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РАЗРАБОТКА МОДЕЛИ РАСЧЕТА ИНТЕЛЛЕКТУАЛЬНОГО ДАТЧИКА КОНТРОЛЯ УЧАСТКОВ ПУТИ
DEVELOPMENT OF A MODEL FOR CALCULATION OF AN INTELLIGENT SENSOR FOR MONITORING PATH SECTIONS

Аннотация: При анализе и синтезе интеллектуальных датчиков в основном может использоваться общая теория рельсовых цепей. Однако необходимо учитывать некоторые особенности из-за отсутствия изолирующих стыков и применения микропроцессорной системы. В статье рассматриваются основные уравнения, позволяющие учитывать особенности, связанные с отсутствием изолирующих стыков, при анализе и синтезе интеллектуальных рельсовых цепей.

Abstract: In the analysis and synthesis of intelligent sensors, the general theory of track circuits can be mainly used. However, it is necessary to take into account some features due to the lack of insulating joints and the use of a microprocessor system. The article discusses the basic equations that allow taking into account the features associated with the lack of insulating joints in the analysis and synthesis of intelligent track circuits.

Ключевые слова: датчики, интеллектуальные датчики, математическая модель, рельсовая цепь, бесстыковая рельсовая цепь

Key words: sensors, intelligent sensors, mathematical model, rail circuit, jointless track circuit.

1 Introduction

For the analysis and synthesis of track circuits without insulating joints, first of all, it is necessary to derive equations for calculating the coefficients of a four-pole network replacing a rail line [1, 2].

The coefficients of a fourpole jointless track circuit (JTC) can be determined on the basis of the equations for the distribution of currents and voltages along the rail line according to the scheme of Fig. 2 under initial conditions different from those accepted for track circuits with insulating joints [3, 8, 12, 14].

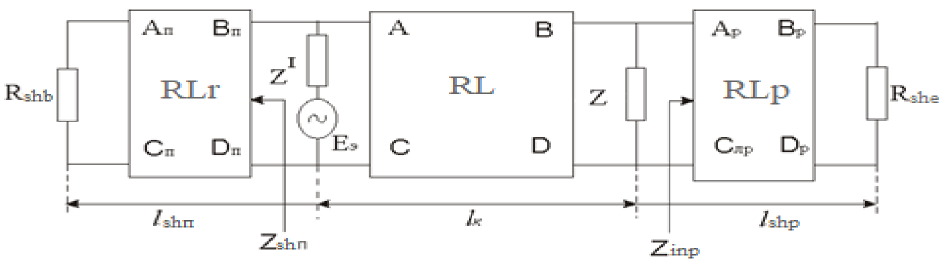

Fig. 1. General equivalent circuit of a jointless track circuit

Comparing the scheme shown in Fig. 2. with the main equivalent circuit of track circuits with insulating joints (TC), it can be argued:

1. The schemes of a jointless track circuit and a track circuit with insulating joints differ significantly from each other and it is impossible to use the coefficients of the RC rail quadripoles for the analysis and synthesis of the BRC. Therefore, for the analysis and synthesis of track circuits without insulating joints, first of all, it is necessary to derive equations for calculating the coefficients of a four-terminal network that replaces a jointless rail line [4, 5, 11].

2. The normal mode of operation of the RLn track circuit will be observed not only when all the rail lines are free, but also if one of the adjacent rail lines is occupied by a moving unit, and its shunt will be removed from the point of connection of the track circuit equipment at a distance greater than section ldsh is called the zone of additional shunting [6, 9, 10].

3. The shunt mode of operation of the RLn track circuit will also depend on the presence of shunts both on the RLn and on a part of adjacent rail lines. In order for the train not to block the traffic light itself when approaching the track circuit, the traffic light must be installed in the direction of the train at a distance ldshk [7, 13].

2. Coefficients of a rail quadrupole of an intelligent sensor

The basic equations are given that allow taking into account the specific features associated with the absence of insulating joints in the analysis and synthesis of intelligent sensors.

The coefficients of the fourpole of a jointless track circuit in intelligent sensor (JTC) can be determined by the equivalent circuit of a jointless track circuit in Fig. 2. under initial conditions different from those accepted for track circuits with insulating joints [7, 15-17].

We will replace adjacent rail lines on the right and left sides with input resistances Zinp and Zinr, then the general equivalent circuit can be represented as the circuit shown in Fig. 4.

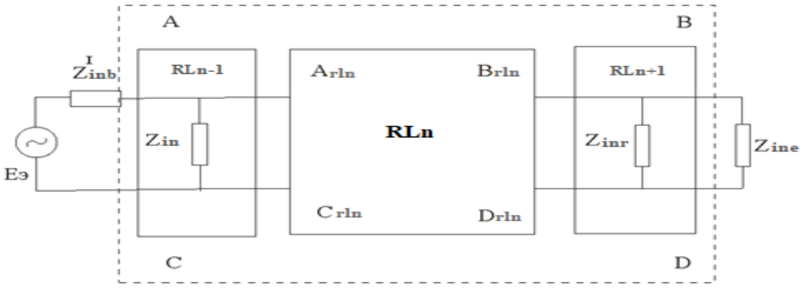

Fig. 2. Transformed equivalent circuit of a jointless rail circuit

The rail quadripole coefficients for the jointless rail circuit A, B, C and D are obtained by multiplying the matrices:

For a number of special cases, the calculation equations for the coefficients of a rail quadripole are greatly simplified and take on a form convenient for practical calculations:

$$A = ch\gamma l + \frac{z_{в}}{Z_{wri} th\gamma_r l_{shr}} sh\gamma l;$$

$$B = z_w * sh\gamma l;$$

$$C = \frac{sh\gamma l}{z_w} + \frac{ch\gamma l}{Z_{wri} th\gamma_{ri} l_{shri}} + \frac{z_{в} sh\gamma l}{Z_{wri} th\gamma_{ri} l_{shri} * Z_{shr} th\gamma_r l_{shr}} + \frac{ch\gamma l}{Z_{wr} th\gamma_r l_{shr}};$$

$$D = ch\gamma l + \frac{z_{в}}{Z_{wri} th\gamma_{ri} l_{shri}} sh\gamma l. \quad (1)$$

if there are insulating joints and choke-transformers at the supply end of the rail circuit, zvp = ∞.

$$A = ch\gamma l + \frac{z_B}{Z_{wr} th\gamma_r l_{shr}} sh\gamma l;\ B = Zwsh\gamma l;\ C = \frac{1}{Z_w} sh\gamma l + \frac{ch\gamma l}{Z_{wr} th\gamma_r l_{shr}};\ D = ch\gamma l \quad (2)$$

3. Result

By substituting in these expressions the values of the obtained equations for the coefficients of the rail quadripole, it is possible to calculate the values of voltages and currents when the insulation resistance of all rail lines changes in any combination, thereby conducting studies of seamless track circuits in all operating modes.

As studies show, as a result of the development of a mathematical model, it is clearly shown that the transition from a relay receiver to an intelligent sensor, a microprocessor-based basis for receiving information along a rail line, reliably performs operating modes in the normal and shunt modes of operation of track circuits, and also when the ballast changes, it reliably fixes the train on plot.

4. Conclusion

A technique is given for the exact determination of the coefficients of a rail quadrupole of jointless rail circuits for asymmetric rail lines with different values of the primary and secondary parameters of adjacent rail lines. Equations for a rail quadripole of a jointless rail circuit for asymmetric rail lines are obtained.

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