PERSEVERANCE CREATES RESILIENCE

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ABSTRACT

The article is dedicated to the 125th anniversary of the birth of Vasily Nikitin, the successor to the Russian inventors of electric arc welding. He became the founder of the theory of electric machines and apparatus for electric arc welding and contributed to creation of electric welding engineering and introduction of electric arc welding in railway transport and in the national economy.

Keywords: history, electrical engineering, electric welding, Vasily Nikitin, Benardos, Slavyanov, theory of electric welding machines, Gosplan, electrothermia, railway, shipbuilding, electric motors.

Background. *Vasily Petrovich Nikitin, a prominent scientist in the field of electrical engineering and electric welding, was born on August 14 (August 2, old style) 1893 in St. Petersburg in the family of a worker-craftsman, descended from serfs of Tver province. The mother of the future academician was a daughter of a locomotive driver. And Nikitin Jr. made his first steps into adult life, apparently, not without the influence of his grandfather [1–4].*

Objective. *The objective of the author is to consider life and work of Vasily Nikitin, the successor to Russian inventors of electric arc welding*

Methods. *The author uses historical retrospective method.*

Results.

The majestic electricity

He received primary education in urban schools: primary 3-grade, 4-grade and technical schools at Vladimir (1909). The boy, simultaneously with his studies, from the age of 15 began working as an assistant locksmith and then as a mechanic to repair steam locomotives in the railway workshops of Nikolaev (now October) railway. In 1914 he graduated from Electromechanical Faculty of St. Petersburg Polytechnic Institute, receiving a degree in electrical engineering.

While still a student, from 1910 he worked as a technician in the design and construction bureau, and from 1912 to 1918, including after the institute, he was a design engineer in the electrical bureau of Baltic Shipbuilding and Mechanical Plant, where he managed the manufacture of the first Russian electric motors for battleships and submarines of the Navy under construction.

In order to obtain practical knowledge in the field of electrical engineering in 1913–1914 he was seconded to the Russian branches and electrical plants in Germany and Sweden firms Volta, Siemens-Schukkert and Universal Electric Company. In electrical installations created for Petropavlovsk and Sevastopol battleships, he was the first to use three-phase asynchronous electric motors, which initiated the use of alternating current in ship devices. In the years 1914–1918, he developed a method of endless starting of powerful asynchronous electric motors.

In 1918, Nikitin served as an engineer in the Office of Irrigation Operations in Turkestan (Irtur), after that he was appointed first as the head of the technical department, and then as manager and chief engineer of the nationalized electromechanical plant REDA. At the plant, under his leadership, they organized the design and production of new types of electric pumps for pumping water from coal mines and other samples of domestic electrical equipment intended for metallurgical and coal industries.

In 1919, together with his factory duties, Nikitin undertook to teach at Ekaterinoslav Mining Institute; from 1921, he was an associate professor, and four years later – a professor and head of the department

«Electromechanics and the use of electrical engineering in the factory business». For him, as a teacher, a characteristic feature was the close connection with the actual design, production needs, which is important in the training of engineers at the present time. From 1919 to 1924 he was a consultant on electromechanical equipment at Yekaterinoslav and Kharkov offices of the production association for exploration and development of oil and gas fields in Azerbaijan (Azneft). Then he was appointed technical head of «Electrician» plant being restored in Leningrad, where the young professor became interested in welding, a promising technological method.

He made the process technology

Electric arc welding was invented in 1882 by Russian engineer N. N. Benardos [5] using a non-consumable carbon rod. It was improved by the inclusion in the process of a melting metal electrode with preheating and protection of the welded product with a molten slag layer in 1888 by N. G. Slavyanov [6]. But electric welding was still little studied and did not find wide application in the national economy of the country. This was due to the lack of design techniques and standard designs of welding equipment, as well as the theory of welding processes.

In the mid-twenties of 20th century, Nikitin, after solving the problem of arc stability in welding conditions, formulated a set of scientific and technical problems that are relevant to the theory of electric machines and arc welding machines. A feature of power sources of electric arc welding operations is intermittent operation with a sharp transition from idle to short circuit mode and back. For stable arc burning,

it is necessary to match the shape of the external steeply-dipping characteristic of the power source (voltage dependence on welding current) and the hard static characteristic while the electric arc is burning (voltage dependence on the arc on current).

The no-load voltage of the power source must be higher than the ignition voltage of the electric arc, but under electrical safety conditions the voltage cannot exceed 40–75 V. The power source must be able to regulate the welding current and withstand the short-circuit current 1,5–2 times higher than the nominal, as short circuit is operating mode. At rated load, the voltage levels of the power supply and the welding arc are assumed to be the same. The recovery time of the electric arc during re-ignition cannot exceed 0,03 seconds.

Based on the scientific statements of Vasily Nikitin's publication «Theory of a Cross Field Generator», and using the electric machine of Kremer «Electrician» plant introduced the first domestic welding DC generator of mixed excitation type SM-1 with a demagnetizing serial differential excitation winding. At each pole of the generator there were two windings. One of them (the main independent excitation) was fed from a small auxiliary generator with a constant voltage (pathogen), attached to the welding generator. The second (serial or service excitation winding) was connected in series with the armature winding and the welding arc.

When the welding circuit was closed by touching the electrode to the product, the magnetic flux of the series winding increased and in the generator the total magnetic flux became insignificant but supported the short circuit current, which was approximately proportional to the current in the winding of the independent excitation. Welding generators operated at almost constant speed of the primary internal combustion engine. Therefore, to regulate the short circuit current (welding current), a rheostat (magnetic regulator) was switched on in the main, independent excitation winding.

Subsequently, the differential excitation welding generator was upgraded. The exciter attached to the generator was replaced by a static semiconductor rectifier, powered by a step-down transformer, the primary winding of which was connected to the AC voltage after the ferroresonant stabilizer. Without a stabilizer, fluctuations in the mains voltage caused fluctuations in the excitation current and welding current, which made the generator unstable.

A device for manual arc welding with the designation STN (Nikitin single-body welding transformer) was also proposed by the scientist at «Electrician» plant. In essence, it consisted of combining into a single whole a dry single-phase step-down transformer and a reactive coil (choke) with adjustment of the welding current when the air gap of the steel magnetic conductor changes and, therefore, the choke inductance. The choke winding was connected to the welding arc circuit in series and counter with the secondary winding of the step-down transformer. When reducing the air gap of the steel magnetic inductor its magnetic flux increases, which leads to a decrease in the magnitude of the welding current. Additional inductance in the welding transformer is also necessary to limit the short-circuit current, which should not exceed the permissible value.

Bonding properties of the volt arc

In 1926–1929, Nikitin was a consultant on organization of welding production at Yekaterinoslav (now Pridneprovskaya) railway, at the factories named after F. A. Artem in Nizhnedneprovsk, G. I. Petrovsky and V. I. Lenin in Dnepropetrovsk (now Dnieper, Ukraine). With his participation, electric welding shops equipped with CM-1 generators and STN devices were designed and equipped. With the help of welding, machine-building production was set up, equipment was restored and repaired for the entire southern industrial region.

Nikitin formulated and tested the principles of current control in welding machines using a movable steel magnetic shunt to increase and change the magnetic flux of scattering and change the transformation ratio of a step-down transformer. The descriptions and principle of operation of the welding DC generator and welding transformers developed by the scientist are given in the textbooks on electrical machines [7–11 and others] and electrical engineering [8–15 and others].

In the article «Voltage arc properties as applied to electric welding of metals, determining the properties of the current source feeding the arc», published in 1928 in «Electricity» magazine (No. 9–10), and in the book «Electric Machines and Transformers for Arc Welding» [16] for the first time from the standpoint of theory, he interprets the essence of electric welding machines of the main types. He also justifies the choice of their rational systems.

In 1929, V. P. Nikitin was invited to Moscow to Research Institute of the People's Commissariat of Communications, where he organized and headed the electric welding laboratory. During his work in the laboratory under his editorship, ten collections of scientific works were published concerning electric welding methods and problems of the theory of stability of electric arc burning under conditions of welding, the theory of electric machines and devices for arc welding, physics and technology of metal joining. Subsequently, the scientific results of studies of electric welding machines were used to develop the theory of transient processes and stability of electric drives.

With the move to the capital, Nikitin's scientific and pedagogical interests expanded steadily. At first, he worked part-time as head of the department of general and special electrical engineering at the Faculty of Ferrous Metals of the Mining Academy (now Moscow University of Steel and Alloys), and at the turn of 1929–1930 he was one of the initiators of creation of the first welding educational institution in the country – Moscow Autogenous-Welding Combine, consisting of

the Workers' College, Technical School and the Institute, where he occupied the posts of Deputy Director for Science and Education and Head of the Department of Electrical Engineering. In 1933, the autogenous-welding institute became part of Moscow Mechanical Engineering Institute (MMMI, now Bauman Moscow State Technical University) as a new structure; in the new structure, Vasily Petrovich served as dean and head of the Electrical Engineering and Electrical Equipment Department. At the same time, in 1934, he was elected of professor Moscow Power Engineering Institute (now National Research University MEI), where he first gave a course on electrothermia.

In 1937, Nikitin defended his doctoral thesis on «Fundamentals of the theory of welding generators» at MMMI and soon headed this university. In 1939, Vasily Petrovich was elected Academician of the USSR Academy of Sciences in the Department of Technical Sciences (specialization – electrical engineering), and the Council of People's Commissars at the same time appointed him a member of the State Planning Committee of the USSR, in 1941 – Deputy Chairman of the State Planning Committee, in 1943 Chairman of the Council of Scientific and Technical Expertise.

High occupancy at important positions forced the scientist in 1939 to leave the post of head of MMMI, at the same time he remained the head of the department until the end of his life. In 1941, Nikitin organized and headed a section on the scientific development of electric welding and electrothermal problems in the USSR Academy of Sciences. Since 1947, he was a member of the Presidium of the USSR Academy of Sciences, in 1951–1954 – Chairman of the Council of Branches and Bases of the Academy of Sciences. In 1939–1942 academician was chairman of the All-Union Council of Scientific and Technical Societies, and in 1939–1943 – Editor of the journal «News of the USSR Academy of Sciences, Department of Technical Sciences» and «Bulletin of Engineers and Technicians».

In 1948 he was awarded the honorary title «Honored Worker of Science and Technology of the RSFSR». In 1956, his monograph «Fundamentals of the Theory of Transformers and Generators for Arc Welding» [17] was published, which summed up the scientific contribution of a scientist to electric welding.

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Vasily Petrovich Nikitin died on March 16, 1956 at the age of 62 years. He was buried in Moscow at the Novodevichy cemetery.

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