In the course of development of high power loudspeakers it has been discovered that the load-carrying capacity is essentially conditioned by the thermal load-carrying capacity of the moving or signal current coil. Now, by an arrangement as herein disclosed the general problem is solved to raise the heat-carrying capacity of a loudspeaker without an incidental increase of dimensions of the moving coil and an incidental increase of the magnet system so that with normal dimensions and weights a considerably greater reproducing power of loudspeakers is secured.

It is already known in the art of high power loudspeakers to fit a perforated cone at the constricted end or throat of the diaphragm in order to create, as it were, a diaphragm pump designed to cause air circulation about the moving coil. However, the increase in power secureable by such arrangement is practically inappreciable because of the low speed of chilling air flow. In fact where medium, high, and highest frequencies are concerned no additional cooling will occur at all because of the low amplitudes in these frequency bands.

According to the invention the heat-carrying capacity of a loudspeaker is enhanced by cooling the moving coil, and, optionally also the field coil with air or a gas such as hydrogen, helium, or the like possessing high heat conducting properties, such fluid being blown through the air gap in which the moving coil oscillates. The cooling air or fluid is furnished from a distinct blower, as for example, a small sized compressor.

In many cases there will be also a chance to connect the loudspeaker with existing compressed air mains. Where hydrogen, helium, or the like is used, it will be evident that care must be taken so that gas losses are minimized, for instance, by causing the gas so used to pass through a circulating or cyclic path.

In what particular way the cooling fluid is brought to the moving coil is of subordinate importance so far as the essential feature of cooling is concerned. For example, the air inlet may be posteriorly of the yoke and central in the core and the air may be caused to flow through a plurality of radial openings in the posteriorly closed air gap. It is furthermore possible to cause the air to flow past the field coil first and to direct it therefrom to the moving coil in which case the air would escape from the loudspeaker at the side or end of the air gap turned towards or facing the diaphragm. Another plan would be to admit the air between field coil and leading pole plate and to thereupon bifurcate the path of flow of the air so that part thereof flows past the moving coil and another part past the field coil with a resultant cooling of both loudspeaker parts. To prevent particles of dirt and dust from getting into the air gap it is recommended to use filtered air for cooling.

The drawings appended hereto illustrate several exemplified embodiments of the object of the invention. Figs. 1 to 4 show several embodiments and the methods of circulating the cooling medium, while Figs. 5 and 6 illustrate special means designed to avoid disturbances in chilling air supply. Fig. 7 shows graphically the technical advance secured by an arrangement according to the invention. Similar elements of construction are designated by identical reference numerals.

Referring to the loudspeaker illustrated in Fig. 1, 1 denotes the diaphragm, 2 the diaphragm frame, 3 the magnet system, 4 the field coil, 5 the moving or signal current coil, 6 the air gap in which the latter oscillates, and 7 the spider insuring centered position. The compressed air in this particular embodiment is admitted upon the posterior side of the yoke 7 through one or more central holes by which it enters through several radial holes 9 into an air chamber 10 located posteriorly of the moving coil. From this comparatively large annular chamber 10 the cooling air is admitted through narrow gaps 11 into the air gap in which the moving coil 5 is accommodated.

By the special design of the annular chamber 10 and the gaps 11 located in the path of flow posteriorly thereof a uniform distribution of the air flow so as to come in contact with the entire moving coil is obtained. Upon the volume of the current allowed to flow through an upper limitation is imposed by incidently produced noises (hissing). By an arrangement constructed according to the invention conditions are made so that the hissing noise will be quite tolerable even with comparatively large volumes of air.

In an embodiment as shown in Fig. 2a the air is admitted at the yoke and is conveyed to the field coil 4 through the opening 12.

The chilling air flows through the gap 12 between the central pole 13 and field coil 4 and then reaches the moving coil 5. In order to maintain the path of flow for the air between the field coil 4 and the middle pole 13 three or four centering pieces 14 are provided between coil 4 and middle pole 13.

Also in this embodiment by a suitable form of construction of the air supply or admission chamber hissing is largely reduced. If the air supply
is properly chosen the noise generated by the air may even be reduced to a point where it falls below the hum level. This condition more particularly is obtainable by reducing the air flow speed at the inlet point to the system below the speed in the gap, in other words, by making the air admission cross-section larger than the outlet cross-section in the air gap, a fact which is clearly distinguishable in the embodiment shown in Fig. 2a.

Now, it has been ascertained that as uniform as possible a distribution or conveyance of the air throughout the whole annular cross-section of air gap 13a and thus also of the air gap 5a wherein coil 5 oscillates is imperative. For in the presence of non-uniform distribution charging may arise at the moving coil 5. Thus, uniform distribution of air according to a further object of the invention is insurmountable by making the air supply duct or channel spiral-shaped or more particularly in the form of so-called Archimedean screw. With constant width of channel, the height grows in accordance with the moving coil. This distance from the beginning of the spiral, for instance, in such a way that at a distance of 180 degrees the height of the channel is half of what it is at the beginning.

Fig. 2b illustrates an air duct channel designed, as suggested above this being a section taken on line 2b—2b in Fig. 2a. The spiral is limited on the inside, in this particular embodiment, by the magnet core 13. Fig. 2b also shows clearly the spacing elements 14.

It will be understood of course that a closed tube or pipe could be used having one or more preferably slot-shaped apertures in the direction of air gap 13a.

In the exemplified embodiment of Figs. 2a and 2b the air passing between the magnet core and field coil causes at the same time cooling of the field coil. Occasionally this is desirable. On the other hand, it may be a disadvantage in so far as the air has already been heated a few degrees and this means a corresponding impairment of the cooling effect of the moving coil. This drawback, which is absent where permanent magnets are used, is avoidable if the air is admitted in a way as shown in Fig. 3. In this embodiment the air supply chamber 17 is formed between the anterior pole plate 18 and the moving coil 5. The air enters through opening 16 of the chamber 17 which again is preferably spiraled, between the anterior pole plate 18 and field coil 4. From the said chamber 17 the air is spread and divided and thus made to flow first through the air gap with moving coil 5 and second, through the space between field coil 4 and middle pole 13 to reach the outlet opening 18 in the yoke 1. If there is no necessity for cooling the field coil no difficulties will be encountered in blocking the air gap at point A so that the entire chilling air available will be caused to flow past in and contact with the moving coil.

In the case of loudspeakers comprising a coil extending beyond the air gap it has been found that under certain circumstances the turns located outside the air gap will not come in perfect contact with the flow of cooling air so that inadmissibly high temperatures were found to arise in these particular turns. According to another object of the invention this difficulty is avoided by fitting flanges upon the pole plate and the central pole so that the air gap is artificially extended suitably to a point beyond the outermost turns of the moving coil. As a result the cool-
trolled by the voice or signal current that the air flow is caused automatically to wax and wane with the power fed to the moving coil.

Fig. 7 graphically illustrates the improved operation obtainable by the invention. This figure shows the signal coil power in terms of watts (abscissa) plotted against the rise of temperature in centigrade of the moving coil (ordinate). These measurements were made with a 150 watt loudspeaker. Graph I shows the rise of temperature in the absence of the cooling air supply while Graph II shows the temperature rise in a loudspeaker subject to air cooling as here disclosed. It will be clearly seen that, for instance, without air cooling, at a temperature rise of 60 degrees the permissible load is only about 55 watts in contrast with around 200 watts for the air-cooled loudspeaker, at the same rise in temperature.

While in the exemplified embodiment here discussed operation with compressed air or raised pressure has been taken as a basis, it will be understood that it is also practicable to work with vacuum.

What we claim is:

1. In a sound translating device, a magnetic field structure having central and outer pole pieces defining a circular air gap, a current-carrying voice coil subject to undesirable heat conditions adapted to oscillate within said air gap, a member surrounding the central pole piece and defining a substantially circular compartment which communicates with the air gap, the central pole piece being provided with an axial bore and with a plurality of passage-ways which communicate between the axial bore and the compartment, and a source of cooling medium connected to said external bore adapted to supply the cooling medium to the compartment through the passage-ways and thence to flow through the air gap whereby the heat generated by the voice coil is dissipated to a large extent.

2. In a sound translating device, a magnetic field structure having a central pole and an outer ring member defining a circular air gap, a current-carrying voice coil subject to undesirable heat conditions adapted to oscillate within said air gap, a substantially cylindrical member surrounding the central pole adjacent the air gap, one end of said member being formed with a flange portion which is in abutting relation with the lower face of the outer ring member and forms an air-tight seal therewith, the opposite end of said member being formed with a flange portion which is in abutting relation with the central pole and forms an air-tight seal therewith, said cylindrical member and the surrounding portion of the central pole forming a compartment, a source of cooling medium disposed externally of the translating device, and means interconnecting the cooling source with said compartment to permit the flow of the cooling medium to the compartment and thence through the air gap whereby the heat generated by the voice coil is dissipated to a large extent.

3. A cooling system for a sound translating device as defined in claim 2 wherein the device is provided with a resistance which is normally disconnected from the voice coil, a switch device under control of the cooling medium and so constructed and arranged that upon failure of the cooling medium supply the resistance is switched to connect with the voice coil whereby the power delivered to the coil is materially reduced.

4. A cooling system for a sound translating device as defined in claim 2 wherein the source of the cooling medium is provided with means for regulating the volume of flow, and means controlled by the strength of the voice coil current for adjusting the regulating means.

5. A cooling system for a sound translating device as defined in claim 1 wherein the device is provided with a resistance which is normally disconnected from the voice coil, a switch device under control of the cooling medium and so constructed and arranged that upon failure of the cooling medium supply the resistance is switched to connect with the voice coil whereby the power delivered to the coil is materially reduced.

6. A cooling system for a sound translating device as defined in claim 1 wherein the source of the cooling medium is provided with means for regulating the volume of flow, and means controlled by the strength of the voice coil current for adjusting the regulating means.

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