

PATENT SPECIFICATION

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(54) UNDERWATER CUTTING AND WELDING TORCH

(71) We, ARCAIR COMPANY, of North Memorial Drive, Route 33 Lancaster, Ohio 43130, United States of America, a corporation organized and existing under the laws 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 cutting and welding torches and in particular electric-arc cutting and welding torches for use under water. Such torches are commonly used 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, oil drilling platforms and the like.

The underwater torches in commercial use generally have a tapered collet that is compressed by means of a screw threaded into a receiving member, for holding the electrode. During operation, because of scale, barnacles, and other foreign material and objects that have been in the water, the electric arc tends to extinguish frequently, requiring a restrike. This is known as pecking the electrode and frequently causes the screw device holding the collet to work loose. This in turn causes the electrode to become loose resulting in arcing inside the torch head which in turn not only can damage the torch, but, if severe, can injure the operator.

Cam actuated clamping devices are not ideal because of the large number of metal parts required for gripping the electrode and the fact that electrode pecking can cause the electrode to become loose with the problems set forth above. As the number of metal parts increases, the problems

of insulating the torch increase and the weight is also increased.

Commercial torches are generally bulky, heavy and of complicated structure requiring a large number of parts and generally have exposed members that can deteriorate because of the electrical current in combination with an aqueous environment or because of the aqueous environment itself.

In order to avoid the above-described problems and to provide an improved underwater cutting and welding torch, it has been discovered in accordance with the invention that the electrode gripping means may comprise electrode clamping surfaces normally forced together by a member which is formed of resiliently deformable, e.g. elastomeric, material. This method of gripping the electrode prevents loosening thereof during pecking and facilitates electrical insulation of the torch by minimizing the number of metallic parts in the torch.

Thus, according to the present invention, there is provided a torch adapted for underwater cutting and welding operations and including a torch body having a fluid passage therethrough and a valve for controlling the flow of a fluid through said passage; a torch head which is in fluid-tight relation with said body and has a fluid passage which communicates at one end with the passage in said body and terminates at the other end with electrode holding means so as to communicate with fluid passage means in an electrode in position in said holding means; means for bringing electrical current to an electrode in position in said holding means; and means for introducing fluid to said torch body passage; and wherein the electrode holding means include electrode clamping surfaces and a member which is formed of resiliently deformable material and is adapted to normally urge the clamping sur-

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faces towards each other so as to grip an electrode inserted between them.

In accordance with one embodiment of the invention, the member formed of resiliently deformable material comprises a sleeve surrounding clamping members carrying the clamping surfaces. Conveniently one of said electrode clamping members is of an electrical conductive material and can provide the means of carrying operating electrical current to the electrode.

In accordance with an alternative embodiment, the electrode holding means includes a first electrode clamping member secured by said head and providing a first electrode clamping surface, and said member formed of resiliently deformable material is affixed to said head and is constructed and arranged to provide a second electrode clamping surface which is normally urged towards said first surface to exert a vice-like grip on the electrode, and the torch also includes positive clamping means in the resilient member to provide more positive holding of the electrode. The resilient member may comprise a block of resiliently deformable material slit through a major part of its thickness from one face thereof, the block being formed on one side of the plane of said slit with a cavity in which is located said first electrode clamping member and forming on the other side of said plane said second electrode clamping surface, the slit extending between the clamping surfaces. With this arrangement, the positive clamping means comprise means such as a screw for drawing the surfaces of the block on each side of the slit towards each other in a vice-like manner. Conveniently, the first clamping member is of electrically conductive material and can provide the means of carrying operating electrical current to the electrode.

Eliminating metallic members and replacing them with lightweight, non-conducting materials results in a compact, lightweight, reliable and easily maintained cutting and welding torch that shows a minimum of deterioration when exposed to or operating in an aqueous environment.

The invention will now be described in greater detail with reference to preferred embodiments and with the aid of the accompanying drawings in which:—

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

Figure 2 is a sectional view taken along lines 2-2 Figure 1 with added fragmentary portion illustrating hose and cable details.

Figure 3 is a fragmentary side view of the torch partially in section illustrating the electrode sealing apparatus.

Figure 4 is a side view partially in sec-

tion illustrating an alternative embodiment of the present invention.

Figure 5 is a partial cross-sectional view of a cable connector useable with the present invention.

Figure 6 is a front elevational view of a third embodiment of the present invention.

Figure 7 is a sectional view taken along lines 7-7 of Figure 6 with added fragmentary portions illustrating hose and cable details.

Figure 8 is a fragmentary side view of the torch partially in section illustrating an electrode in operating position.

Figure 9 is a side view partially in section illustrating a fourth embodiment of the present invention.

Figure 10 is a sectional view of a torch head detailing an alternate valve arrangement.

There is shown in Figure 1 an underwater cutting and welding torch designated generally as 10 having a gas operating lever assembly 12, and a head assembly 14.

The torch 10 has a torch body 16 having therein a fluid conduit 18 communicating with a valve bore 20 which in turn communicates with threaded aperture 22 which in turn receives a hose fitting 24 to which is attached a fluid conduit 26. Through conduit 26 a fluid such as oxygen gas is admitted to the torch.

Disposed within valve bore 20 is a valve stem 28 projecting outwardly of the torch body 16 through fluid tight fitting 30. The end of the valve stem 28 within torch body 16 contains a sealing member 32 held in place by screw 34. The valve stem 28 is held in the normal closed position by means of spring 36. Outwardly of the torch body 16 is a gas operating lever 38 pivotably connected to valve stem 28 by means of pin connector 40. Thus by moving the lever 38 toward the torch body 16 the valve stem moves to the right admitting fluid to conduit 18.

Head 14 is mounted on torch body 16 and held in fluid-tight relation thereto. The head 14 comprises a head block 42 having a first fluid passage 44 communicating with fluid passage 18 in body 16. Sealing means 46, such as an O-Ring, is included to prevent fluid leaks between the torch body 16 and the head block 42. Included in head block 42 is a second fluid passage 48 having disposed therein a check valve assembly 50. The check valve assembly 50 is included to prevent foreign materials from flowing back into the torch thereby fouling the valve assembly. The check valve assembly 50 also prevents hot particles from entering the torch thereby preventing burning of the inside of the torch 10. The entire check valve assembly is

preferably constructed from polytetrafluoroethylene, which is non-conducting and inert to normal operating environments for this torch.

5 Communicating with fluid passage 48 is an aperture 52 wherein there is a sealing member 54. Sealing member 54 is a resilient seal having an inside diameter smaller than the outside diameter of the electrode normally used with this torch. Sealing member 54 is held in place by retaining ring 56 which in turn is held in place by electrode gripping members or shoes 58, 60. Gripping members 58, 60 are held in place by a member formed of resiliently deformable material, the member being in the form of elastic ring 62. Gripping member 60 is of conductive material such as copper and extends through a slot in head block 42 and is retained by cap 43, having a complimentary slot, by means of screws (not shown) extending through cap 43, head block 42 and fastened body 16 which also position head block 42 to body 16 compressing sealing member 46. If the screws are of a conducting material, electrolysis thereof can be prevented by applying a non-conducting coating such as silicone rubber to the exposed portions. On the protruding end 64 of member 60 a suitable socket is formed to receive the conducting portion of waterproof electrical cable 66. The protruding end 64 of member 60 and the adjacent section of the covering of cable 66 are in turn covered with a suitable insulating cover 68 such as heat shrinkable, non-conducting tubing, such as vinyl or polyester tubing, to form a water-tight seal. Cable 66 is formed in a loop as shown in figure 1 and fastened to the fluid hose by a suitable clamp 70. The opposite end of cable 66 has a suitable fitting 72 for connection to an electrical power source (not shown). The hand loop formed by cable 66 and torch 10 aids in positioning and steadying the torch when in use. The loop also allows the operator to flex hand and fingers thereby minimizing fatigue and cramps due to the operating environment and at the same time retaining possession of the torch.

The bare end of electrode 80 is inserted so that it extends back into passage 48 containing check valve 50. This tends to stabilize the position of the electrode.

The lower gripping member or shoe 58 is complimentary in shape to upper member 60 but does not extend beyond sealing member 56. Both shoes 58, and 60 when assembled form a tapered circular aperture 74 with a transverse space or slot 76 across the aperture 74. As shown in Figure 3, the shoes 58, 60 are forced apart to receive the bare end 82 of hollow coated electrode 80, the coating being shown as

84. The elastic ring 62 forces the shoes 58, 60 toward each other thereby tightly gripping the electrode 80. Sealing member 54 forms a seal around electrode 80 thereby preventing fluid leaking around the electrode.

In order to increase the life expectancy of the torch and operator safety, the exposed surfaces of shoe 60, except for electrode contact surface 73, can be coated with a non-conducting abrasion resistant material such as epoxy.

In the torch shown, only shoe 60 need be constructed from a conducting material such as a copper alloy. It is preferred that handle 38, pin 40, screw 34, and fitting 24 be constructed from metals, for strength, ease in fabrication, and minimized expense of fabrication. Handle 38 is provided with a non-conducting abrasion-resistant coating also. The balance of the parts can be fabricated from known electrically insulating materials such as plastics thereby minimizing electrical arcing possibilities thus assuring greater operator safety. These materials make a more compact, lightweight, easier-to-maintain torch. It also increases efficiency because of the torch being lightweight and compact.

In operation the torch 10 is connected to an electrical power supply (not shown) by means of fitting 72 in conductor 66 thereby providing power to grip or contact shoe 60 and hence to the electrode 80. Tubing or hose 26 is connected by means of a coupling 86 to a source of fluid such as oxygen gas under pressure. When under water the operator signals the person on a barge or land where the source of power and fluid are kept to turn on the current. He then can strike his arc and start gas flow through the electrode by pulling lever 38 toward body 16 and proceed to cut. When the electrode 80 is consumed he calls for power to be turned off and can readily change electrodes.

Shown attached to power cable 66 and hose 26 by means of clamps 94, 96 is an electrode extractor 98 having a general configuration of a T with an aperture slightly larger in diameter than the electrode. If the used electrode stub is short, the extractor aperture 100 is placed over the stub and the stub can be readily removed. This allows more of the electrode to be consumed and provides ready access to a stub extractor. Normally an operator would require the use of pliers or another tool to remove the stub.

If the torch is to be used for welding, a welding electrode of the same diameter as the cutting electrode is inserted between shoes 58, 60. The welding electrode is not hollow as no gas is required during welding. The torch can be adapted to elec-

trodes of differing diameters by changing the contact shoes 58, 60 to provide the required size for aperture 74.

There is shown in Figure 4 an alternative embodiment wherein electrical conductor 68' is affixed to torch 10' along one side of body 16' and head block 42'. This construction eliminates the hand loop of figure 2 if operator preference and operating conditions warrant.

Figure 5 shows an alternative cable connector 88 for the end of cable 68' that is connected to the source of electrical power. Such connectors 88 are commercially available and have an electrical connector 90 sheathed in a waterproof covering 92 sealed to cable 68' to provide rapid water-tight connection to another cable with a suitable mating connector (not shown).

While the materials of construction are known, the use of such non-conducting materials for a major portion of an underwater torch has not been heretofore shown. Materials selection can vary depending upon the individual facilities available for molding and fabricating taking into account water absorption, strength, resistance to safe concentrations of oxygen, abrasion resistance and impact resistance of these materials.

It is also contemplated that the electrode shoes can be held in a rigid receptacle using an elastomeric block, wedge or the like against which one or both shoes can be moved.

The torch illustrated in Figures 1, 2, 3 and 4 has been found to be satisfactory for almost all underwater cutting and welding applications. It is possible, however, that where the diver encounters heavy corrosion, barnacles, or other non-conducting coatings on the submerged article being cut he will severely strike, in hammer-like fashion, such a coating with the torch in order to initiate and maintain the arc. Such banging as it is called in the trade could lead to arcing of the electrode 80 to the conductive shoe 60.

In order to provide an even greater positive gripping force on the electrode there is shown in Figures 6 and 7 a torch 110 having a gas operating lever assembly 112 and a head assembly 114.

The torch 110 has a torch body 116 identical in structure to the torch body of figure 1 and 2.

The gas operating lever assembly 112 and the valve assembly shown as 120 are also identical with the gas operating lever assembly and valve assembly as described in connection with figures 1 and 2.

Head assembly 114 is mounted on torch body 116 and includes a head block 122 affixed to body 116 as by screws 124, 126 (Figure 6). Head block 122 includes a first

fluid passage 128 communicating with fluid passage 118 in a body 116. Sealing means 130, such as an O-Ring, is included to prevent fluid leaks between the torch body 116 and the head block 122. Included in head block 122 is a second fluid passage 132 communicating with fluid passage 128 and having therein a check valve assembly 134 similar to the check valve assembly of the torch as shown in figures 1 and 2.

Fluid passage 132 communicates with aperture 136 wherein is disposed electrode sealing member 138 which is held in place by retaining ring 140 which in turn is held in place by upper electrode gripping shoe 142 and lower electrode gripping shoe assembly 144.

Upper shoe 142 is of a conductive material such as copper and extends through a slot in head block 122 and is retained by cap 146 having a complementary slot; cap 146 and head block 122 both affixed to body 116 by screws 124, 126. The screws 124, 126 are recessed in the cap and covered with a silicone rubber to prevent contact of the screw head with the operating environment. On the protruding end 148 of upper shoe 142 there is formed a socket 150 having internal threads complementary to a threaded connector 152 on electrical cable 154 so that the electrical cable 154 can be readily removed from the torch. The connection is covered by a suitable insulating cover 156 such as heat shrinkable, non-conducting vinyl or polyester tubing to form a water-tight seal. Cable 154 is formed in a loop similar to the loop shown and described in connection with figure 2.

Lower shoe assembly 144 includes a face member 160 having an electrode gripping member or shoe portion 161 complementary to the electrode gripping portion of upper shoe 142 and a covering portion that covers upper shoe 142 on its upper and front exposed surfaces. Face member 160 has a horizontal slot 162 so constructed that when the face member 160 is affixed to the upper shoe 142 and by screw 164 the lower gripping portion of face member 160 can be moved toward and away from upper shoe 142 to grip the electrode. This motion is achieved by a lead screw device 166, actuated by knob 168. In effect the lead screw device 166, in conjunction with face member 160 and upper shoe 142, acts as a vice to securely grip the electrode. By manufacturing face member 160 from a resilient non-conducting material such as NYLON the self-hold feature of the elastic ring of the torch of Figure 1 is achieved and reinforced by a positive vice-like holding feature included in the same structure.

Figure 8 shows an electrode 170 inserted

in the torch by forcing apart shoe 142 and shoe 161 to initially seat the electrode. Knob 168 is then tightened to provide the added force to more firmly secure the electrode 170 to the torch.

Torch 110' of Figure 9 is identical to torch 110 of figures 7 and 8 and illustrates a replaceable cable 154' affixed to the torch 110' in a manner similar to the embodiment of Figure 4 by means of a covered conductor 172 affixed to the torch body 116'.

In Figure 10 the check valve 134 has a body similar to 3c as shown in Figures 1 and 2 and this body is provided with a circumferential groove 180 for receiving a locking set screw 178 displaced in a mating threaded aperture in head block 122, thus insuring positive positioning of the valve. A spring 174 is disposed between the electrode backing surface of said valve body and the valve ball to provide a more positive seating of the ball when the flow of gas is turned off. There is also shown in Figure 10 a screen or other mesh device 176 placed in fluid passage 128 which serves as a flash arrestor and a particle filter. These last two additions to the torch further enhance safety to the operator while the torch is in use.

As with torches of Figures 1-4 and the torches of Figures 6-9, only shoe 142 need be constructed from a conducting material such as copper or a copper alloy. It is also preferred that the gas operating lever handle, hinge pin, and valve screw be of metallic materials as well as head screws 124, 126. The handle is provided with a non-conducting abrasion resistant coating and all exposed metallic surfaces are coated with non-conducting coatings.

WHAT WE CLAIM IS:

1. A torch adapted for underwater cutting and welding operations and including a torch body having a fluid passage therethrough and a valve for controlling the flow of a fluid through said passage; a torch head which is in fluid-tight relation with said body and has a fluid passage which communicates at one end with the passage in said body and terminates at the other end with electrode holding means so as to communicate with fluid passage means in an electrode in position in said holding means; means for bringing electrical current to an electrode in position in said holding means; and means for introducing fluid to said torch body passage; and wherein the electrode holding means include electrode clamping surfaces and a member which is formed of resiliently deformable material and is adapted to normally urge the clamping surfaces towards

each other so as to grip an electrode inserted between them.

2. A torch according to claim 1 in which the member formed of resiliently deformable material comprises a sleeve surrounding clamping members carrying the clamping surfaces.

3. A torch according to claim 2 wherein one of said electrode clamping members is of an electrical conductive material and is adapted to carry operating electrical current to said electrode.

4. A torch according to claim 3 wherein said one clamping member is of a metallic material and the remaining torch members are of non-conducting lightweight materials.

5. A torch according to claim 3 or claim 4 wherein said electrode clamping member and said electrical conducting means are covered by a non-conducting material.

6. A torch according to claim 1 wherein said electrode holding means includes a first electrode clamping member secured by said head and providing a first electrode clamping surface, and said member formed of resiliently deformable material is affixed to said head and is constructed and arranged to provide a second electrode clamping surface which is normally urged towards said first surface to exert a vice-like grip on the electrode, said torch also including positive clamping means in said resilient member to provide more positive holding of said electrode.

7. A torch according to claim 6 wherein said resilient member comprises a block of resiliently deformable material slit through a major part of its thickness from one face thereof, the block being formed on one side of the plane of said slit with a cavity in which is located said first electrode clamping member and forming on the other side of said plane said second electrode clamping surface, the slit extending between the clamping surfaces and the positive clamping means comprising means for drawing the surfaces on each side of the slit towards each other.

8. A torch according to claim 6 or claim 7 in which said first electrode clamping member is of an electrical conductive material and is adapted to carry operating electrical current to said electrode.

9. A torch according to claim 8 wherein said first electrode clamping member is of a metallic material and the remaining torch members are of non-conducting lightweight materials.

10. A torch according to claim 8 or claim 9 wherein said first electrode clamping member and said electrical conducting means are each covered by a non-conducting material.

in the torch by forcing apart shoe 142 and shoe 161 to initially seat the electrode. Knob 168 is then tightened to provide the added force to more firmly secure the electrode 170 to the torch.

Torch 110' of Figure 9 is identical to torch 110 of figures 7 and 8 and illustrates a replaceable cable 154' affixed to the torch 110' in a manner similar to the embodiment of Figure 4 by means of a covered conductor 172 affixed to the torch body 116'.

In Figure 10 the check valve 134 has a body similar to 3c as shown in Figures 1 and 2 and this body is provided with a circumferential groove 180 for receiving a locking set screw 178 displaced in a mating threaded aperture in head block 122, thus insuring positive positioning of the valve. A spring 174 is disposed between the electrode backing surface of said valve body and the valve ball to provide a more positive seating of the ball when the flow of gas is turned off. There is also shown in Figure 10 a screen or other mesh device 176 placed in fluid passage 128 which serves as a flash arrestor and a particle filter. These last two additions to the torch further enhance safety to the operator while the torch is in use.

As with torches of Figures 1-4 and the torches of Figures 6-9, only shoe 142 need be constructed from a conducting material such as copper or a copper alloy. It is also preferred that the gas operating lever handle, hinge pin, and valve screw be of metallic materials as well as head screws 124, 126. The handle is provided with a non-conducting abrasion resistant coating and all exposed metallic surfaces are coated with non-conducting coatings.

WHAT WE CLAIM IS:

1. A torch adapted for underwater cutting and welding operations and including a torch body having a fluid passage there-through and a valve for controlling the flow of a fluid through said passage; a torch head which is in fluid-tight relation with said body and has a fluid passage which communicates at one end with the passage in said body and terminates at the other end with electrode holding means so as to communicate with fluid passage means in an electrode in position in said holding means; means for bringing electrical current to an electrode in position in said holding means; and means for introducing fluid to said torch body passage; and wherein the electrode holding means include electrode clamping surfaces and a member which is formed of resiliently deformable material and is adapted to normally urge the clamping surfaces towards

each other so as to grip an electrode inserted between them.

2. A torch according to claim 1 in which the member formed of resiliently deformable material comprises a sleeve surrounding clamping members carrying the clamping surfaces.

3. A torch according to claim 2 wherein one of said electrode clamping members is of an electrical conductive material and is adapted to carry operating electrical current to said electrode.

4. A torch according to claim 3 wherein said one clamping member is of a metallic material and the remaining torch members are of non-conducting lightweight materials.

5. A torch according to claim 3 or claim 4 wherein said electrode clamping member and said electrical conducting means are covered by a non-conducting material.

6. A torch according to claim 1 wherein said electrode holding means includes a first electrode clamping member secured by said head and providing a first electrode clamping surface, and said member formed of resiliently deformable material is affixed to said head and is constructed and arranged to provide a second electrode clamping surface which is normally urged towards said first surface to exert a vice-like grip on the electrode, said torch also including positive clamping means in said resilient member to provide more positive holding of said electrode.

7. A torch according to claim 6 wherein said resilient member comprises a block of resiliently deformable material slit through a major part of its thickness from one face thereof, the block being formed on one side of the plane of said slit with a cavity in which is located said first electrode clamping member and forming on the other side of said plane said second electrode clamping surface, the slit extending between the clamping surfaces and the positive clamping means comprising means for drawing the surfaces on each side of the slit towards each other.

8. A torch according to claim 6 or claim 7 in which said first electrode clamping member is of an electrical conductive material and is adapted to carry operating electrical current to said electrode.

9. A torch according to claim 8 wherein said first electrode clamping member is of a metallic material and the remaining torch members are of non-conducting lightweight materials.

10. A torch according to claim 8 or claim 9 wherein said first electrode clamping member and said electrical conducting means are each covered by a non-conducting material.



11. A torch according to any one of claims 1 to 10 wherein there is included in said fluid passage in said head a check valve constructed from inert materials for preventing back flow of fluid and other foreign objects into said torch body.
12. A torch according to any one of claims 1 to 11 wherein said valve includes a lever pivotably connected to a valve stem projecting from said body whereby an operator may control the flow of fluid through said torch.
13. A torch according to claim 12 wherein said lever is of a metallic material covered with a non-conducting synthetic material.
14. A torch according to any of claims 1 to 13 further including sealing means associated with said electrode holding means to provide a substantially fluid-tight seal around the periphery of said electrode.
15. An underwater cutting and welding torch as claimed in claim 1, substantially as hereinbefore described and as illustrated in Figures 1 to 3, Figures 1 to 3 as modified by one or both of Figures 4 and 5, Figures 6 to 8, or Figures 6 to 8 as modified by one or both of Figures 9 and 10.

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