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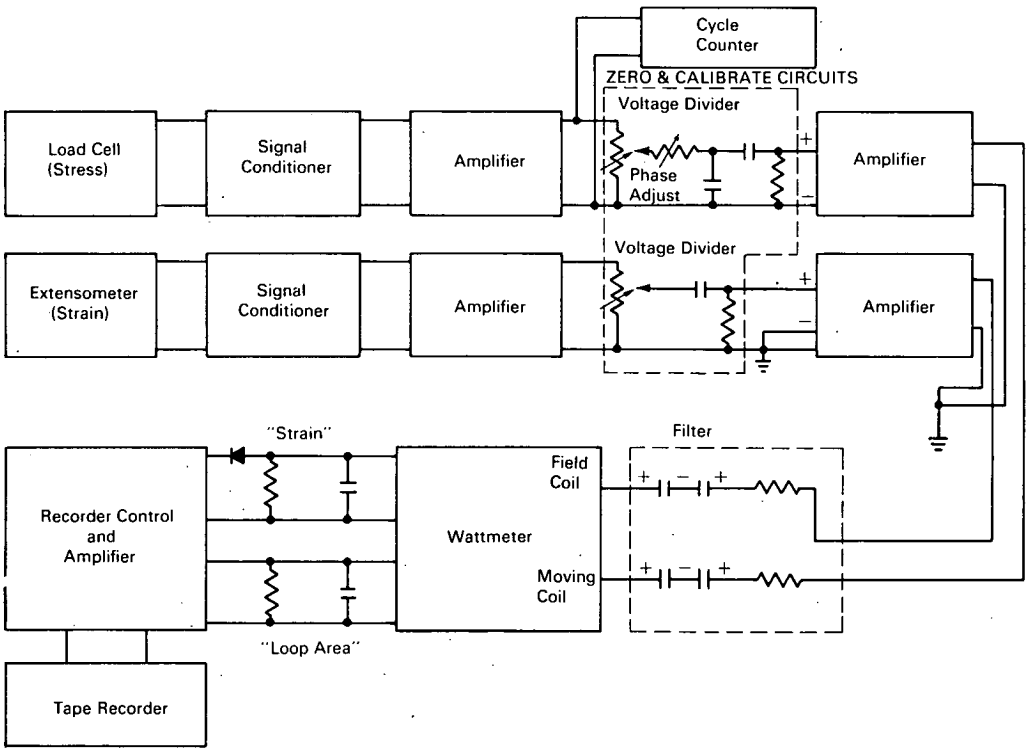
NASA TECH BRIEF

Circuit Measures Hysteresis Loop Areas at 30 Hz



The problem:

To devise instrumentation that will measure hysteresis loop areas as a function of time during fatigue testing of specimens subjected to sinusoidal tension–compression stresses at a frequency of 30 Hz. An X–Y plotter, which is generally used to measure hysteresis loop areas, does not have the frequency response necessary to follow loops at 30 Hz.

The solution:

An analog circuit based on the analytically derived fact that when the sinusoidal stress signal (shifted by 90 degrees) is multiplied by the strain signal, the dc signal component in the product is proportional to the hysteresis loop area.

How it's done:

A wattmeter is used to multiply the stress and strain signals. An amplifier in series with another amplifier is used between the bridge signal conditioner and the wattmeter to increase the stress signal to a level acceptable to the wattmeter. Two amplifiers are used in a similar manner to amplify the strain signal.

The signal representing hysteresis loop area is fed into a 2-channel tape recorder through a recorder

(continued overleaf)

control and amplifier unit. The recording is a continuous plot of hysteresis loop area versus time. A plot of strain amplitude versus time is also recorded.

The wattmeter reads zero when its input consists of two sinusoids that differ in phase by 90 degrees. It is therefore necessary, after scaling by means of the voltage dividers (in the zero and calibrate circuits), to use the "phase adjust" resistor to shift one of two reference sinusoids from an oscillator until the wattmeter reads zero. Two sinusoidal signals which differ in phase by a known amount, and of measured amplitude, are fed into the wattmeter to provide a calibration signal. This signal is also recorded on the tape.

Notes:

1. The wattmeter can be replaced by Hall Effect multipliers at a considerable reduction in cost.
2. Details concerning this innovation are given in Report No. 67-101, "Final Report of Experimental Studies of Cumulative Damage," March 1967, prepared by Midwest Applied Science Corporation. This report may be obtained from:
   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B67-10519

Patent status:

No patent action is contemplated by NASA.

Source: C. Hoffman and D. Spilo
of Midwest Applied Science Corporation
under contract to
Marshall Space Flight Center
(MFS-13069)