NASA TECH BRIEF

Marshall Space Flight Center

A System for Early Warning of Bearing Failure

Bearings on the verge of failure generate ultrasonic frequencies of measurable amplitude before audible or mechanical signals can be detected. This fact suggests that ultrasonic detection equipment may provide the most useful way to monitor incipient bearing failure. The ultrasonic signal appears prior to a temperature rise or increase in driving torque. A series of ball bearing performance tests were run on several identical ball bearings under a variety of load, speed, temperature, and lubrication conditions. Bearing temperature, torque, vibration, noise, strain, cage speed, etc. were monitored to discover which measurements were most suitable as indicators of ball bearing condition. A total of sixty-six data points were taken during the thirty-three different tests.

The tests were conducted on a hybrid boost bearing test vehicle. Tape records were made under steady-state conditions of a variety of speeds and loads. Sample sections were selected from the taped data for a narrow band spectral analysis with a real time analyzer. An artificial flaw was created across the inner race surface of one bearing using an acid etch technique to produce the "scratch". Tape records obtained before and after the etching established a characteristic frequency response that identifies the presence of the flaw. These data were used to develop a prototype diagnostic system.

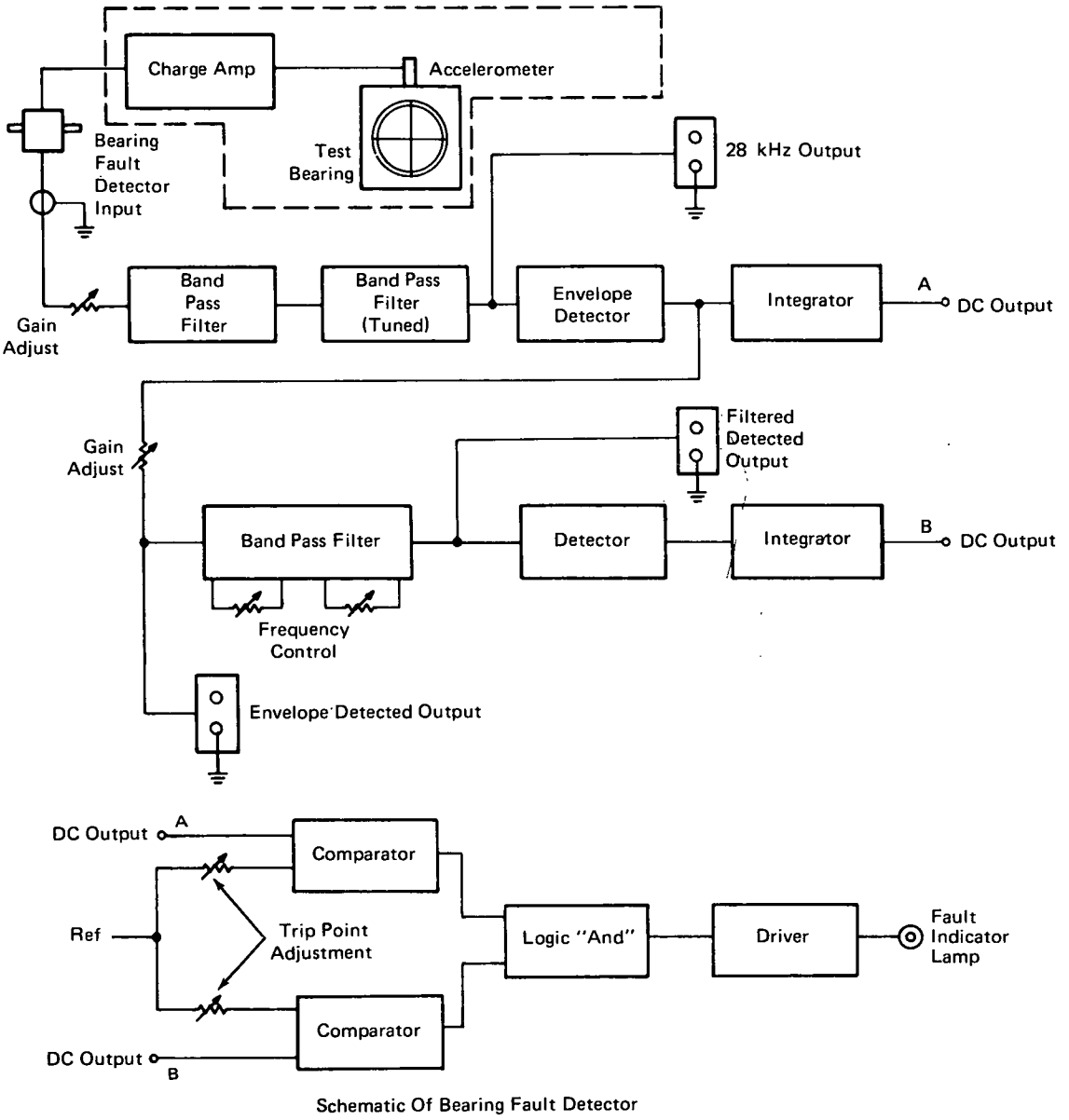
The experimental determination of a bearing system resonance that is related to an induced bearing defect provides criteria which can be used for the detection and evaluation of bearing faults. The availability of two discrete indications permits the construction of a logic circuit which will give a fault indication only when both are present. The overall signal level produced at 28 kHz provides the first indicator of a bearing fault. The second indicator is that modulation occurs at discrete frequencies depending upon the bearing speed and upon which component incurs the initial damage.

The electronic circuit for the bearing fault detector is shown in the illustration. Housing vibration from the bearing under test is converted to a charge signal by a securely attached high-frequency response accelerometer. The charge is detected by a charge amplifier, and a voltage proportional to the housing acceleration is produced. This voltage is amplified and presented to the input of a bearing fault detector. The bearing fault detector clearly indicates the presence of damage in the bearing. In this test the level of damage is so minor that other indicators such as torque, noise, temperature, and direct audio range frequency vibration would not have detected the presence of a fault. The bearing fault detector may be used to evaluate the performance of newly installed bearings to guarantee that ball and race damage has not occurred prior to or during assembly as well as to monitor the rate of deterioration of an operating system.

Notes:

1. This test equipment may be of interest to bearing manufacturers and users, particularly those working with devices, such as gyros, in which the bearing operation is critical.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&TS-TU
   Huntsville, Alabama 35812
   Reference: B72-10494

(continued overleaf)



Schematic Of Bearing Fault Detector

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Marshall Space Flight Center
Code A&TS-PAT
Huntsville, Alabama 35812

Source: J. J. Broderick, R. F. Burchill, and H. L. Clark of Mechanical Technology Inc. under contract to Marshall Space Flight Center (MFS-21877)