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Study Made of Acoustical Monitoring for Mechanical Checkout

The motion of the parts of a mechanical component generates mechanical vibrations that can be detected by transducers giving an analog electrical signal output (sonic signals). It has been established by previous work that sonic signals are symptomatic of, and can be correlated with, component condition. They can and have been used for accurate valve timing and other purposes. The sonic signal analysis technique has the particular advantage of not requiring disassembly of the component for analysis of its operation and condition.

A study program was initiated to test the theory that determination of component condition by sonic signal analysis would provide a satisfactory technique for mechanical checkout. In the course of the study, equipment and techniques were developed for sonic signal acquisition and analysis with the ultimate objective of designing automated equipment to perform signal analysis and provide both a qualitative and quantitative readout.

Preliminary analysis of the criteria for this study indicated that the feasibility, at least initially, of sonic signal analysis equipment would probably be limited to mechanical components that are expensive and have low production rates. For these reasons, the large valves on the S3D and F-1 engines were used for the study. These valves also are subject to contamination if disassembled.

Multiple operations of the opening and closing of each of the S3D valve types (fuel, lox, and gas generator) were studied and analyzed. Also studied were the signals acquired from six different F-1 lox valves.

The results of the study demonstrate that the subject technique provides a powerful tool for mechanical component development and failure analysis. The results strongly support the theory that the technique is potentially a powerful tool for mechanical component checkout. The technique also provides the unique capability of predicting component failures by detecting incipient malfunctions. This capability does not require disassembly of the component or removal from its system. Skilled personnel may extract from analysis of the sonic signature valuable information about the operation of a valve without previous sonic signatures from the valve. Thus, the technique can be used for one-of-a-kind items for the purpose of first item acceptance, failure analysis, and development of end item quality standards and test procedures. Application to production runs can utilize an automatic go and no-go version of the system (to be developed) that can be operated by regular inspection personnel.

Note:

Inquiries concerning this innovation may be directed to:

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Patent status:

No patent action is contemplated by NASA.

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