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SYSTEM FOR PRODUCING AND TRANSMITTING HIGH FREQUENCY SOUND ENERGY

Filed Nov. 21, 1919

Fig. 1.

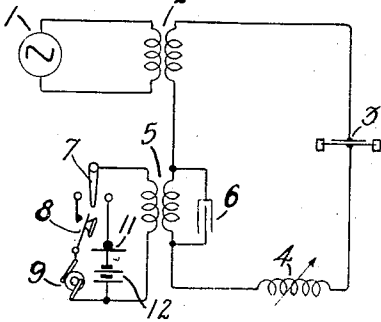


Fig. 2.

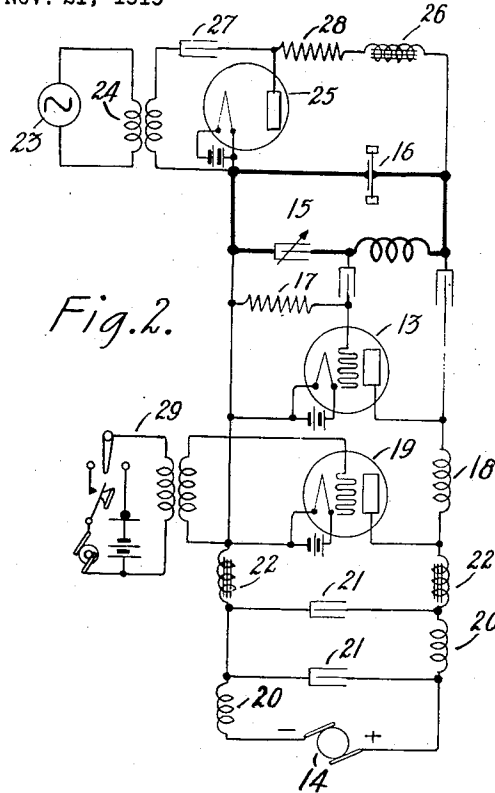


Fig. 3.

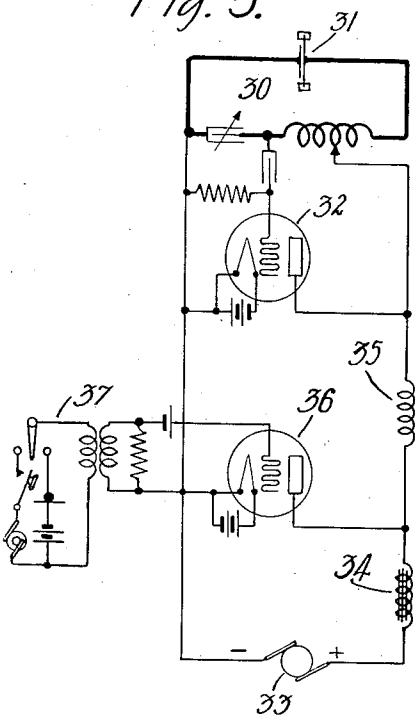
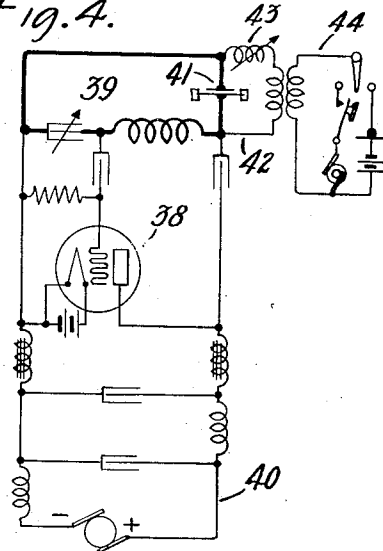


Fig. 4.



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UNITED STATES PATENT OFFICE.

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SYSTEM FOR PRODUCING AND TRANSMITTING HIGH-FREQUENCY SOUND ENERGY.

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This invention relates to systems for producing and transmitting high frequency sound energy, and more particularly to systems for signaling or teledynamic control in which high frequency electrical energy is used to produce high frequency sound energy.

An object of the invention is to provide means for producing high frequency sound and varying it in accordance with signals or control impulses.

A further object of the invention is to provide an arrangement whereby a condenser transmitter may serve to convert modulated electrical energy into correspondingly modulated sound energy.

A feature of the invention is the provision of a vacuum tube oscillator with an oscillatory circuit, including a capacity element which may serve to transmit modulated sound waves.

It has previously been proposed to produce high frequency electrical energy, to convert said electrical energy into high frequency sound energy, and to transmit the sound energy to a distant point where it may be detected and utilized for signal or other teledynamic purposes.

According to the present invention a vacuum tube oscillator or other source of high frequency electrical oscillations is associated with a condenser transmitter in such manner that modulated or otherwise modified high frequency sounds are produced by the transmitter. The condenser may constitute an element of the oscillator and at the same time serve as the modulator and sound producing device.

In the drawing, Fig. 1 illustrates an arrangement in which a condenser transmitter serves to modulate high frequency electrical energy and to produce correspondingly modulated high frequency sound energy. Fig. 2 illustrates a modified system in which a condenser transmitter serves as an element of a vacuum tube oscillator and also as a high frequency sound producer. Fig. 3, illustrates a further modification similar to that of Fig. 2, except that the space current source of the vacuum tube oscillator serves also to polarize the condenser transmitter. Fig. 4 illustrates an additional modification in which the condenser transmitter serves as

an element of the oscillator, as a modulator and as a high frequency sound producer.

Referring to Fig. 1, high frequency oscillator 1 is connected by the transformer 2 to a circuit including a condenser transmitter 3, a tuning inductance 4 and secondary winding of transformer 5. A capacity element 6 shunted across the secondary winding of transformer 5 serves as a path for high frequency current. A signaling circuit including a switch 7 is connected to the primary winding of transformer 5 and has two branches, one including a key 8 and low frequency current source 9, and the other including the microphone 11 and direct current source 12, so that this circuit may serve for telephony, for telegraphy or for control impulse transmission.

In operation, the circuit including condenser transmitter 3 may be tuned by inductance 4 to the frequency of the oscillations supplied by source 1. If switch 7 is closed in one of its two positions, and the corresponding signal transmitter is operated, high frequency oscillations from source 1 and low frequency impulses from the primary circuit of transformer 5 are simultaneously impressed upon condenser 3. It is well known that the attracting force between the plates of a condenser varies as the square of the impressed electromotive force. In the case of condenser 3, the impressed electromotive force is the sum of two alternating electromotive forces. It is also well known that a force varying as the square of the sum of two harmonic forces has as one effective component a periodic force having the frequency of the higher frequency component and having an intensity characteristic or amplitude varying in accordance with that of the lower frequency force. If condenser 3 be constructed so that the varying attraction of its plates and their resulting displacement may set up corresponding disturbances in the surrounding medium, there will be propagated in this medium sound waves, of the frequency of the oscillations of source 1, varying in amplitude in accordance with the low frequency electrical impulses supplied by the primary circuit of transformer 5. If the condenser is specially designed for submarine operation and is placed in water, a high frequency sound

wave modulated in accordance with speech, other signaling energy, or teledynamic control impulses, as the case may be, will be transmitted through the water.

In the modification of Fig. 2, as in Figs. 3 and 4, there is indicated by heavy black lines an oscillatory circuit which serves in conjunction with a thermionic discharge device associated therewith as an oscillation generator. The general operation of generators of this type is well known and will not be discussed here, except to point out that the oscillatory circuit or certain of its elements may serve to so couple the input and output circuits of the thermionic discharge device as to cause it to produce continuous oscillations. As illustrated, thermionic discharge device 13 is supplied with space current by a source 14 and has its input and output terminals connected to oscillatory circuit 15 which includes a condenser transmitter 16. The oscillator tube 13 is provided with a high resistance leak path 17 connecting its cathode and impedance control element in well known manner. A high frequency retard coil 18 is provided to prevent the high frequency energy from traversing the space current circuit. A thermionic discharge device 19 which acts as a modulator, as will be later explained, has its cathode and anode connected to the same space current source 14. Between the discharge devices 13 and 19 and their common source is a reactance network comprising series inductances 20 and shunt capacity elements 21, the function of this network being to prevent ripples in the unidirectional current supplied to the tubes. Low frequency choke coils 22 are also connected in series with source 14 to hold substantially constant the total value of the unidirectional current. The input or grid filament circuit of modulator 19 is associated with a signal or control circuit 29 in every respect like that of the primary circuit of transformer 5 in Fig. 1. A source 23 of alternating current is connected by a transformer 24 to a rectifying circuit connected across the terminals of condenser 16 and serves to impress a unidirectional polarizing electromotive force upon this condenser. The rectifying circuit consists of a shunt thermionic rectifier element 25 and a series choke coil 26 to hold constant the rectified or unidirectional electromotive force. A series capacity element 27 serves to prevent the rectified electromotive force from being dissipated in the secondary winding of transformer 24, and a series resistance 28 may be used as a regulation device. It is therefore possible to polarize condenser 16 to any desired potential. Any other suitable arrangement may be used for polarizing the condenser.

In operation, a polarized condenser trans-

mitter transmits sound waves of frequency and amplitude corresponding to the variable current supplied thereto, as is well known. Variable electromotive forces applied to the input circuit of tube 19 correspondingly vary its impedance, and the amount of the constant current from source 14 which tube 19 diverts from tube 13. The space current of oscillator tube 13 and the amplitude of the oscillations produced thereby will therefore be determined by the signal or control circuit 29. It is therefore evident that polarized transmitter 16 will transmit high frequency sound waves of a frequency chiefly determined by the electrical constants of oscillatory circuit 15 and of an amplitude determined by the variation current in circuit 29.

Referring to Fig. 3, an oscillatory circuit 30, including a condenser transmitter 31, is associated with thermionic discharge device 32 in such manner as to constitute a generator of oscillations of substantially the natural frequency of circuit 30. The space current source 33 is connected to discharge device 32 through low frequency choke coil 34 and high frequency retard element 35 corresponding in function to elements 22 and 18 respectively, of the system illustrated in Fig. 2. A thermionic modulator tube 36, the impedance of which is controlled by circuit 37, serves to determine the amplitude of the oscillations supplied to transmitter 31. Source 33 is conductively connected to the terminals of transmitter 31 and serves to polarize it directly, thus avoiding the necessity of a special polarizing source.

The system shown in Fig. 4 makes use of an oscillator consisting of a thermionic device 38 and an oscillatory circuit 39 including a condenser transmitter 41. These elements and the space current supply circuit 40 correspond exactly to the arrangement shown in Fig. 2. The principal difference between this circuit and that of Fig. 2 is that condenser transmitter 41 is unpolarized. Connected to the terminals of this condenser is a circuit 42 including the tuning inductance 43. An associated signal or control circuit 44 serves to impress a low frequency electromotive force upon transmitter 41 simultaneously with the high frequency oscillations. As explained in connection with the operation of the system of Fig. 1, transmitter 41 will emit high frequency sound waves of a frequency determined chiefly by the electrical constants of oscillatory circuit 39 and of an amplitude determined by the signal or control currents of circuit 44.

It will, of course, be understood by those skilled in the art that the specific circuits herein shown and described are merely illustrative of particular forms in which the invention may be embodied. The details of the circuits and the arrangements of the

various elements may be materially varied from what is set forth. The invention is therefore to be limited only by the scope of the appended claims.

5 What is claimed is:

1. A condenser sound transmitter and means for applying an electromotive force thereto, means for simultaneously causing variations in said applied electromotive
10 force at two different rates, and further means whereby the resultant sound waves reproduce the variations in the applied electromotive force.

2. A condenser sound transmitter, means
15 for applying thereto an electromotive force simultaneously varying in accordance with high frequency currents and with other lower frequency currents, whereby said transmitter serves to emit modulated high
20 frequency sound waves, and further means whereby the resultant sound waves reproduce the variations in the applied electromotive force.

3. An oscillator comprising a resonant
25 frequency determining circuit, and an elec-

tric discharge device having input and output circuits connected thereto, said resonant circuit including a condenser sound transmitter constituting a substantial part of the capacity in said circuit.

4. An oscillator comprising an electric
30 discharge device having coupled input and output circuits, a condenser sound transmitter associated with said output circuit, means for supplying current in said discharge device, and means for varying said
35 current in accordance with low frequency impulses.

5. Means for producing modulated high frequency sound comprising a condenser
40 sound transmitter, a vacuum tube oscillator connected thereto, and means for varying in accordance with lower frequency impulses the amplitude of the oscillations produced by said oscillator.

45 In witness whereof, I hereunto subscribe my name this 19th day of November, A. D., 1919.

IRVING B. CRANDALL.