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The First Main Line in Russia

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ABSTRACT

The article is dedicated to the 170th anniversary of the first Russian railway main line St. Petersburg–Moscow. The country's railway transport, as the main type of transportation, has a rich history and remarkable patriotic, labour, scientific, and technical traditions. We must remember them. The emergence of railways in Russia, as in other countries of the world, was accompanied by many problems that needed to be solved: financing methods, types of ownership, track gauge, types of traction and signalling, traffic management and control, competition with other modes of transport, etc. The stage of emergence of railways in Russia is very instructive. What extreme points of view were expressed, and how long did it take to start building main lines? After the society realised the need for construction of railways, it became obvious that the costs required are not affordable neither for the state, nor for creditors, nor for private entrepreneurs.

To better understand how construction of the first railway in Russia was conducted, the article offers many illustrations.

Keywords: main line, formation and construction, survey and design, construction sites, bridges, stations, signalling, steam locomotives, coaches.

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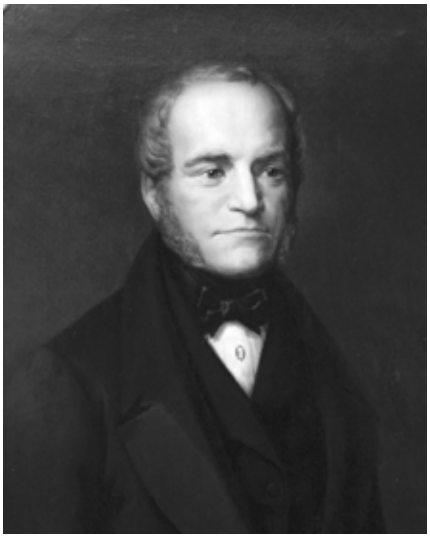
The text of the article originally written in Russian is published in the first part of the issue.
Текст статьи на русском языке публикуется в первой части данного выпуска.

On July 8, 1826, the Ministry of Railways discussed for the first time a number of proposals for construction of railways in Russia and rejected them, noting that such roads are economically unprofitable, and that they are difficult to be maintained in our climate, especially in winter. And in the future, there were many opponents of railways in Russia comprising the Chief manager of transportation routes K. F. Tol, the Minister of state property Count Kiselyov, the Minister of finance E. F. Kankrin, the Minister for war Count Chernyshev, the Minister of the imperial court Prince Volkonsky, the Chairman of the State Council prince Vasilchikov, the Minister of the interior L. A. Perovsky, the head of the Commission of projects and estimates of the Department of transportation routes M. G. Destrem and a number of other government officials.

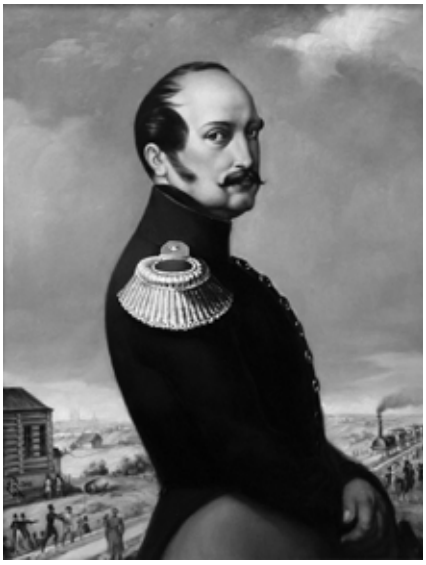
The arguments of opponents of construction of railways were expressed by Minister of finance E. F. Kankrin: «*Not only should the idea of covering Russia with a whole network of railways be considered as exceeding any real possibility, but a sole construction of a railway from St. Petersburg to Kazan should be recognised as several centuries premature. The government can draw its subjects into the greatest losses. Steam traction can in no case be allowed on railways, because due to the lack of coal in Russia, it will entail destruction of forests. For transportation of troops, railways are also unsatisfactory, since they should have a huge number of carts (cars) for this item, which are not needed at all in ordinary times. Duty-free import of cast iron and rails will entail the exit from the state of capital and, finally, alienation of land for the roadbed and various buildings will require enormous costs*». There were especially many critics among the owners of canals and stagecoaches, who were afraid of losing their monopoly on transportation of goods and passengers.

While such discussions were going on, in England and the United States, massive construction of railways began. And yet, in Russia there were many people who believed that it was in a country with vast areas that railways were needed, since they were a reliable means of communication that allowed to regularly move large masses of goods with minimal expenditure of manpower and resources.

In August 1834, following the invitation of the Mining department, a famous Austrian engineer, professor at the Vienna Polytechnic Institute Franz Anton Gerstner came to St. Petersburg to organise construction of railways in Russia (Pic. 1). In September Gerstner left St. Petersburg via Moscow and Kazan for the Urals to get acquainted with the real conditions and possibilities of railway construction.



Pic. 1. Franz Anton Gerstner.



Pic. 2. Emperor Nicholas I.

Upon his return to St. Petersburg, he submitted to Emperor Nicholas I (Pic. 2) a detailed note in which he outlined his views on construction of railways. He noted that «*... there is no country in the world where railways would be more profitable and even necessary than in Russia since they make it possible to shorten long distances by increasing speed of movement*».

Pic. 3. Nicholas I discusses railway projects.

Gerstner proposed to build a road between St. Petersburg and Moscow, then to connect Moscow with the main waterway of the country – the Volga with the line Moscow–Kazan or Moscow–Nizhny Novgorod (Pic. 3). Then he intended to connect the line between St. Petersburg and Kazan with Odessa or Taganrog, pointing out that with assistance of the shipping company along the Volga and the Caspian Sea, the Asian trade of Russia would be ensured, and the competition of England would be eliminated. But for a start, he considered it expedient to build some kind of small line in order to dispel doubts about the possibility of operating the railways in winter conditions. Only then, relying on the experience gained, he did plan to start building a main line from St. Petersburg to Moscow.

Somewhat later, this proposal included only construction of St. Petersburg–Moscow line, and then it all came down to construction of an experimental St. Petersburg–Pavlovsk railway on an equity basis (Pic. 4).

On March 9, 1835, Gerstner submitted a petition «*for permission to establish a company with a capital of 3 million roubles for construction of a railway from St. Petersburg to Tsarskoe Selo, Pavlovsk and Kolpino in the form of the first experience in construction of this kind of track, to prove usefulness of the railway for the public, shareholders and the state with this construction*».

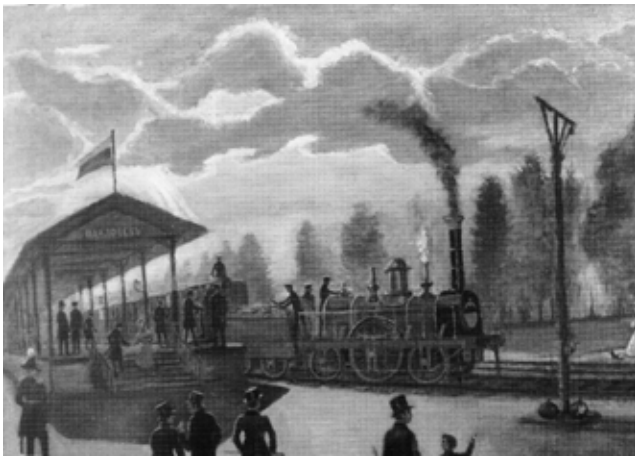
On June 8 or 19, 1835, Emperor Nicholas I wrote a resolution with his own hand on Gerstner's note. There is no date on the resolution, but it might become the date of founding of railways in Russia. The content of the resolution is literally the following: «*I read it with great attention and was convinced, as before, in favour of this cause: but I am not convinced that Gerstner would find enough capital to start such a huge enterprise. On this subject I wish written explanations from him; then, if necessary, I will call him to myself. I will allow the road to Tsarskoe Selo, if he will present plans to me*».

Thus, despite all doubts on the part of the government officials closest to the Emperor about the expediency of railways, their fate was decided by the will and conviction of usefulness and necessity for the country by Emperor Nicholas I. The Tsarskoye Selo railway was built in 1837. The experience of the Tsarskoye Selo railway showed that in the harsh climatic conditions of Russia, railways can operate steadily and generate income for their owners.

The next issue was construction of new lines in Russia. All proposals from both domestic and foreign entrepreneurs and financiers were based on the joint-stock form of ownership. For construction of a railway between St. Petersburg and Moscow, many different proposals and applications were received, but they were all rejected.

The most solid proposal with the assistance of P. P. Melnikov and Count A. A. Bobrinsky, who was very close to the sovereign, came from German bankers Dufour and Harkart. They were famous for being the first bankers of the sprawling commercial city of Leipzig and establishing Dresden railway, one of the best in Europe in technical terms, and bringing in a good income.

The proposal was as follows (as described by P. P. Melnikov): St. Petersburg–Moscow railway is being built by the joint-stock company being formed. The calculations assumed transportation



Pic. 4. Tsarskoye Selo railway.

of 200000 passengers and 24 million poods of cargo per year.

«*From the environment of a company consisting of foreign, mainly German capitalists and based in Leipzig, the Board of Directors is formed, which is located in St. Petersburg. The Government Commission will oversee the actions of the chief director, and the government can be the closest participant in the case, leaving behind a part of the shares. The main advantage that bankers ask for is the government's guarantee for a 4 % income on shares, which guarantee will not lead to any additional payment from the treasury, if the income of the road is more than 4 %, and meanwhile, an important and useful business will be performed without a donation from the state and an unforgettable monument to the present reign will be erected*». In the future, such a guarantee of the government for the receipt by shareholders of a certain income has found widespread use.

This proposal and the justifications attached to it were received by Nicholas I, who ordered formation of a special committee to study them and develop proposals.

Throughout 1841, there was a fierce struggle between the supporters of construction of St. Petersburg–Moscow railway and its opponents. The final decision was made on January 13, 1842, at a special meeting in the presence of the Emperor.

Concluding the debate of the meeting, the Tsar said that he had come to a conclusion about the usefulness of St. Petersburg–Moscow railway in terms of its influence on industry and trade, and that the road should be arranged with government funds and remain within its hands. At the beginning of 1842, a corresponding decree was issued. This is how the first state (state-owned) railway in Russia was born.

Since all the ministers were against the construction of St. Petersburg–Moscow railway, Nicholas I (Pic. 2) established a Special Committee to carry out this enterprise and appointed the heir to the throne, Tsarevich Alexander Nikolaevich, the future Emperor Alexander II, as chairman.

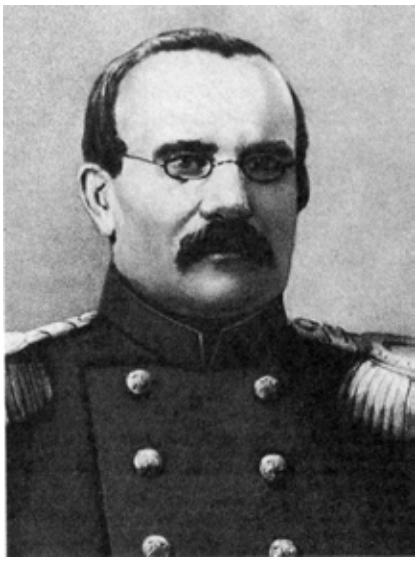
Already on January 29, 1842, the first meeting of this committee was held under the chairmanship of the heir to the crown. At this meeting, a draft Decree of Nicholas I was prepared for the Governing Senate, a Construction Commission was formed, and the Minister of finance was instructed to allocate funds necessary for construction of a railway between the capitals.

On January 30, 1842, the Construction Commission under the chairmanship of Count Benckendorff began its work; it was entrusted to carry out surveys and draw up an estimate for Colonels P. P. Melnikov (Pic. 5) and N. O. Kraft (Pic. 6). The decision of the Committee was approved on February 1, 1842, by Nicholas I.

On August 11, 1842, after the appointment of Count P. A. Kleinmichel as Chief Governor (Pic. 7), changes were made in the higher bodies in charge of the railways.

By the decree of Nicholas I to the Governing Senate of August 11, 1842, the Construction Commission was abolished, and the Department of Railways was established, whose duties included management of all railways. Under it, a temporary technical commission was formed during construction of St. Petersburg–Moscow railway.

Pic. 5. Engineer Lieutenant General P. P. Melnikov.



Pic. 6. Engineer Major General N. O. Kraft.

Pic. 7. Count P. A. Kleinmichel.

Pic. 8. Monument to Nicholas I in St. Petersburg.

When designing the railway, there were two proposals, one – to lead the road directly to Moscow, the other – with a call to Novgorod. Nicholas I (Pic. 8) imposed the following resolution: «*To arrange the road in a direct direction, because I do not find any good reason to lead it to Novgorod, which will not lose the benefits that it uses*».

The projected line was divided into two construction sections: St. Petersburg–Bologoye (Northern Directorate), headed by P. P. Melnikov, and Bologoe – Moscow (Southern Directorate), headed by N. O. Kraft (Pic. 9).

To carry out exploration work, seven special parties were formed, staffed by graduates and students at the Institute of the Corps of Railway Engineers, which were headed by N. I. Lipin (Pic. 10), I. G. Verigo, P. P. Zuev, V. I. Kirchner, A. I. Shtukenberg (Pic. 11) and others. In one of the groups a railway engineer D. I. Zhuravsky (Pic. 12) worked, who later became the country's largest scientist in the field of bridge construction.

The main field work was completed in the spring of 1843. The total length of the explored variants of the route was 6000 km, or about 10 km per 1 km of track.

There was no experience in design and construction of railways in the 1840s. Therefore, in 1842, Major of the American service J. Whistler was invited to consult on construction of the St. Petersburg–Moscow road (Pic. 13). His advice was highly professional and very helpful

Pic. 9. Scheme of St. Petersburg–Moscow railway.

Pic. 10. N. I. Lipin.

Pic. 11. A. I. Shtukenberg.

Pic. 12. D. I. Zhuravsky.

to the builders. In 1847 he was awarded the Order of St. Anne, II degree.

P. P. Melnikov was responsible for development of technical conditions and standards for design and construction of St. Petersburg–Moscow main line. He suggested a 5 ft (1524 mm) track, which is 89 mm wider than Stephenson's. The choice of a track wider than 4 feet 8.5 inches provided a more convenient placement of the locomotive mechanism, an increase in the volume of the boiler, the weight of the cargo in cars, and better stability of rolling stock. The gauge proposed by P. P. Melnikov was adopted throughout the Russian railway network.

P. P. Melnikov invented and introduced many technical and railway terms that are still used today. For example, stations of I, II, III and IV classes, which were located on the main line, respectively, at a distance of about 160, 80, 40 and 20 km.

The issues of organising construction of railways in the 1840s presented significant difficulties due to the lack of experience in design and construction of such large lines as St. Petersburg–Moscow railway. The more respect is given to the optimal solutions found by the pioneers.

The construction of the road began in the summer of 1843. To bring the administrations as close as possible to the objects under construction, the Northern Administration was located at Chudovo station (111 versts from St. Petersburg) (Pic. 14), the Southern – first in Vyshny Volochek

Pic. 13. J. Whistler (1800–1849).

(an important centre of the systems of channels connecting the Volga with the Neva) (Pic. 15), and then in Tver (it was supposed to tranship cargo from the Volga River) (Pic. 16).

On St. Petersburg–Moscow railway, pointless switches with double movable rails were used. They were much more stable in the horizontal plane and provided a smoother entrance to the branch compared to switches with single movable rail. However, the presence of a rupture in the track at the beginning of the turnout could lead to derailment of rolling stock going in trailing direction. Soon, switches appeared with two movable straight blades from ordinary rails, which were the prototype of modern switches.

Wooden beams were used as an under-switch base. They had required elasticity, significant strength, were simple in shape, easy to operate and manufacture.

The organisational and technological construction plan provided for:

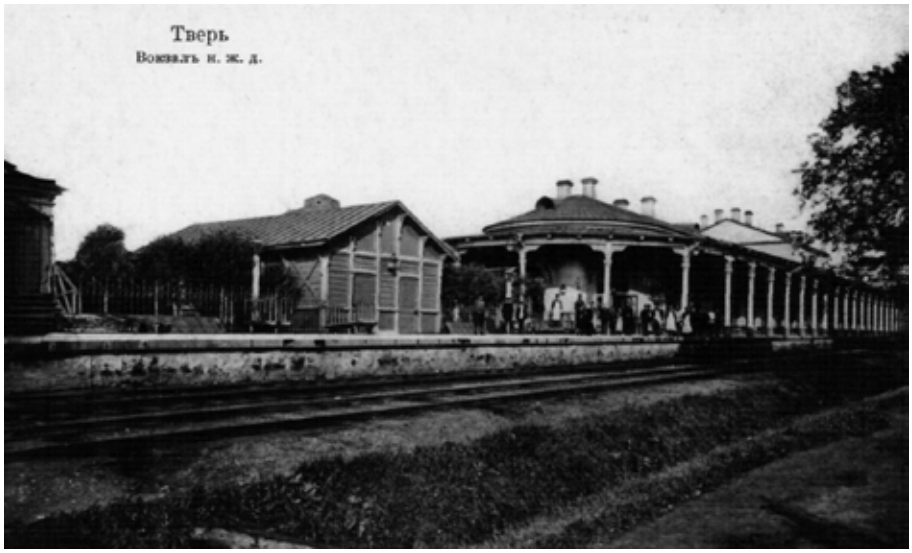
- Selection of support bases in the zones of adjoining the route to the waterways of communication, along which the supply of materials and equipment was carried out.
- Multi-beam method of construction work, when they are carried out from one point in several directions at the same time.
- Stage-by-stage commissioning of road sections, which speeds up and reduces the cost of construction.

The acceleration of construction was facilitated by introduction of elements of mechanisation of work. For example, during development of a huge excavation between Valdai and Berezaika stations, earth-moving machines similar in design to excavators were used. When driving the piles of the bridge crossings, steam piles were used. For transportation of soil, specially designed earth-carrying cars and a track for them were used.

Difficult problems arose during construction of 19 overpasses, 69 pipes and 184 bridges, including across large rivers as the Volga, Volkhov, Tvertsa, Msta. D. I. Zhuravsky supervised the design of bridges. One of the features of bridge crossings was the significant height of supports, which made it necessary to use large spans instead of small ones to avoid the rise in construction costs. In addition, the

Pic. 14. Railway bridge at Chudovo station.

Pic. 15. Vyshny Volochek.

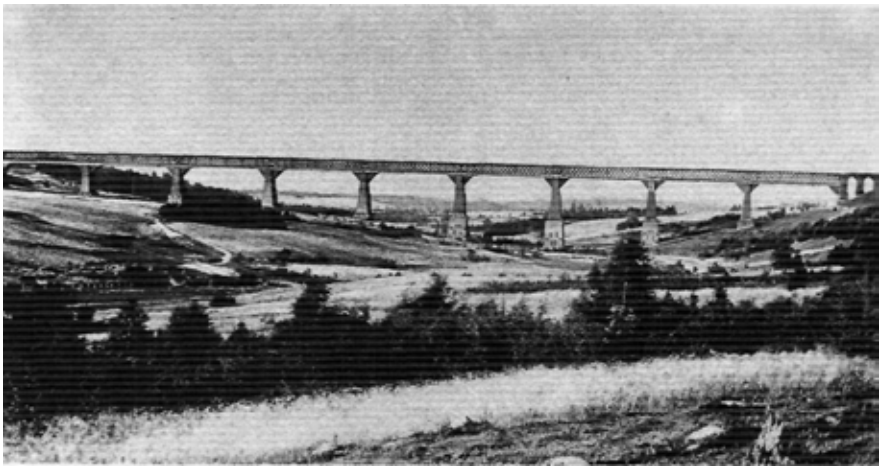


Pic. 16. Tver Station.

frequently placed supports at small spans impeded navigation and made it difficult for ice to pass through.

D. I. Zhuravsky refused to blindly copy large-span structures of wooden bridges known at that time. Rightly believing that the arch system at high bridges heights would require construction of massive and expensive supports, he turned his attention to lighter beam spans with wooden trusses, proposed by the American engineer W. Howe. However, there was no theory for calculating such structures, which raised serious doubts about correctness of the approach to assigning dimensions of the sections of individual elements.

In 1845, D. I. Zhuravsky created a theory for calculating lattice trusses, giving a method for determining the forces in individual elements. In particular, he found that the cross-sections of vertical metal strands were assigned in the Howe trusses unreasonably: the strands at the supports are heavier loaded and should be more powerful. For design reasons, a constant cross-section of the truss chords was provided along the entire length, while in single-span structures, the chord cross-section could



Pic. 17. Verebyinsky viaduct.

be fully used only in the middle of the span. For bridges of large spans, the scientist proposed a continuous beam system that ensures the rational use of the belt material.

Based on the research, D. I. Zhuravsky gave recommendations on the calculation of the Howe trusses and developed projects for wooden bridges across all major watercourses on St. Petersburg–Moscow railway line. Five groups of span structures with lengths from 16,4 to 60,8 m were developed. The design of structures was accompanied by comprehensive studies of their work under load and the properties of the building materials used.

The span structures of all bridges had wooden multi-lattice continuous trusses formed by the superposition of several simple triangular lattices on top of each other, which significantly improved the work of compressed elements.

The Verebyinsky viaduct became a unique bridge crossing (Pic. 17). According to contemporaries, this viaduct was considered one of the best structures of this type, not only in Russia, but in Europe and America.

The Msta bridge had nine spans of 61 m each. Its supports were pyramidal wooden tower structures on a stone foundation, sheathed with iron.

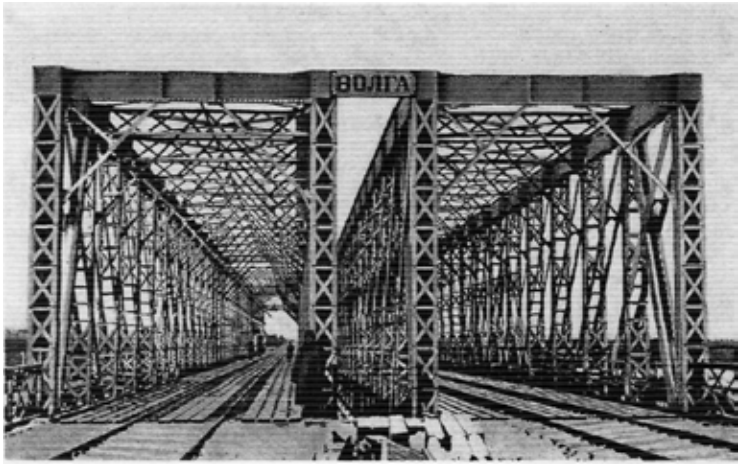
A feature of the bridge over the Volkhov, which had five spans of 51 m each, was a ten-meter adjustable navigable span of the opening system. The author of the project, engineer V. I. Grave, to ensure the balance of the system at any opening angle, proposed a counterweight to the original design.

The bridges across the Volga (Pic. 18) and Tvertsa each had three spans 59,6 m long. The bridges across the Obvodny Canal and the river Slavyanka were significantly different from the others. The stretched belts of the Howe trusses used in the span structures of these bridges were metal (iron).

The Aleksandrovsky Mechanical Plant of St. Petersburg–Moscow Railway became the firstborn of railway engineering. Passenger locomotives of 2-2-0 type produced by the plant were later designated «B». An internal eccentric steam distribution mechanism set in motion double (expansion) spools, which made it possible to reverse the machine and change the degree of filling the cylinders with steam. In a tubular boiler, a cone draft was used, which made it possible to regulate the process of fuel combustion, depending on intensity of operation of the steam engine. The pressure in the boiler increased up to 8 atm, the power of the steam locomotive – up to 130 hp. It drove trains of six cars at a speed of 40 km/h. In addition, steam locomotives of 1-2-0 and 1-2-1 types were built.

Commercial steam locomotives of 0-3-0 type produced by the Aleksandrovsky plant (Pic. 19), which received the designation «D», were similar in many design solutions to passenger locomotives. They had a power of about 140 hp and drove 22-coach trains at a speed of 15 km/h.

The first domestic freight wagons (Pic. 20) appeared on St. Petersburg–Moscow railway. They began to be built at Alexandrovsky plant in 1846. The cars were four-axle, with wooden bodies, a central hitch, without side buffers, and with a hand-operated braking device. The carrying capacity of the covered car with a container of 7,8 tons was 8,2 t. For bulk and long cargo, four-axle platforms with a tare weight of 6 tons and a carrying capacity of 10 tons were



Pic. 18. Entrance to the railway bridge across the Volga.

also built. Their axial load was 4 tons instead of 10 tons, for which the rail track was designed.

In 1845, Academician B. S. Jakobi (Pic. 21) received a task to set up telegraph communication along St. Petersburg–Moscow railway, which was under construction. Before the completion of this project, the German company Siemens, invited to participate in organisation of such a connection, laid a cable line, which consisted of two copper wires, insulated with gutta-percha and placed in a wooden gutter, filled with an insulating mass. The line was laid along the side of the track at the ends of the sleepers. It began to be exploited in 1852 with the use of Siemens telegraphs, and then Morse, since the latter provided more reliable communication.

However, the design of the laid cable turned out to be unreliable, therefore, in 1854, at the suggestion of B. S. Jacobi, it was decided to replace it with an overhead line, which had three steel wires with a diameter of 5 mm, suspended on poles by means of iron hooks with insulators. 16 pillars were installed per verst. In the future, overhead communication lines were also used on all railways under construction.

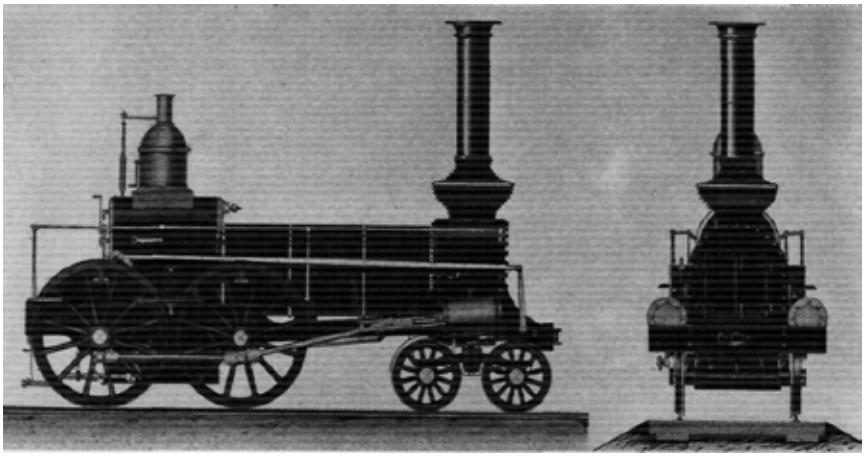
All projects of the buildings of St.Petersburg–Moscow railway are permeated with the ideas of the Tsar's favourite, the architect K. A. Ton (Pic. 22). Ton designed the entire area of 644 km road as a single ensemble in the form of a gigantic square. Nikolaevsky railway station (Pic. 23) was built in 1844–1851 according to the project of Konstantin Ton, with the participation of Rudolf Zhelyazevich. The building combines the forms of the Italian Renaissance and ancient Russian motives. A novelty at the time was a solution with a metal covering over the end sections of railway tracks and adjacent passenger platforms. If the passenger station building itself was designed by Ton in traditional forms and structures, then the landing stage had no analogues in the architecture of the past. The triangular trusses of the apron cover created a completely new image of the transport interior.

The station building is round in plan, located along the length of the entire adjacent square. Konstantin Andreevich used the motives of the town halls of Western European cities, the clock tower indicates the direction of the main entrance. The Emperor himself took an active part in the design of the new station (Znamenskaya) square.

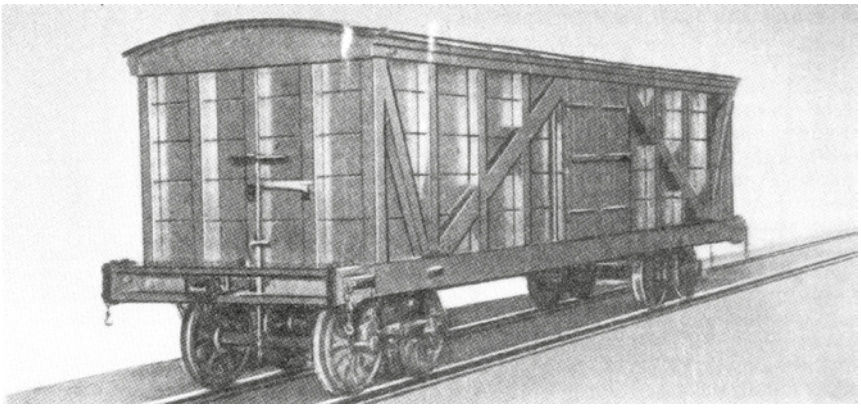
N. I. Miklukha was appointed the first head of the passenger station and the station of St. Petersburg–Moscow railway (Pic. 24). His apartment was located in the very building of the station, in addition, the offices of employees, the railway administration, and the imperial premises were located here.

Leningradsky railway station (until 1855 – Petersburgsky, in 1855–1923 – Nikolaevsky, in 1923–1937 – Oktyabrsky) (Pic. 25) is the oldest of the nine stations in Moscow. The station building was built in 1844–1851 according to the project of Konstantin Ton by the architect Zhelyazevich. For the station, the construction commission chose the Kalanchevsky wasteland on the northeastern outskirts of Moscow.

The construction of Peterburgsky railway station in Moscow began in 1844 under the direction of the managing head of transportation routes, Peter Kleinmichel, who had disagreements with Ton. So, Kleinmichel demanded the use of brickwork with thin seams, which seemed to him

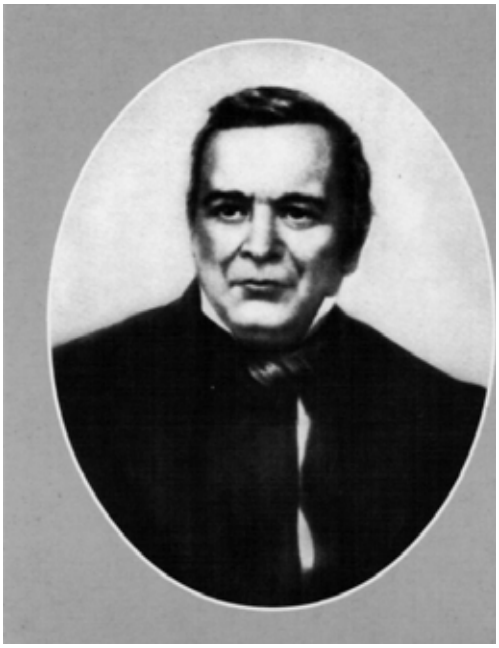


Pic. 19. The first domestic commercial steam locomotive.



Pic. 20. The first covered car of St. Petersburg–Moscow railway.

Pic. 21. B. S. Jacobi.



Pic. 22. Architect K. A. Ton.

Pic. 23. Nikolaevsky railway station in St. Petersburg.

more aesthetic. The architect refused to comply with this instruction, fearing a violation of the solidity of walls and the occurrence of cracks. As a result of conflicts in 1847, the work was entrusted to Rudolf Zhelyazevich, who was more flexible.

The construction was completed in 1851. The building was a stylistic pair of the station in St. Petersburg, but it was smaller in size. The central part of the building was occupied by a spacious two-story lobby. The premises of the station were decorated with oak parquet and marble Swedish stoves. The imperial halls had massive oak doors and mirrored wardrobes. The second floor of the main building of the station was allocated for the apartments of employees.

As the work progressed, the road opened section by section. In 1847, a permanent traffic was opened between St. Petersburg and Kolpino. In 1848 service traffic was carried out to Chudovo station and between Tver and Vyshny Volochk. The opening of the entire road to Moscow took place on November 1, 1851.

Once construction was completed, the initial period of its operation is also of interest. In the absence of sufficient experience in operating railway transport, it was believed that only people accustomed to a clear army order could ensure safety and regularity of movement in the best way.

Therefore, by order of the Main Directorate of Railways and Public Buildings dated September 23, 1851, No. 180, 14 separate military workers, 2 conductor and 1 telegraph companies were formed for operation of the railway. They were recruited by the military department from among the non-commissioned officers and privates of active military service.

Pic. 24. I. N. Miklukha.

Pic. 25. Nikolaevsky railway station in Moscow.

There were 3500 people in the military workers' companies. One of the conductor companies included steam locomotive drivers, their assistants, and firemen.

In total, during construction of St. Petersburg–Moscow main line, about 46 million cubic meters of earthworks were carried out, two large stations were built in both capitals, as well as other 34 stations, and 190 bridges. The construction of this railway cost 67 million roubles (one third of the annual budget of the Russian Empire in 1842). In the middle of 19th century, this railway was the most technically advanced and the longest (644 km) double-track railway in the world.

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