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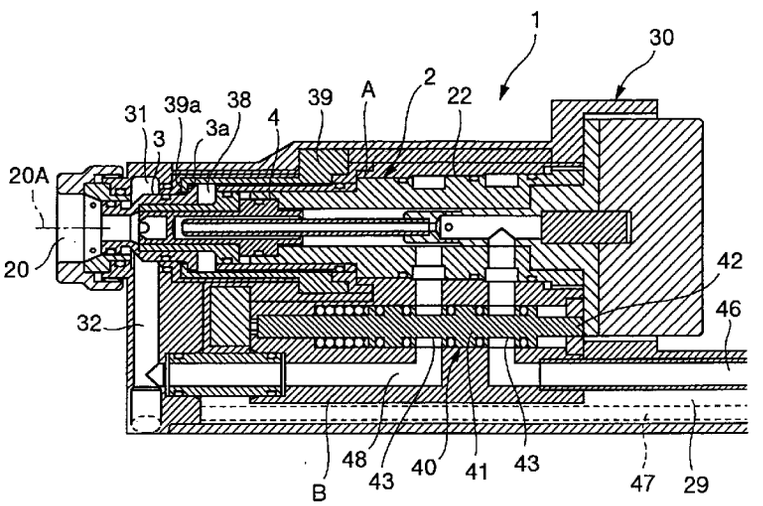
(54) CARTRIDGE TYPE PLASMA TORCH

(57) A cartridge type plasma torch in which expendables can easily be replaced, cooling water and operation gas are securely sealed when expendables are replaced, and the accessibility to a work piece during operation can be improved. For this purpose, the cartridge type plasma torch includes an expendable cartridge (2) including an electrode (4) and /or a torch nozzle (3), and a torch main body (30) which has supply lines for supplying cooling water and operational gas to the expendable cartridge (2), and which allows the expendable cartridge (2) to be mounted and / or dismounted from an end opposite to an arc injection port (20) when viewed in a longitudinal direction of the torch.

FIG.1



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Description

Technical Field

The present invention relates to a cartridge type plasma torch which is used for welding or cutting, and particularly relates to a cartridge type plasma torch which allows expendables of the plasma torch to be easily mounted therein and/or dismounted therefrom.

Background Art

Plasma welding and plasma cutting have much higher energy density, and are more excellent in operability compared to the other machining methods (for example, TIG welding, and gas cutting), therefore they are used in various fields. However, in the conventional plasma torch which is used for plasma welding and plasma cutting, replacement (mounting / dismounting) of expendables such as a torch nozzle and an electrode is very difficult compared to the other machining methods. For this reason, its excellent operability is not fully utilized. In order to eliminate the above disadvantage, various proposals have been conventionally made, and some examples are as follows.

A cassette type plasma torch, for example, as shown in Figs. 7, 8A, and 8B is described in Japanese Patent Application Publication No. 3-27309, Japanese Utility Model Application Laid-open No. 62-96967, and Japanese Utility Model Application Laid-open No. 62-96968. The cassette type plasma torch consists of a torch main body 51 and a torch head 52. The torch main body 51 includes a cooling water supply conduit line 68a, a cooling water discharge conduit line 54, a reactant gas supply conduit line 55, and a high frequency stand 56. The torch head 52 includes a plasma arc injection port 53, a torch cap 34, a torch nozzle 3, an electrode 4, a water conduit line 68, and the like. The torch main body 51 is separable from the torch head 52, and the torch head 52 is attached at the front-end portion of the torch main body 51 by screwing a cassette screw 61 which is provided at the periphery of the front-end portion of the torch main body 51 and a cylindrical cassette screw 62 which is provided at the base end portion side of the torch head 52. With a single motion of screwing in or unscrewing the aforementioned cassette screw 62, the torch head 52 is easily mounted in and / or dismounted from the torch main body 51.

At this time, the base end portion (the side which is inserted into the torch main body 51) of the torch head 52 is formed in a cone form, and a plurality of seal portions 57, 58, and 59 in a tapering form are formed on the periphery surface of the cone body. The front-end portion (the side which is in contact with the aforementioned base end portion of the torch head 52) of the torch main body 51 is formed in an inverted cone form corresponding to the torch head 52, and inverted tapering seal portions 57a, 58a, and 59a corresponding to the torch head 52 are formed on the inner surface of the inverted cone body. Further, in some cases, O-ring grooves are formed at the tapering seal portions 57, 58, and 59 side of the base end portion of the aforementioned torch head 52, or the inverted tapering seal surfaces 57a, 58a, and 59a side of the front-end portion of the torch main body 51, and O-rings 63, 64, and 65 are inserted into the O-ring grooves.

As the result of inserting the torch head 52 in the front-end portion of the torch main body 51 and screwing in the cassette screw 62, the helmeticity among the cooling water supply conduit line 68a, the cooling water discharge conduit line 54, and the reactant gas supply conduit line 55 is maintained at the aforementioned junction portion in a tapering form. As for the electric connection between the torch main body 51 and the torch head 52, electric current can be applied through each of the working faces of the tapering seal portions 57, 58, and 59, and of the inverted tapering seal portions 57a, 58a, and 59a.

As described above, in the conventional cassette type plasma torch, the cooling water supply conduit line 68a, the cooling water discharge conduit line 54, and the reactant gas supply conduit line 55 are sealed by the O-rings 63, 64, and 65 at the tapering seal portions 57, 58, 59, 57a, 58a, and 59a. At the same time, they are electrically connected through the working faces of these tapering seal portions. For this reason, when dust or the like enters the aforementioned tapering seal portions, it is possible that electrical contact failure occurs, and electric discharge occurs among the seal portions to burn out the torch. It often happens that the aforementioned O-rings are damaged by the electric discharge, and that cooling water are mixed into reactant gas so that the quality in welding or cutting is degraded. In addition, each of grooves 66, 66a, 67, and 67a, which communicates with each of the cooling water discharge conduit line 54 and the reactant gas supply conduit line 55, is provided so as to be laid on one another concentrically with respect to the arc injection axis 20A. As a result, the outside dimension of the entire torch body becomes large, and therefore the torch cannot be used for a work which especially requires accessibility thereto.

In Japanese Patent Application Laid-open No. 2-6072, a cartridge type plasma torch shown in Figs. 9 and 10 is disclosed. A cartridge 71 is replaceable as an expendable article. An electrode 72 and a torch nozzle 73, which are insulated by an insulator 74, are replaced by an outside cartridge dismounting device and cartridge mounting device by one operation, therefore they are integrated in such a way as to be fixed to each other. A ring-shaped groove 76 is included at a top portion or a tail portion 75 of the electrode 72, and a ball 78 and a rock ring 79 under the ball 78 are included at the inner end portion of a hole 77 in a torch main body 70 side where the cartridge 71 is inserted. When the cartridge 71 is inserted into the hole 77 from the front-end portion

of the torch main body 70, the ring-shaped groove 76 opposes the ball 78, and the rock ring 79 is pressed upward, pressing the ball 78 into the ring-shaped groove 76, so that the cartridge 71 is engagingly secured in the torch main body 70. By carrying out the above operations in inverse order, the aforementioned engagingly securing means is instantly released, and the cartridge 71 is easily dismounted.

However, in the aforementioned cartridge type plasma torch, the electrode 72, the insulator 74, and the torch nozzle 73 composing the cartridge 71 are designed to be replaceable by one operation by an automatic replacing device or the like, therefore they need to be completely and integrally constructed. Accordingly, even when, for example, only the torch nozzle 73 is desired to be replaced, the entire unit of the cartridge 71 must be replaced, therefore the aforementioned cartridge type plasma torch tends to be very uneconomical, and has a disadvantage of higher running cost.

Further, in Japanese Utility Model Application Publication No. 5-3860, a torch with an easy joint shown in Fig. 11 is disclosed. A torch main body 81 is attachable and detachable to and from a torch support body 82, and a front-end portion for connection 83 of the torch main body 81 is inserted in and connected to the inside of a main cylinder body 84 of the torch support body 82. The torch main body 81 and the torch support body 82 have gas introducing holes 85 and 86, which can communicate with each other when connected, at respective axis portions, and have water supply conduit lines 87 and 88, and water discharge conduit lines 89 and 90 for cooling water of the torch main body 81. The above water supply and water discharge conduit lines of the torch main body 81 and the torch support body 82 are designed to be communicated with each other at the time of connection of the torch main body 81. Specifically, a cooling water introducing hole 93 of the torch support body 82 and a water supply port 91 of the torch main body 81, and a discharge hole 94 and a discharge port 92 of the torch main body 81, are respectively communicated with each other.

The cooling water introducing hole 93 of the torch support body 82 is provided with a valve 95, and the valve 95 is abutted to a valve seat 97, which is provided at the end portion of the opening of the cooling water introducing hole 93, by the compressive force of a compression spring 96, and closes the cooling water introducing hole 93. A valve rocker arm 98 is provided at the front end of the valve 95, and the front-end portion of the valve rocker arm 98 is protruded inside the main cylinder body 84 when the cooling water introducing hole 93 is closed. When the torch main body 81 is connected to the torch support body 82, the cooling water introducing hole 93 is opened by pressing the protruded valve rocker arm 98 by the front-end portion for connection 83 of the torch main body 81, and by reversing the valve 95 against the compressive force of the compression spring 96. When the torch main body 81 is separated from the torch support body 82, the valve 95 closes the cooling water introducing hole 93 by the compressive force of the compression spring 96, therefore cooling water is prevented from dripping at the time of separation of the torch main body 81.

However, in the aforementioned torch with an easy joint, it cannot be confirmed that the valve 95 is surely opened and cooling water starts full circulation when the torch main body 81 and the torch support body 82 are connected. Consequently, if the valve rocker arm 98, which opens and closes the valve 95, is broken, or if impurities or the like in cooling water are accumulated between the valve 95 and the valve seat 97, the torch is used while insufficient cooling water flows therein. As a result, there is a possibility that the torch body 81 is burnt down due to insufficient cooling water.

Disclosure of the Invention

The present invention is made to eliminate the aforementioned disadvantages of the conventional art, and its object is to provide a cartridge type plasma torch in which only the expendables which need to be replaced can be easily replaced. The other objects are to prevent cooling water from dripping from a torch main body when an expendable cartridge and the torch main body are separated, to confirm secure connection when they are connected, and to surely carry out the seal of cooling water and operational gas, and the electric connection. Further, another object is to improve the accessibility of the plasma torch to a work piece.

The cartridge type plasma torch in accordance with the present invention is a plasma torch for plasma welding or plasma cutting, which includes an electrode, and a torch nozzle for injecting plasma arc from the electrode together with operational gas received from the surroundings of the electrode, and is characterized by including an expendable cartridge including the electrode and / or the torch nozzle, and a torch main body which has supply lines for supplying cooling water and operational gas to the expendable cartridge, and which allows the expendable cartridge to be mounted and / or dismounted from an end opposite to an arc injection port when viewed in a longitudinal direction of the torch. The aforementioned supply lines are desired to be placed at the position where the axes thereof are displaced with respect to an arc injection axis.

According to the structure, the expendable cartridge can be easily replaced from the rear-end portion (an end opposite to the arc injection port when viewed in a longitudinal direction of the torch) of the torch main body. The component parts of the expendable cartridge are constructed to be minimum replacement units (an electrode, a torch nozzle, and the like) so as to be easily dissembled and assembled at the time of replacement of only the parts which need to be replaced, therefore after replacing the parts which need to be replaced, the

expendable cartridge can be inserted into the torch main body. Consequently, running cost can be reduced. Further, by displacing the axes of the supply lines with respect to the arc injection axis, the supply lines of cooling water and operational gas in the torch main body to the electrode and the torch nozzle are axially displaced with respect to the axes of the electrode for generating arc and the torch nozzle, and can be formed in parallel therewith. Accordingly, the outside width of the front-end portion of the torch can be decreased, therefore the accessibility of the plasma torch to a work piece is improved. As a result, the plasma torch is applicable to a wider variety of work pieces.

A cartridge type plasma torch in accordance with the present invention is a plasma torch for plasma welding or plasma cutting, which includes an electrode, and a torch nozzle, and is characterized by including an expendable cartridge including the electrode and / or the torch nozzle, a torch main body which has supply lines for supplying cooling water and operational gas to the expendable cartridge, and which allows the expendable cartridge to be mounted therein and / or dismounted therefrom, and a cylinder type valve which is provided at the midpoint of the supply lines, and which opens the supply lines when the expendable cartridge has been completely inserted into the torch main body, and closes the supply lines when the expendable cartridge is separated from the torch main body. The cylinder type valve may move in a direction different from the direction in which the cooling water flows when opening or closing the supply line for supplying cooling water. Further, the cylinder type valve may open or close both of the entrance to the expendable cartridge from the supply line and the exit to the supply line from the expendable cartridge at the same time.

According to the above structure, when the expendable cartridge is separated from the torch main body, the cylinder type valve closes the supply lines of the cooling water and operational gas of the torch main body, therefore cooling water does not leak into the inside of the torch, or does not adhere thereto, so that the cooling water does not mix with the operational gas. Consequently, degradation in quality of plasma welding or cutting which is caused by the mixing can be prevented. Further, as the result that the valve moves in a direction different from the direction in which cooling water flows, the impurities mixed in the cooling water do not adhere to the portion where the valve seals the cooling water when it is closed, even if the impurities may adhere to the cooling water supply conduit line. Accordingly, the valve is returned to the position at which it is completely closed, therefore the cooling water is surely stopped. Further, by opening or closing both of the entrance and the exit to and from the expendable cartridge at the same time, the passage of a medium such as cooling water or the like can be surely opened or closed.

Further, an electric connection section between the expendable cartridge and the torch main body can be connected with screws. According to the above structure, even if dust or the like enters the electric connection section between the expendable cartridge and the torch main body, the expendable cartridge is inserted into the torch main body by being screwed in, therefore after eliminating the dust or the like by force, the connection can be maintained on the working face of the screws so that the connection is surely made.

It is preferable that any one of the expendable cartridge, the torch body, and the cylinder type valve is provided with a detecting means for detecting at least any one of the separation and the completion of the insertion of the expendable cartridge from and into the torch body.

According to the above structure, it is detected that the expendable cartridge is surely inserted into the torch main body. By controlling the operations of an outside plasma electric power source, a cooling water pump, and so on based on the detecting signal, malfunctions such as water leakage, electric discharge in the torch, and so on, which are caused by poor incorporation can be prevented. As the result, the torch can be surely operated after replacing the expendable cartridge, and the durability is increased.

Further, it is preferable to provide an interlock means which inputs a detecting signal from the detecting means, and which stops the operation of at least any one of a power source and a cooling water pump when the detecting signal shows the separation, and actuates the power source and the cooling water pump when the detecting signal shows the completion of the insertion.

According to the above structure, when the expendable cartridge is poorly connected or is not completely connected, the power source or the cooling water pump can be stopped by the interlock means. Accordingly, the torch is prevented form being burnt, and an accident which gives an electric shock to an operator, or the like can be prevented, so that there is an advantage in durability and safety. In addition, the operation of turning off the plasma power source, which is made by an operator every time the expendable cartridge is replaced, becomes unnecessary. Therefore the operational efficiency of the replacement of expendables can be improved.

Brief Description of the Drawings

Fig. 1 is a longitudinal sectional view of a cartridge type plasma torch in accordance with the present invention;

Fig. 2 is a front view of the cartridge type plasma torch in accordance with the present invention;

Fig. 3 is a longitudinal sectional view of an expendable cartridge in accordance with the present invention;

Fig. 4 is a longitudinal sectional view of a torch main body in accordance with the present invention;

Fig. 5 is a longitudinal sectional view of the cartridge type plasma torch in which a second example of a cylinder rod in accordance with the present invention is applied;

Fig. 6A is a section taken along a VI A - VI A line of Fig. 5, and is an explanatory view with a valve being opened;

Fig. 6B is an explanatory view with the valve in Fig. 6A being closed;

Fig. 7 is a longitudinal sectional view of the conventional cassette type plasma torch;

Fig. 8 A is a side view of a torch main body of the plasma torch in Fig. 7;

Fig. 8B is a side view of a torch head of the plasma torch in Fig. 7;

Fig. 9 is a longitudinal sectional view of the conventional cartridge type plasma torch;

Fig. 10 is a sectional view of a replaceable cartridge section of the plasma torch in Fig. 9; and

Fig. 11 is a longitudinal sectional view of the conventional torch with an easy joint.

Best Mode for Carrying out the Invention

A preferable embodiment of a cartridge plasma torch according to the present invention will be described in details with reference to the attached drawings.

Figs. 1 and 2 respectively show a longitudinal sectional view and a front view of a front-end portion of a cartridge type plasma torch 1 according to the present invention. The plasma torch 1 consists of an expendable cartridge 2 including expendables such as a torch nozzle 3, an electrode 4, and the like, and a torch main body 30 having a hole into which the expendable cartridge 2 is inserted. When divided broadly, the torch main body 30 consists of an insertion section A provided with a hole into which the expendable cartridge 2 is inserted, and which is coaxial with an arc injection axis 20A, and a supply conduit line section B having passages for supplying cooling water and operational gas to the expendable cartridge 2. Incidentally, the torch main body 30 is made of synthetic resin to be provided with the property by which the torch main body 30 is electrically insulated from the outside.

Figs. 3 and 4 are sectional views of the expendable cartridge 2 and the torch main body 30. First, the expendable cartridge 2 will be explained in detail based on Fig. 3. The electrode 4, a guide cylinder 5, and the torch nozzle 3 are provided at the front-end portion of the expendable cartridge 2, and are placed in a concentric form so that each axis matches to the arc injection axis 20A.

The electrode 4 is to produce arc in the area between a work piece and itself by an outside electric power source which is not illustrated, and consists of an electrode stand 6, and an electrode piece 7 which is attached at the center portion of the foremost end of the electrode stand 6 by brazing, press-fitting, or the like. The guide cylinder 5, which is made of material having an insulating property, for example, ceramic, resin, or the like, is inserted in the front-end side of the periphery portion of the electrode stand 6, and the electrode 6 is supported by the torch main body 30 with the guide cylinder 5 between them.

Further, the front-end part of the periphery portion of the guide cylinder 5 is inserted into the rear portion of the torch nozzle 3 having electrical conductivity, and the torch nozzle 3 is electrically insulated from the electrode 4 by the guide cylinder 5. As for the shape of the torch nozzle 3, the front portion has a smaller diameter than the rear portion, and the middle portion has a taper 3b so that the diameter from the rear portion to the front portion is gradually made smaller. A flange portion 3a in a ring form, which is protruded to the outside, is provided at the periphery of the rear end portion of the torch nozzle 3, and when the expendable cartridge 2 is inserted into the torch main body 30, the position of the expendable cartridge 2 is determined by placing the front-end surface of this flange portion 3a against the reference plane inside the torch main body 30.

A plasma gas chamber 38 (see Fig. 1), which is surrounded by the inner face of the torch main body 30, is provided at the periphery portion of the guide cylinder 5 supporting the electrode 4, and operational gas is supplied to the plasma gas chamber 38 from an operational gas supplying device on the outside through an operational gas supply conduit line, which is not illustrated, in the torch main body 30. The operational gas supply conduit line is provided in the supply conduit line section B in the torch main body 30. The plasma gas chamber 38 is communicated with a space at the front-end side of the electrode piece 7 by a gas nozzle 19 provided at the front-end portion of the guide cylinder 5 to be in a swirl form. The operational gas emits from the gas nozzle 19, turning towards the center of the space at the front-end side of the electrode piece 7, and is designed to be injected from the front-end portion of the torch nozzle 3.

An electrode cooling chamber 8 is provided at the central portion of the electrode stand 6 of the electrode 4 along the axial direction, and the electrode cooling chamber 8 is sealed by a seal member (for example, an O-ring, hereinafter referred to as an O-ring) 10 which is attached on the periphery portion of the electrode stand 6. In addition, the front portion side of a cooling water inlet conduit line 9 is inserted in the electrode cooling chamber 8. Cooling water entering from a conduit line inside the cooling water inlet conduit line 9 cools the inside of the electrode cooling chamber 8, and is discharged from a cooling water discharge conduit line 17, which is described below, by way of a passage surrounded by the outside of the cooling water inlet conduit line 9 and the electrode cooling chamber 8.

A cartridge body 12 having electrical conductivity is provided on the base end side of the expendable car-

tridge 2. The electrode 4 is mounted in the front-end axis portion of the cartridge body 12 with a screw 18, and a cylinder 11 having insulating properties is connected to the periphery of the front-end portion of the cartridge body 12 with the front-end portion of the cartridge body 12 being inserted in the cylinder 11. The aforementioned guide cylinder 5 is inserted between the front-end portion of the cylinder 11 having insulating properties and the front-end portion of the electrode 4. The connection of the cartridge body 12 and the cylinder 11 can be made by bonding them with, for example, an adhesive or the like, or by attaching them with a screw.

As shown in the drawing, in this embodiment, the connection of the cylinder 11 and the guide cylinder 5, and the connection of the guide cylinder 5 and the torch nozzle 3 are respectively made only by inserting the guide cylinder 5 into the cylinder 11 and the torch nozzle 3, and they can be easily dissembled. However, the entire body of the expendable cartridge 2 may be integrally constructed by attaching the cylinder 11, the guide cylinder 5, and the torch nozzle 3 with screws.

The rear portion of the aforementioned cooling water inlet conduit line 9 is fixed and housed in the axis portion of the cartridge body 12 by, for example, brazing. A cooling water filling conduit line 16 and the cooling water discharge conduit line 17 are provided at the rear portion of the cartridge body 12. The cooling water filling conduit line 16 sends cooling water into the conduit line inside the cooling water inlet conduit line 9 from the torch main body 30 side, and the cooling water discharge conduit line 17 discharges cooling water, which has cooled the electrode 4, into the torch main body 30 side by way of the passage surrounded by the outside of the cooling water inlet conduit line 9 and the electrode cooling chamber 8.

Cooling water grooves 15 in a ring form are provided at the portions where the periphery portion of the cartridge body 12 passes the inlet of the cooling water inlet conduit line 16 and the outlet of the cooling water discharge conduit line 17. This ring-shaped cooling water groove 15 is provided in order that the cooling water is supplied without problems even if the aforementioned cooling water conduit line in the expendable cartridge 2 side and the cooling water conduit line in the torch main body 30 side are displaced in the periphery direction, when the expendable cartridge 2 is inserted into the torch main body 30. Further, in order to seal each of the cooling water grooves 15, O-ring grooves are provided at the periphery portion of the cartridge body 12, and O-rings 10 are inserted therein.

In addition, a cartridge fixing screw 13 is provided at the rear portion of the periphery of the cartridge body 12, and a handle 14 is attached at the rear-end portion of the cartridge body 12. The expendable cartridge 2, after inserted into the torch main body 30, is manually screwed in by using the handle 14, and fixed in the torch main body 30 with the cartridge fixing screw 13. When the expendable cartridge 2 is to be dismounted from the torch main body 30, it is suitable to perform the above operations in inverse order.

Next, the torch main body 30 side will be explained in detail. A ring-shaped cooling chamber 31 is provided inside the front end of the insertion section A of the torch main body 30. The ring-shaped cooling chamber 31 is a cooling water conduit line which is provided around the middle portion of the periphery of the torch nozzle 3 so as to be in a ring form when the expendable cartridge 2 is inserted in the torch main body 30. The aforementioned taper 3b at the middle portion of the periphery of the torch nozzle 3 allows the cooling chamber 31 to contain larger amount of cooling water, thereby increasing the cooling efficacy. A nozzle cooling water inlet conduit line 32 in the supply line section B of the torch main body 30 is connected to the ring-shaped cooling chamber 31, and a cooling water return conduit line 33 (see Fig. 2) in the supply line section B of the torch main body 30 is also connected to the ring-shaped cooling chamber 31. The nozzle cooling water inlet conduit line 32 is communicated with the cooling water discharge conduit line 17 at the cartridge body 12 through a cylinder type valve which is described below, and the cooling water return conduit line 33 is connected to an outside cooling water pump, which is not illustrated in the drawing, by way of a discharge conduit line 47 in the supply line section B. Incidentally, the discharge conduit line 47 is provided in a synthetic resin packed bed 29.

An electrical supply sleeve 39 is provided behind the ring-shaped cooling chamber 31 inside the torch main body 30. The electrical supply sleeve 39 is almost in an cylindrical form, and has a ring-shaped flange portion 39a which is protruded inward (in an axial direction) at the front-end portion. When the expendable cartridge 2 is inserted into the torch main body 30, the position of the expendable cartridge 2 is determined by placing the aforementioned flange portion 3a of the torch nozzle 3 of the expendable cartridge 2 against the end face of the flange portion 39a of the electrical supply sleeve 39. Electricity for pilot arc is supplied to the torch nozzle 3 through the electrical supply sleeve 39.

A shield gas cap 35 is provided at the front-end portion of the insertion section A of the torch main body 30, and further, a torch cap 34 is attached at the front-end periphery portion of the shield gas cap 35. When the expendable cartridge 2 is being inserted into the torch main body 30, the shield gas cap 35 is fitted onto the front-end periphery of the torch nozzle 3. The axes of the shield gas cap 35 and the torch cap 34 match to the axis of the torch nozzle 3. The shield gas chamber 36 is provided between the shield gas cap 35 and the torch cap 34, and a shield gas supply conduit line, which is provided in the supply line section B and is not illustrated in the drawing, is connected to the shield gas chamber 36. The shield gas cap 35 is provided with a shield gas nozzle 37 which is communicated with the shield gas chamber 36, and shield gas emits from the

shield gas nozzle 37.

A cooling water leakage protection cylinder 40 is provided in the supply line section B of the torch main body 30. A cylinder rod 41 of the cooling water leakage protection cylinder 40 is normally given a momentum towards the rear side of the torch 1 by the elastic force of a spring 45. When the expendable cartridge 2 is not inserted in the torch main body 30, the cylinder rod 41 is moved to the rear side of the torch 1, and a lever 42 at the rear portion of the cylinder rod 41 is protruded from the rear end portion of the torch main body 30. When the expendable cartridge 2 is inserted into and fixed in the torch main body 30, the protruded lever 42 is pressed against the momentum, which is given by the spring 45, by the reverse side (the side near the front end of the torch 1) of the handle 14 of the expendable cartridge 2, so that the entire body of the cylinder rod 41 is moved toward the front side of the torch 1.

Two of grooves 43 are provided in a ring form at predetermined positions of the periphery of the cylinder rod 41, the O-rings 10 are inserted in the periphery at the positions before and after each of the two grooves 43. The torch main body 30 is provided with a conveying conduit line (supply line) 46 for sending cooling water from the cooling water pump, which is not illustrated, to the cooling water filling conduit line 16 of the expendable cartridge 2, and a nozzle cooling water conveying conduit line (supply line) 48 for sending drainage from cooling water discharge conduit line 17 of the expendable cartridge 2 to the nozzle cooling water inlet conduit line 32. The cylinder rod 41 passes through the conveying conduit line 46 and the nozzle cooling water conveying conduit line 48 in such a way as to be perpendicular to each axis, so that the cylinder rod 41 opens and closes the conveying conduit line 46 and the nozzle cooling water conveying conduit line 48. Specifically, the aforementioned two of the grooves 43 at the cylinder rod 41 are designed to match to the positions of conveying conduit line 46 and the nozzle cooling water conveying conduit line 48 when the expendable cartridge 2 is completely fixed in the torch main body 30. At this time, the conveying conduit line 46 is communicate with the cooling water filling conduit line 16, and the nozzle cooling water conveying conduit line 48 is communicated with the cooling water discharge conduit line 17 through the respective grooves 43. When the expendable cartridge 2 is dismounted form the torch main body 30, the cylinder rod 41 is moved toward the rear side of the torch 1 by the aforementioned momentum given by the spring 45, and the positions of two of the grooves 43 are completely moved off the positions of the conveying conduit line 46 and the nozzle cooling water conveying conduit line 48 to close these cooling water conduit lines.

A detecting means for detecting the condition of the insertion of the expendable cartridge 2 is provided at the front-end portion (the end portion opposite to the lever 42) of the tube of the cooling water leakage prevention cylinder 40. A signal detected by the detecting means is outputted to an interlock means 50. The interlock means 50 is connected to the aforementioned power source and cooling water pump which are not illustrated in the drawing, and gives a signal to stop and restart the operations of the power source and the cooling water pump. It may be suitable that the interlock means 50 is connected to either one of the power source or the cooling water pump. In the embodiment, as an example of the detecting means, a micro switch 49 is provided, and a lever 49a of the micro switch 49 is protruded inward from the front-end portion of the tube of the cooling water leakage prevention cylinder 40. When the expendable cartridge 2 reaches the position where it is completely fixed in the torch main boy 30, the cylinder rod 41 is pressed forward, and the lever 49a is pressed by a front-end portion 44 of the cylinder rod 41. When the expendable cartridge 2 is dismounted, the cylinder rod 41 moves backward, and the lever 49a is released.

Next, the operation according to the above structure will be explained. The expendable cartridge 2 is taken out of the rear-end portion of the insertion section A of the torch main body 30 by loosening the cartridge fixing screw 13 by manually turning the handle 14. The expendable cartridge 2 consists of the electrode 4, the torch nozzle 3, the cartridge body 12 and so on. These parts are simply inserted, or simply screwed in, therefore each of them is easily disassembled and replaced. Accordingly, the expendables of the torch 1 can be easily replaced in a short time without using special tools or the like. In addition, it is possible to only replace a part which is worn out and should be replaced (for example, only the electrode 4, or only the torch nozzle 3), so that there is a great advantage in running costs.

The O-ring 10 is inserted in each of the seal portions of the cooling water and the operational gas in the torch main body 30 and the expendable cartridge 2, thereby surely sealing cooling water and operational gas. Further, high current such as welding current passes through an electric connection section which is surely connected with the cartridge fixing screw 13 and the screw 18. Therefore even if dust or the like should be mixed into the electric connection section, electric current flows through the working faces of the screws with stability. The aforementioned O-rings 10 are inserted in the portions away from the electric connection section, therefore the O-rings 10 are not damaged by electric discharge or the like occurring to the electric connection section, and can surely seal cooling water and operational gas. As the result, it is possible to prevent an accident in which the torch 1 is burnt down by electric discharge occurring to the electric connection section.

The expendable cartridge 2 is mounted and / or dismounted from the rear end portion of the insertion section A of the torch main body 30, specifically, the end face opposite to an arc injection port 20 when viewed in

a longitudinal direction of the torch 1. As for the shape of the expendable cartridge 2, the front-end portion is thinner, and the diameter gradually becomes larger toward the rear side, in order that the expendable cartridge 2 is smoothly mounted and dismounted. The cooling water and the operational gas supply conduit lines are placed so that the axes are displaced with respect to the arc injection axis 20A, specifically, the axes are displaced from the axis of the insertion section A (the axis of the torch nozzle 3) of the torch main body 30 toward the inside of the supply line section B side. Accordingly, the size of the portion near the arc injection port 20 of the torch main body 30 can be decreased, and an outside width H of the insertion section A of the torch main body 30 can be decreased. Consequently, the accessibility to a work piece is improved, therefore the cartridge type plasma torch 1 of the present invention is applicable to a work piece to which the conventional plasma torch is inapplicable due to the accessibility thereto. As the result, an operation can be continued with the torch 1 without replacing it with the other types of plasma torch, therefore the time for the replacement is reduced, and the operation efficiency is increased.

When the expendable cartridge 2 is completely inserted and fixed in the torch main body 30, the cylinder rod 41 of the cooling water leakage prevention cylinder 40, which is provided at the cooling water inlet port and the cooling water outlet port of the torch main body 30, is pressed toward the front side of the torch 1 against the momentum which is given by the spring 45. The positions of two of the grooves 43 which are provided at the periphery of the cylinder rod 41 match to the positions of the conveying conduit line 46 and the nozzle cooling water conveying conduit line 48. At this time, the cooling water sent from the outside cooling water pump is allowed to circulate inside the electrode 4, the periphery portion of the torch nozzle 3 of the expendable cartridge 2, and so on. Specifically, the cooling water, which enters the electrode cooling chamber 8 by way of the conveying conduit line 46, the groove 43, the cooling water filling conduit line 16, and the inside of the cooling water inlet conduit line 9, flows through the passage surrounded by the outer face of the cooling water inlet conduit line 9 and the electrode cooling chamber 8, and is guided to the ring-shaped cooling chamber 31 by way of the cooling water discharge conduit line 17, the groove 43, the nozzle cooling water conveying conduit line 48, and the nozzle cooling water inlet conduit line 32. The cooling water is returned to the cooling water pump from the ring-shaped cooling chamber 31 by way of the cooling water return conduit line 33, and the discharge channel 47. Thereby cooling the electrode 4 and the torch nozzle 3.

When the cylinder rod 41 reaches the front-end portion of the cooling water leakage prevention cylinder 40 as described in the above, the lever 49a of the micro switch 49 is pressed down, and the micro switch 49 is actuated. Thus the micro switch 49 outputs a signal to the interlock means 50 to inform the interlock means 50 that the expendable cartridge 2 is completely inserted and fixed in the torch main body 30. By receiving the aforementioned output, the interlock means 50 actuates the power source and the cooling water pump.

When the expendable cartridge 2 is separated from the torch main body 30, the cylinder rod 41 is pressed back to the rear end side of the torch main body 30 by the momentum given by the spring 45, and the positions of the grooves 43 and 43 are displaced. Thereby closing the conveying conduit line 46 and the nozzle cooling water conveying conduit line 48 to stop the circulation of the cooling water. At this time, the lever 49a of the micro switch 49 is returned to cancel the operating condition, and the condition of the output contact signal of the micro switch 49 is changed and is outputted to the interlock means 50, informing the interlock means 50 that the expendable cartridge 2 is separated from the torch main body 30. As a result, the interlock mean 50 stops the operation of the power source and the cooling water pump.

In this way, the ring-shaped grooves 43 of the cylinder rod 41 of the cooling water leakage prevention cylinder 40 function as valves. The valves open at the time of completion of the connection of the torch main body 30 and the expendable cartridge 2, and close at the time of the separation, therefore cooling water is prevented from leaking in or out of the torch 1. Specifically, the cylinder type valve consists of the cylinder rod 41 of the cooling water leakage prevention cylinder 40, and the grooves 43 and 43. In addition, the cylinder rod 41 moves in a direction (in the above example, almost perpendicular direction) which is different from the direction in which cooling water flows, therefore even if impurities or the like in the cooling water adhere to the cooling water grooves 43, the aforementioned impurities never adhere to the portion which seals the cooling water. Accordingly, when the expendable cartridge 2 is separated, the cylinder rod 41 is returned to the position at which the valve is surely closed by the momentum given by the spring 45. At this time, the leakage of the cooling water is far more effectively prevented by the O-rings 10 provided at the positions on the periphery before and after the grooves 43 and the cooling water groove 15 at the expendable cartridge 2 side. Accordingly, the cooling water is not mixed into operational gas, and therefore the decline in the quality of welding or cutting, which is caused by the cooling water, is prevented.

The micro switch 49 detects that the expendable cartridge 2 is completely incorporated in the torch main body 30, and based on the detected signal, the interlock means 50 actuates the power source or the cooling water pump. Thereby enabling to prevent a problem such as water leakage, or electric discharge inside the torch 1 which is caused by the faulty incorporation. Further, when the expendable cartridge 2 is dismounted from the torch main body 30, it is detected with the

micro switch 49, and by the interlock means 50, the power source and the cooling water pump are automatically stopped. Accordingly, when replacing the expendables, an operator does not need to manually stop the plasma power source and the cooling water pump, therefore the operability is improved at the time of replacement.

Next, the second example of the cylinder rod 41, which moves in a direction different from the direction in which cooling water flows, will be explained with reference to Fig. 5. Fig. 5 shows the state of the insertion of the expendable cartridge 2. The cylinder rod 41 is provided with a cooling water filling hole 21 for filling cooling water into the expendable cartridge 2, and a cooling water discharge hole 22 for discharging the cooling water from the expendable cartridge 2. These cooling water filling hole 21 and the cooling water discharge hole 22 intersect the axis of the cylinder rod 41 at right angles. A guide groove 25 in a helical form is provided at the periphery face of the lever 42 at the rear end portion of the cylinder rod 41.

The lever 42 is covered with a rod cap 23, and a pin 24 is provided at the inside of the rod cap 23 so as to be protruded toward the lever 42 side. The pin 24 is engaged with the guide groove 25 of the lever 42. The rod cap 23 is attached in such a way as it moves in the longitudinal direction of the torch 1, but it is not allowed to rotate. The rod cap 23 is normally given a momentum in a rearward direction by the cylinder rod 41 given a momentum by the spring 45, and when the expendable cartridge 2 is not inserted in the torch main body 30, the rod cap 23 is protruded from the rear-end portion of the torch main body 30. The cylinder rod 41 is fastened to a fastening member 40b at the end portion opposite to the lever 42, and is rotatable inside the supply line section B, but is not able to move in the longitudinal direction of the torch 1.

In the above cylinder rod 41, when the rod cap 23 is pressed forward at the time of the insertion of the expendable cartridge 2 into the torch main body 30, the pin 24 is moved forward along the guide groove 25 in a helical form. Following the above, the cylinder rod 41 rotates about its axis, and the cooling water filling hole 21 and the cooling water discharge hole 22 rotate. When the expendable cartridge 2 is completely inserted in the torch main body 30, the direction of the cooling water filling hole 21 matches to the direction of the hole of the conveying conduit line 46 as Fig. 6A illustrates. Similarly, the direction of the cooling water discharge hole 22 matches to the direction of the nozzle cooling water conveying conduit line 48, and as in Fig. 6A, cooling water is circulated.

When the expendable cartridge 2 is separated form the torch main body 30, the rod cap 23 is returned to the back of the cylinder rod 41 by the momentum given by the spring 45, and the pin 24 is moved in the direction opposite to the above along the guide groove 25 so that the cylinder rod 41 rotates in the opposite direction. As a result, as shown in Fig. 6B, the direction of the cooling water filling hole 21 is completely displaced from the direction of the hole of the conveying conduit line 46, and the same thing happens to the cooling water conveying conduit line 48, so that the cooling water is stopped. Accordingly, in this example, the cylinder type valve consists of the cylinder rod 41 of the cooling water leakage prevention cylinder 40, the cooling water filling hole 21, and the cooling water discharge hole 22.

In this way, in the above example, the cylinder 41 also moves in a direction different from the direction in which the cooling water flows. Specifically, in the second example, the cylinder rod 41 rotates about its axis. Accordingly, similarly to the above description, impurities in the cooling water do not adhere to the outer surface 41a of the cylinder rod 41, the inner face of the cylinder tube side, and the cooling water seal surface other than the cooling water filling hole 21 and the cooling water discharge hole 22. As a result, when the expendable cartridge 2 is separated, the cylinder rod 41 is rotated by the momentum given by the spring 45 up to the position where the cooling water filling hole 21 and the cooling water discharge hole 22 are surely closed.

In the present embodiment, the micro switch 49 is used as an example of a detecting means for detecting the condition of the insertion of the expendable cartridge 2, but the detecting means is not limited to the micro switch 49, and a proximity switch or the like can be used. The location of the detecting means is not limited to the front-end portion of the tube of the cooling water leakage prevention cylinder 40 as in the present embodiment, but it can be placed at the middle portion of the tube or the like. Further, the above detecting means can be placed at the cylinder rod 41 side or the expendable cartridge 2 side when placing it in the position other than the torch main body 30.

In the above embodiment, the examples are explained, in which the cooling water supply conduit line is opened and closed by the cylinder type valve, but the supply conduit line of operational gas can be also constructed so as to be opened and closed by the cylinder type valve similar to the above. In this case, the operation and the effects are obtained similarly to the above.

Industrial Availability

The present invention is useful as a cartridge type plasma torch in which only the expendables necessary to be replaced can be easily replaced, cooling water and operational gas are securely sealed when expendables are replaced, while the electrical connection is surely made, and in which the accessibility to a work piece is improved during the operation.

Claims

1. A plasma torch for plasma welding or plasma cutting, which includes an electrode (4), and a torch

nozzle (3) for injecting plasma arc from said electrode (4) together with operational gas received from the surroundings of said electrode (4), comprising:

an expendable cartridge (2) including said electrode (4) and / or said torch nozzle (3); and a torch main body (30) which has supply lines for supplying cooling water and operational gas to said expendable cartridge (2), and which allows said expendable cartridge (2) to be mounted and / or dismounted from an end opposite to an arc injection port (20) when viewed in a longitudinal direction of the torch.

2. The cartridge type plasma torch in accordance with Claim 1, wherein the aforementioned supply lines are placed at the position where the axes thereof are displaced with respect to an arc injection axis (20A).

3. A plasma torch for plasma welding or plasma cutting, which includes an electrode (4), and a torch nozzle (3) for injecting plasma arc from said electrode (4) together with operational gas received from the surroundings of said electrode (4), comprising:

an expendable cartridge (2) including said electrode (4) and / or said torch nozzle (3);
a torch main body (30) which has supply lines for supplying cooling water and operational gas to said expendable cartridge (2), and which allows said expendable cartridge (2) to be mounted and / or dismounted therein and / or therefrom; and
a cylinder type valve (40) which is provided at the midpoint of the aforementioned supply lines, and which opens the aforementioned supply lines when the expendable cartridge (2) has been completely inserted into said torch body (30), and closes the aforementioned supply lines when said expendable cartridge (2) is separated from said torch body (30).

4. The cartridge type plasma torch in accordance with Claim 3, wherein said cylinder type valve (40) moves in a direction different from the direction in which the cooling water flows when opening or closing the aforementioned supply line for supplying cooling water.

5. The cartridge type plasma torch in accordance with Claim 3, wherein said cylinder type valve (40) opens or closes both of the entrance to said expendable cartridge (2) from the aforementioned supply line and the exit to the aforementioned supply line from said expendable cartridge (2) at the same time.

6. The cartridge type plasma torch in accordance with any one of Claims 1, 2, 3, 4, and 5, wherein an electric connection section between said expendable cartridge (2) and said torch main body (30) is connected with screws.

7. The cartridge type plasma torch in accordance with any one of Claims 1, 2, 3, 4, and 5, wherein either one of said expendable cartridge (2) or said torch body (30) is provided with a detecting means (39) for detecting at least any one of the separation and the completion of the insertion of said expendable cartridge (2) from and into said torch body (30).

8. The cartridge type plasma torch in accordance with any one of Claims 3, 4, and 5, wherein said cylinder type valve (40) is provided with the detecting means (39) for detecting at least any one of the separation and the completion of the insertion of said expendable cartridge (2) from and into said torch body (30).

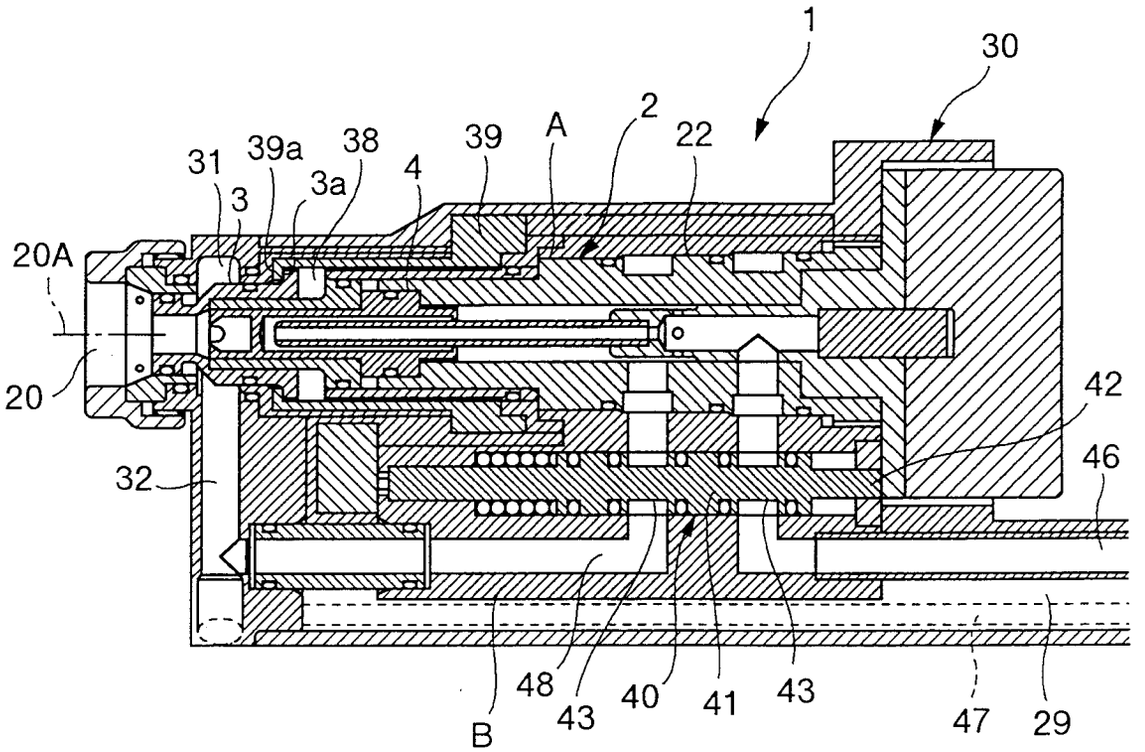
9. The cartridge type plasma torch in accordance with Claim 7, further comprising:

an interlock means (50) which inputs a detecting signal from said detecting means (39), and which stops the operation of at least any one of a power source and a cooling water pump when the aforementioned detecting signal shows the aforementioned separation, and actuates the aforementioned power source and the aforementioned cooling water pump when the aforementioned detecting signal shows the aforementioned completion of the insertion.

10. The cartridge type plasma torch in accordance with Claim 8, further comprising:

an interlock means (50) which inputs a detecting signal from said detecting means (39), and which stops the operation of at least any one of a power source and a cooling water pump when the aforementioned detecting signal shows the aforementioned separation, and actuates the aforementioned power source and the aforementioned cooling water pump when the aforementioned detecting signal shows the aforementioned completion of the insertion.

FIG.1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39
38
39a
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3
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20A
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42
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32
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41
43
47
29
B

FIG.2

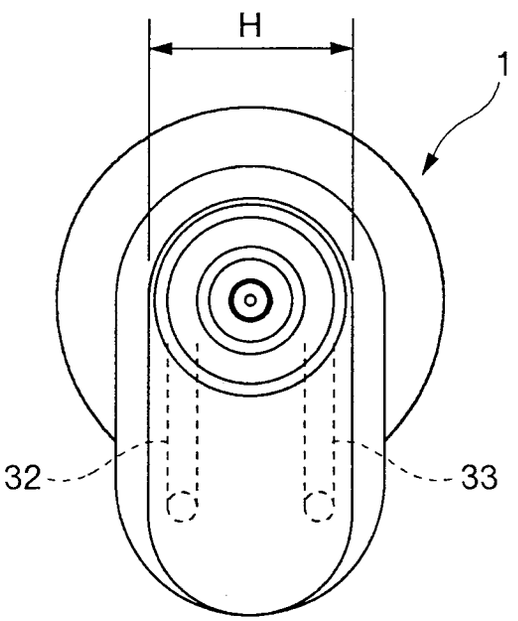
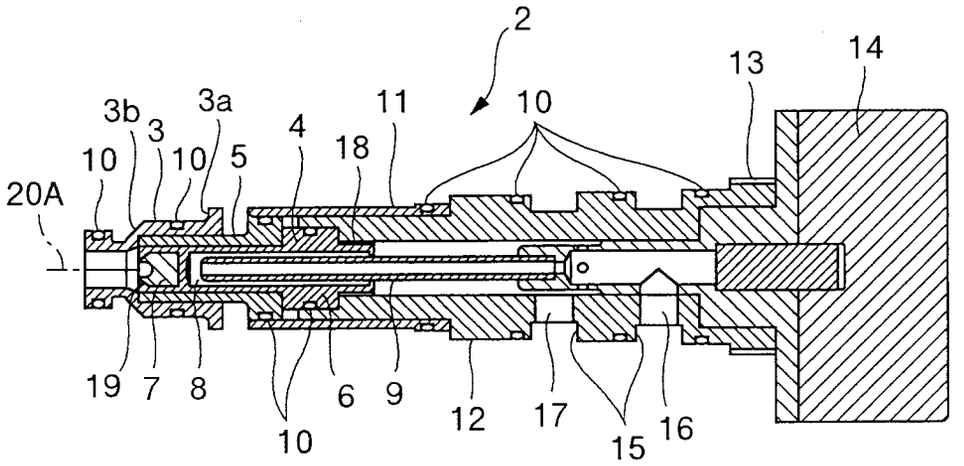

H
1
32
33

FIG.3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3a
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20A
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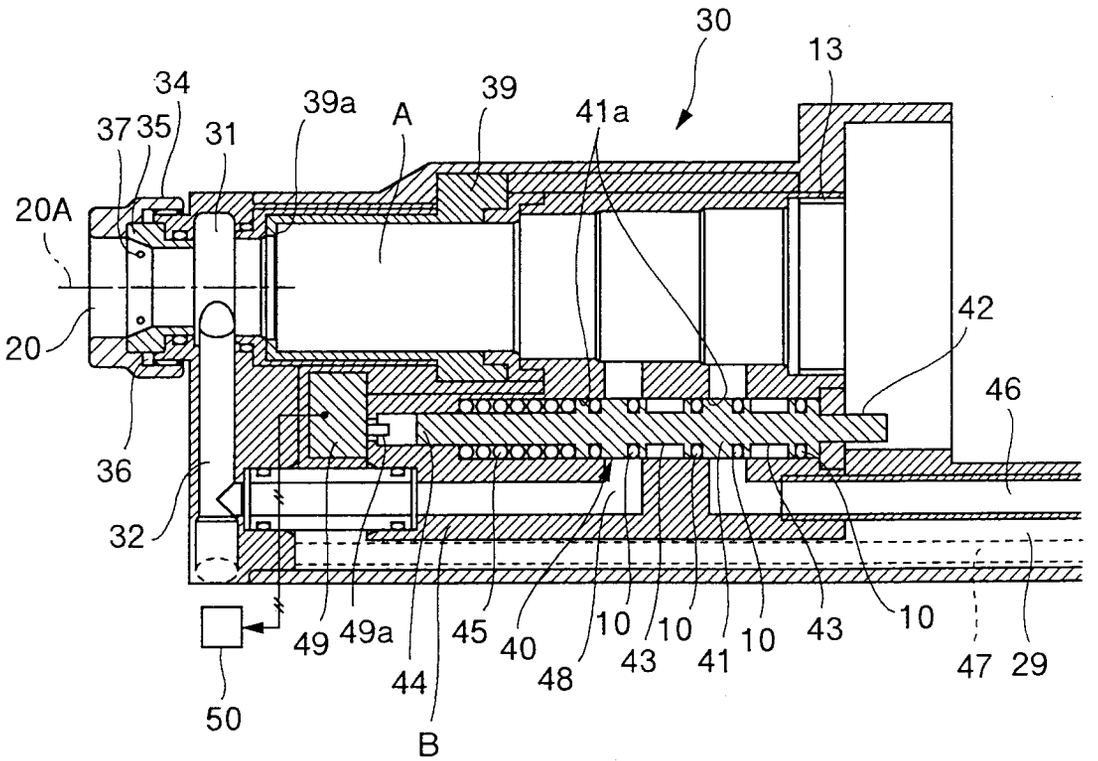
16

FIG.4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44
50
B

FIG.5

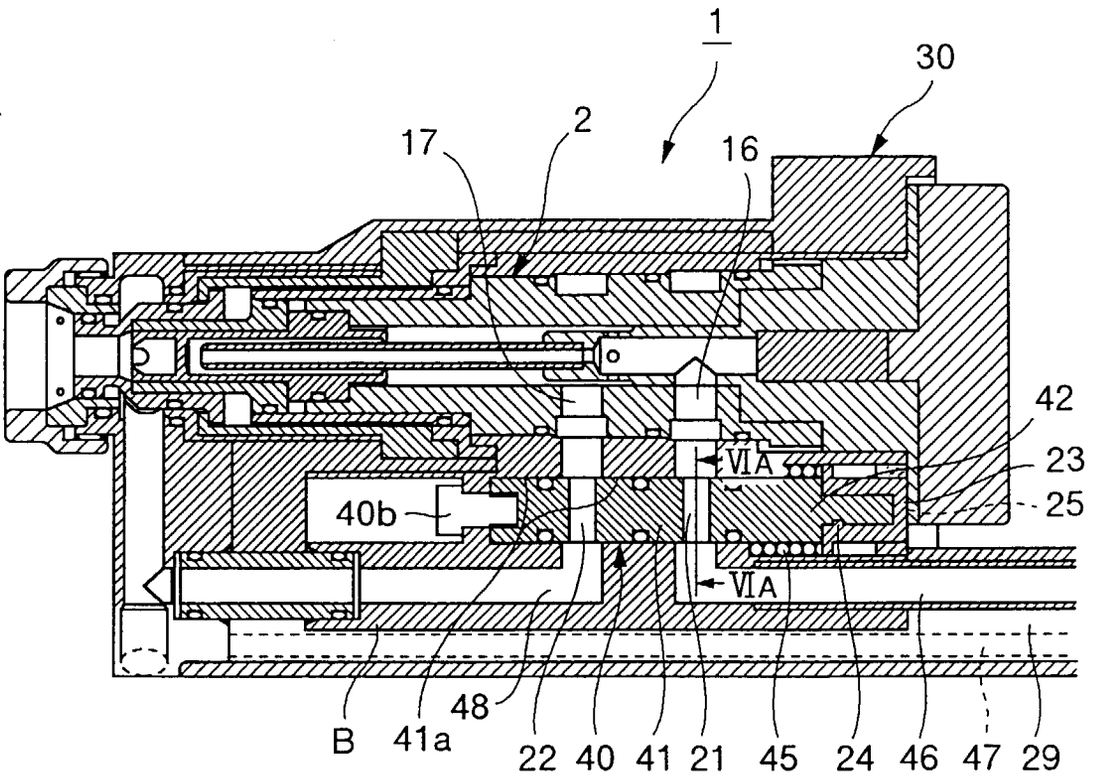


FIG.6A

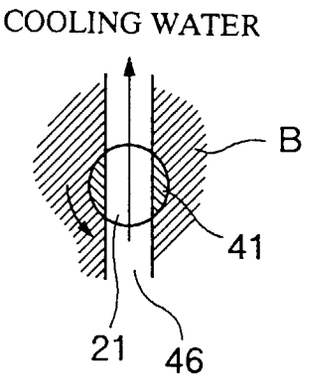


FIG.6B

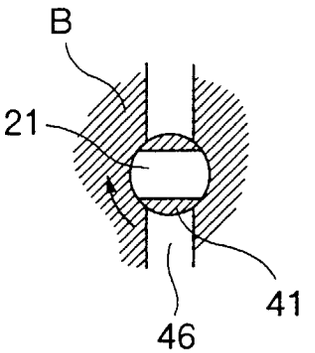


FIG.7
CONVENTIONAL ART

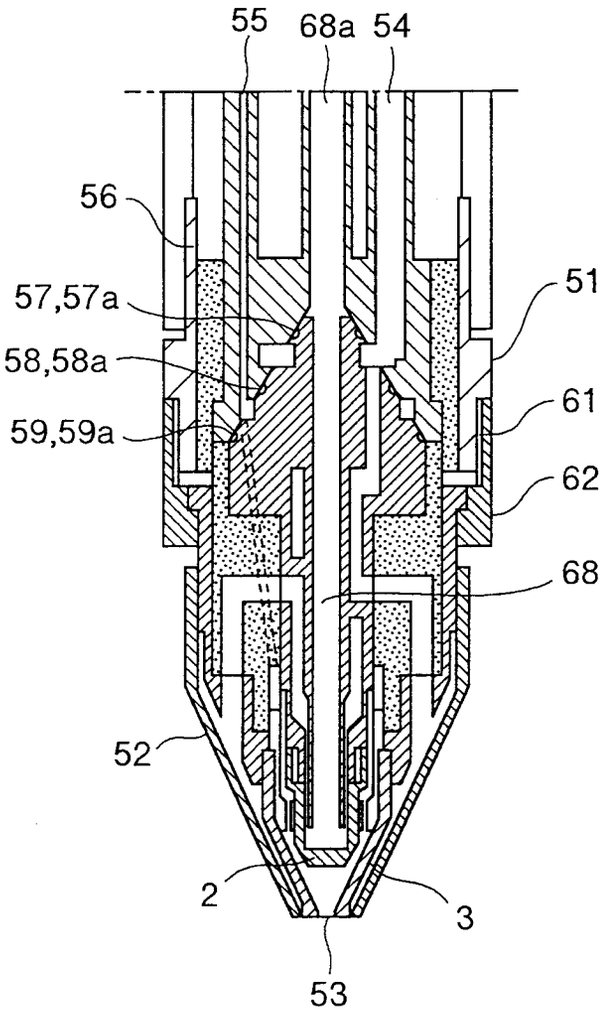


FIG.8A
CONVENTIONAL ART

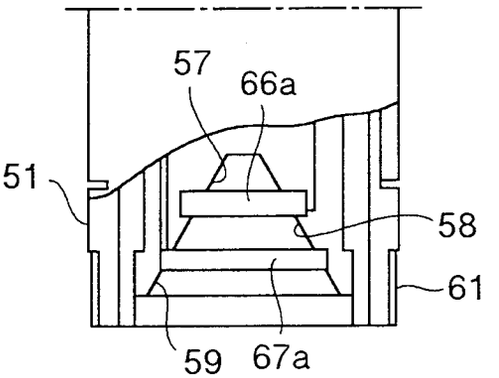


FIG.8B
CONVENTIONAL ART

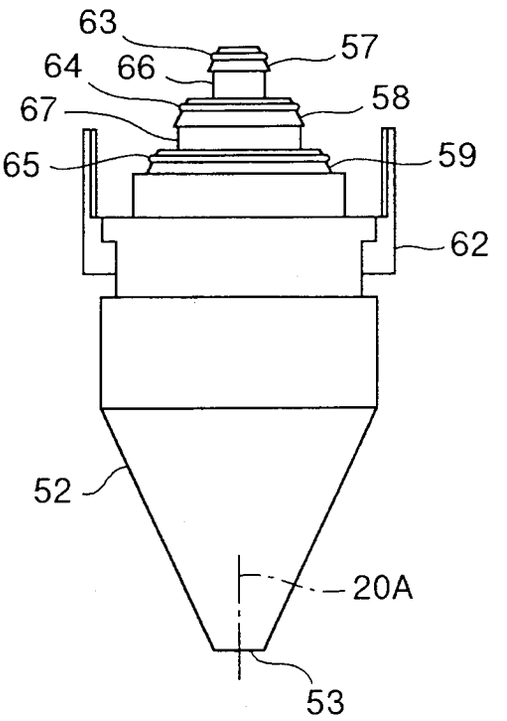


FIG.9

CONVENTIONAL ART

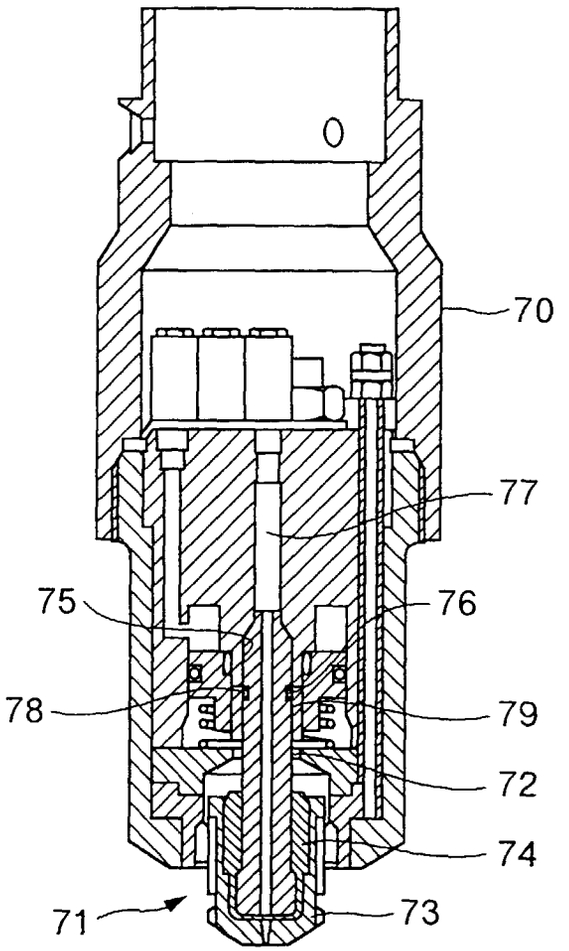


FIG.10

CONVENTIONAL ART

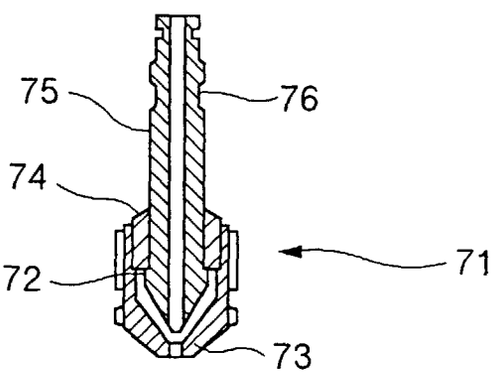
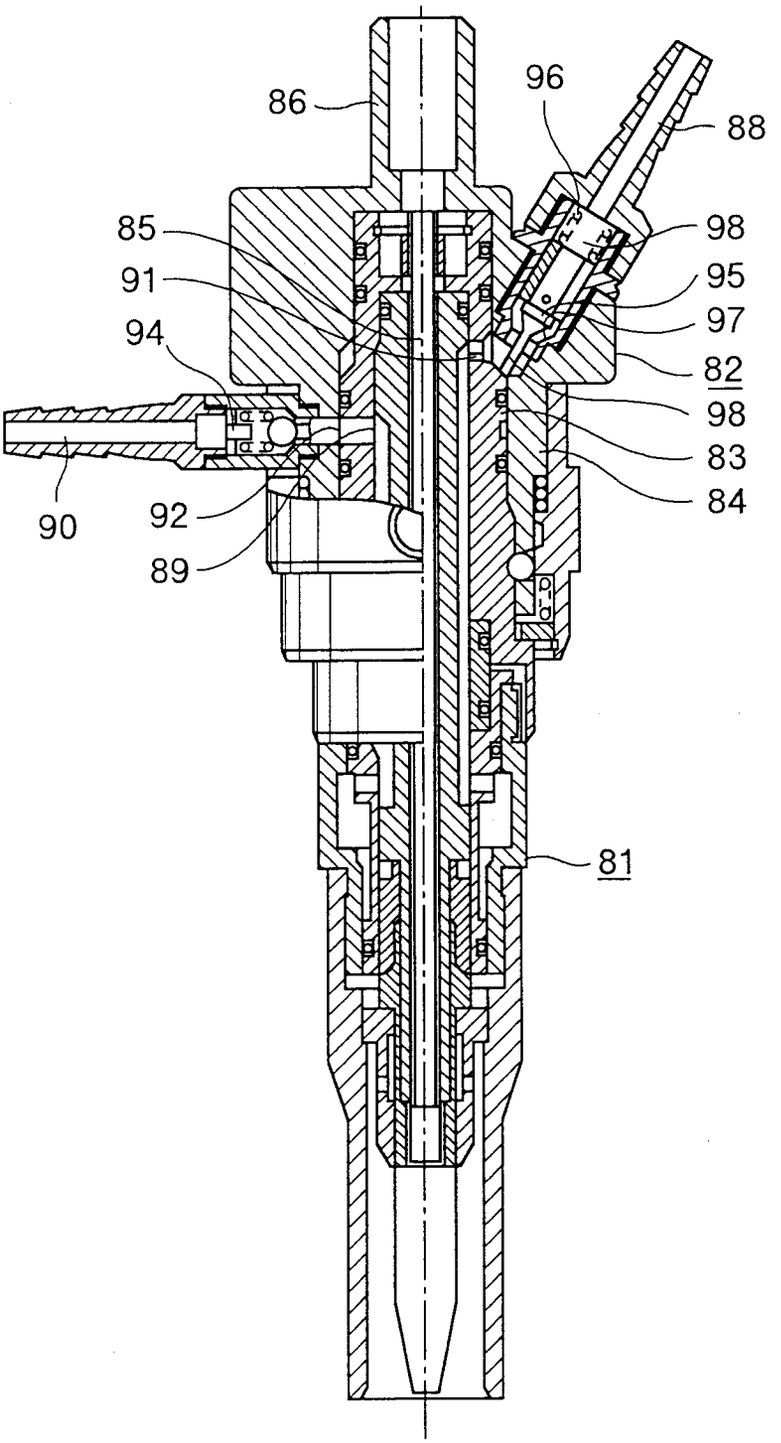


FIG.11

CONVENTIONAL ART



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP96/03331

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^6 B23K10/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl^6 B23K10/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1926 - 1997
Kokai Jitsuyo Shinan Koho 1971 - 1997
Toroku Jitsuyo Shinan Koho 1994 - 1997
Jitsuyo Shinan Toroku Koho 1996 - 1997

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 5-5589, B2 (Nippon Steel Welding Products & Eng. Co., Ltd.), January 22, 1993 (22. 01. 93)(Family: none)	1 - 10
A	JP, 49-32578, Y1 (Hitachi, Ltd.), September 3, 1974 (03. 09. 74)(Family: none)	1 - 10

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
February 3, 1997 (03. 02. 97)	February 18, 1997 (18. 02. 97)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)