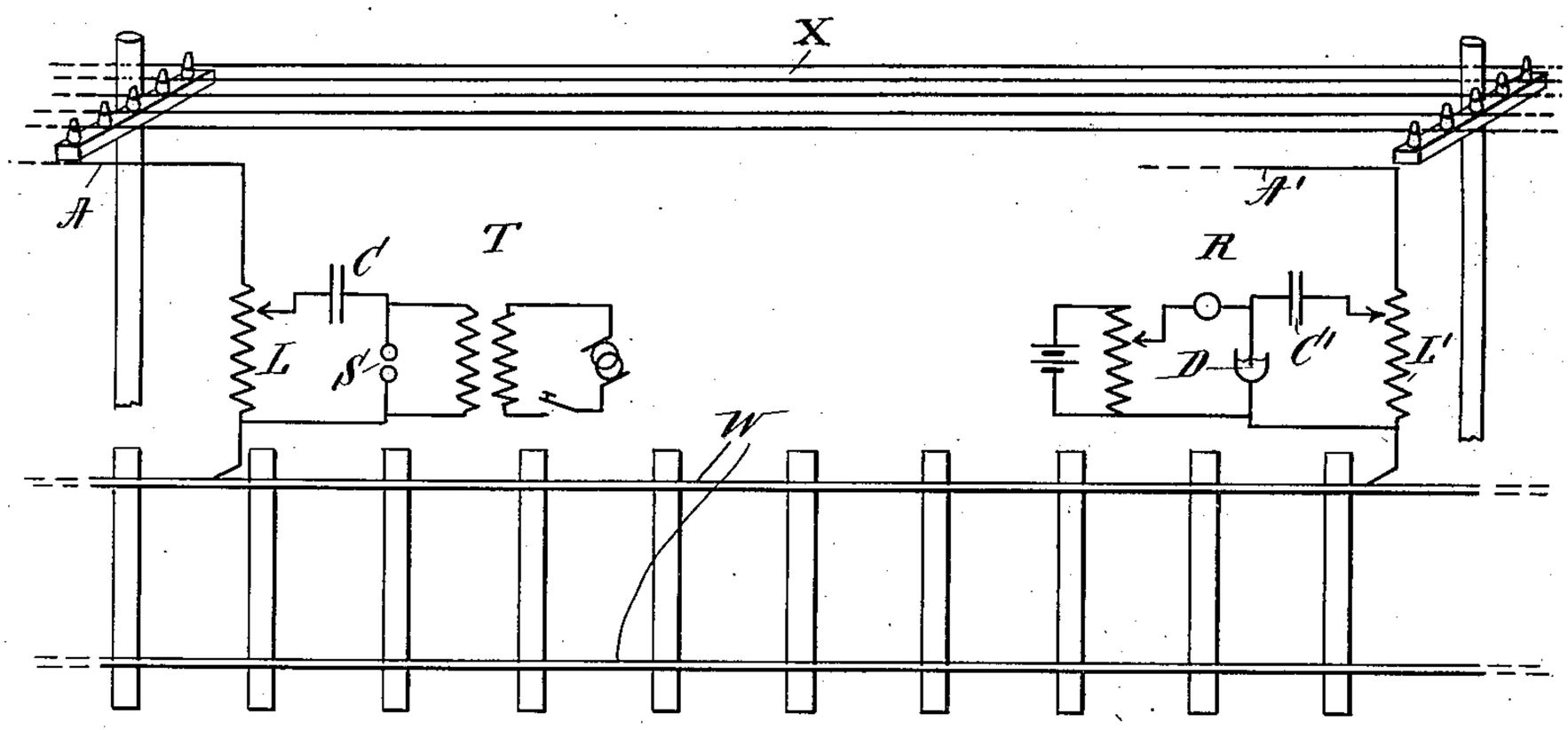

Fig. 7.

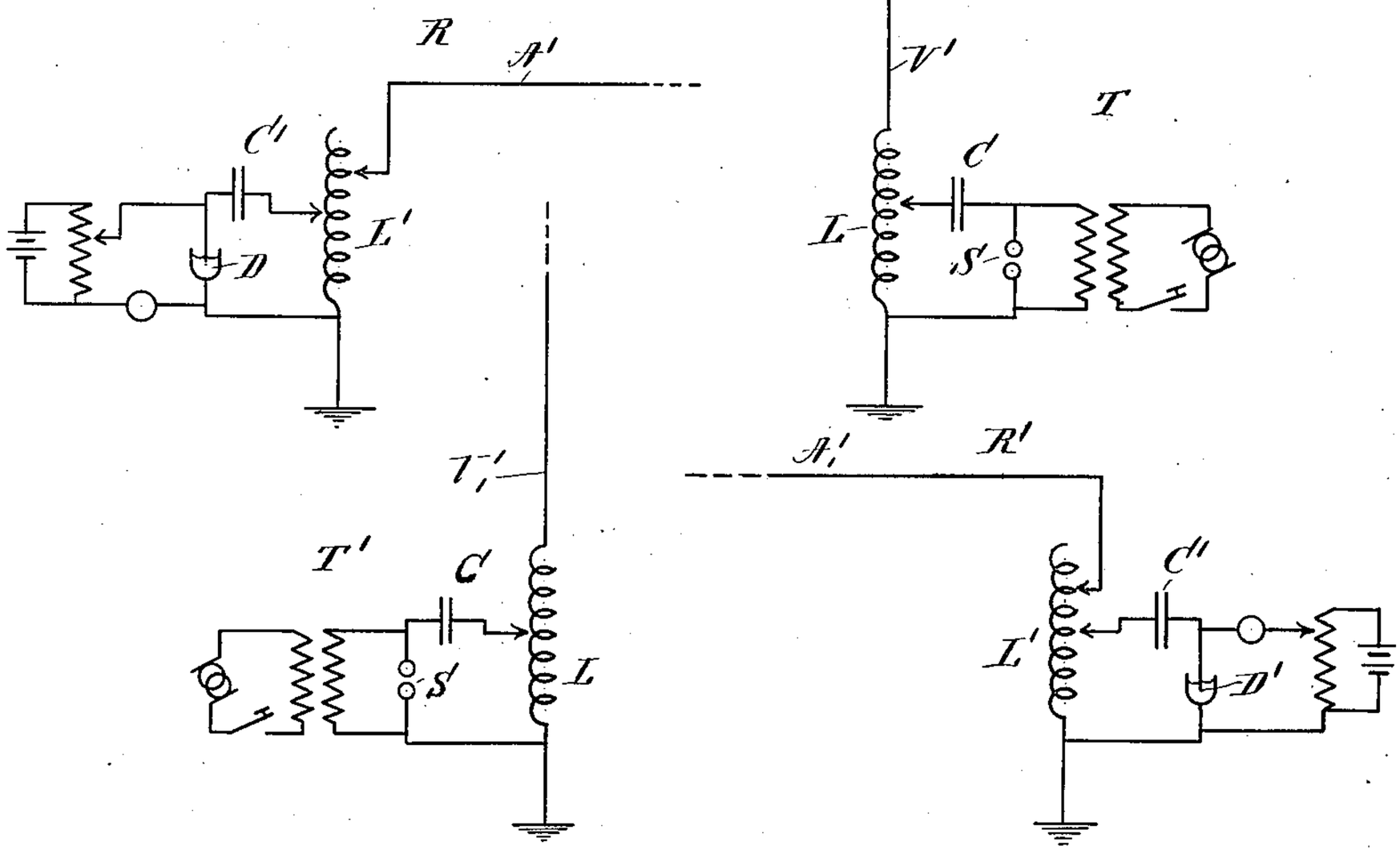

Fig. 8.

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4 SHEETS—SHEET 4.

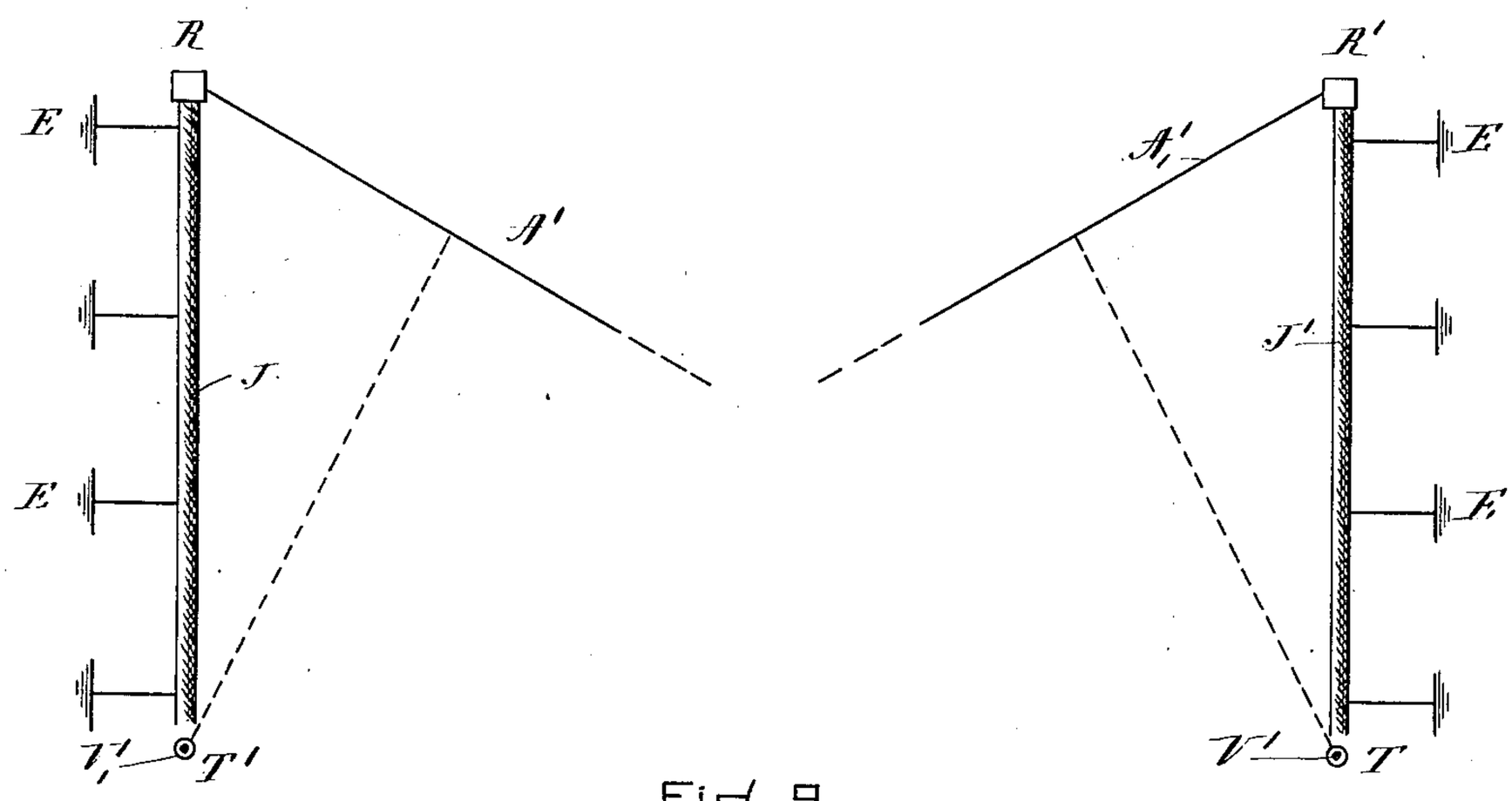

Fig. 9.

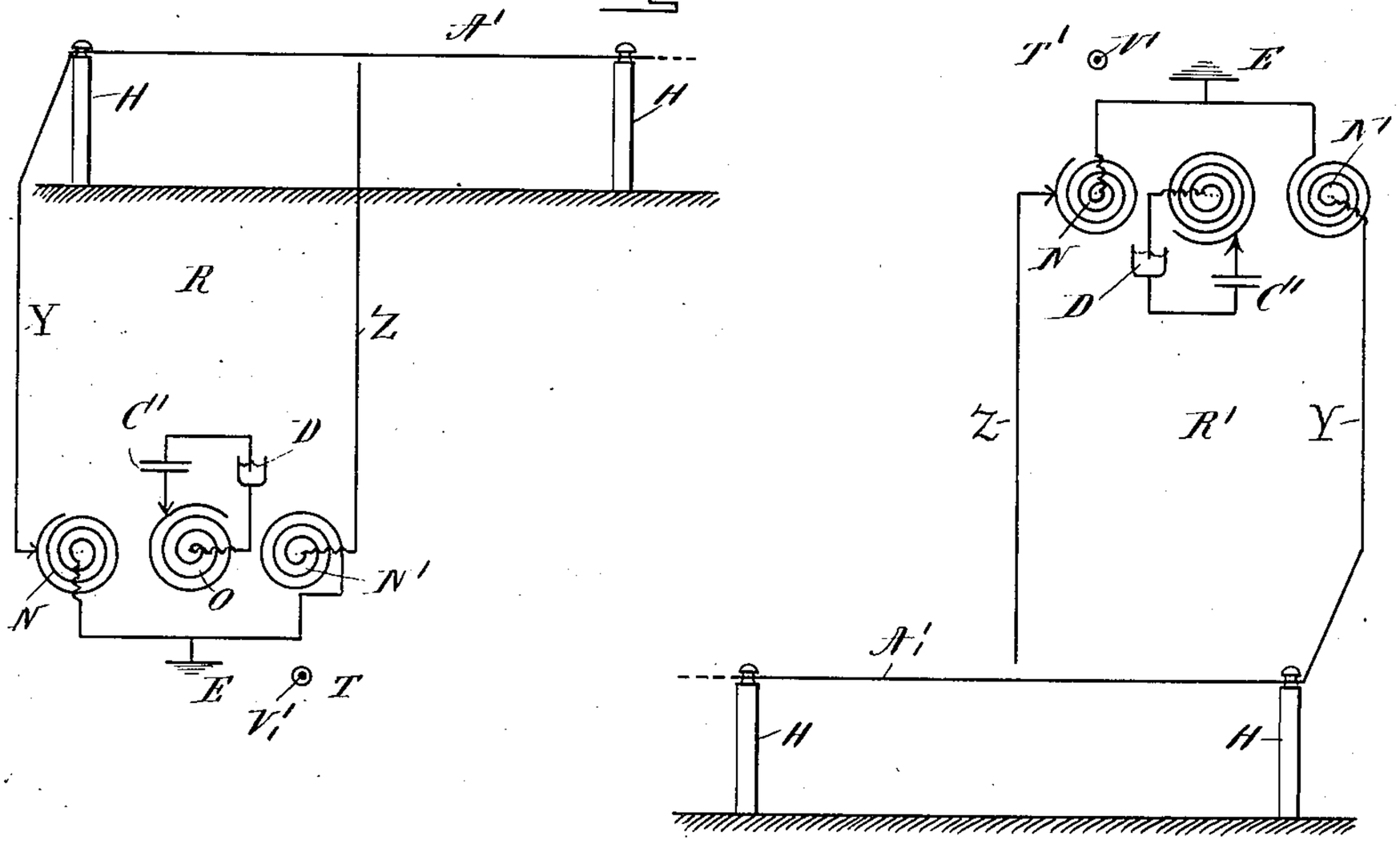

Fig. 10.

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UNITED STATES PATENT OFFICE.

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WIRELESS TELEGRAPHY.

1,101,533. Specification of Letters Patent. Patented June 30, 1914.

Application filed June 20, 1906. Serial No. 322,534.

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 Wireless Telegraphy, of which the following is a specification.

My invention relates to wireless telegraphy and the objects of my invention are to provide transmitting and receiving systems whereby the radiation of electromagnetic signal waves may be concentrated in a definite general direction and whereby the general direction from which the electromagnetic signal waves which operate a receiving device emanate may be determined; to increase the efficiency of transmission of electromagnetic waves over land; and to increase the efficiency of duplex working.

The principles upon which my invention is based are illustrated in the drawings, which accompany and form a part of this specification and which show in diagram several embodiments of my invention which have proven efficient in practice; but it is to be understood that I do not limit myself to the particular circuits and systems herein shown inasmuch as many modifications may be made therein without departing from the principle of my invention.

In the drawings, Figures 1, 2, 3 and 7 represent wireless telegraph systems each comprising a transmitting system at one station and a receiving system at another station. Figs. 4, 5 and 6 represent receiving systems. Figs. 8, 9 and 10 represent duplex wireless telegraph systems, each comprising a transmitting and a receiving system at each station.

In the figures, A represents a horizontal or an approximately horizontal transmitting antenna; A′ A'_1 represent horizontal or approximately horizontal receiving antenna; V′ V'_1, represent vertical transmitting antenna; L L′ are inductances; C C′ are condensers; S is a spark gap; M is a high potential transformer; G is an alternator; K is a key; D is an oscillation detector; F is a telephone or signal indicating device; B is a battery; and P is a potentiometer.

T, T′, represent transmitting systems and R, R′, represent the corresponding receiving systems.

In Fig. 1 the preferably symmetrically-placed, horizontally-extending, transmitting antennæ A A at station T are shown as connected by the inductance L, which constitutes an auto-transformer, with the oscillating circuit S C L; and similar receiving antennæ A′, A′, at station R are connected by the inductance L′ to the receiving circuit L′ C′ D which is attuned to the frequency of the waves radiated by the antennæ A, A. Any suitable means however may be employed to create electrical oscillations in A, A, and any suitable system of circuits may be employed for conveying the oscillations created in A′, A′, to the oscillation detector D.

In Fig. 1 the antennæ are not connected to earth, while Figs. 2 and 3 show systems which are substantially the same as that of Fig. 1, except in Figs. 2 and 3 each antenna is grounded.

In Figs. 1, 2 and 3 the transmitting antenna A and the receiving antenna A′ extend in substantially the same direction so that each antenna A of station T is substantially a continuation of its corresponding antenna A′ at station R and the antennæ, consequently lie in substantially the same vertical plane.

In Fig. 2 the transmitting antenna A points directly away from the receiving station R and the receiving antenna A′ points directly toward the transmitting station T.

In Fig. 3, the transmitting antenna A is directed away from the receiving station R and the receiving antenna A′ points directly away from the transmitting station T.

Fig. 2 represents the preferred arrangement of antennæ and Fig. 3 represents the next best arrangement.

By arranging the antenna A in the manner shown in Figs. 2 and 3 the radiation from the transmitting systems is a maximum in the general direction of the receiving systems, and by directing the horizontally-extending receiving antennæ toward or away from the source of radiation, which source may be a vertical antenna, the response of the oscillation detector is a maximum. In this manner the general direction from

which signals emanate may be determined, whether the radiation source be a horizontal antenna or a vertical antenna. It will be understood of course that the antennæ A and A′ may be rotated about a vertical axis or, preferably, as shown in Fig. 6, a number of horizontally extending antennæ A^1, A^2, A^3, etc., may be used and a switch Q cooperating with the contacts U may be employed to connect any desired antenna with the oscillation detector circuit. While the antenna need not be horizontal, the directive effect becomes less noticeable as they approach the vertical.

The receiving antennæ A′ may be as long as desired for instance from 200 feet to one quarter of a mile in length, and they may be supported by relatively short poles H, H, as indicated in Fig. 5, so that the elevation of the antenna may be small as compared to their length. No supporting poles need be used when the ground is a poor conductor, and good results have been obtained by merely laying the antenna along the ground, as shown in Fig. 4.

In Fig. 7, W represents a railway track and X the telegraph wires which usually are strung on poles beside the track. The antennæ A and A′ are shown as placed near the telegraph wire and as grounded on the track. I have discovered that all longitudinal cross-country conductors, such as railway tracks and masses of telegraph or telephone wires act as wave-chutes and lead off the waves in the direction in which they extend, thus draining the ether of the wave energy in their immediate neighborhood. Thus if a transmitting system, having either a vertical or horizontal antenna, is operated in the immediate vicinity of a railway track and is grounded to the rails, or in the immediate vicinity of a line wire system, a maximum field of force will be created in the direction of said track or line wire system. Preferably, as shown in Fig. 7, horizontal transmitting and receiving antenna should be employed, the lower ends thereof being grounded on the track and the horizontal portions paralleling the track and line wires in which case an enormous field of force will be concentrated between the two parallel conducting systems. By this means the distances by which signals may be transmitted by electromagnetic waves overland may be greatly increased. The receiving apparatus will respond to the electrical oscillations created by said waves in the antenna A′, but as ascertained by experiment, will not respond to any induction effects which may be created in said antenna A′ by telegraphic or telephonic currents traversing the line wires X.

In Figs. 8, 9 and 10 the transmitting station may be placed at a relatively short distance from its home receiving station and may be situated approximately in the perpendicular bisector of the horizontally extending portion of the antenna of said home receiving station. Each receiving antenna A′, A'_1, preferably is directed toward its corresponding district transmitting station as indicated by dotted lines. By so arranging the antennæ practically no effect is produced on the horizontal antennæ A′, A'_1, by the radiation from the antennæ V'_1, V′, respectively, so that duplex working is rendered possible. Preferably the receiving operator is located at the transmitting station and the current variations produced in the circuit of the oscillation detector may be conveyed to the operator's head telephone by lead covered cable which may either be buried in the earth or carried by poles. If said cable is not buried it must be well earthed at both ends and at intermediate points, as shown in Fig. 9 in which J, J′, represent metal covered cables connecting the local circuits at R, R′, to the station houses T, T′.

Fig. 10 shows another way in which the signals received at R, R′ may be conveyed to receiving operators located at T T′. In this case the horizontal antenna is connected by the wire Y with one primary N′ and a dummy wire Z is connected with the other primary N, so that the strong signals transmitted from the home transmitting stations will be neutralized upon the secondary O and no effect will be produced upon the oscillation detector D. Weak signals from the district transmitting stations will develop currents in the secondary O which will cause the detector to respond.

I claim:

1. In a system of wireless telegraphy a substantially horizontal receiving antenna, divided into two parts, each connected to a detector between them, in correspondence with a substantially horizontal transmitting antenna in the same vertical plane.

2. In a system of wireless telegraphy a substantially horizontal receiving antenna, divided into two parts, each connected to a detector between them, in correspondence with a substantially horizontal transmitting antenna in the same vertical plane, and having its generator end nearer to the receiver than its tail end.

3. In a system of wireless telegraphy, a substantially horizontal transmitting antenna and a receiving antenna, said transmitting antenna being substantially in the vertical plane passing through said receiving antenna.

4. In a system of wireless telegraphy, a substantially horizontal receiving antenna and a transmitting antenna, said receiving antenna being substatially in the vertical

plane passing through said transmitting antenna.

5. In a system of wireless telegraphy, a substantially horizontal transmitting antenna and a substantially horizontal receiving antenna, said antennæ lying in substantially the same vertical plane.

In testimony whereof, I have hereunto subscribed my name this 11th day of June 1906.

LEE DE FOREST.

Witnesses:
A. H. HOOD,
D. S. TOVELL.