United States Patent [19]

Jacobs

[11] **3,882,847**

[45] **May 13, 1975**

[54] **LOW-COST PNEUMATIC APNEA OR RESPIRATION MONITOR**

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[22] Filed: **Dec. 11, 1973**

[21] Appl. No.: **423,762**

[52] **U.S. Cl.** ..... **128/2 S;** 128/142; 340/279

[51] **Int. Cl.** **A61b 5/10;** A61m 16/00

[58] **Field of Search** ..... 128/25, DIG. 29, 203, 2 R, 128/142, 147.2, 145.8, 145.6; 340/279

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[57] **ABSTRACT**

Low-cost pneumatic apnea or respiration monitor adapted to sound an alarm for a patient whose breathing is controlled by a ventilator or whose respiration has ceased.

In the disclosed arrangement, pressure from an air pressure source is modulated by chest movement to admit air to either of two air storage tanks, each of these storage tanks having an adjustable throttle or bleed valve in a vent. Each tank feeds air to a low pressure actuated switch or valve which actuates an alarm when the pressure falls below a critical low value in the storage tanks indicating a slowing or cessation of breathing.

9 Claims, 7 Drawing Figures

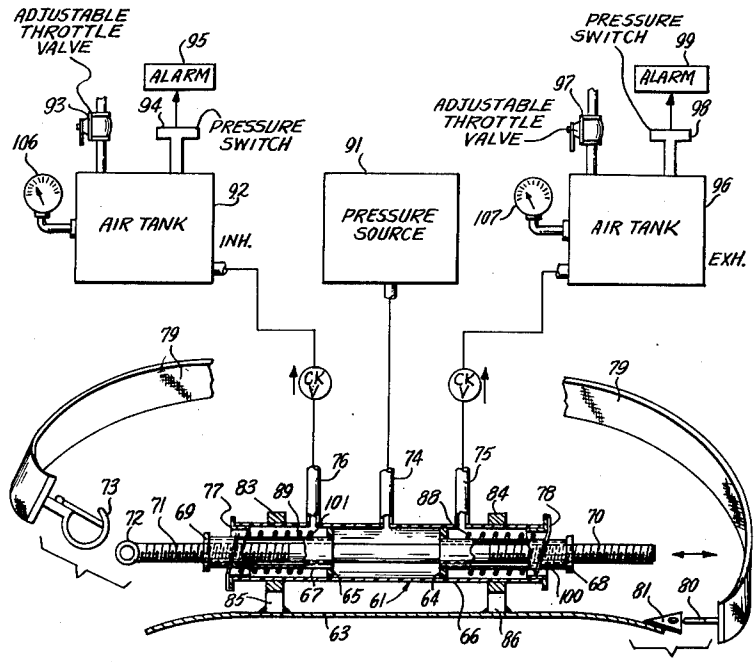


Fig. 1.

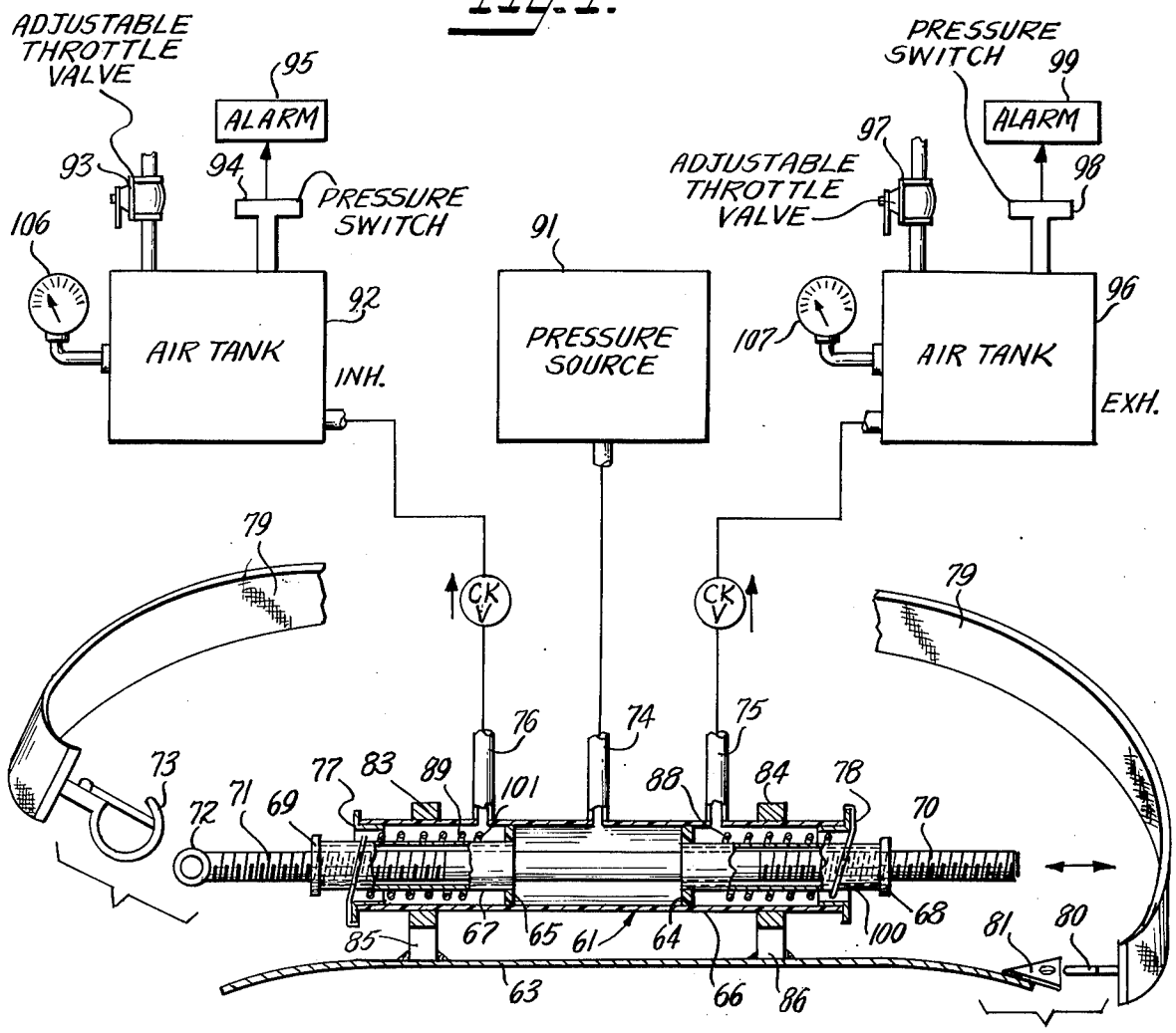


Fig. 2.

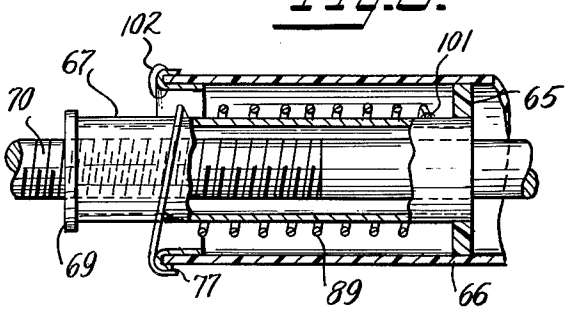


Fig. 3.

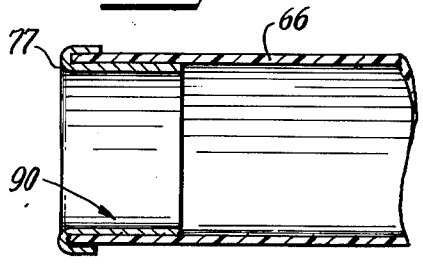


Fig. 4.

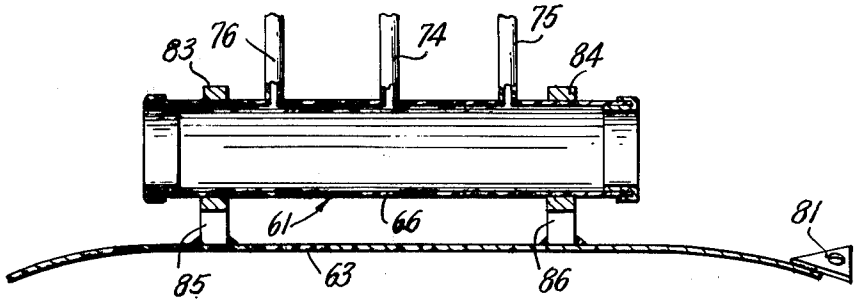


Fig. 5.

MID RESPIRATION

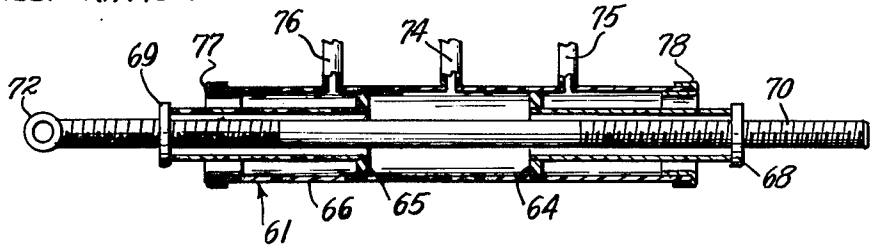
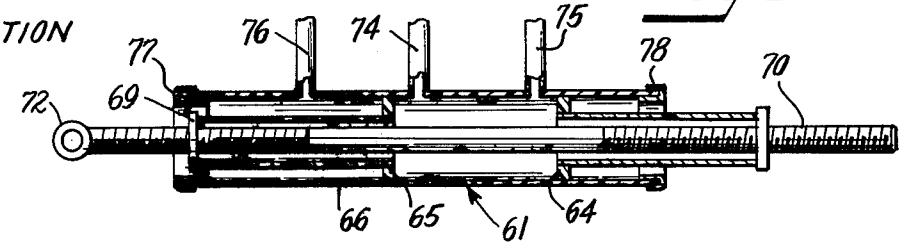


Fig. 6.

EXHALATION



INHALATION

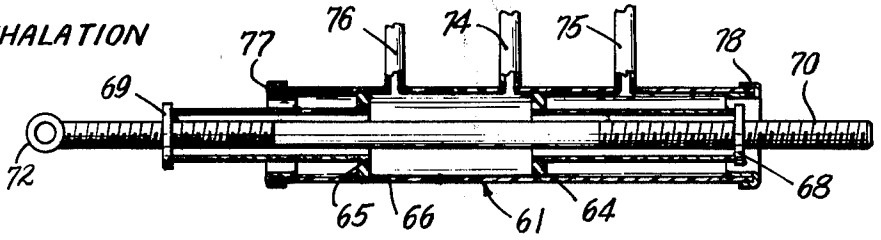


Fig. 7.

LOW-COST PNEUMATIC APNEA OR RESPIRATION MONITOR

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates to a low-cost apnea or respiration monitor which is adapted to sound an alarm for a patient whose breathing is controlled by a ventilator or which signals the stopping of breathing in a patient not on a respirator whose illness requires monitoring.

More particularly, the invention relates to a low-cost, reliable, respiration monitor which operates on simple mechanical and pneumatic principles and is not subject to electrical failure as may be caused by deterioration of electronic components such as capacitors, vacuum tubes, or transistors.

In the pneumatic system described herein, pressure from an air pressure source is modulated by chest movement to admit air to either or two air storage tanks, each of these storage tanks having an adjustable bleed valve. Each tank feeds air to a low pressure switch or valve which actuates an alarm when the pressure falls below a critical low value in the storage tanks indicating a slowing or cessation of breathing.

OBJECTS OF THE INVENTION

An object of the invention is to provide a low-cost apnea or respiration monitor which is free from capacitors, vacuum tubes and other electronic components and which operates on pressure fluid principles. The pressure system is provided with time delay means to indicate by audible, visual, and other alarm means failure of breathing of the patient in either the inspriatory or expiratory phase of each respiration cycle to indicate cessation of breathing by the patient.

BRIEF DESCRIPTION OF THE DRAWING

Other objects of the invention will become apparent from the following detailed description and drawings, in which:

FIG. 1 is a partially diagrammatic illustration showing the chest air valve unit connected to the appropriate pneumatic pressure sources and delay air storage tanks for inhalation and exhalation, respectively.

FIG. 2 is detail partly in section and partly in elevation of one end of the chest air valve unit showing the spring meter mechanism for the air valve piston.

FIG. 3 is a sectional view showing one of the stops at each end of the chest air valve unit which limits the reciprocating movement of air valve piston in response to inspiration and exhalation.

FIG. 4 is an elevational view of the rigid chest mounting plate which can be detached from the air valve unit when the latter is repaired or replaced.

FIG. 5 is a sectional diagrammatic view of the chest air valve unit in mid respiration.

FIG. 6 is a sectional diagrammatic view of the chest air valve unit in exhalation phase.

FIG. 7 is a sectional diagrammatic view of the chest air valve unit in inhalation phase.

The several figures herein illustrate a pressure system for an apnea monitor in which thoracic movement actuates alarms or signals. The basic principle of the pressure chest monitor system is that increments of air supplied to an air tight tank will gradually build up the pressure in that tank to the level of the source of air pressure. If the tank has a continuous slow vent or leak

the maximum pressure that can be built up by a regular series of inputs will be lower because of leakage. A calibrated pressure switch or valve connected to the air tank will be actuated if the incoming increments of air continue for a time period set by the adjustable throttle valve for respiration rate. The actuation of the switch due to this change in input to the tank can be utilized to energize an alarm indicating that the input has decreased or stopped entirely. A pressure gauge connected to the tank measures the respiration rate on the lowest swing of the guage's needle. The slower the respiration rate the higher the pressure is in the tank per impulse and the faster the respiration, the lower pressure per impulse. Thus, the tank acts as an adjustable timing means for varying or delaying the timing of pressure built up in the system and activating the alarm means.

FIG. 1 is a schematic view of an air valve **61** receiving air under pressure from source **91** through input **74** to a tubular member **66.** Preferably this tube should be transparent and the impact-resistant synthetic resin known as ABS, available from the Carlon Company, has been found satisfactory. Tubular member **66** has two other ports **75** and **76** extending respectively to air tanks **96** and **92.** Each of the air tanks has an adjustable throttle valve **97** and **93** respectively, and a low pressure switch **98** and **94** respectively.

Tube **66** is supported on a breastplate **63** by means of footing members **85** and **86,** each of which holds a circular supporting unit **83** and **84.** The tube **66** is snugly retained near each end by these ring-shaped members **83** and **84.** Within the tube member **66** is a reciprocating unit comprising a rod **70** having an eye-shaped member **72** at one end. This member **70** is threaded to receive threaded members **68** and **69.** Secured to threaded members **68** and **69** are tubular members **67** and **100.** The opposite ends of the tubular members **67** and **100** carrry piston unitis **64** and **65.** These piston units **64** and **65** are slidable within the tube **66.** As shown in FIGS. **5, 6** and **7** they shift from the mid position of FIG. **6** to the left and right in accordance with the motion of rod **70.**

Rod **70** may be connected at eye **72** to a snap fastener **73** that is secured to a body belt member **79** that surrounds the body of the patient. The opposite end of belt **79** as shown at the right side of FIG. **1** has a detachable hook **80** that may be secured in a corresponding opening **81** that is part of the chestplate **63.**

As portrayed in FIG. **7,** when the patient takes a breath, the belt **79** pulls on eye **72** drawing the rod **70** to the left. The two plungers **64** and **65** will then be positioned so the air in the pressure tank can enter tube **66** at port **74** and escape at port **76.** This adds an increment of air to tank **92.**

Conversely, as shown in FIG. **6,** when the patient breathes out belt **70** becomes slack, allowing rod **70** to move to the left under the influence of two springs to be described presently. At this moment of exhalation, as shown in FIG. **6,** the pistons **64** and **65** permit air from the pressure tank to enter at port **74** and to leave port **75** to go to tank **96.**

Thus, tank **92** can be designated the inhalation tank and the tank **96** can be designated the exhalation tank. Since both tanks are equipped with adjustable throttle valves **93** and **97,** any slowness of operation of rod **70,** or cessation of motion thereof, will soon result in a rise of pressure in one or the other of the two tanks. Such

rise in pressure will actuate the appropriate signal alarm 95 or 99 to notify an attendant of the critical situation respecting this particular patient.

Pressure gauges 106 and 107 may be attached to timing tanks 92 and 96. To an observer, the pressure gauges will indicate the breathing conditions of the patient by registering the low and high pressure cycles in the attached tank. Too high pressure would indicate that the patient's chest is not moving sufficiently for proper breathing.

The spring suspension that causes rod 70 to return to the extreme right position when not under any pull from the belt 79 is shown in detail in FIG. 2. This figure shows the left half of the rod 10 portrayed in FIG. 1. The piston member 65 is a snug fit within the plastic tube 66 and carries a tubular member 67 which is secured to the threaded member 69 at its other end. Consequently, the weight of one end of rod 70 is carried through the agency of member 69, tube 67 and piston 65 by the tube 66.

Exactly similar support means is found at the right end of tube 66 and rod 70 where piston 64 carries the tubular member 100 threaded member 68 and the right end of threaded rod 70.

It will be seen that the threaded members 68 and 69 can position the pistons 64 and 65 in different lengthwise locations along rod 70 and thereby determine the interval between the passage of these pistons over the ports 75 and 76.

Referring again to FIG. 2, the tube member 67 is surrounded by coil spring 89. This coil spring is secured, as by soldering, to the tube 67 at point 101. The other end of the spring is secured, as by crimping, over the edge of tube 66. The spring 89 is under partial compression when the rod 70 is in mid position shown in FIG. 5. At this moment the other spring 88 at the right end is under partial tension. Consequently, rod 70 is released from any pull by the belt 79 will spring to the right end under the impetus of two springs. This is the situation in FIG. 6.

It is desirable that pistons 64 and 65 be limited in their extreme movements to avoid pulling them from tube 66. FIG. 3 shows such a stop member comprising a rubber grommett which fits snugly over the end of tube 66 and projects inwardly into the tube to the point where the motion of the piston is to be stopped. This grommett is indicated as 77 and 78 in FIG. 1.

FIG. 4 is a partial detail of the supporting means and the tube 66 carried by the supporting means. This figure might be regarded as the stationary portion of the air valve, the other elements moving more or less in accordance with the pull on belt 79 produced by the action of the patient's chest in breathing. Footing members 85 and 86 are shown attached to the breastplate 63. The latter is shown as slightly curved at each end to conform to the human anatomy. At the top of parts 85 and 86, ring-shaped members 83 and 84 are secured and in turn carry the transparent tube 66 approximately at each end thereof. At the right end of breastplate 63 an apertured projection 81 provides means for detachably connecting the body belt 79 to the breastplate.

From the above description of a preferred embodiment of my pneumatic respiration monitor, it will be seen that no electricity is employed in the vicinity of the patient and need not be employed in the same room as the patient. If the alarms 95 and 99 are electrical, they can be energized by pneumatic tubing from an adjoining room. In some situations (operating rooms, for example), electrical sparks are to be avoided at all costs. The alarms may be pneumatic, such as an air whistle.

What is claimed is:

1. A pressure fluid breathing monitor for a patient comprising:
- a support,
- a valve means having two relatively movable valve parts;
- a body belt adapted to partly surround the patient's chest;
- means connecting one end of the belt to one valve part and means for connecting the other end of the belt to said support;
- said valve parts moving relatively to each other in response to the inhalation and exhalation motions of the chest;
- a source of pressure fluid connected to the valve means;
- pressure fluid operated alarm means including two alarm devices, each connected to said valve means by a separate conduit means, one alarm responding to abnormal inhalation motion and the other to abnormal exhalation motion;
- conduit means connecting said alarm means to said valve means to receive pressure fluid therefrom for operation of said alarm device;
- delay means connected to said conduit means to control the time interval wherein the pressure fluid effects the activation of the alarm means; and,
- said relatively movable valve parts controlling the flow from said pressure fluid source to said conduit means in response to the inhalation and exhalation motions of the chest.

2. The breathing monitor as claimed in claim 1 wherein one valve part is mounted on a support resting on the chest with one belt end connected to the support and the other belt end connected to the other valve part.

3. The breathing monitor as claimed in claim 2 wherein the movable valve parts comprise two nested outer and inner parts, with the source of pressure fluid and the conduit means connected to the other valve part.

4. The breathing monitor as claimed in claim 3 wherein the outer part comprises a tubular member secured to said support and having three spaced ports, one connected to the source of pressure fluid and the others to the conduit means, and wherein the inner part carries means to interconnect the pressure fluid source to either of said ports.

5. The breathing monitor as claimed in claim 4 wherein spring means are provided to act on the inner part to bias it to a desired position to interconnect the pressure fluid source to a port.

6. The breathing monitor as claimed in claim 4 wherein the delay means comprises a vent to permit a portion of the pressure fluid flowing to the alarm device to escape.

7. The breathing monitor as claimed in claim 6 wherein an adjustable throttle valve controls the flow through the vent.

8. The breathing monitor as claimed in claim 4 wherein the delay means comprised a fixed volume

tank with a throttle valve controlling the flow and quantity of fluid within the tank.

9. The breathing monitor as claimed in claim 5 wherein the delay means comprises a fixed volume tank connected to the conduit means, a vent connected to the tank, an adjustable throttlevalve to control the flow through the vent and a conduit connecting said tank to said alarm device.

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