C. CHUDZIKOWSKI.

ELECTRIC MUSICAL INSTRUMENT.

APPLICATION FILED MAY 29, 1914.

1,322,229. Patented Nov. 18, 1919.

4 SHEETS—SHEET 1.

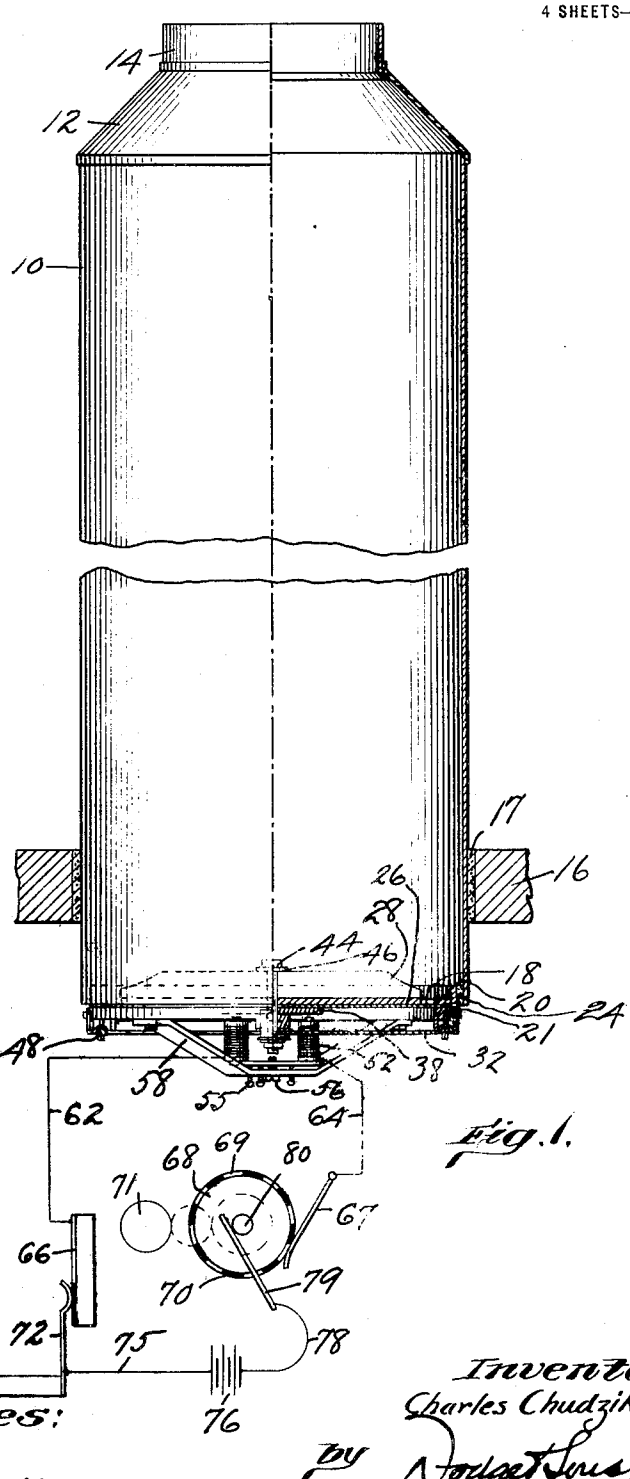


Fig. 1.

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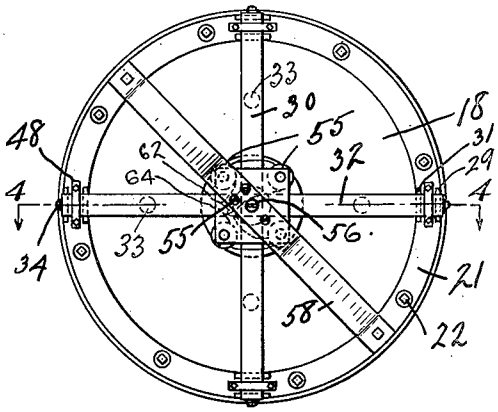


Fig. 2.

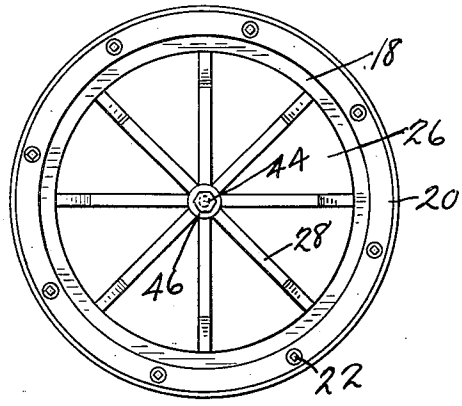


Fig. 3.

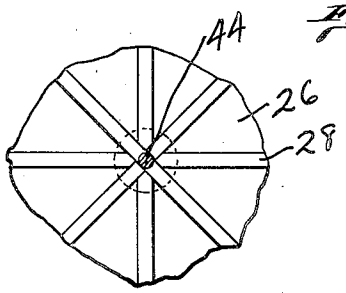


Fig. 5.

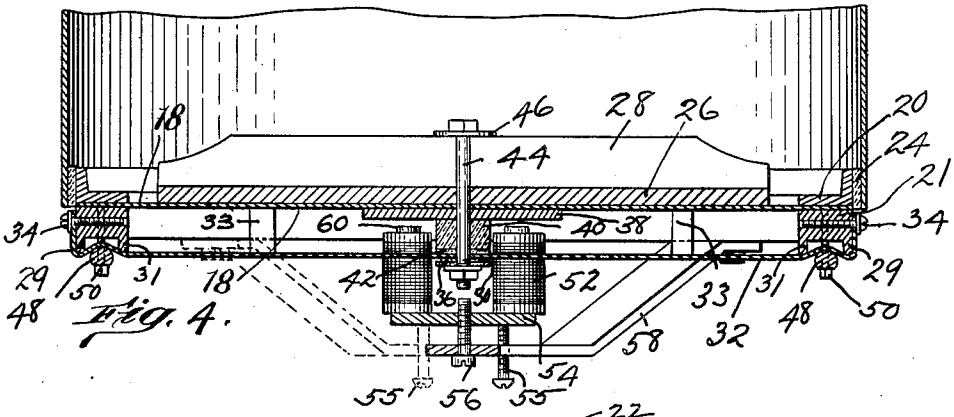


Fig. 4.

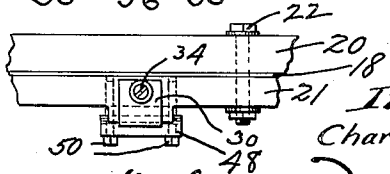


Fig. 6.

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4 SHEETS—SHEET 3.

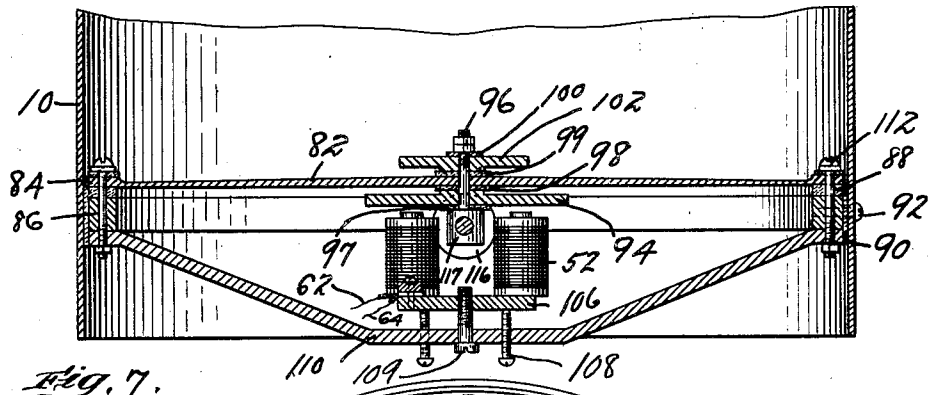


Fig. 7.

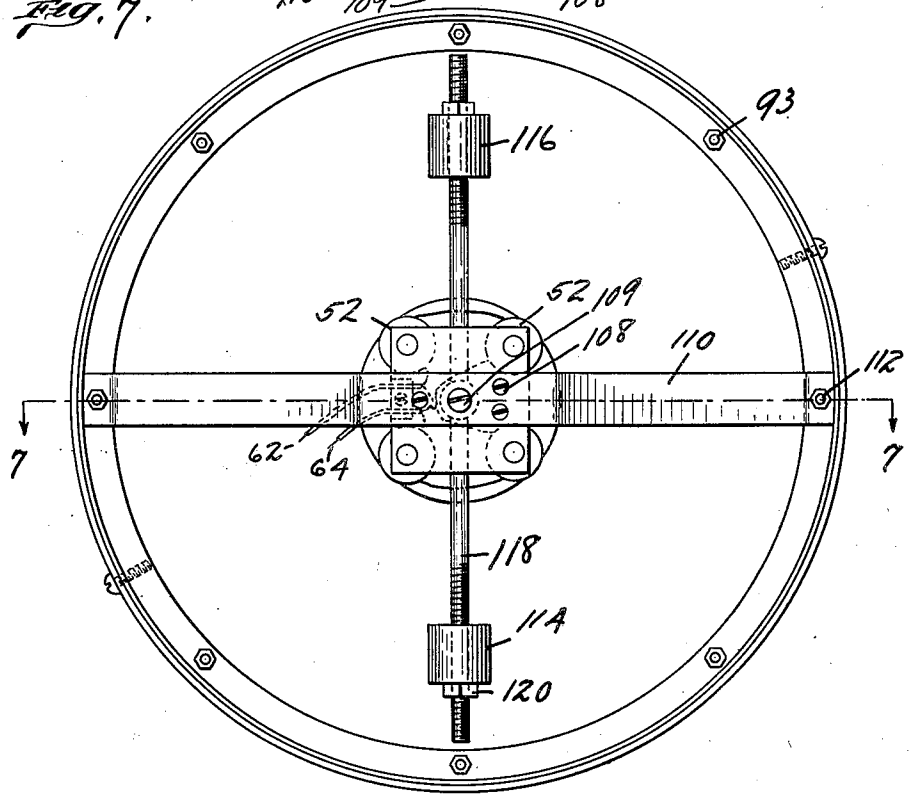


Fig. 8.

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4 SHEETS—SHEET 4.

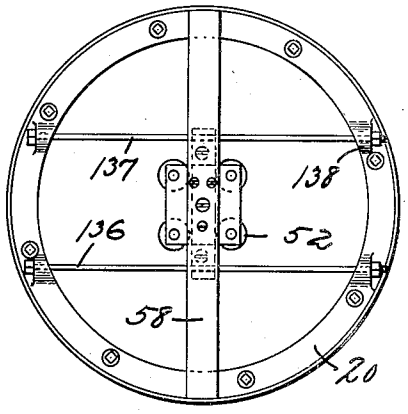


Fig. 9.

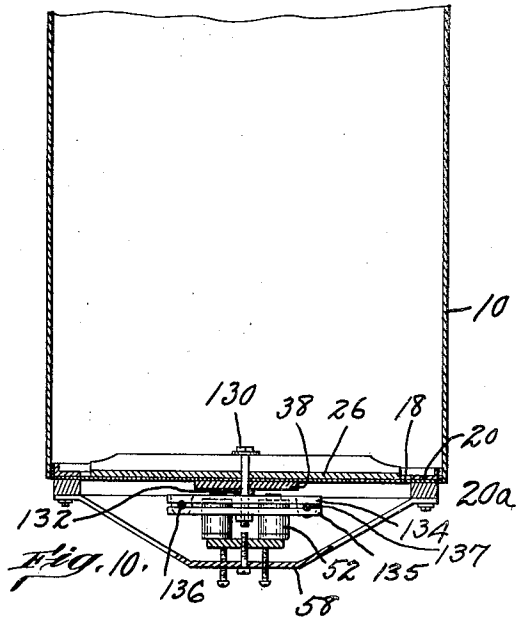


Fig. 10.

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UNITED STATES PATENT OFFICE.

CHARLES CHUDZIKOWSKI, OF CAMBRIDGE, MASSACHUSETTS, ASSIGNOR TO CHORAL-CELO COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

ELECTRIC MUSICAL INSTRUMENT.

1,322,229. Specification of Letters Patent. Patented Nov. 18, 1919.

Application filed May 29, 1914. Serial No. 841,352.

To all whom it may concern:

Be it known that I, CHARLES CHUDZIKOWSKI, a citizen of the United States, residing at Cambridge, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Electric Musical Instruments, of which the following is a specification.

This invention relates to an improvement in electric musical instruments of that type wherein tuned sonorous bodies are vibrated electromagnetically.

The essential matter of invention resides in a diaphragm of peculiar construction and mounting applied to and forming a closure for a resonator preferably likewise of special form, the combined diaphragm and resonator together with means for electromagnetically vibrating the diaphragm, constituting a sound-producing device which by proper proportioning, tensioning, and vibrating of the diaphragm is caused to give off a predetermined musical note which the resonator relieves of any extraneous sounds or overtones, and delivers as a pure and single tone.

The invention will be readily understood from an inspection of the accompanying drawings, in which Figure 1 is a sectional elevation of one unit, showing diagrammatically the means for controlling the vibrations of the sonorous body, Fig. 2 is a bottom plan view of the diaphragm and its supporting ring, Fig. 3 is a top plan view of the same, Fig. 4 is a vertical section taken on the line 4—4 in Fig. 2, Fig. 5 is a fragmentary plan view of the diaphragm, showing how the ribs are shaped at the center, Fig. 6 is a fragmentary side elevation, Fig. 7 is a central vertical section taken on the line 7—7 in Fig. 8, Fig. 8 is a bottom plan view of a modified form of diaphragm, Fig. 9 is a bottom plan view of another modified form of the invention, and Fig. 10 is a central vertical section of the same.

As illustrated in Figs. 1 to 6, inclusive, the sonorous body comprises a diaphragm which is secured to or suitably positioned in proximity to one end of a resonator 10. The resonator comprises preferably a cylindrical sheet-metal tube, having a main body-portion of uniform cross-section, a tapering portion 12, and a reduced neck 14. By this construction the length of tube required to give the proper resonance is reduced, yet the opening of the neck is sufficient to enable the requisite loudness and volume of tone to be emitted.

The resonators are of various lengths, according to the tone to be produced, and they are supported by a frame 16, preferably felted at 17, or supported in any other suitable manner, and they are held either in a horizontal or a vertical position. Although I have shown cylindrical resonators with reduced opening at one end, I do not wish to confine myself to this particular construction, as I may use resonators of any desirable shape, size, or material; even in some cases making the tubes of concrete and square in cross-section; and I hold all this to be well within the province of my invention.

As here shown, a sheet of flexible material 18, such as leather, or cloth which has preferably been rendered impervious to air, is clamped between a pair of rings 20, 21, said rings being held together by screws or bolts 22. The ring 20 is preferably L-shaped in cross-section, and its periphery is kept from contact with the interior of the tube 10 by a ring of yielding material 24, such as felt, or the like, which acts as a packing to form a tight joint between said ring and tube, and also to prevent contact between the two metal surfaces, when the rings supporting the diaphragm are inserted in the tube.

Mounted upon the sheet 18 is a disk 26, preferably of wood, which is stiffened by ribs 28, here shown as radially disposed and shaped at their inner ends to form a tight joint one with another, said disk being slightly less in diameter than the opposing flange of the ring 20. By this construction the central portion of the diaphragm, and in fact its entire area with the exception of a relatively narrow annular zone, is rendered rigid or relatively rigid, while such annular zone is left flexible. The flexure is thus localized or confined to an annular zone just within the clamping rings. The stiffening disk and ribs being firmly secured to the diaphragm, become in effect or in fact a part of the diaphragm. The disks 26 and ribs 28 may be cast integrally of aluminum, to produce a light stiff member.

The ring 21 is preferably provided with a plurality of diametrically opposed pairs

of ribs 29, 31, there being four in the present instance, the ribs of each pair being separated from each other to form a U-shaped cross-section of the ring at this point. A pair of strips or bands 30, 32, preferably of highly resilient material of considerable tensile strength, as vanadium steel, are located at right angles each to the other. These bands span the ring 21, extending over the ribs 29, 31, and have their outer ends secured to the exterior of the ring 21 by screws 34. These bands cross each other at the center of the ring, and are preferably riveted together at the center.

I do not wish to confine myself to the use of strips or bands as a tensioning means, or to any particular method of straining the same, as I may use rods of various cross-sections and any suitable means for applying tension thereto. In other words, any known and suitable means of giving the necessary tension may be employed.

An armature 38, preferably in the form of a disk of soft iron having a central boss 40, preferably of non-magnetic material, is located between the flexible sheet 18 and the bands 30, 32, and said boss is separated from said bands by a felt washer 42. A bolt 44 passes through the center of the disk 26, armature 38, boss 40, the bands 30, 32, and a felt washer 36, and clamps them all together, said bolt having a washer 46 under its head, which engages the upper surfaces of the ribs 28 at their inner ends. Thus the bands 30, 32 and the flexible diaphragm and stiffener are all secured together so that they will vibrate together. A bar 48 engages each band 30, 32 near its end, between the ribs 29, 31, and is clamped against said band by means of screws or bolts 50, which are threaded into the ring 21 on opposite sides of each band. These bolts are adapted to vary the tension of the bands 30, 32, and consequently the pitch of the note emitted by the diaphragm. Where the diaphragms are tuned to pitches so high that the strain on the full length bands 30, 32, would be excessive to bring them to pitch, I preferably shorten the effective vibrational length of the bands in any suitable manner, as for example, by the insertion of posts or bridges 33, one end of which is secured to the diaphragm and the other end of which bears against the band.

Owing to the connection of the central portion of the diaphragm with the tensioned bands 30, 32 at their point of intersection, the diaphragm 18 though it may be itself somewhat lightly stressed, can vibrate only in unison with the bands 30, 32, or to the extent determined by the character and tension of said bands. By increasing the tension upon these bands, the pitch of the tone produced by the diaphragm can be raised, while by lessening the tension it may be lowered, and in this way proper tuning may be effected. The resonator being proportioned as to its diameter, length, etc., with reference to the particular note which the diaphragm is to give off, will tend to damp or suppress all overtones or extraneous sounds, but will respond to and strengthen or amplify the note to which the diaphragm is tuned. The sonorous body is arranged to be vibrated by means of a pair of electromagnets 52, in the present instance composed of four coils mounted upon a plate 54, which is adjustably supported by the screws 55, 56, coöperating with a truss 58 secured at its ends to the ring 21. By means of the screws 55, 56 the positions of the poles 60 of the electromagnets are adjusted, both for proximity and parallelism, with relation to the disk or armature 38, so that the latter shall not strike said poles during its vibration by the electromagnets.

The coils of the electromagnets are connected together and by wires 62, 64 to a contact member 66, and a brush 67, respectively. The means for intermittently energizing the electromagnets comprises a pulsation device comprising a uniformly rotated ring or disk 68, having alternate teeth and insulating material 70, engaged by the brush 67. The rotation of the disk 68 is suitably timed by the synchronizer 71, of any suitable type such as is employed in the musical instrument known as the "Choralcelo," which is shown and described more or less fully in U. S. Letters Patent No. 1,098,983 granted to M. L. Severy and G. B. Sinclair, and dated June 2nd, 1914, among numerous patents to said parties.

The contact-member 66 coöperates with a brush 72 carried by a key 74, like the key of a piano, and said brush 72 is connected by a wire 75 to one pole of a current source 76, the other pole of said source being connected by a wire 78 to a brush 79, and this brush is in engagement with a shaft 80, which carries the disk 68. The disk 68 is rotated at a constant speed by the synchronizer 71, and when the key 74 is depressed to cause the brush 72 to engage the contact-member 66, pulsatory current is transmitted to the electromagnets 52, the frequency of said pulsations being dependent upon the speed of rotation of the disk 68 and the number of teeth thereon. The screws 50 are turned until the sonorous body emits the desired tone, which indicates that it has been brought to the right pitch, the impulses of the magnets being correctly timed and the conditions of the resonator correctly planned to produce this result. Although only one unit is shown, it is to be understood that the instrument preferably comprises a series of these units each tuned to the required pitch.

As illustrated in Figs. 7 and 8, the sonorous body comprises a diaphragm 82, prefer-

ably made of metal, although any other suitable material may be employed. The diaphragm or disk 82 is formed with a peripheral rim 84, which is preferably of substantially the same thickness as the center of the disk. This disk is tapered slightly from its center to the rim 84, this being accomplished by shaping the disk so that its cross-section decreases gradually from the center to the rim. But in some cases the diaphragm need not be a uniform taper, but may be otherwise shaped for particular qualities of tone.

As shown, the disk is tapered on both sides or faces, that is, both faces of the disk are slightly conical, although one face of the disk may be flat and the other face conical from the center to the rim. The cross-sectional shape of the diaphragm is varied in accordance with the pitch of the tone which it is desired shall be emitted thereby. By thus making the diaphragm of greater thickness at its center than at a point just within the rim 84, I localize the flexure of the disk, causing the same to occur wholly or almost wholly in a narrow annular zone just within the clamped or peripheral edge of the disk, thus attaining the same substantial result that is attained by the construction set forth in Figs. 1 to 6 inclusive. Under both constructions, the flexure of the main central area of the disk is precluded or rendered so slight as to be negligible.

The rim 84 may be separated from direct engagement with a ring 86, by a ring of yielding material 88, such as felt or the like. The ring 86 is fitted on its external periphery with a ring 90, of felt or other suitable packing, and this in turn tightly fits the interior of a resonator tube 10. The ring 86 is secured in place within the tube 10 by screws 92, and is clamped to the rim 84 by bolts 93. By this construction the ring 86 is held from direct engagement with the tube 10, and a substantially air-tight end is provided for the resonator tube.

An armature 94, in the form of a disk, is secured to the under or outer face of the disk 82 by a bolt 96, which passes through felt washers 97, 98, 99, 100, and a plate 102, these parts being all clamped together tightly, but direct contact between opposing metal surfaces is preferably prevented, as by the felt washers. The plate 102, which may conveniently be of some heavy material, serves as a rider to load the diaphragm, and lower its normal pitch. On the lower or outer side of the disk 82 and carried by the head 117 of the bolt 96, are radial rods 118 threaded to receive weights 114 and 116 and jam-nuts 120. These weights serve to supplement that of the rider 102, and by reason of their adjustability may be made to balance each other. It is obvious of course that the weight put in 102 may be added to 94, and 102 omitted, in cases where the exact amount of this weight is previously known, but in other cases it is convenient to have 102 in the form of an easily changeable member.

A pair of electromagnets 52 is mounted upon a plate 106, with their poles in proximity to the armature disk 94, the positions of said poles being regulated by means of screws 108, 109. The former are threaded through a truss bar 110, which may be held in place against the ring 86 by screws or bolts 112, but is preferably cast integrally with said ring, and the screws 108 engage the outer face of the plate 106, while the screw 109 is threaded through said plate. The electromagnets 52 are connected to a source of current and controlled in the manner set forth above.

It will be understood, however, that the tapering diaphragm can be employed without the weights. By the use of the form of resonator shown, the length of pipe required is reduced very materially as compared with what would be required with a fully open pipe.

As illustrated in Figs. 9 and 10, the sonorous body comprises a stiff member 26, which may be made of aluminum or wood, and secured to a sheet of flexible material 18 held by rings 20, 20^a, in a manner similar to that hereinbefore described, and constituting a stiffened or reinforced diaphragm. An armature 38, preferably in the form of a disk of soft iron is located under the sheet 18. A bolt 130 passes through the member 26, armature 38, collar 132, and a pair of clamping plates 134, 135. This bolt is arranged to clamp the plates 134, 135 against a pair of tension members 136, 137, and to clamp the various parts together to form a comparatively rigid structure. The tension members 136, 137, may be a pair of parallel wire rods which pass through ears 138 provided on the under side of the ring 20^a. A pair of electromagnets 52 may be adjustably mounted on a truss 58, as already explained. The operation of this form of the invention is substantially the same as heretofore explained, the tension of the members 136, 137 being adjusted by means of nuts on the ends of said members.

The combined diaphragm and resonator when equipped with electromagnetic means for effecting vibration of the diaphragm, may constitute one sound-producing member or element of a musical instrument, a number of such elements equal to the number of notes desired being of course employed. As these are to take the place of other sonorous bodies heretofore employed in similar relations, the claims are directed to the combined diaphragm and resonator, with means for effecting vibration of the diaphragm, rather than to a complete musical instrument.

It will be observed that in the circular form of diaphragm shown and described, the backing or stiffening plate or member is of circular form and concentric with the outer ring which supports the outer edge of the diaphragm. The annular flexing zone of the diaphragm is hence of uniform width throughout, and the backing or stiffening member produces no isolated or separated bearing points which would tend to distort the body of the diaphragm, or make initial lines of rupture. In this way the diaphragm is caused to move facewise, uniformly throughout its area, with the minimum of wear upon the diaphragm.

A clear distinction is to be drawn between a mere conical sound-wave collector or funnel on the one hand, and a resonator, properly so-called, in which the relative dimensions or proportions are made with special reference to strengthening or reinforcing a particular tone, note or sound, and to suppressing other or extraneous sounds.

I claim:

1. In combination with a tubular resonator, a diaphragm stretched across the mouth of the resonator and secured at its outer edge thereto, said diaphragm being rigid with the exception of a narrow annular zone near its circumference; intersecting bands extending diametrically across the diaphragm in proximity thereto and carried by the resonator; and a connection between the central portion of the diaphragm and the intersecting bands, whereby the diaphragm and said bands are caused to vibrate in unison and as determined by the tension of the bands.

2. In combination with a tubular resonator and an annular support applied to the mouth or end thereof, a diaphragm applied to said support and closing the mouth of the resonator, said diaphragm having a rigid central portion and a relatively flexible circumferential zone; intersecting bands extending diametrically across and in proximity to the diaphragm; means for longitudinally stressing said bands; and posts or bridges extending from the diaphragm to the stressed bands, and serving to shorten the effective vibrational length of the bands.

3. A sound-producing device comprising a tubular resonator; a diaphragm secured at its outer edge to said resonator and comprising a flexible sheet; a braced rigid disk closely joined to said sheet and extending nearly to the circumference of the latter; a tensioned band extending diametrically across the diaphragm; connections between said tensioned band and the diaphragm; an armature carried by said diaphragm; and an electromagnet supported in proximity to said armature and serving by attraction thereof to vibrate the diaphragm.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CHARLES CHUDZIKOWSKI.

Witnesses:

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