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NASA TECH BRIEF

Multicolor Stroboscope Pinpoints Resonances in Vibrating Components

The problem:

To devise a stroboscopic system that will rapidly scan a vibrating multicomponent assembly and provide a visual indication of resonant components. Conventional stroboscopic systems employ a light flashing at a frequency of 1 to 5 cps slower or faster than the vibration frequency. The apparent rate of displacement of the vibrating component indicated by these systems is equal to the difference between the flash frequency and the vibration frequency. Each component must be observed for at least 0.5 second to estimate its displacement amplitude relative to that of adjacent components. If the light is pulsed to flash when the driving force of the vibration exciter crosses zero, those components at resonance will be illuminated at the positive and negative peak displacements (amplitudes). For small displacement amplitudes, this arrangement shows only a slight increase in the component dimensions parallel to the direction of vibration.

The solution:

A visual detection system, using three different colored lights that are pulsed at the same flash frequency but at different phases.

How it's done:

The three lights are arranged to flash at the peak positive and negative forces as well as the zero-force crossing of the vibration exciter. The relative position of the vibrating component at the time of flashing is determined by the phase shift between the force and displacement that occur at resonance. Below resonance, displacement from the mean position is indicated by the lights which flash at the peak of force; while at resonance, the light which flashes at the zero-force crossing illuminates the component at its point of displacement from the mean position. For displacement amplitudes above a certain minimum, the conditions below, at, and above resonance are illuminated. When the component is at mechanical resonance, it is surrounded by a halo which corresponds in color to that of the light which flashes when the force is zero. The lights which flash at the peak of the force provide a reference position, and the colors allow rapid visual scanning of a multicomponent assembly for pinpointing of resonant components. These resonant components are identified by halos of the zero-force color.

In tests using only two colors of light, the signal used to drive the lamps was obtained from a three-phase tachometer attached to the vibration exciter alternator. One light was controlled directly from this signal, and the other from the rotor voltage of a synchronous motor. In this way the phase angle between the firing of the two lamps could be varied by simply adjusting the position of the rotor in the synchronous motor.

Notes:

1. While the displacement resolution (0.01-inch peak-to-peak amplitude) of this system is no better than that of a standard stroboscope, it will facilitate the isolation of resonant components in a complex assembly.
2. This system may be adaptable to a number of applications: in environmental component testing, either for relative evaluation or warning of vibration extremes; in short-range communication of limited security, based on modulating the phase shift of two colors; and in advertising or demonstrations where the novelty of displaying two

(continued overleaf)

objects or causing an object to suddenly shift its apparent position could be used to attract attention.

Patent status:

Title to this invention, covered by U.S. Patent No. 2909059, has been retained by the California Institute Research Foundation, Pasadena, California.

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