

PATENT SPECIFICATION

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(54) A PLASMA-ARC CUTTING MACHINE

(71) We, NAOYOSHI HOSODA of 2-20-18 Denenchofu, Ota-ku, Tokyo, Japan, and TAKESHI HOSODA of 2-22-7 Wakabayashi, Setagaya-ku, Tokyo, Japan, both Japanese citizens, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a plasma-arc cutting machine, and particularly to a small-size pencil-type plasma-arc cutting machine which is easily used with one hand and is more effective than a conventional machine.

In the operation of a conventional plasma-arc cutting machine, the end of the nozzle is separated by a certain gap from the surface of the base metal to be cut.

Since the electrode of the conventional machine is arranged at a fixed position with respect to the nozzle, the distance between the electrode and the base metal depends directly on the distance between the end of the nozzle and the base metal. The distance between the electrode and the base metal should be maintained within a certain range so as to obtain a stable plasma-arc. Consequently it requires a great deal of skill to operate such a conventional machine. When an operator uses such a machine, he watches the end of the nozzle in order to maintain the proper distance away from the base metal. Hence, because the intense light generated by the arc inevitably comes into his eyes, he requires an eye shield.

This kind of plasma-arc cutting machine includes flow passages for inert gas and for cooling water for cooling the nozzle, resulting in a large machine which must be held in two hands when being used.

Furthermore, it is known that the diameter of the heated spot produced by the plasma-arc on the base metal is rather large during operation, when the optimum distance between the nozzle and the base metal is maintained. However, if the diameter of the nozzle is made smaller so as to reduce the spot diameter, at a certain point there results a series arc which is generated via the nozzle. Accordingly, it is

impossible to make the diameter of the plasma-arc as small as one wishes by reducing the diameter of the nozzle.

It is an object of the present invention to provide a small size pencil-type plasma-arc cutting machine free from the abovementioned defects, which is easily held in one hand during use, in which no skill is required to maintain the distance between the electrode and the base metal, in which a small diameter of the heated spot formed by the plasma-arc on the base metal is obtained (by which smaller work pieces can be handled), and in which there is no need for the operator to observe the intense light generated by the arc.

This object is accomplished according to the present invention by a plasma-arc cutting torch, comprising a body adapted to be held by a hand of an operator and having at one end a hollow nozzle, tapering toward a lower end intended to be placed in contact with a workpiece to be cut, and having a central bore lined by material having high temperature resistance and low heat-conductivity, an electrode mounted within said bore in a manner so that the tip of the electrode is axially movable within the bore, an annular cavity within the body of the torch and surrounding the electrode and arranged for circulation of coolant water, the space around the electrode within the bore being arranged to be supplied from the upper end of the torch with an inert gas, the portion of the central bore around the electrode tip near the lower end of the nozzle being tapered to a narrower bore at a portion to be connected with the workpiece, and the lower end of the nozzle having radially directed slots in the contact face of the nozzle and the insulating lining thereof for passage of shield gas from the central bore when the torch is in contact with a workpiece.

The present invention will now be described in detail with respect to the preferred embodiment illustrated in the accompanying drawings, wherein:—

Figure 1 is a longitudinal sectional view of a plasma-arc cutting machine according to the present invention; and

Figure 2 is an enlarged view of the nozzle of the machine of Figure 1.

Referring to the drawings, in Figure 1 there is shown a small size pencil-type plasma-arc cutting machine according to the present invention.

A hollow pencil-type torch body 1 made of an insulating material comprises a body 1a an upper portion 1b and a lower portion 1c of which the lower part is tapered off, the connection between the body 1a and the lower portion 1c being sealed by an O-ring in order to prevent leaking of inert gas therethrough.

A cooling water pipe 2 having a flange 2a in its top end is fitted into the torch body 1a, the outer surface of the flange 2a contacting the inner surface of the torch body 1a. A gas pipe 3 is arranged centrally inside the cooling water pipe member 2, the top of the outer surface of the center gas pipe member 3 contacting the inner surface projecting inwards of the flange 2a. Accordingly there exists an annular space constituting a cooling water chamber 4 between the two pipes 2 and 3, in which space cooling water flows via inlet and outlet conduits 5 which are mounted at the top of the cooling water pipe member 2.

The cooling water pipe 2 is surrounded by a shield gas pipe 6 of which the outer surface contacts the inner surface of the torch body 1a. The shield gas pipe 6 has an inward projecting flange at its lower end, and contacts the cooling water pipe 2 at its top end and also at its lower end by the flange.

Hence, there exists an annular space constituting a shield gas chamber 7 between the two pipes 2 and 6, through which an inert shield gas supplied from an inlet pipe 8 positioned at the top of the shield gas pipe member 6 flows via openings 9 formed at the lower end thereof. At the lower surface of the shield gas pipe member 6, a screw is threaded, with which the female screw tapped on the upper inner surface of the lower torch portion 1c engages.

At the enlarged lower portion 3a of the center gas pipe member 3 a conical nozzle 10 is mounted by engaging a male screw formed in the upper cylinder portion 10c of the conical nozzle 10 with a female screw formed on the lower inside surface of the enlarged lower portion 3a. An inner top end of an upward outer projecting ring 10a of the conical nozzle 10 is contacted with the outer lower end of cooling water pipe 2, and the top end of the upward outer projecting ring 10 is also in contact with the lower end of the shield gas pipe 6.

Between the lower part of the central gas pipe member 3 and the upper outward projecting ring 10a there is an annular lower cooling water chamber 4a which communicates with the elongated cooling water chamber 4.

The inert shield gas which has flowed through the annular space between the two pipe members 2 and 6 and through openings 9 then flows through an annular space 11 be-

tween the lower torch portion 1c and the nozzle 10.

The conical nozzle 10 having a tapered nozzle lower end 10b includes a central opening 12 extending along its axis. The lower inner surface of the opening 12 is tapered corresponding to the nozzle 10. An insulation pipe 14 which is made of a material having high temperature resistance and low heat conductivity, and which in its outer shape conforms to the central opening 12, is inserted in the central opening 12 of the nozzle 10; the lower end of the central hole in the insulation pipe 14 is rounded off, as shown in Figure 1A. Radially directed slots 13 (see Figure 1A) are provided in the contact surface of the nozzle and insulation pipe which, in use, touch the workpiece.

A gas ring member 16 is fitted centrally into the upper part of the torch body 1a for supply of inert gas to the centre of the machine and is adjacent to the flange 2a of the cooling water pipe 2 with an insulating ring 15 being interposed therebetween. An inlet pipe 17 for supplying inert gas is mounted to the center gas ring member 16. The upper female screw ring portion 16a of the center gas ring member 16 engages with an exterior threaded surface of a screw ring 18.

An electrode holder 19 with a hollow open top for holding an electrode 20 is inserted into the screw ring 18 by engaging a lower outer threaded surface of the electrode holder 19 with the inner threaded surface of the screw ring 18. The upper torch portion 1b, having a center hole through which the electrode holder 19 passes, is capped onto the screw ring 18 by engaging its threaded inner surface with the threaded outer surface of the screw ring 18. Between the upper torch portion 1b and the electrode holder 18 a seal is formed by an O-ring, as shown in Figure 1. The electrode holder 19 includes an electrode holding portion 19a, projecting downwards into the center gas ring member 16, the insulation ring 15 and the center gas pipe member 3 in such a way that the electrode holding portion 19a does not contact them. The inside lower end surface of the electrode holding portion 19a is tapered off.

A chuck member 21 is fitted into the hollow of the electrode holder 19 and its top end projects over the top end of the electrode holder 19. The lower end portion of the chuck member 21 is divided longitudinally into several branches, and tapered off.

The electrode 20 is gripped firmly by the chuck member 21 which has a long hollow for holding the electrode 20 by pushing downwards the chuck member 21 via a push plate 22 by turning an adjusting knob 23 made of an insulating material, the female screw of the adjusting knob 23 engaging with the male screw formed on the upper outer surface of the electrode holder 19.

A guide ring 24 is arranged in the lower end of the center gas chamber 25 of the center gas

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pipe member 3 and has a central opening along its axis, through which the electrode passes. The outer surface of the guide ring 24 contacts the center gas pipe member 3 and is provided with dual spiral grooves 26. When the center inert gas passes through the dual spiral grooves 26 it acquires a revolving motion, which promotes the thermal pinch effect in the nozzle, and further helps the arc to center in the opening of the insulation pipe 14.

The electrode 20 is easily moved up and down relative to the nozzle by turning the electrode holder 19 by means of a turning ring 27 mounted to the electrode holder 19 by a screw 28.

The cutting operation of the machine of the present invention will now be described.

With the nozzle 10 not in contact with the metal workpiece 31, the electrode 20 is connected to the cathode of an electric source 29 via a terminal 30 and the base metal 31 to be cut is connected to the anode of the electric source 29. The electrode 20 is moved towards the workpiece 31 to a point near the lowermost end of the nozzle 10 by turning the turning ring 27. Cooling water is supplied to the cooling water chamber 4. The shield and centre insert inert gases, such as argon gas, nitrogen gas, or a mixture thereof are supplied to the shield gas chamber 7 via the inlet pipe 8 and to the center gas chamber 25 via the inlet pipe 17, and the shield gas then rushes out of the annular space 11 between the lower torch portion 1c and the nozzle 10 and the center gas out of the central opening 12 of the nozzle 10.

Then the lower end of the nozzle 10 is brought into contact with the base workpiece 31, resulting in striking an arc from the lower end of the electrode 20 onto the workpiece just under the electrode 20. The electrode 20 is then moved away from the workpiece 31 by turning the ring 27 to establish the proper electrode distance for cutting, keeping however the nozzle 10 in contact with the workpiece. The machine is moved along the cutting line, always maintaining contact between the nozzle 10 and the workpiece. The center gas then passes outward from the central opening 12 through the radial slots 10 in the contact surface of the nozzle, and this helps to cool the workpiece for better cutting efficiency.

The amount of electric current is varied according to the thickness of the workpiece 31 to be cut.

55 WHAT WE CLAIM IS:-

1. A plasma-arc cutting torch, comprising a body adapted to be held by a hand of an operator and having at one end a hollow nozzle, tapering toward a lower end intended to be placed in contact with a workpiece to be cut,

and having a central bore lined by material having high temperature resistance and low heat-conductivity, an electrode mounted within said bore in a manner so that the tip of the electrode is axially movable within the bore, an annular cavity within the body of the torch and surrounding the electrode and arranged for circulation of coolant water, the space around the electrode within the bore being arranged to be supplied from the upper end of the torch with an inert gas, the portion of the central bore around the electrode tip near the lower end of the nozzle being tapered to a narrower bore at the portion to be connected with the workpiece, and the lower end of the nozzle having radially directed slots in the contact face of the nozzle and the insulating lining thereof for passage of shield gas from the central bore when the torch is in contact with a workpiece.

2. A torch as claimed in Claim 1, which also includes an annular space between the outer surface of the nozzle and the lower edge of the torch body, which body does not extend to enclose the lower end of the nozzle, the space being arranged for passage of inert shielding gas.

3. A torch as claimed in Claim 1 or 2 which includes means for forming a pilot arc from the electrode to the lower portion of the nozzle.

4. A torch as claimed in Claim 1, 2, or 3, substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

5. A method of cutting a metal workpiece wherein a torch as claimed in any preceding Claim is used, wherein an electrical current is completed between the electrode and the workpiece, the electrode is moved within said bore toward the lowest end of the nozzle, cooling water and an inert gas are supplied to the torch, the lowest end of the nozzle is contacted with the workpiece so that an arc is struck between the workpiece and the electrode, the electrode is moved a suitable distance away from the workpiece, the inert gas from the central bore passing outward along the radial slots, and the torch is moved over the workpiece to cut it along a desired line.

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The outer surface of the guide ring 24 contacts the center gas pipe member 3 and is provided with dual spiral grooves 26. When the

- 5 center inert gas passes through the dual spiral grooves 26 it acquires a revolving motion, which promotes the thermal pinch effect in the nozzle, and further helps the arc to center in the opening of the insulation pipe 14.

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