

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

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In the report the design of immersion multi-element inclined piezoelectric transducer intended for use in installations of the automated ultrasonic control of a welded seam of thick-walled pipes during their manufacture is offered.

Feature of piezoelectric transducer design will be, that set of the same piezoelements are placed on the common prism from plexiglas, a working surface of a prism is flat. Piezoelectric transducer is intended for the control of plane-parallel products. Walls of pipes of the big diameter $\varnothing 1020 - 1420$ mm with the certain degree of the admission can be considered as plane-parallel object of the control.

Authors made pre-production models of piezoelectric transducers and their laboratory researches are executed. The placement of accommodation of piezoelements on the piezoelectric transducer prism is shown on fig. 1.



**Fig. 1. Accommodation of piezoelements on the prism
(it is shown in the plan in the developed kind)**

Each piezoelement enters in metal of a wall of a pipe a pulse beam of shift waves under a corner 50° . At the control of a welded seam of a pipe one mirror reflection from a ground surface of a wall is used. Each piezoelement can work as usual inclined piezoelectric transducer in the combined mode. The pair the nearest to each other piezoelements, placed in different lines, can work in separately – combined mode. The pair the piezoelements placed by a number in one line can work in a mode of tandem. In a mode of tandem it is possible to use any pair of piezoelements, except for pair separately – combined a mode. In each step of work detector one piezoelement is raised, and reception of echo – signals is expedient for carrying out all piezoelements, i.e. in one step it is possible to realize some operating modes of piezoelectric transducers. Thickness of a layer of water between a radiating surface of a prism (a working surface) and a surface of object of the control can be varied in limits from 8 mm up to 60 mm.

Adjustment of piezoelectric transducer on any control reflector (CR) is reduced to change of a corner of piezoelectric transducer inclination concerning a surface of a control sample of object of the control. At adjustment it is enough to use any piezoelement in the combined mode or in any other mode. At correct adjustment the layer of water has cornered kind (the corner of an inclination is close to 10° that improves an opportunity of washing off air balls, settling on a working surface of a prism. Especially it is important, when the acoustic block is located above a surface of object of the control. Working frequency of piezoelectric transducer's piezoelements is equal 5 MHz. In piezoelectric transducer's case for each piezoelement with the purpose of reduction of influence of length of

a connecting radio-frequency cable by a level of amplitudes echo-signals the high-frequency transformer is used, allowing to work with a radio-frequency cable in length up to 32 m.

At performance of laboratory researches the generator of shock excitation has been used: duration of a pulse $0.1 \mu\text{s}$ (at a level 0.5), amplitude is 150 V. Echo-signals were observed on an output of the radio-frequency amplifier: a strip of amplification is 0.5 – 30 MHz, coefficient of amplification 200. For CR through aperture with diameter 2 mm in a steel plane-parallel sample is used. Amplitude of echo-signal is not less than 0.7 V from a ground part CR and not less than 0.3 V from the top part CR. The following results are received. The width of a zone of the control of a piezoelement of object of the control over an axis X is equal 13 mm (at a level 0,5) and is constant on depth up to 200 mm, and the zone on an axis Y is changes: on depth 30 mm it is equal 12 mm, on depth 60 mm – 16 mm, on depth 90 mm – 22 mm.

Use of set of piezoelements in a design of one piezoelectric transducer allows to carry out a principle of electronic scanning of metal of object of the control one piezoelectric transducer, the controlled one mechanism of scanning, i.e. in this case disappears necessity of use of group of mechanisms of scanning for management single piezoelectric transducers. Results of tests of pre-production piezoelectric transducer models in real conditions of the control of a welded seam of thick-walled pipes will be taken into consideration in the creation of a series immersion multi-element inclined piezoelectric transducers of the specialized purpose.