T. A. EDISON.

APPARATUS FOR RECORDING OR REPRODUCING SOUNDS.

APPLICATION FILED MAY 24, 1905.

963,362. Patented July 5, 1910.

Fig. 1.

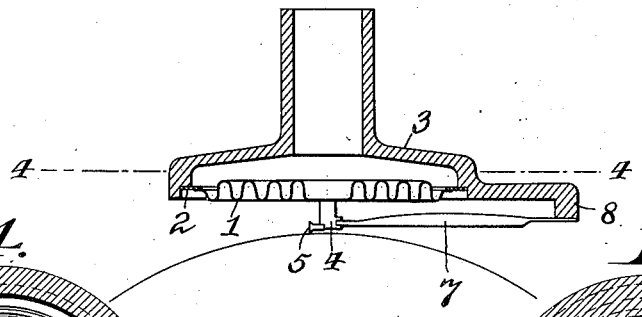


Fig. 4.

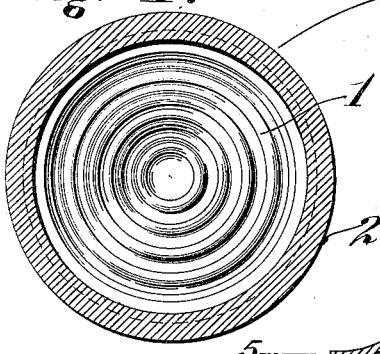


Fig. 5.

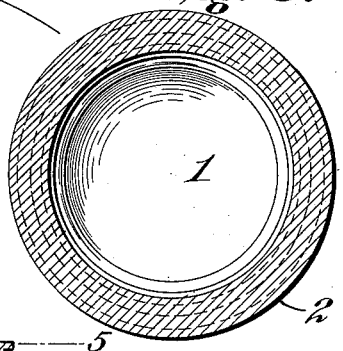


Fig. 2.

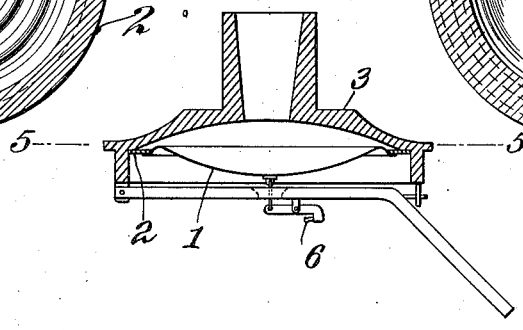
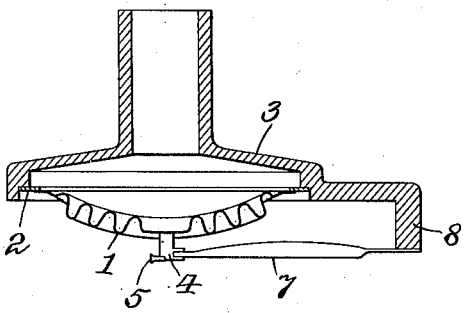


Fig. 3.



Witnesses:
Edgeworth Sperry
Wm. C. MacArthur

Inventor
Thomas A. Edison
by Frank L. Dyer
Attorney.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, ORANGE, NEW JERSEY.

APPARATUS FOR RECORDING OR REPRODUCING SOUNDS.

963,362. Specification of Letters Patent. Patented July 5, 1910.

Application filed May 24, 1905. Serial No. 261,950.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, Orange, in the county of Essex and State of New Jersey, have invented certain Improvements in Apparatus for Recording or Reproducing Sounds, (Case B,) of which the following is a description.

My invention relates to various new and useful improvements in apparatus for recording or reproducing sounds, and my object is to provide an apparatus for the purpose which shall permit a more accurate recording of the sound waves free from waves or disturbances, due to the recording mechanism itself, and a more accurate reproduction of the same than is possible by methods and apparatus heretofore known.

In an application for Letters Patent filed on even date herewith, and relating to methods of recording or reproducing sounds, I have pointed out the cause or origin of the false, discordant and inharmonic sounds which are created within the recording mechanism, and which become recorded to affect the character of the reproduction.

With diaphragms as now made a thin plate, or a series of superposed plates, of greatly reduced diameter has been tightly clamped at the edge, so that any vibration must take place by the flexing or bending of the diaphragm itself. Such a diaphragm, moreover, acts practically as a reed and produces a note of its own, so that it vibrates sympathetically with certain notes within the range of music, and thereby produces inharmonic resultant tones which become recorded with the other sounds. Furthermore, such a diaphragm, in vibrating, vibrates locally so as to form a large number of nodes, as has been demonstrated by the production of the so-called Chaladni figures, and these vibratable local areas are also probably responsive to certain musical tones or overtones to result in the production of certain extraneous sounds, which become recorded and mar the reproduction. Moreover, such a diaphragm, owing to its clamped edges, vibrates with relative difficulty, and, hence, is not as sensitive as it should be; and, since it vibrates locally, the local vibrations are not communicated to the recording stylus, and, consequently, a proportionate loss of energy takes place to weaken the recorded sounds.

Notwithstanding the inherent lack of sensitiveness which is characteristic of ordinary diaphragms, the fact is that in the attempt to obviate the production of the inharmonic sounds referred to, it has been the practice to purposely further diminish the sensitiveness of the diaphragm to such an extent that the volume or strength of the inharmonic sounds is reduced so that they are not so prominent; but this practice has been ineffective for the purpose, and the diaphragms are so lacking in sensitiveness that the delicate overtones which accompany the fundamental tones, and which give to music its pleasing quality, are weakened in most cases so as to be practically inaudible, while distortion of the sound sought to be recorded is produced.

In correcting the faults which exist in diaphragms as now constructed, I have produced a diaphragm which is entirely free from any audible fundamental tone or overtone of its own, and which, therefore, does not vibrate sympathetically with any tones within the range of music. I thus prevent not only the distortion of the original sound waves, but I also prevent the production of inharmonic sounds, such as are produced with diaphragms as heretofore made. Furthermore, my improved diaphragm can be and is extremely sensitive, so as to accurately respond to and effect the recording of all fundamental tones as well as their overtones. Finally, with my improved diaphragm, inertia due to weight is reduced to a minimum, and, consequently, false vibration caused by overthrow and retardation is largely overcome, this being especially true in the case of vibrations of high frequency. I attain this result by employing a rigid diaphragm of a novel type, which, instead of vibrating in the usual way, vibrates as a whole, the entire displacement taking place at the edges, and I employ with that diaphragm at the periphery thereof an extension or continuation of soft pliable yielding material so as to operate practically as a hinge, the whole having no audible tone within the range of music. I have constructed diaphragms of extreme lightness, and, at the same time, so rigid that the loudest sounds ordinarily used in the art do not set any special local area in vibration sufficient to produce Chaladni figures, so that the whole vibrates or follows the sound waves with great accuracy by being forced.

In order that the invention may be better understood, attention is directed to the accompanying drawings, forming part of this specification and in which:

Figure 1, is a sectional view of a suitable recording apparatus embodying my present improvements, showing a flat corrugated diaphragm; Fig. 2, a similar view of a reproducing apparatus embodying my improvements, showing a dished or concave diaphragm; Fig. 3, a similar view of a recording apparatus, embodying my invention and showing a diaphragm that is both corrugated and dished; Fig. 4, a plan view of the diaphragm shown in Figs. 1 and 3, and Fig. 5, a plan view of the diaphragm shown in Fig. 2.

In all of the above views, corresponding parts are represented by the same numerals of reference.

A diaphragm 1, is shown in Figs. 1 and 4 as being provided with concentric corrugations, made so deep that the diaphragm acts as a rigid body to sound waves, and vibrates to and fro like a piston without bending or flexing at the center, as with ordinary diaphragms clamped at the edges. The rigidity of the diaphragm is such that if clamped at the edges in the usual way it would not vibrate under the effect of sounds as ordinarily used in this art. Furthermore, the diaphragm is so rigid that it is free from local vibrations which with ordinary diaphragms produce Chaladni figures. The diaphragm shown in Figs. 2 and 5 is dished or scooped for the same purpose, but this is not quite so effective when deep corrugations are used. In any case, the diaphragm should be as light as possible, and be stiff enough to vibrate as a rigid body. It will, therefore, be understood, that the diaphragms may be both dished and corrugated, as shown in Fig. 3, in order that metal of exceeding thinness can be used. Preferably the diaphragm is made of very thin metallic magnesium, which is extremely light and very rigid when corrugated, particularly when both dished and corrugated, and very thin sheets can be used—much thinner in fact than with glass diaphragms as now commonly employed. To this rigid piston-like diaphragm is secured around its outer edge a ring 2, preferably of soft rubber, which is held in place by shellac or other cement, so as to form practically a yielding extension of the diaphragm, and which, when the diaphragm vibrates to and fro, vibrates practically as a hinge having a negligible resistance. The ring 2, may be made of other materials than rubber, such as leather, paper, thin collodion, etc., but thin rubber tissue is preferable for obtaining great sensitiveness. This ring 2, is cemented or otherwise secured without tension to any suitable arrangement of head or body 3, with which a speaking tube, listening tube or horn may be connected.

When used for recording purposes a foot 4, carrying a suitable recording stylus 5 (Figs. 1 and 3), is cemented or otherwise secured to the diaphragm. When used with a reproducer, a reproducing stylus 6 (Fig. 2) is preferably pivoted to the usual floating weight and connected to the diaphragm by a link in the usual way.

In order to take the thrust imposed by the rotation of the recording surface with respect to the recording stylus, I extend a link 7, between the foot 4, and an arm 8, depending from the head 3, said link being made preferably of wood so as to be very light, and having its vertical dimension greater than its transverse dimension, and of constantly varying section reduced to a very thin leaf at the end where it is secured to the arm 8, whereby the formation of nodes will be prevented and the fundamental tone of the link be so grave as to be below the range of ordinary music, as I describe and claim in my application filed November 13, 1903, Serial No. 180,998. When the diaphragm vibrates it follows the very slight arc which the free end of the link describes, the yielding ring 2, permitting the diaphragm to move laterally to the desired extent, so that there is no cramping in operation.

Since the diaphragm can vibrate only to and fro as a rigid body, like a piston, any yielding is necessarily confined to and takes place entirely within the small free portion of the ring 2, extending between the diaphragm and the cement which holds the ring in place. This yielding section can have no audible local disturbing tone; and hence, all of its movements, as well as those of the diaphragm, are forced, and the recorder is, therefore, caused to accurately follow the sound waves.

Since the action of the diaphragm is analogous to that of a piston subjected to pressure, first on one side and then on the other, it follows that any movements of the yielding section or bulging thereof beyond the movement of the diaphragm will diminish the amplitude of the latter, and for this reason the yielding section should be very thin and the area very small. In practice, I increase the diameter of the rigid diaphragm to as great an extent in proportion to the yielding material as possible, the latter being usually about six per cent. of the whole area. In this way I concentrate nearly the whole of the condensations and rarefactions of the sound waves upon the diaphragms proper, so as to cause it to give the maximum response thereto, and prevent, to the greatest possible extent, loss of pressure due to yielding of the yielding section.

When a rigid diaphragm of my improved type is used in connection with reproducing apparatus a number of advantages are secured, as when employed with a recording apparatus. In the first place, owing to its extreme sensitiveness, the diaphragm accurately follows and responds to the recorded sounds; and, owing to its extreme lightness, inertia is reduced to a minimum so as to reduce the tendency of the diaphragm to leave the record, particularly when the recorded waves are very deep or of high frequency. Furthermore, the great lightness of the diaphragm materially reduces wear upon the recorded surface. In the next place, since the diaphragm is free from any fundamental tone or overtone of its own, it cannot respond sympathetically with any of the recorder sounds to thereby distort the reproduction and make it inharmonic. Finally, since the diaphragm is incapable of vibrating locally, the creation of extraneous sounds from that cause in the reproduction is also overcome.

While I have described my improved apparatus in connection with the recording and reproduction of sounds phonographically, and wherein the recorder forms, or the reproducer follows, a record of varying depth, it will be understood that the apparatus can be effectively utilized with machines of the gramophone type, wherein a zig-zag record groove is formed, it being only necessary in the latter case to connect the diaphragm with a recorder adapted to form, or with a reproducer adapted to follow, such a zig-zag record groove.

Having now described my invention what I claim as new therein and desire to secure by Letters Patent is as follows:

1. In apparatus for recording or reproducing sounds, the combination of a body and a very thin diaphragm formed of a light metal, said diaphragm being dished or concave, and provided with deep concentric corrugations, said diaphragm being connected to said body by a hinge of a material having greater pliability than that of the diaphragm, substantially as set forth.

2. In apparatus for recording or reproducing sounds, the combination of a body and a very thin diaphragm formed of magnesium, said diaphragm being dished or concave, and provided with deep concentric corrugations, said diaphragm being connected to said body by a hinge of a material having greater pliability than that of the diaphragm, substantially as set forth.

3. In apparatus for recording or reproducing sounds, a very thin diaphragm formed of a light rigid and elastic metal, said diaphragm being dished or concave for practically its whole width, and provided throughout with deep concentric corrugations, substantially as set forth.

4. In apparatus for recording or reproducing sounds, the combination with a body and a diaphragm secured thereto by a hinge of yielding material so as to be capable of lateral movement, of a stylus connected to said diaphragm and a light rod anchored at one end and connected at its other end to said stylus for receiving the thrust thereof, said rod being so shaped as to give forth no audible tone in vibrating, substantially as set forth.

5. A diaphragm made of metallic magnesium and having a concave portion formed with concentric corrugations, substantially as set forth.

6. A diaphragm made of metallic magnesium and united to a circumferential section of small area composed of material having greater pliability than magnesium and which is adapted to operate as a hinge under the movements of the diaphragm, substantially as set forth.

This specification signed and witnessed this 20th day of May, 1905.

THOS. A. EDISON.

Witnesses:
FRANK L. DYER,
ANNA R. KLEHM.

Corrections in Letters Patent No. 963,362.

It is hereby certified that in Letters Patent No. 963,362, granted July 5, 1910, upon the application of Thomas A. Edison, of Llewellyn Park, Orange, New Jersey, for an improvement in "Apparatus for Recording or Reproducing Sounds," errors appear in the printed specification requiring correction as follows: Page 2, line 37, after the word "effective" the word *as* should be inserted; page 3, line 19, the word "recorder" should read *recorded;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of September, A. D., 1910.

[SEAL.]

C. C. BILLINGS,

Acting Commissioner of Patents.