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A. HUND

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MODULATION SYSTEM

Filed Nov. 2, 1931

FIG. 1

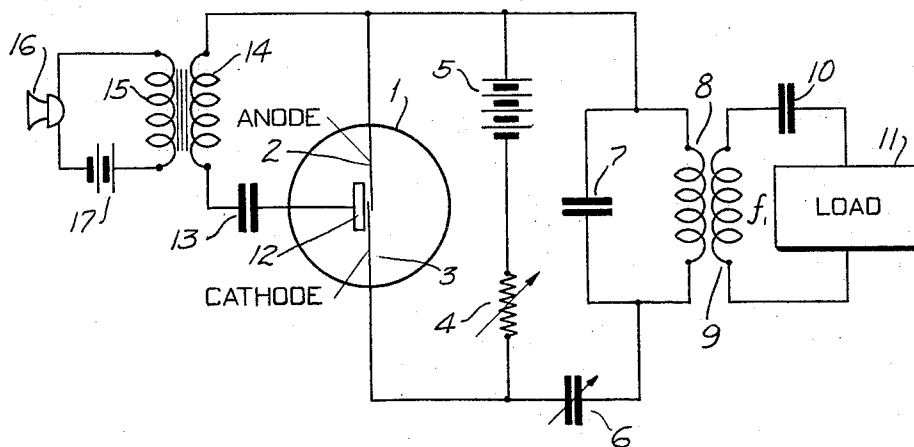
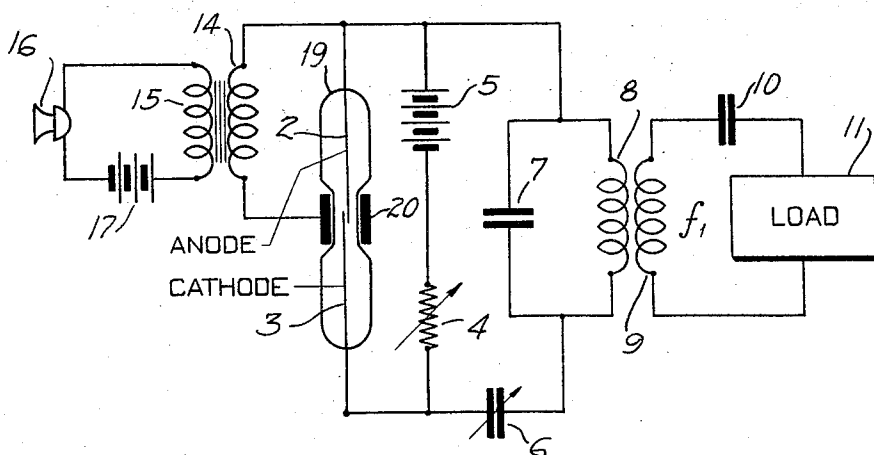


FIG. 2



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MODULATION SYSTEM

Application filed November 2, 1931. Serial No. 572,551.

My invention pertains in general to radio signalling and specifically relates to a system for producing modulated high frequency oscillations.

5 One of the objects of my invention consists in providing means for producing modulated high frequency oscillations through the agency of electrostatically controlled ionization discharges.

10 Another object comprises providing a high frequency generator and modulator employing an ionization discharge tube having an electrostatic control electrode.

A further object consists in producing a modulation system in which the energization of a high frequency oscillation circuit is accomplished by relaxation oscillations produced by ionization discharges modulated by an electrostatic control electrode coupled with a source of modulation energy.

20 These and other desirable objects will be apparent from the following, reference being had to the accompanying drawing in which like reference numerals designate corresponding parts throughout and in which;

25 Fig. 1 is a diagrammatic representation of one embodiment of the modulation system of my invention; and

30 Fig. 2 is a diagrammatic representation of an alternative form of the system of Fig. 1.

Referring to the drawing in detail, and particularly to Fig. 1, there is provided a glow or ionization discharge tube 1 which comprises an envelope enclosing a pair of electrodes 2 and 3. In the present embodiment of my invention, this envelope is provided with an attenuated atmosphere or helium maintained at a pressure of substantially 12 millimeters of mercury, although other suitable gases can be used at other suitable pressures. The electrodes 2 and 3 are of small area and disposed in a manner such as to reduce inter-electrode capacitance to a minimum. The electrodes 2 and 3 are connected with an external circuit including a variable resistance 4, and a source of direct current 5 connected in series therewith. Connections from the electrodes 2 and 3 are further extended to include a condenser 6 connected in series with a closed circuit comprising

ing a capacitance 7 and inductance 8. The inductance 8 is electromagnetically coupled to an inductance 9 connected in series with a capacitance 10 and load 11. The circuit 9—10—11 is resonant to a desired high frequency designated as the frequency f_1 . In this specification the term "high frequency" will be used as denoting inaudible frequencies used for carrier purposes such as in wired radio or space radio signalling. The load 11 is indicative of any work circuit or device for the utilization of modulated high frequency oscillations produced according to my system.

A control electrode 12, in the form of a metallic plate, is disposed adjacent the gap between the electrodes 2 and 3. The control electrode 12 is connected through a capacitance 13 and a winding 14 to the electrode 2. It has been found, however, that the capacitance 13 may sometimes be omitted. The winding 14 comprises the secondary of an audio frequency transformer having a primary winding 15 connected in series with a microphone 16 and source of current 17. The circuit 15—16—17 is indicative of any source of modulation energy.

In accordance with my invention, the source of current 5 applies a potential difference to the electrodes 2 and 3, the electrode 2 having a positive potential and being considered the anode, and the electrode 3 having a negative potential and being considered the cathode.

The following procedure was pursued in experiments to produce modulated high frequency oscillations in accordance with my invention: The variable resistance 4 was adjusted to a minimum value whereupon the voltage of the source of direct current 5 was approximately 360 volts. A dense glow discharge was then observed between the electrodes 2 and 3 and extending along the major portion of the cathode electrode 3. Such an ionization discharge produced no oscillations and the control electrode 12, when excited by modulation energy, produced no apparent effect. After this primary glow or ionization discharge was initiated, the variable resistance 4 was adjusted so that the

effective resistance was gradually increased to a point where oscillations suddenly set in. As the effective resistance was increased the enveloping glow discharge along the electrode 3 receded towards the end of the electrode 3 proximate to the electrode 2. When, as the resistance 4 was increased in value, the glow or ionization discharge approached to within a few millimeters of the end of electrode 3, it suddenly quenched and immediately another ionization discharge appeared and extending along the major portion of the electrode 3 in the form of an enveloping glow.

This secondary glow discharge, which is indicative of a state of oscillation, is similar in extent to the primary glow discharge but is characterized in being much fainter in appearance. After the secondary or oscillation glow discharge was once established, it was found that the effective value of the resistance 4 could be decreased over a wide range without destroying the state of oscillation. That is, having once established the oscillation glow discharge, the effective value of the resistance 4 may be diminished without interrupting the oscillation glow discharge and, of course, without causing the reappearance of the primary glow discharge, although the effective value of the resistance 4 may be at a point initially arrived at in establishing the primary glow discharge or even beyond this point.

When the secondary or oscillation glow discharge is established between the electrodes 2 and 3, oscillations will be set up in the circuit 7—8 due to discharges through condenser 6. The current appearing in the circuit 7—8 can be adjusted for a frequency equal to the fundamental frequency of the relaxation oscillations as well as to other frequencies which are integral multiples of the fundamental frequency. The circuit 9—10—11 is tuned to a desired one of these integral multiple frequencies designated as the frequency f_1 . The oscillations produced by the glow discharge tube 1 bring about the recurrent energization of the oscillation circuit 7—8 for producing, in the circuit 9—10—11, sustained high frequency oscillations of the frequency f_1 suitable for carrier purposes in radio signalling.

In accordance with my invention, modulation energy in circuit 15—16—17 induces electromotive forces in the winding 14 for causing varying potentials on the control electrode 12. However, when the secondary or oscillation glow takes place, that is, when the tube 1 is producing oscillations, the control electrode 12 becomes effective for controlling the glow or ionization discharge in accordance with modulation energy whereupon modulated high frequency oscillations appear in the circuit 7—8 and are transferred by the selection circuit 9—10 to the load 11.

As before stated, when the secondary or oscillation glow discharge is established between the electrodes 2 and 3, the effective value of the resistance 4 may be decreased over a wide range without destroying the state of oscillation in the associated circuit. It was noted in experiments that, as the value of the resistance is decreased, the fundamental frequency of the relaxation oscillations, as produced by the glow discharge tube, was altered in discrete steps having a sub-multiple relation with the frequencies of the oscillations appearing in the circuit 7—8, this being an indication that the circuit 7—8 controls and stabilizes the relaxation oscillation in a manner more fully set forth in my co-pending application Serial Number 495,630, filed November 14, 1930, and entitled "Oscillation generator".

It is an especial feature of my invention that the space conduction produced in the discharge tube employed in my system is brought about by my ionization between comparatively cold electrodes in contradistinction to space conduction in the usual thermionic tubes which is brought about by electronic emission from a heated cathode.

Fig. 2 depicts an alternative form of my modulation system employing a different construction of space discharge tube set forth in detail in my co-pending application, Serial Number 572,552, filed November 2, 1931, and entitled, "Space discharge tube and mounting therefor". This form of space discharge tube 19 comprises a tubular envelope having a central constriction around the gap between the electrodes 2 and 3. An annular metallic control electrode 20 is provided exteriorly encircling this constriction and is connected with the winding 14 as in Fig. 1. It will be noted that the condenser 13 is omitted in Fig. 2 as the external control electrode 20 prevents a direct current flow and directly produces an electric field for controlling the ionization discharge between the electrodes 2 and 3. The winding 14 can be connected as shown in the figure, between the control electrode and the anode electrode 2, or between the control electrode and the cathode electrode 3. The operation of the circuit of Fig. 2 is otherwise similar to the operation of the circuit of Fig. 1.

It will now be apparent that I have provided a novel form of modulation system for producing modulated high frequency oscillations through the agency of electro-statically controlled ionization discharges. Although I have shown a preferred embodiment of my modulation system it will be understood that modifications can be made therein without departing from the intended scope of my invention. I do not therefore desire to limit myself to the foregoing except insofar as may be pointed out in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A modulation system comprising, means for producing high frequency oscillations including a gaseous discharge tube having a cold cathode, an anode and a control electrode, a plurality of condensers serially connected with respect to each other and to said cathode and anode, a source of ionizing potential and series resistance therefor connected in parallel with said plurality of condensers and to said cathode and anode, an output circuit comprising, an inductance connected in parallel to one of said plurality of condensers and means for impressing modulating potentials on said control electrode and anode.

2. A modulation system comprising, means for producing high frequency oscillations including a gaseous discharge tube provided with a cold cathode and anode and an exterior control electrode, a plurality of condensers serially connected with respect to each other and to said cathode and anode, a source of ionizing potential and a series resistance therefor connected in parallel to said plurality of condensers and to said cathode and anode, a load circuit including an inductance connected in parallel with one of said plurality of condensers, a source of modulating potentials, an input circuit comprising an inductance connecting said source of modulating potentials to said exterior control electrode and said anode.

AUGUST HUND.