Sept. 18, 1962 D. ARANY 3,054,856

SOUND REPRODUCING SYSTEM

Filed Feb. 24, 1959

Fig. 1.

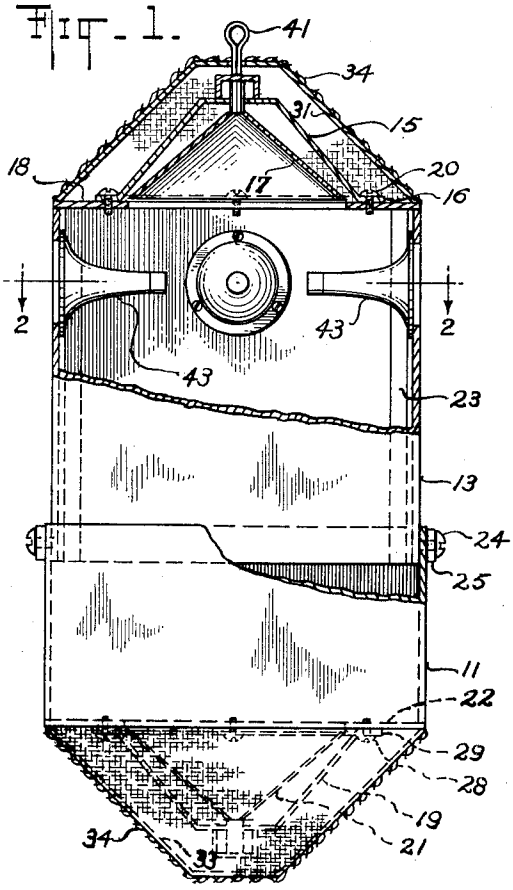


Fig. 2.

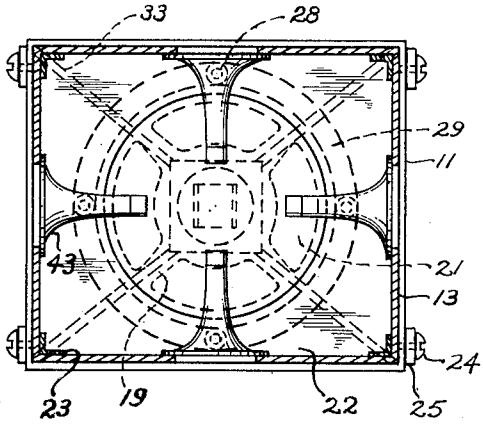


Fig. 3.

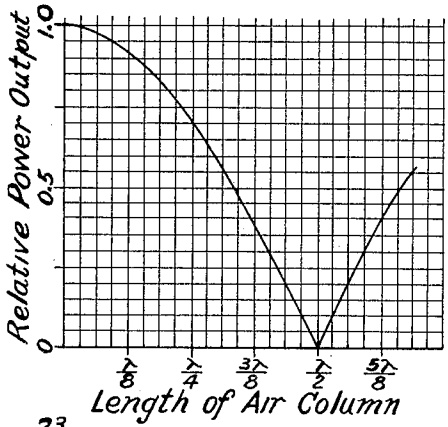


Fig. 4.

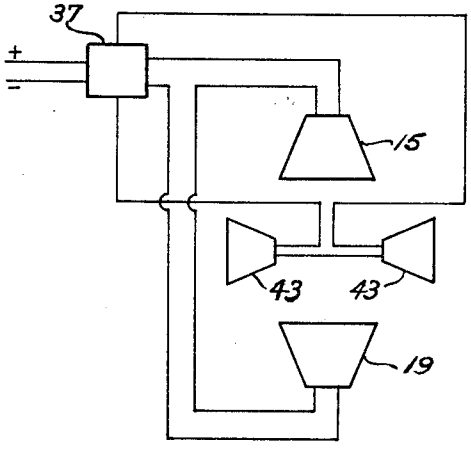
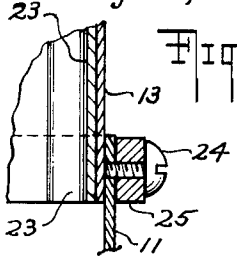


Fig. 5.



INVENTOR.
DONALD ARANY
BY Raymond F. Kramer
ATTORNEY

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SOUND REPRODUCING SYSTEM

Donald Arany, Flushing, N.Y.
(251 Links Drive W., Oceanside, N.Y.)

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The present invention relates to a new and improved system for the non-directional emission of sound with desirable wide frequency response. More particularly, it relates to an arrangement in which a plurality of loudspeakers is located with concave ends facing each other with a confined gas column in between.

In accordance with the present invention a sound reproducting system comprises, in combination, a walled chamber, a plurality of loudspeakers forming substantial proportions of ends of the chamber and located with their concave or open ends facing, and means for phasing input electrical signals to the opposed speakers so that the vibratile elements of such speakers will be stimulated to vibrate in the same direction in response to electrical signals, the distance between the speakers being maintained at a length at which low frequency sound will be accentuated.

An embodiment of the invention is a system comprising, in combination, a thin-walled, hollow, longitudinal chamber substantially impervious to air and having the longitudinal interior walls covered with sound-absorbent material and a pair of substantially identical conoidal woofer speakers located at the ends of the chamber, concave ends facing each other, and forming substantial proportions of the chamber ends, the chamber being extensible and contractable to a plurality of fixable positions in which the woofers are at any of a variety of distances, from one to eighteen inches apart. In some such suitable systems the sound-absorbent material need not be used on the longitudinal interior walls. It is also unnecessary to have identical woofer speakers because speakers of different designs and characteristics can also be sufficiently useful and might sometimes even be preferable in the invented arrangement when the unbalance itself is helpful in extending frequency response. Electrical signals, transformable into audible sound, are divided by an electrical cross-over circuit or a mechanical filter, e.g., a perforated baffle, located between the woofers, into higher and lower frequency components at a selected desired frequency between 0.3 and 8 kilocycles per second. The higher frequency portion of the signal is fed to a plurality of tweeter speakers located intermediate the ends of the thin-walled chamber, facing outwardly about the periphery thereof. The wiring of the low frequency signal circuit between the cross-over circuit and the woofer speakers is such that the speakers are in push-pull relationship and the lower frequency signal portion stimulates the speakers to vibrate in the same direction. In such a described embodiment of the invention the distance between the speakers is set at that which best helps to accentuate the low frequency response. The tweeter speakers may be of a horn type construction to minimize back radiation effects and will be wired to optimize the high frequency emission, most probably and most usually in push-push rather than in push-pull relationship.

The invention, its operation, advantages and various objects thereof will be readily apparent from the following description of an embodiment of the apparatus, taken in conjunction with the accompanying drawing in which:

FIG. 1 is a partially cutaway sectional elevation of an embodiment of the invention;

FIG. 2 is a sectional plan view along plane **2—2**;

FIG. 3 is a curve in which are plotted emitted sound power (as relative power output) against distance between woofer speakers (length of air column);

FIG. 4 is a schematic diagram of an embodiment of the electric circuits; and

FIG. 5 is an enlarged view of one means of setting the distance between woofer speakers.

Numeral **11** designates a thin-walled longitudinally extending hollow chamber wall portion into which is fitted another similarly shaped wall portion **13**. As illustrated, these chamber walls are of nearly square cross-section but they may be rectangular, circular, triangular, elliptical, hexagonal or of any other desired geometric shape in section. They are usually constructed of thin plastic sheets or tubing which is substantially air and sound impermeable but other equivalent non-permeable materials such as metal and wood may also be employed. Fixed to the upper chamber portion **13** is loudspeaker **15** which is a woofer, designed for low frequency sound emission. The vibratile diaphragm element, of this speaker is designated by numeral **17**. Similarly, fixed to the lower chamber portion **11** is woofer **19** having a vibrator **21**. The speakers are held to chamber ends **18** and **22** respectively by screws **20** and **28** through speaker housing flanges **16** and **29**, ends being threaded to receive them and the flanges being drilled to clearance diameter. It is obvious that any other suitable fastening means may be used instead. Instead of having end sections **18** and **22**, to which the speakers are fastened the speaker and housing may be the ends about which the side wall portions are fitted or shaped. In either case the speakers form substantial proportions of the chamber ends and the chamber ends are kept closed to confine the air or gas column between the speakers.

Unlike ordinary speaker arrangements, in the present invention the conoidal woofers are situated with their open or concave ends facing each other. The sound energy radiated by the concave facing surfaces is confined within the substantially impermeable hollow longitudinal chamber. The invented apparatus emits sound from the rear or convex surfaces of the speakers.

The corners of the upper part of the chamber are strengthened by being fastened to angle irons **23** or similarly shaped structural members which extend the length of the upper or interior telescoping part. The angle irons also aid in rigidifying the chamber and act as a backing for the chamber wall where the lower part of the column is held to it. The means illustrated for adjusting the column length is simple, yet efficient. Obviously, any other suitable method of releasably or adjustably fastening may also be used. As shown, screws **24** are threaded into chamber wall **11** and threaded discs **25** which are fastened to wall **11**. The screws bear on the upper chamber wall **13** and thereby frictionally hold the normally telescopable chamber walls in fixed relationship. By loosening the screws, sliding the walls and refastening the screws **24**, the distance between woofer speakers may be adjusted as desired. The screws or other suitable holding means employed should be flat and inconspicuous if possible. Preferably, they are covered with a masking substance.

In the drawing, in FIGS. 1, 2 and 5, where the contact and joinder of the major sections of the chamber are illustrated, no clearance between the sections is shown. Being sufficiently rigid the chamber walls do not spring open where the tightening screws are located and do not produce an air gap to destroy the airtight integrity of the chamber. When there is a danger that the walls will be distorted on tightening of screws **24**, other fastening means will be used instead. For example, one part of the chamber may be longitudinally slotted in multiple and the other may contain screw and nut combinations which ride in the slots and can be tightened to hold the chamber sections

together. This latter type fastening means has the advantage of inherently tending to close chamber air gaps rather than to open them when the holding screws are tightened.

Frameworks **31** and **33** extend from the ends of the chamber and past the speakers. Over these frames are stretched sound-permeable decorative coverings, usually of cloth, to conceal the speakers, make the apparatus attractive and still allow the free radiation of sound waves from the speakers. The decorative coverings are shown symbolically and are designated by numeral 34. In the drawing the exterior walls of the chamber are not covered with cloth or other decorative material. However, it is considered desirable that either a cloth, flock or other coating should be used to improve the appearance of the article, which is normally in sight in the living quarters of the home. It is preferred to select a material which will not resist sliding, will not tear easily and won't be marked badly by the set screws or other means used to set the air column length.

The interior walls of the air-impermeable chamber may be coated or covered with a sound absorbing material. Transverse baffles, which may be perforated, may also be added. However, the coating and baffles are not necessary to obtain excellent sound reproduction, although they may be desirable, and therefore, in the interest of clarity of the drawing they are not illustrated. To the upper speaker **15** there is fastened loop 41 or other means for affixing the speaker assembly to a means of support. Such support loop or holding means may be located wherever suitable so long as the structure at the point of attachment is strong enough to sustain the weight of the chamber and speakers.

Within the chamber there may be located one or more tweeter speakers **43** for emission of higher frequency sound. For most uniform distribution of the higher frequency sound a plurality of these speakers is distributed about the periphery of the chamber. If the tweeters are comparatively large in size or are located so that considerable portions thereof are within the chamber, as in the illustrated embodiment, it is apparent that they will limit to some extent the travel of the sliding adjustable chamber walls. This limiation is not serious in usual situations where smaller tweeters are used and are positioned as near the top or bottom of the chamber as is possible. In those assemblages where the speaker and signal characteristics are fixed and it is unnecessary ever to adjust chamber length, limitation on the degree of adjustability is unimportant and the tweeters may be located within the chamber wherever desired. Where tweeters are large and adjustment of chamber length is vital to secure best low frequency response, it may be necessary to mount the tweeter speakers outside the chamber walls, but this is done at the expense of the more attractive appearance of the flush walled chamber with no unsightly projections.

As is shown in the schematic electrical diagram in FIG. 4, an electrical signal drives a cross-over circuit **37** from which the split signal is fed to the woofers and tweeters. In the view given only two tweeters are illustrated in the interest of clarity. They are shown wired in series but may also be arranged in parallel or in series-parallel combinations. The woofer speakers are so wired to the source of signals, which are transformable into audible sound, that the vibratile elements of both speakers move in the same direction in response to a given signal. The source of signals, which is not shown, is merely indicated by plus and minus signs. Opposed tweeter speakers may also be so wired as to obtain the benefit of a push-pull effect.

To describe the push-pull effect with respect to the woofers in a different way, one might say that the speakers are fed energy 180 degrees out of phase electrically, which, since they are positioned 180 degrees from each other, causes the sound waves emitted by the speakers to be moving in the same direction at any given moment.

The cross-over circuit **37**, which separates the higher and lower frequency signals, is of conventional type and need not be described further. The cross-over point will usually be set between 0.3 and 15 kilocycles, more frequently between 0.3 and 8 kilocycles per second, but may be set wherever preferable, depending on the woofer speaker design, so long as the point is within the ranges given. Instead of employing an electronic cross-over circuit such as that previously referred to, the inherent speaker design and characteristics themselves, in combination with the chosen spacing, may serve as the cut-off means to prevent high frequency radiation from the woofers and improve the low frequency response, respectively.

The distance between woofer speakers in the device of this invention may be set to accentuate the low frequency radiation and so improve the low frequency response characteristics of the speaker system. As will be seen by reference to FIG. 3, when the woofers are set at a distance equal to one-half the wavelength of the incoming or input signal, that and shorter wavelengths or higher frequencies may be canceled. Thus, that wavelength may be considered as the cross-over point as far as the woofer is concerned. Shorter wavelengths may be emitted from the tweeters receiving the higher frequency signal component. Changing the distance between the woofer speakers allows easy alteration of the cut-off point. In some instances it is not necessary to reproduce the higher frequency sounds and in those cases the invented speaker system may be operated without the tweeters, the distance between woofers and their inherent characteristics, i.e., frequency response, governing the maximum frequency of emitted sound.

In operation the invented device has many advantages over the conventional speaker systems. Unlike more expensive and less compact speakers and enclosures heretofore considered necessary to insure high fidelity sound reproduction, the present device is self-contained, compact, easily portable and economical, since it is of simple construction and utilizes only a minimum of parts, most of which are standard items. No complex speaker configurations, cabinets or other means to back load the speaker are required, the opposed speakers themselves in the impermeable chamber serving as mutual transducers to the external air environment. The convex or rear faces of the speakers serve to send the sound out evenly in all directions without the directional emission of a typical commercial installation.

Among the other advantages of the invention is the accentuation of the lower frequency sound. As is shown by the curve of FIG. 3, the accentuation of a range of wavelengths of the low frequency sound is a function of the length of the chamber. The chamber length, or the distance between the woofer vibratile elements, will normally be set at the length, between one-half and eighteen inches, and usually over one inch, at which the low frequencies being reproduced will be accentuated. It is seen that below one-half of a wavelength setting the power curve is approximately straight line and this straight line effect or radiated power falls off or decreases with increasing frequency. The power fall-off is at a much lower rate at lower frequencies than that which would obtain in the absence of the invented device; therefore it can be said that the lower frequency sound waves are accentuated.

The attractive and functional sound reproducing device of this application can be decoratively or unobtrusively placed in any environment. It may be vertically suspended from a wall or ceiling. It may be so positioned in a corner or in the center of a room. When fitted with legs, floor mounting is feasible and in other cases the sound reproducing device may be hung from a floor pedestal. The

invented item is suitable for inclusion in or with other pieces of furniture or utilitarian articles, such as lamps.

Only one type of highly preferred chamber construction has been described. In other devices the chamber might be of single tubular wall construction with the speakers being slidable within, but this would possess certain inherent disadvantages. When the speakers are moved closer together in such an apparatus the chamber wall shields some of the sound emanating from the convex surface of the speaker and, to some extent, directionalizes it. As a possible alternative in which such disadvantages would be avoided, the chamber might be made of material which is collapsible in accordion style, with the speakers being fixed at the ends.

The invention has been described with particular references to a particular embodiment and a specific type of application but it is evident to one of skill in the art that many other embodiments may be made within the scope of the invention, equivalents may be substituted therein and it may be applied to other kinds of speaker systems, e.g., stereophonic systems. The illustrated embodiment is not to be considered as limiting the invention, the example of the apparatus exemplified by the drawing and description being given only to facilitate understanding of the invention herein claimed.

What is claimed is:

1. A sound reproducing system comprising in combination a closed walled chamber having two ends and a thin-walled enclosure connecting the ends, a plurality of loudspeakers having both concave and convex speaker surfaces, the loudspeakers comprising substantial proportions of the ends of the walled chamber and being so positioned that the concave speaker surfaces at opposite ends of the chamber face each other, and a means for phasing the electrical signals to the speakers so that the vibratile elements of the speakers will be stimulated to vibrate in the same direction in response to a signal.

2. A sound reproducing system comprising in combination a closed walled chamber having two ends and a thin-walled enclosure connecting the ends, both ends and side of the chamber being of material which is substantially impervious to air, a plurality of loudspeakers of conoidal shape, which are mounted at the ends of the chamber with concave ends facing each other, and which cover substantial proportions of the chamber ends, and electrical means for phasing electrical signals to the speakers in push-pull relationship so that the vibratile elements of the speakers will be stimulated to vibrate in the same direction in response to a signal and means for controllably varying the distance between the speakers.

3. A sound reproducing system comprising in combination a thin-walled chamber substantially impervious to air, which chamber comprises two ends and a thin-walled side connecting the ends, a plurality of conoidal woofer speakers mounted at the chamber ends with concave surfaces thereof facing each other, which speakers comprise substantial proportions of the chamber ends, a means for separating electrical signals into higher and lower frequency components, the separation being effected at a frequency between 0.3 and 15 kilocycles per second, a sweeter speaker intermediate the ends of the thin-walled chamber and facing outwardly, means for feeding higher frequency components of the signals to the tweeter speaker and electrical means for feeding the lower frequency signal component to the woofer speakers and phasing the woofer speakers in push-pull manner so that the vibratile elements of the speakers will be stimulated to vibrate in the same direction in response to a signal, with the distance between the vibratile woofer speaker elements at the ends of the chamber being that great enough to cause accentuation of the lower frequency sound.

4. A sound reproducing system comprising in combination a thin-walled chamber substantially impervious to air, which chamber comprises two ends and a thin-walled enclosure connecting the ends, a plurality of conoidal substantially identical woofer speakers mounted at the chamber ends with concave surfaces thereof facing each other, which speakers comprise substantial proportions of the chamber ends, means for separating electrical signals into higher and lower frequency components, the division being effected at a frequency between 0.3 and 15 kilocycles per second, a tweeter speaker intermediate the ends of the thin-walled chamber and facing outwardly, means for feeding the higher frequency component of signals to the tweeter speaker and electrical means for feeding the lower frequency signal component to the woofer speakers and phasing the woofer speakers in push-pull manner so that the vibratile elements of the speakers will be stimulated to vibrate in the same direction in response to a signal, with the distance between the vibratile woofer speaker elements at the ends of the chamber being that between one-half and eighteen inches which causes accentuation of the lower frequency sound.

5. A sound reproducing system comprising in combination a thin-walled hollow chamber substantially impervious to air, which chamber comprises two ends and a thin-walled enclosure connecting the ends, a plurality of substantially identical woofer conoidal loudspeakers mounted at the chamber ends with concave surfaces thereof facing each other, which speakers comprise substantial proportions of the chamber ends, the chamber being extensible and contractable to a multiplicity of fixable positions in which the vibratile elements of the woofer speakers are from one to eighteen inches apart, an electrical cross-over circuit for dividing electrical signals, transformable into audible sound, into higher and lower frequency components at a frequency between 0.3 and 8 kilocycles per second, a plurality of tweeter speakers located intermediate the ends of the thin-walled chamber radiating high frequency sound energy outward from the chamber, means for feeding the higher frequency signal component to the tweeter speaker and means for feeding the lower frequency signal component to the woofer speakers and phasing the woofer speakers in push-pull manner so that the vibratile elements of the speakers will be stimulated to vibrate in the same direction in response to a signal.

6. A sound reproducing system comprising in combination a thin-walled hollow longitudinal chamber substantially impervious to air, which chamber comprises two ends and a thin-walled tubular enclosure connecting the ends, a plurality of substantially identical conoidal woofer speakers mounted at the chamber ends with concave surfaces thereof facing each other, which speakers comprise substantial proportions of the chamber ends, the chamber being extensible and contractable to a multiplicity of fixable positions in which the vibratile elements of the woofer speakers are from one to eighteen inches apart, an electrical cross-over circuit for dividing electrical signals, transformable into audible sound, into higher and lower frequency components, at a frequency between 0.3 and eight kilocycles per second, a plurality of tweeter speakers of conoidal speaker shape located intermediate the ends of the thin-walled chamber and about the periphery thereof, facing outwardly from the chamber, means for feeding the higher frequency signal component to the tweeter speakers and electrical means for feeding the lower frequency signal component to the woofer speakers and phasing the woofer speakers in push-pull manner so that the vibratile elements of the woofer speakers will be stimulated to vibrate in the same direction in response to a signal.

References Cited in the file of this patent

UNITED STATES PATENTS

2,297,972	Mills	Oct. 6, 1942
2,832,843	Miessner	Apr. 29, 1958
2,869,667	Leslie	Jan. 20, 1959
2,872,516	Hoffman	Feb. 3, 1959