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RESEARCH ON MAKING OF A WIG WELDING TORCH WITH WELDING WIRE MECHANISED FEEDING

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Abstract— Research on WIG welding are oriented currently in two directions, namely increasing performance of welding equipment and increasing the quality of welds and welding productivity knowing that WIG welding is characterized, especially in manual built up welding, by low productivity due to operator module with inserting periodically the wire into the metal bath. A measure towards increasing WIG welding productivity is the welding wire feed rate mechanisation by using specialized equipment and materials. In this regard, the most familiar process is the orbital welding of pipes where both the welding speed and the wire feed rate are achieved mechanically.

Keywords—WIG welding, WIG mechanization, WIG welding head, welding wire, mechanical feed

I. Introduction

THE major manufacturers of welding equipment in the world are currently manufacturing specialized welding torches for MIG (metal inert gas) welding with mechanical feeding of welding wire of small Ø i.e. 0.8 mm, 1.0mm, and 1,2mm respectively. To drive the welding wire one uses standard feeding devices used in MIG (metal inert gas) / MAG (metal active gas) welding or specialized devices to be mounted on the welding equipment or facilities which allows mechanization, automation or robotics of WIG welding process. Manufacturing of such torches and equipment differ from one company to another.

II. Procedure for Paper Submission

Figs 1 and 2 bellow illustrate an example of a welding torch i.e. the newest type of WIG welding torch with wire mechanical feeding, manufactured by FRONIUS company.

The novelty is that the guiding tube (Bowden) of the wire electrode is incorporated in the hose with the torch wiring which makes it more compact, ergonomic, and allowing a smooth and fast replacement of the guiding tube according to the diameter of the welding wire and, last but not least, the torch looks more aesthetic. In the past, a guiding tube was attached outside the WIG torch for welding wire feeding purposes - by means of some standard fixed clamps attached to the wiring hose. A digital potentiometer mounted on the welding head allows a high-precision adjustment of the feed rate of the welding wire or welding current in real time, i.e. even during welding, depending on the technological requirements, [1].

Fig. 2. WIG TTW 4000 KD (Fronius) welding torch head – close-up view

Moreover the welding head enables vertical positioning of the welding wire relative to electrode position, adjusting the lead angle when entering into the metal bath or turning the device for bringing the welding wire in front of or behind the torch according to the direction of welding i.e. to the left - by pushing or to the right - by pulling. The disadvantage of these torches is the relatively high cost price.

The analysis of welding torch with wire mechanical feeding manufactured by specialized companies has allowed the design and producing within IMF department, (welding shop) of a welding torch to permit and meet at the highest possible level the requirements of WIG welding with wire mechanical and as close to the performance offered by the manufacturers as possible, but at a much lower cost price, given the limited financial possibilities available to purchase such products.

In the next part of our paper we shall make a presentation of the welding torch prototype, [2].

Fig. 3 below shows an overview of the welding torch with the welding wire drive and guiding device.

Fig. 3. Overview of WIG welding equipment

The main components of the welding equipment are:

1) *WIG welding torch itself;*
2) *Welding wire positioning and guiding head;*
3) *Welding wire guiding tube (Bowden);*
4) *Euro hitch;*
5) *Welding wire feed control switch.*

The *welding torch* is a handle used in standard WIG welding; it is manufactured by Fronius and delivered with MAGIC WAVE - 300 universal welding facility which equips the laboratory of welding equipment and technology in protective gas environment within the IMF department specialised in welding engineering. Due to the wear of thread for fixing and tightening the welding wire made of tungsten in the welding head. This torch was decommissioned when launching the research and the implementation of the new equipment but which through a change made in the tightening system was recommisioned. The welding torch consists of the following parts: welding head, wiring hose, couplers for power supply and return water, shielding gas hose and the control bus bar for welding torch and welding cycle. Coupling welding torch to the source is specific to Fronius WIG welding sources, [3].

Fig. 4 shows the *positioning and guiding head of welding wire* is shown in Fig. 4 below and includes the following components:

1)Attachment flange;
2)Adjustment flange;
3)Guiding tube;
4)Contact nozzle;
5)Connector;
6)Attachment and tightening screws.

Attachment flange made of an insulating and indurated material fixes the welding positioning head rigidly to the welding torch body in the head area through an elastic sleeve self-tightening chuck collet. It allows the vertical adjustment of the positioning head and the sliding bar positioning in the front or behind the torch, depending on the welding direction i.e. to the left or right.

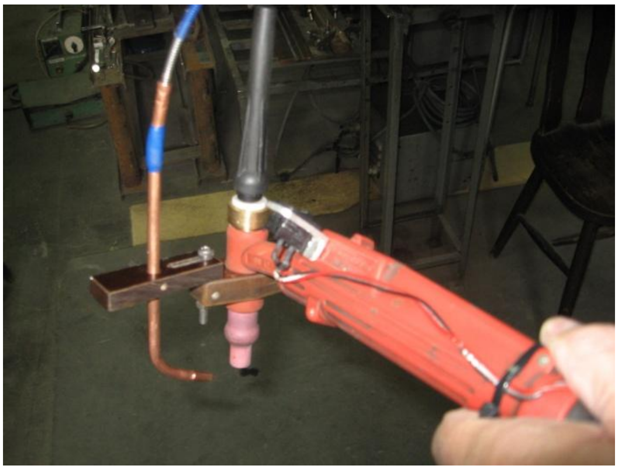

Fig. 4. The positioning and guiding head of the wire electrode

The adjustment flange is also made of indurated material and fitted with a milled groove and allows the positioning of the guiding tube for delivery and proper positioning of the welding wire in the tungsten wire area and in the electric arc area, respectively. It allows the horizontal adjustment of the positioning head and the rotating of the sliding bar, respectively

The guiding tube is made of copper pipe Ø6x1mm and its role is to lead the welding wire in the arc area. By sliding into the adjustment flange hole it allows vertical positioning of the contact nozzle for placing adequately the wire into the metal bath. The guiding tube is provided at both ends with two threads, M4 inside and M6 outside, respectively, for mounting and fixing the sliding bar to the flexible guiding tube (bowden) designed for fixing the wire and for the mounting of contact nozzle, respectively. The guiding tube is provided with a curvature in the contact nozzle area at an angle of 60º to the vertical axis of the tube for bringing and placing the wire at right angle in the metal bath, i.e. a 15-30º angle to the surface of the welded part. In order to prevent wire crimping and to reducing the friction in the guiding tube, a steel flexible tube or a raylon tube is inserted before bending. This would prevent tube bending and flattening.

Fig. 5 below shows the two types of guiding tubes.

Fig. 5. Types of guiding tubes

It seems that in the end one will opt for raylon tube to reduce wire friction inside curvature area. In terms of wear, the tube made of steel option is better, but it has been shown that frictions inside are higher.

Contact nozzle, see Fig. 5 (right), serves to guiding more accurately the welding wire in the metal bath and is chosen according to the diameter of the wire used in welding. In fact it is a standard gas nozzle used in MIG / MAG welding with altered thread (from M6 to M4) for the purposes of mounting it at the end of the guiding tube. The contact nozzle is made of copper. It is stipulated that it is intended to accurate guidance of the wire and for this reason it is provided with a hole calibrated to wire diameter, $d = d_s + 0.1 .. 0.2$ mm. However it does not have the function of transmitting the power to the wire when using the MIG / MAG welding.

The connector links the flexible hose guiding the wire and the guiding tube of positioning head. This part is made of copper Ø6x1x40mm - see Fig. 6 below; it is provided with an internal thread M5 for screwing the guiding tube made of raylon and the flexible guiding tube made of steel or raylon, respectively. Therefore this part ensures the continuity of guiding route of the welding wire from the feeding device to the positioning head.

Fig. 7 shows an "exploded view" of the wire guiding route with the connector, and Fig. 8 shows the view of the assembled tube, an operation that is performed after placing the wire in the positioning head to facilitate this operation.

Fig. 6. Connector

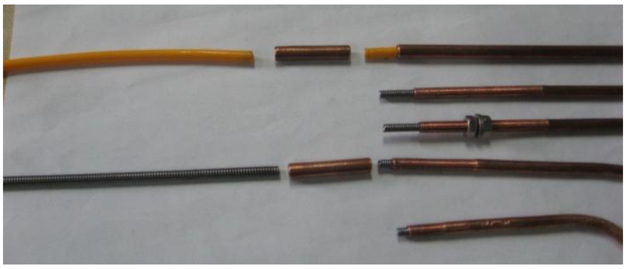

Fig. 7. Wire guiding route assembly deployed

Fig. 8 Guiding tubes assembling

The guiding tube (or Bowden) of the welding wire has the role of guiding the wire from the feeding device of WFD wire to the welding head. This can be a flexible guiding tube made of steel or one made of raylon – see Fig. 9 below.

Fig. 9. The flexible guiding tube made of: raylon - left; steel – right

The guiding tube made of raylon has the advantage of reducing the friction of the wire but it wears faster. The flexible tube made steel increase the friction with the wire raising drive problems and fluctuations in the wire feed speed with negative consequences on welding. One end of the guiding tube clicks into Euro hitch, and the guiding tube of the positioning and guiding head is mounted at the other end. The guiding tube is chosen according to the diameter of the wire used in welding, as the inner diameter of the tube is being calibrated to the wire diameter, $d_i = d_s + 0.15...0.20$mm. Usually, a guiding tube may be used for two neighbouring wire diameters i.e. 0.8 mm - 1.0 mm or 1.0 mm - 1.2 mm. Extent frictions occur if the inner diameter of the tube is too small and the wire may jam in the tube. If the inner diameter is too large, wire crimping occurs in the tube with negative effects on feed speed regularity and process stability. In the case of flexible tubes made of steel one should avoid spring effect of the tube that can generate even the tube crimping if the frictions occurring in the tube are too large. This can be avoided by using tubes made of more rigid and thicker steel wire, or tubes embedded in the plastic material by injection (see Fig. 9 - right). The flexible guiding tube should also be fixed into the Euro hitch to prevent detachment under the forces of friction existing in the tube. An alternative for increasing the rigidity of the guiding tube is by inserting it into a tube of greater stiffness – see Fig. 10 below.

Fig. 10. The guiding tube reinforced with plastic tube

The guiding tube is mounted externally on the torch hose by means of plastic clamps, paratape of scotch tape.

This is a disadvantage because it can be used only for a single diameter wire. However this disadvantage was eliminated, as seen above, by the Fronius company by making use of a guiding tube included in the WIG torch wiring kit.

Euro hitch is a standard subset used in all welding torch to connect the torch to guiding tube, (in this case) the wire feed device, WFD - see fig. 11 below.

Fig. 11. Euro hitch mounted on WFD a10-med44 (ESAB)

The electrical connection for WFD control is ensured through Euro hitch.

WFD Control switch is rigidly mounted on the WIG welding head through an attachment flange – see Fig. 12 below.

Fig. 12. Wire control switch

The control switch has two positions off - on. Operating the control switch is made only after firing the arc and forming the metal bath and determines the WFD control and wire instant feed. When stopping the process, the operation is reversing, i.e. the wire advance decouples through switching the control switch on 0. The wire feed stops and the feed advance followed by quenching the arc.

III. Conclusion

In conclusion it is considered that within our research a WIG welding torch with mechanical feed was designed and manufactured without any investment but only on the basis of existing facilities within the laboratory of welding equipment and technology in protective gas environment, thus allowing us to carry on with our experimental research.

Thus savings of approx. Euro 1000 were made i.e. the cost of a welding torch with wire mechanical feeding manufactured by the welding equipment manufacturing companies.

Welding torch thus manufactured will be mounted on a standard WIG welding facility to which will one shall attach a WFD wire feed device used in MIG/MAG welding facilities

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