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DEVELOPMENT PRODUCTION TECHNOLOGY ROLLER OF THE INTRODUCTORY BOX OF THE CRATE №23

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Abstract

The article deals with the deformation of hot metal, which is produced using rolls of a rolling stand. Rolling of metal to the finished profile is carried out by gradual settling and pulling of workpieces in roll calibers. The rolls operate at a temperature of 1100 °C with wear of the contact surfaces during operation. The wear of the rolls leads to deterioration of the surface quality of the finished rolled products. This leads to a deviation in the size of the workpiece of the product and from the specified technological regulations forced to replace the rolls with a stop of production.

Keywords: development, technology, roller, roll, wear, rolling, powder, composition, shape, size, particles.

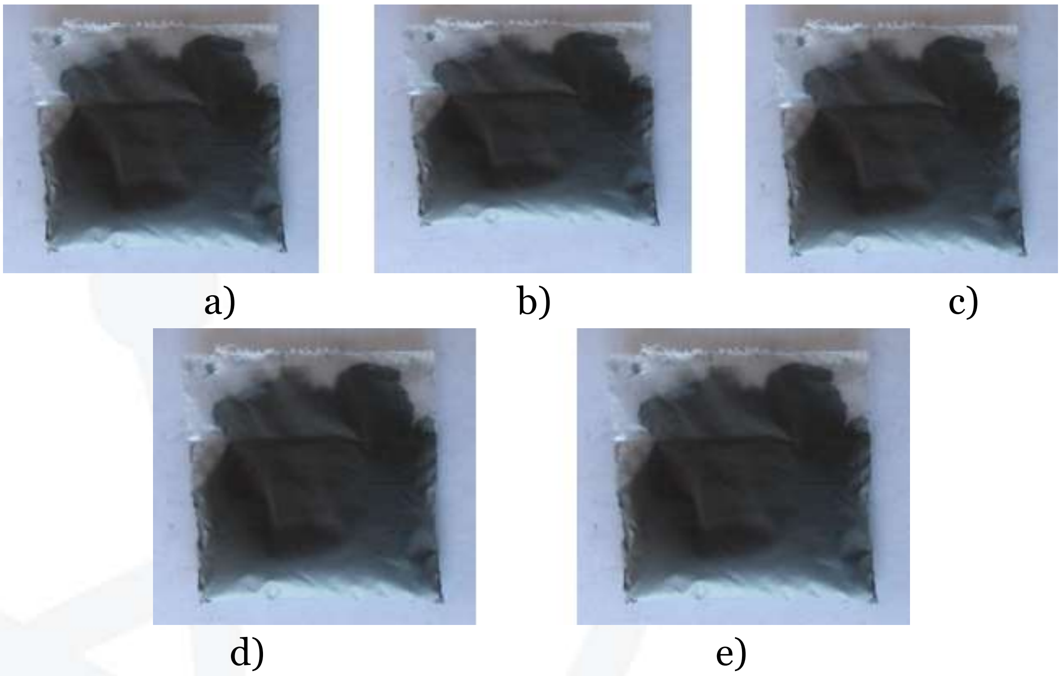
Introduction

The deformation of the hot metal is carried out by means of rolls of the rolling stand. Rolling of metal to the finished profile is carried out by gradual settling and pulling of workpieces in roll calibers. The rolls operate at a temperature of 1100 °C with wear of the contact surfaces during operation. The wear of the contact surfaces of the roll occurs from rolling friction and sliding friction between the roll and the hot metal. The wear of the rolls leads to deterioration of the surface quality of the finished rolled products. This leads to a deviation in the size of the workpiece of the product and from the specified technological regulations forced to replace the rolls with a stop of production.

The possibility of using the powder metallurgy method for the manufacture of the roller of the introductory box of the crate №23 from fine powders of refractory metals is investigated.

The physicomechanical properties of fine powders of refractory metals have been studied. The morphology of the structure of refractory metals and compounds is analyzed. The mechanisms of particle growth in low-temperature plasma conditions have been established.

Experimental samples of tungsten metal powders (Fig.1) of various granulometric compositions were obtained. Comprehensive studies of the chemical and phase composition, shape and size of particles, distribution of powders by granulometric composition, microhardness were carried out.



a) b) c)

d) e)

Fig.1 Tungsten metal powders of various granulometric composition: a) metal powder m/v 3,08; b) metal powder m/v 3,34; c) metal powder m/v 3,1; d) metal powder m/v 3,28; e) metal powder m/v 2,98.

The results of the study are shown in Figures 2-6 and 1, 2-tables.

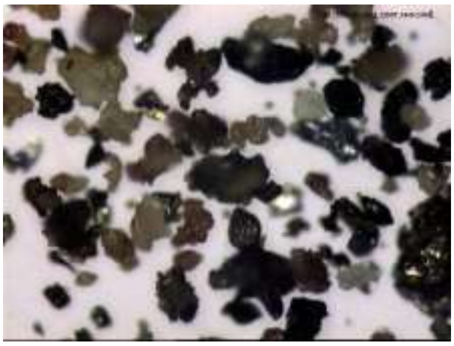


Fig.2. WC microstructures.

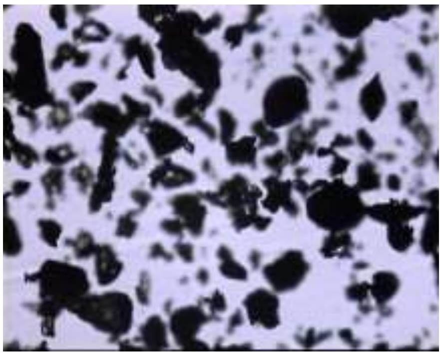


Fig.3. Dimensions and morphologies of WC powders, X500

Fig.4. View of an aqueous suspension of a 3W micro-powder under a microscope with outgoing light.

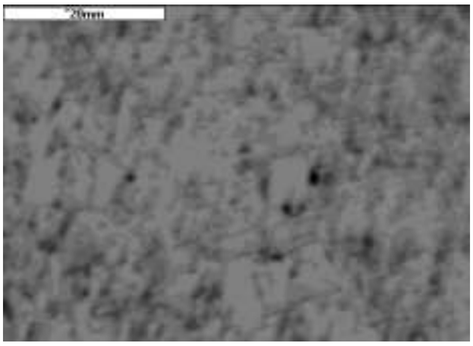


Fig.5. The structure of the compacted powder 3 W

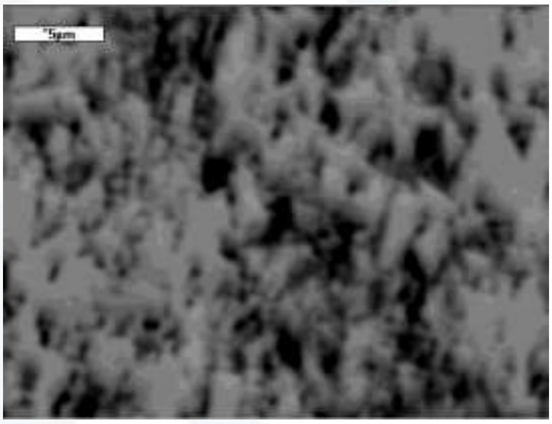


Fig.6. Structure of compacted hard alloy powder

Table 1. Compositions of mineral phases of 2 WC powder according to X-ray spectral microanalysis on a Jeol microprobe

3,2			
Elmt	Spect. Type	Element, %	Atomic, %
Fe K	ED	0.55	1.02
W M	ED	94.08	52.82
C		5.37	46.17
Total		100.00	100.00

Table 2. The composition of the phases of the powder of the carbide billet according to the results of X-ray spectral microanalysis

1,1				1,2		
Elmt	Spect.Type	Element, %	Atomic,%	Elmt Atomic	Spect.Type	Element,%
Co K	ED	1,52	4,97	Co K,4.43	ED	1,39
W M	ED	90,81	95,03	Sb L, 0,80	ED	0,52
				W M, 94,77	ED	92,65
Total		92,33	100			94,56

The manufactured roller of the introductory box of the crate № 23 according to the proposed technology was delivered for industrial testing to JSC "Uzmetkombinat".

A pair of rollers (№ 1 and № 2) was installed on 14.01.2011 for rolling reinforcement № 16. This pair of rollers has been in operation for three companies rolling reinforcement profile № 16. After the next revision, the rollers were decommissioned, due to a crack formed on roller № 1. No defects were found on roller № 2.

The total metal removal amounted to 3,846 tons.

In the next company rolling rebar № 16 on 25 crates, a stop valve was operated, in which rollers № 2 (former in operation) and № 3 (new) were installed.

The assembled box with experimental hard alloy rollers has been operated to date (6 companies) The total removal of metal was

- New roller - 8,367 tons
- Roller operating from the date of installation - 12,123 tons

In the course of the research work, the following results were obtained:

1) The reasons for the failure of the existing bandages of rolling rolls are analyzed. Based on the results of the analysis, the following conclusions were made:

- – Due to the wear of temperature and pressure, the contact surfaces wear out;
- – As a result of a sharp temperature fluctuation, cracks form on the contact surfaces;
- – As a result of uneven contact with the rental, chips are formed;
- – The hardness of the metal decreases, the structure changes.

2) The technical characteristics were analyzed and the mechanical properties of a set of rolling rolls of refractory alloys were studied, on the basis of which two grades of hard alloys were selected for the manufacture of bandages with the following chemical composition: a) metal-ceramic material (Patent IH DP 9400608.1), with a chemical composition - titanium carbide 45-48%; nickel 1.5-2.0%; tungsten 1.0-1.5%, iron 4-5%, lanthanum hexaboride 0.15- 0.25%, molybdenum - the rest.

б) hard alloy grade VK6, with chemical composition: tungsten carbide 92%; cobalt 6%.

The "stacks" were made of the new hard alloys mentioned above and the mechanical characteristics of these "stacks" were investigated:

1. On metal-ceramic material:
- – Hardness – 90 HRA;
- – Flexural strength – 800 MPa;
- – Impact strength – 0,58 kgm/cm².

2. For hard alloy VK6:
- – Hardness – 88 HRA;
- – Flexural strength – 1200 MPa;
- – Impact strength – 0,67 kgm /cm².

3. The project participants, with the assistance of JSC "UZKTJM", developed working drawings and molds for obtaining the part "Roller of the introductory box of the crate № 23" (Fig. 7.).

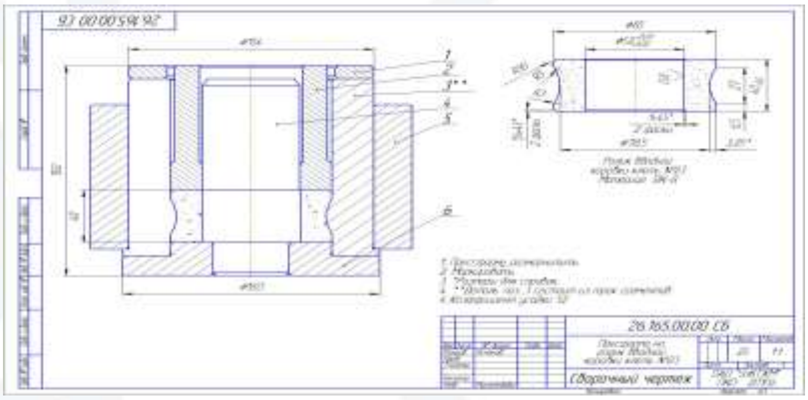


Fig.7. Assembly drawing of the mold for the roller of the introductory box of the crate № 23.

A new type of plasma chemical reactor for hydrogen reduction of tungsten and molybdenum oxides has a distinctive feature of bringing energy into the reaction zone. The energy is introduced not only in the form of a plasma jet, but also in the form of an additional flow of gas heated to a high temperature entering the reaction zone through a porous permeable wall heated by an electric heater.

A new type of plasma chemical reactor was created based on the following considerations. The process of plasma chemical reduction in a conventional reactor, in which d/D is 1/10, is divided no more than 0.03 seconds, and the plasma flow, when flowing freely in a large volume, quickly loses reserves of thermal energy, therefore some part of the powder that has fallen into the peripheral region of the jet remains under-restored. Thus, it is necessary to extend the residence time of tungsten oxide particles in the hot zone.

The design diagram of the plasma chemical reactor is shown in Fig.8. A plasma jet with a diameter of 30-40 mm is compressed by a porous molybdenum pipe with an inner diameter of 40-50 mm, which is coaxially located in a porous pipe made of stainless steel. Between the porous pipes there is a molybdenum heater for heating the passing gas.

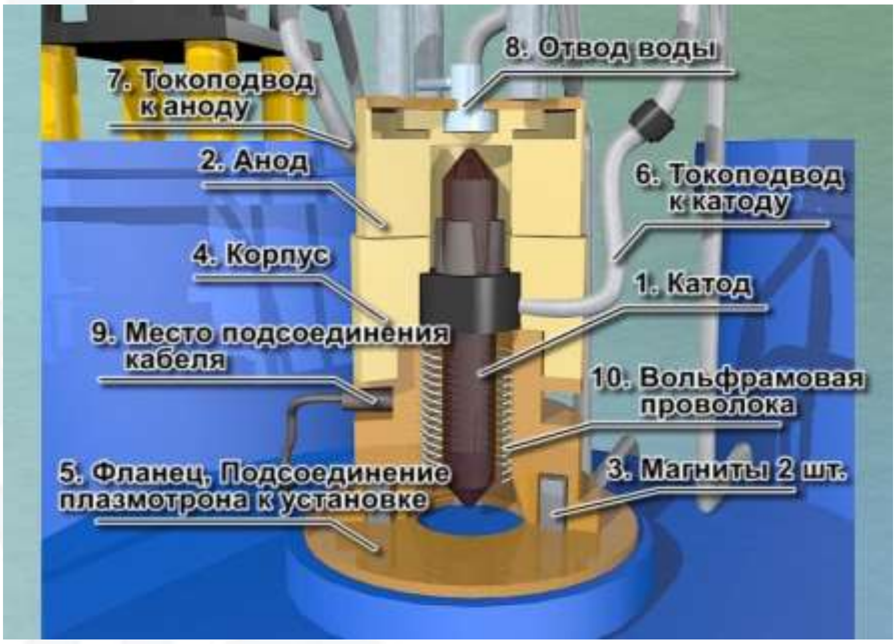


Fig.8. Plasma torch with an increased degree of processing of raw materials

The above-described design is placed in a hermetic casing, where additional hydrogen is injected, which, heating up between the porous pipes, compresses the plasma jet.

Technological studies of the new reactor were carried out on a reinforced plasma laboratory installation. The power of the plasma torch was maintained in the range of

45-55 W, the heater power was 16-18 KW, the hydrogen consumption through the plasma generator was 20 mz/h, through the heater from 40 to 60 m^3/h. Consumption of tungsten oxide is 6-10 kg/h. The temperature of the hydrogen heated by the heater is 1500 - 1600 ^{o}C. Thus, the total power was no more than 75 KW, and the total hydrogen consumption was up to 80 m^3/h, at the same time, the power of the plasma torch according to the traditional scheme is 100 KW with a hydrogen consumption of 75 m^3/h.

The study of the obtained powders showed that the average grain size according to Fischer is 0.07 - 0.09 microns with an oxygen and moisture vapor content of 0.5% by weight (Table 3).

X-ray phase analysis showed the presence of β - tungsten up to 50%, I - tungsten up to 35%, and the rest is amorphized tungsten without the presence of oxide phases. In the process of obtaining powders in the new reactor, practically no powder was found in the sedimentation chamber under the reactor, which indicates that all the incoming tungsten oxide was recovered and the tungsten UDP fell on the filters.

Table 3. Fischer grain size and mass fraction of oxygen in powders obtained in a plasma chemical reactor.

№ №№	Selection point	Fischer grain size, microns	Mass fraction of oxygen and moisture vapor , %
11	W plasm. from the filter	0,08	0,5
22	W plasm. from the filter	0,09	0,5
33	W plasm. with sedimentation chamber	0,09	0,5
44	W plasm. from the filter	0,07	0,4

Technology of manufacturing "stacks" of new hard alloys:

1. Restoration is carried out by the recovery furnace CTN-1.6. Recovery mode:

The first recovery of WO_3:
– hitch 2-3 kg/boat;
– hydrogen consumption 4-6 m^3;
– temperature recovery 850-950 ^{o}C;
– recovery time 20 minutes.

The second recovery WO_2:
– hitch 2-3 kg/boat;
– hydrogen consumption 4-6 m^3;

– temperature recovery 950-1100 °C;
– recovery time 20 minutes.

After the second recovery, W of metal is obtained.

2. W metal gives for sifting (nylon mesh 018-014 (GOST 6613-86));
3. Hardening – all boats are added and mixed;
4. Sifting (nylon mesh 018-014 (GOST 6613-86));
5. Dry grinding. Carbidization mixture/W+C (WC):

– technical carbon 6-6.2% + W 93.8-94%;
– mixing time 2 hours.

Dry grinding is carried out in a ball (steel balls) mill.

6. Carbidization is carried out in a graphite tube furnace in the following modes:

– carbidization temperature 1450-1700 °C;
– hydrogen consumption 0.7 m^3/hour;
– promotion 30 min/boat.

7. Dry grinding is carried out in a ball (steel balls) mill for 20-30 minutes.
8. Obtained tungsten carbide transfers to sieving (mesh grade 018-014 (GOST 6613-86)).
9. Cobalt Recovery:

– cobalt is restored in a 2-zone reducing furnace at a temperature of 550-650 °C;
– advance 20 min/boat;
– suspension 0.7 kg Co;
– hydrogen consumption 5-6 m^3/h.

The finished metal cobalt gives a sifting.

10. For the additive in WC, a synthetic rubber solution in gasoline (B - 70) is prepared with the following modes:

– 8% synthetic rubber and 92% gasoline dissolves 48 hours in the reactor;
– standing for 48 hours;
– the SK solution in gasoline is filtered. The filter consists of four layers: gauze, mesh, pure cotton and gauze.

11. Wet grinding. 700 kg VK6 balls, 72 l alcohol (C_2H_3H), 12 kg Co and 188 kg WC are dissolved in wet grinding mills in the following mode:
12. Filtering. The finished pulp-like liquid is filtered on the smallest grid.
13. The solution is distilled in a distiller:

– steam temperature 110°C;
– steam pressure 2.5 kgf/cm^2;
– drying of the mixture 24 hours;
– cooling of the mixture for 24 hours.

14. Sifting. Sifting the VK mixture on a sieve is exentricated
15. Kneading. Mixtures of VC in a solution of SK in gasoline are mixed into a screw mixer.
16. Drying. The process is carried out in the steam cabinet in the following mode:
– steam temperature 110 °C;
– steam pressure 2.5 kgf/cm^2;
– drying of the mixture 24 hours;
17. Sifting. Sifting the VK mixture onto a cleaning sieve.
18. Granulation. VK mixtures are granulated in a granulator for 5-10 minutes.
19. Pressing:
– suspension 1850 kg mixture VK6;
– pressure crimping 150 kgf/cm^2.
20. Drying. The process is carried out in the steam cabinet in the following mode:
– steam temperature 110 °C;
– steam pressure 2.5 kgf/cm^2;
– drying of the mixture 48 hours;
21. Rejection.
22. Mechanical processing.
23. Sintering. The product is sintered in a 3-zone sintering furnace in the following mode:
– promotion of 60 minutes in 18 parts;
– hydrogen consumption 2.5- m^3/h.
24. Sandblasting.
25. OTC and sharpening.
26. Finished products.
27. Packing

The new alloy being developed has a higher hardness and wear resistance compared to existing alloys and will be intended for processing hard-to-process materials.

The most effective ways to create such an alloy are the use of tungsten nanopowders and intensive grinding of the WC phase. The article shows that as a result of the conducted research, it was revealed that the developed alloy differs from standard fine-grained alloys by an ultra-fine-grained structure.

The results of research work on the first stage of the project will be used for further development of technology and manufacture of a set of carbide bandages of rolling rolls, as well as for localization of production of parts "roller of the introductory box of the crate № 25", "roller of the introductory box of the crate №23", etc. operated by JSC "Uzmetkombinat".

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