ти, ученый почувствовал себя больным. Целые дни проводил он дома. Посещал только физическую лабораторию, где подолгу засиживался, беседуя о всевозможных научных новостях. В ночь с 26 на 27 мая 1896 года холостяк Столетов в возрасте 56 лет умер от воспаления легких и ослабления сердечной деятельности.

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Александр Григорьевич Столетов – один из основателей современной теоретической электротехники, незримый соавтор всех генераторов, трансформаторов, электродвигателей и солнечных батарей, оставивший глубокий след в электростатике, магнетизме, электромагнетизме, в фотоэлектрических приборах и фотометрии.

Всем этим, естественно, пользуется сейчас и транспорт, однако многоотраслевая принадлежность электротехники не позволяет отдать никому из потенциальных потребителей заслуг русского физика условную пальму первенства. И это только подчеркивает несомненную величину его таланта и полезности для науки и общества.

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MULTIPLICATION OF DRIVING FORCES

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ABSTRACT

Alexander Stoletov went down in history as the founder of one of the scientific schools of Russian physicists, played a prominent role in creation of the theory of photoelectric effect and photometric control, establishment of a wonderful community of electricity and light, study of electrical phenomena in rarefied gases. By his example he trained and involved in science a whole galaxy of scientists, engineers, approved themselves in various fields of electrical engineering, achieved excellent results when transporting electricity over long distances, the construction of electric motors, electric lamps and electronic tubes, solar batteries. Multifaceted activities of professor of Moscow University A. G. Stoletov is shown in the article with an obvious desire to confirm priorities belonging to him, and the publication itself is devoted to the 175th anniversary of the great scientist.

ENGLISH SUMMARY

Background. *Alexander Stoletov was one of the greatest Russian scientists, whose scientific activity led to excellent results in different aspects of physics, in particular creation of theory of photoelectric effect and photometric control, establishment of a wonderful community of electricity and light, study of electrical phenomena in rarefied gases.*

Objective. *The objective of the author is to demonstrate life and scientific journey of the prominent Russian scientist.*

Methods. *The author uses historical method.*

Results. *The founder of Russian physicists' scientific school, founder of theoretical electrical engineering and professor of Moscow University Alexander Stoletov was born on the 10th of August (29th July, old style) 1839 in Vladimir, in a large (he was one of six children) merchant family.*

On leaving school with a gold medal in 1856 a young man entered mathematical department of physico-mathematical faculty of Moscow University. Four years later Stoletov graduated with honors from the University, and the department of physics wanted him to continue working at this department, but as his education was paid by the government, Stoletov had to work six years «in favor of Ministry of Public Education».

Combat engineer of magnetic fields

In September 1861, Alexander received permission to return to university to prepare for getting a professorship. In summer 1862, after getting a special scholarship for talented graduate, established by professors K.A. and S. A. Raczynski, he was sent to a trip abroad. Until December 1865 he underwent a training under the guidance of prominent professors in Heidelberg, G ttingen, Berlin, Paris at the Sorbonne.

Abroad Stoletov performed the first study. Together with K. A. Rachinsky he found out that dielectric properties of the medium did not affect the interaction between magnets and conductors.

Since February 1866 a young researcher, received a teaching position of mathematical physics and physical geography at Moscow University, began lecturing. In May 1869, he presented his master's thesis of theoretical nature entitled «The overall objective of electrostatics and bringing it to the simplest case», in which he found the distribution of electricity on an arbitrary number of conductors placed in space. In June of the same year Stoletov was approved in the rank of associate professor at the Department of Physics. He organized the physics club, which functioned at his apartment.

Shortly afterwards Stoletov developed nervous breakdown and spent nearly a year in hospitals, it was forbidden for him to read and write. After recovery, in 1871 he went on a business trip abroad to conduct experiments in a laboratory of Kirchhoff, which were related to his

doctorate thesis «The study of magnetization function of soft iron», which he presented in April 1872.

It was believed that iron magnetization was proportional to the induction of magnetizing field. Giving sample of calcinated iron the toroid shape (to eliminate the demagnetization factor), he found that with increasing magnetic field, the magnetic permeability first increased, reached a maximum and then began to decrease. Stoletov's work was of great importance for the calculation of electric motors and generators.

In June 1872 century he became non-tenured professor, and the following year tenured professor at Moscow University. He was the lecturer of mathematical physics and physical geography, then moved on to the presentation of experimental physics, was vigorously engaged in organizing workshops and equipping physics laboratory, which was opened in 1874. It contributed not only to training sessions of students, but also to research work.

The first major laboratory research of Stoletov was his experiment in measurement of the ratio of the electromagnetic unit of quantity of electricity to the electrostatic one. The proportionality coefficient was close to the speed of light.

In 1881 at the 1st World Congress of Electricians in Paris Stoletov made a report on the results of research. For this work his Physical Laboratory was awarded «Diploma of cooperation». At the congress, several proposals of Russian scientist were adopted: the preservation for use in the theory and practice of electrical measurements of the electromagnetic and electrostatic systems of units; establishing Ohm resistance unit (in 1880 15 different units of resistance were applied); the precise definition of the relationship that exists between the electromagnetic and electrostatic units.

… And airship of Tsiolkovsky

Physics club, which worked under his supervision at his Moscow apartment, about twelve years later merged with the physical division of the Society of Natural History. Merger suddenly turned for Stoletov to a momentous event, quite apparent confirmation of his scientific authority. Alexander Stoletov then was elected as a chairman of department, and these events quickly pushed him to the active and close cooperation with colleagues.

Not only the number of scientific reports on meetings of specialized committees significantly increased, but also the range of research topics expanded.

In fact, under the guidance of Stoletov physical division turned into an outpost of Russian science, and also with the participation of «natural scientists» of that time there was a consistent struggle for domestic priority for many discoveries and inventions that were suppressed or unfairly attributed to foreigners. It is known how Alexander Stoletov reacted to these events and what efforts he made to defend undervalued projects and to try to help unrecognized talents.

There was an impression that every meeting of physicists was connected with small discoveries, notable singles, and promising reports. That, for example, A. I. Dobrokhotov –Maikov introduced to his colleagues electric lamp, invented by him, F. S. Butkevitch demonstrated recently designed electric clock, P. M. Golubitskiy all evening enthusiastically conducted propaganda of telephony – while simultaneously showing his own inventions in this field. In particular, large speaker phone, precursors of loud-speakers, familiar to all.

By the way, Golubitskiy in 1887, as evidenced by his contemporaries, told Stoletov about the works of C. Tsiolkovsky, a young teacher from Kaluga province. After reading them, Alexander Stoletov immediately appreciated the scale of the figure of the future founder of cosmonautics and invited him to come to Moscow. Tsiolkovsky had not only the opportunity to introduce his projects to the scientific world, which was closed for him until this moment, but also to enter into long and fruitful relationship with many prominent researchers, including professor N. E. Zhukovsky.

Such reports, like that of Tsiolkovsky, were intended, of course, for the specialists, but the division with the participation of Stoletov conducted periodically public lectures.

Popularization of science (especially domestic) at Stoletov's time was compulsory part of the voluntary functions of the members of the Society of Natural History. In 1882, they all helped to organize Russian art-industrial exhibition in Moscow. It showed a lot of exhibits relating to domestic new technology – including current transformer, a wonderful invention of I. F. Usagin. In this exhibition, Muscovites saw the first electric railway for the city – forerunner of the tram.

In 1882, becoming head of the department of experimental physics at Moscow University, professor Stoletov obtained necessary funds and rebuilt physical lecture hall, equipping it with the necessary lecture attributes: gas, water, electric light, heliostat for sunlight, gas engine and generator, experimental table, dimming system, screens, boards, etc. He had a great desire not only to teach but also to explore the undiscovered.

Three laws at once

German physicist Hertz discovered that an electric spark jumps easily between two electrodes when they are illuminated with ultraviolet rays. In February 1888 Stoletov began the study of this phenomenon. He set vertically to each other zinc plate and a metal grid connected to the positive and negative poles of the electric battery. To investigate current in the air environment, galvanometer was first applied. Today, this technique is used in studies of the electric current through gases. Through the air gap between the plate and the grid current was unable to pass through. However, when light of electric arc was directed through a grid to the plate, galvanometer showed the presence of current in the circuit. Increasing the voltage (at constant illumination of the plate), Alexander Stoletov discovered that an electric current in the circuit did not obey Ohm's law: first, the current increased, and then its value changed more slowly and reached a maximum value. So scientist obtained current-voltage characteristic of the photocell.

Later cause for voltage-saturation current was discovered. D. Thompson and F. Leonard in 1899 proved that the light, which was incident on the metal plate, broke electrons away. When the voltage increases, more electrons reach the grid and the current increases. But if voltage is such that the grid is reached by such a number of electrons, which is flying out of the plate, then a further increase in the voltage does not increase the current strength.

Stoletov set three laws of the photoelectric effect: 1. Saturation photocurrent is directly proportional to the light flux incident on the cathode. 2. Maximum velocity of photoelectrons, which left cathode, decreases with increasing wavelength of light. 3. A critical wavelength (different for each metal) exists, with the excess of which the photoelectric effect ceases. Since it is in the long-wavelength range of spectrum, it is called a photoelectric threshold.

Now the first law of the photoelectric effect can be explained in terms of classical wave physics: the more is luminous flux, the more energy is transferred to the cathode, and the greater is the number of electrons

emitted from the cathode. To explain the second and third laws of the photoelectric effect Einstein turned to representation of the photons (light quanta), which have an energy proportional to electromagnetic waves frequency.

Photon incident on the metal is absorbed by one of the electrons of this metal. A portion of the energy electron consumed to break out of the metal, and the rest of the energy it carries in the form of kinetic energy. With decreasing frequency of electromagnetic wave, photon energy decreases. Therefore kinetic energy of the electron and its velocity decrease, which explains the second law of the photoelectric effect.

In case of critical frequency photon energy is enough only to commit the exit-work function, and in case of further reduction in frequency the photoelectric effect ceases, which explains the third law of the photoelectric effect. Currently soundtrack of sound movies is played due to photoelectric effect.

Continuing his studies, in 1888 Stoletov created the first photocell (a device that converts light into electricity): plate and grid were placed in a glass jar, from which air could be deflated. Now photocells are used for process automation, alarm systems, telephotography. They read drawings and then produce parts, open and close doors and gates, stop press, when the hand of man is in the danger zone.

The scientist measured the current non-self-gas discharge for different values of gas pressure in the vessel, voltage, distance between the grid and the plate. He found that the current reaches its maximum value at a certain gas pressure and that this pressure is dependent on the voltage and the distance between the grid and the plate. But if the gas pressure is multiplied at which the maximum current is observed on the distance between the plate and the grid and then the result is divided by the voltage, a constant is obtained (later called the constant of Stoletov).

Theoretical meaning of the constant has been discovered after the death of the scientist by British physicist Townsend. Electrons traveling from the plate to the grid on their way break the molecule to positive balances and electrons. At a certain pressure, the electrons ionize the greatest number of molecules, and it turns out that the most powerful current of the possible currents at a given voltage to the set distance between the plate and the grid.

Regularities, discovered by Stoletov, formed the basis of modern theories of electrical discharges in gases. Its vacuum system for the study of electrical phenomena in rarefied gases became the prototype of the vacuum tube, which has made a real revolution in electrical engineering. Radios and transmitters, X-ray machines and discharge tubes, radars and electronic microscopes, video and electronic computers were made possible due to the work of the Russian physicist.

In 1889 in Paris at the II-nd International Congress of Electricians Stoletov was elected as its vice-president. He was: an honorary member of the Imperial University of St. Vladimir, the Society of Natural History, Kiev Physical and Mathematical Society, Kiev Society of Natural History; a member of Moscow Mathematical Society, Russian Physico-Chemical Society, Paris Societe Francaise de Physique; a founding member and correspondent of Paris Societe internationale des electriciens; foreign member of London Insitution of Electrical Engineers.

But he was not elected at St. Petersburg (Russian) Academy of Sciences. His candidacy was put forward for election. On the 14th of April 1893 at a meeting of the Division of Physical and Mathematical Sciences Academy President surprisingly for all he postponed election for an indefinite period, motivating the decision by the fact that Stoletov, as a man with a restless character, had many enemies, and he would probably be outvoted. Then, his candidacy was withdrawn.

In 1893 the thirty years period of Stoletov's work at Moscow University ended and he received a formal notice of resignation. Accustomed to the constant work and a wide scope of activities, the scientist felt sick. He spent whole days at home. He visited only the physics laboratory, where he spent a lot of time, talking about all scientific news. In the night from 26 to 27 May 1896 Stoletov, a single man, died of pneumonia and a weakening of the heart at the age of 56.

Conclusion. *Alexander Stoletov is one of the founders of modern theoretical electrical engineering, invisible co-author of all generators, transformers, motors and solar panels, has left a deep mark in electrostatics, magnetism, electromagnetism, in photovoltaic devices and photometry.*

All these, of course, is now applied in transport sector, however diversified accessory of electric engineering does not allow to give any of potential consumers of the merits of the Russian physicist a conditional palm of victory. And it underscores the value of his undoubted talent and usefulness for science and society.

Keywords: physics, electrical engineering, Stoletov, electromagnetic system, electric motor, laws of the photoelectric effect, electronic tube, solar battery.

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