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NASA TECH BRIEF

Ames Research Center

Laser Vibration Analyzer

The problem:

To measure the vibration of a structure under test or in operation without attaching vibration sensors, such as strain gages or inertial transducers.

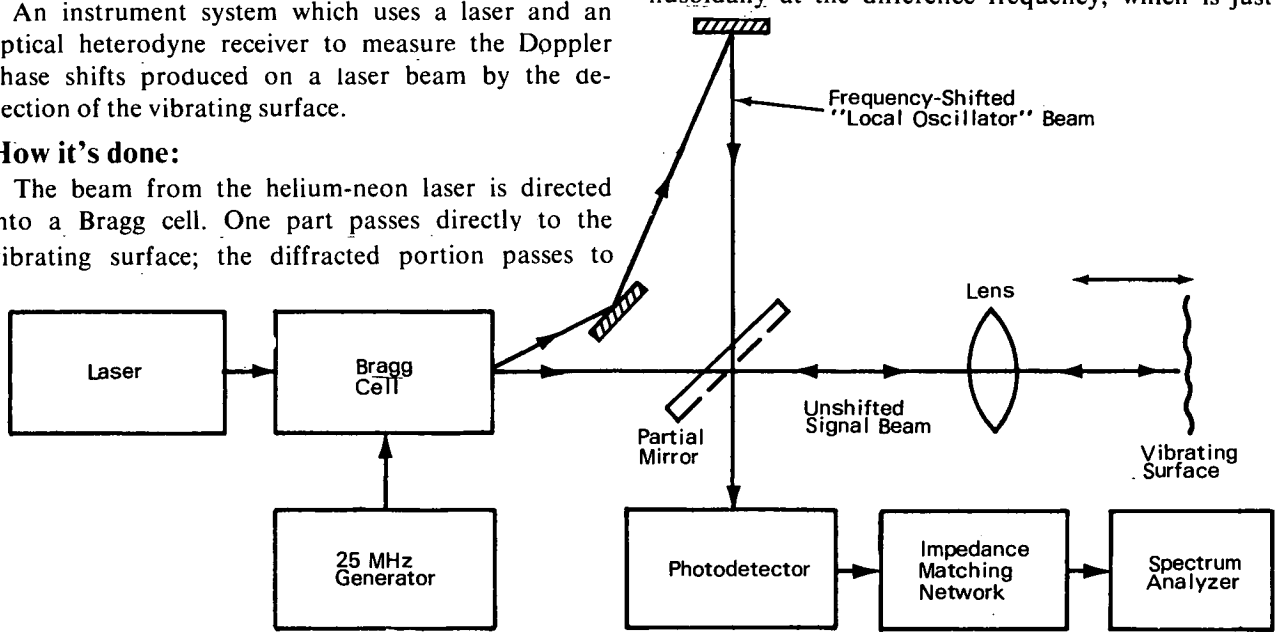
The solution:

An instrument system which uses a laser and an optical heterodyne receiver to measure the Doppler phase shifts produced on a laser beam by the deflection of the vibrating surface.

How it's done:

The beam from the helium-neon laser is directed into a Bragg cell. One part passes directly to the vibrating surface; the diffracted portion passes to a beamsplitter mirror and directly into the photodetector to serve as the reference or local oscillator beam. The frequency of the diffracted laser beam is shifted in the Bragg cell by plane-traveling acoustic waves in water. The amount of the shift is large compared to the Doppler shifts in the light reflected from the vibrating surface. The reflected light from the vibrating surface returns through the instrument optical system to the beamsplitter, where it is combined with the reference beam to produce interference with patterns which are sensed by the photodetector.

If the reflecting surface remains stationary, the interference patterns at the photodetector vary sinusoidally at the difference frequency, which is just equal to the shift or system intermediate frequency (IF). If the surface moves, the phase or frequency of the interference changes, producing frequency modulation of the system IF. The shift provides a frequency bias so that motions toward or away from the instrument produce distinctive Doppler modulations which define the direction of the motion as well as its magnitude. The process signal from the detector is displayed visually on a spectrum analyzer.



Block Diagram of Vibration Measurement System

(continued overleaf)

Notes:

1. Vibration frequencies from 1 to 0.5 MHz have been measured, with displacements from 1.27 cm peak-to-peak down to about 10^{-4} microns.
2. Related material can be found in Tech Briefs B70-10439 and B71-10145.
3. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference:
   NASA-CR-985 (N68-14070), Study of Vibration Measurement by Laser Methods

Patent status:

This is the invention of a NASA employee, and U.S. Patent No. 3,355,934 has been issued to him. Inquiries about obtaining license rights for its commercial development should be addressed to the inventor, Mr. John V. Foster, at the NASA - Ames Research Center.

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