Nov. 5, 1929. H. C. HARRISON 1,734,624

PISTON DIAPHRAGM HAVING TANGENTIAL CORRUGATIONS

Filed April 16, 1926 2 Sheets-Sheet 1

Fig. 1

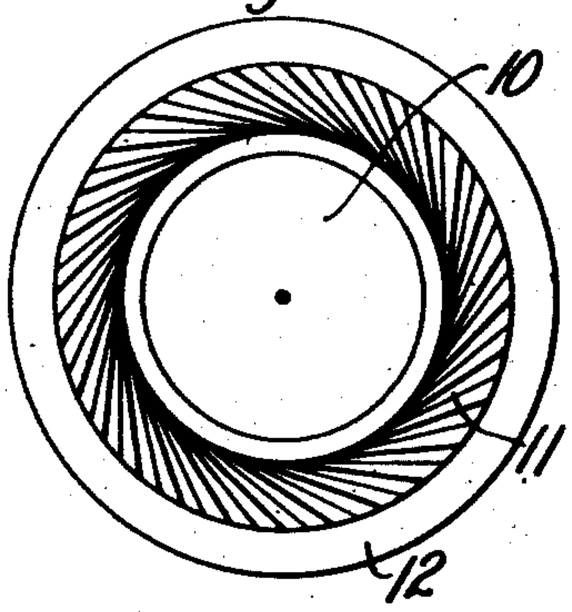

Fig. 2

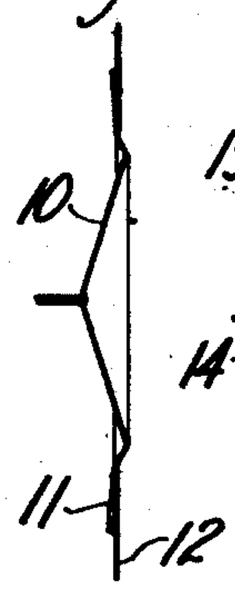

Fig. 3

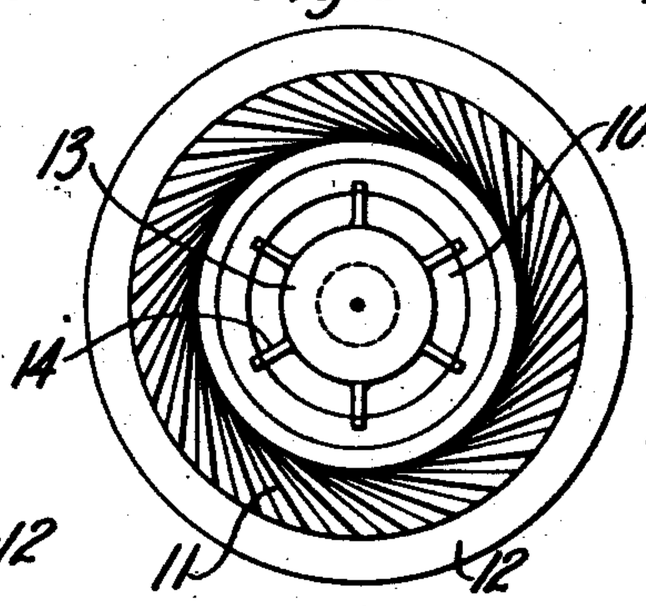

Fig. 4

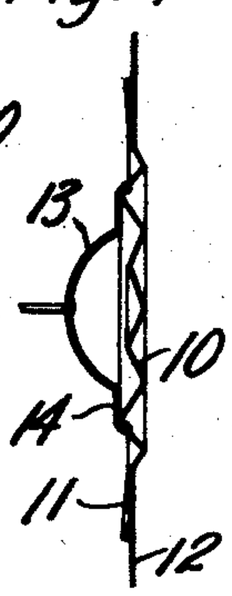

Fig. 5

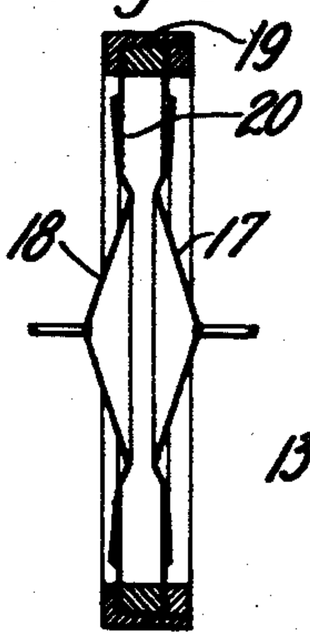

Fig. 6

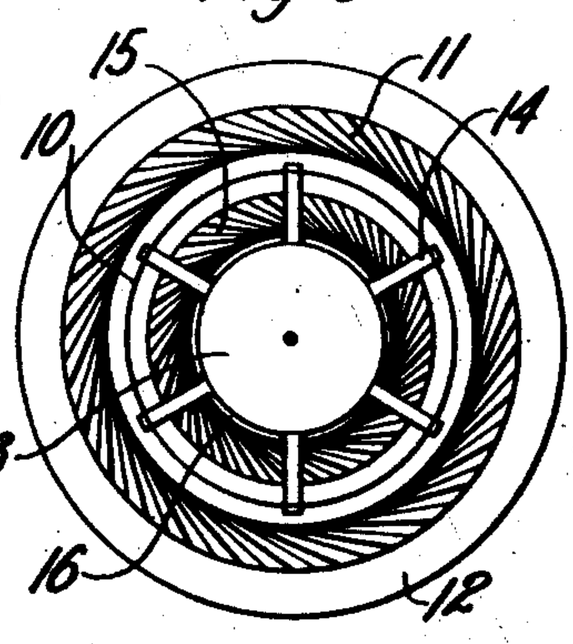

Fig. 7

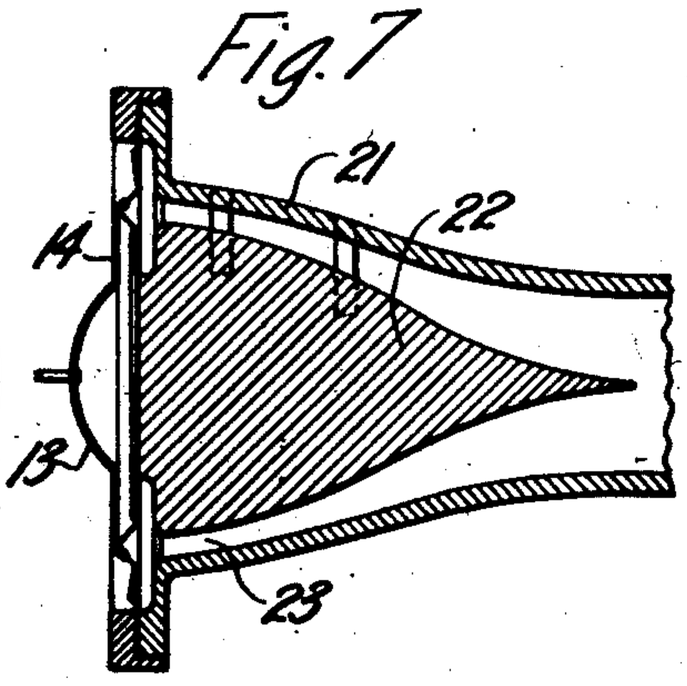

Fig. 8

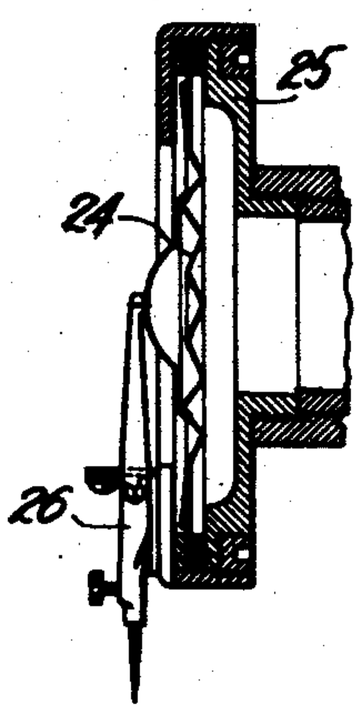

Fig. 9

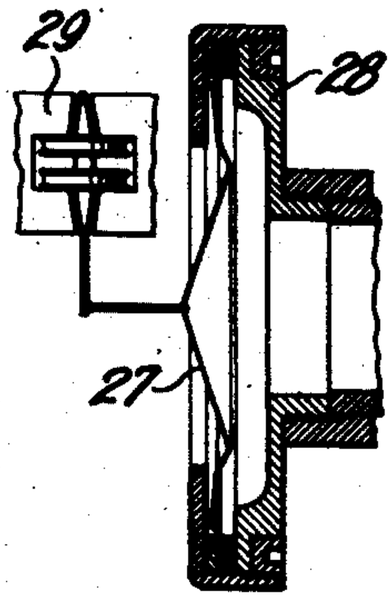

Fig. 10

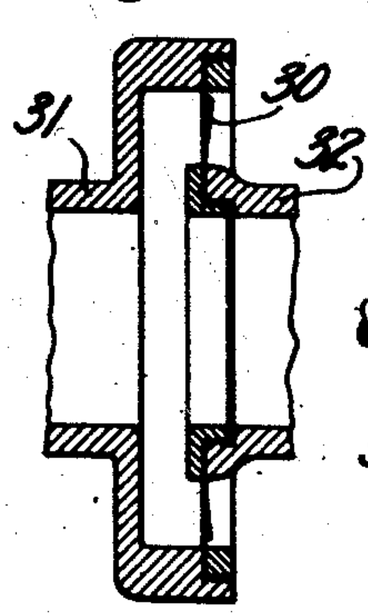

Fig. 11

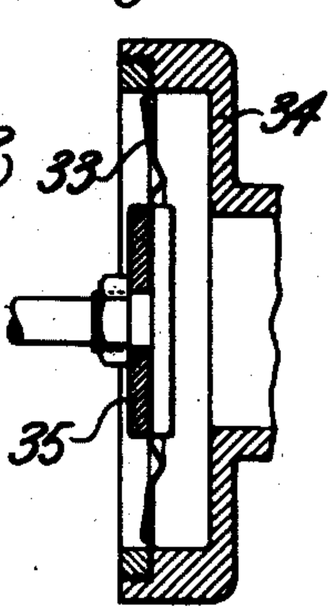

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Fig. 12

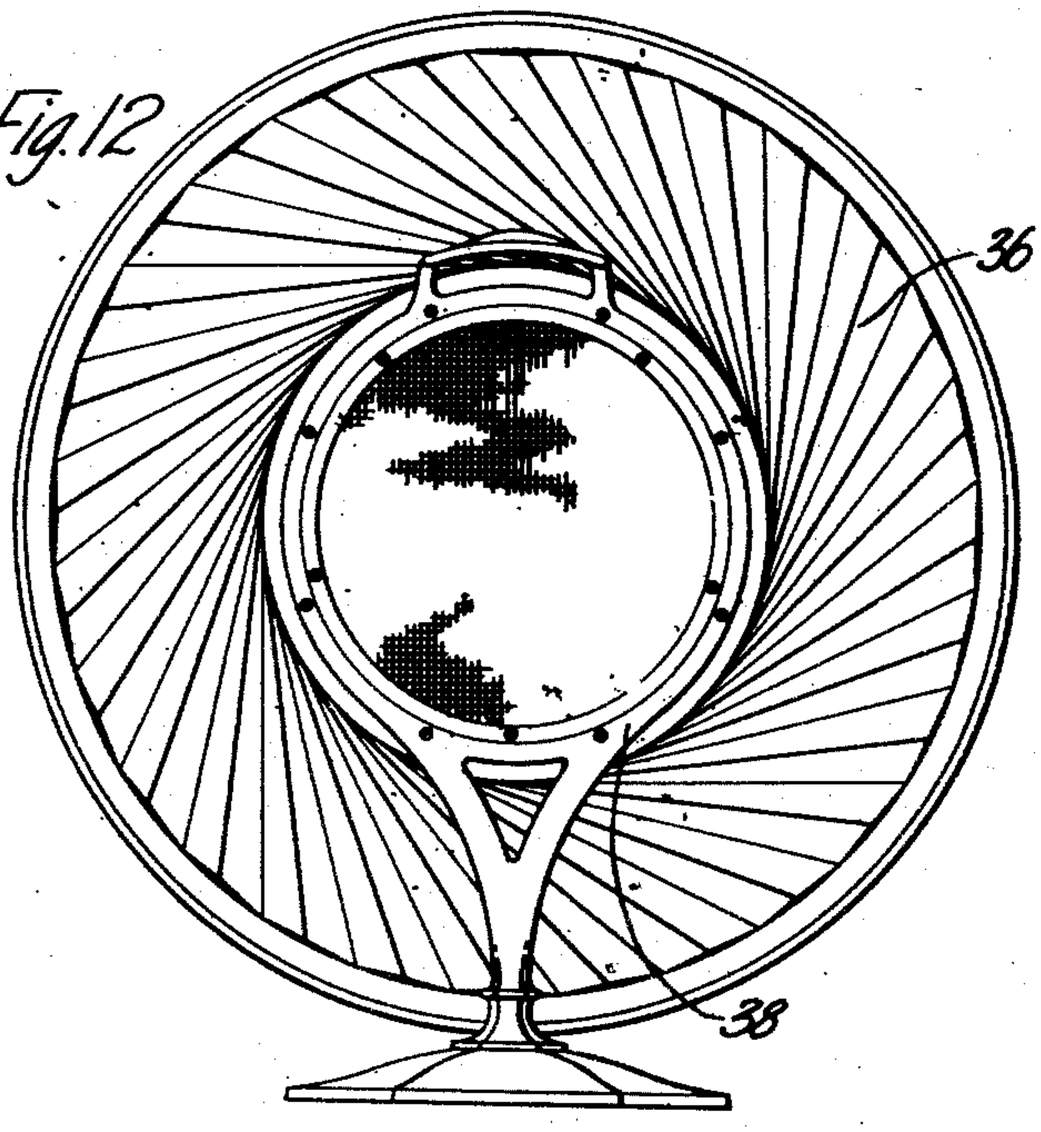


Fig. 13

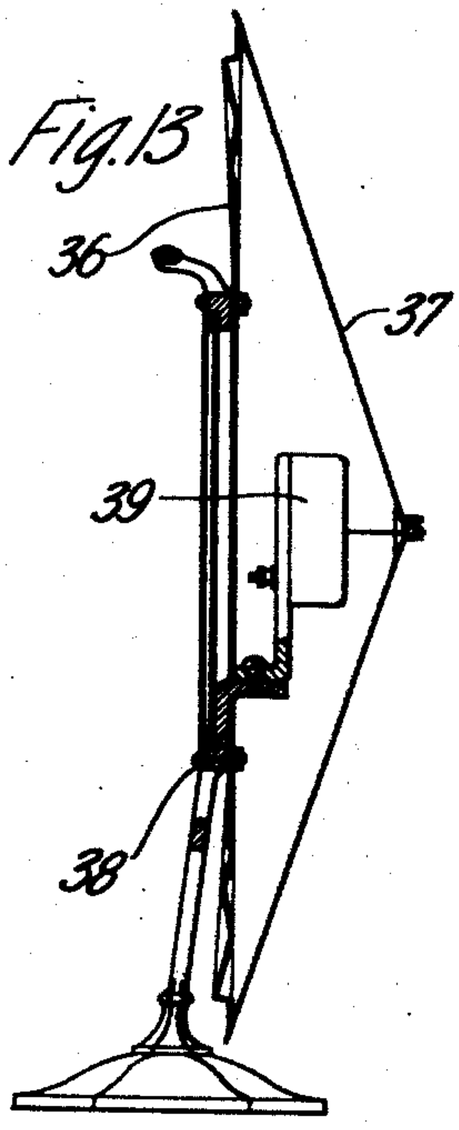


Fig. 15

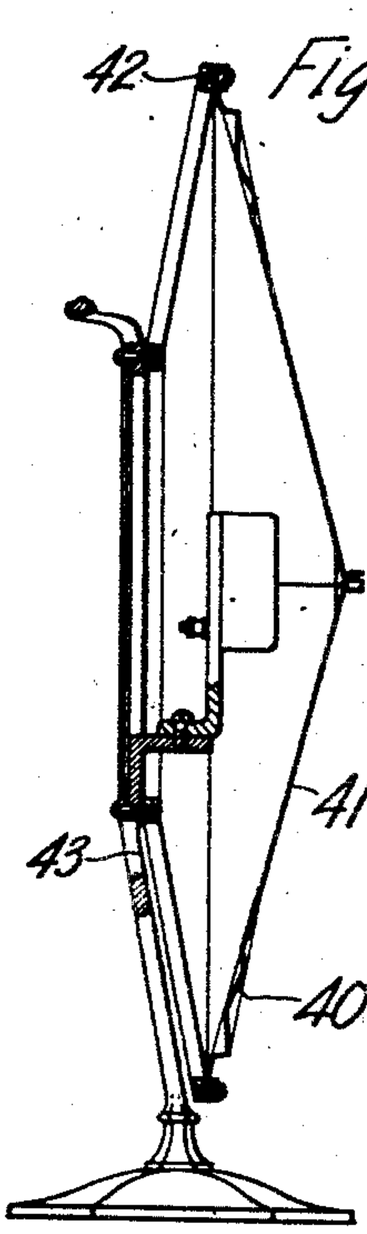
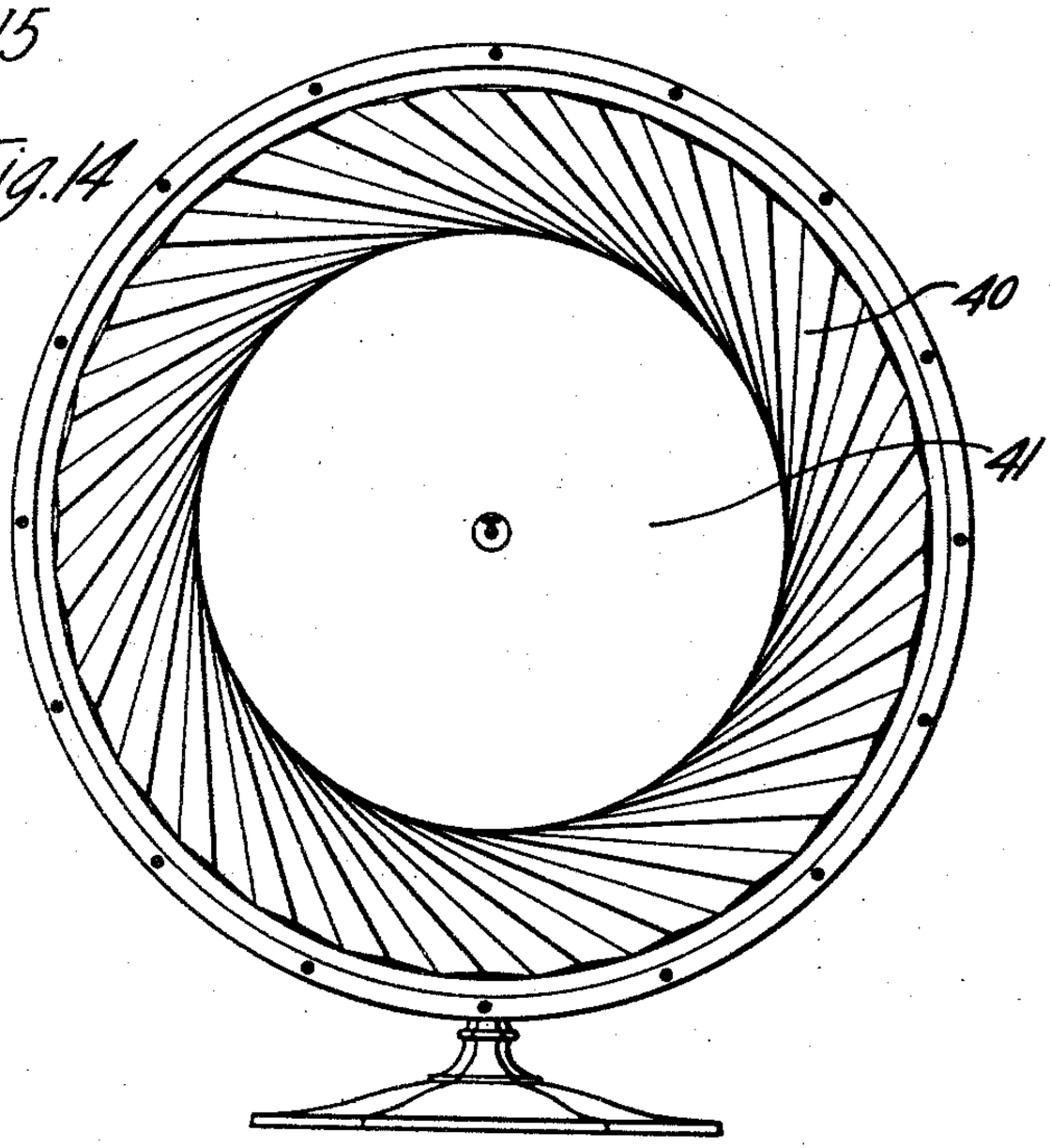


Fig. 14



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Patented Nov. 5, 1929 1,734,624

UNITED STATES PATENT OFFICE

HENRY C. HARRISON, OF PORT WASHINGTON, NEW YORK, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

PISTON DIAPHRAGM HAVING TANGENTIAL CORRUGATIONS

Application filed April 16, 1926. Serial No. 102,454.

This invention relates to diaphragms of the so-called piston or plunger type, such for example as disclosed in an application, Serial No. 33,619, filed May 29, 1925, of which the present application is a continuation in part.

It is the general object of this invention to provide a diaphragm which when used in acoustic devices will respond accurately to and reproduce truly and without rattle all frequencies within the normal audible range.

In accordance with the general features of this invention, there is provided a piston or plunger type diaphragm with low series elasticity, that is low elasticity between the moving plunger and a stationary housing or frame to which the periphery of the diaphragm may be secured.

In a specific embodiment of this invention, a diaphragm stiffened over the greater portion of its area is provided at its periphery with a concentric flexing area produced by means of tangentially arranged corrugations extending substantially perpendicular to the radii drawn to the inner ends of the corrugations. Such corrugations may be made to form flexing lines of low elasticity but with stiffened areas having a natural period well above that of the audible range.

Referring to the drawings:

Fig. 1 is a side view of a piston diaphragm having tangential corrugations;

Fig. 2 is a section view of Fig. 1 through the center;

Fig. 3 is a side view of a piston diaphragm having tangential corrugations and a spider driving member;

Fig. 4 is a section view of Fig. 3 through the center;

Fig. 5 is a section view through the center of two piston diaphragms having tangential corrugations mounted in a housing to form a tight chamber between them;

Fig. 6 is a side view of an annular piston diaphragm having tangentially corrugated portions extending from both edges;

Fig. 7 is a section view through the center of an acoustic mounting for a diaphragm of the type shown in Fig. 6;

Fig. 8 is a section view through the center of a phonograph reproducer employing a piston diaphragm having tangential corrugations;

Fig. 9 is a section view through the center of a horn type loud speaking receiver employing a piston diaphragm having tangential corrugations;

Fig. 10 is a section view through the center of a pipe expansion joint employing tangential corrugations;

Fig. 11 is a section view through the center of a diaphragm piston having tangential corrugations and suitable housing;

Fig. 12 is a side view of a loud speaker employing a tangentially corrugated annular member for supporting a large direct acting piston diaphragm;

Fig. 13 is a section view of Fig. 12 through the center;

Fig. 14 is a side view of a loud speaker employing a large direct acting conical diaphragm having an annular portion tangentially corrugated; and

Fig. 15 is a section view of Fig. 14 through the center.

Referring to Figs. 1 and 2, the central portion 10 is conical to secure stiffness and the annular portion 11 surrounding the central portion is tangentially corrugated to secure flexibility and the outer edge 12 is flat to provide a clamping rim or annulus.

Figs. 3 and 4 are side and section views, respectively, of a modified design of the piston diaphragm having a central portion 10 employing a plurality of concentric corrugations to secure stiffness, a tangentially corrugated annular portion 11 to secure flexibility, an outer flat edge 12 to provide a convenient clamping rim, and a driving spider member 13 with a plurality of radially extending arms 14 for making connection with the piston portion 10. The spider member in this design is employed as a part of the coupling between the diaphragm and the driving element. This coupling may be designed as a mechanical transmission line according to the methods shown in my copending application Serial No. 33,619, filed May 29, 1925.

Fig. 5 shows an application of two piston diaphragms 17 and 18 mounted in a housing 19 in such manner that the space between

them forms a tight chamber and permits their being used for the variable element in such devices as a thermometer, barometer or other similar device when the chamber 20 is filled with the appropriate fluid. An advantage of this type of diaphragm in such a device is that it permits a large amplitude of movement.

An annular type of piston diaphragm with tangentially corrugated annular supporting portions at each edge and suitable mounting for its use in an acoustic device is shown in Figs. 6 and 7. The annular piston portion 10 is supported by the outer tangentially corrugated portion 11 and the inner tangentially corrugated portion 15. The corrugated portions have clamping rims 12 and 16 by which the diaphragm is held in its housing. The coupling member for attaching the driving element to the diaphragm is shown by the spider 13 and its plurality of radial arms 14 and it is similar to the driving member shown in Figs. 3 and 4. The mounting for such an annular piston diaphragm is shown in Fig. 7 and consists of a housing member 21 and an internal member 22. These two members form a tight annular chamber 23 in front of one side of the diaphragm and direct the vibrations produced by the diaphragm in this chamber through its passage towards the mouth of a horn (not shown). The cross-section area of the chamber 23 immediately in front of the diaphragm and its rate of change in cross-section is such as to properly load the diaphragm and transmit sound to the mouth of the horn without unnecessary losses as described in my prior application referred to above.

An application of a piston diaphragm employing tangential corrugations to a phonograph reproducer is shown in Fig. 8. The diaphragm 24 is mounted in a siutable housing or sound box 25 and is connected to a suitable stylus arm 26 through appropriate coupling members.

An application of a piston diaphragm employing tangential corrugations to a horn type receiver or loud speaker is shown in Fig. 9. The diaphragm 27 is mounted in the housing or sound box 28 and is coupled to a driving element 29.

An expansion joint for connecting pipe may be readily made by employing a sheet of material having an annular portion tangentially corrugated and having mounting rims on each edge. This is shown in Fig. 10 in which the tangentially corrugated annular member 30 is attached to the adjoining ends of two pieces of pipe 31 and 32. The flexibility of the annular member 30 permits considerable longitudinal movement.

An application of a diaphragm piston having tangential corrugations is shown in Fig. 11. The diaphragm piston 33 is mounted in the housing 34 and connected with a rigid piston member 35. This arrangement is applicable to certain pump or engine devices operating upon or by a fluid.

The application of a tangentially corrugated flexing member to a large direct acting type loud speaker is shown in Figs. 12 and 13. The tangentially corrugated annular supporting member 36 is attached at its outer periphery to the periphery of the cone 37 and at its inner edge to the mounting member 38. The tangentially corrugated member, which may be readily flexed, thus supports the cone in a manner to afford minimum resistance to its vibration as a whole, or piston fashion. The driving element 39 is mounted on the main supporting member 38 and attached to the cone 37 in any suitable manner.

An annulus of tangential corrugations may be applied to the outer area of the cone as is shown in Figs. 14 and 15. In this arrangement the tangential corrugations 40 are directly applied to the outer edge of the material of which the cone 41 is formed. The rim just beyond the corrugated annulus is clamped in the rigid ring 42 which in turn is mounted on the support 43.

When used in an acoustic device, the small areas between the flexing lines or corrugations are designed to have a critical frequency above the range important in speech and music and thus eliminate the usual rattle taking place in many types of diaphragms. The tangentially corrugated area makes it possible for the diaphragm to vibrate as a piston through a relatively large amplitude which is desirable in most cases, whether the diaphragm is used in acoustic devices or as a diaphragm piston in a pump, engine, or other mechanical device where piston diaphragms are applicable.

While it is preferred to have the outer corrugations of the diaphragm tangential to the inner portion it is within the scope of the invention to vary their direction so long as their function of lending flexibility is not destroyed, as would be the case if the direction were radial.

What is claimed is:

1. An elastic vibrational element having a corrugated portion, the corrugations of said portion forming like angles with radii at the periphery of said element.

2. An elastic vibrational element comprising a stiffened central portion, and an annular corrugated portion, the corrugations in said annular portion forming like angles with radii at the periphery of said element.

3. An elastic vibrational element comprising a rigid portion and a flexible portion said flexible portion consisting of straight line corrugations approximately tangential to the periphery of said rigid portion.

4. An elastic vibrational element having a stiffened circular central portion surrounded by a corrugated annular portion whose cor-

rugations are tangential to and converge adjacent to each other along the periphery of the said circular central portion.

5. In combination, a piston diaphragm having a tangentially corrugated portion and another portion, a supporting member engaging the periphery of said diaphragm and driving means attached to said other portion at portions distant from the center of the diaphragm for producing vibrations in said diaphragm.

6. In an acoustic diaphragm, a stiffened portion and an annular flexible portion, the width of the flexible portion being less than the width of the stiffened portion, the said flexible portion being tangentially corrugated to form small areas which have a critical frequency above the range important in speech and music.

7. In an acoustical device, a diaphragm provided with a stiffened portion and with a flexible peripheral portion formed of a plurality of tangential corrugations non-resistant to vibrations perpendicular to the plane of the diaphragm but resistant to vibrations parallel to that plane, said stiffened portion occupying the major portion of the diameter of the diaphragm.

8. In an acoustical device, a diaphragm provided with a stiffened central area and with a flexible peripheral area comprising a plurality of straight line tangential corrugations extending substantially perpendicular to radii drawn to the inner ends of the corrugations.

9. In an acoustical device a diaphragm provided with a stiffened portion, and with a flexing portion comprising a plurality of straight line corrugations non-resistant to vibrations perpendicular to the plane of the diaphragm but resistant to vibrations parallel to that plane.

10. In an acoustical device, a diaphragm comprising a flat peripheral clamping portion, a centrally curved stiffened portion, and an intermediate flexible portion comprising a plurality of corrugations extending substantially tangentially to the central stiffened portion, the corrugations being substantially non-resistant to forces perpendicular to the plane of the diaphragm but highly resistant to forces parallel to that plane.

11. In an acoustical device, a diaphragm comprising a flat peripheral portion, a dished central stiffened portion and an annular intermediate portion of closely adjacent corrugations, means for supporting the diaphragm at the flat portion and driving means attached to the stiffened portion of the diaphragm.

12. In combination, a diaphragm comprising a curved central portion, a flat outer portion, and an annular intermediate portion having corrugations substantially tangential to the central portion and diminishing in width and depth as they approach the points of tangency, means for supporting the diaphragm at its flat portion and means for driving the central portion.

13. In an acoustical device, a diaphragm having a peripheral portion, a stiffened central portion, and an intermediate flexible portion comprising a plurality of corrugations forming like angles with radii extending through the periphery of the stiffened portion, means for supporting the diaphragm along the peripheral portion, and driving means attached to the stiffened portion of the diaphragm.

14. In an acoustical device, a diaphragm comprising a stiffened central portion, an outer portion, and an intermediate portion formed with alternate elevations and depressions providing a large number of lines of flexure disposed at angles less than straight angles to intersecting radii of the diaphragm.

15. In an acoustical device, a diaphragm comprising a stiffened central portion, an outer portion, and an intermediate portion comprising a plurality of longitudinally stiffened sections, each section being disposed at an angle less than a straight angle to intersecting radii of the diaphragm, said sections having lines of flexure between each other and being of a length greater than the distance between the outer edge of the central portion and the outer edge of the intermediate portion.

16. In an acoustical device, a diaphragm having an outer portion, a central portion, and an intermediate portion so shaped as to be more flexible than the central portion or the outer portion, means for supporting the diaphragm along the outer portion, and driving means connected with the central portion at points removed from the center thereof.

In witness whereof, I hereunto subscribe my name this 15th day of April, A. D. 1926.

HENRY C. HARRISON.

DISCLAIMER

1,734,624.—*Henry C. Harrison*, Port Washington, N. Y. PISTON DIAPHRAGM HAVING TANGENTIAL CORRUGATIONS. Patent dated November 5, 1929. Disclaimer filed June 9, 1930, by the patentee and the assignee, by mesne assignments, *Western Electric Company, Incorporated.*

Hereby disclaim from the scope of said claim 11 of said Letters Patent any and all acoustical devices other than those in which the diaphragm driving means is attached to the diaphragm at points removed from the center thereof.

Please enter the disclaimer in the following words—i. e., in claim 11, at the end thereof, add "at points removed from the center thereof".

[*Official Gazette, June 24, 1930.*]