Jan. 2, 1923.

1,440,834.

C. V. LOGWOOD.

RADIOCOMMUNICATION.

FILED JULY 2, 1921.

2 SHEETS—SHEET 1.

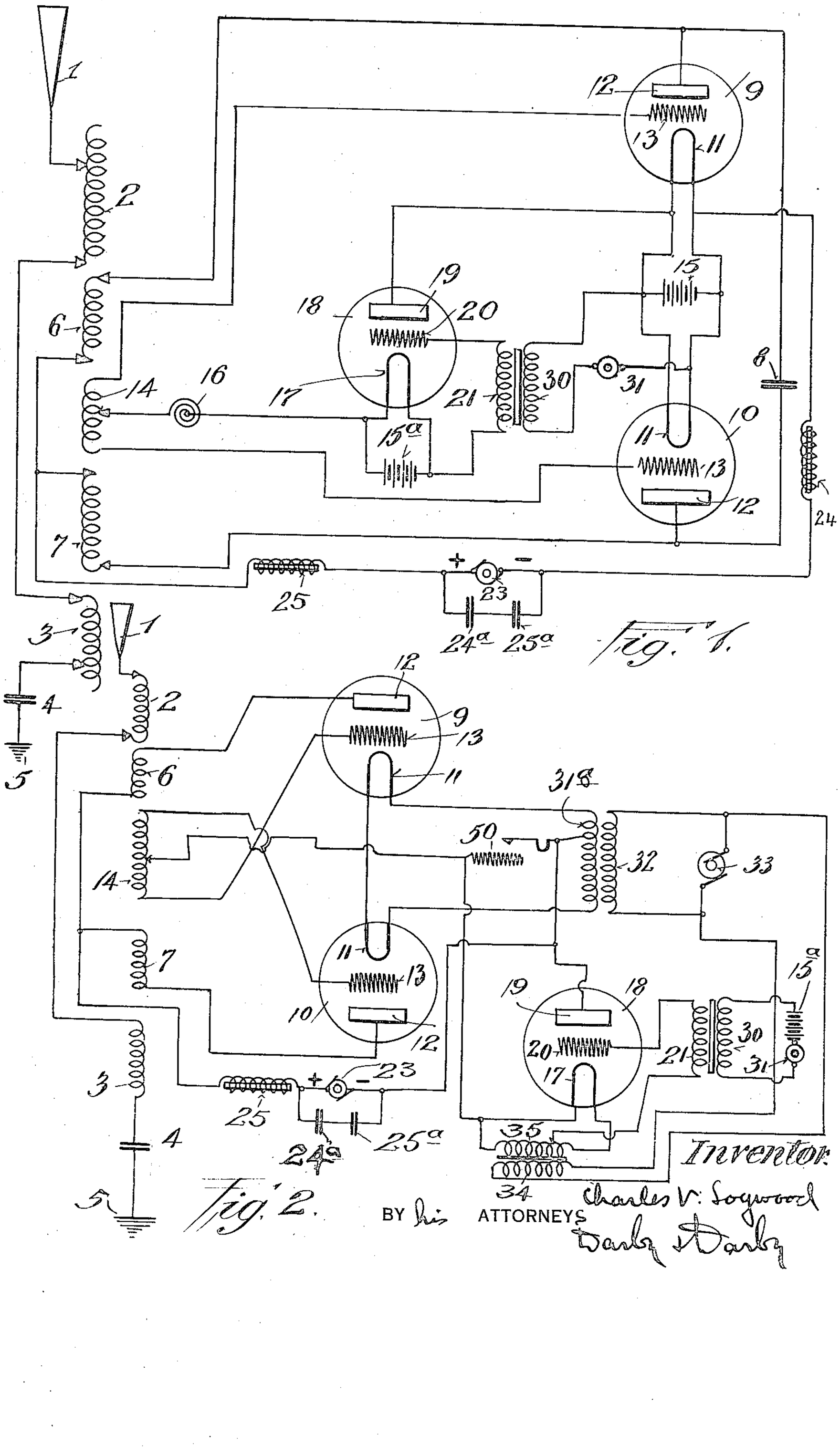

Fig. 1.

Fig. 2.

Inventor:
Charles V. Logwood
BY his ATTORNEYS
Darby & Darby

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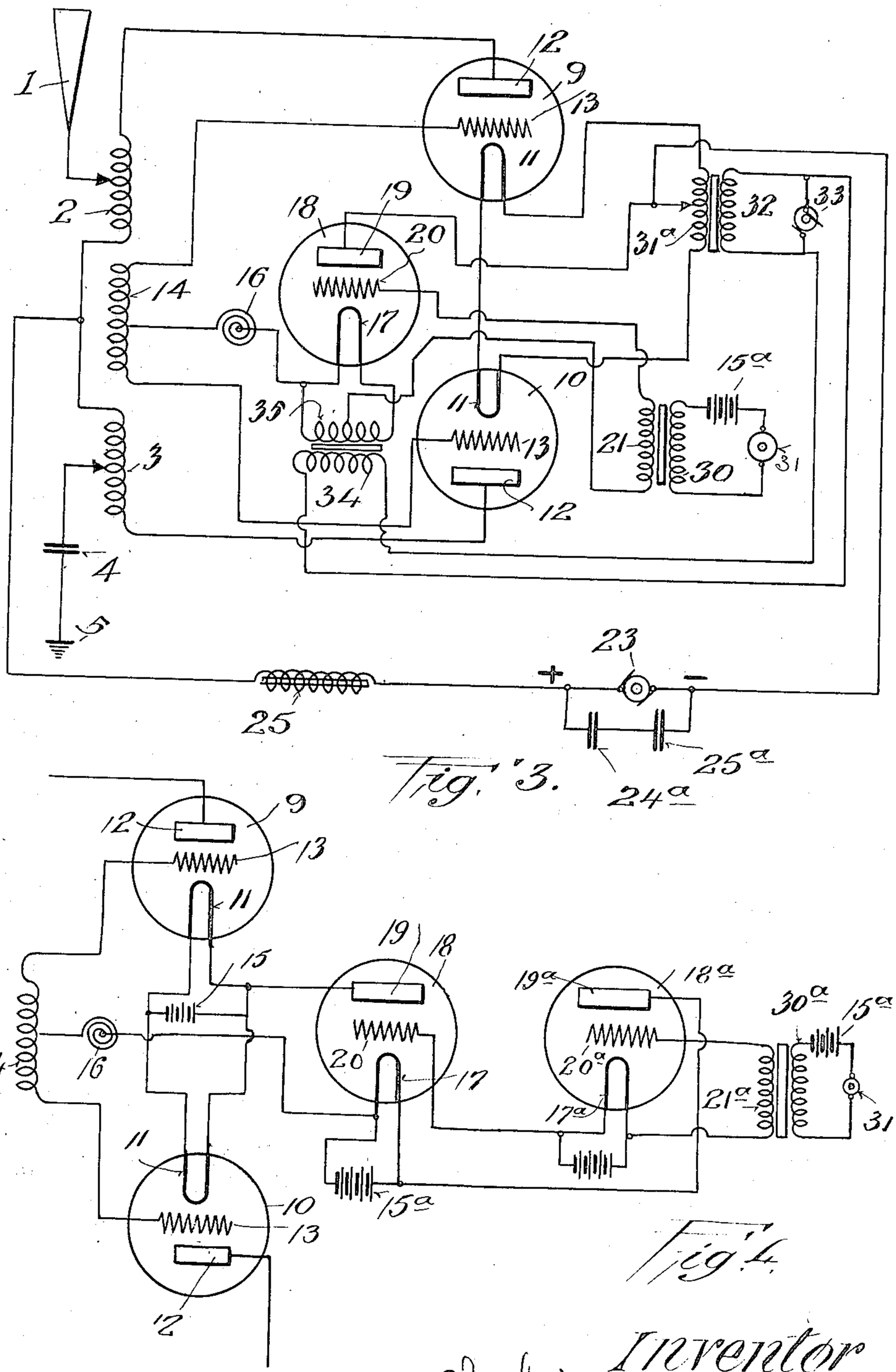

Fig. 3.

Fig. 4.

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Charles V. Logwood
BY his ATTORNEYS
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Patented Jan. 2, 1923. 1,440,834

UNITED STATES PATENT OFFICE.

CHARLES VEYNE LOGWOOD, OF CHICAGO, ILLINOIS, ASSIGNOR TO DE FOREST RADIO TELEPHONE & TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

RADIOCOMMUNICATION.

Application filed July 2, 1921. Serial No. 482,035.

To all whom it may concern:

Be it known that I, CHARLES V. LOGWOOD, a citizen of the United States, residing at Chicago, in the county of Cook, State of Illinois, have made a certain new and useful invention in Radiocommunication, of which the following is a specification.

This invention relates to radio communication, and is particularly directed to systems that are employed for the transmission of signals through the medium of high frequency currents.

The object of the invention is to provide a signaling system which is simple and efficient and economical in manufacture.

A further object of the invention is to provide a system of the character set forth wherein the electrical power of radiation is materially increased.

A further object of the invention is to provide a system which will lengthen the distance of transmission of signals, such as wireless telephone, without distortion, to a distance greater than has heretofore been obtained with simple non-complicated circuits.

Further objects of the invention will appear more fully hereinafter.

My invention consists substantially in the combination, construction, location and relative arrangement of parts and circuits employed in connection therewith, all as will be more fully hereinafter set forth, as shown in the accompanying drawings and finally pointed out in the claims.

Referring now to the drawings,—

Fig. 1 is a diagrammatic view illustrating a circuit arrangement embodying my invention, showing the same in connection with a wireless telephone transmitter system;

Fig. 2 is a similar view for a slightly modified arrangement showing in addition to the telephone circuit a wireless telephone transmitter system;

Fig. 3 is a similar view showing a still further modified arrangement; and

Fig. 4 is a similar view showing a modification of the type of resistance path that is employed in accordance with my invention.

The same part is designated by the same reference character wherever it occurs throughout the several views.

Referring to Fig. 1, I show an insulating circuit of the open radiating type, comprising the antenna 1, the inductances 2, 3, condenser 4, and earth connection 5. The primary circuit includes inductances 6 and 7, inductively associated with inductances 2, 3, of the radiating circuit and condenser 8, and vacuum tubes 9 and 10. Each of the vacuum tubes contain or have associated therewith the usual three electrodes, namely, the filament electrode 11, and the plate electrode 12 and the intermediate or grid electrode 13. The grid electrodes of the two tubes 9, 10, are connected to each other through the inductance 14, which is inductively associated with the coils 2, 6, 7 and 3, as shown. The vacuum tubes 9 and 10 are connected in shunt to the coils 6, 7, and the condenser 8. The filament electrodes 11 of the vacuum tubes 9 and 10 are connected in parallel, and are heated from a common source, for example, the battery 15. All connections to the inductances 2, 6, 7 and 3 are adjustable, as indicated, and the inductance 14 has an adjustable tap connection including a choke coil 16 leading to the filament electrode 17 of a vacuum tube 18, which filament electrode 17 is heated from a suitable source, for example, battery 15ª. The plate electrode 19 of vacuum tube 18 is connected to one leg of the filaments 11 of the tubes 9, 10. The grid electrode 20 of the vacuum tube 18 is connected to its filament 17 through the transformer coil 21. With this arrangement it will be apparent that there is no conductive connection between the grid electrodes 13 of vacuum tubes 9 and 10 and any other electrode or electrodes thereof, the only connections effected being the inductive relation between the grid and plate electrodes and the high resistance leakage path existing between the filament and the plate electrodes of the vacuum tube 18 in the evacuated vessel thereof. Current is supplied to the plate electrodes 12 of the vacuum tubes 9, 10, from a suitable source of current, for example, generator 23, shunted by condensers 24ª, 25ª. One terminal, usually the negative terminal of the current source 23, is connected to one leg of the filaments 11 of the vacuum tubes 9 and 10, through the choke coil 24, and the other terminal is connected through the choke coil 25 to the respective plate electrodes 12 of the vacuum tubes 9 and 10, thereby constituting the usual B battery circuit of the oscillating audion circuit. The choke

coils 25 and 24 tend to filter out excessive currents. Choke coil 16 prevents high frequency currents from passing through the leakage path and the condensers 24ª and 25ª absorb changes of commutator ripples.

I have found this circuit to be an exceptionally good oscillating circuit, giving a very high efficiency in power supply to the radiating circuit. The plate electrodes of the vacuum tubes 9 and 10 being fed by a supply of current from a generator 23, causes a change of potential in the grid electrodes 13 of the vacuum tubes 9 and 10, by inducing an opposite potential, thereby causing the current to increase or decrease in the plate electrodes 12 of the respective tubes 9 and 10. An increase of positive potential on one grid electrode 13 increases the plate current, while in the other tube a negative charge is impressed on the grid, which further deflects the current to the other tube until the oscillation completes the cycle and reverses the process causing a shift of the polarity which in turn reacts throughout the circuit. Thus it will be seen that the grid electrode 13 of one tube is always influenced by the opposite tube. It will be apparent that through the operation of oscillation there is a necessity for equalizing the negative charge on the grid electrodes 13, and to accomplish this I employ a resistance. It is obvious that a high resistance is necessary, and, for that reason, I employ the resistance represented by the evacuated space between the filament 17 and the plate 19 of the vacuum tube 18. The current source 15ª which heats the filament 17 of the vacuum tube 18 is isolated from the ground and is connected through the choke coil 16 to the grid electrodes 13 of the vacuum tubes 9 and 10, as hereinbefore described. Thus a positive potential is impressed on the plate electrode 19 of the tube 18 from a current source 15 employed for heating the filaments 11 of the tubes 9 and 10, so that the internal resistance of the tube is sufficient to prevent short circuiting the filaments 11 to grids 13, as in power transmission sets this must be avoided, and excessive grid currents must necessarily be checked. Where the system is to be employed for telephone transmission, the primary coil 30 which is inductively associated with the coil 21 connected between the grid 20 and filament 17 of vacuum tube 18, is connected through microphone 31, which derives its current as illustrated, though to these variations I do not desire to be limited or restricted, from the current source 15, which is employed to heat the filament 11 of the vacuum tubes 9 and 10. When words are spoken in the microphone 31, currents are induced through the transformer 30, 21, to the grid 20 of vacuum tube 18, thus stopping or increasing the leak current which passes from the filaments 11 of vacuum tubes 9 and 10 through the plate electrode 19 of tube 18 to the grid electrodes 13 of vacuum tubes 9 and 10. Thus the variations of wave forms cause speech to be transmitted through the radiating system 1 to 5, and, of course, at the receiving end accordingly.

With this circuit I have found it possible to transfer through the prima y oscillating circuit with only 8 micro-henries of inductance with an efficiency of 60 per cent output to input, using a capacity of .008 microfarads across the plates. This inductance corresponds to one and a half turns of a helix 8 inches in diameter, thus a frequency of two million is easily obtained without any damage to the power tubes employed for generating the high frequency currents.

I have found that it is advisable that the tubes 9 and 10 be so associated to the inductances employed that the plate of one tube is always influenced by the grid of the other tube with a capacity of .01 microfarads. I have obtained a wave length from 200 to 5,000 meters without changing any of the constants of the circuit other than the inductance in each plate circuit, and employing an inductive grid circuit as shown with a period of only 200 meters.

In Fig. 2 I show a substantially identical arrangement as shown in Fig. 1, varying therefrom only in diagrammatic illustration, illustrating the application of the system to wireless telegraphy, and also to show a modification as to the means employed for lighting the filaments of the respective vacuum tubes 9, 10 and 18. It will be observed that the circuit arrangements of the vacuum tubes 9 and 10 are the same in this figure as described in connection with Fig. 1, with the vacuum tube 18 connected between the grids and filaments of the respective vacuum tubes 9 and 10, as hereinbefore described. In this instance, however, the filaments 11 include in the circuit thereof one coil, 31ª, of a transformer, the second coil, 32, of which is connected in shunt around the terminals of an alternating current generator 33, whereby alternating current is supplied through a transformer 32, 31ª, to the filaments 11, to light the same. Alternating current 33 is also connected in shunt to the primary coil 34 of the transformer, the secondary coil, 35, of which is connected in series with the filament electrodes 17 of the vacuum tube 18 whereby the filament 17 is supplied with heating current, as will be obvious. In this arrangement the microphone 31 is connected in a microphone circuit supplied with current from a suitable source such as the battery 15ª. When it is desired to use this circuit and system for radio telegraph transmission I have found it efficient to connect the telegraph key as shown between the grids 13 and the filaments

11, i. e., in the leak path of the vacuum tubes 9 and 10. In Fig. 3 an effort has been made to lay out the same circuit arrangement as that of Fig. 2, omitting the telegraph key 50, in the same diagrammatic scheme employed for the illustration of Fig. 1, whereby the similarity thereof will be readily apparent. I have also incorporated in this view the modification wherein the inductive coupling between the antenna earth circuit and the plate circuit of the vacuum tubes 9 and 10, is modified to a conductive coupling therebetween, thereby enabling the elimination of inductance coils 6 and 7.

In Fig. 4 I have shown an arrangement for effectively increasing sensitiveness of modulation effected by the microphones 31, where exceedingly high power is being generated by the oscillion system. In this arrangement the vacuum tubes 9 and 10 are connected through the resistance formed by the vacuum tube 18, to their respective filaments, but instead of the grid filament circuit of the vacuum tube 18 being directly controlled by the microphone, the grid electrode 20 is insulated from its filament by the vacuum of tube 18^a, the grid filament circuit 20^a, 17^a, thereof being directly controlled by the microphone circuit 15^a, 30, through the transformer 21^a, 30^a, the plate electrode 19^a being connected to the filament electrode 17 of vacuum tube 18.

Many other modifications and changes in details will readily occur to those skilled in the art without departing from the spirit and scope of my invention as defined in the claims and shown in the accompanying drawings, and I, therefore, desire to have the foregoing description and the drawings used in connection therewith regarded in an illustrative rather than in a limiting sense; but having now set forth the objects and nature of my invention, and having shown and described circuits showing the embodiment theroef, what I claim as new and useful and desire to secure by Letters Patent is:

1. A radio signaling system, comprising an antenna earth system, a plurality of vacuum tubes having hot and two or more cold electrodes, means for associating said cold electrodes with said antenna earth system, and with said hot electrodes, and a vacuum tube interposed between one set of cold electrodes and the filament electrodes whereby the space between the electrodes of said last mentioned vacuum tube constitutes a resistance in the circuit between said set of cold electrodes and the filament electrodes, and means for varying the conductivity of the space of the vacuum tube by and in accordance with signals.

2. A radio signaling system, comprising an antenna earth system, a plurality of vacuum tubes having hot and two or more cold electrodes, means for associating said cold electrodes with said antenna earth system, a circuit connecting one set of said cold electrodes with said hot electrodes including a high resistance, and means for varying said resistance by and in accordance with signals.

3. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein a resistance, and means for varying said resistance by and in accordance with signals.

4. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuited connected between said grid electrodes and said filament electrodes and including therein a resistance, and means for varying said resistance by and in accordance with signals, and means for associating said audions with said antenna earth system.

5. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein a resistance, and means for varying said resistance by and in accordance with signals, and means included in said plate and grid circuits for associating said audions with said antenna earth system.

6. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein a resistance, and means for varying said resistance by and in accordance with signals, and means included in said plate and grid circuits for associating said audions with said antenna earth system and with each other.

7. A radio signaling system comprising an antenna earth system, a plurality of audions having a plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit con-

necting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein a vacuum space, and means for varying the conductivity of said vacuum space by and in accordance with signals.

8. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein a vacuum space and means for varying the conductivity of said vacuum space by and in accordance with signals, and means for associating said audions with said antenna earth system.

9. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein a vacuum space, and means for varying the conductivity of said vacuum space by and in accordance with signals, and means included in said plate and grid circuits for associating said audions with said antenna earth system.

10. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein a vacuum space, and means for varying the conductivity of said vacuum space by and in accordance with signals, and means included in said plate and grid circuits for associating said audions with said antenna earth system and with each other.

11. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the separated electrodes of a vacuum tube, and means for varying the conductivity of the space between the electrodes of said vacuum tube by and in accordance with signals.

12. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the separated electrodes of a vacuum tube, and means for varying the conductivity of the space between the electrodes of said vacuum tube by and in accordance with signals, and means for associating said audions with said antenna earth system.

13. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the separated electrodes of a vacuum tube, and means for varying the conductivity of the space between the electrodes of said vacuum tube by and in accordance with signals, and means included in said plate and grid circuits for associating said audions with said antenna earth system.

14. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the separated electrodes of a vacuum tube, and means for varying the conductivity of the space between the electrodes of said vacuum tube by and in accordance with signals, and with each other.

15. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the filament and plate electrodes of an auxiliary audion, and means for impressing a signal current upon the grid electrode of said auxiliary audion.

16. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each

other, a circuit connected between said grid electrodes and said filament electrodes and including therein the filament and plate electrodes of an auxiliary audion, and means for impressing a signal current upon the grid electrode of said auxiliary audion, and means for associating said audions with said antenna earth system.

17. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the filament and plate electrodes of an auxiliary audion, and means for impressing a signal current upon the grid electrode of said auxiliary audion, and means included in said plate and grid circuits for associating said audions with said antenna earth system.

18. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the filament and plate electrodes of an auxiliary audion, and means for impressing a signal current upon the grid electrode of said auxiliary audion, and with each other.

19. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the separated electrodes of a vacuum tube, and means for varying the conductivity of the space between the electrodes of said vacuum tube by and in accordance with signals, and means for heating the hot electrodes of said audions and said vacuum tube from the same source of current.

20. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the separated electrodes of a vacuum tube, and means for varying the conductivity of the space between the electrodes of said vacuum tube by and in accordance with signals, and means for associating said audions with said antenna earth system, and means for heating the hot electrodes of said audions and said vacuum tube from the same source of current.

21. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the separated electrodes of a vacuum tube, and means for varying the conductivity of the space between the electrodes of said vacuum tube by and in accordance with signals, and means included in said plate and grid circuits for associating said audions with said antenna earth system, and means for heating the hot electrodes of said audions and said vacuum tube from the same source of current.

22. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the separated electrodes of a vacuum tube, and means for varying the conductivity of the space between the electrodes of said vacuum tube by and in accordance with signals, and with each other, and means for heating the hot electrodes of said audions and said vacuum tube from the same source of current.

23. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the filament and plate electrodes of an auxiliary audion, and means for impressing a signal current upon the grid electrode of said auxiliary audion, and means for heating the filament electrodes of all of said audions from the same source of current.

24. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other

and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the filament and plate electrodes of an auxiliary audion, and means for impressing a signal current upon the grid electrode of said auxiliary audion, and means for associating said audions with said antenna earth system, and means for heating the filament electrodes of all of said audions from the same source of current.

25. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the filament and plate electrodes of an auxiliary audion, and means for impressing a signal current upon the grid electrode of said auxiliary audion, and means included in said plate and grid circuits for associating said audions with said antenna earth system, and means for heating the filament electrodes of all of said audions from the same source of current.

26. A radio signaling system comprising an antenna earth system, a plurality of audions having plate, grid and filament electrodes associated therewith, a circuit connecting said plate electrodes to each other and to said filament electrodes, a circuit connecting said grid electrodes to each other, a circuit connected between said grid electrodes and said filament electrodes and including therein the filament and plate electrodes of an auxiliary audion, and means for impressing a signal current upon the grid electrode of said auxiliary audion, and with each other, and means for heating the filament electrodes of all of said audions from the same source of current.

In testimony whereof I have hereunto set my hand on this 23rd day of June, A. D., 1921.

CHARLES VEYNE LOGWOOD.