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Comparison of the switch control circuit with main supply and central supply circuit, and analysis of the sequence of operation of the НПС block

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Abstract: Railway switch control systems on railway are essential to ensure safe and efficient traffic. In this article, the development of automated control systems of railway switches, their technological basis, safety issues and energy efficiency improvement approaches are considered. The main attention is focused on the production and practical use of a microelectronic alternative version of the relay НПС block, which belongs to the dialing group, of modern control blocks, in particular, based on the technical requirements for railway automation and telemechanics equipment, and their harmonious operation with telemechanics tools.

Keywords: Class II relays, ВУ, ПВУ, МУ, ПУ relays, Switch Control Circuit. НПС block, Current sensor, optocouplers, light-emitting diodes, modern microcontroller boards, dial group block.

1. Introduction

Modern practice has shown that relay, mechanical, processor-relay railway transport automation and telemechanics systems have a number of disadvantages, their use is limited and technically ineffective. Currently, relay devices that perform interconnection of switches and signals are increasingly being replaced by microprocessor systems. This is due to the following reasons.

Firstly, maintenance of microelectronic systems compared to relay systems, the high cost of such systems shows that their implementation is economically feasible.

Secondly, indicators of microelectronic systems due to the use of excess reserves of individual constituent elements of the system and advanced diagnostic systems.

Thirdly, by providing employees with quick information and by expanding the functional capabilities of the systems due to the simple integration of railway automation and telemechanics microelectronic systems into high-level train traffic control systems (DM, control centers, etc.).

Taking into account the above, in this article, I propose to develop a model of a microelectronic НПС unit consisting of microelectronic devices, intended for use in centralizing relay-processors and microprocessors of the dial group.

2. Research methodology

In railway automation and telemechanics, much information about the switch control circuit is provided in standard albums and typical solutions. In this article, I will explain in detail which types of power supply are used in switch control depending on the size of the station and the location of the switch: the difference between the central supply and the main supply switch control circuits, why the main supply is necessary, and how the **НПС block (Figure 1)**, which belongs to the setting group serving route formation in the process of controlling distant switches with main supply, operates through current flow circuits of its constituent relays in sequence.

The main difference between the switch control circuit with main supply and the switch control circuit with central supply is that, instead of the polarized relay **Р** in the switch electric drive, a **ПС** combined relay of type СКПР3-2800 is installed. In the switch drive control circuit at the central post, since direct current with a voltage of 220 V is used for the control circuits, a 0.5 A fuse is installed as protection. To reduce the nominal voltage of the direct current in the control current, a 12 kΩ resistor is connected in series with the **ПС** relay in the circuit produced by the selenium rectifier valve. When such a resistor is connected, if the control circuit is supplied with alternating current of 50 Hz frequency, the maximum distance of the switch electric drive is 2 km. When the cable length is between 2 km and 3.5 km, the 12 kΩ resistor is replaced with a 10 kΩ resistor, and the СКТ-I transformer with its I and II windings connected in series is also connected in series. A capacitor with a capacitance of 4 μF connected in parallel to the **ПС** relay windings shunts the alternating component and protects the relay from armature vibration. When the switch is moved from the plus position to the minus position, the working battery voltage of 220 V is supplied to the **ПС** relay through the 12 kΩ resistor. In this case, the current in the **ПС** relay circuit is sufficient to move the polarized armature of the relay, but not enough to attract the neutral armature. After the polarized armature is conducted through contacts 121–123, the **ПС** relay is shunted with the 12 kΩ resistor, and the **ПС** relay attracts its neutral armature, connecting the working current main line to the electric drive windings. The neutral armature The neutral armature of the **ПС** relay shunts the 12 kΩ resistor through contacts 31–32 during the switch transfer, which ensures precise relay operation when the switch is not fully transferred and the drive is reversing.

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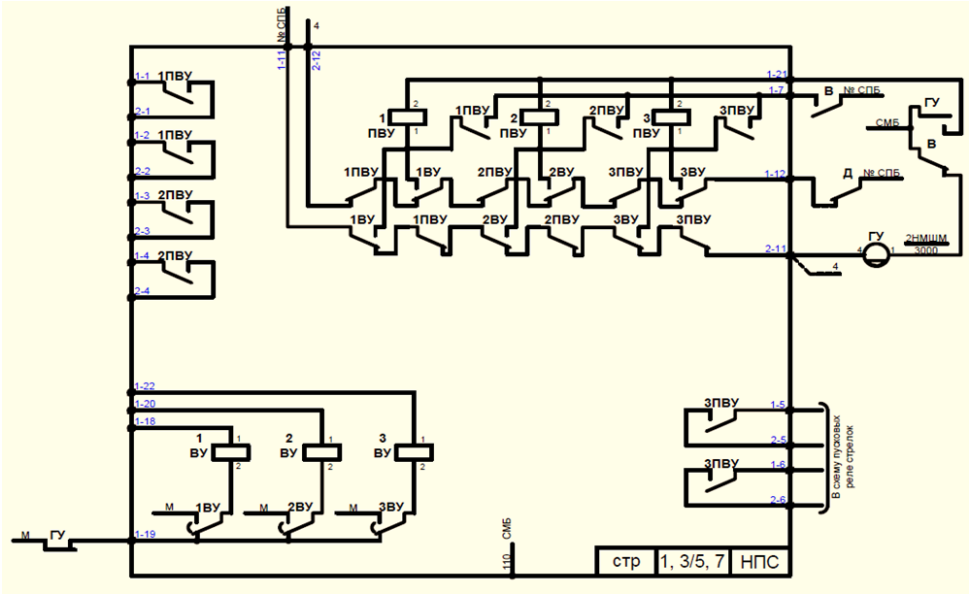


Fig. 1. Principal Circuit Diagram of the НПС Block

The switch electric drive control circuit with main supply is considered the most economical if the working current main line is intended to transfer one or at most two switches simultaneously. In route interlocking, the number of switches transferred simultaneously is not constant, but depends on the length of the route and the current position of the switches before the route is set. Therefore, when the working current main line is designed to transfer more switches simultaneously, the voltage drop in it exceeds the permissible value, which leads to the slowing down or complete stoppage of switch transfer.

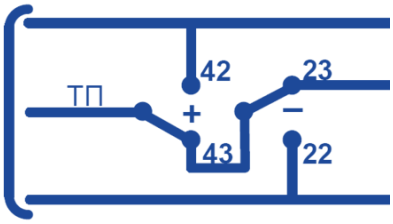


Fig. 2. Switch Commutator

A scheme has been developed to limit the number of switches transferred simultaneously according to the calculated cross-section of the main line. Since switches located at long distances are supplied specifically by the main supply, each switch commutator with main supply uses an **НПС** block consisting of two types of relays inside: the auxiliary control relay **ВУ** and its repeater **ПВУ** relay. One **НПС** block is installed for every three switch commutators. In addition, a group control relay **ГУ** of type **НМШ2-3000** is installed for all switches on this main line.

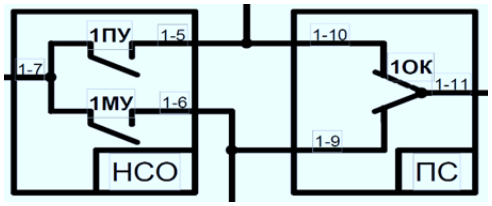


Fig. 3.1. МУ Relay Contact and Figure 3.2. ОК Relay Polarized Contact

During the route setting process, the **ПУ** or **МУ** relay of the switches included in the route is energized. In addition, according to the following circuit: **ТП** through contacts **41 - 43** and **21 - 23** of the switch commutator **(Figure 2),** the contact of the control relay (for example, **МУ** in **Figure 3.1**), when the switch is transferred to the minus position and the **ОК** relay contact (**Figure 3.2**), which monitors that the switch is in the plus position, only the **ВУ** relay of the switches that need to be thrown is energized.

Below, the operating sequence of **three ВУ** relays are expressed example of the **1VU** (**Figure 4**), relay and its circuits and diagrams. The **1VU** relay is energized when the **П (+24V)** supply comes to terminal **1-18** and the **М (-24V)** supply simultaneously comes to terminal **1-19**, bringing it into a current-carrying state. It then self-locks until the switch transfer is completed and the corresponding control is obtained.

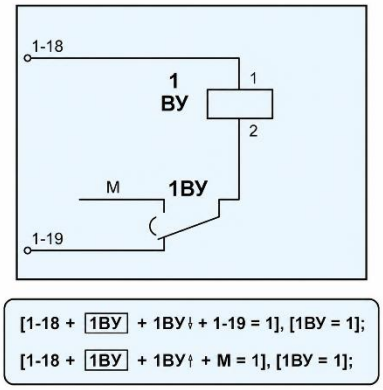


Fig. 4. Circuit and Diagram of the 1ВУ Relay in Energized State

The **2ВУ** relay is also energized when the **П (+24V)** supply comes to terminal **1-20** and the **М (-24V)** supply simultaneously comes to terminal **1-19**, bringing it into a current-carrying state. It then self-locks until the switch transfer is completed and the corresponding control is obtained. The operation of the **3VU** relay is similar to the above two relays, that is, when the **П (+24V)** supply comes

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ENGINEER

to terminal **1-22** and the **M (-24V)** supply simultaneously comes to terminal **1-19**, it is energized and self-locks until the switch transfer is completed and the corresponding control is obtained.

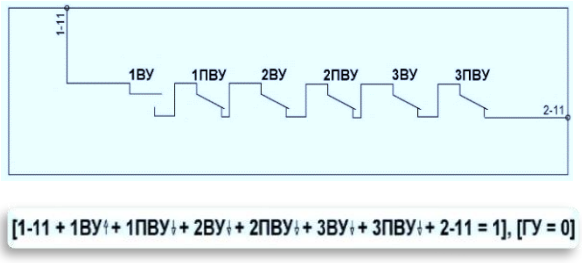


Fig. 5. Circuit and Diagram of the ГУ Relay in De-energized State

When any of the **ВУ** relays is energized, their contacts interrupt the circuit of the group control relay **ГУ (Figure 5),** causing it to de-energize and release its armature with a delay of 0.8 seconds.

Through the front contacts of the **ГУ** relay, the excitation circuit of the **ВУ** relay is interrupted, while through its back contacts the circuits for energizing the **ППВУ** relay are connected. The delay of the **ГУ** relay ensures that the sequential excitation circuit of the **ППВУ** relay is connected only after all the **ВУ** relays of the switches included in the route have been activated. The front contacts of the **ППВУ** relay are introduced into the excitation circuit of the **НПС** relay in series with the contacts of the **ПУ** and **МУ** relays belonging to the switch in the switch control circuit.

The connection scheme of the **ППВУ** relay is designed in such a way that, depending on the calculated cross-section of the main line, it ensures the simultaneous excitation of one or two **ППВУ** relays, which in turn allows one or two switches to be thrown simultaneously. Below, the operating sequence of all **1ППВУ**, **2ППВУ**, and **3ППВУ** relays is expressed through circuits and diagrams.

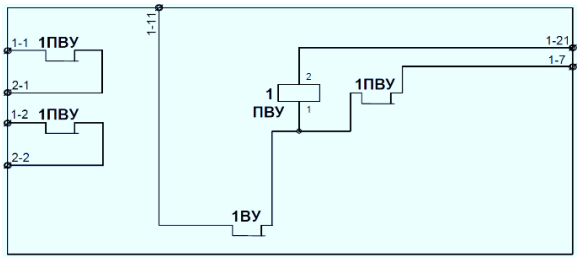


Fig. 6. Circuit and Diagram of the 1ППВУ Relay in Energized State

When it is necessary to ensure the simultaneous switching of two Switch Control Circuit, a second circuit with contacts marked by dashed lines is connected to the scheme. After the **ППВУ** relays are energized, a self-locking circuit is activated through their own contacts.

If double-sided control of switches is available in the main supply area, the second excitation circuit of the **ППВУ** relay is interrupted through the contact of the **Д** relay, which cancels centralization.

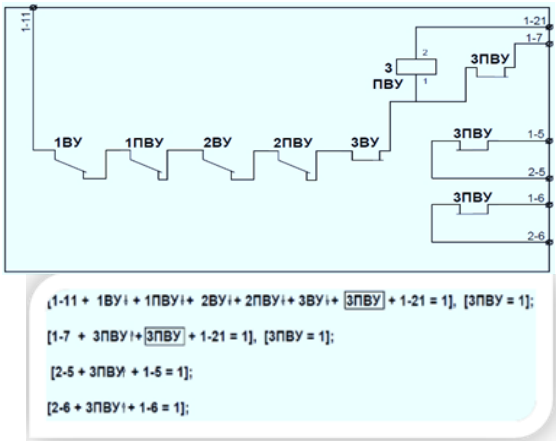


Fig. 7. Circuit and Diagram of the 3ППВУ Relay in Energized State

In addition to the main excitation circuit, the **ППВУ** relay has a locking circuit through its own contacts and the front contacts of the **В** relay. Such locking ensures that the **ППВУ** relay can only be connected for the next switch operation when there is no current in the working supply line. This is necessary to prevent disconnecting the bus intended for simultaneous operation of two switches while one of them has not yet been fully transferred.

3. Conclusion

Scientific analyses in railway automation and telemechanics demonstrate that **centralized supply** and **trunk supply** schemes differ significantly in both technical and functional aspects. While the centralized supply scheme is suitable for small stations, the trunk supply scheme ensures efficiency in managing switches located at long distances in large stations.

In trunk supply schemes, the use of the **ПС** combined relay, resistors, transformers, and capacitors provides mechanisms to control voltage drops and guarantees stable relay operation. This configuration ensures energy efficiency, precise monitoring, and high reliability in route centralization processes.

Scientifically grounded results

Energy efficiency: The trunk supply scheme allows one or two switches to be operated simultaneously according to the calculated section, ensuring rational use of electrical energy.

Monitoring accuracy: Sequential operation of the polarized and neutral armatures of the **ПС** relay prevents incorrect reversals and ensures reliable monitoring of switch positions.

Route centralization: Sequential activation of **ВУ** and **ППВУ** relays guarantees safe and orderly control of switches included in the route.

Blocking circuits: The blocking function of the **ППВУ** relay ensures that subsequent switches are connected only when the trunk line is free of current, thereby strengthening

operational safety.

Recommendations

Station design: For large stations, trunk supply schemes should be prioritized, as they effectively manage distant switches.

Energy saving: Optimal selection of resistors and transformers in trunk supply schemes can reduce energy consumption.

Safety enhancement: Improving PVU relay blocking circuits will further increase safety in route centralization.

Technical maintenance: Regular diagnostics and preventive inspections of relays and transformers ensure stable system performance.

Innovative application: Introducing modern electronic monitoring blocks and digital relays can significantly improve the efficiency of trunk supply schemes.

Practical applications

Large stations: Trunk supply schemes enable fast and safe route centralization.

Long-distance switches: They serve as energy-efficient and reliable solutions for managing remote switches.

Modernization projects: Trunk supply schemes can be adopted as key technical solutions when upgrading existing centralized supply systems.

In conclusion, the trunk supply switch control scheme is not only technically efficient but also plays a crucial role in ensuring railway transport safety. These scientific findings and recommendations highlight that the application of trunk supply schemes in railway automation systems is a decisive factor in improving station management efficiency and ensuring the stable operation of transport infrastructure.

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Kh. Tuychiev, Kh. Tuychiev
*Assessment and improvement of constructive safety of the Damas light passenger vehicle……..**5***

A. Azizov, F. Sindarov
*Comparison of the switch control circuit with main supply and central supply circuit, and analysis of the sequence of operation of the HTIC block……..**10***