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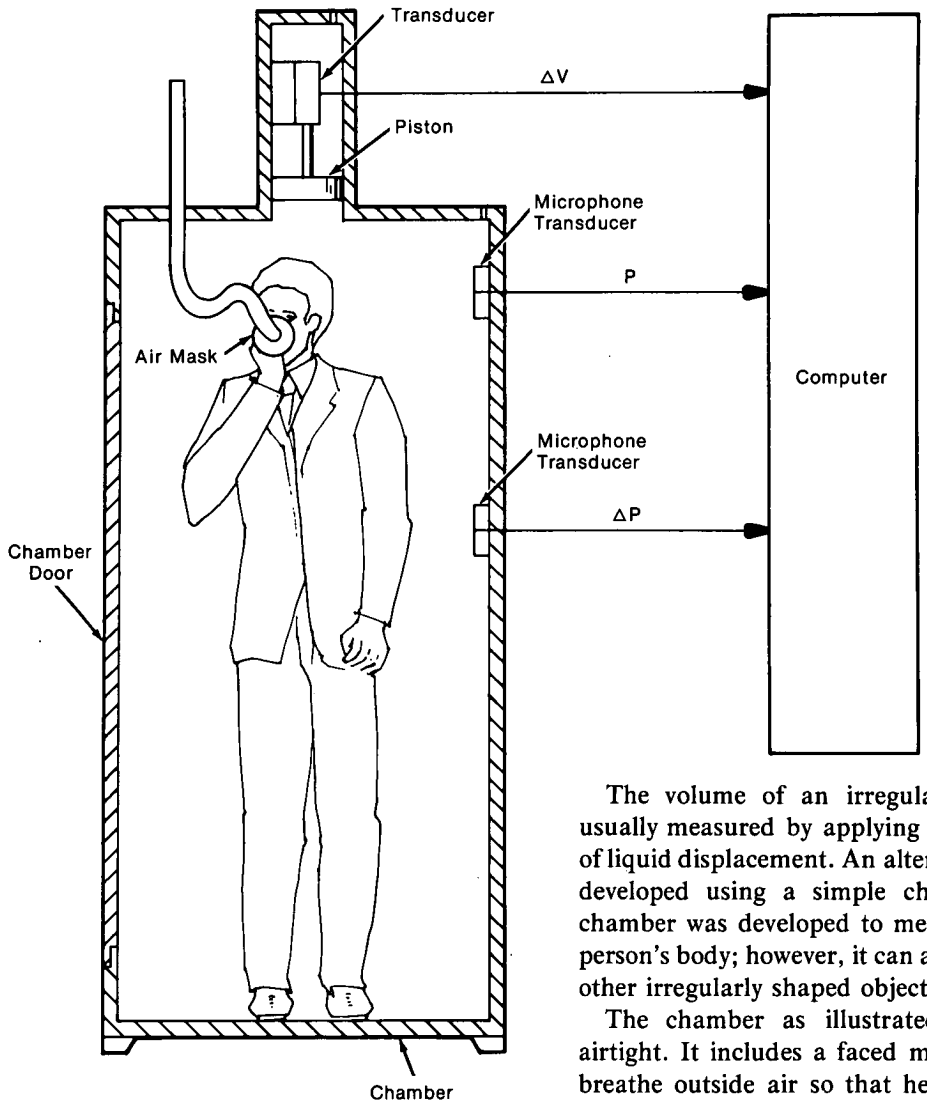
# NASA TECH BRIEF

*Lyndon B. Johnson Space Center*



## Volume Measuring System




Volume Measuring System

The volume of an irregularly shaped object is usually measured by applying Archimedes' principle of liquid displacement. An alternate method has been developed using a simple chamber and air. The chamber was developed to measure the volume of a person's body; however, it can also be used to measure other irregularly shaped objects.

The chamber as illustrated is designed to be airtight. It includes a faced mask for the person to breathe outside air so that he does not disturb the chamber environment. The chamber includes a piston to vary the air volume inside. Also included are two microphone transducers which record the pressure information inside the chamber.

(continued overleaf)

Once the person is inside and the chamber closed, the air volume is reduced by a known amount, $\Delta V$, by the piston. A signal corresponding to $\Delta V$ is fed into a computer. Next, infrasonic signals are introduced into the chamber at some selected frequency in the range between 1 to 100 Hz. These signals are picked up by the microphone transducers which feed the corresponding pressure P and change-in-pressure $\Delta P$ signals into the computer.

The objective is to determine the air volume in the chamber when the person is inside. When this volume is subtracted from the total volume of the chamber, the remainder becomes the volume of the person's body.

The air volume is determined from the isentropic gas equation expressed by

$$P = \left(\frac{M}{V}\right)^{\gamma} \quad (1)$$

where P is the pressure, V is the air volume, M is the mass of air, and $\gamma$ is the ratio of specific heat at constant temperature ($\gamma = 1.4$ for air). By changing the volume by $\Delta V$, the equation becomes

$$\frac{\Delta P}{\Delta V} = \frac{-1.4}{V}\left(\frac{M}{V}\right)1.4 = \frac{-1.4P}{V} \quad (2)$$

Solving this equation for V becomes

$$V = \frac{-1.4P}{\Delta P/\Delta V} \quad (3)$$

Volume V now is determined by the computer, since all the values on the right-hand side of this equation are known. The computer then subtracts V from the total chamber volume. The remainder is the volume of the person's body.

**Note:**

Requests for further information may be directed to:

Technology Utilization Officer
Johnson Space Center
Code AT3
Houston, Texas 77058
Reference: TSP74-10271

**Patent status:**

This invention has been patented by NASA (U.S. Patent No. 3,769,834). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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Source: J. S. Ogle of
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