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FREQUENCY MODULATION SYSTEM

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Fig. 1.

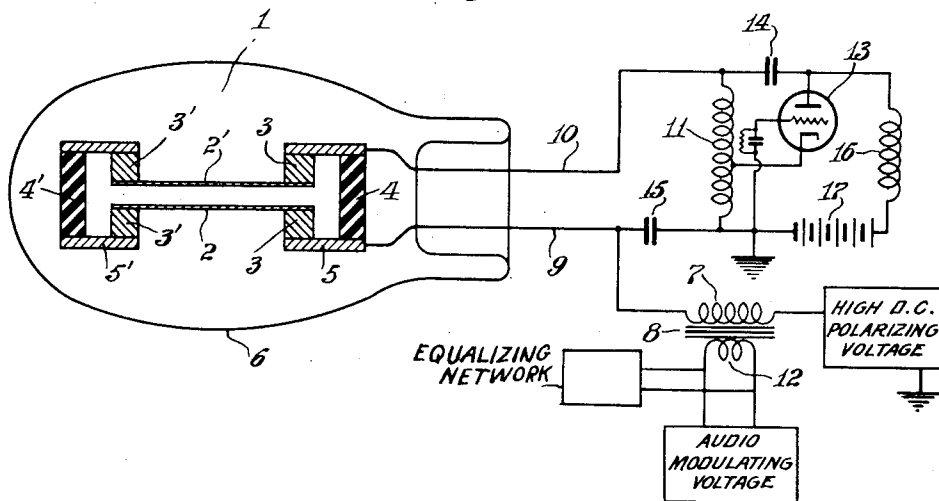
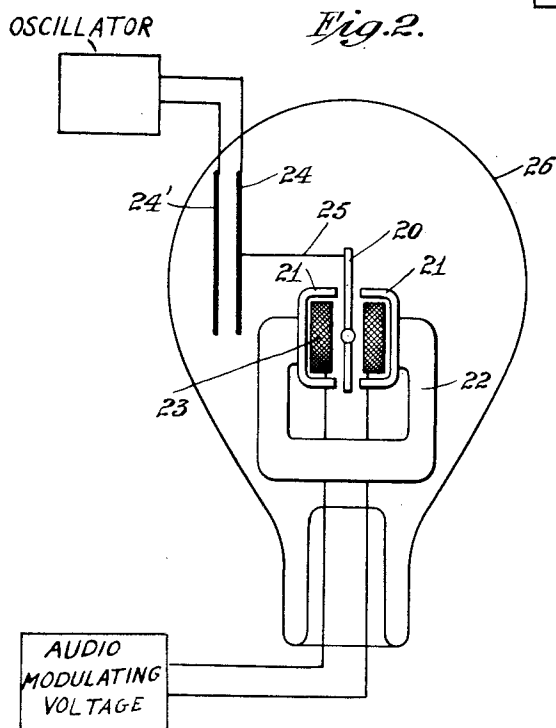


Fig. 2.



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FREQUENCY MODULATION SYSTEM

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10 Claims. (Cl. 179—171.5)

This invention relates to new and useful improvements in the production of frequency-modulated waves.

The object of the invention is to produce large frequency swings and to operate at relatively high power levels.

In accordance with the invention a capacity is incorporated as part of the resonant circuit of an oscillator. The spacing between plates of the capacity is varied in accordance with the audio signal that is to be modulated upon the transmitter wave. The entire condenser system is enclosed in a high vacuum, whereby high radio-frequency voltages may be applied between the relatively closely spaced plates.

Fig. 1 is a diagrammatic illustration of the invention and Fig. 2 is a cross section of a modification of the condenser system shown in Fig. 1.

Fig. 1 shows a conventional Hartley oscillator in which the tuning capacity is provided by the capacity of the special frequency-modulating condenser 1. It consists of two membranes or plates 2, 2' (preferably of Duralumin) mounted on stretching rings 3, 3' of conducting material, and held at a conveniently small distance apart by insulating spacers 4, 4'. The rings and spacers 3, 4 and 3', 4' are held within metal sleeves 5, 5', and have a suitable rigid mounting structure (not shown) within an evacuated glass envelope 6.

Very large voltages can be applied between plates 2, 2' without danger of breakdown.

A large D. C. polarizing voltage of several thousand volts such as 5,000 to 20,000 volts is applied between the plates from a suitable source, over secondary winding 7 of an iron core transformer 8, conductor 9, sleeve 5, ring 3, plate 2, ring 3', sleeve 5', ring 3', plate 2', ring 3, sleeve 5, conductor 10, inductance 11, and ground. Audio modulating voltage is superimposed upon this polarizing voltage from a suitable source over primary winding 12 of transformer 8, so that the total of D. C. plus modulating voltage between plates 2, 2' varies in accordance with the desired modulation envelope. This modulating voltage should be as large as possible, but must never have a peak amplitude exceeding the polarizing voltage. Since a voltage applied between the two plates of a condenser causes a mechanical force to be exerted between the plates, and since the plates 2, 2' are flexible, the spacing of the plates and hence the capacity of the condenser will vary with the modulating voltage. This causes the frequency of the oscillations generated in oscillator 13 to vary likewise, thus producing a frequency-modulated wave. 14 and 15 are,

respectively, a blocking and a radio frequency bypass condenser, 16 is a radio frequency choke and 17 is a B battery.

In order for the wave to be a pure frequency-modulated wave, the deflection of the condenser plates must be independent of the modulating frequency. This can be achieved by stretching the membranes 2, 2' so that their resonant frequency approximates the highest frequency that is to be modulated upon the system. At frequencies appreciably below this resonance, the amplitude of vibration will be proportional to the applied force (i. e., to the modulating voltage) and independent of frequency. At the resonant frequency one can prevent excessive response either by an electrical equalizing network in the audio system, or by providing some form of damping so that the response at resonance will be approximately the same as the response at frequencies below resonance. This latter result can be obtained by the appropriate use of rubber or other material capable of damping mechanical vibration.

In a system such as shown in Fig. 1 the ratio of frequency swing to carrier frequency will be equal to half the ratio of capacity variation in the frequency-modulating condenser to the total capacity of the resonant circuit. For large frequency swings one should therefore keep the total circuit capacity at a minimum and the capacity variations large. This can be accomplished by utilizing the frequency-modulating condenser to supply all of the tuning capacitance of the circuit.

While the variation in capacity obtained in the arrangement shown in Fig. 1 is based upon electrostatic forces, the system is by no means limited to this particular case. One could also employ a balanced armature type of mechanism to provide an actuating force, and then couple this to a diaphragm through a link mechanism as illustrated schematically in Fig. 2.

A balanced armature 20, is positioned between pole pieces 21 of a permanent magnet 22. A coil 23 to which the voice currents are applied is seated within pole pieces 21 surrounding the armature 20 to operate it in accordance with the audio frequency modulating voltage. The condenser plates are 24 and 24', the former being mechanically linked with armature 20 as indicated at 25 to translate the vibration thereof into capacity variations. As in Fig. 1, the assembly is enclosed in a highly evacuated envelope 26.

What I claim is:

1. A frequency modulation system comprising an oscillation generator, a variable condenser

forming a part of the oscillating circuit thereof, said condenser having two condenser plates only, at least one of said plates being flexible, means for applying a high direct current voltage directly between said condenser plates so as to exert a unilateral force therebetween and maintain said flexible plate under tension, and means for superposing a variable signal voltage on said direct current voltage.

2. A frequency modulating system as set forth in claim 1, in which said condenser comprises the entire tuning capacitance of the oscillating circuit, the arrangement being such that a high ratio between capacity variations and the total capacity of said circuit is maintained.

3. A frequency modulation system comprising a pair of condenser membranes, means for stretching said membranes to tune them to resonance at a frequency corresponding to the highest frequency of the band of signal frequencies to be transmitted, an evacuated envelope for enclosing said membranes, means for applying a band of signal frequencies across said membranes and filter means for attenuating the highest frequencies of said band to prevent said membranes from resonating at said highest frequencies.

4. In combination, a condenser having two flexible plates, a device for stretching said plates and holding them apart a small distance, an evacuated envelope enclosing said condenser, a source of D. C. polarizing voltage for said condenser, and a modulating voltage superimposed on the polarizing voltage.

5. In combination, an oscillator having a resonant circuit including a condenser, two flexible plates for said condenser, stretched so that their resonant frequency approximates the highest modulating frequency, an evacuated envelope enclosing said condenser, a source of D. C. polarizing voltage applied to one of said plates, and an audio-frequency modulating voltage superimposed on the polarizing voltage.

6. In combination, an oscillator having a resonant circuit including a condenser, two flexible Duralumin plates for said condenser, a device for stretching said plates and holding them apart a small distance, the resonant frequency of said plates when stretched approximating the highest modulating frequency, an evacuated envelope enclosing said condenser, a source of D. C. polarizing voltage of several thousand volts, an iron core transformer having a secondary winding in a

connection from said source to one of said plates, and an audio-frequency modulating voltage having a peak amplitude below the polarizing voltage applied to the primary of said transformer.

7. A modulation system comprising a condenser including two flexible condenser plates, a mounting circumferentially engaging the plates and maintaining them under tension in slightly spaced juxtaposed position, means for applying a direct current polarizing voltage between said plates, and means for superposing a modulating voltage on the polarizing voltage, arranged to flex the plates variably in accordance with variations in the modulating voltage, thereby varying the condenser capacity.

8. A modulation system comprising an oscillator having a resonant circuit including a condenser, said condenser including two flexible metal condenser plates and means for holding said plates under tension and slightly spaced, means for applying a high direct current polarizing voltage of the order of several thousand volts across said plates, an iron core transformer having a secondary winding connected to one of said plates and carrying said polarizing voltage, and means for applying to the primary of said transformer an audio frequency modulating voltage having a peak amplitude below the polarizing voltage.

9. A frequency modulation system comprising an oscillation generator, a source of audio frequency signals, a condenser including a pair of juxtaposed flexible condenser plates forming a part of the oscillating circuit of said generator, and means connected to said source for flexing said flexible plates and thereby varying the capacity of said condenser in accordance with the audio frequency signals from said source.

10. A frequency modulation system comprising a pair of capacitatively associated condenser plate membranes, means for tensioning said membranes and thereby tuning both membranes to resonance at a frequency corresponding to the highest frequency of the band of signal frequencies to be transmitted, means for applying said band of signal frequencies across said plate membranes, and filter means for attenuating the highest frequencies of said band and thereby preventing said plate membranes from resonating at said highest frequencies.

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