V. Sel'skii and A. Sel'skii (Russia)

PROSPECTS FOR USING STONELEY WAVES IN MONITORING THE QUALITY OF CLAD METALS

Speaker: Alexander Bogunov, General director
JSC "Pulse Technology", Krasnoyarsk

JSC «Pulse technologies»

Address: 660001
RUSSIA,KRASNOYARSK,
KRASNOY ZVEZDI ST, 1
Email: limom1@yandex.ru

JSC «Pulse technologies»

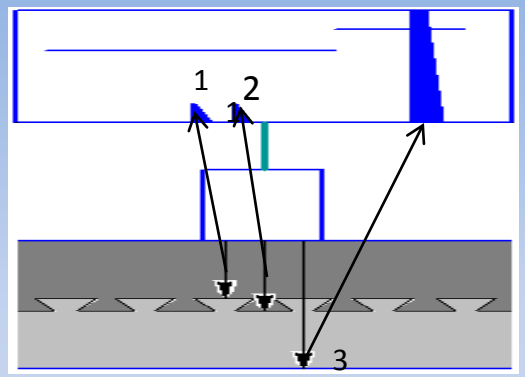
Fabrication of the steel-aluminum transition inserts for anode holder of aluminum electrolyzers.

Development of the explosive welding technology with a dovetail-type bond.

About 200 000 steel-aluminum inserts were manufactured and delivered to aluminum industry.

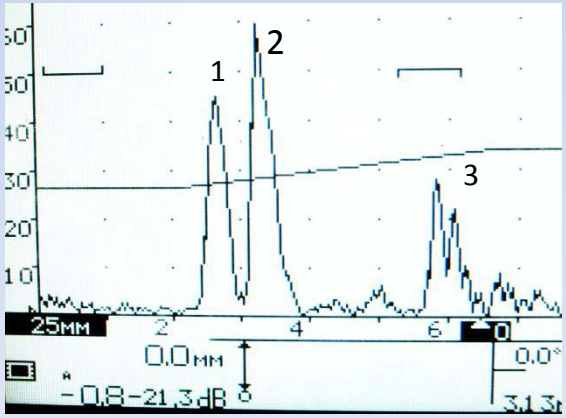
1. Ultrasonic test of products with bimetal dovetail-type connection

a) Scheme



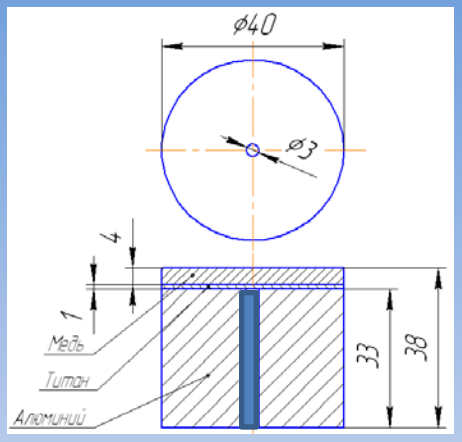
Inspection

b) Device display

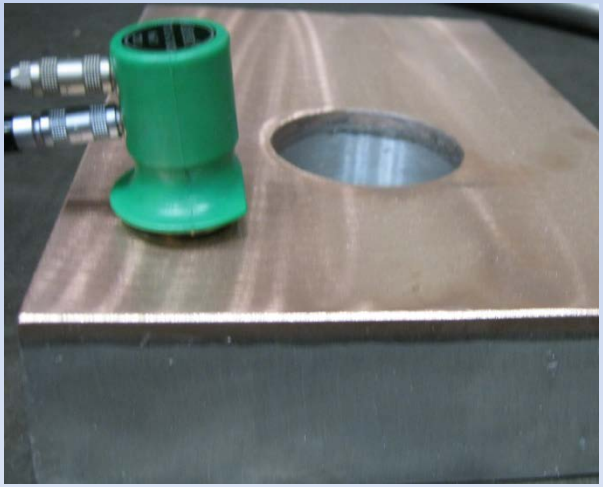


Ultrasonic inspection method can be used to control not only the bimetals with a flat boundary but the ones with a dovetail-type connection too

2. Flaw detector calibration sample and its application



sketch sample

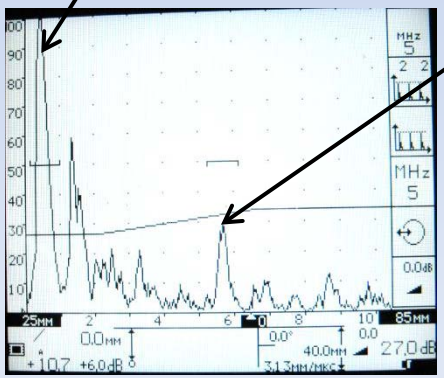


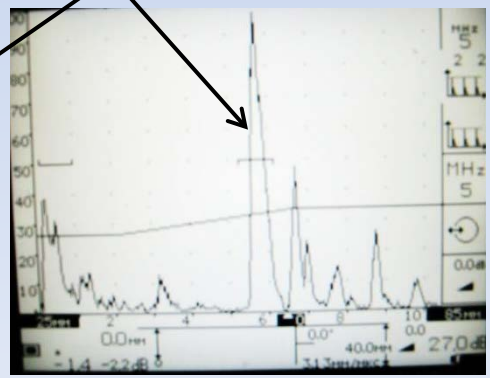
ultrasonic testing takes a lot of time!

instrument calibration:

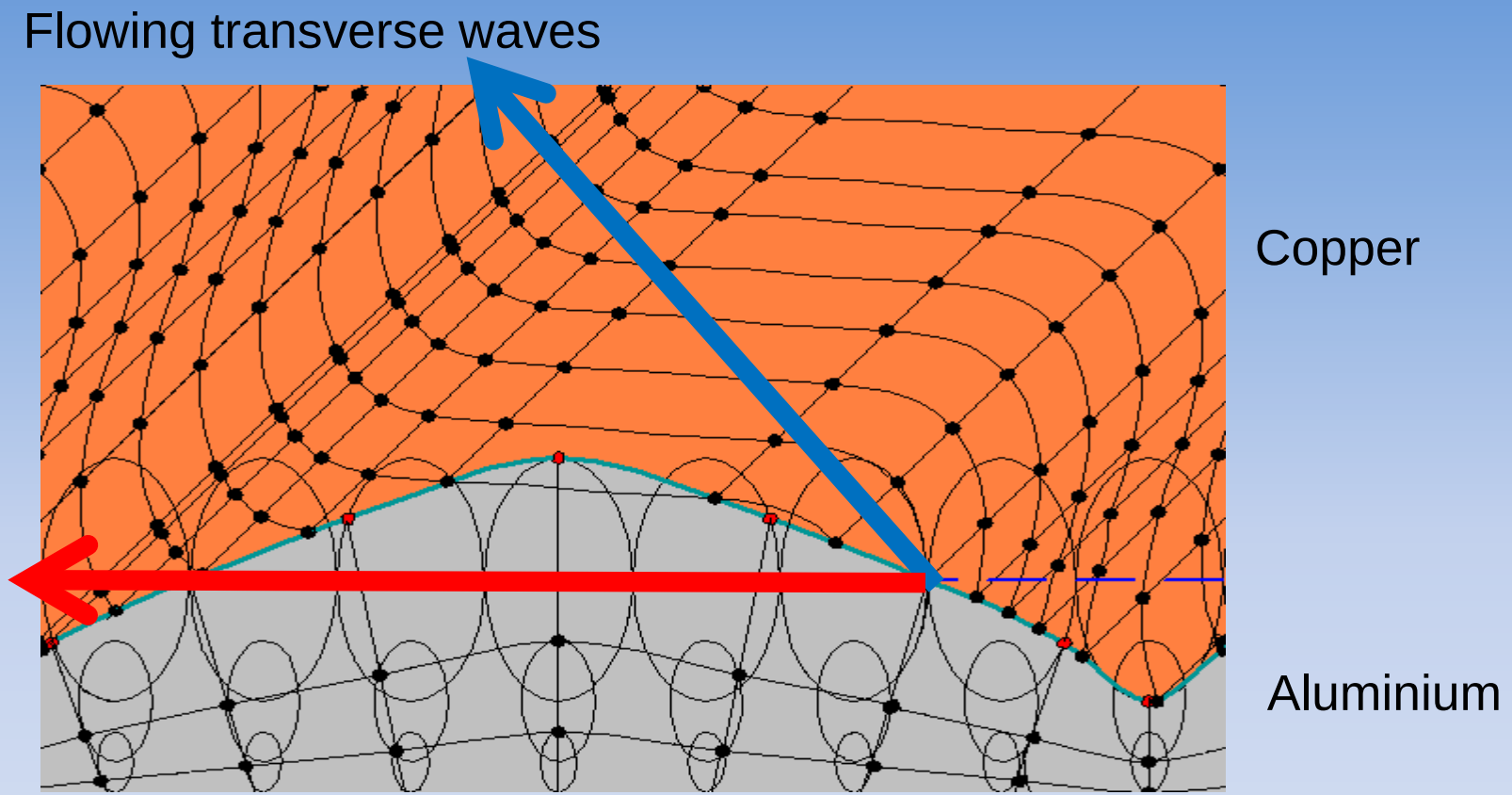
a) signal from the defect

b) bottom signal





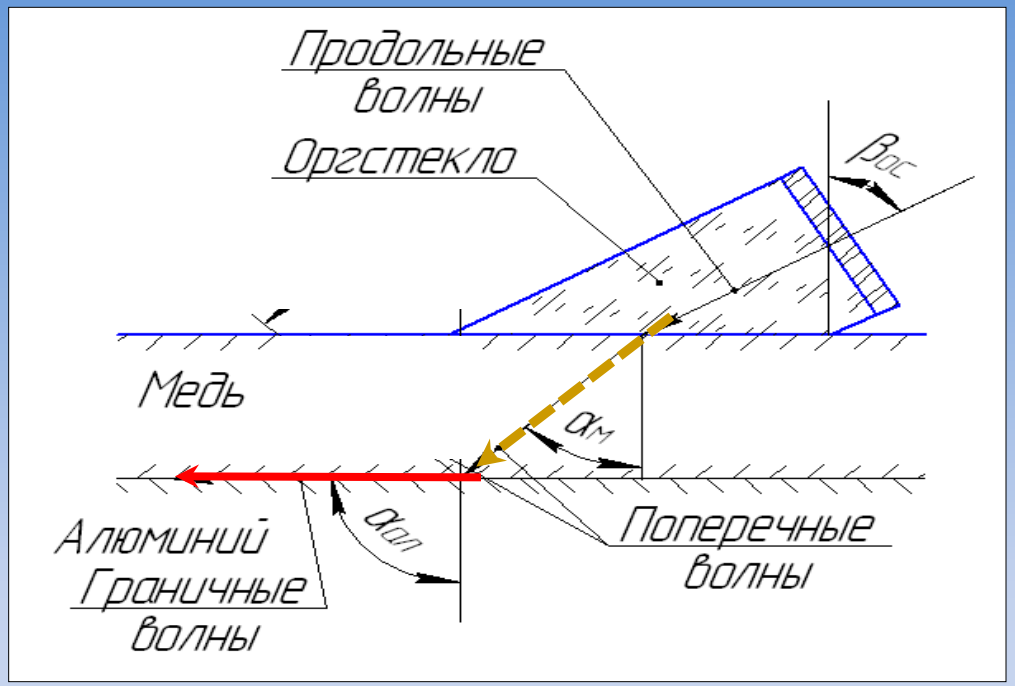
3. Stoneley waves



Stoneley Waves are bending sound waves on the border of connection two metals with different acoustic properties.

They are continuously accompanied by release of transverse waves in the metal with a lower sound speed.

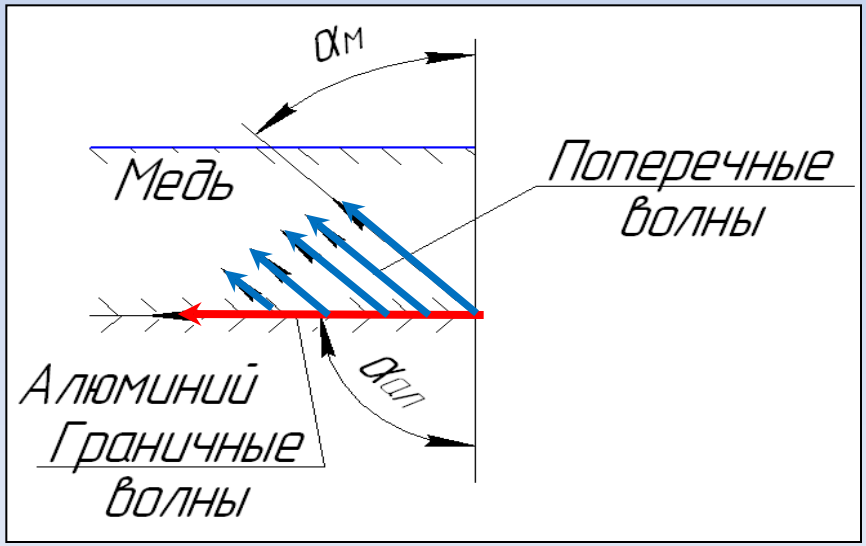
4. How Stoneley waves are formed



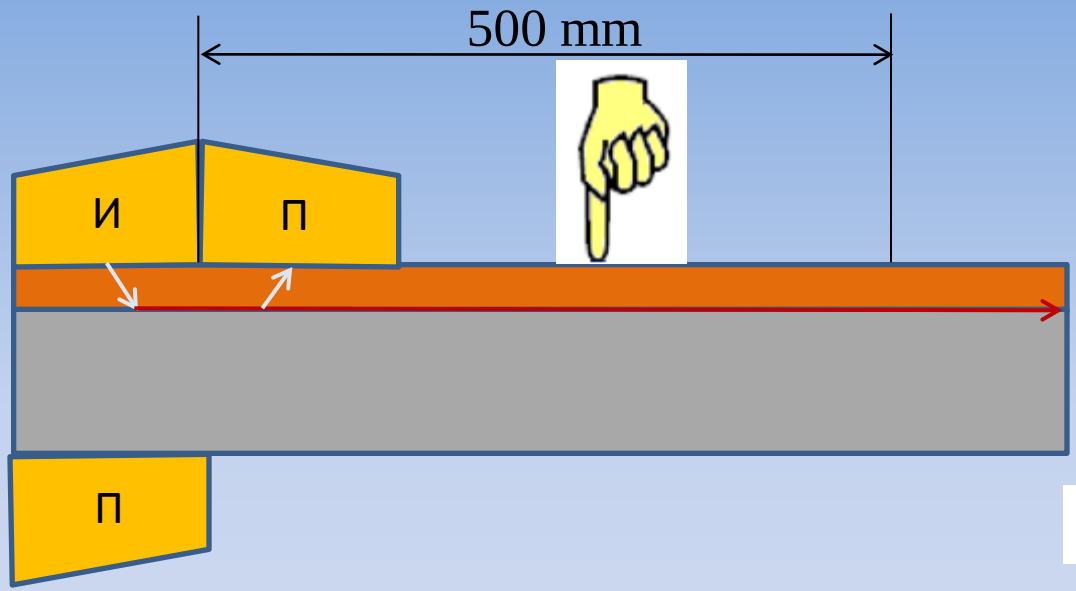
$$\frac{\sin \alpha_м}{C_t^м} = \frac{\sin \alpha_{ал}}{C_t^{ал}}$$

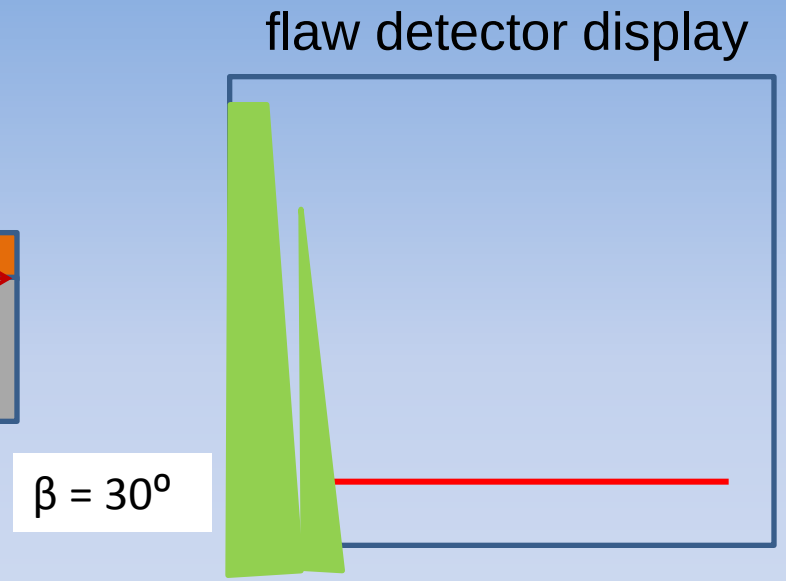
Stoneley wave formation on the boundary of two metals due to reflection and refraction law (Snellius law)

Stoneley wave accompanying by the continuous discharge of the transverse waves in the copper layer



5. Experimental verification of the Stoneley waves formation and transverse waves arising





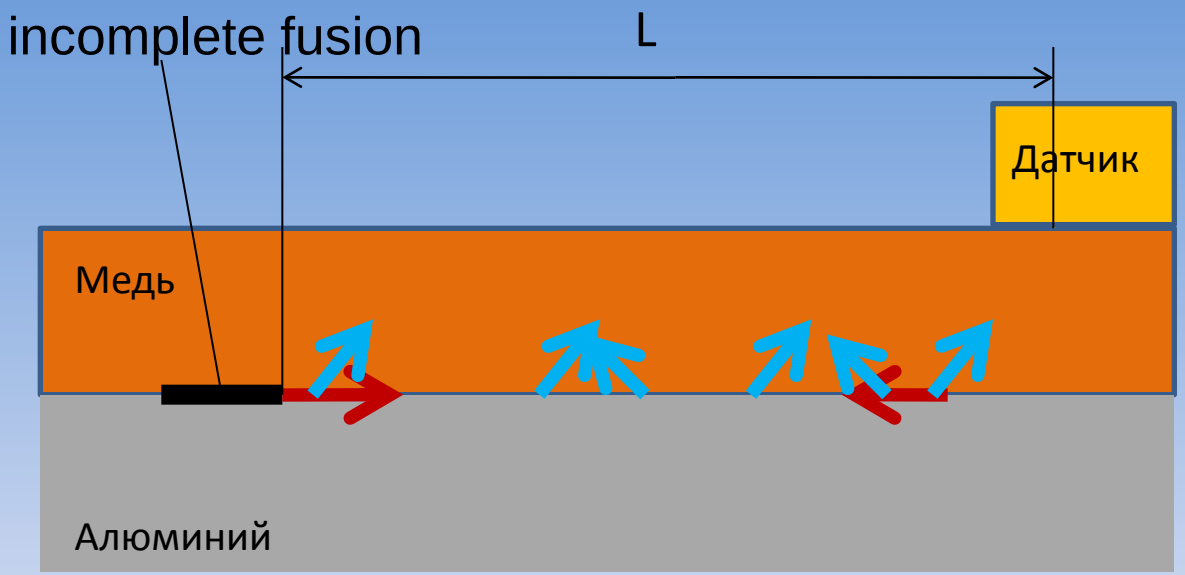
Transmitted signal is observed at the distance between the sensors of 0.5m, it does not respond to palpation of the copper surface.

There is no waves outflow in the amount of aluminum at any angle.

CONCLUSION

Stoneley waves exist on the "copper - aluminum" border and are accompanied by an active outflow of transverse waves only into copper.

6. How Stoneley waves work



resulting transverse waves

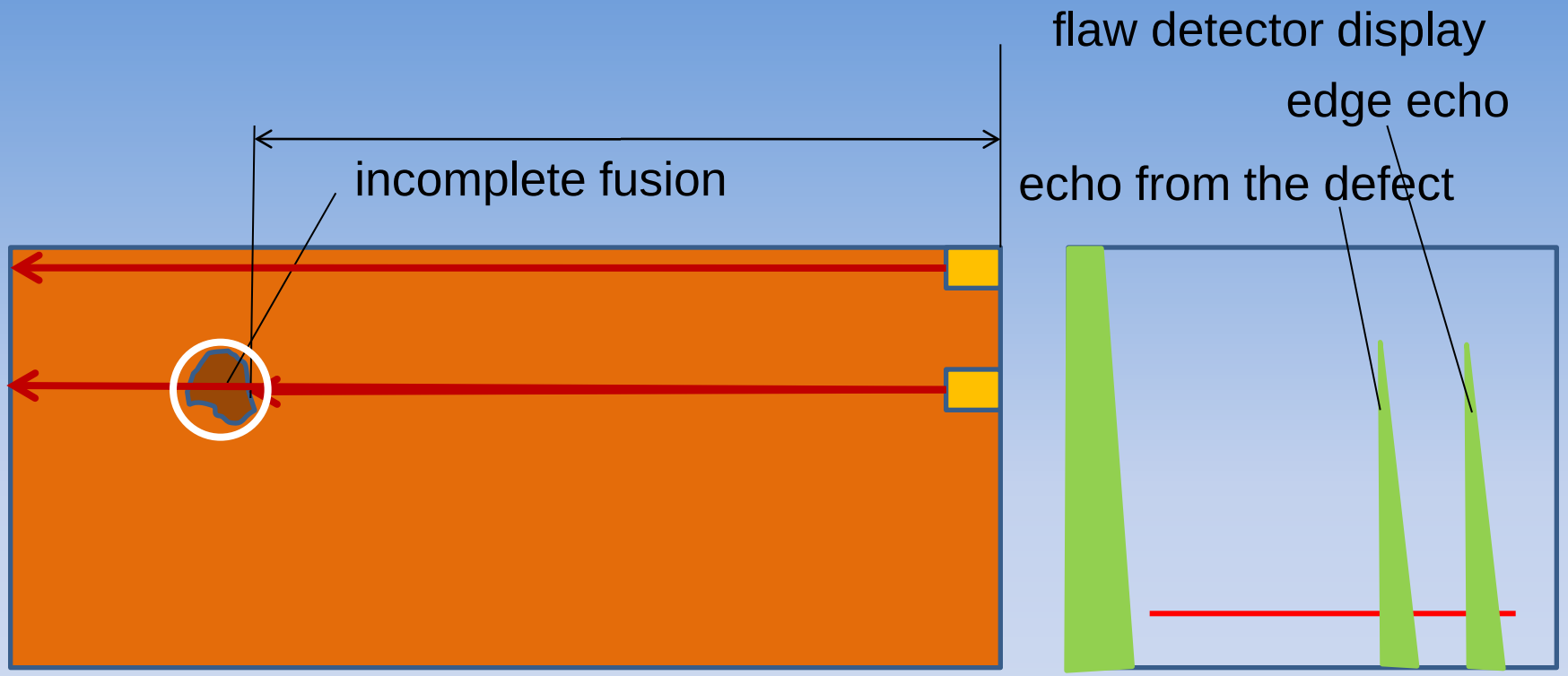
Stoneley waves

1. Starting of the pulse of transverse waves into copper.

2. Conversion of the transverse waves into the Stoneley waves on the metal border by the transverse waves outflow back into copper.

3. The signal reflection from the defect edges, sensor receiving of resulting transverse waves. By the echo time delay and the Stoneley waves velocity the device detects the distance L from the sensor to the edge of the defect.

7. Defective areas searching by Stoneley waves



Scanning in turn along all edges of the plate with the signal direction from the edge.

As a result approximate contours of the defective area emerge.

Search of the incomplete fusion defective areas speeds up significantly

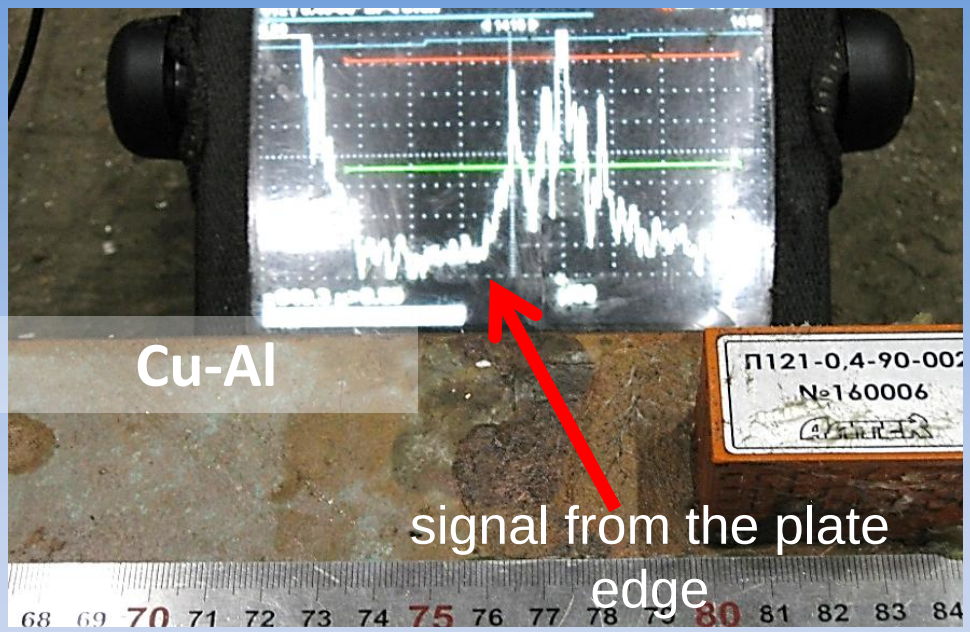
8. Equipment

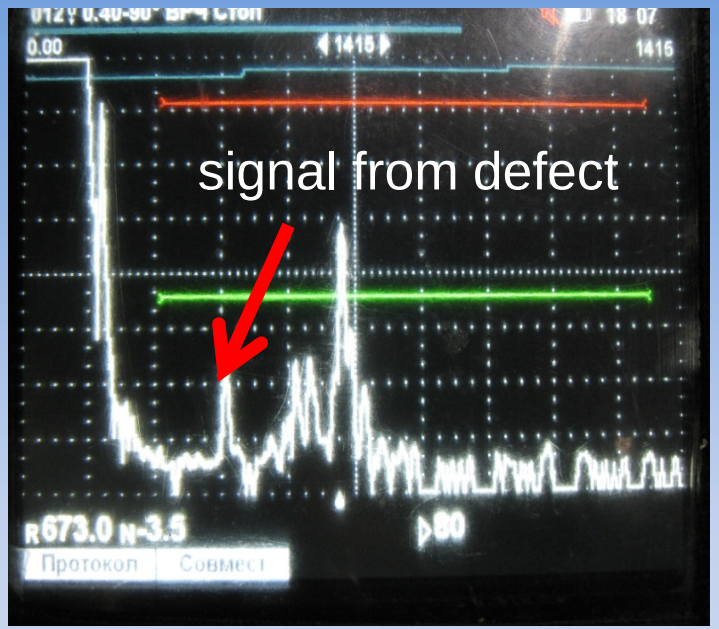
1. Ultrasonic defector flaw UD3-204 "Peleng".
Frequency range 0.4 - 10.0 MHz.
Gain control range 100 dB.
Reflectors Coordinate Measuring up to 5000mm

2. Piezoelectric transducer P121-0,4-90-002.
Frequency 0.4 MHz.
Angle of transverse waves entry:
into steel, aluminum, titanium 90˚
into copper ≈ 50˚

3. Other detectors are suitable, those provided with the frequency register of 0.4 MHz and the value of the input angle of 90˚, and similar by the main parameters.

9. Photos of experiments





1) According to the arrival time of the Stoneley wave, reflected from the plate end, velocity on the border of Cu-Al is defined 2320 m/s, the wavelength 5,8mm, f = 400kHz.

2) The end plate reflection is steadily recorded at a distance up to 1m.

3) Stoneley wave velocity within this range is constant.

CONCLUSIONS

1. Initiation of Stoneley waves on the metal boundary in bimetal "copper-aluminium" is possible in principle.

2. Stoneley waves on the boundary "copper - aluminum" are all the way accompanied by transverse waves outflow into copper only.

3. There are standard devices and sensors that are finalized to initiate low-frequency Stoneley waves on the metal border "copper-aluminum."

4. The group velocity of Stoneley waves at the border "copper-aluminum" is 2320 m/s at a frequency of 0.4 MHz the wave length is 5.8 mm.

5. The echo signal from the incomplete fusion edge Ø ≈ 12mm (S ≈ 100mm^2) at Stoneley waves frequency of 0.4 MHz is clearly observed at a distance of up to 1000mm.

6. Implementation of the method will significantly improve the performance of ultrasonic testing of bimetallic plates.

THANKS FOR YOUR ATTENTION!