June 26, 1928. 1,675,031

F. A. KOLSTER

LOUD SPEAKER SYSTEM

Filed Sept. 17, 1925

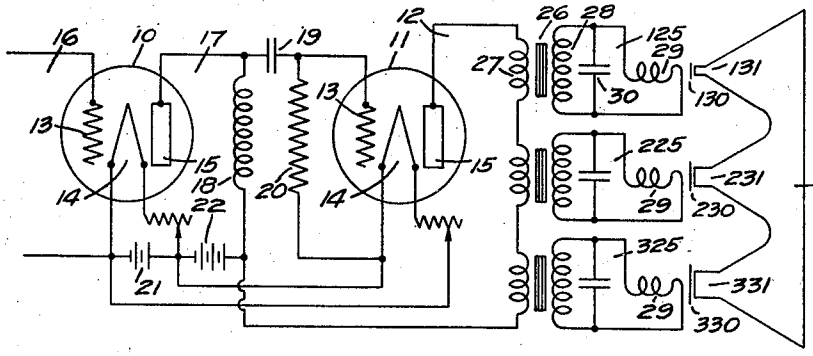


FIG. 1.

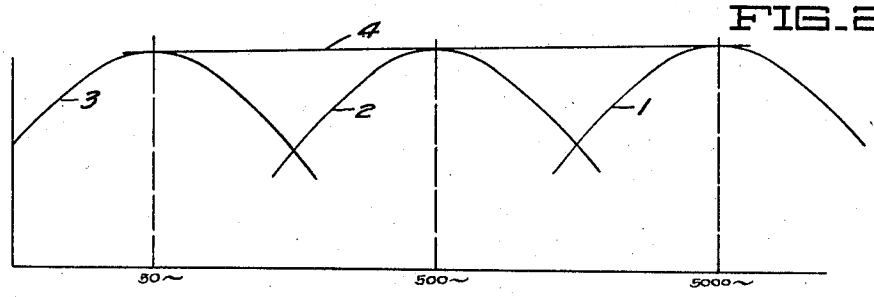


FIG. 2.

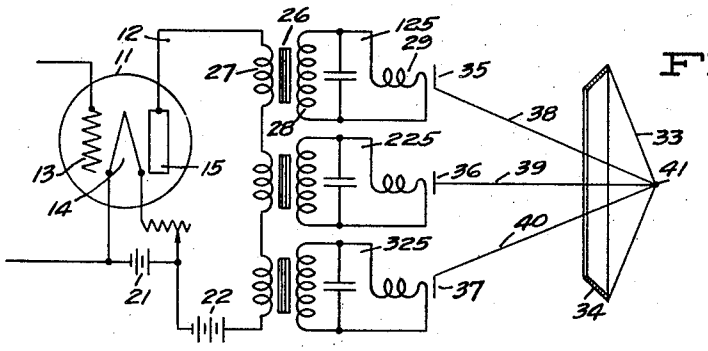


FIG. 3.

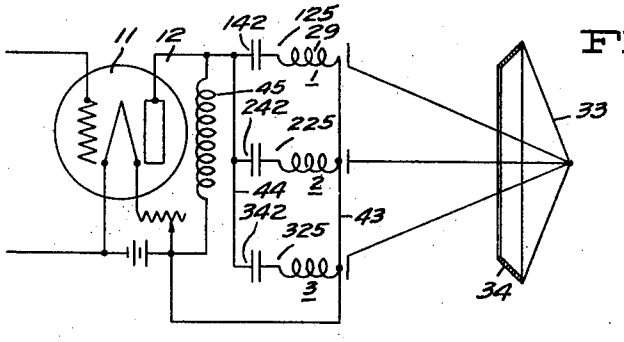


FIG 4.

INVENTOR
Frederick A. Kolster.
BY
White & Priest
his ATTORNEYS.

Patented June 26, 1928. 1,675,031

UNITED STATES PATENT OFFICE.

FREDERICK A. KOLSTER, OF PALO ALTO, CALIFORNIA, ASSIGNOR TO FEDERAL TELEGRAPH COMPANY, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF CALIFORNIA.

LOUD-SPEAKER SYSTEM.

Application filed September 17, 1925. Serial No. 56,800.

This invention relates generally to a system for translating electrical energy modulated at voice frequencies into sound waves. More specifically the invention applies to devices which are known as loud speakers and which are commonly employed in radio broadcast receivers for converting the detected and amplified radio energy into sound.

It is an object of this invention therefore to devise a translating system which will translate electrical energy modulated at voice frequencies into sound waves with substantially no distortion; that is, a system in which a translator will give substantially the same response for any frequency within the entire range of voice frequencies.

It is a further object of this invention to devise such a system in which the voice frequency range is divided up into a plurality of frequency bands by means of a plurality of electrical units. It is proposed to allow each unit to translate its frequency band into mechanical vibrations.

It is a further object of this invention to provide a single aperiodic reproducer for converting the mechanical vibrations into sound waves and to actuate this reproducer jointly by a plurality of electrical units. It is proposed that these electrical units shall be so designed as to have their points of resonance spaced along the entire voice frequency range.

It is a further object of this invention to devise a system which converts the electrical energy into mechanical vibrations by means of a plurality of electrical units and to impose these vibrations longitudinally upon a plurality of rods and to connect these rods to a common aperiodic diaphragm.

Further objects of the invention will appear from the following description where I have disclosed the preferred embodiments of my invention.

Referring to the drawings:

Figure 1 shows a loud speaker system applied to the output of a vacuum tube amplifier and constructed according to the principle of my invention.

Fig. 2 shows sound response curves for the system disclosed in Fig. 1.

Fig. 3 is an application of the system shown in Fig. 1.

Fig. 4 is another modification of the system shown in Fig. 1.

When electrical energy is modulated by means of the human voice or by music the result is to produce a plurality of superposed electrical vibrations which range in frequency all the way from 50 to 10,000 cycles per second. In the past loud speakers have usually been constructed with a single magnetic unit which had its pole pieces placed in proximity to a steel diaphragm. With such loud speakers there are two different inherent sources of distortion. One is the natural resonance of the winding of the magnetic unit which is resonant at some point within the voice frequency range. The other is due to the natural mechanical resonance of the diaphragm. If a sound response curve for such a loud speaker is plotted between sound response and frequency for a given energy input, it will be found that the curve will have several humps or peaks which correspond to these resonant points. The curves also fall off rapidly for the lower frequencies and for the higher frequencies. Therefore, such a loud speaker will convert the electrical vibrations into sound at greater efficiency for certain frequencies than for others, thus producing distortion.

It has been found by experimentation that if a loud speaker will give uniform response or faithful reproduction for frequencies ranging from 50 to 5000 cycles per second no appreciable distortion will be apparent. The system of this invention has therefore been designed to give a flat top characteristic response curve for frequencies ranging from 50 to 5000 cycles per second. However, it should be understood that the same principles may be applied to produce a flat top response curve for frequencies ranging up to as high as 10,000 cycles per second.

In that embodiment of the invention shown in Fig. 1 of the drawings the system is shown as applied to the output of a cascade vacuum tube amplifier. This amplifier is preferably of the standard impedance coupled type so as to produce a faithful amplification of the entire voice frequency range. Thus there is shown two vacuum tubes 10 and 11 comprising the usual grid 13, electron emission element 14 and plate 15. The input circuit 16 of the vacuum 10 is suitably coupled to some source of electrical energy modulated at voice frequency and is

connected to the grid 13 and electron emission element 14 in the usual manner. In the output circuit 17 of the tube 10 there is an impedance 18 having its upper terminal electrically connected with the grid 13 of the vacuum tube 11 in series with the condenser 19. The usual grid leak 20 is connected between the grid 13 of the vacuum tube 11 and the electron emission element 14 of this tube. The electron emission elements 14 of the vacuum tubes 10 and 11 are energized from a common A battery 21, and the output circuits 17 and 12 of the two vacuum tubes are energized from a common B battery 22.

In the output circuit 12 of the vacuum tube 11 there is provided a plurality of electrical units, each of which converts a portion of the output energy into mechanical vibrations. These electrical units are so designed that they each convert electrical energy into mechanical vibrations most efficiently at a certain point along the voice frequency range, and these points are distributed along the voice frequency range from 50 to 5000 cycles. Three of these electrical units 125, 225 and 325 have been shown and they each preferably comprise a transformer or other coupling arrangement 26 having a primary winding 27 and a secondary winding 28. The secondary 28 is connected to the magnet windings 29 of a telephone unit which telephone unit also in the case of the unit 125 includes a diaphragm 130. A capacitance 30 is connected in shunt with the windings 29. The inductance value of the windings 29 and of the capacitances of the condensers 30 are so selected that the electrical units will be resonant at some frequency within the voice range and the arrangement is such that the resonant points are spaced throughout the voice frequency range or at least from 50 to 5000 cycles per second. To prevent the resonance peaks from being too sharply defined a large amount of damping is introduced by making the windings 29 of comparatively high resistance. To prevent the introduction of distortion due to the mechanical resonance of the diaphragms, it is preferable to construct the diaphragm for the telephone units which translate the higher frequencies relatively smaller in diameter than the diaphragms which are employed to translate the lower frequencies. It is also preferable to provide a common sound amplifying horn which is constructed in such a manner that the low frequency sound waves will be radiated out of the sound horn with equal efficiency to the sound waves of higher frequency. Thus the diaphragm 230 for the unit 225 is made relatively larger in diameter than the diaphragm 130 and accordingly the diaphragm 330 for the electrical unit 25 is made relatively larger in diameter than the diaphragm 230. Also, the throat 231 of the sound amplifying horn 32 is made relatively larger than the throat 131 of the electrical unit 125 and also the throat 331 of the electrical unit 325 is made relatively larger than the throat 231.

Fig. 2 of the drawing shows response curves for the electrical unit disclosed in Fig. 1. These response curves are plotted between sound response and frequency in cycles per second. Curves 1, 2 and 3 show the response of the individual units 125, 225 and 325 at different voice frequencies for constant input of energy. It will be noted that the resonant peak of curve 3 is arranged to be substantially at 50 cycles while the peak of curve 2 is positioned at 500 cycles and the peak of curve 1 is at 5000 cycles. The resultant response curve for the individual units taken together is represented by means of curve 4 which will be substantially a straight flat line between the frequencies of 50 to 5000 cycles. This means that for a given input of energy into the system the response will be substantially the same between the frequencies of 50 to 5000 cycles per second. The electrical units in reality serve to divide up the voice frequency range into a plurality of frequency bands which are spaced along the voice frequency range and to translate these frequency bands into sound waves.

Instead of having these electrical units operate separate mechanical reproducers it is preferable to have them operate a single aperiodic reproducer. Thus, as shown in the modification in Figs. 3 and 4 the electrical units 125, 225 and 325 actuate a single aperiodic diaphragm. This reproducer is preferably in the form of a conical aperiodic diaphragm 33 suitably supported at its edges as by a rigid rim 34. The magnetic unit 129 of the electrical units 125, 225 and 325 in this case are provided with armatures 35, 36 and 37 which connect with rods 38, 39 and 40. These rods connect to the apex 41 of the conical diaphragm 33 and actuate this diaphragm by their joint action. In the operation of this system the magnetic units 29 set the armatures 35, 36 and 37 into mechanical vibration and these armatures vibrate the rods 38, 39 and 40 longitudinally to actuate jointly the conical diaphragm 33. Since this diaphragm is aperiodic no distortion will be introduced due to mechanical resonance.

The system shown in Fig. 4 is somewhat similar to that shown in Fig. 3 but differs in the manner in which the electrical units 125, 225 and 325 are coupled to the output 12 of the vacuum tube 11. In this case, the magnetic units 29 are individually connected in series with the condensers 142, 242 and 342, and are connected in parallel by the

conductors 43 and 44. The conductors 43 and 44 are suitably coupled to the output circuit 12 as by means of an impedance 45. The operation of this arrangement is substantially the same as the system shown in Fig. 3. The values of the series inductances and capacitances are so selected that the electrical units 1, 2 and 3 will attain a value of minimum impedance at spaced points along the frequency range, as for example, at 50 cycles, 500 cycles and 5000 cycles. As in the case of the other system, the combined effect of the electrical unit upon the diaphragm 33 will be to obtain a flat top characteristic response curve for the entire system.

I claim:

1. In a system of the class described, a source of electrical energy modulated at voice frequencies, means for separating said voice frequencies into a plurality of frequency bands spaced along the voice frequency range, and translator means including a single aperiodic diaphragm for converting said energy into sound waves.

2. In a system of the class described, a source of energy modulated at voice frequencies, a plurality of magnetic units electrically associated with said source, means for distributing the energy to said units in accordance with the frequency of the same, and a single aperiodic reproducer mechanically vibrated by energy from said units.

3. In a system of the class described, a source of electrical energy modulated at voice frequencies, and means for translating said energy into sound vibrations comprising a plurality of tuned magnetic units having their resonant peaks distributed along the voice frequency range, and a single aperiodic sound reproducer actuated in accordance with the energy in said units.

4. In a system of the class described, a source of electrical energy modulated at voice frequencies, a plurality of separate magnetic telephone units electrically connected with said source, a capacitance associated with each unit whereby said units are resonant at different points along the voice frequency range, and a single diaphragm mechanically vibrated by all of said units.

5. In a system of the class described, a source of electrical energy modulated at voice frequencies, means for converting said energy into separate groups of mechanical vibrations applied to separate mechanical members, a single aperiodic diaphragm, and means for causing said separate mechanical members to jointly actuate said diaphragm.

6. In a system of the class described, a source of electrical energy modulated at voice frequencies, means for converting said energy into separate groups of mechanical vibrations applied to separate mechanical members, a conical aperiodic diaphragm, and means for connecting said mechanical members to the center of said diaphragm.

7. In a system of the class described, a source of electrical energy modulated at voice frequencies, means for translating said energy into mechanical vibrations including a plurality of magnetic units having separate armatures, means associated with said units whereby the energy in each unit will rise to maximum for a certain frequency, the maximum points of the different units being distributed along the voice frequency range, a plurality of rods separately vibrated by said units, and an aperiodic diaphragm, said rods jointly acting to vibrate said diaphragm from each of said armatures.

In testimony whereof, I have hereunto set my hand.

FREDERICK A. KOLSTER.