TRENDS IN IMPROVEMENT OF AUXILIARY EQUIPMENT FOR WELDING PRODUCTION

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Main trends in development of mechanized welding equipment for fabrication of structures made in and outside Ukraine are analyzed, and basic requirements to them are indicated. Versatile rotators comprising a new generation of drives with computer numerical control and commutatorless motors are considered. Specific features of their operation are pointed out, and their advantages are noted. Also, the article analyzes the methods for reinstalling roller supports in a driving roller device, and considers some methods for elimination of drift of a workpiece in welding or surfacing.

Keywords: *welding, surfacing, cutting, workplace, organization, equipment, rotator, manipulators, new solutions*

Successful performance of operations of welding, reconditioning and strengthening surfacing, as well as cutting of different metal structures, ensuring of their quality and efficiency of operations greatly depend on arrangement and fitting of workplaces. Various means and equipment making the welders' work easier and allowing a considerable improvement of the efficiency and accuracy of the performed operations have a great role here. As a rule, this equipment includes means of welding production mechanization, in particular, various types of rotators, tilters, columns for welding and surfacing automatic machines.

The purpose of this work is discussion of the directions of development and production of auxiliary mechanical equipment for welding and surfacing both in Ukraine (specialized plant (Ilnitsa Plant of Mechanical Welding Equipment), and beyond it (by the materials of 2009 Essen Exhibition).

Technical publications have descriptions of various mechanization means for organization of welding and surfacing productions [1, 2], which provide guidelines for selection and design of various equipment of this type.

As before, the main requirement made of mechanical auxiliary welding equipment, is the stability of the workpiece rotation, i.e. maintaining the welding speed. Great importance is attached to the smoothness of the workpiece rotation (without vibrations, jerks, jamming, etc.) that is achieved, first of all, due to rigidity of the rotator bed, accuracy of manufacturing the tooth gears, minimum clearances in the seats, reliability of fastening the workpiece in the rotator faceplate.

Recently much higher requirements have been made to the quality of work performed using mechanized arc processes, realized by semi-automatic and automatic machines of varying degrees of technical perfection, also with additional movements (degree of automation, use of groove following, devices for arrangement of deposited beads, etc.). All this requires widening the capabilities of equipment for organization of modern workplaces for welding, surfacing and cutting of steels and aluminium alloys in the following directions: stabilization of welding and surfacing speed, solving the problems of positioning of the workpiece or welding tool, improvement of the processes, associated with making the weld start and crater welding up. Most of these problems are solved without application of any additional equipment, for instance, without position sensors at positioning or organizing repeated cycles in wide-band surfacing, etc. Equipment of this type should have systems of programming and acquisition of data bases. Particularly urgent are the problems of energy- and resource-saving, solved by optimization of the systems of control and adjustment for them that provide optimum paths of motion of the workpiece or welding tool.

An interesting direction of improvement of the considered type of equipment is that, which it directly involves the modes of welding equipment operation (welding speed is functionally dependent on welding current) $v_w - f(I_w)$. Realization of this direction also requires the availability of a certain data base, providing the following advantages:

- accurate setting and maintaining of the correspondence of energy characteristics of the arc and welding displacement;
- mechanized welding and surfacing station being independent of the operator's qualifications;
- quality performance of welding or surfacing with a uniformly formed bead, having a marketable appearance immediately after performance of the arc process cycle.

Realization of such capabilities in operation of auxiliary equipment for welding and surfacing requires application of adjustable electric drives of working displacement with sufficiently large adjustment range, and, what is highly important, high response. Here the main problems for mechanical welding equipment remain to be ensuring rotation of the welded

Figure 1. All-purpose manipulators with asynchronous electric motor in the rotation drive

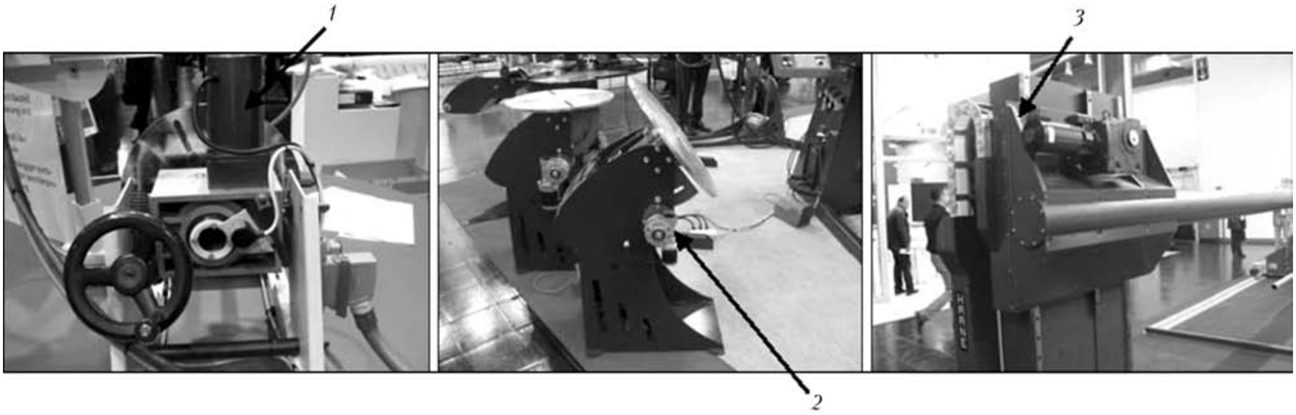

Figure 2. All-purpose manipulators with valve electric motors (*1–3*)

(surfaced) workpiece with the set speed during automatic or semi-automatic welding (surfacing) and moving the workpiece at travel speed into a position convenient for welding.

At present the auxiliary equipment systems use electric drives based on commutator and commutatorless (as a rule, valve) DC electric motors with thyristor or transistor regulators of the frequency of shaft rotation, and the recently becoming accepted asynchronous electric motors with frequency regulators.

Let us consider some types of modern mechanical welding equipment. In the Essen Exhibition this equipment was presented by various manufacturing companies from Hong-Kong, Taiwan, China, as well as Germany, France, Great Britain, Italy, Sweden, Greece, etc.

Figure 3. Control unit of valve electric motor

In mechanical welding equipment of the leading companies (JAVAC, Germany; Key Plant, Great Britain; ESAB, Sweden; Lambert Jouty, France, etc.) asynchronous motors in a set with standard reduction gears or reduction gears produced in-house, as well as motor drives, are mainly applied as the rotation drive (Figure 1). Frequency converters of asynchronous electric motors manufactured by different companies are applied for adjustment of the speed of rotation.

Companies involved in manufacture of mechanical welding equipment also displayed in the exhibition manipulators, in which the rotation drive uses a valve electric motor (Figure 2).

Valve electric motor is a synchronous motor the operation of which is based on the principle of frequency regulation with self-synchronization. The controller of valve electric drive (Figure 3) controls the moment applied to the rotor, and unlike the DC brush-type motor, switching in the valve electric motor is performed and controlled by electronic devices.

Valve electric motors with electronic control systems often combine the best properties of contactless motors: high response and dynamics; positioning accuracy; wide range of rotation frequency variation; absence of components requiring maintenance; high overload capacity by moment; high energy values (efficiency > 90 %, cos $\varphi > 0.95$); long service life, high reliability and increased operating life owing to absence of sliding electric contacts; low heating of electric motor in operation in modes with possible overloads.

Local manufacturer of diverse mechanical auxiliary welding equipment — Ilnitsa Plant of Mechanical

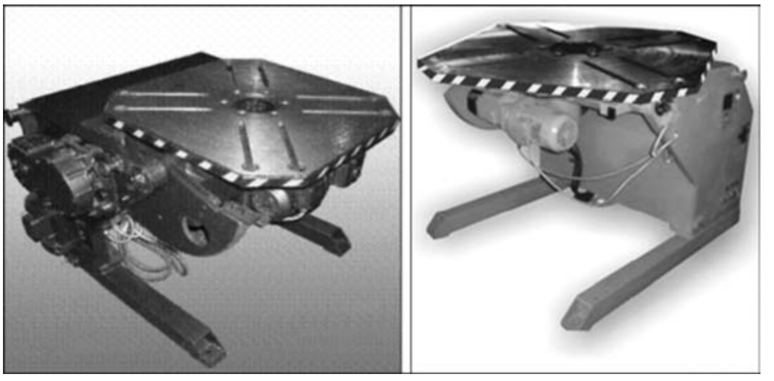

Figure 4. All-purpose manipulators manufactured by IPMWE

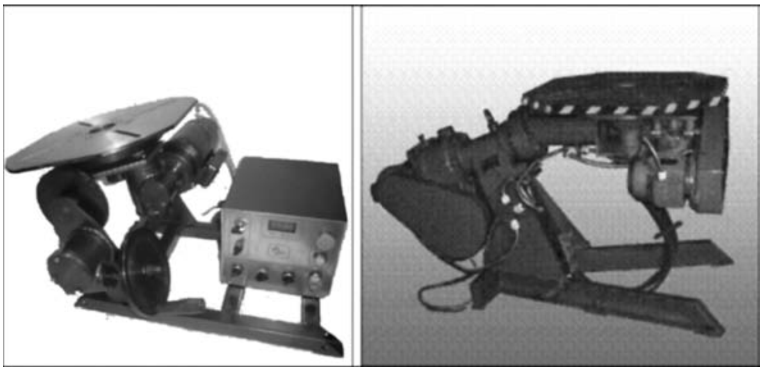

Figure 5. New models of IPMWE manipulators based on drives with valve electric motors

Welding Equipment (IPMWE) pays a lot of attention to various rotation drives. Starting from 2001, the plant during two years had transferred to application of converters of asynchronous motor rotation frequency (Figure 4). Foreign developments, in particular, General Electric electric drive (VAT-200 model) are used as asynchronous electric drives.

IPMWE is working towards introduction of new generation electric drives of valve type. At the beginning of 2009, a number of experimental manipulators were developed which are based on local electric drives. Today IPMWE is ready for commercial production of manipulators with new generation electric drives (Figure 5) that will allow programming some elements of workpiece rotation both by rotation speed, and by angle of workpiece rotation. In addition, at all the same characteristics, the overall dimensions and weight of valve electric drives are smaller than those of electric drives with an asynchronous electric motor. Comparative technical characteristics of these rotators with adjustable electric drives based on asynchronous and valve electric motors are shown in the Table.

There exists a great diversity of driving roller devices (Figure 6) with the same requirements to the speed of rotation, accuracy of mounting the rollers relative to workpiece axis, time required for readjustment of the rollers for the required workpiece diameter. At inaccurate position of roller axis relative to the axis of workpiece rotation, such a phenomenon as shifting of the workpiece being welded along its axis (drift) is observed, leading, in its turn to deviation of the weld from the welding position. Shifting depends on workpiece diameter and angle of non-paral-

Comparative technical characteristics of rotators with adjustable electric drives based on asynchronous and valve electric motors

Parameter	SPS 150-150S (Figure 1)	PRO 1 (Figure 2)	M211080 (Figure 4)
Maximum lifting capacity, kg	125	120	125
Faceplate rotation frequency, min^{-1}	0.5–9.0	0.5–5.0	0.16–5.0
Faceplate angle of inclination, deg	0–180	0–90	0–135
Faceplate diameter, mm	500	350	450
Rated welding current (duty cycle = 100 %), A	500	300	500
Mains voltage, voltage/frequency, Hz	230/50	230/50	230/50
Setting the inclination	Manually		
Overall dimensions ($L \times B \times H$), mm	1050 × 880 × 1080	480 × 325 × 470	850 × 695 × 400
Weight, kg, not more than	100	50	75

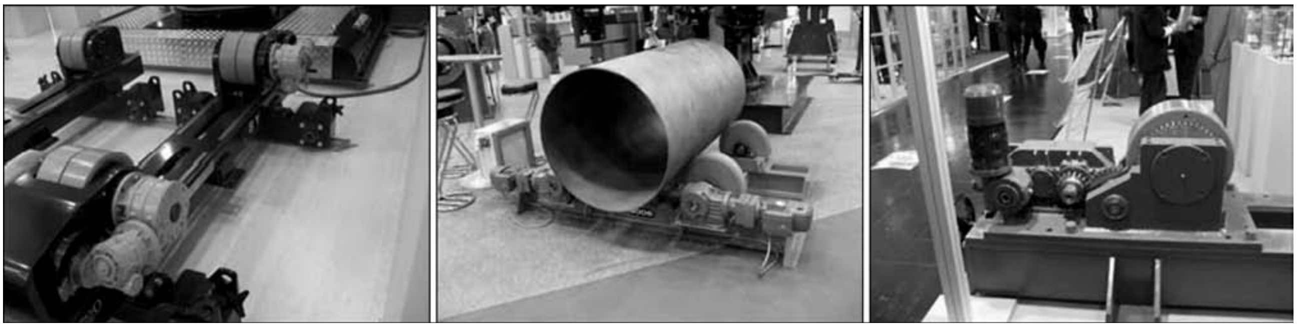

Figure 6. Driving roller rotators with different drive layouts

Figure 7. Retaining roller

Figure 8. Working body of the following system mounted on the welding head

lelism of the axes of workpiece and rollers. Different companies have different solutions for this problem. Lampert Jouty mounts a system for following the deviation of the workpiece and depending on this value, the system gives a signal in the automatic mode to the drive of final rotation of roller axes.

IPMWE solves this problem by mounting mechanical rotating rests (Figure 7), as well as displacement of the actuator (weld following) of the welding head, using the following system (Figure 8).

There are several methods for reinstallation of the roller supports, the driving roller device sections into the required position, but from those displayed in the exhibition, the following can be singled out:

• using screw–nut transmissions. It enables simultaneous displacement of two roller supports and elimination of small misalignments by height between roller support sections;

• using rests of different designs, the most widely spread here is fixing of roller supports by holes and displacement of roller supports — a faster, but more labour-consuming process.

Introduction of the new generation of roller supports will be actively pursued further on, as they have a number of advantages, namely possibility of reducing the power inputs and widening the capabilities of mechanical auxiliary equipment, as well as considerable improvement of the quality of manufactured products. New systems of regulation with feedbacks by welding equipment parameters will be also developed.

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