July 21, 1936. R. F. MALLINA 2,048,508

PNEUMATIC SOUND REPRODUCER

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FIG. 1

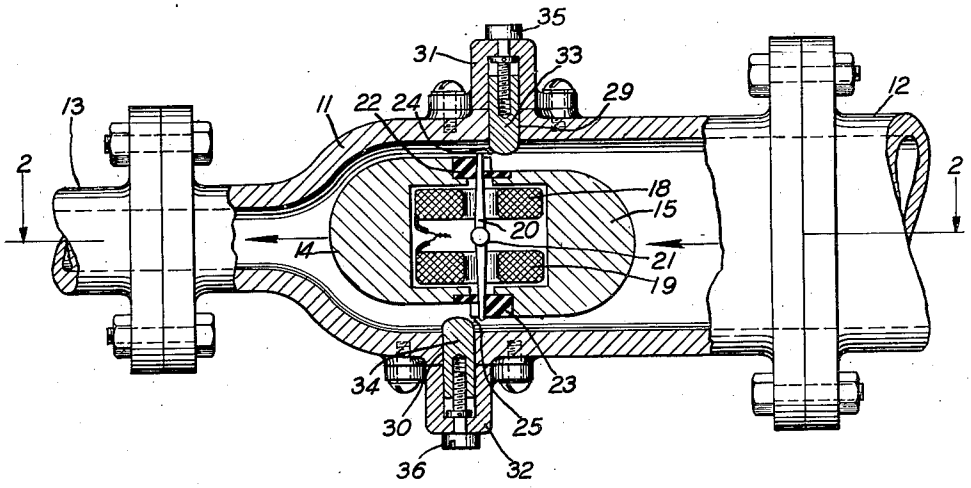


FIG. 2

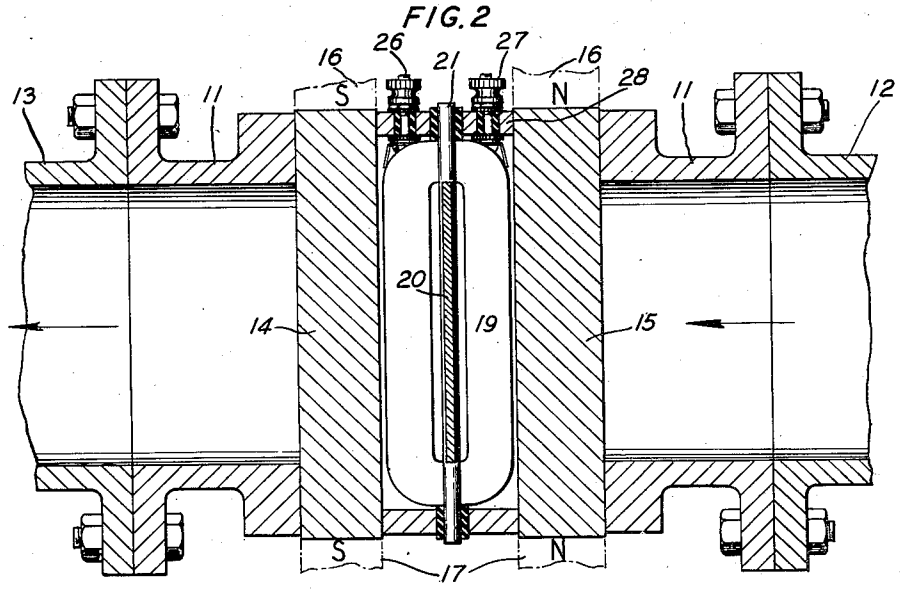


FIG. 3

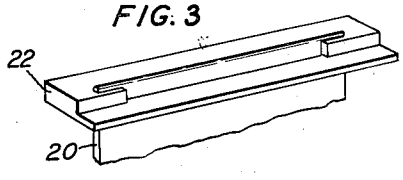
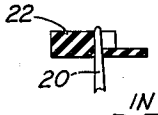


FIG. 4



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FIG. 5

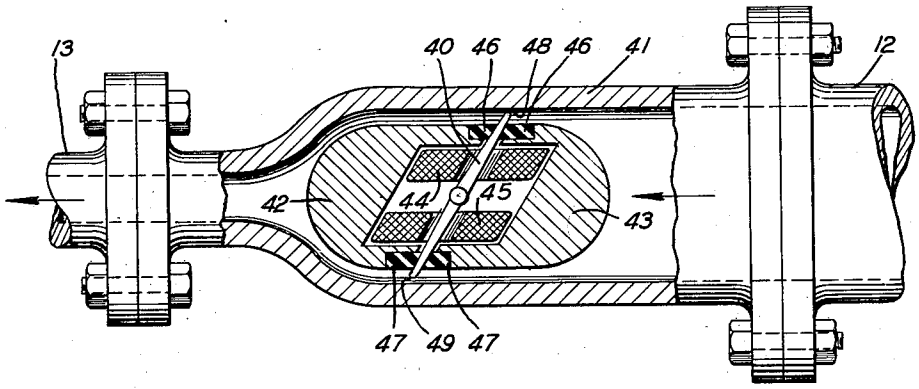
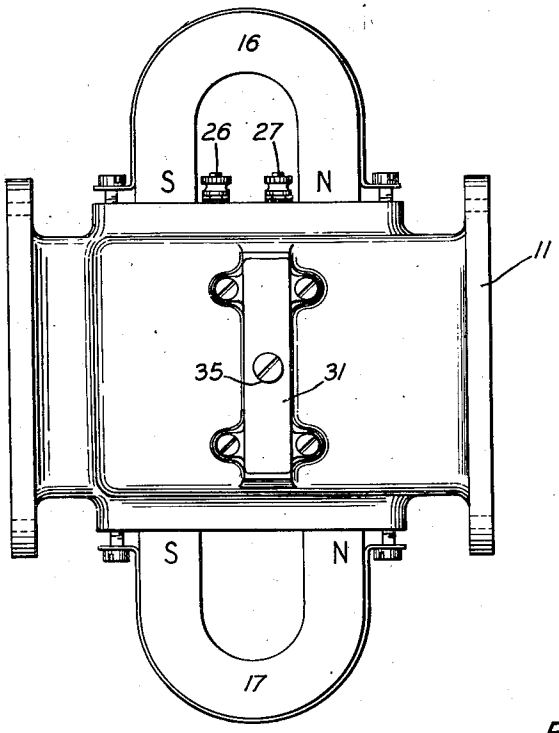


FIG. 6



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PNEUMATIC SOUND REPRODUCER

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Application May 31, 1934, Serial No. 728,201

6 Claims. (Cl. 179—113)

This invention relates to improvements in sound reproducing devices and particularly to loud-speakers of the pneumatic type in which currents representing the sounds to be reproduced operate suitable means for modulating an air stream to produce large volumes of sound.

The object of the invention is an efficient and inexpensive modulator for loud-speakers of this type.

According to one important feature of the invention, the modulator is held in static balance by the action of the air stream thereby eliminating the turning movement of the air pressure on the modulator.

The preferred structure, according to the invention, comprises a rubber damped balanced armature mounted for vibration about its medial axis which is disposed transversely in the center of the air conduit to form two orifices equal in area between the tips of the armature and the walls of the conduit. The armature extends through signal current coils which are surrounded by bifurcated pole-pieces suitably contoured in the direction of the air flow and disposed to form working gaps with the armature. Flux is fed to the pole-pieces by permanent or electromagnets external to the conduit and the vibrations of the armature produced by the interaction of the steady and alternating fluxes are damped by rubber blocks engaging both sides of the armature near the armature tips.

The armature may be mounted either at right angles to the axis of the conduit or at a suitable angle (such as 30° to 45°) to the transverse axis of the conduit. The right angle construction is inherently of higher efficiency but requires that the inner wall of the conduit be contoured to form the necessary orifices. With the angular arrangement the efficiency is somewhat decreased but the axes of the orifices may be parallel to the axis of the conduit.

In the drawings, Fig. 1 is a sectional view of a modulator mounted at right angles to the axis of the conduit;

Fig. 2 is a sectional view taken as indicated in Fig. 1;

Figs. 3 and 4 are detail views of the armature damping structure;

Fig. 5 is a sectional view of the alternate construction in which the armature is mounted at an angle to the transverse axis of the conduit, and

Fig. 6 is an assembly view showing the housing for the orifice adjusting members of Fig. 1 and an arrangement of the magnets which is applicable to either embodiment of the invention.

In Fig. 1, the conduit 11 composed of brass or other non-magnetic material is connected at one end to a source of compressed air by means of the pipe 12 and at the other end to a suitable horn of which only a portion of the throat 13 is shown. The pole-pieces 14, 15 extend across the conduit and project through the walls on either side to make contact with the magnets 16, 17 which are shown in Fig. 6 as permanent magnets but for loud-speakers of great output capacity the large magneto-motive force required may be supplied by electro-magnets. The signal current coils 18, 19 are housed between the pole-pieces and the armature 20 is pivoted at its center between the coils on the shaft 21 which is journaled in the pole-piece spacing member 28 as shown in Fig. 2. The pole faces are recessed to receive the rubber damping members 22, 23 which surround the armature as shown more clearly in Figs. 3 and 4 and hold it in its proper position at right angles to the axis of the conduit. At the section where the armature is pivoted, the conduit is substantially rectangular in cross-section and has slots 29, 30 extending the full width of the armature. The slots are closed by housings 31, 32 in which the sliding blocks 33, 34 are fitted to form the orifices 24 and 25. By means of the screws 35, 36 the blocks may be accurately adjusted to make the orifices equal and of any desired size. This adjustment is preferably made with the air applied to the modulator so that the slight deflection of the armature due to the air pressure will not result in orifices of unequal areas.

When the coils 18 and 19 are not carrying currents, the armature 20 is stationary in its mid-position as shown and a continuous stream of air flows through the orifices to the horn but when currents representing the sounds to be reproduced are supplied to the terminals 26, 27 of the coils, an alternating flux is set up longitudinally in the armature and the armature vibrates between the pole faces in the well known manner. The vibrating armature tips vary the areas of the orifices to produce variations in the air stream corresponding to the signal current variations which are accordingly reproduced as audible sounds from the horn.

Since the armature is rigidly pivoted at its center, the areas exposed to the air pressure on opposite sides of the axis are equal and the steady air pressure therefore has no tendency to displace the armature from its center or neutral position. It is well known that pneumatic loud-speakers

are capable of producing sounds of great volume since a large proportion of the acoustic energy is derived from the compressed air. Modulators which are not statically balanced, however, must be extremely rugged to withstand the unbalanced static stresses. The balanced structure of this invention, on the other hand, may be relatively light and inexpensive and yet be capable of producing a large percentage of modulation. It will be readily seen that this structure is inherently of high efficiency since the area of the orifices varies substantially directly with the armature displacement.

The alternate form shown in Fig. 5 is, in general, similar in construction and operation to the structure just described. The essential difference is that the armature **40** is mounted at an angle of from 30° to 45° to the transverse axis of the conduit so that axes of the orifices are parallel to the walls of the conduit **41**. The configuration of the pole-pieces **42**, **43**, the coils **44**, **45** and the damping members **46**, **47** is modified to adapt them to the inclined position of the armature but obviously their functions are the same as in the structure of Fig. 1. While the area of the orifices **48**, **49** does not vary directly with the armature displacement but rather as the cosine of the angle of displacement with a consequent decrease in percentage modulation as compared with the structure of Fig. 1, this disadvantage may be more than compensated by the advantages of a straight path on the flow of the air through the orifices.

What is claimed is:

1. In an acoustic device, a conduit for a fluid stream, a valve disposed midway said conduit, said valve being mounted for rotation about its medial axis transversely of the conduit so that it is statically balanced in said conduit and electromagnetic means including pole pieces within the conduit defining streamlined passages adjacent the valve for moving said valve in accordance with the sound to be reproduced.

2. In an acoustic device, the combination with a conduit for a fluid stream and a modulator pivoted on its medial axis mounted in the conduit with its axis disposed transversely of the conduit, of means for adjusting the area of the fluid path around the ends of the modulator, and means for vibrating the modulator in accordance with the sounds to be reproduced.

3. In an acoustic device, the combination with a conduit for a fluid stream, a pair of furcated pole-pieces within the conduit and a pivoted modulating member disposed between the pole-pieces and extending toward opposite walls of the conduit, of means for vibrating the member between the pole-pieces in accordance with the sound to be reproduced, and means for independently adjusting the orifices between the conduit walls and the modulating member.

4. In an acoustic device, the combination with a conduit for a fluid stream, a pair of furcated pole-pieces within the conduit and an armature pivoted on its medial axis in static balance between the pole-pieces and having end portions forming equal orifices adjacent the walls of the conduit, of means for vibrating the armature in accordance with the sounds to be reproduced, and means for damping the armature vibrations.

5. In an acoustic device, the combination with a conduit for a fluid stream, a pair of furcated pole-pieces dividing the conduit into two passages adjacent the walls of the conduit, an armature pivoted on its medial axis and extending into said passages, means for resiliently holding the armature between the pole-pieces at an angle to the transverse axis of the conduit, and means for vibrating the armature in accordance with the sounds to be reproduced.

6. In an acoustic device, a conduit for a fluid stream, and an electromagnetic structure within the conduit comprising pole pieces defining air gaps and dividing the conduit into two restricted passages, and a vibrating armature pivoted between the pole pieces projecting through the gaps into the passages and varying the flow of fluid through the passages in accordance with its own vibrations.

RUDOLPH F. MALLINA.