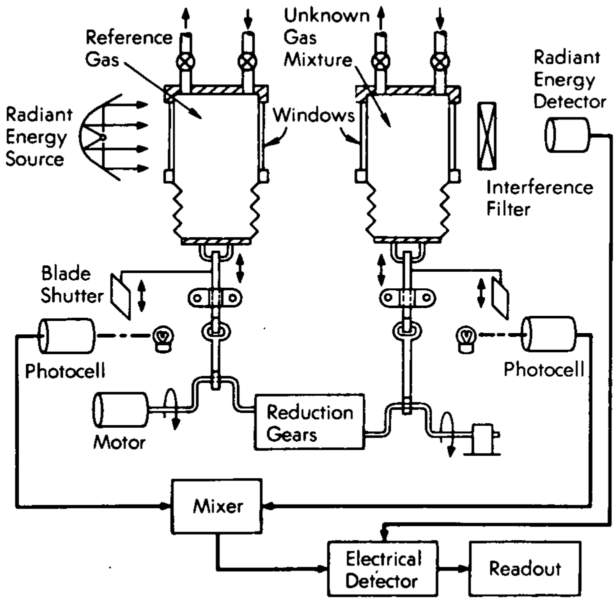
NASA TECH BRIEF

Ames Research Center

Nondispersive Infrared Analyzer for Specific Gases in Complex Mixtures

The problem:

To develop a practical nondispersive infrared analyzer for identifying and measuring particular diatomic or polyatomic gases in complex gas mixtures. Available nondispersive infrared gas analyzers are simple in structure and capable of high sensitivity; however, they are typically large and heavy and may be subject to serious gas cross-sensitivity effects. Additionally, the analyzers capable of good gas discrimination usually require the use of pneumatic detectors that have a low frequency response and are often the source of zero drift and noise.



The solution:

The densities of a reference gas and the unknown gas mixture are modulated in such a way that a mixing of absorption effects on light energy passing through the gases to a photodetector produces a signal component that is related to the absorption caused by the reference-gas component in the unknown gas mixture.

How it's done:

As indicated by the diagram, the unknown gas mixture and the reference gas (that is, the component being sought) are contained in windowed cells, and the gas densities are caused to vary periodically by mechanically operated bellows. Radiation from a blackbody source is directed through both gas cells and the interference filter to a photodetector. Certain wavelengths of the radiation are absorbed in each gas; hence, the intensity of the radiation reaching the photodetector is an oscillating function of the absorption characteristics of the reference gas and the gas mixture.

The density of the reference gas is caused to vary at a frequency, f_1, by the compressor bellows, and the density of the unknown gas mixture is varied at a second frequency, f_2.

A blade shutter for the reference gas is interposed periodically between a lamp and a photocell; the photocell generates an electrical signal which alternates at the frequency f_1; another blade shutter gives rise to a signal for the unknown gas mixture at a frequency f_2. The two signals are then beat together

(continued overleaf)

in the mixer to produce a difference signal at a frequency $(f_1 - f_2)$ which is led to the electrical detector, usually a phase-lock amplifier or similar device which is capable of selecting from one input signal a particular signal component corresponding to another input signal, in this case the output of the radiant energy photodetector.

There will be signal mixing in the radiation seen by the photodetector since the densities of the reference and unknown gases are varied at the frequencies f_1 and f_2, respectively, and the absorption process is exponential and hence inherently nonlinear. Accordingly, the electrical signal generated by the photodetector will have frequencies f_1, f_2, $(f_1 + f_2)$, $(f_1 - f_2)$, etc. Since the signal component corresponding to the particular gas to be analyzed in the unknown mixture is $(f_1 - f_2)$, the output of the electrical detector will be the $f_1 - f_2$ component in the signal from the radiant energy photodetector. The amplitude of this signal component is directly proportional to the concentration of the specific gas in the unknown. This output signal is fed into a readout system for display or recording.

The apparatus and technique permit the arbitrary and convenient selection of a particular gas to be analyzed and minimizes spurious signals introduced by other gases in the mixture being analyzed.

Notes:

1. The mechanically operated bellows can be replaced with a speaker coupled to a suitable oscillator; in this instance, the blade shutter can be omitted, for the signal frequencies f_1 and f_2 described in the text can be derived from the power oscillator that drives the speaker.
2. Requests for further information may be directed to:

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Reference: TSP 72-10198

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Mail Code 200-11A
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