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CONTENTS

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WELDING PRODUCTION IN THE ECONOMY OF UKRAINE

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The growth in volumes of production and consumption of structural materials continues to be an important component in the development of modern economy. For stabilization and growth of the Ukrainian economy, it is necessary to dramatically increase the consumption of rolled metal with an emphasis on industrial construction, implementation of large-scale infrastructure projects, heavy, power and transport engineering. Moreover, the processes of welding, cutting, surfacing and coating are the most preferred and widespread means for creating a wide range of competitive products. In the near term, it remains vitally important for Ukraine to maintain different power, processing, mining, agricultural, defence equipment and infrastructure facilities in order to extend their service life through the use of innovative welding and metal treatment technologies. 9 Ref., 2 Figures.

Keywords: *welding production, national economy, metal consumption, industry of Ukraine, machine building and innovative technologies, small business*

Role of welding in the development of the national economy. The highly-developed material production is the basis of modern civilization. A large role here is played by structural materials. At first, the 20th century was called the «cast iron age», since the melting of cast iron in the world exceeded the production of steel, and in 1913 it amounted to 78.5 mln t (steel — 72.4 mln t). By the end of the 20th century, steel production reached 800 mln t, and the production of cast iron — about 500 mln t (approximately 63 %), which allowed calling it the «steel age». In the second half of the 20th century, such knowledge-intensive technologies of steel production as vacuum arc remelting, electron beam melting, plasma remelting, electroslag and induction melting were developed and introduced into the industry. The development of these processes was stimulated not only by the need in manufacturing civilian industry products, but to an even greater extent by the requirements of the military-industrial complex, which needed a high-quality metal to solve its problems.

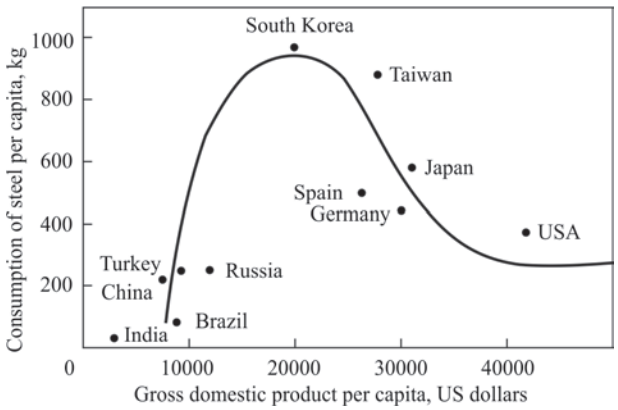

Figure 1. Curve of intensity of steel application

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Analysts from the International Iron and Steel Institute (IISI) came to the firm conclusion about a direct correlation between the growth in steel consumption and the general economic level of countries with high growth rates of gross domestic product (GDP). By the end of the 20th century and in the subsequent years in such countries as the USA, Germany, and Japan, the annual consumption of rolled steel was maintained at the level of 420–590 kg/person. In Ukraine, in 2007 the own consumption of rolled steel amounted to approximately 25 % of the industrial, i.e. 8.7 mln t, and the specific consumption of rolled products reached approximately 190 kg/person. In Russia, this indicator was at the level of 250 kg/person. For many countries, an increase in domestic steel consumption is an essential condition for building a highly-developed economy (Figure 1) [1]. Therefore, the dynamic development of the Ukrainian economy is impossible without a significant increase in metal consumption. At the same time, in connection with the intensification of the deindustrialization process in the Ukrainian economy, in 2013 the specific consumption of rolled steel decreased to about 140 kg/person.

Although steel holds a leading position in the world market (93 % by weight of the total production of structural materials), its positions are pressed by aluminum, plastics and polymers; composites and ceramics are being introduced into production. Alloys based on nonferrous metals (Al, Cu, Ni, Mg, Ti) and plastics amount to about 7 % of the group of structural materials. In the group of nonferrous metals and plastics, dominating positions are occupied by aluminum (38 %) and plastics (23 %) [2].

Starting from the second half of the 20th century, the demand for steel was satisfied not only due to the growth of the physical volume, but to a significant ex-

*Calendar of November**

NOVEMBER 1, 1917 Union Carbide & Carbon Company was registered. In 1892 J. T. Morehead and T. Wilson, founders of Wilson Aluminium Company, performed first commercial melting of carbide. Further on J.T. Morehead transformed this company in Union Carbide Corporation, creating powerful industrial company on calcium carbide production, which is the main raw material for acetylene production.

NOVEMBER 2, 1942 Members of Soviet tank commission saw the samples of the new German tank «Panther». Tank hull was built from rolled surface-hardened armor plates of medium and low hardness, connected by «tonguing joint» and welded with double weld. Turret was set on armored basement welded of sheets of 80 mm thickness, thickness of turret basement is 100 mm. «Panthers» in many respects were modernized samples of Soviet tank T-34. However, taking into account that they were assembled by manual arc welding and Soviet ones were assembled with the help of automatic high-speed welding Germany could not quickly and in sufficient amount supply «Panthers» and «Tigers» in the lines.

NOVEMBER 3, 1916 War ship Vendetta (D69), fleet destroyer of type V of the Royal British and Australian Navy of the time of the Second World War, was laid. On October 17, 1917 it was included in the Royal British Navy. On October 11, 1933 it was transferred to the Royal Australian Navy. Fleet destroyer Vendetta was the first all-welded vessel built in Australia. Vendetta and other ships of this class were 390 feet (120 m) length and 2800 t tonnage. The ship was constructed using electric arc welding.

NOVEMBER 4, 1953 Firstly the tests were carried out and then the traffic was opened on all-welded bridge in Kyiv of 1543 m length. Without waiting the complete end of construction of pilot welded bridges, the decision was made on start of manufacture and assembly of spans of the largest all-welded bridge over the Dnieper River. The leading role in designing, manufacture and assembly of spans was given to Electric Welding Institute and personally to E.O. Paton. The project of the bridge was developed by «Ukrproektstalkonstruktsiya» Institute. The bridge of 1543 m has 24 spans, four of them are navigable of 87 m height. The main scopes of works on welding of the main girders were carried out using automatic and semiautomatic machines of PWI development. The technological process of assembly and welding of main girders was performed by straight-line flow method.

NOVEMBER 6, 1936 Formal opening of Volodarsky Bridge — bridge over the Neva River in Saint-Petersburg. The project required pivot span in the middle of the bridge, side spans in accordance with the requirements of navigation could not already be every 100 meters. The pivot span of the bridge was double-leaf bascule system with stationary horizontal rotation axis with rigidly fixed counterbalances. Structure of the pivot span for the first time was made metallic and all-welded. For the time of bridge construction, the design works were started in 1931, application of electric welding in such a critical construction and in such scopes should be considered brave innovation.

NOVEMBER 7, 1938 Formal opening after reconstruction of Blagoveshchensky bridge (earlier also Nikolaevsky and Lieutenant Shmidt bridge), first permanent bridge over the Neva River in Saint-Petersburg. For economy of money and time it was decided to use the old bridge bearings, subjecting to reconstruction only their upper part. Due to design the new bridge was outstanding achievement of Soviet building engineering of the thirties. A series of significant improvements in bridge construction technique were implemented at its construction. Electric welding was used for joining the elements of span structure instead of rivets. Such method of joining of steel elements was for the first time used for manufacture of such a tremendous and critical structure.

NOVEMBER 7, 1937 Birthday of N.M. Voropai (1937–2014), Dr. of Tech. Sci. representative of the Paton school. Worked on theoretical and experimental development of scientific fundamentals of physical and metallurgical processes in mechanized gas-shielded welding. He developed the methods of regulation of arc characteristics with consumable and non-consumable electrode, arc welding in atmosphere of high pressure, argon-arc and microplasma welding using different polarity current pulses, arc welding with activated wire, electric-plasma polishing of the surface of electrode wire.

*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.

NOVEMBER 11, 1976 Alexander Calder (1898–1976) died. He was American sculptor, which gained world-wide fame due to intricate figures of wires and so-called mobiles — kinetic sculptures, which is driven by electricity or wind. In 1926 he moved to Paris, where he joined the circles of surrealists and constructivists. At that time he found the new form of sculpture, i.e. figures from wire. These figures are the pictures in space endowed with humor and movability of puppets. Flexible material, from which they were made, allows easy change of figure pose. He was a well-known sculptor, which carried to perfection the art of development of sculptures by welding.

NOVEMBER 12, 1942 The record of assembly and welding of ship hull was set at Richmond Yard dockyard. It was necessary only four days for that. Due to replacement of riveted structure and rivet technology on welded structure and welding in ship construction allowed saving 500 t of steel. Construction cycles dropped to 50 days. In order to decrease the time and reduce the manufacture costs, decrease residual stresses and deformations the scheme of «partition» of hulls for sections was developed. Each section was welded from separate sheets and elements of a set that allowed manufacturing the ship on a flow line in the workshop at several sites.

NOVEMBER 14, 1949 The first fly of seaplane Be-6, a multipurpose flying boat of development of marine aircraft construction CDB at aircraft factory No.31. The first variant of plane was carried out using welding, but it got unsatisfactory characteristic (presence of cracks in the structure). Later on in a new model Be-12 welding was used for parts of corrosion-resistant alloy AMg-6T. It provided economy of mass at each such part up to 8.8 %. Replacement of manufactured from casting and forgings large-sized parts of ship (lamps, manhole frames, strakes etc.) by welded ones provided significant saving of weight and increased corrosion resistance of the structure.

NOVEMBER 15, 1878 American inventor Thomas Edison established General Electric Company. Initially it was named Edison Electric Light and after joining in 1892 with Tomson-Houston Electric Company founded by another prominent American inventor E. Tomson got its modern name. Edison being aggrieved that his name escaped from the sign left the company. Ch. Coffin became its president, professor Edison was appointed a technical director. From the date of its establishment the company was a pioneer in many branches of welding science and technology, being the place of development of joining technologies. It became one of the main distributors of resistance welding in the USA in the beginning of its development.

NOVEMBER 16, 1931 The first fly of apparatus «Stal-2», Soviet short range passenger aircraft with one conventional engine of air cooling of development of DB of engineer Putilov (NII GVF). This was the first serial aircraft with all-welded structure of frame. The peculiarity of the aircraft was manufacture of welded frame of stainless steel of «Enerzh-6» grade. Skin of planes, tail unit and air-frame stern-post is linen, side parts of fuselage is plywood, front part of fuselage is dural.

NOVEMBER 17, 1972 The first fly of MiG-23BN, Soviet supersonic special bomber-fighter of the third generation. Its production requiring multiple complex and specific technological processes and fitting, was organized at Tushinsky machine-building plant (TMB), having known experience of work with steel structures and welding. Gained experience and welding technologies of structural steels were used in mastering the welded sections of fuselage MiG-23. TMB tried to implement manufacture of welded bays of MiG-23 from titanium, but technologically complex material did not give satisfactory results. Welding of tanks from VNS-2 at the end was mastered at «Znamya truda» plant.

NOVEMBER 18, 1939 British airplane carrier «Ark Royal» went hunting for German battle ship «Bismarck». For the first two years of the Second World War it participated in many naval operations of the Royal Fleet, where was distinguished in combat actions. One of the famous ships of that time. Welding was widely used in ship construction, namely 65 % of hull structures were made using it, including transverse and longitudinal bulkheads, decks (except for flight and upper hangar decks), outer skin above the lower hangar deck, foreship. Due to welding weight of hull of airplane carrier was reduced by 500 t that gave the possibility to rise armoring.

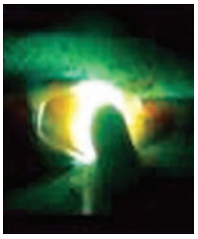
NOVEMBER 19, 1938 Birthday of N.P. Trigub (1938–2012), Dr. of Tech. Sci., representative of the Paton school. He made significant contribution in development of domestic production of titanium ingots. He developed a technology of electron beam melting with cold hearth and batch supply of liquid metal in mould, electron-beam guns and units for production of ingots of 20 t weight. Scientific-production center «Titan» and production of ingots of titanium and titanium alloys for industry was organized under his leadership.

NOVEMBER 20, 1996 Delta II Heavy, rocket of the second generation of carrier rockets of Delta family was launched in Mars side. It was designed and constructed by aircraft building Company McDonnell Douglas. The rockets of the second generation were called «heavy» since they were used for on-orbit delivery of heavy cargo. Application of friction stir welding made welds and joints of the rocket lighter, besides the structure was strong and carried tremendous loads during the fly. Friction stir welding was also used in manufacture of Delta IV rockets.

NOVEMBER 21, 1943 Tests of tank IS-2 took place in the field under Moscow. Armor hull of the tank (except for the front in machine parts) were welded from rolled armor plates of 90, 60, 30 and 20 mm thickness. From the middle of 1944 with the availability of rolled armor of high strength the front part started to be welded of 90 mm armor plates. Front parts with other were joined by welding. Streamlined turret represent itself armor casting of complex geometry, its edges of 90 mm thickness were located under angle to vertical line in order to increase shell ballistic strength. The frontal part of turret with fire slit for gun, formed with intersection of four spheres, was caste separate and welded with the rest parts of the turret.

NOVEMBER 22, 1922 Birthday of Eila Hiltunen (1922–2003), Finnish sculptor. The earlier works were made of marble and bronze, from the end of 1950th started experimenting with casting and welding. In 1966 Hiltunen was awarded with the Higher State Honor of Finland for people of art, i.e. Pro Finlandia medal. One of the most famous works of Eila Hiltunen is a monument to composer Johan Sibelius in Helsinki. Reduction of the monument stands close to United Nations Headquarters in New York.

NOVEMBER 23, 1802 Russian scientist V.V. Petrov (1761–1834) discovered an electric arc, the phenomenon, without which welding with electricity is impossible. The scientist connected to a powerful battery two small pieces of coal, touched by them each other and little bit drew apart. For the first it was sparks, then the gap between the coals was filled with blinding flame, which on form reminded arc-shaped bridge. That was a discovery of the electric arc discharge, the brightest for the next 100 years light source. Discovery by V.V. Petrov of electric arc attracted attention of the scientific community. A year before publishing of the book about Petrov's experiments in 1802, the arc was mentioned in «Peterburgskie vedomosti».



NOVEMBER 24, 1881 French engineer A. Meritins patented a device for welding of transferred arc, consisting of holder with carbon electrode connected to positive pole, and cast iron plate connected to negative pole. The holder and plate were located in a chamber with porthole. Meritins used this device only for welding of lead plates (French patent No. 146010 dated November 24, 1881).

NOVEMBER 25, 1937 End of the World Fair of 1937 in Paris, at which the symbol of Soviet hall became a 24 meters sculptural group «Worker and Kolkhoz woman», made of stainless steel on Vera Mukhina design and dedicated to the achievements of socialist industrialization. In the Soviet Union it was the first large welded structure. Prof. P.N. Lvov, the first among the welders Cavalier of Lenin Order, put on hand and made huge sculptures without full-scale models. The elements of figures were tailored by a template and tapped out by model fragments from sheets of stainless steel, which were after that welded to parts of tubular carcass.

NOVEMBER 27, 1918 Birthday of B.E. Paton, an outstanding Ukrainian scientist in the field of welding, metallurgy and technology of materials and materials science, prominent public figure and talented organizer of science, academician of the National Academy of Sciences of Ukraine, Academy of Sciences of the former USSR and Russian Academy of Sciences, President of the NAS of Ukraine, International Association of Academies of Sciences, director of the PWI, honoured personality of science and technology of the Ukrainian SSR, laureate of the Lenin Prize and State Prizes of the USSR and Ukraine, twice Hero of the Socialist Labour of the USSR, Hero of Ukraine. Boris Paton, together with his father E.O. Paton, established a world-known Paton scientific school.

NOVEMBER 28, 1907 Birthday of V.I. Dyatlov, a scientist, which for the first time patented a new principle of design of arc automatic machines for electrode feeding with constant rate, which does not depend on arc voltage or any other factors. He in 1942 was the first person who paid attention on self-regulation of arc in consumable electrode welding, investigated this phenomenon and proposed to use it in other automatic machines. In a series of cases self-regulation of arc is so intensive that there is no need to apply sufficiently complex schemes of automatic arc regulation.

NOVEMBER 29, 1939 A day before beginning of the Soviet-Finland War, KV-1 tanks were sent to the battle front. The front part of turret with file port for a gun formed by intersection of four spheres were cast separately and welded with other turret armor parts. Turret of serial KV was manufactured in three variants, namely cast, welded with rectangular compartment and welded with rounded compartment. Thickness of armor in welded turrets was 75 mm and that of cast was 95 mm since cast armor was less strong. In 1941 welded turrets and tank side armor plates of some tanks were additionally reinforced, namely 25 mm armor shields were fixed on them using bolts, moreover an air gap was remained between the main armor and shield, i.e. this variant of KV-1 virtually got spread armoring.

NOVEMBER 30, 1911 Beketov N.N. died (1827–1911). He was a Russian physical chemist, one of the founders of physical chemistry and chemical dynamics, laid the basis for a principle of aluminothermics. In 1859 he developed a method of metal production based on alumothermics, i.e. reduction of their oxides by aluminum. The scientist proved that a charge mixed of aluminum and iron oxide powders burns at temperature making several thousand degrees transforming in iron and slag. Instead of aluminum it was possible to use magnesium, and reduce from oxide not only iron, but also series of other metals (chromium, boron, titanium). This discovery recently found application in metallurgy for manufacture of carbon-free metals, ferro-alloys, foundry alloys and in the process of alumothermic welding.