Nov. 10, 1936. N. W. McLACHLAN 2,060,098

DEVICE FOR EMITTING OR RECEIVING SOUND

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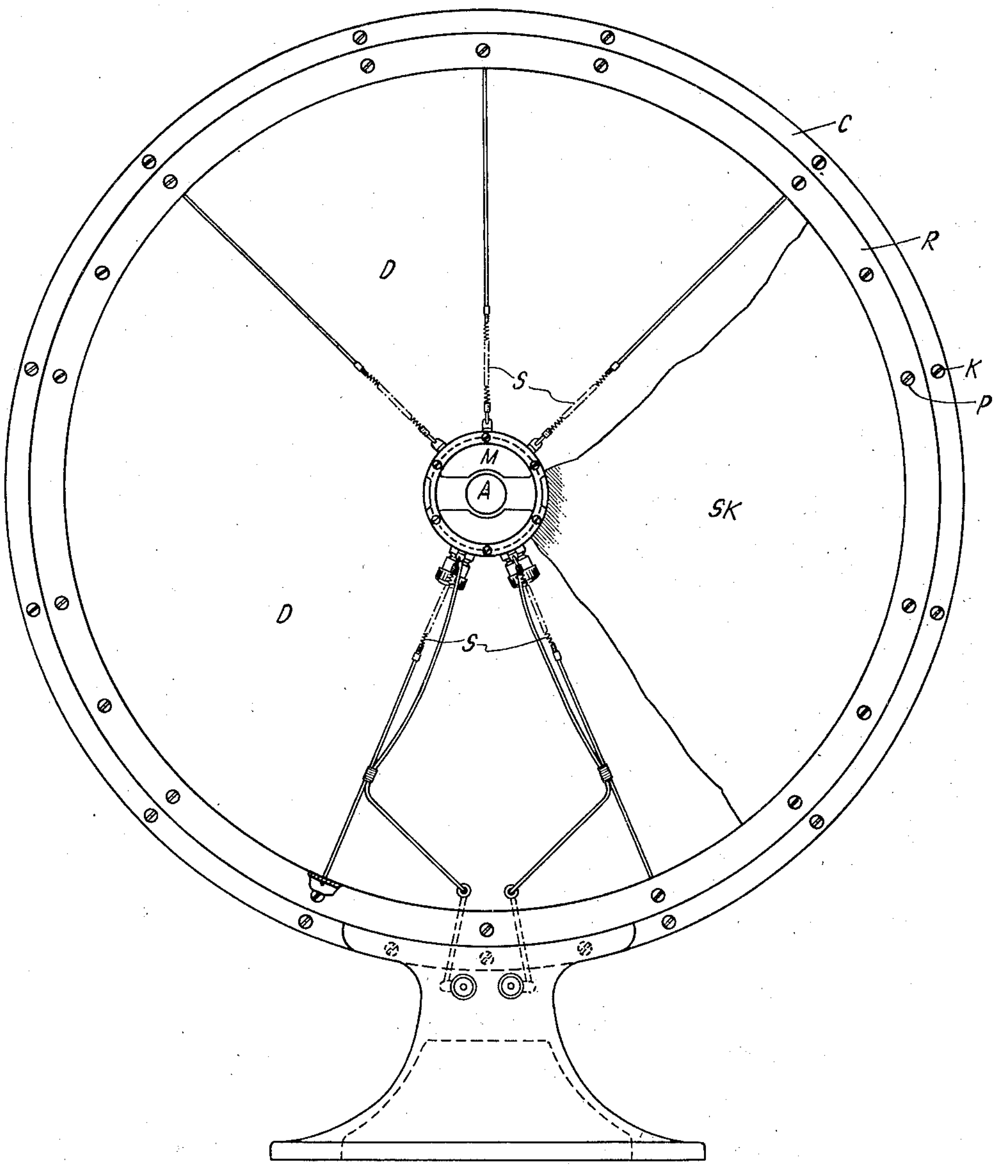
Fig. 1



INVENTOR
NORMAN W. McLACHLAN
BY Fred J. Adams
ATTORNEY

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Fig. 2

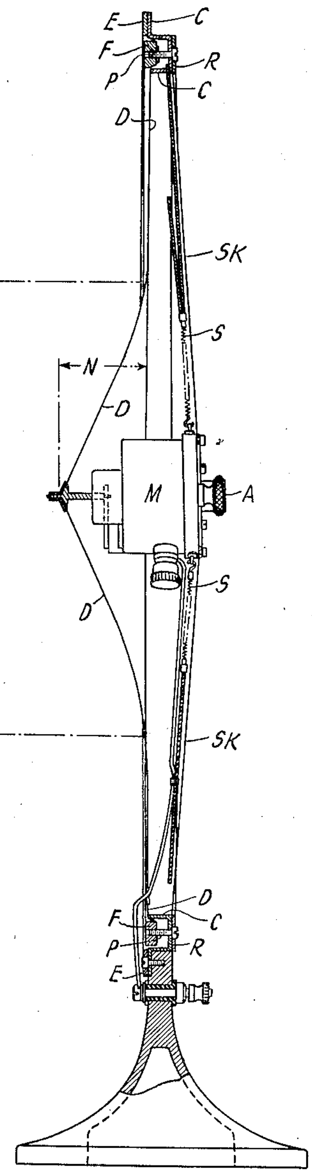
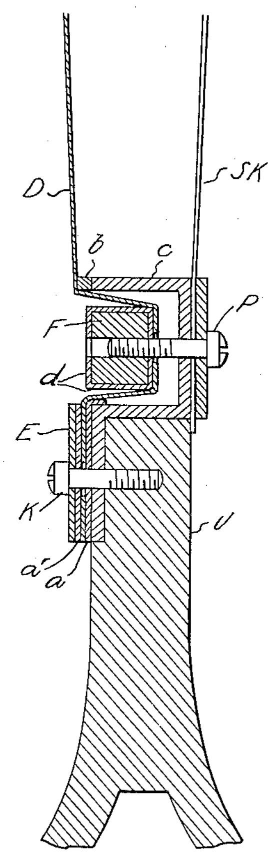


Fig. 3



INVENTOR
NORMAN W. McLACHLAN
BY Ira J. Adams
ATTORNEY

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UNITED STATES PATENT OFFICE

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DEVICE FOR EMITTING OR RECEIVING SOUND

Norman William McLachlan, Rochester, England, assignor to Radio Corporation of America, a corporation of Delaware

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In Great Britain April 30, 1925

21 Claims. (Cl. 181—31)

My invention relates to telephone receiver devices and particularly to such devices capable of the translation of relatively large amounts of vibratory energy.

An object of my invention is to provide an improved diaphragm device for telephone devices.

Another object of my invention is to provide a fabric diaphragm.

Another object of my invention is to provide a stiffened fabric diaphragm.

Still another object of my invention is to provide a diaphragm having a more complex shape than previous diaphragms.

A still further object of my invention is to provide a diaphragm having in combination properties of a plane diaphragm and of a conical diaphragm.

According to one feature of the present invention a sound emitting or receiving device comprises a substantially conical diaphragm made of fabric or the like, which is "doped" with such material as will impart to it the requisite degree of stiffness and tautness. A suitable material for this purpose is a mixture of celluloid and acetone or other suitable solvent.

In place of a single diaphragm a plurality of diaphragms may be employed.

I have found that the sensitivity curve and general acoustic qualities of such diaphragms depend to a considerable extent upon the degree of tension applied to the fabric of the said diaphragm.

According to another feature of this invention, therefore, I provide improved means for adjusting the tension on the diaphragm of an acoustic instrument.

In one form of construction I produce a U shaped channel ring, to which the diaphragm is clamped, and means for drawing the diaphragm into, that is, towards the base of, the channel ring, whereby tension is put upon the diaphragm.

Other objects and structural details of my invention will be apparent from the following description when read in connection with the accompanying drawings, wherein:

Figure 1 is a view in vertical elevation of a preferred embodiment of my invention and,

Figure 2 is a vertical section of the same embodiment of my invention.

Figure 3 is an enlarged sectional view of the diaphragm mounting.

Referring to the drawings, a preferred form of my invention may comprise means for drawing the diaphragm into the channel ring comprising a tension ring, which may, if desired, be enclosed in rubber or other suitable damping material, and is drawn against the diaphragm by means of a plurality of bolts which pass through the diaphragm, the channel ring, and a clamping ring. The bolts, of which there may be, for example, twelve, spaced equally round the circular outer part of the diaphragm, are each provided with a wing nut on the back of the clamping ring. If these nuts be screwed up to the bolts, the tension ring is pulled into the U of the channel ring, taking the material of the diaphragm with it, and thereby tensioning the said diaphragm to any desired degree.

In a modification, the channel ring is provided with a flange to which the diaphragm is clamped.

In another modification, the diaphragm is clamped between two channel rings, and the tension ring is carried by bolts screwed into one of the said channel rings. This arrangement obviates the necessity for perforating the diaphragm for the tension ring bolts.

Any or all of the parts of the apparatus over which the diaphragm is stretched, or between which it is clamped, may be provided with rubber, felt or the like surfaces.

The microphone, telephone, gramophone stylus or like movement, the vibrating member of which actuates or is actuated by the diaphragm or diaphragms, is mounted resiliently with respect to the means for supporting the said diaphragm or diaphragms. If desired, there may be a series of interconnected vibrating systems between the movement and the support and between the movement and the diaphragm.

In one form, the diaphragm is constructed of a "doped" or impregnated fabric formed as a cone, and held at its base by a pair of rings clamped together. This diaphragm actuates or is actuated by a movement, whose vibrating member is secured to a center piece attached to the apex of the cone. The natural frequency of the system as a whole depends chiefly upon the size, shape, stiffness and effective mass of the cone, the stiffness and mass of the vibrating member, and the mass of the movement. By varying these factors, the fundamental natural frequency can be varied.

It has been found in practice that there are no pronounced natural frequencies, but a variation in quality due to the change in the sensitivity curve, i. e. the amplitude frequency curve, can be obtained by the alteration of one of the factors. The movement is freely or resiliently supported from the clamping rings of the diaphragm and as a result local acoustic coloration, due to the support, is avoided.

The material of which the diaphragm is made may be a closely woven fabric or cloth, which may conveniently be cut to the shape of a sector of a circle, and arranged to form a cone, the longitudinal edges being joined by glue or stitching, for example; the base is then secured between two rings or fastened to a hoop and a suitable tension applied at the apex. The celluloid or other solution is then applied to one face of the cone. When this coat is dry, the other face is coated and the process repeated until the requisite number of coats have been applied. The thickness of the coating can be varied from the center outwards. The pull on the apex can be released a few hours after doping, and it is advisable to allow shrinkage of the base to take place by releasing the periphery from the outer ring, unless the cone is to be very flat all over. This flattening, due to the shrinkage, can be controlled by (1) the magnitude of the tension, (2) the angle of the sector from which the cone is made, (3) the number of coats of dope, and (4) the condition of the base during and after doping, i. e whether free, fixed or partially constrained. The cone can also be formed by doping the sector first and then joining the two radial edges. If desired the cone can be moistened by the dope and put in a conical mould (male or female) or held in such a way as to preserve a conical shape (variable or fixed angle) and assume the necessary degree of stiffness and tautness.

In a cone constructed in this manner, there is no perceptible coloration of the tone, due to the material, as is usually the case with paper or metal.

Preferably the cone has either a variable angle, the angle at the center being fairly large, or a fixed angle cone of large angle may be employed. It has been found that a narrow angle cone i. e. one having a very pointed vertex tends to give "boom" or frequency distortion.

If desired the center or vertex of the cone can be reinforced by one or more conical pieces of the fabric or other suitable material, to give any desired stiffness.

When employing two cones, these may be either commonly or separately connected to one or two resiliently mounted movements, and arranged either apex to apex or inside one another.

A sounding board, sound reflector or the like may be provided in proximity to the cone and may carry the means for resiliently supporting the movement, movements or other vibrating systems. The board or reflector may be of box-form, planar, a curved surface, conical or formed as the frustum of a cone. Means may be provided for varying the position of the reflector relative to the diaphragm, thereby altering the pitch level of the output or input, according as the diaphragm is used as a reproducer or otherwise.

When a plurality of cone diaphragms or a plurality of movements and interconnected vibrating systems are employed, each may have a different natural frequency, so that a blended and purer reception or emission of sound is obtained. Any part or parts of the device may, if desired, be damped mechanically or otherwise, and means may be provided for adjusting the resilience of the means for supporting the movement.

Referring to the drawings, D is a "doped" cloth diaphragm, which is secured at its periphery between two rings C and E, which are held together by a number of screws K. These rings may be made of wood, metal or other suitable material, according to the acoustic effect required.

The tautness or radial tension of the diaphragm is controlled by means of a ring F, whose position can be adjusted by a series of screws P, so that when the ring F is drawn into the channel formed in the ring C, the tension is increased.

The shape of the diaphragm is of great importance in the acoustic output of the instrument at various frequencies, the general pitch level for any given type of reed being largely determined by the dimensions L and N. If the diameter L is small, the low tones are weak. Increasing L results in an increase in the intensity of the low tones, due to the tendency of the conical portion (which is the only stiff part) to move as a whole at low frequencies, there being little motion of the flat portion of the diaphragm, which acts mainly as a baffle to prevent circulation of the air between the back and front of the diaphragm. Since the conical portion tends to move as a whole at low frequencies, the greater its diameter (within the limits set by increase of mass), the greater is the mass of air moved and the stronger the low tones. Thus, by varying the diameter of the conical portion, the acoustic properties of the diaphragm can be altered. If desired, to avoid coloration due to the supporting rings C, E, and the tension ring F, the doping of the diaphragm may fall short at the periphery, so that the material in contact with the supporting structure is undoped. The doping within this ring, and near its edge, may be graduated to avoid a sudden change in mechanical properties of the diaphragm. A similar result can be attained by insulating the diaphragm from the rings, by felt or other damping material. As shown in Fig. 3, the diaphragm D is insulated from the inner edge of ring C by a ring *b* of felt, and from the outer edge thereof by a felt ring *a*. A ring of felt *a'* is inserted between the diaphragm and ring E and tension ring F is covered by a layer *d* of felt. It will be understood that any other suitable damping material may be used instead of felt. By thus mounting the movement M resiliently and placing damping material between the diaphragm and its supporting frame, all vibration of the frame is prevented.

After doping the cone with celluloid and acetone, it is advisable to put a coat of aeroplane dope on each side to enable it to withstand climatic conditions and keep its proper shape.

The movement M, which may be either of the reed or coil driven electromagnetic type, is freely suspended from the outer rings C and E by means of springs S. The natural frequency of these springs should be low. If the former type of movement be employed the reed of the said movement is fixed to the point of the cone by a center piece of material, such as duralumin, brass or steel. In addition to the springs S, the movement has a certain amount of support from the silk front SK. This is glued to an outer supporting ring R. At the center of the silk front a ring, having finger grips, is glued, and held to the back of the movement by screws. The finger grips serve to hold the movement during its adjustment, which can be effected by means of the milled head A. The silk SK should be quite thin to avoid resistance to the variations in air pressure.

While the instrument is in operation, the radial tension upon the diaphragm should be maintained as small as possible.

A flat or curved sound board (not shown) may be mounted at the back or the front of the diaphragm, to act as a sound reflector. If desired the movement may be mounted on the said sound board.

When a sound reflector is used with the apparatus shown in the figure, the acoustic properties of the loudspeaker can be varied by altering the position of the reflector, the pitch tending to rise as the reflector is brought nearer the diaphragm.

By the devices and means thus described I am enabled to provide means for producing markedly superior reproduction of sound. I am further enabled to use a fabric, and a stiffened fabric, as well as a fabric of spinnable fibers in the production of sound.

While I have shown but one embodiment of my invention in the foregoing drawings and descriptions it is capable of various modifications therefrom without departing from the spirit thereof, and it is desired therefore that only such limitations shall be imposed thereon as are required by the prior art or indicated by the appended claims.

I claim as my invention:

1. The process of stiffening a conical, fibrous diaphragm which comprises applying a plurality of successive coats of stiffening material thereto, the number of coats applied adjacent the vertex being different than the number of coats applied adjacent the periphery.

2. In an acoustic device, a substantially conical diaphragm, a support for the vertex thereof, a member mounted adjacent the periphery of said diaphragm, a vibration damping substance interposed between said member and said diaphragm, and means for applying tension to the periphery of said diaphragm whereby the diaphragm engages said vibration damping substance under tension.

3. In an acoustic device, a support, a diaphragm, means for vibrating said diaphragm, yielding means connected between said first mentioned means and said support and additional yielding means interposed between the outer portion of said diaphragm and said support.

4. In an acoustic device, a diaphragm, a channel shaped member, the outer portion of said diaphragm lying within said channel, an element engaging said diaphragm and a plurality of elements for moving said element within said channel for tensioning said diaphragm.

5. In combination, an acoustic diaphragm comprising a woven fabric member having a conical central portion and a plane rim portion, and means engaging the peripheral portion of said diaphragm for maintaining said diaphragm under tension.

6. An acoustic diaphragm comprising a member of fabric material having a conical central portion and a plane rim portion, the diameter of the conical portion being substantially one half of the diaphragm diameter, means engaging the peripheral portion of said diaphragm for maintaining said diaphragm under tension, and contractile colloidal stiffening means incorporated into said fabric material for maintaining the shape of the tensioned diaphragm.

7. An acoustic diaphragm comprising a fibrous member, and a colloidal stiffening material incorporated into a portion only of said diaphragm.

8. An acoustic diaphragm comprising a fibrous member having a conical portion and an annular portion there around, and stiffening means incorporated into said conical portion and in part only of said annular portion.

9. In a loudspeaker device, a vibration producing means, a diaphragm connected to said vibration producing means, said diaphragm comprising a fibrous sheet member provided with a coating of stiffening material on a portion only thereof, and means fastened to the unstiffened peripheral portion of the fibrous sheet member for supporting said diaphragm.

10. In combination, a diaphragm of fibrous material, a support, means for fastening the periphery of said diaphragm to said support, said support and fastening means cooperating to maintain said diaphragm under tension, and means for vibrating said diaphragm connected to a central portion thereof at a point out of the plane through the peripheral portion of the diaphragm whereby the central portion of said diaphragm has a conical shape which tapers off to a plane surface in the peripheral portion of said diaphragm.

11. In combination a woven fabric diaphragm, a support for the periphery of said diaphragm, means for securing the peripheral portion of said diaphragm to said support, driving means for said diaphragm having a portion thereof secured to a central portion of said diaphragm, said diaphragm having a central conical portion and a substantially flat, flexible peripheral portion, and stiffening means incorporated into said woven fabric diaphragm for maintaining the shape thereof.

12. A loudspeaking diaphragm consisting of a single elastic sheet held in permanently curved shape whereby said sheet is always under tension along its vibratory surface, and a driving member associated with the central portion of said sheet.

13. A direct-acting diaphragm of loudspeaking area consisting of a single elastic sheet held in permanently curved shape whereby said sheet is always stretched along its vibratory surface.

14. Apparatus for the reproduction of sound comprising a diaphragm consisting of a fabric material impregnated with a stiffening substance, said diaphragm having a relatively stiff conical portion and a flexible portion substantially surrounding said stiff portion, a frame surrounding said diaphragm to which said diaphragm is fastened, and a driving mechanism having a portion thereof secured substantially to the centre of the conical portion.

15. The method of making large, direct acting, acoustic diaphragms of conical form which comprises stretching a piece of woven fabric into the desired shape, impregnating the woven fabric with a stiffening material, and holding the woven fabric as stretched until the stiffening material has become set.

16. The method of making large, direct acting, acoustic diaphragms of conical form which comprises cutting a piece of fabric material into the shape of a sector of a circle, arranging the cut piece of material to form a cone and joining the longitudinal edges, securing the periphery of the cone to a supporting member, applying a suitable tension to the apex of the cone, applying a stiffening material to the fabric material, and permitting the stiffening material to dry before releasing the tension at the apex of the cone.

17. The method of making a large, direct acting, acoustic diaphragm which consists in mois-

tening a piece of fabric with a stiffening material, shaping the moistened piece of fabric material into a conical diaphragm by means of a mould, and maintaining the shape of the diaphragm by means of the mould until the stiffening material has hardened.

18. The method of making a large, direct acting, acoustic diaphragm which consists in moistening a piece of woven fabric material with a stiffening material, moulding the moistened material into the form of a cone, and retaining the moistened material in its moulded shape until the stiffening material has dried.

19. The method of making a large, direct acting, acoustic diaphragm which consists in moistening a piece of woven fabric material with a stiffening material, applying tension to the moistened material so that it assumes a conical shape, and maintaining the tension until the stiffening material hardens so that the fabric material retains its conical shape.

20. A large, direct acting, acoustic diaphragm consisting of stretched woven fabric held in shape by stiffening material applied in moist form and allowed to dry while the diaphragm is stretched.

21. A large, direct acting, acoustic diaphragm consisting of woven fabric stretched to have a central conical portion and an annular portion surrounding said conical portion, said woven fabric being impregnated with a soluble colloidal stiffening material which maintains said fabric in its stretched shape.

NORMAN WILLIAM McLACHLAN.