

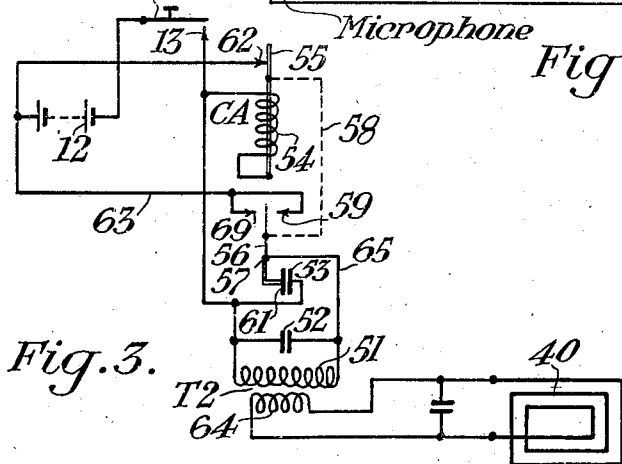
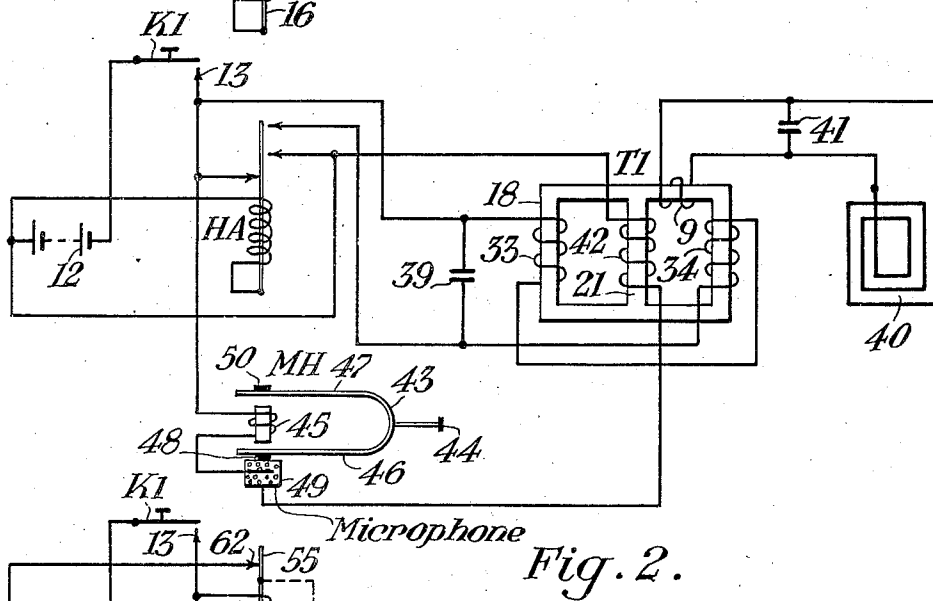
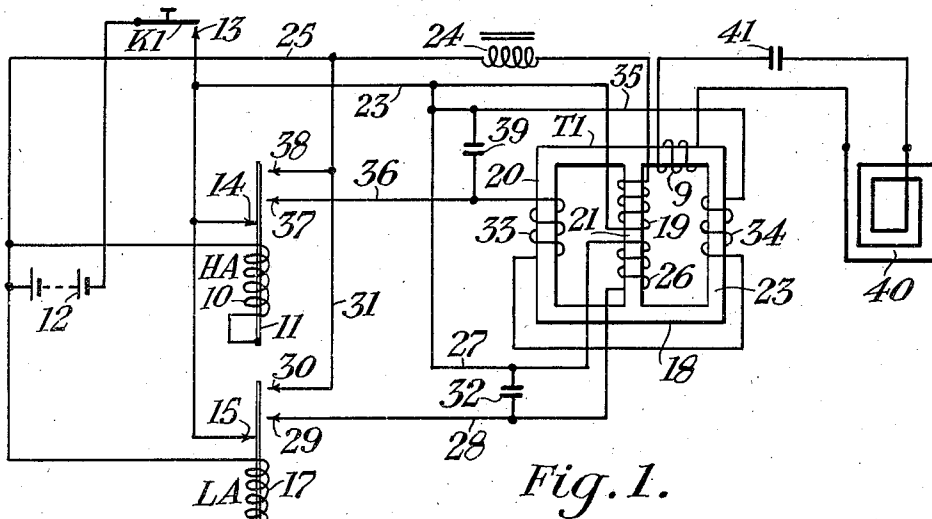
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MEANS FOR SUPPLYING PULSES OF MODULATED CURRENT

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MEANS FOR SUPPLYING PULSES OF
MODULATED CURRENT

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My invention relates to means for supplying pulses of modulated current, and more particularly to means for supplying frequency modulated current pulses.

It has been proposed that current of a preselected characteristic be used in connection with railway train telephone communication equipment for providing special emergency alarm signals. In such an arrangement the alarm current must be of a characteristic that it is efficiently transmitted through the circuit or medium used to transmit the telephone current and of a characteristic that it will be effectively received through the telephone receiving apparatus. Also, a relatively simple and reliable construction of the supply means is desirable.

Accordingly, a feature of my invention is the provision of novel means for supplying current of a preselected characteristic.

Another feature of my invention is the provision of novel and improved means for supplying pulses of modulated current, and which current is adaptable to being used with telephone equipment.

A more specific feature of my invention is the provision of novel and improved means for supplying pulses of frequency modulated carrier current which are adaptable to being used with train telephone communication equipment of the carrier type using frequency modulation.

Again, a feature of my invention is the provision of novel means of relatively simple and inexpensive structure for supplying pulses of modulated current.

Other features, objects and advantages of my invention will appear as the specification progresses.

The foregoing features, objects and advantages embodying my invention I attain by the provision of means including vibrators or interrupters to impulse excite tuned circuits from a direct current source. In this way pulses or trains of oscillations will flow in the tuned circuit in response to each impulse or shock excitation of the tuned circuit. The tuned circuit includes, or has electrically associated therewith, means for varying the reactance of the circuit at a rate corresponding to a given signal and in this way the oscillations of the tuned circuit are modulated according to such signal.

In a preferred form of the invention I provide two vibrators of different rates of vibration. One vibrator operates at a relatively high rate of vibration and impulse excites a circuit tuned to resonance at a preselected carrier frequency, and

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which circuit includes a winding mounted on a closed iron core structure of a transformer. A second vibrator or interrupter operates at a relatively low rate of vibration and impulse excites a circuit tuned to resonance at a preselected audio frequency and which latter circuit includes another winding mounted on the transformer core structure. Each pulse or train of audio frequency oscillations serves to vary the permeability of the core structure and thereby modulate the carrier frequency oscillations. To increase the amount of change of the permeability of the core structure, a direct current polarizing winding is preferably mounted on the core and energized from a direct current source. A secondary or output winding of the transformer loosely couples the transformer to a load circuit or element.

Since there is no fixed phase relationship between the two vibrators, the pulse supplied to the output circuit will be of carrier frequencies varied over a range predetermined by the change of inductance of the transformer in response to the modulating frequency current. This is so because the excitation of the audio tuned circuit causes the flux of the iron core, and therefore the permeability of the core, to be varied at the resonant frequency of the circuit, and the carrier frequency will be varied due to such change in the permeability of the iron core. Such pulses or trains of frequency modulated current delivered to the load circuit will follow in rapid succession at a rate corresponding to the rate of vibration of the high vibrator and these pulses will be of a characteristic that will be heard in the loudspeaker of receiving apparatus capable of receiving such frequency modulated carrier telephone current.

In another form of the invention, the reed or vibrating member of a vibrator actuates one plate of a capacitor interposed in a tuned transformer circuit. Hence the frequency at which the train of oscillations start in this tuned circuit will be different for each alternate pulse because of the change in the capacitor associated with the reed. There will thus be supplied to the output winding of the transformer a frequency modulated pulse which will be of a characteristic that it will be heard in telephone receiving apparatus designed for reception of frequency modulated telephone current.

I shall describe three forms of apparatus embodying my invention and shall then point out the novel features thereof in claims.

In the accompanying drawings, Figs. 1 and 2 are diagrammatic views showing two different

forms of apparatus embodying my invention when used to supply pulses of frequency modulated carrier current due to changes in the permeability of an iron core of a transformer. Fig. 3 is a diagrammatic view showing another form of apparatus embodying my invention when used to supply pulses of frequency modulating carrier current by changes in the capacitance of a tuned circuit of a high frequency transformer.

In each of the several views like reference characters are used to designate similar parts.

Referring to Fig. 1, the reference characters HA and LA designate a first and a second vibrator, respectively. These vibrators may take any one of several different forms, and they are shown as of the tuned reed type. The vibrator HA, for example, includes an operating winding 10 and a tuned reed contact member 11. An operating or energized circuit is provided for the vibrator, which circuit extends from one terminal of a source of direct current, such as a battery 12, through contact 13 of a key switch K1 when closed in a manner to later appear, contact 14 and contact member 11 of the vibrator HA and winding 10 of the vibrator to the other terminal of the battery 12. Vibrator LA is similar in construction except as to its rate of vibration and is provided with an energizing circuit extending from battery 12 through the key contact 13, contact 15 and tuned reed contact member 16 of the vibrator, and winding 17 of that vibrator to the other terminal of battery 12. Thus with the key contact 13 closed, the two vibrators HA and LA are energized and the respective reed contact members are set into vibration. The parts are so proportioned that vibrator LA vibrates at a relatively low rate and vibrator HA at a relatively high rate. I shall assume by way of illustration that vibrator LA vibrates at a rate of say 5 times per second, and vibrator HA vibrates at a rate of 50 times per second. Other rates of vibration can, of course, be used.

A transformer T1 is provided with a three-legged iron core structure 18. A polarizing winding 19 mounted on center leg 21 of the core structure is energized from battery 12, current flowing from battery 12 through key contact 13, wire 23, winding 19, a choke coil 24 and wire 25 to the other terminal of battery 12, the purpose of choke coil 24 being to prevent loss of alternating current energy in the circuit. Polarizing winding 19 is proportioned to provide a predetermined flux in the iron core structure. A modulating winding 26 is also mounted on the center leg 21 of the core structure and this winding has connected across its terminals a capacitor 32 to form a tuned circuit. This tuned circuit is shock or impulse excited through a circuit including a contact of the vibrator LA and which circuit can be traced from battery 12 through key contact 13, wires 23 and 27, the tuned circuit comprising winding 26 and capacitor 32, wire 28, contacts 29 and 30 of vibrator LA when contact member 16 swings to the right as viewed in the drawing, and wires 31 and 25 to battery 12. This tuned circuit is tuned to resonance at a predetermined modulated frequency and which frequency I shall assume by way of illustration to be an audio frequency of 1000 cycles per second. Thus each vibration of the vibrator LA, contact 29—30 is closed and the tuned circuit is impulse excited from the battery 12 with the result that oscillations flow in the tuned circuit during the period of each vibration that the contact 29—30 of the vibrator is open. It follows therefore that the flux of the core struc-

ture is varied by the oscillations flowing in winding 26 and such variation is increased by proper proportioning of the flux created by the polarizing winding 19.

Two coils 33 and 34 are mounted on outside legs 20 and 22, respectively, of the core 18 of the transformer and are connected in series to a capacitor 39 to form a tuned circuit, and which tuned circuit is impulse excited by the operation of vibrator HA. A current impulse is supplied to this tuned circuit through a circuit including battery 12, key contact 13, wires 23 and 35, the tuned circuit, wire 36, contacts 37 and 38 of vibrator HA when the contact member 11 of that vibrator swings to the right as viewed in Fig. 1, and wires 31 and 25 to battery 12. I shall assume by way of illustration that this tuned circuit including coils 33 and 34 and capacitor 39 is tuned to resonance at a carrier frequency of 100,000 cycles per second. Thus each vibration of the vibrator HA, the tuned circuit is impulse excited and a train of oscillations persists in the circuit during the period of each vibration that the contact 37—38 of the vibrator HA is open. The frequencies of this train of carrier oscillations will depend upon the superposed flux in the iron core, and which flux is varied with the audio frequency of 1000 cycles per second due to the impulse excitation of the tuned circuit including winding 26 and capacitor 32. Consequently the carrier oscillations will be frequency modulated at the audio frequency oscillations.

There is a fourth or output winding 9 mounted on the core structure 18 of transformer T1 and this output winding 9 is connected to a transmitting coil 40 through a capacitor 41; coil 40 being in turn coupled to a transmitting circuit or medium (not shown) of telephone system with which the apparatus of the present invention is associated. For example, in a train telephone system of the carrier inductive type disclosed in my Letters Patent of the United States No. 2,064,642 granted December 15, 1936, for Railway train communication system, the coil 40 would be mounted on a train for inductive relation to the track rails and line wires paralleling the track.

Since there is no fixed phase relation between the two vibrators LA and HA the high energy component of the carrier frequency at the beginning of a pulse will be sent out at carrier frequency varying over the range determined by the change of the inductance of the transformer T1 in response to the excitation of the audio frequency tuned circuit including the winding 26. It is to be seen therefore that the load circuit including the transmitting winding 40 receives a rapid succession of pulses of frequency modulated current. Also, on the assumption that the carrier frequency of these pulses corresponds to the carrier frequency of the associated train telephone system, these pulses will be heard in the loud-speaker of the receiving apparatus of the telephone system. That is to say, that whenever key K1 is actuated to close contact 13, the tuned vibrators LA and HA are powered and current impulses are supplied to the tuned circuits and the load circuit including transmitting coil 40 receives a rapid succession of pulses of frequency modulated carrier current, and which pulses will be sounded in the loud-speaker of the receiving apparatus associated with the load circuit. The sound or tone heard in the loud-speaker will have three characteristics, one depending upon the rate at which the key contact 13 is closed and 75 opened, another upon the rate of operation of

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the audio frequency vibrator LA and a third upon the rate of the high rate vibrator HA.

Referring to Fig. 2 a tuned circuit comprising coils 33 and 34 of transformer T1 and capacitor 39 is impulse excited by current from battery 12 through a high rate vibrator HA the same as in Fig. 1.

The reference character MH designates a vibrator of the so-called "microphone hummer" type. A tuning fork 43 is mounted rigidly at its heel to a base 44 and has an electromagnet 45 disposed between its tines 46 and 47 for causing continued vibrations of the tines in response to energization of the magnet in a manner to appear shortly. A microphone button 48 of a microphone 49 is fixed on the tine 46 and a corresponding button 50 is fixed on the tine 47, the two buttons 48 and 50 being proportioned to load the tines equally and to affect only slightly the vibrations of the tuning fork.

The magnet 45 of the device MH and a winding 42 mounted on the center leg 21 of the core structure of transformer T1 are energized in series through the microphone 49, current flowing from one terminal of battery 12, through key contact 13, when closed, winding of magnet 45, microphone 49 and winding 42 of transformer T1 to the other terminal of battery 12. Thus, whenever the key contact 13 is closed, the tines of the fork 43 are set into vibration and the winding 42 of the transformer is energized to different degrees due to the operation of the microphone 49. That is, the current flowing through the winding 42 is varied at a rate corresponding to the frequency of the tuning fork, and which frequency I shall assume to be an audio frequency of 1000 cycles per second. Such variations of the current flowing through winding 42 of the transformer T1 cause corresponding variations in the flux superimposed in the core of the transformer, and in turn cause the permeability of the transformer core to be varied due to the current through the winding 42 rising and falling in step with the operation of the microphone 49.

An output winding 9 of transformer T1 of Fig. 2 is connected to transmitting coil 40 the same as in Fig. 1, except capacitor 41 is connected in multiple with the winding 40.

It is to be seen that in Fig. 2, the closing of the key contact 13 causes the tuned circuit including winding 33-34 of transformer T1 to be impulse excited through the operation of the vibrator HA and the carrier frequency oscillations of this tuned circuit to be frequency modulated at the audio frequency variations of the permeability of the transformer as caused through the operation of the device MH. Consequently, there are supplied to the transmitting coil 40 pulses of frequency modulated carrier current which are capable of being transmitted through the transmitting circuit of an associated communication system and an audio tone sounded in the loud-speaker of receiving apparatus of any station of the associated communication system.

Referring to Fig. 3, a tuned circuit including primary winding 51 of a transformer T2 and capacitors 52 and 53 in multiple is impulse excited by current impulses supplied from battery 12 through a vibrator CA. Vibrator CA is of the tuned alternator type having an operating winding 54 and a tuned reed contact member 55. An auxiliary contact member 56 pivoted at 57 is operatively attached to the reed contact member 55 through a connection indicated conventionally by

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a dotted line 58. Thus, the two arms of the contact member 56 oscillate about the pivot 57 in response to the vibrations of the reed member 55. The top portion or arm of member 56 as viewed in Fig. 3 alternately engages two contacts 59 and 69 each oscillation and the lower portion of the contact member 56 is disposed to vibrate one plate 61 of capacitor 53 to vary the capacitance thereof.

Operating winding 54 of the vibrator CA is energized from battery 12 when key K1 is actuated to close its contact 13, the circuit including contact 62 of the vibrator, as will be readily understood by an inspection of the drawing. The parts are proportioned for the reed contact member 55 to be vibrated at a predetermined rate.

Operation of the vibrator CA causes current impulse to be applied to the tuned circuit when the contact member 56 swings to the right to engage contact 59 and when it swings to the left to engage contact 69, a circuit being completed from battery 12 through key contact 13, the tuned circuit, wire 65, contact member 56, either contact 59 or 69, and wire 63 to battery 12. That is to say, the tuned circuit is impulse excited twice each vibration of the vibrator CA. The tuned circuit comprising transformer winding 51 and the capacitors 52 and 53 is tuned to resonance at a predetermined carrier frequency which I shall assume to be 100,000 cycles per second when the plate 61 of capacitor 53 occupies the position corresponding to that shown in the drawing. The resonant frequency of the tuned circuit is varied between a maximum and a minimum value by the movement of the plate 61 of capacitor 53. Hence, the frequency at which the pulses or trains of oscillation start in the tuned circuit will be different each alternate exciting impulse because of the change in the capacitor 53. There will thus be present in the output winding 64 of transformer T2 a frequency modulated electromotive force. Winding 64 is connected to transmitting coil 40 coupled to the transmitting circuit of the associated telephone system, the same as explained in connection with Figs. 1 and 2.

It is to be seen therefore that with the apparatus of Fig. 3, successive pulses of a frequency modulated carrier current are supplied to the transmitting circuit for sounding a corresponding tone in the loud-speaker of the receiving apparatus associated with such transmitting circuit.

Although I have herein shown and described only three forms of means for supplying pulses of modulated current embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a tuned circuit tuned to resonance at a definite carrier frequency, means including a current source and a vibrator connected to said circuit to periodically impulse excite the circuit to create successive pulses of said carrier current, means including an oscillating member to vary the reactance of said tuned circuit to frequency modulate said pulses of carrier current, and a load element electrically coupled to the tuned circuit to receive said pulses of frequency modulated carrier current.

2. In combination, a tuned circuit tuned to resonance at a definite carrier frequency, a vibrator operable at a definite rate of vibration, circuit means including a contact of said vibrator and a direct current source connected to said tuned

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circuit to successively impulse excite the tuned circuit to create successive trains of oscillations of said carrier frequency, modulating means including a vibrating member, and said modulating means related to said tuned circuit in such a manner as to vary the reactance of the tuned circuit at a rate corresponding to the rate of the vibrations of said vibrating member whereby said trains of oscillations are frequency modulated.

3. In combination, a tuned circuit tuned to resonance at a selected carrier frequency, an interrupter having a circuit closing contact member and motor means to actuate said contact member to close a contact at a selected rate, circuit means including a direct current source and the contact of said contact member connected to said tuned circuit to impulse excite the tuned circuit at said selected rate to create in the tuned circuit pulses of said carrier frequency current, modulating means having a vibrating member and motor means to actuate the vibrating member at a selected rate, and said modulating means disposed to vary the electrical characteristics of said tuned circuit to frequency modulate said pulses of carrier frequency current.

4. In combination, a tuned circuit tuned to resonance at a selected carrier frequency, an interrupter having motor means to periodically close a contact, circuit means including a direct current source and said interrupter contact connected to said tuned circuit to impulse excite the tuned circuit to create in the tuned circuit a series of wave trains of said carrier frequency current, modulating means having a motor for actuating a vibrating member at a given rate, said vibrating member electrically connected with said tuned circuit to vary the reactance of the tuned circuit at said given rate, and a load circuit coupled to said tuned circuit to receive a series of wave trains of said carrier current frequency modulated due to said reactance variation of the tuned circuit by said modulating means.

5. In combination, a tuned circuit including a winding mounted on an iron core structure and a capacitor, said tuned circuit tuned to resonance at a given carrier frequency, a first circuit means including a source of current and a vibrator connected to said tuned circuit to periodically impulse excite the tuned circuit; a second circuit means including another winding mounted on said core structure, a current source and a vibrating member to vary the permeability of said core structure; and a load circuit including an output winding mounted on said core structure receiving successive pulses of frequency modulated carrier current due to said impulsing excitation of the tuned circuit and permeability variation of said iron core structure.

6. In combination, a tuned circuit including a winding mounted on an iron core structure and a capacitor, said tuned circuit tuned to resonance at a predetermined carrier frequency, a first circuit including a direct current source and a vibrator connected to said tuned circuit to impulse excite said tuned circuit at a rate predetermined by the rate of vibration of said vibrator; a second circuit including a source of direct current, another winding mounted on said core and a vibrating member to vary the flux of said core structure; and an output circuit including an output winding mounted on said core receiving a series of pulses of frequency modulated carrier current due to said impulse excitation of said tuned circuit and flux variation of said core structure.

7. In combination, an iron core transformer,

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a first tuned circuit including a winding of said transformer and a capacitor tuned to resonance at a predetermined carrier frequency, a second tuned circuit including a winding of said transformer and a capacitor tuned to resonance at a predetermined audio frequency, a first circuit including a current source and a first vibrator connected to said first tuned circuit to periodically impulse excite that tuned circuit, a second circuit including a current source and a second vibrator connected to said second tuned circuit to periodically impulse excite that tuned circuit, and a load circuit including an output winding of said transformer receiving pulses of frequency modulated carrier current due to said excitation of said first and second tuned circuits.

8. In combination, an iron core transformer, a first and a second tuned circuit including a first and a second winding respectively of said transformer, said first tuned circuit tuned to resonance at a definite carrier frequency and said second tuned circuit tuned to resonance at a definite audio frequency, a first and a second vibrator operable at a first and a second rate respectively when energized, means to at times energize said vibrators, a first circuit including a current source and a contact of said first vibrator connected to said first tuned circuit to impulse excite that tuned circuit at a rate corresponding to said rate of the first vibrator, a second circuit including a current source and a contact of said second vibrator connected to said second tuned circuit to impulse excite that tuned circuit at a rate corresponding to said rate of the second vibrator, and a load circuit including an output winding of said transformer receiving successive pulses of frequency modulated carrier current due to said excitation of said tuned circuits.

9. In combination, an iron core transformer, a first and a second tuned circuit including a first and a second winding respectively of said transformer, said first tuned circuit tuned to resonance at a definite carrier frequency and said second tuned circuit tuned to resonance at a definite audio frequency, a first and a second vibrator operable at a first and a second rate respectively when energized, means including a manual operable contact key to at times energize said vibrators, a first circuit including a current source and a contact of said first vibrator connected to said first tuned circuit to impulse excite that tuned circuit, a second circuit including a current source and a contact of said second vibrator connected to said second tuned circuit to impulse excite that tuned circuit, and a load circuit including an output winding of said transformer receiving successive pulses of frequency modulated carrier current due to said excitation of said tuned circuit and which pulses have three characteristics one due to a rate of operation of said key contact, one due to the rate of vibration of said second vibrator and one due to the rate of vibration of said first vibrator.

10. In combination, a transformer having a three legged iron core structure formed with a center leg and a first and a second outside leg, means including a direct current source and a first winding mounted on the center leg of said core to create a given flux in said core, a first tuned circuit including a first and a second coil mounted on said first and second outside leg respectively of said core and tuned to resonance at a given carrier frequency, circuit means including a current source and a first vibrator contact connected to said first tuned circuit to periodically impulse ex-

cite that tuned circuit at a rate determined by the vibrating rate of the first vibrator, a second tuned circuit including a winding mounted on the center leg of said core structure and tuned to resonance at a given audio frequency, circuit means including a current source and a second vibrator contact connected to said second tuned circuit to periodically impulse excite that tuned circuit at a rate determined by the vibrating rate of the second vibrator, and an output circuit including an output winding mounted on said core structure receiving a series of carrier current pulses frequency modulated at the audio frequency of said second tuned circuit due to said impulse excitation of said first and second tuned circuits.

11. In combination, an iron core transformer, a tuned circuit including a winding of said transformer and a capacitor tuned to resonance at a definite carrier frequency, a first circuit including a current source and a vibrating contact connected to said tuned circuit to periodically impulse excite said tuned circuit; an oscillator including a tuning fork, a microphone varied by the oscillations of the tuning fork and a magnet to actuate the fork; a second circuit including a second winding of said transformer, a current source, said magnet and said microphone to vary the permeability of said transformer core at a rate corresponding to the oscillating frequency of said tuning fork; and a load circuit including an output winding of said transformer supplied with pulses of frequency modulated carrier current due to said excitation of said tuned circuit and permeability variation of said transformer core.

12. In combination, an iron core transformer, a tuned circuit including a winding of said transformer and capacitance tuned to resonance at a definite carrier frequency, means including a current source and an intermittent contact device connected to said tuned circuit to periodically shock excite the tuned circuit to create successive trains of carrier oscillations in the tuned circuit; a vibrator including a tuning fork, a microphone varied by the vibrations of the fork and means to vibrate the fork; circuit means including a current source, said microphone and a winding of said transformer to vary the flux of said transformer core at a rate corresponding to the rate of vibration of said tuning fork; and a load circuit including an output winding of said transformer supplied with successive wave trains of

frequency modulated carrier current due to said excitation of said tuned circuit and said variations of said core flux.

13. In combination, a transformer, a tuned circuit including a winding of said transformer and a capacitor tuned to resonance at a given carrier frequency, a vibrator having a motor for vibrating a contact actuating member at a given audio frequency, means including a current source and contacts governed by said contact actuating member connected to said tuned circuit to impulse excite the tuned circuit, means actuated by said contact actuating member connected to said capacitor to vary the capacitance of the capacitor between a maximum and a minimum value each vibration of said member, and a load circuit including a winding of said transformer receiving current pulses of said carrier frequency modulated at said audio frequency due to said impulse excitation of the tuned circuit and said variation of said capacitor.

14. In combination, a transformer, a tuned circuit including a winding of said transformer and a capacitor tuned to resonance at a definite carrier frequency, a vibrator having a centrally pivoted member and a motor to vibrate said member about its pivot at a definite audio frequency, circuit means including a current source and two contacts closed alternately by the vibration of one end of said pivoted member connected to said tuned circuit to impulse excite the tuned circuit, said pivoted member having its end opposite said one end connected to a plate of said capacitor to vary its capacitance between a maximum and a minimum value each vibration of said member, and a load circuit connected to a winding of said transformer to receive successive pulses of frequency modulated carrier current due to said impulse excitation of the tuned circuit and capacitance variation of said capacitor.

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