interference at 25 Hz also increased and it values exceed the limit current of the interference in rails at 25 Hz.

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UDC 629.4.012

## AUTOMATION OF THE DETECTING DEFECTS IN MOVABLE ARMATURE OF THE SIGNALLING RELAY

The purpose of the work is to develop a method for revealing of the movable armature defects of a signalling relay based on the measurement of the transient current when the relay is turned on and off with subsequent currents' processing using wavelet transform.

The time dependences of transient currents during relays switching have been investigated for relay in various technical conditions: in operable condition, as well as with artificially created defects (bends) of contact springs [1,2]. The measured data have been analyzed in the time and frequency domain using the wavelet transform modifications (CWT, DWT, DWPT).

The analysis of the transient currents was carried out using segmentation of the current characteristics of the relay. At first and third segments, which corresponded to unmovable anchor state, the transient current increase with time during relay switch-on approximately as the exponential function. The time constants of the current were calculated by approximating of the measured currenttime dependences by exponential function.

The presence of defects in the movable armature of the relay practically hadn't effect on the values of calculated time constants.

However, these values strongly depended on the technical condition of the relay magnetic circuit and the relay coil, as well as on the voltage applied to the coil terminals. This behavior of the relay time constant on the first segment of the relay current characteristic makes it possible to use this parameter for monitoring the technical state of the electromagnetic relay system.

Defects of the armature and contact springs led to the appearance of additional features at the second segment of the relay transient current curve, which corresponded to the movement of the armature. The magnitude of these features on the current curve depended on the value of bending of the relay's contact spring. The width and appearance time of the features at the second segment of the current-switching curve correspond to the non-simultaneous switching of the relay contacts. To determine the amplitude (energy) of these features (peaks) on transient current curve, their duration and the times of appearance, the wavelet transform was used. The results of investigations confirmed the possibility of determining the defects of the relay movable armature by using wavelet analysis of the second segment of the relay transient current characteristic.

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UDC 656.259.12

## AC IMPEDANCE OF R65 TYPE RAILS ON 1520 MM TRACK IN THE AUDIO FREQUENCY RANGE

Knowledge of the exact AC rail impedance in a wide frequency range is necessary for designing and modeling audiofrequency track circuits, determining of the return traction current distribution in rails of high-speed railways, etc. Results of the rail impedance investigations were published in papers of Carpenter and Hill, Mariscotti and Pozzobon [1] and others. A theoretical analysis of frequency dependence of rail impedance is based mainly on the so-called Carson/Pollaczek model or simply Carson's method that was proposed almost simultaneously by Carson and Pollaczek. Based on Carson's work [2],

In this work the comparative analysis of the calculating methods for AC impedance of R65 type rails of a track 1520 mm gauge in the audiofrequency range have been performed.

Results of AC rail impedance measurements and theoretical description of frequency dependence of impedance for wires above lossy ground are briefly reviewed. Mathematical formulation of Carson's method and the complex image method proposed by Deri with co-workers for impedance of transmission lines were represented. The impedance of running rails of R65 type on the track of 1520 mm gauge have been calculated by using Carson's method and the complex image method. Due to the insufficient amount of literature data concerning