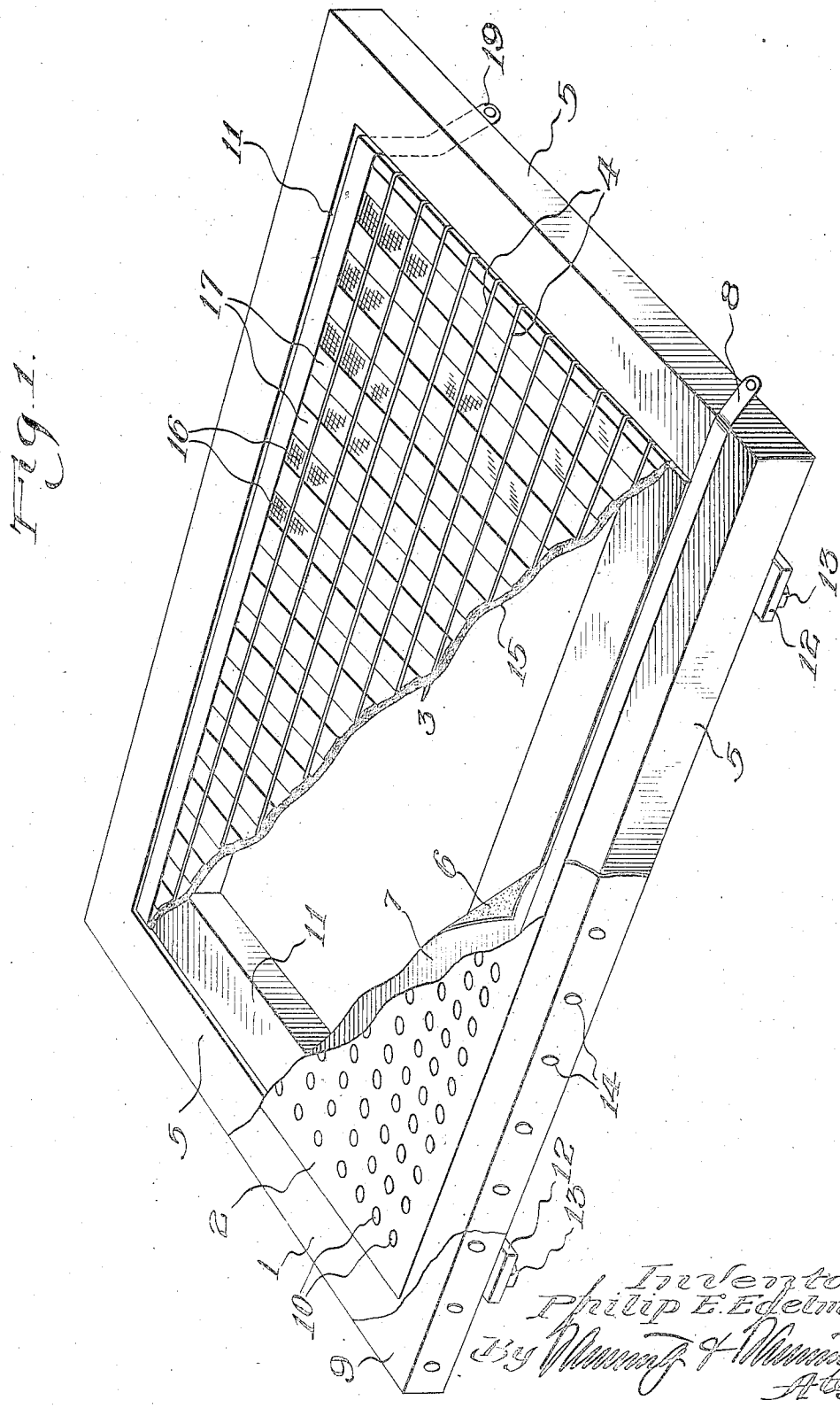
June 24, 1930. P. E. EDELMAN 1,767,657

CAPACITY REPRODUCER

Filed Aug. 9, 1929 2 Sheets-Sheet 1

Fig. 1.



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Filed Aug. 9, 1929 2 Sheets-Sheet 2

Fig. 2.

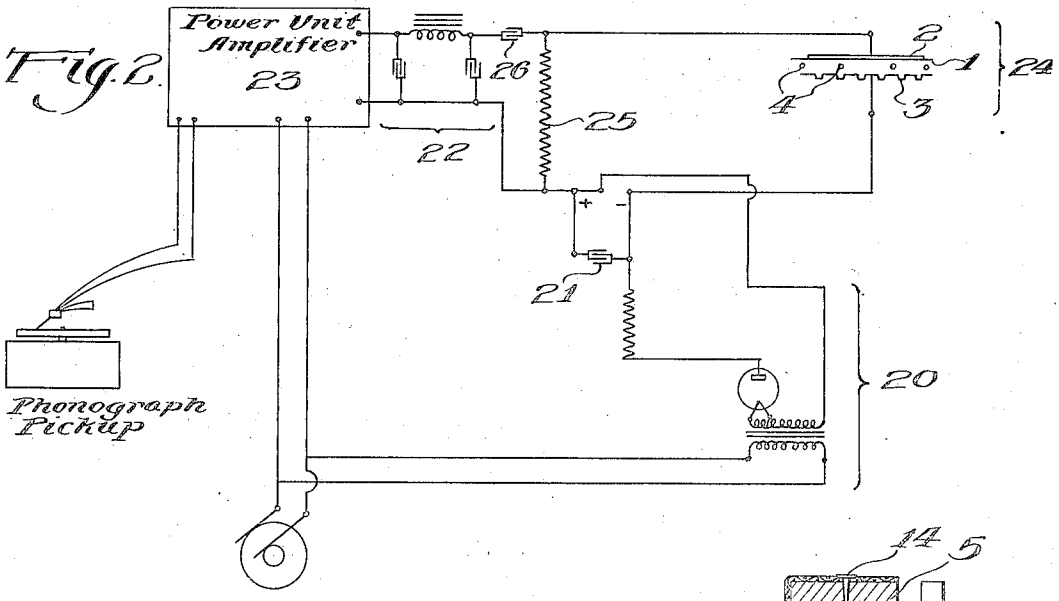


Fig. 3.

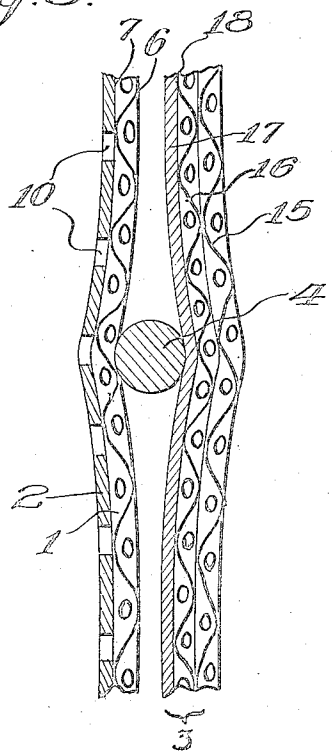
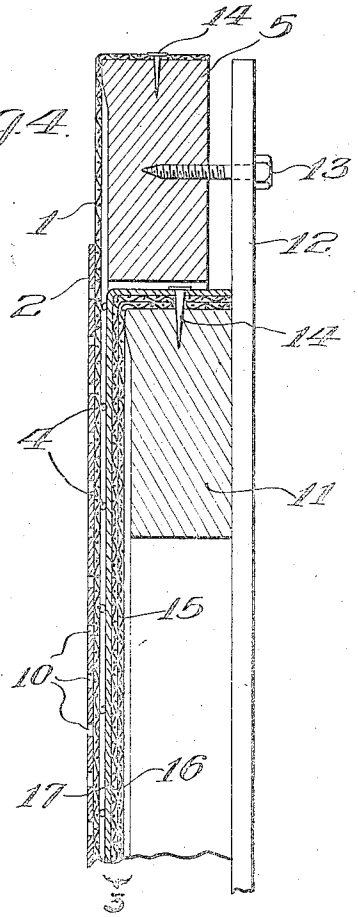


Fig. 4.



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Patented June 24, 1930 1,767,657

UNITED STATES PATENT OFFICE

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CAPACITY REPRODUCER

Application filed August 9, 1929. Serial No. 384,739.

My present invention relates to capacity reproducers, and is in part a continuation of my application for Letters Patent of the United States, Serial No. 352,201, filed April 3, 1929.

An object of the invention is to increase the frequency response and amplitude response of reproducers of this class, while at the same time eliminating objectionable "fuzzy" or "back-lash" rustle sounds common to previously known apparatus of this type when operated at maximum volume of response.

Various other objects will presently appear, and the novel features are more particularly pointed out in the appended claims. Various changes may be made within the spirit of the invention, as defined by the appended claims.

A capacity reproducer of this type is generally adaptable to any use to which apparatus of this class is suitable, such for example, as for operation on the output of a radio set, a phonographic apparatus, a public address system, or reversely for sound pick-up service.

By a series of elaborate tests I have discovered that "back-lash" sounds previously common to such apparatus when operated near maximum response limits may be eliminated by a new departure in this art, namely, the introduction of flexible threads to control the relative space positions of the operative members of the reproducer. Generically, the invention consists in placing flexible "back-lash" preventing means intermediate the operative reproducer members, and more specifically, and preferably, the use of fibrous thread relatively loosely disposed between said members. Thereby the surprisingly new and useful result sought is attained in that the identical operative members of the reproducer, which would otherwise emit "back-lash" or "fuzzy" sounds when the reproducer is operated near its maximum limits, will, when reassembled with the aforesaid thread means therebetween, reproduce pure tones at maximum amplitude free from "back-lash" sounds.

By the term "back-lash" sounds is meant, the "buzzing" disagreeable noise most probably caused by the return together of the operative members immediately following a transient electrical stress of considerable energy value which has just been impressed thereon. This fact has long been known to workers in the art, and has heretofore necessitated working the operative members at relatively low efficiency in order to keep below the critical input values of impressed electrical energy, which are sufficient to set up the aforesaid "back-lash" effect.

I am illustrating a preferred form of my invention in detail by way of exemplification of a suitable practical structure therefor typical of a class of equivalent structures common to and within the spirit of the aforesaid invention.

Reference is made to the accompanying drawings, in which—

Figure 1 is a perspective view, partially broken away for illustrative purposes to disclose the relation of the working parts of a reproducer embodying my invention;

Fig. 2 is a suitable diagram of an operating electrical circuit therefor;

Fig. 3 is a diagrammatic sectioned representation explanatory of the most probable theory of operation afforded by the invention; and

Fig. 4 is a sectioned view showing the relation of frames 5 and 11 of Fig. 1.

The essential elements of a reproducer of this type are firstly, a dielectric diaphragm 1 carrying and supporting an electrically conductive coating or electrode 2; secondly, a co-operating air permeable electrode 3 disposed closely adjacent thereto; and thirdly, means to control against "back-lash" effect, preferably threads 4 sandwiched between said dielectric diaphragm 1 and the air permeable electrode 3.

The dielectric diaphragm

The dielectric diaphragm 1 may appropriately be made in any desired size having an area of preferably at least 250 square inches of any desired shape, rectangular or

otherwise, or may be made as large as required, as for example, 264 square feet, or more. The dielectric diaphragm member 1 is preferably made from a flexible fabric, such as empire cloth or varnished or dielectric impregnated silk or linen or cotton cloth. Silk empire cloth of commerce, for example, in thickness of at least .003 inch, and preferably not more than .006 inch, is a suitable material for the purpose when supported on a frame 5. So is black empire cloth of commerce containing asphaltum of at least .004 inch, and not more than .0055 inch thickness satisfactory, for example, for said material. Any other equivalent material of like general properties may be used.

Essential qualities of the material used for the diaphragm 1 are flexibility, good mechanical and dielectric strength, stabilized chemical composition of long life immune to decomposition effects of oxygen, atmosphere, and particularly of ozone naturally present in the operation of the diaphragm 1; high electrical disruptive strength, preferably not less than 900 volts, high dielectric constant, preferably not less than 3 as compared to air, and good elasticity, as well as soft pliable texture. The diaphragm 1 is preferably stretched at moderate tension of the support member 5. One surface of the membrane 1 is preferably dusted or coated with a non-conducting powder 6, such as mica dust or finely divided talcum powder to minimize the mechanical friction and adhesion property thereof in service by providing a non-sticky surface afforded by said dust 6. This dust surface 6 is normally held by the natural adhesion effect of the material of diaphragm 1, or by means of a thin coating of varnish thereon, and is of very minute thickness, preferably of the order of value of such a small magnitude as only .00005 inch.

The other surface of membrane 1 is preferably first coated with a thin even layer of insulating varnish 7, such as gold japan varnish of commerce, by means of which the thin flexible electrode coating 2 is held and supported on diaphragm 1. The preferred mode of applying the electrode coating 2 is to roll or brush thin aluminum foil 2 on the varnished surface 7 of diaphragm 1 while said varnish 7 is in the process of drying, and of very sticky or adhesive consistency. The aluminum foil 2 may be of thickness preferably not over .0001 inch, and the variety sold in commerce of less thickness than this and supported for handling purposes by a paper layer is suitable. A metal foil ribbon 8 is similarly cemented to aluminum foil 2 by varnish 8 and serves as a contact terminal for electrode coating 2 to permit application of electrical potential to the entire surface of electrode 2.

The dielectric membrane prepared as aforesaid is both flexible and light in weight. Also it is substantially free from any disturbing natural period of its own which might be force vibrated to produce disturbing noisy sounds in service. The tension under which diaphragm 1 is placed should normally be very moderate, and is not critical over a wide range of values as long as the said tension is sufficient to draw out all visible wrinkles from the said material of diaphragm 1, but not so great as to cause diaphragm 1 to emit a musical drum sound when tapped vigorously by a workman's finger. Since material specified for diaphragm 1 is naturally waterproof and normally oxidized in the process of its manufacture, it tends to retain its elastic and shape properties indefinitely, and so far as is known, permanently. Also the electrical characteristics of the material specified for diaphragm 1 are known to be of reliable stability and permanence. Should, by chance, a slight imperfection originally exist in the impregnated cloth 1, the varnish 7 tends to repair the defect. If said repair is insufficient, however, the operating potential applied thereto in service will merely transiently puncture at the defective spot and burn away a small hole in the foil coating 2 sufficient to clear the defect. Since this hole becomes visible, the break may be repaired by scraping away a small amount of the foil surface 2 adjacent to the ruptured spot, and revarnishing same, after which, if desired, a patch of foil may be applied to cover the repair. Normally the specified material never punctures in service, as there is a large margin or safety factor between the rated dielectric strength and the largest normally applied peak voltage to which the material of diaphragm 1 is ever subjected in service. When desired the foil 2 may be subsequently coated with varnish or any other suitable protective or decorative or utility surface 9, such as paint which is non-conducting, or coated flexible or crepe paper or fabric 9, or this element 9 may be omitted as it does not affect the electrical operation of diaphragm 1.

When desired, the diaelectric diaphragm 1 coated as aforesaid may be allowed to dry for several hours before use or may be oven dried at moderate temperature range, preferably not exceeding 200° F. If the foil 2 is employed in the variety sold in commerce with numerous perforations or small holes therein, it tends to lay closer and smoother against diaphragm 1 because no air pockets of small size are trapped between foil 2 and diaphragm 1 in such case due to the holes 10 therein. Also such holes 10, besides allowing escape of small portions of trapped air when the coating 2 is applied

to diaphragm 1, further assist in the more rapid drying of the adhesive varnish 7.

The air permeable electrode

While the air permeable electrode 3 may be supported on the same frame 5 as is used for holding diaphragm 1 in the manner disclosed in my aforesaid application for Letters Patent of the United States, Serial No. 352,201, filed April 3, 1929, I prefer to employ another frame member 11 for the purpose. Frame 11 may then be mounted in operative relation with respect to frame 5, and supported or carried thereon by means of members 12 and co-operating adjusting screws 13. Members 12 are made suitably of wood strips having elasticity sufficient to permit screws 13 to adjust the relative position of frame 11 with respect to frame 5. Frame 11 is appropriately of smaller area than frame 5 to afford a different natural period of vibration response to it and the elements it directly carries, than the natural period of vibration response of frame 5 and the elements it directly carries. The possibility of undesired frame resonance effects in service is thereby obviated. While, as shown, a single frame 11 suffices for supporting the air permeable member 3 in the case of a capacity reproducer of moderate size, for example, of the order of magnitude not exceeding 1000 square inches of area, I prefer to employ a plurality of such frames as 11 as illustrated in my application for Letters Patent of the United States, Serial No. 356,894, filed April 22, 1929, in the case of very large magnitude capacity reproducers for theatre and like use which may have a working area as great as 400 square feet or more.

Inasmuch as the exact size of the supporting frames, such as supports 5 and 11 respectively, as well as the shape thereof, does not appear to materially affect the response characteristics of the reproducer other than to somewhat extend the amplitude of low frequency response of the reproducer as the size is increased, persons skilled in this art have obvious wide limits in design and shape, as well as structural dimensions and materials suitable for the supports 5 and 11. Kiln dried wood is a suitable material for the frame supports 5 and 11 and any suitable fastening means, such, for example, as tacks 14 may be used to attach the elements respectively carried thereby.

While it is permissible to omit element 15, presently to be described, the same is preferably used for manufacturing convenience, as well as to impart a sound controlling effect on the air permeable electrode 3. Any porous or air permeable fabric having flexibility and elasticity, such as ordinary muslin of good quality, is suitable for element 15, and this fabric is stretched tightly on supporting frame 11. In the case of a frame 11 of large dimensions, a stronger fabric, such as linen crash, may be used for member 15.

Also over frame 11 there is supported and stretched with considerable initial tension a woven metal cloth or screen 16. The material used for element 16 may be ordinary tinsel cloth of commerce of either straight tinsel or crinkled tinsel lame variety, and preferably purchased with linen instead of cotton supporting threads therefor, or it may be finely woven metal screen prepared preferably from soft copper wires in mesh in the range 60 mesh to 150 mesh, either plainly meshed or in dutchweave type with spaced heavier wires interposed in the weave in one direction, as set forth in my application for Letters Patent of the United States, Serial No. 355,957, filed April 17, 1929. In any case, it is essential that this metal cloth or woven material be flexible and relatively thin, such, for example, within the range of thickness of .002″ to .015″. Tinsel cloth of commerce has been found suitable for the purpose. So has copper wire screen of 100 mesh of commerce been found satisfactory. Also a woven wire screen of 60 mesh having interposed wires of thickness in the range 150% to 200% of the thickness of the main portion of such screen material at intervals of ¾″ to 1½″ in one direction along the area of such material, has been found satisfactory for the purpose.

In general, the thinner metal cloth or screen material is more suited to frames 11 of moderate dimensions up to an area of about 4 square feet, while woven metal material for the element 16 may permissably be of heavier material in the range preferred as aforesaid in the case of a frame 11, of larger magnitude having an area, say of 5 to 25 square feet. It is desirable in any case to have the material or woven metal 16 evenly and smoothly stretched on frame 11 without wrinkles.

The elements 17 next and presently to be described may permissibly be omitted, more particularly in the case where a screen material 16 is employed in which heavier wires are interwoven at intervals therein as aforestated is used. But even in such case, the result is better when the elements 17 are employed, and in this event said elements 17 are preferably cemented directly over the aforesaid heavier spaced wires of the said screen material 16.

The elements 17 consist preferably of thin soft metal ribbons, or relatively thick metal foil, such as lead or tinfoil, of thickness within the range .001″ to .003″, and width within the range ¼″ to ½″. A lead foil ribbon ⅜″ wide and .0015″ thick has been found suitable. Also in some instances it is desirable to employ material for elements

17 of varying thicknesses, that is to say, alternate strips 17, or every third or fourth such strip 17 may appropriately be of double thickness to the thickness of the remainder of the strips 17. The last named detail of structural combination may be extended to any other desired relative differing range of thicknesses for successively disposed strips 17 carried by woven metal element 16, but substantially as good results may also be had when the thickness, as well as the width of members 17 is uniformly similar.

The strips 17 are appropriately and permanently cemented to woven metal member 16 by means of sodium silicate cement 18 or ordinary waterglass of commerce. The strips 17 may suitably be applied to member 16 in spaced relation by drawing each strip over a small supply of the aforesaid cement, and promptly and smoothly applying each said strip 17 and rubbing same gently down on the material 16. The said cement sets rapidly and holds the strips 17 tenaciously to the material 16. At the same time, the cement 18 normally penetrates through the woven metal material 16, and causes the material 16 to adhere to the fabric 15 at a plurality of small areas corresponding to the position of the strips 17 on member 16. Cement 18 is sufficiently electrically conductive even after it has set into crystal-like form to electrically interconnect the strips 17 and metal material 16.

A terminal 19 may be brought out so that electrical potential can be applied to the entire air permeable electrode thus constructed. The air permeable electrode 3 thus is prepared as a laminated porous structure having a plurality of soft metal areas afforded by strips 17, and is essentially flexible and capable of acting in the function of a sound emitting member analogous to the similar property of the dielectric diaphragm 1 aforedescribed. The vibrations of the air permeable member 3 are observable in normal service thereof.

As regards the relative area and spacing of the strips 17, considerable latitude is afforded anyone skilled in this art without greatly affecting the result. It is preferred, however, in view of numerous tests, and in order to obtain the best range of frequency response of the reproducer using such air permeable member 3, to have the total working area of the strip members 17 at least 50% as great as the total area of the woven metal member 16. Satisfactory results will be had, for example, if this ratio is increased to as much as 75% instead of 50%, but thereafter the air dampener effect of increased strip area 17 relative to woven metal area 16 results in loss of efficiency. A decrease of the said ratio to 25% or less is still operative, but causes the reproducer to observably have a tendency to emphasize higher pitch response when such lower ratio of relative areas is used.

As a practical example, when lead strips for element 17 are used 3/8" wide and .0015" thick, the spacing between strips may suitably be 1/4 to 3/8 inch; and with nearly, but not quite as pleasing result, the spacing may be as much as 3/4 or 1 inch. The more wide spacing is more appropriate in the case of material for woven metal member 16, comprised by wire screen having interwoven therewith spaced wires in one direction as aforesaid at intervals of 3/4 inch or more.

I am describing the observed limits of dimensions found suitable for such reproducers, because the results obtainable by departures from such ranges are definitely proven to be less pleasing and to restrict the range of frequency response to limits narrower than such as are deemed to be suitable for quality response range.

Obviously, some of the strips 17 may be made wider than others, but no advantage is obtainable by such modification which cannot be more conveniently obtained by coordinated spacing and selection of the dimensions of the strips 17 of uniform size. In the case of tinsel cloth for member 16, the strips 17 should be applied crosswise over member 16 so as to interconnect electrically the individual spaced tinsel metal strands of said tinsel cloth. The most suitable width for strips 17 is preferred in the range 1/4 inch to 3/8 inch, not only for convenience of construction, but because a better air permeable electrode 3 with better operating characteristics thereby results.

By the term "air permeable" is meant that characteristic of the laminated structure described for flexible member 3 whereby air can freely flow through the muslin or fabric member 15, and the woven metal member 16 at portions not covered by strips 17. At the same time, when member 3 is operated or flexed the movement of the strips 17, as well as the solid portion of member 16 thereof, and the solid portion of member 15 thereof is able to distribute force to a considerable amount of air and cause sound waves to be emitted by member 3.

As will presently be set forth, both members 1 and 3 operate as sound emitters in operation, each acting in opposite phase at a particular instant, so that air is pushed out for such a particular transient time to cause a sound wave to be emitted for each particular case in both directions with respect to the members 1 and 3. The energy transmitted to the air medium at each such transient instant largely propagates straight from the members 1 and 3 for a considerable distance, and does not attenuate as rap-

idly as in the case of other types of sound emitters. Furthermore, the sound energy so set up when members 1 and 3 are stressed by applying varying electrical potential thereto strikes the surrounding air over a relatively large distributed area. It is an observed fact that a listener at a distance of say five feet from such a reproducer appears to hear the emitted sound at substantially the same intensity as when positioned forty feet away therefrom.

It may be here remarked that a laminated structure as aforedescribed for member 3 is relatively dead to sound, per se, and has substantially no forced vibration characteristic when stressed.

The initial tension at which member 3 is supported on frame 11 is not critical, but should in any case preferably be greater than the tension at which member 1 is supported on frame 5, but not so large that member 3 cannot freely vibrate in operation. Owing to various sizes and operating circumstances, the exact tension may be widely varied within limits easily determined by brief trial in any particular case by anyone skilled in the art, so that the most pleasing result is readily arrived at by one or two observations. The minimum tension in any case is that necessary to hold member 3 normally in place without wrinkles of "flabby" surface portions, and a tension slightly greater than the minimum usually suffices for the purpose.

The means to eliminate back-lash rustle noises

If the elements supported as aforedescribed on frames 5 and 11 were assembled without the use of means, such as threads 4 interposed, the reproducer of Fig. 1 would still be operative and suitable in all respects if the amplitude of vibration is kept below the point at which rustle or back-lash noises begin. However, for large amplitudes and in order to obtain a relatively high efficiency of response, I find that means such as elements 4 are essential to avoid rustle noise. The means employed are, for example, shown as fabric threads 4, but any equivalent material of like general properties may be used for the purpose.

It will be noticed that the threads 4 are preferably of non-conducting material, such as silk, linen or cotton in the common form, sold as thread or twisted thread or floss in the market. Strips or thin ribbons of insulating material may also be used for elements 4. I have determined that various sizes of such threads are suitable for elements 4, provided that the spacing between successive threads 4 is proportioned according to the thickness. A few examples of thread sizes and spacing between threads 4 found suitable are listed herewith in order of merit. If wires or insulated wires are substituted for the threads 4, an operative result may be had, but at much reduced efficiency and with incomplete mitigation of rustle noises. Also if the threads 4 are continuously fastened to either member 1 or member 3, the result is not as good as when they are not so fastened, but permitted merely to lie against the portions of members 1 and 3, free to move or roll or twist in service.

The following table indicates an exemplification of thread size and spacing between threads suitable for the purpose:

Thread material	Size	Approximate diameter	Spacing
		Inch	
Spool cotton	90	.003	½ to 1 inch.
Spool cotton	70	.004	¾ to 1¼ inches.
Spool cotton	60	.005	1 to 1½ inches.
Spool cotton	8	.01	2½ to 3½ inches.
Spool silk	A	.0035	¾ to 1½ inches.
Spool linen	Button.	.013	3 to 4½ inches.

It may be remarked that the thinner the thread used, the closer same may be spaced for elements 4, and that the thicker the threads are, the further they must be spaced. Also as the thickness of the threads increases, such increase is accompanied by some loss of efficiency. For the stated reasons, a thin thread relatively closely spaced is preferred. The thickness of the thread for elements 4 also depends on the thickness of the material of diaphragm 1 in the ratio that the thinner the material of diaphragm 1 is, the thicker the material of threads 4 may be without loss of operating efficiency.

The preferred structure, as shown in Fig. 1, may, for example, have threads 4 of No. 90 spool cotton spaced ¾ inch apart, and tensioned sufficiently to lie against member 3. Then upon completion of assembly such threads 4 lie sandwiched between members 1 and 3 in the form of substantially spaced rows of twisted fabric free to move or alter their positions under the action of stresses. Under normal use, the polarizing potential applied to electrode 2 and member 3 causes member 1 and member 3 to be attracted towards each other with sufficient force to draw portions of elements 1 and 3 adjacent to threads 4 closely against members 4.

In the case of a thin silk diaphragm material for membrane 1, this normal effect is sufficient to make ridges visible on the foil surface 2 corresponding to points of contact of membrane 1 against threads 4. An important new result is, however, attained in that the threads 4 are substantially non-conductive, so that the electrostatic force of attraction holding member 1 against threads 4 is relatively less at such points of contact. As a matter of fact, the residual force due to adhesion, friction, retention of dielectric

strain in material 1 and/or vacuum suction effect is easily broken down as rapidly as necessary, due to the presence of the thin non-conductor threads 4. Such threads 4 are further able to roll or twist, as well as flex, with respect to members 1 and 3, so that adhering friction effects are substantially minimized, thereby permitting maximum response of members 1 and 3 to the applied electrical stresses.

A further fact is that upon returning from any particular transient force which separates member 1 from member 3, the elasticity causes members 1 and 3 to tend to strike together. Such back-lash effect normally would produce undesired rustle noise, but due to means 4 the return shock is first absorbed by having the return force compress against threads 4 so that most of the area of members 1 and 3 does not contact until substantially all of the return force due to elasticity is so broken and dissipated. The operation is identical in either case, whether threads 4 are wound in spaced relation around member 3 carried on frame 11 or similarly supported by frame 5 adjacent to member 1.

In the other operating case, where member 1 and member 3 have been transiently drawn as close as possible together by electrical stress due to the application of operating potential to electrode surface 2 and air permeable electrode diaphragm 3, elastic forces and/or assisting forces due to applied electrical stresses normally compel the member 1 temporarily held by vacuum suction to member 3 to follow member 3 on its return to normal position, unless some means, such as elements 4, are used to promptly break such temporary vacuum.

Since member 3 is air permeable and air freely flows through the woven metal material 16, and since further the small diameter of the threads 4 leaves a thin line of contact with respect to members 1 and 3, air is freely admitted to break any vacuum suction effect between strip members 17 and diaphragm 1. This desired effect is assisted by twisting action of the threads 4 influenced by the vibratory stresses applied to members 1 and 3. Any particular section or portion of membrane 1 is thereby permitted to flex and/or roll about threads 4 as a fulcrum with respect to member 3, and similarly each thread 4 acts as a fulcrum for the free motion of element 3. The actual result of this novel structure is that back-lash noises or fuzzy rustle sounds are eliminated at even the maximum amplitude of vibration of members 1 and 3.

The operating circuit

Any suitable operating circuit may be employed to actuate the capacity reproducer set forth. Thus, in Fig. 2 essentially, a source of polarizing potential 20 normally causes electrode surface 2 to be attracted toward air permeable electrode 3, and press membrane 1 against threads 4. Then when fluctuating or alternating currents or voice or sound varying potentials are applied to electrode 2 and electrode 3, members 1 and 3 are caused to move exactly in response thereto. The polarizing voltage supplied by source 20 may be afforded by small series connected batteries or a small transformer rectifier resistance capacity unit in customary manner. Its value should be well below the breakdown limit of material used for diaphragm 1, and also higher than the largest peak voltage of the impressed voice or audio frequency currents. A practical value for the polarizing voltage, for example, is 500 volts, direct current.

The reservoir condenser 21 should have a capacity of at least ½ mfd. to keep the capacity reproducer charged when same is operated by a temporary electrical fluctuation of considerable magnitude, as when a percussion instrument is being reproduced. In some cases, as for example, when the operating audio current is obtained from a phonograph pick-up apparatus, a filter circuit 22 may appropriately be connected between the customary vacuum tube amplifier unit 23 and the capacity reproducer 24 to eliminate scratch sounds or other undesired noises. The use of terminal resistance 25 in combination with capacity 26 permits reproducer 24 to be used with an amplifier unit 23 which need not of itself be constructed to match the impedance of reproducer 24. Such an arrangement permits reproducer 24 to faithfully reproduce musical and voice sounds at maximum amplitude or volume of response free from disturbing noises. Due to the improved construction set forth, even the reproduction of loud sounds set up by percussion instruments does not permit back-lash effects to interfere with true response thereto free from buzzing sounds previously found when threads or equivalent means 4 were not used.

In Fig. 3, the diagram illustrates the most probable theory of operation whereby rustle noises due to back-lash are avoided. Considering a small sectioned portion of the membrane 1 adjacent to one thread 4 and the co-operating portion of air permeable electrode 3, it will be evident that thread 4 may serve as a shock absorbing roller or fulcrum to break the return force normally tending to cause member 3 and member 1 to strike together. Also element 4, by its small area of contact and ability to roll or twist, permits air to rapidly break vacuum suction causing adherence of element 17 to membrane 1 when stresses draw these parts together with rapid acceleration. In general, the two diaphragms 1 and 3 may operate

in opposed phase, that is to say, with both unit portions of member 1 and 3 pushing the surrounding air outwardly at a particular instant. However, if thread or like means 4 are not employed, there may be sufficient temporary adhesion of member 1 to member 3 to cause same to temporarily combine as a single laminated diaphragm, thereby introducing distortion and loss of efficiency. The means 4 prevent this undesired possibility; previously observed to be a fact in operation, when large values of operating electrical stresses were employed.

While I have endeavored to set forth the most probable theory of the operation, and to explain the function of the back-lash preventing means 4, my invention is not to be understood as depending upon such theory because the structure exemplified for the purpose is demonstrated to be fully operative to attain the objects sought, regardless of the exact nature of operating characteristic causing the desired action. The result too is attained without loss of efficiency or volume of response. So too, where I have specified exemplifications of suitable dimensions and proportions, same are to be considered as desirable and not necessarily limiting proportions because in many cases nearly as good results can nevertheless be obtained by wide departures from the exact values indicated as demonstrated to be suitable.

In general, however, close attention to details of structure specified will afford most pleasing and efficient results. I believe that I have now fully set forth my invention and the step forward in this art which it teaches, so that various changes may be made within the spirit of the invention and the scope of the appended claims.

I claim:

1. A capacity reproducer consisting of operating members comprising two electrodes with a dielectric between and a plurality of separately spaced flexible means interposed between said electrodes to mitigate the back-lash effect thereof.

2. A capacity reproducer consisting of operating sounding electrode members and unwoven threads interposed therebetween.

3. A capacity reproducer consisting of sounding electrode members and spaced unwoven threads sandwiched therebetween.

4. In an acoustic condenser employing sounding members, means to prevent rustle noises at large amplitudes of response of said members consisting of loosely disposed spaced insulating elements interposed between said members.

5. A capacity reproducer consisting of an air permeable electrode, a co-operating dielectric diaphragm therefor, an electrode coating carried by said dielectric diaphragm, and flexible spaced insulator elements loosely stretched between said dielectric diaphragm and said air permeable electrode.

6. A reproducer consisting of a plurality of co-operating sounding members, means to actuate said members, and spaced thread shaped elements interposed between said members.

7. A capacity reproducer consisting of an air permeable electrode, a co-operating dielectric diaphragm therefor, an electrode carried by said diaphragm, and spaced thread elements disposed between said air permeable electrode and said dielectric diaphragm.

8. In the art of acoustic condensers, a dielectric diaphragm, an electrically conductive coating carried thereby, a co-operating air permeable electrode, means to dispose said electrode adjacent to said diaphragm, and back-lash controlling means spaced and linearly disposed between said electrode and said diaphragm.

9. A capacity reproducer consisting of sounding members, means to actuate said sounding members, and a plurality of spaced linearly disposed insulator elements sandwiched between said sounding members.

10. In an acoustic condenser, structure for an air permeable electrode therefor consisting of an electrically conductive flexible woven material, a plurality of spaced metal strips fastened thereto, and a plurality of spaced thread-like elements movably supported with respect to said metal strips.

11. In an acoustic condenser, structure for a dielectric diaphragm and its conductive coating consisting of a dielectric impregnated fabric, a coating of finely divided powder on one surface of said impregnated fabric, a perforated thin metal foil coating on the other surface of said impregnated fabric, and an insulating adhesive disposed to hold said perforated foil on said fabric.

12. An acoustic condenser consisting of two flexible stretched sounding members, means to actuate said members, spaced flexible elements disposed between said members, and means to maintain one of said sounding members under less tension than the other.

13. A capacity reproducer consisting of a dielectric diaphragm, a conductive coating on said diaphragm, a co-operating air permeable electrode held adjacent to said diaphragm, and thin spaced flexible elements disposed between said diaphragm and said air permeable electrode.

In testimony whereof, I have hereunto set my hand this 30th day of July, 1929.

PHILIP E. EDELMAN.