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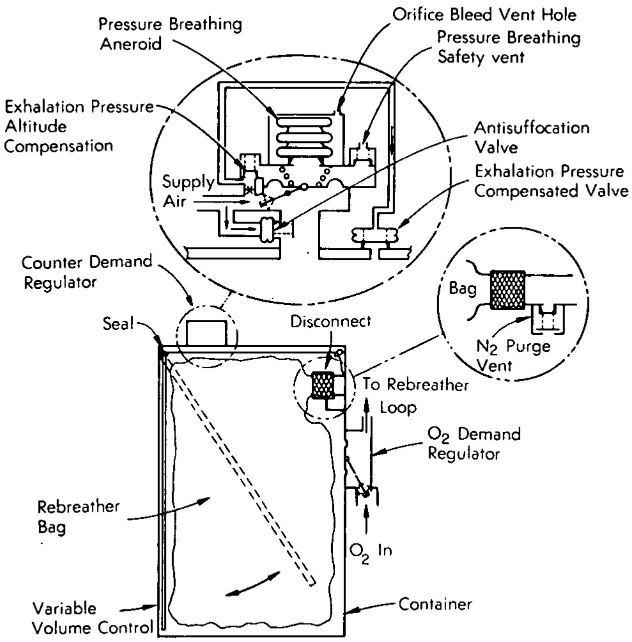
Counter Lung

In a closed-loop rebreathing system, it is necessary to maintain the loop pressure relatively constant as the pilot inhales and exhales. A counter-lung is incorporated in a closed rebreather loop to accommodate a user's breathing tidal volume so that the loop pressure is relatively constant during breathing cycles.



The counter-lung is a flexible bag within a rigid container. The inside of the bag is connected to the breathing loop; the outside is pressurized with air at about one inch of water pressure above cabin pressure to prevent cabin air from leaking into the system. At altitudes where the rebreathing loop must be operated at pressures over ambient, the counter-lung is pressurized to the standard breathing schedule starting at 11.6 km cabin altitude.

The counter-lung pressure control regulator supplies gas pressure to the outside of the bag from an available aircraft source during the inhalation portion of the breathing cycle; the pressure is controlled according to a prescribed pressure schedule by an aneroid control. A pressure-compensated valve allows venting of air from the pressurized container during exhalation in order to maintain a fixed operating pressure.

Loss of air supply pressure to the demand regulator of the counter-lung would result in the lack of control of counter pressure on the outside of the bags; this would cause the counter-lung to be virtually inoperative, and the oxygen demand regulator would then be forced to supply the full tidal volume needs of each breathing cycle with the pilot's exhalation escaping from around the mask. If the demand regulator fails to operate, because of loss of air supply pressure, the anti-suffocation valve shown in the diagram permits exposure of the outside of the bag to ambient pressure and thus provides normal breathing action without benefit of pressurized breathing conditions. The anti-suffocation valve is spring-loaded so that it is normally open, but a diaphragm at the back of the valve is referenced to the inlet air supply pressure and this forces the valve into the closed position as long as normal supply pressure is available. When the pressure falls below a selected value, the valve opens and restores ambient pressure into the space surrounding the counter-lung.

The demand regulator is so located that its diaphragm is referenced to the counter-lung container

(continued overleaf)

pressure which, in turn, is already altitude compensated. Thus, this method of diaphragm reference eliminates the need for an additional altitude aneroid.

The nitrogen vent shown in the figure is designed to remove nitrogen continuously from the rebreather loop; during operation with 100% oxygen feed, nitrogen may be released from body cavities, liquids, and tissues. The amount of gas vented during each breathing cycle is the difference in volume between the fully-inflated counter-lung and the pilot's tidal volume; thus, each pilot can set the volume control to suit his tidal volume. During each exhalation, the vent valve will open when the bag becomes fully inflated and the loop pressure begins to rise above the air pressure in the container. Conversely, on inhalation, when the rebreather bag becomes fully collapsed and the loop pressure begins to fall below the air pressure, the demand regulator will open to supply oxygen from the electrolysis cell.

Notes:

1. The following documentation may be obtained from:

    National Technical Information Service
    Springfield, Virginia 22151
    Single document price $3.00
    (or microfiche $0.95)

    Reference:
    NASA CR-73396, Aircraft Oxygen System Development, Laboratory Breadboard System Test Report.

2. With few modifications, the counter-lung can be adapted for underwater breathing in a ditched aircraft; no electrical or mechanical power is required.
3. Requests for further information may be directed to:

    Technology Utilization Officer
    Ames Research Center
    Moffett Field, California 94035
    Reference: TSP 72-10219

Patent status:

No patent action is contemplated by NASA.

Source: Andrew D. Babinsky and Raymond J. Kiraly of TRW, Inc./Mechanical Products Division under contract to Ames Research Center (ARC-10248)