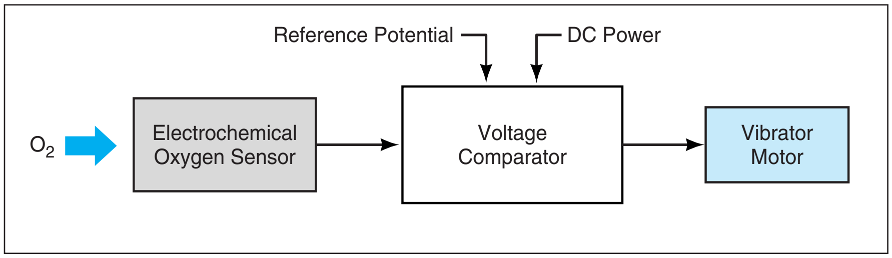
Oxygen-Partial-Pressure Sensor for Aircraft Oxygen Mask

Vibration of the mask against the wearer's nose warns of low oxygen pressure.

Lyndon B. Johnson Space Center, Houston, Texas

A device that generates an alarm when the partial pressure of oxygen decreases to less than a preset level has been developed to help prevent hypoxia in a pilot or other crewmember of a military or other high-performance aircraft. Loss of oxygen partial pressure can be caused by poor fit of the mask or failure of a hose or other component of an oxygen-distribution system. The deleterious physical and mental effects of hypoxia cause the loss of a military aircraft and crew every few years.

The device is installed in the crewmember's oxygen mask and is powered via communication wiring already present in all such oxygen masks. The device (see figure) includes an electrochemical sensor, the output potential of which is proportional to the partial pressure of oxygen. The output of the sensor is amplified and fed to the input of a comparator circuit. A reference potential that corresponds to the amplified sensor output at the alarm oxygen-partial-pressure level is fed to the second input of the comparator. When the sensed partial pressure of oxygen falls below the minimum acceptable level, the output of the comparator goes from the "low" state (a few millivolts) to the "high" state (near the supply potential, which is typically 6.8 V for microphone power).



The **Comparator Triggers the Motor** into operation when the partial pressure of oxygen, measured by the sensor, falls below a preset value represented by the reference potential.

The switching of the comparator output to the high state triggers a tactile alarm in the form of a vibration in the mask, generated by a small 1.3-Vdc pager motor spinning an eccentric mass at a rate between 8,000 and 10,000 rpm. The sensation of the mask vibrating against the crewmember's nose is very effective at alerting the crewmember, who may already be groggy from hypoxia and is immersed in an environment that is saturated with visual cues and sounds. Indeed, the sensation is one of rudeness, but such rudeness could be what is needed to stimulate the crewmember to take corrective action in a life-threatening situation.

The level chosen for triggering the alarm is the partial pressure of oxygen at an altitude of 11,000 ft (≈3.35 km). Because the response time of the electrochemical sensor is about 10 seconds, the device would ordinarily not respond to a sudden but temporary decrease in the partial pressure of oxygen. The device is equipped with a double-pole/double-throw pushbutton switch for turning on the motor temporarily so that the crewmember can verify that the device has power and the vibrations can be felt. When the alarm has been triggered by low oxygen partial pressure, cycling the same pushbutton switch causes the motor to be turned off for a short time (about 30 seconds). There is also a locking power switch that the crewmember can use to turn the device off in the event of a system failure that turns on the vibrator motor.

This work was done by Mark Kelly and Donald Pettit of **Johnson Space Center**. *Further information is contained in a TSP (see page 1).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-23309.

Three-Dimensional Venturi Sensor for Measuring Extreme Winds

Advantageous features include ruggedness, rapid response, and high dynamic range.

John F. Kennedy Space Center, Florida

A three-dimensional (3D) Venturi sensor is being developed as a compact, rugged means of measuring wind vectors having magnitudes of as much as 300 mph (134 m/s). This sensor also incorporates auxiliary sensors for measuring temperature from -40 to +120 °F (-40 to +49 °C), relative humidity from 0 to 100 percent, and atmospheric pressure from 846 to 1,084 millibar (85 to 108 kPa).

Conventional cup-and-vane anemometers are highly susceptible to damage by both high wind forces and debris, due to their moving parts and large profiles. In addition, they exhibit slow recovery times contributing to an inaccurately high average-speed reading. Ultrasonic and hot-wire anemometers overcome some of the disadvantages of the cup-and-vane anemometers, but they have other disadvantageous features, includ-