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NASA TECH BRIEF

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Isometric Scan Method for Ultrasonic Evaluation of Composite Panels

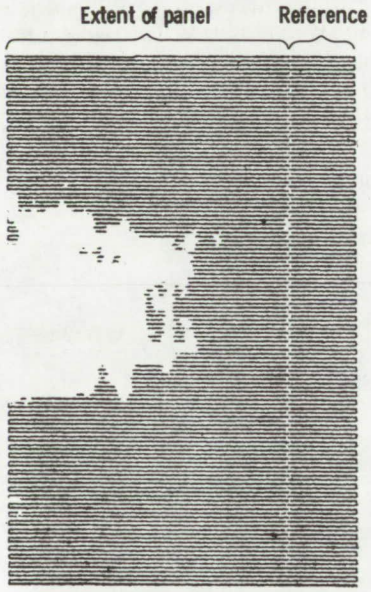

Figure 1. - Ultrasonic C-Scan of composite panel specimen.

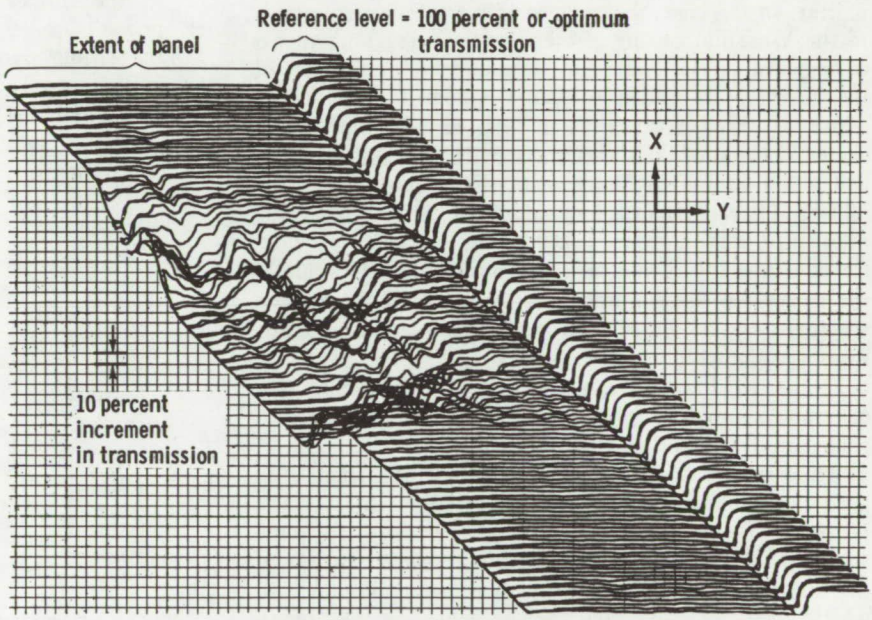

Figure 2. - Isometric Scan (I-Scan) of composite panel specimen.

The Problem:

Ultrasonic scanning is one principal nondestructive evaluation technique for inspecting composite structures such as those made of graphite fiber-epoxy laminates. The current practice is to transmit a beam of ultrasound through a composite panel to generate either a black and white or greytone "C-scan" to show flaws (e.g., delaminations). Figure 1 is an example black and white C-scan in which the black area represents good transmission of the ultrasound. The white area corresponds to regions with delaminations and hence poor or no transmission of ultrasound. This type of scan does not, however, present the whole picture. Instead, it presents only that slice which corresponds to an arbitrary cutoff level of the transmitted signal amplitude. Moreover, this particular C-scan taken alone does not provide sufficient information on the quality of the piece relative to some standard. A greytone C-scan would show more about signal transmission variations, in the white area for example, but this information would not be fully quantitative. With either type of C-scan, additional information is required for complete evaluation.

What is needed, therefore, is a method that presents not only the signal amplitude values but also provides a reference value (or values) in a single image (for economy as well as ease of evaluation).

The Solution:

An isometric scan method for displaying the transmitted ultrasound provides the kind of picture desired. The I-scan form of data presentation provides more direct information on the nature and severity of flaws present in a test specimen and is more easily interpreted by the inspector than the conventional C-scans currently used. It

(continued overleaf)

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also offers potential savings in inspection time and cost. For example, recent tests with a graphite-epoxy composite panel indicated that at least 10 C-scans were needed to produce the information displayed in one I-scan. Comparison of the I-scan in Figure 2 with the C-scan of Figure 1 will indicate that not only improved qualitative but also quantitative information is immediately apparent by inspection of the I-scan.

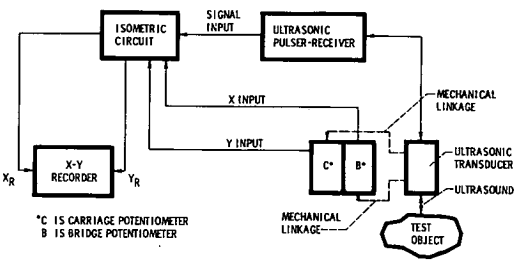
How It's Done:

The specimen is scanned using a conventional water immersion ultrasonic system and either through transmission or reflector plate methodology. To generate the I-scan in Figure 2, the carriage and bridge drives are geared to helipots to produce an X and Y voltage corresponding to the coordinates of the scanning head relative to the specimen. The X and Y signals are conditioned and mixed in a specially devised circuit and transmitted to an X-Y plotter. In this case, the carriage scan traverse corresponds to the Y-motion on the plotter and the bridge increments correspond to the X-motion. A preselectable portion of the X-voltage is added to the Y-voltage to produce an offset of each successive scan line. In addition, a calibrated fraction of the ultrasonic signal (after amplification and conditioning) is added to the X-motion on the plotter. The net effect is to produce the three-dimensional impression seen in Figure 2. Moreover, the circuit provides for adjusting the X-motion amplitude so that the value of the ultrasonic signal corresponding to a given point on a specimen can be ascertained by referring to the graduations on the graph paper used in the plotter. Thus, as indicated in Figure 2, a particular line spacing, for example 3 mm, can be made to represent a 10 percent change in ultrasound transmission.

The specific utility of this mode of isometric scan presentation is evident when one attempts to rate the properties of a particular specimen relative to some standard. The "standard" may well be some portion of the specimen itself. This is exemplified by Figure 2 in which the "smooth" area can be taken as that representing acceptable properties. Alternately, the "standard" may be artificial, as for example the water in which the specimen is immersed. Thus, a fixed distance through water can, for many composites, serve as a reference by providing an easily reproduced signal amplitude representing, say, 100%. A water reference was used in plotting the I-scan of Figure 2 simply by allowing the scan head to traverse slightly beyond the edge of the specimen during each pass. Of course, appropriate reference values can also be generated by purely electronic means. However this is done, the chief merit of the I-scan concept outlined herein is that considerable quantitative information is available at a glance and the interpretation of the data is thereby facilitated.

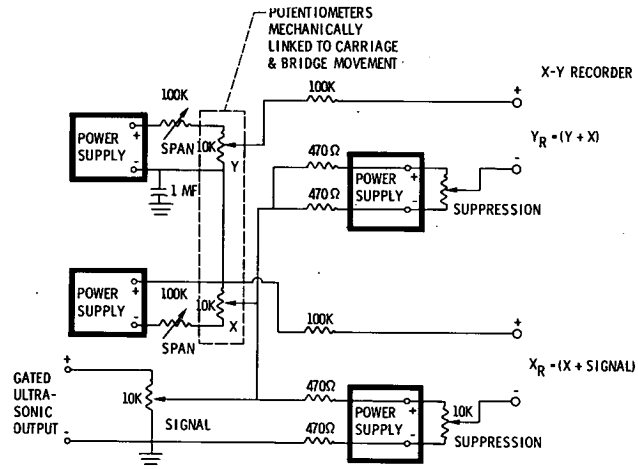
Notes:

1. In the isometric scan system block diagram, the carriage and bridge potentiometers are heavy-duty helipots rated for over 100,000 cycle life. The potentiometers are coupled directly to the pulley shafts of the carriage and bridge drives.



ISOMETRIC SCAN SYSTEM BLOCK DIAGRAM

2. In the isometric circuit diagram, the four separate power supplies were found necessary to fully isolate the various signals and avoid crosstalk. The signal input is derived from the ultrasonic pulser-receiver after gating and amplification. This is based on a video signal having an amplitude in the range from 0 to 1.0 VDC approximate.



ISOMETRIC CIRCUIT DIAGRAM

3. No additional documentation is available. Specific technical questions, however, may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B75-10014

Patent Status:

NASA has decided not to apply for a patent.

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