Dec. 22, 1925. 1,566,337

W. H. MARTIN

SOUND RADIATOR

Filed Sept. 26, 1923

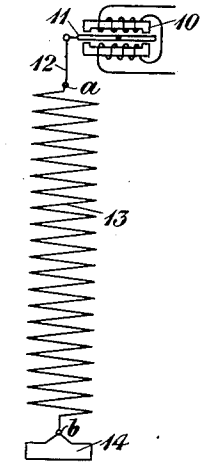


Fig. 1

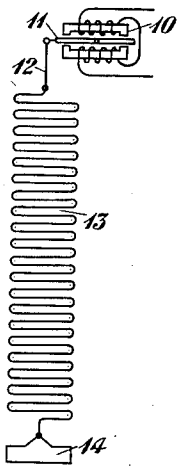


Fig. 2

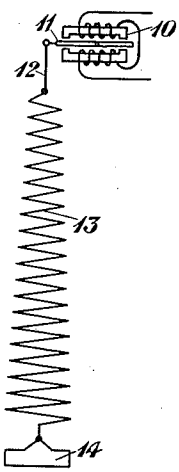


Fig. 3

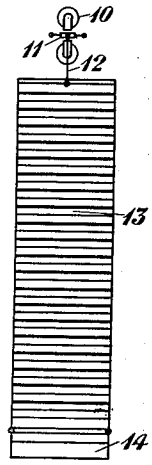


Fig. 4

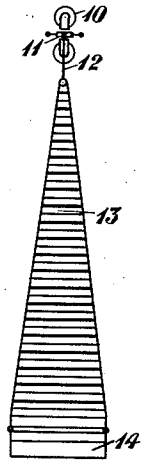


Fig. 5

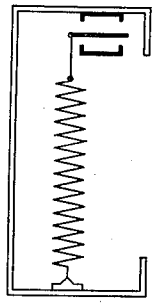


Fig. 6

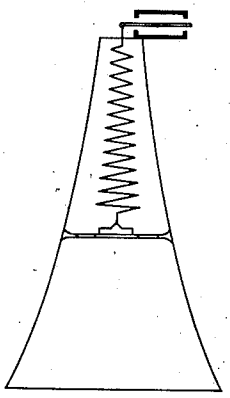


Fig. 7

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UNITED STATES PATENT OFFICE.

WILLIAM H. MARTIN, OF CHAPPAQUA, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SOUND RADIATOR.

Application filed September 26, 1923. Serial No. 664,988.

To all whom it may concern:

Be it known that I, WILLIAM H. MARTIN, residing at Chappaqua, in the county of Westchester and State of New York, have invented certain Improvements in Sound Radiators, of which the following is a specification.

This invention relates to a sound radiator to be used in connection with a sound reproducer such as is employed in connection with phonographic apparatus, loud speaking receivers for broadcast receiving, public address systems and the like.

For the reproduction of vocal and musical sounds, a sound radiator is desirable which is capable of radiating equally well the sound waves of all the frequencies involved in speech and music. The use of the ordinary simple diaphragm for this purpose has been found to be unsatisfactory as it has a natural period which tends to distort the sounds. It is proposed by the present invention to overcome this difficulty by employing a crimped or corrugated sheet supported at one end, and so arranged that longitudinal vibrations may be imparted thereto from the opposite end by means of some suitable driving mechanism, such as a phonographic reproducer or the armature of the magnetic system of a loud speaking receiver. By proper design of the shape and proportions of such a sheet it may be made to radiate all frequencies within a given range equally well or it may be made to radiate the frequencies within the range with any desired relative amplitude.

The invention may now be more fully understood by reference to the accompanying drawing, Figures 1 to 5 inclusive of which illustrate a number of different modifications of the crimped or corrugated sound radiator forming the subject matter of the present invention, while Figs. 6 and 7 show the sound radiator mounted in a sound box and horn respectively.

While the sound radiator of the present invention may be used in connection with sound reproducers of any kind, such, for example, as phonograph reproducers, it is shown, for purposes of illustration, as being used in connection with the magnetic receiving arrangement of a loud speaking receiver of the type employed for public address systems and radio broadcast reception. A magnetic sound reproducer 10, of well known type, having a balanced armature 11, is illustrated in Fig. 1. The armature 11 is connected by a link 12 to one end of a crimped sheet 13, which is secured at its opposite end to a fixed support 14. Sound waves impressed upon the magnetic arrangement 10 cause the armature 11 to vibrate, thereby imparting longitudinal vibrations to the crimped sheet 13. These longitudinal vibrations cause the air to be drawn in and sent out from between the successive crimps or corrugations of the sheet, thereby setting up vibrations in the surrounding air corresponding to the sound waves actuating the magnetic arrangement.

Instead of using a sharply crimped sheet as a sound reproducer, a corrugated sheet of the type shown in Fig. 2 may be used. The sheet may also be given different shapes in order to produce different effects. For example, in Fig. 3, the successive corrugations or crimps in the sheet are made of increasing length. In Fig. 4, the sheet is shown as being of uniform width from top to bottom, while in Fig. 5 the sheet is so constructed as to be wider at the bottom than at the top. Other modifications of the form of the reproducer will readily suggest themselves, depending upon the effect which it is desired to attain.

The crimped or corrugated sheet may be made of any suitable material, depending upon the characteristics desired. For example, heavy paper or other fibrous material is a very satisfactory material. Also celluloid or metal may be used. Obviously, also, the elasticity of the material used for the sheet and the elasticity of the crimps or corrugations may be varied to produce the desired results.

While the theory underlying the sound radiator of the present invention is not definitely established, the following principles are believed to be applicable and are submitted for the purpose of assisting in understanding the invention. Referring to Fig. 1, for example, at low frequencies the propagation of the vibrations from *a* to *b* will be such as to compress all of the crimps or corrugations practically simultaneously. At higher frequencies, since the wave lengths are shorter, the crimps at the lower end of the sheet may not be compressed until those at the upper end are being expanded. This will cause neutralization between the effects

produced by the lower crimps and some of those above them. At still higher frequencies the mode of propagation along the sheet will be such that there will exist simultaneously alternate intervals of compression and expansion along the sheet. In this manner the propagation of vibrations along the sheet corresponds to the propagation of electrical vibrations for a circuit. The sheet has mass, elasticity (particularly at the crimps), and dissipates energy in setting the air in motion. These properties correspond respectively to the inductance, to the inverse of the capacity, and to the resistance of an electrical transmission line.

At the higher frequencies, waves propagated along the sheet from *a* to *b* undergo phase shift and attenuation, just as do electric waves in a transmission line. The result is that the portion of the sheet effectively radiating energy to the air becomes smaller as the frequency of the waves propagated becomes higher. In other words, an increasingly large number of crimps tends to neutralize the action of other crimps or corrugations as the frequency is increased. For a given displacement at the end *a* of the sheet the velocity at *a* increases with the frequency. Furthermore, the energy imparted to the air increases as the square of this velocity. Accordingly, to attain the desired condition of having the energy radiated to the air constant for a given frequency range, the decrease in the effective radiating area with increase in frequency is desirable. This rate of change of effective radiation of sound energy with frequency can be controlled by changes in the mass and elasticity of the material used for the sheet, by changes in the elasticity of the crimps or corrugations as determined by their shape and dimensions, and by the size and shape of the plate itself, independent of the corrugations. Various methods of changing these factors are illustrated in Figs. 1 to 5 of the drawing and have already been described.

The propagation of waves over the sheet is, as in the case of the transmision line, effected also by the termination at the far end *b*. The clamping at *b*, therefore, may be made either rigid or flexible, depending upon the result desired. The nature of this termination becomes of small importance as the length of the plate is increased and as the frequency of the vibrations becomes higher. This is in analogy to the well known property of a transmission line, viz, that as the line becomes longer the impedance of the distant termination produces less effect upon the input characteristics of the line so that when the line attains a certain length its characteristics will be independent of the terminating impedance.

By the means above indicated the combination consisting of the receiver and vibratory crimped sheet can be made to have an efficiency of sound power output to electrical power input which is constant over a particular range of frequencies or which varies in some desired manner.

The crimped sheet may be mounted in a box, as shown in Fig. 6, or in a horn, as shown in Fig. 7, to obtain directivity and also to partially confine the air acted upon by the motion of the sheet. This confinement of the air may be desirable as a means of increasing the energy imparted to the air. The confinement of the air also increases the damping of the motion of the crimped sheet.

It will be understood that the terms "crimped" and "corrugated," as used in the claims, are intended to be synonymous in their meaning and are not to be understood as limited to the modifications shown in Figs. 1 and 2 respectively.

It will also be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. A sound radiating member having a crimped surface, said member being secured at one end and having means at the other end for subjecting said member to longitudinal vibrations of speech frequencies, thereby imparting corresponding lateral vibrations to the air, and the length of said member being such that for the higher voice frequencies only a part of the surface of said member will efficiently produce lateral vibrations.

2. A bellows shaped sound radiating member secured at one end and having means at the other end for subjecting said member to longitudinal vibrations of speech frequencies, thereby imparting corresponding lateral vibrations to the air, and the length of said member being such that for the higher voice frequencies only a part of the surface of said member will efficiently produce lateral vibrations.

3. A bellows shaped sound radiating member secured at one end and having a telephone receiver armature connected thereto at the other end to impress longitudinal vibrations thereon, thereby imparting corresponding lateral vibrations to the air, and the length of said member being such that for the higher voice frequencies only a part of the surface of said member will efficiently produce lateral vibrations.

4. A sound radiating member having a crimped surface, said member being secured at one end and having a telephone receiver armature connected thereto at the other end to impress longitudinal vibrations thereon, thereby imparting corresponding lateral vi-

brations to the air, and the length of said member being such that for the higher voice frequencies only a part of the surface of said member will efficiently produce lateral vibrations.

5. A loud speaking sound radiating member having a uniform corrugated surface, said member being secured at one end and having longitudinal sound vibrations applied thereto at the other end, thereby imparting corresponding lateral vibrations to the air, and the length of said member being such that for the higher voice frequencies only a part of the surface of said member will efficiently produce lateral vibrations.

6. A mechanical transmission system for radiating vibratory energy into the air comprising a vibratory member having a crimped surface, said member being secured at one end and having means for applying longitudinal vibrations thereto at the other end, thereby imparting corresponding lateral vibrations to the air, and the length of said member being such that for the higher voice frequencies only a part of the surface of said member will efficiently produce lateral vibrations.

7. A mechanical transmission system comprising a member having a crimped surface, said member being secured at one end, and means for impressing speech frequency vibrations longitudinally upon the other end of said member whereby the corrugations of said member will be alternately expanded and compressed to transmit the lateral vibrations to the air, and the length of said member being such that for the higher voice frequencies only a part of the surface of said member will efficiently produce lateral vibrations.

In testimony whereof, I have signed my name to this specification this 25th day of September 1923.

WILLIAM H. MARTIN.