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COMPLEX DIAGNOSTIC SYSTEM FOR ELECTRIC TRAINS

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Failures of rolling stock machine units in railway transport reduce their technical use ratio and availability that results in high operating costs in this branch. The main reason of this situation is high level of rolling stock wear and also insufficient observability of units' technical state during manufacturing, repair process and maintenance. It's possible to reduce a number of unplanned repairs, and as a result, to decrease operating costs by means of diagnostic systems implementation in plants and in depots for providing of manufacturing and repair quality, and systems for control and monitoring of rolling stock units technical state during maintenance and repair. After analysis of existing diagnostic devices used in plants and depots for estimation of motor driven rolling stock (MDRS) technical state, a number of disadvantages, such as lack of automated diagnostic process, wide duration of diagnostics, lack of automated formation of conclusion about diagnosed object operational feasibility, low level of functional capabilities which do not allow to provide completeness of MDRS electro-section diagnostics, and results in reduction of the whole electro-section technical state diagnostics reliability, influence of human factor on formation of conclusion about availability of one or other unit, are detected. Developed by SPC «Dynamics» specialists stationary system for complex diagnostics of electrical train is intended for complex diagnostics of MDRS electro-sections technical state by combination of different systems providing diagnostics of wheel-motor units, electrical insulation, collector, automated braking system, including undercar compressor, electric control circuits, power and auxiliary electric circuits of electro-section on test stretches in manufacturing or repair in one complex.

Table . List of diagnosed units and trains.

№	Title of subsystem	List of diagnosed units and trains
1	Subsystem for diagnostics of wheel-motor units	Axle-box units; Traction electric motor; Reducer.
2	Subsystem for diagnostics of power electric circuits insulation	Pantograph; High-speed circuit breaker; Power circuits contactors; Starting resistors; Winding of traction motors; Radiators and heaters; Protection devices for heating circuits and auxiliary electric machines protection; Auxiliary circuits contactors.
3	Subsystem for diagnostics of pantograph	Rising and dropping springs; Tractions; Flexible couplings; Reducing valve.
4	Subsystem for diagnostics of pneumatic breaking system	Break valve of motorman; Air distributor; Electric air distributor; Breaking and power lines; Reservoirs; Breaking cylinders; Clack valve of reservoirs; Break release indicator.
5	Subsystem for diagnostics of electric control circuits	Traction motors; Protection and alarming devices; Circuits for control of auxiliary circuits and heating; Doors and pantographs.
6	Subsystem for diagnostics of power electric circuits	Circuits of traction motors armature windings; Circuits of traction motors exciting windings; Circuits of excitation reducing (inductive shunt); Power devices; Reverse switch; Starting resistors; Resistors of excitation reducing; Sequence.
7	Subsystem for diagnostics of auxiliary circuits	Circuits of radiators and heaters; Heating contactors; Circuits of voltage divider; circuits of compressor motor; Contactors of auxiliary machines; Inter-car high-voltage connectors.
Total: more than 200 diagnosed units and trains		

Different methods of technical diagnostics for estimation of the most important equipment technical state are extensively used in stationary system for complex diagnostics COMPACS®-EXPRESS-TR3:

1) wheel-motor unit – by methods of viabroacoustic diagnostics in six most loaded components of wheel-motor unit with specified and constantly holding speed level;
2) insulation of power and auxiliary electric circuits – by means of combined estimation of resistance and characteristics of insulation charge process (factors of absorption and polarization) on specified sites;
3) pantograph – based on estimation of effort characteristics and time intervals during lifting and sinking of pantograph in operating range of heights;
4) electropneumatic breaking system – by the analysis of gas-dynamic processes characteristics, occurring in pneumatic system when operating mode is specified;
5) electric control circuits – by the analysis of electric parameters in the definition processes of control actions for electro-section electric circuits;
6) power electric circuits – by estimation of power circuit sections resistances during operation of power switch devices in all combinations;
7) auxiliary electric circuits – by the resistances analysis of high-voltage auxiliary circuits sections during operation of their devices.

Structure and construction of the developed system provide independent automated complex diagnostics of the most important equipment of MDRS in ready assembled on the test-sites. This allows to reduce considerably the expenses for their elementwise diagnostics, repair and set-up.

System allows to diagnose more than 15 types of electrical trains. System can be integrated into diagnostic net of depot for monitoring of the whole depot electrical trains technical state, quality of their repair, manufacturing discipline. In the Table the list of units and trains automatically diagnosed by the system is shown. The offered system for complex diagnostics of MDRS electro-sections provides significant increase of electro-section diagnostics reliability due to great functional capabilities and allows to repair electric trains based on actual technical state. Thus, complex diagnostics includes diagnostics of the most important equipment in electro-section: wheel-motor units, electric insulation, pantograph, autobreaking system, including undercar compressor, electric control circuits, power electric circuits, auxiliary electric circuits, and takes no more than 3,5 hours, that allows one diagnostician to diagnose up to 2 electro-sections for the one 8-hours shift, and also repair electro-section by means of one diagnostician and one/two mechanical technicians for 1-2 shifts. This system for complex diagnostics of electric trains COMPACS®-EXPRESS-TR3 is implemented and successfully operates at more than 10 enterprises of OAO «Russian Railways».