

PATENT SPECIFICATION

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(54) ELECTRIC-ARC TORCH

(71) We, AIR PRODUCTS AND CHEMICALS INC., of P.O. Box 538, Allentown, Pennsylvania 18105, United States of America, a Corporation of the State of Delaware, United States of America, 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 pertains to electric-arc torches and in particular, underwater-arc torches for use in cutting and gouging metal objects.

Torches for use underwater find utility in salvaging sunken vessels, repairing floating vessels such as ships, barges, and the like; and in construction, and maintenance of fixed structures such as bridges, seawalls, piers, oil drilling platforms, and the like. Conventional underwater torches are illustrated in U.S. Patents 2,396,307; 2,417,650; 3,462,463; and 3,751,625. The last named patent illustrates an underwater torch that has found acceptance in the trade.

All of the foregoing torches were developed for use with the conventional underwater cutting technique employing a hollow tubular electrode and oxygen gas. In the conventional underwater cutting technique an arc is struck between the piece being cut and the electrode, and oxygen gas is forced down through the bore of the electrode to achieve the chemical cutting action under the influence of the arc.

Such torches require auxiliary sources of oxygen which are usually maintained on the diving support ship and piped to the torch via long lengths of hose.

In order to modernize underwater cutting a new method has been devised which is described and claimed in our copending U.K. Patent Application No. 7658/77 (Serial No. 1,573,781). According to said copending application there is provided a method of removing metal from an object submerged in a liquid medium comprising the steps of:

establishing an electric arc between an electrode and the object; and

directing at least one stream of high pressure liquid so as to pass between the electrode and the object and to impinge and carry metal away from the object. As described in that application the high pressure liquid can be the water in which the operation was taking place. This new process, which is not dependent on oxygen or chemical reaction in the cutting process, thus involves directing liquid toward the arc, for example by directing a high pressure jet alongside the electrode, instead of passing an oxygen-containing gas through a hollow electrode.

A new torch has now been designed which employs an electrode carrying means and means for directing the stream of high pressure liquid toward the arc and which, although capable of more general application, is of particular use in carrying out the method of the above-mentioned copending application.

According to the present invention there is provided an underwater electric arc torch for use in cutting and gouging metal objects, said torch comprising in combination:

an electrically insulating handle having an outer surface adapted to facilitate gripping by the hand of a user;

an electrically conductive torch head mounted on said handle said torch head including an elongate recess arranged to receive and hold an elongate electrode, and a passage in said head terminating in at least one nozzle-like aperture adjacent said recess, said recess and said passage having parallel longitudinal axes; said head having an electrically insulating coating on all outwardly exposed surfaces to prevent electrical shock to the user thereof; means for bringing electrical current from a source of such current to an electrode held in said recess; and

means for bringing water under pressure to said passage, the passages and recess arrangement being such that in use of said torch said water exits from said nozzle-like aperture at high pressure in a direction generally along the electrode toward the projecting end thereof and toward an arc struck between said electrode and said workpiece.

Torches may be constructed according to the invention having a relatively small number of conductive members, and furthermore may be constructed in a form which is compact, light-weight, safe and durable, and suitable for use as an underwater cutting and gouging torch employing relatively few electrical conducting members and incorporating means for positively gripping the electrode.

Embodiments of torches in accordance with the invention will now be described by way of example with particular reference to the accompanying drawings of which:

Figure 1 is a front elevational view of a torch according to the present invention.

Figure 2 is a left side elevational view of the torch of Figure 1.

Figure 3 is a partial sectional view taken along the line 3—3 of Figure 2 with the hose and cable in partial section for illustrative purposes extended in a longitudinal direction.

Figure 4 is a front elevational view of an alternative embodiment of the torch head of the present invention.

Figure 5 is a front elevational view of yet another alternative embodiment of the torch head of the present invention.

Figure 1 illustrates the underwater electric-arc torch of the present invention.

The torch includes a handle 10 and a head designated generally as 12. The handle 10 is shown to be in the shape of an elongated cylinder having thereon a plurality of grooves or ribs of semi-circular cross section 14 to facilitate gripping by the operator during use. While the handle 10 is shown as cylindrical, its shape is not critical; the handle need only be adapted to the hand of an operator for guiding the torch head 12 toward the workpiece.

In describing the torch head 12, reference should be taken to both Figures 1 and 3. The head 12 includes a conductive member 16 which can be a solid block of metal such as copper or a brass alloy. The block 16 contains a recess 18 of generally cylindrical shape to accommodate a cylindrical electrode. The diameter of recess 18 is selected based upon the diameter of the electrode being employed. With the torch of the present invention a graphite electrode such as normally employed in the air-carbon arc cutting and gouging process is used. The electrode is first covered with a thin metallic copper coating to enhance the conductivity between block 16 and the electrode. In those portions projecting from the torch, the electrode is provided with a suitable protective covering such as disclosed in U.S. Patent 3,835,288. The preferred waterproof coating is a thermosettable epoxy resin applied directly on top of the copper coating. One such resin is sold by Michigan Chrome and Chemical Company under the trade designation MICCRONTYPE 650 epoxy as disclosed in the aforementioned patent. To ensure posi-

tive contact of the electrode to the block 16 and to prevent movement of the electrode as a result of the arc, a member 20 for positively clamping the electrode is included in the head. Member 20 can be a simple threaded stem with a star-shaped knob which communicates through block 16 to recess 18 to positively clamp the electrode within the recess by turning the knob as is well known in the art.

Also included in block 16 is a passage terminating in a nozzle-like aperture 24, the nozzle-like aperture 24 being disposed adjacent that portion of recess 18 opening onto the surface of head 12. The nozzle-like aperture 24 can be of any shape; however, a simple circular cross-section is found to be very effective. The passage 22 extends through block 16 and communicates with a counter bore and partially threaded opening 26 in head 12 opposite aperture 24. Threaded into the threaded portion of counter bore 26 is a liquid conduit adapter 28 which in turn is connected to a hose 30. Hose 30 includes a suitable connector 32 on the opposite end for connection to a source of water under pressure as will hereinafter be explained. Also included in the conduit is a control valve or clamp 34 for admitting or preventing water from entering passage 22. The water is preferably supplied to conduit 30 by a high pressure pump. The pump may be a submersible type which is located near the workpiece or the water may be pumped from a remote location such as a surface tender.

Adjacent the counter bore 26 is a second threaded recess 36 which receives an electrical conduit adapter 38 which in turn is connected to an electrical conduit 40 having on its opposite end a suitable electrical connector 42 for connection to a source of current such as a power supply contained on the diving tender. Electrical conduit 40 is provided with suitable shielding which extends to adapter 38 to prevent stray electrical currents from coming in contact with the diver.

Head 12 is covered with an insulated coating 44 to prevent contact of the electrical conducting block 16 by the diver. Only the inner portion of the recess 18 does not have an insulating coating so that there can be good electrical contact between the electrode (not shown) and conducting block 16.

There is shown in Figure 4 another embodiment of the head 12' of the present invention having an electrode gripping member 20'; the electrode recess 18' is as described in relation to Figures 1, 2 and 3. The embodiment of Figure 4 includes a plurality of nozzle-like apertures 50 adjacent recess 18 for directing the liquid down along the electrode in a manner identical to the nozzle-like aperture 24 of the embodiment of Figure 1.

Figure 5 discloses yet another embodiment of a torch head 12'' including an electrode clamping member 20''. In this embodiment the electrode recess 60 is an elongate box having

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a cross-sectional shape in the form of a rectangle with generally semi-circular ends to receive a generally elongate flat electrode having a complementary cross-sectional shape such that as disclosed in U.S. Patent 3,566,069. The so-called flat electrode may be made from a carbonaceous material, e.g. graphite, and is provided with both the copper coating and, for the portions projecting beyond the torch head 12", a waterproof coating such as disclosed in relation to the cylindrical electrode used in the embodiment of Figures 1—3. In the embodiment of Figure 5 a plurality of nozzle-like apertures 62 are disposed alongside one of the flat sides of the rectangular shaped aperture 60 for directing water generally along the electrode and toward the projecting end thereof.

In the foregoing description a torch is disclosed that will accommodate a copper coated graphite electrode having a waterproof coating thereon. The torch is adapted to carry current to the electrode so that an arc can be struck between the electrode and a workpiece being cut underwater. The nozzle-like aperture 24 or apertures 50 and 62 communicates with a passage 22 which receives water under pressure directed toward the arc to remove the molten metal which is produced as a result of the arc between the electrode and the workpiece. Thus, there is disclosed a torch which is suitable for performing all types of underwater cutting and gouging operations without the need for a source of oxygen and all the attendant valve mechanisms required when using oxygen underwater.

Furthermore, the torch of the present invention can be used for welding by simply inserting a welding electrode of proper size in the recess 18 and applying a current to the electrode without using liquid forced under pressure through passageway 22.

The torch of the present invention can be embodied in many geometrical forms, the choice being limited only by that which is convenient to an operator.

WHAT WE CLAIM IS:—

1. An underwater electric arc torch for use in cutting and gouging metal objects, said torch comprising in combination:
 - an electrically insulating handle having an outer surface adapted to facilitate gripping by the hand of a user;
 - an electrically conductive torch head mounted on said handle said torch head including an elongate recess arranged to receive and hold an elongate electrode, and a passage in

said head terminating in at least one nozzle-like aperture adjacent said recess, said recess and said passage having parallel longitudinal axes; said head having an electrically insulating coating on all outwardly exposed surfaces to prevent electrical shock to the user thereof; means for bringing electrical current from a source of such current to an electrode held in said recess; and

means for bringing water under pressure to said passage, the passage and recess arrangement being such that in use of said torch said water exits from said nozzle-like aperture at high pressure in a direction generally along the electrode toward the projecting end thereof and toward an arc struck between said electrode and said workpiece.

2. A torch according to claim 1 wherein a solid copper coated graphite cutting and gouging electrode is held in said recess.

3. A torch according to claim 1 or claim 2 wherein the recess has associated therewith means for positively clamping the electrode.

4. A torch according to any preceding claim wherein the passage terminates in a plurality of nozzle-like apertures for directing said water at high pressure in a direction generally along said electrode.

5. A torch according to any preceding claim wherein the torch head is a unitary member.

6. A torch according to any preceding claim wherein said recess is an elongate cylindrical bore to receive an electrode of generally cylindrical shape.

7. A torch according to any one of claims 1 to 5 wherein said recess is an elongate bore having a cross sectional shape in the form of a rectangle with generally semi-circular ends to receive a generally elongate flat electrode having a complementary cross-sectional shape.

8. A torch constructed, arranged and adapted to operate substantially as hereinbefore described and as shown in Figures 1 to 3 of the accompanying drawing.

9. A torch according to claim 8 having a head substantially as shown in Figure 4 of the accompanying drawing.

10. A torch according to claim 8 having a head substantially as shown in Figure 5 of the accompanying drawing.

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Furthermore, the torch of the present invention can be used for welding by simply inserting a welding electrode of proper size in the recess 18 and applying a current to the electrode without using liquid forced under pressure through passageway 22.

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said head terminating in at least one nozzle-like aperture adjacent said recess, said recess and said passage having parallel longitudinal axes; said head having an electrically insulating coating on all outwardly exposed surfaces to prevent electrical shock to the user thereof; means for bringing electrical current from a source of such current to an electrode held in said recess; and

means for bringing water under pressure to said passage, the passage and recess arrangement being such that in use of said torch said water exits from said nozzle-like aperture at high pressure in a direction generally along the electrode toward the projecting end thereof and toward an arc struck between said electrode and said workpiece.

2. A torch according to claim 1 wherein a solid copper coated graphite cutting and gouging electrode is held in said recess.

3. A torch according to claim 1 or claim 2 wherein the recess has associated therewith means for positively clamping the electrode.

4. A torch according to any preceding claim wherein the passage terminates in a plurality of nozzle-like apertures for directing said water at high pressure in a direction generally along said electrode.

5. A torch according to any preceding claim wherein the torch head is a unitary member.

6. A torch according to any preceding claim wherein said recess is an elongate cylindrical bore to receive an electrode of generally cylindrical shape.

7. A torch according to any one of claims 1 to 5 wherein said recess is an elongate bore having a cross sectional shape in the form of a rectangle with generally semi-circular ends to receive a generally elongate flat electrode having a complementary cross-sectional shape.

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