

# IMPROVEMENT OF METHOD OF PLASMA SURFACING WITH SIDE FEEDING OF FILLER WIRE

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A method of plasma surfacing with side feeding of solid and flux-cored wires was improved. A feature of this method is an alternating pulse nature of burning of straight polarity arcs between plasmatron nonconsumable electrode–item and plasmatron nonconsumable electrode–wire that increases surfacing efficiency and decreases base metal penetration depth.

**Keywords:** plasma surfacing, filler wire, magnetic blow, straight polarity plasma arc, alternating mode of arcing, increase of surfacing efficiency, penetration of base metal

Several methods of plasma surfacing with side feeding of filler wire [1–3] were developed for commercial application:

- plasma jet surfacing with current-carrying filler wire at electrically neutral item (Figure 1, a);
- plasma arc surfacing with neutral filler wire (Figure 1, b);
- twin-arc surfacing at which plasmatron, wire and item are alive (Figure 1, c)

An analysis shows that each of the methods have its advantages and disadvantages. Plasma arcing takes place between the filler wire and plasmatron nonconsumable electrode in surfacing with neutral item. Efficiency of surfacing increases in this case, however, there is a possibility of appearance of lacks of fusion in the base metal due to low heat input. Small process efficiency is the main disadvantage of the second method of plasma surfacing with neutral filler wire. The most widespread is the third method providing for twin arcing: one arc burns between plasmatron nonconsumable electrode and item and second one – between plasmatron nonconsumable electrode and filler wire. At that, regulation of heat input into the

wire as well as item can be performed during change of current of two arcs.

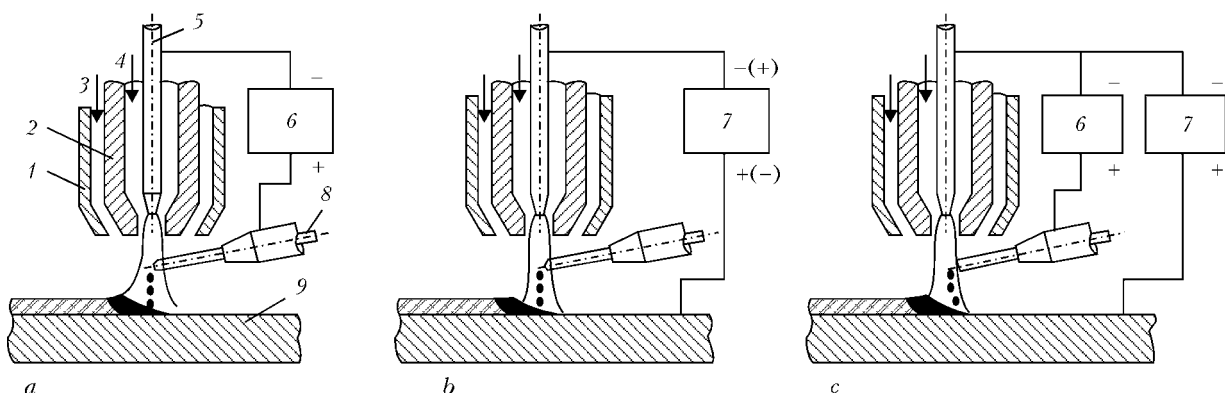
However, magnetic blow is observed in simultaneous burning of two arcs and their electromagnetic coupling, thus, current of the arc of plasmatron nonconsumable electrode–filler wire is to be limited. Its maximum value can be taken from relationship [4]  $I_a = 0.266I + 90$  (A).

Surfacing efficiency of more than 10 kg/h [4] as well as reduction of depth of penetration in the base metal cannot be obtained at that resulting in increase of surfacing costs.

Thus, the known methods of plasma surfacing with side feeding of the filler wire have one or another disadvantages and problem of increase of technical and economical indices of this process is still relevant.

The aim of the present study lies in improvement of efficiency of the process of plasma surfacing with filler wire by increase of the heat input in the filler wire at controlled heat input into the base metal.

The effect of magnetic blow appearing during an interaction of two arcs is to be reduced to a minimum for achievement of the indicated aim. A method of plasma surfacing with alternating burning of straight polarity arc was developed to solve this task. The method provides for burning of only one arc at each



**Figure 1.** Scheme of plasma surfacing with side feeding of filler wire by plasma jet with current-carrying filler wire (a), by plasma arc with neutral filler wire (b) and by twin arc (c) [3]: 1, 2 – shielding and plasma-shaping nozzles, respectively; 3, 4 – shielding and plasma gases; 5 – electrode; 6, 7 – power source of indirect and direct arcs; 8 – wire; 9 – item



plasmatron nonconsumable electrode–item made 160 A, of plasmatron nonconsumable electrode–filler wire was 210 A; duration of pulse of the arc current being 0.1 s for plasmatron nonconsumable electrode–item and 0.3 s for plasmatron nonconsumable electrode–filler wire; surfacing rate made 8.72 m/h, consumption of plasma argon showed 4 l/min and 18 l/min of argon for shielding.

Degradation of quality of formation of the deposited bead at pulse duration increase should be noted.

## CONCLUSIONS

1. It is shown that efficiency is increased and penetration depth of the base metal is reduced at plasma twin-arc surfacing with side feeding of filler wire and alternating burning of straight polarity pulse arc.

2. It is determined that duration of the current pulses should not exceed 0.3 s for providing good formation of the deposited metal.

3. The unit for plasma surfacing by filler wire with alternating burning of pulse arc was developed. The unit is universal since other methods of plasma surfacing can also be realized.

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## Memorable dates

# AT THE ORIGINS OF INTEGRATED DEVELOPMENT OF WELDING PRODUCTION

*80 years ago Evgeny O. Paton for the first time in the world put forward an idea about integrated development of the theory and practice of welding and started forming specialized research and design organization with the purpose of solving various tasks in the path of progress of welding production*

In 1929 academician Evgeny Oskarovich Paton, known bridge-builder, takes a decision to apply welding in bridge construction, and organizes an electric welding laboratory. The scientist rather quickly designed rational welded assemblies of span structures, machines and boilers, developed methods of strength testing and analysis of welds, began designing the bridge decking, started consulting designers and production specialists. Welding was already applied in bridge repair and construction in the USSR and other

countries, but many specialists were unwilling to eliminate riveting and bolted joints, fearing failures which occurred in bridges across the Albert channel in Belgium. For three years E.O. Paton with several associates performed a large scope of work to study strains, developed a number of welded structures and proved that the designers did not take into account the features of welding and simple replacement of technology lead to catastrophies. He came to the conclusion that the success of welding development and introduction depends on solving a number of problems, lying in metallurgical, electrical engineering and many other planes. Having made sure that weld quality depends on welder's qualifications, E.O. Paton poses the task of developing a reliable process of welding with automatic machines.

In 1932 in the All-Ukrainian Academy of Sciences off-site sessions in Kharkov (at that time capital of Ukr. SSR) and in the cities of Donbass region, E.O. Paton made presentations to production teams and general public on the problems and advantages of welding production. His article «Paths of electric welding development during the Second Five-Year Plan period» was published in specialized journals and as individual brochures in Russian and Ukrainian. It gives a comprehensive analysis of the condition of



E.O. Paton among the participants of 1st All-Union Conference on submerged-arc welding (1940)