Sept. 16, 1941. W. L. WOOLF 2,255,840

COMMUNICATING DEVICE AND SYSTEM

Filed Oct. 7, 1937

Fig. 1

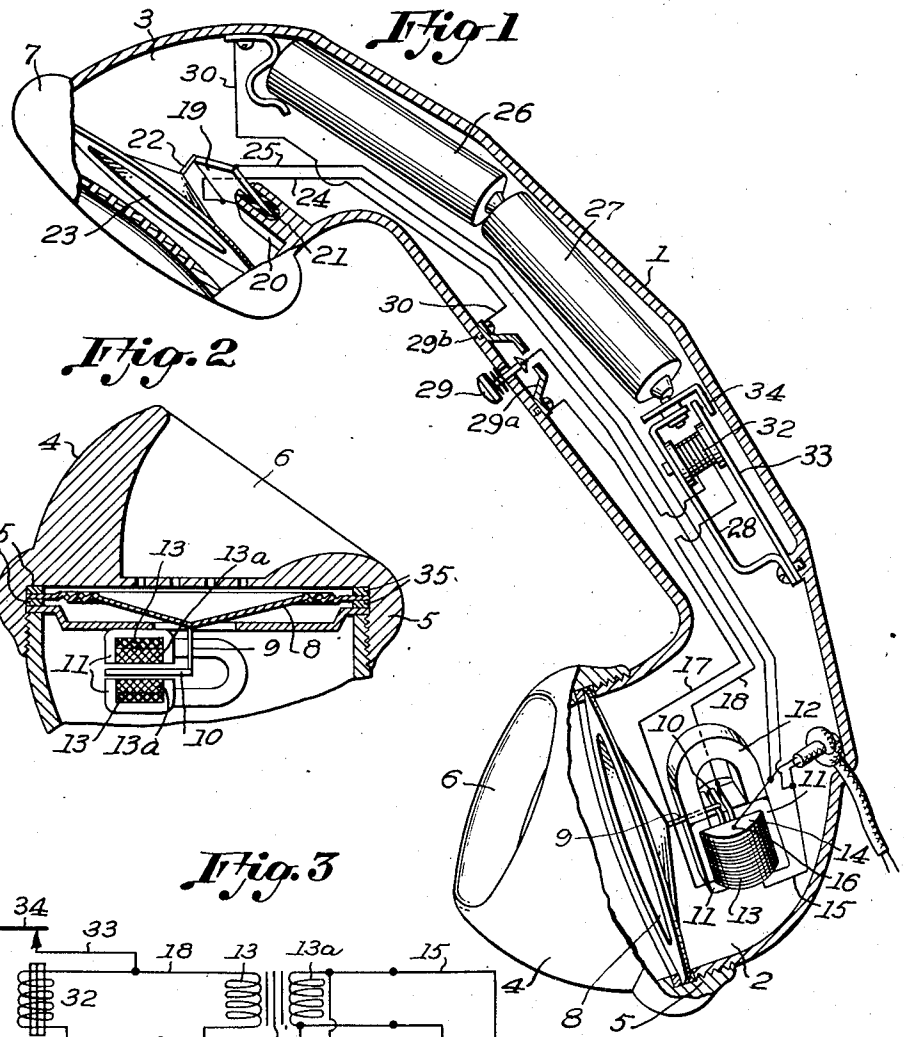

Fig. 2

Fig. 3

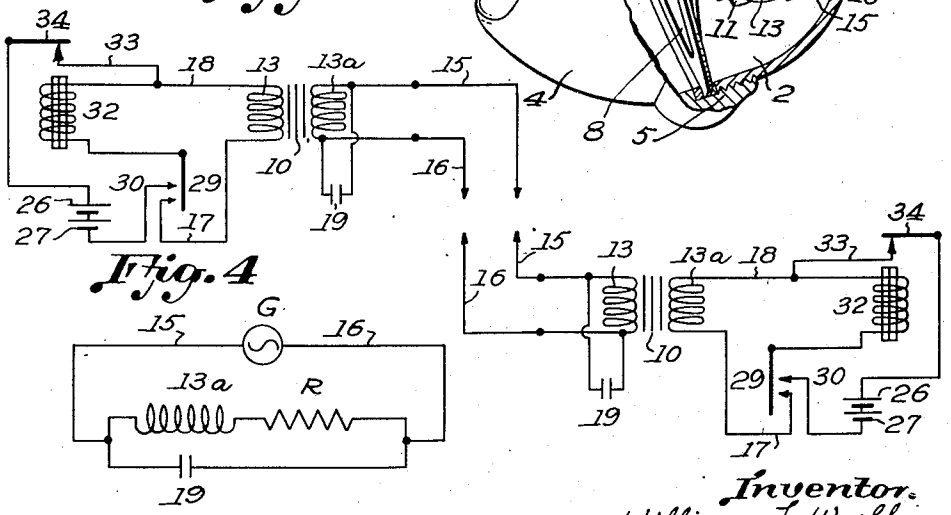

Fig. 4

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COMMUNICATING DEVICE AND SYSTEM

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19 Claims. (Cl. 179—1)

This invention relates to improvements in telephone instruments.

Its object is to provide a telephone instrument capable of operating over long periods at very low maintenance cost. A further object is to provide an instrument so simplified as to affect a low first cost. A still further object is to supply an instrument capable of reproducing speech with a high degree of intelligibility.

The instrument and its manner of working will be fully understood by reference to the enclosed drawing in which like numbers refer to like parts.

Figure 1 is a perspective of the instrument showing the casing cut away and enclosing the essential working parts on the inside.

Figure 2 is a cross section showing portions of the transmitter.

Figure 3 is a schematic diagram of a telephone system employing this device.

Figure 4 is a theoretical schematic circuit for the purpose of explaining the manner in which the device works.

In one embodiment of the invention, it consists of a hollow handle 1, terminating in two hollow extremities which contain respectively the transmitter 2 and receiver 3. The mouthpiece 4 with threaded portion 5 and horn like air chamber 6 screws on to that end of the handle containing the transmitter and seals it in; similarly earpiece 7 screws on to the opposite end and seals in the receiver 3.

Transmitter 2 is of the self generating type fully described in my co-pending application Serial 154,617, July 20, 1937. It employs a diaphragm 8 supported by rings 35 (Figure 2) and connected by pin 9 to armature 10 disposed in a magnetic field between pole piece 11 magnetized by magnet 12. Two windings 13 and 13*a* are wound on spool 14 surrounding armature 10. The inner winding 13*a* known as the voice coil is wound with a higher impedance and greater number of turns than the outer winding 13 which is known as the signal coil. The two coils in close proximity to each other with the armature forming a soft iron core, function as a transformer when operating together as hereinafter described. The voice coil terminates in leads 15 and 16. Leads 15 and 16 connect to the voice coil of a similar transmitter to form a complete telephone system. By the manner hereinafter described, it will be observed that the two leads 15 and 16 constitute the sole connecting means between two instruments and serve to carry both voice and signal impulses, thus permitting a complete system with two wires only.

The signal coil terminates in leads 17 and 18. Lead 17 is connected to stator contact 29*a* of the double pole single throw switch 29 and lead 18 is connected to one terminal of the buzzer coil 32. The other terminal of buzzer coil 32 is connected to the movable contact of switch 29.

The receiver in the earpiece 7 may consist of an instrument identical in every respect to the transmitter above described except that it is provided with a voice coil winding of very much higher impedance than that of the transmitter. In another embodiment of this invention, the receiver consists of a crystal 19 of Rochelle salts or other crystal of suitable properties, supported by a clamp like holder 20 lined with rubber damping material 21. The signal voltage is applied to the crystal 19 through leads 24 and 25 which are attached to leads 15 and 16 thus connecting the receiving element 19 in parallel with the voice coil 13*a*. To one end of the crystal 19 is attached a connecting pin 22. The other end of this pin is attached to the stiffened central portion of a diaphragm 23 supported by rings not shown in the earpiece 7.

Perforations in the bottom of the horn like air chamber 6, admit the energy of the spoken voice to the diaphragm 8, causing vibrations which are transmitted through pin 9 to the armature 10. These vibrations induce a voltage in the coil 13 which is transmitted into the leads 15 and 16. These electrical impulses are carried over transmission leads 15 and 16. Such a transmitter is herein referred to as a self generating transmitter. Impulses in leads 15 and 16 are conducted to an instrument identical to that described. Upon reaching the other end of the wire, the energy is divided, one portion of it going through the voice coil 13*a* and a portion being impressed across the crystal 19. The nature of the crystal is such that when the voltage is applied across one axis, a distortion of form takes place in the axis at right angles thereto, causing a movement in the pin 22 which is transmitted to the diaphragm 23. That portion of the current which flows through voice coil 13*a* causes the vibration of the armature 10 which is transmitted through the pin 9 to the diaphragm 8.

By making the impedance of the receiver high, compared with that of the transmitter, it is not necessary for the operator to use a talk listen switch as the major portion of the energy generated in coil 13*a* will flow through conductors 15 and 16 rather than through conductors 24 and 25. Furthermore, by employing a parallel circuit as shown in Figure 4, in which the voice coil 13*a* consists of inductance and resistance repre-

sented by R and the receiver element is the equivalent of a condenser or an instrument of comparatively much higher impedance and capacity as is the case with the crystal. The self generating telephone at the sending end becomes the equivalent of a generator G (Figure 4). Its energy is sent over leads 15 and 16 to a receiver in which the incoming signal is divided in a parallel resonant circuit consisting of the inductance 13*a*, resistance R and capacitance 19. If now the resonant frequency of the parallel circuit 13*a*, R and 19 is made high compared with the highest frequency expected to be transmitted, the impedance of the circuit as a whole will increase with an increase in frequency.

This device may be made to reproduce signals over a very wide frequency range and can be made to reproduce especially well above 4000 cycles at which frequency attenuation in most telephones becomes very pronounced.

As the impedance increases, the voltage in conductors 15 and 16 increases. Furthermore, as the frequency increases, the impedance of 13*a* increases and the impedance of 19 decreases, consequently a constantly increasing proportion of the energy of the incoming signal passes through the earpiece as the frequency rises. Thus it will be seen that the sensitivity of the earpiece increases with the increase in frequency. It is a well known fact that attenuation takes place rapidly at the high frequency end in the conventional telephone. The loss at high frequencies weakens the signal strength of overtones and high frequency sounds such as sibilants and consonants with a consequent loss in the intelligibility of speech sounds. The present device not only does not lose efficiency at high frequencies but gains efficiency as the frequency increases, thus greatly adding to the perceptibility of speech and to fidelity of voice quality. Tests with this instrument have demonstrated that intelligibility of speech persists at lower sound levels than is the case with conventional telephones.

After determining the frequency characteristics of a communicating system of this type, including the transmission lines, values of resistance, inductance and capacity in the transmitter and receiver are selected to compensate for undesirable characteristics. If attenuation at various frequencies is not too irregular, complete compensation may be effected. The process of compensation consists of—

1. Plotting the given uncorrected frequency versus attenuation of the line or device to be corrected.
2. Plotting the curve with reverse characteristics which will effect the correction desired, and
3. Determining the resistance, inductance and capacity in the parallel circuit, some part of whose curve, corresponds to the reverse curve above.

Even where complete compensation cannot be effected within practical limits, corrective measures of a lesser but practical degree can be taken which result in speech of pleasing quality and very high intelligibility.

Inasmuch as the energy of the voice is employed to generate the only electric current consumed during the process of conversation, the cost of electrical power for conversational purposes is entirely eliminated, thus making this an exceptionally economical instrument to operate. It does not contain carbon granules which constantly deteriorate with use. In fact deterioration with use is practically negligible. The very low power input and power output to which the instrument is subjected, permits it to last almost indefinitely with negligible servicing. The high voltage transmitted permits the transmission of adequate power with extremely small current and since the line losses are proportional to the square of the current, the transmission losses are very low. The low current ratio to wattage may either be utilized to save copper in a given length of wire or to extend the radius of operation.

The signal system consists of a source of electrical energy which may be a hand operated generator, a bell ringing transformer, or a battery. In the embodiment shown, the source of energy consists of dry cells 26 and 27 and buzzer 28. There is provided a double pole single throw switch 29 having a movable contact which when depressed bridges contacts 29*a* and 29*b* and thereby connects the battery to the buzzer through lead 30 and also connects the buzzer coil 32 to the signal winding 13 through lead 18. The buzzer is provided with the usual coil 32 with a soft iron core, a vibrating tongue 33 and contact point 34. When current is passed through coil 32 by depressing switch 29, the soft iron core is magnetized and attracts the vibrating tongue away from contact point 34 thus breaking the electrical connection of the source of electric power with the coil 32. The sudden break in the contact causes a rapid collapse of the magnetic field surrounding coil 32, generating a comparatively high back voltage which passes through coil 13 and induces a still higher voltage in voice coil winding 13*a*. This voltage is transmitted through leads 15 and 16 to the voice coil winding of the earpiece in the instrument at the other end of leads 15 and 16, causing a buzzing signal sound to be radiated by both the receiver and transmitter. Not only is this signal system sufficiently compact to be housed in the hollow handle of a hand telephone, but it utilizes the same transmission wires as the communicating system.

It will be apparent that this instrument may take numerous forms without departing from the basic idea. Having fully described this invention, what is claimed is:

1. A telephone instrument employing a transmitter in which the major impedance component is an inductive reactance and a receiver in which the major impedance component is a capacitative reactance, said transmitter and said receiver being electrically connected to each other in parallel, the natural resonance frequency of the parallel circuit being 4000 cycles per second or greater.

2. A telephone instrument employing a transmitter in which the major impedance component is an inductive reactance and a receiver in which the major impedance component is a capacitative reactance, said transmitter and said receiver being electrically connected to each other in parallel, the natural resonant frequency of said parallel circuit being comparatively high with respect to the frequencies the system is called upon to reproduce, the capacitative inductive and resistive elements of said parallel circuit being so selected as to cause the variations in frequency response to be equal and opposite to the variation in frequency response resulting from all other constructional details of the system.

3. In a communicating instrument, a trans-

mitter of the self generating type, said transmitter employing a diaphragm connected to a balanced armature operating in a magnetic field, said armature vibratably operable under the influence of a current carrying coil surrounding said armature, and a receiver the electrical behavior of which is substantially the equivalent of a condenser.

4. In a communicating instrument a self generating transmitter comprising a diaphragm connected to a balanced armature operating in a magnetic field, a wire coil surrounding said armature, said coil being connected in parallel with a receiver, said receiver having an impedance several times greater than the voice coil of the transmitter.

5. In combination in a telephone instrument a transmitter of the self-generating type and a receiver of the crystal type, the electrical characteristics of the transmitter and receiver being so chosen that the transmitter offers a lower impedance to voice frequencies below 2000 cycles than does the receiver.

6. A telephone handset comprising a housing consisting of a hollow handle with two hollow extremities, a self generating transmitter of the balanced armature type employing a diaphragm connected to an armature balanced in a magnetic field and vibratably operable by a current carrying coil surrounding said armature in one extremity of said handle and a receiver in the other extremity, the transmitter being sealed in by a mouthpiece provided with a horn like member and the receiver being sealed in by an ear cap, said receiver having an impedance substantially higher than said transmitter.

7. In a communicating instrument, a signalling device employing a circuit breaker consisting of a vibratable conductor normally in contact with a second conductor, a solenoid, a source of electrical energy, a circuit for energizing said solenoid from said source through said circuit breaker conductors, a switch for closing and interrupting said circuit, said solenoid being so located with respect to said vibratable conductor that when energized by closing said switch, it attracts the vibratable conductor and breaks its contact with said second conductor, thus cutting off the electrical supply to said solenoid, and developing a back electromotive force, said vibratable conductor again making contact with said second conductor after said solenoid is deenergized, this cycle resulting in an alternating current in a signal coil coupled in parallel with said solenoid and inductively connected to a voice coil, the back electromotive force of said solenoid energizing said voice coil, said voice coil surrounding a vibratable armature attached to a diaphragm, said alternating current in said voice coil causing said armature to vibrate the diaphragm resulting in an audible signal.

8. In a communicating instrument, a signalling device employing a circuit breaker consisting of a vibratable conductor normally in contact with a second conductor, a solenoid, a source of electrical energy, a circuit for energizing said solenoid from said source through said circuit breaker conductors, a switch for closing and interrupting said circuit, said solenoid being so located with respect to said vibratable conductor that when energized by closing said switch, it attracts the vibratable conductor and breaks its contact with said second conductor, thus cutting off the electrical supply to said solenoid, and developing a back electromotive force, said vibratable conductor again making contact with said second conductor after said solenoid is deenergized, this cycle resulting in an alternating current in a signal coil coupled in parallel with said solenoid and inductively connected to a voice coil, the back electromotive force of said solenoid energizing said voice coil, said voice coil surrounding a vibratable armature attached to a diaphragm, said alternating current in said voice coil causing said armature to vibrate the diaphragm resulting in an audible signal, said voice coil being connected to a remote signal receiving device, said signal receiving device comprising a voice coil, an armature in said voice coil, vibratable in a magnetic field between two pole pieces, said armature mechanically connected to sound radiating diaphragm.

9. In combination in a communicating instrument, a communicating device and a signalling device, said communicating device comprising a self generating transmitter in which the major impedance component is an inductive reactance and a receiver in which the major impedance component is a capacitance reactance, said transmitter and said receiver being connected in parallel and said signalling device being substantially as described in claim 7.

10. A telephone instrument comprising a hollow handle with two hollow extremities, a transmitter being housed in one extremity, a receiver housed in the other extremity and a signal generating device housed in said hollow handle, said signalling device being substantially as described in claim 7.

11. A telephone instrument comprising a hollow handle with two hollow extremities, a transmitter being housed in one extremity, a receiver housed in the other extremity and a signal generating device housed in said hollow handle, said signalling device being substantially as described in claim 7 and said communicating device consisting of a self generating transmitter and a crystal earphone.

12. A telephone instrument comprising a hollow handle with two hollow extremities, a transmitter being housed in one extremity, a receiver housed in the other extremity and a signal generating device housed in said hollow handle, said signalling device being substantially as described in claim 7 and said communicating device consisting of a self generating transmitter and a crystal earphone, the major impedance component of said transmitter being an inductive reactance and the major impedance component of said receiver being a capacitative reactance, said transmitter and receiver being connected in parallel.

13. In a communicating instrument of the type employing a voice coil to operate a diaphragm, a signalling device employing said diaphragm to produce an audible signal, said voice coil being inductively connected to a signal coil, said signal coil being connected across a solenoid, a switch which when closed connects a source of electrical energy to said solenoid, said solenoid being part of a circuit breaker, said circuit breaker comprising in addition to said solenoid a vibratable conductor normally in contact with a second conductor, said conductors forming a part of the circuit for energizing said solenoid, said solenoid being so positioned as to attract said vibratable conductor causing it to break the circuit, with a resultant back electromotive force in said solenoid and permitting contact again between the conductors, this cycle

causing a periodic vibration when said switch is closed, whereby said signal coil connected across said solenoid induces a current in said voice coil thereby causing said diaphragm to radiate an audible signal.

14. The process of controlling frequency response characteristics of a telephone comprising the employment of a transmitter in which the major impedance component is an inductive reactance, the employment of a receiver, the major impedance component of which is a capacitative reactance, said receiver and said transmitter connected in parallel, the variations of the values of resistance, inductance and capacitance in said transmitter and receiver to resonate at such frequency that the slope of the frequency response curve within the limits of frequency for which the telephone is designed approaches in slope and direction the slope and direction of the frequency response desired.

15. An electrical instrument for intercommunication comprising a transmission circuit and a call circuit, the transmission circuit including a voice transmitter coil of predetermined impedance, the call circuit including a coil of lower number of turns than the transmitter coil, the call coil being wound primary to the voice transmitter coil as a secondary winding, the call circuit including means to generate a pulsating current in the call coil.

16. A telephone instrument comprising a transmitter in which the major impedance component is an inductive reactance and a receiver of the capacitive type connected in parallel with said transmitter, the constants of said transmitter and receiver being such that the natural resonant frequency of the parallel combination lies within the voice frequency range.

17. In a communicating system, the combination of a telephone transmitter comprising a coil arranged in a magnetic field and a sound responsive diaphragm with means controlled thereby for varying said magnetic field, a signal current generator, a second coil arranged in inductive relation to said first coil, and a circuit connection for supplying current from said generator to said second coil.

18. In a communicating system, the combination of a signalling circuit, a telephone transmitter connected to said circuit and comprising a coil arranged in a magnetic field, a magnetic armature arranged within said coil, a sound responsive diaphragm for vibrating said armature, a second coil arranged in inductive relation with said first coil, a signal current generator, and means for at will connecting said second coil to said signal current generator.

19. A telephone instrument comprising a hollow handle having two hollow extremities, a transmitter housed in one extremity and comprising a coil arranged in a magnetic field and involving a sound responsive diaphragm with means controlled thereby for varying said magnetic field, a second coil arranged in inductive relation to said first coil, a signal current generator housed within said hollow handle, and circuit connections including a push-button switch mounted on said hollow handle for at will connecting said signal generator to said second coil.

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