However, in the case of a matrix array probe, the controller thereof has a large number of control channels (hereinafter referred to simply as “the channels”) for independently controlling the timing (phase) of each transducer to transmit and receive an ultrasonic wave.

For example, in the case of a 64-channel controller, which is currently in frequent usage, the maximum number of elements of a matrix array probe is 8x8=64, and the number of split surfaces in the longitudinal direction and the lateral direction is small, leading to an excessive noise level.

[0010]

Further, increasing the number of channels of a controller requires newly developed hardware and software for a controller, thus requiring excessive cost and time.

[0011]

Embodiments of the present invention are made with a view toward solving the problems described above. Embodiments of the present invention provide a phased-array flaw-detection device which has a function for exciting a plurality of elements in circles in sequence and a function for exciting the plurality of elements in rows in sequence, and which is capable of simultaneously carrying out the two functions thereby to focus, for example, an ultrasonic beam into a circle and to cause the ultrasonic beam to travel in any direction and is also capable of reducing noise level without increasing the number of channels of a controller, and also to provide a phased-array flaw-detection method.

Solution to Problem

[0012]

According to a first aspect of the present invention, there is provided a phased-array flaw-detection device including: a phased-array probe having a plurality of ultrasonic transducers which are separated in a concentric circle pattern, separated in rows that are orthogonal to a reference line that passes through the center of circles, and positioned line symmetrically with respect to the reference line; and a controller having a plurality of control channels, wherein the controller is configured to simultaneously excite pairs of the ultrasonic transducers that are line symmetrical with respect to the reference line at the same phase.

[0013]

According to a second aspect of the present invention, there is provided a phased-array flaw-detection method, the method including: providing a phased-array probe having a plurality of ultrasonic transducers which are separated in a concentric circle pattern, separated in rows that are orthogonal to a reference line that passes through the center of circles, and positioned line symmetrically with respect to the reference line; and simultaneously exciting pairs of the ultrasonic transducers that are line symmetrical with respect to the reference line at the same phase.

Advantageous Effects of Invention

[0014]

According to embodiments of the present invention, a plurality of ultrasonic transducers are separated in the concentric

CLAIMS

1. A phased-array flaw-detection device comprising:

a phased-array probe having a plurality of ultrasonic transducers which are separated in a concentric circle pattern, separated in rows that are orthogonal to a reference line that passes through the center of circles, and positioned line symmetrically with respect to the reference line; and

a controller having a plurality of control channels,

wherein the controller is configured to simultaneously excite pairs of the ultrasonic transducers that are line symmetrical with respect to the reference line at the same phase.

2. The phased-array flaw-detection device according to claim 1,

wherein the phased-array probe has a circular detection surface for transmitting and receiving an ultrasonic beam, and

the detection surface has a plurality of segments divided into a plurality of arc-shaped portions that are symmetrical with respect to the reference line.

3. The phased-array flaw-detection device according to claim 2,

wherein dividing lines of the segments are composed of a plurality of concentric circular dividing lines that divide the circle into a plurality of annular portions, and a plurality of linear dividing lines which divide the annular portions into the arc-shaped portions and which are parallel to each other.

4. The phased-array flaw-detection device according to claim 3, wherein the linear dividing lines are orthogonal to the reference line passing through the center and are in contact with at least two points on the circumference of the circular dividing lines.

5. The phased-array flaw-detection device according to claim 3, wherein the number of the circular dividing lines is equal to or more than five.

6. A phased-array flaw-detection method, the method comprising:

providing a phased-array probe having a plurality of ultrasonic transducers which are separated in a concentric circle pattern, separated in rows that are orthogonal to a reference line that passes through the center of circles, and positioned line symmetrically with respect to the reference line; and

simultaneously exciting pairs of the ultrasonic transducers that are line symmetrical with respect to the reference line at the same phase.

7. The phased-array flaw-detection method according to claim 6, wherein, in vertical flaw detection carried out on a test piece, which has a cylindrical external surface, toward a centerline of the cylindrical shape from outside the test piece, and angle beam flaw detection in an axial direction, the reference line is directed in a circumferential direction that is orthogonal to the axial direction of the cylindrical shape to carry out flaw detection inspection on the test piece.

8. The phased-array flaw-detection method according to claim 6, wherein the number of circular dividing lines is equal to or more than seven, the number of linear dividing lines is equal to or more than fourteen, and the number of the ultrasonic transducers is equal to or more than sixty-four.

9. The phased-array flaw-detection method according to claim 6, wherein focusing the ultrasonic beam traveling along the reference line into a circle, by combining two delay rules of

one delay rule for the plurality of ultrasonic transducers separated in the concentric circle, are excited in sequence from an outer ring to finally the central element so as to focus the ultrasonic beam into a circle, and

another delay rule for the plurality of ultrasonic transducers separated on the rows that are orthogonal to the reference line, are excited in sequence in the direction along the reference line.