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HIGH-COMPLIANCE SPEAKER AND ENCLOSURE COMBINATION

Original Filed March 4, 1968

Fig. 3

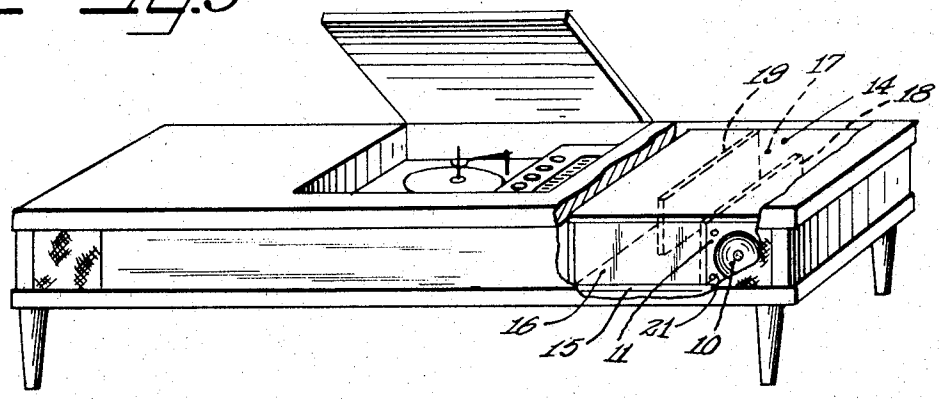


Fig. 2

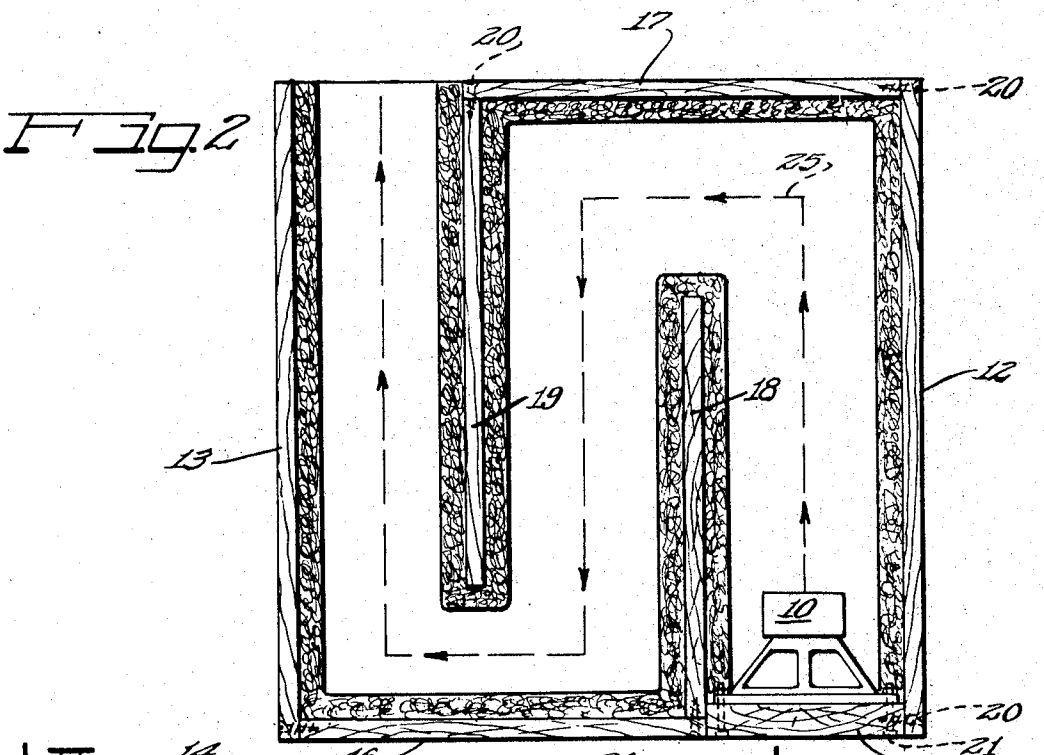
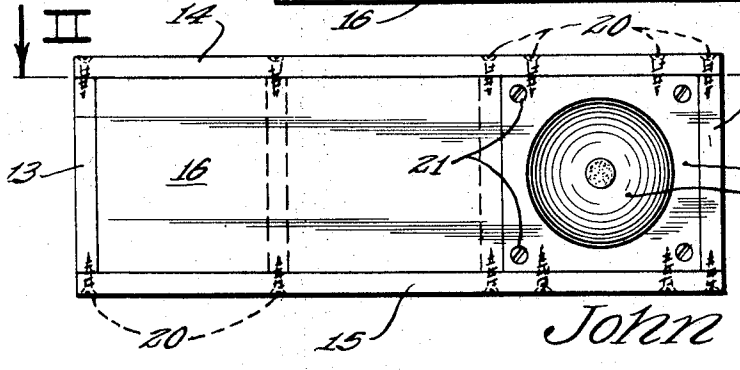


Fig. 1



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HIGH-COMPLIANCE SPEAKER AND ENCLOSURE COMBINATION

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Continuation of application Ser. No. 710,246, Mar. 4, 1968. This application July 22, 1969, Ser. No. 847,791
Int. Cl. G10k 13/00
U.S. Cl. 181—31 5 Claims

ABSTRACT OF THE DISCLOSURE

A small diameter, high-compliance speaker of very low resonant frequency is incorporated in a vented, folded column enclosure having a mean path length equal to one quarter wavelength at the speaker resonant frequency. The arrangement allows the high-compliance speaker to handle substantial power while further improving its low frequency response in accordance with tuned enclosure theory.

This is a continuation of application Ser. No. 710,246, filed Mar. 4, 1968, now abandoned.

This invention relates to speakers in general and, in particular, to speakers of the high-compliance type. More specifically, the invention is concerned with a self-contained speaker system utilizing a small high-compliance speaker of low resonant frequency in a vented, folded column enclosure tuned to further augment the speaker's low frequency response. In accordance with the invention, the entire system is fabricated as a unitary structure which may readily be inserted in a cabinet opening, behind a decorative screen, etc.

It is a known fact that low frequency sound reproduction requires relatively large movements of air masses. Consequently, the so-called "woofers," that is low frequency sound reproducers, generally have large cone areas. It is not uncommon to have conventional woofers with cone diameters of 15" and, in some cases, even 18". It is also well-known that a speaker must be housed in a good enclosure, for good bass and mid-bass operation. Depending upon the size of the speaker and its resonant point, the conventional enclosure is a massive structure indeed.

Assuming one had the necessary space and resources, selection of audio components of high quality would yield an excellent sound reproduction system. While such a system would be both massive and expensive because each component would be selected on the basis of quality alone, the audio results would be truly gratifying.

There is a sizable segment of the public willing to purchase the type of equipment specified above. These persons are often referred to as "purists," and in general, pay little attention to cost and size in the pursuit of their goal of faithful sound reproduction. Naturally, the audio industry stands ready to satisfy this market demand. The larger market, however, is that consisting of the ordinary consumer who is desirous of a good music system but is conscious of size and cost limitations. It is relatively simple to provide an inexpensive system for such a market. It is, however, quite an engineering feat to provide a low cost, compact system of high quality.

The greatest obstacle to producing an inexpensive, high quality sound system resides in the lower sound registers. Adequate low frequency reproduction has always required massive speakers in massive enclosures with equally massive audio output transformers. These items effectively precluded a true high quality system

being made available to the ordinary consumer at a reasonable price.

The development of the high-compliance speaker and the perfection of transistorized audio amplifiers have revolutionized the high-fidelity industry. The high-compliance speaker is, as its name implies, one whose speaker cone is loosely suspended and capable of large free air movement. The loose suspension makes it possible to produce speakers of extremely low resonant frequencies, and consequently, conventional enclosure techniques, designed to augment low frequency response, are inappropriate. Rather, the high-compliance speaker is designed to work with a sealed chamber type of enclosure in which a trapped air mass of given volume provides an air spring for the cone, thus allowing the speaker to handle large input power. With such speakers, "book shelf" enclosures of limited size and cost, yet of relatively good frequency response, became available. Even here, however, the speakers and enclosures had to be relatively large for good low frequency performance. The drawback of the high-compliance speaker is the requirement of a driver amplifier capable of delivering large amounts of undistorted power. The high quality, inexpensive, compact system for the general consumer had not arrived as yet.

This invention combines the advantages of inherent low frequency response capability of even a small high-compliance speaker with the low frequency response augmentation techniques of conventional enclosure design to form a novel speaker system of extremely small size, low cost and of exceptional low frequency response characteristics for use with moderate to low cost amplifiers. In applicant's preferred embodiment, his high-compliance speaker has a cone diameter approximating 5¼" and a free air resonance of about 58 cycles. The vented, folded column enclosure has an over-all volume of less than one cubic foot and has its shortest dimension determined by the maximum dimension of the speaker frame. With this combination, the effective frequency response of the tuned speaker system extends down to 30 cycles—an achievement unheard of with a speaker and enclosure of these sizes.

There is a sacrifice in total power handling capability of the speaker—since the normal air loading is not present. However, if additional power capability is desired, two or more speaker systems may be used together. The unit is inexpensive, small and self-contained. Not only is it possible to deliver true low frequency response to the general consumer at a reasonable price, it can be done in cabinetry which is tasteful and free from design restrictions imposed by the need for large areas of grille cloth. Further, due to the self-contained feature of the speaker system, the cabinet may be manufactured much more inexpensively than was heretofore possible. Aside from these obvious advantages, there is the important aspect of aesthetics. No longer need the "hi-fi" system be a massive piece of cabinetry or an assemblage of isolated components. Now a true high-fidelity cocktail table, desk or other furniture piece is feasible.

Accordingly, the primary object of this invention is to provide a novel acoustical system including a small diameter, low resonant frequency, high-compliance speaker and a folded column enclosure enhancing the low frequency response of the speaker while providing substantial loading therefor.

Another object of this invention is to provide a small, low cost, excellent performing high-compliance speaker and vented folded column enclosure combination which may be unitarily constructed and readily and economically installed in all types of cabinets.

Other objects and features of this invention will become apparent upon a reading of the specification in conjunction with the drawing in which:

FIG. 1 represents a front view of a speaker-enclosure combination constructed in accordance with the invention;

FIG. 2 is a side view of the speaker-enclosure combination FIG. 1 with one wall removed to reveal the internal construction; and

FIG. 3 is a partially cut away pictorial representation of the speaker-enclosure combination of the invention integrated into the design of a conventional furniture piece, in the instant illustration, a low table.

Referring now to FIG. 1, a small diameter, high-compliance speaker **10** is shown mounted, by means of bolts **21** or other suitable fasteners to a baffle board **11**, which may be constructed of plywood or similar material. Baffle board **11** is generally square in shape and is of appropriate size to snugly fit an aperture formed by the walls of the enclosure. As best seen in FIG. 2, the enclosure defines a well-known folded column including oppositely disposed top and bottom walls **12** and **13**, left and right side walls **14** and **15**, and front and rear walls **16** and **17**. The respective walls are assembled in a manner to produce a box of generally rectangular configuration when viewed from the front, rear, top or bottom positions and of generally square configuration when viewed from either side.

Construction details of the enclosure are not critical although in accordance with good acoustic enclosure design and construction practice, all corners and seams of the enclosure should be sealed and the various members thereof fastened to each other by means of glue and relatively large screws. A plurality of such screws (indicated by reference character **20**) are disposed at various positions about the enclosure. It will be understood that the number and positions of screws **20** are illustrative only and again should be dictated by good enclosure construction techniques.

Since both front and rear walls **16** and **17**, respectively, measure approximately ⅔ the distance between the top and bottom walls **12** and **13**, generally square shaped apertures result when they are put in place. The apertures are designed to be at diagonally opposite corners of the enclosure with the upper aperture formed to receive baffle board **11** with speaker **10** and the lower aperture serving as a vent to the atmosphere. A pair of internal divider walls **18** and **19** is mounted substantially as shown to form a folded column defining a path of serpentine configuration which has a mean length substantially equal to one quarter wavelength at the resonant frequency of speaker **10**. The mean path is indicated by the dashed line **25**. All inside surfaces of the enclosure are treated with acoustically absorptive material for preventing spurious resonances or standing waves from developing within the enclosure.

While baffle board **11** may be fabricated from plywood, a pressed fiber type of material may be advantageously used for the walls of the enclosure. One such material is marketed under the trade name "Coresote". A practical arrangement of the speaker-enclosure combination of the invention utilizes a 5¼" diameter high-compliance speaker having a free air resonance of 58 Hz. The enclosure is fabricated of ¼" Coresote fiber material and has overall dimensions of 6" by 15" by 15" and encloses a volume of less than one cubic foot. This speaker-enclosure combination is capable of producing substantial sound energy down to 30 Hz.

As mentioned previously, the high-compliance speaker requires an air spring to handle acoustic power. It is well-known that conventional loading techniques for such speakers are unsatisfactory. It is also well-known that placing a speaker in a sealed chamber type housing raises the resonant frequency of the system above that of the free air resonance of the speaker unless the enclosure is large enough to be considered "infinite." However, high-compliance speakers may be readily constructed with such low resonant frequencies that the increase in resonant frequency of the system experienced when mounting the speaker in a relatively small sealed box still results in a speaker-enclosure combination capable of faithfully delivering the very lowest sound registers.

What has been done is use a small high-compliance speaker of low resonant frequency (approximately 60 Hz.) and, by conventional enclosure techniques, extend the frequency response of the system to approximately 30 Hz. while also loading the speaker to provide adequate power handling capability. There seems to be no question that the speaker of this combination, if mounted in a properly selected sealed-type enclosure, could handle more power without distortion than it can handle in the instant environment. However, the frequency response of such an arrangement would nowhere near approach the 30 Hz. obtained in accordance with the teachings of this invention.

With a speaker-enclosure combination of such small size and relatively low cost, it will immediately be apparent that vast freedom of cabinetry design becomes available. No longer need a home hi-fi or stereophonic console be of massive proportions to reproduce good low frequency sound. With the small overall size and especially the small frontal speaker radiation area of the instant enclosure, cabinet dimensions and styles are almost unrestricted. For example, as shown in the drawing, a true cocktail or coffee table housing a complete stereophonic system may be readily envisioned when the speaker systems of the invention are placed on their sides. The cut away portion shows the combination of the invention in position. Note that the cabinet itself need not have a bottom since the speaker-enclosure is self-contained. The central area of the cabinet includes a conventional record changer and tuner-amplifier combination all within a well, which is accessible by a lift top. It will be readily apparent that the speaker-enclosure combinations may also be placed upright to allow design of a compact desk type enclosure. The combinations are limitless.

A major advantage in the speaker-enclosure combination of the invention resides in the fact that it is unitarily constructed and as such constitutes a self-contained speaker system. This construction gives rise to substantial savings in design of the console cabinetry for housing the systems. No longer need the cabinet provide the acoustic rigidity formerly required, but need merely serve as a "decorative shell" into which the speaker-enclosure combinations of the invention are inserted.

In more expensive units, where it may be desired to provide more power handling capability, two or more of the speaker-enclosure combinations may be used together. It will also be apparent that should a separate high frequency reproducer be desired (no single cone speaker made has ever adequately covered the full spectrum of audible sound) it may be conventiently mounted in front wall **16** of the enclosure without seriously detracting from the enclosure performance. If need be, the enclosure dimensions may be altered somewhat to accommodate these high frequency reproducers.

I claim:

1. In combination; a high-compliance loudspeaker having a low natural resonance; a rigid acoustic enclosure defining an open-ended tuned column housing said loudspeaker; sound absorptive means in said column; means mounting said loudspeaker in one end of said column; the mean path length of said column being chosen to augment the low frequency response of said high-compliance loudspeaker and provide substantial loading therefor, whereby said loudspeaker may be effectively operated at frequencies well below the frequency of said natural resonance said column being folded and having a cross sectional area which is approximately equal to the loudspeaker.

cross sectional area of the cone of said high-compliance

2. The combination as set forth in claim 1, wherein said rigid acoustic enclosure is fabricated of compressed fibrous material and wherein said sound absorptive means include sound dampening material lining the interior of said folded column.

3. The combination as set forth in claim 3 wherein said rigid acoustic enclosure is fabricated of Coresote.

4. The combination of a high-compliance speaker and a speaker enclosure, said speaker enclosure having an elongated folded path, said high-compliance speaker being mounted substantially at one end of the elongated folded path and said folded path being opened at the opposite end thereof, a sound absorbing medium disposed along the walls of the enclosure defining the folded path, and the path length of said column being substantially one-quarter wavelength of a frequency which approximates the in-air resonance of said high-compliance speaker.

5. The combination as set forth in claim 4 wherein the cross sectional area of said folded path is approximately equal to the cross sectional area of the cone of said high-compliance loudspeaker.

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