E.O. Paton Electric Welding Institute of the National Academy of Sciences of Ukraine

International Scientific-Technical and Production Journal

The Paton WELDING JOURNAL

Issue 10 2019

Published Monthly Since 2000

English translation of the monthly «Avtomaticheskaya Svarka» (Automatic Welding) journal published in Russian since 1948

Address
E.O. Paton Electric Welding Institute,
International Association «Welding»
11 Kazimir Malevich Str. (former Bozhenko Str.),
03150, Kyiv, Ukraine
Tel.: (38044) 200 60 16, 200 82 77
Fax: (38044) 200 82 77, 200 81 45
E-mail: journal@paton.kiev.ua
www://patonpublishinghouse.com/eng/journals/tpwj

State Registration Certificate
KV 4790 of 09.01.2001
ISSN 0957-798X
DOI: http://dx.doi.org/10.15407/tpwj

Subscriptions
12 issues per year, back issues available.
$384, subscriptions for the printed (hard copy) version, air postage and packaging included.
$312, subscriptions for the electronic version (sending issues of Journal in pdf format or providing access to IP addresses).
Institutions with current subscriptions on printed version can purchase online access to the electronic versions of any back issues that they have not subscribed to.
Issues of the Journal (more than two years old) are available at a substantially reduced price.

CONTENTS

KZESO IS 90!
(Interview with the head of PrJSC KZESO Mikitin Ya.I.)

This year we celebrate 90 years from the day of establishment of KZESO — acknowledged world leader in the field of creation and manufacture of suspended and stationary rail welding machines. In respect of a jubilee the editorial board initiated an interview with a Head of Board of Private Joint Stock Company «Kakhovka Plant of Electric Welding Equipment», Hero of Ukraine Mikitin Ya.I., which we believe will be interesting to the readers.

Yarosvav Ivanovych, please, tell how the plant was founded, what stages of its establishment and development can be outlined?

On September 1, 1929, Kakhovka Artisan-Industrial School (till 1914 it was a plant of agricultural equipment of merchant I. Gurevich), which provided training of the basics of metal and woodworking, manufactured and repaired different agricultural equipment, started on its territory commercial production of piston rings for tractor engines. We assume this date as a Plant's birthday.

In the beginning of the 1950th Kakhovka Plant «Avtotraktorodetal No.22» was renamed as Kakhovka Repair-Mechanical Plant and its activity came under the administration of «Dniprobud», which at that moment took part in construction of Kahovka HPP. At the same time, there was reconstruction of the enterprise following the set general plan, its area was expanded, engineering buildings, boiler house, storehouses were constructed, new lines were laid. The result of these reforms was increase of number of subdivisions, engineer specialists and the main thing was a real perspective of transformation of plant into multibusiness enterprise.

«Welding» history of KZESO has started from 1959, when by the initiative of B.E. Paton specialization of the Plant was changed and it started output of electric welding equipment. Was it a happy coincidence — choice of a small plant from Ukrainian province for manufacture of new welding equipment?

A life-changing for the Plant governmental decree No. 624 «On further implementation into production of welding engineering» was issued on July 5 (August 15) 1959 following a request of E.O. Paton Electric Welding Institute (PWI) and personally its Director B.E. Paton, who managed to see in a small machine-building enterprise on the South of Ukraine the potential for mastering new type of production. The Plant equipped by that time with novel production equipment, competent staff and oriented on implementation of modern technologies, was ready to become an area for fulfillment of governmental program on manufacture of welding equipment.

On January 1, 1960 Kakhovka Mechanical Plant was renamed as the Plant of Electric Welding Equipment. At that time, still Soviet enterprise started to demonstrate their products at international exhibitions, namely A482 automatic machine in Swedish city Goteborg, automatic device ABS with power supply in Dutch city Utrecht.

What did cooperation with PWI give to the Plant?

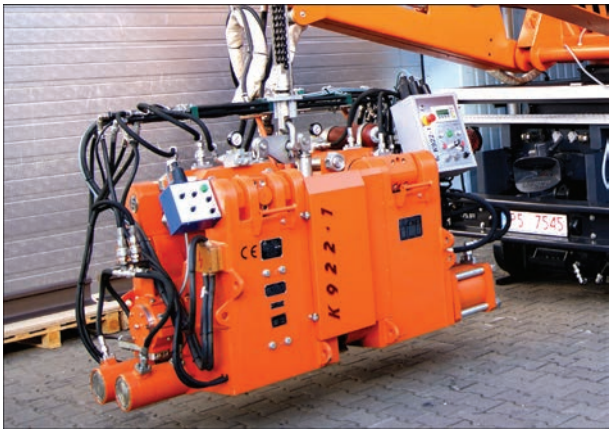
In January 1964 Kakhovka Plant of Electric Welding Equipment created a branch of research design —

technological bureau of PWI of the National Academy of Sciences of Ukraine. The main aim is to provide as soon as possible implementation into production of the achievements of science and technology, strengthen the connections of scientific and design organizations with production for successful mastering of new welding equipment. Created at that time powerful tandem of science and production became a starting point in modern success of KZESO. An engineering center was created at the Plant to mobilize engineering findings. Its work in tight cooperation with PWI (in particular, with department No.26 headed by Acad. of the NAS of Ukraine S.I. Kuchuk-Yatsenko) significantly reduced the terms necessary to realize technical ideas. The breakout to the world market was, first of all, possible due to the fact that we in proper time understood that in order to be competitive it is necessary to have modern science, qualified staff, first-rate ideas, novel technologies and well-equipped production.

Development of rail welding machines requires complex efforts in design, construction and creation of welding technology, etc. How did you manage to form a team for solution of such complex tasks? How do you attract youth to the Plant?

We always present our Plant as a high-tech enterprise that, certainly, stipulates presence of professional staff at each step of manufacture of welding equipment. Today, approximately 50 % of workers have professional technical education and almost 25 % are the specialists with higher education. This allows solving different technical problems; accept the challenges of continuous technological development. Our designers, technologists, engineers constantly improve their qualification level, master new programs for designing.

I would like to notice that a lot of family dynasties work at our enterprise. No matter how pathetic it may

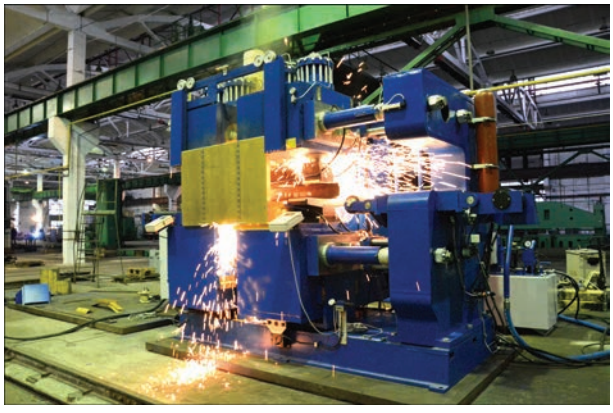


be, but experience of manufacture of welding equipment hands on from grandfathers to grandsons. Today, at the end of second decade of the XXI century, our veterans, started their carrier at Kakhovka Plant back in 1960th, have still been working together with young specialists.

How the Plant provide for the needs in labor and engineering force?

The enterprise has implemented the system for training of staff of almost all trade jobs. Experienced specialists explain theoretical material and practical lessons take place under conditions of real production. To get the specialists with higher education we send inquires to technical universities of our region. Besides, around 100 people graduated from higher education institutions by assignment from the enterprise.

Ukrainian rail welding machines of «KZESO» type work on 5 continents in more than 100 countries. What helps you long years to keep the leading positions in the world market? What tasks should be fulfilled due to activity of competitors from China and other countries and output of counterfeit goods?



Annual mastering of new and new types of welding equipment has become typical for the scientists of PWI and Kakhovka machine-building engineers. Up-to-date science and modern production created an inseparable tandem, which is the locomotive that leads the Plant to set aim, namely to be a leader in its field in the world market, not simply move with the requirements of times, but think long-term and pass ahead the competitors by a step or even two.

For the last decade we a lot of times faced with the examples of copying of our products, attempts to issue welding equipment under «KZESO» trademark at different territories. Of course, these are unpleasant moments, but our analysis of such cases shows that these counterfeit goods do not work at all or have totally low indices of efficiency and operation life. I feel sorry for such clients, which trying to save, or being led into confusion, buy counterfeit goods and very soon face with a lot of problems.

KZESO produced more than 3000 rail-welding machines, about 80 % of which were supplied abroad. When foreign deliveries began, who initiated them?

K922 machine, Chengdu, Shenzhen, China

The first deliveries abroad were made to France (1971), Japan, Austria (1973), Sweden, Poland, Czechoslovakia, Hungary, USA, Cuba, Romania (1975) and the PWI was the initiator of these deliveries.

How do you form a stock of orders and how wide is sales geography?

A stock of our orders is formed in different ways taking into account specifics of our products and terms of its manufacture. There are regular clients, with whom

it is enough to discuss volume of order and specification, because they work with us for decades and sure in quality of equipment and decency of fulfillment of contract terms from the enterprise side. Every year we have new clients, which necessarily come to Kakhovka, to see production facilities, personally discuss conditions of future contracts. We are happy about renewal of active cooperation with «Ukrzaliznytsia». If during the last 10 years the Plant has manufactured more than 90 % of welding machines and complexes to export in the countries of the far abroad, then now at last we started to get orders of equipment for construction and repair of Ukrainian rails.

K920 machine, Kuala-Lumpur, Malaysia

The enterprise has a marketing department, where young and progressive specialists analyze and study new markets and push forward our unique products in new directions. Certainly, we every year take part in international exhibitions and specialized events that also opens new possibilities for further development of KZESO. Wining confidence of customer and complete fulfillment of its needs and wishes is one of our principles in competition for leadership and stock of orders.

Welding machines of «KZESO» trademark work on all five continents, in more than 100 advanced countries of the world.


K945 machine, Wales, Great Britain

Which problems does the Plant face with in the epoch of 4th industrial revolution due to implementation of digital technologies in all spheres of activity? How do you imagine the direction of further development of rail welding machines?

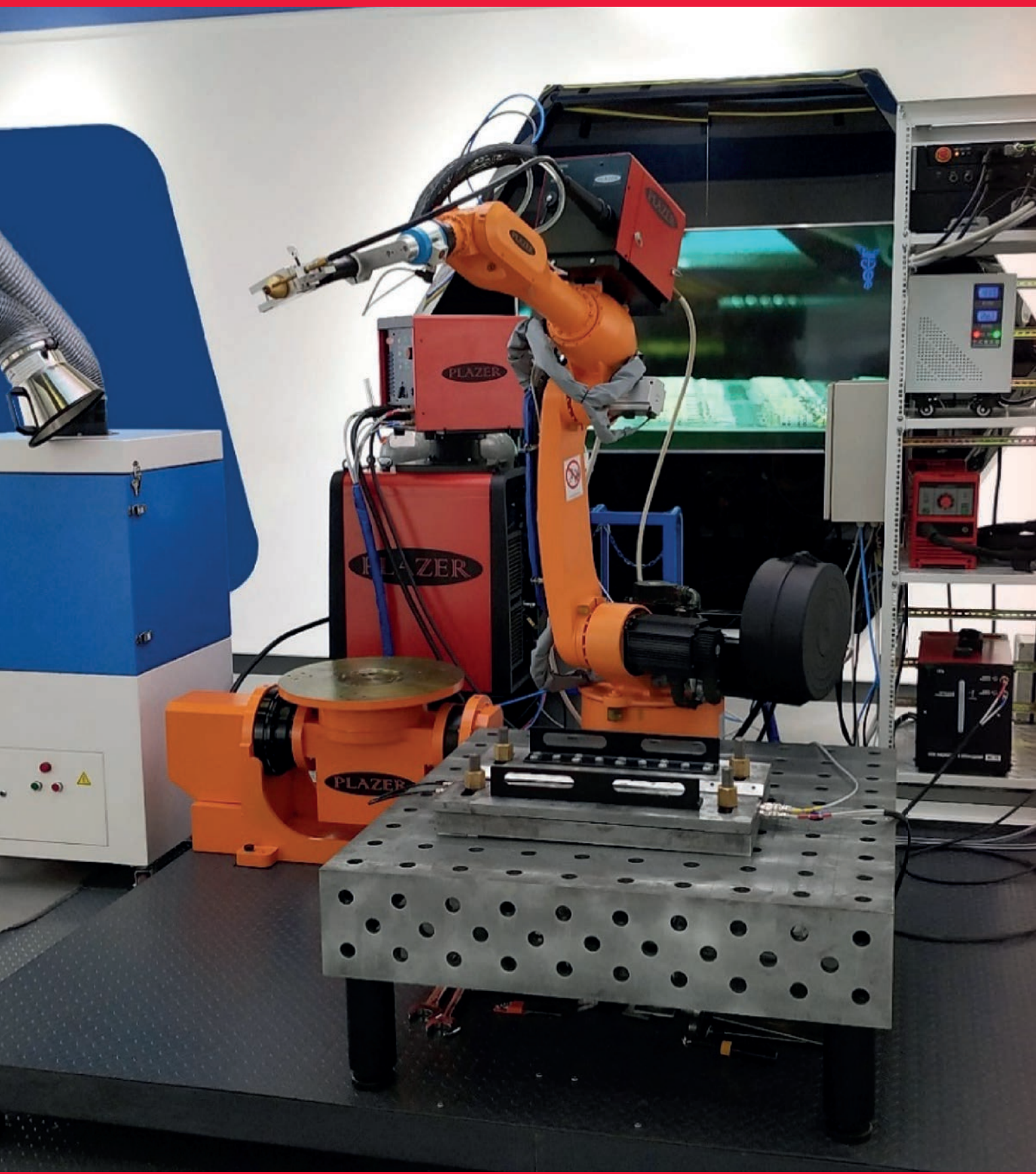
The equipment will always change. Everything keeps up with the development of science. Concord existing between the advanced science, presented by PWI, and modern engineering enterprise, KZESO, give the best results in fulfilment of time requirements, and, certainly, our clients.

As for development of rail welding equipment, it is necessary to note, that machines and complexes of KZESO are already the equipment of future. By the determination of Russian Acad. S. Glaziev, one of the authors of theory of technological setup, «KZESO» rail welding machines fulfil the requirements of the highest 6th technological setup, i.e. being the equipment of XXI century. Use of the elements of artificial intelligence in the recent models of KZESO machines for welding of rails in combination with modern computer equipment and specially developed software allows performing preliminary testing of butt joint, set corresponding mode of welding, follow the welding progress and remove disadvantages, use the algorithms for verification of quality and ultrasonic testing of each butt joint being welded, develop e-passport of welding.

I may definitely say that KZESO is the manufacturer of modern welding machines and complexes, which already use technologies of future that will be still relevant for many years. And we move forward, improve and with confidence in own forces look in the future.

Interview was recorded by
Oleksandr Zelnichenko

MULTIFUNCTIONAL ROBOTIC COMPLEX



E.O. Paton Electric Welding Institute
11 Kazimir Malevich Str., 03150, Kyiv, Ukraine
Tel.: + 38 (044) 205-25-16, 205-25-40
E-mail: vn@paton.kuev.ua, vnkorzhyk@qq.com

им. Е.О.ПАТОНА

FOR PLASMA-ARC WELDING

Performable technologies:

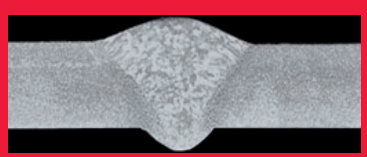
- Pulsed-arc consumable electrode (filler wire) welding
- TIG welding with filler wire feed
- Plasma welding with and without filler wire
- Plasma spot welding with and without filler wire feed
- Welding in «soft plasma» mode with filler wire feed
- Hybrid plasma-MIG consumable electrode welding

Characteristics of welding robot

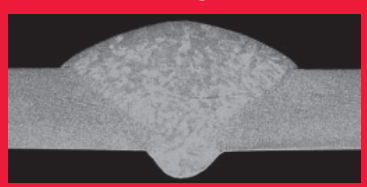
Work area, mm	1420
Number of axes	6
Lifting capacity of the «wrist», kg	10
Lifting capacity of the «elbow», kg	12
Maximum positional repeatability error, mm	0.02
Maximum path error, mm	0.10

Welded joints of aluminium AMg5 alloy

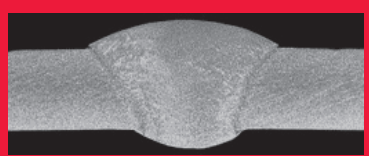
Plasma



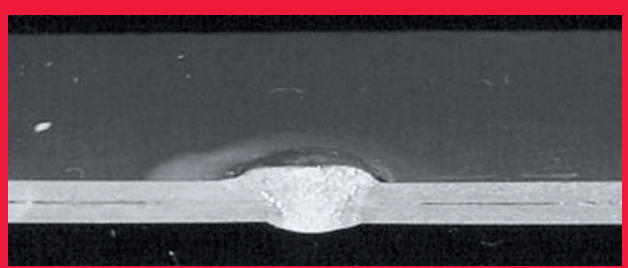
MIG

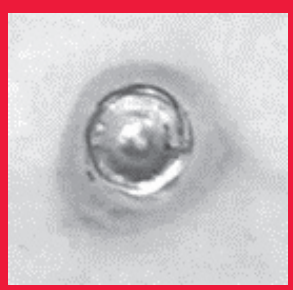


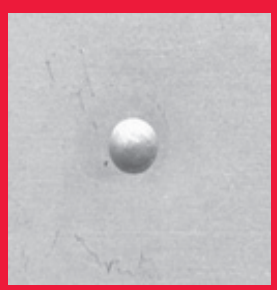
TIG



Seam welding of 4 mm sheets







Plasma spot welding of 1 + 1 mm sheets

PLAZER©

LLC «Research and Production Center «PLAZER»
10-A Filatov Str., office 2/10, Kyiv, Ukraine
Tel./fax: +38 (044) 247-42-55, 247-44-57
E-mail: michail@bigmir.net, plazer2010@meta.ua
www. plazer.com.ua

BEGINNING OF THE ERA OF SPACE WELDING TECHNOLOGIES

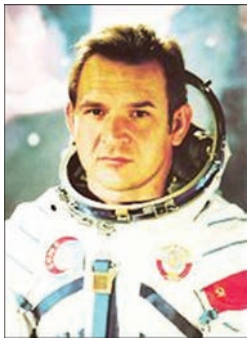
Academician B.E. Paton

In October 16, 1969, for the first time in the world on the «Soyuz-6» space vehicle the USSR pilot-cosmonauts Georgy Shonin and Valery Kubasov conducted experiments on welding and cutting in open space using the universal automated unit «Vulkan».

Sergei Pavlovich Korolev, creator of practical cosmonautics, already in the early 1960s, specified the task before the E.O. Paton Electric Welding Institute to develop a program of experiments to perform welding and cutting in space. This research program, the ultimate aim of which was the creation of welding equipment and technologies for joining materials in space using welding, began to be realized in 1964, and in October, 1969, the experiments were conducted.

Georgy Stepanovich Shonin (1935–1997) — USSR pilot-cosmonaut, Hero of the Soviet Union

In 1957 he graduated from the Yeisk Naval Aviation School. He served in the Soviet Navy. In 1960, he was selected to the cosmonaut corps. In 1968 he graduated from the NE. Zhukovsky Air Force Engineering Academy, Candidate of Technical Sciences. In October 11–16, 1969, he made a space flight as the commander of the «Soyuz-6» space vehicle. Since November, 1990, G.S.Shonin was reserved.



Valeri Nikolayevich Kubasov (1935) — USSR pilot-cosmonaut, twice Hero of the Soviet Union

In 1958 he graduated from the Moscow Aviation Institute. In 1966 he worked at the RSC «Energia». He was involved in designing of manned space vehicles. In 1966–1993, he was on the rolls in the cosmonaut corps. He made three flights into space (1969, 1975, 1980). In October, 11–16, 1969 he made the first space flight as a flight engineer of the «Soyuz-6» space vehicle (in the crew with Georgy Shonin). During the flight, for the first time in the world an experiment on welding in space was conducted. After leaving the cosmonaut corps, he continued his work in the RSC «Energia», and since 1997 he was a research adviser.

Automated welding unit «Vulkan»

The automated welding unit «Vulkan», in which experiments on welding and cutting in open space were conducted, was designed and manufactured at the E.O. Paton Electric Welding Institute.

In creation of the unit leading scientists, designers, technologists, assemblers of equipment and testers of the Institute took part. A great help in creating the unit was provided by the specialists of the S.P. Korolev RSC «Energia». It allowed performing fusion welding in three different methods: by a low-pressure arc with a consumable electrode, by a constricted low-pressure arc with a hollow cathode and an electron beam. The unit «Vulkan» consisted of two compartments. In a one (nonsealed) of them, devices to perform each of the mentioned welding methods and a rotating table with samples to be welded were located. During operation, in that compartment a low pressure — space vacuum was maintained. In another (sealed) compartment, an autonomous battery power source, a secondary power source (SPS was designed by the Institute of Electrodynamics of the NAS of Ukraine), control units and measuring instruments were installed. The unit was equipped with a remote con-

trol. The mass of the equipment is about 50 kg. The power of welding devices for different methods ranged from 0.6 to 1.0 kW.

The unit «Vulkan» was located in the airlock compartment of the «Soyuz-6» space vehicle. For the period of experiments, that compartment was depressurized. Inside the pressure was maintained close to the outboard pressure of $1 \cdot 10^{-4}$ mm Hg. During the experiment, the crew was in a sealed return compartment, separated from the airlock compartment by a closed hatch.

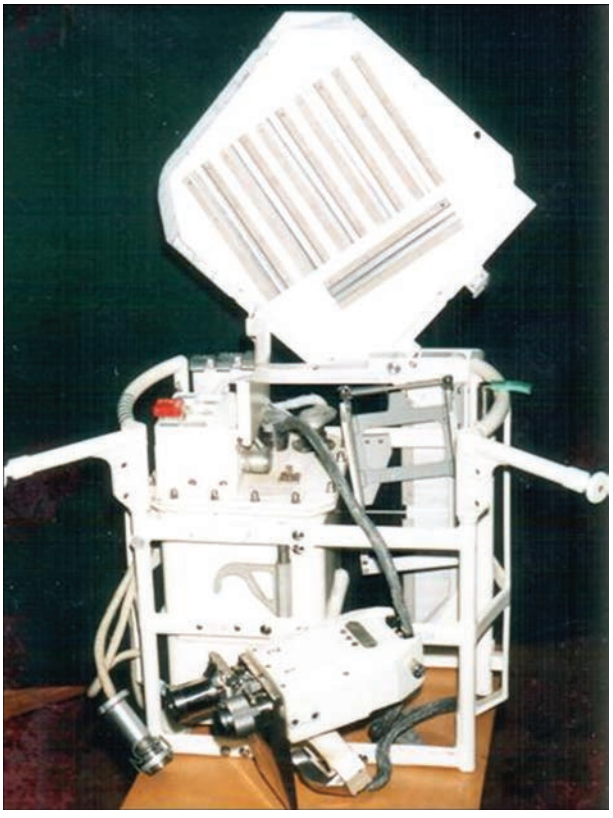
Kubasov V.N. and Shonin G.S. with the unit «Vulkan» before flight at the «Soyuz-6» space vehicle (1969)

Outer space, where manned space vehicles and stations fly, differs from the conditions on Earth by a number of so-called outer space factors and, first of all, by microgravity and space vacuum. Experiments on welding in space were a completely new direction among the works performed by our Institute. Therefore, when the directions of works on welding in space were determined, different types of welding both in the solid phase as well as fusion one were considered. But the most flexible and widespread types of welding works in space for performing possible assembly and repair-restoration operations are the methods of fusion welding. To apply welding methods that require the use of gases in outer space is very difficult. Outer space is a completely open infinite volume. Therefore, gas molecules are rapidly removed into outer space. Great difficulties also arise when using the method of arc welding with a consumable electrode in space. As the pressure of surrounding atmosphere decreases, the nature of arc discharge is changed. At low pressure, the plasma-forming substance is no longer gas, but fumes of filler and welded materials. Although the pressure of fumes in the region of the arc column is higher than the surrounding one, it is not enough to obtain a localized arc discharge. A great influence on the process of arc welding with a consumable electrode is exerted by microgravity. It complicates the transition of molten electrode metal into the weld, and the metal droplets located on the electrode can reach very large sizes. The problems discussed above are practically absent in electron beam welding. Space vacuum only contributes to a high-quality performance of electron beam welding, and microgravity does not significantly affect this process.

Paton B.E. and Kubasov V.N. near the unit «Vulkan»

The carried out experiments made it possible to establish that the most suitable type of welding in outer space is electron beam welding. It was found that during prolonged zero gravity and space vacuum, the processes of welding and cutting with an electron beam proceed stably and the necessary conditions for normal formation of welded joints and cuts are provided. Thus, the experiments carried out in

Set of the «Universal» equipment for manual electron beam welding



Universal manual tool (URI)

the unit «Vulkan» provided a wealth of information that allowed creating new models of space welding equipment in future and develop technologies for welding in space.

The carried out experiment started the era of space welding technologies.

The works on creation of equipment and technologies for welding in outer space were continued.

During the work in outer space on board a space vehicle, the most unexpected situations may arise that require the use of welding and related technologies, and often the type and scope of operations will have to be determined by cosmonauts directly in situ. They will have to work in different areas of a space vehicle and deal with different structural materials. For these purposes, at the E.O. Paton Electric Welding Institute a universal working tool (URI) was created. The tests of URI in outer space were carried out aboard the «Salyut-7» station by cosmonauts S.E. Savitskaya and V.A. Dzhanibekov. The carried out experiments on welding, cutting, brazing and coating showed good results and confirmed a high efficiency of the URI equipment in outer space.

The next generation of equipment for welding in outer space was the creation of the «Universal» equipment. Its main difference from the URI was the more than double increase in output power. In addition, a number of basic components was modified, which provided an increase in reliability of the tool. The «Universal» complex passed comprehensive on-land tests and was recommended for the use as a standard tool at orbital manned stations. Unfortunately, for a number of objective reasons, the «Universal» complex was not tested in outer space, although it was supposed to be tested both on board the space shuttle «Columbia» as well as at the «Mir» station.

Hand electron beam tool of a new generation

Analysis of the results of on-land technological experiments, conducted using the «Universal» equipment showed that it can be used to weld aluminum and titanium alloys, as well as stainless steel of up to 1.5 mm thickness.

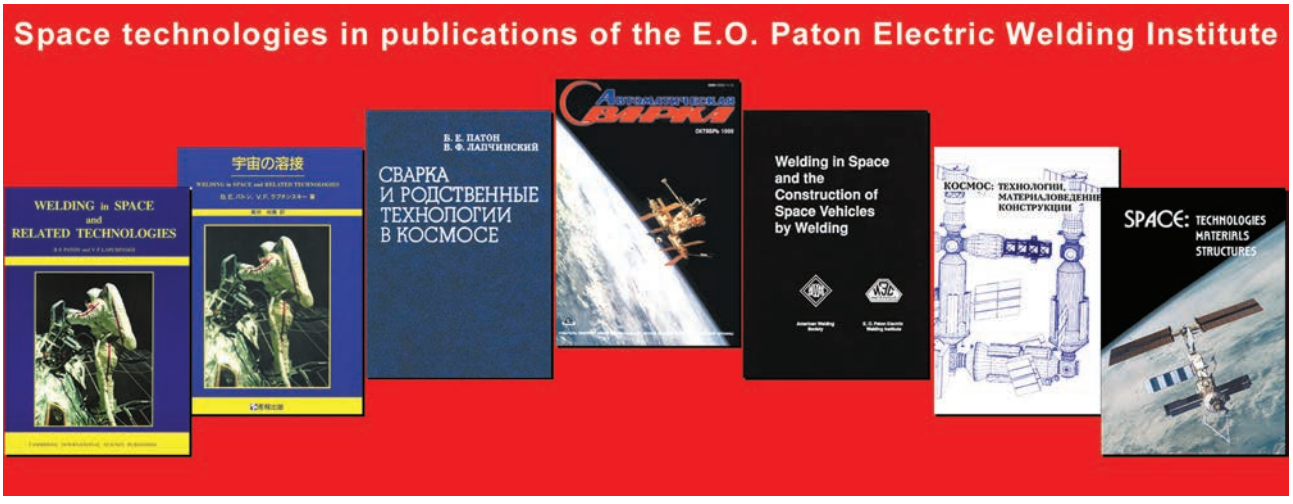
At present, at the E.O. Paton Electric Welding Institute the works on creation of the next generation of electron

beam tool for welding in outer space are carried out, which includes triode electron beam gun, separated from high-voltage power source. The separation of electron beam gun from power source and the use of flexible high-voltage cable with small-sized high-voltage connector for this purpose makes it possible to significantly reduce the dimensions and weight of the tool, increase its maneuverability when carrying out technological processes in outer space, increase the duration of continuous operation and operational reliability, as well as to facilitate the replacement of tools for different technological purposes directly outboard the space vehicle.

In electron beam tool of a new generation, the power was significantly increased — up to 2.5 kW, which allows welding aluminum and titanium alloys, as well as stainless steel with a thickness of 6 mm. The electron-optical gun system allows obtaining a sharply focused beam with a diameter of not more than 0.6 mm. The mass of the gun is 2.5 kg (twice lower than in the «Universal»). The life of cathode is significantly increased and is equal to 30–40 h. The replacement of a worked out cathode unit can be performed in orbit during 5–10 min. The tool is provided with the possibility to operate not only in manual but also in automatic mode using robotic devices or manipulators.

Recently, all over the world the works related to exploration of the Moon are carried out. At the E.O. Paton Electric Welding Institute, the equipment is developed to perform electron beam welding under the conditions of the Moon surface when creating long-term lunar bases and infrastructure for these constructions. Taking into account special physical conditions on the Moon surface, first of all, ultrahigh vacuum (up to 10^{-13} mm Hg), the necessary sealing of joints can be reliably secured only by welding. Therefore, the creation of welding equipment and technologies for assembly and repair-restoration works on the Moon surface is very relevant during its exploration by a human. In addition to ultra-deep vacuum, there are other physical features on the surface: a sharp change in temperatures from +140 °C at day-time to –170 °C at night, reduced gravity (1/6 of gravity on Earth), lunar dust (regolith), etc. All these features should be taken into account when developing both welding equipment as well as when creating auxiliary devices — workplace of the operator. In the developed design of a gun the conditions for electron beam formation in an ultra-deep vacuum were taken into account, which differ significantly from those in on-land vacuum installations and in near-Earth space, where space vehicles and manned space stations fly.

We are convinced that space welding equipment and technologies, the foundation of which was laid 50 years ago by the «Vulkan» experiment, will find application in different projects during construction of industrial complexes on Earth orbit, exploration of the Moon and flights to other planets, and also on the study of fundamental space phenomena.



INTERNATIONAL CONFERENCE «BEAM TECHNOLOGIES IN WELDING AND MATERIALS PROCESSING»

In the period **from September 9 to 13, 2019** , IX International Conference «Beam Technologies in Welding and Materials Processing» (LTWMP-2019) was held in Odessa at «Arkadia» hotel. The Conference was organized by the E.O. Paton Electric Welding Institute of the NAS of Ukraine, NTUU «Igor Sikorsky Kyiv Polytechnic Institute» and International Association «Welding».

More than 60 scientists and specialists from Ukraine, Slovakia, Germany, Belarus and China took part in the Conference. It was organized in the form of plenary and poster sessions; conference working languages were Russian, Ukrainian and English (synchronous translation of the papers was provided). 37 presentations were made during the plenary and poster sessions.

The Conference was opened by Academician I.V. Krivtsun, Deputy Director of PWI, Chairman of Conference Program Committee. In his address he noted that papers on laser subjects, hybrid and 3D technologies were submitted for presentation at the conference, as well as papers on electron beam technologies in welding and special electrometallurgy. Academician I.V. Krivtsun also noted the role of the vapour-gas channel in beam technologies at formation of welded joints and role of the synergic effect in hybrid technologies.

Let us mention some of the papers which give an idea about the issues raised at the conference:

- «Features of formation of metal structure of products from titanium alloys, produced by 3D printing with application of profiled electron beam by xBeam 3D Metal Printing Technology», *Kovalchuk DV.*, PJSC «NVO «Chervona Hvilya», Kyiv;
- «Contribution to the welding of hot-rolled aluminium-lithium alloys by electron beam», *Drimal Daniel*, PRVA ZVARACSKA a. s., Bratislava, Slovak Republic;
- «Specialized technological electron beam equipment for realization of additive process of layer-by-layer manufacturing of metal products with application of powdered materials», *Nesterenkov VM.*, PWI, Kyiv;
- «Electron beam melting of high-temperature titanium alloys of Ti–Si–Al–Zn–Sn system», *Severin A.Yu.*, SC «SPC Titan» of PWI, Kyiv;
- «Optimization of technological parameters of layer-by-layer formation of products from VT6 titanium alloy using EBW based on mathematical modeling», *Kandala SM.*, PWI, Kyiv;

Academician I.V. Krivtsun addressing the Conference at the opening

Participants of LTWMP-2019 Conference

● «Optimization of technological operations of laser welding and laser surfacing of elements of small-sized nozzle blocks of liquid rocket engines», *Shelyagin VD*, PWI, Kyiv;

● «Modeling of temperature fields in electron beam sintering», *Semenov O.*, PWI, Kyiv;

● «Electron beam technology as a method of producing thermal barrier coatings of ZrO_2–Y_2O_3 system with good functional characteristics on different types of metal bond coats», *Kuzenkova VV*, LLC «Paton Turbine Technologies», Kyiv;

● «Formation of consumable electrodes from sponge titanium by the method of electron beam surface melting», *Pikulin AN.*, SPC «Titan» of PWI, Kyiv;

● «Microstructure of VT20 titanium alloys produced by the method of layer-by-layer electron beam surfacing with application of local powdered materials», *Matviichuk VA.*, PWI, Kyiv;

● «Hybrid laser-microplasma welding of stainless steels», *Khaskin VYu* Chinese-Ukrainian Paton Institute of Welding, Guangzhou, PRC;

● «Adaptive control of the process of laser welding and surfacing of parts of a complex shape, while ensuring the geometrical accuracy of trajectory movements», *Kombarov VV*, SPC «KHAI-Engineering». Kharkiv;

● «Regularities of the effect of the parameters of selective laser melting (SLM) on formation of a single layer from high-temperature nickel alloy INCONEL 718», *Adzhamskyi S.V.*, LLC «Laser additive technologies of Ukraine», Dnipro;

● «Structure and properties of the joints of AA7056 T351 aluminium alloy, made by electron beam welding», *Berdnikova EN*, PWI, Kyiv;

● «Modeling of the stress-strain state of steam turbine blades from titanium alloy at reconditioning repair with application of electron beam surfacing», *Kandala SM*, PWI, Kyiv;

● «Investigations of laser-casting process of producing bimetals for different functional purposes», *Salii SS.*, NTUU «Igor Sikorsky Kyiv Polytechnic Institute», Kyiv;

● «EBW and heat treatment of sparsely doped titanium alloys based on β-phase», *Belous VYu*, PWI, Kyiv;

● «Elimination of humping effect in laser-arc welding of higher strength steels», *Khaskin VYu* Chinese-Ukrainian Paton Institute of Welding, Guangzhou, PRC;

● «Structure and properties of dissimilar titanium-aluminium welded joints, produced by laser welding», *Sidorets VN*, PWI, Kyiv;

● «Hybrid system for electron beam evaporation and ion sputtering», *Kuzmichev A.I.*, NTUU «Igor Sikorsky Kyiv Polytechnic Institute»;

● «Electron beam melting of sparsely doped titanium-based alloys», *Berezos V.A.*, SPC «Titan» of PWI, Kyiv;

● «Investigation of the features of the processes of welded joint formation in laser welding of steels and alloys in different positions», *Bernatskyi AV.*, PWI, Kyiv;

● «Effect of condensed multilayer protective coatings on cyclic strength of VT-6 alloy», *Mikitchik AV.*, International Center for Electron Beam Technologies of PWI, Kyiv;

● «Microstrengthening of the boundaries of deposited layers in items produced by electron beam surfacing», *Khokhlova YuA.*, PWI, Kyiv.

Presentations on laser application in medicine, for 3D printing of plastics and two presentations on application of non-beam concentrated heat sources were also made:

- «Effect of pulsed-arc welding modes on thermal cycles and geometrical parameters of welds and HAZ of welded joints made by high-alloyed welding consumables», Poznyakov V.D., *PWI*, Kyiv;
- «Melting temperature of metal nanoparticles in plasma», *Dragan GS,* SRI of Physics of I.I. Mechnikov Odessa National University.

Outside of conference program, *APMk hachev*, Director of the Center of Chemical Technologies of the Academy of Engineering Sciences (Kam'yanske) spoke about the directions of the Center activity on restoration of hafnium, zirconium, niobium and molybdenum production in electron beam remelting units in Ukraine.

Polishko AA. (PWI) made a presentation about YPIC/WRTYS 2020 «Young Professionals International Conference on Welding and Related Technologies», May 19–22, 2020, Kyiv (https://ypic2020.com) and invited the scientists, specialists and business leaders to take part in it as presenters, listeners and sponsors. Representatives of a number of Ukrainian industrial enterprises from Kyiv, Dnipro, Zaporizhzhia, Kharkiv, Kryvyi Rih, Kam'yanske, using laser and beam technologies in the production cycle, also participated in the conference without making presentations.

The Conference was completed by a Round Table on «New developments in the field of 3D beam technologies». During the round table urgent problems of development of beam welding technologies were discussed in relation to manufacturing 3D products from various metallic materials, and finished products were demonstrated, which were manufactured by laser 3D prototyping (LLC «Laser Additive Technologies of Ukraine») and in electron beam units (PJSC «NVO «Chervona Hvilya», PWI).

Proceedings of LTWMP-2019 Conference will be published by the end of 2019. The Proceedings of the previous eight LTWMP Conferences can be ordered from «Avtomaticheskaya Svarka» Editorial Board or received in the public domain in PWI publishing house site at the following link: http://patonpublishinghouse.com/eng/proceedings/ltwmp.

Friendly, hospitable and creative atmosphere of the Conference contributed to development of useful discussions, and establishing business contacts. Conference participants unanimously supported the proposal to conduct the following tenth International Conference on beam technologies in welding and materials processing (LTWMP-2021) in September 2021 in Odessa, Ukraine.

Organizing Committee of LTWMP-2019 Conference expresses gratitude and appreciation to PJSC «NVO «Chervona Hvilya», High Energy Technologies Companies, Chinese-Ukrainian Paton Institute of Welding, PWI «Titanium» Center, PWI Electron Beam Welding Center, and PWI International Center for Electron Beam Technologies for their assistance in conducting the Conference.

Dr. A.T. Zelnichenko

*Calendar of October**

OCTOBER 1, 1934 Presidium of the USSR AS appointed E.O. Paton (1870–1953) as a director of Electric Welding Institute. To recognize welding as a reliable technological process it was necessary to carry out complex investigations of mechanics of welded structures, processes of metallurgy and materials science of welding, arc discharge physics; it was a need in development of apparatuses, materials and new welding technologies. These are the purposes, which made a basis for establishment by the initiative of E.O. Paton the first in the world practice Institute, which in the next years won leading grounds in development of welding engineering and technologies.

OCTOBER 2, 1934 First fly of training, two-seater low-wing aircraft AIR-9 with M-11 engine of Yakovlev DTB, piloted by pilot Yu.I. Piontkovsky. On July 4, 1937, pilots Irina Vishnevskaya and Ekaterina Mednikova made a woman international record for light aeroplanes of the first category. They reached 6518 m height. The fuselage of the plane is truss, welded of steel tubes and additionally braced. Such a decision was very unusual for that time, but significantly simplified plane production.

OCTOBER 3, 1967 Experimental rocket airplane «North American X-15A-2» gained the speed of 7273 km/h that is 6/72 times higher the sound velocity. First and for the 40 years single in the history piloted hyperacoustic air vehicle-plane performed suborbital piloted space flights. The peculiarity of airplane «North American X-15» was wide application of welding in its production. Thus, around 70–80 % of welded structures were in the airplane structure.

OCTOBER 4, 1957 First artificial Earth satellite was launched. Work of designers and manufacturers during satellite production was carried out simultaneously due to constricted terms. The main difficulty was in manufacture of spherical semi-shells by hydrodrawing, their welding with frame and polishing of the outer surfaces, even minor scratches were not allowed on them; welding of welds should be tight and was X-ray controlled, and tightness of assembled container was checked by helium leak detector.

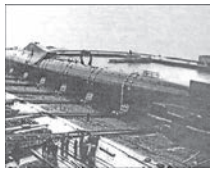
OCTOBER 5, 1929 Birthday of N.P. Lyakishev (1929–2006), researcher-metallurgist, academician of the RAS and NAS of Ukraine. He developed a series of sparsely-alloyed cold-resistant steels with good weldability for main gas pipelines of northern designation and technological processes of their commercial production. He initiated implementation in the metallurgy of the process of direct iron production. In 1975–1984 he was a director of I.P. Bardin TsNIIchermet; in 1987–2004 he was a director of A.A. Baykov Institute of Metallurgy and Materials Science.

OCTOBER 6, 1893 Birthday of Meghnad Saha (1893–1956), Indian physicist and astronomer, member of the Royal Society of London (1927). The scientific works of M. Saha refers to thermodynamics, static physics, astrophysics, theory of propagation of radio waves, nuclear physics. An important scientific basic for development of arc welding was a theory on plasma ionization. To characterize the process of ionization M. Saha in 1921 proposed the equitation, named after that by his name. In development of this equation in 1924 I. Langmuir derived the formulae for determination of the level of ionization of vapors of substance evaporating from heated surfaces.

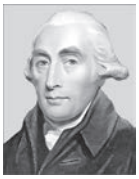
OCTOBER 7, 1934 Akulov N.S. (1900–1976), Soviet physicist, academician, specialist in the field of ferromagnetism developed in 1934 the first magnetic flaw detector. He studied influence of magnetic fields on different characteristics of ferromagnetic metals. He was awarded with the USSR State Prize for application of developed theory of ferromagnetism in metal flaw detection.

OCTOBER 8, 1936 Birthday of V.N. Zamkov (1936–2005), a well-known scientist in the field of metallurgy and welding of titanium alloys. Among the works of V.N. Zamkov it is necessary to note the development of a new method of argon-arc welding of titanium over a flux layer, which allowed fundamentally changing titanium welding technology, and thus, solving the problem of increase of welded joint quality. Under his direct leaders there were developed fundamentally new consumables for welding, namely fluxes and flux-cored wires.

*The material was prepared by the Steel Work Company (Kryvyi Rih, Ukraine) with the participation of the editorial board of the Journal. The Calendar is published every month, starting from the issue of «The Paton Welding Journal» No.1, 2019.



OCTOBER 9, 1950 USSR State Prize was awarded to B.I. Medovar, R.I. Lashkevich (PWI), G.K. Slysh, A.M. Garagulya, P.I. Sobolev (Khartsyzsk Pipe Plant) for development of a new high-performance method of automatic twin arc welding of large diameter pipes. Method of automatic twin arc welding of pipes promoted rapid development of domestic pipe production.



OCTOBER 10, 1731 Birthday of Henry Cavendish (1731–1810), British physicist and chemist. In 1766 Cavendish published the first important work on chemistry «Artificial air», where he informed about discovery of «combustible air» (hydrogen). He extracted (1766) carbon dioxide and hydrogen in pure form, accepting the latter as phlogiston, determined the main composition of air as a mixture of nitrogen and oxygen. He derived nitrogen oxides. These discoveries were an important constituent for next development of technology of autogenous welding.

OCTOBER 11, 1963 Howaldtswerke-Deutsche Werft Company in Kiel lied down a keel Otto Hahn, one of the fourth ever built merchant ships with nuclear power system. It was set afloat in 1964. In 1968 38-megawatt nuclear reactor of the ship was launched and seal trial was started. In October of the same year Otto Hahn was certified as merchant and research ship. In order to secure a crew it was decided to weld a reactor block in special large compartment. At that particularly rigid requirements were made to the welds and for this multiple tests of their quality were carried out.

OCTOBER 12, 1940 Soviet pilot V. Kokkinaki started testing of the second variant of single-seat plane Il-2, Soviet attack aircraft designed at DTB-240 under the leadership of Ilyushin S.V. Being the main attack power in the Soviet aviation, Il-2 attack aircraft played outstanding role in the Second World War. It was the war-plane of the most mass production in the history of air construction. In total there were produced 36 thou. The fuselage of the aircraft was all-metal or mixed type. The front part represented itself welded shell (armored hull) of stamped sheets of armor of 4–6 mm thickness, joined by riveting and welding. Developed high-performance technology of combined welding of elements of structure of Il-2 and Yak-7 of hardened steel was honored with Stalin Prize in 1946.

OCTOBER 13, 1941 State Defense Committee made a decision on construction of two plants in Barnaul, one of them on production of tank T-50. Tank hull was welded of armour sheets of 45 mm thickness, except for bottom and top (20 mm). In welded faceted turret 45 mm gun of 1934 year type and coaxial with it machine-gun of 7.62 mm bore were located. Sheet of the hull of T-50 were joined by welding and located under high tilting angles. To 1942 the engineering drawings for hull of homogenous armour of 40 mm thickness optimized for semi-automatic welding were prepared.

OCTOBER 14, 1948 The first in the history of aviation supersonic flight took place in 1947. It was done by pilot Charles Yeager on «Bell X-1» plane with liquid rocket which was launched from carrier aircraft Boeing-B29 and gained 2600 km/h velocity. Airframe was made of high-strength aluminum, fuel tanks were welded of steel. Welding was also used in manufacture of airframe parts.

OCTOBER 15, 1992 Publication of one of the patents of B.I. Medovar (1916–2000), leading scientist in the field of welding and metallurgy, academician, representative of the Paton school. Starting from 1960 he was developing the theoretical fundamentals of materials science and metallurgy of austenite steel welding. He was dealing with the problems of surfacing, remelting and casting. He is one of co-authors of technology of electroslag welding. Starting from 1979 he was a head of the works on development of new class of structural metallic materials obtained by electroslag remelting method.

OCTOBER 16, 2104 The last model of new generation of iMac computers was issued. The main peculiarity of it was strikingly thin body. In presentation it was mentioned in passing about some revolutional welding technology, which allowed making the body significantly thinner. It emerged that for joining the parts of new iMac the technology of rotation friction welding was used. As a result it was possible to get smoother and stronger joint, which provides the possibility to make the part thinner at that this process uses less energy than traditional joining technologies. Thanks to this thickness of body edge in Apple compurer is only 0.5 cm.

OCTOBER 17, 2001 Day of death of P.I. Sevbo (1900–2001), a well-known designer and scientist, representative of the Paton school, which for a long time was a head of design bureau of the E.O. Paton Electric Welding Institute. During the Second World War the personnel of the bureau under P.I. Sevbo leadership rapidly developed and implemented tens of specialized apparatuses and machines for automatic welding of armour hulls of T-34 tank. In the post-war years P.I. Sevbo actively worked on development and improvement of welding equipment for many braches of industry. He developed a series of projects related with complex automation of welding production.

OCTOBER 18, 1888 Method of metal-arc welding developed by N.G. Slavyanov was tested on public in presence of state commission in welding of crankshaft steam-engine. This date is considered as a birthday of Russian electric welding. The first in the world welding shop (so called electric casting factory with electric generator) was organized at the plant and since 1889 the record started to be kept «Record on works carried using electric casting of mining engineer Slavyanov at Perm cannon plant». Certificates on quality of performed works after part operation was mandatory attached to the record.

OCTOBER 19, 1958 Opening of the First International Exhibition in Brussels, where one of the main sights was Atomium. One the symbols of Brussels is a huge steel construction located on North-West, on Heysel park hill. It was designed by architect André Waterkeyn and constructed under the leadership of André and Michel Polak. By the idea of Waterkeyn its structure symbolizes beginning of new age, i.e. age of science, exploration of space and peaceful usage of nuclear energy. These unusual structure consists of 9 spheres «atoms» and presents a model of crystal of ferrum enlarged 165 bln times. Atomium can be considered as an anthem of welded structures of the XX century.

OCTOBER 20, 1480 Birthday of Vannoccio Biringuccio (1480–1539), Italian alchemist, metallurgist and architect. He was studying alchemy, metallurgy and casting for a long time in Italy, Czechia and Austria. He was a well-known in Europe casting craftsman and dealt with manufacture of military equipment in Florentine Republic. Here in 1529 Biringuccio casted one of the largest for that time cannons of more that 6 t weight and 6.7 m length. In his ten-volume work «Pyrotechnics» he describes, in particular, creation of butt joint using forge welding with the help of silver, broken glass and other materials. This was the way for joining swards and other types of weapon.

OCTOBER 21, 1954 Birthday of I.V. Krivtsun, leading scientist in the field of theoretical investigations and mathematical modelling of physical phenomena in low-temperature technological plasma, academician, representative of the Paton school. He developed such novel hybrid processes as laser-microplasma welding of metals of small thicknesses, laser-plasma powder surfacing and spraying of ceramic materials, laser-plasma deposition of diamond and diamond-like coatings. For practical implementation of indicated technological processes it was developed a series of integrated laser-arc plasmatrons, which have no analogues in the world practice. I.V. Krivtsun is the author of more than 270 research works, four monographs and ten patens.

OCTOBER 22, 1967 During the International Exhibition in 1967 the visitors were able to see the largest in the world open air geodesic dome, known as Montreal biosphere. The dome was constructed using approximately 65000 parts, including 13 km of extruded aluminum tubes welded in hexagon. It has no inner bearing elements and almost all 80 tons structures stands on five pylons filled with concrete.

OCTOBER 23, 1953 First public performance of the largest for that time helicopter YH-16 Transporter. It was piloted by Harold Peterson and George Callahan and became the first in the world helicopter with two gas turbine engines. Length of heavy transport helicopter made 24 m, diameter of two main rotor — 25 m. Such a dimensions were explained by technically set duration of flight, i.e. 2250 km. For the first time high-frequency resistance welding was used in construction of the helicopter.

OCTOBER 24, 1804 Birthday of Wilhelm Eduard Weber (1804–1891), German scientist-physicist. The main works of scientist belong to the field of magnetic phenomena and electricity. He determined an absolute system of electric measurements. The unit of measurement of magnetic flux is named after him. It was stated in 1881 at International Electric Congress in Paris.

OCTOBER 25, 2005 Start of operation of airliner A380, wide-body passenger plane, the largest serial airliner in the world. According to the designers, the most complex problem in development of plane was the problem of weight reduction. Seat capacity is 525 passengers in the cabin of three classes and 835 passengers in one class configuration. Progressive welding technologies and improved aluminum alloys were used for reduction of plane weight. For lower panels of fuselage laser welding of stringers and skin was used that significantly reduced amount of fasteners.

OCTOBER 26, 1972 Sikorsky I.I. (1889–1972) died. He was a world-known aircraft designer of Ukrainian origin. First serially produced helicopter of his design Sikorsky R-4 Hoverfly flied for the first time on January 13, 1942. Its fuselage was framed and welded of steel tubes. Whole fuselage had linen skin. The cabin was with Plexiglas windows and aluminum aprons between them.

OCTOBER 27, 1984 Official opening of through traffic on Baikal-Amur mainline (construction in 1938–1984) of 3819 km length. Nowadays there is reconstruction of mainline, including laying of continuous track using alumothermic welding.

OCTOBER 28, 2013 Zumvalt class missile destroyer was set afloat. Zumvalt destroyer is the key part of the SC-21 program of USA Nay . Program started in 1991 was directed on development of a family of universal ships of new generation. Destroyers of this series are the multipurpose and designed for attacks of enemy on shore, counter-air missions and fire support from sea. Development of this type of ship is one of the recent achievements of military equipment. Arc welding having increased requirements to weld quality was widely used in this project realization.

OCTOBER 29, 1955 Battle ship Novorossiysk (until 1948 ship of Italian Navy «Giulio Cesare») went down in Sevastopol harbor. 829 people died. In May 1955 it was included in the Black Sea Navy Fleet and regardless declining ages (44 years) it became the most powerful ship in USSR. Repair was carried out in Sevastopol with wide application of welding.

OCTOBER 30, 1961 The most high-capacity explosive device in the history of humanity was exploded in Novaya Zemlya. AS of USSR headed the development of bomb AN602. Capacity of explosion is 575 megatons in TNT equivalent.

OCTOBER 31, 1935 First pilot variant of DI-6 plane (CDB-11), Soviet two-seat fighter was given by the plant-manufacturer for ground and plant tests. In the process of manufacture of this fighter atomic-hydrogen welding was used for the first time in the USSR for welding of wing spars. Fuselage of DI-6 is framed and welded of steel tubes with light outer cage, coated from the back side with linen. The wings are two-spar and welded of tubes. Later on the plane started to be produced with welded fuel tanks.