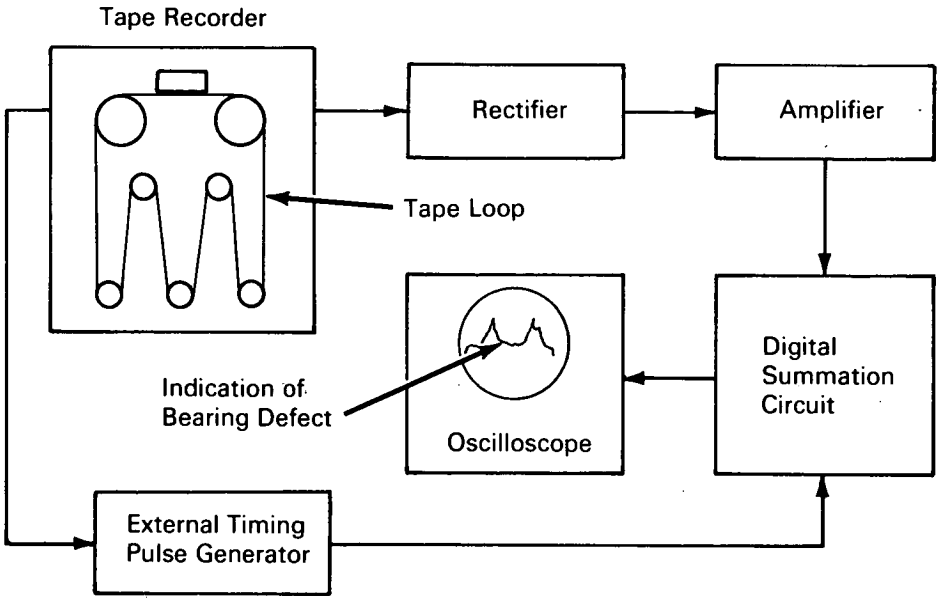
December 1967

Brief 67-10658

NASA TECH BRIEF

Damages in Rolling Element Bearings May Be Detected Early



The problem:

In critical machine components, it would be advantageous to have a dependable method for early detection of damage or small defects in rolling element bearings. Such damage or defects, although small, are usually indicators of impending bearing failure.

The solution:

A detection method that operates on the principle that an impact is generated each time a defect in an otherwise smooth surface is in intimate moving contact with another smooth surface. For example, the impact generated every time a ball rolls over a crack or dent in an outer race.

How it's done:

A tape recording is made of vibrations picked up on the housing around the bearing under study. A part of the recorded signal is played back as a tape loop that contains one ON and one OFF order for triggering of an external timing pulse generator. The generator introduces pulses with a time interval T_s. With the tape loop running, pulse generation is started by the ON order and pulses are then generated until the tape loop has completed one revolution when the ON order repeats the sequence. The time interval T_s between pulses is externally varied in accordance with bearing configuration and size plus rotational speed in order to monitor the specific component under investigation. A digital summation circuit, constantly coupled to the played-back, amplified, and rectified vibration signal initiates a sweep cycle each time the pulse generator is triggered. During this sweep cycle the summation circuit memorizes the incoming rectified

(continued overleaf)

vibration signal during a present time interval T, where $T \leq T_S$. Memorizing is accomplished by dividing the T signal interval into 1024 time bits, measuring the average signal level within each bit, and storing the result as 1024 digits in the memory. Because the pulse generator produces pulses at intervals of T_S during the ON order period, the memory cycle is also repeated at each interval T_S. Each memorized set of 1024 digits is added to the previous sets in the digital memory, so the memory always contains the sum of previously memorized signal sections.

A set of peaks in the vibration signal, repeating with time interval T_S, will cause a high number (ones versus zeros) in one or more memory locations, the same for each memory cycle, therefore building up peaks at such locations. Random pulse trains or sequences not related to T_S do not have this effect. Through this detections of peaks accumulated in the summation memory, pulse sequences with the selected time interval T_S (or its multiples) are detected with great accuracy, thus providing the desired analysis information.

Notes:

1. The particular summation circuit used must measure each signal bit many times to be accurate. The ON-OFF orders on the tape loop insure identical repetition of trigger pulses for each tape revolution.
2. This development is in conceptual stage only, and as of date of publication of this Tech Brief, neither a model nor prototype has been constructed.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: B. Weichbrodt
of General Electric Company
under contract to
NASA Headquarters
(HQN-10031)