June 17, 1958 R. R. PERLMAN 2,839,150

LOUD SPEAKER HAVING MEANS FOR UTILIZING THE BACK WAVE

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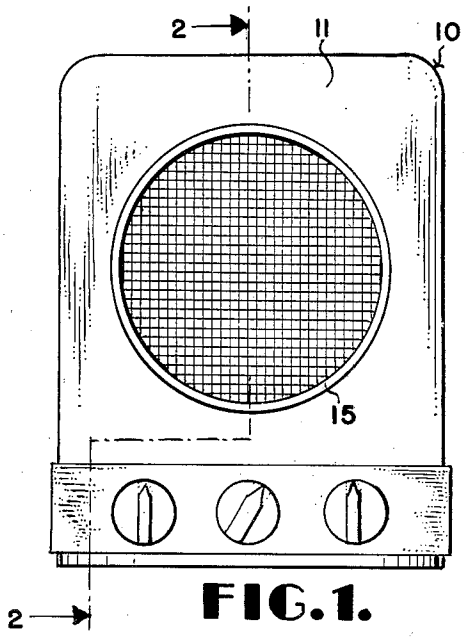


FIG. 1.

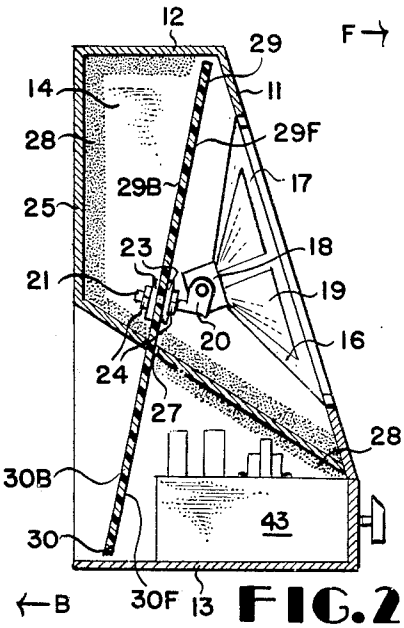


FIG. 2.

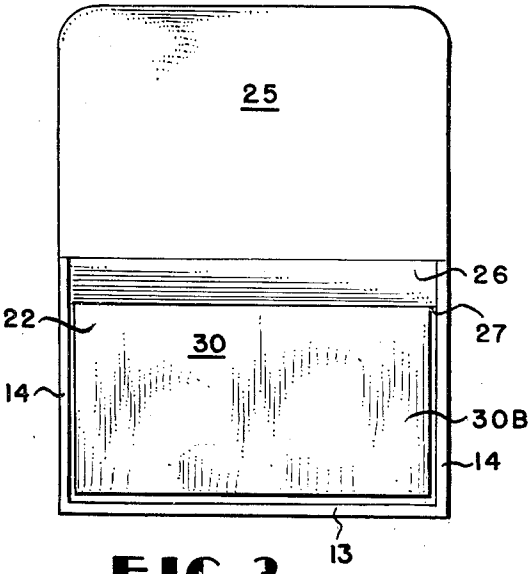


FIG. 3.

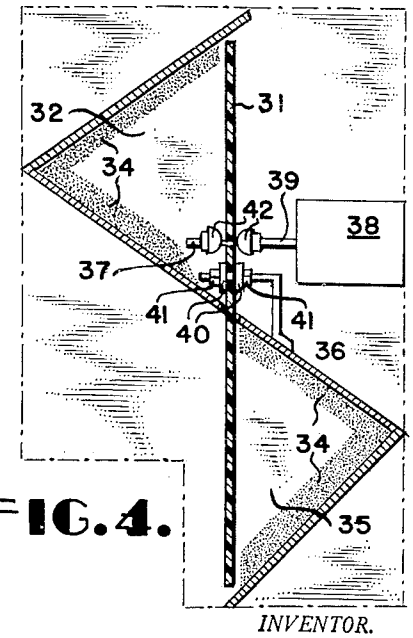


FIG. 4.

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LOUD SPEAKER HAVING MEANS FOR UTILIZING THE BACK WAVE

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4 Claims. (Cl. 181—31)

This invention relates to an acoustical reproducing device and more particularly to an acoustical arrangement adapted to reproduce sound vibrations with a high degree fidelity.

It is an object of this invention to provide an acoustical translating system whereby electrical variations are transformed into corresponding acoustical vibrations over a wide frequency range and with a maximum degree of fidelity.

A further object of this invention is to provide an arrangement of the character indicated wherein both the low and high sound frequencies are reproduced with a high order of efficiency and fidelity and wherein distortions commonly encountered in sound reproducing systems are reduced, minimized or eliminated.

A further object of this invention is to provide an enclosure for a loud speaker of conventional type wherein the efficiency and fidelity of the speaker are considerably enhanced and the sound reproduced thereby is widely dispersed.

A still further object of this invention is to provide a system of the character indicated wherein the sound reproducing device occupies a minimum amount of space and eliminates the necessity for large sized enclosures, baffles or cabinet structures.

It is also an object of this invention to enhance the quality, power, efficiency and fidelity of a loud speaker sound reproducing device.

In the accompanying drawings:

Figure 1 is a front elevational view of a loud speaker system,

Figure 2 is a cross-section of Figure 1 taken along line 2—2 thereof,

Figure 3 is a rear elevational view thereof,

Figure 4 is a cross-section of another form of the invention.

Figures 1, 2 and 3 illustrate an embodiment of my invention wherein the sound reproducing characteristics of a conventional cone-type speaker are improved and enhanced in accordance with the present invention. The speaker enclosure comprises a cabinet designated generally by the numeral **10** having a front panel **11**, a top panel **12**, bottom panel **13** and side panels **14**. Such speaker cabinets are conventional particularly in conjunction with public address, amplifier or other sound reproducing systems. The front panel of the cabinet is inclined with respect to the base and is provided with a circular opening **15** within which a sound reproducing device, such as a cone-type loud speaker, is mounted. The bottom of the cabinet may contain an amplifier **43** or any other piece of electronic equipment associated with the speaker or it may be left empty if desired.

The loud speaker is of conventional form being comprised of a rigid frame **16**, which is secured to the front panel **11** along its outer rim **17**. The frame is secured to a rigid housing **18** which encloses the armature or magnet and voice coil structure of the speaker. A cone type

diaphragm **19** is mounted within the frame and is physically secured to the voice coil within the housing. The loud speaker may be conventional in every respect.

Secured to rigid housing **18** is a bracket **20** having a threaded post **21** extending therefrom to which plate **22** is secured. Plate **22** comprises a rectangular sheet of substantially rigid material which is capable of a small degree of flexure. In the embodiment of the invention herein illustrated the sheet may advantageously be formed of a phenolic resin such as Bakelite, although other similar suitable sheet materials may be employed for this purpose such as plastic impregnated or laminated paper or fabric. Desirable results have been achieved by a plate .02 inch thick. Plate **22** is provided with a centrally disposed perforation through which post **21** extends. Washers **23** which may advantageously be formed of rubber or similar material are disposed on either side of the plate and the plate is clamped therebetween by means of nuts **24**. The plate is thus clamped at its medial or central portion. The use of the rubber washers having been found advantageous in order to impart a small degree of elasticity to the clamping assembly. The plate is substantially rectangular in order to conform to the configuration of the cabinet illustrated herein as will more clearly appear hereafter. It should be noted that plate **22** is mounted substantially parallel to the upper portion of the cone in order to provide efficient acoustical coupling between the cone and the upper half of the plate. Said plate extends diagonally across the enclosure. Cabinet **10** is provided with a rear wall **25** which extends substantially half the distance from top panel **12** of the cabinet. A diagonally extending wall **26** completes the enclosure of the back of the loud speaker and the upper half of the plate. Diagonal wall **26** is provided with a laterally extending slot **27** in order to permit the bottom portion **30** of plate **22** to be extended therethrough. Slot **27** is of sufficient width to provide adequate clearance and permit the free vibratile movement of the plate.

The interior surfaces of the top, back and diagonal walls are provided with a layer of sound absorbent material **28**. There is thus formed an enclosed chamber behind the loud speaker within which the upper half **29** of plate **22** extends. The chamber is provided with sound absorbent material along the walls thereof so as to absorb sound energy within the chamber and to prevent reflection or radiation of the sound energy at the back of the speaker to the outside atmosphere. Sound vibrations set up by the back of the cone are thus transmitted through the air to the forward surface **29F** of plate **22** but are otherwise absorbed by the material on the walls of the upper chamber. The sound absorbent material on the walls of the enclosure absorbs the acoustical energy developed at the back surface **29B** of the upper half of the plate. As a result of this arrangement the upper half **29** of plate **22** is driven by the sound energy generated by the back surface of the cone and vibrations are set up therein which correspond to these sound waves and are in phase therewith.

The effect of the vibration and flexure of the upper half **29** of plate **22** causes a corresponding flexure and vibration of the lower half **30** thereof, but in opposite phase or direction. Thus, as the sound energy causes the upper half of plate **22** to be flexed forwardly in the direction of the arrow designated F in Figure 2, there results a corresponding backward flexure of the lower half of the plate in the opposite direction indicated by the arrow designated B. As the sound energy flexes the upper half of the plate backward in the B direction, the lower half of the plate also reverses its direction and moves forward in the F direction. Thus, as the upper half of

the plate is caused to vibrate in phase with the back wave of the loud speaker cone, the lower half thereof is correspondingly vibrated in opposite or 180° out of phase therewith.

The similar sound absorbent chamber is provided in the lower half of the cabinet facing the opposite or forward surface 30F of the vibratile plate 22. The wall areas facing the interior surface of the lower portion of the vibratile plate are covered with a similar suitable layer of sound absorbent material. The acoustical energy developed by the forward surface 30F of the lower half of the vibratile plate 22 is thus effectively confined and absorbed within the lower chamber or enclosure. It will now be noted that the back surface 30B of the lower half of the vibratile plate is exposed to the atmosphere and is thus capable of developing and radiating acoustical energy in accordance with the vibration thereof. Vibratile plate 22 is of substantially rectangular shape and corresponds in configuration to rectangular shape of the cabinet. The peripheral edges of the plate are spaced from the top, bottom and side walls of the cabinet a sufficient distance to permit the free vibratile movement of the plate thereby confining the sound energy within the cabinet as much as possible and allowing for radiation from the exposed portion of the plate only. The arrangement is such that the upper half of the vibratile plate 22 is provided with a substantially enclosed sound absorbent chamber facing one side thereof while the lower half of the vibratile plate is similarly enclosed in a sound absorbent chamber with respect to the opposing face thereof. The opposing half surface areas of the plate are thus coupled to a source of acoustical energy such as a loud speaker and to the atmosphere respectively.

In the normal operation of a loud speaker it is presently understood that when the speaker cone moves forward or in the direction indicated by the arrow F in Figure 2, the air or atmosphere in front of the cone is compressed and that simultaneously said forward motion of the cone causes a rarefication of the atmosphere along the back surface of the cone. The action is very much in the nature of a piston reciprocating within a cylinder. On the reverse or backward movement of the cone in the direction indicated by the arrow B in Figure 2, this action is reversed and the air in front of the cone is rarefied while the air behind the cone is simultaneously compressed. At long wave lengths the compression wave at the front of the speaker is cancelled by the simultaneous rarefication wave developed at the back of the speaker cone. This effect is well understood in the art and results in a very low efficiency and fidelity in loud speaker operation at low frequencies. In order to reduce or prevent the cancellation of the waves developed at the front and back of a speaker, various expedients have been suggested by the art including extensive baffling arrangements and bass reflex cabinets, in order to achieve the desired reproduction of sound particularly at low frequencies. These arrangements have called for large size baffles or enclosures which often cannot be accommodated in the normal size room.

The instant arrangement overcomes many of the drawbacks of these systems and provides a speaker system capable of efficient, effective and faithful reproduction of sound within practical apparatus and space limitations. This result is accomplished by the instant arrangement wherein one half portion of vibratile plate 22 is acoustically coupled to the back of the cone and the reverse or opposing surface of the other half portion of the plate is coupled to the outside atmosphere. Thus when the speaker moves forward in its compression movement, as viewed by listener indicated by the arrow F in Figure 2, the air between the back of the cone and the upper half of the plate is rarefied thereby causing the upper half portion of the plate to be deflected in the same direction as the movement of the cone. Since plate 22 is centrally clamped at its medial point, the deflection of the upper portion of the plate simultaneously causes the lower portion of the plate to be deflected backward or in the opposing direction as indicated by the arrow B in Figure 2. Thus, the lower half of the vibratile plate simultaneously causes a similar compression wave in the atmosphere at the rear of the cabinet. A simultaneous compression wave is initiated both at the front and rear of the cabinet thus preventing the cancellation effect heretofore referred to with respect to the conventional type speaker arrangements 18. As the cone reverses its movement in the second half of the cycle and develops a rarefication wave with respect to the listener, the deflection of the upper and lower portions of the vibratile plate in opposite directions simultaneously develops a rarefication wave in the atmosphere at the back of the lower half of the vibratile plate, thus reenforcing the second half of the cycle. The employment of the centrally clamped vibratile plate, one-half of which is driven by the acoustical energy developed at the back of the cone, thus results in a 180° mechanical phase inversion of the acoustical energy normally present at the back of a speaker. The arrangement further results in the simultaneous development of compression and rarefication waves in the atmosphere to the front and rear of the speaker system. Additionally, acoustical absorption chambers are provided for preventing the radiation of the undesired or interfering acoustical energy.

The arrangement results in a substantial increase and extension of the low frequency range which the loud speaker system is capable of reproducing. The reproduction of the low frequencies is enhanced and accentuated to produce a more faithful reproduction of the entire frequency band. The use of the rubber washers in mounting the plate results in a soft suspension for the plate which prevents any resonance developing in the plate and permits the use of relatively stiff light plates. Figure 4 illustrates a modified form of the invention wherein a vibratile plate 31 is provided with a direct mechanical coupling to an acoustical driver or motor. One surface of the upper half of plate 31 is located in juxtaposition with an enclosed chamber 32, the interior walls of which are lined with an acoustical absorbing material 34. A similar chamber 35 is located in juxtaposition with the opposing surface of the other half of the vibratile plate and is similarly provided with walls lined with acoustical absorbing material as shown at 34. A bracket 36 is secured to one of the walls of the chamber and is provided with a post 37 which extends through a centrally disposed perforation in plate 31. Washers 40 are positioned on either side of the plate perforation and the plate is clamped therebetween by means of nuts 41. An acoustical motor or driver unit 38 has extending therefrom a drive shaft 39 which passes through an additional perforation in plate 31 and is spaced a small distance from the clamping point. The plate is coupled to the drive shaft by means of hemispherical elements 42 which bear against the opposing surfaces of the plate and are fixedly secured to the drive shaft. The driver may be any source of vibratile energy such as for example the magnetic motor embodied in a conventional loud speaker construction or may be any other type of driver unit as is well known to those skilled in the art. The motor should be rigidly mounted with respect to the enclosure. It should be noted that in this embodiment of the invention, washers 40 need not be of a soft elastic material such as the rubber washers employed in the embodiment of the invention illustrated in Figures 1, 2 and 3, since a completely rigid clamping of the plate can be tolerated when the vibratile plate is mechanically coupled to the source of vibratory energy. Resonant effects being eliminated by the damping characteristics of the motor and its associated electronic equipment. It will be understood that the effective frequency range of

this arrangement may be varied by increasing or decreasing the size of the plate. Thus, for efficient low frequency operation, the size of the plate may be increased whereas plates of smaller dimensions are advantageously utilized for the high frequency ranges.

I have here shown and described a preferred embodiment of my invention. It will be apparent, however, that this invention is not limited to this embodiment, and that many changes, additions and modifications can be made in connection therewith without departing from the spirit and scope of the invention as herein disclosed and hereafter claimed.

Having disclosed my invention, what I claim as new and desire to secure by Letters Patent is:

1. An acoustical system comprising a substantially centrally clamped vibratile plate having exposed half surfaces, a sound absorbent chamber located in juxtaposition with substantially one half surface area of one side of said plate and a second sound absorbent chamber located in juxtaposition with the remaining substantially one half surface area of the opposing side of said plate, a source of acoustical energy coupled to one of the exposed half surfaces of said plate, the other of said exposed half surfaces being exposed to the outside air.

2. An acoutical reproducing system comprising a substantially centrally clamped vibratile plate having exposed half surfaces, a first sound absorbent chamber located in juxtaposition with substantially one half the surface area of one side of said plate, a second sound absorbent chamber located in juxtaposition with the remaining one half surface area of the opposing side of said plate, a source of acoustical energy comprising a loud speaker capable of radiating a forward and a back wave of acoustical energy, one of the exposed half surfaces of said plate being acoustically coupled to said source of acoustical energy so as to be activated by said back wave, the other of said exposed half surfaces being exposed to the outside atmosphere.

3. An electro-acoustical reproducing device comprising an enclosure having a front, top, bottom and side walls, a cone type loud speaker mounted in an opening

formed in the front wall of said enclosure, a substantially centrally clamped vibratile plate extending across the interior of said enclosure having a portion thereof extending behind said speaker, a first sound absorbent chamber in juxtaposition with substantially one half the surface area of one side of said plate and a second sound absorbent chamber located in juxtaposition with the remaining one half surface area of the opposing side of said plate whereby a surface of said first half portion of said plate is acoustically coupled to said loud speaker and a surface of said second half portion is exposed to the outside atmosphere.

4. An electro-acoustical reproducing device comprising an enclosure having a front, top, bottom, and side walls, a cone type speaker having a frame rigidily mounted in an opening formed in said front wall, a rigid housing extending from said frame, a bracket rigidly secured to said housing having a threaded post extending therefrom, a plate extending across the interior of said enclosure and having a substantially centrally disposed perforation therethrough, elastic washers positioned on either side of said plate at said perforation and nuts located at either side of said elastic washers for clamping the plate therebetween, a sound absorbent chamber located behind said speaker, substantially one half portion of said plate extending between said speaker and said sound absorbent chamber, a second sound absorbent chamber in juxtaposition with the remaining half of said plate along the surface thereof opposite to that along which said plate is exposed to said first sound absorbent chamber, the opposing surface of said remaining half being exposed to the outside atmosphere.

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