NASA TECH BRIEF

Hydraulic Servo System Increases Accuracy in Fatigue Testing
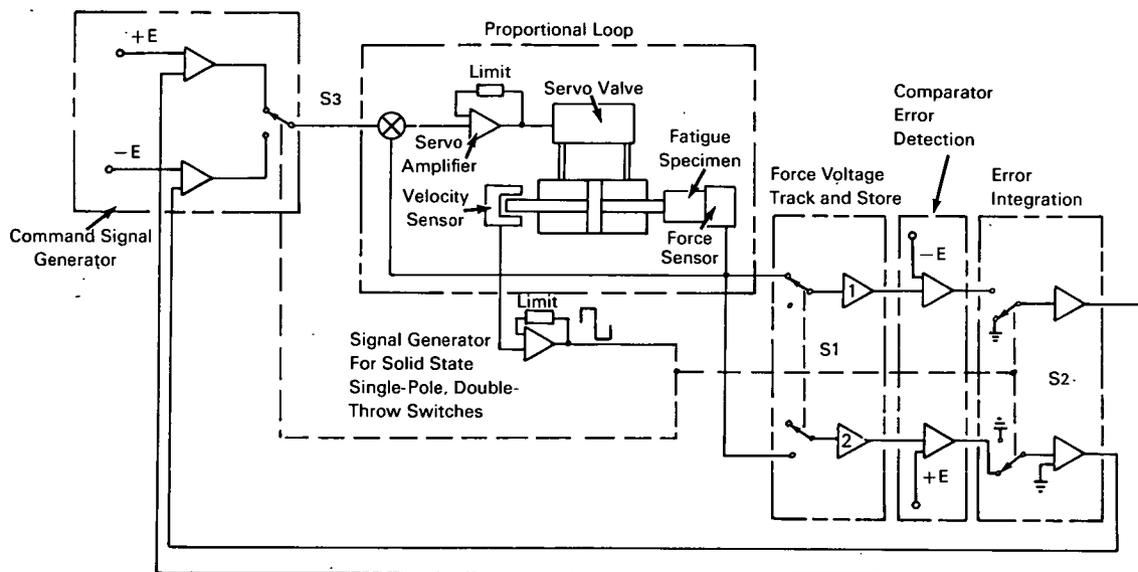
HIGH FREQUENCY PRECISION CYCLIC LOADING SYSTEM

The problem:

To increase accuracy in applying fatigue loading to a specimen under test. The conventional hydraulic proportional loop loading system has a closed loop gain near the ultimate to allow the use of a minimum-size servo valve for high frequency response. Large overshoot and cyclic effects caused by this high gain are eliminated by causing the system command to change levels whenever the velocity changes sign. Manual adjustment of the command level is then required to achieve the desired peak forces. Such a system exhibits relatively large force errors for small changes in system gain, component drift, and changes in test specimen characteristics.

The solution:

An error sensing electronic control loop, coupled to the hydraulic proportional closed loop cyclic force generator, which provides an accurately controlled peak force to the specimen. The error sensing loop maintains an accuracy of 0.1% at the peak force points, thereby eliminating manual adjustment of the command levels.

How it's done:

The fatigue loading system, shown in the diagram, consists of a proportional loop hydraulic system and an error sensing electronic control loop.

The proportional loop consists of a servo amplifier with a limit control, a servo valve which drives a

piston, a velocity sensor, a force sensor, and the fatigue specimen. Frequency control is obtained by setting the limits on the servo amplifier. This is the normal assembly used for fatigue loading of a specimen.

To increase the accuracy of the system, an error-sensing electronic control loop is added to the proportional loop. This control loop consists of a signal generator, a force voltage tracker and storer, an error detection comparator, an error integrator, SPDT switches, and a command signal generator.

The electronic error sensor tracks and stores the force sensor's output voltage to the point where the velocity changes sign, i.e., the point of maximum force. The stored output voltages are then compared with the desired command reference voltages in the error detection comparator. An error signal generated for each peak is integrated and added to the appropriate command voltage level, and the composite command signal is fed to the proportional loop hydraulic system.

The velocity sensor of the proportional loop system triggers the signal generator which drives the SPDT switches. These switches, S_1 and S_2, appropriately channel the inputs and outputs of the error sensing electronic control loop to achieve proper feedback voltages, S_3, into the proportional loop.

The entire loading system is rapidly convergent, and continuously strives to drive the system error to, and maintain it at zero.

Notes:

1. The system was developed for specimen testing requiring dynamic forces of ± 5000 pounds at a frequency of 50 Hz.
2. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Langley Research Center
   Langley Station
   Hampton, Virginia 23365
   Reference: B67-10637

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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(LAR-217)