Regula
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MAGNETO-OPTICAL DEVICES
For nondestructive investigation of metal surfaces

EDDY-CURRENT MAGNETOGRAPHING DEVICE
REGULA 7515M

Operating Manual

2019

CONTENTS

INTRODUCTION

The present Operating Manual (OM) is the main operational document for the eddy-current magnetographing device (hereinafter referred to aas the "device" or "ECMD") Regula 7515M used as add-in module of magneto-optical devices (MODs) for identification and detection of falsification of vehicle identification numbers (VIN) Regula 7505M.

The OM contains the information on the device and its design, principle of operation and technical characteristics. It also provides instructions on the correct and safe use of the device (intended use, technical maintenance, simple routine repairs, storage and transportation) and on its technical condition evaluation when making a decision regarding its repairs.

The document is elaborated under the requiments of the international standarts.

1 DESCRIPTION AND OPERATION

1.1 Device function

The device of eddy-current magnetographing is designed for examining the surface of items made of conductive materials and increasing the sensitivity of magnetographing process (magnetic copying) in the superficial layers of ferromagnetic items. The device is viewed as an add-in module of Regula 7505M intended for magneto-optical visualization of VINs when carrying out forensic examinations.

The device enables examination of markings on data carriers made of aluminum alloys (silumin bodies of the blocks of cylinders and reducers, manufactory's aluminum plates, duraluminium bodies) and extends the functionality of the equipment when examining weak signals in the superficial layers of ferromagnetic items, e.g. – residual (accumulated) tension.

1.2 Technical specifications

Basic technical specifications of the device:

Table 1

Scanner supply voltage, V	24
Current in scanner conductor (peak value), A	90-110
Magnetic field tension on scanner conductor surface (peak value), kA/m	30-35
Nonflatness of examined surface, mm, max	0.5
Scan rate, max, mm/s	50
Effective width of copying, mm, max	20
Time of continuous work (without recharge), min, minimum	40 (≈120 copies)
Capacity of controller accumulator (ACC) (set of 2 nickel-metal-hybrid ACC of 6F22 (9 V)), min	170 mAh
Charge time of ACC (charge current, max 24mA)	≈8 hour
Design life of the device, years, min	5
Design life of ACC, charge cycles, min	500
Overall dimensions of scanners, mm	28×30×35
Controller overall dimensions, mm	160×100×30
Overall dimensions of charging unit, mm	100×80×30
Device weight, g, max	900
Climatic conditions for operation and storage	in accordance with technical requirements for magneto-optical devices Regula 7505

1.3 Delivery set

Device delivery set (Fig. 1):

Table 2

Controller (1)	pos. 1
AL-scanner (1)	pos. 2
Fe-scanner (1)	pos. 3
ACC (2)	
Charging unit of controller ACC (1)	pos. 4
Test-object №1 (Al) (1)	pos. 5
Test-object № 2 (Fe) (1)	pos. 6
Magnetizing attachment of Fe-scanner (1)	pos. 7
Inductors for scanners (SPCS*) (5)	pos. 8
Device Operating Manual (OM)(1)	

* – Spare Parts and Components Set

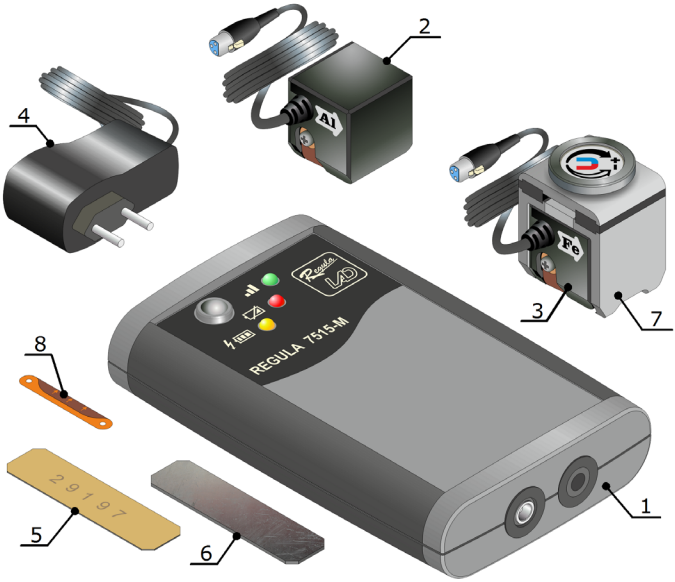
1.4 Structure and Operation of the Device

The device consists of 2 basic structural elements (Fig. 2): the controller and the scanner. Scanners are specialized according to the type of the examined material. Thus, Al-scanner is intended for electro-conductive non-ferromagnetic materials and Fe-scanner for ferromagnetic materials. Two ACC are the power supply source of the device controller. These batteries are charged by a subsidiary charging unit. Device function control is carried out in the composition of Regula 7505M using test-objects №1 and №2.

Magnetographing with the use of the device consists in the successive execution of a number of operations. Demagnetize, place and fix the magnetic tape on the examined surface beforehand. Connect the scanner corresponding to the examined material type to the device controller. Switch on power supply of the device controller and move the scanner is moved along the examined surface.

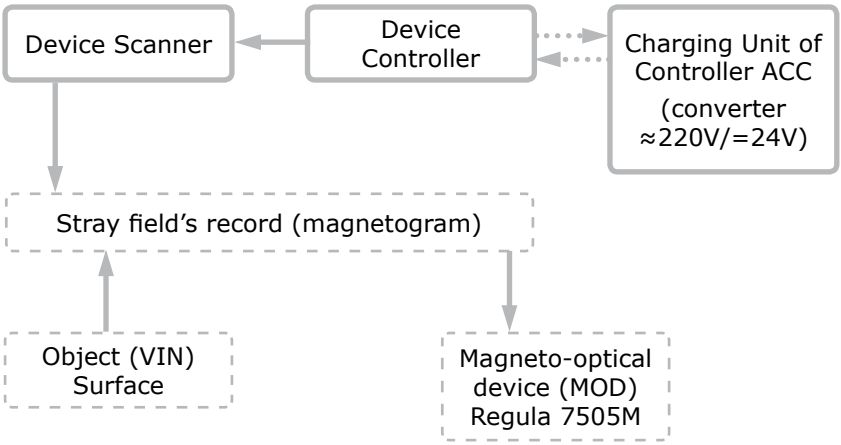
The device controller creates and sends voltage impulses with set parameters to the scanner. Pulse current, which flows in the scanner conductor, creates around the scanner the alternating magnetic field, which induces eddy currents in the conductive material of the object. The eddy currents trajectories and connected with them magnetic stray fields reflect the lines of electric resistance specified by the form, sizes and positioning of defects in the examined item. The obtained magnetogs of the object (VIN) stray fields are visualized by Regula 7505M under its OM. The obtained images are processed and analyzed for the following expert appraisal.

Figure 1



External view of the device

Figure 2

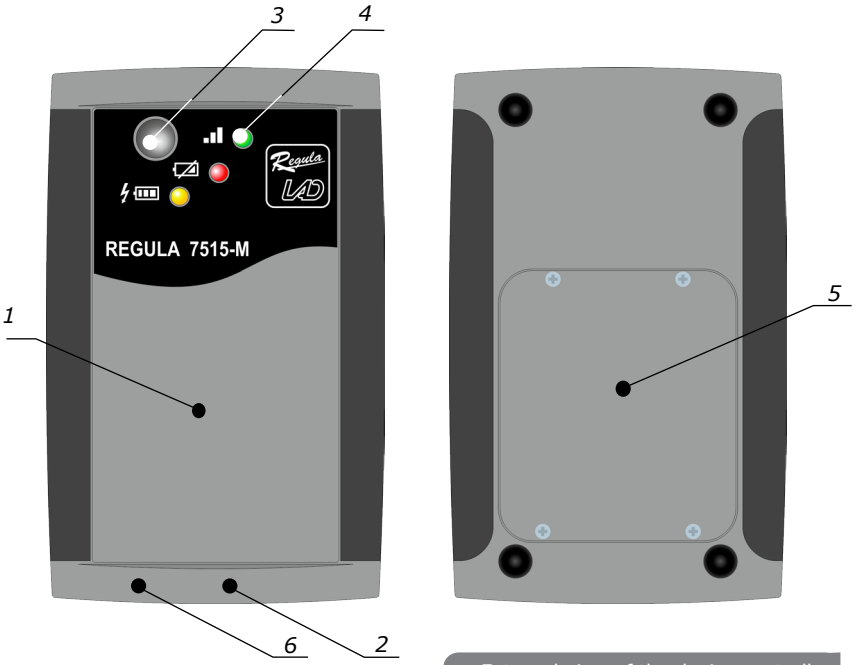


Structural scheme of the device as a component of regula 7505M

External view of the device controller with the basic controls of indication and commutation is shown in Fig. 3:

Figure 3

a) top view **b)** bottom view



External view of the device controller

1 – controller body;

2 – connection socket for scanners;

3 – control button;

4 – state indicators of the controller and ACC charge;

5 – ACC cells;

6 – connection socket for the network power unit.

The device controller (Fig. 3) is produced in a metal body (pos. 1). The controller side slab has a socket for connecting the scanner (pos. 2), and ACC charging device (pos. 6).Its bottom panel provides access to the ACC compartment. The control button (pos. 3) and state indicators of the controller and ACC charge (pos. 4) are located on the front panel of the controller body.

During the operation the device controller creates and sends voltage impulses with set parameters to the scanner. These parameters correspond to the type of the connected scanner and the selected operating mode. Moreover, the controller carries out self-diagnostic, controls ACC charge and provides its additional charge (if the ACC charging device is connected).

After the scanner socket (pos. 2) is connected and power supply of the controller device is activated with the button (pos. 3), the indicators may have the following states:

- Only the green indicator glows – controller state and ACC charge are normal; the scanner is activated – it receives voltage impulses necessary for magnetographing;
- The green indicator glows and the red indicator blinks impulsively – ACC charge is needed;
- The green indicator blinks impulsively – the current operating mode. The indicator blinks one time when switching on the controller and changing its operating modes. The numbers of flashes correspond to the power level of Fe-scanner (see paragraph 2.3 for the power levels);
- None of LEDs glows – ACCs are absent or are fully discharged, the device controller malfunction;
- The controller switches off automatically one minute after its activation to save energy and protect the scanner from overheating.

To save energy and protect the scanner from overheating, the controller is switched off automatically in a minute after activation.

When the ACC charging device is connected to the controller device (socket – pos. 6) and its power supply is connected to the mains 220V, the yellow indicator (pos. 4) may glow. The glowing means the presence of external power supply (=24V) at the controller input, which provides additional ACC charge of the ACC including the ACC charge during the device operation process.

The access to ACC for their charge and replacement is carried out by unscrewing 4 screws and removing the cover of the ACC cells (pos. 5).

External view of AL-scanner is given in Fig. 4.

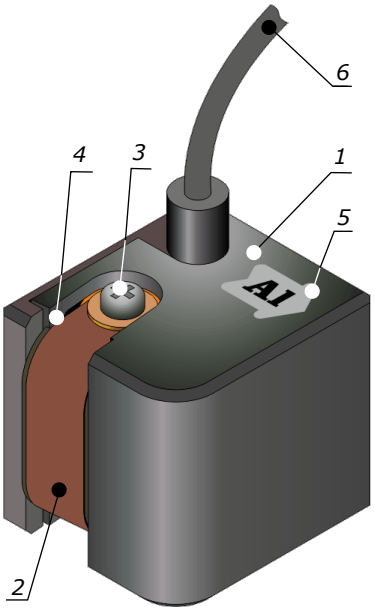
The Al-scanner is intended for examination of non-ferromagnetic materials. The scanner is shown in Fig. 4. It is designed in a plastic body (pos. 1). The eddy-current inductor (pos. 2) is inserted into the groove in the lower part of the scanner and fixed with screws (pos. 3) on the pads.

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 4



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.

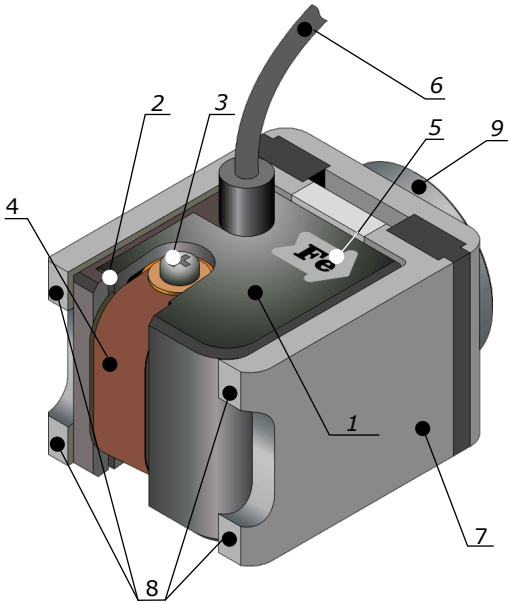
External view of AI-scanner

The Fe-scanner is intended for examination of ferromagnetic materials. Its construction (Fig. 5) is similar to the construction of the dynamic Al-scanner: elements pos. 1–6 (see the description of Fig. 4).

The specific feature of this type of the scanner is a magnetic excitation system (Fig. 5 pos. 7, pos. 7) which includes a source of permanent magnetic field adjustable by the flywheel (pos. 9) and magnetic cores with polar tips (pos. 8).

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 5



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- magnetizing attachment (18 mm);

8 – polar tips;

9 – flywheel adjusting the level of magnetization.

External view of Fe-scanner

ATTENTION!

НЕ СНИМАЙТЕ НАСАДКУ-НАМАГНИЧИВАТЕЛЬ!
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 measurement, tools and accessories

Magneto-optical device Regula 7505M (used in composition with ECMD) belongs to the category of displaying(not measuring) devices. Therefore, means of operation control of Regula 7505M and ECMD as its component are produced as test-objects, simulating widespread modified changes of VINs (pouring by polymers, pressing in fragments, and removal of the metal superficial layer). The control order of device serviceability with the use of the test-objects is described in detail in paragraph 2.1.3. of Regula 7505M OM and 3.3 of the given OM.

Characteristics of the test-object of the device:

Test-object №1 (Al) (Fig. 6) is the imitator of Category "A" control object (the data carrier of the vehicle body). It is executed in the form of a plate made of a sheet of aluminum alloy 1 mm thick. The initial number 20165 is applied by machining process (cold pressing). The initial number was made in the following way: manual stamping using "№10 type" markers kit and hammer on a massive anvil. The depth of digits relief makes about 0.3-0.4 mm.

Three digits of the initial number were modified as follows: "0" for "9", "6" for "9" and "5" for "7". Thus, the altered number appears as **"2<u>9</u>1<u>9</u>7"** (the altered digits are underlined).

Digit **"0"** in the initial number was altered manually using **<u>cold calking</u>** of the element (bulkhead) of digit "9" with the help of a bench tool and then stamping of the new digit "9" over the remaining contour of digit "0".

Digit **"6"** in the initial number was altered in the following way: dismantling (cutting-out) of the initial number fragment bearing digit "6" with the help of a blanking tool, swap (180° rotation), **<u>pressing in</u>** of the cut-out fragment with digit "6" (thus digit "6" is transformed into digit **<u>"9"</u>**).

Digit **"5"** in the initial number was altered manually using the process of pouring of the digit relief by polymer (epoxy spackling); stamping of the new digit "7" over soft spackling.

After the digits of the initial number were modified, the following operations were executed on the test-object: scraping; spackling;

Figure 6

a) surface image of test-object No1

b) magneto-optical visualization of magnetogram of test-object No1

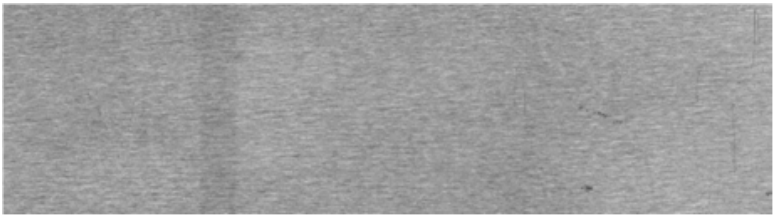
priming; two-layer tinting with aerosol motor enamel using cold drying using technology corresponding to repairs coating.

Test-object №2 (Fe) (Fig. 7) is the imitator of Category "A" control object (the data carrier of the vehicle body). It is executed in the form of a plate made of a sheet of tool steel 2 mm thick **"20165"**. The initial number is applied by machining process of pressing (cold pressing). The initial number was made in the following way: manual stamping using "№10 type" markers kit and hammer on a massive anvil. The depth of digits relief makes about 0.3-0.4 mm.

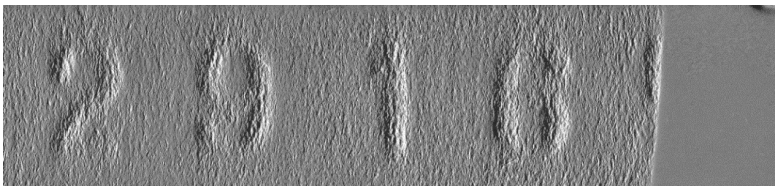
All digits of the initial number were removed by removing the metal superficial layer of the test-object to the depth of 0.5 mm. The superficial layer was removed from the initial marking by machining process of cutting (milling and polishing).

As a result of the mentioned processing of the test-object surface, the initial marking can not be observed by visual-optical methods (as the relief is removed). However, internal residual tension, produced as a result of deformation of the metal when executing the initial marking, remains in the superficial layer of the test-object metal.

Figure 7



a) surface image of test-object No2



b) magneto-optical visualization of magnetogram of test-object No2

Function control

- Take out the test-objects of the device and make their magnetic copy as described in paragraph 2.3;
- Perform magnetic copy stitching in the PC as described in paragraph 2.2.1.3 of Regula 7505M OM;
- Compare the results of the obtained magnetic copies stitching with the control images, shown in Figure 6 and Figure 7. If comparison results are positive, the device operation can be considered as normal. Comparison criteria the results of the obtained magnetic copy stitching with the control images for Al-scanner are as follows:
  - compare the processing quality of the alteration features of the initial number digits (the contours traces of the initial marking digits on the 2th and 6th digit position and fragments pressing-in contours on the 4th digit position as well as the traces of machining process on the 4th and 6th digit position shall be visible)
  - compare the processing quality of the digits of the secondary number (the contours of all digits shall be visible)

Comparison criteria of the results of the obtained magnetic copy stitching with the control images for Fe-scanner are as follows:

- compare the processing quality of the digits contours of the remoted initial number (the contours outlines of all digits shall be visible)

- in case of malfunction during any of the operation control stages see paragraphs 3 and 4.

1.6 Marking

The device marking is executed in the form of a label on the back side of the device controller and provides information as follows:

- manufacturer's name or trade mark;
- symbolic notation of the device;
- manufacturer's serial number of the device;
- date of manufacturing (year and month);
- rated voltage, V;
- rated current, A;
- TC marking;
- national mark of conformity (certification);

Device seals are applied with destructive labels on the device controller body. Sealing violation deprives the User of warranty maintenance.

1.7 Packaging

The case with the hardware of the device and the SPCS (Spare Parts and Components Set) are packed in cardboard packaging.

The device is transported and stored in special transportation packaging (wooden or cardboard) of the delivery set.

2 INTENDED USE

2.1 Operating restrictions

IT IS STRONGLY PROHIBITED TO:

- Disconnect the scanner socket if the controller is activated. I.e. it is prohibited to disconnect the scanner if the green indicator of the controller is switched on.
- use other charging units different from the stipulated ones
- use faulty network sockets and power supplies for ACC charge
- turn on the device with apparent damages of protective isolation and conductors
- turn on the device when protective shrouds are removed

The User should observe the following operating restrictions when operating the device:

- Climatic operational conditions as described in paragraph 1.1.1 of Regula 7505M User's Guide. Do not use the device under the rain out-of-doors or out of a vehicle. In case water or condensate appear on the body of the device elements, stop the device operation and proceed with it only after drying;
- the device should not be exposed to impacts and strong vibration when operating and transporting it;
- observe quality norms for power supplies, under paragraph 1.1.2.4 of Regula 7505M User's Guide;
- all commutations of the device components connected with opening and closing of electric sockets shall be carried out with deactivated power supply of the device.

NON-OBSERVANCE OF DEVICE OPERATING RESTRICTIONS CAUSES THE LOSS OF THE MANUFACTURER'S WARRANTY.

Limitations of use:

- it is possible to examine only electro-conductive materials when the scanner type is chosen correctly;
- do not operate the device with damaged (through breaks with sharp edges, heavily crushed), and dirty magnetic tapes with bent edges (see paragraphs 2.2.2.2 and 3.2.2 of Regula 7505M User's Guide. Failure to observe these requirements may result in discrepancies during stitching and jamming of magnetic tapes in the device;

- when using the device on the surfaces with nonflatness more than 0.1 mm on the basic area of 18x20mm or roughness more than Rz 80μm, the quality of the magnetic copy is not guaranteed due to significant contact losses
- recharge ACC according to 3.1 at least once in 2 months

2.2 Preparation for use

Activation order:

- Choose the scanner corresponding to the type of the examined material: Fe- scanner for ferromagnetic materials (steel, cast iron); Al-scanner for non-ferromagnetic electro-conductive materials (nonferrous metals and their alloys)
- Connect the chosen scanner (Fig. 1, pos. 2 or pos. 3) to the controller socket (Fig. 1, pos. 1)
- Turn on the device controller using the button (Fig. 3, pos. 3) and make sure that ACC are charged enough according to the state of indicators (Fig. 3, pos. 4) as described in paragraph 1.4. If it is necessary, charge ACC under paragraph 3.1
- Press shortly the button (Fig. 3, pos. 3) to turn off the device controller and carry out the operations necessary to start magnetographing under paragraph 2.3
- Turn on Regula 7505M under paragraph 2.2 of Regula 7505M User's Guide.

2.3 Device use

Magnetic copying of the examined object consists of the following steps:

- Prepare the examined surface as described in paragraph 2.2.2.3 of Regula 7505M User's Guide
- Prepare (demagnetize) the magnetic carrier as described in paragraph 2.2.2.3 of Regula 7505M User's Guide;
- Execute a magnetic copy execution.

ATTENTION!

THE DEMAGNETIZATION PROCESSES OF THE MAGNETIC CARRIER AND MAGNETOGRAPHING MUST BE CARRIED OUT IN THE SAME DIRECTION (SEE FIG. 8). OTHERWISE THE MAGNETIC RECORDING WILL BE WEAK, AND IN CASE OF WEAK SIGNALS IT CANNOT BE EXECUTED AT ALL.

In order to prevent errors of the direction coordination, a visual noticeable tag should be placed on the magnetic tape surface, e.g. as is shown in Fig. 8 to make a "start" point by a felt-tip pen at the beginning of the magnetic tape.

The magnetic carrier should be demagnetized as described in paragraph 2.2.2.3 of Regula 7505M User's Guide. The demagnetizer must be moved from left to right relative to the "start" point (see Fig. 8a).

The demagnetized magnetic tape is placed on the examined surface without overturns, i.e. so that the "start" point is always at the left edge.

When carrying out magnetographing the demagnetizer is also moved from left to right relative to the "start" point (see Fig. 8b). And the scanner body must be placed in the way that the direction of the arrow with the symbol indicating the type of examined materials and the direction of the preliminary demagnetization are the same, i.e. from left to right.

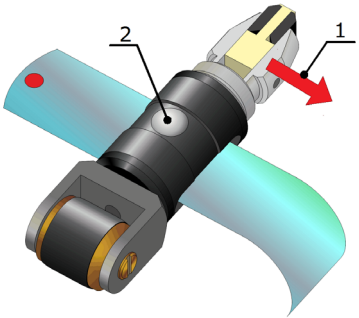
Note:

If the device and Regula model 7505 are not delivered together, the demagnetizer may exchange the polarity. In this case when carrying out scanning, turn over the tape before placing it on the object ("start" point to the right edge).

Magnetic copy:

- Put the magnetic tape on the prepared number area of a vehicle and fix its end on the examined surface by a magnetic clamp, adhesive tape or manually (try to avoid skewness and shifts relative to the examined number);
- Fix the other end of the magnetic tape stripe in the same way (if one end of the magnetic tape stripe is fixed firmly, the other end may be left loose). The operator may choose any way of the magnetic tape fixation;
- Place the body of the device scanner so that the relief tag (Fig. 5, pos. 5) in the form of an arrow is directed forward in the scanning direction (Fig. 8b). Put the scanner on the fixed stripe of the magnetic tape, make sure they have a tight contact with the examined surface.
- Switch on the power supply of the device controller with the button (Fig. 3, pos. 3), make sure the green LED glows (Fig. 3, pos. 4). If necessary, hold down the button to choose the required power mode (for Fe-scanner only). The number of flashes is in proportion to the set power level of Fe-scanner;
- Move the scanner slightly pressing it to the surface from the beginning of the examined fragment to the end. The speed of scanning should not exceed 50 mm/s.

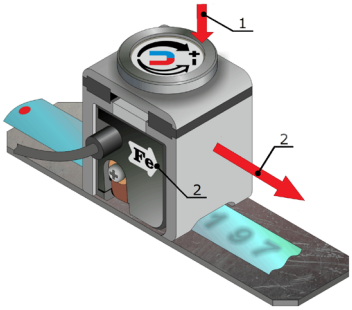
Figure 8



1 – direction for demagnetizer movement;

2 – position of the demagnetizer button (on top).

a) demagnetization, demagnetizer moves from left to right



1 – pressing force;

2 – direction for scanning (scanner movement).

b) magnetographing, scanner moves from left to right

Coordination of the processes of demagnetization and magnetographing by the direction

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;

- Press shortly the button (Fig. 3, pos. 3) to switch off power supply of the device controller (Fig. 3, pos. 3); make sure the green LED is switched off (Fig. 3, pos. 4);

- Take the magnetic tape with the copy off the examined object and disconnect the clamps. When executing the given operation avoid any contact of the magnetic clamps and the scanner with the magnetic tape surface in the area of the magnetic copy execution. Otherwise the magnetic copy can be partially demagnetized and "unnecessary" elements of magnetization (spots or stripes unrelated to the examined object) may appear in it, that can complicate the following examinations;
- Stitch the magnetogs in the USB device for magneto-optical visualization of complex Regula 7505M
- Put the magnetic copy into the corresponding compartment of the magnetic tapes case (the compartment for non-examined magnetic copies is red marked). If it is necessary, a comment can be applied on the magnetic copy with a marker from the device set
- If the operative examination of the magnetic copy is impossible (e.g. due to lack of the visualization device), make 1-2 safety magnetic copies more.

Choosing the optimal level of magnetographing power

The level of magnetographing power is regulated by holding the control button on the controller and is indicated by the number of flashes of the power indicator. For the Fe-scanners the level of examined object magnetization is additionally regulated with a flywheel being a part of the magnetizing attachment (Fig. 5, pos. 9). The flywheel is used to smoothly change magnetic field strength in the gap between the polar tips (Fig.5, pos. 8).

Changing the level of the Fe-scanner power (Fig. 11) 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. 11b as the data are more complete and detailed.

ATTENTION!

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.

Examples of efficient use of the device

The result shown in Fig. 9 can be considered as an example of the device efficient use for examination of homogeneity of the surface composition of the item made of aluminum alloy.

The image of the object surface in the form of a magnalium plate of 1 mm thickness is shown in Fig. 9a. The plate contains such artificially formed relief elements and defects as:

- Not specially marked through holes of 1.5 mm diameter; holes of 0.4–1.2 mm diameter and '133' impressed digital stamp visible with the naked eye;
- Well-noticeable visually parallel scratches pos. 1 of 200-300 μm width;
- Hardly-noticeable visually curved scratch pos. 2 of 100 μm width;
- Casually located insignificant superficial defects 3 in the form of small grey spots which correspond visually to indiscernible indents, surface dirt and accumulations of (extrinsic) ferromagnetic inclusions which embedded in the sample surface as a result of its mechanical process. The results of visual-optical data analysis cannot help to extract the accumulations of ferromagnetic inclusions from a number of insignificant superficial defects pos. 3.

All above-mentioned relief elements including scratches pos. 1 and pos. 2 are clearly observed aas a result of visualizing the magnetogram of the examined object (Fig. 9b) and their contrast is higher than that of the optical image. It attests sensitivity of magnetographing and visualization devices to superficial defects such as scratches of 100 μm width and resolution not less than 200 μm.

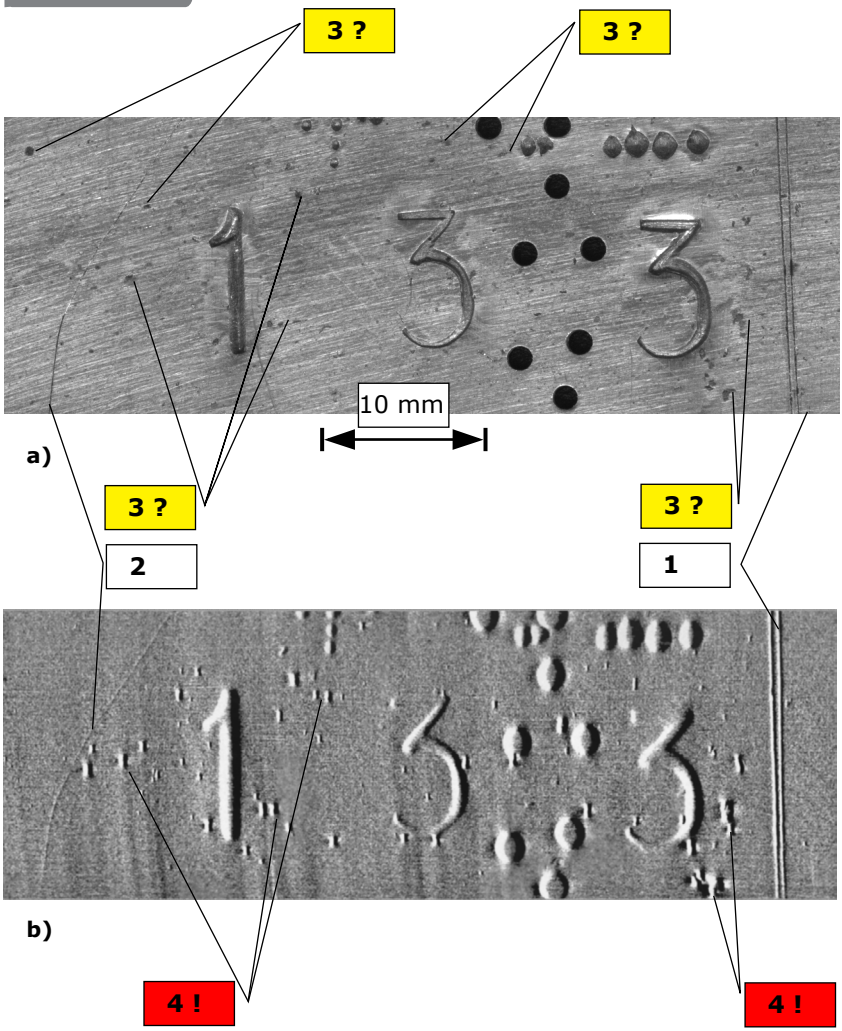
Moreover, visualization enabled to detect by brightness and contrast the accumulations of ferromagnetic inclusions pos. 4 from a number of insignificant superficial defects pos. 3.

The ability to detect superficial ferromagnetic inclusions is an important control feature, so long as it enables to examine e.g. the transfer of metal (steel) microparticles from matrix and punch to the face and back surface of an aluminum carrier of VIN data.

The following example (Fig. 10) shows the device potential when investigating joint welds in aluminum and their defects.

The image of the object surface is shown in Fig. 10 a. The object is made of aluminum alloy and has a trimmed joint weld. The object is made of 2-sheet magnalium fragments of 2 mm thickness connected with a butt weld (arc welding). The weld surface is trimmed with a manual abrasive tool and covered with a paint film layer of 100 μm.

Figure 9



1 – scratches of 200-300 μm width;
2 – scratch of 100 μm width;
3 – insignificant superficial defects;
4 – accumulations of ferromagnetic inclusions

Photo (a) and magneto-optical visualization results of the object magnetogram (b). The aluminum object has superficial ferromagnetic inclusions

You can also observe visual-optically such artificially formed relief elements and defects, as:

- Incomplete fusion (pos. 1) at joint edges;
- curved scratches pos. 2 of 100-200 μm width well-discernible with the naked eye;

However, visual-optical data do not help to establish the belonging of the scratches pos. 2 to the paint film or the metal of the sample surface.

In the results of magnetogram visualization of the given object (Fig. 10 b) incomplete fusion (pos. 1) is observed at joint edges, and their detailing degree is higher, than that of the optical image. Obviously the curved scratches (pos. 2) belong to the paint film, so long as they are absent in the results of the visualization of the object magnetogram.

Moreover, visualization enabled to detect the overlap of electrode metal pos. 3 and machining process paths pos. 4 not observed visual-optically through the paint film layer.

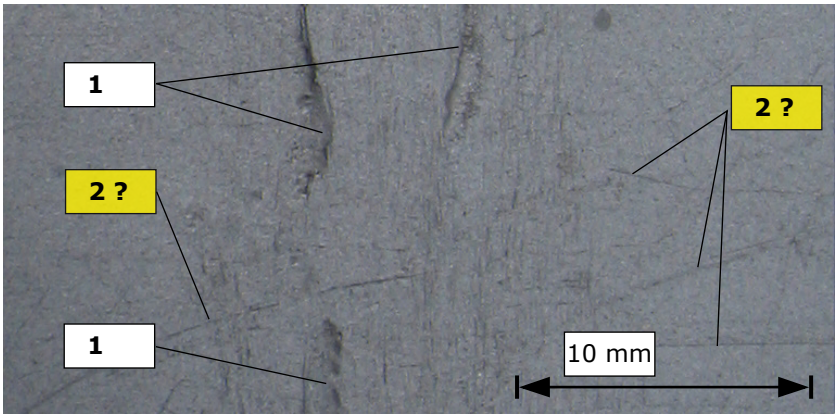
The possibility to observe the structure and defects of joint welds in the objects of aluminum alloys is an important control feature, as it enables to examine e.g. the ways of VIN data alterations based on welding technologies.

The following example (Fig 11) shows the probabilities of sensitivity increase of magnetographing when investigating weak signals of residual stress in ferromagnetic materials when applying different power levels of the Fe-scanner (see paragraph 2.3 for the power levels).

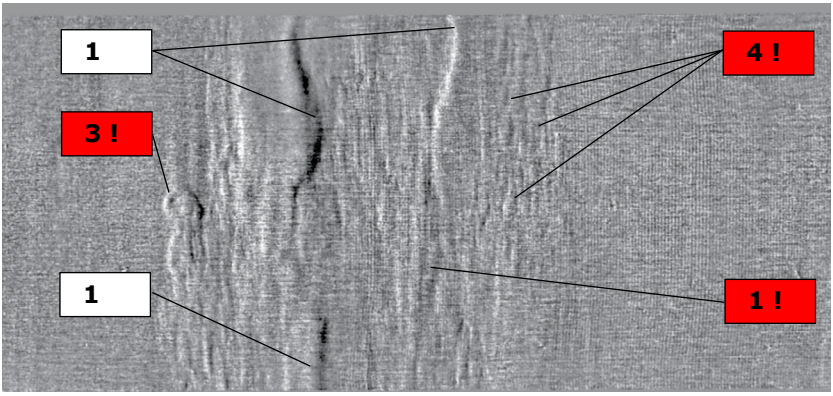
The manufacturing techniques of the test-object with the examination results shown in Fig. 11 do not differ from those of test-object №2 (Fe). The only difference is the material used. I.e. the surface photo image of this test-object being similar to those shown in Fig. 7a – is a polished surface with a completely removed relief of the initial marking (cut with the superficial layer of the metal).

It should be noted that **high sensitivity level of magnetographing enables to control efficiently metal internal tension only on flat and smooth surfaces**. Otherwise, if the object surface is covered with deep scratches, in consequence of this high sensitivity level of magnetographing, the signal of these scratches will be amplified manyfold in the record and as a result it will "camouflage" a useful signal from internal stress.

Figure 10



a)

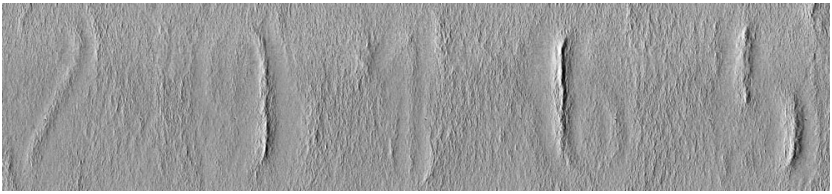


b)

1 – incomplete fusion at weld edges;
2 – surface scratches;
3 – overlap of electrode metal;
4 – paths of machining process.

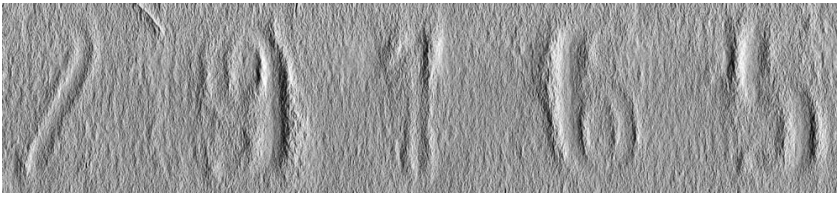
Photo image (a) and magneto-optical visualization results of the object magnetogram(b) made of aluminum alloy with a trimmed joint weld on the device surface under the paint film layer of 100 μm

Figure 11



a)

b)



c)

The results of magneto-optical visualization of magnetograms of the test-object made of ferromagnetic alloys with minimal (a), medium (b) and maximal (c) power levels of the Fe-scanner

3 MAINTENANCE

3.1 General instructions

Daily technical maintenance of the device provides for the operations as follows:

- external examination (visually check the integrity of the controls, indication and commutation, as well as the integrity of isolation and the scanner cable conductors);
- control of ACC charge is carried out by trial activation depending on the state of the charge indications as described in paragraph 1.4. If required (indication of ACC discharge), charge ACC under the requirements of paragraph 3.1;
- clean of the front panel, controls and scanner surfaces from dust and fatty films with a soft tissue paper (scouring cloth) or a wad wetted in the ethyl alcohol;
- cleaning the electrical-contact surfaces of the scanners and inductors (in the area of fixing screws Fig. 4–5, 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.

Approximate ethyl alcohol consumption per working shift makes 5 g.

Technical maintenance of the device when preparing it for storage and in the storage mode:

- place and package all device components, put into the transportation package;
- at least once per two months recharge ACC under the requirements of paragraph 3.1.

Current technical maintenance of the device includes ACC recharge. The device ACC require regular recharge to prevent their untimely failure. Recharge periodicity depends on the indication state (paragraph 1.4), but at least once in 2 months. When charging ACC safety measures described in paragraph 2.1 shall be observed.

Charge order of the ACC:

- Connect the charging unit to the wall outlet (alternating current of 220 V, 50 Hz) and connect to the corresponding controller socket (Fig. 2, pos. 6). If the indicators of the charging unit are activated, there are voltage supply (24V) and contact in ACC sockets.

- Wait ≈ 8 hours(till full charge). Do not interrupt charging as it may lead to ACC capacity decrease.
- Disconnect the charging unit from the wall outlet.
- Carry out function control according to paragraph 2.2.

3.2 Safety measures

Observe safety measures as described in paragraph 2.1 when performing the device technical maintenance.

3.3 Serviceability test

For operational serviceability test see “control function” section of paragraph 2.2.

4 ROUTINE REPAIRS

4.1 Safety Measures

When carrying out routine repairs, safety measures must meet the requirements of paragraph 2.1.1.

4.2 General Instructions

According to this User's Guide the user is to perform the following routine repairs: replacement of the ACC and replacement of the scanner inductor.

4.3 Instructions on Repairs

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 from the device delivery set (Fig. 1, pos. 8). It is recommended to clean electrical-contact surfaces before installing the inductor.

ATTENTION!

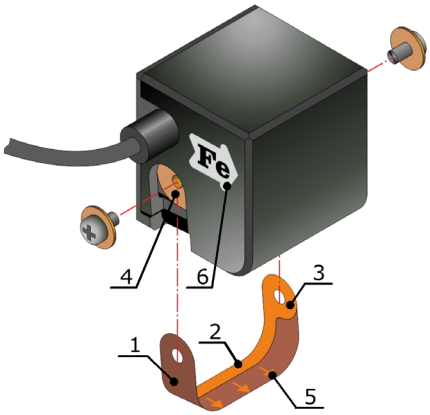
DO NOT INSTALL HOMEMADE INDUCTORS ON THE SCANNER. IT MAY DISABLE THE DEVICE. IT IS ALLOWED TO USE ONLY THE INDUCTORS PRODUCED BY THE MANUFACTURER.

Inductor replacement is shown in Fig. 12.

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 12



Inductor replacement for dynamic scanners

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.

5 STORAGE

The device should be stored in the manufacturer's packaging.

Climatic storage conditions:

Table 3

air temperature range	from +5 °C to +40 °C (discharged ACC shall be stored at the temperature of approximately +5 °C which enables to maintain their characteristics for several years)
relative air humidity	up to 80 % at +15 °C
atmospheric pressure	100 +/- 4 KPa (750 +/- 30 mm)

When preparing the device for storage, it is recommended to perform maintenance as described in paragraph 3.2.

The maximum number of devices in the stack - not more than 10 pcs.

6 TRANSPORTATION

During transportation, use the manufacturer's packaging (provided in the delivery set). Climatic storage conditions stipulated in paragraph 5 must be observed. Protect the device from shock and vibrations.

7 RECYCLING

Recycling of the device must be carried out under the rules adopted at the customer's enterprise. ACC and their charging unit require special recycling rules.

8 ACCEPTANCE CERTIFICATE

(to be completed by the manufacturer)

Eddy-current magnetographing device Regula 7515M

Serial number _____

is produced and accepted in accordance with obligatory requirements of state standards, current technical documentation and considered serviceable.

Responsible for acceptance

_____	_____	_____
(position)	(signature)	(full name)

_____

(year, month, day)

Seal:

Manufacturer: JV RIODIN
Ukraine, 01133, Kiev, Leonid Pervomaisky street, 9a-26,
Phone/Fax: + 38 044 246 4164, + 38 044 288 0549,
E-mail: riodin.kiev@gmail.com

Address for mailing claims with regard to the quality of the device:
ZAO NPP Regula
29 Kozlova Lane, Minsk 220037, Republic of Belarus
Tel. +375 17 224 66 44, Fax +375 17 318 95 73
E-mail: support@regulaforensics.com
Web: www.regulaforensics.com

9 SALE CERTIFICATE

(to be completed by the manufacturer)

Eddy-current magnetographing device Regula 7515M
Serial number _____ is sold to:

Seal:

Seller's name _____
Date of sale _____

Ukraine, 01133, Kiev, Leonid Pervomaisky street, 9a-26,
Phone/Fax: + 38 044 246 4164, + 38 044 288 0549,
E-mail: riodin.kiev@gmail.com