ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 7 , July 2019

Development of a Rail Lash Demagnetization Device and Their Comparative Analysis with Existing Ones

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ABSTRACT: The proposed device can be used for demagnetization of materials from ferromagnets, the base of which is used in rail welding production for welding rail lashes. In addition, it can be used for demagnetization of various materials that are used in the oil and gas industry. When laying railway tracks, 725 meters of rail lashes are used, which are welded 25 meters each, as approved in Gosstandard. Usually, whips used in welding are magnetized by technological processes and transportation. Since the lashes are made at metallurgical plants by rolling on a magnetically broaching mill, residual magnetism remains in the finished rails, which negatively affects the welding process. When welding, the butt joint foams, cracks, and in some cases diverges. On electrified railways, the possibility of emergency situations is sometimes not excluded. Therefore, when assembling elongated lashes, the docking rails should be demagnetized.

KEYWORDS: Magnetization, EMF, impulse, induction, strength, core.

I. INTRODUCTION

There are a number of demagnetizing technical devices, both stationary and mounted on a mobile vehicle. Known demagnetization devices are usually called demagnetizers. Demagnetizers are usually placed on mobile locomotives, which consist of an oscillating circuit containing a solenoid connected in parallel and a capacitor unit. They are powered by alternating voltage from the generator. The poles of the magnets are located at distances from 10 to 50 mm above the rail junctions [1].

When moving the demagnetizing device at a speed of 5 km/h along the connecting rails, an electromagnetic field gradually increases at the beginning, and then gradually decreases, which leads to demagnetization of the area. One of the drawbacks of this device is the high energy consumption up to 10 kW and the current pulse distortion due to the use of large capacitors up to 920 microfarad, the low quality of degaussing of rail lashes [2]. The view of this has to move the device along the rails in the forward and in the opposite direction several times.

At the same time, a lot of energy is expended for lowering and raising the frame on the locomotive in the spring. There is another DC demagnetizer that contains a series circuit of a resistor, a charging switch and a capacitor battery. In addition, an energy storage device is inserted into the oscillating circuit [3], which has a magnetic system and is connected in series with the solenoid.

A disadvantage of this device is that it cannot demagnetize fixed rail lashes. There is also a shunt for the demagnetization of insulating joints, which contains a ferromagnetic core with a magnetic system on high-power permanent magnets [4]. They are fixed to the bottom of the rails by springs, which allows you to mount and dismantle the device without disassembling the joint [5].

II. LITERATURE SURVEY

The demagnetization of a permanent magnet is to create a field strength opposite to the residual magnetization. In this case, the magnetization of the track circuit decreases slightly and is compensated within the limits of the permissible value. In this case, the induction of demagnetization is achieved from 30–40 μT to 10 μT [6].

There is also degaussing of a rail scourge by a variable electromagnetic field. This device has the disadvantage of not completely demagnetizing the joint, which leads to the repetition of the cycle. This increases the electricity, the processing time, which leads to the heating of the solenoid and the complexity of setting electrical

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parameters [7]. Preserving the residual magnetization leads to the closure of the insulated joint by metal particles, leading to disruption of the automatic locomotive signaling system (ALSS).

At the present level of development of science and technology, it is necessary to create such devices that would provide ease of maintenance and management.

III. EXPERIMENTAL RESULTS

The frequency converter is assembled on the basis of a diode-thyristor module from the company "Semikron", which can operate at both low frequency and high. These modules have high efficiency. and have reversibility in the direction. To convert the energy, drivers are used, that is, devices of matching boards for changing the output current, adjusting the frequency and pulse duration. The converter device provides a change in power factor and allows you to change the current in both directions.

Automatic control of the converter is carried out by the device link, which provides stabilization of voltage, temperature, and demagnetization device parameters. A feature of the control system is the ability to supply a demagnetizing device, consisting of 4 coils with minimal active resistance (0.017 Ohm) and significant inductance (1.5 H).

The proposed control system allows obtaining significant currents up to 300A in a pulsed mode and maintaining the shape of rectangular pulses, which is important when degrading rail lashes with a single electromagnetic field.

A converter that operates as a key for large values of voltage and current for short durations of pulses. This allows the use of the proposed converter with automatic controls of power devices. In this case, large values of electromagnetic induction can be controlled to reduce the coercive forces, both positive and negative, when degaussing rail lashes.

The control unit uses the ATMEGA8 microcontroller, which makes it possible to ensure the operation of the elements in real time. This allows you to implement an algorithm for managing complex technological processes, which has in its assets various devices for determining the magnetic field induction, the speed of movement of rail lashes, and the temperature of the inductors.

Multiprocessor control systems have built-in peripheral modules and ports. The software complicates these multiprocessor devices, due to the large amount of memory flowing in a short time.

Therefore, a single-processor system with simple hardware and software is applied to the control unit. Our conversion system consists of two processors that perform frequency conversion and carry out the work of the control unit and communication with the upper level system.

The six-channel PWM signal performs the work of the driver control unit with the addition of a pause. In case of an accident, switching off of PWM signals and program correction is used.

The developed device allows using it on mobile and mobile mechanisms with improved energy parameters and characteristics. It allows you to demagnetize rail lash around the perimeter and volume. The created pulsed electromagnetic field allows you to demagnetize the rail lash to the size of the intensity of the electromagnetic field of the Earth.

A device for pulsed demagnetization of rail lashes consists of a power source, a demagnetizing inductance coil, a control unit and a frequency converter (Fig.1).

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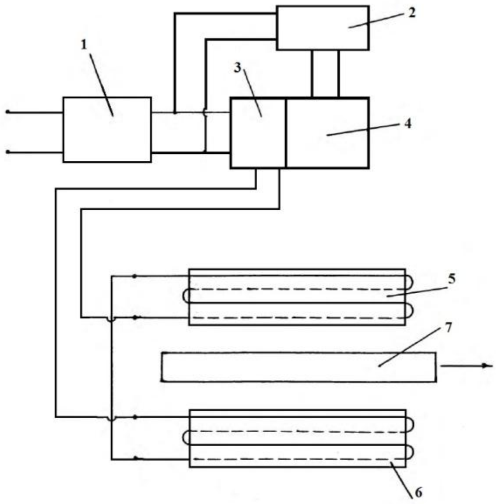

Fig.1. Schematic block diagram of pulsed demagnetization of rail lashes

The pulsed demagnetization device for rail lashes contains a power transformer 1, a power converter 2, a frequency conversion unit 3, a control system 4 and a forked demagnetization winding performed in the form of two inductors 5 and 6.

The frequency converter is made of a diode-thyristor module from the company "Semikron", working to emit signals with a frequency of 0.1 Hz to 1000 kHz in a rectangular pulse mode with opposite parameters on both sides of the junction.

The frequency converter includes recording devices: an electronic ammeter for alternating voltage with a measuring range from 0 to 200 A at a frequency of 50 Hz and a digital voltmeter that shows an input voltage of 380 V, its outputs are connected to a frequency conversion unit. The control system allows receiving rectangular pulse signals and protects the converter against the influence of reverse currents. At the same time, the power converter feeds the control system created on the basis of the ATMega8 microprocessor, which allows adjusting the pulse duration from 10 to 30ms, and the pulse repetition rate within 5÷25 Hz. The microprocessor control system provides the automatic supply of control voltage and current, automatically turns off the device when the temperature of the inductance increases, and automatically controls the rail supply system during rail welding operations (Fig.2).

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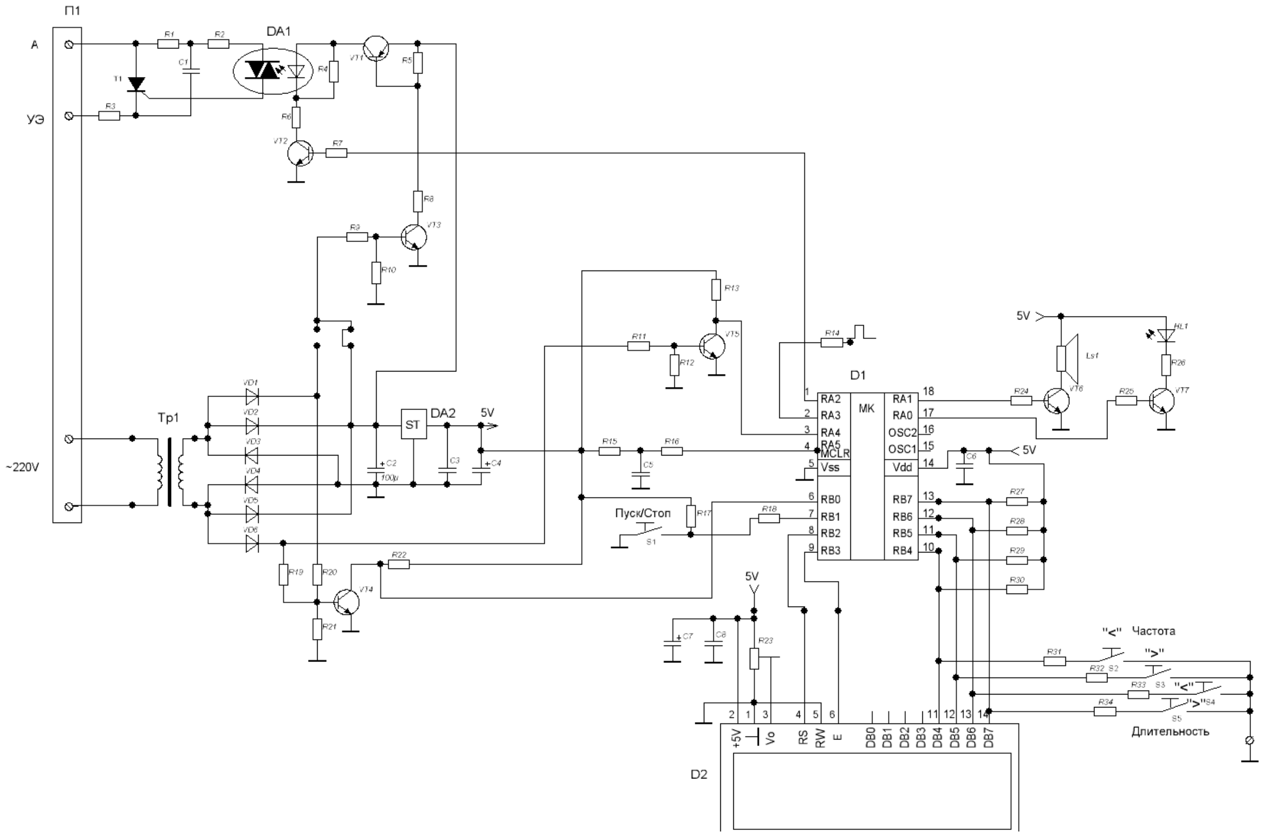

Fig.2. Expanded electrical circuit of electric power units

Inductors are a solenoid with 125 turns of rectangular copper wire S=56mm^2. Fiberglass is used as insulation of turns, which ensures reliable operation when the coils are heated to 120°. For cooling the coils, two 40W fans are provided (not shown in the drawings). The coils are connected to the output ends of the frequency conversion unit in a series-opposite circuit, which ensures the flow of a positive pulse through one coil, and another through a negative one. This ensures the destruction of positive and negative values of the coercive force (Fig.3).

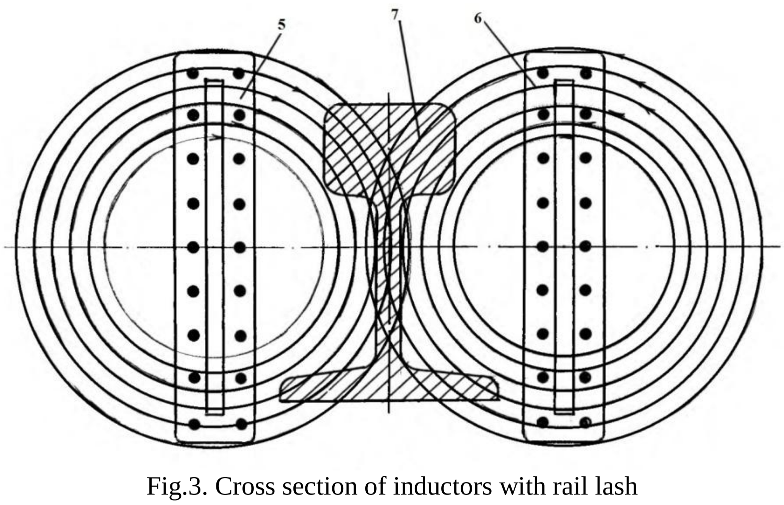

Fig.3. Cross section of inductors with rail lash

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International Journal of Advanced Research in Science, Engineering and Technology
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Consider the work of the proposed device when degaussing volume-hardened rails in the process stream of rail welding production.

The rails connected in the whip are automatically fed by a lingering mechanism to the assembly site where the demagnetizer is installed.

After supplying electrical power, the transformer lowers the AC voltage from 220V to 120V and supplies the power converter, which converts the AC voltage to DC. The power converter feeds the frequency conversion unit and at the same time the control system, on the panel of which the knobs for setting the frequency F and pulse duration T are installed. Gently rotating these knobs set the frequency from 5 Hz to 25Hz and the pulse duration from 10 to 30ms. The values are controlled by displaying 8Hz and 30ms on the display. At the same time, it is necessary to control the amperage on the ammeter, which should not exceed 30A, otherwise the inductors will overheat.

The electromagnetic field created by the inductors demagnetizes the rails over its entire cross section. The proposed device pulsed demagnetization allows you to control the magnitude of the magnetic field to the normalized value of demagnetization rail lashes with induction value 1.2T to 30 ÷ 40μT. When there is a magnetic field of reverse polarity, which reduces the coercive force, while ensuring complete demagnetization of the rail scourge.

IV. CONCLUSION AND FUTURE WORK

This device has passed production tests at the enterprise UE "RSP-14" JSC "Uzbekistan Railways". The test results showed that the developed device for rail demagnetization in many ways surpasses the existing technical solutions and is recommended for mass implementation in the rail welding industry in terms of energy and operational characteristics. The demagnetization device can be used on mobile devices (trolleys), as well as in mobile platform cars (rail cars) for degaussing rail lashes, in order to avoid ALSS malfunctions during their operation.

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