FLUIDIC BREATHING ASSISTOR
16 Claims, 5 Drawing Figs.

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References Cited

UNITED STATES PATENTS
3,267,947 8/1966 Bowles .................................. 137/81.5
3,280,832 10/1966 Burns .................................. 137/81.5 X
3,379,194 4/1968 Ziermann ................................. 137/81.5 X
3,389,698 6/1968 Kadosch et al. .......................... 137/81.5 X
3,419,029 12/1968 Straub ................................. 137/81.5
3,435,822 4/1969 Ziermann et al. ........................ 137/81.5 X

ABSTRACT: A fluidic breathing assistor comprises a bistable fluidic amplifier of the wall-attachment type which selectively supplies a power stream of breathable gas to a patient's lungs via an outlet channel, or dumps the power stream into an exhaust channel along with exhaled air entrained by the power stream from the outlet channel. Means are provided to switch the power stream from the outlet channel to the exhaust channel when the lungs are inflated to a predetermined adjustable pressure, the power stream remaining so switched until the patient begins to inhale. A downstream vent passage communicating between ambient air and the outlet channel serves four functions during four respective operating modes: (1) during inhalation, substantial ambient air is entrained by the power stream via the downstream vent to increase the air flow to the lungs; (2) toward the end of inhalation, the downstream vent begins to bleed power stream gas providing a gradual, rather than sudden decrease of flow to the lungs; (3) during exhalation, the downstream vent bleeds substantial exhaled air from the outlet channel to minimize resistance to exhalation; and (4) after exhalation sufficient ambient air is provided to the outlet channel via the downstream vent to prevent further evacuation of the lung by the exhausting power stream.
FLUIDIC BREATHING ASSISTOR

BACKGROUND OF THE INVENTION

The present invention relates to intermittent positive pressure breathing (IPPB) devices, and more particularly to an improved device of this type embodying a fluidic element. Intermittent positive pressure breathing devices are helpful to patients who are able to breathe spontaneously at a self-controlled rate, but whose overall pulmonary function is deficient. For example, respiratory deficiencies such as emphysema and chronic asthma are commonly treated with IPPB therapy. The desired features of an IPPB device may be summarized as follows:

a. The inspiratory phase of the breathing cycle is initiated by patient demand. The breathing assist remains passive until the patient begins to inhale and only a slight inspiratory effort should be sufficient to trigger the element.

b. Inspiration continues until the desired maximum lung inflation pressure is achieved. This maximum inflation pressure is adjustable to accommodate the requirements of the individual patient.

c. The inspiratory flow rate is adjustable.

d. The rate of flow to the patient’s lungs is relatively high at the onset of the inflation phase and gradually tapers off as the lungs approach maximum inflation pressure. This provides for a slight pause or dwell time in the breathing cycle near full inflation, which pause is necessary to complete full ventilation of the alveoli in spite of uneven flow restriction in the lungs.

Specifically, the lungs are made up of a network of tiny passages of varying resistance leading to the alveoli. If the flow rate to the lungs toward the end of the inflation phase is made relatively low, pressure is maintained in these passages for a time which is sufficient to insure that the desired ventilation is achieved.

e. Expiration is passive, the breathing assist offering only imperceptible restriction to the exhaled air.

f. Once the patient’s lungs have been emptied by the natural recoil of the lung-thorax system, evacuation of further air from the lungs is terminated and the breathing assist remains in a passive state until the patient once again initiates inhalation.

There have been a number of prior art attempts at providing fluidic IPPB devices, but none of these have successfully achieved all of the desired characteristics (a) through (f) enumerated above. For example, in U.S. Pat. No. 3,292,623 a fluidic respirator is disclosed which does not successfully achieve characteristics (a), (d), (e), and (f). U.S. Pat. No. 3,368,555 discloses a respiration apparatus employing two fluid amplifiers and is deficient in that it fails to achieve characteristic (c) listed above. Further, this latter respiration apparatus requires one or more diaphragm-type valves, a check valve, as well as two fluidic elements to achieve the remaining desired IPPB characteristics, and is therefore believed to be unduly complex and costly.

Fluidic respiratory devices are also disclosed in U.S. Pat. Nos. 3,280,832 and 3,379,194, but both are primarily resuscitation devices which cycle automatically without waiting for inhalation to be initiated by the patient and are therefore lacking characteristic (a) enumerated above. Such devices have utility in resuscitation techniques where the patient is unable to initiate inhalation by his own efforts, but tend to destroy the self-controlled rate and rhythm of a patient who is able to breathe spontaneously but have overall pulmonary functional deficiencies. In addition, the latter two patents disclose devices which are deficient with regard to characteristic (f) enumerated above.

It is therefore an object of the present invention to provide a fluidic breathing assist device having all of the characteristics (a) through (f) enumerated above.

It is still another object of the present invention to provide a fluidic IPPB device employing a single fluidic element.

SUMMARY OF THE INVENTION

In accordance with the principles of the present invention, a fluidic breathing assist comprises a bistable fluidic element of the wall-attachment type in which a power stream of breathable gas is stably directed through a suitably vented interaction region employing two receiver channels separated by a flow splitter. One receiver channel serves as a respiratory channel and conducts the power stream and ambient air entrained thereby to the patient during the inflation mode of the device. During exhalation, the power stream is directed to the other receiver channel which is vented to ambient and thereby serves as an exhaust. Air exhaled by the patient during the exhalation mode is conducted by the respiratory channel back into the interaction region from which it is entrained by the exhausting power stream. Switching of the power stream from the respiratory channel to the exhaust channel is accomplished by a negative feedback passage communicating between the downstream portion of the respiratory channel and a control nozzle which issues a control stream to deflect the power stream toward the exhaust channel when the downstream pressure in the respiratory channel reaches a predetermined level.

An upstream vent passage is defined through the exhaust channel sidewall and is so named because it communicates between ambient pressure and a location near the exhaust channel upstream of the flow splitter. By virtue of this upstream vent, wall attachment is weaker during exhalation than during inhalation so that only a small inspiratory pressure by the patient is required to switch the element to the inhalation mode.

A downstream vent passage is so named because it communicates between ambient pressure and a location in the respiratory channel downstream of the flow splitter. During inhalation, the power stream entrains substantial ambient air from the downstream vent (as well as from the exhaust channel and upstream vent). Toward the end of the inhalation portion of the cycle, increasing lung pressure causes a portion of the power stream gas to bleed from the respiratory channel to ambient via the downstream vent thereby providing a gradual decrease in the pressurization of the lungs as the latter approaches maximum inflation pressure. During exhalation, the downstream vent serves as a bleed path for the pressurization of the exhaled gas, the remainder of which is entrained by the exhausting power stream. In this manner, the fluidic element provides imperceptible resistance to exhalation. At the end of exhalation, further evacuation of the patient’s lungs is prevented by the downstream vent which supplies sufficient ambient air to the respiratory channel to maintain the downstream end of the respiratory channel at ambient pressure in spite of continued entrainment of air from the respiratory channel by the exhausting power stream. Adjustment of the maximum inflation pressure for each patient is achieved by virtue of a control valve disposed in the negative feedback path. Variable sensitivity over switching from exhalation to inhalation is achieved by provision of a control passage disposed opposite the first mentioned control passage and communicating with ambient via an adjustable control valve.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of one specific embodiment thereof, especially when taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a diagrammatic representation of a fluidic breathing assist according to the principles of the present invention illustrating the inhalation mode of the device;
FIG. 2 is a diagrammatic representation of the device of FIG. 1, illustrating operation of the device at the end of the inhalation mode just prior to switching to the exhalation mode. FIG. 3 is a diagrammatic representation of the device of FIG. 1, illustrating the exhalation mode of the device. FIG. 4 is a diagrammatic representation of the device of FIG. 1, illustrating operation at the onset of switching from the exhalation to inhalation mode.

**Detailed Description of the Preferred Embodiment**

Referring now specifically to FIG. 1 of the accompanying drawings, there is illustrated a fluidic breathing assistor comprising a plurality of nozzles, channels and passages formed and defined by techniques well known in the fluidics art. A power nozzle 11 is responsive to the application of pressurized fluid thereto for issuing a defined power stream of fluid into an interaction region 13. As illustrated in FIG. 1, a source of pressurized breathable gas 15 is connected to power nozzle 11 via a flow rate control element 17 which permits adjustment of the flow rate of the breathable gas applied to the power nozzle. The pressurized gas is from source 15 mixed with entrained air, or air enriched with oxygen, or in some cases, an admixture of such gases and vaporized or nebulized medication to be delivered with the gas to the patient's lungs.

Element 10 is of the wall-attachment type, meaning that left and right sidewalls 19 and 21, respectively, of interaction region 13 are disposed, so as to permit the power stream to attach to either sidewall. Opposing left and right control nozzles 23 and 25 are defined through the upstream ends of respective sidewalls 19 and 21. A generally V-shaped flow splitter 29 is disposed at the downstream end of interaction region 13, and along with respective sidewalls 19 and 21 defines respective receiver channels 31 and 33. Channels 31 and 33 are disposed such that when the power stream is attached to sidewall 19, substantially all of the power stream flow is received via receiver channel 31, and likewise, when the power stream attaches the sidewall 21 substantially all of the power stream flow is received by receiver channel 33. The downstream end of receiver channel 33 is vented to ambient pressure and therefore is designated as an exhaust channel. The downstream end of receiver channel 33 is connected to a fluid conduit 35, which in turn is connected to either a mouthpiece or a face mask 37 adapted to be applied over the face of the patient. Hence, channel 33 is designated as the respiratory channel.

An upstream vent passage 27 extends through sidewall 19 at a location downstream of control nozzle 23 and upstream of the apex of flow splitter 29. Upstream vent passage 27 communicates between interaction region 13 and an ambient pressure environment through an opening 28. Ambient pressure from opening 28 is also supplied to control nozzle 23 via a control valve 30, for example, of the type disclosed in the U.S. Pat. No. 3,292,623.

A downstream vent passage 39 is defined through sidewall 21 downstream of the apex of flow splitter 29 and communicates between respiratory channel 33 and ambient pressure. A pressure sensing port 41 is defined through sidewall 21 at a location between the downstream vent passage 39 and the downstream end of respiratory channel 33. Pressure sensing port 41 communicates with control nozzle 25 via a negative feedback passage 43. A control valve 45 is disposed in negative feedback passage 43 and may be of the same type as control valve 30 discussed above.

In describing the operation of fluidic breathing assistor 10, reference is made to FIGS. 1 through 5 which diagrammatically illustrate five respective operating conditions. It is to be noted that in these FIGS. the power stream flow is represented by thick shaded arrows, that entrained flow is represented by thin arrows, and that exhaled flow is represented by thin arrows, and that exhaled flow is represented by unshaded thick arrows.

In the inhalation mode illustrated in FIG. 1, the power stream is attached to sidewall 21 and is directed via respiratory channel 33 to the patient's lungs. The fast moving power stream entrains air in its immediate vicinity, thereby reducing the static pressure in interaction region 13 to a level somewhat less than atmospheric pressure. Because of this reduced pressure, air is drawn in to element 10 through control channel 23, upstream vent passage 27, and exhaust channel 31. In addition, as the power stream flows through respiratory channel 33, it also entrains ambient air via downstream vent passage 39. As a consequence of all the entrainment, the flow to the patient is approximately double that of the power stream upon issuance from power nozzle 11.

Respiratory channel 33 gradually widens as the downstream end of the channel is approached. The stream thus decelerates as it travels downstream and static pressure at the downstream end of channel 33 increases as pressure is recovered therefrom. The increase of static pressure in channel 33 is proportional to the patient's intrathoracic pressure. As the patient's lungs begin to inflate the static pressure adjacent pressure sensing port 41 increases, and the gas begins to flow back through feedback passage 43. For the condition illustrated in FIG. 1, the feedback flow has not yet become sufficiently great to cause switching of the power stream.

In FIG. 2, element 10 is illustrated in a mode of operation just prior to the end of inhalation and on the verge of switching to the exhalation mode. As illustrated, the pressure in the patient's lungs has increased substantially producing a corresponding increase in static pressure at sensing port 41. Likewise, the airflow through feedback passage 43 increases. The volume of air entrained through the downstream vent passage 39, exhaust passage 31, upstream vent passage 27 and control nozzle 23 gradually decreases as the back pressure in respiratory channel 33 increases. With the increasing back pressure, gas begins to bleed from downstream vent passage 39. As a result of both the decreased entrainment and the bleed from downstream vent passage 39, the total air available to the patient tapers off from about double the power nozzle flow to somewhat less than the power nozzle flow. Thus the rate of increase of pressure in the patient's lungs decreases toward the end of the inhalation phase, permitting a slight dwell time at or near full inflation.

Control valve 45 and feedback passage 43 permit adjustment of the feedback flow to interaction region 13 via control nozzle 25. The momentum of the feedback flow deflects the power stream, gradually detaching the stream from interaction region 21. When the detachment is achieved in the patient's lungs, as determined by the setting of control nozzle 45, the power stream is switched toward the exhaust channel 31 and attaches to sidewall 19. Such switching initiates the exhalation phase of operation.

FIG. 3 represents the exhalation mode for element 10 and, as illustrated, the power stream is deflected so as to flow out of exhaust channel 31. Exhalation is promoted by the elasticity of the patient's lungs and chest cavity. The exhaled air flows from the patient back into element 10 exiting through the downstream vent passage 39 and exhaust channel 31. It is to be noted that the flow direction through downstream vent passage 39 is opposite that during the inhalation mode. The capability of downstream vent passage 39 to conduct substantial portions of the exhaled flow renders element 10 imperceptibly resistant to exhalation by the patient. Whereas the power stream entrains substantial amounts of the exhaled air through exhaust channel 31, this entrainment of itself would be insufficient to render the resistance of element 10 to exhalation imperceptible. However, the venting action of downstream vent passage 39 combined with the power stream entrainment of remaining exhaled fluid renders exhalation resistance negligible.

During exhalation, the power stream also entrains air form control nozzles 23 and 25 and from the upstream vent passage.
27. The air entrained from control nozzle 25 is supplied by a portion of the exhaled flow conducted through feedback passage 43. The air entrained from control nozzle 23 and upstream vent passage 27 is supplied from ambient through opening 28. The inflow of air from upstream vent passage 27 and control nozzle 23 tends to weaken the attachment of the power stream to sidewall 19. However, this effect is counter-balanced during exhalation by the combined effect of the flow expelled directly into interaction region 13 via respiratory channel 33 and by the exhaled flow reed back via passage 43 through control nozzle 25.

FIG. 4 illustrates the operation of element 10 at the end of exhalation, that is, after the patient's lungs have been emptied by the natural recoil of the lung-thorax system. In this mode, evacuation of remaining air in the patient's lungs would cause discomfort; however, further evacuation is prevented by the downstream vent passage 39. More particularly, after cessation of naturally exhaled airflow through respiratory channel 33, the power stream still tends to entrain fluid from respiratory channel 33 into exhaust channel 31. Downstream vent passage 39 supplies sufficient ambient air to channel 33 to fulfill the entrainment requirements of the power stream and still maintain the downstream end of respiratory channel 33 at ambient pressure. In this regard, it is noted that the power stream entrains air directly from respiratory channel 33 and also from control nozzle 25, and that the vent passage 39 supplies sufficient ambient air to both locations to satisfy the entrainment requirements. Since the static pressure at the downstream end of respiratory 33 is maintained at ambient pressure, there is no further evacuation of the patient's lungs by the air-entraining power stream.

In the operation mode illustrated in FIG. 4, the power stream remains attached to sidewall 19, flowing out through exhaust channel 31. A force balance exists in the interaction region 13 with the momenta of the added flows through control nozzle 23 and upstream vent 27 tending to detach the power stream from sidewall 19 and with the entrained flow through respiratory channel 33 and control nozzle 25 tending to keep the power stream attached to sidewall 19 and directed toward exhaust channel 31. To the patient, the device in this operational mode is completely passive, neither supplying nor evacuating air from the lungs, and remaining stable until inhalation begins.

Referring now to FIG. 5, element 10 is illustrated on the verge of switching to the inhalation mode due to a slight inspiratory effort by the patient. The switching at the end of exhalation (FIG. 4) is disrupted when the patient begins to inhale. The amount of inhalation effort required of the patient to initiate the inhalation mode in element 10 is determined by the setting of control valve 30 which in turn determines the ambient flow rate from opening 28 to control nozzle 23. Control valve 30, therefore, serves as a sensitivity control, adjustable in accordance with the inhalation capability of each patient to determine the switching level of the power stream.

The disruption of the force balance at the start of inhalation by the patient results directly from the change of direction of the inflowing ambient air through downstream vent passage 39, such inflow now being directed toward the inhaling patient rather than being entrained by the exhausting power stream. The power stream begins to be deflected toward the patient by flow through control nozzle 23 and the stream once again attaches to sidewall 21 to begin the inhalation process and the start of another respiratory cycle.

In view of the above description of the operation of element 10, the following structural characteristics of the element should be emphasized. For one thing, upstream vent passage 27 serves two important functions: (1) supplying additional ambient air for entrainment by the power stream during inhalation; and (2) limiting the attachment of the power stream to sidewall 19 during exhalation to permit sensitive control of switching in accordance with the setting of control valve 30. The downstream vent passage 39 serves four distinct functions: (1) during inhalation, substantial ambient air is entrained by the power stream from vent passage 39 to increase the airflow to the patient substantially in excess of the power stream flow; (2) during exhalation, the downstream vent 39 begins to bleed gas from respiratory channel 33 at the back pressure therein begins to build up, and therefore a gradual change in the airflow rate to the lungs is achieved during exhalation, the downstream vent passage 39 conducts substantial amounts of the exhaled air from respiratory channel 33 to ambient, thereby minimizing resistance of element 10 to exhalation; and (4) at the end of exhalation, sufficient ambient air is provided to respiratory channel 33 to maintain the downstream end of respiratory channel 33 at ambient pressure.

It is important that the vent passage 27 be located upstream of the apex of divider 29, and that downstream vent passage 39 be located downstream of the apex of flow splitter 29. In this regard, the particular location of the flow splitter apex and the downstream vent passage involves a trade-off of desired characteristics. More specifically, the further upstream the flow splitter apex is located, the greater is the pressure recovery in respiratory channel 33 during the inhalation mode. On the other hand, the further downstream one locates the flow splitter apex, the lower is the resistance to exhaled flow during the exhalation mode of element 10. In addition, the width of downstream vent passage 39 at its narrowest point is desirably quite wide so as to permit maximum inflow of entrained air during inhalation and outflow of exhaled air during exhalation. On the other hand, if the vent passage 39 is made too wide, pressure recovery in respiratory channel 33 during inhalation is compromised.

In view of the above considerations, a typical configuration, in which pressure recovery during inhalation and flow resistance during exhalation are mutually optimized, has the following dimensions:
- Power nozzle width \( W \)
- Flow splitter distance downstream from power nozzle \( \text{11W} \)
- Minimum cross section of downstream vent passage \( 39 \) between 2 and \( \frac{1}{2}W \)

The above relative dimensions are of course approximate and variations therefrom can, in many cases, produce satisfactory IPPB operation.

The fluidic breathing assistant, as described above, is readily adaptable for operation with a nebulizer for delivering to the patient a fine aerosol of inhalable gas. Techniques for introducing such a mist into the inhaled stream are well known and may be exemplified by the technique disclosed in U.S. Pat. No. 3,379,194.

While I have described and illustrated one specific embodiment of my invention, it will be clear that variations of the details of construction which are specifically illustrated and described may be resorted to without departing from the turn spirit and scope of the invention as defined in the appended claims.

I claim:

1. An improved fluidic breathing assistant of the type in which pressurized breathable gas is supplied to a patient via a bistable fluidic element and in which said bistable fluidic element includes a power nozzle responsive to application of said pressurized breathable gas thereto for issuing a power stream, a respiratory receiver channel for conducting said power stream to said patient during the inhalation mode of said breathing assistant, an exhaust receiver channel for conducting said power stream to ambient and receiving entrained exhaled air from said respiratory channel during the exhalation mode of said breathing assistant, means for switching said power stream from said respiratory receiver channel to said exhaust receiver channel when the static pressure in said respiratory receiver channel reaches a predetermined level and means for switching said power stream from said exhaust receiver channel to said respiratory receiver channel upon initiation of inhalation by said patient, the improvement comprising
downstream vent means communicating between ambient air and said respiratory receiver channel and responsive to below-ambient pressure in said respiratory receiver channel for supplying substantial inflow of ambient air to said respiratory receiver channel.

2. The fluidic breathing assistior according to claim 1 further comprising only one fluid feedback passage, said feedback passage being disposed to conduct fluid above a predetermined pressure from the downstream end of said respiratory channel into interaction with said power stream to switch the latter to said exhaust channel.

3. The fluidic breathing assistior according to claim 1, wherein said downstream vent means is further responsive to above-ambient pressure in said respiratory receiver channel for bleeding fluid from said receiver channel to ambient.

4. The fluidic breathing assistior according to claim 3 wherein said means for switching said power stream from said respiratory receiver channel comprises a feedback passage having an ingress opening proximate the downstream end of said respiratory receiver channel and arranged to issue feedback fluid in deflecting relationship with said power stream to deflect the latter into said exhaust receiver channel, said breathing assistior being devoid of means for feeding back fluid flowing downstream in said exhaust receiver channel.

5. A fluidic breathing assistior for supplying breathable gas to a patient via a respiratory channel upon initiation of inhalation by the patient and for exhausting gas exhaled by the patient into said respiratory channel, said fluidic breathing assistior including a fluidic element comprising:

- an interaction region;
- a power nozzle responsive to application of pressurized breathable gas thereto for issuing a power stream of said breathable gas into said interaction region;
- first and second opposed sidewalls defining respective sides of said interaction region, each sidewall disposed to permit attachment of said power stream thereto;
- a flow splitter having an apex disposed at the downstream end of said interaction and defining said respiratory channel in receiving relation to said power stream between said first sidewall and said flow splitter, and defining an exhaust channel in receiving relation to said power stream between said second sidewall and said flow splitter, said exhaust channel being vented to ambient at its downstream end;
- negative feedback means responsive to a predetermined static pressure at said downstream portion of said respiratory channel for deflecting said power stream from said respiratory channel to said exhaust channel;

- downstream vent means communicating between ambient pressure and a specified portion of said respiratory channel between said flow splitter apex and said downstream portion of said respiratory channel, said downstream vent means being responsive to below-ambient static pressure at said specified portion of said respiratory channel for supplying ambient air to said respiratory channel, and responsive to above-ambient static pressure at said specified portion of said respiratory channel for bleeding fluid from said respiratory channel.

6. The combination according to claim 5 wherein said exhaust channel is devoid of negative feedback means for feeding back fluid from said exhaust channel to said interaction region.

7. The fluidic breathing assistior according to claim 6, further comprising upstream vent means communicating between ambient air and said interaction region through said second sidewall for supplying ambient air for entrainment by said power stream.

8. The fluidic breathing assistior according to claim 7, further comprising control means for selectively varying the flow rate of said power stream.

9. The fluidic breathing assistior according to claim 8 wherein said power nozzle has a width W, the distance between said power nozzle and the apex of said flow splitter is approximately 11W, and the width of said downstream vent means at its narrowest point is between 2W and 2.5W.

10. The fluidic breathing assistior according to claim 9 wherein said negative feedback means comprises:

- a control nozzle defined through said first sidewall at the upstream end of said interaction region;
- a pressure sensing port defined through said first sidewall at said downstream portion of said respiratory channel; and
- a fluid passage interconnecting said pressure sensing port and said control nozzle.

11. The fluidic breathing assistior according to claim 10, further comprising feedback adjustment means for selectively adjusting said predetermined static pressure, said feedback adjustment means comprising a control valve disposed in said fluid passage.

12. The fluidic breathing assistior according to claim 11, further comprising:

- a second control nozzle defined through said second sidewall at the upstream end of said interaction region; and
- a fluid passage interconnecting said second control nozzle to ambient air.

13. The fluidic breathing assistior according to claim 12 further comprising sensitivity control means for selectively adjusting the inspiratory effort required of said patient in order to switch said power stream from said exhaust channel to said respiratory channel, said sensitivity control means comprising an adjustable valve disposed in said fluid passage.

14. The fluidic breathing assistior according to claim 13, wherein said negative feedback means comprises:

- a further control nozzle defined through said first sidewall at the upstream end of said interaction region;
- a pressure sensing port defined through said first sidewall at said downstream portion of said respiratory channel; and
- a fluid passage interconnecting said pressure sensing port and said further control nozzle; and
- feedback adjustment means disposed in said last-mentioned fluid passage for selectively adjusting said predetermined static pressure.

15. The fluidic breathing assistior according to claim 14, further comprising control means for selectively varying the flow rate of said power stream.

16. The fluidic breathing assistior according to claim 15, wherein said power nozzle has a width W, the distance between said power nozzle and the apex of said flow splitter is approximately 11W, and the width of said downstream vent means at its narrowest point is between 2W and 2.5W.