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SOUND TRANSLATING DEVICE

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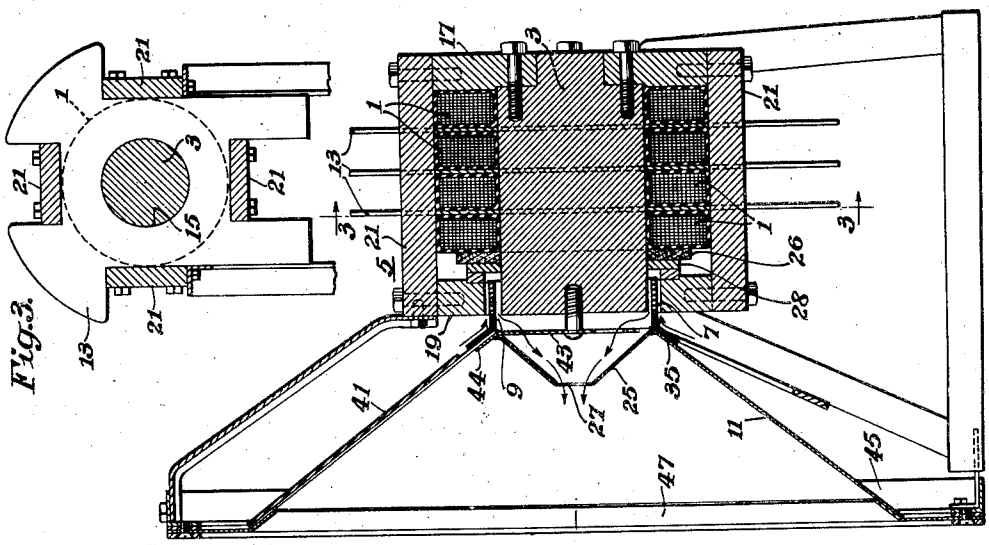


Fig.3.

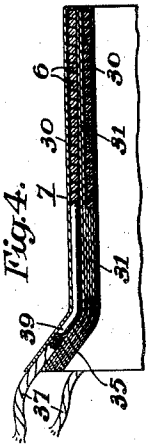


Fig.4.

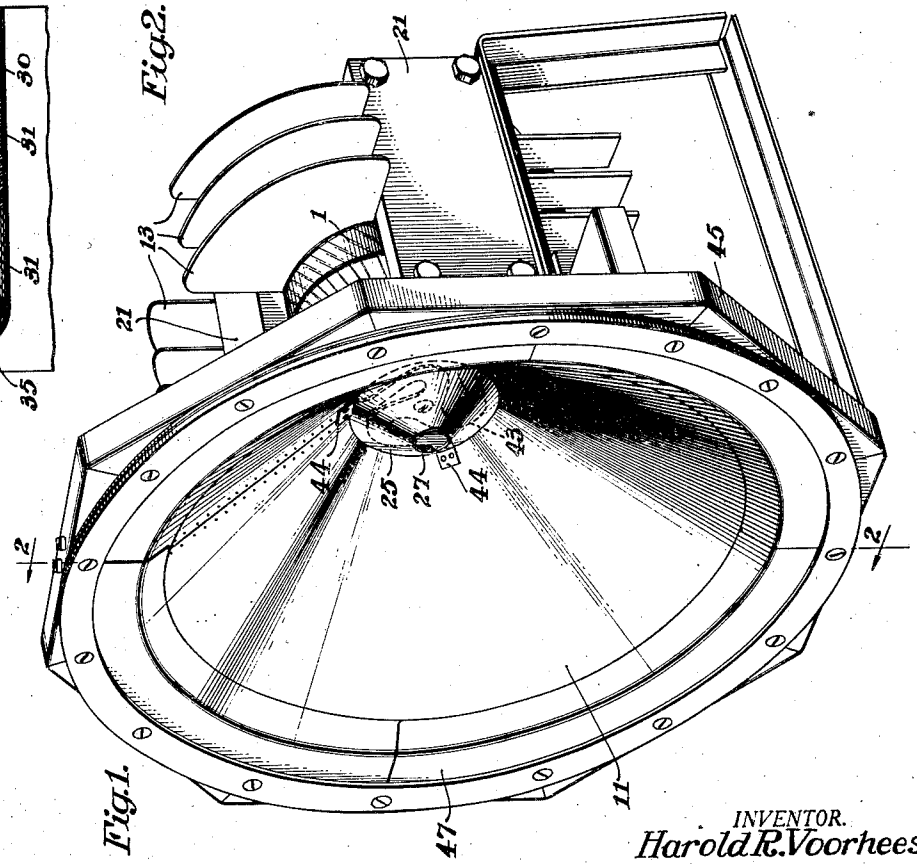


Fig.2.

Fig.1.

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SOUND TRANSLATING DEVICE

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9 Claims. (Cl. 174—115.5)

My invention relates to sound translating devices and, more particularly, to loudspeakers of the electro-dynamic type.

In the operation of electro-dynamic loudspeakers of the high-power type, it is necessary to transmit large mechanical forces from the voice coil to a heavy, substantially inflexible cone structure at frequencies which adequately cover the usual voice or music range. To do this satisfactorily, necessitates a voice coil and supporting structure of great rigidity, but of minimum mass. It is also imperative that the voice coil itself shall have a relatively large diameter and that it shall be so rigidly supported as to maintain its circular shape, especially in the event that soft, highly conductive wire is used for the coil.

Should the loudspeaker be destined for use in situations exposed to the weather, such as in church belfries and the like, it is a further requirement that the cone and the voice coil be substantially unaffected by heat and moisture.

In view of the fact that the field current required by high-power electro-dynamic speakers is quite large, it is obvious that an excessive amount of heat will be developed during their operation, which heat would ordinarily have a deleterious effect upon the voice coil and also upon the insulation used on the wire constituting the field winding. Heretofore, the heat developed has been a serious limitation upon the power that a loudspeaker of the described type could handle.

Furthermore, when voice coils of large diameter are used to actuate proportionately large conical diaphragms, a large portion of the apex of the cone must necessarily be cut away sufficiently to accommodate the coil form mounting. This cutting away destroys an area of the cone which, otherwise, would be effective in radiating high frequencies by reason of its low mass factor and its contiguity to the locus of application of the driving force.

It is, accordingly, an object of my invention to provide a loudspeaker that shall be capable of handling tremendous power.

A further object of my invention is to provide an improved voice coil that shall be rigid and not liable to be deformed under large driving forces. A further object of my invention is to provide, in a loudspeaker of the type described, heat radiating means that shall prevent excessive temperature rise when the device is operated.

A further object of my invention is to provide a composite diaphragm for loudspeakers of the high-power type that shall be equally as effective at high audio frequencies as at low audio frequencies.

Another object of my invention is to provide means, actuated by the voice coil when in motion, for causing a current of cooling air to pass over the said voice coil.

A still further object of my invention is to provide simplified and improved means of fastening external flexible leads to the moving coil structure of an electrodynamic speaker.

The foregoing objects, and other objects appurtenant thereto, I prefer to accomplish by so forming the voice coil by a molding process that the metallic conductor is imbedded in a mass of insulating material, preferably a phenol condensation product, such as "bakelite", by providing the device with a plurality of heat radiating elements in intimate contact with the major metallic portions thereof, and by replacing the area of the diaphragm cut away to accommodate the voice coil mounting by a small truncated cone, having an open end, coaxial with the main diaphragm.

The novel features that I consider 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 drawing, in which

Figure 1 is a view in perspective of my improved loudspeaker;

Fig. 2 is a sectional view in elevation of the device shown in Fig. 1, taken along a line corresponding to the line 2—2 in the said figure;

Fig. 3 is a sectional view, reduced in size, in elevation, taken along a line corresponding to the line 3—3 in Fig. 2; and

Fig. 4 is an enlarged sectional view exemplifying the manner in which my improved voice coil and mounting are constructed.

It is, of course, to be clearly understood that the actual device as commercially constructed is many times larger than shown in the drawing, Figs. 1 and 2 of the drawing being substantially one quarter natural size.

Referring to the drawing, the essential features of my loudspeaker include a multi-section field coil 1 disposed axially on a center core 3 of a yoke 5 of magnetic material, a moving armature or coil structure 7 positioned in an annular air gap 9

of the magnetic field circuit of the yoke, and a large truncated cone diaphragm 11 secured at its small end to the moving coil in driven relation.

For the purpose of conducting away heat developed within the field structure of the speaker, I have provided a plurality of heat radiating elements such as plates or fins 13 of good heat conducting material, preferably copper, having central openings 15 closely fitting around the center core 3, in thermal contact therewith, and extending outwardly for conducting away the heat. The field coil preferably is formed in a plurality of pancake sections as indicated, intercalated with the fins that are adapted to conduct away heat from many points within the coil structure.

The outer portion of the yoke structure consists of a base plate 17 and an outer ring pole piece 19 connected by spaced bars 21, forming therebetween a plurality of openings through which the heat conducting fins extend, preferably, beyond the yoke, in heat radiating relation with the air. It is preferred, in some cases, that the fins likewise make thermal contact with the bars 21 of the yoke, for purposes of heat equalization between the fins and bars. The foregoing arrangement is more clearly shown in Fig. 3. If desired, the conducting plates may be radially slit to prevent a short circuit action upon the field coil with regard to unfiltered current pulsations therein, particularly where the field is used as a filter choke in the supply circuit.

The foregoing construction is very effective in reducing the heating of the field structure. For the purpose of carrying away heat developed within the voice coil structure 7 by the voice currents, and to minimize any conduction of heat from the pole pieces 3 and 19 across the air gap to the moving coil structure, I have provided a small truncated cone 25 secured at its base, as by cement, at or near the small end of the large diaphragm 11 in reentrant relation therewith. The apex of the small cone is provided with an opening 27, through which air is adapted to circulate. I have found that this arrangement results in a pumping action for effecting a unidirectional flow of a gaseous coolant such as air, as indicated by the arrows in Fig. 2, down between the outer pole piece and the moving coil form, around the end of the form, and outwardly between the coil form and the inner pole piece or core, thereby serving to cool the moving coil structure. In accordance with principles of aero-dynamics, a concentration of air currents is formed within the small cone adjacent the open end of the apex when the cone is drawn toward the inner pole-piece, thereby resulting in a pressure area that is higher than that outside of the cone, and causing a flow of air from the high pressure to the external low pressure area. When the cone moves in the opposite direction, there is developed substantially no difference in air pressures and hence a uni-directional air flow results from the foregoing dissimilar actions. The air is caused to flow downwardly between the outer pole piece and the coil form by reason of the fact that the space under the air gap is closed, as by a copper shading ring 28. A felt compression ring 26 is interposed between the ring 28 and the top of the field coil 1. Otherwise, if the space were unconfined, there would be a flow of air only upwardly between the inner pole piece and the coil form, whereas flow on both sides of the coil is desirable. In the field structure of sound producing devices of this type, having the outer yoke in the form of a closed shell of magnetic material, the space below the air gap is ordinarily closed to air leakage whereby an air flow would be established down the outside of the moving coil, without the use of a seal such as the ring 28.

From the foregoing description, it will be seen that the pumping action of the small cone provides means responsive to the signalling currents supplied to the voice coil for cooling the latter. It is also obvious that the flow of air serves to carry away some heat from the pole pieces. Likewise, the air may be caused to circulate over other portions of the magnetic field structure.

In addition to the cooling effect caused by the small open ended cone 25, the latter is effective in materially increasing the radiation of sounds or vibrations in the higher audio frequency range, particularly because the small cone is in close driven relation with the moving coil, the high frequency vibrations generated in the coil 7 being imparted directly to the small cone independently of the vibrations imparted to the large cone 11. The size of the opening 27 in the apex of the small cone also controls the cushioning effect of the air confined between the inner core and the small cone and hence controls appreciably the low frequency amplitude of vibration of the large cone.

Referring to Fig. 4, the voice coil turns 6 and mounting form 7, according to my invention, are molded as a single unit. The form is composed of external and internal sheets or laminations 30 and 31, respectively, of fibrous material such as fabric or paper, or combinations thereof, impregnated with a phenol-resin compound, similar to "bakelite", of such a nature that, when cured or polymerized, gives a rigid, weather-proof structure having a relatively small mass. This compound has the well known advantage that after polymerization it will not soften with heat. The turns of wire 6, preferably of enameled aluminum, are so embedded in the molded form 7 that there is no tendency for the turns to vibrate locally with respect to the form.

The moving coil structure is constructed by impregnating the fibrous layers, with the uncured phenol-resin, and winding in proper sequence on a mandrel. The internal layers 31 are preferably of paper, and the external layers or covering 30 are preferably of a fabric such as silk. The voice coil winding is generously coated with the phenol-resin compound during the winding process. For the purpose of forming a truncated conical flange 35 on one end of the coil form, for securing to the cone, the laminated layers are preferably radially slit at this end in such manner that, when wound on the mandrel, the laminated material will be caused to assume the desired angle shown in the drawing.

There may also be embodied in the above structure means for securing flexible terminal leads 37, for external circuit connections, to the ends 39 of the voice coil winding. In the present example but one of such ends is shown. During the winding operation, these ends are bent as shown so as to terminate preferably in the flange 35, although if desired, they may terminate short of the flange. For this connection, the flexible lead is soldered or welded to the ends 39 of the relatively rigid wire of the voice coil, preferably within the laminated structure of the flange 35, whereby after curing, the ends of these wires are held rigidly and the flexible lead is brought out of the rim of the flange at a desired distance from the pole pieces. This construction obviates the necessity of fastening the flexible leads to the diaphragm by various

means, as has heretofore been the custom. When heat and pressure are applied during the curing process, the phenol-resin 33 is forced completely around the wires, and the fabric and wires are formed into a compact, rigid, unitary structure that is so strong and light that large forces are adapted to be transmitted from the voice coil to the diaphragm at high audio frequencies without appreciable sound distortion and without danger of mechanical deformation of the parts of the structure subjected to said forces.

In consonance with the features of construction of the above rigid, weatherproof moving coil structure, the diaphragms 11 and 25 are preferably constructed of materials having similar durable properties. In the device that I have constructed and used, I have employed for the diaphragm layers of fabric and a phenol-resin compound, in a combination commercially known as "micarta". It is preferable that the radial edges of the diaphragm, when the cone is formed, be brought together edge to edge and that an extra strip 41 be cemented and riveted thereto in order to secure the edges together. This results in uniform diaphragm thickness at the small end of the cone for securing the same to the flange 35 of the coil form as shown, as by means of cement. If desired, a seamless cone may obviously be molded and, furthermore, it has been found desirable, in some cases, to mold the cone into a unitary structure with the coil form for purposes of maximum strength and great durability.

The moving coil is centered in the air gap by means of a resilient spider 43 secured at its center to the inner pole piece. The spider is preferably of light, flexible metal, such as phosphor-bronze or duralumin, the arms of which have upturned ends 44 for attachment to the flange of the coil form as by rivets, and preferably securing the small end of the cone between the ends 44 and the flange on the coil form. The base of the large cone is supported by the main framework 45 by means of an annular strip 47, preferably of rubberized fabric or other flexible material, that is secured at one edge to the framework and, at the other edge, to the base of the cone, in accordance with the usual practice.

By reason of the foregoing novel features of construction, I am enabled to provide a loudspeaker of the electro-dynamic type, having a greatly increased overall power rating for the production of tremendous volume of sound, which construction is particularly adapted to exposure in all kinds of weather and heat conditions. I have, furthermore, provided a loudspeaker having greatly improved acoustical properties under conditions of large volume of power.

Although I have disclosed but one embodiment of my invention, I am entitled to all changes in construction, within the spirit of the appended claims, that would occur to one skilled in the art. For example, although I have illustrated a loudspeaker having an electromagnetic field it is within the scope of my invention to employ a strong permanent magnetic field in combination with the above described voice coil cooling means. It is further within the limits of my invention to use the above features of construction in connection with any sound translating device such as a transmitting microphone of the dynamic type for example.

I claim as my invention:

1. In a loudspeaker, a voice-coil and unitary sound-radiating and voice-coil cooling means associated therewith.

2. In an electrical translating device, means for simultaneously generating sound waves in accordance with undulatory signalling currents and for causing a flow of a coolant unidirectionally through said device.

3. In an electrical translating device, means adapted to move in response to undulatory signalling currents, and means associated therewith for simultaneously pumping a coolant unidirectionally through said device.

4. In a sound translating device, an armature of the moving conductor type adapted to carry heavy signalling current, means responsive to said current for causing a unidirectional flow of air or other coolant over said armature.

5. In a sound translating device, a vibratory armature subject to undesirable heat conditions, a magnetic field structure having pole pieces adjacent said armature, and means operated by said armature for causing a cooling stream of air to flow between the poles and said armature.

6. In a sound translating device of the moving coil type, a magnetic field structure having an air gap in which the moving coil is adapted to vibrate, means secured to said coil for causing a unidirectional flow of air up one side of said coil, and structure cooperating with said air gap and said means for causing a unidirectional flow of air down the other side of said coil.

7. In a loudspeaker, a relatively large conical diaphragm adapted to radiate low frequency sound waves, a voice coil affixed to said diaphragm, and means carried by said diaphragm having the double function of radiating high frequency sound waves and of supplying a cooling air current to said voice coil.

8. A relatively large conical diaphragm having means concentric with the axis thereof for setting up an unidirectional axial air current during vibratory movement of said diaphragm.

9. The invention set forth in claim 1, characterized in that the cooling means is constituted by a relatively small truncated conical diaphragm, the base of which is directed toward the voice-coil.

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