INTERVIEW WITH PROF. S.I. KUCHUK-YATSENKO, THE DEPUTY DIRECTOR OF THE E.O. PATON ELECTRIC WELDING INSTITUTE

The welding society in Ukraine and far abroad is familiar with the amazing achievements of the E.O. Paton Electric Welding Institute (PWI) in the field of flash-butt welding. This direction is headed by Prof. Sergey I. Kuchuk-Yatsenko, the academician of the NAS of Ukraine, the merited worker of science and technology of the former UkrSSR. His research activity is associated with the fundamental research works of physical-metallurgical processes in welding of different metals in the solid phase, purposeful study of rapid-running processes of heating and fracture of single contacts at the high energy concentrations. He obtained new data on the peculiarities of formation of joints with the formation of thin layer of melt on the contact surfaces of parts being welded, its behavior under the effect of electrodynamic forces and interaction with gas environment in the contact zone. The new regularities were established characterizing power characteristics of the process of contact melting of metals, the algorithms of automatic control of basic process parameters were determined with the purpose of obtaining the best conditions of heating and deformations of the parts being welded.

The practical result of fundamental research works, carried out by Prof. S.I. Kuchuk-Yatsenko and his staff, was highly appraised:

1966 — the Lenin prize for the development and implementation of machines for flash-butt welding of rails in the repair and construction of seamless railroads;

1976 — the State Prize of the UkrSSR for creation and industrial implementation of new technology and highly-efficient assembly-welding complexes for serial production of large-sized structures of unified elements;

1986 — the State Prize of the USSR for creation of technologies and equipment for flash-butt welding of structures of high-strength aluminium alloys;

2000 — the E.O. Paton Prize of the NAS of Ukraine.

Prof. S.I. Kuchuk-Yatsenko published over 350 scientific papers in the authoritative specialized journals, received 740 author's certificates and patents, prepared 11 Candidates and 2 Doctors of Technical Sciences. He was decorated with two orders of the Red Banner of Labour, Order of the «Badge of Honour», Order of Prince Yaroslav the Wise of the Fouth and the Fifth classes, and medals.

On the eve of the 85th birthday anniversary of Prof. S.I. Kuchuk-Yatsenko the Editorial Board of the Journal recorded the interview with the jubilee person connected to one of the directions of his activity: welding of rails.

Dear Professor, how the permanent interest to the topic «Welding of rails» may be explained?

Prof. S.I. Kuchuk-Yatsenko

Indeed, the publication of articles on the topics related to welding of rails is regularly continuing in «The Paton Welding Journal», and at the PWI scientists deal with this problem for several decades. In fact, the PWI deals with creation of flash-butt welding technology of rails and design of equipment from the early 1960s.

At the PWI for the first time in the world practice the technology of flash-butt welding of thick-walled parts was developed using the continuous flashing of large-section parts, providing a great improvement of power characteristics of the process, namely 3–4 times reduction of the specified capacity of the source and enabling its full automation. In the development of this technology Professors B.E. Paton and V.K. Lebedev actively participated. On the basis of this technology the original generation of welding equipment was created patented in the leading countries of the world. For the first time in the world flash-butt welding was used to join the rails directly on the track in the construction of seamless high-speed railways.

How widespread did the created technology of welding rails become at that time? Was there a feeling that the problem had been solved completely?

The technology and equipment quickly gained a wide application on the railroads of the USSR. The production of new welding equipment according to the PWI documentation was mastered by Kakhovka Plant of Electric Welding Equipment, with which we have many years of fruitful cooperation. This development was highly appraised by the state: it was awarded the Lenin Prize. We had every reason «to rest on laurels». But the development of any direction does not allow even a temporary stop. At first, new production demands arise with the development of transport systems, and secondly, under competitive conditions there is a need for continuous improvement of the technology and equipment. For these

Machine K155, 1959
(S.I. Kuchuk-Yatsenko *at the left*)

purposes the PWI Center «Pressure Welding» was established in 1987 for industrial implementation and a wide mastering of the PWI developments. The base of its staff formed the PWI specialists.

How did the technical and commercial relations with foreign companies develop?

Even under the conditions of closed market, starting since the 1970s, the leading international railway companies of Austria, France, Japan, the United States and other countries showed an interest to the technology and equipment. Already from the beginning of the 1970s the export of rail welding equipment with accompanying technologies for welding began from Ukraine. On the one hand, it encouraged our producers for modernization of equipment and, on the other hand, for establishment of long-term fruitful cooperation with the Austrian company «Plasser & Theurer», US «Norfolk Southern Corporation», «Holland LP», «Progress Rail Service Corporation», Canadian «E.O. Paton International Holdings Inc.» etc. At the present time we stilll continue to cooperate with the foreign companies, improving the technology and equipment taking into account the most rigid requirements in this area. In several decades, the PWI has developed more than 10 generations of rail welding machines, which production was mastered by Kakhovka Plant of Electric Equipment with the participation of the PWI. Now almost in all the continents of the world more than 1,500 rail welding machines operate, being designed at the PWI and manufactured at Kakhovka. The PWI specialists provide engineering maintenance of this equipment and it is not only limited by setting up the equipment and staff training. With improvement of the structure of railway transport and construction elements of the railway track the new challenges appear to be solved by welders.

How would you characterize the newly emerging challenges?

Until the mid-1970s in welding of rails the our proposed technology with a continuous flashing was used, and after a while the technology of pulsed flashing was offered by the PWI. Already in 1976 the first machine was sold to the USA, and since 1976 until the beginning of the 1980s, over 35 machines such as K355A were sold. The construction of new high-speed mainline railroads required solving of two main problems: the use of high-strength rails, characterized by an increased wear resistance, and meeting the higher requirements to the geometrical dimensions of track.

In the last decade many countries experience an intense reconstruction of railways and rail track. Here, high-strength rails having hardness of up to *HB* 400 are used. According to the technological specifications a practical full strength of welded joints with the base metal of rail steel and high plastic properties are required. It was not managed to obtain these characteristics using the traditional technology. At the PWI the systematic studies of weldability of new high-strength rails of different world producers (Austria, China, Russia, USA, Ukraine, Japan) are carried out to develop welding technologies, providing the required mechanical properties. This meantime raises the need in a substantial change of control systems of welding machines and designs of their separate units.

What new approaches were realized in welding of rails?

In particular, it was found that for a high quality welding of high-strength rails the technology of contact heating and mechanical part of design of machines need a substantial change to provide 1.5–2 times increase in compression forces. It was also found that to produce the stable high quality of high-strength rails joining the strictly preset energy input in welding is required. For this purpose the electronic system was developed providing the stabilization of energy input at changes of different conditions of operation of the equipment, as well as at its operation under the field conditions. In the development of systems of automatic computerized control of weld-

Yaroslav Mikitin,
the Management Director of Kakhovka Plant of Electric Welding Equipment

A close cooperation connects KPEWE with PWI and Prof. S.I. Kuchuk-Yatsenko has been a reliable support to this unity of production and science already more than 50 years. He was among the pioneers of the electric welding machines production at the South of Ukraine in Kakhovka. He has been always a driving force in implementation of new models of equipment which later were recognized throughout the world. Taking into account a many-year experience of business and personal relationships with Sergey Ivanovich, I would like to say the following: he is a world famous scientist in the field of flash-butt welding, and welding of rails, railway frogs and pipes is the priority of his research. I, personally, consider him to be my teacher. I am proud that the destiny disposed me to be almost all my conscious labor life together with Sergey Ivanovich. Sergey Ivanovich, I am eternally grateful to You for the plant and the business You adore. I wish You a strong health, new creative ideas and realizations!

Valery Krivenko, the Director of Engineering Centre «Pressure Welding»

Sergey I. Kuchuk-Yatsenko together with Boris E. Paton were initiators of foundation of the engineering centre «Pressure Welding» in 1987. At that time it was only a beginning of wide-scale industrial implementation of machines and technologies for flash-butt welding of pipes and rails both in the USSR as well as abroad. Already in those years they could foresee that a wide-scale implementation of new welding technologies is impossible without a special research engineering department being a part of the PWI. The fundamental base of the new engineering centre was composed of engineers of the PWI Experimental Design Technological Bureau having already the experience of implementation of welding equipment and technologies to the industry.

Since the end of the 1980s the area of industrial implementation of rail welding equipment of the PWI was sufficiently widened due to making the contracts for sale of rail welding machines to Canada, USA, China and later India, Turkey, South-Eastern Asia, South America, Australia. Sergey Ivanovich was a direct participant of all technical and commercial negotiations and conclusion of many export contracts, which allowed bringing the PWI research engineering developments to the world market.

Machine K900 (Singapore, 1994)

ing process another significant problem was solved allowing during welding the simultaneous stabilization of the position of long-rail sections after welding.

It is known that in the process of service of seamless track the stresses occur in fixed rails caused by change in temperature, i.e. under the influence of environment. Their effect leads to deformation of rail sections, violation of preset sizes of the track, and in critical situations leads to accidents. The most dangerous are compressive stresses, which may lead to «ejection» of a section.

A bold decision was suggested: in welding of rails of infinite length to create tensile stresses in the sections of such value that at the preset range of changing temperatures in the rails the compressive stresses could not occur. For this purpose during welding it is necessary to provide the tension for value, correlating with proper calculated value of drop of temperatures. The applied technology of flash-butt welding allows performing this operation, as it envisages the bringing the parts together in the process of flashing. An understanding was reached that it is necessary to provide control of welding process with simultaneous control of tension force of sections being welded. This problem was solved by creation of algorithms of control of the welding process basic parameters.

What types of the designed equipment allow meeting the updated requirements of the customers?

As a result of carried out developments a new generation of welding machines and technology, named «pulsating flashing», was developed and patented in the leading foreign countries. The first machines of this type K900, K920 and K921 were designed at the PWI and tested at the railways of the USA together with «Norfolk Southern Corporation» and other US customers.

From the mid-1990s at the PWI a new generation of rail welding machines for welding of rail sections with tension of K922 type was designed. Their production was mastered by Kakhovka Plant of Electric Welding Equipment. All the rail welding enterprises of Ukraine were equipped with these machines (more than 10 machines). They were also delivered

Machine K921 (USA, 1994)

Machine K922 (produced since 2003)

Machine K945 (Great Britain, Wales, 2013)

to the rail welding enterprises of Russia and China, where with their help the construction of seamless high-speed railways was realized.

How promising is the use of high-strength rails?

Since 2011, at the Ukrainian enterprises the production of high-strength rails was started and at the same time at the PWI the technology of their welding is being tested. In addition, on demands from different countries the developments of welding technologies of new generations of high-strength rails are performed at the PWI. At the present time, the task of laying out the rails is put forward, providing a cargo capacity of 1.2 billion gross tons, which is 2–3 times higher than wear resistance of the operated rails. The organizing of works on laying out the rails during construction of high-speed roads is improved. At the request of English company «Network Rail» a new generation of rail welding machines such as K945, designed for welding with tension of long sections of up to 1000 m was developed at the PWI, was patented and manufactured at Kakhovka Plant of Electric Welding Equipment in 2014.

How is the quality control of rail joints organized?

The algorithms for estimation of quality of welded rails in real time were determined. Computerized system of in-process quality control of the rails joints on the basis of integrated evaluation of the influence of real deviations of welding parameters from the set optimal values was developed.

In the system of rail welding enterprises of «Ukrzaliznytsya» a unified system with the use of Internet for system control of quality of welded joints of rails on the main areas of railway communications was created, allowing processing information for 60,000 butts per year, evaluating their quality, performing rejection and providing information on the state of equipment and need in its preventive measures.

The readers are probably interested to know whether there is an experience in the application of rail welding machines, designed and manufactured in Ukraine, for welding rails in the subway?

Yes, today there is a successful experience in welding of rail tracks using the developed equipment and technology for the subway in the USA, China, Singapore, Russia and Azerbaijan, and the joining of sections is carried out directly in the tunnels.

Thank you, Professor, for the interesting and detailed information on the touched topic. We wish you a good health, many long years of successful work, every happiness and prosperity.

Editorial Board of «The Paton Welding Journal»

Dennis Shears, the Ex-President of «E.O. Paton International Holding Inc.»

Our continuous cooperation with the PWI and Prof. S.I. Kuchuk-Yatsenko is continuing since early 1990s after we had purchased first rail welding machine K355 for «Norfolk Southern Corporation».

During our first contact with the Institute the welding process and machine were little known to us.

Prof. S.I. Kuchuk-Yatsenko worked very close with us and provided a great amount of information and materials, which allowed our company to develop itself and become a main buyer of machines for flash-butt welding. Such cooperation allowed establishing the strong mutual relations with the PWI and, in particular, became the ground for our great respect to Prof. S.I. Kuchuk-Yatsenko.

Soon after concluding the contract with the PWI we found some more market variants for machines of the new designs. The first one appeared to be the new machine with upsetting force of 100 t allowing obtaining the tightness of rail not applying any additional devices. That machine was very successful and a great deal of its sales proved it. Due to such success one more machine for welding was created, including welding of closing butt directly on the track, which also gained a great popularity and was successfully replicated with many modifications.

The machines of the mentioned designs appeared due to a fruitful work of Prof. S.I. Kuchuk-Yatsenko. Today we are at the final stage of creating the machine with new design of head for welding of rail switches and frogs. In combination with new process it will allow considerable extension of market capabilities for the machines for flash-butt welding of rails.

We very appreciate our cooperation with Prof. S.I. Kuchuk-Yatsenko and the help he renders us during such a long period.

We send our best wishes to Prof. S.I. Kuchuk-Yatsenko on the day of his jubilee and hope to continue our cooperation and friendship.