H. J. VAN DER BIJL.

RADIO TRANSMISSION.

APPLICATION FILED AUG. 30, 1915.

1,301,525. Patented Apr. 22, 1919.

Fig. 1

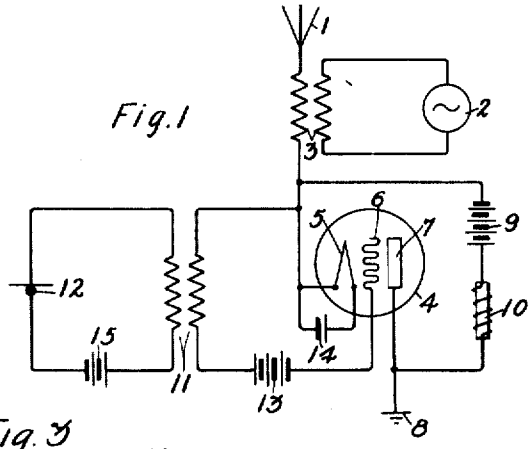


Fig. 3

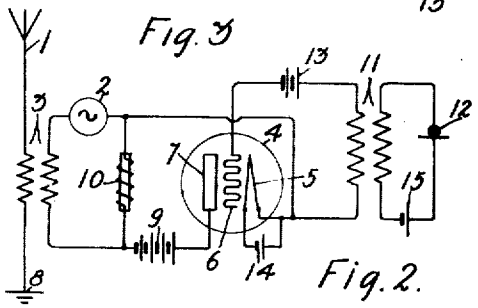
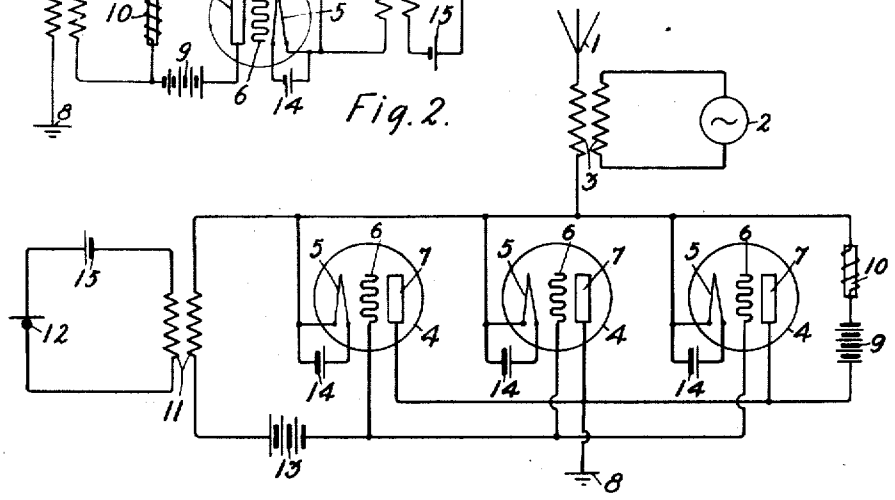


Fig. 2.



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UNITED STATES PATENT OFFICE.

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RADIO TRANSMISSION.

1,301,525. Specification of Letters Patent. Patented Apr. 22, 1919.

Application filed August 30, 1915. Serial No. 47,998.

To all whom it may concern:

Be it known that I, HENDRIK JOHANNES VAN DER BIJL, a subject of the King of Great Britain, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Radio Transmission, of which the following is a full, clear, concise, and exact description.

This invention relates to the art of transmission of intelligence by means of high frequency waves. Its object is to provide means whereby the power radiated from an antenna is varied or modulated in accordance with the wave forms of telephonic or telegraphic currents.

It has been found, in attempts to develop the art of radiotelephony, that a serious limitation has been imposed by reason of the fact that any telephone transmitter at present known to the art is incapable of handling all the energy which is required for successful modulation of high frequency power for commercial radiotelephony. The present invention, therefore, provides a method in which it is not necessary that the primary source of modulating waves shall handle directly all the modulated power required to be radiated from the antenna. This method depends upon the fact that an electromotive force impressed upon the input circuit of a thermionic amplifier of the "audion" type produces an apparent change in the impedance of its output circuit; in particular, a change in electromotive force impressed upon the input circuit, resulting from a change in impedance in a local circuit associated with said input circuit, causes the impedance of the output circuit of the amplifier to vary in such a way as to produce therein much greater changes in power than take place in the above mentioned local circuit. The thermionic amplifier in this case acts as a magnifying device for changes of power in the local circuit, and on account of this property a primary source of modulated power, capable of handling only a small amount of power, may be used to produce much larger changes, for example, in a transmitting antenna.

The object of this invention is, therefore, accomplished by inserting such a variable impedance path, for example, the output circuit of a thermionic repeater, into the transmitting antenna, said antenna carrying high frequency currents, and thereby producing large changes in radiated power at the expense of but small changes of power in the primary modulating source, which may be a telephone transmitter or a telegraph key.

In this specification the antenna is taken to be the aerial and its ground connection, that is, the continuous high-frequency path from the free extremity of the aerial to the ground and the immediate source of electromagnetic waves in the ether. It may include a condenser, and therefore need not be a complete metallic path.

The nature of this invention will be more clearly understood by reference to the drawings, in which Figure 1 represents one embodiment of this invention, showing a method of connection of an amplifier in series with an antenna; Fig. 2 represents a preferred form which is better adapted to the modulation of large amounts of power, such as would be required in commercial operation; and Fig. 3 shows another method of placing the amplifier effectively in series with the antenna by means of a transformer.

Referring to Fig. 1, 1–8 is an antenna or a high frequency line; 2 an alternator or other source of high frequency currents; 3 is a transformer by means of which power is introduced into the antenna from the generator 2; 4 is a thermionic amplifier of the "audion" type having an electron-emitting cathode 5, a grid 6, and a plate 7. The antenna system is earthed at the point 8. The plate circuit is completed through the choke coil 10 and the battery 9. A transformer 11 serves to impress upon the input circuit of the amplifier variations in electromotive force due to the operation of the microphone 12 in the local circuit. Batteries 13 and 14 are connected as usual in the operation of the amplifier, and battery 15 supplies current to microphone 12.

An objection to the device as shown in Fig. 1 is that the output impedance of the thermionic amplifier, as at present constructed, is so high that it cannot be efficiently inserted directly into an antenna circuit. To overcome this difficulty, and to provide also for the modulation of larger amounts of power, a number of these elements may be connected in parallel as shown in Fig. 2, in which corresponding parts are denoted by the same numerals as in Fig. 1.

In connecting such thermionic elements in parallel, it is necessary only to connect respectively all the cathodes, all the grids and all the plates. The cathodes may be heated by separate batteries, as shown, or may be connected in parallel or in series and operated from one battery. In Fig. 3 the variable impedance of the output circuit is placed directly in the generator circuit, but since that circuit is coupled to the antenna by transformer 3, this output circuit is effectively in series with the antenna and generator, since an impedance that is connected into a circuit by means of a transformer is equivalent, for forced oscillations, to a certain other impedance connected directly into that circuit. The function of the choke coil 10 is to exclude direct current from the generator 2.

The operation of the system is as follows:

The generator 2 impresses high-frequency power upon the antenna. Due to the choke coil 10, practically the whole of the high frequency current must flow through the amplifier and is superposed upon the space current of the amplifier. The choke oil is necessary in order to provide a conducting path for direct current in the output circuit. A variation in resistance in the microphone 12, due to voice waves impinging upon it, causes an electromotive force to be impressed upon the input circuit, which, in consequence of a well known property of the amplifier, produces an apparent change in the output resistance of the device, this change in output resistance causing a change in the amplitude of the high-frequency antenna current. Further, since the thermionic amplifier is a non-distorting device, the impedance changes in its output circuit are copies of the impedance changes in the microphone circuit.

Although this invention is described as applied to a wireless transmitting system, it is obvious that instead of the antenna shown, a wire circuit may be substituted, for example, a telephone line, without in any way departing from the idea underlying the invention. I, therefore, desire not to be limited to a wireless transmitting system, but intend this invention to include the use of this modulating apparatus in connection with wire systems, as well as with wireless systems.

What is claimed is:

1. A modulating system comprising an antenna to be supplied with signal waves, means for supplying high frequency power to be modulated to said antenna, an audion having a cathode and anode and an auxiliary electrode, means for serially introducing the impedance between said anode and cathode into said antenna, and means for controlling the potential of said auxiliary electrode in accordance with a signal.

2. A modulating system comprising an antenna to be supplied with signal waves, means for supplying high frequency power to be modulated to said antenna, an audion having a cathode and anode and an auxiliary electrode, means for serially introducing the impedance between said anode and cathode into said antenna, whereby all of said high frequency power flows between said anode and said cathode, and means for controlling the potential of said auxiliary electrode in accordance with a signal.

3. In a radio transmission system, an antenna, a source of oscillations connected thereto, an asymmetric thermionic impedance element in series with said antenna, said impedance element having a cathode, an anode and an impedance controlling element, and means for varying the potential of said controlling element with respect to said cathode to vary the impedance of said thermionic element in accordance with signals.

4. In a system for radio transmission, an antenna, a thermionic cathode and an anode in an evacuated vessel and serially included in said antenna, an impedance control electrode in said vessel, means for impressing an electromotive force of signal wave form upon said electrode, and means for impressing high frequency power to be modulated upon said antenna.

5. In a radio signaling system, an antenna, a thermionic impedance in series therewith carrying all the antenna current, said impedance having space current electrodes directly connected to points in said antenna and an impedance controlling element, and signaling means for varying the potential of said impedance controlling element with respect to one of said space current electrodes.

6. In an electrical transmission system, the combination with a transmission circuit by which energy is transmitted directly from one station to another, of a space discharge device having an anode, a cathode and an impedance varying element, said device being included serially in said circuit so that all of said energy of said transmission circuit passes through said discharge device and means for applying a low signaling frequency electromotive force between said cathode and said impedance varying element.

7. A high frequency circuit by means of which energy is directly transmitted to a distant station, an asymmetric thermionic impedance device in series arrangement in said circuit, said impedance device having a cathode, an anode and an impedance controlling element, and means for varying the potential of said controlling element with respect to said cathode to vary the series impedance of said circuit in accordance with signals.

8. A high frequency circuit including a source of high frequency current, an asymmetric thermionic impedance device in series arrangement in said circuit, said impedance device having a cathode, an anode, a source of space current, and an impedance controlling element, means for varying the potential of said controlling element with respect to said cathode to vary the series impedance of said circuit in accordance with signals, and means associated with said circuit to transmit energy varying proportionally to that of the current in said circuit.

9. A transmitting station comprising an electron discharge device having a cathode, an anode and an impedance varying element, a source of unidirectional electromotive force in circuit with said cathode and anode, and an alternating current source in series with said cathode and anode.

10. A transmitting station comprising an electron discharge device having a cathode, an anode and a grid, an input circuit connected to said cathode and grid, signaling means associated with said input circuit to control the impedance of said device, a source of unidirectional current in a circuit connecting said cathode and anode, and an alternating current source in a series circuit with said cathode and anode.

11. In combination, a plurality of electron discharge devices, each having a cathode, an anode and a grid, an input circuit having one terminal connected to each of said cathodes and the other terminal connected to each of said grid elements, signaling means associated with said input circuit to control the impedance of said electron discharge devices, a source of unidirectional electromotive force having one terminal connected to each of said cathodes, and the other connected to each of said anodes, and means for supplying alternating current in series circuit with said cathode and anode.

12. A transmitting station comprising an electron discharge device having an anode, a cathode and an impedance varying element, a source of unidirectional electromotive force in a series circuit including said anode and cathode, and a source of alternating electromotive force in a second series circuit including said anode and cathode.

13. A transmitting station comprising an electron discharge device having an anode, a cathode and an impedance varying element, a source of unidirectional electromotive force in a series circuit including said anode and cathode, a source of alternating electromotive force in a second series circuit including said anode and cathode, and means in one of said series circuits for preventing flow of current therein caused by said source of electromotive force in the other of said series circuits.

14. An electron discharge device having an anode, a cathode and an impedance varying element, a source of unidirectional electromotive force in a series circuit including said anode and cathode, a source of alternating electromotive force in a second series circuit including said anode and cathode, means in the first of said series circuits for preventing current therein from said source of electromotive force in the second of said series circuits, said second circuit being of such character that substantially no current from the source of electromotive force in said first circuit can flow therein.

In witness whereof, I hereunto subscribe my name this 27th day of August, A. D. 1915.

HENDRIK JOHANNES VAN DER BIJL.