

[54] HIGH-VELOCITY BREATHING VALVE

[72] Inventor: Ewald Koegel, 946 E. Sunshine Drive, San Antonio, Tex. 78228

[22] Filed: Oct. 21, 1970

[21] Appl. No.: 82,656

[52] U.S. Cl. 137/512, 137/512.1, 137/525

[51] Int. Cl. F16k 15/14

[58] Field of Search 137/525, 512.1, 512.15, 512.4, 137/63 R; 128/145.5, 147, 142.2; 137/512

[56] References Cited

UNITED STATES PATENTS

2,954,048 9/1960 Rychlik 137/512
3,006,363 10/1961 Jackson 137/525

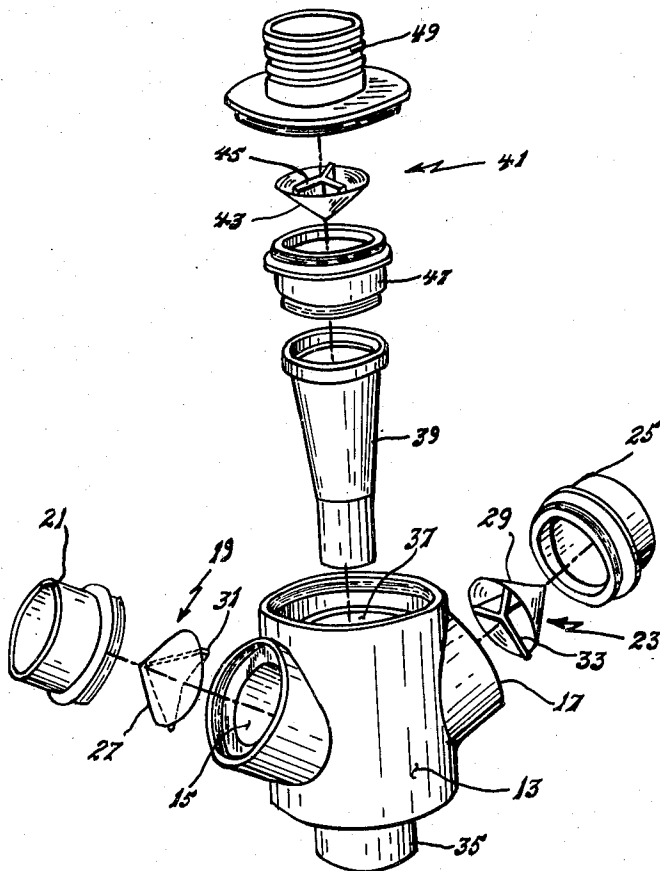
3,242,921 3/1966 Seeler 128/145.5
3,348,539 10/1967 McDonald 128/142.2
3,473,561 10/1969 Svenson 137/525

Primary Examiner—Samuel B. Rothberg
Assistant Examiner—William H. Wright
Attorney—Harry A. Herbert, Jr. and Arsen Tashjian

[57] ABSTRACT

A high-flow, low-resistance minimal dead space breathing valve having intake and exhaust flow paths separated but coaxial and coupled with in-line K-valves which reduce turbulence and flow resistance to a minimum. The breathing valve is particularly suitable for making very accurate maximal breathing capacity and oxygen cost determinations under conditions of severe exercise.

5 Claims, 2 Drawing Figures



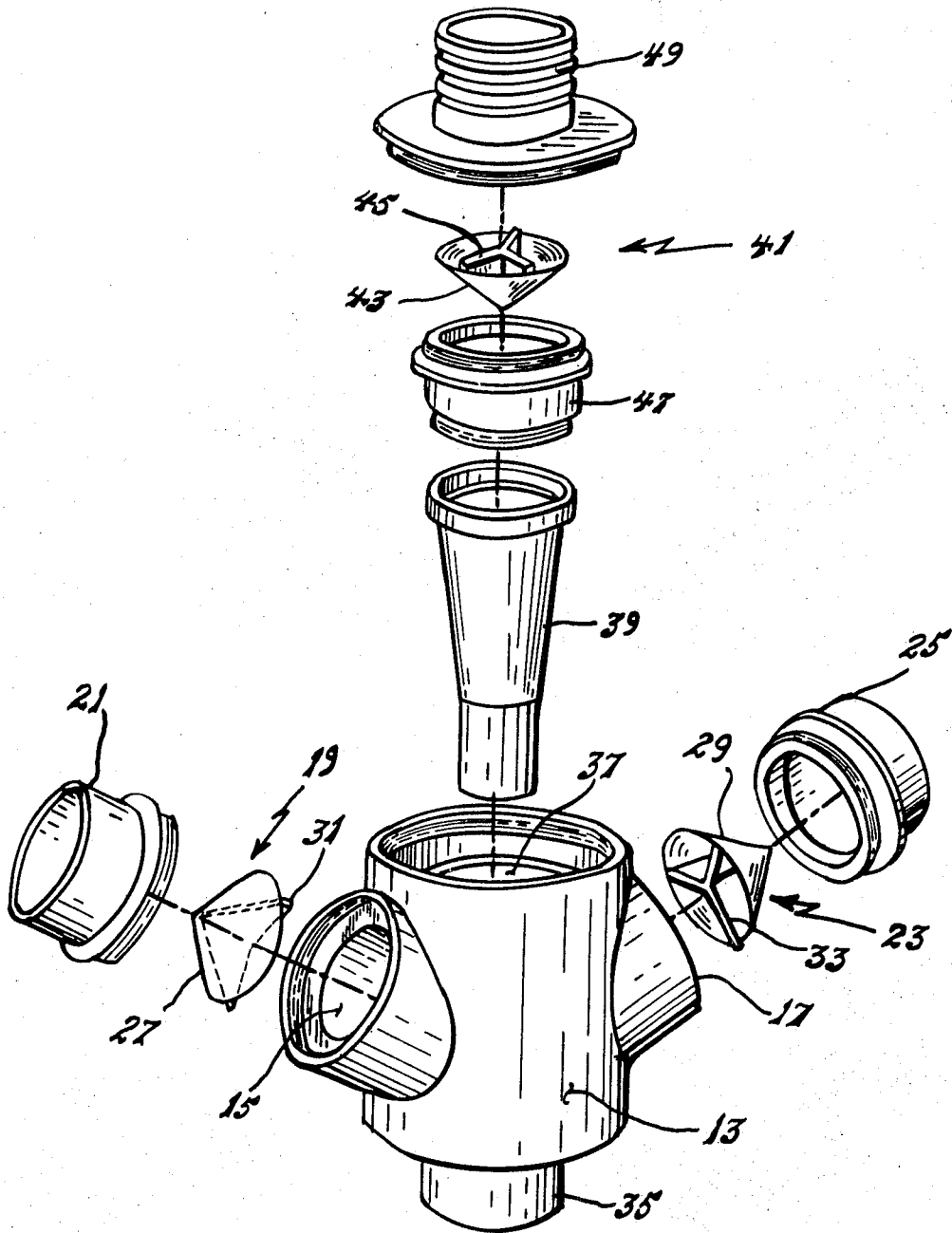


FIG. 1

INVENTOR
 EWALD HOEGEL
 BY *Harry A. Herbert Jr.*
Arden Tashjian and
 ATTORNEYS

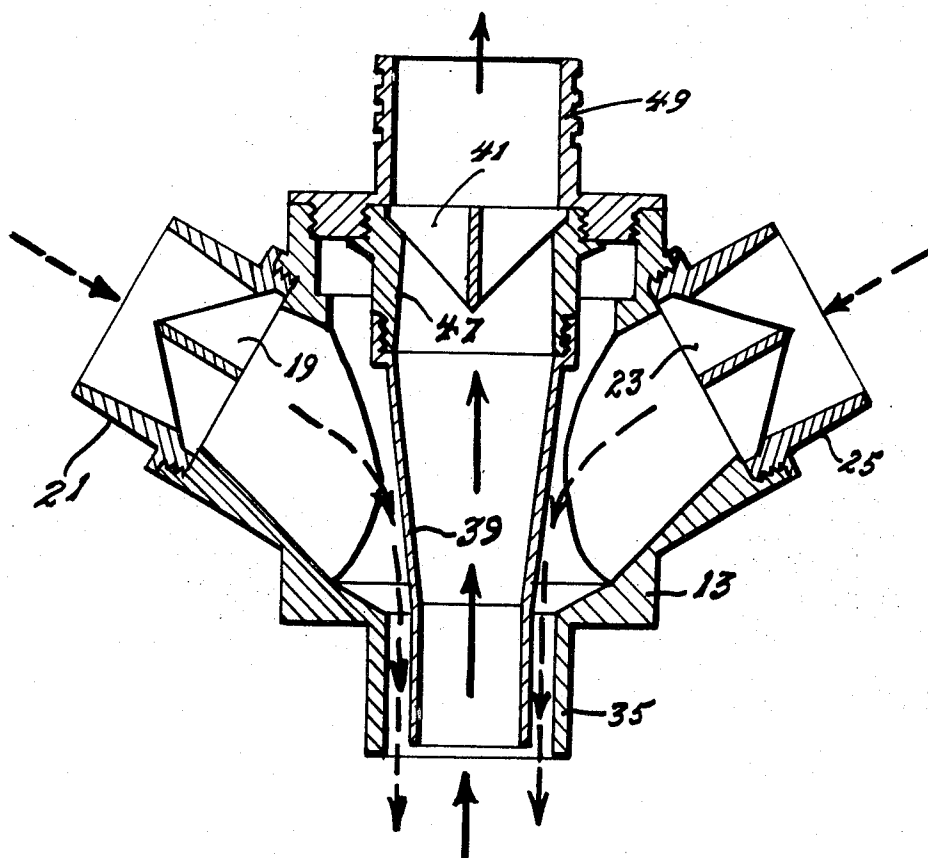


FIG. 2

INVENTOR
 EWALD HOEGEL
 BY *Harry A. Herbert Jr.*
Brown Tashjian
 ATTORNEYS

HIGH-VELOCITY BREATHING VALVE

BACKGROUND OF THE INVENTION

This invention relates to a high-velocity breathing valve and, more particularly, the invention is concerned with providing a high-flow, low-resistance minimal dead space breathing valve for making accurate determinations of breathing capacity and oxygen cost of severe exercise.

The dead space and flow resistance characteristics at high flow rates of currently available breathing valves are such that most previous determinations of breathing data in physiological studies are not very reliable. Relatively high turbulence and back pressure in the presently known valves produces a marked effect on patients being tested, especially under conditions of complete exhaustion. This detrimental effect is caused by airflow resistance which builds up at the high flow rates.

Another drawback of breathing valves presently in use is the dead space which is required in all known designs. In making determinations of maximal breathing capacity, exhaled gas collection and oxygen cost under severe exercise, it is most desirable to use a valve with an absolute minimum of dead space and one which has very low flow resistance. The minimal dead space permits substantially all of the gaseous matter to be collected and the low flow resistance allows full flow of air under severe exertion.

SUMMARY OF THE INVENTION

The present invention is concerned with providing a high-flow, low-resistance minimal dead space breathing valve for situations where high flow rates are met and flow resistance must be kept to a minimum. Intake and exhaust flow paths are separated but coaxial so that no additional dead space is added by the breathing valve. Further, this separation of flow paths when coupled with the novel in-line K-valves leads to appreciable reduction in turbulence and flow resistance over conventional designs. The hereinafter described valve is particularly suitable for very accurate determinations of maximal breathing capacity, exhaled gas collection and for studies of the oxygen cost of severe exercise.

Accordingly, it is an object of the invention to provide a high-velocity breathing valve which utilizes in-line K-valves to produce very low back pressure and turbulence at all flow rates.

Another object of the invention is to provide a breathing valve wherein the exhaust and intake flow paths are separated but remain closely in line thereby further reducing flow resistance over conventional designs.

Still another object of the invention is to provide a breathing valve useful in a system for making an extremely accurate determination of oxygen cost under conditions of severe exercise. No additional dead space is added by the breathing valve.

A further object of the invention is to provide a breathing valve which is substantially smaller and more compact than presently available valves while still maintaining a much lower than normal flow resistance.

A still further object of the invention is to provide a high velocity breathing valve which is simple in construction and easily disassembled and cleaned.

These and other objects, features, and advantages will become more apparent after considering the following detailed description taken in conjunction with the illustrative embodiment in the accompanying drawings wherein like members are used throughout to identify like elements.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view in perspective of a high-velocity breathing valve according to the invention; and FIG. 2 is a view in vertical cross section of the valve of FIG. 1 in assembled condition with arrows showing the flow direction of the intake air and the expiration gases.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings, the breathing valve includes a main housing 13 with two inlet ducts 15 and 17. The inlet duct 15 is provided with an inlet in-line K-valve 19 held in position by the threaded sleeve 21. Likewise, the inlet duct 17 is provided with an inlet in-line K-valve 23 held in position by the threaded sleeve 25. The sleeves 21 and 25 are threadably attached to the main housing 13. The in-line K-valves 19 and 23 are conical in configuration and include flexible membranes 27 and 29 molded on a conical form and cemented to Y-section supports 31 and 33 which are made to the same conical shape at one end. The conical valves 19 and 23 are unique in that they do not disturb the linearity of the airstream and have a low opening pressure.

The main housing 13 is designed to accommodate a standard mouthpiece (not shown) and includes a tube 35 attached to its lower end which is preferably a tubular section of the main housing 13. The inlet ducts 15 and 17 form 60° included angles with the cylindrical axis of the main housing 13. The exhaust duct is coaxial with the tube 35 for attaching the mouthpiece. Within the housing 13 and coaxial therewith, there is positioned a conical air expander 39 which allows expansion of the exhaled air as it passes toward the exhaust valve 41. This reduces the velocity and turbulence of the exhaled air before it reaches the valve 41 thereby preventing valve flutter. The exhaust valve 41 includes a flexible membrane 43 cemented to a Y-section support 45. A valve seating element 47 is threadably attached to the upper end of the air expander 39. An outlet tube 49 is threadably attached to the housing 13 and adapted to receive the valve seating element 47 to form the exhaust duct assembly. Various devices such as gasometer, gas bag or other collection devices can be attached to the outlet tube 49.

The breathing valve may be constructed of any lightweight material which is reasonably resistant to breakage and cleaning solutions. Synthetic resin materials such as Plexiglas and Implex are especially suitable for use as the fabrication material in the manufacture of the breathing valve and Implex has the added advantage of being more durable.

MODE OF OPERATION

In operation, one of the primary uses of the breathing valve is for air collection to obtain accurate expired air samples from patients exercising at heavy workload levels. A standard mouthpiece (not shown) is attached to the breathing valve at the tube 35 and directs the air from the valve to the patient's mouth.

The air enters the inlets 15 and 17 after passing through the threaded sleeves 21 and 25 and the conical K-valves 19 and 23. The K-valves 19 and 23 open to allow the air to enter the main housing 13 when the patient inhales. The air then passes through the tube 35, into the mouthpiece (not shown) and then into the patient's mouth.

When the patient exhales, the valves 19 and 23 are caused to close by the exhalation pressure and all of the expired air passes into the conical air expander 39. The valve 41 then opens and the expired air passes out through the outlet tube 49 to a gasometer or gas bag for analysis. The diameters of the inlet tube 35 and the lower end of the conical air expander 39 are so proportioned that their free areas are equal.

The breathing valve has been tested by exertion of patients on a motor-driven treadmill to exhaustion. They breathe through the valve during the entire exercise procedure. The individuals tested were unable to detect any airway restriction during expiration or inspiration, even at complete exhaustion. Airflow resistance measurements across the breathing valve under clinical conditions indicate that no significant restriction to breathing is present. In addition, no evidence of leaking or sticking of the in-line K-valves 19, 23 and 41 was evident. The small dead space and low resistance characteristics at all flow rates of the hereinbefore described breathing valve make

it possible to determine very accurately the maximal breathing capacity and oxygen cost under conditions of severe exercise.

Although the invention has been illustrated in the accompanying drawings and described in the foregoing specification in terms of a preferred embodiment thereof, the invention is not limited to this embodiment or to the preferred configuration mentioned. It will be apparent to those skilled in the art that my invention could have extensive use in other operations where it is desirable to control the flow of gases such as high altitude oxygen mask and gas masks.

Also, it should be understood that various changes, alterations, modifications, and substitutions particularly with respect to the construction details can be made in the arrangement of the several elements without departing from the true spirit and scope of the appended claims.

Having thus described our invention, what I claim and desire to secure by Letters Patent of the United States is:

1. A high-velocity breathing valve for controlling the flow of intake air and exhaust gas to and from an individual, said breathing valve comprising a main housing having at least one inlet duct operatively connected to the sidewall thereof, an in-line K-valve positioned in said inlet duct for restricting the flow of air to the inward direction, a tubular section at the lower end of said main housing for attachment to a standard mouthpiece, said inlet duct being operatively connected to said tubular section, an exhaust section within said main housing having an exhaust duct opening in the upper end thereof, an outlet tube attached to said exhaust duct for connection with a gas collection device, means in said exhaust section for separating the exhaust flow path from the intake flow path

while maintaining the flow paths in coaxial relationship, and an in-line K-valve positioned in said exhaust duct for restricting the flow of expiration gas to the outward direction.

2. The high velocity breathing valve defined in claim 1 wherein said main housing is cylindrical in configuration and includes two inlet ducts operatively connected to the sidewall thereof forming 60° included angles with the central axis of said main housing, each of said inlet ducts having an in-line K-valve positioned therein.

3. The high-velocity breathing valve defined in claim 2 wherein said in-line K-valves are conical in configuration and include a flexible membrane formed by molding on a conical form, and a Y-section support shaped to the same conical form at one end, said membrane being cemented to said Y-section support to form said K-valve.

4. The high-velocity breathing valve defined in claim 2 wherein said means for separating the intake flow path from the exhaust flow path includes a conical air expander positioned within said exhaust section, said conical air expander serving to allow expansion of the exhaled air as it passes toward said outlet tube, thereby reducing the velocity and turbulence of the air before it reaches the in-line K-valve positioned in said exhaust duct.

5. The high-velocity breathing valve defined in claim 4 wherein the diameters of the tubular section at the lower end of said main housing and the lower end of the conical air expander are so proportioned that their free areas are equal, thereby preventing airway restriction during expiration and inspiration under severe exercise conditions.

* * * * *

35

40

45

50

55

60

65

70

75