The collection of mechanisms by P.L.Chebyshev at the department of theoretical and applied mechanics of St. Petersburg university

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Abstract. The paper presents some information and photos dealing with mechanisms by the great Russian mathematician P.L.Chebyshev. These mechanisms are kept at the revived Cabinet of Practical Mechanics of the History of Physics and Mathematics Museum of St. Petersburg State University (SPBU). This revived cabinet is now located at the Mathematics and Mechanics Faculty of SPBU in Peterhof.

1. Introduction
In 2021 we celebrate the 200-th anniversary of the great Russian mathematician Pafnuty Lvovich Chebyshev’s birth (1821-1894). In this article we present the photos and information about the mechanisms by P. L. Chebyshev at the revived Cabinet of Practical Mechanics of the History of Physics and Mathematics Museum of St. Petersburg State University (SPBU). Nowdays the History of Physics and Mathematics Museum consists of two sections: the section of physics, the exposition of which is presented at the Research Institute of Physics named after V.A. Fok, and the section of mathematics, mechanics and astronomy, the exposition of which is located at the Mathematics and Mechanics Faculty of SPBU (websites: https://spbu.ru/universitet/ekspozicii-i-kollekciyi-spbgu (in Russian), https://izi.travel/ru/80f1-the-history-of-physics-and-mathematics-museum/en). The main curators of this revived cabinet are Galina Sinilshchikova and Boris Trifonenko, the head of the History of Physics and Mathematics Museum in Peterhof.

We should mention that in the modern scientific literature the family name of our great mathematician can be written in different ways. The well-established spelling of the surname is Chebyshev, for example, many scientific papers in mechanics and mathematics deal with the Chebyshev Polynomials, the Chebyshev Bias, the Bertrand–Chebyshev theorem and others. However, there are other spelling versions (for different languages). For example, the French spelling is done in the famous Internet project ”Mechanisms by Tchebyshev” (Russian version: https://www.tcheb.ru/, English version: https://en.tcheb.ru/, by 2009-2021 Mathematical Etudes Fund). In the following we will use the spelling Chebyshev in the main part of this article.
The authors of the project "Mechanisms by Tchebyshev" state that they are collecting all the mechanisms created by the great Russian mathematician Pafnuty Lvovich Chebyshev. This project includes information about mechanisms, museums, references to books, and the main part of the project is the computer animation of mechanisms. The project is often demonstrated to students at the Mathematics and Mechanics Faculty of SPBU. We use the demonstrations from this project for educational purposes, in lectures on theoretical mechanics, on the history of mechanics, and in the tasks for the laboratory computing workshop, for example [1], [2]. Anyway, the information about our department in this project is still incomplete, some new facts arise.

2. Some articles concerning Chebyshev’s mechanisms

There are some recent articles concerning the Chebyshev mechanisms, for example [3], [4]. In the article [4] the main attention is given to the description of Chebyshev’s mechanisms kept at the main building of SPBU in the Museum of History of St. Petersburg University (the address: 7/9 University embankment, St. Petersburg, Russia, web-site (in Russian) https://spbu.ru/muzey-istorii-spbgu). The five original Chebyshev mechanisms are exposed there: Plantigrage Machine in metal, Wheelchair, Sorting mechanism, Bicycle, Press. The name of these mechanisms are given according to the investigations (in 1945 and 1948) by the famous Russian mechanicians I. I. Artobolevsky and N. I. Levitsky [5], [6] (in Russian). There is some description of mechanisms by P.L. Chebyshev in English in a handbook for engineers [7] (translated from Russian in 1975).

In 2018, the lavishly illustrated book - (photo album) [8] was presented at the Cultural Forum in St. Petersburg. The various collections and models kept at St. Petersburg State University are described there. In this book we can find modern photos of the original models of the Russian mathematician P.L. Chebyshev made with his own hand or according to his drawings.

In this article we pay more attention to Chebyshev’s mechanisms kept at the Mathematics and Mechanics Faculty (the History of Physics and Mathematics Museum) in Peterhof. These mechanisms have been carefully preserved by collaborators of the Department of Theoretical and Applied Mechanics of SPBU for decades. The Address of the Mathematics and Mechanics Faculty and the Department of Theoretical and Applied Mechanics of SPBU is Stary Peterhof, 28, University Prospekt, St. Petersburg, Russia (see also [9]).

3. Mechanical cabinet and Chebyshev’s mechanisms

According to the General Charter of the Imperial Russian Universities (in the summer of 1863), a new department named "Analytical and Practical Mechanics" was organized, and the Cabinet of Practical Mechanics was established for that department. The term "Applied" used in the name of this Cabinet in the previous papers, f.e. [4], should be changed into "Practical" which is more correct. Later (in 1890-ies) this cabinet was often called the Mechanical Cabinet.

A decisive role in the organization of the cabinet was played by the Private Associate Professor, later Professor M. F. Okatov. In this cabinet there were devices and mechanisms that previously belonged to the Technological Cabinet, which ceased to exist after the adoption of the Charter in 1863. The collection of the Cabinet of Practical Mechanics used to be replenished. At the turn of the 20th century this cabinet became the main place in St. Petersburg for keeping the different models in mathematics. For example, in this cabinet there were the models for geometry modeling from the catalogue by German mathematician Alexander von Brill. Also there were the different models for kinematics of mechanisms, among them the kinematic models from the catalogue by German mechanical engineer Franz Reuleaux, mechanisms developed by P.L. Chebyshev, and others.

In the modern collection of the revived Cabinet of Practical Mechanics the models developed by P.L. Chebyshev hold a special place. Here are the names of these mechanisms: 1. Seven
models of planar linkage mechanisms prepared by the university mechanical engineer Frantzen (see figures 1-7). Previously, in the article [4] we mention only four models. The description of these mechanisms is done in [5], [6]. These mechanisms are similar to those held at the Polytechnical Museum in Moscow and the Museum of Arts and Crafts (Conservatoire National des Arts et Métiers) in Paris. 2. The multilink mechanism with stops in extreme positions (see figure 8). We can mention that this mechanism is not written in the list of 1945 in [5] by I.I. Artobolevsky and N.I. Levitsky. But it is done in 1948 [6]. 3. Two wooden draft models of a multiple-bar walking mechanism (plantigrade machine) with marks made by P.L. Chebyshev (see figures 9-10). The plantigrade machine in figure 9 has a famous scheme based on the Lambda-mechanism. A draft model in figure 10 has a scheme based on the X-mechanism, we
see the links in the center of a machine as the letter X. 4. The centrifugal regulator, one of the two regulators mentioned in [5] and [6].

**Figure 7.** Mechanism providing two driven link oscillations per crank revolution.

**Figure 8.** Multiple-bar two-dwell mechanism (with stops in the extreme positions)

**Figure 9.** Plantigrade machine. A wooden draft model based on Lambda-mechanism (with the marks by P.L. Chebyshev)

**Figure 10.** Plantigrade machine. A wooden draft model based on X-mechanism (with the marks by P.L. Chebyshev)

4. Conclusion
All these mechanisms by P.L. Chebyshev are of great historical-scientific value. The original wooden Chebyshev mechanisms and principles of their work are of great interest for both students and their teachers in mechanics and mathematics at the Department of Theoretical and Applied Mechanics and the Mathematics and Mechanics Faculty of St.Petersburg State University.

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