Regula forensic science systems

Certified Quality Management System

HARDWARE AND SOFTWARE SYSTEM
FOR FORENSIC EXAMINATION OF
FIREARMS AND AMMUNITION SERIAL NUMBERS
REGULA 7517.

EDDY-CURRENT MAGNETOGRAPHING DEVICE
REGULA 7517B

User's Guide

Regula Ltd.
2017

СОДЕРЖАНИЕ

INTRODUCTION

The current User's Guide is the main operational document to the eddy-current magnetographing device Regula 7517B (hereinafter — the ECMD or the device) which is included into the hardware and software system for forensic examination of firearms and ammunition serial numbers Regula 7517. As a part of the hardware and software system the ECMD is used together with the magneto-optical device Regula 7517A and magnetizing equipment Regula 7517C.

The User's Guide contains information concerning the ECMD design, principles of operation and specifications. It also provides instructions on the correct and safe use of the device (intended use, maintenance, routine repairs, storage and transportation) and on its technical condition evaluation when deciding whether it is necessary to send the ECMD for repairs.

1 DESCRIPTION AND OPERATION

1.1 Device function

Regula 7517B is intended for examining the surface of objects made of electroconductive materials and increasing the sensitivity of the magnetographing (magnetic copying) process in the upper layers of ferromagnetic objects. The ECMD is used as a module that enhances magneto-optical devices Regula 7517 intended for forensic examination of firearms and ammunition serial numbers.

The ECMD allows examining serial numbers on data carriers made of aluminum alloys and extends the possibilities of equipment in examination of weak signals in surface layers of ferromagnetic objects, e.g. residual (internal) stress.

1.2 Technical specifications

Main technical specifications of ECMD:

Table 1

Parameters and Specifications	Values or comments
Controller power supply, V/A	12/1
Magnetographing current, A, not more than: – static scanners – dynamic scanners	 1500 150
Effective magnetographing width, mm, not more than	20
Effective magnetographing width – static scanners, mm, not more than	17
Nonflatness of examined surface, mm, not more than: – dynamic scanners – static scanners	 0.5 2
Scanning speed, mm/s – dynamic scanners	50
ECMD design life, years, not less than	5
Dimensions (L×W×H), mm: – static scanners – dynamic scanners – controller – power adapter	 30×45×75 28×30×35 160×100×30 100×80×30
ECMD total weight (gross), kg	3.5
Climatic conditions for operation and storage	in accordance with technical requirements for magneto-optical devices Regula 7517A

1.3 Delivery set

The ECMD delivery set is given in Table 2 and shown in Figure 1.

Table 2

Name	Quantity, psc.	Marked in Figure 1 as
Controller	1	pos. 1
Static Al-scanner	1	pos. 2
Static Fe-scanner	1	pos. 3
Magnetizing staple	1	pos. 4
Spare conductors of the inductor for static Al-scanners	3	pos. 5
Spare conductors of the inductor for static Fe-scanners	3 (pairs)	pos. 6
Dynamic Al-scanner	1	pos. 7
Dynamic Fe-scanner	1	pos. 8
Magnetizing cap of the dynamic Fe-scanner (wide — effective magnetographing width 18 mm)	1	pos. 9
Magnetizing cap of the dynamic Fe-scanner (narrow — effective magnetographing width 8 mm)	1	pos. 10
Spare conductors for dynamic scanners	5	pos. 11
Power adapter	1	pos. 12
Car power adapter	1	pos. 13
Test object № 1 (Al)	1	pos. 14
Test object № 2 (Fe)	1	pos. 15
User's Guide	1	not shown in Fig. 1

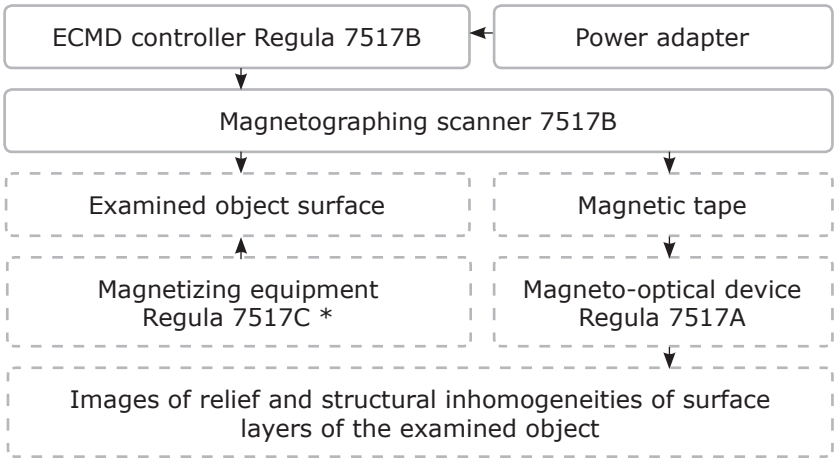
Figure 1

ECMD:
a — external view, b — packed in transportation packaging
(* — pos. 5, 6, 11, 13, 14 and 15 are laid under pos. 1)

1.4 Configuration and operation

The ECMD consists of two main components (Fig. 2): a controller and a magnetographing scanner. The scanners are differentiated according to the type of examined material: ECMD Al-scanners are intended for electroconductive non-ferromagnetic materials, Fe-scanners — for ferromagnetic materials. ECMD operation is controlled with the help of test objects № 1 and № 2 (Fig.1, pos. 14 and 15) when used with the magneto-optical device Regula 7517A.

Figure 2



* — optionally for ferromagnetic objects of examination.

Scheme of ECMD operation when being a part of the hardware and software system Regula 7517

Magnetographing with the ECMD includes several steps. First of all, demagnetize magnetic tape, then put it on the examined surface and fix. Choose a scanner according to the type of the examined material and connect it to the ECMD controller. Switch on the power supply of the ECMD controller and perform magnetographing. Static scanners are installed directly in the area of examination, while dynamic scanners are moved along the examined surface.

The ECMD controller forms and sends voltage impulses with specified parameters to the scanner. Pulse current flowing in the scanner conductor (inductor) generates around it an alternating

magnetic field which induces eddy currents in the electroconductive material of the object. Trajectories of eddy currents and their associated magnetic stray fields display the lines of electrical resistance determined by the form, size and location of defects in the examined object. Obtained magnetic copies of object stray fields are visualized using the magneto-optical device Regula 7517A as described in the User's Guide to Regula 7517A. Obtained images are processed and analyzed for further expertise.

1.4.1 ECMD controller

The ECMD is shown in Figure 3 where all its main controls are marked.

The ECMD is designed in a metal body (pos. 1). Its bottom panel contains a socket for connecting scanners (pos. 2). The top panel contains a socket for connecting the power adapter (pos. 3). A display (pos. 4) is located on the front panel. The following controls are available under the display: ON/OFF button (pos. 5), buttons for power adjustment and menu navigation (pos. 6), a button for accessing the menu and selecting parameters (pos. 7), a button for sending impulses to the scanner (pos. 8).

Figure 3

1 — body;

2 — socket for connecting scanners;

3 — socket for connecting the power adapter;

4 — display;

5 — ON/OFF button;

6 — buttons for changing parameters;

7 — button for accessing the menu and selecting parameters;

8 — button for sending impulses to the scanner.

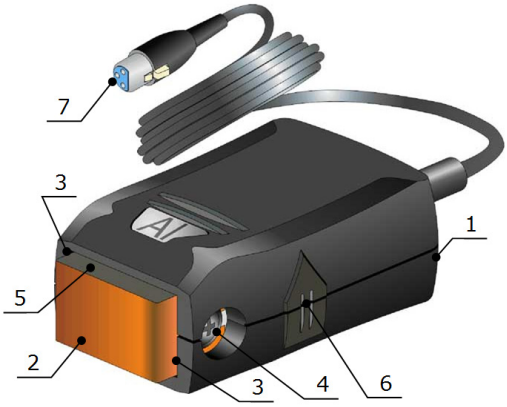
External view of the ECMD controller

1.4.2 Static Al-scanner

A static Al-scanner is intended for examination of non-ferromagnetic materials in hard-to-reach places where an examined object cannot be scanned (scanning is ineffective) using a dynamic scanner. It enables the operator to carry out magnetic copying of the surface with considerable nonflatness (up to 2 mm). The static Al-scanner is shown in Fig. 4. It is designed in a plastic body (pos.1). The conductor of the eddy-current inductor (pos. 2) is inserted into the corresponding grooves (pos. 3) and fixed on scanner pads with screws (pos. 4). The system of conductor (pos. 2) tension is an elastic cushion (pos. 5). It makes the inductor and magnetic tape uniformly fit curvilinear areas of examination. There is an arrow (pos. 6) designed in relief on the scanner body (pos. 1). The arrow shows the direction of preliminary tape demagnetization. The scanner is connected to the controller via the cable connector (pos. 7).

To carry out magnetic copying, press the scanner to the examined surface to which a demagnetized magnetic tape is attached. Then send a single voltage impulse with specified parameters from the ECMD controller to the inductor.

Figure 4



1 — body;

2 — inductor;

3 — grooves for installing the inductor;

4 — screws for fixing the inductor;

5 — elastic pressing cushion;

6 — direction of preliminary tape demagnetization;

7 — connector for connecting the scanner to the controller.

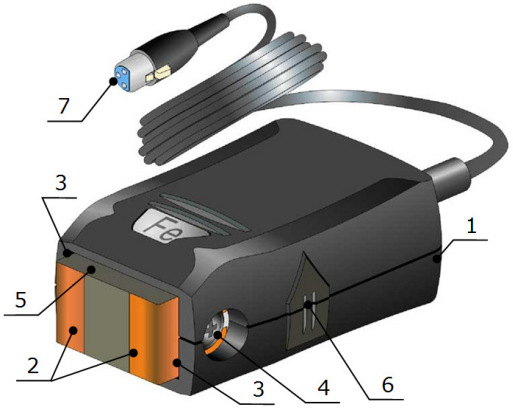
External view of the static Al-scanner

1.4.3 Static Fe-scanner

A static Fe-scanner is intended for examination of ferromagnetic materials in hard-to-reach places where an examined object cannot be scanned (scanning is ineffective) using a dynamic scanner. It enables the operator to carry out magnetic copying of the surface with considerable nonflatness (up to 2 mm). Its construction (Fig. 5) is similar to the construction of the static Al-scanner. A specific feature of the static Fe-scanner is the construction of the inductor and the method of magnetic copying. The conductor of the eddy-current inductor (pos. 2) is designed in the form of two pads with adjustable gap width which determines the height of the examined area.

To carry out magnetic copying, put the magnetic tape between the pads (pos. 2) and the cushion (pos. 5). Press the contact pads of the inductor (pos.2) directly to the **examined electroconductive surface**. Magnetize the examined object using a set of permanent magnets from the delivery set of Regula 7517C or a staple (Fig. 1 pos. 4) from the delivery set of Regula 7517B. Then send a single voltage impulse with specified parameters from the ECMD controller to the inductor. Take into account that the examined area is the direct emitter of magnetic field recorded to magnetic tape.

Figure 5



1 — body;

2 — inductor (two pads);

3 — grooves for installing the inductor;

4 — screws for fixing the inductor;

5 — elastic pressing cushion;

6 — direction of preliminary tape demagnetization;

7 — connector for connecting the scanner to the controller.

External view of the static Fe-scanner

1.4.4 Dynamic Al-scanner

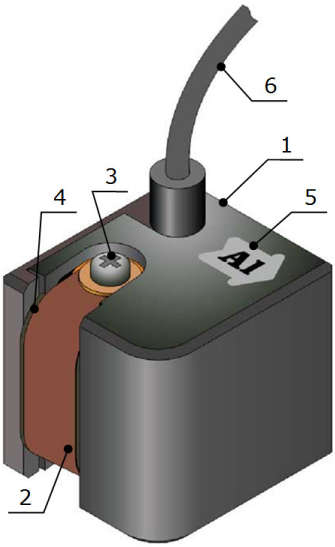
The dynamic Al-scanner is intended for examination of non-ferromagnetic materials. The scanner is shown in Fig. 6. It is designed in a plastic body (pos.1). The conductor of the eddy-current inductor (pos. 2) is inserted into the groove in the lower part of the scanner and fixed with screws (pos. 3) on the pads.

The system of conductor tension is designed in the form of a dielectric cushion (pos. 4). An arrow (pos. 5) with a symbol indicating the type of examined material shows the direction of magnetic tape demagnetization (preliminary) and examined object scanning. The scanner is connected to the controller via the cable (pos. 6) connector.

During operation the ECMD forms and sends voltage impulses with specified parameters to the scanner inductor. To carry out magnetic copying, fix a demagnetized magnetic tape on the examined surface. And then move the scanner in the direction indicated by the arrow (pos. 5) along the examined area.

When carrying out magnetic copying of a relief surface, the elastic pressing cushion (pos. 4) deforms the inductor (pos. 2) in accordance with the current surface relief.

Figure 6



1 — body;

2 — inductor;

3 — screws for fixing the inductor;

4 — elastic pressing cushion;

5 — arrow (with a symbol indicating the type of examined materials) which shows the direction of scanning;

6 — cable for connecting the scanner to the controller.

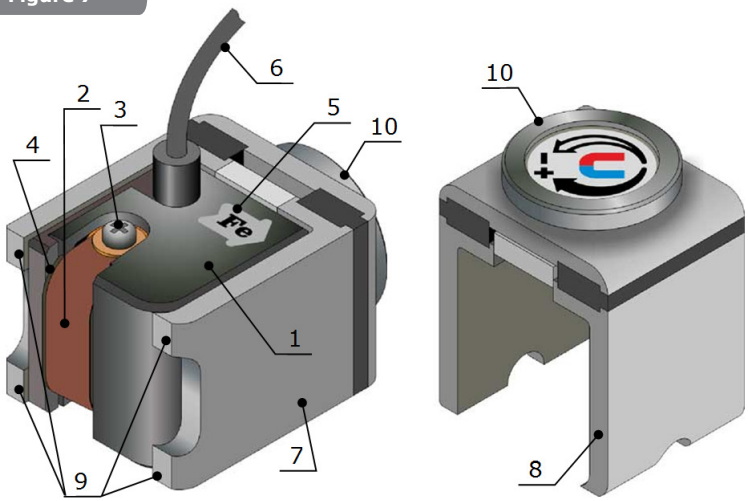
External view of the dynamic Al-scanner

1.4.5 Dynamic Fe-scanner

The dynamic Fe-scanner is intended for examination of ferromagnetic materials. Its construction (Fig. 7) is similar to the construction of the dynamic Al-scanner: elements pos. 1–6 (see the description of Fig. 6).

The specific feature of this type of the scanner is a magnetic excitation system (Fig. 7 pos. 7, pos. 8) which includes a source of permanent magnetic field adjustable by the flywheel (pos. 10) and magnetic cores with polar tips (pos. 9). To excite magnetic stray fields of the defects located in the subsurface layers of a ferromagnetic object, during magnetic copying polar tips (pos. 9) of the magnetic excitation system should make tight contact with magnetic tape and the examined surface.

Figure 7



1 — body;

2 — inductor;

3 — screws for fixing the inductor;

4 — elastic pressing cushion;

5 — arrow (with a symbol indicating the type of examined materials) which shows the direction of scanning;

6 — cable for connecting the scanner to the controller;

7 — wide replaceable magnetizing attachment (18 mm);

8 — narrow replaceable magnetizing attachment (8 mm);

9 — polar tips;

10 — flywheel adjusting the level of magnetization.

External view of the dynamic Fe-scanner

The wide attachment (pos. 7) is used in the majority of cases. Effective magnetographing width for this attachment is 18 mm. **The narrow attachment (pos. 8)** is used for examining small-size objects when polar tips of the wide attachment do not make tight contact with the examined surface. Effective magnetographing width for the narrow attachment is 8 mm. To examine thick-walled objects, it is possible to additionally magnetize them using a set of permanent magnets from Regula 7517C delivery set.

If there is no external source of magnetization for the examined object, the use of an attachment (pos. 7 or 8) is obligatory.

1.5 Means of operation control, tools and accessories

Operation of Regula 7517B is controlled together with the magneto-optical device Regula 7517A which is a part of the hardware and software system for forensic examination of firearms and ammunition serial numbers Regula 7517. The system Regula 7517 belongs to the category of observation equipment, not to measuring devices. Therefore ECMD operation is controlled using test-objects that imitate alterations of number plates by the most frequently used methods (pouring with polymers, pressing in fragments, removing superficial layers of metal). The procedure of ECMD operation control with the use of test-objects is described in paragraph 1.5.2 of the current User's Guide.

1.5.1 Test objects

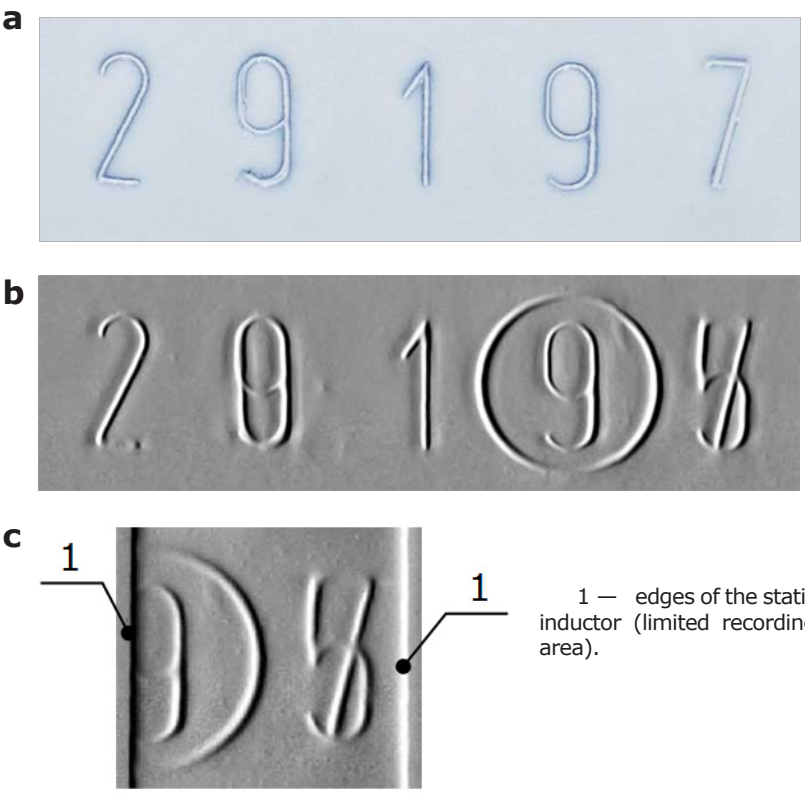
Test object № 1 (Al) (Fig. 8) imitates a number plate on an aluminum object. It is a plate made of D16AT aluminum alloy 1 mm thick with the initial number «**29165**» which was applied by mechanical processing (cold stamping). The initial number was manually stamped using a «Font № 10» stamping set and a hammer on a massive anvil. The depth of digit relief — 0.3–0.4 mm.

Three digits of the initial number were modified: «**0**» to «**9**»; «**6**» to «**9**» and «**5**» to «**7**». As a result the altered number appears as «29197» (the altered digits are underlined).

Conditions of altering «**0**» of the initial number: manual **cold calking** of the «**0**» bulkhead using bench tools; stamping digit «**9**» over the remaining contour of «**0**».

Conditions of altering «**6**» in the initial number: a fragment of the initial number with digit «**6**» was dismantled (cut out) with the help of a notching unit, rotated by 180° and **pressed back in** (so that digit «**6**» transformed into digit «**9**»).

Figure 8



1 — edges of the static inductor (limited recording area).

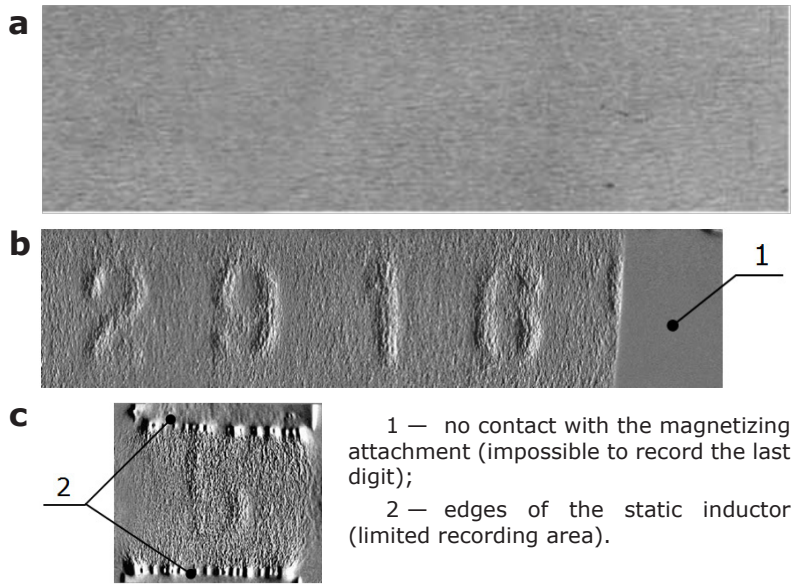
Control of ECMD operation (with Al-scanners) using test object № 1: a — image of the surface, b and c — magneto-optical visualization of the magnetogram made with dynamic (b) and static (c) scanners

Conditions of altering «**5**» in the initial number: **pouring the digit relief with a polymer** (epoxide putty); stamping digit «**7**» over the poured putty that has not yet solidified.

After altering digits of the initial number, the following procedures were applied to the test object: grinding, spackling, dressing, priming, two-layer spray-on painting with aerosol motor enamel using the technique of cold drying in accordance with the repaired coating type.

Test object № 2 (Fe) (Fig. 9) imitates a removed number plate on a ferromagnetic object. It is a plate made of U7A tool steel 2 mm thick with the initial number «**29165**» which was applied by mechanical processing (cold stamping). The initial number was manually stamped using a «Font № 10» stamping set and a hammer on a massive anvil. The depth of digit relief — 0.3–0.4 mm.

Figure 9



1 — no contact with the magnetizing attachment (impossible to record the last digit);

2 — edges of the static inductor (limited recording area).

Control of ECMD operation (with Fe-scanners) using test object № 2: a — image of the surface, b and c — magneto-optical visualization of the magnetogram made with dynamic (b) and static (c) scanners

All digits of the initial number were removed by cutting out the surface layer of metal on the test object to the depth of about 0.5 mm. Removal method: mechanical processing — cutting out (milling with further grinding).

As a result of processing the surface of the test object, the initial number cannot be observed visually or by optical methods (as the relief was removed). But in the surface layer of metal of the test object there are residual internal stresses formed as a result of metal deformation after initial marking.

1.5.2 ECMD operation control:

- take the test objects and carry out magnetic copying in accordance with paragraph 2.3;
- perform magnetic copy stitching on the PC in accordance with paragraph 2.2.1.3. of the User's Guide to the device Regula 7517A;
- compare the results of magnetic copy stitching with the reference images given in Fig. 8 and Fig. 9. If the results are considered satisfactory, the device operation is normal.

To compare the results of magnetic copy stitching with the reference images (for Al-scanners), it is necessary to:

– compare the quality of processing the signs of initial number alterations (traces of initial number contours in the 2nd and 6th digit position and contours of stamping fragments in the 4th digit position should be observed; traces of mechanical processing may be visible in the 4th and 6th digit position);

– compare the quality of processing the digits of the secondary number (the contours of all digits should be observed).

To compare the results of magnetic copy stitching with the reference images (for Fe-scanners), it is necessary to:

– compare the quality of processing the contours of the secondary number digits (the contours of all digits should be observed).

In case any malfunctions occur at any stage of device operation control, see paragraph 3 and 4.

1.6 Marking

ECMD marking in the form of a sticker is applied to the back panel of the device controller. The following information is provided on the sticker:

- manufacturer's name and/or trade mark;
- manufacturer's model identification;
- serial number of the device according to the manufacturer's numbering system;
- rated voltage, V;
- rated current, A;
- certification mark.

The device is sealed with breakable stickers on the body of the ECDM controller. If the seals are damaged, the user loses the right for warranty service.

1.7 Packaging

The case with ECMD components is packed into a cardboard packaging.

The device is transported and stored in special shipping containers (a cardboard box or a wooden container).

2 INTENDED USE

2.1 Operating limitations and safety measures

IT IS STRICTLY PROHIBITED TO:

- DISCONNECT THE SCANNER CONNECTOR DURING CONTROLLER OPERATION. THAT MEANS IT IS PROHIBITED TO DISCONNECT THE SCANNER WHEN THE DISPLAY OF THE SCANNER CONTROLLER IS SWITCHED ON;
- REPLACE THE SCANNER INDUCTOR DURING CONTROLLER OPERATION;
- USE IMPROPER POWER ADAPTERS OF THE ECMD CONTROLLER;
- USE DEFECTIVE POWER OUTLETS AND POWER SOURCES FOR THE ECMD CONTROLLER;
- TO SWITCH ON THE DEVICE IF PROTECTIVE ISOLATION, SCANNER CONDUCTORS OR INDUCTORS ARE DAMAGED;
- TO SWITCH ON THE DEVICE IF PROTECTIVE SHROUDS ARE REMOVED.

Non-observance of device operating conditions that are obligatory in accordance with safety measures, may lead to the loss of device operability:

- climatic operating conditions are described in paragraph 1.1.1. of the User's Guide to the magneto-optical device Regula 7517A. In case water (or condensate) appears on the device components, stop the device operation and proceed with it only after drying;
- protect the device from strokes and vibrations during transportation and operation;
- power quality standards for the device power supply sources must meet the requirements given in paragraph 1.1.2 of the User's Guide to the magneto-optical device Regula 7517A;
- Connect and disconnect cables and device components only if the power supply is off.

ATTENTION!

- Electroconductive materials only can be examined provided that the scanner and the magnetization system (for ferromagnetic materials) are properly chosen.
- Device operation is not allowed when magnetic tape is damaged (cut-through breaks with sharp edges, strongly

crumpled), dirty or with bent edges (see paragraph 2.2.2.2 of the User's Guide to Regula 7517A). Violation of these requirements may result in stitching discrepancies and magnetic tape jamming in the device.

- When using the ECMD on surfaces with nonflatness over 0.1 mm per basic area of 18×20 mm or with roughness over Rz 80 mkm, the quality of the magnetic copy is not guaranteed.

NON-OBSERVANCE OF DEVICE OPERATING LIMITATIONS GIVEN IN PARAGRAPH 2.1 CAUSES THE LOSS OF THE MANUFACTURER'S WARRANTY.

2.2 Preparation for use

To switch on the device, do the following:

- connect the power adapter (Fig. 1 pos. 12 or pos. 13) to the controller (Fig. 3 pos. 3);
- select a scanner according to the type of examined material: Fe-scanners — for ferromagnetic materials (steel, cast iron); Al-scanner — for non-ferromagnetic electroconductive materials (non-ferrous metals and their alloys);
- connect the selected scanner (Fig. 1 pos. 2, 3, 7 or 8) to the controller connector (Fig. 3 pos. 2);
- press the ON/OFF button (Fig. 3 pos. 5) to switch on the ECMD controller and make sure that the scanner has been properly selected (see the information appeared in the top line of the display, Fig. 10a). If necessary, adjust the level of scanner inductor power and other operating parameters of the controller in accordance with paragraph 2.3;
- carry out the operations necessary for starting the process of magnetic copying (see paragraph 2.3);
- switch on the magneto-optical device Regula 7517A as described in paragraph 2.2.1.2 of the User's Guide to the device Regula 7517A.

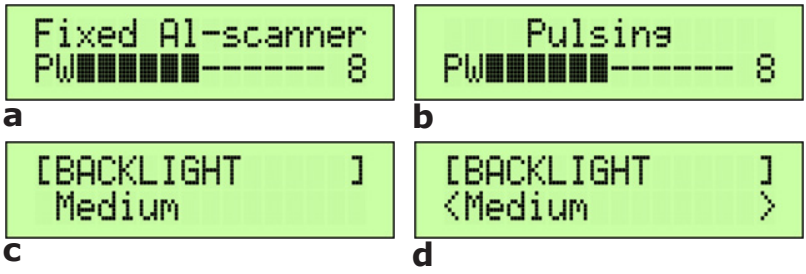
2.3 Device use

2.3.1 Operating the controller

- Press the ON/OFF button (Fig. 3, pos. 5) to switch on/off the controller.

- The buttons (Fig. 3 pos. 6) are used for adjusting the magnetographing power (the power level is shown on the display in the bottom line — Fig. 10, the power value is saved for every scanner individually).
- Press the «PULSE» button (Fig. 3, pos. 8) to send impulses to the scanner in order to carry out magnetographing (the tart of the process is indicated by a sound signal and the «Pulsing» inscription appearing in the top line of the display — Fig. 10b).
- Press the button (Fig. 3, pos. 7) to enter the controller menu. The display shows the parameter in the top line and its value — in the bottom line (Fig. 10c). Use the buttons (Fig. 3, pos. 6) to select the parameter which is to be changed. Press the button (Fig. 3, pos. 7) once again to enter the mode of parameter changing (Fig. 10d). To exit the menu, press the ON/OFF button (Fig. 3, pos. 5).

Figure 10



Indication of the operating modes:
a — main mode, b — mode of sending impulses,
c — menu (selecting a parameter), d — menu (changing a parameter)

2.3.2 Controller menu parameters

- [PULSE WIDTH] — determines the magnetographing power. It is also displayed in the second line of the main mode (Fig. 10a), selected individually for every object of examination and its magnetizing conditions (Fig. 13).
- [PULSE TIMEOUT] (for static scanners only) — determines the time delay between pressing the «PULSE» button and sending impulses to the scanner. Use the time delay when it is impossible to simultaneously press the «PULSE» button

and hold the examined object, the scanner, magnetic tape and the magnetic excitation system correctly.

- [PULSE REPEAT] (for dynamic scanners only) — determines the time of automatic breakout in sending impulses to the scanner after pressing the «PULSE» button. For manual breakout press the «PULSE» button once again. It is determined by the time necessary for scanning the examined object.
- [BUZZER] — switches on/off the sound signal accompanying the procedure of sending impulses.
- [BACKLIGHT] — sets brightness of the lighting of the controller display.
- [TURNOFF TIME] — determines a period of time after a button was last pressed before automatic switching off of the controller.

2.3.3 Preparing for operation

To obtain a magnetic copy of the examined object, do the following:

- prepare the examined surface in accordance with paragraph 2.2.2.3 of the User's Guide to the device Regula 7517A;
- prepare (demagnetize) magnetic tape in accordance with paragraph 2.2.2.3 of the User's Guide to the device Regula 7517A;
- make a magnetic copy.

ATTENTION!

THE PROCESSES OF DEMAGNETIZING MAGNETIC TAPE AND MAGNETOGRAPHING SHOULD COINCIDE IN DIRECTION (SEE FIG. 11). OTHERWISE MAGNETIC RECORDING WILL BE WEAK. IN CASE OF WEAK SIGNALS THE RECORDING WILL FAIL.

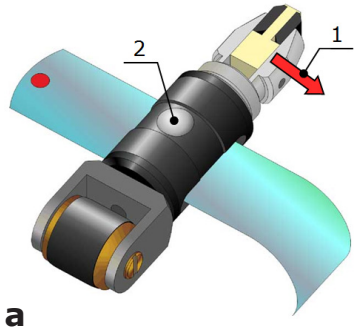
To avoid mistakes in defining the directions, make a clearly visible mark on the surface of the magnetic tape, e.g. mark a «starting point» at the beginning of the magnetic tape as shown in Fig. 11.

Demagnetization of magnetic tape is to be carried out in accordance with paragraph 2.2.2.3 of the User's Guide to Regula 7517A. In addition it should be noted that the demagnetizer moves from left to right relative to the «starting point» (see Fig. 11a).

Put the demagnetized magnetic tape on the examined surface without turning it over, i.e. the «starting point» must be on the left.

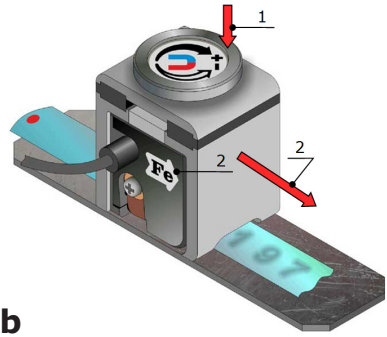
When making a magnetic copy with dynamic scanners, the scanners also move from left to right relative to the «starting point» (see Fig. 11b). The scanner body should be positioned so that the direction of the relief arrow on it and the direction of preliminary demagnetization coincide.

Figure 11



a

1 — direction for demagnetizer movement;
2 — position of the demagnetizer button (on top).



b

1 — pressing force;
2 — direction for scanning (scanner movement).

Matching the directions of the demagnetizing process and magnetographing:
a — preliminary demagnetization of magnetic tape,
b — magnetographing with dynamic scanners

Note:

If the ECMD and the magneto-optical device Regula 7517A are not supplied simultaneously, it is possible to reverse the polarity of the demagnetizer. In this case before scanning turn the magnetic tape so that the «starting point» is on the right and then put it on the examined object.

2.3.4 Making a magnetic copy with dynamic scanners

1. Put magnetic tape on the prepared number plate of the examined object and fix its end on the examined surface using a magnetic clamp, sticky tape or manually (avoid skews and displacement relative to the examined number).

2. Fix the other end of the magnetic tape similarly (if the beginning of the magnetic tape is securely fixed, the other end may stay loose). The operator is to decide how to fix the magnetic tape.

3. Position the body of the ECMD dynamic scanner so that the relief arrow (see Fig. 4–5, pos. 6 or Fig. 6–7, pos. 5) is directed forward in the direction of scanning (Fig. 11b). Put the scanner on the fixed magnetic tape. And make sure that the contact between the examined surface and the scanner is tight.

4. Press the button (Fig. 3, pos. 5) to switch on the ECMD controller. Check the first line on the display (Fig. 10a) to make sure that the type of the scanner has been chosen correctly. If necessary, select the required emission power using the buttons (Fig. 3, pos. 6). The scale in the second line of the display (Fig. 10a) shows the selected power level.

5. Use the «PULSE» button to start sending impulses to the scanner. Make sure that the word «Pulsing» appeared in the first line of the display.

6. Move the scanner slightly pressing it to the surface from the beginning of the examined fragment to the end (Fig. 11b, pos. 2). The speed of scanning should not exceed 50 mm/s. Otherwise the magnetizing signal will be recorded to the tape in the form of vertical black and white lines. To obtain a good-quality copy, the operator should control the contact between the scanner and the examined surface visually and manually. If the conditions of magnetic copying are not observed (displacement of magnetic tape, no contact between the examined surface and the scanner or the scanner moved aside), repeat all operations starting from magnetic tape demagnetization.

7. Take the magnetic tape with the obtained copy off the examined object and remove the clamps. When taking off the magnetic tape, avoid its contact with magnetic clamps and the scanner in the area of the obtained magnetic copy. Otherwise the magnetic copy may be partially demagnetized, «irrelevant» magnetization elements (spots and stripes irrelevant to the examined object) may appear. It will make further examination more complicated.

8. Carry out magnetic copy stitching using the magneto-optical device Regula 7517A.

9. Put the magnetic copy into the corresponding cartridge of the case for storing magnetic tape. The cartridge for storing magnetic

tape with recorded data is marked with a red marker. If necessary, use the marker (from the delivery set of the magneto-optical device Regula 7517A) for applying a comment to the magnetic tape strip.

10. If prompt examination of the obtained magnetic copy is impossible (e.g. a visualization device is not available), make 1–2 extra magnetic copies.

2.3.5 Making a magnetic copy using the static Al-scanner

When making a magnetic copy using the static Al-scanner, the scanner is pressed to the surface in the required area of examination (do not move it along the examined object). Perform operations described in subparagraph 1–5 that explain the procedure of making a magnetic copy with dynamic scanners (see paragraph 2.3.4). **The direction of the arrow (Fig. 4–5, pos. 6) on the static scanner body should coincide with the direction of demagnetizer movement (Fig. 11a).** After pressing the «PULSE» button the controller sends a single impulse. As soon as the word «Pulsing» in the first line of the display disappears, you may take the scanner off the examined object and perform operations described in subparagraph 7–10 (see paragraph 2.3.4).

2.3.6 Making a magnetic copy using the static Fe-scanner

Making a magnetic copy using the static Fe-scanner is similar to making a magnetic copy using the static Al-scanner. But there are two important requirements which must be observed:

1) the surface of the examined object must be in galvanic contact with the inductor vanes. That is why before pressing the scanner to the examined object, place the magnetic tape between the pressing cushion of the scanner and the vanes of its inductor (Fig. 12a). Clean the examined object surface in the area of contact with the inductor vanes from paint-and-lacquer coating and dirt which worsen the electrical contact;

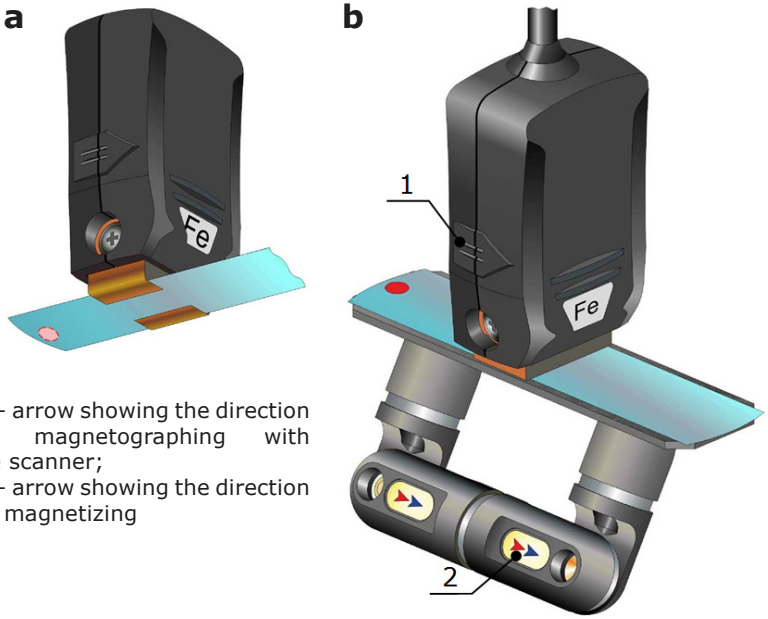
2) Magnetize the examined object with permanent magnets from the delivery set of the magnetizing equipment Regula 7517C or with the magnetizing staple from the delivery set of the ECMD (Fig. 12b). **Polarity arrows of the magnetizing staple should indicate the same direction as the relief arrow (on the scanner body). And the latter should coincide with the direction of preliminary demagnetization of magnetic tape (Fig. 11a).**

2.3.7 Choosing the optimal level of magnetographing power

For all scanners the level of magnetographing power is regulated with the buttons on the controller (Fig. 3, pos. 6) and is shown in the second line of the display. For the Fe-scanners the level of examined object

magnetization is additionally regulated with a flywheel being a part of the magnetizing attachment (Fig. 7, pos. 10). The flywheel is used to smoothly change magnetic field strength in the gap between the polar tips (Fig. 7, pos. 9). When using the static Fe-scanner, the level of magnetization is determined by the configuration of magnetizing staples installed on the examined object (Fig. 12, pos. 2).

Figure 12



1 — arrow showing the direction for magnetographing with the scanner;
2 — arrow showing the direction for magnetizing

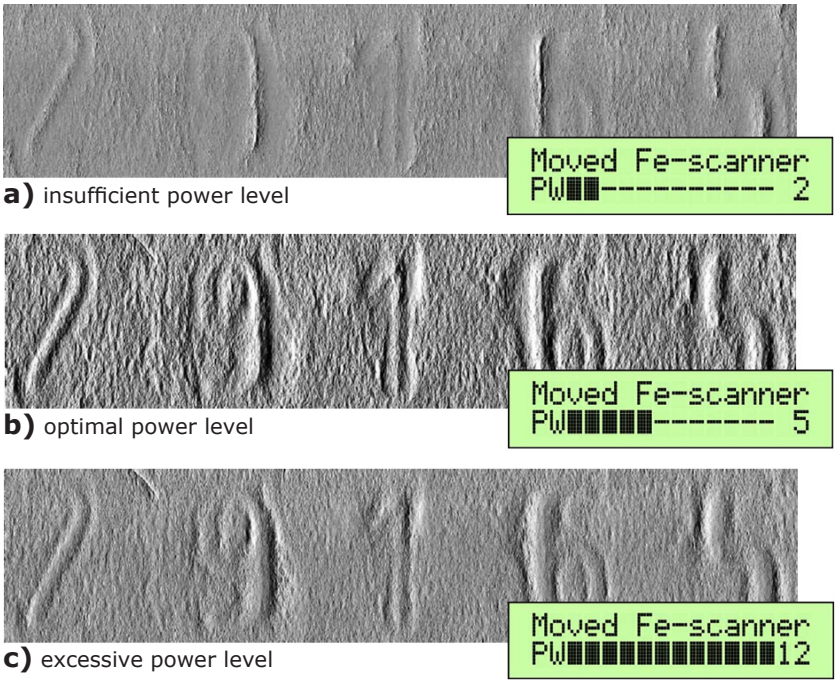
Magnetographing with the static Fe-scanner:
a — preliminary installation of the magnetic tape strip under the inductor vanes, b — pressing the scanner with a magnetic tape strip to the examined object on which the magnetizing staple is installed

The example given below (Fig. 13) shows the possibilities of increasing the sensitivity of magnetographing when examining weak signals of residual stresses in ferromagnetic materials using different levels of the Fe-scanner power.

Fig. 13 shows the results of examining the test object № 2 (Fig. 1 pos. 15, Fig. 9) from the ECMD delivery set at different levels of magnetographing power.

Changing the level of the Fe-scanner power (Fig. 13a, b, c) causes changes in the ratio of signal to noise (visibility of digit contours against the surrounding pattern-noise). It should be noted that the visibility of digit contours is better in Fig. 13b as the data are more complete and detailed.

Figure 13



a) insufficient power level

b) optimal power level

c) excessive power level

Choosing the optimal level of magnetographing power. Visualized magnetic copies of the test object (made of ferromagnetic alloy) were obtained with the dynamic Fe-scanner.

THE OPTIMAL POWER LEVEL IS BEING SELECTED BY EXPERIMENT FOR EVERY EXAMINED OBJECT, FOR ITS MAGNETIZING SYSTEM AND THE RECORDING SCANNER ACCORDING TO THE BEST VISIBILITY OF EXAMINED INHOMOGENEITIES.

2.3.8 Choosing the scanner type: static or dynamic

Dynamic scanners allow obtaining long-length magnetograms of the examined surface (limited only by the length of the magnetic tape strip). They are suitable for most examination cases. Static scanners make magnetograms of limited length (the area of examination does not exceed 17×20 mm). But they have several advantages:

1) allow examining the surface with nonflatness up to 2 mm (compare with acceptable nonflatness 0.5 mm for dynamic scanners);

2) are used in hard-to-reach places where the scanner cannot be moved along the surface of the examined object.

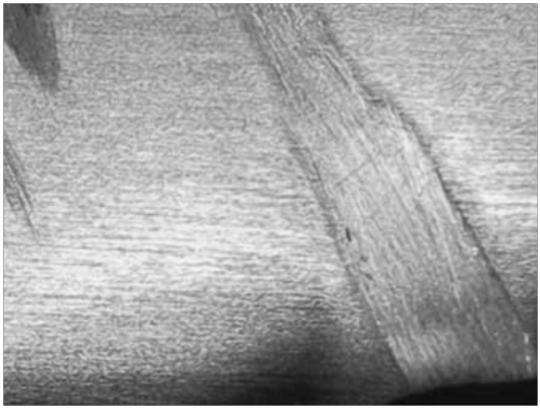
Nonflatness of the examined surface is the main criterion for choosing the scanner type. Use dynamic scanners when examining the surface with nonflatness up to 0.5 mm. Use static scanners to increase the quality of magnetographing when examining the roughly processed surface with height difference exceeding 0.5 mm. The example given below (Fig. 14) demonstrates the possibility of increasing the sensitivity of magnetographing by using static scanners.

Fig. 14a represents a photo of the examined object surface where the examined object is made of a ferromagnetic alloy. The original number «114» was mechanically removed with a blunt instrument. As a result a deep (≈ 1,5 mm) cavity appeared in the area of the number plate.

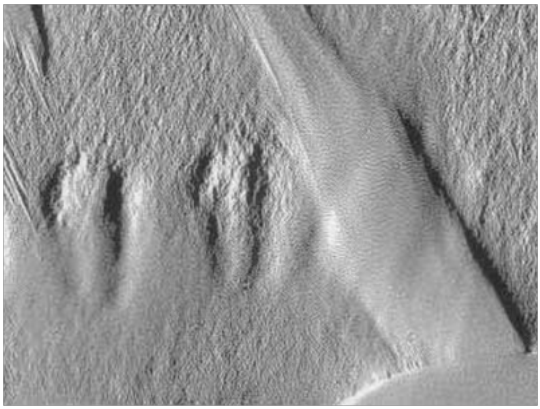
The magnetic copy (Fig. 14c) obtained with the static Fe-scanner differs from the magnetic copy obtained with the dynamic Fe-scanner (Fig. 14b). The one obtained with the static scanner gives a possibility to see the contours of the removed digit «4» (was situated in the area of considerable nonflatness of the examined surface) more clearly.

Figure 14

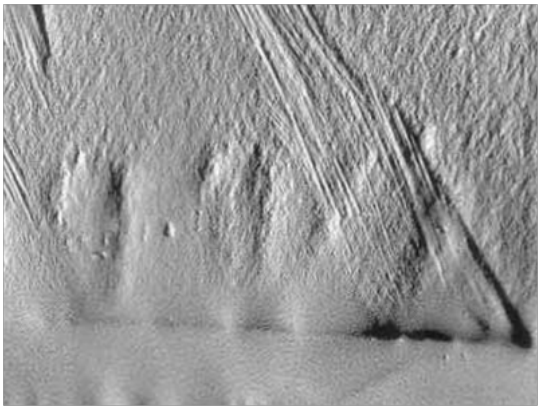
a



b



c



Advantages of using the static scanners:
a — photo of the examined surface with considerable nonflatness ,
b and c — magneto-optical visualization of magnetograms obtained using the dynamic (b) and static (c) Fe-scanners

3 MAINTENANCE

3.1 GENERAL INSTRUCTIONS

Daily maintenance of the device involves the following procedures:

- external inspection (visually check the integrity of controls and indicators; check the scanner cable isolation and connectors);
- cleaning the front panel, controls and the surface of the scanners from dust and oily films with a soft tissue or a wad wetted in ethyl alcohol (rate of alcohol application — 5 g);
- cleaning the electrical-contact surfaces of the scanners and inductors (in the area of fixing screws Fig. 4–5, pos. 4 and Fig. 6–7, pos. 3) using a dry tissue or a wad wetted in ethyl alcohol. It is prohibited to use abrasive materials for cleaning the inductors. It may lead to damaging the contact layer of the inductor.

ECMD maintenance when putting it in storage:

- arrange and pack the ECMD components into the transportation packaging.

3.2 Safety measures

Observe safety measures in accordance with paragraph 2.1 when servicing the ECMD.

3.3 Checking the device operability

Check the device operability in accordance with paragraph 1.5.2 «ECMD operation control» of the current User's Guide.

4 ROUTINE REPAIRS

4.1 Safety measures

When carrying out routine repairs, observe the requirements given in paragraph 2.1.

ATTENTION!

IT IS PROHIBITED TO DO REPAIRS WHEN THE CONTROLLER POWER SUPPLY IS SWITCHED ON. SWITCH OFF THE CONTROLLER AND DISCONNECT THE SCANNER CONNECTOR FROM THE CONTROLLER BEFORE DOING REPAIRS.

4.2 General instructions

According to the current User's Guide the user is allowed to do only the following repairs: replace the conductor inductors after they are worn out.

4.3 Instructions on repairs

4.3.1 Scanner inductor replacement

The scanner inductor is replaced if any mechanical damage occurs such as rupture, fracture, puncture or a considerably crumpled state. These damages lower the quality of magnetographing.

The inductor is replaced by an analogous one (which corresponds to the scanner type) from the device delivery set. It is recommended to clean electrical-contact surfaces (see paragraph 3.1) before installing the inductor.

ATTENTION!

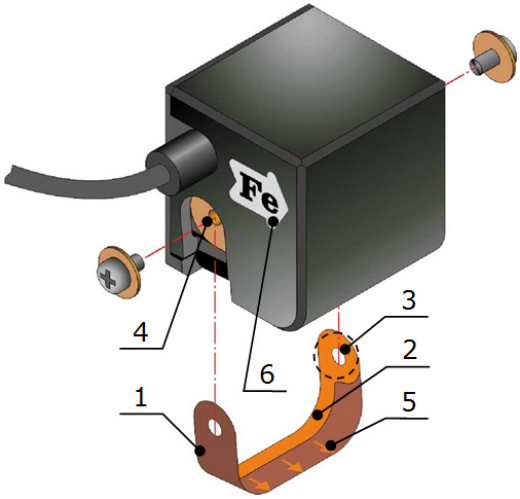
DO NOT INSTALL HOMEMADE INDUCTORS ON THE SCANNER. IT MAY DISABLE THE DEVICE. IT IS ALLOWED TO USE ONLY THE INDUCTORS PRODUCED BY THE MANUFACTURER.

4.3.2 Inductor replacement for dynamic scanners

For dynamic scanners (Al and Fe) only one type of the inductor is provided (Fig. 1, pos. 11). Inductor replacement is shown in Fig. 15. The inductor consists of an insulating substrate (pos. 1), on one side of which a copper electroconductive layer (pos. 2) is applied. The inductor is attached to the scanner with the help of two screws (the electroconductive layer inwards) so that its contact areas (pos. 3) abut the contact pads of the scanner (pos. 4).

Install the inductor so that during magnetographing the strip of the electroconductive layer was at the back relative to the direction of the dynamic scanner movement. I.e. the direction of arrows on the internal side of the inductor (pos. 5) must coincide with the direction of scanning indicated on the scanner body (pos. 6).

Figure 15



1 — insulating substrate of the inductor;
2 — electroconductive layer of the inductor;
3 — contact areas of the inductor;
4 — contact pads of the scanner;
5 — arrow showing the direction of inductor magnetographing;
6 — arrow showing the direction of scanner magnetographing.

Inductor replacement for dynamic scanners

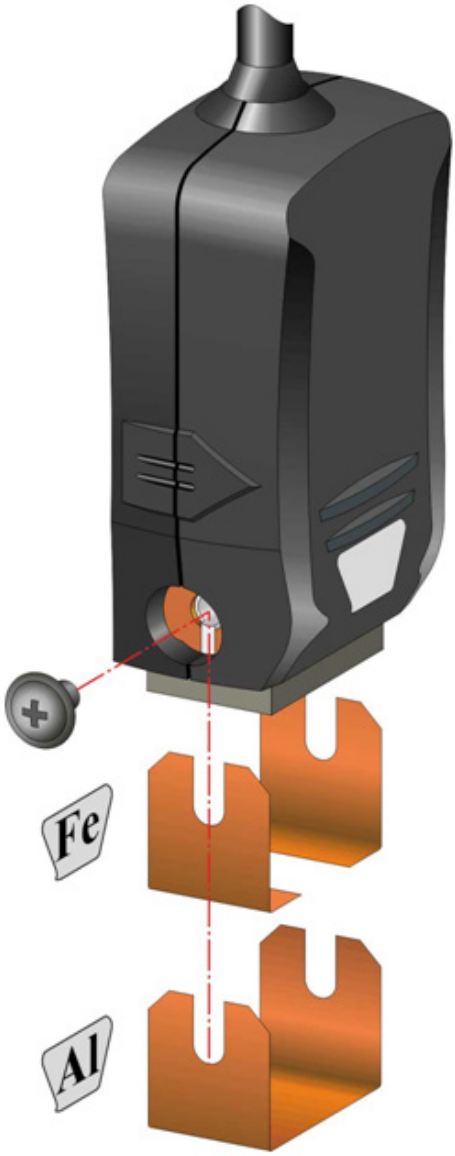
4.3.3 Inductor replacement for the static Al-scanner

Inductor construction and installation for the static Al-scanner are analogous with those of dynamic scanner inductors. To install the inductor, insert it into the corresponding grooves (Fig. 16). The electroconductive layer occupies the whole area of the inductor. That is why the polarity does not matter when installing the inductor. If there is an insulating substrate, install the inductor with the electroconductive layer inwards.

4.3.4 Inductor replacement for the static Fe-scanner

The inductor of the static Fe-scanner consists of two L-shaped conductors. Bend flat conductors before installation as shown in Fig. 16. After installation cut the extra length of the conductor using scissors. The size of the gap determines the height of the plate for magnetographing (Fig. 9c). Adjust the gap in accordance with the size of the examined area because the conductors should keep galvanic contact with the examined object.

Figure 16



5 STORAGE

The device should be stored in the manufacturer's packaging. Climatic storage conditions are given in Table 3.

Table 3

air temperature	from +5 to +40°C;
relative air humidity	up to 85 % at the temperature of +15 °C;
atmospheric pressure	100 ± 4 KPa (750 ± 30 mm Hg)

6 TRANSPORTATION

The device should be transported in the manufacturer's packaging (included in the delivery set). Observe the climatic conditions given in paragraph 5. Protect the device against shock and vibration.

7 RECYCLING

Recycling of the device shall be carried out in conformity with the rules adopted at the customer's enterprise.

8 MANUFACTURER'S WARRANTY

The warranty period makes 24 months from the date of sale provided that all terms of the given User's Guide are observed. Do not remove any seals set by the manufacturer during the whole warranty period.

Storage period makes ___ months from the date of manufacturing.

Mean lifetime makes 5 years.

9 ACCEPTANCE CERTIFICATE

(to be completed by the manufacturer)

Hardware and software system for forensic examination of firearms and ammunition serial numbers Regula 7517. Eddy-current magnetographing device Regula 7517B № _____
(serial number)
is produced and accepted in accordance with obligatory requirements of state standards, current technical documentation and considered serviceable.

Responsible for acceptance _____

_____ _____
(signature) (Full name)

_____
(year, month, day)

Seal

Manufacturer — Regula Ltd.
Address for mailing claims with regard to the quality of the device:
1 Volokha Street, Office 314, Minsk, 220036, Republic of Belarus
Phone: +375 17 2862825 Fax:+375 17 2136897
e-mail: mail@regula.by
http://www.regulaforensics.com

10 SALE CERTIFICATE

(to be completed by the seller)

Hardware and software system for forensic examination of firearms and ammunition serial numbers Regula 7517. Eddy-current magnetographing device Regula 7517B № _____ is sold to:
(serial number)

Seal

Seller's name _____
_____

Date of sale _____

1 Volokha Street, Office 314, Minsk, 220036, Republic of Belarus
Phone: +375 17 2862825 Fax: +375 17 2136897
e-mail: mail@regula.by http://www.regulaforensics.com