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A Non-return Valve for Continuous Use with the Emerson Postoperative Ventilator

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To assess clinical status and to help determine ventilatory requirements of patients receiving prolonged ventilation, it is necessary to know the tidal volumes given and the ratio of physiologic deadspace-to-tidal volume.

Compressible ventilator volume¹ becomes important with small tidal volumes and high pressures where the error introduced becomes relatively large in the measurement of ventilatory volumes and the physiologic deadspace-to-tidal volume ratio. To correct for this, nomograms² and a correction factor² have been proposed, but these only correct for the volume error. Haddad and Richards² also proposed a modification to eliminate having to correct the measured results. We have constructed a system to be used continuously with the Emerson † Postoperative Ventilator, which acts as: (1) a non-return valve system; (2) an eliminator of compressible volume; (3) a "safety" inlet if a spontaneous inspiratory effort is made out of phase with the ventilator.

CONSTRUCTION

Components used are standard parts which can be modified with ease. In addition, two

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§ Ohio Chemical Company, Madison, Wisconsin.

¶ Air Shields, Hatboro, Pennsylvania.

• Bird Corporation, Palm Springs, California.

brass adaptors have to be made. Commercial components are: (1) Hope § Resuscitator Valve Assembly [X 2] (217-5591-801); (2) Air Shields ¶ Exhalation Valve (24 600 70); (3) Bird • Mantle (993 895); (4) Bird • Mask Adaptor (993 957).

The section of the body of the Hope valves carrying the intake to the bag is cut off, giving two right-angled fittings. The cap assemblies are then modified by turning one down externally on a lathe, the other being turned internally to make a tight, permanent, press fit, aligning the holes in the cap through which exhalation normally occurs. Both of the cylindrical skirts of the caps are then shortened a quarter of an inch (fig. 1). (The second skirt is shortened solely to produce a symmetrical system which can be assembled easily.)

The cap assemblies are screwed into the bodies. One of the side arms is plugged by the Bird Mantle, the other being connected to the Air Shields valve by an easily-made brass sleeve. Another brass fitting is made to connect the valve body, to which the Air Shields valve is attached, to the tubing from the ventilator (fig. 2). The shortened skirt facing away from the ventilator allows spontaneous respiration (from the atmosphere) if the patient breathes out of phase with the ventilator. The ventilator then has to be modified by removing all the one-way valves from the piston to the patient-tube connection. The entry valve immediately behind the front panel on the inspiratory limb must be blocked off.

To pressurize the Air Shields Valve, the normal Emerson valve pressurizing tube is removed and the Bird Mask Adaptor fitted onto

the outlet. A 15-mm. adaptor to an endotracheal tube is used to take the line from there to the Air Shields valve.

The deep breath can be retained, but the entry tube from the deep breath MUST remain connected at all times or else air will be taken into the piston, lowering the predicted oxygen concentration.³ If the deep-breath feature is removed, the one-way valve for it must be blocked off.

The valve opens when the pressure difference across it is 2.5 cm. H₂O and has a flow resistance of 3.5 cm. H₂O/l/second at a flow rate of 1.25 liter per second. The pressure requirement of 2.5 cm. H₂O for opening the

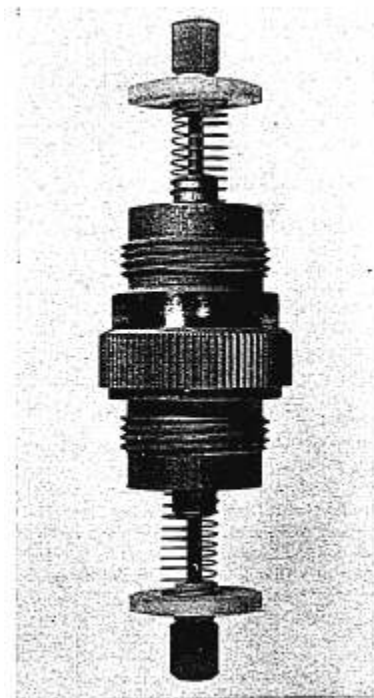


FIG. 1. Modified cap assembly, showing shortened skirts and press-fitted central section.

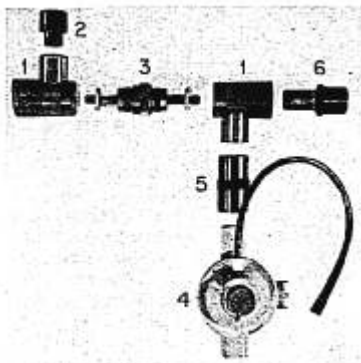


FIG. 2. Exploded view, showing: 1. Shortened valve bodies. 2. Mantle (to plug side-arm). 3. Modified cap assemblies (see also fig. 1). 4. Air Shields exhalation valve. (Attached tubing is not of full length nor is the connection for pressurization shown.) 5, 6. Brass adaptors. (5 fits over side arm of shortened valve body and over inlet arm of exhalation valve. 6 fits into the shortened valve body taking the corrugated tubing from the ventilator on the other end.)

valve serves two purposes: (1) Ensures pressurization of the exhalation valve before inspiratory flow commences; (2) Prevents flow from the compressible volume by delaying the commencement of exhalation until the pressure in the cylinder and tubing is lowered during the filling stroke of the piston.

With pneumotachographic measurement, there is no flow from the compressible volume and no retrograde flow during the filling stroke. One minor problem in the use of the valve is condensation in the small-diameter tubing used to pressurize the Air Shields valve which requires occasional emptying (8 to 12 hours). Clear plastic tubing should be used.

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