April 18, 1933. R. F. MALLINA 1,904,156

PNEUMATIC SOUND REPRODUCER

Filed Aug. 6, 1931

FIG. 1

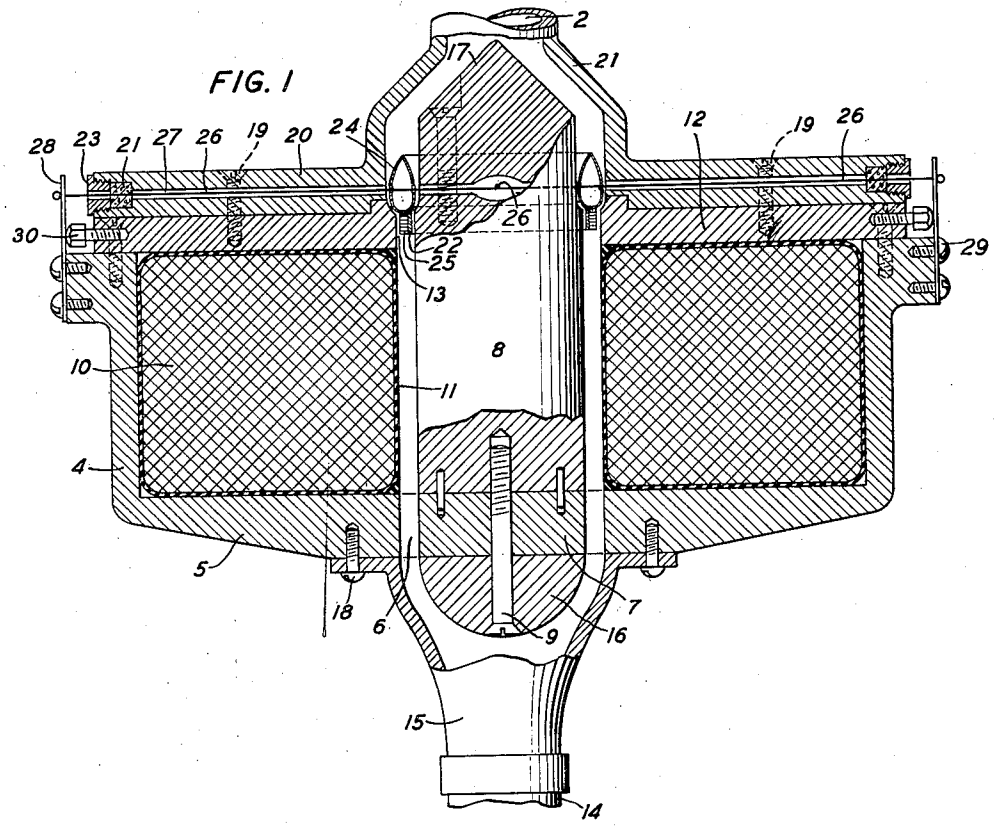



FIG. 2

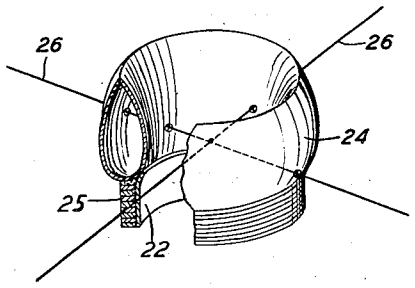



FIG. 3

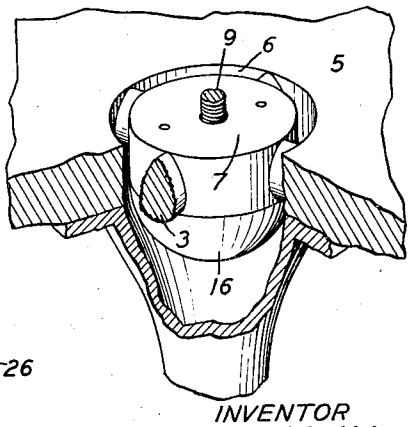
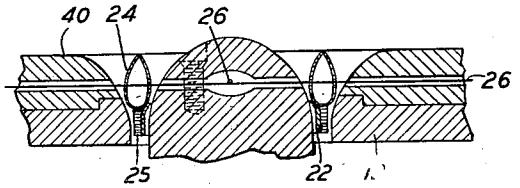



FIG. 4

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BY

ATTORNEY

Patented Apr. 18, 1933 1,904,156

# UNITED STATES PATENT OFFICE

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## PNEUMATIC SOUND REPRODUCER

Application filed August 6, 1931. Serial No. 555,413.

This invention relates to improvements in sound reproducing devices and particularly to such devices as employ vibratory elements to modulate fluid streams for producing large volumes of sound.

An object of this invention is to faithfully reproduce sound with great volume.

One of the features of this invention is to provide an improved valve mechanism for modulating a fluid stream in accordance with telephonic signals or vibrations.

In general, the invention provides an electrodynamic unit for modulating a fluid stream in accordance with telephonic current variations in which the magnetizing winding and the annular pole piece provide with the core an annular passage for the fluid stream in the exit of which and in spaced relation to the walls thereof is supported, by a resilient suspension member, a toroidal valve of stream-line cross-section having a cylindrical portion immersed in the steady flux field for carrying the exciting winding.

Referring to the drawing,

Fig. 1 represents a cross-sectional view of a pneumatic sound reproducing device embodying the invention adapted for use with a horn;

Fig. 2 represents a perspective view of the valve mechanism and coil assembly for modulating the fluid stream;

Fig. 3 represents a perspective view partly in section showing the manner of supporting the core of the electromagnet in the fluid stream; and

Fig. 4 represents a modification of the structure shown in Fig. 1 showing a coil and valve assembly suitable for a pneumatic loud speaker for use in a baffle board.

A hollow cylindrical casing 4 of magnetic material is provided with a wall 5 at one end having a centrally located substantially annular opening 6 which is formed by a cylindrical block 7 and radial arm 3 both of which are shown as integral with the casing. Supported within the casing 4 on the block 7 by means of the screw 9 is a cylindrical core 8 of magnetic material and of the same diameter as the block 7. Within the casing is disposed a toroidal coil 10 which serves as the magnetizing winding when connected to a source of direct current. The inner diameter of this winding is substantially the same as the outer diameter of the annular opening 6 and forms with the core 8 an annular passage for a continuous stream of air. The coil 10 has a lining 11 of suitable insulating material to present a smooth surface to the air stream. A cover 12 of magnetic material which is provided for the casing 4 has a central opening of substantially the same diameter as the inner diameter of the coil 10 through which the core 8 projects and with which it forms an annular air-gap 13 for a valve 24 and a coil 25 through which the telephone current flows.

A conduit 14 leading from a suitable source of air or gas under pressure is connected to the wall 5 by a flange member 15 and screws 18 to communicate with the annular fluid passage 6. Projecting within the flange member 15 is a dome-shaped member 16 secured to the casing by means of the screw 9 to provide a stream-line entrance to the passage 11. To the opposite end of the core 8 is secured a radially slotted cup 17 which provides a stream line exit. Supported on the cover or annular pole piece 12 by means of the screws 19 is a face plate 20 having a central opening 21 for connection to a suitable horn. The face plate 20 is provided with four radial conduits 27, the outer ends of which are counter-bored and threaded.

The valve mechanism consists of a hollow toroidal shaped member 24 of aluminum, its alloys or any light metal, or it may be made of any suitable light non-metallic material such as phenol condensation products. A depending cylindrical member 22 of non-metallic material cemented to the lower edge of the valve 24 carries the exciting coil 25. The valve 24 is supported freely in the exit of the annular passage 6 for the fluid stream by means of two wires 26 which are disposed at right angles to each other and extend through diametrically opposed perforations in the valve 24 at which points the valve is suitably secured to the wires which extend through the conduits 27 in the face plate 20 and are

supported at their ends by means of flat springs 28 secured to the case 4 by means of screw 29. Screws 30 are threaded radially in the periphery of the cover 12 and have heads which bear against the springs 28 for the purpose of tensioning the wires 26 and adjusting the valve 24 and the coil 25 in the air stream and the air-gap.

In the threaded counter-bores in the periphery of the cover 20 the glands 21 of suitable packing material are compressed around the wires 26 by means of the screw plugs 23 to prevent excessive vibration of the wires and also to prevent the leakage of air at these points. The adjacent ends of the cap 17 and of the core 8 are made slightly hollow to provide space for the crossing of the wires 26 and soldering them at this point in order to prevent any rattle.

As in any electrodynamic receiver the coil 10 is connected to a suitable source of direct current which provides a steady field between the annular pole 12 and the core 8 in which the coil 25 is suspended and the coil 25 is connected to a source of variable current to be translated into sound. The conduit 14 is also connected to a suitable source of air or gas supplied at constant pressure which flows through the passage 6 and is modulated at the exit in accordance with the variations of the current through the coil 25.

In Fig. 4 which shows a modification for use with a baffle board the face plate 40 is provided with a beveled stream-line opening forming with the end of the core 41 a rapidly expanding annular exit in which the valve 42 is supported. Other structural features are the same as shown in Fig. 1.

Although the invention has been shown as applicable to pneumatic receivers having either a horn or a baffle board the use to the horn radiator is preferable since it permits the use of lower air pressures, other things being equal, and therefore reduces the high frequency hissing noise. In order to further reduce the tendency of this type of reproducer to hiss, the valve and the conduits are stream-lined.

What is claimed is:

1. A sound reproducer, comprising a magnet having a magnetic air-gap, a current conducting coil disposed in said air-gap, a movable stream-line member to which said coil is secured, and means forming a fluid passage-way in said magnet, said stream-line member being disposed in the exit of said passage-way.

2. A sound reproducer arrangement, comprising a magnet having an annular magnetic air-gap formed by a cylindrical core and a plate having a circular perforation, an annular movable stream-line member, a current conducting coil immersed in said air-gap and secured to said member, a baffle having a perforation aligning that in said plate and circumambient said movable member, and means forming a fluid passage-way in said magnet leading to the magnetic air-gap, the movable member being disposed in the exit of said passage-way whereby fluid passing through said passage-way will be modulated at the exit thereof in accordance with the sounds to be reproduced, said movable member being arranged to move with the current conducting coil.

3. An acoustic device comprising a magnet having a magnetic air-gap, a current conducting coil immersed in said air-gap, a movable stream-line member attached to said coil, and means forming a stream-line fluid passage-way through which fluid passes, said movable stream-line member being disposed in the exit of said passage-way to vary the area thereof, and to modulate the fluid passing therethrough in accordance with the sounds to be reproduced.

4. In an acoustic device and sound reproducer of the type in which a fluid stream is modulated in accordance with the sounds to be reproduced, a magnet having a magnetic air-gap formed by its core and a perforated plate, a baffle having a perforation aligning that in said plate, an end of said core projecting through the perforation in said baffle and having an inwardly curved surface, the bounding wall of the perforation in said baffle having an outwardly curved surface, a current conducting coil disposed in said magnetic air-gap, and a valve member attached to said coil and supported between the baffle and the projecting end of the magnet core.

5. In an acoustic device, a baffle having a perforation, a magnet having a core portion and a wall portion forming a magnetic air-gap, the perforation in said baffle being in alignment with the outermost bounding surface of said air-gap and the core portion of said magnet extending outwardly through the perforation in said baffle, a current conducting coil in said air-gap and a valve member attached to said coil and supported in the space between the baffle and the extension of the magnet core.

6. A sound reproducer comprising a cylindrical member, means surrounding said member and in spaced relation thereto to form an annular duct for a fluid stream, a toroidal shaped valve disposed at the exit of said duct, and means responsive to telephone current variations associated with said valve for modulating the fluid stream.

7. A sound reproducer comprising a cylindrical member, means surrounding said member and in spaced relation thereto to form an annular duct for a fluid stream, a hollow toroidal valve having a depending portion and a winding responsive to telephone currents supported on said portion for modulating a fluid stream.

8. A sound reproducer comprising a mag-

net having a cylindrical core and a pole piece forming therewith an annular air-gap and duct for a fluid stream, a coil responsive to telephone current variations disposed in said duct, a toroidal valve associated with said coil for modulating the air stream in accordance with the telephone current variations, and means for adjustably supporting said valve and coil in said duct.

9. In an acoustic device, an annular duct for a fluid stream, a valve disposed in the exit of said duct, and means responsive to telephone current variations associated with said valve for modulating said fluid stream in accordance with telephone currents.

10. In an acoustic device, means forming an annular duct for a fluid stream, a toroidal shaped valve, means for supporting said valve centrally in the exit of said duct to permit the fluid to flow on each side thereof, and means responsive to telephone currents associated with said valve for modulating said fluid stream in accordance with telephone currents.

11. A sound reproducer comprising a magnet having a core and an annular pole piece surrounding one end of said core and forming therewith an annular air-gap, means including said pole piece surrounding said core to form an annular passage for a fluid stream, a telephone current coil in said air-gap and a valve associated therewith, a horn associated with said passage at one end and a fluid supply conduit connected to the other end, said core being provided at each end with stream-line projections extending into the entrance of said horn and the exit of said conduit.

12. An acoustic device comprising an annular duct for a fluid stream, an annular valve for modulating said fluid stream in accordance with telephonic variations, means for supporting said valve mid-way between the walls of said duct for vibration in its own plane and longitudinal of said fluid stream.

13. In a pneumatic telephone device, a cylindrical member, means surrounding said member and in spaced relation thereto forming an annular duct for a fluid stream, a toroidal shaped valve disposed in the exit of said duct, means responsive to telephonic currents associated with said valve, and means resiliently supporting said valve for longitudinal vibrations in said fluid stream.

14. A pneumatic sound reproducer comprising a duct for a fluid stream, a valve member in said duct and electromagnetic means associated therewith for modulating said stream in accordance with the sound to be reproduced, and a tensioned wire bridging said duct for supporting said valve freely therein.

15. A pneumatic sound reproducer having a duct for a fluid stream, a valve in said duct and electromagnetic means associated therewith for modulating said fluid stream in accordance with sound to be reproduced, a wire for supporting said valve freely in said duct, and means for adjusting the tension in said wire.

16. A pneumatic reproducer comprising a duct for a fluid stream, a valve in said duct and electromagnetic means associated therewith for modulating the fluid stream in accordance with the sound to be reproduced, said valve having a stream-line section, the major axis of which is longitudinal said stream, and means supporting said valve in said duct, said supporting means being incapable of obstructing or directing the fluid stream.

17. A pneumatic sound reproducer comprising a duct for a fluid stream having an increased area at the exit thereof, a valve, electromagnetic means for vibrating said valve in accordance with the sound to be reproduced and means for resiliently supporting said valve centrally in the exit of said duct.

18. A pneumatic sound reproducer comprising a duct for a fluid stream having diverging walls at the exit thereof, a valve having a stream-line section resiliently supported between said walls and in space relation thereto, and electromagnetic means for vibrating said valve in accordance with sound to be reproduced.

19. A pneumatic sound reproducer comprising a duct for a fluid stream, a valve and means for supporting said valve freely in the exit of said duct and for longitudinal vibration therein, the course of the fluid stream being independent of said support, and electromagnetic means for vibrating said valve in accordance with the sound to be reproduced.

20. A pneumatic sound reproducer comprising a duct for a fluid stream, a valve having a stream-line cross-section, and means for supporting said valve freely in the fluid duct for vibrating in accordance with the sound to be reproduced, said valve forming with said duct an outlet having diverging walls for the modulated fluid stream.

In witness whereof, I hereunto subscribe my name this 28th day of July 1931.

RUDOLPH F. MALLINA.