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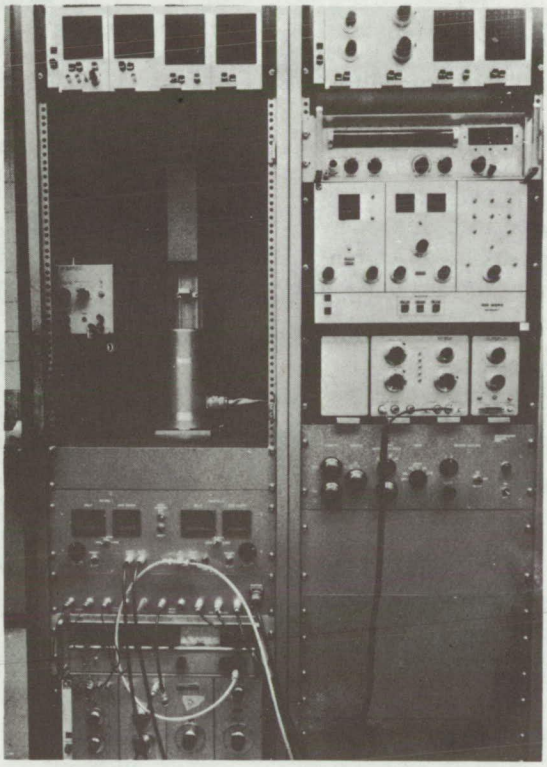
NASA TECH BRIEF

Mossbauer Vibration Calibration Systems Evaluated



MOSSBAUER EFFECT VIBRATION CALIBRATOR

Manufacturers of jet engines, scaled-down missile models, turbopumps, and a number of other devices will be interested in this novel application of nuclear resonance (Mossbauer effect) to vibration analyses. This system can be used for measurement of the velocity of high frequency, low amplitude vibration within a velocity range of 0.01 to 8.4 mm/sec at frequencies up to 200 kHz for the partial resonance and off-resonance cases, and within a velocity range of 0.045 to 1.70 mm/sec at frequencies significantly higher than 200 kHz for the resonance case. Applications include ultrafine testing, calibration of piezoelectric shakers, vibration transducers, reference accelerometers, and use as a general research tool.

The Mossbauer effect is a nuclear resonance fluorescence phenomenon involving emission of a gamma photon without recoil energy losses. A suitable radioactive nucleus is deposited in a host crystal so that

(continued overleaf)

the nucleus is not free to recoil arbitrarily upon emitting a gamma photon. Emission from this source is allowed to shine through an absorber containing an identical nucleus, and resonance may be observed by detecting transmitted gamma photons. Moving the source with respect to the absorber shifts the energy of the photon through the Doppler effect and disturbs the resonant condition. A detailed, sophisticated discussion of the Mossbauer effect is found in the reference in Note 1.

When Mossbauer materials with strong and well known absorption characteristics are employed, measurements of Mossbauer spectra obtained under vibration indicate the magnitude of vibration. This is the method involved in calibration techniques. The Mossbauer Effect Vibration Calibrator is shown in the photograph. Of two units in the system developed, the first unit is a highly precise calibration standard divided into two categories; namely, Mossbauer effect materials (a radioactive source and various absorbers) and hardware (spectrometer and A.C. gating unit). The second unit is a vibration measuring system or transfer standard. It is a secondary standard which is portable and smaller than the calibration standard and may be used for calibrating accelerometers or other devices.

The calibration standard is housed in a dual relay rack cabinet which also contains a work area. A granite surface plate is mounted therein and provides a stable surface for vibration calibrations. It also serves as the base for the spectrometer. A scintillation detector and absorber holder are rigidly attached to a vertical adjustable slide which maintains alignment of the various components. This whole assembly together with a guide ring for mounting the device to be calibrated is firmly screwed to the granite plate.

Detailed descriptions of the radioactive source, three basic types of absorbers, spectrometer, A.C. gating unit, and the nuclear electronic components used with the calibration standard (as well as of the parts of the transfer standard) are furnished in additional available documentation. (See Note 3).

The spectrometer provides a to and fro movement between a source and absorber for obtaining Mossbauer spectra. The A.C. gating unit supplies the means for performing wave tracing and multiple point calibration of accelerometers and other vibration measuring equipment. For convenience and storage, electronic components are mounted in the cabinets containing the calibration standard. Sufficient lead shielding is used to maintain personnel radiation exposure within acceptable levels.

Notes:

1. A discussion of the Mossbauer effect is given in NASA SP-132, "Aerospace Measurement Techniques," edited by Gene G. Mannella in the article, "The Mossbauer Effect and Its Application to Measuring Technology," by Helmut G. Lackner, pp. 1–27 (1967), for sale by the U.S. Government Printing Office, Washington, D.C. 20402; price: $1.00.
2. An instrument designed for measurement of vibrations in transducers is described in NASA Tech Brief B67-10339, "Vibration Analysis Utilizing Mossbauer Effect," September 1967, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price: 15 cents.
3. Documentation is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price: $3.00. Reference: TSP69-10125.

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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