ACOUSTICALLY FILTERED PHONOGRAPHIC REPRODUCER

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This invention relates to a phonographic reproducer of the acoustical type such as is commonly used on acoustical-type dictating machines; more particularly, the invention relates to providing such reproducers with an acoustical filter adapted to eliminate substantially all sound radiation to the outside air from the vibratile parts of the reproducer.

Acoustical-type reproducers include a sound box closed at the bottom by a vibratile diaphragm. This diaphragm is vibrated by a moving record through a stylus system so as to reproduce the recorded sounds, the reproduced sounds being collected by the sound box and being thence conveyed to a receiver such as a horn or head set. Such reproducers also radiate sound to the outside air, which radiated sound is commonly referred to in the art as “needle talk.” When the reproducers are used to reproduce high-level recordings such as are made, for example, by electrically operated phonographic recorders, the radiated sounds attain such high volume level as to obscure the intelligibility of the reproduced sounds from the horn or head set and to be very annoying to others who may work in the vicinity of the reproducing machine. I have found that this undesired sound radiation from the vibratile parts of an acoustical-type phonographic reproducer can be eliminated very simply by providing the reproducer with an appropriate acoustical filter and that this filter, when properly designed, will not affect deleteriously either the quality or level of response of the reproducer.

It is accordingly an object of my invention to provide an improved acoustical-type phonographic reproducer having a high fidelity and efficiency of sound reproduction which is substantially without undesired sound radiation or needle talk.

It is another object to provide an improvement for acoustical-type reproducers of dictating machines, which is adapted to increase the clearness and intelligibility of reproduced sounds so that they can be transcribed faster and with greater accuracy.

It is another object to provide an acoustical-type phonographic reproducer with an acoustical filter which comprises a protective closure for the diaphragm of the sound box.

It is another object to support the stylus system of the reproducer by the protective closure of the acoustical filter.

It is a further object to fulfill the aforesaid objectives by very simple apparatus which can be mounted on standard acoustical-type phonographic reproducers as heretofore manufactured and sold.

Other objects and features of my invention will be apparent from the following description and the appended claim.

In the description of my invention reference is had to the accompanying drawings, of which:

Figure 1 is a central vertical section through a phonographic reproducer embodying my invention;

Figure 2 is a bottom plan view of this reproducer; and

Figure 3 is a circuit of the approximate electrical analogue of the filter.

The phonographic reproducer shown in the accompanying figures comprises a basic reproducer arrangement common in the art such as is illustrated by the Holland Patent No. 1,207,404, patented December 5, 1946. Such a reproducer arrangement comprises a sound box 1 including a circular casing 2 having integral therewith a tubular neck 3 which is adapted to be connected to a horn or head set (not shown). This casing has an internal sound chamber 4 which has an opening leading through the neck 3 and which is closed at the bottom by a diaphragm 5. The diaphragm is mounted between two rubber gaskets 6 and 7 which are held in place by a ring 8 that is screw-threaded to the interior surface of an annular flange 9 of the casing, there being a metallic ring 10 interposed between the gasket 7 and the ring 8.

Below the sound box there is a depending arm 11 for supporting a stylus system that is adapted to couple operatively the diaphragm to a moving phonographic record R fractionally shown, by way of example, as of the cylindrical type. This arm has a forked bottom portion 12 which carries a pivot pin 13 in parallel relation to the diaphragm. Straddling the forked portion are two arms 14 of a bracket 15, which have apertures engaged respectively by conical end portions of the pin 13. This bracket has two vertically-spaced lugs 16 and 17. In the upper lug there is a hole forming a bearing 18 and in the lower lug there is a threaded hole engaged by a screw 19 that has a V-bearing 20 at its inner end portion; the screw 19 being held in adjusted position by a lock nut 21. The bearings 18 and 20 are engaged by the conical ends 22 of a pivot shaft 23. To this shaft is secured a biasing weight 24 which extends diametrically from the bracket 15 across the sound box. It will be observed that this floating weight is universally supported in that it has an up-and-down freedom of move-
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3

4

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ment relative to the record about the pivot rod 13 and a lateral freedom of movement in the bearings 20 and 22. Extending from the free end portion of the biasing weight is a pin 25 which passes through a U-shaped member 26 that is carried with the sound box so as to restrict the biasing weight to a limited range of movement.

The biasing weight is provided with a central hole 27 and with the opening standards 28 at the side of the hole 27 which is nearest the free end of the weight. These standards carry a pivot pin 29 on which is pivoted a stylus lever 30. This stylus lever is connected at its inner end to the diaphragm by a link 31 that passes through the central hole 27 of the biasing weight. At the free end of the stylus lever there is mounted a reproducing stylus 32 which is adapted to ride in the groove of a phonograph record. Normally, the phonographic reproducer is carried above the record and the stylus pressure on the record is provided by the force of gravity acting on the weight 24. During reproducing, ready tracking of the stylus in the record groove is enabled by the universal freedom of movement afforded the biasing weight. It will however be understood that for the purposes of my invention the stylus pressure need not be provided by the gravitational force on the weight 24 but may be augmented or supplied substantially by a spring-bias of the member 21 provided by a torsional spring 33 on the pin 13 as illustrated in Figure 1. When the stylus pressure is produced chiefly by spring action, the reproducer may be operated in a vertical position as well as in the horizontal position shown.

During operation of the reproducer the diaphragm is vibrated according to the modulations in the groove of the record to generate corresponding sounds within the sound chamber 4. These sounds are then conveyed through the neck 13 to the horn or headset. Also, the diaphragm will generate sounds at its lower side which are radiated into the outside air in the reproducers as heretofore commonly used. Theoretically, the stylus lever and link 31 also radiate sounds but these are negligible in comparison to those radiated by the diaphragm. In order to eliminate the undesired sound radiation of the diaphragm, I have mounted an acoustical filter 34 on the bottom of the sound box across the diaphragm. This filter is constructed so as to have an attenuation band through the audio spectrum of the frequency response range of the reproducer. This is accomplished preferably by providing a filter of the low-pass type which has its cut-off frequency at the low end of that spectrum.

This filter 34 comprises a closure member 35 that is made preferably integral with the ring 8 aforementioned. This closure member—which serves also as a protective means for the diaphragm—is spaced from the diaphragm to form an internal sound chamber 35 at the side of the diaphragm opposite the chamber 4. This chamber 35 is separate from the chamber 4 and is closed except for a restrictive orifice 37 to pass the air to the outside. However, the chamber has a sufficient volume so that it will not exert any undesired restrictive influence on the free vibration of the diaphragm. Thus the acoustical filter is prevented from adversely affecting the response of the reproducer.

Furthermore I support the entire stylus system of the reproducer by the closure member 35 since this facilitates the assembling and servicing of the reproducer. To this end the arm 11 is secured as by soldering to the closure member as indicated in Figure 1.

The orifice 37 in the closure member has preferably a minimum diameter providing only the necessary clearance for the link 31. The orifice is however made effectively long by an internal tube 38 in the chamber 35 which is secured at its outer end to the closure member. When the orifice is made effectively long and small in diameter the inerterance of the air within the orifice is made large enough that with a volume of the chamber 35 provided readily in practice the resonant frequency of the chamber—which is slightly below the cut-off frequency of the filter—occurs at the lower end of the frequency range of the reproducer. Thus the attenuation band of the filter is throughout substantially the entire response range of the reproducer. I have found that when the resonant frequency is of the order of 500 cycles per second the average attenuation in the useful frequency-response range of the reproducer is generally of the order of 15 decibels. This is a substantial attenuation which in practice is found to eliminate almost entirely all outside sound radiation or so-called noise talk.

The approximate electrical analogue of the acoustical filter 34 is shown in Figure 3. In this circuit the driver D corresponds to the diaphragm 5 and typically has an internal impedance which is high relative to the impedance of the filter. The capacity C corresponds to the acoustical capacity of the chamber 35 and has the value

\[
\frac{V}{\Delta d}
\]

where V is the volume of the chamber 35, \(d\) is the density of air and \(c\) is the velocity of sound. The inductance M corresponds to the inerterance of the orifice 37 and has the value

\[
\frac{5 \times 10^{-5} L}{\pi^2}
\]

where L is the length of the orifice 37 in cms. and \(\pi\) is its radius in cms. The resistance \(R_r\) refers to the frictional resistance of the orifice 37 and has the value

\[
4.74 \times 10^{-6} \frac{L}{\pi^2}
\]

and the resistance \(R\) refers to the radiation resistance of the orifice, this being the load for the filter, and has the value \(2.5 \times 10^{-7}\) when \(f\) is the frequency in cycles per second. The resonant frequency \(f_0\) of the filter has then the value

\[
\frac{1}{2\pi \sqrt{CM}}
\]

and the attenuation for the filter is equal to the formula

\[
1 \left[1 - \left(\frac{f}{f_0}\right)^2\right] + 2\pi \sqrt{CM} \left[R_r + R_m\right]
\]

By way of preferred example the invention has been carried out successfully to eliminate substantially all undesired sound radiation from the diaphragm, without deleteriously affecting the level or quality of the reproduced sounds of the reproducer, by employing the following values: V, approximately 7 cu. cm. (1 cm. deep by 3 cm. diameter); \(r\), approximately .11 cm. and \(f\), approximately .82 cm. With these values the resonant frequency of the chamber 35 is approximately 340 cycles per second. It will be under-
stood that these values are illustrative and that therefore no unnecessary limitation thereto is intended since the values are not particularly critical.

It is to be noted that I may use as an additional element a suitable sound-absorption material 48 such as Celotex or felt within the sound chamber 36 as indicated in Figure 1. This sound-absorption material improves slightly the low-frequency characteristic of the filter in the vicinity of its resonant frequency. However, it is not considered that the use of this sound-absorption element is important in most practical applications.

While I preferably employ, and have herein particularly shown and described, a simple one-stage filter of the low-pass type for the purposes of my invention, it will be understood that in the broader aspects of my invention I may employ filters of two or more stages as well as other suitable types of filters and that I intend therefore no unnecessary limitation of my invention to the type of filter herein particularly described. It will moreover be apparent that other modifications and changes may be made without departure from the scope of my invention, which I endeavor to express according to the following claim.

I claim:

In an acoustical-type phonographic reproducing apparatus comprising a sound box having a vibratile diaphragm, a biasing weight supported at one side of said diaphragm for universal pivotal movement, a stylus lever pivoted to said biasing weight on an axis substantially parallel to said diaphragm, and a member coupling one end of said stylus lever to the central portion of said diaphragm; an acoustical filter on said sound box for attenuating the radiation of sound from said one side of the diaphragm to the outside air comprising a closure member secured at its edge in air-tight relation to the rim of said diaphragm to provide an air chamber between the diaphragm and the closure member, and a single open-ended tubular member extending through the central portion of said closure member having a clearance opening leading from said chamber and through which passes said coupling member, said tubular member having a length sufficient to provide an air interance resonant with the compliance of the air in said air chamber at a frequency in the lower portion of the audio spectrum, and said compliance being substantially greater than that of said diaphragm.

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