July 26, 1932. E. PODSZUS 1,868,640

SOUND REPRODUCING APPARATUS

Filed June 19, 1930

Fig. 1.

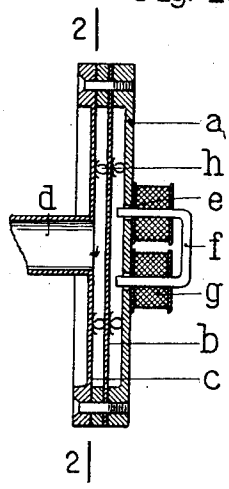


Fig. 2.

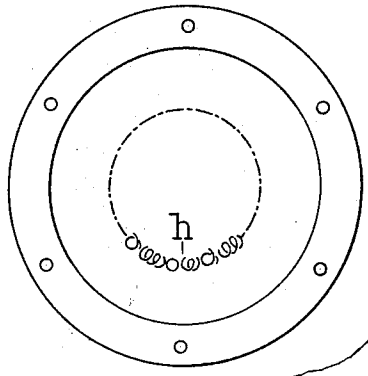
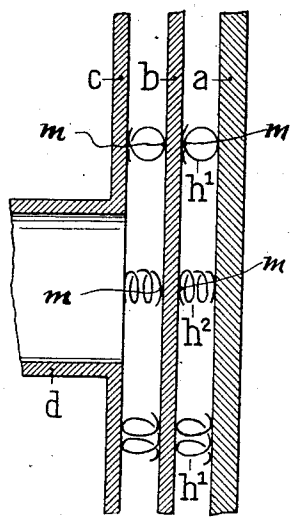


Fig. 3.



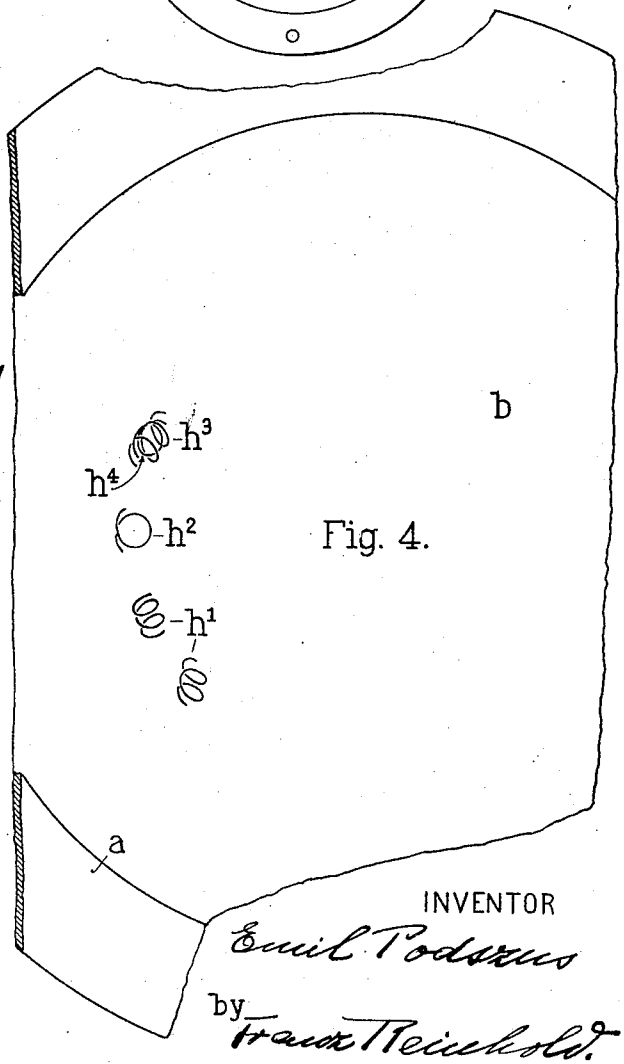


Fig. 4.

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UNITED STATES PATENT OFFICE

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SOUND REPRODUCING APPARATUS

Application filed June 19, 1930, Serial No. 462,332, and in Germany June 26, 1929.

My invention relates to improvements in sound reproducing apparatus, and more particularly in sound reproducing apparatus comprising a diaphragm adapted to be vibrated in accordance with the oscillations of the sounds to be reproduced, such as are used for example in telephones and loudspeakers. The object of the improvements is to provide a sound reproducing apparatus in which the natural vibrations of the diaphragm are checked and partly used for intensifying the desirable vibrations imparted to the diaphragm by the sound reproducing device. My improved checking means are useful in sound reproducing apparatus of any type comprising a diaphragm and particularly in apparatus provided with a comparatively rigid diaphragm of high elasticity, such as telephones and the like. For checking the said natural vibrations of the diaphragm I apply thin checking members to those points of the diaphragm where they are adapted to check particularly the overtones of the natural vibrations of the diaphragm, while they do not interfere with the vibrations imparted to the diaphragm by the sound reproducing device by reason of their thin construction and proper distribution on the diaphragm, so that they insure correct reproduction particularly of the sounds of high frequency which are essential in reproducing sounds in the correct timbre.

For the purpose of explaining the invention an example embodying the same has been shown in the accompanying drawing in which the same reference characters have been used in all the views to indicate corresponding parts. In said drawing,

Fig. 1 is a sectional elevation showing a telephone receiver,

Fig. 2 is a sectional elevation taken on the line 2—2 of Fig. 1,

Fig. 3 is a sectional elevation on an enlarged scale showing the construction of the checking members, and

Fig. 4 is a side view of Fig. 3 with the disk closing the telephone receiver removed.

In the example shown in the drawing the sound reproducing device comprises a box *a* having a diaphragm *b* fixed thereto by means of a disk *c* carrying a tubular member *d*. Through holes *e* made in the bottom of the box *a* the cores *f* of an electromagnet *g* are passed into position for acting on the diaphragm.

The diaphragm *b* is acted upon by checking members made in the form of exceedingly thin wires *h* having a thickness of say 0,018 millimeters and made from tungsten, steel or other material of high elasticity, the said wires being in contact with the bottom of the box *a* and the disk *c*, which bottom and disk are preferably disposed at a distance of from 1–2 millimeters away from the diaphragm. The said wires are bent into curved or other irregular shape, and in the example shown in the figures they are in the form of fine coils or curved springs and they are in point contact with the diaphragm. They may be in loose engagement with the diaphragm, but I prefer to fix the same to the diaphragm by means of lacquer or glue for securely coupling the same with the diaphragm in the desired positions.

The said checking members are exclusively applied to the points of the diaphragm corresponding to the loops of the overtones of the natural vibrations of the diaphragm, and their number and power are such that they take up the increase of the amplitude of the desired vibrations caused by the natural vibrations of the diaphragm in case of median excitation thereof, and therefore they are different in size and thickness according to the intensity of the vibration to be checked. Preferably I use a diaphragm having a comparatively low natural frequency because in such a diaphragm the higher tones are more readily excited in a regular way.

The elastic reaction of the checking members depends on their number, on the thickness and the curvature of the wire, and the character of the material. It is not necessary to apply checking members to all the loops of the natural vibrations of the diaphragm, or to apply such checking members to all the points of a loop, but it is sufficient to apply the checking members to the loops of the natural vibrations the frequencies of which are close to those of the overtones of

the sounds to be reproduced. But for obtaining pure vibrations the checking members are preferably disposed symmetrically of the diaphragm, and where several natural vibrations overlap I provide stronger checking members by providing comparatively thick wires or a plurality of thin wires. Ordinarily I have found that it is desirable not to apply more checking members than is necessary for obtaining the result aimed at. I have found that in a circular diaphragm it is necessary to apply checking members to a single concentric zone. The position of the zone to which the checking members must be applied can be determined theoretically or by experiment, for example by means of figures of sand produced on the diaphragm by vibration. In simple forms of diaphragms such as circular diaphragms the said figures are known.

Where high checking power is needed several wires are disposed in contact with each other, so that the checking power is increased by the frictional engagement of the checking members. By the said frictional engagement objectionable noises are not produced by reason of the thinness of the wires.

Preferably the contacting checking members are different in form, as is shown in Fig. 3, in order that the members are differently coupled with each other and the diaphragm is uniformly sensitive as to the characteristic high tones.

As appears from Fig. 1 the zone of the diaphragm which is acted upon by the vibrating device f, g is as far as possible free of checking members, the dimension of the said free zone being such that the natural vibration of the said free zone is at least 3000 per second, and the desired vibrations imposed on the diaphragm can be developed without being checked.

It is important that the dimension of the checking members be comparatively small, and therefore the bottom of the box and the disk c are disposed closely to the diaphragm. The distance between the said supporting members and the diaphragm should not be more than a small fraction of a centimeter, and in the example shown in the figure it is from 1–2 millimeters. The radius of the curvature of the checking members depends on the said distance between the diaphragm and the support of the checking members, and therefore it is not more than a few millimeters.

By disposing the checking members at opposite sides of the diaphragm, as is shown in Fig. 1, a uniform checking action is insured. In case of transformation by pressure I dispose the checking member in the area of the transformation.

Therefore the arrangement of the checking member is particularly simple in diaphragms for telephone receivers in which ordinarily a single series of checking members is disposed concentrically of the center of the diaphragm, and on a circle dividing the radius of the diaphragm along the golden section. Golden section as here employed is a geometrical term and signifies a bisection of the diameter of a circle such that one section thereof is equal to the chord of a regular decagon inscribed within the circle. The relation may be expressed in the equation, $r(r-x)=x^2$, in which r is the radius and x a section thereof. The relation corresponds substantially to the division of a line on the ratio of 3 : 5.

The checking effect may be increased by disposing the said checking members concentrically of the disk in a closed circle, and in this case the effect is further increased by closing the circle of the checking members as far as possible for example by inserting particularly fine checking members between the checking members of normal size. In this construction the checking action is supported by the obstruction of the flow of air within the circle of checking members.

The checking device has been described herein as applied to a sound reproducing apparatus in which the diaphragm is fixed at its margin to its carrier. But it may also be used in systems having freely supported diaphragms, in which case the checking members may be constructed for supporting the diaphragm.

Preferably the checking members are applied to loops of those overtones of the natural vibration which are next to the fundamental natural vibration of the diaphragm.

The springs act as coupling members, and thus they act by their vibration on the vibrations of the diaphragm.

Ordinarily the checking members are made from wire which may be irregularly crumpled or bent into coils. But I wish it to be understood that I do not limit myself to these features and that checking members may be made from other elastic bodies such as bands.

Figs. 3 and 4 show some examples of plac-ing the checking members between the diaphragm and their support. As shown at h^1 the coils are simply located with their axes parallel to the diaphragm, and some or all the windings of the coils are glued to the diaphragm. At h^2 a coil is shown the axis of which is more or less perpendicular to the diaphragm, and at h^3, h^4 a pair of coils is shown which are combind into a single checking member, and which are in frictional engagement with each other. In Fig. 3 at m, m small bodies of material such as lacquer or glue are indicated, by which the coils h^1 may be secured in position upon the diaphragm b. I have, however, explained above that such securing bodies need not in all cases be

employed, and that a loose engagement may in particular cases suffice.

I claim:

1. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and damping members in the form of bodies made from filaments of highly eleastic hard material engaging said diaphragm at some parts of the surface thereof and leaving the other parts bare.

2. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and damping members in the form of bodies made from filaments of highly elastic metal engaging said diaphragm at some parts of the surface thereof and leaving the other parts bare.

3. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and damping members in the form of bodies made from highly elastic hard filaments engaging said diaphragm at the loops of the overtones of the natural vibrations of the diaphragm and leaving the other parts bare.

4. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and checking members in the form of wires of highly elastic material and a thickness of from 1/100 to 5/100 of a millimeter engaging said diaphragm at points permitting the overtones of the natural vibrations of the diaphragm to be selectively checked.

5. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and damping members in the form of exceedingly fine bodies of highly elastic hard material engaging said diaphragm at opposite sides and at some points thereof and leaving the other parts bare, and rigid supporting members for said damping members located a small distance away from said diaphragm.

6. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and damping members in the form of bodies made from filaments of highly elastic hard material engaging said diaphragm at some parts of the surface thereof and leaving the other parts bare, and a rigid supporting member for said damping members, the distance between said diaphragm and said supporting member being a small fraction of a centimeter.

7. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and damping members in the form of bodies made from curved filaments of highly elastic hard material engaging said diaphragm at some parts of the surface thereof and leaving the other parts bare, the number, the thickness and the curvature of said filaments being such that the increase of the amplitude of the vibration caused by the natural vibration of the diaphragm in case of median oscillation is damped thereby.

8. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and damping members in the form of bodies made from highly elastic hard filaments engaging said diaphragm at some parts of the surface thereof and leaving the other parts bare, some of said damping members being in frictional engagement with each other and being so thin that obnoxious noises are not produced.

9. A sound reproducing device, comprising a diaphragm clamped along its margin, means for vibrating said diaphragm in accordance with sounds to be reproduced, and damping members in the form of bodies composed of curved filaments of highly elastic hard material, the radius of the curvature of said filaments being a small fraction of a centimeter.

10. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and damping members in the form of bodies made from filaments of highly elastic hard materials engaging said diaphragm along a narrow zone disposed concentrically of the diaphragm and dividing the radius of said diaphragm along the golden section.

11. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and damping members in the form of bodies made from tungsten filaments engaging said diaphragm at some parts of the surface thereof and leaving the other parts bare.

12. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and damping members in the form of bodies made from steel filaments engaging said diaphragm at some parts of the surface thereof and leaving the other parts bare.

13. A sound reproducing device, comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, damping members disposed concentrically of the diaphragm in position for engaging the loops of the natural vibrations of the diaphragms, and additional damping members between said first named damping members sufficient to close the circle of the damping members.

14. A sound reproducing device, comprising a box having a closed bottom and nearly closed top, a diaphragm between said bottom and top, and damping members engaging said diaphragm at the loops of the natural vibrations thereof.

15. A sound reproducing device including a plane-surfaced body, a vibratory diaphragm extending in parallelism to the plane surface of said body and spaced at an interval from the plane surface thereof, and a dampening member in the form of a helix of wire arranged in the interval between the diaphragm and the body first named engaging the surface of the diaphragm and the opposite plane surface of the body first named at opposite points and secured in such position.

16. The structure of claim 15, the helix being secured to the diaphragm.

17. A sound reproducing device including a plane-surfaced body, a vibratory diaphragm peripherally secured and extending in parallelism to the plane surface of the body first named and at an interval from the plane surface of the body first named, means arranged opposite the diaphragm at a point within its periphery for setting the diaphragm in vibration, and means for dampening diaphragm vibration, such means including a plurality of helical springs arranged in the interval between the plane surface of the body first named and the diaphragm and secured in position at equal distances from that point in the extent of the vibratory diaphragm opposite which the vibratory means are situated.

18. A sound reproducing device comprising a diaphragm, means for vibrating said diaphragm in accordance with the sounds to be reproduced, and a dampening member in the form of a body made from a filament of highly elastic, hard material engaging said diaphragm in point contact.

In testimony whereof I hereunto affix my signature.

DR. EMIL PODSZUS.