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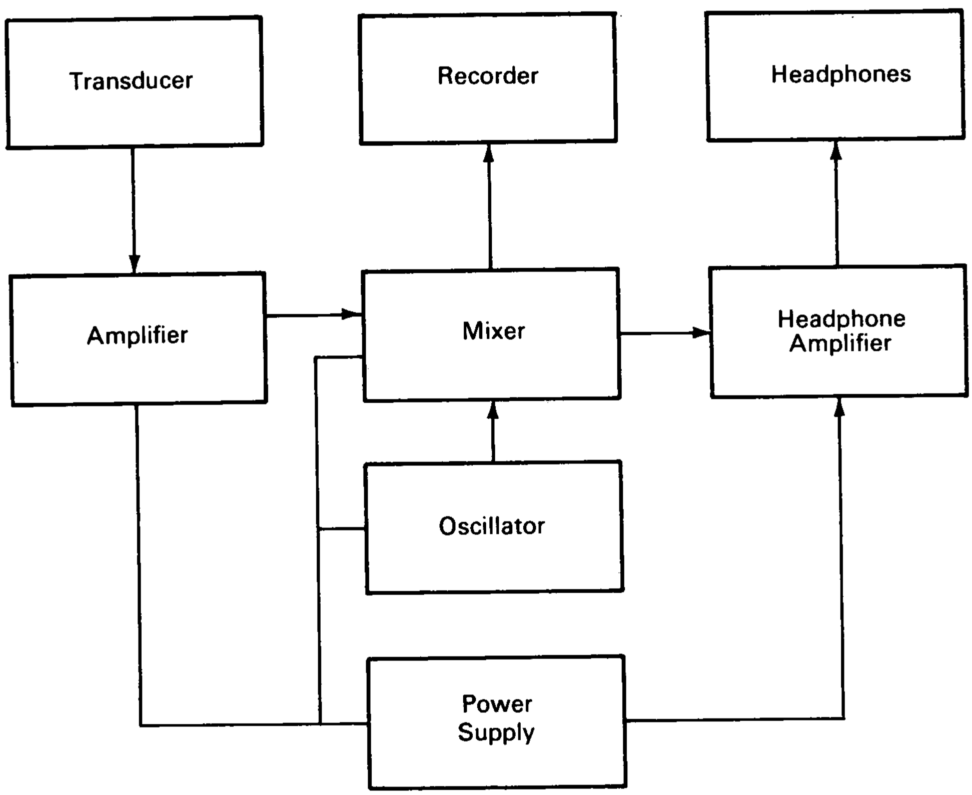
NASA TECH BRIEF

Ultrasonic Emission Method Enables Testing of Adhesive Bonds



The problem:

To investigate the applicability of the acoustic emission effect (the generation of acoustic energy by mechanically stressed materials) as a means for testing of adhesive bonds.

The solution:

Preliminary tests on a number of adhesive bonds subjected to tensile stresses indicate that detection of the acoustic energy emitted by the bonds at frequencies above 16 kilocycles per second can be used as a method for determining bond strength.

How it's done:

The test adhesive is applied to form a bond between two small aluminum blocks. A piezoelectric transducer is then secured to one of the blocks and the specimen is mounted in a tensile tester. The transducer,

(continued overleaf)

used to detect the acoustic energy generated by the adhesive bond as it is subjected to an increasing tensile stress, is a disk of barium titanate–lead zirconate, having a frequency response up to more than 100 kilocycles per second.

The output of the transducer on the stressed specimen is amplified with a gain of 5000 at a center frequency of 31 kilocycles per second and a bandwidth of 5 kilocycles per second, allowing energy in a band of 28 to 32 kilocycles per second to be amplified and processed. The input of the amplifier handles large signals below 28 kilocycles per second without distortion, allowing noise pulses of less than 28 kilocycles per second either from the test fixture or a shop environment to be attenuated and thus not disturb the system. The amplifier output is fed to a mixer along with a signal from a 32 kc oscillator. The mixer produces the sum and difference frequencies of the two inputs, although only the difference frequency is used. The output frequency of the transducer is now translated to a range of 100 cycles to 4 kilocycles per second. This signal is detected and used to drive a recorder to plot average frequency as a function of applied stress (monitored in a separate channel) in real time. Thus the data can be interpreted while the sample is being stressed. A set of headphones may also be connected to the mixer to enable an operator to listen to the acoustic signals generated by the system. These signals can easily be distinguished from the noise generated by the test stand or environment. The stressed adhesive bond produces high-pitched crackling sound pulses of very short duration.

Notes:

1. This method has been found useful in measuring adhesive bond strengths on metal honeycomb core panels. Tests with phenolic cores, however, indicate that this material introduces noise which masks acoustic signals generated by the adhesive bond.
2. The method may find application in predicting adhesive bond strengths on large structures, which are normally tested with hydraulic pressure or static stresses. For such measurements a relatively large number of transducers would be required to pinpoint the weak areas.
3. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B66-10341

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: Gerald Schmitz
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Marshall Space Flight Center
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