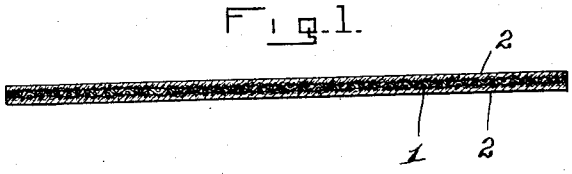
Sept. 1, 1925. 1,552,311

G. D. KELLOGG

ACOUSTIC DIAPHRAGM

Filed June 8, 1922

Fig. 1.



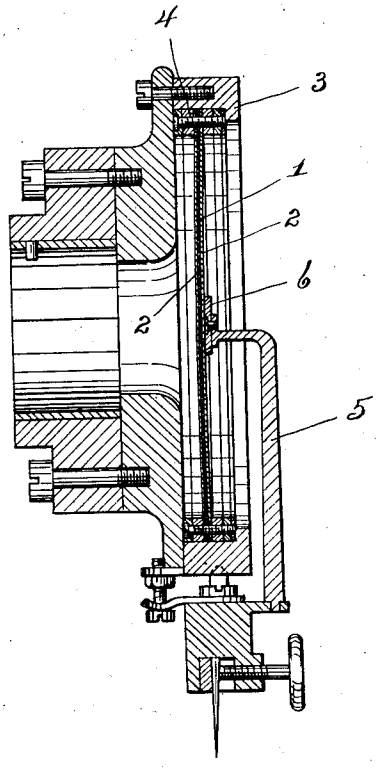


Fig. 2.



Fig. 3.

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Patented Sept. 1, 1925. 1,552,311

UNITED STATES PATENT OFFICE.

GEORGE D. KELLOGG, OF ALBANY, NEW YORK.

ACOUSTIC DIAPHRAGM.

Application filed June 8, 1922. Serial No. 566,844.

To all whom it may concern:

Be it known that I, GEORGE D. KELLOGG, a citizen of the United States, residing at Albany, in the county of Albany and State of New York, have invented new and useful Improvements in Acoustic Diaphragms, of which the following is a specification.

Reference may be had to the accompanying drawings, and the reference characters marked thereon, which form a part of this specification. Similar characters refer to similar parts in the several figures therein.

The principal object of the invention is to obtain more faithful recording and more faithful and pleasing reproductions of sounds.

Other objects will appear in connection with the following description.

Acoustic diaphragms, such as those used in sound-boxes, phonographs and the like, have been made of various materials varying somewhat in elasticity and resiliency, but in all of which, so far as I am aware, the diaphragm was inherently capable of substantially free or undamped vibration upon the termination of the vibrational impulse.

A more faithful and pleasing reproduction of recorded sounds can be obtained by damping the vibrations of the diaphragm. This result I attribute to the fact that where the diaphragm is inherently capable of substantially free and undamped vibration, a single vibrational impulse imparted to the diaphragm causes it to vibrate a number of times after that impulse is terminated, the first few of the successive vibrations being of almost the same amplitude and sound-producing force as the original vibration, the result of which, in a phonograph or the like, is that a second vibrative impulse is imparted to the diaphragm while it is still under the sound-reproducing vibrational influence of the immediately preceding, but terminated, vibrational impulse.

Undamped sound-producing vibrations set up in such a diaphragm by successive vibrative impulses thus overlap, interfere with, and modify one another.

In carrying out my invention, I employ a diaphragm inherently capable of damped vibrations only, by which I mean that while the diaphragm is responsive to a vibrative impulse, the vibrations due to that impulse cease or become negligible as to producing, or interfering with the production of, sound, approximately as soon as that impulse is terminated.

The results of many experiments have shown that it is desirable to use in an acoustic diaphragm a soft elastic substance, such as soft vulcanized rubber; and that, by combining with this elastic substance suitable adulterants or fillers, the resultant body can be made inherently capable of damped vibrations only, and can thus be made to accomplish the object of my invention.

For certain purposes of the invention, however, it is not necessary to use rubber; and good results can be obtained by the use of various other soft elastic substances such as gutta-percha, reclaimed rubber, or rubber substitute.

By reclaimed rubber, I mean rubber which has been vulcanized and thereafter devulcanized so far as practicable.

By rubber substitute, I mean any of the synthetic rubber compounds which are employed in place of soft vulcanized rubber. These are usually made from oxidized oils, such as linseed oil, cottonseel oil, or other vegetable oils, acted upon either by chlorid of sulfur, or by sulfur boiled with the oil at a high temperature. Such compounds are well known in the art, and further description of the same is deemed unnecessary.

Whatever highly elastic substance is employed in carrying out my invention, I add thereto a sufficient quantity of adulterant or filler to so modify and control the elastic substance that the diaphragm made from the product is inherently capable of damped vibrations only.

The nature and character of the adulterant or filler can be varied in the treatment of various elastic substances to bring about the desired result.

Certain adulterants or fillers suitable for this purpose are, asphalt or other bituminous substance, litharge, and whiting; and these may be combined with the selected elastic material in such proportions as will bring about the desired result.

In combining an elastic material with a filler or adulterant as above set forth, it is desirable to cure or vulcanize the mixture, and for this purpose to add a small amount of sulfur to the mixture.

I have produced a highly satisfactory acoustic diaphragm embodying my invention by employing a mixture of crude rub-

ber, reclaimed rubber, asphalt, litharge, whiting; and sulfur in the following proportions: Crude rubber 5 per cent, reclaimed rubber 45 per cent, asphalt 10 per cent, litharge 5 per cent, whiting 33 per cent, sulfur 2 per cent.

The method of manufacture is as follows:

The ingredients are mixed in a mixing machine such as is commonly used in the manufacture of rubber compounds, and when thoroughly mixed are placed in a calendering machine and rolled into sheets of the desired thickness. The sheets are then vulcanized or cured to the desired degree.

The vulcanization can be accomplished by any known method, and preferably in the manner in which soft vulcanized rubber products are produced.

Diaphragms of the desired size and form can be cut from these vulcanized sheets and used in sound-boxes and the like, in which they may be mounted in any known manner.

While a diaphragm made as above described may be used with good results, I prefer to incorporate in the diaphragm, a supporting body of fibrous material.

For certain purposes of the invention such a supporting body may be formed of cords of fibrous material in any known manner; but I prefer to employ the cords in the form of an interwoven fabric. I use the term "interwoven" in its broad sense as including interweaving by means of loops as in knitted fabric, although I prefer to employ a fabric composed of warp and weft threads; and I have found cotton sheeting weighing three to five ounces per square yard to be suitable.

In making a diaphragm by the use of such a fabric the fabric is first subjected to the action of a friction-machine whereby its surfaces are opened up and roughened. The frictioned fabric is then impregnated with a compound such as that above described and the calendered sheets of the compound are then applied to both sides of the frictioned fabric, and closely associated therewith by passing the fabric and the applied sheets through either a frictioning machine or a calender machine until the desired thickness is obtained.

As diaphragms of different thicknesses may be desired for different purposes, as many of the calendered sheets as necessary may be applied to the respective sides of the fabric to obtain the desired thickness. The fabric with the applied calendered sheets is then vulcanized into a unitary body.

If preferred, the mixture of ingredients above described can be dissolved in a solvent such as ether, gasoline or the like, and spread on the respective sides of the frictioned fabric in thin layers, and the solvent allowed to evaporate; and successive layers may be thus applied until the desired thickness is obtained, after which the fabric with the applied material is vulcanized.

Fig. 1 of the drawings is a cross-section of an acoustic diaphragm made in accordance with my invention, in the preferred manner above described.

Fig. 2 is a similar view showing the diaphragm mounted in a sound-box suitable for use in a phonograph.

Fig. 3 is a similar view of a diaphragm made in accordance with my invention without the use of the sheet of fabric.

Referring to Figs. 1 and 2 of the drawings, 1 is the sheet of fabric, and 2 is the material vulcanized upon the sheet of fabric as above described.

The diaphragm rests upon an annular shelf or flange, 3, within the sound-box and is held in position by a confining or clamping ring, 4.

The stylus-bar, 5, of the sound-box may be connected with the diaphragm in any known manner, but I prefer to have the stylus-bar formed with a head, 6, which has only simple contact with the diaphragm.

I prefer to mount the diaphragm in the sound-box without straining or stretching the diaphragm, whereby the elastic material in the diaphragm is free from strain except that due to acoustic action.

With a diaphragm of this character, practically all of the force of the impulse transmitted to the diaphragm by the stylus-bar is converted into vibrational movement of the diaphragm, and little or none of such force is used or lost in stretching the diaphragm.

This results in the vibrations being distributed over practically the whole surface of the diaphragm, and not localized at the point of contact of the head of the stylus-bar with the diaphragm, as is the tendency in the case of elastic diaphragms made of stretched elastic material, or material inherently capable of substantially undamped vibration.

In Fig. 3 I have shown a diaphragm made in accordance with my invention without the use of the sheet of fabric. I do not wish to be limited to any particular elastic substance or any particular filler to be used therewith in carrying out my invention broadly, as various well known equivalents for the substances above particularly specified may be employed for certain purposes of the invention.

From numerous experiments and tests, it appears that, when the elastic substance has been so modified by combination with a suitable adulterant or filler that the modulus of resilience of the vulcanized product is less than one-half that of substantially pure soft vulcanized Pará rubber, certain of the objects of my invention can be accomplished

by the use of such product in an acoustic diaphragm.

These tests have also apparently shown that vulcanized compounds suitable for carrying out my invention respond in a similar manner both to tests as to the modulus of resilience, and to tests made by the use of Shore's scleroscope in which the material is tested by the rebound of a pellet or shot falling thereupon from a given height; and I have thus found that vulcanized substances in which the elastic material has been so modified by an adulterant or filler that the rebound of the pellet in such a testing machine is less than half that of its rebound from substantially pure soft vulcanized Pará rubber, are adapted for carrying out my invention.

By whatever method the test is made, however, it appears that the soft vulcanized material suitable for carrying out my invention, has less than one-half the resiliency of substantially pure soft vulcanized Pará rubber.

I have also ascertained by tests that diaphragms made as above described produce highly satisfactory results when the combination of the rubber or other highly elastic substance and filler is such that they together have an elongation at the point of rupture less than one-third that of substantially pure soft vulcanized Pará rubber, or when the elongation of a testing piece three inches or less long, one inch or less wide and ratio of width to thickness less than ten, shall at the point of rupture be less than two hundred fifty per cent.

What I claim as new and desire to secure by Letters Patent is—

1. A sound-box having a non-resonant acoustic diaphragm containing a highly elastic substance and a filler combined by chemical reaction, said diaphragm being supported within the sound-box without strain upon the elastic material except that due to acoustic action.

2. A sound-box having a non-resonant acoustic diaphragm containing semi-soft vulcanized rubber free from strain except that due to acoustic action.

3. A sound-box having a non-resonant acoustic diaphragm containing semi-soft vulcanized rubber, and a filler, said diaphragm being supported within the sound-box without strain upon the elastic material except that due to acoustic action.

4. A simple, semi-soft, non-resonant acoustic diaphragm for sound-boxes containing an elastic substance and an inelastic substance united by chemical reaction free of strain or tension and inherently capable of damped vibrations only.

5. A simple, semi-soft, non-resonant acoustic diaphragm for sound-boxes containing rubber, and a filler vulcanized, free of strain or tension and inherently capable of damped vibrations only.

6. An acoustic diaphragm for sound-boxes comprising a non-resonant fabric-supported homogeneous body the preponderant portion containing an elastic substance free of strain or tension and an inelastic substance and inherently capable of damped vibrations only.

7. An acoustic diaphragm for sound-boxes comprising a sheet of non-resonant woven fabric having mounted thereupon a preponderant homogeneous body containing a highly elastic substance and an inelastic substance free of strain or tension whereby the vibrations of the elastic substance are damped.

8. An acoustic diaphragm for sound-boxes containing a highly elastic non-resonant substance and a filler free of strain or tension, elastic substance and filler united by chemical reaction having a resilience less than one-half that of substantially pure soft vulcanized Pará rubber.

9. An acoustic diaphragm for sound-boxes having incorporated therein a homogeneous non-resonant body of rubber and a filler, vulcanized together and having a resilience less than one-half that of substantially pure soft vulcanized Pará rubber.

10. A sound-box having a non-resonant acoustic diaphragm comprising a fabric-supported body the preponderant portion containing a homogeneous body of highly elastic substance and a filler, said diaphragm being supported within the sound-box without strain upon the elastic material except that due to acoustic action.

11. A sound-box having a non-resonant acoustic diaphragm comprising a fabric-supported body the preponderant portion containing a homogeneous material of semi-soft vulcanized rubber and a filler, said diaphragm being supported within the sound-box without strain or tension upon the rubber except that due to acoustic action.

12. An acoustic diaphragm for sound-boxes containing a homogeneous non-resonant body of highly elastic substance and a filler, together having an elongation at the point of rupture less than one-third that of substantially pure soft vulcanized Pará rubber.

13. An acoustic diaphragm for sound-boxes having incorporated therein a non-resonant homogeneous body of rubber and a filler free of tension or strain, said rubber and filler united by chemical reaction and having an elongation at the point of rupture less than one-third that of substantially pure soft vulcanized Pará rubber.

14. An acoustic diaphragm for sound-boxes containing a preponderant homogeneous non-resonant elastic substance and a bituminous substance.

15. An elastic diaphragm for sound-boxes containing a homogeneous non-resonant body of elastic rubber and asphalt.

16. An acoustic diaphragm for sound-boxes containing non-resonant rubber, a filler and sulphur vulcanized together into a homogeneous soft body having less than one-half the resiliency of substantially pure soft vulcanized Pará rubber.

17. An acoustic diaphragm for sound-boxes containing non-resonant rubber, a filler and sulphur vulcanized together into a homogeneous soft elastic body free of strain or tension and having an elongation at the point of rupture less than one-third that of substantially pure soft vulcanized Pará rubber.

18. An acoustic diaphragm for sound-boxes containing a homogeneous body of non-resonant rubber and a filler vulcanized together free of strain or tension and in such proportions that the elongation of a test piece three inches or less long, one inch or less wide, and ratio of width to thickness less than ten, shall at the point of rupture be less than two hundred fifty per cent.

19. A diaphragm for sound-boxes containing a preponderant homogeneous non-resonant body of soft vulcanized elastic material and a filler free of strain and having less than one-half the resilience of substantially pure soft vulcanized Pará rubber.

20. An acoustic diaphragm for sound-boxes containing a homogeneous soft elastic body free of strain and formed of crude rubber, reclaimed rubber, asphalt, litharge, whiting and sulphur vulcanized together.

21. An acoustic diaphragm for sound-boxes having incorporated therein a homogeneous body of non-resonant soft elastic material and filler of less than one-half the resiliency of substantially pure soft vulcanized Pará rubber.

In testimony whereof, I have hereunto set my hand this 6th day of June, 1922.

GEORGE D. KELLOGG.