

TRANSFORMATION OF MINE BATTERY LOCOMOTIVE 4,5 ARP INTO A TROLLEY LOCOMOTIVE

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ABSTRACT

The article considers the reconstruction of mine battery locomotive 4,5 ARP into a trolley locomotive. All of the important changes of the motor, operations, illumination devises/lighting installation, signaling, achieving the needed cohesive mass/weight and all necessary requirements, such us motorman cab, trolley, information about the consumed current supply by the motors and the voltage at the trolley circuit. All sections of the mechanical and the braking systems are described as well as the current intensity system and the auxiliary electrical installation. There are pictures displaying the developed locomotive and results from the service tests.

The small trolley locomotives of a mass of 4-5 tons are applied in mining practice as face machines, driving machines and auxiliary equipment. In Bulgaria, in fact trolley locomotives of that mass were not manufactured and were not imported. For those reasons, wherever there is a need of trolley locomotive, battery machines were used, as a rule. The crisis, which spread over mining industry in the last years, made difficult the use of battery locomotive. Main factor for that was the high cost of the accumulator batteries. In many of the mines, where conditions did not allow utilizing of heavier machines, the reconstruction of the existing battery locomotives "4,5 ARP" to operate on a trolley circuit started on a local level, without any serious precautions of mine safety.

Due to the need of light trolley locomotives and availability of free unused battery machines with mass of 4,5 tons, the team of the Research and Development Department for mine equipment to the UMG "St. Ivan Rilski" decided to develop a practical and inexpensive trolley locomotive on the base of the existing battery "4,5 ARP" (fig.1).

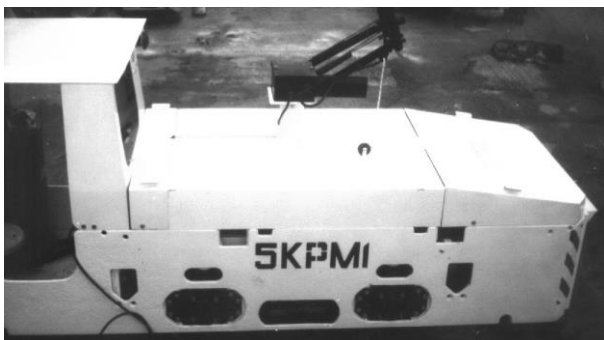


Figure 1.

The following tasks have to be solved:

1. According to the requirements of Safety Guide for operation with a trolley circuit.
 - 1.1. Availability of a cab for the motorman.
 - 1.2. Light signaling – headlight in the direction of moving and a red light in the opposite direction.
 - 1.3. Sound signaling – mechanical and electrical.
 - 1.4. Trolley
 - 1.5. Safe mechanical and electro-dynamical brake.
 - 1.6. Ensuring the necessary visibility in both directions.
2. Ensuring the necessary mass of cohesion since the accumulator battery is liquidated.
3. Adjusting the electrical equipment in conformity to its operating on trolley circuit.

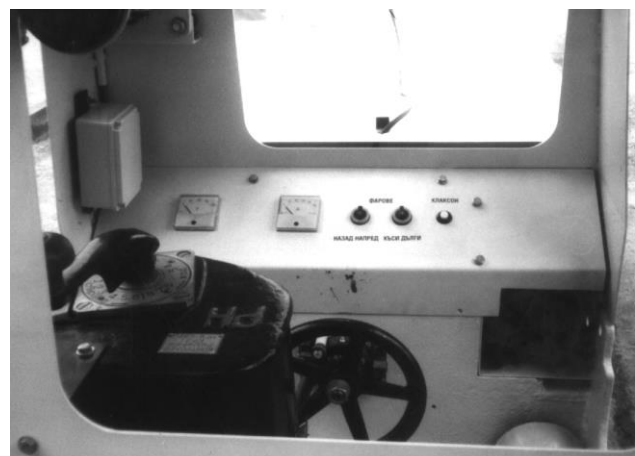


Figure 2.

The cabin (the superstructure) was designed and produced by six millimeter sheet. It is provided to be fastened to the frame by six bolts and if necessary to be in position to be easily removed. On the front and the rear side there are apertures and supports for fastening of the two headlights and the rear

lights, as well. On the front side is situated the control panel (fig.2).

There are an amper-meter and a voltmeter, which read respectively the current supply to the motors and the voltage of the circuit. There also are the different control switches for headlights and the horn. In the cabin a place is envisaged for the main switch and the voltage transformer, supplying the auxiliary devices.

To provide the necessary illumination of the road, a normal duty headlight was engineered on the basis of the optical element of VAZ 2103 automobile. The headlight is cased in aluminum alloy and it is composed by three parts – front one, in which the optical element is situated, body and rear lid. Into it a 24 volts 50/55 W bulb with two lights is mounted, which allows besides the choice of illumination of the road, also a duplicate/spare light in occasion of burning out of one of the lights.

The sound signaling is fulfilled by a mechanical bell and an electrical horn.

The trolley is similar to those used into the Russians trolley locomotives K7 and K10. Keeping in mind the small room and the higher manoeuvre ability of the machine, some changes are developed. A construction was engineered (fig.3) with only one electrically removable arm and lightened frame.



Figure 3.

Current supply is completed by an aluminium slider, and current is derived by an appropriate flexible conductor to a shoe gear.

The mechanical brake of the locomotive does not sustain any change. A very safe and convenient electro-dynamic brake is incorporated. For that purpose, the engines are set to a generating (braking) regime, and the operation is fulfilled by the controller of the locomotive driver.

Removing the battery bucket the visibility from the cabin becomes excellent and it complies with all requirements.

The ensuring of necessary cohesive mass at the release of the batteries was accomplished in the following way. A 30 millimeters thick steel plate was placed on the bottom of the cabin. The compartment for the starting resistors in the front part of the locomotive was filled with metal waste and was poured with concrete. The basic part of the extra mass was ensured by a specially prepared bucket (fig.4) It was also filled with metal waste and was poured with concrete. This was the way to be provided a cohesive mass of about 5000 kg.

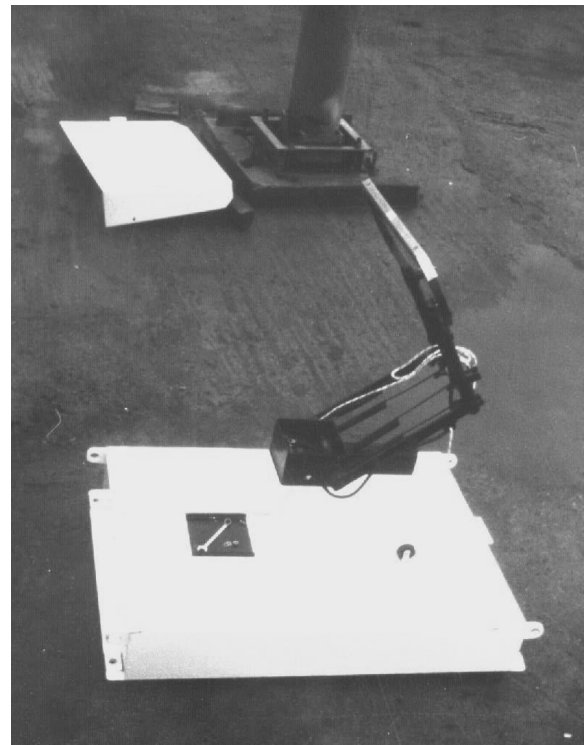


Figure 4

The electrical equipment of the locomotive went through corrections in the realization of several tasks:

1. Operating on trolley circuit at significant variations of the incoming voltage.
2. Improving the operation of the locomotive in motoring and braking regime.
3. Increasing the traction possibilities and velocity of the locomotive.
4. Ensuring a stable and safe voltage for the auxiliary electrical consumers.
5. Increasing the exploiting safety of the electrical equipment.

At the trolley circuits there always exists a loss of voltage, for which compensation the voltage at the traction station increases with 20-30%. Practically, current supply of the circuits, in which locomotives "4,5 ARP" are operating, reach up to 140-150V.

The engines of these machines are designed for 80V. When voltage is increased to more than 100V, they suddenly get

worse due to the commutation of the collector and they rapidly fail.

To solve that problem and increasing the haulage and speed abilities of the locomotive, haulage motors type "EDR-7P" were amended. There were mounted two additional poles to compensate the electrical armature reaction. The rig tests done figure the following:

1. The motor remains with dark commutation at voltage 150-160 V.
2. The motor operates stable and without sparking at nominal capacity at higher velocity and higher voltage.

The consequence of introducing the additional poles is not only a considerable improvement of the commutation at higher voltages, but also increasing by 20-30% the power of the motor at the respective voltage amplification.

The battery locomotive "4,5 ARP" operates by the Russian controller of the type "GR-9M". The last ensures only seven stages for accelerating the locomotive and controlling the speed.

For improving the operation control and providing a convenient electro-dynamical brake a controller of the type "KP-1" was applied to the trolley locomotive. The controller was produced at the Research and Development Department for mine equipment. Additionally two diodes "D161-250/10" were mounted to decrease the commutation of the contacts. This controller possesses eight haulage positions and seven braking positions, as it ensures very stable operation for all modes.

The starting and restraint resistors were recalculated according to the new electromechanical characteristics of the motors. There were laid resistors of the type "BR-1", shared by heavy locomotives K7 and K10. The alteration of the degrees leads to smoother accelerating of the locomotive and helps the efficiency of the electro-dynamical brake.

A stabilizator-voltage transformer from 130V to 24V with power capacity 200W was specially invented for the current supply of the auxiliary electric consumers. It provides a stable outgoing voltage at variation of the incoming one within 40%.

The reconstruction of the motors "DR-7П", by introducing the additional poles, the laying of the controller "KR-1" and the changed starting and restraint resistors increase significantly the exploitation security of the particular elements and of the locomotive in overall.

With the so described changes, the locomotive "5KPM1" was created in the Research and Development Department for mining equipment. All functional tests, at which the machine showed satisfactory parameters, were performed there.

The locomotive was delivered in 2000 to "Lucky-Gorupso" Co where it has been operating since. The reports from the mining management are that the locomotive has excellent parameters and high exploitation safety. For the last mentioned there is a fact that speaks for itself, that until this moment it operates free of failures.

In 2002, after a request of the management of the "Lucky-Gorupso" Co two other locomotives were reconstructed, which are operating in the mine at the moment.

*Recommended for publication by Department of
Electrical Engineering, Faculty of Mining Electromechanics*