1.3.70. A THREE-DIMENSIONAL PHASED ARRAY ULTRASONIC TESTING TECHNIQUE

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Introduction. Phased array ultrasonic testing techniques have become widespread in various industrial fields. In the phased array techniques, target objects are scanned with focused ultrasonic beams transmitted from an array probe. We have been developing a novel phased array system called 3D Focus-UT which enables us to scan target objects volumetrically at one time with a matrix array probe.

Three-Dimensional Phased Array Technique. A schematic image of a 3D phased array scanning and a photo of 3D Focus-UT are shown in fig. 1 and fig. 2, respectively. With a matrix array probe, target objects can be scanned volumetrically at one time or at least in less time than the conventional 2D phased arrays. Moreover, the scanned data can be evaluated in a 3D space, while operators have to check sector images one by one for the 2D phased arrays. Thus, the total inspection time of the 3D phased arrays is much shorter than that of the 2D phased arrays. In addition, detectability becomes higher because of the narrower and more focused beams created by the matrix array probe. The advantages of the 3D phased arrays compared to the 2D phased arrays are summarized below.

– Inspection speed is increased by 3D scanning.

– Spatial resolution is higher due to point-focused ultrasonic beams created by the matrix array probe.

– 3D rendered imaging provides easy-to-understand inspection results and facilitates evaluations.

Application. A 3D image of flat bottom holes (FBH) in a stainless steel test piece is shown in fig. 3 (a). The test piece had a thickness of 70 mm and 25 FBHs each with a depth of 20 mm. The diameters of the FBHs were 1 and 2 mm as illustrated in fig. 3 (b).

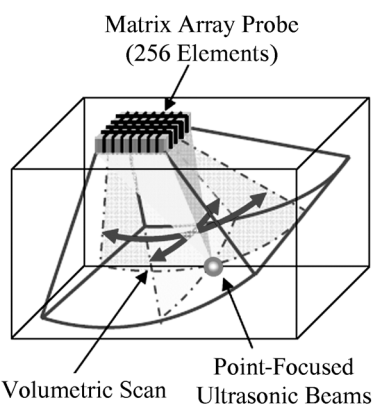

Fig. 1. Schematic image of 3D phased arrays

Fig. 2. Photo of 3D Focus-UT

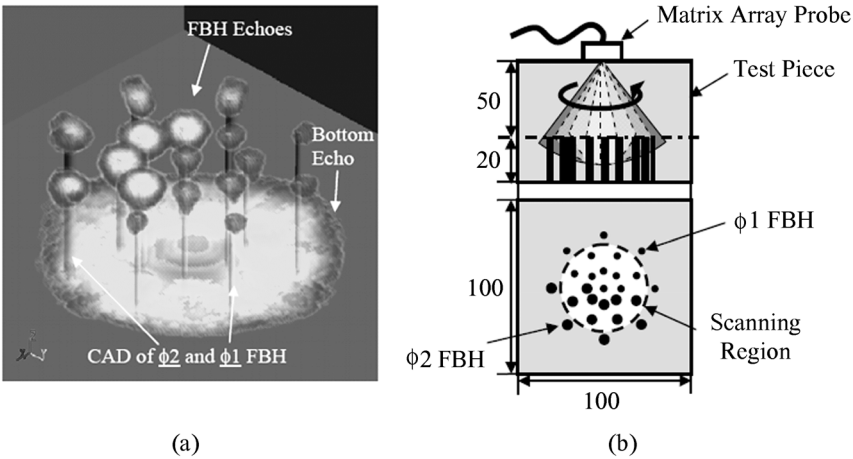

Fig. 3. (a) 3D image of FBHs in a stainless steel test piece and (b) schematic images of the test piece and the rotational sector scan

The probe used in this case was designed to transmit longitudinal waves at 2 MHz. The probe had 256 (16 × 16) elements. The pattern of the 3D scan was rotational sector scan, which was composed of 24 sectors positioned around the center line of the sectors in increments of 7.5 deg as illustrated in fig. 3 (b). The whole scan was performed electrically as the probe was kept at a one position without moving, and the entire time from beginning the 3D scanning to obtaining the 3D image was several seconds. As shown in fig. 3 (a), the 3D-CAD images of the FBHs and the inside walls of the test piece were superimposed on the echo image so that the correspondence of echoes and their reflection sources is easily determined.

Some other examples of 3D scanning will be presented in the presentation.