July 22, 1969 J. WALKER 3,456,755

HYDRAULIC LOUDSPEAKERS

Filed July 29, 1963 2 Sheets-Sheet 1

Fig. 1

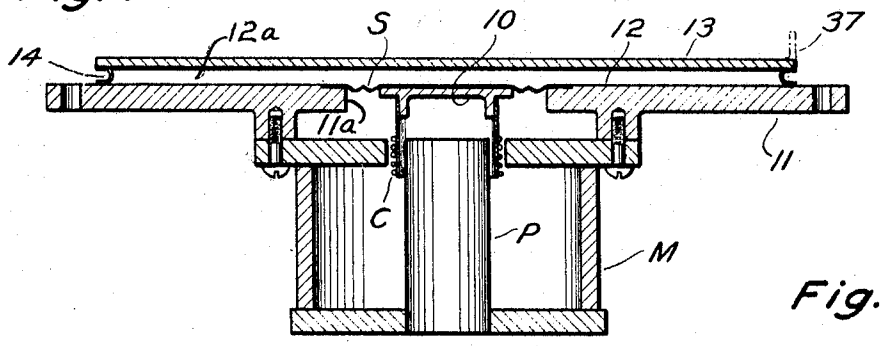


Fig. 2

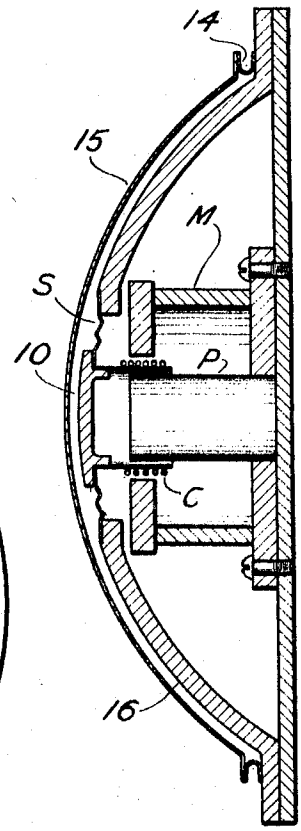
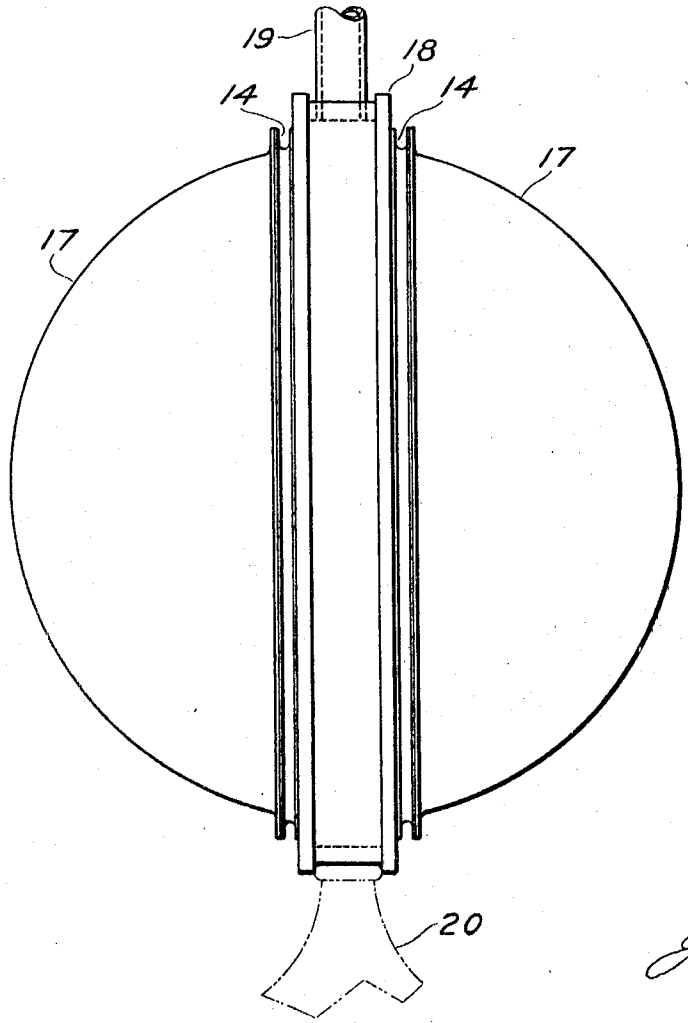


Fig. 3



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Filed July 29, 1963 2 Sheets-Sheet 2

Fig. 4

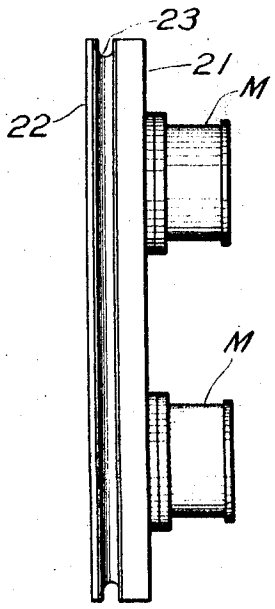


Fig. 5

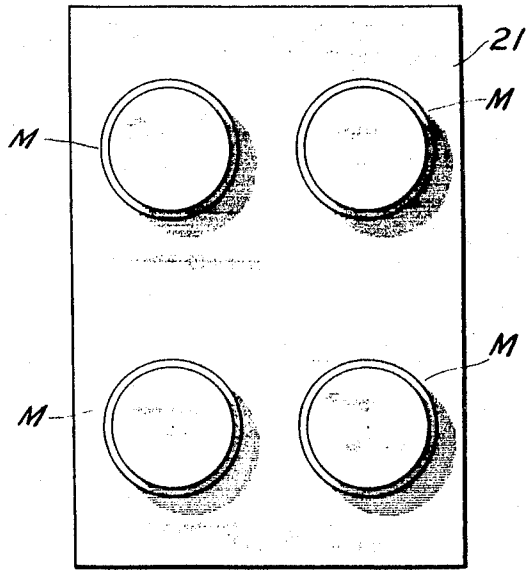


Fig. 6

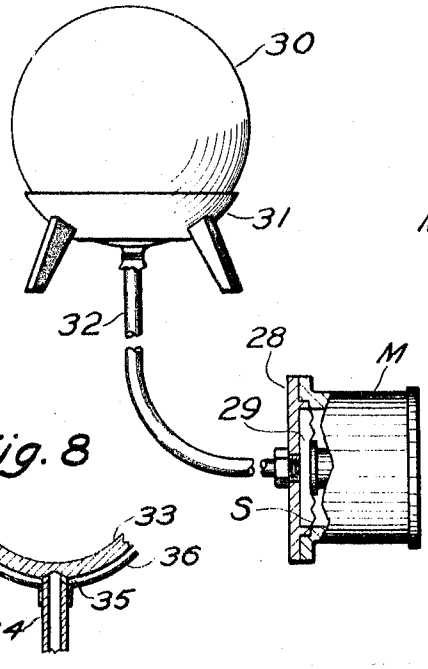


Fig. 7

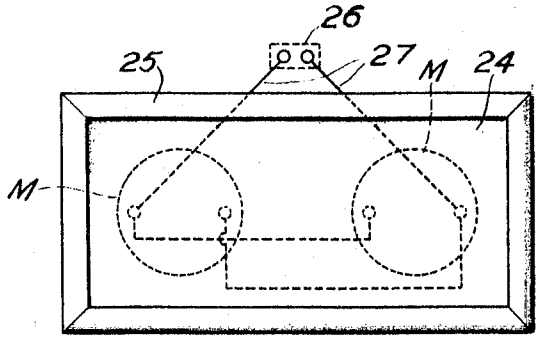


Fig. 8

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HYDRAULIC LOUDSPEAKERS

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Int. Cl. H04r 7/16; G10k 13/00
U.S. Cl. 181—31 10 Claims

This invention relates to loudspeakers and more particularly to the means of transmitting the acoustic energy developed by the speaker motor, from said motor to the element producing atmospheric rarefactions and compressions. Briefly stated, it refers to a hydraulic speaker.

In the various conventional types of speakers, such as magnetic, dynamic, balanced armature and induction, the final or sound-producing unit is in the form of a hollow cone having forwardly diverging surfaces. This frusto-conical construction, which has an inherent rigidity, enables the driving unit of a speaker motor to be attached to the small end of the cone and still ensure a comparatively uniform motion of the sound-producing surface. This, together with the relatively light weight of the cone material, while reducing distortion to a minimum, also eliminates, to a large degree, the damping effect that would be present with a sound-producing element of heavier construction.

The foregoing advantages of the speaker cone become less apparent as the included angle of the cone is increased, and if this increase is carried to an excess in an effort to construct a more compact unit, the resulting decrease of fidelity and increase of distortion will become objectionable. It has also been established that a plurality of speakers must be used in combination if it is desired to reproduce all frequencies in the audio range. The various units are known as "woofers," "tweeters" and "mid-range," and are coupled by filter net works which separate the various frequency ranges and channel them to the correct speakers.

It is the object of the present invention to provide a loudspeaker having an acoustic energy-producing unit which is not subject to distortion due to its particular form.

A further object of the invention is the provision of a loudspeaker of compact form, for installation in a restricted or limited space.

Yet another object of the invention is the provision of a unit which will fit unobstrusively into the surrounding decor.

A still further object of the invention is the provision of a loudspeaker that can be either wall or ceiling mounted.

Another object of the invention is the provision of a loudspeaker that can be utilized for advertising display purposes.

Yet another object of the invention is the provision of a loudspeaker which will reproduce throughout the entire audio range without sacrifice of fidelity or creation of distortion. These and other objects of the invention will become apparent during the course of the following description and appended claims, taken in connection with the accompanying drawings forming a part hereof.

In the drawings:

FIGURE 1 is a cross sectional view of the speaker taken on the longitudinal center line thereof.

FIGURE 2 is a view similar to FIG. 1 showing a modified form and arrangement of elements.

FIGURE 3 is a side elevation of a speaker comprising a double unit formed by two speakers similar to the one shown on FIG. 2.

FIGURE 4 is an elevation of a panel type speaker having a plurality of driving motors.

FIGURE 5 is a rear elevation of the speaker shown on FIG. 4.

FIGURE 6 is a further embodiment utilizing the basic, novel signal transmitting media.

FIGURE 7 is a front elevation of a speaker similar to that of FIGS. 4 and 5, the speaker being made in the form of a picture.

FIGURE 8 is a fragmentary sectional detail showing a further modification of the speaker illustrated on FIG. 6.

Referring to the drawing in detail, and more particularly to FIG. 1, it will be seen that a conventional permanent magnet type of driving motor is illustrated, comprising the usual form of magnet M having a centrally disposed pole piece P. A voice coil is mounted in concentric relationship with the pole piece P as indicated by C, and is adapted to reciprocate under the action of the residual flux of the magnet and any signal which may be impressed upon the coil. The coil form is closed at its outer end by means of a flanged disc or closure **10**, which is preferably constructed of light weight material. A rigid plate or flange **11**, of annular configuration, is attached to the magnet M in concentric relation therewith, and has its front face **12** in substantially coplanar alignment with the outer face of the flanged disc **10**. The diameter of the aperture **11***a* of the annular plate **11** is somewhat larger than the outside diameter of the disc **10**, and the intervening space between these two elements is bridged by a spider S in the usual manner. The material from which the spider S is made, must in this instance, be impervious to any liquid with which it may be in prolonged contact, and it must be secured to the plate **11** and the disc **10** in such a manner that the intervening space between said plate and said disc is effectively sealed.

The acoustic energy producing unit in this embodiment comprises a relatively thin and light weight diaphragm **13**, adapted to be in concentric alignment with, and in relatively close proximity to, the plate **11**, to which it is secured by means of a suitable bellows type gasket **14**. This gasket must permit free movement of the diaphragm **13**, and also must effectively seal the space **12***a* between said diaphragm and the surface **12** of the plate **11**, this space **12***a* being adapted to form a liquid-containing pressure chamber.

Filling and vent holes, complete with plugs, not indicated, will be provided in the plate **11**, in order that the space between the diaphragm **13** and the front face **12** of the plate **11** can be completely exhausted of all air, and filled with a suitable liquid of low viscosity. The liquid layer should be as thin as possible, and actually only needs to be slightly in excess of the maximum length of travel of the diaphragm.

In the embodiment illustrated in FIG. 2, the principle of operation is identical with that of the foregoing. It is adapted to especially to ceiling mounting, and, as can be seen from the drawing, the diaphragm **15** differs from the diaphragm **13** only in the respect that its exterior face is of convex configuration as compared to the flat construction of **13**. A plate **16**, which corresponds with **11** of FIG. 1, is also of curved construction complementary to the diaphragm **15**.

In all other respects the two designs are similar, the compactness of the assembled unit being evident in both cases.

Referring now to FIG. 3, this embodiment embraces a pair of speakers similar to the one shown on FIG. 2, the diaphragm **17** being curved to a greater extent than the diaphragm **15**. When the speakers are mounted on a centrally located annular member or ring as shown, the general shape of the complete assembly will be spherical. This embodiment lends itself to suspension from a ceiling, as by a conduit **19**, or it can be adapted to fit on a stand as indicated in phantom at **20**. In one case the leads from an amplifier can be introduced through the conduit **19**, and in the other case they can be brought up through the stand **20**.

In the embodiment disclosed by FIGS. 4 and 5, a panel type of speaker is shown which can readily be flush-mounted in a wall or ceiling. This design is also based on the same principle as described heretofore, and differs only in the fact that plate **21**, diaphragm **22** and gasket **23**, corresponding to like parts **11**, **13** and **14** of FIG. 1 respectively, are rectangular in shape instead of being circular, plus the fact that a plurality of driving motors, as indicated by the magnets M, has been provided. If desired, the voice coils of the individual driving motors can be designed to reproduce a predetermined band of frequencies, all of which, with their related harmonics, will be transmitted to the single diaphragm **22**. A conventional cross over network, comprising the usual band pass filters, will of course be utilized for such a multiple speaker system.

A speaker of similar design is illustrated by FIG. 7 wherein the diaphragm **24** is in the form of a picture suitably enclosed by a frame **25**. In this embodiment, a hanger **26** has been provided which is adapted to be connected to an amplifier, the lead in wires **27**, to the driving motors, can then be utilized to hang the picture.

The particular type of speaker shown on FIG. 6 is especially adapted to display or advertising purposes. In this design the magnet M has a flange or plate **28** secured to the front end thereof. A pressure chamber **29** is formed by the space existing between the interior of said flange, and the spider S and the disc **10**. The diaphragm, comprising a substantially resilient, spherical balloon or envelope **30**, suitably supported, as by a stand **31**, communicates with the pressure chamber **29**, connection between the two being provided by means of a tube **32** having relatively rigid walls.

FIG. 8 discloses a fragmentary detail of a modification of the design of FIG. 6. In this case, instead of using a hollow balloon, having the entire interior liquid filled, it is proposed to provide a form **33**, comprising a hollow metal or plastic sphere of substantially rigid construction, with a suitable connection **34** having ports or apertures **35** as indicated on the drawing. The resilient envelope **36**, which in effect forms a sound-producing diaphragm, can then be sprayed on in liquid form, measures being taken to preclude the possibility that it might adhere to the surface of the sphere or form **33**. Liquid can then be introduced into the system in sufficient quantity to ensure a layer of the liquid between the inner surface of the diaphragm **36**, and the outer surface of the spherical form **33**.

If it is desired to make a speaker of the type shown on FIG. 1 more directional, the diaphragm **13** can be provided at its edge with a lip or forwardly extending flange **37**, as indicated in phantom on said figure, with a negligible sacrifice of compactness.

All of the embodiments of the invention will operate on the principle that a liquid under pressure exerts an equal force in all directions. It will be apparent, therefore, that a diaphragm subjected to the fluctuations of pressure incidental to the movements of a voice coil carrying a signal, will respond in a uniform manner over its entire surface.

Inasmuch as the area of the diaphragm will ordinarily be much greater than the area of the liquid subjected to the piston-like action of the voice coil driven discs, the voice coils will have to be designed for a greater travel than those of the conventional cone type speakers. It should be further noted in connection with the speakers having a plurality of driving motors, that obviously, correct phase relationship will have to be observed in the wiring thereof.

In all of the embodiments described and illustrated, a driving motor of the permanent magnet type has been used, however, it will be understood that other types of motors can be used with equal facility. I therefore do not limit this application to any one type of driving means, and while I disclose a preferred embodiment of the invention, it will be further understood that modifications may be made within the spirit and scope of the appended claims.

I claim:

1. A loudspeaker comprising a driving motor having acoustic energy-producing means, a diaphragm resiliently connected to said loudspeaker and hydraulic means adapted to transfer the energy from said producing means to said diaphragm, the inner surface of said diaphragm being adapted to form one wall of a liquid-containing pressure chamber.

2. A loudspeaker comprising a driving motor having acoustic energy-producing means, a flange mounted on said motor and having an aperture therein in concentric alignment with said energy-producing means, a flexible spider fixedly attached to said flange and said energy-producing means whereby the aperture of said flange is effectively sealed, a flexible gasket substantially concentric with said flange and being attached to the outer face thereof in liquid-sealing relationship whereby a depressed area is formed within said gasket and on the outer face of said flange, a diaphragm adapted to cover said depressed area and being resiliently connected to said flange by said gasket.

3. A loudspeaker as in claim **2** wherein said flange and said diaphragm are of convex outer configuration, said driving motor being contained within the concave interior of said flange.

4. A loudspeaker comprising a plurality of driving motors having acoustic energy producing means, said motors being mounted on a common flange, a diaphragm and hydraulic means adapted to transfer the energy from said producing means to said diaphragm.

5. A loudspeaker comprising a plurality of driving motors having acoustic energy producing means, each of said motors being responsive to a different band of frequencies, a diaphragm and hydraulic means adapted to transfer the energy from said producing means to said diaphragm.

6. 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.

7. A device in accordance with claim **6** wherein said input and radiator diaphragms are coaxially disposed.

8. A device in accordance with claim **7** wherein said diaphragms are parti-spherical.

9. A loudspeaker comprising a driving motor having

acoustic energy-producing means, a diaphragm, and hydraulic means adapted to transfer the energy from said producing means to said diaphragm, said motor having a fluid-containing pressure chamber at one end thereof; said diaphragm comprising a fluid-filled flexible envelope, and fluid transmitting means connecting said chamber and said envelope.

10. A loudspeaker as in claim **9** said envelope being adapted to enclose an inner form whereby the amount of liquid necessary for the operation of the speaker can be kept at a minimum.

References Cited

UNITED STATES PATENTS

1,416,582	5/1922	Sealey	274—6
1,451,422	4/1923	Hahnemann	181—32
1,730,528	10/1929	Robbins	274—6
3,093,207	6/1963	Bozak	181—32
3,347,335	10/1967	Watters et al.	181—.5
1,862,582	6/1932	Schlenker	181—31
2,756,281	7/1956	Pittinger	179—115.5
3,160,225	12/1964	Sechrist	181—31.1
3,200,901	8/1968	Basseches	181—32

FOREIGN PATENTS

1,089,415	9/1960	Germany.
1,146,757	5/1957	France.

STEPHEN J. TOMSKY, Primary Examiner

U.S. Cl. X.R.

179—115.5; 181—32