Feb. 28, 1956 H. SEELER 2,736,331

RESUSCITATOR

Filed April 1, 1952

Fig. 1

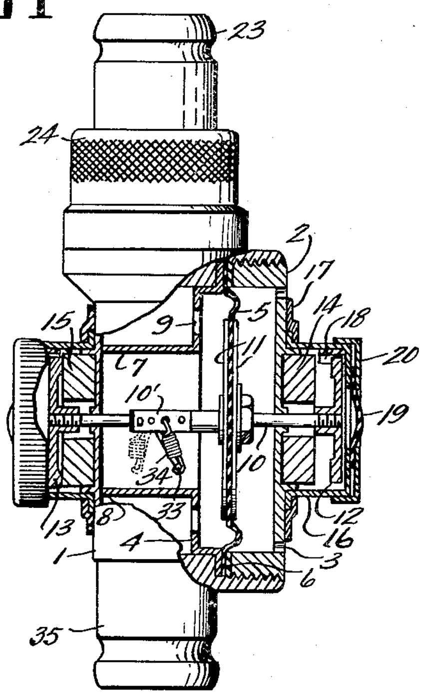


Fig. 2

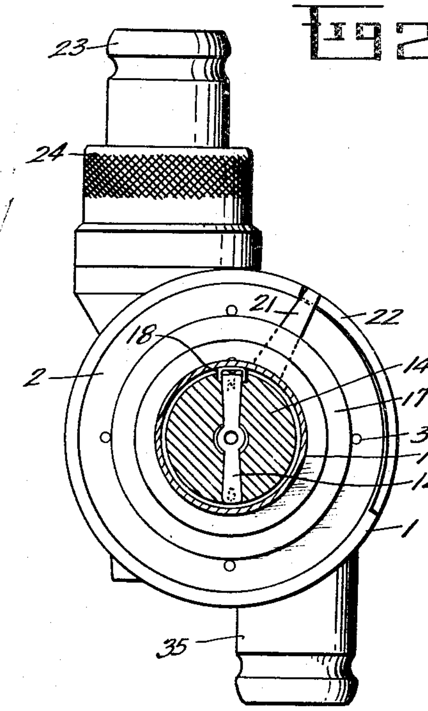


Fig. 3

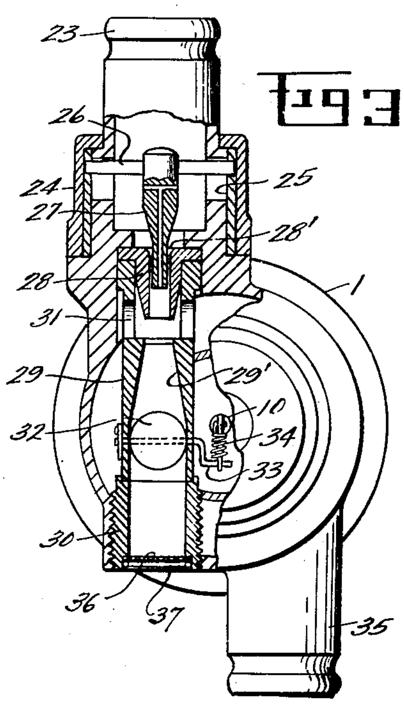
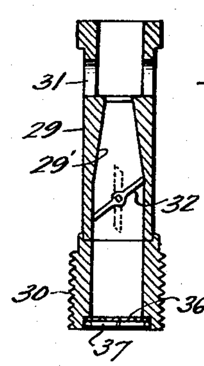


Fig. 4



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RESUSCITATOR

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7 Claims. (Cl. 137—63)

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

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 having novel means for adjusting the inhalation and exhalation pressures.

The principal object of the invention is to provide a resuscitator including an aspirator into which flows a gas under pressure suitable for use in resuscitating human patients and wherein a butterfly valve within the aspirator is actuated to open and closed positions by an overcenter spring means and by a pressure actuated means associated with a slidable rod and wherein a separate yieldable force producing means at opposite ends of the slidable rod includes a permanent magnet and armature capable of relative rotation to vary the attractive force between the magnet and armature.

A further object of the invention is to provide a resuscitator of the kind which includes an aspirator or Venturi tube in which flows a gas under pressure suitable for use in resuscitating human patients, wherein a butterfly valve in the aspirator downstream from a lateral opening therein is rigidly connected to a simple crank operating means, wherein a coil spring connected to the crank operating means is actuated by a slidably mounted rod fixed to a diaphragm, wherein adjustable magnetic force producing means are provided at opposite ends of the slidably mounted diaphragm-actuated rod and wherein a gas flow channel in the resuscitator is in communication with the lateral opening in the aspirator, with a tube leading to a face mask and with one side of the rod-actuating diaphragm, whereby the butterfly valve when brought to open position by the diaphragm and slidably mounted rod, acting through the coil spring and crank operating means, functions to produce the exhalation phase of the resuscitation cycle and when brought to closed position functions to produce the inhalation phase of the resuscitation cycle.

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 side elevation view partly in cross section of the present resuscitator.

Fig. 2 is a front elevation view partly in cross section of the present resuscitator.

Fig. 3 is a rear elevation view partly in cross section of the present resuscitator.

Fig. 4 is a longitudinal cross section taken through the aspirator and associated control valve.

Referring to 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 against a flat end wall of the body 1, as at 8. Outwardly of the extension 7 the wall member 4 is pierced by a series of openings 9. An actuating rod 10 centrally of the housing 1 is slidably guided by means of openings in the housing wall and in the end cap or cover 2. The rod 10 is rigidly fixed to a pair of diaphragm supporting plates or disks 11. At opposite ends of the rod 10 are similar bar-like armatures 12 and 13 of soft iron in threaded engagement with the rod. These armatures are free to turn on the ends of rod 10 so that their relative positions with respect to a pair of circular permanent magnets 14 and 15 may be varied to provide a biasing means. The magnets, which each have a central passage therethrough, are press fitted into a circular recess in the housing 1 and in the threaded cap 2. Each magnet is of Alnico and is magnetized in a bi-polar pattern as indicated by the letters N and S in Fig. 2. Thus the armature 12 in Fig. 2 is in a position for maximum attraction toward the magnet and therefore a maximum force would be required to move the armature away from the magnet when it is contacted therewith. However any rotation of the armature 12 away from the position shown in Fig. 2 will diminish the attractive force between the armature and magnet and if there is a 90° relation between the armature and the opposite magnetic poles the force will be very little if any at all. The magnetic effect in the magnet fans out slightly from the exact bi-polar pattern, so that the magnetic force between the armature and magnet merely diminishes as the armature is rotated from the maximum force position illustrated. Exact calibration of the force producing arrangement is accomplished experimentally, since there are many variables in any design. For instance the relative width of the armature is critical because the armature is influenced very markedly as long as any of the metal thereof is close to the bi-polar axis extending from the letter N to the letter S.

The construction at opposite sides of the housing is similar and only that at the right of Fig. 1 will be described in detail. The magnet 14 and armature 12 are housed in a flanged cylinder 16 rotatably mounted on the housing 1 by means of a ring bearing 17 rigidly connected to the housing 1. Mounted in the cylinder 16 is a small U-shaped bracket 18 which fits over one end of the armature 12, so that rotation of the cylinder 16 causes rotation of the armature 12. An aperture in the outer end of the flanged cylinder 16 is closed by a thin rubber disk 19 held in place by an apertured cap 20 which is knurled on the outer cylindrical surface. Rotation of the cylinder 16 and armature 12 is accomplished by grasping the knurled cap 20 and turning in one direction or the other. The purpose of the rubber disk 19 is to permit finger operation of the push rod 10 in case of failure of the rod actuating means or in case of sticking of the parts. With one hand an operator may span the resuscitator and exert alternate force on the opposite ends of the push rod to cycle the rod back and forth at a prescribed breathing rate. In order to indicate the exact relative position of the armature 12, a pointer 21 is fixed on the cylinder 16 and extends out through a thin recess in the bearing ring 17 to indicate on a quadrant 22 the angular position of the armature 12 with reference to the bi-polar axis N-S.

A supply of oxygen or compressed air at about +10 inches of water (gage pressure) enters the resuscitator at the tubular fitting 23, having a rotatable sleeve 24 mounted thereon. An inner sleeve 25 which rotates with the sleeve 24 includes opposite cam slots into which the opposite ends of the crosspin 26 extend (see Fig. 3). A tapered valve element **27** fixed on pin **26** has a T-shaped passage therein to permit a minimum flow of gas even when the valve element 27 is fully seated on the beveled valve seat **28'** of the nozzle **28**. The latter is flanged outwardly for retention in the housing **1** by means of an aspirator tube **29**. The tube is in turn held in place by a threaded tube member **30**. The aspirator includes the usual Venturi formation **29'** therein and also a plurality of spill ports **31** upstream from the Venturi formation. Downstream from the Venturi formation **29'** is a butterfly valve or cycling valve **32** mounted for rotation on one end of a crank **33**. The other or offset end of the crank has a tension spring **34** hooked thereover and the spring extends through a suitable opening in a flattened portion **10'** on the push rod **10**. An outlet connection **35** on the housing **1** is used to connect the resuscitator to a suitable face mask (not shown). It is further noted that the outer end of tube **30** is open to the atmosphere but may be covered by a small circular screen **36** retained in place by a snap ring **37**.

The operation of the resuscitator will be explained by reference to Figs. 1 to 4. Noting Fig. 1 first it will be seen that the valve actuating diaphragm **5** is shown in the extreme right-hand position of displacement with the left-hand armature **13** contacting the permanent magnet **15**. The butterfly valve **32** is now open and the aspirator is acting to produce suction within the resuscitator and in the fitting **35**. This suction effect continues until the patient's lungs are substantially empty of air and gaseous products of respiration. The pressure on the left-hand side of the diaphragm now goes below atmosphere and atmospheric pressure acting on the right-hand side of the diaphragm finally pushes the diaphragm to the left as the armature **13** is pushed free of the magnet **15**. The force that will be required to free the armature from the magnet will depend on the relative rotative position of the armature with respect to the N-S polar axis of the magnet. Therefore the degree of negative pressure which will develop during the exhalation phase of the resuscitation cycle will depend on the rotative setting of the armature **13**. Also it should be noted that once the armature is pushed free of the magnet the attractive force declines rapidly. Thus the rod **10** moves suddenly and causes a decisive action of the crank **33** and overcenter spring **34**, so that the butterfly valve **32** rapidly rotates to a new position.

Assuming now that the valve **32** has snapped to the closed position (Fig. 4), with the crank **33** and spring **34** in the dotted line position of Fig. 1, oxygen flow is now possible only through the spill ports **31** and into the resuscitator housing. This oxygen flow now reaches the patient's lungs by way of the fitting **35** and a suitable conduit. The armature **12** will now be in contact with the magnet **14** and will be retained thereon by a force dependent on the position of the armature with respect to the N-S polar axis of the magnet. As the oxygen fills up the patient's lungs, the pressure in the resuscitator increases rapidly to thus increase the pressure on the left-hand side of diaphragm **5** above atmosphere. When the differential force thereon exceeds the holding force of the magnet **14** on the armature **12**, the armature is suddenly pushed free of the magnet. The degree of positive pressure which develops during the inhalation phase will depend on the rotative adjustment of the armature **12** with respect to the magnet **14**. The armature **12** being pushed free of the magnet **14**, the rod **10** moves to the right causing spring **34** to move to the right past the axis of rotation of the crank **33** and valve **32**. The spring now causes the valve **32** to snap to open position again to start another exhalation phase of the resuscitation cycle.

The cycling rate of the resuscitator will depend on the rate of oxygen flow into the aspirator by way of the fitting **23**, since filling of the lungs will depend on the flow of oxygen out through the spill ports **31** into the resuscitator housing **1**. Emptying of the lungs being accomplished by suction developed by the aspirator, the rate of emptying will depend on the rate of flow of oxygen through the aspirator. Thus it will be seen that the cycling rate of the resuscitator will be dependent on the setting of the flow control valve **27** reciprocably mounted in the fitting **23**. Even with the valve element **27** fully seated on the valve seat **28'**, a bare minimum flow can take place through the T-shaped passage in element **27**.

The present application embodies improvements over the resuscitator disclosed in my U. S. Patent No. 2,581,450 of January 8, 1952.

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, valve operating means connected to said valve and extending outside of said aspirator, a reciprocably mounted means in said housing, means responsive to changes in pressure in said chamber for moving said reciprocably mounted means in opposite directions as the pressure in said chamber rises and falls, means connected between said valve operating means and said reciprocably mounted means to actuate said valve from closed to open position and vice versa as said reciprocably mounted means is moved in opposite directions by the action of rising and falling pressure in said chamber, separate adjustable biasing means acting in opposition on said reciprocably mounted means for biasing the latter means in opposite directions, and each of said biasing means including a magnet and an armature adjacent thereto, each of said magnets having opposed magnetic poles on opposite sides of the reciprocably mounted means providing a polar axis transverse to the reciprocably mounted means, said magnet and said armature being rotatably adjustable with respect to each other between a position wherein the armature lies in a plane parallel to the plane of the polar axis to produce a maximum holding force of the magnet on the armature to a position wherein the armature lies in a plane perpendicular to the plane of the polar axis to produce a minimum holding force of the magnet on the armature.

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 movably mounted valve in said aspirator downstream from said ports, valve operating means connected to said valve and extending outside of said aspirator, 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, spring means connected between said valve operating means and said rod to actuate said valve from closed to open position and vice versa as said rod is moved in opposite directions by the action of rising and falling pressure in said chamber, separate adjustable biasing means at opposite ends of said rod for biasing

said rod in opposite directions, and each of said biasing means including a magnet and an armature adjacent thereto, each of said magnets having opposed magnetic poles on opposite sides of the rod providing a polar axis transverse to the rod, said magnet and said armature being rotatably adjustable with respect to each other between a position wherein the armature lies in a plane parallel to the plane of the polar axis to produce a maximum holding force of the magnet on the armature to a position wherein the armature lies in a plane perpendicular to the plane of the polar axis to produce a minimum holding force of the magnet on the armature.

3. In a resuscitator, a cycling valve, means to actuate said valve from open to closed position and vice versa including a slidably mounted element, separate adjustable biasing means acting in opposition on said slidably mounted element and associated therewith for biasing said element in opposite directions, and each of said biasing means including a magnet and an armature adjacent thereto, each of said magnets having opposed magnetic poles on opposite sides of the element providing a polar axis transverse to the element, said magnet and said armature being rotatably adjustable with respect to each other between a position wherein the armature lies in a plane parallel to the plane of the polar axis to produce a maximum holding force of the magnet on the armature to a position wherein the armature lies in a plane perpendicular to the plane of the polar axis to produce a minimum holding force of the magnet on the armature.

4. In a resuscitator, a cycling valve, means to actuate said valve from open to closed position and vice versa including a slidably mounted rod, an armature rotatably mounted on each end of said rod, a magnet adjacent to each of said armatures and alternately contacted by the respective armatures as said rod is moved back and forth to accomplish the movement of said cycling valve each of said magnets having opposed magnetic poles on opposite sides of the rod providing a polar axis transverse to the rod, each of said armatures being rotatable with respect to its respective magnet between a position wherein the armature lies in a plane parallel to the plane of the polar axis to produce a maximum holding force of the magnet on the armature to a position wherein the armature lies in a plane perpendicular to the plane of the polar axis to produce a minimum holding force of the magnet on the armature.

5. In a resuscitator, a housing having a pair of opposite parallel walls, a slidably mounted rod extending through said pair of walls, actuating means inside said housing and connected to said rod for actuation of a resuscitation cycling valve, an armature on each end of

said rod outside of said pair of walls, a magnet adjacent to each of said armatures and alternately contacted by the respective armature as said rod is moved back and forth to accomplish movement of said cycling valve, each of said magnets having opposed magnetic poles on opposite sides of the rod providing a polar axis transverse to the rod, and each of said armatures being relatively rotatable with respect to its respective magnet between a position wherein the armature lies in a plane parallel to the plane of the polar axis to produce a maximum holding force of the magnet on the armature to a position wherein the armature lies in a plane perpendicular to the plane of the polar axis to produce a minimum holding force of the magnet on the armature.

6. In a resuscitator, a slidable valve actuating rod, actuating means for said rod, an iron armature rotatably mounted on said rod, a permanent magnet adjacent to said armature and surrounding said rod, said magnet having opposed magnetic poles on opposite sides of the rod providing a polar axis transverse to the rod, and said armature being relatively rotatable between a position wherein the armature lies in a plane parallel to the plane of the polar axis to produce a maximum holding force of the magnet on the armature to a position wherein the armature lies in a plane perpendicular to the plane of the polar axis to produce a minimum holding force of the magnet on the armature.

7. In a device of the class described, a slidably mounted rod, control means operable to move said rod, an armature rotatably mounted on each end of said rod, a pair of ring shaped magnets encircling said rod and located closer to each other than said armatures so as to be alternately contacted by the respective armatures as said rod is moved back and forth, each of said magnets having opposed magnetic poles on opposite sides of the rod providing a polar axis transverse to the rod, each of said armatures being rotatable with respect to its respective magnet between a position wherein the armature lies in a plane parallel to the plane of the polar axis to produce a maximum holding force to a position wherein the armature lies in a plane perpendicular to the plane of the polar axis to produce a minimum holding force of the magnet on the armature.

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