POSSIBLE WAY TO INCREASE THE EDDY CURRENT INSPECTION PRODUCTIVITY

V. Uchanin [1] , G. Nardoni [2]
[1] Karpenko Physico-Mechanical Institute of National Academy of Sciences, Lviv
[2] I&T Nardoni Institute, Folzano, Brescia, Italy

Eddy current (EC) method is widely applied for inspection of semi-finished components (like forgings) for the purpose of the surface defect detection. The manual inspection of large forgings by EC method is time consuming due small size of probe needed for sensitive crack detection. In this case the EC probes with elongated sensitivity area are applied to increase the inspection productivity. But such probes don’t secure the sensitivity requirements assurance due low performance characteristic. Best productivity can be achieved by application of the multiplexing inspection systems based on array type probes. But such systems are expensive enough and difficult in recalibration for different size forgings.

Special EDDYLINE type EC probe was developed to increase EC inspection productivity. EDDYLINE type EC One-Channel Array probe consists of 5 separate EC probes connected by specially developed matching unit to summarize the signal responses of each separate EC probe for operation with one channel flaw detector [1]. All separate EC probes are realized by double differential scheme for better noise suppression [2]. Each of these probes is installed inside the 12 mm diameter cylindrical aluminum case. Due such connection high sensitivity length (near 60 mm) was created. At the same time high spatial resolution was provided because each of EC probes is operated separately with the same sensitivity as before connection.

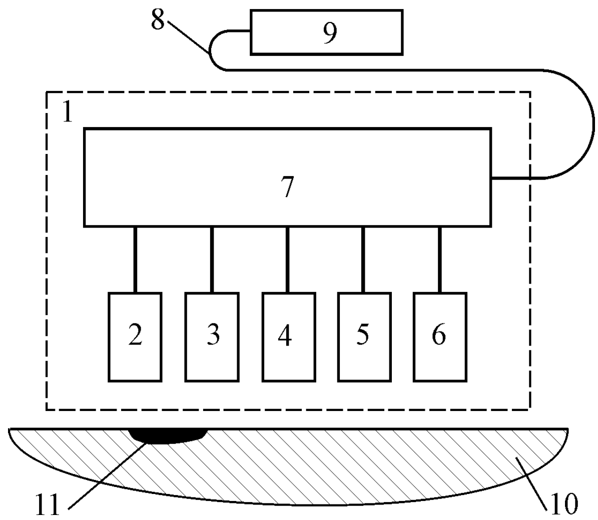

Fig. 1. The scheme of EC inspection with EDDYLINE type EC probe.
1 – EDDYLINE type EC probe; 2-6 – double differential type EC probes; 7 – matching unit; 8 – connecting cable; 9 – flaw detector; 10 – inspected specimen; 11 – flaw.

The investigations were carried out with the application of the special reference standard specimen fabricated from ferrous steel 45 with smooth (A – Ra 1.25 μm) and rough (B – Rz 160 μm) surfaces (fig. 2). Surface roughness on the surface B is simulated in the form of the sawcut grid with sawcut pitch, thickness and depth 1.0; 0.5 and 0.16 mm respectively. The artificial electrical-discharge-machined slots were 0.1 mm wide 30 mm long with depth 0.1; 0.2; 0.5; 1.0 and 2.0 mm on the smooth surface A and 0.6; 1.5 and 3.0 mm on the rough surface B.

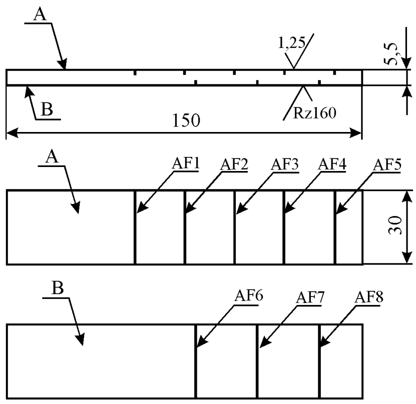

Fig. 2. Specimen for EDDYLINE type EC probe investigations.

All defects on both (A and B) surfaces in presented specimen were successfully detected with high signal to noise ratio. Let us consider the specificity of EDDYLINE type EC probe by the example of signals from shallowest 0.1 and 0.2 mm depth slots.

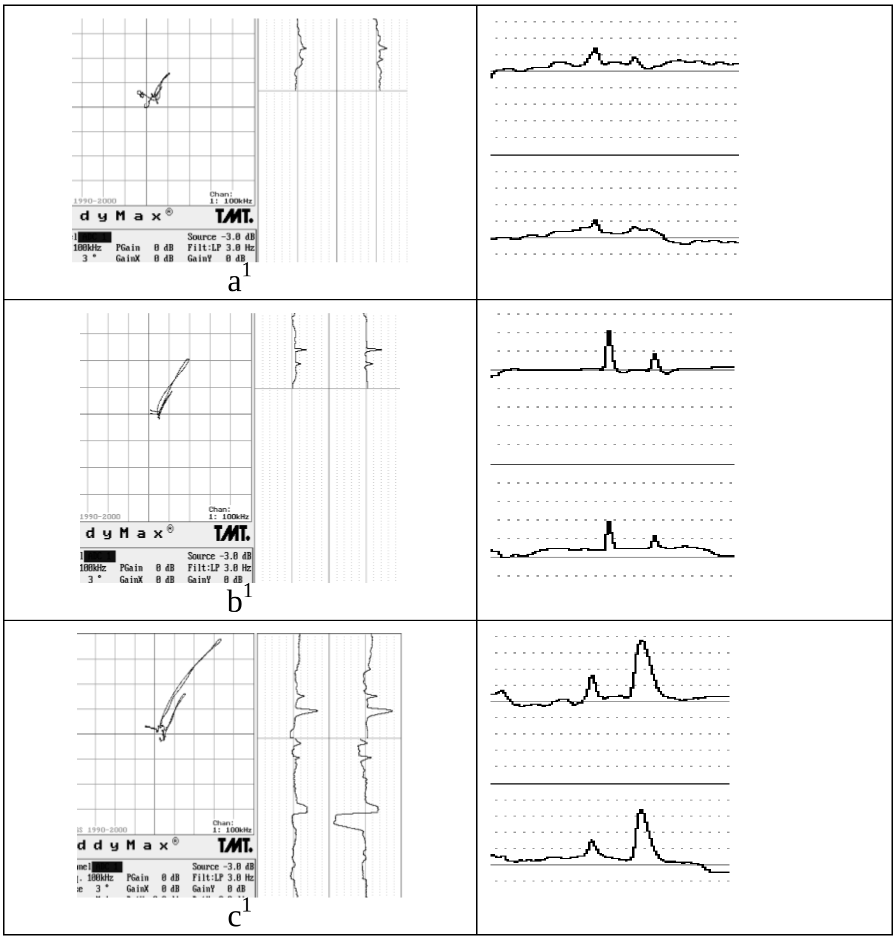

Fig. 3. EDDYLINE type EC probe signals in complex plane (a^1,b^1,c^1) and in time base mode (a^2,b^2,c^2) for one (a), two (b) and three (c) probes scanning across the shallowest 0.1 and 0.2 mm depth slots.

Fig. 3a show the signals of EDDYLINE type EC probe from shallowest 0.1 and 0.2 mm depth slots in situation when only one double differential type EC probe was scanned across the flaw area. At this time other 4 probes were situated out of specimen (in the air). Next picture (Fig. 3b) show the signals of the same slots when two double differential type EC probes were scanned across the flaw area simultaneously. And last picture (Fig. 3c) show the signals of the same slots when three double differential type EC probes were scanned across the flaw area at the same time.

So, each of additional probes scanned across the long crack increase the signal amplitude proportionally to the number of probes transferred across the flaw.

Fig. 4 shows the lift-off signal of EDDYLINE type EC probe in complex plane and in time-base mode for comparison. You can see the opposite direction of lift-off signal (Fig. 4) in comparison with signals from the flaws (Fig. 3)

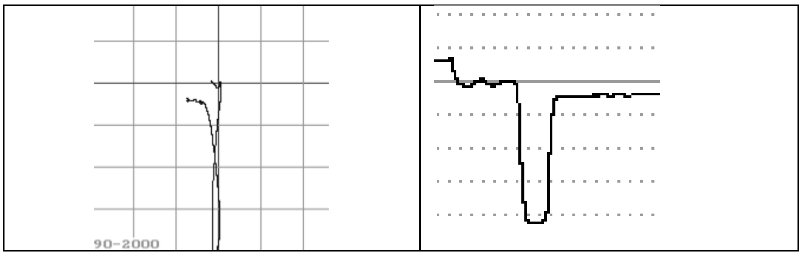

Fig. 4. Lift-off signals of EDDYLINE type probe in complex plane (left) and in time-base mode (right).

Special ferromagnetic and stainless steel specimens with 0.2; 0.3; 0.5; 1.0 and 2.0 mm depths electrodischarge slots were produced for calibration of the EDDYLINE type EC probe before inspection. Fig. 5 show the signals of EDDYLINE type EC probe from 0.2 and 0.5 mm depth slots in ferromagnetic steel specimen on the screen of ELOTEST B 300 flaw detector on operational frequency 200 kHz.

a b

Fig. 5. Signals in complex plane obtained for 0.2 mm (a) and 0.5 mm (b) depths slots in ferromagnetic steel specimen (upward) and lift-off signal (downward).

Fig. 5 show the differentiation of flaw signals and lift-off by the hodograph direction. Such feature permits to improve the inspection reliability. EDDYLINE type EC probes were successfully applied for inspection of forgings in connection with ELOTEST B 300 flaw detector. Similar results were obtained with the signals of EDDYLINE type EC probe with 0.2 and 0.5 mm depth slots in stainless steel (nonferromagnetic) specimen on the operational frequency 610 kHz.

Conclusions. New EDDYLINE type EC one-channel **array** type probe was developed to increase the EC inspection productivity. Developed EC probes were successfully applied for detection of cracks in ferromagnetic and stainless steel tube forgings. Application of EDDYLINE type EC probes facilitates the increase in inspection productivity 4…5 times.

1. Uchanin V., Nardoni G., Nardoni P. et all. New eddy current one-channel array probe for efficient inspection of tube forgings // Proc. of 14th Int. Conf. “Application of Contemporary Non-Destructive Testing in Engineering”, Sept. 4-6, 2017, Bernardin, Slovenia. – P. 213-217.

2. Uchanin V. Surface double differential type eddy current probes, Lviv: Spolom. – 2013. – 268 p. (in Ukrainian).