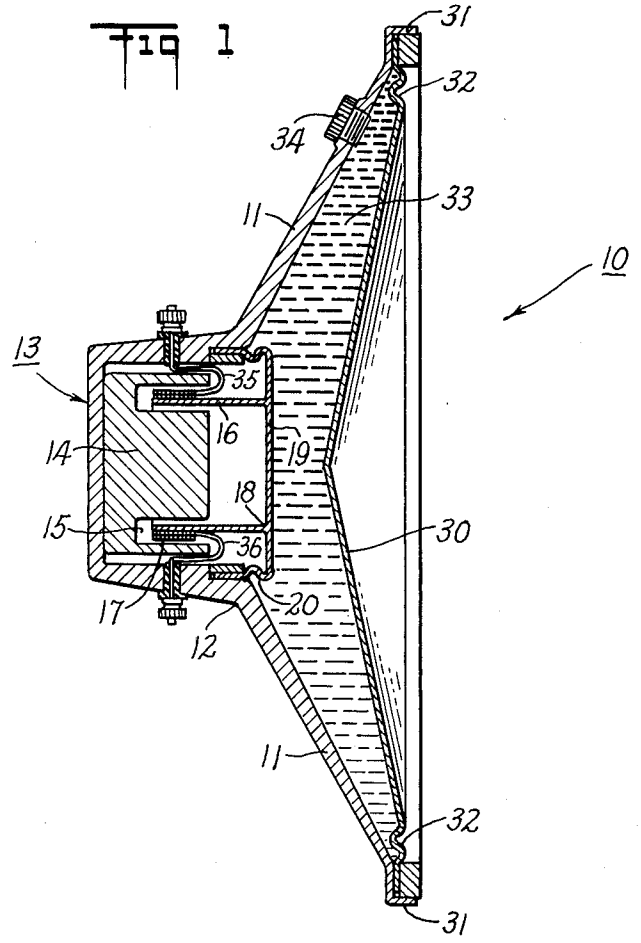
Aug. 17, 1965 M. T. BASSECHES 3,200,901

LOUD-SPEAKER

Filed April 20, 1964

Fig 1



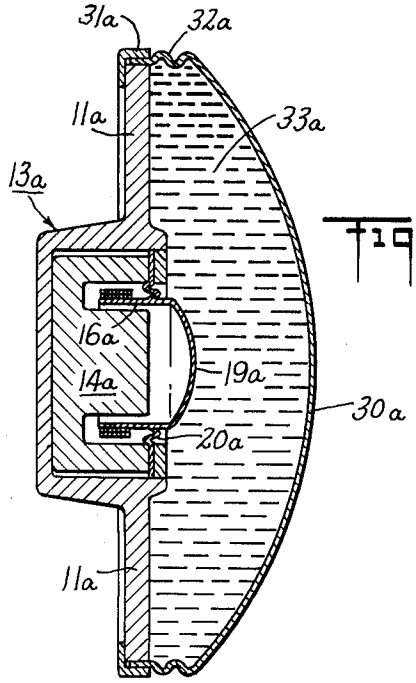


Fig 2

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LOUD-SPEAKER

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This invention relates to a loud-speaker device, and more particularly to a novel loud-speaker device having particular utility in reproducing, with minimum distortion, frequencies within the audio range.

Still more particularly, this invention relates to a transducer device whereby impressed electrical signals of a given amplitude and frequency cause concomitant movements of a radiating diaphragm to cause said diaphragm accurately to translate electrical input signals and to move in accordance with the frequency and amplitude of the impressed signals.

Still more particularly, this invention relates to a high fidelity loud-speaker device wherein the vibratory motion produced by a transducer having a diaphragm or driver input surface is hydraulically transmitted to a large radiating diaphragm, to cause such large diaphragm to move as a unit at the frequency of the transducer and through an amplitude proportionately smaller than the first mentioned diaphragm or input surface.

Modern loud-speakers may be divided into two classes. The first class is known as the magnetic speaker and incorporates, typically, a high intensity magnetic field. A voice coil is movably suspended in the field and is connected to a radiating one, usually comprising papier-mache, and more recently expanded polyurethane foam. The voice coil is connected to the apex of the cone, the rim of the cone being movably suspended to a frame. Electrical signals in the audio range (about 25 to 20,000 cycles per second) are impressed on the voice coil, generating a magnetic field of varying nature, depending upon the signals. The reaction between the high intensity field and the field generated by the voice coil causes a movement of the voice coil and a consequent movement of the cone apex. The motion imparted to the cone apex in turn causes a movement of the entire cone resulting in the production of sound.

Other permanent magnet speakers include so-called horn type radiators in which a diaphragm other than a cone may be employed.

The second general class of speaker in common use is known as an electrostatic speaker and consists of a conductive diaphragm suspended in a polarized field. Audio signals are impressed on the conductive diaphragm, causing the latter to be attracted and repelled in accordance with the impressed signal.

While the permanent magnet type speakers are in widespread use and are capable of high quality reproduction of sound, certain drawbacks inhere in the use of all such speakers heretofore known. Specifically, by applying the moving force to the apex of the cone, there is introduced a relative movement of the various portions of the cone, with a concomitant distortion of the emitted sounds.

Similarly, since both the front and rear surfaces of the cone are sound radiating surfaces, it is necessary to enclose or baffle the cone type speaker to phase the rear radiation with the front radiation, or, alternatively, to cancel out the effects of the rear radiation.

In either instance, to effect a phasing or cancellation of the effects of the rear radiation, it is necessary that the speaker be mounted in a large enclosure, with its accompanying high expense, waste of living space, and detraction from the general decor.

Electrostatic speakers, on the other hand, while capable of high quality sound reproduction, are generally extremely expensive because of the requirement to provide an apparatus to generate the high polarizing voltages necessary for their operation. Additionally, electrostatic speakers for the reproduction of the full audio frequency range must be provided with extremely large radiating surfaces, since the reproduction of sounds, particularly in the low frequency range, requires the movement of considerable volumes of air and the amplitude of movement which may be achieved though the use of the electrostatic principle is extremely limited.

It is therefore an object of my invention to provide a high quality reproducer of sound which overcomes many of the drawbacks of sound reproducing devices heretofore known.

A still further object of the invention is the provision of a transducing system which introduces a minimum of distortion or coloration of the input audio signal.

Still a further object of the invention is the production of a transducer or loud-speaker system which is capable of high fidelity sound reproduction and which requires little or no baffling of the system.

Still a further object of the invention is the production of a high fidelity loud-speaker which operates on a hydraulic principle, whereby a large radiating surface or diaphragm is caused to move as a unit, with a minimum of relative movement between the parts of the said diaphragm in response to movements of larger amplitude by a smaller input surface or diaphragm.

Still a further object of the invention is to provide a device of the class described which may occupy less space than units heretofore known, while providing higher quality sound reproduction, particularly in the lower audio range.

To attain these objects and such further objects as may appear herein or be hereinafter pointed out, I make reference to the accompanying drawings, forming a part hereof, in which:

FIGURE 1 is a vertical cross-sectional view of a loud-speaker in accordance with my invention;

FIGURE 2 is a vertical cross-sectional view of a further embodiment of a device in accordance with my invention.

Referring now to the drawings, in FIGURE 1 there is shown a loud-speaker device **10** including a combined frame and fluid container **11**. While the frame and container **11** are of generally conical configuration, it will be readily understood that the particular configuration may be varied and, hence, should not be taken in a limitative sense.

At the apex portion **12** of the container **11**, there is supported a more or less conventional transducer **13** which, in the illustrated embodiment, operates on the permanent magnet-voice coil principle. It will be understood by the skilled worker that substantially any transducer device capable of translating electrical impulses into mechanical movement may be employed and that the utility of the loud-speaker is by no means limited to use with magnetic voice coil transducers.

The transducer **13** includes a permanent magnet assembly **14**, preferably generating a high flux within the cylindrical gap **15**. Suspended within the gap **15**, on a cylindrical mandrel **16**, there is wound a suitable voice coil **17** of an impedance which, in accordance with known practice, is matched to the impedance of the output of the amplification system employed. The mandrel or voice coil support **16** is secured at its forward end **18** to an input diaphragm **19**, which may also be referred to as a pressure producing diaphragm or instrumentality.

The diaphragm **19** is movably mounted to the frame **11** by a cylindrical or annular spring suspension **20** which permits a relative movement between the diaphragm and the frame **11**, and which tends to reestablish an initial

positional relationship between the said diaphragm and the frame when moved from its initial position. Preferably, the suspension **20** is of the linear acting type, i.e. within the range of movement calculated for the diaphragm, the restoring force exerted by the suspension **20** on the diaphragm is substantially constant.

A radiating diaphragm **30** is secured to the rim **31** of the frame **11** through the medium of a further suspension **32**. It will be understood that the suspensions **20** and **32** may be comprised of resilient material, such as nylon, accordion pleated to permit excursions of the various diaphragms supported thereon. However, other forms of suspensions for the diaphragms may be employed.

The space **33** between the diaphragms **19** and **30** is filled with a relatively incompressible liquid, such as a light hydraulic fluid, water or the like. Preferably the space is entirely filled and there is provided a drain and fill plug **34** through which the said fluid may be introduced or removed. Optionally, sealing gaskets (not shown) may be disposed between the diaphragms and the suspensions at all points where leakage may occur or, alternatively, one or both of the diaphragms may be formed integrally with the suspensions and/or with the container.

Leads **35**, **36** of the voice coil are, in accordance with usual practice, connected to the output of an audio amplifier.

It will be readily recognized from the foregoing that the electrical signals impressed on the voice coil **17** will cause the mandrel **16** and, hence, the input diaphragm **19**, to vibrate or move in accordance with the amplitude and frequency of the impressed signal. Since the volume within the container must remain constant, a movement of the diaphragm **19**, for instance, in the direction of radiating diaphragm **30**, must be compensated for by a forward movement of the radiating diaphragm **30**, the latter movement being smaller than the movement of the diaphragm **19** in view of the larger area of the diaphragm **30**.

When the diaphragm **19** shifts away from the radiator diaphragm **30**, it will be understood that such a movement would tend to increase the volume of the container and that the radiator diaphragm **30** will move toward the diaphragm **19**, to maintain the volume at a substantially constant level partially under the influence of the spring suspension **32**, where such a spring suspension is employed, and under the influence of atmospheric pressure which bears against the outer surface of the diaphragm **30**.

From the foregoing it will be appreciated that the inward and outward movements of the input diaphragm result in concomitant inward and outward movements of the radiator diaphragm, the latter movements being of a smaller excursions due to the increased area of the radiating diaphragm as compared with the input diaphragm.

It will be further observed that the hydraulic pressure exerted on the inner surface of the radiating diaphragm is applied equally over each portion of the area of such diaphragm and the same therefore moves substantially as a unit. Such unitary movement results in a smooth, substantially undistorted response, eliminating the harmonic and intermodulation distortions customarily occurring in cone type speakers due to the break up or simultaneous movement in different directions of various parts of the cone.

It will be further appreciated that there is no substantial requirement for baffling since, unlike the conventional cone speaker, there is no significant rearward sound radiation.

It will be readily appreciated that while the system may

be utilized for full frequency range sound reproduction, it may be found desirable, in certain instances, to provide a plurality or independent units, and to divide the electrical impulses into frequency ranges, with the appropriate frequency ranges directed to the proper units, depending upon the resonance characteristics of the unit.

Further, it will be understood that a loud-speaker in accordance with the invention may be used, for instance, as the woofer in a high fidelity system, with other component types providing the mid-range and/or tweeter response.

In certain instances it may be found desirable to dispose the radiating diaphragm and the input diaphragm in close proximate relation one to the other. In the embodiment of FIGURE 2, where like parts are given like reference numerals, the transducer **13***a* is disposed entirely within the container **11***a*, with portions of the rearward housing of the transducer being formed in common with the inner faces of the container **11***a*. In the embodiment of FIGURE 2, the input diaphragm **19***a* and the radiating diaphragm **30***a* are parti-spherical in configuration and are concentrically disposed one to the other. This arrangement is highly desirable in that a wide dispersion of sound is achieved, and the possibility of phasing problems, which might result should the pressure reach one portion of the radiating diaphragm before it reaches other portions, is eliminated.

The arrangement of FIGURE 2 is particularly desirable for the reproduction of the very high frequencies.

From the foregoing it will be recognized that there is disclosed a loud-speaker or transducer system which is capable of reproducing sound with the highest fidelity, substantially free of the distortion encountered in heretofore known systems. Moreover, the ability to utilize the system without the requirement for baffling or enclosing the same enables the production of loud-speaker systems of comparatively small size and high quality.

Having thus described my invention and illustrated its use, what is claimed as new and is desired to be secured by Letters Patent is:

1. A loud-speaker device comprising a sealed, liquid filled container of substantially fixed volume, a relatively stiff radiating diaphragm forming a boundary of said container, a relatively stiff sound generator diaphragm forming a second boundary of said container, said sound generator diaphragm being of lesser area than said radiator diaphragm, first and second flexible suspension means interposed between said container and said radiating and generator diaphragms, respectively, for mounting said input and radiator diaphragms to said container to permit excursions of said diaphragms relative to said container without substantial deformation of said diaphragms, and transducer means connected to said sound generator diaphragm for moving the latter responsive to the amplitude and frequency of electrical impulses applied to said transducer means.

2. A device in accordance with claim **1** wherein said input and radiator diaphragms are coaxially disposed.

3. A device in accordance with claim **2** wherein said diaphragms are parti-spherical.

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