# Innovative messenger wire for an overhead contact line system

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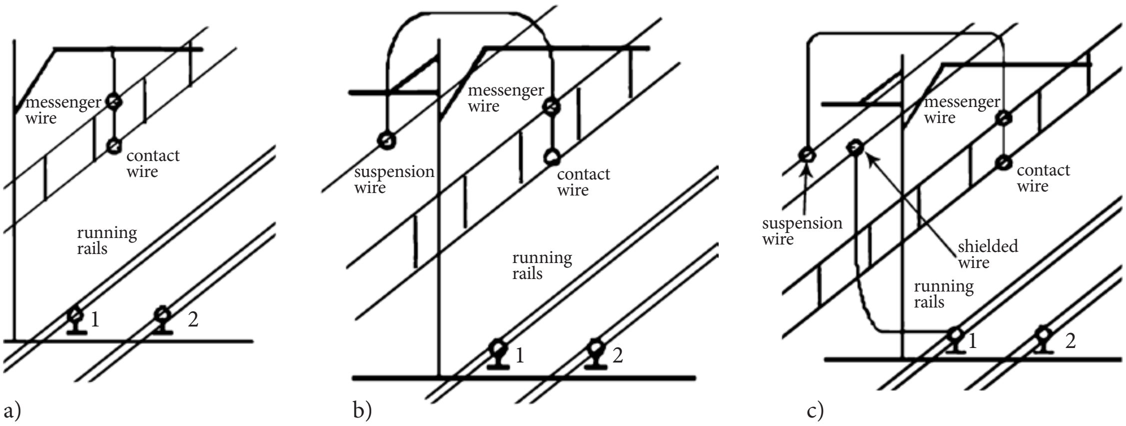
## Introduction

An indicator of the efficiency of electrical energy use is the level of losses recorded during transportation and use. Increasing the efficiency of this process therefore is a major task for today's society and business, including the railway industry. The primary components and methods of transporting electricity in an over-head contact line system for railways are shown in Figure 1.

The messenger or catenary is no less of an important element of the overhead catenary system than the contact wire, both from the point of view of reliability, and from the point of view of energy efficiency.

## Innovative messenger wire

In order to improve this system, Russian developers have come up with new components and methods designed to enhance the performance of the messenger wire. As well as boasting high mechanical durability, limiting changes in wire length during fluctuations in temperature, and boosting resistance to corrosion, by utilizing copper, the electrical conductivity of the wire and its aerodynamic characteristics are improved. At the same time the wire is compatible with standard fittings and suitable for mass production. In addition, plastically deformed catenary CC brand wires are




a) b) c)

**Fig. 1.** Description of overhead contact line system of railways:
a) the catenary (messenger) wire, the contact wire, running rails;
b) the same but with the a reinforcing wire;
c) the catenary wire, the contact wire, the reinforcing wire – (reverse) wire, connected in parallel with the rails

suitable for supporting not only the bearing cable, but also to strengthen other wires used including the electric connectors of a contact suspension bracket and feeding line wires.

There are number of advantages of using a new copper wire besides its enhanced durability and capability to limits the use of the alloys in the system: it reduces the amplitude and intensity of jumping and the probability of break when a connected cable is damaged as a result of external influences. It also reduces the level of fatigue of metal in the cable; increases life cycle due to self-clearing of fluctuations; reduces snow accumulation and frost formation at the expense of a unique design; has high mechanical durability; reports on slight changes in length following fluctuations in temperature; steady against corrosion; good electric conductivity; excellent aerodynamic characteristics; standard diameters; and is suitable for mass production without compromising the cost of the final product.

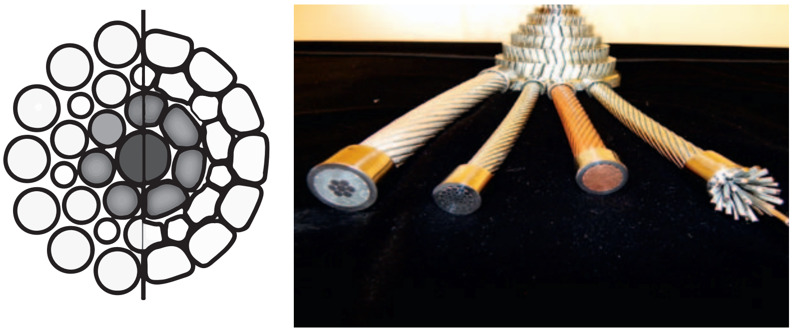


**Fig. 2.** Types of catenary wires: a) round; b) compacted

To highlight these characteristics in a messenger wire, we will consider the example of the copper compacted wire CC-120 which is proven to be an effective product. This wire consists of 36 condensed copper wires of various diameters, and has an increased strength and lower resistance. Figure 2 shows a cross-section of the wire which comprises round wires C-120 and compacted wire CC-120. Comparative characteristics of some of the catenary wires used in Russia are presented in Table 1.

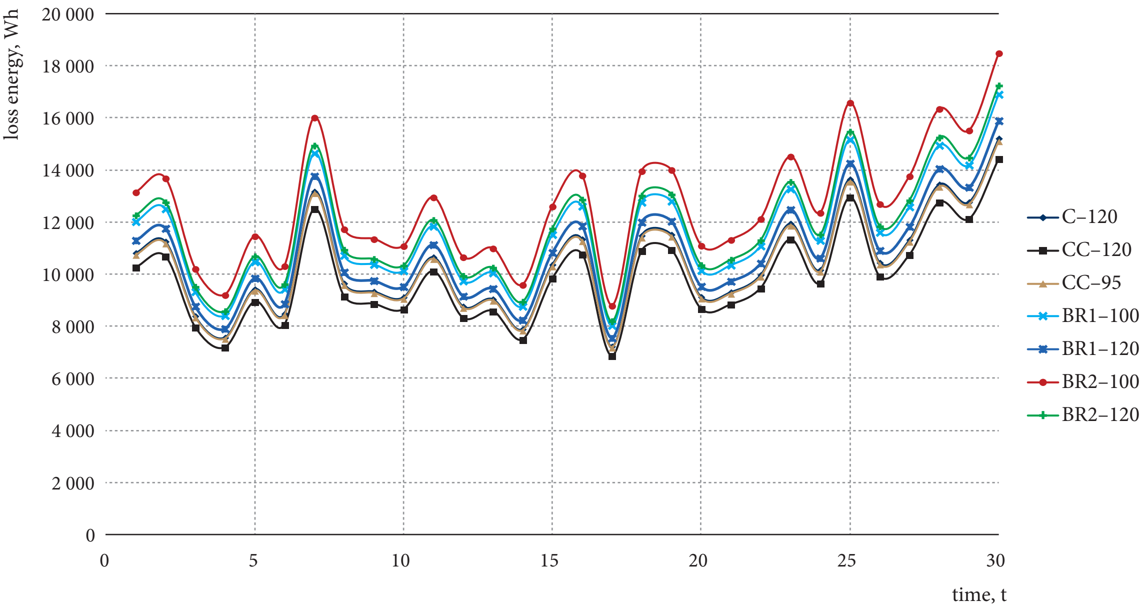



**Fig. 3.** Variations in the loss of electrical power in different messenger wires

**Table 1.** Comparative characteristics of some of the catenary wires used in Russia

| Indicator | Catenary wires | | |
|---|---|---|---|
| | C-120 | C-150 | CC-120 |
| Nominal diameter, mm | 14.0 | 15.8 | 14.0 |
| Nominal cross section, mm$^2$ | 120 | 150 | 120 |
| Nominal area of the cross section of all the wires in the cable, mm$^2$ | 117.0 | 148.0 | 140.06 |
| Weight of 1 000 m cable, kg | 1 045 | 1 321 | 1 251 |
| Specific electric resistance at 20°C, Om/km | 0.1580 | 0.1238 | 0.1383 |

## Analytical studies and evaluation of the effectiveness of the innovative messenger wire

**Table 2.** The average calculated loss of electrical energy and power

| Brand of messenger wire | C-120 | CC-120 |
|---|---|---|
| Loss of electrical power, kWh | 62,49 | 59,25 |
| Loss of electrical nergy, kWh/month | 46 496,66 | 44 085,72 |
| Loss of electrical energy, kWh/year | 557 959,92 | 529 028,7 |

**Table 3.** The calculated loss of electrical energy and power

| Indicator | | Brand of messenger wire | |
|---|---|---|---|
| | | C-120 | CC-120 |
| Average for August 2014, the value of power losses | kW | 62,518 | 59,27 |
| Average for January 2015, the value of power losses | kW | 62,47 | 59,23 |
| Electrical energy losses in August 2014 | kWh | 46 513,46 | 44 101,652 |
| | % | 0,88 | 0,83 |
| Electrical energy losses in January 2015 | kWh | 46 479,86 | 44 069,798 |
| | % | 0,88 | 0,84 |

The Volzhskiy branch of the Moscow Power Engineering Institute conducted an analysis of the technical losses of electrical energy in contact lines to determine the economical efficiency of CC messenger wires. The calculations show power losses and energy consumption for the summer and winter months for standard round and compacted wires. The results of calculations are presented in Tables 2 and 3.

Similar calculations were made for different brands of messenger wires. The results are shown the graph in Figure 3. In accordance with Russian Railways (RZD) requirements, modifications were made to the plas-tically deformed catenary wires to replace the steel core with zinc or copper-plated to increase their suitability for high-speed railways.

## Potential application of innovative messenger wires for overhead contact lines/catenary systems

At the 79th General Assembly of the International Electrotechnical Commission (IEC) held in Minsk in 2015, during a meeting of the TC-9 committee, "Electric equipment and systems for the railroads," the Russian delegation outlined the details of the existing international standards, “Railroad carrier cables of contact network GOST 32697-2014” including data on the compacted wires. It also offered to initiate the development of the IEC new standard on the messenger wires for overhead contact line/catenary systems. A German patent for the construction and production technology plastically deformed steel wires and cables from different materials (Patent № DE-102014101833) was subsequently received in 2016.



## Conclusion

Replacing various messenger wires with the innovative plastically deformed carrying wire of MK series, which was developed following research into its settlement characteristics and use with a variety of catenary systems, will result in a decrease in electrical energy losses of 6-22% depending on extent and load of the catenary system. Introducing the new wire in catenary systems with high levels of railway traffic, and thus high electricity costs, is the most effective deployment method.

It would be expedient at reconstruction and construction of new railroads to apply this new innovative technology. The compacted wires offer strong electrical resistance due to the use of a larger quantity of copper with an identical diameter which increases the wire’s capacity and durability.

The AHG-14 working group created by the TC-9 committee continues to actively analyze the national standards of wires used in the IEC countries, and after considering the views of experts in the field, will submit its final conclusions on a new standard at the scheduled meeting of TC-9 committee in October 2016.

More information is available at www.energoservise.com.