July 2, 1940. L. M. HART 2,206,012

SOUND TREATING DEVICE

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FIG. 2.

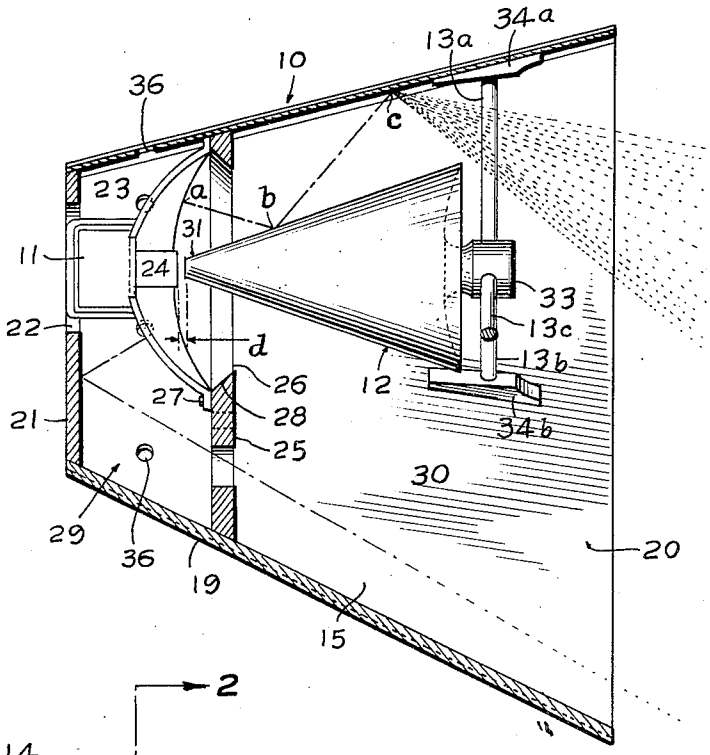

FIG. 1.

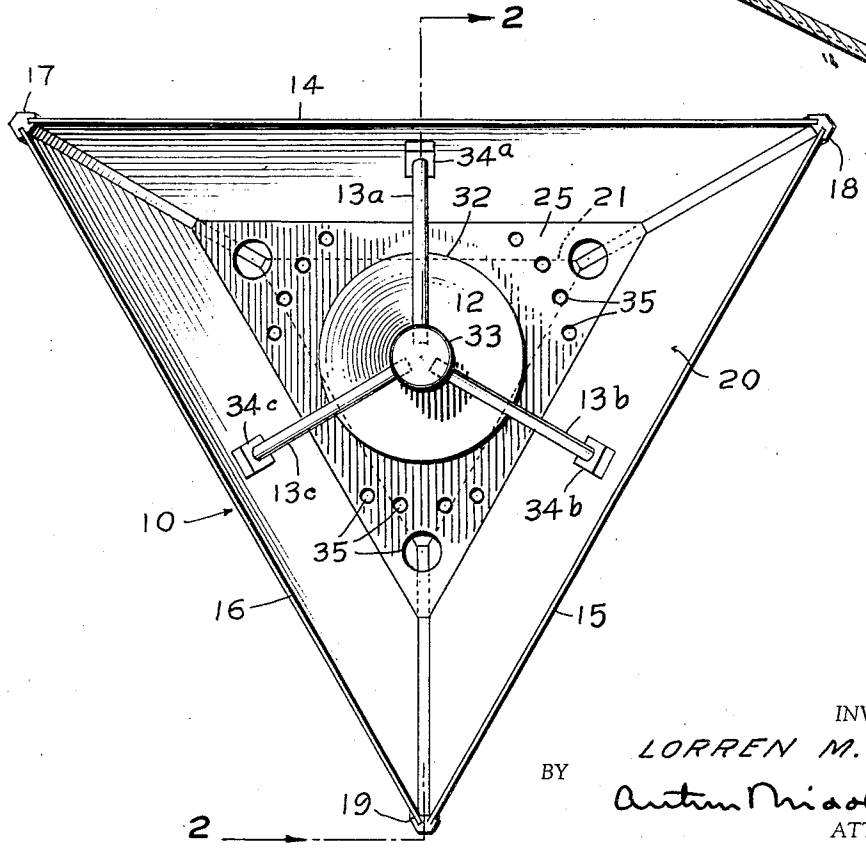

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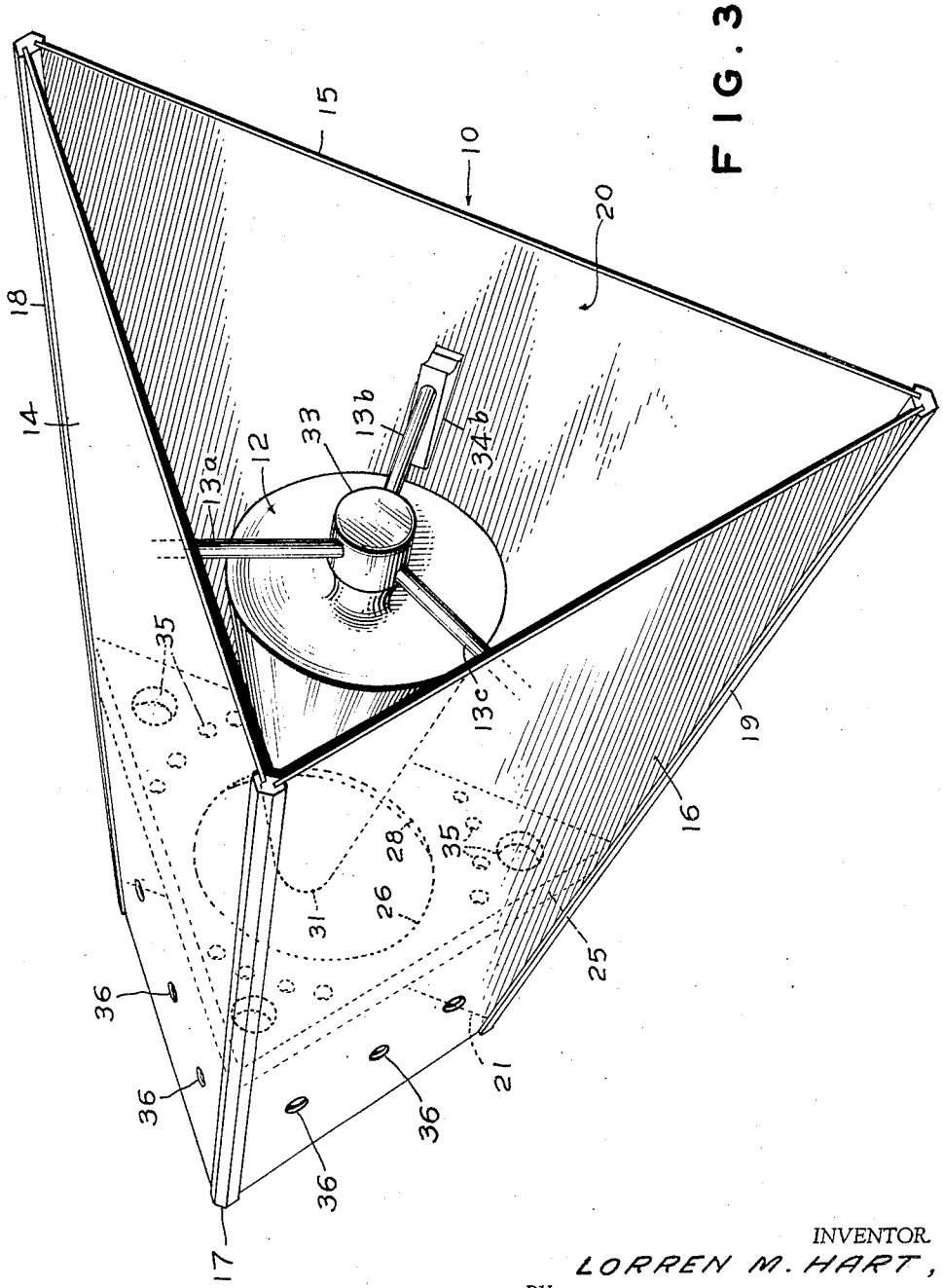
FIG. 3.



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UNITED STATES PATENT OFFICE

2,206,012

SOUND TREATING DEVICE

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8 Claims. (Cl. 181—31)

This invention relates to improvements in sound reproduction and the amplification and modification thereof, in order to give clarity and speaking resonance to the same and to restore the original tonal quality and definition thereof.

My invention has for one of its objects an improved apparatus for the amplification of complex sound waves emanating from a vibratory surface actuated by mechanical or electrical impulses, in connection with radio, phonograph or other means of reproducing the sounds or tones of the human voice, musical instruments or the like. The principles upon which these improvements are based are fundamental and devolve upon the theory of speaking resonance that is acquired when a sound vibration emanating from any source is impinged upon fibrous material with the objective of clothing the vibrations with fibrous resonance inherent in the substance with which the sound waves are brought in contact. The principle is best illustrated from the well-known action which occurs in reference to a piano sounding board or the frame or body of a musical instrument upon which strings are applied under tension and set into vibration. These resulting vibrations produce frequencies or wave lengths which are impinged upon the sounding board or surface of the instrument and reverberate from the surface of such walls or sounding boards clothed with a resonant quality of sound which produces tones musical to the ear. Such vibrations or primary frequencies so-called, of themselves do not constitute a musical note or tone, but will carry the sonant quality of the construction material of the element that sets up the vibrations, such as metal strings or violin strings that are adapted to that purpose.

Such vibrations and sounds emanating from the primary source, when delivered as in broadcasting or mechanical recording of such sounds, lose their resonant quality when in their reception and redelivering, they emanate from a metallic or other substance that does not possess the resonant quality of the original instrument. Thereby subtle harmony overtones, and quality of the voice and musical sounds are lost since the emitted sounds become metallic and unnatural. These qualities of sound I propose to restore by the methods employed by my invention as described herein.

Furthermore, the complex sound waves set up by and emanating from the face of a cone speaker are treated as primary frequencies approximating the pitch and tone characteristic of the original sources of such sounds. These complex sound waves, actuated by the vibrations of the concave surface of the diaphragm of the speaker are concentric in form and have a tendency to focalize immediately in front of the speaker. This produces to a great extent a distortion or confusion of the sound waves that are impinged one upon the other and lose their original definition, pitch and tonation to a very large degree. By so focalizing immediately in front of the diaphragm, the sound waves interfere with each other and are mutually distorted so as to lose the thrust effect of the sound beam created and thus lose the carrying power thereof. This requires more power in the actuation of the speaker which results in blare, blast and metallic cast so discordant to the human ear.

Another object of my invention is to control and direct the vibratory sound waves emanating from the reverse or convex surface of the diaphragm of a cone speaker and to so apply the same as to enlarge the volume of sound produced in the amplifying chamber by the opposite or concave surface of the speaker, as described above.

In general practice the cone speaker is mounted upon a baffle board, having an outlet for the sound waves set up by the concave surface of the diaphragm. This mounting is positioned near or attached rigidly to one of the walls of a cabinet or other housing of the speaker, having a similar outlet, so that the sound waves are delivered directly into outer space for audition without obstruction or modification.

The vibrations from the reverse or convex side of the speaker diaphragm set up sound waves coincident with those impelled by the face or concave side, but such sound waves have a beam or thrust directly opposite to that of the concave surface and carry in an opposite direction, having an exit in the rear of the cabinet or speaker mounting. This results in conflicting sounds due to reverberation within the housing, or extraneous sounds in contrast to the sounds emitted from the front of the speaker.

For the purpose of my invention, such vibrations emanating from the convex side of the speaker diaphragm are similarly treated as primary frequencies. The spreading sound waves produced thereby are thrust outwardly from the diaphragm and impinge upon the converging tensioned walls of the air chamber in the rear of the speaker mounting, correspondingly to the impingement effected by the cone deflector positioned on the opposite side of the speaker. By this activity the tensioned walls of the ampli-

fier impart the same tonal quality and definition to such sound waves as that which is delivered to the waves emanating from the concave surface of the diaphragm.

With the purpose of preventing the exit of these sound waves from the rear opening of the amplifying chamber, such opening is fitted with a baffle or panel board conforming to the triangular configuration between the walls of the amplifying chamber and is attached rigidly thereto, thus creating a closed air chamber in the rear of the speaker. The sound waves emanating from the rear surfaces of the diaphragm and impinging upon the inner walls of this air chamber, deflect at an opposite angle of impingement and are thrust upon the rear baffle or panel board from which they reflect in an opposite direction towards the interior mounting of the cone speaker. Outlets are provided in the speaker mounting in such manner as to permit the passage of these reflected sound waves into the air chamber in front of the speaker, where they synchronize with and augment the volume of sound produced by the sound waves emanating from the concave side of the speaker diaphragm. The configuration of the enclosing triangular walls of the amplifier contribute largely to this result in providing an expanding air chamber for the amplification and outlet of the combined vibratory sound waves set up by both sides of the speaker diaphragm, in conformity with the angles of impingement and reflection of the sound waves within the same.

According to the invention it is proposed to treat sound in an improved sound conditioning device comprising a hollow resonating construction or resonator of fibrous material of truncated tapered shape and cornered cross-sections. Disposed within the resonator and coaxial therewith is a tapered reflector, the cross-sections of which are dissimilar to those of the resonator.

More specifically, the resonator is triangular while the deflector is round in cross-section.

A dynamic loud speaker is directly associated with and preferably disposed within the resonator body, and the sound emitting diaphragm of the loud speaker is adjacent to the minor end of the deflector which latter is adapted to receive concentric sound waves from the diaphragm.

Other features have to do with the triangular shape in particular of the resonator body in conjunction with tensioning means comprising three sound posts which spring from a common foundation whereby they are interbalanced with respect to their tensioning effect upon the respective resonator walls.

Still other features have to do with the mounting of the loud speaker as by means of a transverse sounding septum intermediate the ends of the triangular resonator, and also with disposing the loud speaker within a chamber formed by the narrow or rear end portion of the resonator.

The objects and principles of my invention are illustrated in an embodiment shown in the several figures of the accompanying drawings which are submitted as a part hereof and in which the characters designate the corresponding parts of the figures referred to in the description thereof.

The invention possesses other objects and features of advantage, some of which with the foregoing will be set forth in the following description. In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit. In the accompanying drawings there has been illustrated the best embodiment of the invention known to me, but such embodiment is to be regarded as typical only of many possible embodiments, and the invention is not to be limited thereto.

The novel features considered characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawings, in which:

Fig. 1 is a view upon the sound or mouth portion of the device in operating position with the base of its triangular cross-section at the top.

Fig. 2 is a longitudinal section of the device taken along line 2—2 of Fig. 1.

Fig. 3 is a perspective view of the device.

The device as a unit comprises as main component portions: a hollow flaring resonating body or resonator 10 of triangular cross-section, a dynamic loud speaker or cone speaker 11 mounted within the resonator, a deflector body 12 of circular cross-section having a conicity substantially similar to that of the flare of the resonator, and furthermore an arrangement of side tensioning members or posts herein called the sound posts 13*a*, 13*b*, 13*c*, which serve to tension the sides or sounding boards of the resonator 10 as will hereafter be explained.

The resonator 10 appears substantially as a truncated pyramid of equal sides and of triangular cross-section, and it comprises the sides or sounding boards 14, 15, 16, which are equal in size and shape and are joined together rigidly edgewise by means of corner strips 17, 18, 19. The resonator or truncated trylon thus has a sound emitting mouth 20 at the flaring end, and is closed by a transverse sounding wall 21 at the small or constricted end, which wall is shown to have an opening 22 in which may lodge the rear end portion of the loud speaker 11 for ventilation purposes.

The loud speaker 11 is coaxial with the resonator 10 and it has the conventional outer shell 23 which houses the sound emitting diaphragm 24 from which sounds emanate as so-called primary frequencies or as virgin sound waves as they may hereinafter be called. The speaker 11 is mounted within the resonator 10 by means of a transverse sounding septum or baffle board 25 having a central sound opening 26 substantially corresponding to the effective portion of the diaphragm, and to the margins of which opening the speaker shell 23 is marginally fastened as at 27. The sound opening 26 is shown to have an inwardly bevelled edge 28. The baffle board 25 is mounted rigidly to the interior walls of the resonator and is disposed relatively near the constricted end or transverse sounding wall 21 of the flaring resonator, the rear end of the speaker being shown to be flush with the outer face of the end wall 21, that is to say, the space between the end wall 21 and the baffle board 25 constitutes a chamber 29 designated as the housing chamber for the speaker or as a supplementary or complementary sound chamber. The space in the front of the baffle board 25 is designated as the air chamber or resonating chamber 30. Both the sound and the rear chambers 30 and 29 supplement or complement each other in their respective sound treating effects so as to

produce resultant sound effects hereinafter to be described.

The deflector body 12 is of smooth conical shape of circular cross-section and its conicity bears a certain relationship to the degree of flare of the resonator, the flare and the conicity of these respective two bodies being controlled by conditions hereinafter defined. This deflector 12 is coaxial with the loud speaker and with the resonator, and is disposed close to the speaker diaphragm and cooperatively associated directly therewith in a manner to receive primary sound frequencies directly from the diaphragm.

Consequently, the deflector 12 has its small end 31 disposed near the center of the diaphragm although spaced therefrom a suitable distance *d* dictated by practical considerations. The diameter of the wide end 32 of the deflector body 12 is made substantially equal to that of the sound opening 26 in the baffle board 25. The aforementioned side tensioning means or sound posts 13*a*, 13*b*, 13*c* herein equally serve as supporting means for the deflector body 12 in that they are inserted into and extend radially from a hub portion 33 of the deflector body, while terminating under compression upon wedge shaped footings 34*a*, 34*b*, 34*c*. These sound posts give the sounding boards 14, 15, 16 of the resonator a desired transverse tension, to assure synchronization of the sound waves and proper resonance. It will be noted that the three sound posts have a substantially interbalanced relationship to one another which is inherent to their triangular arrangement, so that as a result the corresponding three sides of the resonator will thus automatically be tensioned each substantially with the same intensity.

The configuration of the resonator 10 is chosen to be that of a truncated triangular pyramid or trylon, and it is thus peculiarly designed to produce an effective enlargement or expansion of sound waves, as experienced in principle when sound waves pass through an air chamber. The sides or panels or tapering walls of this triangular configuration are fabricated from thin sections of fibrous sonorous material, such as well seasoned woods or wood fiber, or else preferably of hard or tempered pressed wood. The size and depth of the triangular configuration is determined by the size of the cone speaker employed, and preferably and approximately the axial depth of the air chamber should be twice the diameter of the speaker.

The baffle board 25 upon which the speaker is mounted is of triangular shape and is rigidly mounted and fits into the interior of the resonator 10 and is disposed relatively near the small end thereof, and has the sound opening 26 therein substantially conformed to the face of the speaker.

The deflector 12 is conical in shape and of circular cross-section, and it thus corresponds to the outlet of the speaker, in order to receive and reflect the primary sound waves emitted from the concavity of the diaphragm surface. The deflector 12 has its wide end portion mounted by way of the sound posts 13*a*, 13*b*, 13*c*, which connect substantially rigidly with the hub portion 33 of the deflector body. These sound posts are set in the footings or bosses 34*a*, 34*b*, 34*c*, which have frictional contact with the flaring walls of the resonator 10 and act as wedges whereby the deflector is positioned centrally, while at the same time the resonator walls or sounding boards are tensioned in order to make them sensitive and responsive to the impingement of the sound waves. The sound posts further act as a means of communicating the vibrations set up in the several walls or sides of the resonator 10 so as to make them vibrate in unison, and the whole body of this configuration becomes solid and integral as in the use of a sound post in the piano, violin or other instruments.

The configuration and dimensioning of the walls or sound boards of the resonator or amplifying chamber 10 is dependent upon the diameter of the cone speaker, and these walls are designed to be substantially parallel to the side or periphery of the deflector, the interrelationship of the deflector and the resonator then being such that sound waves are emitted or projected from the mouth of the resonator in substantially rectified non-focalizing condition, as will be presently explained. The axial depth of the air chamber is determined by the angles of impingement and reflection of the sound waves produced by the speaker and should be tentatively twice the diameter of the face of the cone speaker. The flaring inner surfaces of the walls of the amplifying chamber act as sounding boards to receive the impingements of the sound waves set up by the deflector of the cone speaker and deflected by the surface of the cone shaped deflector 12 so as to impinge upon the flaring walls or sounding boards and to give a positive and desired direction to the sound waves emerging from the resonator, so that the sound waves thus treated should fill all parts of the auditorium, instead of concentrating or refocalizing in front of the outlet or mouth of the air chamber, or otherwise neutralizing themselves. This treatment of the primary sound waves, namely, deflection followed by resonation is illustrated by and will be more clearly understood from Fig. 2, where a primary frequency or virgin sound wave is shown for example to emanate at *a* from the diaphragm of the speaker. At *b* it touches upon and is deflected by the conical surface of the deflector body 12 and thus under the theoretical angle of reflection is thrown on to the fibrous sound boards of the resonator whence from point *c* it rebounds again and in a desired direction and use through the mouth of the resonator. It will now be understood that with the proper inclination or tapering of the reflecting surfaces involved relative to one another, the primary frequencies will be treated so that the resulting sound waves reach the auditorium substantially undistorted; or, differently expressed, a given deflector conical surface will determine the slope of the coordinated resonator faces or vice versa, in order to meet the requirement of rectification of the resultant sound waves as well as their clothing with resonance.

Now, referring to Fig. 1, it will also be noted that in the corner portions of the resonator there is a thinning of the intensity of the sound waves. This, however, is made up for, and the total resultant sound effect appears to be supplemented or complemented, and the total thrust of the sound blast intensified, for the reason that sound waves emanating rearwardly from the speaker are reflected from the rear transverse sounding board, for instance at a point *e* from where they are reflected forwardly and are caused to pass through the sound openings 35 provided in the corner portions of the baffle board. The rearward sound waves thus reversed supplement or complement the direct forward sound waves from the speaker, and give body and strength to the

sound originating from the primary frequencies of the diaphragm. Due to the rigid interconnection of all resonating walls, the contributory treated sound waves are synchronized so that they properly enhance intensity and improve quality of the resultant sound effect. Vent openings 36 are provided in that section of the sounding boards 14, 15, 16 which extend between the transverse end wall and the baffle board 25.

The narrow end of the resonator 10 including the sounding wall 21, together with the holes 35, is particularly efficacious in the treating or amplification of the high frequencies due to the impingement thereof from the rear side of the cone speaker upon narrow walls of the rear chamber 29.

The rear chamber 29 is substantially closed and the sound waves reverberating therefrom find exit through the openings in the baffle board and blend with the sound waves produced from the front end of the speaker.

In this way the high frequencies receive additional emphasis by impingement upon the narrow walls of the rear chamber which is integral with the resonating chamber 30, and this is believed to be the cause of the increase in the sonic volume as shown by amplitude tests.

In practice, when sound waves are delivered through an enclosed air chamber, certain reverberations are created within the air chamber which conflict with the beam or thrust of the vibratory waves. The impedence resulting therefrom obstructs the free passage of the sound waves through the air chamber and produces a blurred effect accompanied by a drum-like tone that becomes dominant and distorts the otherwise natural pitch and quality of the sounds sought to be amplified.

In referring to the non-focalization of the sound waves, it may be explained that concave loud-speakers tend to direct their sounds to a focal point in the same way that a lens focuses light. It is this focussing that is to be avoided. Where the loud-speaker would ordinarily concentrate its sound at a focal point, it is herein proposed to place the deflector so as to disperse these sounds outwardly to the side walls of the resonator. At the point of impingement on the side walls then, I begin the treatment of the sounds for clarifying and beautifying them, so the musical attributes may well be said to be contributed to the sounds by the walls of the resonator and not by the loud-speaker. I have attempted to illustrate this different quality in the sounds as indicated in one kind of line for the sound waves going to the side wall and another kind of line for the waves deflected therefrom. The deflected waves flare as indicated and pass to the auditorium in many directions.

A purpose of my invention is to prevent such interference and obviate the resulting distortion by means of openings or air vents provided in the walls of the amplifying chamber near and around the speaker mounting as well as in the mounting that is the baffle board itself to admit of air circulation within the chamber which breaks up the air pockets formed by such reverberations and effectually suppresses such extraneous sounds.

The sound treating device thus constructed and comprising a dynamic or cone speaker actuated by electrical mechanism capable of delivering primary sound frequencies with fidelity and volume without distortion, faithfully amplifies and enlarges such sound frequencies, gives definition and speaking resonance thereto and restores the original clarity, pitch and tone quality of the sounds sought to be reproduced.

I claim:

1. A sound conditioning device comprising a resonating hollow construction having the outer contour substantially of a truncated pyramid-shaped body of triangular cross-section formed by side walls of fibrous resonating material, said walls connected with one another at their respective edges; and a construction comprising three outwardly radiating sound posts disposed within said resonating construction and so that each side of that construction is engaged by the outer end of one associated sound post under pressure, the respective sides thus to be tensioned transversely and outwardly by the respective sound posts, said construction further comprising a common base for the inner ends of said sound posts, which base causes said sound posts to interbalance in a manner to substantially equalize among them the tension of the respective sides imposed by the pressure engagement between the posts and the respective sides of the resonating construction.

2. A sound conditioning device comprising a resonating hollow construction having the outer contour substantially of a truncated pyramid-like body of triangular cross-sections, formed by side walls of fibrous resonating material, said walls connected with one another at their respective edges, and a cone-shaped deflector of circular cross-sections disposed within and coaxially with said hollow construction.

3. A device according to claim 2, with the addition of a dynamic loud speaker having a sound emitting diaphragm, disposed coaxial with said resonating construction and with said deflector and associated with the minor end portion of the construction, the speaker diaphragm consequently being disposed adjacent the small end of said cone-shaped deflector, the latter being adapted to receive concentric sound waves thrust from the face of the loud speaker.

4. A sound treating device having in combination therewith a loud speaker, comprising a fibrous three sided resonator, means for supporting the loud speaker therein, a conical deflector disposed in the resonator with its apex adjacent to and coaxial with the loud speaker, and means for uniformly tensioning the sides from a common support.

5. Apparatus according to claim 4, wherein the loud speaker is supported from a septum that has sound passages therethrough.

6. Apparatus according to claim 4, wherein there is a septum and a closed end at the smaller end of the resonator, and the loud speaker is enclosed in a space between the septum and the closed end.

7. Apparatus according to claim 4, wherein the loud speaker is connected with and supported from the resonator at a point intermediate its length.

8. Resonating apparatus comprising a tapered hollow amplifying device of triangular cross-section of fibrous material, and tensioning means for the sides comprising a sound post for each side and a common support for the posts.

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