Metsbytservis Engineering Company

PLASTICALLY DEFORMED CARRIER CABLE FOR CONTACT NETWORK

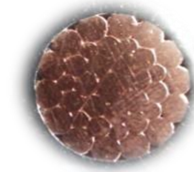
For Railways Companys

Innovative products for energy infrastructure

Providing simple solutions to complex challenges

Patent DE102014101833

COPPER WITH THE STRENGTH OF BRONZE



Achieved goal: Create a carrier copper

(without alloys, only due to the design)

- High mechanical strength (copper with the strength of bronze)
- Slight changing of the length with temperature fluctuations
- Better electrical conductivity and less electrical resistance
- Provides greater vibration stability and self-sustaining vibration
- Better aerodynamic characteristics and corrosion resistance
- Standard diameters
- Enough tech in mass production without a significant increased cost

The design reduces power losses by 11.35 % as compared with serial design & by 28.7 % as compared with Bronze cable

Experience of application - the busiest areas of the South-Ural, West & East Siberian, Sverdlovsk Railway

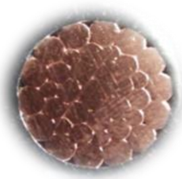
IN VIEW OF THIS EXPERIENCE, THE IEC TECHNICAL COMMITTEE (TC-9) HAS ACCEPTED OUR PROPOSAL TO ESTABLISH THE STANDARD IEC ON THE CARRIER CABLE OF CONTACT NETWORK OF RAILWAYS. THE PROPOSAL WAS SUPPORTED BY GERMANY, FRANCE, SWITZERLAND, ITALY, JAPAN, CHINA, BELGIUM, AUSTRIA.

Basic electromechanical characteristics (confirmed experimentally in the "conductor - fitting" system)

Diameter mm	Section mm^2	Electric resistance Ohm/km	Breaking load kN
10,7	83,4	0,2209	32,944
12,6	120	0,1533	45,73
14	140	0,1380	58,5
15,8	190	0,1008	72,26

the production technology of plastically deformed suspension cable - German Patent № DE102014101833

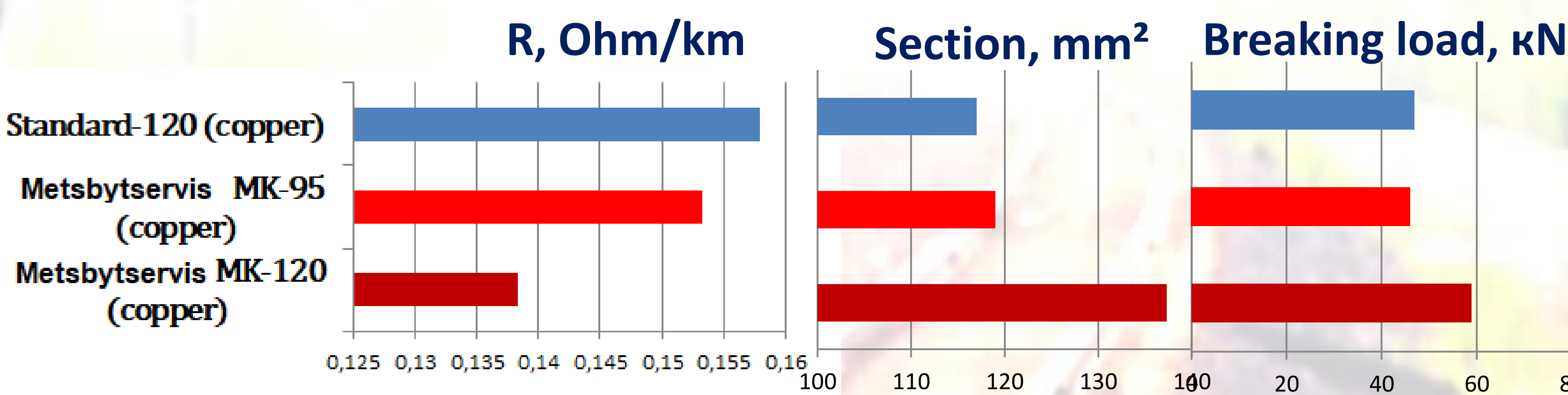
Prime cost of the transmission 1 ampere for MK 120 -11€, for standard Cu-120-13,96€.



Ø 14mm

Ø 12,6mm

Ø 14mm



In accordance with the task of the Russian Railways, we have developed modifications of plastically deformed suspension cable

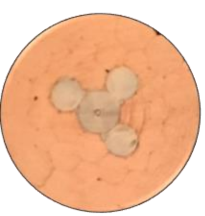
version with a steel core, zinc- or copper-plated

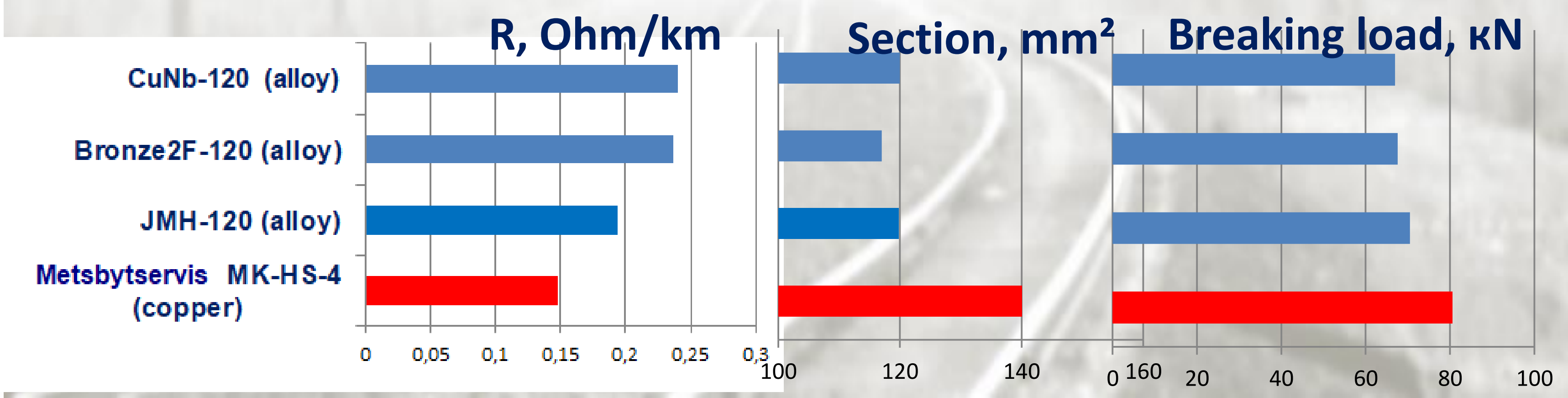
Purpose: use on <u>high-speed Railways</u>

<u>The electrical and mechanical characteristics in the embodiment with steel core</u>

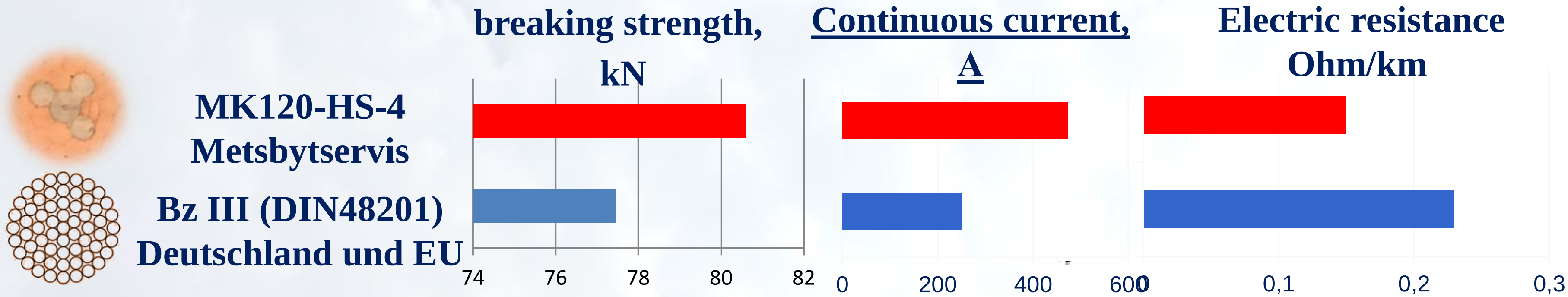
Diameter, mm	Section (Cu) mm²	Breaking force, kN	Specific electric resistance, Ohm/km, at 20 °C, at most
10,7	83,41	39,1	0,235
12,6	119,84	54,6	0,164
14	133,4	<u>80,6</u>	0,145
15,8	182,2	80,4	0,108

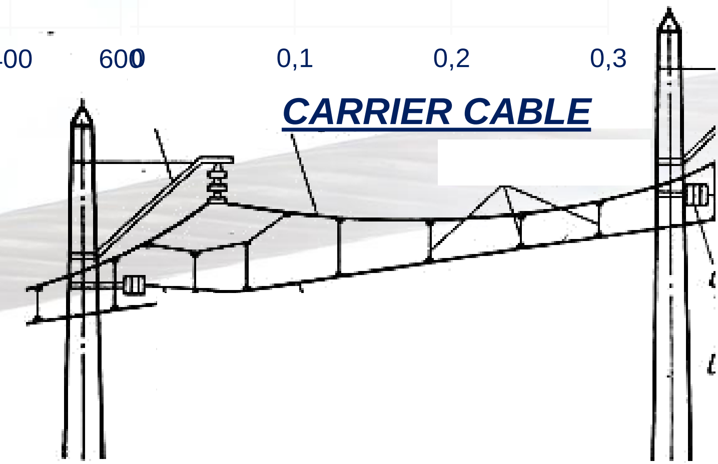
strength is achieved by using a central wire with increased strength and structure of the cable.



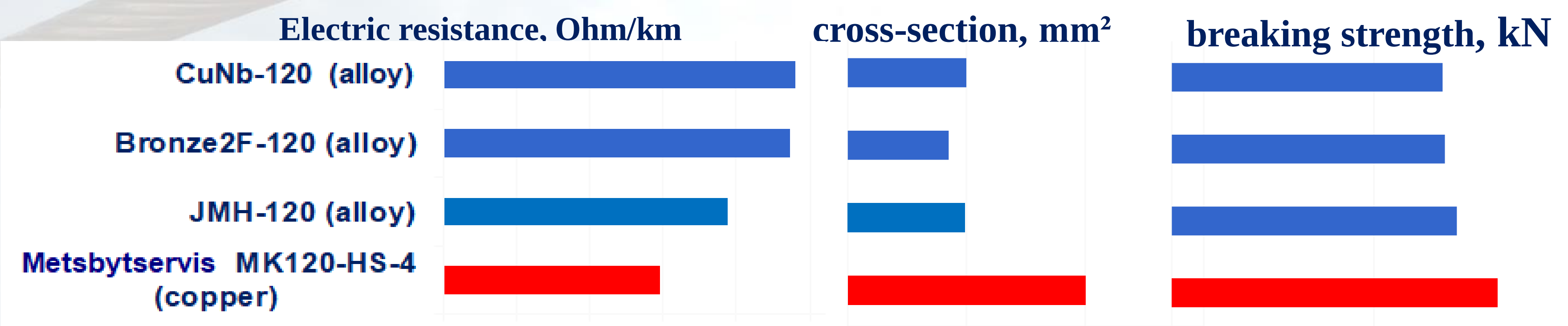


Compared to standard conductors DIN 48201 (Ø 14mm)





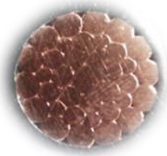
Comparison with other similar products from global companies



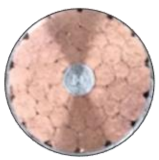
Compared to standard conductors DIN 48201 Bronze, alternative by Metsbytservis - copper + steel core

Russian Railways

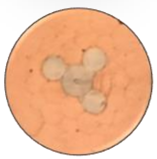
MK



MK-HS-1



MK-HS-4



nominal cross-cut, mm²	Target cross-section, mm²	Wires number	Rope diameter, mm	Weight Kg/km	Breaking strength, kN			Continuous current, A		
					Bz I	Bz II	Bz III	Bz I	Bz II	Bz III
70 DIN	65,81	19	10,5	596	32,51	38,64	44,14	285	245	175
MK 70	**83,4**	**36**	**10,7**	**780**	**32,944**			**366**		
MK70-HS-1	**83,4**	**36**	**10,7**	**774**		**38,3**			**347**	
MK70-HS-4	**83,4**	**36**	**10,7**	**766**			**44,2**			**343**
95 DIN	93,27	19	12,5	845	46,08	54,76	62,56	355	305	215
MK 95	**119**	**36**	**12,6**	1110	**48,73**			**457**		
MK95-HS-1	**119**	**36**	**12,6**	1102		**54,8**			**442**	
MK95-HS-4	**119**	**36**	**12,6**	1089			**62,9**			**435**
120 DIN	116,99	19	14	1060	56,68	67,57	77,46	410	350	250
MK 120	**138,7**	**36**	**14**	**1300**	**58,6**			**511**		
MK120-HS-1	**138,7**	**36**	**14**	**1281**		**69,56**			**501**	
MK120-HS-4	**138,7**	**36**	**14**	**1108**			**80,6**			**473**
150 DIN	147,11	37	15,8	1337	72,67	86,37	98,67	470	410	290
MK150	**182,2**	**36**	**15,8**	**1690**	72,76			**612**		
MK150-HS-1	**182,2**	**36**	**15,8**	**1678.3**		**87,6**			**577**	
MK150-HS-4	**182,2**	**36**	**15,8**	**1658**			**98,8**			**572**

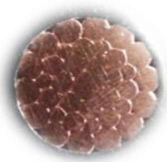
DIN

A comparison carried out by Siemens AG

SIEMENS
Ingenuity for life

Compared to standard conductors DIN 48201 Copper

MK



nominal cross-cut mm²	Target cross-section mm²	Wires number	Rope diameter, mm	Weight kg per km	Computational breaking strength, kN	Continuous current, A
70_DIN	65,81	19	10,5	596	26,38	310
MK 70	**83,4**	**36**	**10,7**	**780**	**32,944**	**366**
95_DIN	93,27	19	12,5	845	37,39	380
MK 95	**119**	**36**	**12,6**	**1110**	**48,73**	**457**
120_DIN	116,99	19	14	1060	46,9	440
MK 120	**138,7**	**36**	**14**	**1300**	**58,6**	**511**
150_DIN	147,11	37	15,8	1337	58,98	510
MK 150	**182,2**	**36**	**15,8**	**1690**	**72,26**	**612**
185_DIN	181,62	37	17,5	1649	72,81	585

Current's calculation conditions:

air temperature: +35°C, wire temperature: 70°C, transverse wind: 0,6 m / s.

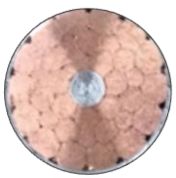
Compared to standard conductors

Possible use cases as a replacement for a standard cable

MK

Standard	average railway load	With a large load and with the planning of development
Standard Cu-120, S=117mm²	MK-95, S=119 mm²	MK-120, S=138 mm²
Standard Cu-95, S=94mm²	MK-85, S=87,7mm²	MK-95, S=119 mm²
Standard Cu-150, S=148mm²	MK-120, S=138 mm²	MK-150, S=190 mm²

MK-HS-1



MK-HS-4

The replacement options are determined by both the cross section and the network operation mode, the maximum (shock) currents, etc.

One of the reasons for using a bronze wire is the risk of reducing strength at high temperatures. The MK cable provides a much longer continuous current. But even with overheating under load up to 150°C strength does not decrease (the results of a series of experiments conducted by the Russian Railways). This allows (by experience of Russian Railways) not to use bronze.

However, for some cases, higher strength is still needed, and we have developed two more designs (MK-HS-1 & MK-HS-4, with steel wires) for such cases. Including for high-speed Railways. It's characteristics for Ø14mm (Section 140 mm²):

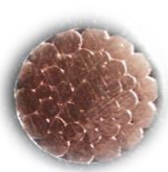
	Continuous Current, A*	Electric resistance, Ohm/km	Breaking load, kN
MK	805	0,1383	55,5
MK-HS-1	789	0,145	69,56
MK-HS-4	756	0,1484	80,6

*** - Current's calculation conditions: air temperature +20°C, wire temperature - 90°C, transverse wind – 1,0 m / s.**

Compared to standard conductors
Comparison of mechanical properties

Diameter mm	Breaking force For cable kN	Increase of breaking force, kN, Increase Concerning the standard cable design			
		Copper		Bronze	
		kN	%	kN	%
10,7	32,944	5,829	21,50%	0,474	1,75%
12,6	45,73	8,093	19,20%	0,64	1,42%
14	55,5	8,655	18,48%	0,05	0,091%
15,8	72,26	17,109	31,02%	1,28	1,80%
➢ All the properties were confirmed by tests					

Diameter, mm	Nominal cross section, mm²	Emergency current, A		Permissible continuous current, A	
		round wire	Compacted	round wire	Compacted
		t = 110 °C	t=160°C*	t = 100 °C	t=150 °C*
10,7	70	556	744,6	520	717,6
12,6	95	643	950,5	600	915,7
14	120	697	1019	650	981
15,8	150	805	1240,8	750	1194



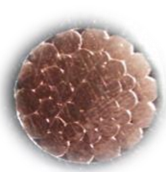
*** - Decrease in durability of plastically deformed cable happens only after an overheat to 200°C (for 30%) within more than 30 minutes.**

The wire was tested at the testing center of Russian Railways Company.

Russian Railways

HANNOVER MESSE 8-12 APRIL 2013

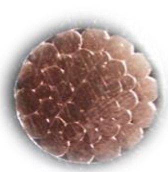
IEC 79th GM MINSK 2015



The program included a thermal softening test at 155 °C, a test of low-temperature creep air resistance, a test of resistance to eolic vibration, a test with repeated heating up to 100 °C and a number of other tests, some of them being applied to suspension cable for the first time.

Strength loss is found to be within allowable limits even after <u>multiple times of overheating to 155 °C</u> during all tests. The cable does not stretch when heated.

- ➢ **With this, in view of a larger cross section of the cable the overheating is caused by amperage, which will be much higher in comparison with standard product.**
- ➢ **Additional investigations of tensile strength during heating to 200 °C gave successful results.**
- ✓ **Additional series of tests was carried out with a fragment of the product which worked a year at the most congested area of the South-Ural, West Siberian, Sverdlovsk Railway.**



Metsbytservis, a Russian engineering company, it created the product that offers good mechanical strength, length almost independent of temperature variations, corrosion resistance, conductivity of copper, better aerodynamic quality and standard diameters; the device that would be quite easy to manufacture in a large-scale production system. The developer took into account that such product had to avoid a considerable rise in price and remain compatible with the standard fittings.

- ✓ The idea resulted in the creation of the copper suspension cable (busbar) of contact system that afforded higher conductivity and mechanical strength (the breaking force is 25–30 %higher) with the original diameter kept.
- ✓ The new wire design also provides lower range and intensity of aeolian vibrations, low risk of wire break or damage caused by external effects and lower tension of conductors. Therefore, the operational lifetime is increased by the self-extinguishing vibration.
- ✓ Among other factors, a new generation of suspension cable is characterized by it’s unique design which is less exposed to icing.
- ➢ We have been able to do without the famous standard solutions. The durability, strength and thermal-softening resistance of the contact system are improved with suspension cable copper-based alloys with additions of cadmium, magnesium, chromium, zirconium and other metals. It enhances the mechanical properties of the wire to different extents, however impairs the electric properties; so its application is limited by the regions of intensive traffic and the cost is greatly increased.

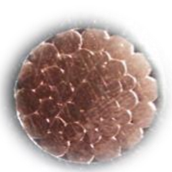
Compared to standard conductors

Comparison of electrotechnical properties

Diameter mm	Section mm² Nominal Standard	Specific electric resistance, Ohm/km, at 20 °C, at most			
		Standard	MK*(Cu)	Br1	Br2
10,7	67,7	0,2723	0,2209	0,3077	0,4107
12,6	94	0,1944	0,1533	0,221	0,2958
14	117	0,156	0,1383	0,178	0,2376
15,8	148	0,1238	0,1008	0,1408	0,1879

* for plastically deformed carrier cables by Metsbytservis Ltd., diameter/section-area ratio is different,

Increase of section with the same diameter,%	Standard Ohm/km	Reduction of specific electric resistance As related to the standard cable design			
		Cu	Bronze 1		Bronze 2
		%	Ohm/km	%	Ohm/km
29,54%	0,0514	18,88%	0,0868	28,21%	0,1898
31,91%	0,0411	21,14%	0,0677	30,63%	0,1425
19,66%	0,0231	11,35%	0,0451	25,34%	0,1047
28,38%	0,023	18,58%	0,04	28,41%	0,0871

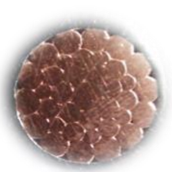


Technical requirements to wires

Nominal diameter, mm	Extreme deviation of actual diameter from the nominal one, %. But no more than	Nominal cross section, mm^2	The actual cross section, mm^2. But no less than		The actual weight of 1km, kg. But not more than	
			Round	Compacted	Round	Compacted
10.70		70.0	67.7	83.4	612	803
12.60	from -2.0	95,0	94.0	119,2	850	1146
14.00	to +6,0	120.0	117.0	137,3	1058	1320
15.80		150.0	148.0	181.8	1338	1748

Comparative characteristics of some of the catenary wires used in the Russian Railways.

Indicator	Catenary wires		
	M-120	M-150	MK-120
Nominal diameter, mm	14,0	15,8	14,0
Nominal cross section, mm^2	120	150	120
Estimated area of the cross section of all the wires in the cable, mm^2	117,0	148,0	140,06
estimated weight of 1 000 m cable, kg	1 058	1 338	1 300
Specific electric resistance at 20°C, Om/km	0,1580	0,1238	0,1383



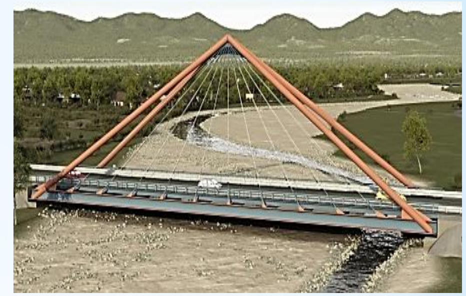
Example of new catenary wire constructions – compacted MK-120 in comparison with standard catenary wires M-120 and M-150.

SOME OTHER PROJECTS IMPLEMENTED

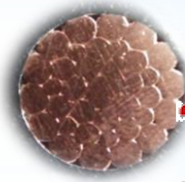
2001г NORILSK NICKEL

Cable barriers 2013

2001



2011



Russian Railways 2012

ROSPATENT

Deutsches Patent- und Markenar

We offer you reduction of expenses, while improving the reliability of power transmission lines and railways contact network.

МЕТСБЫТ СЕРВИС

Thank you for your attention!

http://metsbytservis.ru

Russian Railways