March 15, 1955 E. A. TAVARES 2,704,185

PUMPING SYSTEM

Filed Jan. 9, 1952

Fig. 2.

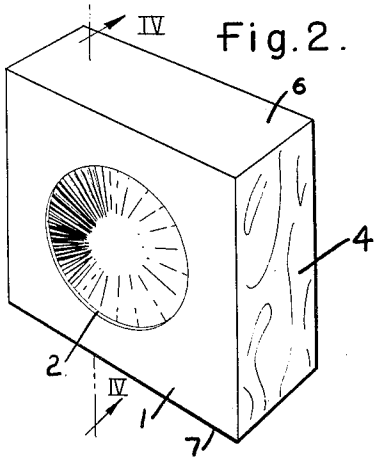
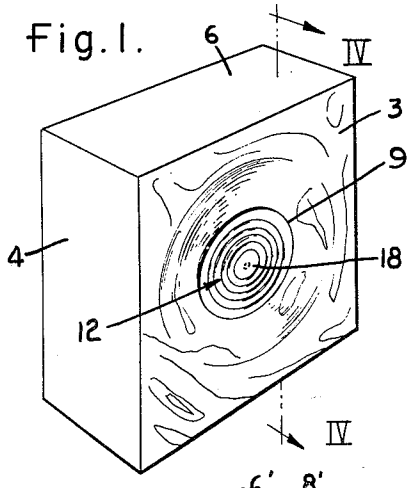


Fig. 1.



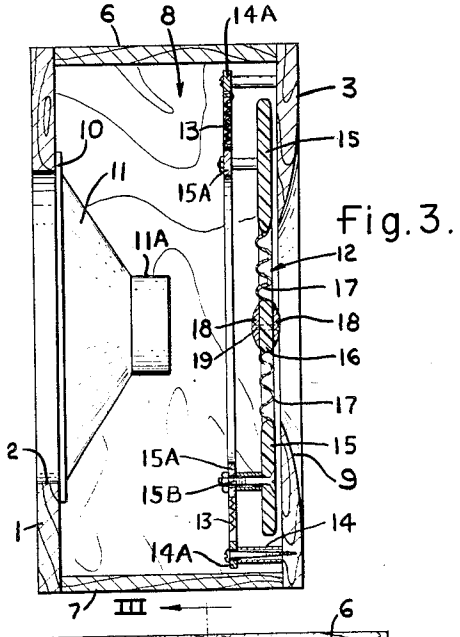


Fig. 3.

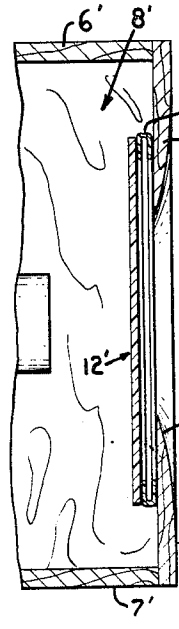


Fig. 5

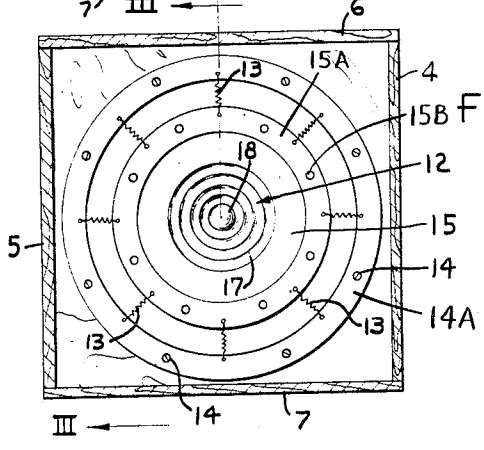


Fig. 4.

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2,704,185

PUMPING SYSTEM

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Application January 9, 1952, Serial No. 265,621

6 Claims. (Cl. 230—49)

Generally speaking, the present invention relates to an improved pumping and/or blower system. More specifically, it relates to an improved pumping and/or blower system adapted to very efficiently convert vibratory motion of suitable motor means into pulsating, virtually unidirectional, flow of air (or any other fluid) and this application is a continuation-in-part of my parent patent application Serial No. 163,994, filed May 24, 1950.

I am aware of the fact that a great many prior art pumping and blower devices and systems have been invented and developed heretofore. Most of such prior art pumping devices are of the type having a confined input and a confined output connected to the pumping device. Also, most such prior art devices are of totally different construction from the device of the present invention. A few prior art blower devices (mostly of the axial-flow fan type) are adapted to be positioned in ambient atmosphere without inlet and outlet ducts sealingly connected to the inlet and outlet of the fan and are adapted to cause movement of the ambient air in a selected direction. Such fans are usually employed for air circulation and ventilation purposes. However, they have a number of disadvantages. In the first place, the rapid rotation of the fan blade, or plurality of blades, produces a very undesirable sound which may annoy people in the room being ventilated by the fan or may even seriously reduce their overall efficiency as indicated by recent studies of the psychological and physiological effects of various levels of background noise or sound upon the average human worker. Furthermore, any slight unbalancing of the ban blades, such as may occur after it has been used for some time, through bumping or bending the fan blades accidentally during the moving of the fan from one location to another, will greatly increase the undesirable sound output produced by the fan during operation. Also the rapidly rotating fan blades constitute a serious accident hazard, particularly if accessible to children and animals, and may lead to severe injury or dismemberment.

Furthermore, such prior art axial-flow fans are exceedingly inefficient movers of air.

Generally speaking, the improved pumping and/or blower system of the present invention includes chamber means having a first port means effectively connecting the interior and the exterior of said chamber means and provided with diaphragm means positioned across and virtually closing said port means and having in association therewith vibratable motor means whereby said diaphragm means can be vibrated. The chamber means is also provided with a second port means effectively connecting the interior and the exterior thereof, and has pumping diaphragm means resiliently mounted in virtually parallel, closely spaced, resiliently displaceable position effectively across said second port means and in effective contact with the air within the chamber and the air outside of the chamber and responsive to oscillation of air within the chamber in a selected frequency range in a manner whereby said pumping diaphragm means will be effectively vibrated toward and away from said second port means when the first driven diaphragm means is vibrating in a selected frequency range thereby producing a pulsating effectively unidirectional, outwardly directed, flow of air from the exterior of the pumping diaphragm means.

From the above description of one generic form of the present invention, it will be apparent to those skilled

in the art that a great many disadvantages of prior art pumping systems, and in particular, the hereinabove mentioned disadvantages of prior art axial flow type fans and/or blowers are virtually completely eliminated in and through the use of the system of the present invention.

For example, the only moving portions in the system of the present invention during operation are the vibratably driven first diaphragm and the pumping diaphragm means vibrating as a result of being effectively air-coupled to the first diaphragm. Neither of these moving parts is capable of injuring a person or animal who may accidentally come into contact with them. Furthermore, they can be vibrated in a selected frequency range outside of the limits of audibility (such as, for example, in subsonic or supersonic frequency ranges) whereby virtually no sound audible to a human being will be produced.

Furthermore, the system of the present invention is a very efficient converter of input energy into output pulsating unidirectionally flowing air; and produces a surprisingly large air flow through the use of a physically small device which consumes a relatively small amount of power.

In addition the pumping and/or blower system of the present invention is exceedingly small, light and portable, and does not have a complicated mechanical system likely to get out of adjustment and require repair or replacement, as is frequently true of prior art axial flow fans, centrifugal blowers and the like.

With the above points in mind, it is an object of the present invention to provide a new and novel pumping and/or blower system adapted to effectively convert vibratory movement (usually produced by suitable motor means) into pulsating, virtually unidirectional flow of air or other fluid.

It is a further object of the present invention to provide a new and novel pumping and/or blower system well adapted for use in imparting movement to air in buildings, homes and similar structures for air circulation and ventilation purposes, and to do so while employing moving parts incapable of injuring a person who may accidentally come into contact therewith.

It is a further object of the present invention to provide a system of the character set forth in the above two objects, which is of small, light, readily portable, cheap, simple, fool-proof construction.

Other and allied objects will be apparent to those skilled in the art after a careful perusal, examination, and study of the accompanying illustrations, the present specification and the appended claims.

To facilitate understanding, reference will be made to the hereinbelow described drawings in which:

Fig. 1 is a front three-quarter perspective view (greatly reduced in size) of one illustrative embodiment of the present invention.

Fig. 2 is a back three-quarter perspective view of the form of the invention shown in Fig. 1 (also greatly reduced in size).

Fig. 3 is a somewhat larger vertical view (partly in vertical section) of the form of the invention shown in Fig. 1, taken in the direction of the arrows III—III in Fig. 4.

Fig. 4 is a vertical sectional view of the form of the invention illustrated in Figs. 1, 2, and 3, taken in the direction of the arrows IV—IV in Figs. 1 and 2.

Fig. 5 is a fragmentary view similar in aspect to Fig. 3, but illustrates a slightly modified form of the invention employing a slightly modified pumping diaphragm and mounting means.

Generally speaking, the improved pumping and/or blower system of the present invention includes chamber means having a first port means therein effectively connecting the interior and the exterior thereof and having a first diaphragm means positioned across and virtually closing said port means with suitable vibratably operable motor means effectively connected thereto. Also generally speaking, the chamber means is provided with a second port means effectively connecting the interior and the exterior thereof having a pumping diaphragm means resiliently mounted in virtually parallel, closely spaced, resiliently displaceable position across said second port

means and in effective contact with the air within the chamber and exterior of the chamber and responsive to oscillation of the air within the chamber in a selected frequency range in a manner whereby said pumping diaphragm means will be effectively vibrated toward and away from said port means when the first vibratably driven diaphragm means is vibrating in a selected frequency range thereby producing a pulsating effectively virtually unidirectional outwardly directed, flow of air from the pumping diaphragm means.

In the specific form of the present invention illustrated in Figs. 1, 2, 3, and 4, the chamber comprises a plurality of walls including a back wall **1** (provided with a first port **2**), a front wall **3**, two side walls **4** and **5** and a top and bottom wall **6** and **7** joining the back wall **1** and the front wall **3** together in spaced relationship to form a small sealed chamber (except for the exceptions noted). The chamber is indicated generally at **8**. The wall **3** is also provided with a second central port **9**, which in the specific example illustrated, is smaller than and in virtual alignment with the first port **2**. The outer mounting rim **10** of a first diaphragm (in this particular case in the form of a cone **11**) is fixedly attached to the inside of the edge of the wall **1**, which is around the port **2** so as to effectively close the port **2**.

In the specific example illustrated herein in Figs. 1, 2, 3, and 4, the pumping diaphragm means comprises a diaphragm, indicated generally at **12**, which is illustrated as being circular and resiliently mounted by an inner mounting ring **15A** fastened by fastening means **15B** to the annulus **15**; said mounting ring **15A** being also fastened to suitable resilient mounting means such as the spring means **13** spaced therearound, the other ends of which are fastened to an outer mounting ring **14A**, which is fastened with respect to the inside of the wall **3** of the box by fastening means such as the screw means **14**. Any other desired type of means may be employed to resiliently mount the diaphragm means **12** with respect to the wall **3** of the chamber. It should be noted that the pumping diaphragm **12** is mounted by the resilient means so that the outer annulus or washer-like portion **15** of the diaphragm **12** is positioned in virtually parallel closely spaced relationship with respect to the inside of the wall **3** immediately around the port **9** therethrough in such manner that the annular portion **15** of the diaphragm **12** lies closely adjacent to a corresponding annular portion of the wall **3** of the chamber. The above mentioned arrangement is such that vibratory oscillation of the pumping diaphragm **12** toward and away from the port **9**, which occurs as a result of vibration and/or oscillation of the air in the chamber **8** produced by vibration of the first diaphragm **11** caused by vibratory actuation thereof by the vibratable motor means **11A**, tends to move the annular portion **15** of the diaphragm **12** toward and away from the adjacent annular portion of the wall **3**, in a manner such that vibratory movement of the pumping diaphragm **12** (including the individual movements of the annular ring portion **15** and the central disc portion **16**) tends to draw in ambient air from laterally adjacent regions and to pump it in a pulsating virtually unidirectional manner outwardly from the diaphragm **12** and the port **9** toward any desired region. The compliance and mass of the pumping diaphragm **12**, the mounting means **13** and the air in the chamber are such that relatively large amplitude vibrational movements of the pumping diaphragm **12** occur and a very much greater quantity of air is pulsatingly, unidirectionally pumped outwardly from the diaphragm **12** than is moved by the first diaphragm **11**. It should be noted that the diaphragm **12** is not directly driven but is driven only through the coupling provided by the air in the chamber **8**, which is in contact with both the pumping diaphragm **12** and the driven diaphragm **11**, and that the mass and effective compliance of the diaphragm are carefully adjusted to values such as to cause a very effective coupling between the two in a selected frequency range whereby a very large pulsating unidirectional flow of air will be outwardly directed from the pumping diaphragm **12**.

In the specific example illustrated, the central disc shaped portion **16** of the pumping diaphragm **12** is effectively connected to the outer annular ring **15** by resilient annular corrugations **17**, which are intended to compliantly couple the outer annular ring **15** to the central disc portion **16**.

In the specific example illustrated, the central disc shaped portion **16** is provided with suitable weight means **18** (which may be adjustable, if desired) adapted to be fastened by any suitable type of fastening means, such as is indicated at **19**, to the disc **16**, and which may be removable for replacement by a greater or lesser weight for modification of the frequency response characteristic of the pumping diaphragm **12**. The central portion of the disc **16** and the outer annular ring **15** are connected by the flexible corrugations **17** for the purpose of reducing the resonant frequency of the pumping diaphragm **12** and the weight **18** carried thereby in that specific form of the present invention adapted to operate in the very low (preferably, though not necessarily, subsonic) frequency range. Of course, if the device of the present invention is intended to operate in higher frequency ranges the weight **18** may be reduced or eliminated entirely and the flexible corrugations **17** and/or the resilient mountings **13** can be suitably modified (usually by making them stiffer) so as to effectively raise the resonant frequency thereof.

It should be noted that the vibratory motor means **11A** may comprise any suitable type of motor means adapted to vibrate the diaphragm or cone **11** in a selected frequency range. In the specific example illustrated, it takes the form of a standard electromagnetic vibratory motor means of the type customarily employed in actuating loudspeaker cones. It may be supplied with an oscillatory electric input signal of a selected frequency suitable to produce optimum air output from the system. The oscillatory input signal may be produced in any desired fashion and by any desired type of device well known in the art and is therefore not illustrated in the drawing. For example, any desired type of signal generator might be used, and might comprise any of various types of oscillators, buzzers, or the like, or the standard alternating current customarily available might be used directly or through the medium of frequency division or multiplication. A. C. or D. C. power supplies can be used. It should also be noted that any type of vibratable motor means, whether electrically energized or not, can be employed within the teachings of the present invention.

Fig. 5 illustrates a slightly modified form of the present invention and corresponding parts will be indicated by similar primed reference numerals. In the specific modification illustrated in Fig. 5, the pumping diaphragm **12'** is shown resiliently connected at its outer periphery to the inside of the wall **3'** by resilient sealing means **20**, which acts to resiliently mount the pumping diaphragm **12'** in spaced relationship with respect to the port **9'** in the wall **3'** of the chamber **8'** and also acts to effectively seal the port **9'** from that portion of the chamber **8'** on the inner side of the pumping diaphragm **12'**. It should be noted that, if desired, the resilient means **20**, shown in Fig. 5, may act merely as resilient, compliant coupling means, and in this case need not act as a sealing means.

The embodiments of the present invention described and illustrated herein are exemplary only and are not intended to limit the scope hereof, which is to be interpreted in the light of the prior art and the appended claims only, with due consideration for the doctrine of equivalents.

I claim:

1. An improved pumping system, comprising: chamber means; a first port means connecting the interior and the exterior of said chamber means; diaphragm means positioned across and closing said port means; vibratably movable motor means operatively connected to the diaphragm means whereby it can be vibrated; a second port means in said chamber means connecting the interior and the exterior thereof; pumping diaphragm means resiliently mounted in virtually parallel closely spaced resiliently displaceable position across said second port means and in effective contact with the air within the chamber and responsive to oscillation of said air in a selected frequency range in a manner whereby said pumping diaphragm means will be effectively vibrated toward and away from said port means when the first driven diaphragm means is vibrating in a selected frequency range thereby producing a pulsating effectively unidirectional outwardly directed flow of air from the pumping diaphragm means.

2. A system of the character defined in claim 1, where-

in the pumping diaphragm means is positioned within the chamber extending across the second port means for resilient displacement toward and away from said port means.

3. A device of the character defined in claim 2, wherein the pumping diaphragm means has a substantially greater vibratory surface area than the area of the second port means.

4. A device of the character defined in claim 3, wherein the pumping diaphragm means includes a central disc-shaped relatively inflexible portion and an outer relatively inflexible annulus resiliently joined thereto.

5. A system of the character defined in claim 4, wherein the outer annulus is effectively resiliently mounted with respect to the second port means.

6. A system of the character defined in claim 5, wherein the central disc-shaped portion of the diaphragm means is provided with adjustable weight means for effectively lowering the resonant frequency thereof into an efficient low frequency air pumping range.

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