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RAILWAY POWER SUPPLY-POWER SUPPLY SCHEME

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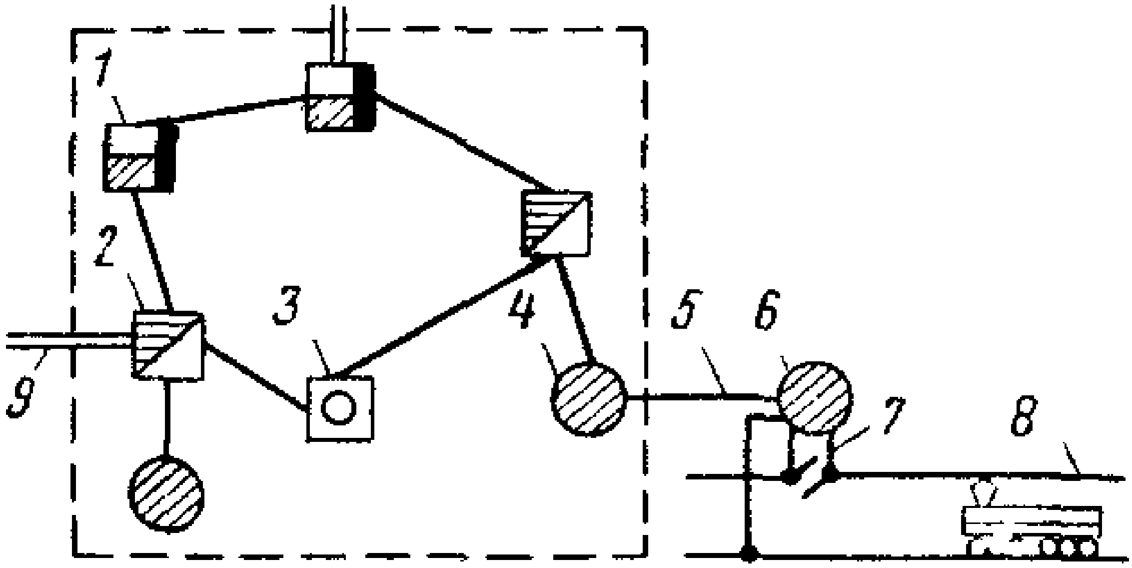
Annotation: Railway transport consumes more than 7% of the energy generated by power plants in Uzbekistan; mainly it is spent on train traction and partly on feeding non-traction consumers (depots, stations, workshops, etc.). Electricity supply Devices of electrified Railways are also used for feeding adjacent district and rural consumers.

Keywords: traction part, transmission lines, power supply, double-chain line

Introduction

According to the rules of technical operation, railway power supply devices must ensure: a) uninterrupted movement of trains with the established mass standards, speeds and intervals between trains at the required traffic sizes; b) reliable power supply of SCB and communication devices, as category I electric receivers; C) reliable power supply to all railway transport consumers.



Schematic diagram of electric power supply for an electrified railway:
1-thermal power plant;
2-hydraulic power plant;
3-nuclear power plant,
4-district transformer substation;
5-district high-voltage lines,
6-traction substation;
7-supply line,
8-contact network;
9-lines connecting power systems

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The power supply system of electrified roads includes devices that make up its external part (power plants, district transformer substations, networks and transmission lines) and the traction part (traction substations and electric traction network; the latter includes a contact network, a rail chain that feeds and sucks lines).

Generators of power plants produce three-phase current with a voltage of 220-380 V, which is then increased at substations to 6-20 kV and transmitted to the power system. Transmission lines up to 600 km long and up to 700 thousand kW are usually AC 35, 110, 220, 330 and 500 kV. At large distances and capacities, DC transmission lines with a voltage of 800 kV or higher are installed. DC lines are cheaper to build, more economical to operate, and have a higher efficiency.

Near the places of electricity consumption, the voltage at transformer substations is lowered to NO-220 kV and the current is fed to the district high-voltage networks. Along with other consumers, traction substations of electrified Railways and transformer substations of roads with diesel traction are also connected to these networks. To ensure reliable power supply for electric traction and district consumers, as a rule, they tend to have two-way power supply for traction consumers from two independent sources — power plants or district substations.

In some cases, traction substations are powered from a single source via two parallel power lines or a single double-chain line. Sections of the contact network are connected to neighboring traction substations so that they also receive two-way power. At the same time, the substations and the contact network are loaded more evenly and with fewer loads, which help to reduce the loss of electricity in the contact network and the power of traction substations.

The contact network is designed to supply electrical energy from traction substations to electric rolling stock and is a set of wires, structures and equipment that ensure the transfer of electrical energy from traction substations to current collectors of electric rolling stock. It is designed in such a way that ensures uninterrupted current removal by locomotives at the highest speeds in any atmospheric conditions.

Traction substations, contact network, workshops, repair and revision shop, storage facilities, etc. are managed by power supply sections that serve 150-250 km of lines at direct current or 200-300 km at alternating current.

Traction substations, depending on the control methods, are divided into substations with manual control and substations with automatic centralized remote control. Management and control of the operation of the equipment of traction substations with manual control is carried out by the operating personnel located at the substations. With automatic centralized remote control, the entire complex of the most important power supply facilities is managed by a single person-an energy dispatcher. The use of new electronic remote control systems for power supply devices makes it possible to halve the number of maintenance personnel at

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The contact network within the power supply sections is divided into distances of 30-50 km of operational length. The contact network distance has a building of the duty station, warehouses, and platforms for installation devices, car fleets and a garage for a recovery car tire with a railway access road. Duty stations are equipped with intercom and other communications. The staff of the distance depends on the size of the movement, the length of the tracks, climate and other conditions and is 15-30 people. Distance workers check the condition of the contact network, take precautionary measures, restore and repair the network. Approximately 80% of the network work is performed without removing the voltage and interrupting train traffic. Therefore, when servicing and repairing the network, special attention is paid to compliance with safety regulations.

Local workshops produce spare parts and parts of the contact network and traction substations, test and repair rectifiers, protection equipment, automation, telemechanics, etc.

Uninterrupted power supply to the contact network and consumers is managed by an energy dispatcher group (4-5 people). The energy dispatcher on duty is responsible for employees of traction substations, contact network distances, as well as personnel servicing power lines suspended from the contact network supports.

In winter, to ensure reliable current collection, measures are taken to combat ice formed on the contact wires, for which the contact network is heated by applying high currents, or the wires are cleaned with vibro-current receivers, scrapers on isolated towers, etc.

From traction substations, electricity is supplied to the contact network via feed lines. A relatively low voltage (3 kV) is the main drawback of the DC system, as a result of which the power (equal to the product of the voltage on the current) with a large traction current is supplied to the electric rolling stock via the contact network. To maintain the desired voltage level on the current collectors of locomotives, traction substations are placed close to each other (20-25 km), and for transmitting large currents, the wires of the contact network have a significant cross-section.

Approximately 2/3 of electrified railway lines run on direct current. On these lines, when the freight turnover increases, additional traction substations are built, the section of the contact network is increased (reinforcing wires are suspended, etc.), so that the increase in the number and weight of trains does not cause a sharp drop in voltage. At the same time.there is an increase in the cost of power supply devices and an increase in the consumption of materials, especially copper. Increasing the power in the contact network due to a significant increase in DC voltage requires the manufacture and operation of traction motors designed for higher voltage, which is associated with great difficulties (the isolation of electrical equipment is very complicated, there is a risk of breakdown of the ionized air layer, etc.).

The single-phase current system with a rated voltage of 25 kV is widely used for pulling trains on the Railways of the USSR. Alternating current makes it possible to significantly increase the technical and economic indicators of electric traction due to the fact that power is transmitted through the contact network at lower currents compared to the DC system, and provides the movement of heavy trains with set speeds at the highest load-carrying capacity of the lines.

Traction substations on electrified Railways operating on single-phase alternating current of industrial frequency are essentially transformer substations that lower the voltage from 110-220 to 25 kV. Since these substations do not convert alternating current to direct current, they do not have rectifier units and associated auxiliary equipment. Their design and maintenance is much simpler and cheaper than DC traction substations. All the equipment of such substations is located in open areas.

The use of single-phase high-voltage alternating current allows you to have a contact network of about 2 times smaller cross-section than with direct current, and to place traction substations at a distance of 40-60 km from each other. This significantly reduces the material and monetary costs of railway electrification.

Increasing the voltage would reduce the loss of voltage and electricity and increase the distance between traction substations, but it is associated with high costs for strengthening insulation, replacing electric rolling stock, etc. To improve the performance of alternating current electrification, a 2x25 kV system has been developed with intermediate autotransformers placed at a distance of 8-15 km. From traction substations to autotransformers, electricity is supplied with a voltage of 50 kV via a contact suspension and an additional supply wire. Further, from the autotransformers to the electric rolling stock, energy is supplied with a voltage of 25 kV. This system is supposed to electrify the Western section of BAM. An important advantage of the system 2x25 kV is the voltage drop and energy as well as reducing the influence of traction network communication line, since the current at traction substation will be returned on the rails and power lead.

Locomotives with static converters and pulsing current engines operate on AC sections. Prototypes of powerful electric locomotives with brushless motors — asynchronous and valve-type-were also built.

Alternating current has an electromagnetic effect on metal structures and communications located along Railways. As a result, dangerous voltage is applied to them, and interference occurs in the communication and automation lines. Therefore, special measures are applied to protect structures, and air communication lines are replaced with cable or radio relay lines and the AV-tomatics are reconstructed. This costs about 20-25% of the total cost of electrification.

The speed of trains with electric traction is directly dependent on the voltage level in the contact network. There are devices for automatic voltage regulation and calculating machines for optimizing operating modes, which helps to increase train speeds and save electricity.

Connecting lines that are electrified at DC and AC is carried out via a contact network at specially equipped railway stations or using dual-power electric locomotives that operate on both DC and AC.

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