CLAIMS

[Claim 1]

An ultrasonic flaw inspection method for a cast bar, wherein, in performing ultrasonic flaw inspection by arranging two phased array type probes in a circumferential direction of the cast bar circular in cross-section at a predetermined angle,

the two phased array type probes are arranged at an arrangement angle α which satisfies following two formulas:

$$2 \times (180° - 2\theta_2 + \theta_3) \leqq \alpha \leqq 2\theta_2 - \theta_3 - \theta_4$$

$$180° - [3\theta_3 + 3(180° - 2\theta_2)] \geqq \theta_4$$

where

θ_2: effective inclined angle of a phased array type probe

θ_3: central angle of OP

θ_4: 1/2 of a central angle of a dead zone of a vertical incident wave of the phased array type probe

O: incident point of the vertical incident wave of the phased array type probe

P: incident point of an inclined angle incident wave at the maximum scanning angle of the phased array type probe, and

an uninspected region by a refracted longitudinal wave and a longitudinal wave of the one of the phased array type probes is complemented with an inspected region by a refracted longitudinal wave and a longitudinal wave of the other phased array type probe.

[Claim 2]

The ultrasonic flaw inspection method for a cast bar as recited in claim 1, wherein the two phased array type probes are arranged so that the incident waves travel downward.

[Claim 3]

The ultrasonic flaw inspection method for a cast bar as recited in claim 1 or 2, wherein a plurality of phased array type probes are arranged at a vicinity of a casting mold outlet of a horizontal continuous casting mold and ultrasonic flaw inspection is continuously performed for a continuous cast bar which is being continuously cast.

[Claim 4]

The ultrasonic flaw inspection method as recited in claim 3, wherein the continuous cast bar is loosely inserted into a through-hole of a dam-like member arranged apart from the casting mold outlet at a downstream side to interrupt flow of the cooling water, and

wherein the phased array type probes are arranged in a state in which the probes are in contact with the cooling water that the flow is interrupted.

[Claim 5]

An ultrasonic flaw inspection device for a cast bar, comprising two phased array type probes arranged in a circumferential direction of the cast bar circular in cross-section,

wherein the two phased array type probes are arranged at an arrangement angle α which satisfies following two formulas:

$$2 \times (180° - 2\theta_2+\theta_3) \leqq \alpha \leqq 2\theta_2 - \theta_3 - \theta_4$$

$$180° - [3\theta_3 + 3(180° - 2\theta_2)] \geqq \theta_4$$

where

θ_2: effective inclined angle of a phased array type probe

θ_3: central angle of OP

θ_4: 1/2 of a central angle of a dead zone of a vertical incident wave of the phased array type probe

O: incident point of the vertical incident wave of the phased array type probe

P: incident point of an inclined angle incident wave at the maximum scanning angle of the phased array type probe, and

an uninspected region by a refracted longitudinal wave and a longitudinal wave of the one of the phased array type probes is complemented with an inspected region by a refracted longitudinal wave and a longitudinal wave of the other phased array type probe.

[Claim 6]

A consistent manufacturing method for a forged product,

wherein, in a consistent production method of a cast product in which a continuous cast bar which is being continuously cast from a casting mold outlet of a horizontal continuous casting device is subjected to short-length cutting, peeling, and heat-treatment in an arbitrary order, and subsequently subjected to forging, the ultrasonic flaw inspection as recited in any one of claims 1 to 4 is performed immediately after casting or between arbitrary processes.

CLAIMS

1. An ultrasonic flaw inspection method for a cast bar,

wherein, in performing ultrasonic flaw inspection by arranging a plurality of phased array type probes in a circumferential direction of the cast bar circular in cross-section at a predetermined angle,

one of the phased array type probes and the other phased array type probe are arranged such that an uninspected region by a refracted longitudinal wave and a longitudinal wave of the one of the phased array type probes is complemented with an inspected region by a refracted longitudinal wave and a longitudinal wave of the other phased array type probe.

2. The ultrasonic flaw inspection method as recited in claim 1, wherein the two phased array type probes are arranged at an arrangement angle α which satisfies following two formulas:

$$2 \times (180° - 2\theta_2 + \theta_3) \leqq \alpha \leqq 2\theta_2 - \theta_3 - \theta_4$$

$$180° - [3\theta_3 + 3(180° - 2\theta_2)] \geqq \theta_4$$

where

θ_2: effective inclined angle of a phased array type probe

θ_3: central angle of OP

θ_4: 1/2 of a central angle of a dead zone of a vertical incident wave of the phased array type probe

O: incident point of the vertical incident wave of the phased

array type probe

P: incident point of an inclined angle incident wave at the maximum scanning angle of the phased array type probe.

3. The ultrasonic flaw inspection method for a cast bar as recited in claim 2, wherein the two phased array type probes are arranged so that the incident waves travel downward.

4. The ultrasonic flaw inspection method for a cast bar as recited in any one of claims 1 to 3, wherein a plurality of phased array type probes are arranged at a vicinity of a casting mold outlet of a horizontal continuous casting mold and ultrasonic flaw inspection is continuously performed for a continuous cast bar which is being continuously cast.

5. The ultrasonic flaw inspection method as recited in claim 4, wherein the continuous cast bar is loosely inserted into a through-hole of a dam-like member arranged apart from the casting mold outlet at a downstream side to interrupt flow of the cooling water, and

wherein the phased array type probes are arranged in a state in which the probes are in contact with the cooling water that the flow is interrupted.

6. An ultrasonic flaw inspection device for a cast bar, comprising a plurality of phased array type probes arranged in

a circumferential direction of the cast bar circular in cross-section, and

one of the phased array type probes and the other phased array type probe are arranged such that an uninspected region by a refracted longitudinal wave and a longitudinal wave of the one of the phased array type probes is complemented with an inspected region by a refracted longitudinal wave and a longitudinal wave of the other phased array type probe.

7. The ultrasonic flaw inspection device for a cast bar as recited in claim 6, wherein the two phased array type probes are arranged at an arrangement angle α which satisfies following two formulas:

$$2 \times (180° - 2\theta_2 + \theta_3) \leqq \alpha \leqq 2\theta_2 - \theta_3 - \theta_4$$

$$180° - [3\theta_3 + 3(180° - 2\theta_2)] \geqq \theta_4$$

where

θ_2: effective inclined angle of a phased array type probe

θ_3: central angle of OP

θ_4: 1/2 of a central angle of a dead zone of a vertical incident wave of the phased array type probe

O: incident point of the vertical incident wave of the phased array type probe

P: incident point of an inclined angle incident wave at the maximum scanning angle of the phased array type probe.

8. A consistent manufacturing method for a forged product,

wherein, in a consistent production method of a cast product in which a continuous cast bar circular in cross-section which is being continuously cast from a casting mold outlet of a horizontal continuous casting device is subjected to short-length cutting, peeling, and heat-treatment in an arbitrary order, and subsequently subjected to forging, ultrasonic flaw inspection is performed immediately after casting or between arbitrary processes, and

wherein the ultrasonic flaw inspection is performed by arranging a plurality of phased array type probes in a circumferential direction of the cast bar circular in cross-section at a predetermined angle, and arranging one of the phased array type probes and the other phased array type probe such that an uninspected region by a refracted longitudinal wave and a longitudinal wave of the one of the phased array type probes is complemented with an inspected region by a refracted longitudinal wave and a longitudinal wave of the other phased array type probe.

9. The consistent manufacturing method for a forged product as recited in claim 8, wherein the ultrasonic flaw inspection is performed by arranging two phased array type probes at an arrangement angle α which satisfies following two formulas:

$$2 \times (180° - 2\theta_2 + \theta_3) \leqq \alpha \leqq 2\theta_2 - \theta_3 - \theta_4$$

$$180° - [3\theta_3 + 3(180° - 2\theta_2)] \geqq \theta_4$$

where

θ_2: effective inclined angle of a phased array type probe

θ_3: central angle of OP

θ_4: 1/2 of a central angle of a dead zone of a vertical incident wave of the phased array type probe

O: incident point of the vertical incident wave of the phased array type probe

P: incident point of an inclined angle incident wave at the maximum scanning angle of the phased array type probe.