



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 5, May 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512

9940 572 462

6381 907 438

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A Method for Controlling the Freedom of Track Sections by the Axle Counting System

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ABSTRACT: It is known that the most important element of almost all railway automation systems that ensure the safety of train traffic are rail circuits. They serve as the primary source of information on the state of monitored sections of the track. However, due to a number of objective reasons (low ballast resistance, limited length, inability to isolate rails from bridge structures, significant operating costs, etc.) sometimes it is technically impractical to use track chains. Control of the free condition of such track sections can also be implemented on the principle of counting incoming and outgoing from the track section, wheelsets. Axle counting systems are designed for operation as part of railway automation and telemechanic systems on railway transport of a common network and on specialized tracks (industrial transport), for control the freedom (occupancy) of branched and unbranched track sections at stations and tracks for any type of train traction. The article discusses one of the ways to control the vacancy of track sections by the axle counting method, where, to determine the error, the method of axle counting and duplication on two track sections is used to check the correctness of the axle count reading.

KEY WORDS: Axle counting, semi-automatic blocking, automatic blocking, track sections, track circuit

I. INTRODUCTION

The main directions that determine the maximum efficiency of the modernization of technical means are:

- replacement of outdated and optimization of new station and floor equipment;
- control and management of train operations from unified dispatch control centers;
- the use of microprocessor technology to minimize operating and construction costs.

Modernization of technical means should be carried out by reducing them and carrying out the following measures:

- replacement of outdated EC systems with MPCs or their modernization according to the hybrid version;
- replacement of operated systems of interval control with systems with the use of axle counters and automatic locomotive signaling with point communication channels (ALS-TKS);
- the use of a centralized control system [1].

Today there are the following technical solutions for the axle counting system [2]:

- on tracks equipped with semi-automatic blocking (including at DC of low-performing lines), to control the freedom of the track, check the arrival of a full train and automatically generate a block signal “track arrival”;
- railway tracks equipped with automatic blocking to control the vacancy of individual sections with movable or metal bridges, on which the isolation of the rails from the elements of the superstructure is not ensured;
- stations equipped with EC or devices of key dependence of arrows and signals to control the vacancy of branched and non-branched sections of the station's tracks;
- level crossings at semi-automatic blocking and automatic blocking, equipped with level crossing signaling, to control the vacancy of the notification areas for crossings and fix the direction of movement and progress of the train.



II. MAIN PART

There are known methods of monitoring track sections, where the check of the vacancy of track sections and the full length of the train is carried out by the station attendant or switchmen of switch posts, for example, with semi-automatic blocking [1]. The disadvantages of this method are the presence of a subjective human factor, significant verification time and high operating costs.

There are also known more effective methods and devices for monitoring the vacancy of track sections, in which the presence or absence of rolling stock on a track section is controlled by supplying an electric current to the supply end of the rail circuit and receiving it at the relay end, where, when the rolling stock is on the track circuit, that is, its employment, the flow of electric current to the receiving element (travel relay) of the rail circuit stops [2]. The disadvantage of such technical solutions is the high material consumption of the track circuit equipment, low energy efficiency and low operational reliability working.

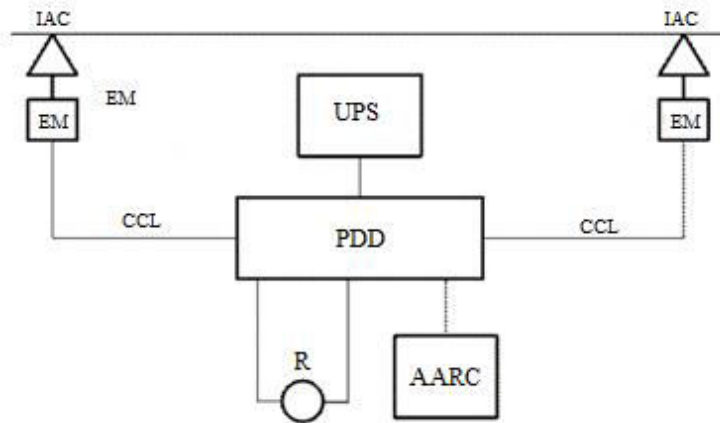


Fig. 1. Block scheme of the axle counting system at the station

- ITM-item axis counter;
- FSEM-floor-standing electronic module;
- UPS-uninterruptible power supply;
- PDD-post decisivedevice;
- CCL-cable communication line;
- R-receiver;
- AARC-remote controllerartificialrecovery counting.

III.RESULT

The closest to the proposed technical solution are devices in which a method for monitoring the vacancy of track sections, separated by rail axle count sensors, includes the transfer of information about the axle count from the i-th and (i+1)-th rail sensors to the (i+1)-th comparator, its comparison, and in the case of coincidence of information about the equality of the number of axles of the rolling stock that followed the i-th and (i+1)-th rail sensors, they give a signal about the free track section along the length from the i-th to the (i+1)-th rail sensors[3].

The disadvantage of this technical solution is that in the event of a malfunction or failure of one of the rail sensors or the comparator, the track section,related to these functional units,finds itself in a position of false employment, and this leads to train delays with corresponding negative consequences for the indicators of the transportation process.

To do this, it is necessary to provide for the elimination of the influence false occupation of track sections on the operation of the device upon appearance of disruptions or renouncement in the rail sensor and the comparison device. This goal is achieved by the fact that in the device for monitoring the vacancy of track sections, operations are introduced to transfer information from the i-th rail sensor to the (i+2)-th comparing device, and the signal about the free track section along the length from the i-th rail sensor to the (i+2)-th is generated by the (i+2)-th comparator.

The proposed method in Fig. 1 is that upon appearance of renouncement or disruptions in operation of the (i+1)-th rail sensor and/or (i+1)-th comparator device information about the account of the axles of the rolling stock is transmitted from the i-th and (i+2)-th rail sensors to the (i+2) th comparing device, which, if the information on the number of axles of the rolling stock coincides, which followed the i-th and (i+2)-th rail sensors, gives a signal about the vacancy of the track section along the length from the i-th to the (i+2)-th rail sensors.

Below is a diagram of Fig. 1, which explains the temporary organization of the method for monitoring the vacancy of track sections using the example of one-way movement of rolling stock.

The drawing shows a rail track 1 with the shown direction of movement of the rolling stock. Along the track, there are rail sensors for counting the axles of the rolling stock 1, 2, 3, to which the comparators device 2 (i), 2 (i+1), 2 (i+2) and 2 (i-1) correspond. Distances between rail sensors 1, 2, 3, 4 are equal to the lengths of monitored track sections 1(i), 1(i+1), 1(i+2), 1(i-1) respectively. From the outputs of each of the rail sensors 1, 2, 3 data on the number of axles of the rolling stock is transmitted through three information links on the corresponding inputs of the comparators 2 (i), 2 (i+1), 2 (i+2) and 1 (i-1), which is shown by solid lines. For example, the output of the rail sensor 1 transmits via information link 3.1 data on the axle count to the first input of the comparator 2 (i), via information communication 4 (i) to the second input of the comparator 2 (i + 1) and via information communication 5 (i) - to the third input of the comparator 2 (i + 2). Similarly, the data on the axle count of the rolling stock are transmitted from the rail sensors 2, 3 and 4. Information from outputs 6.1, 6.2 and 6.3 of the comparators 2 (i), 2 (i+1), 2 (i+2) determines the free or occupied state of the corresponding block sections.

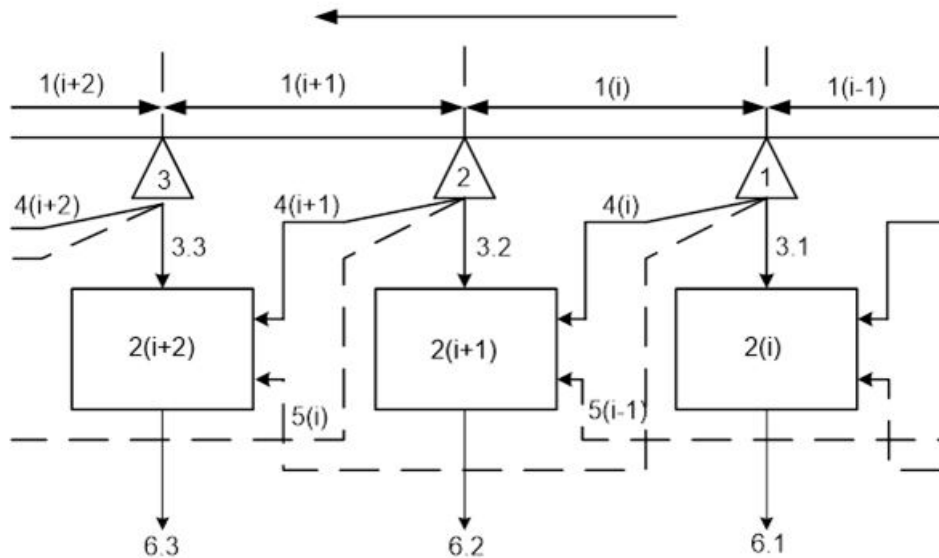


Fig. 1. Method for monitoring the freedom of track sections

The device according to the proposed method for monitoring the vacancy of track sections operates as follows.

If all functional units of the device of all sections of the track are operational and the rolling stock proceeded in full force along the track section 1(i), then on the second run of the comparator device 2 (i+1), data on the number of axles of the rolling stock included in section 1 (i). After the rolling stock releases section 1 (i), the first input of the comparator device 2 (i + 1) via information communication 4(i) will receive data on the number of axles of the rolling stock. If the data received via information links 4 (i) and 3.2 coincide, then at the output 6.2 of the comparator 2 (i+1) a signal is generated that determines the freedom of section 1(i) from the rolling stock.

Similarly, in normal operation, the remaining rail sensors and comparators function during the subsequent movement of the rolling stock along the track sections in the direction shown. This causes the alternating appearance of signals at outputs 6.2, 6.3, etc. comparing devices 2 (i), 2 (i+1) and 2 (i+2), which determine the sequential release of path sections.

Renouncement, for example, rail sensor 2 or comparator device 2 (i+1), and also the appearance of failures in their work will cause the absence of the corresponding signal at the output 6.2 of the comparator device 2 (i+1) after a real full-speed release by the rolling stock of section 1(i). Therefore, in the device shown in Fig. 1, after the appearance of a failure in the operation of the rail sensor or the comparator and the absence of a corresponding output signal at its



output, data on the number of axles of the rolling stock that followed the track sensor 1, are transmitted via information link 5 (i) to the third input of the comparator 2 (i+2) and are compared with the data received via information link 4 (i+1). If the data on the number of axles that have passed through sensors 1 and 2 are equal to each other, then at the output of the comparator 2 (i+2), a signal is generated about the freeness of two track sections: 1(i) and 1 (i+1) in total. In Fig. 1, for clarity, the dotted line shows the input information connections from the rail sensors to the third inputs of the corresponding comparators.

Thus, if a malfunction occurs in the operation of the rail sensor or the comparator device, which in the known devices leads to significant train delays, in this case, two adjacent monitored track sections are checked and on the basis of this, a decision is made by the corresponding comparator about their vacancy even if one of them is falsely occupied.

IV. CONCLUSION

A method for monitoring the vacancy of track sections separated by rail axle counting sensors and comparing devices, including transferring information about axle counting from the i-th and (i+1)-th rail sensors to the (i+1) comparing device, its comparison also in the case of coincidence of information on the equality of the number of axles of the rolling stock, followed by the i-th and (i+1)-th rail sensors, give a signal about the vacancy of the track section along the length from the i-th to the (i+1)-th rail sensors, differ in that if the (i+1)-th rail sensor or the (i+1)-th comparing device fails or malfunctions, information about the axle count of the rolling stock from the i-th and (i+2)-th rail sensors is transmitted to the (i+2)-th comparator device, which, if the information on the number of axles of the rolling stock coincides, following the i-th and (i+2)-th rail sensors, gives a signal about the free track section along the length from the i-th to the (i+2)-th rail sensors.

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