Aug. 14, 1928. 1,680,694

G. RAMSEY

SOUND REPRODUCING METHOD AND APPARATUS

Filed April 21, 1924 2 Sheets-Sheet 1

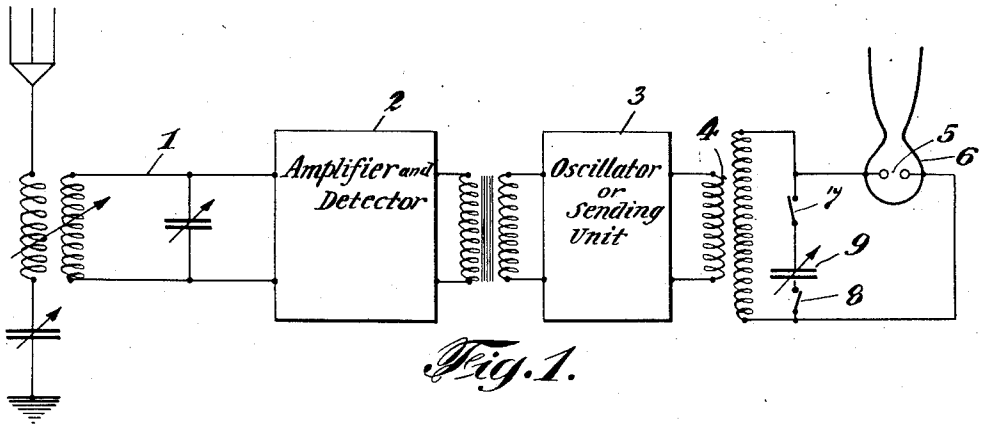


Fig. 1.

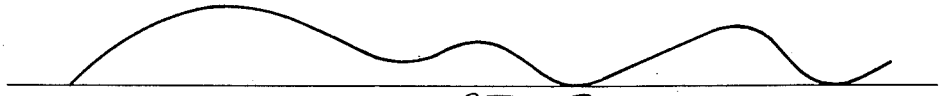


Fig. 2.

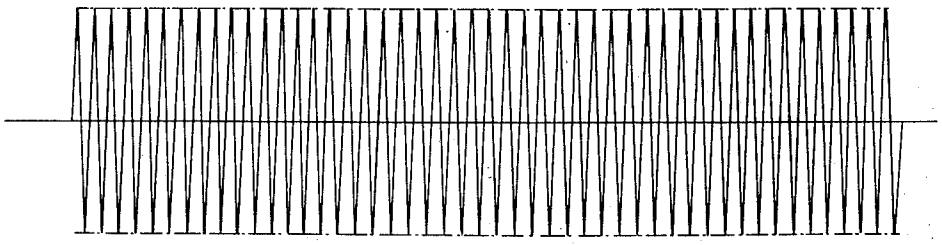


Fig. 3.

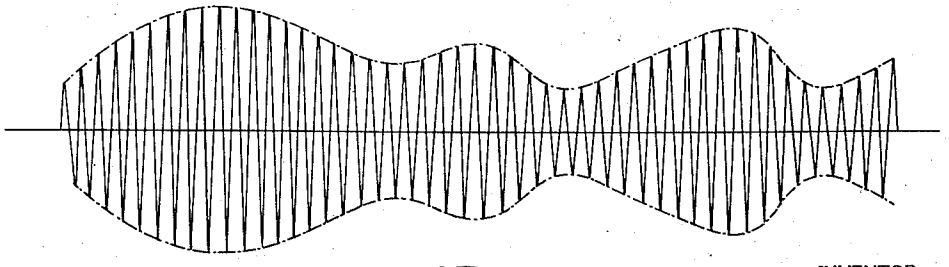


Fig. 4.

INVENTOR

George Ramsey

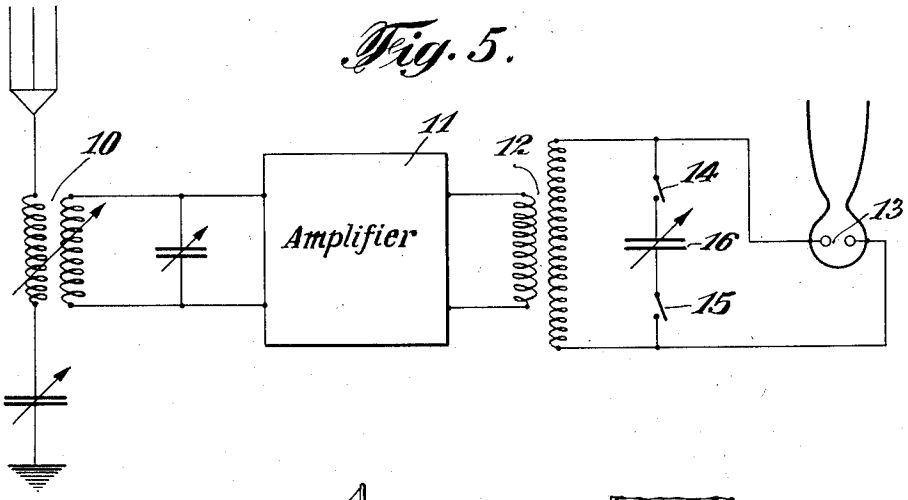
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SOUND REPRODUCING METHOD AND APPARATUS

Filed April 21, 1924 2 Sheets-Sheet 2

Fig. 5.



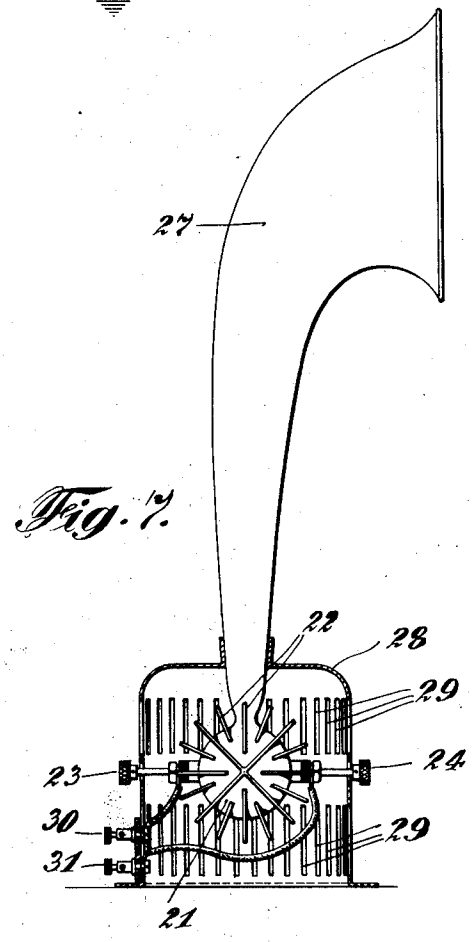


Fig. 7.

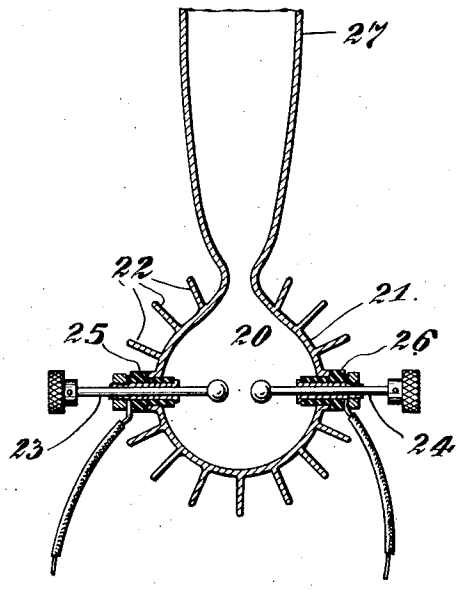


Fig. 6.

George Ramsey
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Patented Aug. 14, 1928. 1,680,694

UNITED STATES PATENT OFFICE.

GEORGE RAMSEY, OF BROOKLYN, NEW YORK.

SOUND-REPRODUCING METHOD AND APPARATUS.

Application filed April 21, 1924. Serial No. 707,863.

This invention relates to translating methods and apparatus, and particularly to methods and apparatus for translating electrical undulations or impulses into corresponding sound undulations or impulses.

The general objects of the invention are to provide a method of and to provide an apparatus for translating electrical undulations directly into sound undulations.

Another object of the invention is to provide a translating device free of moving parts.

Other and important objects of the invention are to provide a method of and to provide an apparatus for subjecting air to the action of electrical undulations to produce sound waves corresponding to the electrical undulations.

Other objects of the invention are to provide a method of and to provide an apparatus for translating electrical undulations into corresponding sound undulations by varying the intensity of an electrical discharge in air in accordance with the electrical undulations.

Among the more specific objects of the invention are to provide a method of and to provide an apparatus for translating audible frequency electrical undulations into corresponding sound undulations by modulating a superaudible frequency electric current in accordance with the undulations to be translated, passing the modulated current across a spark gap, and subjecting the atmosphere to the effect of the variations in intensity of the superaudible frequency electric spark.

In the prior art electrical undulations or impulses have generally been translated into sound waves through the instrumentality of mechanical moving parts such as a diaphragm or the like which acts upon the atmosphere and is electromagnetically vibrated in response to the electrical undulations to be translated. With such devices it has been difficult to obtain accurate or undistorted translation on account of the inertia of the diaphragm and the fact that in most cases the diaphragm has a natural period or periods of vibration, all of which render it difficult if not impossible to make a diaphragm move accurately in accordance with the variations in the electric current to be translated. Also these prior art devices require a fairly large number of parts, including one or more electromagnets having a large number of turns.

In accordance with the foregoing and other objects of the present invention these difficulties of the prior art may be overcome by modulating a superaudible frequency current with the undulations to be translated and passing this modulated current across a spark gap positioned in an air pocket which may be in communication with the small end of a suitable horn or the like. Due to the variations in the dynamic action of the spark and the variations in the instantaneous rate of heating of the air in the pocket, the column of air inclosed in the horn is set into corresponding vibration. If the carrier current is unmodulated the only vibration produced is of superaudible frequency, and hence no sound is produced, i. e., the column of air in the horn is vibrated at a frequency which is superaudible. However, when the carrier current is modulated with the audible frequency undulations which are to be translated into sound waves, the intensity of the spark is varied in accordance with these undulations and hence corresponding vibration of the air column enclosed by the horn is produced. In other words, the superaudible frequency vibration of the air column in the horn is modulated at audible frequency thus producing a sound which corresponds to the modulation.

In order to keep the pocketed air at suitable temperature under continued operation of the apparatus the wall surrounding the air pocket may be made of a good heat conducting material, blackened and provided with suitable fins to increase radiation of heat. The electrodes which form the spark gap may be adjustable to vary the length of the spark, and preferably both electrodes are adjustable so that the length of the spark may be varied without shifting the position of the center of the spark with respect to the walls of the air pocket.

Figure 1 of the drawings shows a radio receiving circuit embodying the invention.

Figure 2 is a time diagram showing an illustrative current wave delivered by the detector of the circuit shown in Figure 1.

Figure 3 is a time diagram illustrating

the carrier current of the sending or oscillating unit of the circuit shown in Figure 1.

Figure 4 is a time diagram illustrating the current delivered to the translating device by the circuit shown in Figure 1.

Figure 5 is an alternative radio receiving circuit embodying the invention.

Figure 6 is a fragmentary sectional view showing the translating device.

Figure 7 is an elevational view showing the mounting of a horn embodying a translating device in accordance with the present invention.

It is realized that the present invention may be practiced in forms other than those herein illustrated and described, and hence it is desired that the present disclosure be considered as illustrative and not in the limiting sense.

Referring to Figures 1 to 4, an oscillatory circuit 1 is arranged to be excited by radio waves and to correspondingly energize an amplifying and detecting unit 2, which may be of any suitable and well known type. An oscillator or other suitable continuous wave sending unit 3, which produces a carrier such as shown in Fig. 3, is connected in any suitable manner to be modulated by the current delivered by the amplifier-detector unit 2. As is well understood in the art the detector current has a wave form such as shown in Figure 2 and modulates the carrier of the sending unit 3, causing that unit to deliver a current of the form shown in Figure 4. The voltage at which the current is delivered by the sending unit 3 may be stepped up by means of a suitable transformer 4, after which it is discharged across spark gap 5 positioned in air pocket 6. As shown by Figure 4 the amplitude of this current varies in accordance with the audible frequency undulations delivered by the amplifier detector unit, and hence the rate at which energy is liberated by the spark within the air pocket varies accordingly. The energy liberated at the spark gap is largely in the form of heat, resulting in expansion and contracting of the pocketed air in accordance with the form of the current shown in Figure 2. This action is probably aided by the variations in the dynamic action of the spark. The air pocket being in communication with the outer air, a sound is produced which corresponds to the electrical undulations of Figure 2.

The sending unit 3 may be operated to generate a carrier current of any suitable superaudible frequency, and a frequency may be selected which permits the design of a high efficiency circuit, and the use of an iron core transformer at 4, if desired. If desired the secondary of transformer 4 may be tuned by closing switches 7 and 8, thus connecting it across variable condenser 9. The apparatus is preferably operated so that the carrier of the unit 3 is only partially modulated as shown in Figure 4, this insuring that the potential delivered to the spark gap will always be sufficient to maintain the spark.

In the form of apparatus shown in Figure 5 an oscillatory circuit 10 is arranged to be excited by radio waves and to correspondingly energize an amplifier 11 of suitable type. The voltage at which the output of the amplifier is delivered may be stepped up by means of a suitable transformer 12, after which the current is passed between the electrodes of spark gap 13. If desired, switches 14 and 15 may be closed to permit the secondary of transformer 12 to be tuned by condenser 16. The heating and dynamic actions within the air pocket are independent of the direction in which the current flows between the electrodes of the spark gap 13, and hence no detector need be associated with the amplifier 11.

Referring to Figure 6, an air pocket denoted in general by 20 is formed by a spherical wall 21 having integral heat radiating fins 22. The wall 21 and fins 22 may be made of suitable heat conducting material such as copper and may be blackened to increase the rate of radiation. Electrodes 23 and 24 are slidably mounted in insulating bushings 25 and 26 respectively, thereby forming an adjustable spark gap within the air pocket 20. In order to insure proper cooling of the electrodes, the bushings 25 and 26 may be made of material which is a good heat conductor as well as an insulator. A horn 27 in communication with the air pocket as shown, may be integral with the walls 21 and may be of any shape desirable from the standpoint of acoustical efficiency.

Referring to Figure 7, the horn 27 is supported by a base 28 which incloses the air pocket, but is provided with suitable apertures 29 to avoid interference with the radiation of heat from the air pocket. Suitable means such as binding posts 30 and 31 are provided for making the necessary electrical connection to the electrodes of the spark gap.

From the foregoing description it is seen that a method and apparatus have been provided by which electrical undulations may be directly translated into corresponding sound waves, that diaphragms or other moving parts have been completely eliminated, and that a translating device of exceedingly simple construction has been produced. It is also apparent that a method and apparatus have been provided whereby a modulated superaudible frequency current may be translated into corresponding sound waves without the necessity of rectification of the current before translation. The in-

vention has been disclosed as applied to radio receiving apparatus, but it will be apparent that it may be applied in many other connections where it is desired to translate electrical undulations into corresponding sound waves.

Having thus described my invention, what I claim is:—

1. The method of reproducing sound which comprises producing an electrical spark by a superaudible frequency current and modulating the spark current with an audible frequency current.

2. The method of reproducing sound which comprises forming a series of sparks at superaudible frequency in air with a current modulated in accordance with the sound to be reproduced.

3. The method of producing sound which comprises subjecting pocketed air to the action of a continuous series of electrical sparks modulated with an audible frequency current.

4. The method of reproducing sound which comprises subjecting pocketed air to the action of a continuous series of electrical sparks and modulating the spark current with current corresponding to the sound to be reproduced.

5. The method of producing sound which comprises subjecting pocketed air to the action of a superaudible frequency spark and modulating the spark current with an audible frequency current.

6. The method of reproducing sound which comprises subjecting pocketed air to the action of a superaudible frequency spark and modulating the spark current with current corresponding to the sound to be reproduced.

7. The method of reproducing sound which comprises subjecting pocketed air to the action of a spark and modulating the spark in accordance with the sound to be reproduced.

8. The method of reproducing sound which comprises producing a spark with superaudible frequency current and modulating the superaudible frequency current with an electrical pulsation of an audible rate.

9. The method of reproducing sound which comprises producing a spark with superaudible frequency current and modulating said current with detected radio signals.

10. A sound reproducing system comprising a spark gap, electrical means connected to said spark gap to produce a superaudible frequency spark, and means to modulate said spark with an audible frequency current.

11. A sound reproducing system comprising a spark gap, a closure at least partially enclosing said spark gap, means connected to said gap to produce a superaudible frequency spark, and means to modulate said spark with an audible frequency current.

12. A sound reproducing system comprising a spark gap, electrical means connected to said gap to produce a superaudible frequency spark, and means to modulate said spark with a varying current corresponding to a sound to be reproduced.

13. A sound reproducing system comprising a spark gap, and electrical means connected to said spark gap to produce a superaudible frequency spark modulated at an audible rate.

14. A sound reproducing system comprising means to establish a column of air, means to vibrate said column of air at a superaudible rate, and stationary electrical means to impress an audible frequency modulation upon the superaudible vibration of the air column.

15. A sound reproducing system comprising stationary electrical means to set up a superaudible frequency air vibration, and means to impress an audible frequency modulation upon the superaudible vibration.

16. The method of reproducing sound which comprises electrically producing directly in air a superaudible frequency air vibration, and modulating the vibration at audible frequency.

GEORGE RAMSEY.