

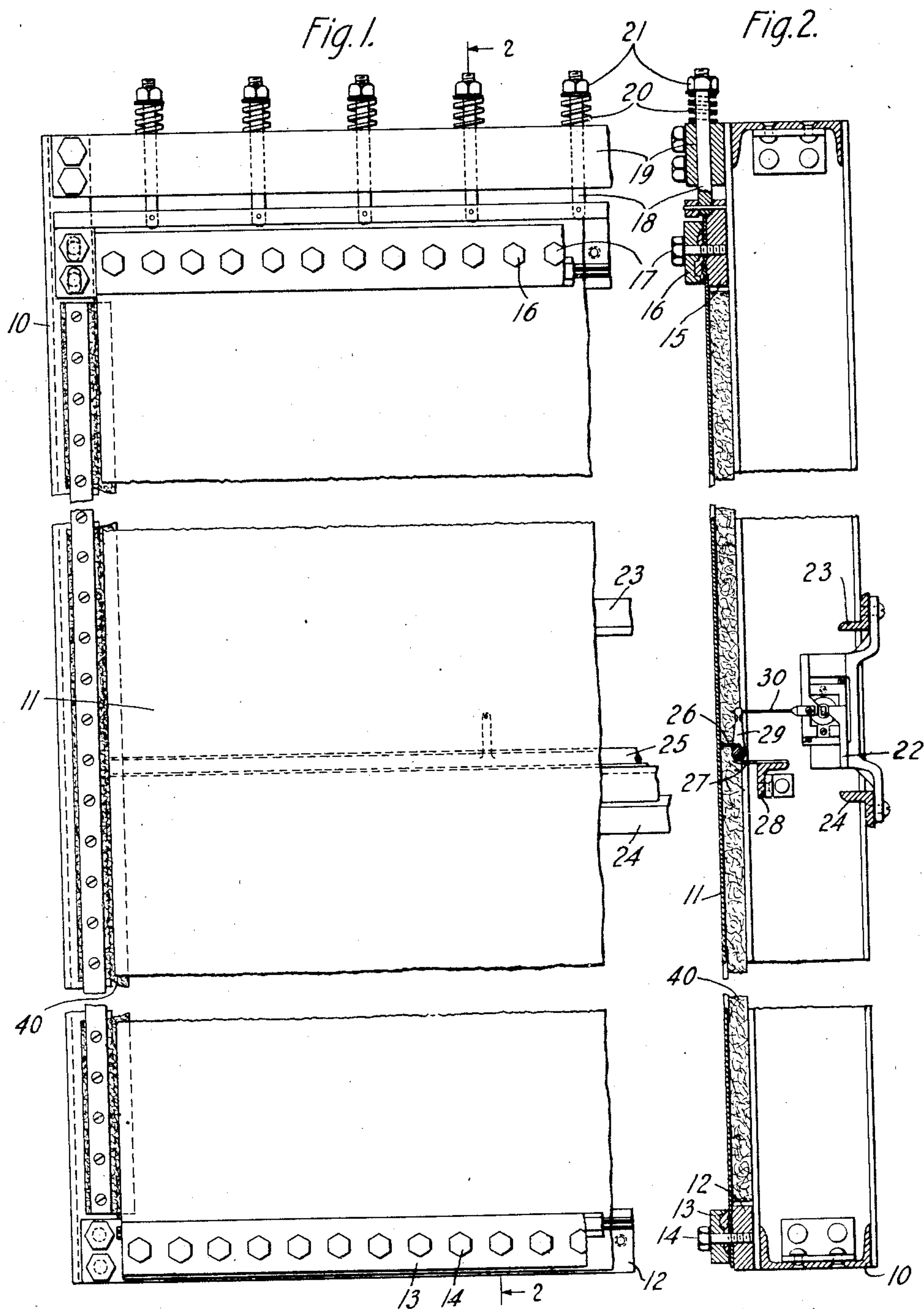
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H. C. HARRISON

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ACOUSTIC DEVICE

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Inventor:
Henry C. Harrison
by *J. E. Roberts*
Attorney

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HENRY C. HARRISON, OF PORT WASHINGTON, NEW YORK, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ACOUSTIC DEVICE.

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This invention relates to acoustic devices, and particularly to a large direct-acting sound radiator.

An object of the invention is to radiate sound energy with substantially uniform efficiency over at least a large portion of the entire frequency range of speech and music.

In accordance with the invention, there is employed a long strip diaphragm tensioned in the direction of its length to such a degree that the velocity of transverse vibrations in the diaphragm propagated in the direction of its length is high, preferably greater than one-quarter of the velocity of sound vibrations in air. In a preferred embodiment, a driving means, such as an electromagnetic receiver is coupled to the diaphragm by means comprising a tubular or like member extending substantially parallel to the diaphragm in the direction of its width, a connecting strip of flexible material extending substantially perpendicular to the diaphragm and tangentially to the tubular member throughout its length, and a similar strip connecting a diametrically opposite element of the tubular member to a rigid support. The driving unit is preferably connected to the tubular member near its midportion in such a manner that the tubular member is moved about an axis parallel thereto.

The invention may be readily understood by referring to the following detailed description and the accompanying drawing, in which

Fig. 1 is a front view of a sound radiator constructed in accordance with this invention, and

Fig. 2 is a view partly in section taken along the line 2—2 of Fig. 1.

Referring now to the drawing a frame 10 serves to support an actuating means and a diaphragm 11 which is preferably made of a light material having high tensile strength, such as duralumin about .002" thick. The length of the diaphragm is preferably greater than twice its width and also greater than half the wave length of the lowest frequency to be radiated. The lower end of the diaphragm 11 is clamped between the serrated surfaces of a projecting portion 12 of the frame 10 and of a member 13 by means of the screws 14. The upper edge of the diaphragm is similarly clamped between the serrated surfaces of clamping

members 15 and 16 by means of the screws 17. The rods 18 secured to the member 15 pass through openings in a projecting portion 19 of the frame 10. For the purpose of tensioning the diaphragm there are provided the compression springs 20 positioned about the rods 18 and the nuts 21 engaging the threaded end portions thereof. Strips 40 of a material, such as felt, are employed for damping vibrations reaching the side edges of the diaphragm. One edge of each of these strips is secured to the diaphragm 11 and an opposite edge to the frame 10.

A driving means, such as an electromagnetic unit 22 is secured to the cross members 23 and 24, the ends of which are in turn secured to the frame 10. A coupling means between the diaphragm 11 and the electromagnetic unit 22 comprises a metallic tubular member 25 which preferably extends parallel to the diaphragm 11 between two of its opposite edges and over the greater portion of its width. Narrow strips 26 and 27 of flexible material, such as paper, are secured, respectively, to the diaphragm 11 and to a rigid support 28. The edges of these strips remote from the diaphragm 11 and the support 28, respectively, are secured to diametrically opposite portions of the tubular member 25. An arm 29 rigidly secured to the tubular member 25 and extending transversely therefrom is connected, at the end remote from the tubular member 25, to the driving rod 30 of the electromagnetic unit 22.

The diaphragm 11 is tensioned to such a degree that the velocity of transverse vibrations propagated along the length of the diaphragm is high and preferably greater than one-half the velocity of sound vibrations in air. If the velocity of propagation in the diaphragm is made substantially equal to that of sound in air, the sound waves radiated from various portions of the diaphragm along a line extending in the direction of its length are substantially in phase, in which case a sound wave radiated from the driven portion of the diaphragm is supplemented or increased in intensity by waves radiated from other portions of the diaphragm. The diaphragm is preferably of sufficient length between its supported ends so that the energy of the waves is largely dissipated by radiation before the waves reach the supported ends, thus diminishing

wave reflection in the diaphragm and consequent peaks and valleys in the frequency response characteristic to small values. Viewed from another aspect, the radiation resistance of the diaphragm, that is, the resistance offered by the air to waves radiated from the diaphragm, should be sufficiently high that all of the vibrational energy is dissipated before reaching the supported ends of the diaphragm. However, since both the radiation resistance and the vibrational energy carried by the diaphragm increase with the degree of tensioning applied thereto, it is apparent that the tensioning should not be excessively high. For instance, if the tensioning were such as to make the propagation velocity in the diaphragm infinite, the diaphragm would act as a plunger, that is, a force applied to the diaphragm would simultaneously displace all parts thereof substantially an equal amount. For all wave lengths of sound smaller than the longitudinal dimensions of the diaphragm, the resistance offered to the driving unit for this condition would be approximately 41 mechanical ohms (dynes per centimeter per second) for each square centimeter of diaphragm area. It has been determined that a diaphragm tensioned to such a degree that the velocity of wave propagation in the diaphragm is equal to at least one-half the velocity of sound in air has a sufficiently high radiation resistance to afford satisfactory results. Vibrations are transmitted along the tubular member 25 at a high velocity, comparable with that velocity of sound in air, this velocity being substantially constant over a wide range of frequencies. When employing the highly stretched diaphragm together with the driving means described, it is apparent that sound waves are radiated from a large surface in such a manner that the waves radiated from various portions of the diaphragm in the direction of its length are all substantially in phase and the small phase distortion along a line in the direction of the width of the diaphragm is substantially constant with respect to changes in frequency. This effect not only explains the increased efficiency obtained with the sound radiator of this invention, but also its uniformity of response with respect to frequency.

While it is particularly advantageous to couple a driving element to the diaphragm of this invention by means including a long tubular member supported substantially as shown in the drawing, it is within the scope of the invention to employ other means for driving the diaphragm. It is within the scope of the invention, moreover, to employ means including a tubular member for coupling a driving element to a different type of diaphragm from that shown and described. For instance, a long laterally pleat-

ed diaphragm secured at its periphery may be coupled to a driving element by means including a tubular member extending in the direction of its length. Such an arrangement is shown and described more fully in my copending application Serial No. 165,286, filed February 2, 1927. The term "tubular member" as used in the specification and claims is intended to include both solid and hollow members of variously shaped cross-sections.

What is claimed is:

1. An acoustic device comprising a long direct-acting diaphragm, and means for tensioning the diaphragm in the direction of its length only to such a degree that the velocity of propagation of transverse waves in said direction therein is greater than one-quarter of the velocity of sound in air.
2. An acoustic device comprising a long direct-acting diaphragm, means for tensioning the diaphragm to such a degree that the velocity of propagation of transverse vibrations therein is greater than one-quarter the velocity of sound in air, and means for applying vibrational forces to a line on the surface of the diaphragm extending angularly with respect to the length of the diaphragm.
3. An acoustic radiator comprising a radiating surface, a driving element, and a distributing system connecting said driving element with said radiating surface, said distributing system being adapted to propagate energy therethrough at a velocity approaching the velocity of propagation of sound in air.
4. An acoustic device, comprising a long direct-acting diaphragm for radiating sound and means for tensioning the diaphragm in the direction of its length to such a degree that sound waves radiated from a plurality of points on said diaphragm along a line extending in the direction of its length are substantially in phase.
5. An acoustic device comprising a diaphragm, the length of which is greater than one-half the wave length of the lowest frequency to be radiated, and means for tensioning the diaphragm in the direction of its length to such a degree that sound waves radiated from a plurality of points on said diaphragm along a line extending in the direction of its length are substantially in phase.
6. An acoustic device comprising a large direct-acting diaphragm for radiating sound, means for tensioning said diaphragm in one direction to such a degree that waves radiated from a plurality of points on said diaphragm along a line extending in said direction are substantially in phase, and means for driving said diaphragm along a line, the phase displacement between driving forces acting along various portions of

said line being small and substantially constant with frequency.

7. A sound radiator comprising a direct-acting diaphragm having a length greater than one-half the wave length of the lowest frequency to be radiated therefrom, and means for so tensioning the diaphragm in the direction of its length that the velocity of vibrations in the diaphragm propagated in the direction of its length, is greater than one-quarter of the velocity of sound in air.

8. An acoustic device comprising a diaphragm tensioned in the direction of its length, the length of said diaphragm being greater than one-quarter the wave length of the lowest frequency to be radiated, actuating means therefor, and a tubular member connected to a portion of the diaphragm between its ends for coupling said actuating means to said diaphragm.

9. An acoustic device comprising a large direct-acting diaphragm having a length equal to at least twice its width, means for tensioning said diaphragm in the direction of its length, and means in contact with the side edges of said diaphragm for damping the vibrations therein.

10. An acoustic device comprising a plane direct-acting diaphragm, a tubular member extending substantially parallel to said diaphragm, means for supporting said tubular member at a plurality of points distributed throughout its length, means for connecting said tubular member to said diaphragm, and means for actuating said tubular member.

11. An acoustic device comprising a plane direct-acting diaphragm, a torsional member extending substantially parallel to said diaphragm for driving it, a rigid support, means attached to said torsional member and connected to said diaphragm at a plurality of points, and means connected to said torsional member and attached at a number of points to said rigid support.

12. An acoustic device comprising a diaphragm, the length of which is greater than

one-half the wave length of the lowest frequency to be radiated, a tubular member extending substantially parallel to said diaphragm and over the greater part of its width, a rigid support, means attached to said tubular member and connected to said diaphragm at a plurality of points, and means connected to said tubular member and attached to said rigid support at a plurality of points distributed throughout the length of said tubular member.

13. An acoustic device comprising a diaphragm having a length equal to at least twice its width, means for tensioning said diaphragm in the direction of its length so that the propagation velocity of vibration therein is greater than one-half the velocity of sound waves through air, a tubular member extending substantially parallel to said diaphragm and substantially perpendicular to the direction of its length, a strip of flexible material extending substantially perpendicular to said diaphragm, one edge of said strip being secured to said diaphragm, the opposite edge of said strip being secured to said tubular member along an element of tangency, a second strip, one edge of which is secured to said tubular member along an element of tangency substantially diametrically opposite to said first mentioned element, a rigid support, the opposite edge of said second mentioned strip being secured to said support, and means for driving said tubular member about an axis near its surface.

14. An acoustic device comprising a direct acting diaphragm tensioned to such a degree that the velocity of propagation of transverse vibrations therein is greater than one-quarter the velocity of sound in air, and means for torsionally driving said diaphragm.

In testimony whereof, I hereunto subscribe my name this 10th day of May A. D., 1927.

HENRY C. HARRISON.