

July 4, 1933.

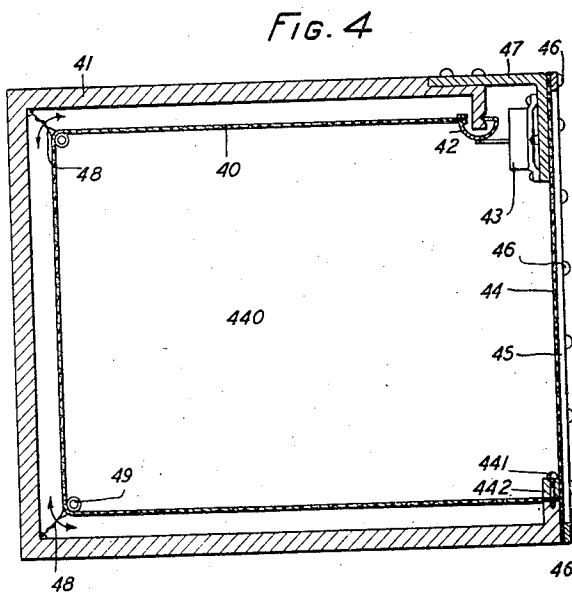
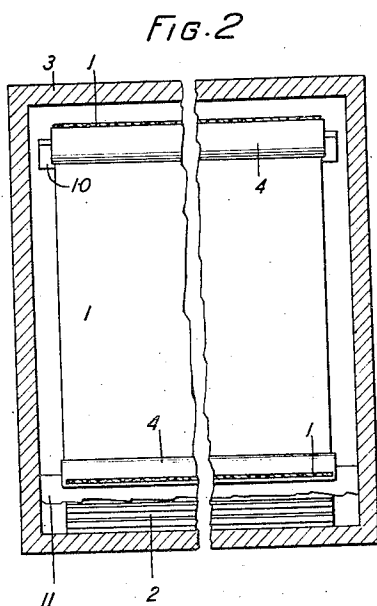
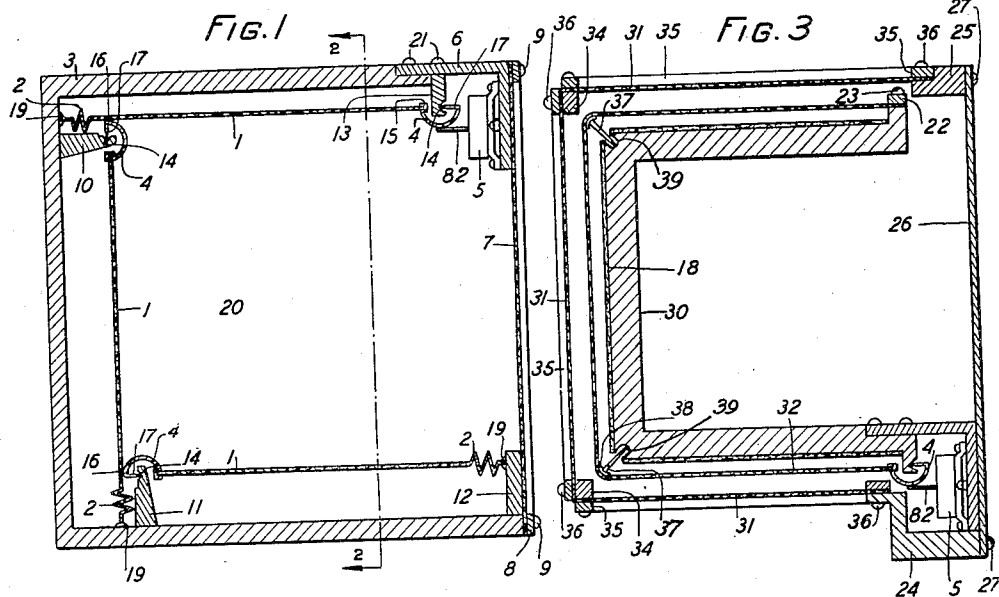
E. H. SMYTHE

1,917,072

ACOUSTIC DEVICE

Filed July 15, 1930

2 Sheets-Sheet 1



INVENTOR
E. H. SMYTHE
BY
Walter C. Kiesel
ATTORNEY

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E. H. SMYTHE

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2 Sheets-Sheet 2

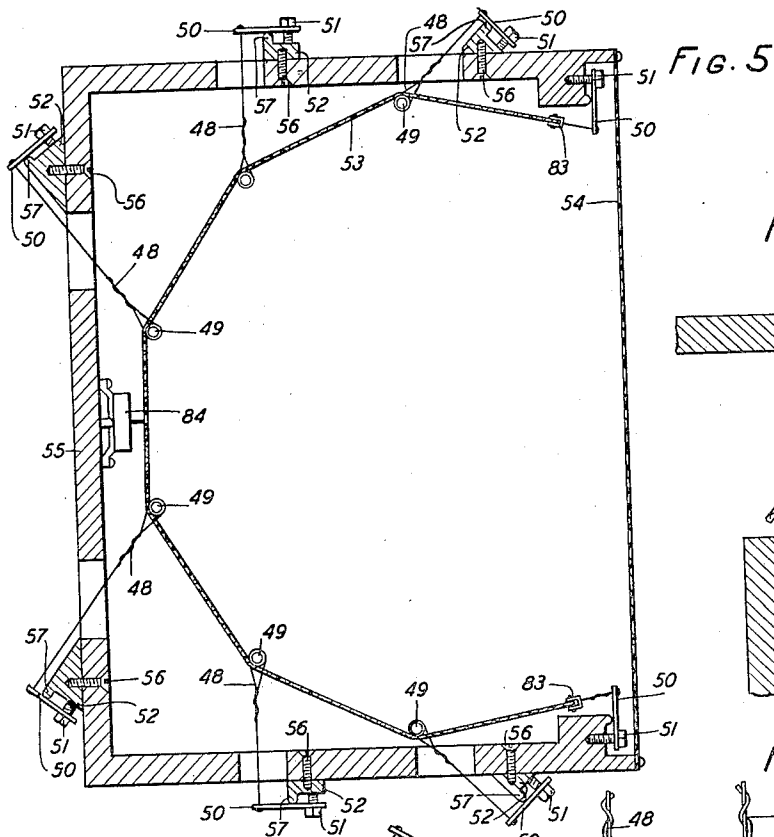


FIG. 7

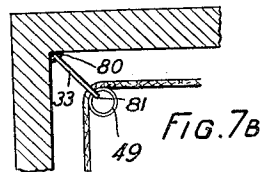
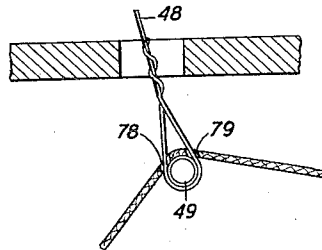


FIG. 7A

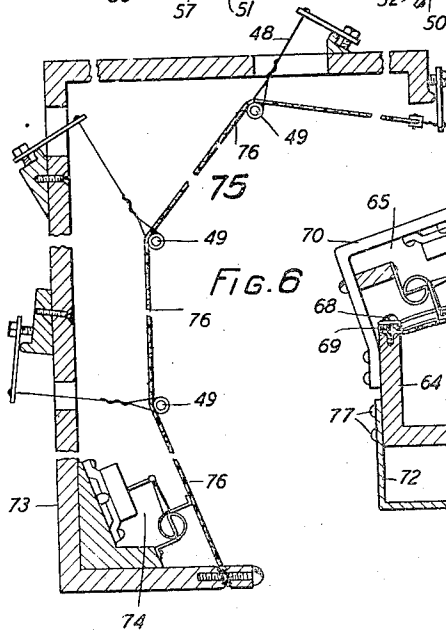
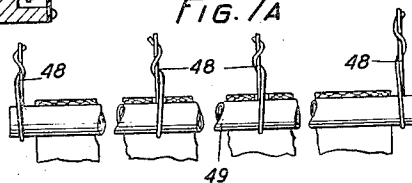
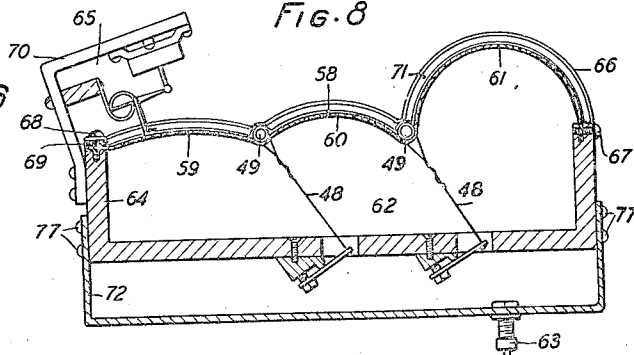


FIG. 8



INVENTOR
E. H. SMYTHE

BY
Walter C. Kiesel
ATTORNEY

UNITED STATES PATENT OFFICE

EDWIN H. SMYTHE, OF EVANSTON, ILLINOIS, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

ACOUSTIC DEVICE

Application filed July 15, 1930. Serial No. 468,101.

This invention relates to acoustic devices, and more particularly to a large direct acting sound radiator.

One object of this invention is to radiate sound energy with uniform efficiency over at least a large portion of the entire frequency range of speech and music.

Another object of this invention is to tension a long direct acting sound radiator such that successive integral or associated portions thereof are under different stretched conditions.

Still another object of this invention is to so position a sound radiator within a chamber that a comparatively large radiating surface is available.

A further object of this invention is to reduce the production of standing waves in long direct acting sound radiators because of reflection at their supports by introducing into the sound radiator a gradually diminishing tension away from the point or line of drive so that the propagation constant decreases in the same direction. This causes wave lengths in the outer range to be shortened, the time required for a disturbance to travel to the supporting edge and back to be increased and, because of the greater number of wave lengths traversed, the waves to be more strongly attenuated in traversing the distance.

One feature of the invention resides in the means employed to tension the sound radiator to the desired degree.

Another feature resides in the means employed to change the direction of the sound radiator and of the wave disturbances therein.

In accordance with this invention, there is provided a long direct acting sound radiator comprising a plurality of integral or associated sections stretched to the same or different degrees. When the various and successive portions are stretched to different degrees, the propagation constant thereof varies along the length of the sound radiator, having its smallest value farthest from the source of the disturbance to be propagated therethrough.

One embodiment of this invention takes

the form of a long direct acting stretched sound radiator encircling or partially encircling and spaced from the walls of a room, or the chamber of a phonograph cabinet, or the like, and turned through the angles or corners where necessary by pivot members or by supports which serve as tensioning means also.

Another embodiment of this invention consists of a long direct acting sound radiator, and means associated therewith to introduce tension therein which diminishes in degree along its length.

Still another embodiment consists of a sound radiator comprising a plurality of associated portions each under the same or different tensioning force, angularly disposed with reference to each other, and operatively interconnected by energy transferring members.

A more complete understanding of this invention will be obtained by reference to the appended drawings wherein:

Fig. 1 is a sectional view of one embodiment of this invention;

Fig. 2 is a fragmentary view of Fig. 1 along the line 2—2;

Fig. 3 is a plan view of a section of another embodiment of this invention;

Fig. 4 shows still another embodiment of this invention;

Fig. 5 shows another embodiment of this invention illustrating how a sound radiator in accordance with this invention may be disposed symmetrically within a chamber;

Fig. 6 shows a modification of the arrangement of Fig. 5;

Fig. 7 is an enlarged sectional view of sound radiator supporting and energy transferring members shown in Figs. 4 to 6 and 8;

Fig. 7A shows more in detail how the tubular members of Fig. 7 may be supported along its length; and

Fig. 7B shows an alternative form which the energy transferring member of Fig. 7 may take;

Fig. 8 is still another embodiment which this invention may take.

There is shown in Figs. 1 and 2 a direct acting sound radiator comprising a plural-

ity of elongated sound translating members 1, of a light-weight, high-strength material, such as duralumin or aluminium, for instance, of about 2 mills thickness, supported within a chamber defining means 3, and which are tensioned to the same or different degrees and are secured along one extremity to members 4, to be described more fully hereinafter, in an elongated U shaped portion 15 thereof, and fastened thereto, for instance, by welding, soldering, cementing or riveting. Near the other extremities of the members 1, which are anchored at 19 to the inner walls of the chamber defining means, are corrugations or serrations 2 providing an elastic termination for each member. Instead of corrugations the members 1 could be provided with enlarged tubular portions such as are disclosed in my Patent 1,821,586, issued September 1, 1931. Each member intermediate the driving means and the last section is secured to a second member 4 at 16, preferably by welding or cementing it thereto. These members 4 are elongated, direction changing, energy transferring elements and are preferably of a light-weight, high-strength material having considerable intrinsic stiffness, so that a rigid and yet not massive element may be obtained. They are shown as C shaped and as having pivot portions 17 fitting into elongated grooves 14 in the extensions 13, 10 and 11 of the chamber defining means 3. The members 4 are capable of oscillating on their pivot portions so as to communicate the movements received by them from a driving unit or preceding sound translating members to the members attached thereto. The driving unit 5 may be of any desired type, for instance, such as is disclosed in my Patent 1,606,133, issued November 9, 1926, and may be supported on a projecting portion 6 secured by screws 21 to the chamber defining means 3. The chamber 20 may be provide with a screen 7 of wire gauze, or fabric, which does not hinder the free passage of sound waves but which conceals or protects the sound translating arrangement. A frame 8 and screws 9 are provided to hold said screen in place.

In operation, the vibrations of the reed 82 connected to the first member 4 will cause its oscillation about its pivot supported by extension 13 in accordance with the sounds to be reproduced and the communication of said oscillations, as vibrations, to the sound translating member connected thereto which, in vibrating, will produce oscillations of the member 4 to which it is connected at 16 thereby transferring the initial, but now partially attenuated, disturbances to the second sound translating member 1 which in turn, through the operation of the member 4 about its pivot supported by extension 11, communicates the vibrations to the final member. If the sound translating members are tensioned to

the same degree, they should be sufficiently long so that there will be a minimum of reflection from the termination of the final associated one. If they are tensioned to different degrees, each succeeding one should, preferably, be under relatively smaller tensioning forces than the preceding one so that the sound disturbance being propagated therein will be offered a gradual decrease in impedance. In other words, the different associated members should be so tensioned that the propagation constant thereof varies along the length of the path of the disturbance being least farthest from its source. In either case, the sound translating members are preferably tensioned to such a degree that the sound disturbances therein are propagated with a velocity greater than one quarter the velocity of sound waves in air. The oscillatable, vibration and, consequently, energy transferring members 4 are preferably of such mass and rigidity that there will be the least possible reflection therefrom when the system is set into vibration to translate the electrical energy received by the driving unit into acoustic energy.

It will be apparent that the sound translating means above described permits of the use of a comparatively large sound radiator in a limited space by providing means whereby the sound radiator may be composed of associated members tensioned to the same or different degrees and operatively interconnected whereby the disturbances or vibrations impressed on one of said members may be communicated to all of the others even though the others are in different planes.

Fig. 3 illustrates another form which this invention may take. There is shown a U shaped frame 30 and spaced therefrom a uniformly tensioned elongated sound radiator 32 preferably of a light-weight, high-strength material, such as duralumin or aluminium, said sound radiator being anchored at one extremity to said frame between a projecting portion thereof and a strip 22 by means of screws 23 (only one of which is shown). At its other extremity said sound radiator is secured to an energy transferring member 4 similar to that described with reference to Figs. 1 and 2, which is pivotally supported on a projecting portion of the frame 30 and capable of being driven by a unit 5. The sound radiator is held spaced from the frame by pivotal supports 37, whose head portions 38 are preferably permanently secured to one surface of the sound radiator by soldering, cementing, welding or riveting it thereto. These pivotal members fit in recesses 39 in frame 30 and may consist, preferably, of a single elongated member. Supports 24, 25 and 35 are provided to which screens 31 may be secured by strips 35 and screws 36. These screens do not impede the free passage of sound waves but serve to

protect and conceal the sound radiator. The sound radiator and supporting frame may be completely enclosed by the back plate 26 secured to supports 24 and 25 by screws 27.

5 If desired the frame 30 may be perforated so that the air on each surface of the sound radiator may have free movement or a layer 18 of damping material may be placed adjacent thereto to absorb the sound energy given off by one surface of the radiator and to prevent undesirable reflection from the frame 30. If desired the walls of Fig. 1 may be similarly treated or perforated.

In operation, the member 4 is caused to oscillate on its pivot portion in accordance with the sounds to be reproduced and to communicate that motion to the sound radiator 32 in which the sound disturbances are propagated and radiated to the atmosphere. The pivotal supports 37 enable the disturbances in the sound radiator to be transferred successively to its non-coplanar portions which are all preferably tensioned to the same degree. It is seen, therefore, that the members 37 perform a function analogous to that of the pivotally supported oscillatable members 4 described in detail with reference to Figs. 1 and 2.

Fig. 4 illustrates still another embodiment of this invention in showing a chamber defining means 41 from whose inner walls an elongated tensioned sound radiator 40 is supported in spaced relation thereto by flexible guy elements 48, clamping block 442, and screws 441 (only one of which is shown), and pivotally supported oscillatable energy transferring member 42 to which the reed of a driving unit 43 is attached. The chamber 440 is provided with a screen 44 at its open end which is secured to the chamber defining means by frame 45 and screws 46. The guy elements 48 may be metal or fibre, one extremity of which is anchored to the means 41 and which extends through an opening 78 in the sound radiator material, around the tubular member 49 secured to the sound radiator, through another opening 79, and twisted around itself as shown more clearly in Fig. 7. An alternative arrangement is shown in Fig. 7B. The guy element comprises a single member 33 anchored to the frame at 80 and to the tubular member 49 at 81. The tubular member 49 is attached to the sound radiator material preferably by soldering or cementing it thereto and is of a material combining the characteristics of rigidity and small mass. The guy members are employed at spaced intervals along the length of each tubular member, as is shown more clearly in Fig. 7A, the spacing being such as to preclude bending of said member.

When the sound radiator 40 is caused to vibrate by the oscillation of the member 42 in accordance with the sounds to be repro-

duced, the elements 48 by being free to move in the direction of the arrows allow the free transfer of energy from preceding to succeeding sections of the sound radiator said successive sections not being coplanar.

The embodiment of this invention shown in Fig. 5 utilizes the energy transferring and membrane direction changing means 48 and 49 shown in and described with reference to Fig. 4 but they are made to serve an additional function as means for introducing desired degrees of tension into various portions of the elongated sound translating membrane 53. Fig. 5 may be considered as a sectional view of a sound reproducing arrangement comprising a symmetrically disposed and, preferably, symmetrically tensioned elongated sound radiating or translating members 53 of a thin, light weight, high strength material, for instance, of aluminium or duralumin. It will be understood that the arrangement shown may be around three walls of a room or cabinet or around the bottom, one wall and top of a cabinet or other enclosure.

The sound translating member is divided into a plurality of non-coplanar portions and secured at the apex of each inner angle formed by their intersections are rigid, tubular members 49 supported by a plurality of guy elements 48 (see Fig. 7A) which are anchored to levers 50 pivoted on the fulcrums 57 forming part of elongated blocks 52 to which the levers 50 are relatively movable through the medium of bolts 51 which thread into said blocks 52. Each of the latter is secured to the chamber defining means 55 by screws 56 (only one of which is shown). Each extremity of the member 53 is secured within the U shaped ribs 83 which are connected to similar levers 50. It will be apparent that by adjustment of the bolts 51 the levers may be caused to exert greater or lesser force on the guy elements anchored thereto and hence greater or lesser strain on the material of the sound translating member and that by the arrangement described gradually varying tension may be produced in the member 53 depending on the force exerted on the guy elements and their angular relations to said member. A sound translating membrane or diaphragm in which the tension gradually diminishes between its driving element 84 and its extremities such that the propagation constant therein varies along its length being least farthest from the source is thus obtainable. It will be understood that instead of the drive shown a line drive such as is disclosed in my Patent 1,778,871, issued October 21, 1930, could be used.

A modification of the embodiment of this invention described with reference to Fig. 5 is shown in Fig. 6. Instead of being driven at its mid-portion, a sound translating member 75 divided into a plurality of non-

coplanar portions 76 is driven near the extremity of one end portion thereof. These non-coplanar portions are under different tensioning forces such that the tension gradually decreases away from the line of drive being a minimum at the extremity of the sound radiator farthest therefrom. The rigid tubular members 49 and the guy members 48 as in the structure of Fig. 5 are of such stiffness and mass that the transfer of the energy to successive non-coplanar portions occurs with the least possible reflection therefrom. The driving means 74 may be of the type described in my Patent 1,778,871, issued October 21, 1930.

In Fig. 8 a sound radiating or translating member 58 is divided into a plurality of portions 59, 60 and 61 of different areas, by the tubular members 49 secured thereto and guy members 48, and is maintained in a tensioned condition by fluid under greater than atmospheric pressure in the chamber 62 formed by the frame 64 and casing 72, the latter being secured to the former by means of screws 77. The fluid is supplied to chamber 62 through the valve 63. Inasmuch as the various portions of the member 58 present varying areas against which the fluid may act, each portion will be under a different tension, the greater the area of the portion, the smaller the tension therein. In Fig. 8, the tension will be greatest in portion 59, smaller in portion 60 and least in portion 61, or, to look at it from another point of view, the tensions in the arcuate portions being greatest in those portions of largest radius of curvature. To minimize leakage of fluid a strip of thin material 71, such as rubber, may be secured to the end walls 66, (only one of which is shown) of the frame 64 and to the edge portions of the member 58 material adjacent said walls. The driving means 65 may be similar to that shown in Fig. 6 and is supported on the bracket 70.

It will be apparent from the various embodiments described above that this invention may take a variety of forms and its scope, therefore, is to be considered as limited only by the appended claims.

What is claimed is:

1. An elongated direct acting sound radiator comprising a plurality of connected angularly disposed portions under different degrees of tension.

2. A direct acting sound radiator comprising a single surface having a plurality of angularly disposed sections under different degrees of tension, and means associated with each section for introducing and maintaining tension therein.

3. A direct acting sound radiator comprising an elongated stretched member having a plurality of portions under different degrees of tension successive portions being

under progressively smaller tensioning forces.

4. A direct acting sound radiator comprising an elongated stretched member, and means for changing the direction of said member, said means also dividing said member into a plurality of portions.

5. A direct acting sound radiator comprising an elongated member having a plurality of non-coplanar portions, means for maintaining said portions in their respective planes, and means for transferring energy from one portion to another.

6. A direct acting sound radiator comprising an elongated member having a plurality of non-coplanar portions each tensioned to a different degree, and means for maintaining said portions under tension.

7. A sound radiator comprising a stretched member having a plurality of non-coplanar vibratory portions, and means for transferring energy from preceding to successive non-coplanar portions.

8. A sound radiator comprising a member having a plurality of non-coplanar portions, and means for introducing into successive portions gradually decreasing degrees of tension.

9. A sound radiator comprising a member divided into a plurality of non-coplanar portions, and means for transferring energy to successive portions, said means comprising pivotal members.

10. A sound radiator comprising a member having a plurality of non-coplanar plane portions, said portions being tensioned to different degrees such that the propagation of velocity of acoustic disturbances therein decreases as the disturbances move farther away from the source thereof.

11. An elongated sound radiating surface comprising a plurality of different plane portions in different planes, means for imparting acoustic vibrations to one of said portions, and a common driving means for all of said portions.

12. Means for reproducing sound comprising a plurality of associated sound translating surfaces, and oscillatable means pivotally mounted for transferring sound vibrations from one surface to another, said means being associated with said surfaces so as to enable sound waves to travel successively from one surface to another.

13. Means for reproducing sound comprising a plurality of associated elongated sound translating surfaces constituting a continuous path for sound waves, and pivotal means for transferring sound vibrations from one surface to another, said vibration transferring means being of a material having the characteristic of high stiffness with low mass.

14. Means for reproducing sound comprising a plurality of associated sound translating portions constituting a continuous path

for sound waves, means for vibrating one of said portions, and oscillatable means pivotally supported for transferring sound vibrations from one portion to another, said oscillatable means being of material having the characteristic of high stiffness with low mass.

15. Means for reproducing sound comprising a plurality of non-coplanar associated sound translating surfaces tensioned to different degrees, and means for transferring sound vibrations from one surface to another.

16. In combination, a chamber defining means, means disposed in said chamber for reproducing sound, said means comprising a plurality of associated non-coplanar sound translating surfaces, means for actuating one of said surfaces, and means for introducing tension in said surfaces and for transferring sound energy to successive surfaces.

17. In combination, a plurality of associated non-coplanar tensioned sound translating surfaces, means for impressing sound vibrations on one of said surfaces, and means for transferring vibrations in preceding to succeeding surfaces, said means being so proportioned that reflection of vibrations therefrom is minimized.

18. A sound reproducing arrangement comprising a sound translating surface of comparatively greater length than breadth, said surface being divided into a plurality of non-coplanar portions, means for imparting acoustic vibrations to one of said non-coplanar portions, and means for transferring energy from preceding to succeeding portions.

19. An acoustic device comprising a single elongated vibratory member having a plurality of angularly disposed portions of like material under different degrees of tension.

20. An acoustic device comprising a single vibratory member having a plurality of associated non-coplanar plane portions and means for introducing tension into said portions and for maintaining them in that condition.

21. An acoustic device comprising a single elongated vibratory member having a plurality of plane portions disposed substantially at right angles to each other, means for imparting vibrations to said member, and means for transferring vibrations from preceding to succeeding portions.

22. An acoustic device comprising a sound translating member in the form of an elongated vibratile sheet having along its long dimension a plurality of arcuately shaped portions, each of a different radius of curvature, successive arcuately shaped portions being of less radius of curvature than preceding portions.

23. An acoustic device comprising a sound translating member in the form of an elongated vibratile sheet having along its long dimension a plurality of arcuately shaped portions, each of a different radius of curvature and each under tension to a different degree.

In witness whereof, I hereunto subscribe my name this 11th day of July, 1930.

EDWIN H. SMYTHE.