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Professor M. V. Vynokurov: stages of freight wagons creation (1930-1950)

***Abstract**. The urgent task of modern historical science is the comprehensive study of the personalities of prominent scientists and engineers who made a significant contribution to the formation of science and technology. The article is devoted to the analysis of the activity of professor M. V. Vynokurov in the field of the creation of freight wagons. In the history of science and technology. M. V. Vynokurov pointed out that it had been decided to produce new wagons using light-alloy steel, which greatly reduced the weight of the dead load. Such a solution was based on the technical experience of the US wagon industry. Particular attention was paid to the unification of the parts and assemblies subjected to the process of wear and damage to the most, were replaced with the current and periodic repairs of the wagon. This important measure has significantly reduced the cost of manufacturing and was important for the organization of repair because it simplified the ability to replace worn parts with spare ones. M. V. Vynokurov is known as a prominent specialist in the field of rolling stock, he devoted his life to the development of carriages and rolling stock. In preparing this article, chronological, typological, comparative methods of historical knowledge, classification and systematization of historical sources and bibliographic material were used that allowed to systematize and critically evaluate the sources used in relation to the question of the stages of the creation of freight wagons. The role of professor M. V. Vynokurov in this process is shown, covering the 1930-1950 years, the most productive years of a scientist and engineer. It was established that due to the personal contribution of M. V. Vynokurov in the unification of parts for different types of freight wagons, there was a reduction in operating costs of railways. This was achieved due to the massive production of various types of freight wagons. Study of the development of freight wagons through the biography of the scientist-engineer M. V. Vynokurov, which is an integral part of the complex of knowledge, implies the application of a systematic approach as a methodological means of scientific knowledge.*

***Keywords:** railway transport; wagons; M. V. Vynokurov; science and technology; engineer*

Introduction

During the period of the railway transport existence, extensive experience in the field of rolling stock has been accumulated. Mykhailo Vasyliovych Vynokurov is a great example of this professional field (1890-1955) – doctor of technical sciences, professor, general director of draft of II rank, specialist in the field of construction of railway crews, dynamic interaction of rolling stock and track, teacher, organizer, founder and first head of the "Wagons" Department of the Dnipro National University of Rail Transport (DIIT).

Methods of the study

In the preparation of this article, chronological, typological, comparative methods of historical knowledge (Pylypchuk & Strelko, 2017; Pylypchuk & Strelko, 2018; Ustiak, 2018, p. 406), classification and systematization of historical sources and bibliographic material were used that allowed to systematize and critically evaluate the sources used in relation to the stages of the creation of freight wagons.

Results and discussion

In the postwar years, the government set the task for the leaders of the railway industry, to exceed the prewar level of transportation, which accordingly required an increase in the carriage rolling stock. It was supposed to accomplish this task, with the help of increased repair of defective wagons and the manufacture of new rolling stock.

M. V. Vynokurov noticed that the Soviet transport needed such wagons, which would be built on the level of the best models of modern technology and would fully meet the operational requirements of the railways. Therefore, he proposed his vision that the most efficient freight wagons should be those which: were the best used according to their carrying capacity and wagon capacity when transporting the widest range of goods; made it possible to carry out loading and unloading works quickly and conveniently; would have the lowest coefficient of packaging with sufficient strength of the wagon structure.

Analyzing the cargo rolling stock in accordance with his own proposals M. V. Vynokurov noticed that some of them did not quite meet the above requirements. In particular, due to the insufficient storage capacity of the covered 50-ton carriages which carrying load was used only by 77%, it turned out that each wagon loaded on average only 40 tons. Due to insufficient floor area and body carrying capacity, the lifting force of the four axle 50 and 60 ton platforms was used only by 55-65% (Vynokurov & Skyba, 1945. p. 27). So, summing up the above analysis, this led to the need to create new types of wagons, which took into account all these disadvantages and develop more advanced designs. Similar questions were also raised in his article by professor V. Povorozhenko and engineer L. Kohan in the journal "Railway Transport" №7.

In accordance with the requirements of the rolling stock department of the All-Union Research Institute of Railway Transport, it developed technical tasks for the design of new freight wagons – box cars, gondolas and platforms. Also at the same time, the task was to determine the optimal values of the basic parameters of freight wagons, based on the most rational use of their carrying load and carrying capacity (Mokrshytskyi, 1946, p. 121).

For complete highlighting of this problem, it is advisable to give a description of each type of wagon separately.

The box wagon is the most versatile since it is intended for the transportation of goods requiring protection from outside air and other conditions. Such circumstances impose special requirements for choosing the main parameters of the box wagon. The strength of the upper structure of the track on most of the mainline and side lines of the national railways allowed loading on the rail not more than 18-19 tons. Such loading limited the carrying capacity of the wagon in 50 tons. Increasing the carrying capacity above 50 tons is also inappropriate and under the terms of using its lifting force. The increase in the lifting force of the car required a simultaneous significant increase in its carrying capacity for improvement in operation.

The experiments conducted by professor M. V. Vynokurov shown that due to insufficient carrying capacity in the existing 50-ton carriages on average 40 tons were transported. It was assumed a sufficient increase in capacity at dimensions 1-B, 0-B, but only if the length of the wagon exceeded 16 m, which meant reducing the carload to 3-3.5 t/m and elongation of the train. Consequently, the accepted carrying capacity of the wagon is 50 tons.

The total and specific capacity of the main types of covered wagons which operated on the railways of the USSR is given in table 1.

Table 1. *The total and specific capacity of the main types of covered wagons which operated on the railways of the USSR*

Wagon names	**Carrying load, t**	**Storage capacity, m^3**	**Specific capacity, m^3/t**
Riveted structure of 1929	50	89,4	1.79
Welded structure of 1936	50	89.8	1.80
Welded structure according to the unified drawing	50	89.0	1.78
Two-axle of the USSR factories production	20	45.4	2.27

According to the specific volumes in the table, the load capacity of the covered ones, especially the 50-ton carriages, can be used only when transporting loads of more than a bulk weigh, heavyweight. However, in practice, in box wagons, a sufficient quantity of low-volume cargo is transported, which, due to the insufficient body capacity of the wagons, can not fully utilize their lifting capacity. Analysis on the operation of covered wagons showed that their carrying capacity in the transport of various goods was utilized on average only by 77%, that is, 50-ton wagons are practically used as wagons with a carrying capacity of 38-40 tons. The unsatisfactory use of the lifting force of wagons is the result of incomplete or insufficient load capacity of bodies.

Mykhailo Vasyliovych Vynokurov stated that along with the above values and the ever-increasing volume of freight traffic with different weight characteristics indicated the feasibility of replenishing the freight car fleet with high-capacity rail wagons.

Confirmation of this was the practice of American railways, which car fleet was replenished with box wagons of increased carrying capacity at a specified period (the load carrying capacity remained unchanged at 36.3 or 45 tons). Consequently, by 1931 the largest capacity of a covered American railway wagon of general purpose did not exceed 93 m^3. The Association of American Railroads (AAR) wagon by the standard of 1937 had a capacity of 105 m^3. In 1940 wagons of capacity up to 108-110 m^3 appeared, and in 1942 the AAR wagon with a storage capacity of 138 m^3 was accepted as a standard. The specific capacity of wagons increased from 2.05 to 3.04 m^3/t.

Also, M. V. Vynokurov noted that wagons with increased specific capacity are, under other equal conditions, more versatile than with a low specific capacity, since they allow better utilization of the carrying capacity of these wagons when transporting not only heavy-weight but light-weight cargoes (cargoes with a small volume weight). It is quite understandable that it is impossible to increase the specific capacity of new wagons to an arbitrary value, because when choosing the volume of wagons, it is necessary to take into account not only lightweight loads, as this will result in irrational use of the volume of wagons in the transport of goods of large weight and in inexpedient increase in the coefficient of tare carriages.

Investigation of the factors that determined the specific capacity of covered wagons (cargo turnover structure, loaded and empty mileage, range of transport, etc.) indicate the expediency of replenishing the freight car fleet with wagons with a specific capacity up to 2.4 m^3/t. With this specific capacity and carrying capacity of 50 tons, wagons should have a capacity of 110 m^3, which was adopted as a basis for the task designing of the wagon.

The choice of a rational relationship between the linear dimensions of the car (length, width and height) is determined, on the one hand, by the specified capacity of the body, and on the other, by the size of the rolling stock. The most economically feasible is the combination of the main dimensions of the wagon, which ensures the best use of the cross-section of the adopted dimension with the smallest possible length of the wagon. In this case, the length of the train, and accordingly the length of the station tracks, will be the smallest for it.

Wagon width, height, and length were determined by the following considerations. Based on the need to maintain the interchange of equipment for different human needs in transportation, the width of the car was 2750 mm. However, with the full use of the 1-B dimension, the width of the wagon could be increased by

100 mm, but this extension of the wagon led to an increase in its storage capacity by only 3-3.5%. Therefore, the width of the wagon was 2750 mm, and the height at the size 1-B it was 2750 mm and at the size 0-B it was 2400 mm. The internal length of the wagon was 1450 mm.

In addition to the lack of capacity, the operational disadvantage of existing four-wheel covered wagons was a relatively insufficient width of the door holes – 1830 mm. With such a width of the doorway, the use of mechanized vehicles during loading of the goods became more complicated.

The presence of only one relatively narrow doors on each side of the wagon made it difficult, and often made it impossible to load long-size carloads suitable for transportation in covered wagons, which affected the versatility of such cars.

M. V. Vynokurov believed that in order to determine the value for which it would be expedient to increase the width of the doorway in the covered four-wheel carriages, one should proceed from the possibility of the passage of the mechanical carriages into the wagon. For this purpose it was intended to increase the width of the doorway to 2400-2500 mm. In 1942 the standard of the covered wagon adopted by the AAR recommended increasing the width of the doorway of general purpose vehicles to 2134-2439 mm (7 or 8 feet) (Vynokurov, 1949).

An increase of the above-proposed width was inappropriate as it would have led to the reinforcement of the doors, and therefore it would have made it difficult to open and to close them. So, the width of the doorway of the freight wagon was 2450 mm.

Alongside with the choice of the most rational in the technical and economic ratio of the main parameters of the wagon, fully satisfying the operational requirements, there was a need to manufacture structures of new wagons at the level of the engineering machinery achievements of that time.

In the developed technical tasks on the new covered wagon, the frame of the wagon was of welded construction from the rolled section and cast steel; it consisted of the center sill, side, longitudinal and transverse beams, buffer, bolster and intermediate beams. Center sill was made of rolled z-section. The above body center plate of the center sill was reinforced with special cast steel and combined with the draft gear stop of the automatic coupling. The upper center plate was supposed to be eased and was on clinkers. The front draft gear stop of the automatic coupling was combined with cast steels of an automatic-coupler striker. To prevent the wearing of the walls of the center sill by the body frame of the friction gear, it was supposed to install variable lining on the walls of the center sill as wearing out were replaced by new ones. In this regard, the distance between the walls of the center sill increased to 350 mm. Also, the increased size was useful for the further modernization of auto-coupling equipment.

The wagon body was foreseen in two variants: a slanting-wall structure with a metal lattice and a wooden upholstery and a full metal structure with a wooden upholstery inside.

To strengthen the design of the body, the frontal walls are designed all-metal from pressed sheets. Such a wall greatly increased the strength and rigidity of wagons in the transverse direction and would prevent from destruction, as well as it would provide better storage of goods.

The weak element in the construction of an existing covered wagon was the roof. Poor attachment of the roof structure, and insufficient strength of the metal roofing on a meter (10000 weights/axle/km) the roof must be completely renewed on average 3-4.5 years. In fact, it was completely restored in shorter terms.

In newly built wagons, for the purpose of increasing the service life and reducing operating maintenance costs, a whole metal roof of pressed sheets was accepted. Mykhailo Vasyliovych noted that this introduction had almost twice strengthened the roof in comparison with the previous designs.

On the USSR railways there operated *gondola* of two types: 50-ton released in the US and 60-tons domestic gondolas. The latter were predominant in the gondola fleet of freight cars of the country.

The general purpose of the gondola was characterized mainly for the transportation of coal, ore and a number of other industrial goods. These cargoes were transported on the networks of the Ural-Kuzbass, Moscow-Donbass, and the upper structure of the track in these directions, as a rule, allowed loading from the wheelset on rails to 20.5 tons. Such loading allowed the weight of the gondola brutto to be up to 82 tons, and its carrying capacity up to 60 tons.

M. V. Vynokurov noted that ccording to the nature of the cargo transported in gondolas, their most advantageous feature was a large carrying capacity, especially in the universal type gondolas of the USSR. The gondolas produced in the USA had a carrying capacity of 63.5 tons, and domestic had 60 tons (Krason & Niezgoda, 2014).

The carrying capacity of the domestic gondola for the transportation of coal, ore and rolled steel products was also sufficient for the full utilization of its loading capacity, as it is indicated in table 2.

Table 2. *The carrying capacity of the domestic gondola for the transportation of coal, ore and rolled steel products was also sufficient for the full utilization of its loading capacity*

Name	**Use of load-carrying capacity, %**	**Use of storage capacity, %**
Ore	100	35
Coal	100	100
Coke	60	100
Rolled metal	100	60-70
Timber	45–56	100
Various equipment (machines, cars)	20–75	–

Such data indicate that the storage capacity of domestic gondolas was 66.8 m^3, sufficient for full utilization of its carrying capacity in the transportation of coal, ore and rolled steel products, which were transported in the gondolas in mass scale.

The lifting force was used the least satisfactory in the transportation of timber and various equipment. Consequently, for the full use of the load capacity during the transportation of such cargoes, the main factor was the length and floor area of the wagon.

Calculating the optimal value of the specific capacity of the gondola and taking into account taking into account the structure of cargo, empty running, the range of transportatios M.V. Vynokurov, proved that this optimal value for the gondola is 1.10 m^3/t, which corresponded to the value of the specific capacity of the existing gondola (1.11 m^3/t). With such indicators of specific capacity and adopted load capacity of 60 tons, the capacity of the gondola body had to be equal to $1.10 \cdot 60 = 60.6$ m^3, which was adopted for the technical task of gondola designing (Vinokurov, 1953).

The study also summarized that the size of the new gondola, load capacity, and storage capacity were close to the existing parameters of the domestic gondola and met the requirements envisaged in the technical specification only with some adjustments regarding the structural characteristics in length or overall characteristics for the existing gondolas. In existing types, the internal length was 12004 mm, in the new ones it was 12400 mm.

Extension of the gondola cab was carried out without changing the existing length of the frame by replacing the structures of the frontal walls by removing the lean-to trussed strut of the corner posts. In order to determine the length, the internal width of the gondola under the conditions of incorporation in the overall dimensions was 2825 mm. The cab height of the gondola was 1.88 m.

After the experiments Professor M. V. Vynokurov indicated the best running qualities and sufficient strength of the domestic type of gondola in accordance with the safety of operation. And he also pointed out the existing disadvantages, among which: the deflection of the truss top chord, breaking of the cemented joint of the truss node, breaking and convexity of cross stays, the deformation of the frontal doors.

Elimination of the above disadvantages of the gondola was assumed by strengthening the upper ratchet strap, replacing the side doors on a swing all-metal door with pressed walls, and replacing the wooden upholstery with a metal one.

In the gondola frame, the most frequent damage was its center sill in the places of installation of the friction gear of the automatic coupling, among them: abrasion and convexity of the upright post of the center sill around the angle stops, vertical cracks in the front or rear angle stop of the automatic coupling, the tearing of the ribs on the welding joints from the vertical wall of the center sill.

To eliminate these disadvantages it is assumed to use a center sill of special rolled products, as well as installing alternating overlays on the walls of the center sill, as in large-sized wagons.

Flat car is an open freight caron designed for the transportation of long-length, piece freight, containers and equipment that do not require protection from the weather. The main type of four-axle flat cars of the USSR railways were side flat cars with a lift capacity of 60 tons. In the fleet of domestic railways, there were also sided flat cars with carrying capacity of 50 tons and without platforms with a lifting force of 50 tons of the US production, as well as flat cars of domestic plants with a lifting force of 60 tons (Naeimi, Zakeri, Shadfar & Esmaeili, 2015).

Characteristics of domestic sided flat cars are given in table 3.

Table 3 *Characteristics of domestic sided flat cars are*

Name	Load capacity, t	Length in the middle, m	Floor area, m^2	Dead load, t	Tare weight ratio	Correlation
Welded structure of 1932	50	12.91	35.9	18.4	0.363	1.39
Rolled section structure of 1936	50	12.87	35.7	22.0	0.366	1.68

According to the data in the table, the use of the load capacity of the 60-ton flat car when loaded with various goods and their data with the characteristics are given in table 4.

An analysis on the lifting capacity of an existing type of 60-ton platform indicates that when transporting various loads accepted for platforms, their lifting force is fully used in the transportation of two or three types of cargo (ore, metals). Other cargoes give a very small load and, on average, the load capacity of four-axle 60-ton platforms does not exceed 35-50%.

Summarizing the analysis M. V. Vynokurov indicates that the most effective for operation is a flat car with a lifting force of 40 tons. However, despite this, it was decided not to limit the availability of flat cars with a lifting capacity of 40 tons for the domestic freight car fleet, since it was impossible to transport heavy piece goods on such flat cars.

Consequently, taking into account a number of advantages of flat cars of lifting capacity 40 tons, as well as the need to have along with this fleet of flat cars, allowed the transportation of heavy fix loads, the main parameters for design were developed on two types of load carrying capacity of 40 and 60 tons.

For the choice of the optimal length of flat car the possibility of adapting it to the conditions of bulk cargoes transportation was taken into account. The internal length of the flat car, equal to 13500 mm, provided the laying of stacks of the most widespread wood species by length (6.5 m).

Table 4. *The use of the load capacity of the 60-ton flat car when loaded with various goods*

The name of the cargo	Possible loading on the flat car	Percentage of load-carrying capacity
Coal	26.9	53.8
Anthracite	28.3	56.6
Coke	18.8	36.6
Peat	10.7	21.4
Wood (round)	29.6	59.1
Sleeper	34.9	69.8
Fuel wood	27.2	54.3
Hardware items	37.4	74.9
Used machines	11.1	22.2
Straw	10.8	21.7
Sugar beet	18.0	36.0
Ferrous metal (scrap)	40.4	80.8
Fluxing material	42.7	85.4
Minerals (apatites)	48.5	87.0

The width of the platform was determined in terms of fitting the platform in size. The height of the sides compared to the existing ones was slightly higher. For longitudinal sides, the height was increased to 755 mm, and for transverse ones - to 605 mm. The increase in the storage capacity of the platform cab has made it possible to significantly increase the utilization rate of new types of platforms.

In order to develop the design of the platform's sides, it was necessary to take into account a number of structural defects of the existing designs of the edge fittings, resulting in massive loss and damage to the sides in operation. Such circumstances were worthy of attention, as the railways suffered from colossal losses to compensate for the premature wear of the sides.

To increase shelf life and reduce operating costs, new types of platforms were made all-metal.

Tank wagons The lifting capacity of tank wagons operating on domestic railways was quite different. The most efficient was a tank wagon with a cubic capacity of 50 m^3, in this connection, the capacity of the new tank wagon was 50 tons. Such a lifting force of a tank with a container of approximately 24 tons gives an axle load of 18.5 tons. In addition, the adopted capacity of the boiler provided the multiplicity with the main tanks of the existing types, determined particularly important for cargo operation (Dadyko & Draichyk, 1954, p. 410).

The design of the tank and especially the boiler was supposed to increase the strength compared with the existing four-axle tanks. The frame of the wagon consists of a center sill, side beams, cross beams (buffer, bolster and cross-bearer) and bearings for supporting the tank shell on the frame. The main requirements were that the thickness of the bottom and armor sheet should be at least 11 mm, and the upper cylindrical part is not less than 9 mm.

Drain devices for kerosene-oil tanks were located at the bottom of the boiler and had the occasion to open it through the hatch cover. For gasoline tanks, the drain device was installed according to the siphon principle.

On the cap of petrol tanks, a safety valve, an exhaust valve and test ports were provided for measuring the level of liquid in the tank. For transportation of heavy fuel oil it was necessary to develop a design of a tank shell with a device for heating, which would greatly facilitate the transportation and exhaust of black oil.

In order to develop the design of drainage devices, the latter must ensure that the products are quickly drained and poured into the tank and guaranteed to be free from the loss of devices along the way.

The number of bogies and axles in the old and new types of wagons was the same. As for the design of the bogie, it had to be improved. The bogie is the most difficult and responsible point in the design of the wagon. The running qualities of the wagon (smoothness, stability, etc.) depend on the device of a bogie and its spring suspension.

A new bogie for all four-wheel freight wagons was assumed with steel molded sides, which were cast along with cellar boxes and molten center bearer. Advantages were given to bogies without lower cross-linking. During the development of bogies designs, special attention was given to the correct choice of spring suspension for the more smooth running of the wagon. The spring suspension was required to provide a deflection at a maximum statistical load of 35-45 mm and the maximum possible deflection of 65-80 mm.

All freight wagons were required to have an automatic coupling and friction draft gear. The relatively rapid wear of individual elements of hexagonal devices led to the conclusion that it is necessary to increase the wear resistance of the draft gear of the automatic coupling (Tekhnycheskyi spravochnyk zheleznodorozhnyka, 1953, p. 304).

M. V. Vynokurov pointed out that it was decided to produce new wagons using low-alloy steel, greatly facilitated the tare weight.. Such a solution was based on the technical experience of the US wagon industry.

Particular attention was paid to the unification of parts and assemblies, that were subjected to the process of wear and damage to the most, were replaced with the current and periodic repairs of the wagon. This important measure has significantly reduced the cost of manufacturing and was important for the organization of repair because it simplified the ability to replace worn parts with spare ones.

Conclusions

The above mentioned basic characteristics of freight wagons, as well as the technical considerations and decisions of professor M. V. Vynokurov, obtained as a result of the analysis of existing designs of freight wagons and the experience of their operation, were the basis for designing and production of new types of freight wagons. His primary task was to provide the railway transport with new freight cars that corresponded to the level of the best samples of modern technology, Mykhailo Vasyliovych embodied in the best way.

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Професор М. В. Винокуров: етапи створення вантажних вагонів (1930-1950)

Анотація. *Актуальним завданням сучасної історичної науки є всебічне вивчення персоналій видатних вчених та інженерів, які зробили вагомий внесок в становлення науки і техніки. Стаття присвячена аналізу діяльності професора М. В. Винокурова у сфері створення вантажних вагонів. В історії науки і техніки М. В. Винокуров відомий як визначний спеціаліст в галузі рухомого складу, він присвятив своє життя розробці вагонів і вагонного господарства. М. В. Винокуров зауважив, що було прийнято випускати нові вагони з використанням низьколегованої сталі, що значно полегшувало вагу тари. Таке рішення базувалося на врахуванні технічного досвіду вагонобудівної промисловості США. Особлива увага приділялася уніфікації деталей і комплектуючих вузлів, які піддавалися в процесі експлуатації зносу і найчастішим пошкодженням, в наслідок чого вони замінювалися при поточному та періодичних ремонтах вагона. Цей важливій захід давав значне зниження собівартості виготовлення і мав велике значення для організації ремонту, тому що спрощував можливість заміни зношених деталей запасними. При підготовці даної статті було застосовано хронологічний,* *типологічний, порівняльний методи історичного пізнання, класифікації та систематизації історичних джерел і бібліографічного матеріалу, які дозволили систематизувати та критично оцінити використані джерела стосовно питання етапів створення вантажних вагонів. Показана роль професора М. В. Винокурова в цьому процесі, охоплюючи 1930–1950 рр., найбільш продуктивні роки вченого та інженера. Встановлено, що завдяки особистому внеску М. В. Винокурова в уніфікацію деталей для різних типів вантажних вагонів, відбулося здешевлення експлуатаційних витрат залізниць. Це досягалося завдяки масовому виготовленню різних типів вантажних вагонів. Вивчення розвитку вантажних вагонів через біографію вченого-інженера М. В. Винокурова, що є складовою частиною комплексу знань, передбачає застосування системного підходу як методологічного засобу наукового пізнання.*

Ключові слова: *залізничний транспорт; вагони; М. В. Винокуров; наука й техніка; інженер*

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Профессор М. В. Винокуров: этапы создания грузовых вагонов (1930-1950)

Аннотация. *Актуальной задачей современной исторической науки является всестороннее изучение персоналий выдающихся ученых и инженеров, которые сделали весомый вклад в становление науки и техники. Статья посвящена анализу деятельности профессора М. В. Винокурова в сфере создания грузовых вагонов. В истории науки и техники М. В. Винокуров известен как выдающийся специалист в области подвижного состава, он посвятил свою жизнь разработке вагонов и вагонного хозяйства. М. В. Винокуров отметил, что было принято выпускать новые вагоны с использованием низколегированной стали, что значительно облегчало вес тары. Такое решение базировалось на учете технического опыта вагоностроительной промышленности США. Особое внимание уделялось унификации деталей и комплектующих узлов, которые подвергались в процессе эксплуатации износу и частым повреждениям, в следствии чего они заменялись при текущем и периодических ремонтах вагона. Это важное мероприятие давало значительное снижение себестоимости изготовления и имело большое значение для организации ремонта, так как упрощало возможность замены изношенных деталей запасными. При подготовке данной статьи были использованы хронологический, типологический, сравнительный методы исторического познания, классификации и систематизации исторических источников и библиографического материала, которые* *позволили систематизировать и критически оценить использованные источники по вопросу этапов создания грузовых вагонов. Показана роль профессора М. В. Винокурова в этом процессе, включая 1930-1950 гг., наиболее продуктивные годы ученого и инженера. Установлено, что благодаря личному вкладу М. В. Винокурова в унификацию деталей для различных типов грузовых вагонов, произошло удешевление эксплуатационных расходов железных дорог. Это достигалось благодаря массовому изготовлению различных типов грузовых вагонов. Изучение развития грузовых вагонов через биографию ученого-инженера М. В. Винокурова, что является составной частью комплекса знаний, предполагает применение системного подхода как методологического средства научного познания.*

Ключевые слова: *железнодорожный транспорт; вагоны; М. В. Винокуров; наука и техника; инженер*

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