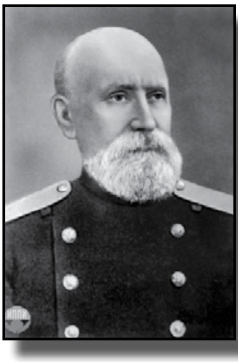
EDITORIAL | ARCHIVED PUBLICATION
DOI: https://doi.org/10.30932/1992-3252-2022-20-6-13

World of Transport and Transportation, 2022,
Vol. 20, Iss. 6 (103), pp. 226–229

Bibliography. The Most Significant Works of Professor N. P. Petrov



Nickolay P. PETROV

Nickolay Pavlovich Petrov is a famous scientist in the field of engineering science. He participated in the preparation of the development strategy of railways in Russian Empire in the second half of the 19th century and in training engineers for railways. He is known as a theorist, and practician of railway construction, participated in the construction of Trans-Siberian, Vladikavkaz and Armavir–Tuapse railroads.

ABSTRACT

In this issue, instead of a review of new books or textbooks on transport and transportation, paying tribute to the oeuvres of our predecessors, the journal reproduces a bibliographic article first appeared more than a century ago in the journal «Zheleznodorozhnoe delo» [Rail Business]. The editors hope that it will help to get an idea of how concise, meaningful and, in modern terms, informative reviews of scientific literature were compiled at that time, as well as the range of scientific problems considered.

By tradition, the publication retains the vocabulary, punctuation and abbreviations adopted at the beginning of the 20th century.

Keywords: railways, history of science and technology, scientific literature.

Acknowledgements: the editors express their gratitude to the staff of the library of Russian University of Transport for their help in preparing the publication.

For citation: Bibliography. The Most Significant Works of Professor N. P. Petrov. World of Transport and Transportation, 2022, Vol. 20, Iss. 6 (203), pp. 226–229. DOI: https://doi.org/10.30932/1992-3252-2022-20-6-13.

The portrait of N. P. Petrov is published at the Website of the Russian Academy of Sciences: https://www.ras.ru/win/db/show_per.asp? P=. id-51715.ln-ru.

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

Professor of Military Engineering Academy and Technological Institute N. P. Petrov enriched Russian technical literature with many fundamental works, representing an independent study of various issues mainly in the field of railway traction and rolling stock. There are more than twenty individual works and brochures by N. P. Petrov. This review offers a brief description of the content of some of these works[1].

I. Outline of teeth of round cylindrical wheels with arcs of a circle (*«Inzhenerniy Zhurnal»*, 1870 and 1875)

Teeth of cylindrical wheels, as is known, are usually limited by arcs of an epicycloid and a hypocycloid. The drawing of these curves can only be done by points, and therefore the curves obtained in this way, in addition to the required painstakingness of drawing, cannot be distinguished either by special regularity or uniformity.

Thus, in view of the importance of tooth wheels in machine business, it was quite natural to have many other, simpler ways of drawing teeth, where the above-mentioned curves are replaced by arcs of a circle, without indicating, however, the magnitude of the error that occurs.

Prof. Petrov in two articles published in «Inzhenerniy zhurnal»: 1) showed how to determine in each given case the magnitude of the error from the use of one or another method of outline; 2) derived formulas that make it possible to analytically determine the magnitude of the radii of replacing arcs of a circle and the position of their centers – provided that the error receives the smallest value, and 3) showed the geometric construction of the teeth, subject to the same condition.

II. Friction in machines (1883)

This work, awarded the Lomonosov Prize by the Imperial Academy of Sciences, is, as it were, the first (theoretical) part of one general work, performed by the author on an extensive scale.

[1] Of the rest of the works of the same author, a review on «Determining the speed of a train on a railway» and «Comparing the conditions for a train to move on a single and double traction railway» were published in «*Zheleznodorozhnoe delo*» of 1890, pp. 362 and 363. Thus, readers of «*Zheleznodorozhnoe delo*» have got an opportunity to get acquainted with almost all the main works of prof. N. P. Petrov, a respected Russian scientist who enjoys authority outside of Russia. – *Ed.*

In this work, prof. Petrov presented a number of theoretical considerations about the very nature of the friction force in case of rotation of axes with abundant lubrication – he pointed out that in this case the internal friction of the liquid lubricant is essential, as well as the thickness and temperature of this liquid layer, which separates rubbing surfaces – he built on this basis an independent hydrodynamic theory, – he derived a formula that allows in each given case determining the resistance caused by friction (with rotating axes), if only the coefficients of friction for these lubricating fluids are known, – he determined the values of these coefficients by a long series of experiments and finally confirmed the validity of the formulas proposed by him by comparing friction values in machines, obtained, on the one hand, by direct measurement, and on the other hand, according to the formula, by inserting the corresponding friction coefficients into it.

III. Description and results of experiments on friction of liquids and machines (1886)

This work, which is a natural continuation of the previous work «Friction in machines», was awarded the Metropolitan Macarius Prize by the Imperial Academy of Sciences in 1889.

The formulas derived in the first work based on the hydrodynamic theory of friction in machines proposed by the author, and the provisions arising from them, were confirmed to a sufficient extent by Girn's experiments. But, not content with this, and desiring, in addition, to find corresponding numerical data for mineral oils, Professor Petrov undertook an extensive series of experiments, which had mainly the following goals:

1) to determine for the most commonly used organic and mineral oils – the numerical value of the coefficient of internal, and partly external friction;

2) to determine by experience the magnitude of the friction force developing in machines, and, moreover, under a wide variety of conditions, and thus verify the validity of the formula he proposed for expressing the friction force;

3) to indicate techniques for recognizing the lubricity of various oils.

IV. Friction in machines and the effect of lubricating fluid on it (1887)

This essay embraces the main results of two previous works of prof. Petrov with an indication of the practical results arising from the experiments and the hydrodynamic theory of the author, with their application to railways and paper mills. In the form of a special application, derivation of formulas expressing the friction force of the central pivot and heel, a description of methods and devices for determining the friction of liquids and a description of methods and devices for testing friction in machines are placed.

In conclusion, a number of examples are given, determining the profitability of using one or another type of lubricant, using the outlines of characteristic curves drawn up by the author and, with determining the amount of fuel and lubricant costs required to overcome friction. These examples clearly show that, depending on the cost of fuel and lubricant, it is sometimes beneficial to use cheap lubricant with a significant coefficient of friction, and sometimes the advantage remains on the side of expensive lubricant with a small coefficient of friction. The graphic technique proposed by the author is extremely simple and can always be applied, as long as there are characteristic curves of various oils. Therefore, it is highly desirable to implement the author's suggestion that determination of internal friction at various temperatures, necessary for the outline of the internal friction curve (characteristic curve), be put in a number of other observations made by both manufacturers and oil receivers.

In connection with the above work, in 1888 in Milan, a special edition of the engineer Pietro Verole appeared, entitled «Ricerche teoriche o sperimentali di Petroff sugli olii lubricauti», in which he presents *in extenso* the main results of theoretical and experimental research of prof. Petrov.

The essence of the work just considered was published by the author, in a condensed form, in 1889 under the title «Resultats les plus marquants do I'etude thooriquo et oxperimentale sur le frottement mediat».

V. Train resistance on railway (1889)

The named essay, which is part of the course read by the author in St. Petersburg. Technological Institute, published, as the author points out in his preface, with a twofold purpose: 1) to contribute to clarification of a very complex and very important for railway operation question of train resistance, and 2) to acquaint young technicians with techniques for critically evaluating data obtained from experiments.

The author successively analyzes questions about resistance of an individual car to movement, then a train of cars and, finally, a steam locomotive, and thus comes to a general expression for resistance of a train, with a steam locomotive at the head. In relation to each of the mentioned resistances, preliminary theoretical considerations are set out, indicating the form of the formula by which this resistance should be expressed; then a description and results of experiments on foreign roads are given, which had the goal of empirically determining the magnitude of these resistances, and the proposals by various investigators of the corresponding empirical formulas are indicated; after a critical analysis of these experiments and proof of their incompleteness, as well as the unsatisfactoriness of various empirical formulas, the author turns to the type of formula he found theoretically and determines the numerical values of the coefficients, using the results of the most satisfactory experiments.

Having made a brief outline of the structure of the track and the track superstructure, as well as rolling stock, the author analyzes in detail the elements of train resistance, which include: air resistance, friction of solid lubricated and unlubricated bodies, resistance from uneven rails and tires, resistance of wheels to rolling, resistance from inertia when changing speed and finally resistance on slopes.

VI. Transshipment and storage of grain. Coal transshipment (1882)

This work, compiled mainly on the basis of the author's own observations abroad, embraces a systematic description of all the most common methods of transshipment of grain and coal, ranging from transshipment with the help of people and the simplest tools, such as bags and baskets, and ending with steam and hydraulic cranes and elevators, grain hoists.

The description is accompanied by the necessary explanatory drawings, approximate calculations and a considerable amount of details and data regarding the dimensions of the most famous devices, their cost, as well as the cost of the work they do. In addition, it is analyzed in detail in which cases one device has an advantage over another, and attention is drawn to the fact that not always mechanical devices, although very ingeniously invented, can compete in terms of the cost of work with ordinary work by people.

The second half of the work contains a description of arrangement of various types of stores for storing grain – up to and including elevator stores. This part of the work, written according to the same plan as the first, was at one time the only detailed description of grain elevators and store elevators in our country, with the exception of Zvyagintsev's pamphlet, published in 1878.

VII. About continuous braking systems (1878)

The purpose of this work, as the author explains, was to provide methods for a complete and correct interpretation of experiments on braking systems, since the only method for assessing the comparative merits of one or another system of brakes consists in prolonged observations on the action of brakes, i.e. mainly in determining the length of the path traveled by the train from the moment the brake signal is given to the moment the train comes to a complete stop.

In conclusion, prof. Petrov comes to the following interesting conclusions:

1) A perfect brake system should act by changing the pressure of the pads on the wheels, depending on the speed of the train. Currently, there is no system that satisfies this condition.

2) A brake system with a constant pressure that does not cause the wheel to slide yet stops the train the faster, the greater is this pressure; the length required to stop the train is more than in the previous case from 1,5 to 2 times.

3) A brake system, where a constant pressure is so great that it already causes slipping, turns out to be most satisfactory at a certain specific pressure on the pads, and any decrease or increase in this pressure requires a longer distance to stop.

In this case, the length of the path for a complete stop of the train is closer to the ideal case than under the previous condition.

It should be mentioned that the formulas proposed by the author and the consequences arising from them were fully confirmed in the experiments of Galton, described in *Engineering* for 1878.

4) It is very important that the force necessary for braking be developed instantly, any gradual decrease in this pressure can only be useful, while an increase is harmful.

Applying his considerations and formulas to comparing the results of experiments carried out abroad and in our country (on St. Petersburg-Varsaw railway) with various brake systems, and comparing them with the results that would be achieved with an ideal brake, the author comes to the conclusion:

a) that the difference in the results of applying different brake systems is not so much due to the brake system, but because the pressure they produce on the wheels is not the same;

b) that the efficiency in all systems is not more than ½;

c) that a further increase in speed of stopping the train can hardly be expected, if only the requirement is maintained that the wheels do not slide along the rails during the entire braking period.

VIII. Determining the speed of a train on a railway with a possible increase in probability of safe movement (1890)

In this brochure, the editing of which was caused by an accident on October 17, 1888, the author draws attention to the fact that in addition to the condition of the track, the characteristics of the locomotive, the habits of the driver, etc., one of the causes of accidents may be a discrepancy between train speed and the data profile and composition of the train.

In view of this, Prof. Petrov gives formulas that allow:

1) determining the maximum safe speed for a given train composition, if only the maximum safe speed is known, with which trains of any other specific composition move along the line;

2) determining for a given profile and composition of the train the maximum speed at which the stop of the train with the help of brakes could be achieved for no more than that at which it is achieved when moving at the highest permissible speed on a horizontal track, provided that when braking, there was also no slip, capable of causing formation of flat spots on the wheels, which had the consequence of hitting the wheels on the rails.

(*Zheleznodorozhnoe Delo [Rail Business]*, 1912).

Editorial staff of World of Transport and Transportation ●