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 08 2020

Published Monthly Since 2000

English Translation of the Monthly «Avtomatychne Zvaryuvannya»
(Avtomaticheskaya Svarka/Automatic Welding) Journal Published in Ukrainian and Russian Since 1948

Founders
E.O. Paton Electric Welding Institute
International Association «Welding»

Publisher
International Association «Welding»

Translators
A.O. Fomin, I.M. Kutianova
Editor
N.G. Khomenko
Electron galley
D.I. Sereda, T.Yu. Snegiryova

Address
E.O. Paton Electric Welding Institute,
International Association «Welding»
11 Kazymyr Malevych Str. (former Bozhenko),
03150, Kyiv, Ukraine
Tel./Fax: (38044) 200 82 77
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/10.37434/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

E.O. PATON INSTITUTE OF MATERIALS SCIENCE AND WELDING WAS FOUNDED AT THE IGOR SIKORSKY KPI

I.V. Krivtsun, P.I. Loboda, S.K. Fomichov and **V.V. Kvasnytskyi**

According to the order of the rector, Professor Zgurovskyi M.Z, Academician of the NAS of Ukraine, in accordance with the Decision of the Academic Council at the National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» on the basis of Engineering Physics (EPF) and Welding (WF) faculties and departments of Laser Engineering and Physics and Technical Technologies of the Institute of Mechanical Engineering (IME) on July 1, 2020, the newly founded E.O. Paton Institute of Materials Science and Welding, the abbreviated name — E.O. Paton IMSW, started its work. The acting Director of the E.O. Paton Institute of Materials Science and Welding, Dr. of Techn. Sci., Professor Loboda P.I., the Corresponding Member of the NAS of Ukraine was appointed. The founded Institute is not an ordinary association of materials science faculties and departments. In essence, it is a new modern form of educational, research and production organization — a cluster, whose activities involve close cooperation with the institutes of the National Academy of Sciences of Ukraine and industrial enterprises. The main idea of creating a new institute is not a usual integration of these three, undoubtedly the most important areas of activity, but the achievement of a certain synergetic effect, when as a result of interaction of particular components, a new quality is formed. The partners of the E.O. Paton IMSW are the institutes of the Department of Physical and Technical Problems of Materials Science of the NAS of Ukraine, first of all, E.O. Paton Electric Welding Institute, I.M.Frantsevich Institute for Problems of Materials Science, V.M. Bakul Institute for Superhard Materials and Physico-Technological Institute of Metals and Alloys. Among the industrial business partners there are strategic enterprises of Ukraine, in particular, the group of Companies «PlasmaTech», one of the leading manufacturers of consumables for welding, mining and metallurgy Company «Metinvest», one of the world's leading manufacturers of basic structural material — steel. The main task of the E.O. Paton IMSW is to accelerate the formation of a scientific worldview of engineering and scientific personnel through a close integration of educational, scientific and practical industrial training. The basis of the scientific worldview is mastering the principles of creating new, or choosing from existing ones, materials with the necessary set of physical, chemical and technological properties that provide a reliable operation of products under certain conditions. Namely the complex of properties depends on the nature, atomic-crystalline structure, microstructure, phase composition of material and directly affects parameters of the processes of materials treatment or manufacture of parts and components of modern engineering. The choice of parameters for the technological process primarily depends on the physical, chemical and technological properties of materials. Therefore, the choice of the most productive, resource- and energy-saving process, the safest for the environment and nature in general for high-tech production, requires knowledge of the relationship between the chemical composition — parameters of technological processes of treatment or manufacturing — microstructure and properties of material or product that provide the performance of the functions specified by the operating conditions. This approach will allow combining knowledge of creation, production, operation and disposal of materials with the longest reliable service life. In other words, combining the efforts of scientific and pedagogical teams of departments will form a modern scientific worldview on the choice of materials and technologies, the most effective power, technical, economic and environmental support of materials at all stages of creating new materials of long-term operation. The main competitive advantage of the E.O. Paton IMSW is that the scientific activities of the departments cover all stages of the product life cycle based on the advanced technologies, starting from the devel-

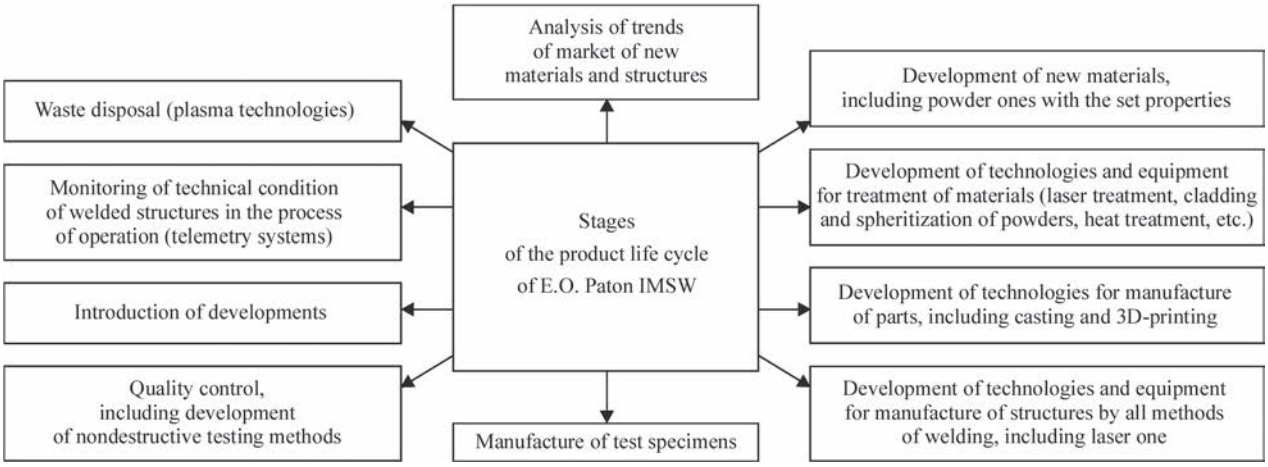


Figure 1. Stages of the product life cycle, which are covered by the activities of the E.O. Paton IMSW

opment of new materials with specified characteristics and the creation of parts and structures and ending in solving recycling problems (Figure 1).

The main purpose of combining scientific and pedagogical potential, methodological and laboratory base of the departments of the Institute is to create conditions for generating scientific knowledge with the direct participation of students (bachelors, masters), graduate students and employers. The main topics for research works are expected to be found on the basis of specific technological problems of industrial products manufacturers. To strengthen both the scientific and pedagogical potential and the laboratory base, close cooperation with the institutes of the National Academy of Sciences of Ukraine is envisaged. Starting from the 2nd year, scientists of the institutes of the National Academy of Sciences of Ukraine will be able to select and manage qualification scientific works of bachelors, masters and doctors of philosophy. Thus, in the field of education, a new quality of training is provided in accordance with a three-level system in keeping with the scheme «Bachelor – Master – PhD». Such training will take place in close cooperation with academic institutes, which, in turn, require the involvement of young researchers, as well as with industrial and partner companies that are in dire need of young, well-trained and highly qualified engineers. At the same time, such training will be carried out within the framework of large scientific and technical and research-production projects, which will be realized by the E.O. Paton IMSW together with academic institutes and business partners. In other words, training will actually take place under conditions as close as possible to real production. This will significantly improve the level and quality of training of graduates — professionals who will be more adapted for further work in science and industry. In the field of science, the main problem of today's Ukraine is the lack of able-minded and talented young scientists — specialists who are able to solve complex problems put forward by modern science, especially materials science. Creation of new laboratories within the E.O. Paton IMSW, their equipping with state-of-the-art research equipment at the financial support of business partners will allow realizing joint large-scale scientific and technical projects with the partner institutes of the NAS of Ukraine and, in particular, international ones with the involvement of young people — students, which are able to solve complex problems of modern materials science. Regarding the field of production, within the newly established laboratories of the E.O. Paton IMSW not only fundamental research works will be carried out, the results of which will provide a significant contribution to modern materials science, but also applied, technological investigations aimed at improving existing and creating new production technologies for producing, treatment and joining of materials. At the same time, the problematic of basic investigations should be formed on the basis of inquiries and unresolved issues of production in order to solve existing problems and increase the efficiency of production processes, provide resource conservation and extend the service life of products and structures, which will create new breakthrough technologies and effective use of energy and labor resources, creation of new materials. The results of such investigations should be used in the creation of technological processes and equipment for their

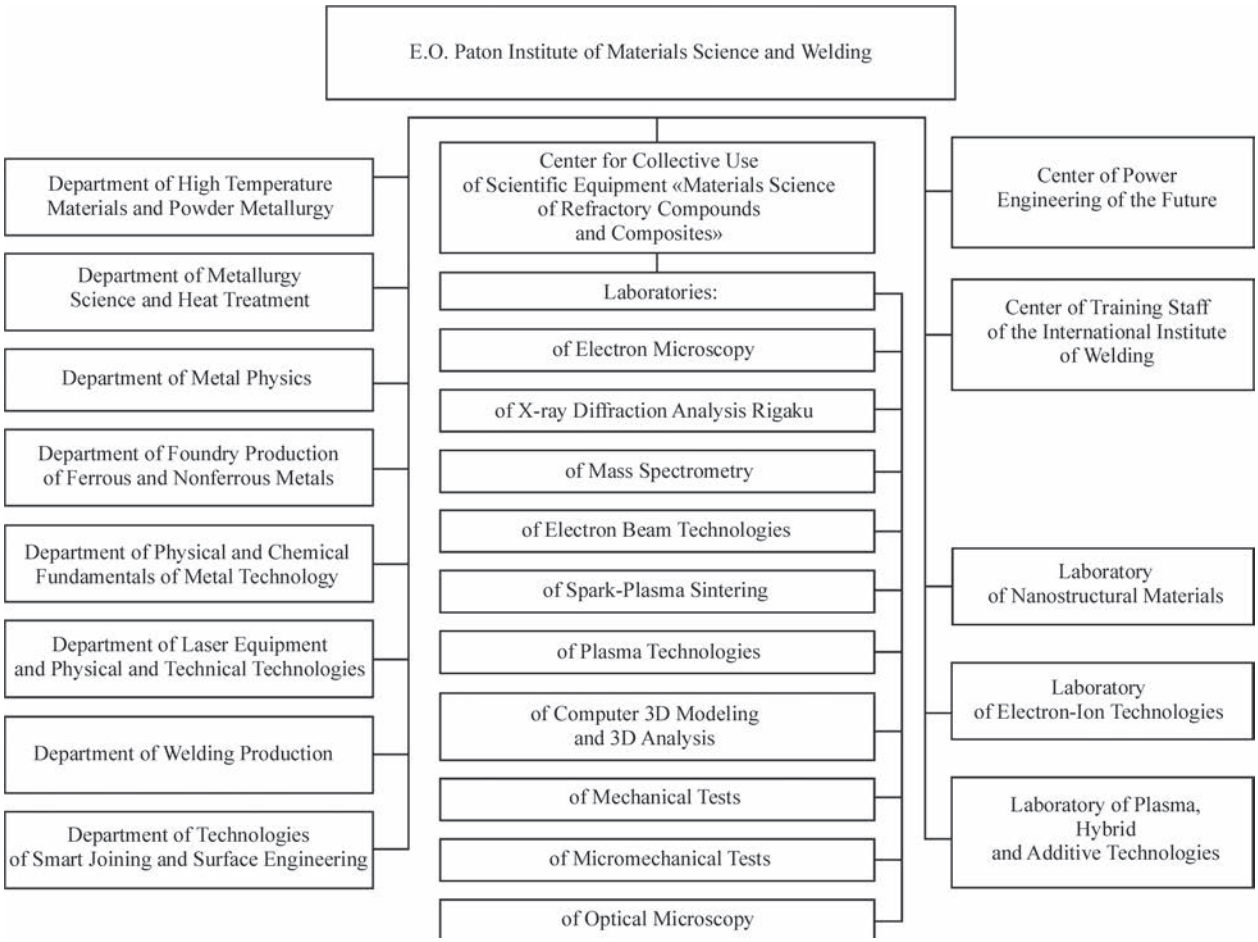


Figure 2. Organiza tional structure of the E.O. Paton Institute of Materials Science and Welding

realization not only at industrial partner enterprises, but also at other industrial enterprises of Ukraine and in the world. According to the proposed concept, approved at the meeting of the Academic Council of the Igor Sikorsky KPI on June 30, 2020, the structure of the E.O. Paton IMSW was organized (Figure 2).

The E.O. Paton IMSW was founded on the base of 9 departments of three faculties of the Igor Sikorsky KPI, in particular:

- Faculty of Laser Equipment and Physical and Technical Technologies — IME;
- Faculty of High-Temperature Materials and Powder Metallurgy — EPF;
- Faculty of Foundry Production of Ferrous and Nonferrous Metals — EPF;
- Faculty of Metallurgical Science and Heat Treatment — EPF;
- Faculty of Physical and Chemical Fundamentals of Technology of Metals — EPF;
- Faculty of Physics of Metals — EPF;
- Faculty of Welding Production — WF;
- Faculty of Electric Welding Machines — WF;
- Faculty of Surface Engineering — WF.

By merging the departments of Electric Welding Machines and Surface Engineering (WF) within the framework of the E.O. Paton IMSW, a new powerful Department of Smart Technologies of Joining and Surface Engineering was founded. The prospects of founding the E.O. Paton IMSW are associated with the expansion of capabilities of individual structural units, being a part of the Institute. In particular, such a merging creates preconditions for strengthening the scientific-innovative and educational potential of structural units, provides an opportunity for lecturers and research associates of large departments to carry out major complex strategic scientific and educational projects of the state-civilization level, including quality of life. In addition, it reduces the process of creating a new innovative competitive product with a simultaneous synergetic increase in the leading scientific schools as well as strengthening and improving the professionalism of scientific and pedagogical potential of departments. This is extremely important, because according to the data of QS World University Rankings

2020, Igor Sikorsky KPI occupies a fourth place among Ukrainian higher educational institutions (HEI), which were included in the ranking of the best universities in the world. When compiling the ranking, the authors are guided by a number of criteria, such as academic reputation of the institution, citation index of articles by its lecturers and associates, percentage of foreign students, reputation of a HEI among employers, etc. However, according to the analysis, the existing domestic network of HEI does not seem to be resulting and efficient as far as it is «closed in itself», and being a modern world-class university implies a tangible participation of the corresponding scientific-production and educational institution in the global space. According to the Regulation on accreditation of educational programs, applied to train applicants for higher education, which is approved by the Order of the Ministry of Education and Science of Ukraine, dated July 11, 2019 No. 977, the self-analysis of departments for compliance with the requirements of the National Agency for Quality Assurance in Higher Education (NAQAHE) was carried out, the results of which indicate an incomplete compliance of particular departments with the current requirements. Therefore, the foundation of E.O. Paton IMSW is one of the ways to overcome the lag of Igor Sikorsky KPI from the world's leading universities and provide a full compliance of the quality of student training by the departments of the Institute and current educational programs at all levels to the Criteria for assessment of the quality of educational programs accepted by NAQAHE. An extensive integration and involvement of institutes of the NAS of Ukraine and employers' enterprises in the implementation of the educational process at the E.O. Paton IMSW creates preconditions for improving the results of its activity according to the criteria for access to educational programs and recognition of learning outcomes, human resources, educational environment and material resources, internal assurance of quality of educational programs, transparency and publicity, learning through investigations. This will promote deepening of the internationalization of the University, strengthening of the international component in all aspects of its activities and, in particular, attract more foreign students and invite well-known foreign scientists and lecturers to participate in the educational process with a simultaneous expansion in the participation of associates of the Institute in the international projects. The world trends in higher education indicate the need in creating favorable conditions within the framework of the University for self-realization of students, young lecturers and scientists, providing a continuous improvement of knowledge of specialists throughout the life, which is one of the most important tasks of founding the E.O. Paton IMSW. A rapid orientation of structural units of the Institute in the training of highly-qualified specialists to the challenges of the world market, taking into account the requirements of employers and industry of Ukraine is provided through the implementation of modern management methods within the framework of the E.O. Paton IMSW, including also the project management. Such approach provides a significant improvement in the quality of scientific and educational projects of a newly founded Institute both at the stage of their preparation for submission and at the stage of realization. On the other hand, the integration provides new enhanced opportunities for students and associates of departments to improve the efficiency of the educational process and investigations through the joint use of modern laboratory facilities of departments of the Institute and the centers and educational and scientific laboratories equipped with the modern equipment, created within the E.O. Paton IMSW jointly with organizations and enterprises. This provides not only the improvement in the quality of training specialists by the departments of the Institute, but also helps to expand the competitiveness of graduates in solving the threefold problem material–treatment–joining. With this aim, the structure of the E.O. Paton IMSW includes research centers and laboratories. In particular, the Center for Collective Use of Scientific Equipment «Materials Science of Refractory Compounds and Composites» includes the following laboratories: Laboratory of Electron Microscopy; Laboratory of X-ray Diffraction Analysis Rigaku; Laboratory of Mass Spectrometry; Laboratory of Electron Beam Technologies; Laboratory of Spark Plasma Sintering; Laboratory of Plasma Technologies; Laboratory of Computer 3D Modeling and 3D Analysis; Laboratory of Mechanical Tests; Laboratory of Micromechanical

Tests; Laboratory of Optical Microscopy. Within the framework of the Institute, the following centers act: the Center of Power Engineering of the Future, the Center of Staff Training in accordance with the requirements of the International Institute of Welding and the following joint educational and scientific laboratories: Laboratory of Nanostructural Materials; Laboratory of Electron-Ion Technologies; Laboratory of Plasma, Hybrid and Additive Technologies (Figure 3).

The founded research centers and laboratories contribute to the solution of both scientific and educational tasks of the E.O. Paton IMSW. They allow strengthening the scientific component by involving not only lecturers of departments to the research team, but also research associates of leading research institutes, enterprises and organizations of Ukraine, provide the creation of a scientific experimental base of collective use with the involvement of modern equipment for research works, strengthen the competitiveness of the E.O. Paton IMSW in the preparation of joint projects within the framework of national and international research programs. In the field of education, the functioning of such structures contributes to the improvement of existing and creation of new programs of training courses for students, which take into account the modern experience and needs of institutions being a part of the National Academy of Sciences of Ukraine, leading companies and enterprises, facilitates the introduction of modern educational technologies, creates a basis for attracting well-known Ukrainian and international scientists to teach series of lectures for students of the Institute (Figure 4), conducting specialized laboratory works in unique equipment.

In addition, the presence of a close cooperation of the team of the E.O. Paton IMSW with scientists from the institutes of the NAS of Ukraine and leading enterprises promotes an increase in the quality of educational and methodical materials of departments, facilitates the organization of a three-level system for preparation of experts according to the scheme bachelor–master–PhD, gives an opportunity to carry out training of experts of all levels under the common scientific management. The innovative component is also of great importance in the work of the Institute. Such a broad integration allows intensifying the process of publishing the results of scientific investigations, promotes concentration of joint efforts in the organization of conferences, seminars, publication of results in well-known scientific journals, which provides an effective information to enterprises and manufacturers about the created new materials and technologies, promotes an exchange of experience with leading experts in Ukraine and in the world. Such work contributes to the development of human resources of the University and relevant scientific schools. In general, the presence of such scientific centers and laboratories in the structure of the Institute contributes to the involvement of enterprises and employers' organizations in the realization of the educational process and scientific work of students and graduate students, facilitates an increase in the quality of performing qualification works by students at all levels and an improvement of teaching disciplines, taking into account modern requirements of science, industry and employers. E.O. Paton IMSW is a part of the joint German-Ukrainian faculty (Otto von Guericke University). It participates in a dual degree program with the Federal University of Uberland (Brazil). An extremely important task is assigned to the Center of Staff Training of the International Institute of Welding (IIW), which is accredited by the Education Center of IIW for training of the following international certified welding specialists according to the training programs: International Welding Engineer, International Welding Technologist, International Welding Inspector. It provides an increase in the level of training not only of bachelors, masters and graduate students of the E.O. Paton IMSW and other engineering faculties of the Igor Sikorsky KPI, as well as certified specialists of enterprises and organizations working in the field of welding. The development of this area of activity is facilitated by the involvement of leading specialists of Ukraine in the creation of the latest methodical base that meets international requirements, including textbooks for training international engineers, technologists and welding inspectors in accordance with the International Institute of Welding, taking into account the trends of development of welding science, equipment and technologies. Thus, the foundation of the E.O. Paton IMSW will provide the existence of the modern educational and scientific center of the international level at the Igor Sikorsky KPI, which

Figure 3. Students work in the Laboratory of Optical Microscopy (*a*); Laboratory of Electron Microscopy (*b*); conducting research in the Laboratory of X-ray Diffraction Analysis Rigaku (*c*); computerized installation PM-300 for plasma-powder surfacing in the Laboratory of Electron-Ion Technologies (*d*)

is aimed at the development of new materials and smart technologies for their joining on the basis of combining the potential of the leading scientific schools of the Igor Sikorsky KPI in the field of materials science, metallurgy, welding, surface engineering and laser technologies, as well as quality assurance of materials, products and structures. And the main advantage of the newly founded structure is the ability to provide the full life cycle of materials, which combines their creation, production, joining, application and disposal. Such an approach allows E.O. Paton IMSW to carry out an expanded range of scientific and innovative projects and increase the contribution of Ukrainian science to modern world materials science.

Figure 4. Yuryi Gogotsi, world famous graduate of EPF of KPI. Dr. of Techn. Sci., Prof., founder of the Institute of Nanotechnology of Drexel University (Philadelphia, USA), nominee for the Nobel Prize in Physics in 2019, delivers an open lecture at the Igor Sikorsky KPI (2020)

AUNP-002 PLANT

AUNP-002 plant was developed by «SP «VISP» Company (Kyiv) and is designed for automatic surfacing of outer surface of parts of rolling mill LPTs-1700, namely clutches, bearing bodies (pads), spindles, by a technological metal layer, using solid wire in shielding gas atmosphere, as well as flux-cored wire. The plant is designed for operation at ambient temperature from 0 up to +30 °C.

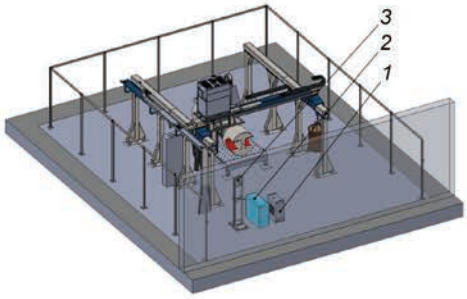
Plant is an equipment complex, allowing surfacing of flat and cylindrical parts by a technological metal layer. The plant base are the assembled left and right columns with rail guides, along which moves the gantry, carrying the process equipment.

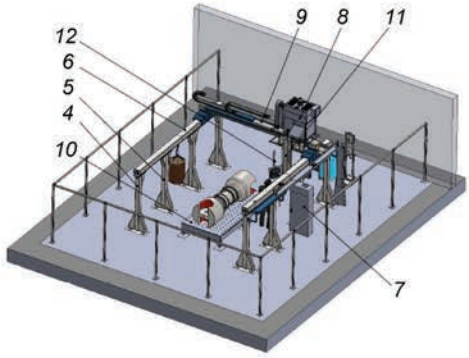
Rail guides, along which the carriage moves, are mounted in the upper part of the gantry. The carriage platform can accommodate exhaust gas filtering system, drums with flux-cored wire or solid wire, as well as a vertical carriage, which provides vertical movement of the torch.

The design allows torch adjustment by height and width, as well as regulation of the angle of inclination. Plant operation is controlled from a remote panel and main display.

Specification

No	Parameter description	Data
1	Dimensions (max) of surfaced parts, mm length width height	 3000 1200 1500
2	Surfacing process	MIG/MAG FCAW-G
3	Surfacing wire diameter, mm	1.6; 2.0; 2.4; 2.8; 3.2
4	Length of gantry horizontal movement, mm	3970
5	Length of horizontal movement of gantry carriage, mm	2500
6	Length of vertical movement of torch carriage, mm	1300
7	Speed of horizontal movement of gantry carriage, mm/min	3–6000
8	Speed of horizontal movement of gantry carriage, mm/min	3–6000
9	Speed of vertical movement of torch carriage, mm/min	3–6000
10	Maximum consumed power of control cabinet, kW	4
11	Maximum consumed power of aspiration system, kW	3
12	Maximum consumed power of welding source, kW	70
13	Maximum consumed power of the plant, kW	77
14	Mains parameters	3N~/50 Hz 380 V
15	Overall dimensions, mm length width height	 5300 5200 4300
16	Weight without welding equipment, kg	5200





1. Autonomous cooling unit
2. Power unit
3. Ramp
4. Side rack
5. Middle rack
6. Guide beam
7. Electric cabinet
8. Exhaust gas filtering system
9. Gantry
10. Welding table
11. Vertical carriage
12. Control panel