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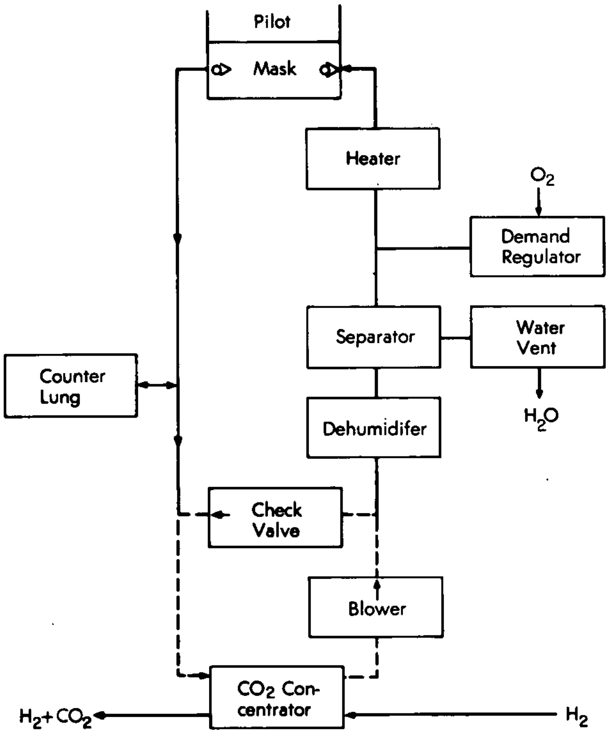
Aircrew Oxygen System

The problem:

To provide breathing oxygen for use in aircraft by a safe, reliable system of low weight and size which also reduces the expense of ground support equipment, such as is required for LOX equipment.



The solution:

A closed-loop rebreather system which includes the pilot. Oxygen generated by water electrolysis is fed into the rebreather loop which provides for nitrogen elimination, water removal, and the removal of carbon dioxide.

How it's done:

The arrangement of the system is shown in the figure. A blower is used to circulate breathing oxygen through the carbon dioxide concentrator which removes the carbon dioxide from the circulating flow and transfers it to the hydrogen stream on the opposite side of the concentrator cell. Parametric testing of single-cell carbon dioxide concentrators has demonstrated good performance independent of oxygen flow rate.

There is a possibility that the blower, check valve, and recirculating loop may not be necessary in the system since it does not appear that the convective transfer of carbon dioxide from the oxygen stream to the electrode is of significant resistance compared to the overall resistance of transfer of carbon dioxide from the oxygen to the hydrogen gas streams in the concentrator. In this event, the system would be simpler, with exhalation flow going directly through the concentrator and back to the pilot.

The pilot's expiration enters the counter-lung which accommodates the pilot's tidal volume during breathing to maintain the loop at constant pressure during the breathing cycle. Inhalation oxygen is drawn from the circulating loop through a heat exchanger used as a dehumidifier; this is required because the flow in the circulating loop will be about 49°C and nearly saturated with water vapor. A separator downstream of the dehumidifier removes the condensed water and directs it to a vent.

Oxygen from the electrolysis cell enters the demand regulator to make up the oxygen consumed by the pilot, the carbon dioxide concentrator, and system venting. Next, the oxygen is heated to a comfortable level for breathing by the pilot; during inhalation,

(continued overleaf)

the counter-lung is collapsed allowing this gas to enter the circulating loop. Check valves in the mask maintain the inspiration and expiration flows in the proper direction. The check valve in the recirculating loop prevents "short circuiting" in the breathing loop.

The system also provides for breathing loop pressure in excess of cabin pressure, as required at cabin altitudes above 38,000 feet (11.6 km). The pressure breathing control will maintain the breathing loop pressure constant at 3 psia (20.7 kN/m^2) at altitudes between 38,000 and 43,000 feet (11.6 and 13.1 km). Above 43,000 feet, loop pressure will remain at 18 inches (4.48 kN/m^2) of water above ambient pressure. At cabin altitudes above 43,000 feet, pressure suits are required, and pressure breathing is accomplished by using air to pressurize the outside of the breathing bag in the counter-lung. The latter pressure is regulated by an aneroid device similar to those employed in currently available pressure-breathing-demand oxygen regulators.

It is necessary to remove the nitrogen from the breathing loop. Nitrogen is released by the human body because of the partial pressure gradients which occur during the breathing of pure oxygen. The breathing loop system accomplishes this by venting a small portion of the pilot's exhaled gases.

Notes:

1. Details of the subsystem components are found in a series of Tech Briefs entitled, "Carbon Dioxide Concentrator," "Water Electrolysis Module," and "Counter Lung."
2. Additional information may be obtained from:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: TSP72-10195

Patent status:

No patent action is contemplated by NASA.

Source: Andrew D. Babinsky, Raymond J. Kiraly, and Richard A. Wynveen of TRW, Inc. under contract to Ames Research Center (ARC-10247)