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NASA TECH BRIEF

Technique for Analyzing Human Respiratory Process

A sophisticated electronic system (MIRACLE II) with several new technological features is now available for automatic, instantaneous, quantitative analysis of the human respiratory process. Respiratory physiologists, inhalation toxicologists, doctors, and other biomedical workers should be interested in this system. It could be vital to all persons with impaired breathing.

The respiratory process involves unrhythmic frequency in number of breaths per minute and gas flow rate in volume per unit time. The frequency is in the form of a wave train of alternating inspiration and expiration cycles, while the gas flow rate is described in electronic terminology as an analog signal.

In the MIRACLE II system, these two dimensions of respiratory quantities are placed within a common frame of reference to render them comparable and compatible with "real clock time" represented in modern electronic systems by pulses with regular periodicity. A synchronization scheme between the regularity of real clock pulse and the irregularity of the breath-wave is devised. The gas flow rate is electronically normalized or compensated with regard to dynamic response characteristics in a time period mode of operation and then converted into higher frequency pulse-rate form. This, in turn, is superimposed onto the alternating inspiration and expiration waveform of a lower frequency.

The two physiological quantities of respiratory flow are thus transformed into a kind of "physiological clock of respiration." All of the respiratory flow measurements can be synchronized and correlated with the real clock time with simplicity and greater accuracy, and all of the necessary information required by the respiratory analysis is provided. Chemical components of respiratory flow such as oxygen, carbon dioxide, nitrogen, and water, which have been separated quantitatively with the aid of a mass spectrometer or other analytical means, can each be synchronized with the real clock time.

Many advantages of the system are apparent. Numerous measurements can be accomplished accurately on a strict one-minute, half-minute, breath-by-breath, or other period basis. The same arrangement also can conduct the earlier mode of "minute-volume on TM" basis customarily used in biomedical practice with greater efficiency.

The TM is defined as the time period to encompass a series of complete breath functions measured from a starting point on the breath wave form to a corresponding point after approximately one minute. Measurement and printout of TM involves complex but precise logic and timing circuitries. The clock-pulse generator provides an even number of 1000 pulses per minute and allows TM to be readout as a percentage of one minute. In the design of the system, the counting period covers the TM period precisely. Virtually no breath is lost during the measurement.

The "minute-volume" of inspiring or expiring flow is obtained during the TM period, which is sufficiently close but not necessarily equal to one minute. When clearly defined and identified by the length of the TM period, the "minute-volume" is more meaningful.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Manned Spacecraft Center, Code BM7
Houston, Texas 77058
Reference: TSP70-10528

(continued overleaf)

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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