

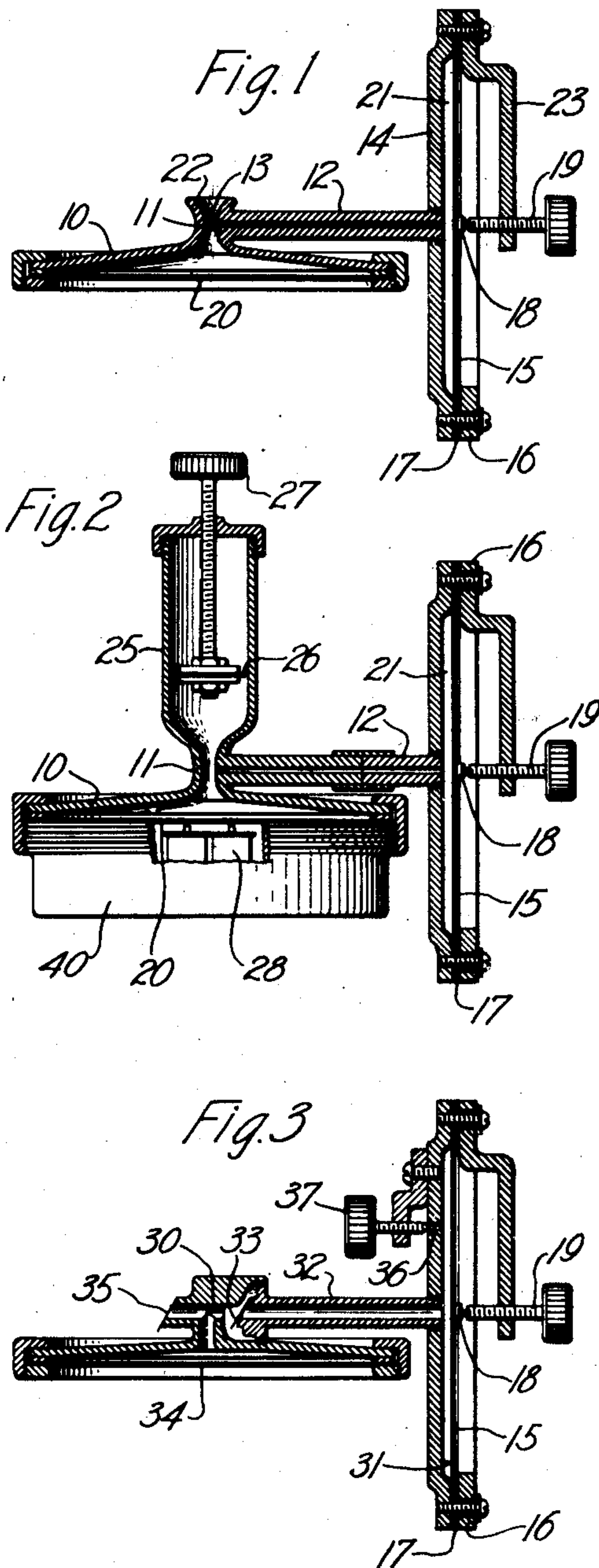
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ACOUSTIC DEVICE

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ACOUSTIC DEVICE.

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This invention relates to fluid wave systems and particularly to systems or devices operated or controlled by acoustic waves.

An object of the invention is to convert oscillatory motion in a fluid into unidirectional motion.

A specific object is to provide a sensitive and effective device by which electrical contacts may be operated in response to acoustic waves or other vibrational forms of energy.

In a preferred embodiment of the invention there is provided a conduit filled with air or other fluid and having a constricted passage with which a second conduit communicates. When oscillations are set up in the fluid contained in the first mentioned conduit by means of sound waves or other suitable driving force, the fluid is caused to move alternately in opposite directions through the constricted passage. As the fluid passes through the constriction, its velocity is increased and its pressure is correspondingly reduced causing a suction of fluid from the second conduit, according to the well known principle of Bernoulli. The oscillatory motion of the fluid in the first conduit thus causes a unidirectional flow of fluid in the second conduit. When it is desired to obtain in this device relatively high efficiency for certain frequencies of oscillatory motion, a suitable resonant chamber is preferably connected to the first mentioned conduit through its constricted portion.

In accordance with another embodiment of the invention, a movable element such as a diaphragm is provided to close a portion of the conduit which communicates with the constricted passage of a second conduit. This diaphragm is employed to open or close electrical contacts associated therewith in response to the oscillatory flow of fluid through the constricted passage. Such a device may be employed as a pneumatic relay in which sound waves impressed on the fluid in the second mentioned conduit cause the operation of an electrical contact.

In another aspect of the invention, an electromagnetic element is employed to drive a diaphragm which closes a portion of a conduit. The vibrations set up by the diaphragm due to alternating current flowing through the winding of the electromagnet, cause a reduction in fluid pressure in a second conduit communicating with the first. If

desired, this reduction in pressure may be employed, as pointed out above, to open or close electrical contacts.

The invention may be readily understood by referring to the following detailed description and the accompanying drawing in which:

Fig. 1 is a sectional view of a pneumatic relay in accordance with this invention;

Fig. 2 shows a modification of the relay shown in Fig. 1, in which a resonant chamber is employed for increasing the sensitivity of the relay at certain frequencies; and

Fig. 3 shows another modification of the relay shown in Fig. 1, in which valves are employed.

Referring now particularly to Fig. 1 of the drawing, the chamber or conduit 10 containing air or other suitable fluid leads through the constricted portion 11, into a reservoir containing the fluid, as for instance, the free atmosphere when air is employed as the fluid. The capillary tube 12 is attached to the constricted portion 11 and communicates therewith through the small opening 13. This small opening offers sufficient resistance to the flow of fluid therethrough that the fluid flowing in tube 12 is prevented from oscillating in response to the varying pressure in constriction 11. The other end of tube 12 is threaded into the casing 14, which is closed by the diaphragm 15 of conducting material to form a substantial air-tight chamber 21. The diaphragm 15 is clamped between the casing 14 and the clamping ring 16, the latter being insulated from the diaphragm by the insulating ring 17. The diaphragm 15 carries a contact element 18, which is normally in contact with the oppositely disposed adjustable contact 19, the latter being threaded through the projecting portion 23 of the conducting clamping ring 16. A diaphragm 20 is employed to close a portion of the conduit 10, but it is not essential to the operation of the device.

In operation the fluid in conduit 10 is actuated either directly by sound waves or the like, or by means of the diaphragm 20, which may be actuated by the sound waves. When air is employed as the fluid and sound waves as the actuating means, it is not essential to the operation of the device, to employ a diaphragm. In this case it is preferable, however, to employ a long, gradually tapered

passage for conducting the sound waves to the constricted passage. The fluid flows back and forth through the constricted portion 11 at a substantially increased velocity and a decreased effective pressure. Consequently, the pressure of the fluid in chamber 21 causes a flow thereof into the constricted portion 11 and out through the opening 22. Due to the resulting decrease in pressure within the chamber 21, the pressure on the outside of the diaphragm 15 causes it to flex inwardly, thus breaking the connection between contacts 18 and 19 and opening the electrical circuit which may be connected therethrough.

The pneumatic relay shown in Fig. 2 differs from the relay of Fig. 1, in that the former is provided with an adjustable resonant chamber 25 and an electromagnetic receiver 40, which serves as a driving element. The chamber 25 communicates with the constricted portion 11 and is provided with a plunger 26, which may be moved by turning the thumb-screw 27 to change the effective length of the portion of the cylinder which communicates with the constricted portion. To obtain high sensitivity in such a device, the plunger should be set so that the fluid moves at a maximum velocity through the constricted portion 11, when a current of the desired frequency is passed through the winding 28 of receiver 40. It is apparent that the device having the adjustable resonant chamber may be employed, if desired, to operate only on a selected band of frequencies.

The relay of Fig. 3 comprises the chambers 30 and 31, which are connected by tube 32 through the valve 33. A portion of the chamber 30 is closed by the diaphragm 34, which may be set to vibration by acoustic waves or other suitable driving force. The valve 35 separates the chamber 34 from a large supply of the fluid employed in the device, as for instance, the free atmosphere when air is employed as the fluid. The chamber 31 is similar to the chamber 21 of the preceding figures, except that an opening 36 is provided for admitting fluid into the chamber 31. The size of this opening may be varied by turning the thumb-screw 37.

In the operation of this device, let it be assumed that the diaphragm 34 is set into vibration by external means. When the diaphragm bows outwardly valve 35 closes and valve 33 opens. The volume of chamber 30 is consequently increased and the pressure of the air therein decreased, thus causing a flow of air from chamber 31 into chamber 30. When diaphragm 34 bows inwardly valve 33 is closed, valve 35, opened, and air forced out of the chamber 30 through valve 35. This operation continues as long as the diaphragm 34 is vibrating, thus resulting in a unidirectional flow of air from chamber 31 to chamber 30 and from the atmosphere into chamber 31 through opening 36. The size of the opening

36 is so adjusted, however, that the pressure in chamber 31 is decreased sufficiently while diaphragm 34 is vibrating to cause the separation of the contacts 18 and 19. When diaphragm 34 stops vibrating, air enters slowly through opening 36, thus increasing the pressure in chamber 31 to that of the atmosphere and causing the contacts 18 and 19 to be again restored to their normal or closed position.

For the best operation of the device, it is desirable that the moving parts of valves 33 and 35 be extremely light and that the natural frequency thereof be well above the frequency at which the relay is operated. Satisfactory results have been obtained by employing a valve of essentially the type shown in the drawing, using a very thin metal foil over the ends of small tubes. It is desirable, moreover, in order to secure the maximum pumping action that the ratio of the volume of chamber 30 to the volume changes caused by the movement of diaphragm 34 be as small as practicable.

It is to be understood that many embodiments of this invention, other than the specific structures shown in the drawing and described herein, are included within the scope of the invention. The structures shown are merely given as examples of devices made in accordance with the invention and the drawing is merely schematic. It is apparent, moreover, that a device in accordance with this invention is operable at frequencies outside of the audible range. The term "acoustic" as used in this specification and the appended claims is, therefore, to be interpreted to include frequencies outside of the audible range.

What is claimed is:

1. An acoustically controlled device comprising constricted means for receiving acoustic waves, and means controlled thereby for producing a uni-directional flow of fluid toward said constricted means.

2. In combination, a fluid conduit having a constricted portion, means for causing fluid to flow alternately through said constricted portion in opposite directions, and means associated with said constricted portion in which a uni-directional flow of fluid is set up in response to said alternate flow.

3. In combination, a fluid conduit having a constricted portion, means for causing fluid to flow alternately through said constricted portion in opposite directions in response to acoustic waves, and means associated with said constricted portion in which a unidirectional flow of fluid is set up in response to said alternate flow.

4. In combination, a fluid conduit having a constricted portion, vibratable means for causing fluid to flow alternately through said constricted portion in opposite directions, and means associated with said constricted portion in which a uni-directional flow of

fluid is set up in response to said alternate flow.

5. In combination, a fluid conduit having a constricted portion, means for causing fluid to flow alternately through said constricted portion in opposite directions, and a second fluid conduit communicating with said first fluid conduit through said constricted portion, the pressure of the fluid in said second fluid conduit being reduced by the difference in pressure of the alternate flow of fluid in said constricted portion.

6. In combination, a fluid conduit, a constricted portion forming a part thereof, a second fluid conduit continuously communicating with said first conduit through said constricted portion, and vibratable means associated with said first conduit for reducing the pressure in said second conduit.

7. In combination, a fluid conduit having a constricted portion, a second fluid conduit continuously communicating with said first conduit through said constricted portion, and means closing a portion of said second conduit and operable in response to wave energy set up in said first fluid conduit.

8. In combination, a fluid conduit having a constricted portion, a second fluid conduit continuously communicating with said first conduit through said constricted portion, and an electrical contact associated with said second conduit and operable in response to wave energy set up in said first fluid conduit.

9. In combination, a fluid conduit having a constricted portion, vibratable means closing a portion of said fluid conduit, a second fluid conduit continuously communicating with said first conduit through said constricted portion, and means closing a portion of said second conduit and operable in response to the vibrations of said vibratable means.

10. In combination, a fluid chamber having a constricted passage, a second fluid chamber connected to said constricted passage and having an electrical contact associated therewith, and vibratable means associated with said first fluid chamber causing the withdrawal of fluid from said second fluid chamber toward said constricted passage thereby operating said electrical contact.

11. In combination, a chamber, a constricted

ed passage forming a part thereof, a second chamber communicating with said first chamber continuously through said constricted passage, a fluid in said chambers, a diaphragm closing a portion of said first chamber for changing the pressure in said second chamber, and a second diaphragm having an electrical contact associated therewith closing a portion of said second chamber, said second diaphragm being flexed in response to pressure changes in said second chamber for operating said electrical contact.

12. In combination, an air chamber, a constricted passage connecting said air chamber with the free atmosphere, a second air chamber communicating with said first air chamber through said constricted passage, a vibratable means associated with said first air chamber, for changing the air pressure in said second air chamber, and movable means carrying an electrical contact and closing a portion of said second air chamber, said movable means being flexed in response to said pressure changes for operating said electrical contact.

13. In combination, a fluid conduit, vibratable means associated therewith, a second fluid conduit resonant to the vibrations of said vibratable means, a constricted passage connecting said conduits, a third conduit connecting with said constricted passage in which a uni-directional flow of fluid is set up in response to the vibrations of said vibratable means.

14. In combination, a plurality of air chambers, vibratable means closing a portion of one of said chambers, a passage connecting said chambers, a second passage connecting said first chamber with the atmosphere, means for closing said first passage in response to the movement of said vibratable means in one direction, and means for closing said second passage in response to the movement of said vibratable means in the opposite direction, the pressure in said second chamber being reduced in response to the vibration of said vibratable means.

In witness whereof, I hereunto subscribe my name this 24th day of November A. D., 1926.

OLIVER E. BUCKLEY.