

[54] **FLUID OSCILLATORS**

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[51] Int. Cl. **F15c 1/08**

[58] Field of Search **137/81.5, 82.6; 290/1, 290/42, 43, 53, 54**

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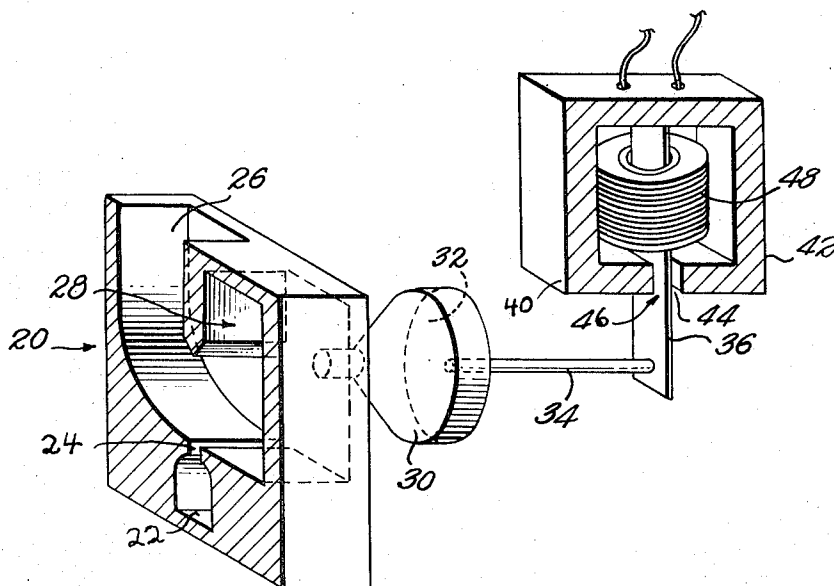
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[57] **ABSTRACT**

A fluid generator system having an improved constant frequency fluid oscillator and a pneumatic generator which utilizes the principles of fluid flow to generate electrical energy. The oscillator has a flow-through cavity and a resonant cavity. In addition, a second cavity cooperates with the resonant cavity so that the frequency being generated will not change with changes in input pressures. The output of the fluid oscillator causes a diaphragm to vibrate a metallic armature in a magnetic field to create an electromotive force.

4 Claims, 5 Drawing Figures



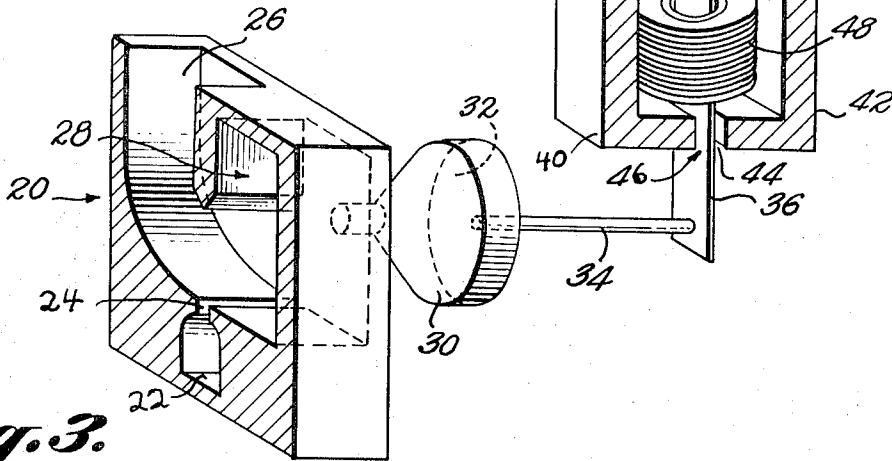
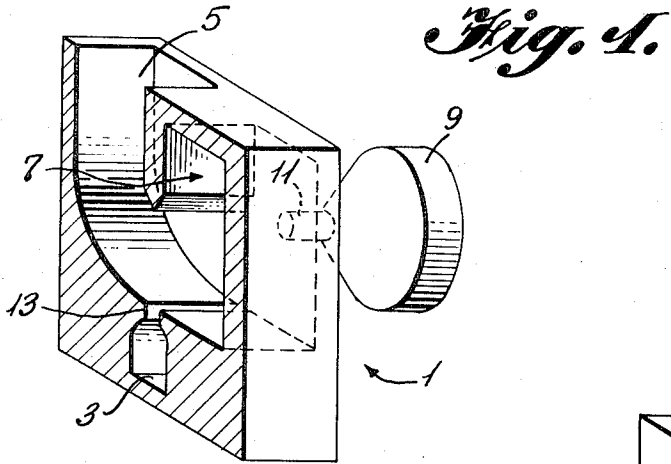


Fig. 3.

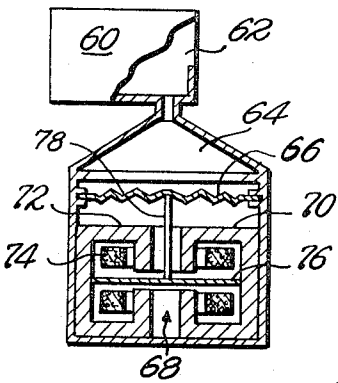


Fig. 4.

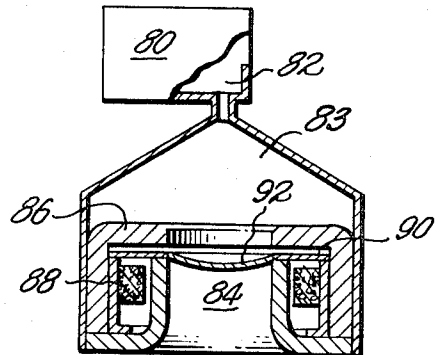
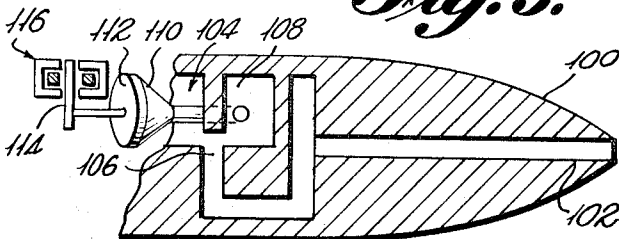


Fig. 5.



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FLUID OSCILLATORS

The invention described herein may be manufactured and used by or for the government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to fluid operated devices, and more particularly to an improved fluid oscillator and a pneumatic generator which utilize the principles of fluid flow.

In small flying projectiles, such as artillery and mortar shells, small power supplies are necessary to actuate the detonator mechanism. Such power supplies have preferably been comprised of small air-driven generators. One such type of air-driven generator consists of a rotatable armature type generator driven by a propeller or turbine. This type of device is often complex in design and tends to produce inconsistent voltages as changes in speed are encountered.

The present invention proposes to eliminate the disadvantages of such mechanical power supplies by the use of a fluid flow generator which is operated by means of a fluid oscillator. In such a generator, a fluid oscillator drives a movable diaphragm in combination with a magnetic coil to produce an electromotive force which is used as a power supply. Fluid oscillators have been found to be inherently reliable and rugged compared to similar complicated mechanical or electrical structures. Furthermore, fluid sources to drive such fluid devices, such as water or air, are readily available.

More particularly, the present invention contemplates the use of a fluid generator which utilizes an oscillator whose frequency does not change with changes in input pressures. This oscillator includes a conventional flow-through cavity and a resonant cavity. In addition, a second cavity cooperates with the resonant cavity and causes an asymmetrical resistance effect upon the particles entering and leaving it. This resistance effect results in a constant frequency being generated, and as such the oscillator is ideally adapted for use in a fluidic generator power source of the type described above.

Among the objects of the present invention is to provide a novel fluid oscillator having a constant frequency; to provide a fluidic generator wherein a constant frequency fluid oscillator is used to generate power therein; and to provide a fluidic generator having a constant frequency fluid oscillator which causes a diaphragm to vibrate a metallic armature in a magnetic field to create an electromotive force.

Other objects and further scope of applicability of the present invention will become apparent from the detailed description to follow, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic view of a constant frequency fluid oscillator;

FIG. 2 is a schematic view of the fluidic generator of the present invention;

FIG. 3 is a second embodiment of the fluidic generator of the present invention;

FIG. 4 is a third embodiment of the fluidic generator of the present invention; and

FIG. 5 shows a fluidic generator used as a power source in a missile-type projectile.

It is known in the art of fluid operated devices that fluid oscillators have a frequency output which is directly related to the input pressure of the fluid. Thus,

an increase in the input pressure causes an increase in the frequency of oscillation of the device. A typical edgetone-resonator type oscillator generally indicated by the numeral 1 is shown schematically in FIG. 1. It has been found that the frequency of oscillation of such a fluid oscillator is given by the equation:

$$f = \alpha o / 2 \pi L \sqrt{P_o / P_1}$$

where αo is the speed of sound, L is the individual particle path length, P_o is the input pressure and P_1 is the pressure at the entrance of the resonator. The configuration of the fluid oscillator 1 includes a fluid power nozzle 3, an output aperture 5 and a resonant chamber 7. In an edgetone resonator type oscillator such as the type shown, a fluid jet stream, for example air or water, will enter through the fluid power nozzle 3, pass through an orifice 13 and out of the output aperture 5. As the fluid jet follows this path, the resonant chamber 7 is evacuated, thereby lowering the pressure in it. When the pressure within the resonator chamber 7 becomes lower than atmospheric, the fluid jet deflects into the resonant chamber 7. This increases pressure in the resonant chamber 7 and when the pressure becomes higher than atmospheric, the fluid jet stream moves out of it. This change is rapidly continuously repeated, thus forming an oscillating fluid device. In order to achieve a constant frequency of oscillation during changes in input pressure, a terminated horn cavity 9 is placed perpendicular to the resonant chamber 7 so its end 11 opens into the resonant chamber 7. This creates a twofold effect. First, the volume of the resonant chamber 7 is increased, and secondly the fluid particles entering the resonant cavity have less resistance than the fluid particles leaving the resonant cavity. Because of this asymmetrical resistance effect, the frequency of oscillation remains relatively constant during changes in input pressures.

FIG. 2 shows a fluidic generator of the present invention, and includes a fluid oscillator 20 of the type described above having a power nozzle 22, an orifice 24 and output aperture 26 and a resonant chamber 28. A terminated horn cavity 30 is provided to keep the frequency of the fluid oscillators constant. A flexible diaphragm 32 is mounted on the fluid oscillator 20 so as to react to changes in pressure within the resonant chamber 28. In the embodiment shown, the flexible diaphragm 32 is mounted at the end of the horn cavity 30. The flexible diaphragm may be mounted at any convenient location within the resonant chamber 28 or horn cavity 30 where there is a substantial pressure differential during oscillation. The diaphragm 32 is a centered type having two ridges to insure tensile strength and to determine its resonant frequency. One end of a rod 34 is attached to the center of the flexible diaphragm 32. The other end of the rod 34 is suitably attached to an armature 36 formed of a metallic reed. The free end of the metallic reed armature 36 is centralized in a magnetic coil 48 between the two pole pieces 40 and 42 of a permanent magnet, which pole pieces are of opposite polarity. This forms air gaps 44 and 46 between the armature 36 and the north and south pole pieces 40 and 42. A conventional coil 48, which is mounted within the pole pieces 40 and 42, surrounds the armature 36.

The operation of the fluidic generator may be described as follows. A fluid flow enters the power nozzle 22 and passes through the orifice 24 to the output aper-

ture 26. As described above in connection with the fluid oscillator of FIG. 1, the pressure in the resonant chamber 28 is decreased, causing the fluid flow to divert into it. When the pressure is regained, the fluid flow retains its normal path. This occurs continuously so an oscillation frequency is established. The changes in pressure within the resonant chamber 28 cause the diaphragm 32 to pulsate inwardly and outwardly. With the rod 34 attached to the diaphragm 32, the metallic reed armature 36 is made to oscillate between the magnetic pole pieces 40 and 42. This oscillation of the armature 36 induces an electromotive force in the coil 48.

Another embodiment of the fluidic generator is shown in FIG. 3. A fluid oscillator 60 produces oscillations, in the same manner as hereinabove described, at a frequency within the audio range. A resonant chamber 62 of the oscillator opens into another chamber 64 within which is mounted an acoustical diaphragm 66. An electromagnetic generator 68 includes pole pieces 70 and 72 of a permanent magnet mounted about a coil 74. A magnetic diaphragm 76 is connected to the acoustical diaphragm 66 by means of a rod-like element 78. Fluid oscillations will cause the acoustical diaphragm 66 to vibrate which will in turn cause the magnetic diaphragm 76 to vibrate. The vibration of the magnetic diaphragm 76 will generate an electromotive force in the coil 74.

A third embodiment of the fluidic generator is seen in FIG. 4. A fluid oscillator 80 is shown having its resonator cavity 82 connected to a cavity 83 in an electromagnetic generator 84, which includes a permanent ring magnet 86 and a coil 88. A metallic ring anchor 90 which carries a diaphragm 92 is mounted within the generator 84 to be acted upon by the pressure in the cavity 83 so that the oscillations in the fluid oscillator 80 cause the diaphragm 92 and its ring anchor 90 to vibrate, thus producing an electromotive force in the coil 88.

FIG. 5 shows the fluidic apparatus of the present invention being used as a power generator in the nose of a flying projectile 100, such as an artillery shell or rocket. The fluid to operate the device, which would normally be air in most applications, enters the projectile 100 at its nose section through a ram tube 102. A fluid oscillator 104 of the type described above has its power nozzle 106 connected to the ram tube 102. A resonant chamber 108 includes a horn cavity 110 having a movable diaphragm 112 which actuates a metallic reel 114 mounted within the electromagnetic generator 16. As described above, the diaphragm 112 forces the metallic reed 114 to vibrate generating and electromotive force within the coil of the generator 116. With this type of fluidic generator, batteries may be replaced in many flying objects. This type of fluidic generator may also be used to recharge batteries, where they are used, during flight.

It will be appreciated that the above description is illustrative only and not limiting, and many modifications may be made to the specific embodiments described above without departing from the spirit and scope of the inventions, which are defined in the appended claims.

We claim:

1. A fluid device for producing oscillations at a constant frequency comprising fluid inlet and outlet means, a source of power fluid, means for directing the power fluid along a normal path to said outlet means, a resonant chamber disposed adjacent to said normal fluid path so that the flow of power fluid in said normal fluid path creates a vacuum in said chamber to cause the power fluid to deviate from said normal path into the vacuum chamber until pressure is restored therein at which time the fluid returns to its normal path, said chamber including a second cavity connecting with said chamber and adapted to maintain a relatively constant frequency of oscillation of the power fluid flow with changes in pressure at said fluid inlet said second cavity comprising an elongated horn-shaped cavity having a closed end and an open end communicating with the resonant chamber.

2. A fluidic generator for producing an electromotive force comprising a fluid oscillator for producing fluid oscillations, an electromagnetic generator including an armature and a coil adapted to produce an electromotive force in response to vibrations of said armature, and means to convert the fluid oscillations produced by said fluid oscillator into mechanical forces to vibrate said armature, said fluid oscillator for producing the periodic fluid forces having a fluid inlet and fluid outlet means, a means for directing a flow of power fluid along a normal path from said inlet means to said outlet means, a resonant chamber disposed adjacent to said normal fluid path so that said flow of power fluid creates a vacuum in said chamber which in turn causes the flow of power fluid to deviate from its normal path into the vacuum chamber until pressure is restored therein at which time the fluid returns to its normal path, said oscillator includes a second cavity connecting with said resonant chamber comprising an elongated horn-shaped cavity having one end closed by a movable diaphragm and having the other end open into said resonant cavity.

3. The fluid generator of claim 2 wherein the force converting means includes a rod-like element having one end attached to said movable diaphragm and the other end attached to said armature whereby changes in pressure due to the fluid oscillations within the resonant cavity of the fluid oscillator cause the diaphragm to expand and contract to thereby cause the armature to vibrate by means of said rod-like element.

4. A fluid oscillator for producing oscillations of constant frequency including:

- a. a fluid inlet means;
- b. a fluid outlet means;
- c. a resonant cavity for producing oscillations of fluid flow; and
- d. a stabilizing means operably attached to said resonant cavity for maintaining the frequency of the oscillation of fluid flow relatively constant with changes in input pressure, said stabilizing means comprising an elongated horn-shaped cavity having a closed end at its large diameter portion and having an open end at the smaller diameter portion connecting into said resonant cavity.

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