United States Patent

[11] **3,540,544**

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[21] Appl. No. **703,079**
[22] Filed **Feb. 5, 1968**
Continuation-in-part of Ser. No. 486,392, Sept. 10, 1965, abandoned.
[45] Patented **Nov. 17, 1970**

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[54] **ACOUSTIC TRANSDUCERS**
10 Claims, 25 Drawing Figs.

[52] **U.S. Cl.** **181/31**
[51] **Int. Cl.** **G10k 13/00**
[50] **Field of Search** 181/31.1, 0.5, 31, 27; 179/1

[56] **References Cited**

UNITED STATES PATENTS

1,943,499	1/1934	Williams	181/27
2,643,727	6/1953	Leon	181/31
2,787,332	4/1957	Fulmer	181/31
2,816,619	12/1957	Karlson	181/31
2,856,022	10/1958	Kurtze et al.	181/0.5
2,896,736	7/1959	Karlson	181/30
2,939,922	6/1960	Gorike	179/121

FOREIGN PATENTS

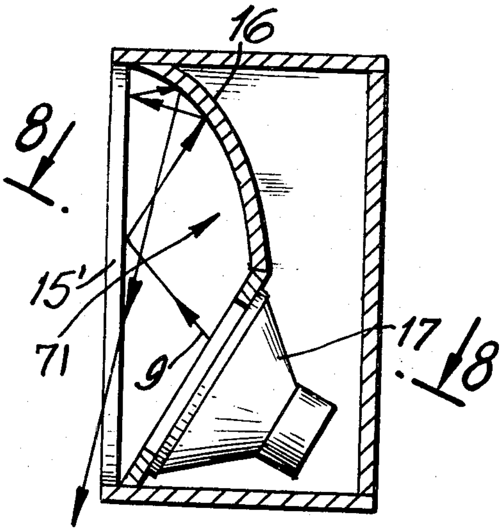
1,137,483	10/1962	Germany	181/31

OTHER REFERENCES

Publication " A New Approach In Loudspeaker Enclosures" by John E. Karlson Audio Engineering Sept.1952 pp.26— 27,58— 61 copy in Unit 282, 181— 31

Primary Examiner—Stephen J. Tomsky
Attorney—Kenyon & Kenyon, Reilly Carr & Chapin

ABSTRACT: This invention is an improvement in acoustic transducers. The improvement is comprised of locating curved surfaces opposite a tapered aperture through which sound waves emanating from a sound source pass.



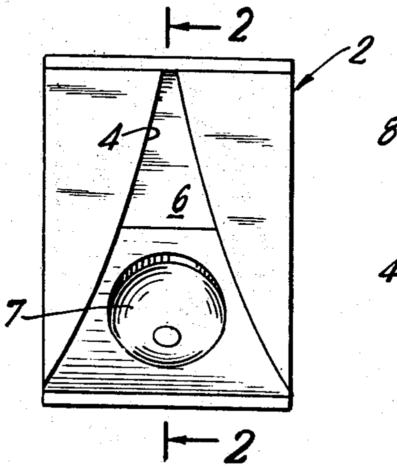


FIG. 1

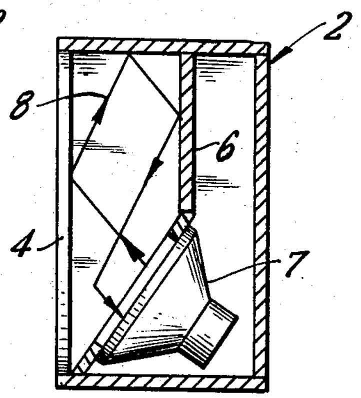


FIG. 2

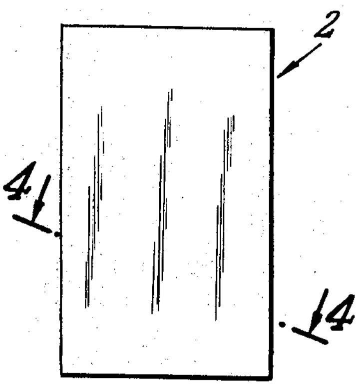


FIG. 1A

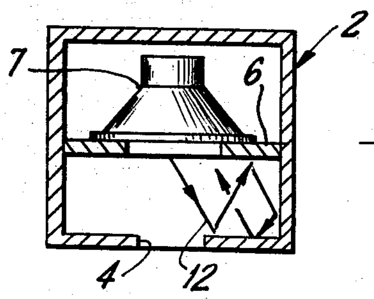


FIG. 4

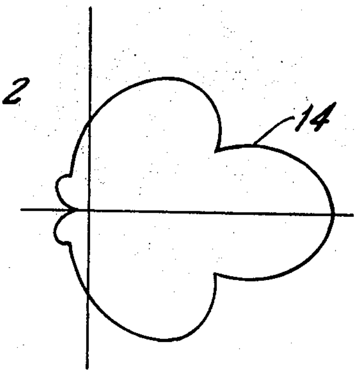


FIG. 5

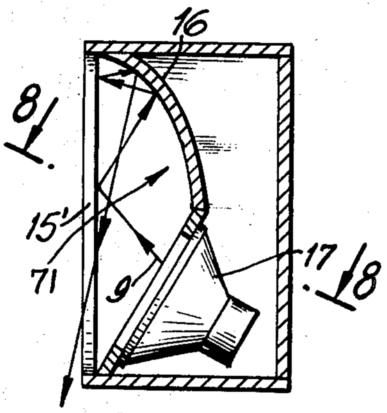


FIG. 6

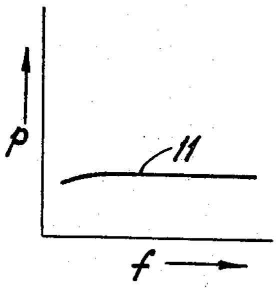


FIG. 7

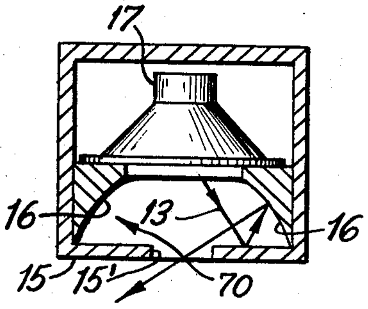


FIG. 8

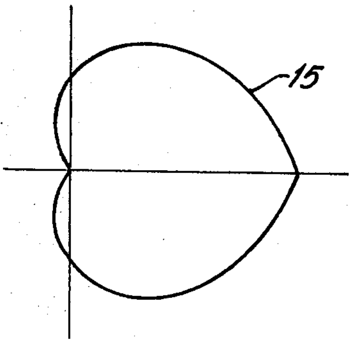


FIG. 9

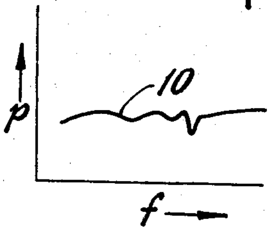


FIG. 3

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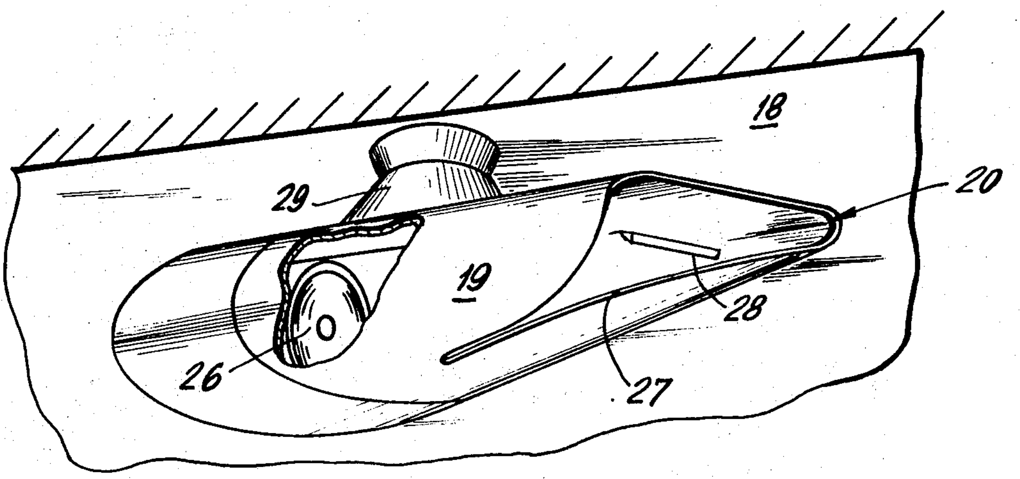

FIG. 10

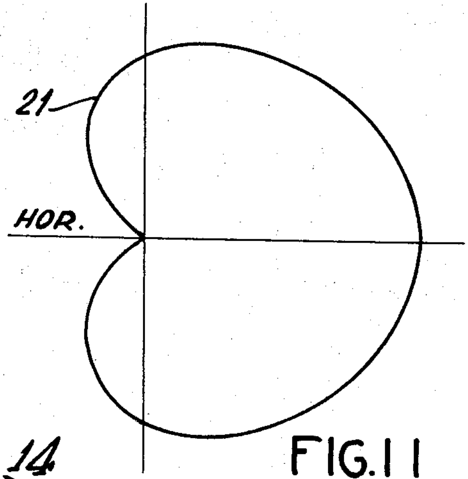

FIG. 11

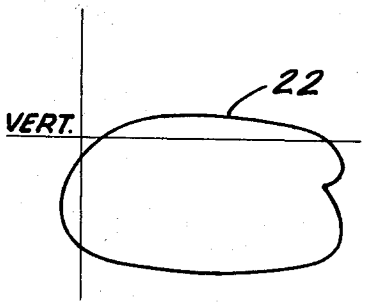

FIG. 12

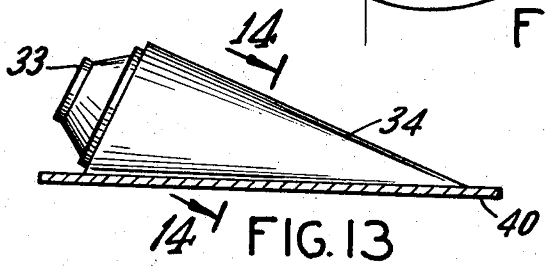

FIG. 13

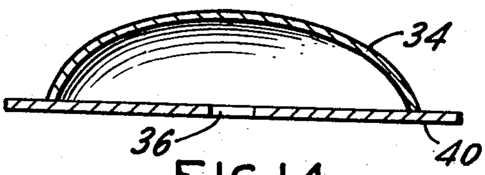

FIG. 14

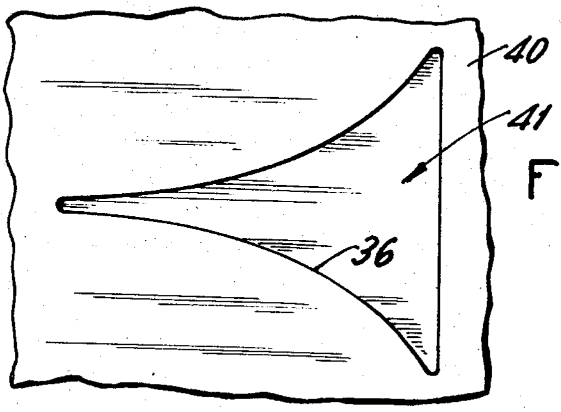

FIG. 15

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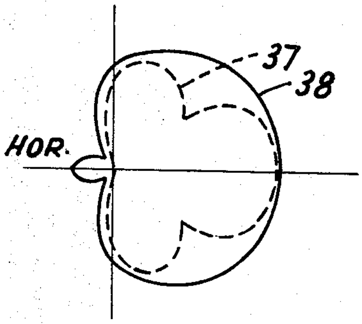

FIG. 16

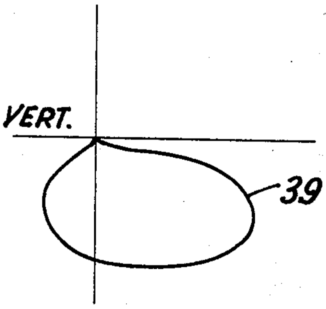

FIG. 17

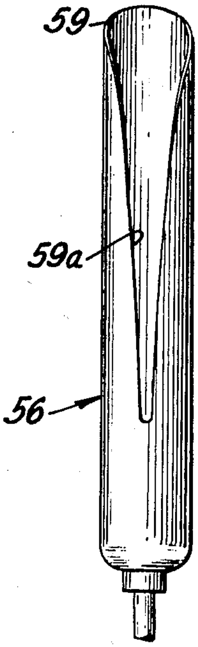

FIG. 18

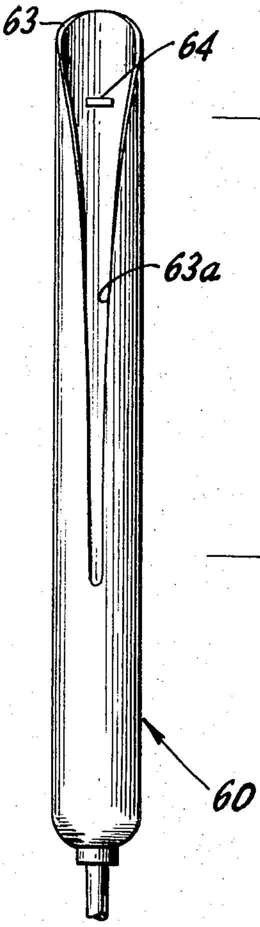

FIG. 19

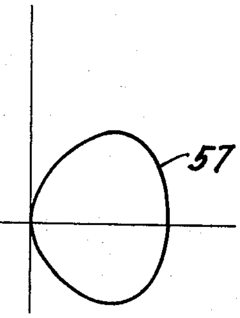

FIG. 20

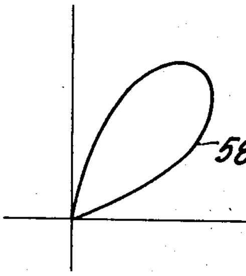

FIG. 21

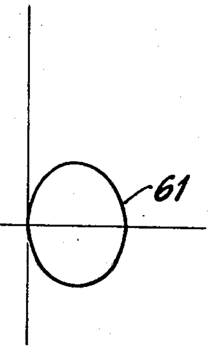

FIG. 22

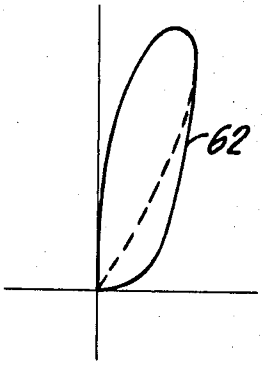

FIG. 23

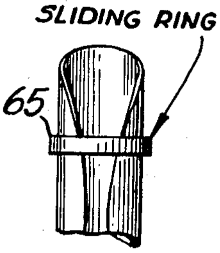

FIG. 24

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ACOUSTIC TRANSDUCERS

CROSS REFERENCES TO OTHER APPLICATIONS

This invention is a continuation-in-part of application Ser. No. 486, 392, **filed Sept.** 10, 1965, **now abandoned by John E. Karlson. Other continuation applications of said application** Ser. No. 486, 392 **are being filed simultaneously with this application and are entitled "Micro-wave Energy Conditioning Device" and "Fluid Flow Energy Conditioning Device."**

FIELD OF THE INVENTION

This invention is directed to the environment of a sound source, and to conditioning sound waves emanating from a sound source. It has been found to have application not only to the transmission of sound, but in structures or assemblies wherein sound waves are being received. The various embodiments depicted by the drawings are representative of some of the structures and assemblies in which this invention has application pursuant to the following teaching.

DESCRIPTION OF THE PRIOR ART

Presently, the state of the art includes the broad concept of applying a tapered aperture in a coupling chamber for loud speakers. This advance is disclosed in U.S. Pat. No. 2,816,619, issued on Dec. 17, 1957 to John E. Karlson.

BACKGROUND AND SUMMARY OF INVENTION

My invention relates to an energy transducer for use in the projection and reception of sound. Such transducers are normally called sound projectors, or speakers and microphones. Many such transducers are applicable to dual use in that they are adaptable to both the projection and reception of energy. Included in such dual use transducers are paging-talk back speakers. In the use of such devices it has been found that the projection and reception patterns are largely identical for a given structure and wavelength. Different structures yield different dispersion patterns and as a consequence we find a wide variety of speaker horns designed to yield specific dispersion patterns. It is the object of my invention to provide a new and simple basic structure which has the advantage of a unique and rarely attained dispersion pattern together with a wide and smooth frequency response and efficient transfer of energy in both directions. My experiments, analysis, and study of these structures has now shown that their performance in different energy forms is remarkably similar, to the extent that some used for sound may also be used for microwaves and vice versa, and their performance with the same wavelengths are largely identical.

The invention of this application is an improvement on my previous invention on acoustic transducers, U.S. Pat. No. 2,816,619 issued Dec. 17, 1957. It is different in that it provides a new and extended utility for transducers characterized by the tapered apertures shown in the accompanying FIGS. and also discloses new techniques and structures which considerably improve the performance; and simplifies the design, engineering, and manufacturing of different models of this invention. The predictable results made possible by this invention also eliminates the need for expensive cut and try methods in meeting critical applications. By means of these disclosures skilled mathematicians can set up the required relationships in a computer and have fundamental outlines for the exact dimensions of various other specific embodiments quickly traced for a wide variety of applications.

In particular, this invention uses curved focusing walls to considerable advantage over the multiplicity of flat panels used in the previous invention of said U.S. Pat. No. 2,816,619. Although, in view of my present developments it is relatively obvious that curved internal walls can be used in this previous invention, there is no disclosure of this since this was not then understood and, of course, no disclosure on the specific curvatures in the internal chamber that would be most advantageous, nor how they would be best applied, or that they could or should be helpfully applied.

The problem solved by this invention has been my most complex problem in the application and use of my patented acoustic transducer and the disclosures presented herein are the result of a final realization of the fundamental requirements for such a solution. The rate of flare in the tapered aperture and its relationship to the length and width of the enclosed chamber still provides the most fundamental requirement for broad band response. Although practicable results have been obtained under the disclosures of my previous patent, more perfect and extended applications are made possible with this invention, which are an improvement.

In the application of this tapered aperture with different forms of coupling chambers it was found that the use of a multiplicity of flat panels in these chambers always presented the possibility of transverse or longitudinal resonances between these panels. In addition, direct reflections into the speaker from such walls would serve to reinforce the output at some frequencies and reduce it at others, depending upon their phase relationship with the speaker motion. Correcting these defects was difficult, expensive, time consuming, and often only partially effective. Obviously, a clear cut and comprehensive solution was highly desirable. The answer to this problem came after it was realized that properly proportioned elliptical curvatures in the front chamber (see FIGS. **6** and **8**) would provide the answer.

The narrowness of the pattern in the vertical plane is quite readily controlled by varying the length of the tapered aperture of this invention. (FIGS. **10—27**) The longer the length of this tapered aperture, the more directive or narrow this dispersion pattern (FIGS. **12—22**) becomes in the plane passing through the axis of this tapered aperture and at right angles with the surface in which this tapered aperture occurs. In this plane, this radiating coupler acts like many others in that as frequency is increased the pattern becomes progressively narrower. By controlling the rate of taper and adding reflective sections (FIGS. **10—28**) in the coupler, the intensity along a given surface or depth can be made remarkably uniform as indicated in FIGS. **12—22.**

When the dispersion in the relative horizontal plane is as broad as shown in FIGS. **11—21**, then very large areas can be covered with maximum efficiency and effectiveness. Attaining such broad dispersion at relatively high frequencies has been characteristically a difficult and troublesome problem for the entire art for many years, and many different approaches have been tried in an attempt at a solid and simple solution. As originally explained in my U.S. Pat. No. 2,816,619, sound projected through the tapered aperture is dispersed very broadly as shown in FIGS. **8—14.** Experience with several practical designs using this tapered aperture has shown that this broad dispersion is often accomplished by a series of lobes of relatively uniform amplitude. As a result the dispersion at some frequencies is not as uniform as desired, even if it is superior to competitive approaches. After a study of this problem it was realized that this condition was due to internal reflections between the flat side walls in the coupler which at some angles served to prevent the release of energy. In correcting this condition it was found that the dispersion pattern could be improved and modified considerably by the use of different curvatures in the internal walls adjacent to and opposite the tapered aperture. The broadest and most uniform dispersion patterns occurred with the use of curvatures approximating an ellipse as shown in FIGS. **10—20.** Narrower patterns will result if parabolic curvatures are used in the internal walls opposite the tapered aperture and a gradually diminishing cross section is used such as is found in the conventional horn. In view of my work, these results are again predictable in any particular design by a detailed study of the reflections within the coupler at all angles included in the plane being studied. Such problems can be most readily resolved through the use of a computer, but are also amenable to careful and painstaking design, as will be apparent to men skilled in the respective arts after study of this disclosure.

SUMMARY OF THE INVENTION

It is an object of the present invention to improve the dispersion pattern of sound waves which pass through the tapered aperture described and claimed in U.S. Pat. No. 2,816,619.

It is a further object of the invention to improve frequency response uniformity and smoothness in the various applications described and referred to herein.

The optimization of sound wave dispersion is achieved by providing a curved surface opposite the wall which has a tapered aperture through which sound waves are passing. The advance of this invention is a provision of a curved structure rather than a flat surface opposite the tapered aperture. A great variety of structures and assemblies can be built to include the tapered aperture through which sound waves pass. The precise curvature for the wall surfaces opposite the tapered aperture can be varied for each application to achieve optimum reflection characteristics for the sound waves preferably within the large environment and, for example, room or auditorium for such, and such variation as is desirable for perfection but not necessary to realize the improvement of the present invention, must be made on an empirical basis after installation of that structure based upon measurement of results obtained in the room in which that structure will operate. The curvature for the presently preferred embodiment of this invention is shown in the drawings, but it is expected that with further experience, and in accordance with my development, additional improvement may be possible.

DESCRIPTION OF THE DRAWINGS

The invention will be described further by way of example with reference to the accompanying drawings wherein:

FIG. 1 is a front view of a prior art acoustical coupling chamber enclosure provided with a tapered aperture opening;

FIG. 1A is a right side view of FIG. 1;

FIG. 2 is a sectional view of FIG. 1 along lines 2–2.

FIG. 3 is a drawing of a graph plotting the wave front emanating from the prior art acoustical coupling chamber;

FIG. 4 is a sectional view of FIG. 1A taken generally along lines 4–4;

FIG. 5 is a graph display of the wave front leaving the prior art coupling chamber;

FIG. 6 is a sectional drawing of an acoustical coupling chamber based on the FIG. 1 device but modified according to the present invention to incorporate the curved surface reflecting panels thereof;

FIG. 7 is a graph display of the wave front emanating from an acoustical coupling chamber having the curved surface panels of the subject invention, especially as shown in FIG. 6;

FIG. 8 is a sectional view of FIG. 6 through lines 8–8;

FIGS. 6 and 8 show an acoustic coupling chamber, or acoustic transducer designed to provide a flat response over a very wide band of frequencies. It uses compound elliptical curvatures to overcome problems of resonance and antiresonance due to reflections from the side and end walls of this chamber interacting with the speaker. These curvatures also improve the dispersion characteristics of this chamber.

FIG. 9 is a graph display of the wave front being released from the coupling chamber having the curved panels of the subject invention, especially as shown in FIG. 8.

FIG. 10 is a perspective view of another acoustical chamber. This FIG. shows a sound projector, which may also be used as a sound pickup, that is specially designed to cover large areas with very exceptional uniformity and efficiency. Elliptical curvatures are again used to improve the smoothness of response and the broad dispersion of the high frequencies. Increasing the length of the tapered aperture increases the narrowness of the pattern in the vertical plane. Essentially the same design may be used as an underwater sound projector-receptor. In this case an underwater sound generator and receptor is used instead of the speaker (FIGS. 10—16). This combination is also capable of covering very large areas efficiently.

FIG. 11 is a graph display of a broad dispersion pattern emanating from the acoustical chamber of FIG. 10;

FIG. 12 is a graph display of the dispersion pattern as modified by the incorporation of reflective surfaces 28 shown in FIG. 10;

FIG. 13 is a side view of a flush mounting sound projector for use in ceilings and walls. It is used to provide uniform sound coverage over much larger areas than conventional ceiling speakers, which beam the sound directly downward rather than horizontally as shown.

FIG. 14 is a sectional view of FIG. 13 along lines 14–14;

FIG. 15 is a bottom view of the flush mounted sound projector illustrated in FIG. 13;

FIG. 16 is a graph showing of the dispersion pattern of sound emanating from the sound projector of FIG. 13;

FIG. 17 is a graph display of the dispersion pattern showing the vertical dispersion pattern emanating from the speaker of FIG. 13;

FIG. 18 illustrates a front view of a microphone provided with the curved surfaces of the subject invention;

FIG. 19 shows a front view of the microphone of FIG. 18 having incorporated therein a small reflective wall 64;

FIGS. 18 and 19 show practicable designs for microphones to be used for improving the fidelity and picking up sounds at comparatively large distances from the microphone.

FIG. 20 shows the dispersion pattern emanating from the microphone of FIG. 18 in a horizontal plane;

FIG. 21 shows a graphic display of the dispersion pattern emanating from the microphone of FIG. 18 in a vertical plane;

FIG. 22 shows a dispersion pattern emanating from the microphone of FIG. 19 in a horizontal plane;

FIG. 23 shows a dispersion pattern emanating from the microphone of FIG. 19 in a vertical plane; and

FIG. 24 is a front view of a microphone with a tapered aperture and a sliding ring.

DESCRIPTION OF PREFERRED EMBODIMENT

As best seen in FIG. 1, an acoustical coupling chamber 2 having a speaker 7 mounted therein is provided with a tapered aperture 4 through which the sound waves pass and are dispersed. This is a prior art showing of an acoustical coupling chamber incorporating the tapered aperture disclosed and claimed in U.S. Pat. No. 2,816,619 (Karlson).

This design, while providing an improvement in the dispersion of sound waves, was found to generate reflective sound waves 8, seen in FIG. 2, when used in combination with flat back panel 6. The reflective wave 8 of the prior art device provided a wave front which appears in graph form as line 10 shown in FIG. 3.

Similarly, transverse reflections 12 seen in FIG. 4 create an imperfect dispersion pattern as shown in FIG. 5 by the multiple lobes generated by plotting line 14.

It has been found by the inventor that the provision of a curved panel or baffle arranged to extend from the speaker 17 to the front panel 15, in which tapered aperture 15′ is located, will effect an improved dispersion pattern. In the preferred embodiment illustrated in FIGS. 6 and 8, concavely curved panels called baffles 16 extend from the speaker 17 to the front panel 15. Baffles 16 are suitably curved so as to reflect sound waves in the direction of the aperture 15′, and across the frontal surface of the speaker 17. The specific curvature of the baffles 16 is a function of the desired dispersion pattern, and may be readily determined by men skilled in the art in light of the teachings of this specification. The curves may be constructed as illustrated, with a sound reflective side baffle or curved surface as shown at 70 and an upwardly extending sound reflective baffle or curved surface as shown at 71. It is understood that an important aspect of the baffles is their sound reflecting surface.

Waves 9 (seen in FIG. 6) and waves 13 (seen in FIG. 8) display the paths which the sound waves emanating from speaker 17 take when provided with parabolic or curved reflecting panels or baffles 16, shown in FIGS. 6 and 8. FIGS. 7 and 9 show the improved wave front along line 11 and horizontal dispersion pattern along line 15 resulting from the use of the curved baffles 16 in combination with the tapered aperture 14.

FIG. 2 illustrates what happens when straight panels 6 are used. At some frequencies and directivities the wave fronts 8 will reflect back into the speaker 7 to either reinforce or reduce the output.

FIG. 3 illustrates the effect of this condition on the frequency response. Conversely, FIG. 6 illustrates a satisfactory wave front 9 in an elliptically curved front baffle 16. Its final directivity is across the speaker rather than into it, therefore not changing the speaker output. The improvements in the frequency response are shown in FIG. 7.

These improvements are very important for the midrange frequencies where our ears are most sensitive and the dimensions of the chamber and the wavelengths involved are of the same order of magnitude. At the very low frequencies, relative to the size of the front chamber, these directivities are no longer critical since the reflected energy only serves to create higher back pressures against the speaker and therefore enables it to deliver more energy into the air. The lower the frequency, the more effective this back pressure becomes. At the very high frequencies these reflected wave fronts have relatively little influence on the speaker output, since the radiating areas (tweeters) for these frequencies are usually very small, and the probabilities of having direct reflections into such small areas are commensurately reduced.

FIG. 6 indicates how an elliptical quadrant curvature in longitudinal dimension of the front chamber makes it possible to have substantially all such reflected wave fronts directed across the speaker.

FIG. 4 also illustrates a similar problem with transverse reflections 12 in the area of the coupling chamber. Again note that reflections readily occur which can affect the performance of the speaker. FIG. 8 shows how a semi-elliptical curvature in this dimension is also effective in avoiding undue resonances and antiresonances. Another advantage of using elliptical curvatures in the transverse dimension is that of better high frequency dispersion. Where wave fronts are released from the coupling chamber in a nonuniform manner, variations in the form of multiple lobes, shown by line 14, will occur as shown in FIG. 5. When corrected by the use of properly curved structures 16 in this dimension, this pattern will approach that shown by line 15 of FIG. 9. In many applications this improvement is of considerable importance. The value of knowing exactly what curvatures are needed for optimum performance is very great where critical applications need such performance and where the size of the coupling chamber used makes it impossible to use flat panels, each individually adjusted to give optimum performance. This is particularly true in tooling up for the production of very small speaker assemblies approximating even the size illustrated to full scale in FIGS. 1 and 1A.

Another acoustical coupling chamber (see FIG. 10) has been developed effecting much the same beneficial dispersion result achieved with the acoustical chamber of FIGS. 6 and 8. The chamber, moreover, may be adapted to an underwater sonar unit. The housing 19 is pivotally mounted by trunnion 29 to an appropriate ceiling or wall, or hull, 18. The loudspeaker or sonar device 26 is arranged in the rear of housing 19 and directs its sound waves through tapered aperture 27 located in housing 19. In order to effect a fuller dispersion pattern close into the coupling chamber, reflective sections 28 may be provided as shown. As seen in FIGS. 11 and 12, the combination of a broad elliptical opening 20 in housing 19, tapered aperture 27, and a reflective section or sections 28, will afford a broad dispersion pattern in the horizontal plane as shown along line 21, and in the vertical plane as shown along line 22. In this coupling, curved surfaces behind the tapered aperture prevent the capture of waves, with resultant discontinuity of dispersion pattern.

FIGS. 10—12 show how an end-driven tapered aperture coupler may be used to considerable advantage for applications where unusually broad uniform coverage is required in the projection of sound into large areas. By substituting an underwater transducer in place of the loudspeaker similar structures may be used wherever this type of coverage is of value in underwater sound or sonar. Such structures may be mounted to a ceiling or the hull of a ship by a suitable pivotable mounting 29 and when used as an underwater projector-receptor this pivotable mounting may be servo controlled for remote control positioning. Vertical wall mountings, and a variety of portable mounts, of course may also be used.

Another acoustical coupling chamber is shown in FIGS. 13—15, wherein a speaker 33 is mounted in a curved housing 34 recessed above ceiling 40. The sound waves of speaker 33 are directed through tapered aperture 36, best seen in FIG. 15, and are reflected therethrough in an optimum dispersion pattern by the curved surface 35 of housing 34, seen in FIG. 14. As shown in the graph of FIG. 16, the dispersion pattern in the horizontal plane is broad as shown by line 38, while a flat reflective surface generates a dispersion pattern as illustrated along the dotted lines indicated by detail number 37. FIG. 17 shows the vertical dispersion pattern resulting from the design of a speaker arranged as shown in FIG. 13, having curved reflective surface 35 and tapered opening 36.

Another acoustical coupling chamber according to this invention is shown in FIGS. 18 and 19, particularly adapted for microphones 56 and 60 as shown, and provided with the curved surfaces as taught herein.

The dispersion pattern for the sound waves, or sensitivity pattern for the microphone, of FIG. 18 is shown in the graph at detail 57 of FIG. 20 (horizontal) and the graph at detail 58 of FIG. 21 (vertical).

The graphs, particularly the vertical graphs, are different because the coupling chambers are of different lengths. Increasing the length of an acoustical coupling chamber shaped as shown in FIG. 18 (or FIG. 19) which has tapered aperture 59*a* (or 63*a*) will narrow the pattern in the vertical plane, as shown in contrasting detail line 58 of the graph shown in FIG. 21 with detail line 62 of the graph shown in FIG. 23. Some narrowing in the horizontal plane may also result from so increasing the length. This can be seen by contrasting line 57 of FIG. 20 with line 61 of FIG. 22.

It is recommended that the longer length acoustical chamber microphone or loudspeaker be provided with a reflective wall or projection 64.

In a practicable microphone design which uses the reciprocal of the improvement in dispersion control, the curvatures within the tapered aperture serve to present the release of energy after it has entered the tapered aperture. This applies specifically to the plane in which the broadcast pickup pattern will not be completely uniform as in a single broad lobe, but rather it will resemble the multilobed pattern shown in FIGS. 5—14 and FIGS. 16—37. Since a microphone of this type will have a broad pickup pattern in the horizontal plane and a relatively narrow pattern in the vertical plane, it will have the ability to pick up sounds over much larger areas than the conventional microphones. This will be particularly true if the pickup pattern resembles that in FIGS. 20 and 21 and FIGS. 22 and 23. Under such conditions, the concept that the strength of a signal varies inversely as the square of the distance must be modified. This law is based on the fact that as energy is released from a source, the energy density in a given area projected to a more distant area will normally decrease as the square of the distance since the projected area will usually be enlarged at the same rate. This is true when the projected area is increased in two dimensions simultaneously but if the increase in the projected area is linear in one dimension only, then the increase in the projected area varies directly as the increase in distance and consequently the strength of the signal will vary directly as the inverse of the distance. In FIG. 12 we see a condition where the latter concept has been found to hold for the relatively high frequencies in acoustical work. The depth of the pattern at the source is substantially the same as at a distance from the source; therefore the dimension of height remains a constant, while the horizontal pattern expands in a linear pattern (fashion). As a result we now have a condition where the strength of the signal will vary directly as the inverse of the distance rather than inversely as the square of the distance. When this holds, the projection or reception of signals into or from a given area included in this pattern will be remarkably uniform. For example, the difference in signal strength where these conditions apply between 50 and 100 feet is only 3 db (at one-half power) which in sound is a barely audible difference, in level. Under normal conditions where the level decreases as the square of the distance, the difference will be one-fourth the power level, or 6 db, which is a definitely discernable difference in level. At 200 feet the former signal would be reduced to one-fourth the original level. Whereas with the normal decrease in signal strength the reduction would be one-sixteenth the level, or down 12 db, which can easily be the difference between a satisfactory and unsatisfactory listening level.

FIG. **19** shows a small reflective wall **64** introduced into the coupler at a position determined primarily by test. A preferable embodiment is as shown in FIG. **10** (also FIG. **19**). When necessary this small reflective wall can be included for its function of augmenting the level at close ranges to the microphone so that the uniform levels of pickup may be accomplished as shown in FIG. **12** (also FIG. **23**). Normally when the acoustical coupler is lengthened to provide highly directive beams the strength of signals at substantially 90° from the axis of such beam projection requires such augmentation by the reflective wall in order to achieve these relatively uniform levels at a constant depth of height below the coupler. The same results may also be obtained by changes in the normal rate of flare in the tapered aperture as shown or through more gradual discontinuities in the walls internal to this aperture as shown. In any event the principle is the same. Enough energy is reflected downwardly (for example) by the device employed to meet the pickup or dispersion pattern (with projectors) requirements of a specific application. Such applications could include microwave antennas and underwater projection and detection equipment.

Note that in FIG. **18** and FIG. **19** microphones of two different lengths are shown. This is to illustrate how increasing the length of the coupling sections will automatically narrow the pattern in the vertical plane as shown in FIG. **21** and FIG. **23**. Some narrowing in the horizontal plane may also be accomplished by the same means as shown by FIG. **20** and FIG. **22**. Further narrowing in the horizontal plane can be accomplished by the use of partially parabolic cross sections, whereas the broadest patterns in this plane will result with the use of elliptical cross sections as shown by FIGS. **18—59** and **19—63**. The narrowness of the patterns and the greater coupling sensitivity to the microphone element afforded by this means makes such microphone assemblies unusually sensitive to sound pickup. In addition, they show a marked improvement in fidelity and definition. The question of what is the effective length of a chamber may well be raised in determining whether or not this particular invention will apply to a given structure. This is especially true where narrow or confined sections may enter into what is obviously an integral part of the main chamber relative to its general contour. In such instances the length of a chamber as described in this invention may be defined as the distance from the position where the widest portion of the tapered aperture occurs (near the end) to the position where the prevailing continuity of said chamber ends.

In some instances it may be desirable to modify the frequency response of the microphone for the purpose of eliminating feedback. This can be done by the addition of a sliding ring **65** fitting over the microphone as shown in FIG. **24**. When feedback occurs it is only necessary to move this ring to some position along the tapered aperture until feedback is either sharply reduced or eliminated. This operates by reason of the selective frequency action of this ring cover for the tapered aperture. The pickup sensitivity of this aperture is greatest where the length from the closed end to the area of the aperture in question is equal in length to one and one-quarter the longest wavelength of the incoming sound waves.

In the foregoing discussion and drawings an attempt has been made to disclose the acoustical coupling constructions which have been found to produce more informative and better shaped dispersion patterns of sound within the most important and noticeable frequency spectrum. Many experiments have been conducted which establish as a practical matter the results described herein are achieved. There has been in addition an attempt made to set forth the present best understanding why and how this coupling operates to achieve these advantages. It should be understood that the phenomena are difficult of precise understanding and not completely understood. These discussions are included in an effort to give those skilled in the art the full benefit of the present thinking with the understanding that it is to be expected that with additional experimentation, data and analysis, some of this understanding will quite possibly prove to be inadequate and in need of modification.

I claim:

1. In an acoustic transducer having a sound source for propagating sound waves, a plurality of walls adjacent said sound source forming an enclosure, and a single substantially triangular opening formed in one of said walls to serve as a passageway for the sound waves from said sound source, said triangular opening extending longitudinally of the enclosure, the longitudinal dimension of said triangular opening constituting a major portion of the longitudinal dimension of said enclosure and the greatest transverse dimension of said triangular opening constituting a major portion of the transverse dimension of the enclosure, said sound source being located relative to said triangular opening so that the face plane of said sound source through which the sound waves are propagated lies at an acute angle to the plane of said triangular opening so that a gradual release of energy is effected through said triangular opening along its longitudinal dimension, and the enclosure being constructed with said triangular opening being adapted to constitute and function as the passageway through which substantially all of the energy from the sound source passes the improvement comprising baffles disposed in the enclosure and having concavely curved sound reflective and focusing surfaces facing said triangular opening thereby enabling improves sound wave dispersion and frequency response.

2. In an acoustic transducer having a plurality of walls forming a sound chamber, a sound source situated for projecting sound waves within said chamber, an elongated opening formed in one of the walls for the escape of sound waves from said sound source, said elongated opening being relatively narrow at one end and relatively wide at its opposite end, the length of said elongated opening constituting a major portion of the length of the chamber and the width of said elongated opening at its relatively wide end constituting a major portion of the width of said chamber, said sound source being located relative to the ends of said elongated opening so that the face plane of said sound source past which the sound waves are propagated lies at an acute angle to the plane of said triangular opening so that a gradual release of energy is effected through said elongated opening along its length, and said sound chamber being constructed so that said elongated opening is adapted to constitute and function as the passageway through which substantially all of the energy from said source passes; the improvement comprising at least one baffle disposed adjacent to said sound source and situated for directing sound waves within the sound chamber and having a concavely curved sound reflective surface facing said elongated opening and extending from adjacent to said sound source generally toward and substantially to adjacent the wall in which the

elongated opening is formed thereby enabling improved sound wave dispersion and frequency response.

3. In an acoustic transducer having a sound source, a plurality of walls adjacent said sound source forming an enclosure, a single tapered opening formed in one of said walls which serves as a passageway for the sound waves from said sound source, said tapered opening extending along a major portion of the length of said enclosure and its greatest width constituting a major portion of the width of said enclosure, said tapered opening being adapted to constitute and function as the passageway through which substantially all of the energy from the sound source passes, and said sound source being so located relative to the tapered opening and the rate of taper of said tapered opening being such that substantially equal amounts of energy are released for equal increments of distance along the longitudinal dimension of said tapered opening; the improvement comprising at least one baffle disposed in the sound chamber and having a concavely curved sound reflective surface facing said elongated opening and extending from adjacent to said sound source generally toward and substantially to adjacent the wall in which the tapered opening is formed thereby enabling improved sound wave dispersion and frequency response.

4. The acoustic transducer of claim 3 wherein the concavely curved baffle is substantially elliptical in curvature.

5. In an acoustic transducer including a sound source disposed in an enclosure having a plurality of walls, with a wall opposite the sound source having a tapered opening extending along the major length of said wall, the improvement comprising concavely curved sound reflective and focusing baffles extending between the sound source and said wall disposed opposite the sound source thereby enabling optimum reflection characteristics for the sound waves emanating from said sound source.

6. The acoustic transducer of claim 5 wherein the concavely curved baffles are substantially parabolic in curvature.

7. An acoustic transducer comprising:

an enclosure formed of a plurality of walls, with one of said walls having an elongated, tapered opening therein;

a sound source situated within said enclosure; and

a plurality of concavely curved sound reflective baffles also situated within said enclosure, and extending between said sound source and the said one of said walls having an elongated, tapered opening therein, a side baffle extending to adjacent the tapered side edges of said tapered opening and a top baffle extending to adjacent the apex of such tapered opening, with the concavely sound reflective curved surfaces of said baffles facing said tapered opening whereby the baffles reflect sound waves in a direction generally transverse to the sound waves emanating from said sound source and generally toward the elongated, tapered opening.

8. In an acoustic transducer having a chamber mounting a sound device and having a plurality of walls providing a substantially closed chamber about the face of said sound device, a single aperture in said chamber, said aperture being tapered, said aperture extending along a major portion of the length of said chamber, with the narrowest part of said tapered aperture being a minor portion of the width of the chamber at the point where said narrowest part is located and the widest portion of the tapered aperture being a major portion of the width of said chamber at the point where said widest portion is located, the improvement thereof in conditioning the sound propagated within said chamber that comprises a sound focusing baffle means having concavely curved walls which direct the sound within the chamber between said tapered aperture and said sound device to improve the dispersion and frequency response characteristics of said acoustic transducer.

9. An acoustic transducer as in claim 8 wherein said baffle means are substantially elliptical in curvature.

10. An acoustic transducer as in claim 8 wherein said baffle means are substantially parabolic in curvature.