IMMERSION MULTI-ELEMENT INCLINED COMBINED TRANSDUCER FOR THE CONTROL OF WELDED SEAMS OF BIG DIAMETER PIPES DURING THE MANUFACTURE

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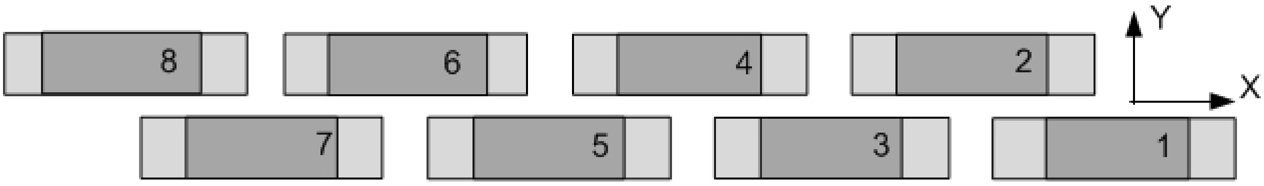
In practice of the automated ultrasonic control of welded seams of pipes of the big diameter in a stream of their manufacture wide application is found by the combined acoustic systems consisting of set single, mainly inclined, with various corners of input of ultrasonic fluctuations of piezoelectric converters probes. Probes are placed symmetrically on different distances from a longitudinal axis of a welded seam and are adjusted for revealing defects in various zones all volume of a welded seam. Single probes are placed in special boots who protect probes from deterioration and create local immersion a tray for acoustic contact. Boots are in turn fixed in the special electromechanical drives providing an opportunity spatial installation probe and reliable deduction probe in strictly set coordinates at scanning of acoustic system along a welded seam during his automated control. The acoustic system as a whole is a complex mechanical acoustic device in the extent 5 m and weight up to one ton.

For essential simplification and reduction of dimensions and weight of acoustic system of installation, authors it is offered immersion probe, the circuit of accommodation of piezoelements in which is resulted on figs 1 (it is shown in the plan in the developed kind). Thus should be provided necessary reliability and productivity of the automated control of welded seams of pipes of the big diameter (Ø 1020 - 1420 mm) with thickness of a wall up to 48 mm.



Figs 1. The circuit of accommodation of piezoelements on the common prism

The converter will consist of lines of the piezoelements, in this case to eight, placed in chessboard order under a necessary corner on the common prism from a glass organic.

Works probe as follows.

The generator ultrasonic system raises in each step only one piezoelement, for example, the piezoelement 1, and reception of the reflected signals from a body of a wall of a pipe and bearing{carrying} the information on quality of welded seam ultrasonic control is carried out by all eight piezoelements. Thus pair the piezoelements placed in different lines, but the nearest to each other (for example, piezoelements 1 and 2), work in separately - combined mode. Pair the piezoelements placed in one line (for example, piezoelements 1 and 3), work in a mode "tandem". In a mode "tandem" any pair piezoelements, except for the piezoelements working in separately - combined mode can work. Besides each piezoelement can work as usual inclined probe in the combined mode.

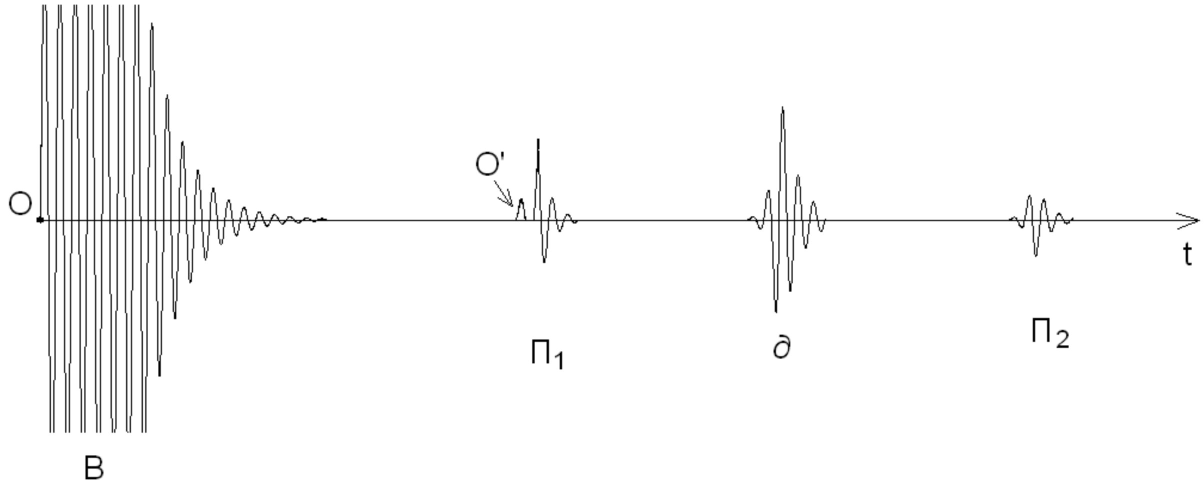
Thus, offered multielement inclined probe in immersion a variant allows to combine three possible verification modes: combined, separately - combined and "tandem". It is known, that in the combined mode volumetric defects, in a mode "tandem" - plane defects, and in separately - combined mode - volumetric and volumetric - plane better come to light.

Hence, offered immersion suggested inclined multielement probe will allow to reveal both volumetric, and volumetric - plane and plane defects, that, in opinion of authors, allows to use multielement probe as replacing the complex and bulky acoustic system constructed from set single probe and coordinate mechanisms of their orientation. Such simplification of mechanical acoustic system is capable to raise quality and reliability of the control of welded seams of pipes.

Some results of laboratory researches offered by authors probe are below resulted. For tests the generator of shock excitation with duration of a pulse at a level 0,5 equal 0,1 μs both amplitude

150V, and the amplifier with a strip of amplification 0,5 ÷ 30 MHz and factor of amplification ≈ 200 has been used. As a control reflector through aperture Ø2 mm in a plane-parallel steel sample thickness 30 mm is used.

The oscillogram echo-signals with are observed on an output of the radio-frequency amplifier, at work of one piezoelement in the combined mode, is resulted on figs 2. On the oscillogram the following designations are accepted: B - a stimulating pulse; Π_1 - echo-signal from a surface of a sample; ∂ - echo-signal from the bottom part of a through aperture; Π_2 - the second reflection echo-signal from a surface of a sample.



Figs 2. Eho-signals the combined mode on an output of the radio-frequency amplifier:
The letter B designates a stimulating pulse which forward front meets t = 0;
Π_1 - the first echo-signal from a surface of a sample; ∂ - echo-signal from a ground part control reflector.

The time interval 0 - Π_1 meets to time of a double course echo-signal in a layer of water. The back front echo-signal Π_1 is the beginning of a zone of the control. As a rule echo-signal Π_2 it appears in a zone of the control, therefore for the qualitative control of a welded seam the level of it echo-signal should be in 3 - 4 times of less level useful echo-signals.

To exclude influence echo-signal Π_2 it is possible in two ways. The first - to increase thickness of a layer of water so that echo-signal Π_2 appeared outside of a zone of the control. For thickness of metal 40 mm the layer of water should be ≈ 60 mm. Clearly, that this way can create complexities at designing and operation of the acoustic block. The second - to reduce thickness of a layer of water so that the back front echo-signal Π_2 defined the beginning of a zone of the control. In this case echo-signal Π_1 will coincide with a stimulating pulse B (thickness of a layer of water is equal 8 - 10 mm). However this way results in reduction of a zone of the control.

For each concrete thickness of a wall of a pipe thickness of a layer of water should provide a necessary zone of the control. Optimum thickness of a layer of water is equal our case 20 - 30 mm.

During laboratory researches probe levels of amplitudes echo-signals on an output of the radio-frequency amplifier have been determined width of a zone of the control (working pathes) on axes X and Y, and also. The width of a zone of the control over a level 0,5 on axis X is equal 13 mm and remains to a constant up to depth 200 mm. The width of a zone of the control over axis Y changes depending on depth: on depth 30 mm it is equal 12 mm, on depth 60 mm - 16 mm, on depth 90 mm - 22 mm. Levels of amplitudes echo-signals on an output of the radio-frequency amplifier (figs 2) the following: $A_{\Pi 1}$ = 0,2 V; $A_{\Pi 2}$ = 0,1 V; $A_{\partial 1}$ = 0,7 V - for the bottom part of a through aperture (a direct beam) and $A_{\partial 2}$ = 0,3 V for the top part of a through aperture (once the reflected beam). Clearly, that at work separately - combined probe or probe "tandem" levels of amplitudes echo-signals Π_1 and Π_2 essentially decrease. Levels of amplitudes echo-signals remain constant at length of radio-frequency cable PK-50 up to 32 m.

During research offered probe in the field of forward front echo-signal Π_1 the signal of a small level O' - the shortest distance on water there and back between the bottom part of piezoelement probe and a surface of a sample has been noticed. The moment of time in which there comes this signal, it is necessary to use for definition of time of a double course of pulse ultrasonic control of shift waves (and other waves) in metal of a pipe. In our case, for example, the time interval O'- ∂ meets to time of a double course of a pulse of shift waves at reflection from the bottom part of a through aperture (a direct beam) sample is equal 30 μs, and at reflection from the top part (once the reflected beam) - 60 μs.

Supervision of this signal O' is useful at adjustment probe with use of a corresponding sample of a pipe. Adjustment probe is reduced to change of a corner of an inclination of a working surface of a prism concerning a surface of a sample. At correct option probe the layer of water has wedge the form (the corner of an inclination is close to 10º). Presence wedge a layer of water is useful for effective washing off bubbles air which stick to a radiating surface of a prism. Especially it is necessary, when the acoustic block is located above a surface of a pipe.

On the basis of the lead researches suggested probe it is possible to draw the following conclusion: use of set of piezoelements in a design of one probe allows to carry out a principle of electronic scanning of a welded seam of pipes one probe, the controlled one mechanism of scanning, i.e. in this case disappears necessity of use of bulky mechanical acoustic system with group of mechanisms of scanning for management single probes.