



**MOTOVILIKHA  
PLANTS**



**METALLURGICAL  
PRODUCTS**

**CATALOGUE**





13 January 1941  
The Order of Lenin



3 June 1942  
The Order of the Red  
Banner of Labour



15 October 1944  
The Order of the Red  
Banner

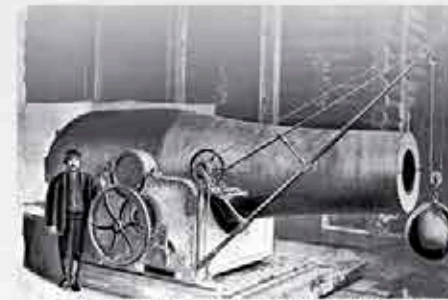


28 June 1945  
The Order of the Patri-  
otic War, 1st class

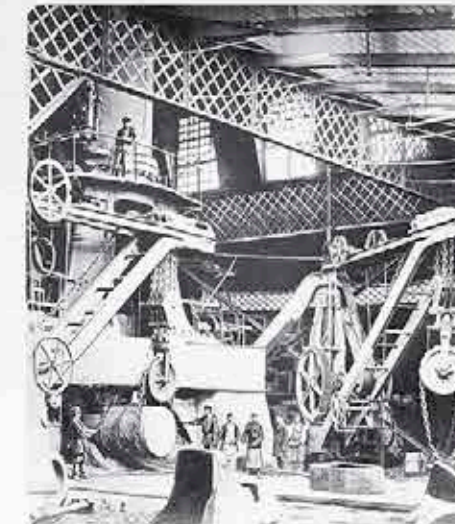


18 January 1971  
The Order of the Octo-  
ber Revolution

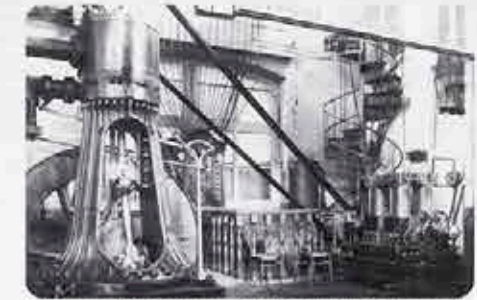
## 1736 – the year of establishment



The Perm Tsar Cannon is a 20-inch combat gun weighting 45,864 kg which is by 4,914 kg more than the Kremlin one weights. It was casted in 1868.



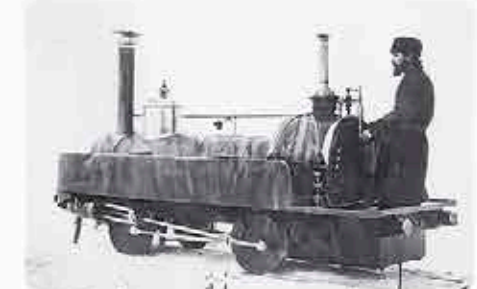
The world's largest 50-ton steam hammer. It forged ingots as heavy as 48 ton and more. The hammer was constructed in 1875 under the supervision of N. V. Vorontsov, Mining Officer. At that time, the 600-ton hammer anvil used to be the largest one-piece casting in the world.



The electrical machine of design by N. G. Slavyanov is the first power station in the Ural region. It was built in 1886.



1871. Pushkar' steamboat manufactured by the Works. They made over 60 steamboats.



1872. The first steam train constructed according to the project by Dmitrii Permyakov, a works' self-taught mechanic.



The Ural's first open-hearth furnace. The works constructed it in 1876.



Nikolay Gavrilovich Slavyanov was the Mining Officer of Perm Cannon Works from 1891 to 1897. In 1888, he invented a method of arc welding. In 1893, his method for joining different types of metals by electric welding (see Slavyanov's glass on the right picture) received the medal of Chicago World Fair for scientific and technological revolution.



XIX c. General view of the works.



30s of the XXth century. The first Soviet Union's steam excavator made by Motovilikha Plants.



1932. Works' management building constructed in XIX century.



Perm manufactured the best dredges in the Soviet Union. They produced 90 % of USSR gold reserve.



## XVIII–XIX centuries

- 1736 **START**  
Vasily Nikitich Tatishchev founded the Motovilikha copper works by the directive of Empress of Russia Anna Ioannovna. The works ensured complete cycle of cooper extraction and treatment.
- 1863–1864 **ESTABLISHMENT OF ARTILLERY PRODUCTION**  
The steel-cannon and iron-cannon works were established on the base of the cooper production. Output of steel guns was mastered at the level of the best world patterns.
- 1871 **PERM CANNON PLANTS**  
The steel-gun and iron-gun works were consolidated into Perm Cannon Works. Perm Cannon Works stamp appeared at each third gun of Czarist Russia.
- 1875 **STEAM HAMMER - TECHNOLOGICAL WONDER**  
Motovilikha Works created the world's largest double-acting 50 ton steam hammer. Perm gun craftsmen came out on the top in production of heavy-caliber artillery.
- 1876 **THE FIRST OPEN-HEARTH FURNACE**  
Motovilikha Works became the first Ural works where open-hearth furnaces were installed. The Works also produced steam boats, steam engines and boilers, rolling mills, and other machinery.
- 1893 **INVENTION OF ELECTRIC WELDING**  
At the World's Fair in Chicago, Mining Master of Perm Cannon Works Nikolay Slavyanov received the medal for yielded scientific and technical revolution. Technique of consumable electrode welding he invented forms the basis of up-to-date welding production. Electrical compaction of casting-ingots, which was also invented by Nilokay Slavyanov, gained widespread currency in production.

## XX–XXI centuries

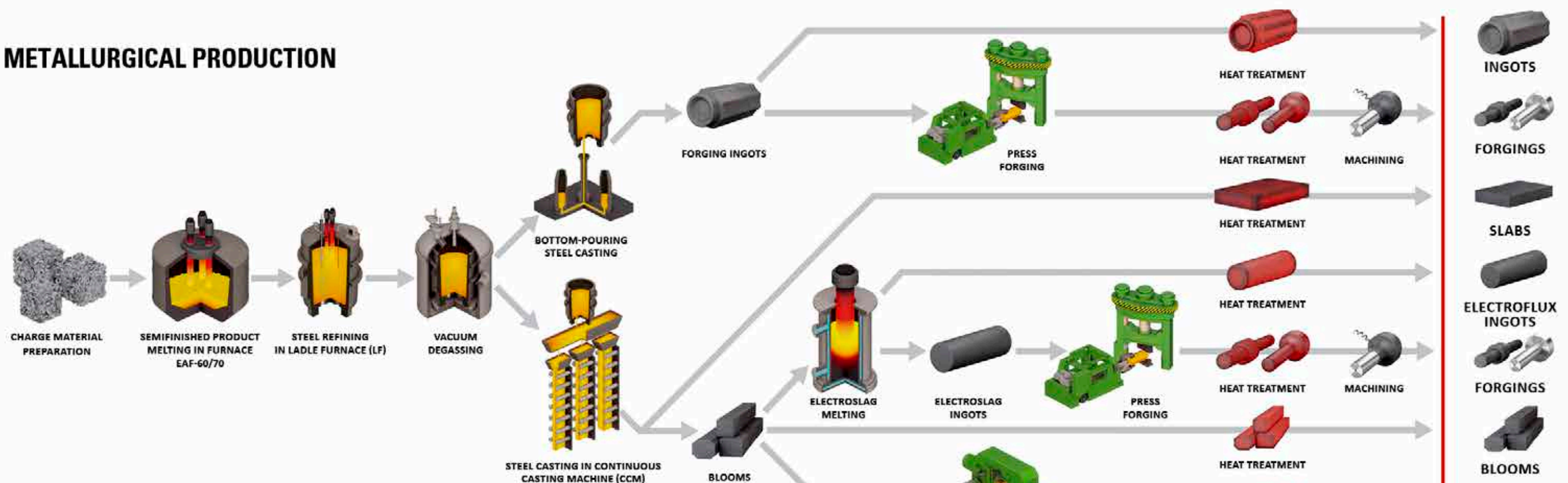
- 1914–1918 **FIRST WORLD WAR**  
Motovilikha Works manufactured each fifth cannon used by the Russian Army.
- 1930s **RECONSTRUCTION AND NEW PRODUCTION**  
After the war, the general plan of Works' reconstruction was implemented. The enterprise mastered manufacturing products for non-ferrous metallurgy, road building, and petroleum and coal-mining industries. Motovilikha Works produced the country's first excavating machine. The works produced dredges, suctiontube dredges, coal cutters, cranes, and other machinery.
- 1941–1945 **GREAT PATRIOTIC WAR**  
In January 1941, the Order of Lenin was awarded to the Works for their merit in creation and mastering manufacture of new armament patterns.

During the war, Motovilikha Works increased artillery output by 8 times. Each fourth gun of the Red Army was made by the Works' craftsmen. 15 times the work collective won the Red Challenge Banner, which thereafter was handed over to the Motovilikha Works for eternal storage. The Works were honoured by another USSR medal for their contribution to victory.

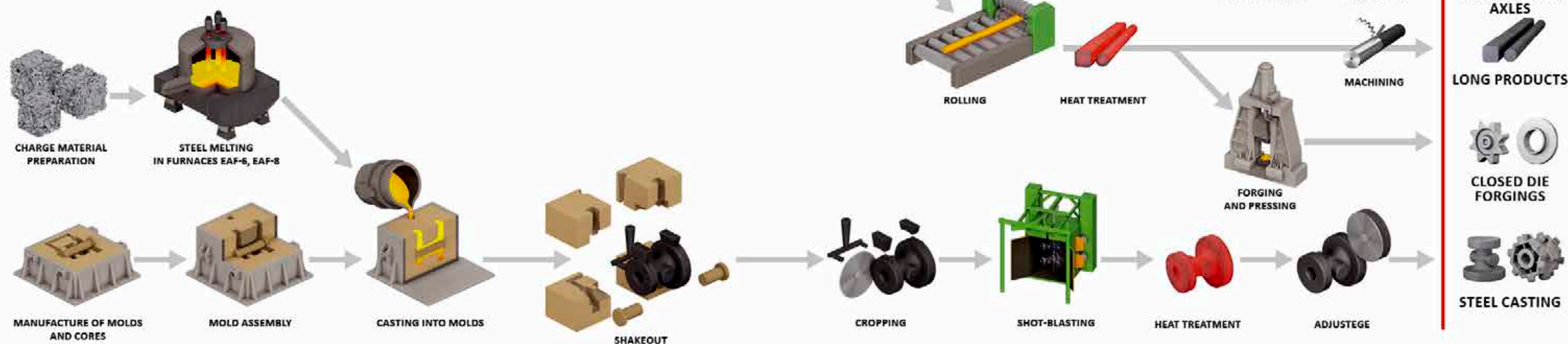
- 1950–1960s **LENIN PLANT**  
Until 1992 the plant was named after the leader of world proletariat. Motovilikha Works assembled the country's first steel continuous casting unit. They implemented advanced technologies: electroslog remelting process, steel treatment in a ladle by synthetic slags, forward-looking types of pressure metal treatment, precision casting.
- 1957–1992 **SWITCH OVER TO PEACEFUL FOOTING**  
Already in 1944, implementation of a plan for reconversion from military production was launched. The plant produced harpoon guns, 0.5 cubic meter bucket excavators, mucking machines, coal-mining machines, perforators, peat presses, hydro turbines, as well as oil pumps, turbodrill joints, beam pumps, drill collars, drill bits, downhole sucker-rods. In 1958 the USA and the Federal Republic of Germany bought licenses for Motovilikha turbodrill manufacture. The plant became a flagship company in designing and producing dredges, which mined 90% of gold in the USSR. The plant was awarded with the fifth medal for mastering new technologies and faithful serving the State.
- 1990s **OPEN MARKET**  
Ratio of military and commercial goods in Motovilikha Works' portfolio shifted in favour of civilian market. The plant started manufacturing crane trucks, established a design office for road-building engineering. It also put into production mixing taps, springs, and vehicle springs.
- 2000s **NEW METALLURGY**  
In 2000 a ladle furnace was commissioned, and in 2002 – an arc electric steel furnace DSP-60/70 (FAI-FUCHS). In 2006, Motovilikha Plants launched a program for metallurgical facilities renewal. Thus, in 2009, there were commissioned a vacuum steel degassing unit and new forging installations: 3000-ton-force hydraulic press unit with 20-ton manipulating device (Danieli). An air separation unit appeared in 2013.
- 2011 **NEW ENGINEERING**  
In the year of 275th anniversary of Motovilikha Plants, they founded and opened new machinery production of special purpose equipment.
- 2015 **PRECISION ALLOYS**  
The Works launched a high-end manufacture of conceptually new multifunctional alloys that have different combinations of hardly compatible features.



## METALLURGICAL PRODUCTION



## FOUNDRY PRODUCTION





**COMPLETE PRODUCTION CYCLE:  
FROM METAL SMELTING  
TO OUTPUT OF ENGINEERING PRODUCTS**

| Basic manufacturing areas | Equipment  |
|---------------------------|--|
| Steelmaking               | Electric steelmaking arc furnace EAF-60/70 (FAI-FUCHS) |
|                           | Ladle furnace for secondary steel refining (FAI-FUCHS) |
|                           | Vacuum degassing plant VD/VOD (Danieli)                |
|                           | Air separation plant                                   |
|                           | Steel continuous-casting plant                         |
|                           | Steel bottom-pouring shop                              |
|                           | Electroslag remelting plants: R-951, U-522             |
| Press forging             | 3,000-ton-force hydraulic press (Danieli)              |
|                           | 2,000-ton-force hydraulic press                        |
|                           | 1,500-ton-force hydraulic press                        |
|                           | 3-ton steam-and-air forging hammer                     |
|                           | 5-ton steam-and-air forging hammer                     |
|                           | Straightening equipment                                |
|                           | Radial forging machine SXP-55 (GFM)                    |
| Die-forging               | 2-ton steam-and-air die hammer                         |
|                           | 3-ton steam-and-air die hammer                         |
|                           | 6-ton steam-and-air die hammer                         |
|                           | 450-ton-force hydraulic press                          |
|                           | 700-ton-force hydraulic press                          |
| Rolling                   | Small section mill 350                                 |
|                           | Heavy section mill 710                                 |
|                           | Straightening equipment                                |
| Steel casting             | Electric steelmaking arc furnaces EAF-6, EAF-8         |
|                           | Molding shop   |
|                           | Pouring shop   |





Electric steelmaking arc furnace EAF 60/70 (FAI-FUCHS)



Bottom-pouring steel casting



Forging complex Danieli



Radial forging machine SXP-55 (GFM)



Forging hammer



Cutting of forgings by bandsaw machines

A forging is a workpiece which is manufactured at press forging equipment by open-die forging.

- Over 200 steel grades including tool, stainless, heat-resistant ones.
- Variety of forging configurations.
- Maximum diameter of shafts is 800 mm, of rings up to 2 000 mm, maximum length is 11 800 mm.
- Maximum forging weight is 12 500 kg.
- Electroslag remelting yields unique properties.
- Minimum order quantity – 1 forging.



## PRESS FORGING EQUIPMENT

| Equipment designation         | Force [ton force]                  | Forging maximum weight [kg] |
|-------------------------------|------------------------------------|-----------------------------|
| Hydraulic presses             | 3 000                              | 12 500                      |
|                               | 2 000                              | 6 000                       |
|                               | 1 500                              | 4 000                       |
| Steam-and-air forging hammers | Falling weight 3 ton               | 75                          |
|                               | Falling weight 5 ton               | 2 000                       |
| Radial forging machine        | Force per one head 1,000 ton force | 4 000                       |
| Straightening press           | 1 000                              |                             |
|                               | 1 600                              |                             |

Due to their capacity the Works manufacture forgings with accuracy of  $\pm 1$  mm and minimum tolerance. The equipment fleet of the enterprise performs all types of machining and heat treatment even for very long workpieces with big diameters. The products can be manufactured according to customer's orders and special requirements of a customer.

Annually Motovilikha Plants launch 2-3 new items in mass production and constantly work on mastering new steel grades.

## INDUSTRIES CONSUMING FORGINGS





## NOMENCLATURE OF FORGINGS

| Rough forging   | Type of forging                | Dimensions [mm]   | Weight [kg]    | Machined forgings   |
|---|--------------------------------|---|----------------|---|
|    | Smooth square and round shafts | Diameter (square side): 170-800<br>Length: 1 500-11 800                               | 300 – 12 500   |    |
|    | Stepped shafts                 | Diameter: 220 – 700;<br>Maximum length: 5 000   | 400 – 8 300    |    |
|    | Discs and pierced discs        | Diameter: 500 – 2 000;<br>Inside diameter: 150 – 350                                  | 350 – 8 000    |    |
|   | Blocks                         | Side: 400 – 1 000   | maximum 8 000  |   |
|  | Pierced cylinders              | Diameter: 350 – 850;<br>Minimum wall thickness: 100                                   | maximum 4 000  |  |
|  | Plates                         | Thickness: 130 – 250;<br>Length: 1 000 – 4 500  | maximum 12 500 |  |
|  | Rolled rings                   | Maximum outside diameter: 2 000;<br>Height: 170 – 800;<br>Minimum wall thickness: 130 | 350 – 8 000    |  |
|  | Mushroom shaped forgings       | Diameter: 600 – 1 100;<br>Core diameter: 170 – 700;<br>Maximum height: 600            | maximum 3 500  |  |

## NOMENCLATURE OF STEEL GRADES

| Steels                          | Steel grades as per foreign standards  |
|---------------------------------|--|
| Constructional carbon           | C15, C45, C60, 080M40, 070M20, AISI 1018, AISI 1045 and others   |
| Constructional low-alloy        | S355J2 and others  |
| Constructional alloy            | 42CrMo4, 25CrMo4, 34CrNiMo6, 36CrNiMo4, 51CrV4, 16MnCr5, 18CrNiMo7-6, 18CrMo4, 39NiCrMo3, AISI 4140, AISI4145, AISI4340 and others |
| Tool                            | 1.2379, 1.2343, 1.2344, 1.2714 and others  |
| Corrosion-resistant (stainless) | X20Cr13, X30Cr13, X22CrNi17, X10CrNiTi18-9, X12CrNiTi18-9 and others   |
| Heat-resistant and refractory   | ЭП 609-Ш, ЭП 961-Ш, ЭП 517-Ш, and other  |

Over 200 steel grades



Forging plant Danieli



Heat treatment of forgings



Forging in mandrel



Disk forging in press



Rough railway car and locomotive axles are the workpieces that are manufactured by forging in radial forging machine.

- Axle manufacturing from in-house made workpieces.
- Manufacturing by forging in radial forging machine.
- Wide Nomenclature of axles: for railway cars, locomotives, trams, axles for underground railway carriages, axles for innovative carriages.
- Electroslag remelting yields unique properties.



## NOMENCLATURE OF ROUGH RAILWAY CAR AXLES

| Drawing  | Description  | Basic dimensions [mm] |        |                   |        | Rough axle weight [kg] |
|----------|--|-----------------------|--------|-------------------|--------|------------------------|
|          |  | Neck D                | Body D | Wheel seat part D | Length |                        |
| RKV-1-01 | Axle with cone-shaped body (maximum load: 23,5 ton)                    | 150                   | 185    | 210               | 2 224  | 527                    |
| RKV-1-02 | Axle with cylindrical body (maximum load: 25 ton)                      | 165                   | 210    | 225               | 2 255  | 611                    |
| RKV-1-03 | Axle with cylindrical body for high-speed railway cars                 | 152                   | 194    | 213               | 2 290  | 568                    |
| RKV-1-04 | Centered axle with cylindrical body (maximum load: 23,5 ton)           | 145                   | 187    | 210               | 2 220  | 496                    |
| RKV-1-07 | Axle with cylindrical body (maximum load: 23,5 ton)                    | 145                   | 187    | 210               | 2 220  | 496                    |
| RKV-1-09 | Axle with cylindrical body for electric motor coaches                  | 155                   | 200    | 221               | 2 480  | 628                    |
| RKV-1-10 | Centered axle with cone-shaped body (maximum load: 23,5 ton)           | 150                   | 185    | 210               | 2 220  | 526                    |
| RKV-1-12 | Axle with cone-shaped body for passenger cars (maximum load: 23,5 ton) | 148                   | 187    | 210               | 2 370  | 548                    |
| RKV-1-17 | Non-motored axle with internal hole for high-speed electric trains     | 170                   | 230    | -                 | 2 340  | 670                    |
| RKV-1-18 | Motored axle with internal hole for high-speed electric trains         | 170                   | 205    | 240               | 2 340  | 649                    |

## NOMENCLATURE OF ROUGH LOCOMOTIVE AXLES

| Drawing | Basic dimensions [mm] |        |                   |        | Rough axle weight [kg] |
|---------|-----------------------|--------|-------------------|--------|------------------------|
|         | Neck D                | Body D | Wheel seat part D | Length |                        |
| RKL-2-2 | 160                   | 218    | 251               | 2 430  | 665                    |
| RKL-2-3 | 210                   | 235    | 275               | 2 550  | 985                    |
| RKL-2-4 | 195                   | 220    | 250               | 2 550  | 840                    |
| RKL-2-5 | 195                   | 215    | 245               | 2 550  | 840                    |
| RKL-2-6 | 195                   | 252    | 275               | 2 550  | 1 040                  |
| RKL-2-7 | 165                   | 212    | 250               | 2 416  | 805                    |
| RKL-2-8 | 178                   | 218    | 250               | 2 610  | 845                    |
| RKL-3-1 | 195                   | 235    | 255               | 2 475  | 890                    |
| RKL-3-2 | 177                   | 232    | 255               | 2 550  | 865                    |
| RKL-3-3 | 195                   | 256    | 270               | 2 475  | 1 065                  |
| RKL-4-1 | 175                   | 220    | 255               | 2 600  | 810                    |
| RKL-4-2 | 175                   | 225    | 255               | 2 680  | 845                    |
|         |                       |        | -                 | -      |                        |
| RKL-5-1 | 195                   | 240    | 275               | 2 492  | 985                    |

Rough railway axles are manufactured from OC steel grade in accordance with GOST 31334-2007 by forging in radial forging machine which ensures increased quality of a finished item. Manufactured axles are approved by certificates of conformity and the permit to use the mark of certification system conformity.

Finished products can be shipped in small batches. Over the last 9 years Motovilikha Plants have mastered manufacturing 13 types of railway car axles and 14 types of locomotive axles. Since 2014, the Works have certificates for manufacturing axles for high-speed electric trains.



Forging of workpieces for railway car axles in radial forging machine



Workpieces for railway car axles after forging



A closed die forging is a workpiece which is manufactured at press forging equipment by hot die-forging.

- Wide Nomenclature of closed die forgings.
- Maximum diameter: 460 mm, maximum weight: 300 kg.
- Stock reserve of items.
- In-house made die tooling.
- Manufacture of die tooling at the expense of a supplier.



## PRESS DIE FORGING EQUIPMENT

| Equipment designation             | Falling weight [ton] | Die-forging maximum weight [kg] |
|-----------------------------------|----------------------|---------------------------------|
| Die-forging steam-and-air hammers | 2                    | 3                               |
|                                   | 3                    | 16                              |
|                                   | 6                    | 90                              |
| Hydraulic presses                 | force: 450 ton force | 300                             |
|                                   | force: 700 ton force |                                 |

The Works are in possession of facilities and technologies to manufacture die forging for aviation application, for military application without receipt by customer's representatives.

Motovilikha Plants have possibility to render die forging from give and take raw materials as well as from stainless and refractory steels.

## CONSUMING OF CLOSED DIE FORGINGS

|   |   |                    |
|---|---|--------------------|
| OIL-AND-GAS AND<br>PETROCHEMICAL<br>ENGINEERING         | MILITARY-INDUSTRIAL<br>COMPLEX AND AVIATION | POWER ENGINEERING  |
| <b>DIE-FORGINGS</b>                                     |   |                    |
| TRACTOR CONSTRUCTION<br>AND AGRICULTURAL<br>ENGINEERING | GENERAL ENGINEERING                         | MINING ENGINEERING |

## NOMENCLATURE OF CLOSED DIE FORGINGS

| Die-forging type   | Dimensions [mm]                               | Weight [kg]  |
|--|---|--|
| Die-forged flange-blanks made as per GOST 12821-80, 12820-80 | Maximum diameter: 460;<br>Maximum height: 590 | 0,15-90 kg on die hammers<br>5-300 kg on hydraulic hammers |
| Components of shut-off valves                                |   |  |
| Stepped shafts   |   |  |
| Gears  |   |  |
| Pinions  |   |  |
| Discs  |   |  |
| Rings  |   |  |
| Sprockets  |   |  |
| Bushings, track links  |   |  |
| Fastening-blanks made as per GOST 7798, 7796, 5915           |   |  |
| Hoist hooks  |   |  |
| Other components   |   |  |

## NOMENCLATURE OF STEEL GRADES

| Steels                          | Grades   |
|---------------------------------|--|
| Constructional carbon           | CK15, CK22, CK25, CK30, CK35, CK40, CK45, CK50, CK55, CK60, CK67 and others  |
| Constructional low-alloy        | S355J2, 42CrMo4, 25CrMo4, 34CrNiMo6, 36CrNiMo4, 51CrV4, 16MnCr5, 18CrNiMo5, 18CrMo4, 39NiCrMo3, AISI 4140, AISI4145, AISI4340 and others |
| Constructional alloy            |  |
| Corrosion-resistant (stainless) | X20Cr13, X30Cr13, X22CrNi17, X10CrNiTi18-9, X12CrNiTi18-9 and others   |



Types of finished closed die forgings



A long products is a workpiece which is manufactured in a rolling mill by hot rolling.

- Cross-section types: round, square, strip.
- Wide Nomenclature of steel grades, including stainless ones.
- Wide range of long products sizes.
- Bars can be shipped in small batches.
- Bars can be manufactured from give and take raw materials (rerolled products).



## ROUND BARS

|                               | Rolling mill 350   | Rolling mill 710  |
|-------------------------------|--|---|
| Diameter [mm]                 | 19, 20, 21, 22, 24, 25, 26, 28, 30, 32, 35, 36, 40, 42, 45, 48, 50, 52, 55, 56, 60, 65, 70, 75, 80 | 105, 110, 115, 120, 125, 130, 140, 150, 160, 170, 180, 190, 200 |
| Length [mm]                   | 3 000 – 6 000  | 2 000 – 5 000   |
| Specifications for dimensions | GOST 2590  | GOST 2590   |

Long products can be additionally machined before shipment.

## SQUARE BARS

|                               | Rolling mill 350   | Rolling mill 710  |
|-------------------------------|--|---|
| Dimensions [mm]               | 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 60, 65, 70, 75, 80, 85, 90 | 100, 105, 110, 115, 120, 125, 130, 140, 150, 180, 200, 210, 220 |
| Length [mm]                   | 3 000 – 4 000  | 2 000 – 4 000   |
| Specifications for dimensions | GOST 2591<br>Technical specifications TU 14-1-4492   | Technical specifications TU 14-1-4492                           |



Rolling on a heavy section mill 710



## NOMENCLATURE OF STEEL GRADES

| Standard         | Grade  |
|------------------|--|
| DIN 17100        | St 37-2  |
| DIN 17100        | CK15, CK22, CK25, CK30, CK35, CK40, CK45, CK50, CK55, CK60                         |
| DIN 17200, 17210 | 37Cr4, 25CrMo4, 14NiCr10, 40NiCr6, 34CrNiMo6, 34CrMo4, 41CrMo4, 19CrNi8 and others |
| DIN 17350        | 55CrNiMoV5, 55NiCrMoV6, 105WCr6  |
| DIN 17145        | 13Mn6  |
| DIN 17350        | 66Mn4, 60MnSiCr4   |
| DIN 17440        | X20Cr13, X30Cr13, X22CrNi17, X10CrNiTi18-9, X12CrNiTi18-9 and others               |





Nanostructured workpieces of multifunctional alloys with special properties.

- Guaranteed provision of hardly compatible mechanical, physical and chemical features in one material.
- Minimum ordered lot weight is 10 kg.
- The Works execute custom orders ensuring required geometry and specified chemical composition of products.



## INDUSTRIES CONSUMING PRECISION ALLOYS

|                         |                        |
|-------------------------|------------------------|
| ELECTRONIC ENGINEERING  | INSTRUMENT ENGINEERING |
| <b>PRECISION ALLOYS</b> |                        |
| DEFENSE INDUSTRY        | AEROSPACE INDUSTRY     |

## HIGH-TECH INNOVATIVE MANUFACTURING

### MAIN EQUIPMENT

| Equipment designation                      |
|--|
| Induction vacuum furnace ZG-0,06L          |
| Air forging hammer MK4136.01               |
| Cross-rolling mill SVP-210                 |
| Saw band RT-330                            |
| High-temperature electrical batch furnaces |

## OUTPUT PRODUCTS

| Product designation | Dimensions [mm]   | Alloy types  |
|---------------------|---|--|
| Bar                 | Diameter: 6 – 20<br>Maximum length: 3 000                           | High-tensile invar alloys ( $\sigma_{\text{ts}}$ – up to 1 100 – 1 300 MPa, $\text{CLTE} \leq 3 \times 10^{-6} \text{ K}^{-1}$ )<br>Invar alloys with $\text{CLTE} \leq 1 \times 10^{-6} \text{ K}^{-1}$ |
| Forging             | Diameter: 20 – 50<br>Maximum length: 1 000<br>Maximum weight: 30 kg | Alloys with tailored CLTE: 36H, 29HK, and other<br>Soft magnetic alloys: 81HMA, 79HM, 50H, and other<br>Hard magnetic alloys: ЮНДКТ5АА, ЮНДКБА, ЮНДЧ, and other  |
| Ingot               | Diameter: 100 – 163<br>Maximum length: 330<br>Maximum weight: 40 kg | Alloys with tailored elastic behavior: 36HXTIO, and other<br>Alloys with high electrical resistance: X20H80, X15H60, and other   |

## BASIC COMPETITIVE ADVANTAGES OF OUTPUT PRODUCTS

(illustrated through an example of high-tensile invar alloy)

| Competitive advantages                                 | High-tensile multifunctional alloy under development  | Closest analogue – 36H alloy (USA)  |
|--|---|---|
| High tensile strength with minimum CLTE                | +<br>$\sigma_{\text{ts}} = 1\,100 \text{ N/mm}^2$<br>$\text{CLTE}_{20-100} = 2 \times 10^{-6} \text{ K}^{-1}$ | $\sigma_{\text{ts}} = 460 \text{ N/mm}^2$<br>$\text{CLTE}_{20-100} = 2 \times 10^{-6} \text{ K}^{-1}$ |
| Wide operating temperature range                       | +<br>(from $-50$ to $+230 \text{ }^{\circ}\text{C}$ )   | -   |
| Corrosion resistance at increased humidity and sea fog | +   | -   |
| Good casting and process characteristics               | +   | +   |

The project Precision Alloys Work was implemented within the frames of trilateral collaboration between Motovilikha Plants PAO, Federal State Budgetary Educational Institution of Higher Professional Education Nosov Magnitogorsk State Technical University, and Ministry of Education and Science of the Russian Federation.

## THE MOST IMPORTANT SCIENTIFIC, RESEARCH, AND TECHNOLOGICAL OUTCOMES OF THE PROJECT

- Mastering the innovative industrial technology for manufacture of nanostructured workpieces of multifunctional alloys with special properties.
- Creation of an up-to-date shop for manufacturing advanced and high-tech products.
- Patents for methods of nanostructuring long-length workpieces with round and square cross-sections that are implemented in continuous flow processes of metallurgical production.
- Know-how existing in the form of process schedules to treat workpieces using different physical processes.



Semifinished products are metallurgical workpieces (blooms, slabs, ingots) produced by steel pouring.


- Over 200 steel grades including stainless and heat-resistant ones.
- Electroslag remelting yields unique properties.
- Wide range of ingot sizes.
- Three sizes of continuous cast workpieces.
- Forged bloom 450x540 is an analogue of ingot.
- Bloom 270x370 is an alternative of ingot with high utilization.



## BLOOMS

|   |                               |                           |
|---|-------------------------------|---------------------------|
|  | Dimensions [mm]               | 270x370, 380x380, 450x540 |
|   | Length [mm]                   | maximum 5 500 mm          |
|   | Specifications for dimensions | RG 232-2005TU             |

## FORGING INGOTS

|   |                               |  |
|---|-------------------------------|--|
|  | Ingot weight [t]              | 4,9; 6,0; 7,3; 9,3; 11,5; 16,0; 17,8     |
|   | Height of ingot body [mm]     | 1 588 – 2 260                            |
|   | Height of ingot hot top [mm]  | 245 – 500                                |
|   | Diameter D [mm]               | 708 – 1 120                              |
|   | Diameter d [mm]               | 564 – 950                                |
|   | Specifications for dimensions | Specifications TU 0883-229-53504410-2004 |

Bottom pouring method is used to cast ingots

## ELECTROFLUX INGOTS

|   |                               |                 |
|---|-------------------------------|-----------------|
|  | Ingot weight [t]              | 0,8 – 9,8       |
|   | Height of ingot body [mm]     | 840 – 2 920     |
|   | Diameter D [mm]               | 410 – 930       |
|   | Diameter d [mm]               | 356 – 902       |
|   | Specifications for dimensions | TU Z RG 72-2006 |

## SLABS

|   |                |               |
|---|----------------|---------------|
|  | Thickness [mm] | 170; 175      |
|   | Width [mm]     | 630; 1 020    |
|   | Length [mm]    | maximum 5 200 |

Semi-finished products can be manufactured in other dimensions.

## NOMENCLATURE OF STEEL GRADES

| Steels   | Steel grades as per foreign standards  |
|--|--|
| Constructional carbon                          | C15, C45, C60, 080M40, 070M20, AISI 1018, AISI 1045 and others   |
| Constructional low-alloy                       | S355J2 and others  |
| Constructional alloy                           | 42CrMo4, 25CrMo4, 34CrNiMo6, 36CrNiMo4, 51CrV4, 16MnCr5, 18CrNiMo7-6, 18CrMo4, 39NiCrMo3, AISI 4140, AISI4145, AISI4340 and others |
| Tool   | 1.2379, 1.2343, 1.2344, 1.2714 and others  |
| Corrosion-resistant (stainless)                | X20Cr13, X30Cr13, X22CrNi17, X10CrNiTi18-9, X12CrNiTi18-9 and others   |
| Heat-resistant and refractory (forging ingots) | ЭП 609-Ш, ЭП 961-Ш, ЭП 517-Ш and others  |

Slabs and blooms are designed for further rolling in section mills or treatment by press forging equipment. Slabs shall be further rolled into plates and sheets.



Bloom



Slabs



Ingot



A steel casting is a workpiece that manufactured by steel casting into a mold.

- Closed cycle manufacture.
- Products can be shipped in small batches.
- In-house patternmaking.
- Manufacturing castings of stainless and refractory steel grades.



## NOMENCLATURE OF STEEL CASTINGS

| Product designation      | Products   |
|--------------------------|--|
| Dredge spare parts       | Dippers, deflectors, half-bushing, lower scoop drums, upper scoop drums assembled, and other |
| Christmas tree bodies    | Casing heads, T-pieces, and other  |
| Tower crane spare parts  | Lifting eyes, cages, wedges, and other   |
| Spare parts, consumables | Grinding sector sets for grinding mills, linings, pallets, crusher plates, and other         |
| Other products           | Rails for hydraulic structures, gear bodies and covers, and other                            |

## STEEL CASTING DESCRIPTION

| Designation        | Large casting  | Precision casting  |
|--------------------|--|--|
| Casting types      | Sand casting of cold hardening mixtures and quick-hardening mixtures | Sand casting of cold hardening mixtures and quick-hardening mixtures, investment casting |
| Steel grades       | 1.0416, 1.0552, 34CrNiMo6, X120Mn12 and others                       | 1.0443, S355JRC, 1.4312, G-X40CrNiSi22-9   |
| Casting groups     | I-III GOST 977-88  |  |
| Casting accuracy   | 12-13 GOST R 53464-2009  | Investment casting: 9-10, cold hardening mixtures: 11-13                                 |
| Maximum dimensions | 2 000 mm in diameter   | Investment casting: maximum 460x460; cold hardening mixtures: 800x400                    |
| Casting weight     | Maximum 3 500 kg   | Investment casting: maximum 20 kg; cold hardening mixtures: maximum 50 kg                |

## NOMENCLATURE OF OUTPUT PRODUCTS

| Product designation                       | Products  |
|---|---|
| Machined forgings                         | As per customer's drawings  |
| Metallurgical tools and tooling           | Continuous-casting machine rollers, chill molds, mandrels, die-tooling, and other   |
| Long mandrels for pipe mills              | Shank ends, working parts, piercers   |
| Products for mining engineering           | Spare parts and consumables for walking and mining excavators, for crashing and milling equipment, rollers for roller-type ring, wrench spanners, and other   |
| Products for power engineering            | Rotor shafts, stepped shafts, rails for hydraulic constructions, pipe tees, body parts of stainless and refractory steels for gas compressor units  |
| Products for nuclear engineering          | Plugs for high-power pressure-tube reactors, leak-tight nuclear doors, pipe tees, blanks of shafts and bodies made as per customer's drawings, and other  |
| Products for hoisting engineering         | Hydraulic power cylinders with maximum rod stroke of 9 000 mm, including cylinders for aerospace equipment, hydraulic cylinder rods and barrels, and other  |
| Own-produced industrial gases             | Oxygen, nitrogen, argon   |
| Customized equipment and metal structures | As per customer's drawings  |
| Mechanical rubber products                | Rings, bushings, sleeves, and other   |
| Machining services                        | Lathe machining, turning-and-boring machining, planning and milling machining, boring (including rotational details), deep drilling, honing, tooth machining, grinding wheel machining, sawing jobs |
|   | Against the customer's drawings   |
| Blank production services                 | Laser and plasma cutting, chopping, bending, roll forging, welding, welding repair, shot-blast cleaning   |
| Heat treatment services                   | Annealing, hardening and tempering, high-frequency current hardening, thyristor frequency converter hardening, carbonization, nitrogen hardening  |
| Painting services                         | Chrome-plating, nickel-plating, phosphate treatment, and other  |



Machined workpieces



Dredge drum, ring for gas compressor units



## INSPECTION METHODS

X-ray (for welding and casting)



Ultrasonic inspection (as per manufactures procedure, GOSTs and specifications)

Magnetic particle inspection

Fluorescent-penetrant inspection

Other types of inspection stipulated by research and engineering documentation for metal products

## CERTIFICATES AND LICENSES

|   |   |   |
|---|---|---|
|  <p>Register of quality systems</p> <p>Certificate of quality management system conformity to GOST ISO 9001-2011 (ISO 9001:2008)</p>   |  <p>Voluntary Certification System Military Register</p> <p>Certificate of quality management system conformity to GOST ISO 9001-2011 and national military standard GOST RV-0015-002-2012</p> |  <p>Federal Service for Environmental, Technological and Nuclear Supervision</p> <p>License for the right to manufacture equipment for nuclear facilities</p>  |
|  <p>Interstate Aviation Committee</p> <p>Certificate for manufacture of aviation materials</p>                                       |  <p>Register of Certification on the Federal Railway Transport (FBO "RC FRT")</p> <p>Certificates of conformity for rough railway car and locomotive axles</p>                               |  <p>Russian Registry of Shipping</p> <p>Certificate of recognition of manufacturing workpieces for shipbuilding</p>  |
|  <p>GSI SLV</p> <p>Certificate of International Welding Society GSI SLV proving qualification of a steel structures manufacturer</p> |  <p>American Bureau of Shipping</p> <p>Certificate of American Bureau of Shipping for manufacture of forgings and ingots</p>   |  <p>Lloyd's Register</p> <p>Certificate of approval of forgings for shipbuilding</p> <p>Det Norske Veritas</p> <p>Certificate of approval of manufacturing steel forgings, including allow steel forgings, for shipbuilding</p> |

### PJSC «Motovilikha plants»

35, 1905 Goda street, Perm, 614014  
 Tel. +7 (342) 260-73-01, 260-75-92  
[market@mz.perm.ru](mailto:market@mz.perm.ru), [www.mz.perm.ru](http://www.mz.perm.ru)

### Export Department

Tel. +7 (342) 260-70-57  
[export\\_office@mz.perm.ru](mailto:export_office@mz.perm.ru)

35, 1905 Goda street, Perm, 614014  
 Tel. +7 (342) 260-73-01, 260-75-92  
[market@mz.perm.ru](mailto:market@mz.perm.ru), [www.mz.perm.ru](http://www.mz.perm.ru)





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