# Sound Powered Radio Transmitter

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SOUND POWERED RADIO TRANSMITTER

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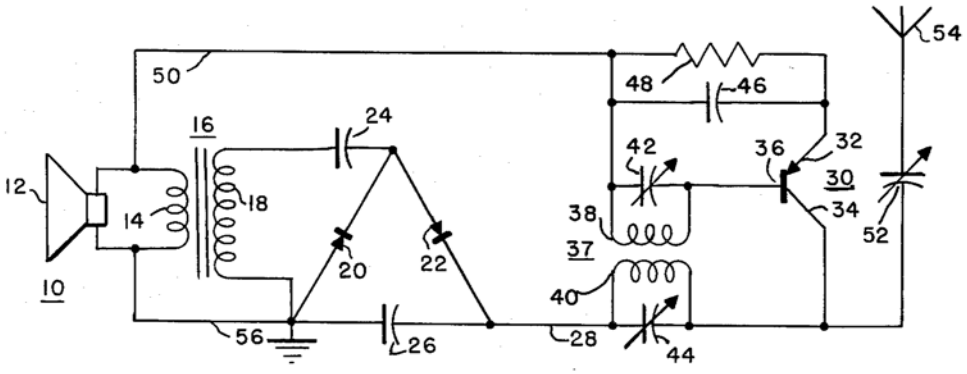


FIG. 1

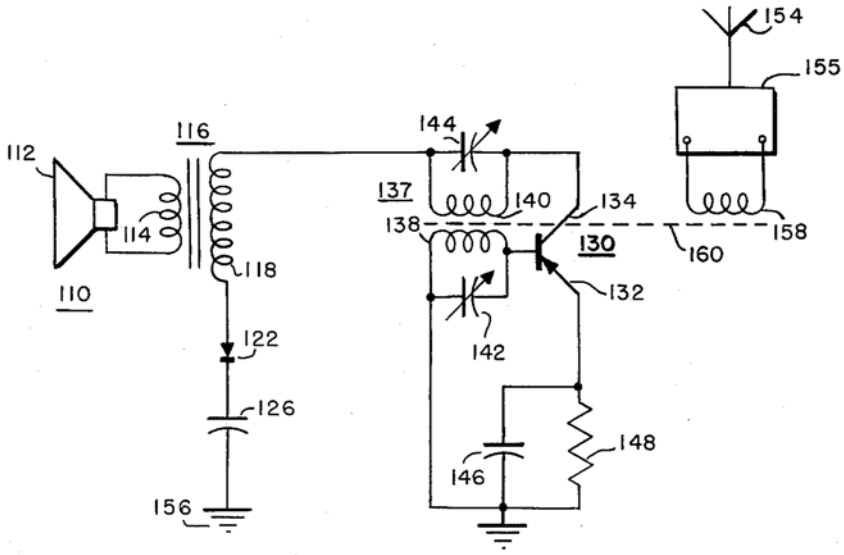


FIG. 2

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# SOUND POWERED RADIO TRANSMITTER

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment of any royalty thereon.

This subject invention relates to the transmission of sound and, more particularly, to the transmission of sound by sound modulated radio frequency oscillations.

In the classic methods of transmitting sounds the voice has been made to carry over considerable distances varying, to a great extent, upon local noise and atmospheric conditions. The development of electromechanical transducers and wire conductors increased the range of the voice where wires were practical.

The development of radio and modulated radio frequency waves improved, still further, the transmission of the voice over considerably greater ranges without the necessity of wires. In practically all known types of radio transmission, however, various amplifiers with regenerative feedback are necessary to sustain oscillation and these amplifiers have always required the use of some power supplied from a battery or other source of energy. In addition, the sound being transmitted usually required amplification before successfully modulating the radio frequency carrier waves.

It is, therefore, an object of this invention to provide a means for transmitting sounds or other low frequency energy without wires.

It is a further object of this invention to provide a means for generating sound modulated radio frequency waves.

It is a further object of this invention to provide a means for utilizing transducer energy to sustain radio frequency oscillations which may be modulated to transmit audio frequency signals.

It is a further object of this invention to provide a means for transducing sound energy into electrical energy to provide power for a radio frequency oscillator which is modulated by the sound energy to transmit sound signals.

Other and further objects of this invention will become apparent from the following specification and the drawing, of which Figs. 1 and 2 show typical embodiments of this invention.

Referring now, more particularly, to Fig. 1, a transducer **10**, with a mouthpiece **12** to receive sound energy, converts the sound energy into alternating electrical energy at sound frequencies. This energy is applied across a primary **14** of step-up transformer **16** whose secondary **18** is connected to rectifiers **20** and **22** and condensers **24** and **26**, which form a voltage doubler rectifier circuit whose output lead **28** is connected to supply power to a transistor **30**. Transistor **30**, having an emitter **32**, collector **34** and base electrode **36**, is connected to transformer **37** whose coils **38** and **40** are connected across condensers **42** and **44** respectively to form tuned circuits. The emitter **32** is connected through grid leak condenser and resistor **46**, **48** and the coil **38** to the base electrode **36**. Coil **40** is connected between lead **28** and the collector **34**, and is inductively coupled



to coil **38** to provide positive feedback to cause oscillation of the transistor circuit at a frequency determined by the resonant frequency of the tuned circuits which include coils **38** and **40**. The emitter **32** is also connected to the input signal across transformer primary **14** by conductor **50**. The modulated output of the oscillator coil **40** is connected through condenser **52** to antenna **54**.

In operation, the audio input to **10** which may be a sound powered telephone, is converted to alternating current electrical energy in a well known manner and fed to the primary **14** of the step-up transformer which serves to increase the voltage output of the sound powered telephone. A typical turns ratio of the transformer would be in the neighborhood of ten. The secondary **18**, which has a voltage output of about ten times the primary voltage, is coupled to the voltage doubler circuit of a type well known in the art. The turns ratio of the transformer is chosen so that the voltage available at the secondary is sufficient, when rectified and doubled, to provide a reliable operating voltage level for the transistor oscillator.

Rectifiers **20** and **22** may be crystal diodes since the voltage and current requirements of these rectifiers are extremely low. The condensers **24** and **26** are chosen to provide an output at **28** essentially free of any audio alternating current components.

The negative output of direct current is applied to the collector **34** of the transistor **30**, which may be of the junction PNP type, through the primary **40** of the oscillator transformer **37**. The base and emitter electrodes of the transistor oscillator circuit return to the positive side of the power supply which is at ground potenital, through the primary **14** of the transformer **16**. In this manner the direct current applied across the transistor is modulated providing amplitude modulation of the self-excited transistor oscillator which can be transmitted through an antenna in a well known way to be received by any radio receiving equipment of the correct frequency. The radio receiver may be a crystal set to provide complete mobility of the apparatus.

The output of a modern sound powered telephone is such that a power up to two milliwatts is available, and the effectiveness with which the power is used by the oscillator depends largely upon the frequency and the characteristics of the transistor employed. At lower radio frequencies two milliwatts is not a significant amount of power for communication purposes; in fact, after deducting the losses inevitable in the transistor oscillating circuit and transformer the actual power transmitted as radio frequency energy is mathematically substantially less than the two milliwatts generated by the sound powered phone. The useful range at low radio frequencies may be actually less than the range of voice, but as the frequency is increased up in the megacycle range, radio frequency power in the order of a few milliwatts becomes quite effective. Substantially, line of sight transmission is being realized in the 30 megacycle range.

The development of more efficient transistors will further increase the power and range, and the constant improvement of transistors in the megacycle frequencies will make the higher carrier frequency of such a sound powered radio telephone more and more practical.

The modulation of the transistor oscillator circuit by means of the detected D.C. component of the voice would also be applicable to the circuit of Fig. 1, and it is a simpler circuit requiring smaller filter capacitors and possibly fewer components. However, in practice the modulator of Fig. 1 appears to provide a clearer signal and is more compatible with use of a voltage doubler circuit which provides more reliable operation.

The circuit generally described above is shown in Fig. 2 and is a species of this invention where the direct current is generated by a half-wave rectifier. In this case the rectification is quite similar to the detection employed in normal amplitude-modulated radio receivers. The detected output of the transformer **118** will be a direct current envelope of the input signal. This direct current envelope not only provides the power to the transistor **130** to actuate oscillating circuit **137**, but also provides the modulating signal to the oscillator.

The antenna **154** may be coupled through any conventional coupling unit **155** to separate coil **158** which is inductively coupled, as indicated by the dotted line **160**, to the oscillator.

The functions of the sound powered transducer **110**, the transformer **116** and the other elements of this circuit are similar to those of Fig. 1, and like elements are similarly numbered.

The time constant of the circuits of Figs. 1 and 2 including the filter condensers **26** or **126** may be either long or short with respect to the period of the lowest frequency alternating current component to be transmitted. The only effect of a change in time constant is to change the quality of transmission by changing the ratio of the peak to average voltage existing on the oscillator circuit. In other words the percentage modulation is shifted by a change in time constant.

The circuit of Fig. 2 is equivalent to vacuum tube plate modulation circuits. The circuit of Fig. 1 is also equivalent to vacuum tube plate modulation circuits but since a higher voltage is generated by the voltage doubler it provides a more reliable triggering action for the oscillator to ensure oscillation.

In both figures the circuit shown is the equivalent of a tuned plate-tuned grid oscillator using PNP junction transistors, but it is obvious that any high alpha transistor, or other transistor that will oscillate at low voltage and current, can be used with any oscillator circuit that can be modulated. Having thus described my invention, what is claimed is:

1. A sound-powered radio frequency communication transmitter comprising a transducer actuated by sound waves to produce alternating current to audio frequencies, a step-up transformer energized by said audio frequency alternating current, a radio frequency transistor oscillator circuit, means including rectifier means connected between said step-up transformer and said oscillator circuit to supply direct and alternating current components as the only source of power for said transistor circuit, and antenna means coupled to said transistor oscillator circuit.

2. In a signal transmitting system, the combination comprising an oscillator circuit including a semi-conductor device as an operating element thereof, and means for modulating said oscillator circuit and providing operating bias potentials for said device, said means comprising an acoustical energy responsive translating device coupled with said semi-conductor device, said translating device being the sole source of operating bias potentials for said semi-conductor device.



3. In a signal transmitting system, the combination comprising, a semi-conductor device having a semi-conductive body and base, emitter and collector electrodes, a parallel resonant circuit connected with said collector electrode, regenerative feedback means including an inductive element connected between said base and emitter electrodes for coupling signals therebetween from said collector electrode and providing sustained oscillation over a range of frequencies, means providing a source of acoustical energy, means coupled with said last-named means for converting said acoustical energy into electrical energy, means for deriving and applying a portion of said electrical energy to said collector electrode for applying operating potentials thereto, the electrical energy converted from said acoustical energy being the sole source of biasing potential for said device, and means utilizing another portion of said electrical energy to modulate said device.

4. In a signal transmitter including an oscillator circuit comprising a semi-conductor device having base, emitter and collector electrodes and regenerative feedback means therefor, the combination comprising, means including a microphone for converting sound wave energy into electrical energy, means connected between said microphone and said device for utilizing said electrical energy to apply a reverse bias to said collector electrode, said electrical energy being the sole source of biasing potentials for said device, and means connected between said microphone and said device for amplitude modulating said oscillator circuit with said electrical energy.

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