

March 3, 1931.

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1,795,154

PHONOGRAPH SOUND BOX

Filed Sept. 30, 1925

2 Sheets-Sheet 1

Fig. 1

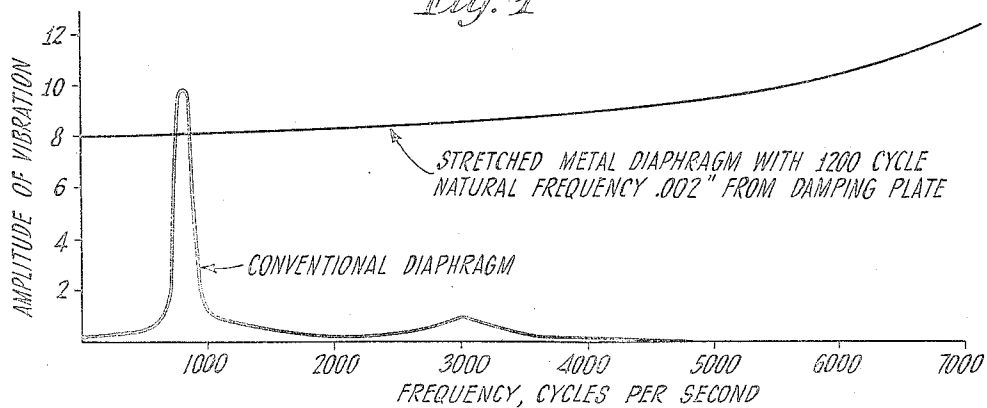
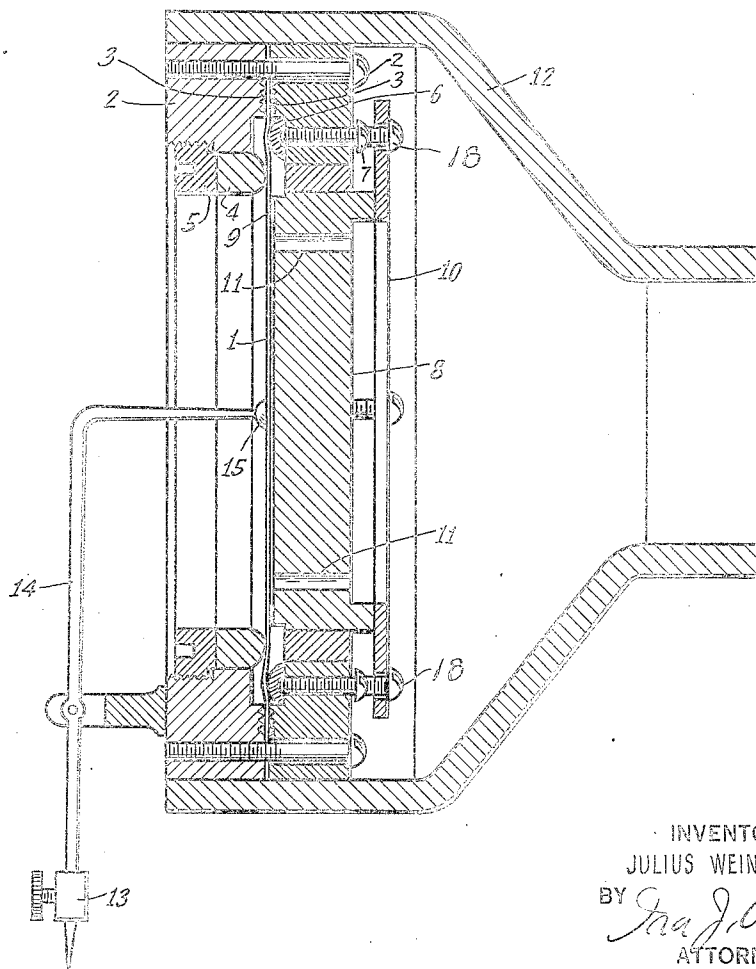


Fig. 2



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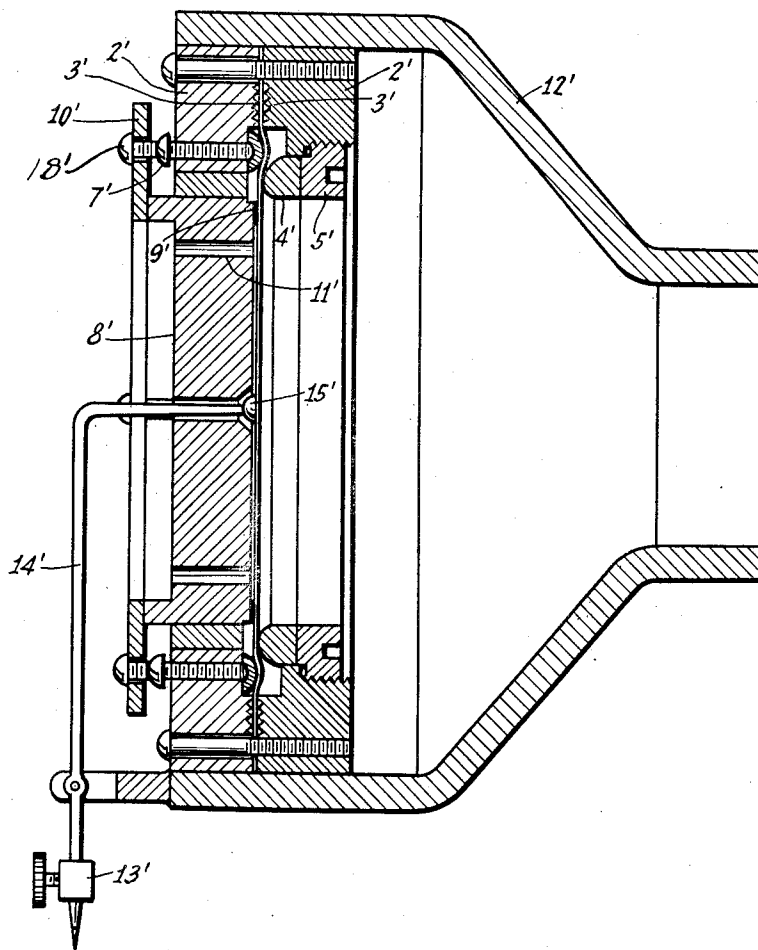
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Fig. 3



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PHONOGRAPH SOUND BOX

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The invention concerns sound reproducing devices and has for its principal object to provide such a device with greatly improved operating characteristics.

Another object of the invention is to provide such a device comprising a vibratory element having a natural period of vibration outside of the normal operating frequency range of the device.

A further object of the invention is to provide such a device in which the vibratory element is highly damped.

Still another object of the invention is to provide such a device having a diaphragm with a natural period of vibration outside the normal operating frequency range of the device and provided with a plate placed close to the diaphragm to provide a small air space between it and the diaphragm.

Still another object of the invention is to provide such a device having a stretched metallic vibratory member separated from a plate by a small air space.

While not limited to such a use the invention has particular application to phonograph sound boxes and it will be explained in connection with these devices to clearly bring out its salient features.

It is customary at present to construct sound boxes having a diaphragm of mica or similar material. For example, cardboard, paper, animal skins or membranes have been used as diaphragms. Such materials are loosely held at the edge in soft rubber gaskets or clamped tightly. One side of the diaphragm is left open, and the lever arm to which the reproducing needle is attached is connected at this side. The other side faces the rear of the sound box, which is usually situated at a distance of a tenth of an inch from the diaphragm, and in the center of this back plate is a large hole perhaps half an inch in diameter which leads to the horn.

Sound boxes of this type have several characteristics which are detrimental to accurate

reproduction. First, the diaphragms mentioned all have natural frequencies of vibration which lie within the ordinary musical range. Usually this natural diaphragm frequency is of the order of a few hundred to 1000 cycles. Also, the cavity formed by the diaphragm and back plate, due to the relatively large spacing employed, has a fundamental natural frequency of the order of magnitude of a few hundred cycles. The natural frequencies of the diaphragm and cavity cause them to resonate to certain tones in the range mentioned, and thus give unduly large response to these frequencies; on the other hand, frequencies considerably removed from this range, such as low frequencies of the order of fifty cycles or high frequencies in excess of say two thousand cycles are poorly reproduced.

In order to secure accurate reproduction of music or speech, it is necessary to reproduce with substantially the same volume frequencies ranging from about 30 to well above 5000 cycles. In fact, to reproduce the letter "s" it is necessary to obtain good volume up to about 10,000 cycles. The low frequencies in music, of the order of 30 to 200 cycles, appear, for example, in the low notes of the piano, the bass viol, the kettle drums, the bass and baritone voices. The high frequencies are necessary to obtain true reproduction of the quality of instruments or voices; that is, voices singing a tone of, say, 500 cycles, may have harmonics up to 5000 or 10000 cycles which cause it to possess its particular quality. On the other hand, the resonance of the usual types of phonograph sound boxes may give an entirely false quality to a voice or instrument; for example, if a baritone is singing a fundamental tone of 250 cycles and the sound box reproduces 750 cycles much more loudly than 250, the third harmonic (750 cycles) of the voice will be reproduced out of all proportion to its true relative value with respect to the fundamental of 250 cycles; and the tone as

reproduced will sound more like a tenor voice singing 750 cycles than a baritone voice singing 250 cycles. This is the reason why baritone voices often sound more like tenor voices on the present day phonographs; and is also the reason why piano records reproduce so poorly, since only the harmonics in the low piano tunes are heard and the fundamentals of these tones hardly at all.

The sound box which is the subject of this invention differs from the accepted variety in that the diaphragm is constructed so as to have a natural frequency considerably above the fundamental tones employed in the singing voice range, and the cavity between the diaphragm and the back of the sound box is made small in volume so as to also have a very high natural frequency. The order of magnitude of the diaphragm frequency is from 5000 to 15000 cycles, although it will be clear that the specification of these definite frequency limits does not imply that the invention is limited to this range; they are merely cited to give some idea of the order of the frequency which is regarded as suitable. The spacing between diaphragm and back of the sound box may be made of the order of a few hundredths or even a few thousandths of an inch. A further object accomplished by this reduced spacing is that the small volume of enclosed air helps to damp the vibration of the diaphragm and smooths out its frequency-response characteristic.

The high natural frequency in the diaphragm may be secured by constructing it out of a thin metallic material, and then stretching it. The material used may be steel or strong aluminum alloy (such as duralumin), or molybdenum; in fact, any metal that will withstand the stretching strain is suitable. The thickness of material employed is a few thousandths of an inch, the diameter of the diaphragm being of the order of one to three inches. Such a diaphragm when unstretched, will have a natural frequency of a few hundred cycles, similar to the ordinary non-metallic phonograph diaphragm. But by subjecting it to the stretching process, its natural frequency may be raised as high as desired, within the limits of strength of the material. It is easily possible to secure a natural frequency of 6000 cycles with any of the materials mentioned, and one may go as high as 15000 cycles with steel diaphragms.

It will be seen, therefore, that the sound box of this invention differs from those in ordinary use in that it employs a diaphragm of metal, stretched so as to have a high natural frequency, as opposed to the ordinary unstretched, non-metallic, low frequency diaphragms.

The invention is illustrated by way of example in the accompanying drawings in which,

Fig. 1 shows a group of comparative curves comparing the operation of the device with a previous device of similar nature,

Fig. 2 is a sectional view of a phonograph sound box illustrating the invention and

Fig. 3 is a sectional view of a modification of the device shown in Fig. 2.

Referring now to Fig. 2, the diaphragm indicated by 1 is firmly clamped between two heavy metal rings 2, 2, by means of ridges or threads as shown at 3, 3. The diaphragm is stretched by bringing the blunt edge of ring 4 up against one side by means of the ring 5 revolving in a thread in 2, and the ring 6 up against the other side by means of screws 7. The pressure exerted by means of rings 4 and 6 is controlled in such fashion that the diaphragm is kept in a vertical plane but at the same time is gradually stretched until it has some particular desired natural frequency. It may be noted, in passing, that the natural frequency of the diaphragm when the back plate 8 is put in place, may be higher than the natural frequency without the back plate, due to the elastic reaction of the air between diaphragm and plate. This increase in frequency depends on the spacing between diaphragm and back plate. A spacing washer 9 is inserted between the diaphragm and the back plate 8 and the latter is held in position by means of the clamping member 10, which is adjustably clamped against the plate 8 by means of the screws 18. The thickness of the washer thus determines the spacing between diaphragm and back plate. The latter is provided with a series of holes indicated at 11, near the outer edge of the diaphragm, so that the sound may pass from the cavity between diaphragm and back plate into the horn. The dimensions of these holes may be advantageously chosen to diminish the ease of passage of sounds having frequencies of the order of the natural frequency of the diaphragm, and thus diminish "scratch" (the latter being in large part due to shock-excitation of the diaphragm into its natural modes of vibration by the friction of the needle on the record.) The horn or tone arm 12 may be connected to the sound box in any convenient manner. The needle holder 13 and lever arm 14 are attached to the front of the diaphragm by wax, as at 15, or in any other convenient manner.

The difference in frequency response characteristics of the high natural frequency stretched diaphragm and an unstretched diaphragm of the conventional type is illustrated in Fig. 1. It will be seen that the conventional type gives a widely varying response in the important range from 0 to 4000 cycles, while the stretched diaphragm is practically uniform in response. The response of the latter does increase at its resonant frequency, but this is considerably outside the range of

the musical tones ordinarily employed and hence is of no practical consequence.

Obviously the action of the damping plate represented by 8 in Fig. 2 is not dependent on its position in the rear of the diaphragm and it may, if desired, be placed in front of the diaphragm. This construction is shown in Fig. 3 in which the same reference numerals with the primes added designate parts corresponding to those in Fig. 2. In this modification an aperture is provided in the plate 8' to permit the angular extension of the arm 14' to pass through. The plate 8' is held in position by the ring 10' fastened to one of the rings 2' by suitable screws. The ring 10' is adjustably clamped against the plate 8' by means of the screws 18'. This construction leaves the side of the diaphragm facing the horn opening free, which may be advantageous in certain cases. If desired the plate 8' may be made in two pieces so that the lever arm 14' may be attached to the diaphragm at 15' conveniently and the plate 8' then placed against the diaphragm and secured by clamp 10'.

It is obvious that the construction indicated may be adapted for use on records made in hill and dale as well as side-cut form or in any other manner. Also, the same principles may be applied to sound boxes arranged to convert the motion of the needle to electric currents, as for example, such wherein the diaphragm is utilized as an element of a condenser transmitter or as an electromagnetic element to induce currents in a magnet winding; and such applications are regarded as within the scope of the invention.

It is also obvious that mechanical arrangements can be devised of different form than those shown in the drawings which will accomplish the same results and such arrangements are also regarded as within the scope of the invention. Also a mica diaphragm may be substituted for the metal one in certain cases.

Having now described my invention, I claim:—

1. A device for translating mechanical vibrations into sound comprising a diaphragm, means for increasing the natural frequency of said diaphragm above the normal operating frequency range of said device and a rigid non-vibratory plate in proximity to one face of the diaphragm and spaced therefrom to form a cavity having a natural resonant period above the normal operating frequency range of said device.

2. A phonograph sound box comprising a diaphragm and a rigid non-vibratory plate in proximity to one of the faces thereof and so located as to form a cavity having a natural resonant frequency above the normal operating frequency range of said sound box.

3. A phonograph sound box comprising a

diaphragm of sheet metal, means for clamping the diaphragm at its edges, means for stretching the diaphragm to substantially increase its natural frequency, a rigid non-vibratory plate mounted in proximity to a face of the diaphragm and so spaced therefrom as to form a cavity having a natural resonant frequency above the normal operating frequency range of said sound box and to exert a substantial damping effect on the vibrations of the diaphragm by means of the air enclosed between the diaphragm and the plate.

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