June 2, 1953 H. SEELER 2,640,479

RESUSCITATOR USING AN AUXILIARY GAS CONSERVING VALVE

Filed Jan. 3, 1952

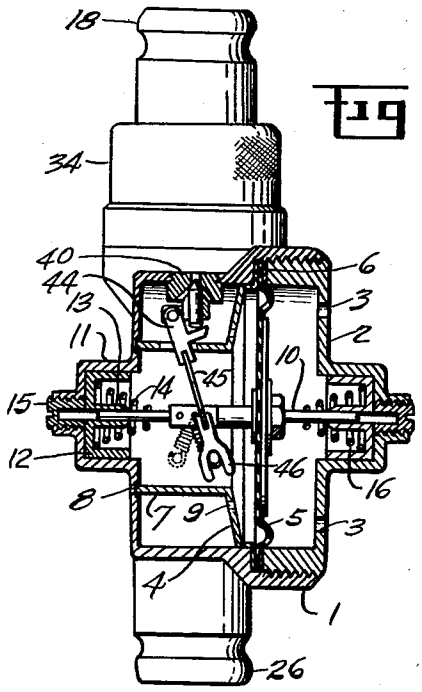


Fig 1

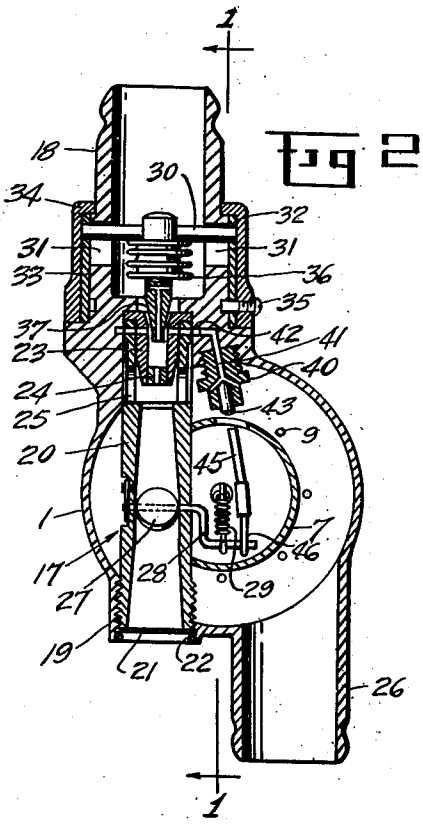


Fig 2

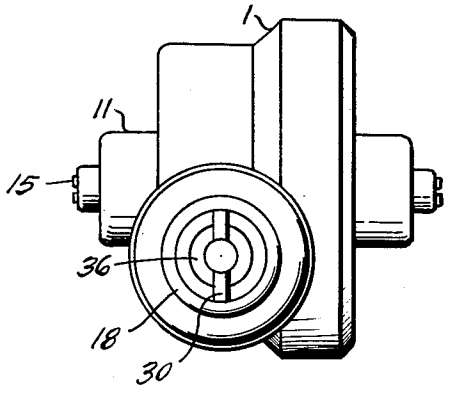


Fig 3

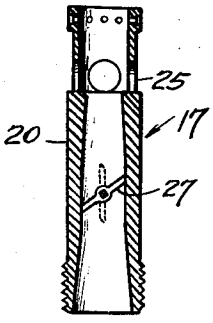


Fig 4

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RESUSCITATOR USING AN AUXILIARY GAS CONSERVING VALVE

Henry Seeler, Dayton, Ohio

Application January 3, 1952, Serial No. 264,825

7 Claims. (Cl. 128—29)

(Granted under Title 35, U. S. Code (1952), sec. 266)

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The invention described herein may be manufactured and used by or for the United States Government for governmental purposes without payment to me of any royalty thereon.

The present invention relates to a resuscitator and relates particularly to improvements over a resuscitator disclosed in my copending application Serial No. 212,818 filed on February 26, 1951, now Patent No. 2,581,450, reissued as Re. 23,496.

The primary object of the invention is to provide a resuscitator of the kind which includes an aspirator into which flows a gas under pressure suitable for use in resuscitating human patients and wherein a crank actuated butterfly valve within the aspirator is automatically moved from an open position to a closed position and vice versa by the action of a pressure responsive means coupled to an overcenter spring means associated with the crank actuated valve and wherein an auxiliary gas valve supplying gas directly into the resuscitator is coupled to the crank actuated valve in such a manner as to open the auxiliary gas valve when the butterfly valve is closed and vice versa, whereby the butterfly valve when open allows gas to flow through the aspirator to produce a suction effect in the resuscitator and when closed causes gas to flow laterally from the aspirator to produce a pressure in the resuscitator in combination with a supplemental supply of gas from the auxiliary gas valve.

A further object of the invention is to provide a resuscitator including a gas inlet valve for regulating the flow rate into the resuscitator wherein the valve is automatically actuated by an aneroid bellows in a manner to reduce the gas flow as the altitude increases, whereby at high altitude the rate of flow into the resuscitator will be reduced and the cycling rate of the resuscitator will be maintained approximately the same as it would be at sea level.

The above and other objects of the invention will become apparent upon reading the following detailed description in conjunction with the accompanying drawing, in which:

Fig. 1 is a cross sectional view of the resuscitator taken on line 1—1 of Fig. 2.

Fig. 2 is a transverse cross sectional view taken through the resuscitator to show the arrangement of the auxiliary gas passage into the resuscitator.

Fig. 3 is a top plan view of the resuscitator.

Fig. 4 is a longitudinal cross section taken through the aspirator portion of the resuscitator.

The present application is a continuation-in-part of my copending application Serial No. 212,818, filed February 26, 1951, now Patent No. 2,581,450, reissued as Re. 23,496, and entitled Resuscitator.

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Referring to Figs. 1 to 4 of the drawing the resuscitator will be described in detail. The main body 1 is of generally cylindrical shape and is closed at one end by a screw threaded cap or cover plate 2 having small openings 3 therein. An annular shoulder within the body provides a seat for a circular wall member 4, a circular diaphragm 5 and a circular gasket 6 in series and these elements are retained by the screw cap 2. The wall member 4 includes a cylindrical extension 7 having its rim edge seated in a shallow groove formed in the body 1 at 8. Outwardly of the extension 7 the wall member 4 is pierced by a series of openings 9. The flexible diaphragm 5 is adapted to actuate a slidable valve actuating rod or stem 10 secured to the diaphragm centrally thereof. The opposite ends of the stem 10 are guided and spring biased by identical structural arrangements which will be described with reference only to the left-hand end thereof. The end wall of the hollow body 1 is formed with a cylindrical boss 11 to slidably receive a cup or thimble 12 having a central sleeve-like extension 13 serving to slidably guide the left-hand end of the stem 10. A spiral coil spring 14 seated in the cup 12 acts to interpose a yieldable force on the stem 10 as it moves to the left. The relative position of the spring 14 in a direction lengthwise of the stem 10 is varied by means of a screw 15 threaded into the boss 11 and bearing at its inner end on the cup 12. The screw 15 is made hollow so as to not interfere with sliding movements of the left-hand end of the stem 10. By varying the relative position of the spring 14 along the stem 10, the resistance to movement of the stem toward the left may be varied accordingly. The compressive effect of the spring 14 determines the minimum negative pressure which obtains in the exhalation phase of the breathing cycle, while the compressive effect of the opposing spring 16 determines the maximum positive pressure applied to the patient during the inhalation phase of the cycle. The spring adjusting screws are manipulated by a screw-driver and after being adjusted to give the desired pressure range the screws are not disturbed. This initial calibration may be accomplished under simulated conditions of use with a manometer installed on the oxygen or air feed line leading to the face mask to determine the actual pressures throughout the resuscitation cycle.

Referring now to Figs. 2 and 4 there is shown

an aspirator assembly 17 which extends through the main body 1 at one side of the central axis or at one side of the slidable stem 10. The aspirator 17 is coaxial with and extends between the gas inlet fitting 18 and a gas outlet or discharge fitting 19. The aspirator includes a tube 20 having a threaded lower end extending into the fitting 19 and having a small screen 21 at the lower end removably secured in place by a snap ring 22. Held in place by the upper end of the aspirator tube 20 is a flanged nozzle element 23 having a flow restricting choke 24 at the gas outlet end directed down the aspirator tube 20. The interior of the tubular member 20 is of flared cross section to provide a diffuser section in the aspirator extending almost to the outlet of nozzle 23. Laterally opening gas ports 25 in the tube 20 adjacent to the outlet of nozzle 23 provide communication to the interior of body 1 and particularly to an annular space between the wall extension 7 and the outer cylindrical wall of the body 1. A gas outlet fitting 26 on the body 1 serves to connect the resuscitator to a face mask or gas supply tube leading to a face mask. A butterfly valve 27 in the tube 20 is rigidly connected to a crank shaft 28 having an offset end portion situated below the stem 10 and connected thereto by an actuating spring 29. The upper end of the spring extends through a flattened central portion of stem 10 and a choice of spring attaching openings may be provided in the stem at closely spaced points. As the stem 10 is shuttled back and forth by action of the diaphragm 5, the spring 29 moves from one side to the other of the axis of rotation of crankshaft 28 thus causing the valve 27 to snap to open or closed position with a sudden movement. When the valve 27 is open the aspirator 17 is effective to pull a vacuum in the aspirator and thus effect the exhalation phase of the breathing cycle. This continues until the lungs of the patient are emptied and then the vacuum effect acts on diaphragm 5 to move the valve 27 to closed position. Now the gas flow from nozzle 23 spills into the aspirator from the ports 25 to start the inhalation phase of the breathing cycle. As the lungs fill up the pressure in the body 1 increases to act on the diaphragm 5 and thereby actuate the valve 27 to the open position again. The frequency of this valve action is determined by the lung capacity and the rate of gas flow through the fitting 26. The rate of flow may be regulated by an adjustable valve now to be described.

The fitting 18 for connection with a source of gas under pressure, such as a cylinder of oxygen or compressed air, has mounted therein a flow regulating valve comprising a transverse rod 30 extending into opposite longitudinal slots 31 in the fitting 18 and also into similar cam slots 32 in the rotatable collar 33. The collar 33 is rotatable by means of an additional flanged collar 34 having a screw 35 extending in radial relation and having the inner end riding in a circular recess. The rod 33 carries a small aneroid bellows 36 having its lower end attached to a tapered valve element 37. The element 37 has a central passage therein opening laterally adjacent to the bellows into the interior of the fitting 18, thus providing a minimal flow even with the valve element 37 in seated position on the nozzle element 23. Ordinarily the setting of the valve element 37 will not be changed after the resuscitator is put in service except by the automatic bellows action. The bellows acts to decrease the flow of gas as the altitude is increased. The reason for providing the flow limiting action is that as the altitude increases the gas has greater expansive power due to the lower barometric pressure. While the gage pressure of the gas supply connected to the inlet fitting 18 is more or less constant, its value is low in relation to sea level barometric pressure. Therefore, the absolute pressure at the nozzle 23 will be reduced appreciably as the altitude increases and consequently the aneroid bellows 36 will tend to expand and throttle the gas flow into the nozzle from fitting 18. This regulation of the rate of flow with changes in altitude is especially desirable in aircraft use and is accomplished without attention by the doctor or aid man. Resuscitation during flight may be necessary not only in everyday high altitude flying but also in air evacuation of sick and wounded patients.

In the present improved resuscitator an auxiliary gas conserving valve is provided to act as an economizer during the time when the butterfly valve 27 is open, that is during the exhalation phase of the breathing cycle. This auxiliary valve includes a valve body 40 having a screw threaded connection with the resuscitator body 1 and having a central passage 41 extending laterally at one end into the hollow resuscitator body and extending at the other end to an annular groove 42 connecting by small radial openings into the interior of nozzle 23. A slidable valve element 43 in the valve body 40 has a tapered seating end portion and a rounded end for actuation by a bellcrank 44 pivoted on the valve body 40. A flexible strip 45 connects the bellcrank 44 to a fork 46 fitting around the offset end of crankshaft 28. By this arrangement the crankshaft 28 is adapted to actuate the valve 27 in the aspirator and also the auxiliary valve 40, 43. The arrangement is such that the valve 27 is open when the valve 40, 43 is closed and vice versa. With the valve 27 open the aspirator 17 acts to draw a vacuum in the resuscitator and thereby slowly evacuate the patient's lungs to perform the exhalation phase of the breathing cycle. At this time the auxiliary valve 40, 43 is closed. Since there will be a minimum gas flow into the aspirator at this time, the gas will thus be conserved and in any case the degree of negative pressure developed toward the end of the exhalation phase should not be large according to most physiologists. In fact some resuscitators never work at negative pressures during the exhalation phases. With the valve 27 closed the gas flowing into the aspirator 17 spills from the ports 25 and flows through the resuscitator into the outlet fitting 26. At the same time the auxiliary gas valve 40, 43 is open and additional gas flows into the resuscitator and thence to the fitting 26. Thus, there will be ample gas flow for producing positive pressure and filling the patient's lungs during the inhalation phase of the breathing cycle. The result of this construction, as well as the aneroid controlled inlet valve, will be a conservation of the available oxygen or other resuscitation medium.

The embodiment of the invention herein shown and described is to be regarded as illustrative only and it is to be understood that the invention is susceptible of variations, modifications and changes within the scope of the appended claims.

I claim:

1. A resuscitator comprising, a housing defining a gas receiving chamber, means providing

a gas inlet into said housing, means providing a gas outlet from said housing into the ambient atmosphere, means providing a fitting on a wall of said housing connecting with said chamber and adapted for connection with a face mask, an aspirator extending across said housing from said gas inlet to said gas outlet and including spill ports opening laterally from the aspirator into said gas receiving chamber, a movably mounted valve in said aspirator downstream from said ports, a valve operating means in said housing responsive to changes in pressure therein during inhalation and exhalation phases of the breathing cycle to actuate said valve from closed to open position and vice versa by the action of rising and falling pressure in said chamber, an auxiliary gas valve means connected between said gas inlet and said chamber, and means connecting said auxiliary gas valve means with said valve operating means to open the latter valve means when the valve in the aspirator is closed and vice versa.

2. A resuscitator comprising, a housing defining a gas receiving chamber, means providing a gas inlet into said housing, means providing a gas outlet from said housing into the ambient atmosphere, means providing a fitting on a wall of said housing connecting with said chamber and adapted for connection with a face mask, an aspirator extending across said housing from said gas inlet to said gas outlet and including spill ports opening laterally from the aspirator into said gas receiving chamber, a first movably mounted valve in said aspirator downstream from said ports, a valve body connected between said gas inlet and said gas receiving chamber, a second movably mounted valve in said valve body, and valve operating means in said housing responsive to changes in pressure therein during inhalation and exhalation phases of the breathing cycle to open the first valve and close the second valve and vice versa as the pressure in said chamber rises and falls.

3. A resuscitator comprising, a housing defining a gas receiving chamber, means providing a gas inlet into said housing, means providing a gas outlet from said housing into the ambient atmosphere, means providing a fitting on a wall of said housing connecting with said chamber and adapted for connection with a face mask, an aspirator extending across said housing from said gas inlet to said gas outlet and including spill ports opening laterally from the aspirator into said gas receiving chamber, a first movably mounted valve in said aspirator downstream from said ports, a valve body connected between said gas inlet and said gas receiving chamber, a second movably mounted valve in said valve body, valve operating means in said housing responsive to changes in pressure therein during inhalation and exhalation phases of the breathing cycle to open the first valve and close the second valve and vice versa as the pressure in said chamber rises and falls, and two separate adjustable biasing means acting in opposition on said valve operating means to determine maximum and minimum pressures in said chamber during said inhalation and exhalation phases of the breathing cycle.

4. A resuscitator comprising, a housing defining a gas receiving chamber, means providing a gas inlet into said housing, means providing a gas outlet from said housing into the ambient atmosphere, means providing a fitting on a wall of said housing connecting with said chamber and adapted for connection with a face mask, an aspirator extending across said housing from said gas inlet to said gas outlet and including spill ports opening laterally from the aspirator into said gas receiving chamber, a movably mounted valve in said aspirator downstream from said ports, a valve operating means in said housing responsive to changes in pressure therein during inhalation and exhalation phases of the breathing cycle to actuate said valve from closed to open position and vice versa by the action of rising and falling pressure in said chamber, an auxiliary gas valve means connected between said gas inlet and said chamber, means connecting said auxiliary gas valve means with said valve operating means to open the latter valve means when the valve in the aspirator is closed and vice versa, and an aneroid controlled valve means in said gas inlet to reduce the gas flow therethrough as the ambient atmospheric pressure is reduced.

5. A resuscitator comprising, a housing defining a gas receiving chamber, means providing a gas inlet into said housing, means providing a gas outlet from said housing into the ambient atmosphere, means providing a fitting on a wall of said housing connecting with said chamber and adapted for connection with a face mask, an aspirator extending across said housing from said gas inlet to said gas outlet and including spill ports opening laterally from the aspirator into said gas receiving chamber, a movably mounted valve in said aspirator downstream from said ports, a valve operating means in said housing responsive to changes in pressure therein during inhalation and exhalation phases of the breathing cycle to actuate said valve from closed to open position and vice versa by the action of rising and falling pressure in said chamber, an aneroid bellows in said gas inlet having one end retained in relatively fixed position, and a movable valve member attached to the other end of said aneroid bellows and adapted to cooperate with an associated valve seat to reduce the area of cross section available for gas flow as the ambient atmospheric pressure is reduced.

6. A resuscitator comprising, a housing defining a gas receiving chamber, means providing a gas inlet into said housing, means providing a gas outlet from said housing into the ambient atmosphere, means providing a fitting on a wall of said housing connecting with said chamber and adapted for connection with a face mask, tubular means extending from said gas inlet to said gas outlet and including a movable valve element to allow gas flow alternately through said tubular means or laterally therefrom into said chamber, a valve operating means in said housing responsive to changes in pressure therein during inhalation and exhalation phases of the breathing cycle to actuate said valve element from one of its operative positions to the other and vice versa by the action of rising and falling pressure in said chamber, an aneroid bellows in said gas inlet having one end retained in relatively fixed position, and a movable valve member attached to the other end of said aneroid bellows and adapted to cooperate with an associated valve seat to reduce the area of cross section available for gas flow as the ambient atmospheric pressure is reduced.

7. A resuscitator comprising, a housing defining a gas receiving chamber, means providing a gas inlet into said housing, means providing a

gas outlet from said housing into the ambient atmosphere, means providing a fitting on a wall of said housing connecting with said chamber and adapted for connection with a face mask, an aspirator extending across said housing from said gas inlet to said gas outlet and including spill ports opening laterally from the aspirator into said gas receiving chamber, a first movably mounted valve in said aspirator downstream from said ports, a valve body connected between said gas inlet and said gas receiving chamber, a second movably mounted valve in said valve body, valve operating means in said housing having connections to said first movably mounted valve and to said second movably mounted valve and related thereto so as to close one valve upon

opening the other valve and vice versa, a slidably mounted rod in said housing, means responsive to changes in pressure in said chamber for moving said rod in opposite directions as the pressure in said chamber rises and falls, and resilient means connected between said valve operating means and said rod to actuate said first valve from closed to open position and vice versa and to actuate said second valve from open to closed position and vice versa as said rod is moved in opposite directions by the action of rising and falling pressure in said chamber.

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No references cited.