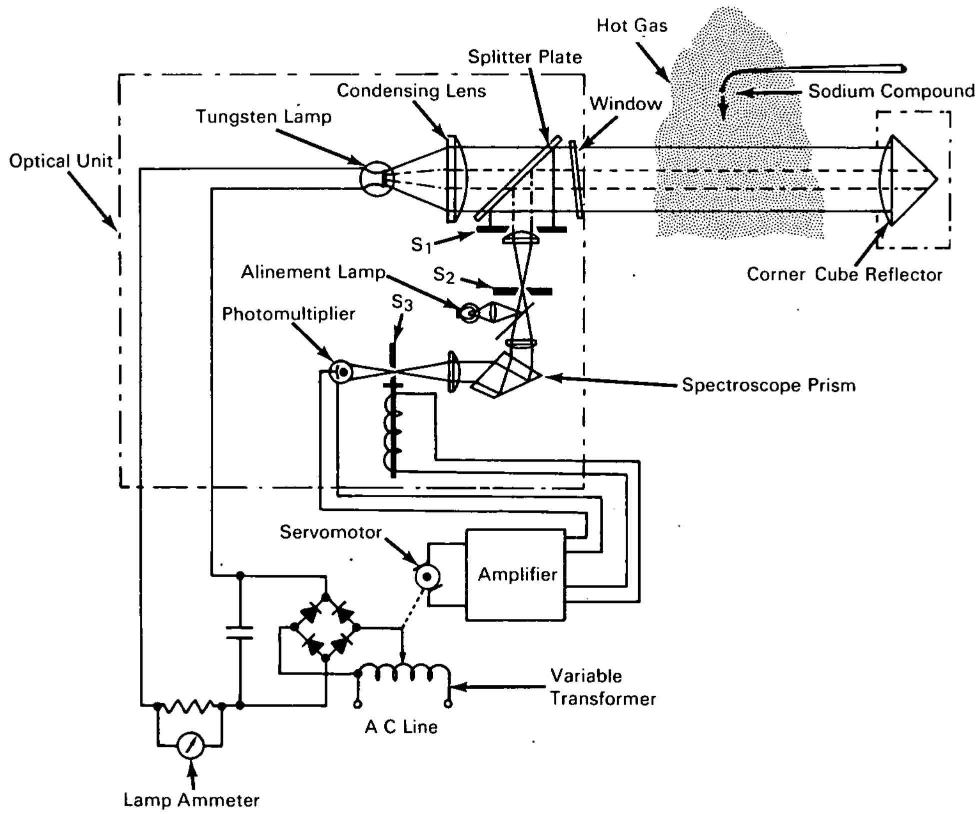
NASA TECH BRIEF

Self-Balancing Line-Reversal Pyrometer Automatically Measures Gas Temperatures



The problem:

To develop an automatic line-reversal pyrometer for measurement of gas temperatures in the range of 2900° to 4500°R. Conventional line-reversal (sodium D-line) pyrometers that have been used for measurement of gas temperatures require critical optical alinement of the reversal point by a skilled technician to achieve reliable results.

The solution:

A self-balancing line-reversal pyrometer (using the sodium D-line) that replaces the two conventional manual operations of the line-reversal method: namely, observing the spectral line through a spectroscope and controlling the lamp current to produce reversal. The self-balancing pyrometer can be used in the field by semiskilled personnel.

(continued overleaf)

How it's done:

The instrument consists of an enclosed optical unit alined with a corner-cube reflector; a probe that injects a powdered sodium compound into the hot gas at an upstream point; and an electrical unit containing a self-balancing system, which adjusts the current through the tungsten ribbon-filament lamp in the optical unit to restore the state of reversal of the sodium D-line, and an ammeter which continuously monitors the lamp current, related to the gas temperature by a previous calibration. An alinement lamp and small mirror are built into the optical unit to enable precise alinement of the optical axes of the tungsten lamp and the corner reflector before the instrument is used for measuring gas temperatures.

The spectroscope prism receives light from both the hot gas (seeded with an appropriate sodium compound) and the lamp through aperture S_1 and entrance slit S_2. Slit S_3 vibrates sinusoidally at a 60 Hz frequency and is positioned along the continuum (continuous spectrum from the lamp) to transmit light to the photomultiplier from the sodium D- spectral line at the slit center position, from a shorter adjacent wavelength in the continuum (at one extreme position of the slit), and from a longer adjacent wavelength in the continuum (at the other extreme position of the slit). Flux from the spectral line is compared alternately with flux from the two adjacent wavelengths during each vibration cycle of the slit. When the spectral line is not at reversal (spectral line brightness does not match the continuum brightness), a difference of light flux between the spectral line and the adjacent wavelengths generates a 120 Hz signal. The signal is transmitted from the photomultiplier to the amplifier, servomotor, and variable transformer, which then adjusts the tungsten lamp current to establish the state of line reversal. At line reversal the lamp temperature is uniquely related to the gas temperature when thermal equilibrium exists between the gas and the atoms of the injected sodium compound. The lamp calibration data then gives the gas temperature in terms of the lamp ammeter reading.

Notes:

1. The upper limit of temperature set by the tungsten lamp at 4500° R can be extended to 6500° R by use of a carbon arc source and absorption wedges to control the intensity of the transmitted light.
2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B67-10268

Patent status:

No patent action is contemplated by NASA.

Source: Donald Buchele
(Lewis-348)