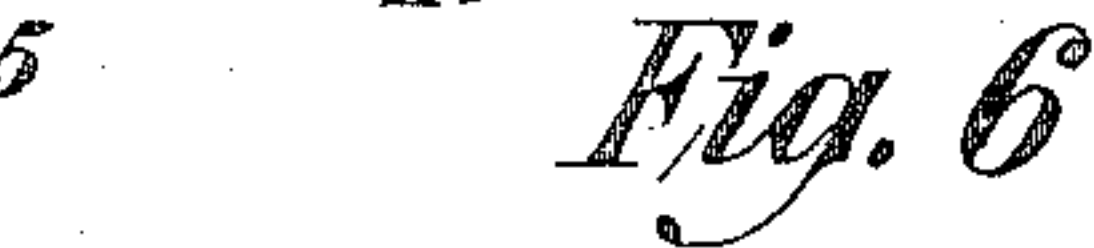
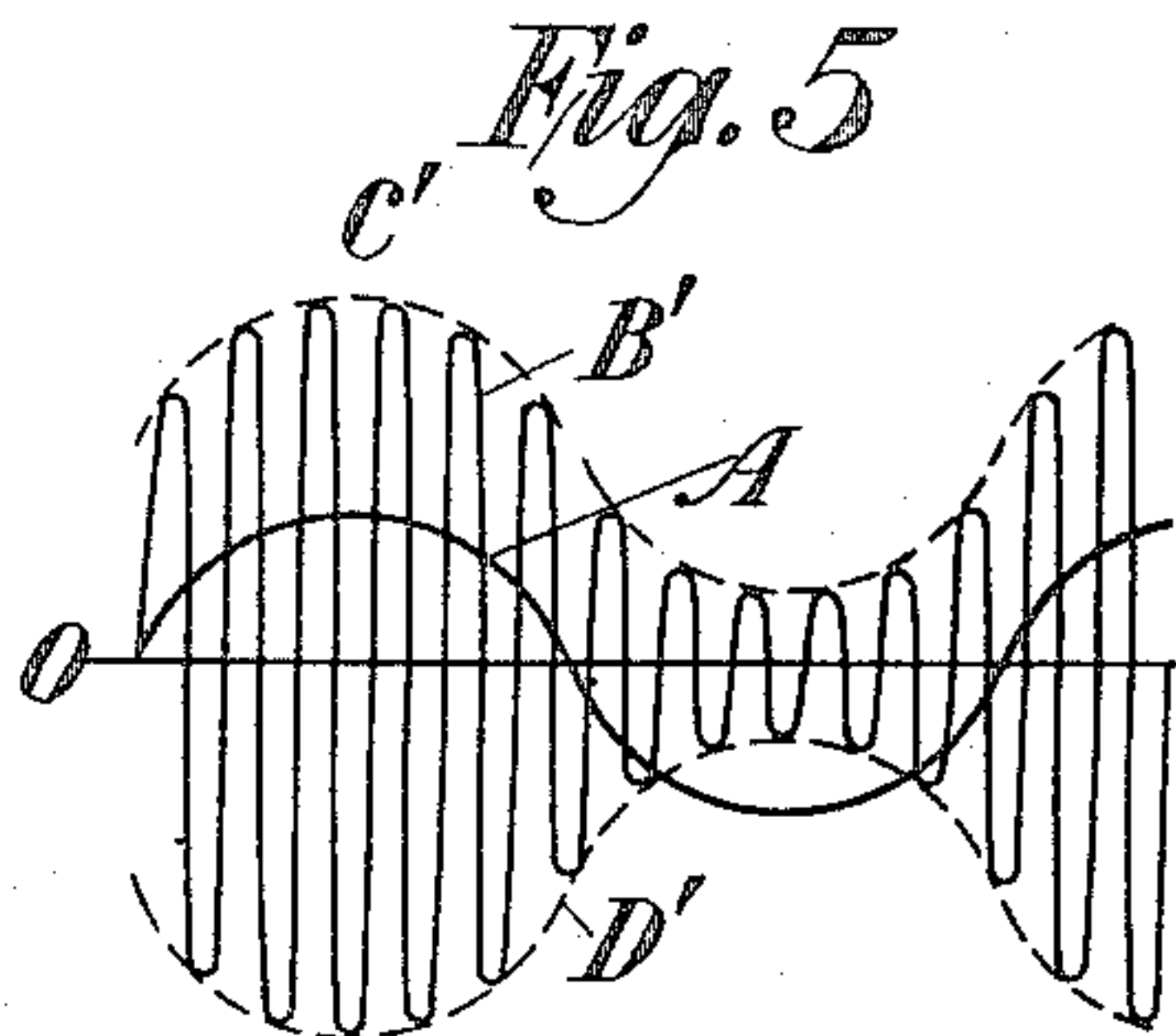
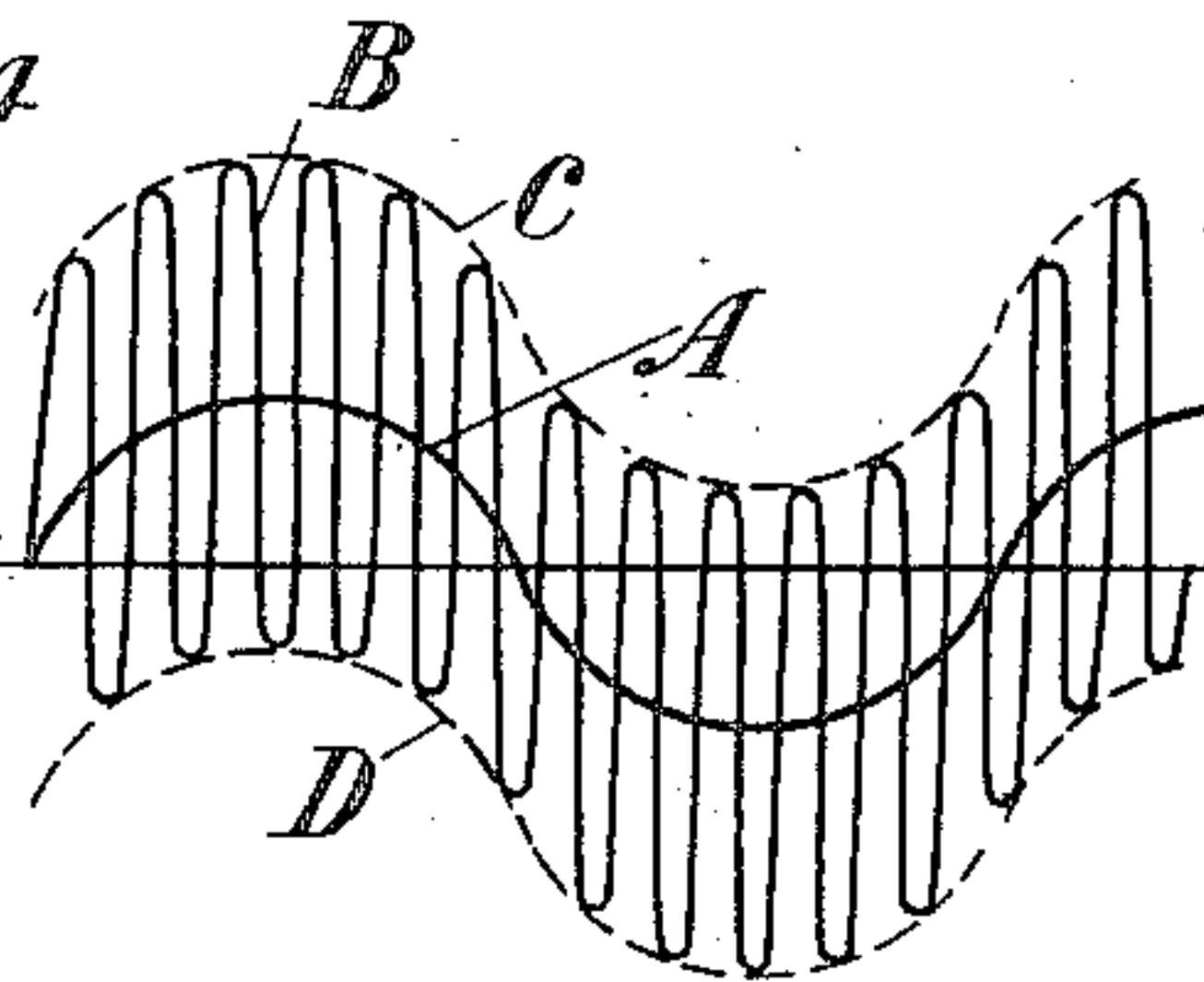
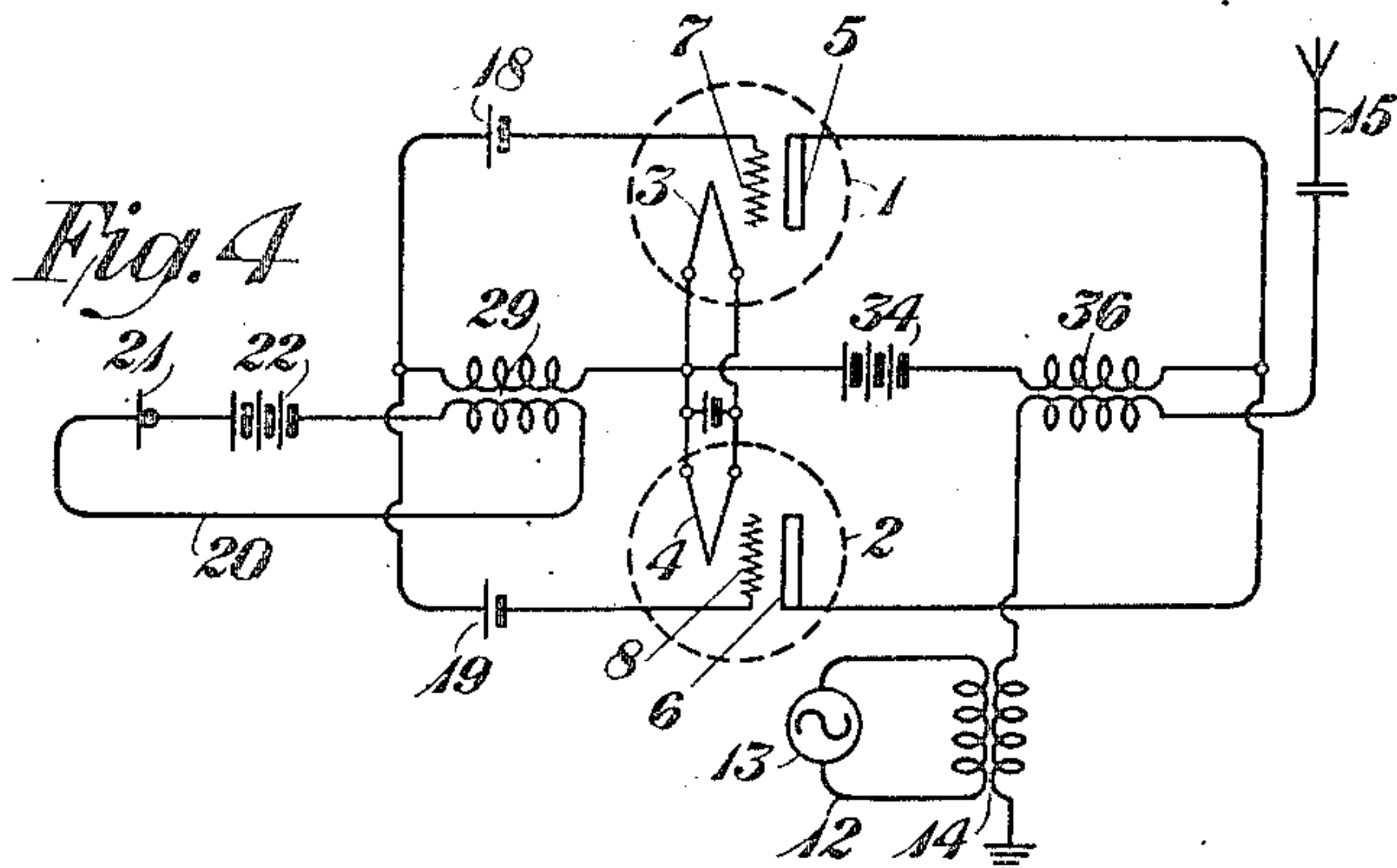
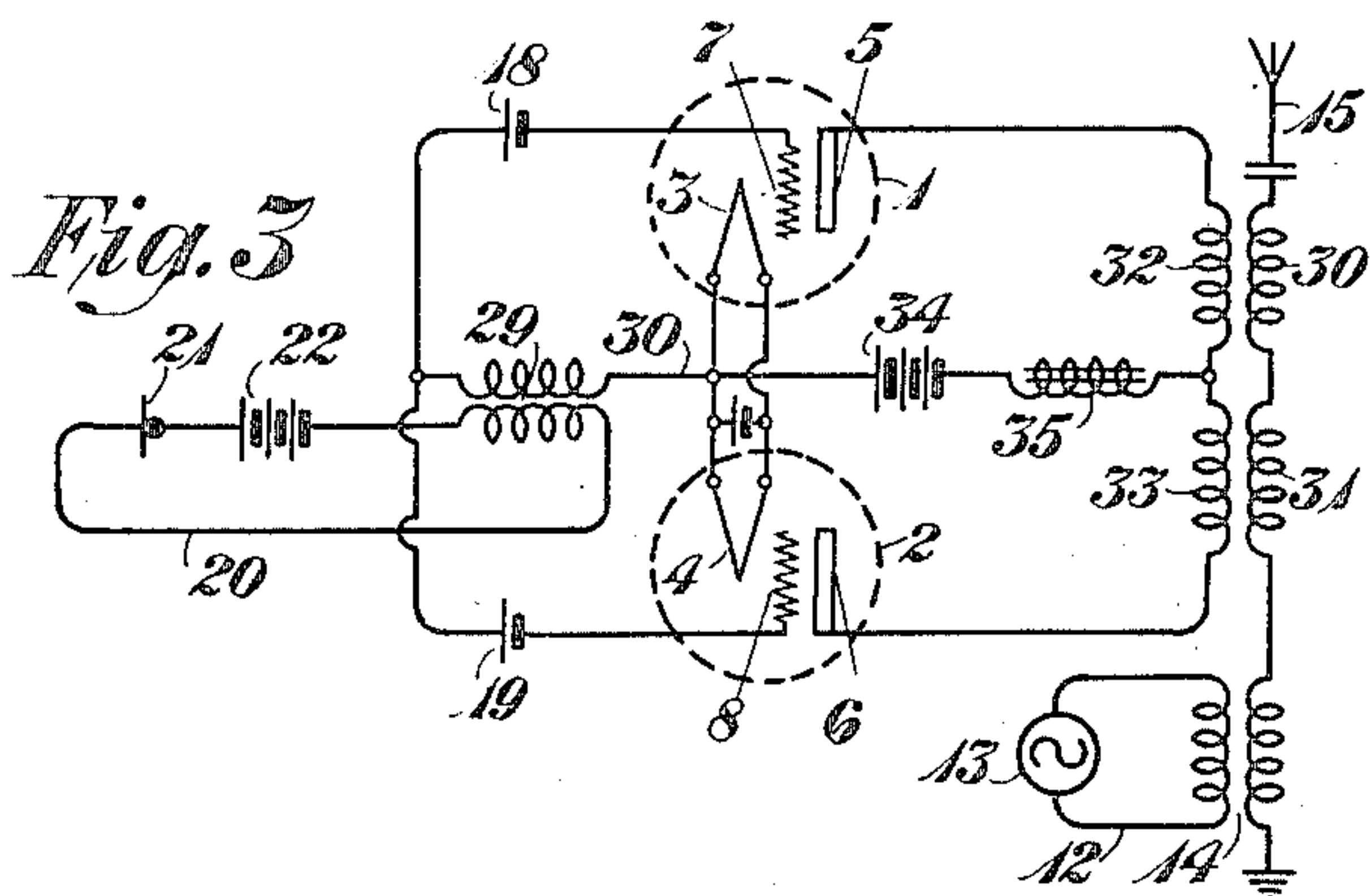
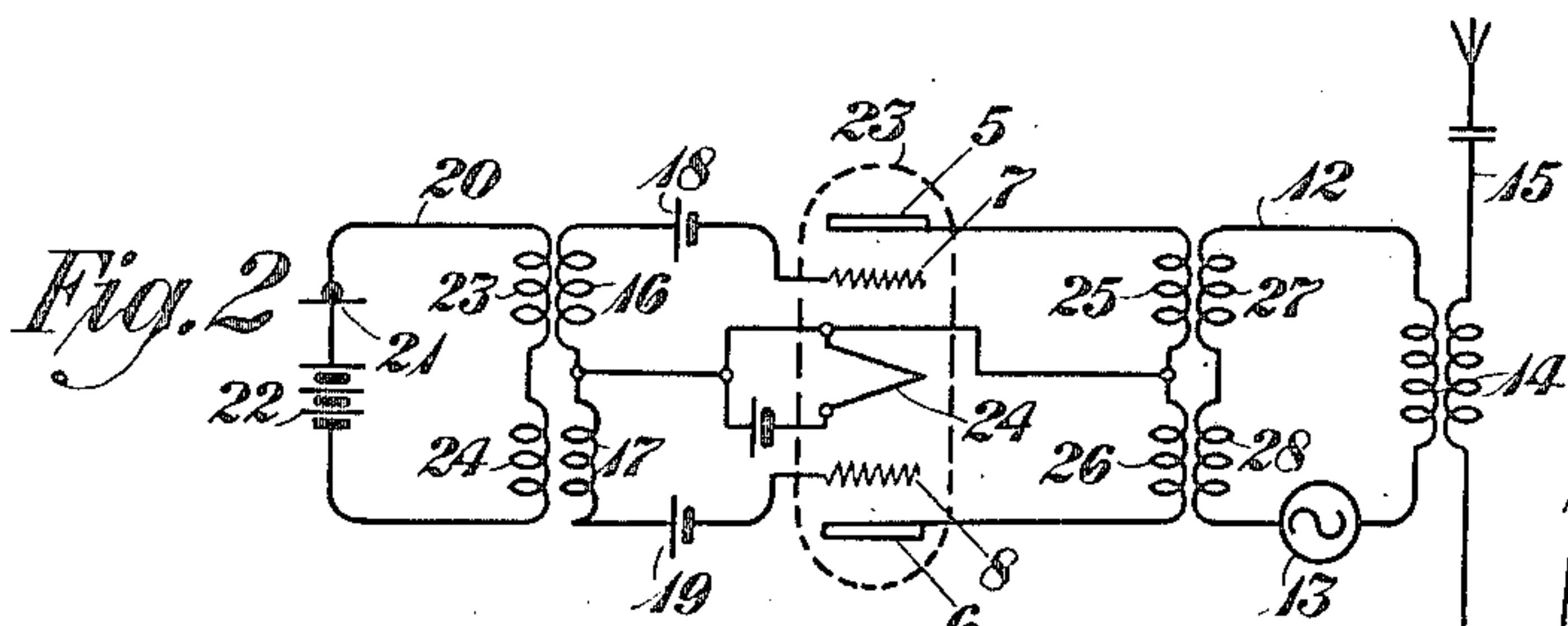
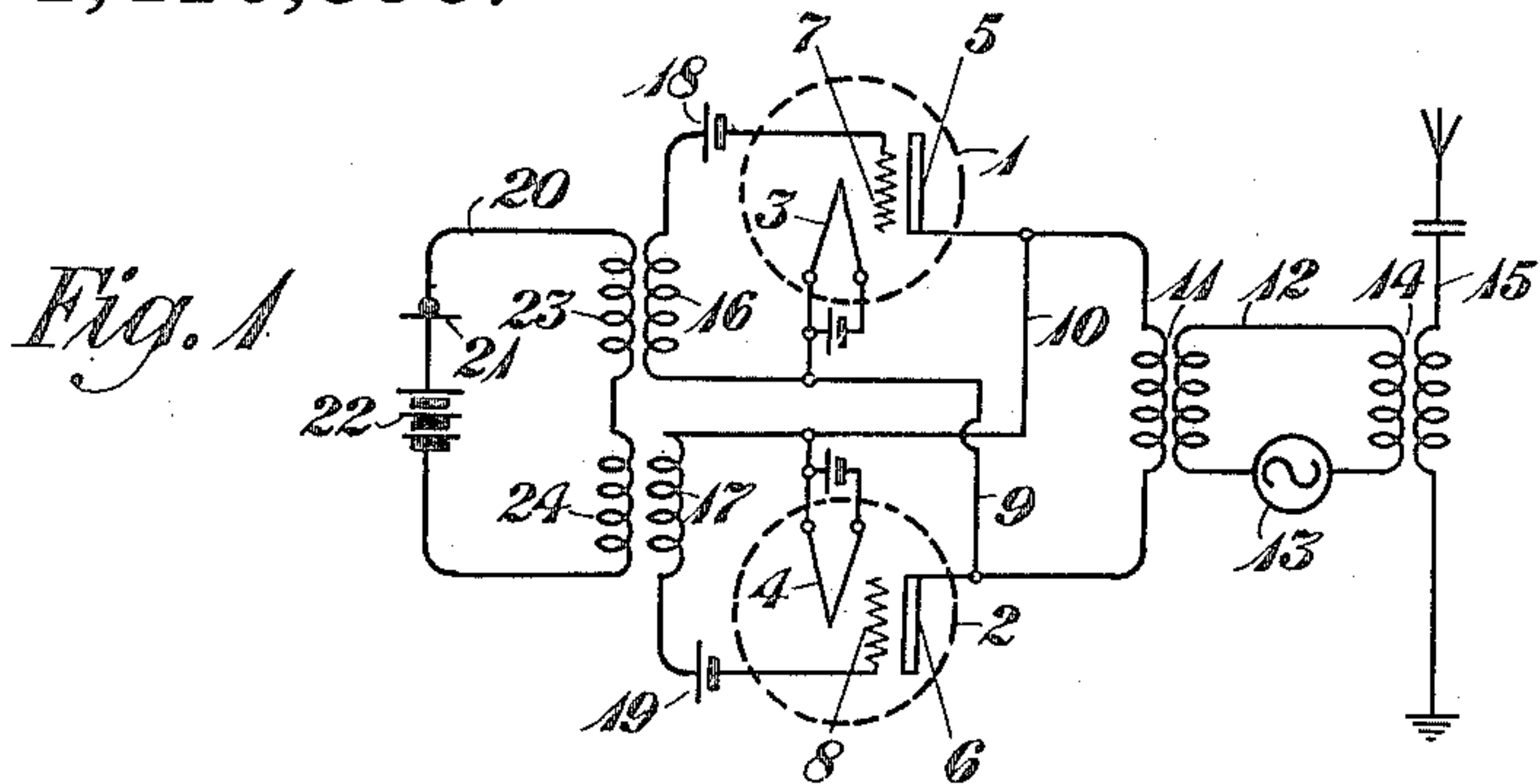


J. R. CARSON.
METHOD OF AND MEANS FOR MODULATING CARRIER OSCILLATIONS.
APPLICATION FILED AUG. 8, 1918.

1,410,890.

Patented Mar. 28, 1922.



INVENTOR.
John R. Carson
BY *G. E. Folk,*
ATTORNEY.

UNITED STATES PATENT OFFICE.

JOHN R. CARSON, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

METHOD OF AND MEANS FOR MODULATING CARRIER OSCILLATIONS.

1,410,890.

Specification of Letters Patent. Patented Mar. 28, 1922.

Application filed August 8, 1918. Serial No. 248,943.

To all whom it may concern:

Be it known that I, JOHN R. CARSON, residing at New York, in the county of New York and State of New York, have invented certain Improvements in Methods of and Means for Modulating Carrier Oscillations, of which the following is a specification.

This invention relates to signaling systems and more particularly to systems in which carrier currents modulated in accordance with signals are employed for the transmission of intelligence.

One of the objects of the invention is to provide a simple and yet efficient arrangement in which vacuum tubes may be employed for modulating carrier currents in accordance with signal waves. Another object of the invention is to provide a vacuum tube modulating arrangement in which the carrier oscillations are modulated in accordance with signal waves by impressing said oscillations and signal waves upon the tube separately, the one upon the input or controlling circuit and the other upon the output circuit. Still another object of the invention has reference to the provision of a system in which both halves of the carrier wave shall be modulated in accordance with the signal. Other and further objects of the invention will also be clear from the detailed description hereinafter given.

The objects of the invention are secured as herein disclosed by impressing the carrier currents to be modulated upon the plate or output circuit of a duplex three element vacuum tube arrangement, and separately impressing signal variations upon the circuit of the controlling electrodes thereof, in such manner as to vary the impedance of the two halves of the duplex vacuum tube arrangement alike, thereby producing like variations in the impedance of the two halves, with consequent variation in the amplitude of the carrier currents.

The invention may now be more fully understood by reference to the following description when read in connection with the accompanying drawing, in which Figures 1, 2, 3 and 4 are diagrams of four different embodiments of the invention, while Figs. 5 and 6 are curves illustrating certain features of the operation.

Referring to Fig. 1, a modulating arrangement is shown comprising evacuated tubes 1 and 2, each provided with filaments 3 and

4, anodes or plates 5 and 6 and controlling electrodes 7 and 8. Filament 3 of tube 1 is directly connected to plate 6 of tube 2 by means of conductor 9, while filament 4 of tube 2 is similarly connected to plate 5 of tube 1 by conductor 10. Plates 5 and 6 are also connected through the primary of the transformer 11, said transformer serving to associate a local circuit 12, including a source of carrier oscillations 13 with the output circuit of the modulating tubes 1 and 2. The local circuit 12 is also coupled by means of a transformer 14 to an antenna or other form of transmission circuit 15. The input or controlling circuit of the tube 1 extends from the filament 3 through a secondary winding 16 of a transformer arrangement to the grid 7. In the same manner a circuit extends from filament 4 through the secondary 17 of the transformer arrangement to the grid 8. These input circuits may, if desired, be provided with direct current sources 18 and 19 to impress a normal potential upon the grids 7 and 8 of such character as to produce the most efficient operation of the tubes. A local circuit 20 including the telephone transmitter 21 or equivalent signaling device, and a direct current source 22, is associated with the input circuit of the tubes by means of primary windings 23 and 24 directly associated with the secondary windings 16 and 17 respectively. The transformer arrangement comprising windings 16, 17, 23 and 24 may comprise either a single transformer provided with several windings, or a pair of transformers, one consisting of windings 16 and 23 and the other of windings 17 and 24. The windings should be so arranged that an impulse in the circuit 20 produces substantially equal grid-filament potentials of like sign in tubes 1 and 2. As shown in Fig. 1, this result is accomplished by having the windings 16 and 17 oppositely wound, although other ways of producing the same result will be readily apparent.

The operation of the arrangement just described is as follows: Oscillations from the source 13 are simultaneously impressed upon the antenna 15 and the output circuits of the tubes 1 and 2, the half-wave of one polarity flowing from filament 3 to plate 5 of tube 1, and the half-wave of the opposite polarity flowing from filament 4 to plate 6 of tube 2. The amount of energy divert-

ed from the antenna 15 to the tubes 1 and 2 will depend upon the conductivity of the tubes which is determined by the potential on the grids 7 and 8. Since the potential of these grids with respect to the corresponding filaments is the same and varies in accordance with the variation in current flow in the circuit 20 produced by the transmitter 21, the amount of energy diverted through the tubes will vary in accordance with the signals produced by the transmitter and the amount of energy radiated by the antenna will be modulated in accordance with the signals. Furthermore, since the conductivity of the two tubes at any given instant is the same, both the positive and the negative halves of the transmitted oscillations will be modulated alike. It will be understood that although the tubes are unilaterally conductive, and hence only half waves flow through each tube, their conductivities or impedances are equal with respect to positive plate-filament potentials since the grid-filament potentials are equal.

25 An alternative arrangement is shown in Fig. 2 in which the modulating arrangement consists of a duplex tube 23 provided with a single filament 24 and pairs of plates and grids 5—6 and 7—8 respectively. An output circuit extends from filament 24 through a winding 25 of a transformer arrangement to the plate 5, and another output circuit extends from the filament 24 through the winding 26 of the transformer arrangement to the plate 6. The local circuit 12, including a source of oscillations 13 is associated with said output circuits through windings 27 and 28 inductively associated with the windings 25 and 26 of the transformer arrangement. This transformer arrangement may comprise either a single transformer of four windings, or two transformers of two windings each. The local circuit 12 is also inductively associated through the transformer 14 with antenna 15. Input circuits for the duplex tube 23 extend from filament 24 through windings 16 and 17 respectively to grids 7 and 8 respectively, these input circuits being coupled to the local signal circuit 20 through the transformer comprising windings 16, 17, 23 and 24 as described in connection with Fig. 1, the transformer windings being so arranged that an impulse in the circuit 20 produces potentials of the same sign on the grids 7 and 8.

The operation of the arrangement of Fig. 2 is similar to that already described in connection with Fig. 1. Oscillations from the source 13 are impressed upon the antenna 15 and upon duplex modulating tube 23, one half-wave flowing from the filament to plate 5 and the other half-wave from the filament to plate 6. Variations caused by the transmitter 21 impress like potential variations upon the grids 7 and 8 thereby varying the

impedance of both paths through the tube 23 alike, so that modulated oscillations are radiated from the antenna, said oscillations being so modulated that both half-waves at a given instant have the same amplitude.

A somewhat different arrangement is illustrated in Fig. 3 in which the modulating device consists of tubes 1 and 2 of the same construction as the tubes of Fig. 1. In this case the local circuit 20, including the signaling means 21 and direct current source 22 is coupled with the input or controlling circuits of the tubes 1 and 2 through a transformer 29, the secondary of which is included in a common path 30 of the two input circuits, so that an impulse in the circuit 20 will produce like potentials on the grids 7 and 8. The source of oscillations 13 is coupled to the antenna through a transformer 14, and the antenna in turn is coupled to the output circuits of the tubes 1 and 2 through a transformer arrangement comprising windings 30, 31, 32 and 33. This transformer arrangement may comprise either a single transformer having four windings or two transformers of two windings each. If desired a direct current source 34 and an impedance coil 35 may be included in a common branch of the two output circuits.

The arrangement shown in Fig. 3 operates as follows: Oscillations from the source 13 are impressed upon the antenna 15 and a portion of the energy is radiated from the antenna, another portion being absorbed by the output circuits of the tubes 1 and 2, the transformer arrangement being such that one half-wave flows from filament 3 to plate 5 and the other half-wave flows from filament 4 to plate 6. The amount of energy absorbed by the tubes again depends upon the potentials applied to the grids 7 and 8, which potentials are varied alike by variations in the signaling circuit 20. Consequently modulated oscillations are radiated from the antenna 15, the oscillations radiated being of such character that both halves of an individual wave are of substantially the same amplitude. In this arrangement the direct current source 34 in the output circuits of the tubes, while improving the quality of modulation, is not essential and may be omitted except when it is desired to provide a particularly exact modulation in accordance with the signal waves.

A still further modification is shown in Fig. 4, which differs from that of Fig. 3 in that the antenna is coupled to a common branch of the output circuits of the tubes 1 and 2 through a transformer 36, instead of being separately coupled to the two output circuits as shown in Fig. 3. When coupled in this manner the two output circuits are in parallel, and oscillations in the antenna circuit will be impressed upon the output

circuits and flow in parallel from filaments 3 and 4 to plates 5 and 6 respectively. Since the tubes are of unilateral conductivity only one half-wave would flow in the output circuits of the tubes and the other half-wave would be unmodulated, were it not for the fact that a direct current source 34 is also included in the common branch of the output circuits. The direct current source 34 should be of a potential at least equal to the maximum amplitude of a half-wave received from the source of oscillations 13, so that in effect oscillations from the source 13 are superimposed upon a direct current from the source 34, and as a result pulsating direct current flows in parallel through the plate circuit of the two tubes. The conductivity of the two tubes is varied in accordance with the signal variations in the circuit 20, which signal variations produce like effects upon grids 7 and 8. As a result the amount of energy absorbed from the antenna by the tubes 1 and 2 varies with the signal variations, and modulated oscillations are radiated from the antenna, both half-waves of which are modulated alike.

It will be understood that the modifications above described are illustrative of a large number of circuit arrangements all capable of producing the same results, and that changes may be made in various features of the organization without departing from the spirit of the invention. For instance in each of the above modifications it will be understood that the arrangements consisting of two tubes such as 1 and 2, or of a single duplex tube 23 are interchangeable, the essential feature of the circuit arrangement being that the input circuit is so coupled to the source of signal variations that like variations of potential are produced on both grids.

The importance of reversing the winding 17 with respect to the winding 16 in Figs. 1 and 2, and of coupling the signaling circuit 20 to the common branch of the input circuits of Figs. 3 and 4 in order to secure like effect upon the grids, will be apparent from a comparison of the diagrams of Figs. 5 and 6. In these figures the curve A represents the signal variation produced by the transmitter 21. If the direction of winding 17 were the same as that of winding 16 in Figs. 1 and 2 an impulse in the circuit 20 would produce an increase in the potential of one of the grids 7 and 8 and a decrease in the potential of the other, so that the conductivity of one of the tubes would be increased and that of the other decreased. Consequently, the half-wave of alternating current flowing through one of the tubes would be increased in amplitude, and the corresponding half-wave flowing through the other tube would be decreased in amplitude.

The resultant oscillations impressed upon the antenna might, therefore, be represented by the curve B of Fig. 5. It will be noted that the envelopes C and D of the curve B vary in accordance with the curve A, but that the vertical distance between the two envelopes at all points is substantially the same. Oscillations of this character, if received at a receiving station, cannot be detected by using a local source of oscillations in accordance with the homodyne or heterodyne method of receiving but can only be detected by using a rectifying arrangement of such character that either the positive or negative half-wave of the oscillations will be eliminated. In other words, a detector must be used which eliminates all of the curve B which is on one side of the base line O. Since this eliminates the effect produced by one of the tubes of the modulating arrangement, this tube performs no useful function and there would be no advantage gained by using a duplex modulating arrangement over an arrangement employing a single tube of unilateral conductivity. Furthermore it will be noted that the wave B of Fig. 5 is simply the resultant wave which is produced when two waves of different frequency are impressed upon the same non-modulating circuit. In other words the wave B represents the sum of a high frequency and a low frequency wave. Consequently if a wave of this character is impressed upon an antenna only a high frequency wave of constant amplitude will be radiated, the low frequency component being practically not radiated at all. The wave B is therefore in no sense a modulated wave.

By arranging the circuits so that signaling impulses produce like effects on both grids in accordance with the present invention, the conductivity of the two tubes is the same at any given instant, and the amplitudes of the two halves of the oscillations radiated will be the same. This is illustrated by the curve B' of Fig. 6 which represents graphically a source of oscillations modulated in accordance with the method of the present invention. It will be noted that the envelopes C' and D' of the curve B', while similar to the signal wave A are opposite in character and that the two halves of any given oscillation are of substantially the same amplitude, but opposite in sign. This wave is a true modulated wave as it is not the sum but product of a high and low frequency wave. By transmitting a modulated wave of this character any known form of detector may be employed at the receiving station, and a detecting arrangement involving the homodyne or heterodyne principle of receiving is especially efficient.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different

from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

- 5 1. In a modulating system, a vacuum tube arrangement for modulating carrier oscillations in accordance with signal waves, comprising a pair of output circuits including evacuated conductive paths, controlling
10 electrodes for varying the impedance of said paths, input circuits for said controlling electrodes, means to impress carrier oscillations on said output circuits, said oscillations
15 tending to produce opposite potentials across said evacuated conductive paths, means to apply a normal potential to each controlling electrode, a circuit for transmitting
20 signal variations, and connections for so associating said last mentioned circuit with said input circuits as to cause independent
25 but like effects upon said controlling electrodes, said controlling electrodes being so arranged with respect to said evacuated conductive paths as to independently produce
30 by said effects equal variations in the impedance of said evacuated conductive paths.
2. In a modulating system, a vacuum tube arrangement for modulating carrier oscillations in accordance with signal waves, comprising a pair of output circuits including
35 evacuated conductive paths, controlling electrodes for varying the impedance of said paths, input circuits for said electrodes having a common path and individual paths,
40 means to impress carrier oscillations on said

output circuits, said oscillations tending to produce opposite potentials across said evacuated conductive paths, means to apply a normal potential to each of said controlling electrodes, a circuit for transmitting
45 signal variations, and connections for so associating said common path with said last mentioned circuit and said individual paths of said input circuits as to cause independent but like effects upon said controlling electrodes, said electrodes being so
50 arranged with respect to said evacuated conductive paths as to independently produce by said effects equal variations of the impedance of said evacuated conductive paths.

3. In a modulating system, a vacuum tube arrangement for modulating carrier oscillations in accordance with signal waves comprising a pair of output circuits including evacuated conductive paths, controlling
55 electrodes for varying the impedance of said paths, input circuits for said electrodes having a common path, a source of direct current for said output circuits, means to superpose carrier oscillations upon said direct
60 current in said output circuits, said oscillations tending to produce opposite potentials across said evacuated conductive paths and means to impress signal variations upon said common path to produce like effects
65 upon both controlling electrodes.

In testimony whereof, I have signed my name to this specification this thirty-first day of July, 1918.

JOHN R. CARSON.