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(71) Applicant
N.P.K. za Kontrolno Zavarachni Raboti (Bulgaria),
Sofie 3; 156 Street, Bulgaria

(72) Inventors
Dimo Todorov Garlanov,
Sergey Ivanov Angelov

(74) Agent and/or address for service
Haseltine Lake & Co., Hazlitt House, 28 Southampton Buildings, Chancery Lane, London WC2A 1AT

(54) Plasma arc torch

(57) The torch comprises a housing 4, a cathode 6 and a nozzle arrangement connected to the housing and surrounding the cathode, the arrangement forming an outlet for a plasma arc generated in use by the torch and directing streams of inert gas, plasma-forming gas and coolant towards a workpiece which is to be cut by the torch. An inner nozzle portion 1 surrounding the cathode 6 defines therewith an inert gas supply passage 5, a plasma arc forming chamber 11—13 communicating with said passage 5, partly defined by the inner nozzle portion 1 immediately in front of the forward discharge end of the cathode and extending to the torch outlet. An outer nozzle portion 3 defines with an intermediate nozzle portion 2 a coolant outlet nozzle 7 which surrounds the torch outlet and which is arranged to direct a shield of coolant to surround the plasma arc emitted through the torch outlet. The intermediate nozzle portion 2 defines with the inner nozzle portion 1 a coolant passage 8 which communicates with the coolant outlet nozzle 7. An inlet 19, 18 admits a supply of plasma-forming gas to the plasma arc forming chamber 11—13 via means 17, 16 (15; Fig. 2).

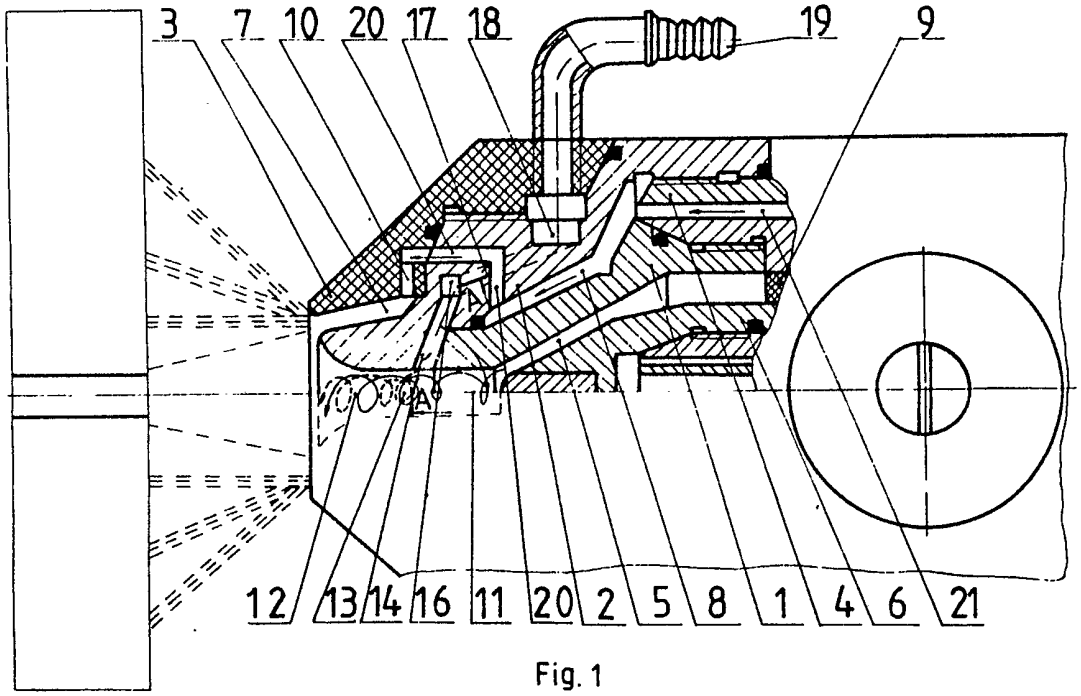

Fig. 1

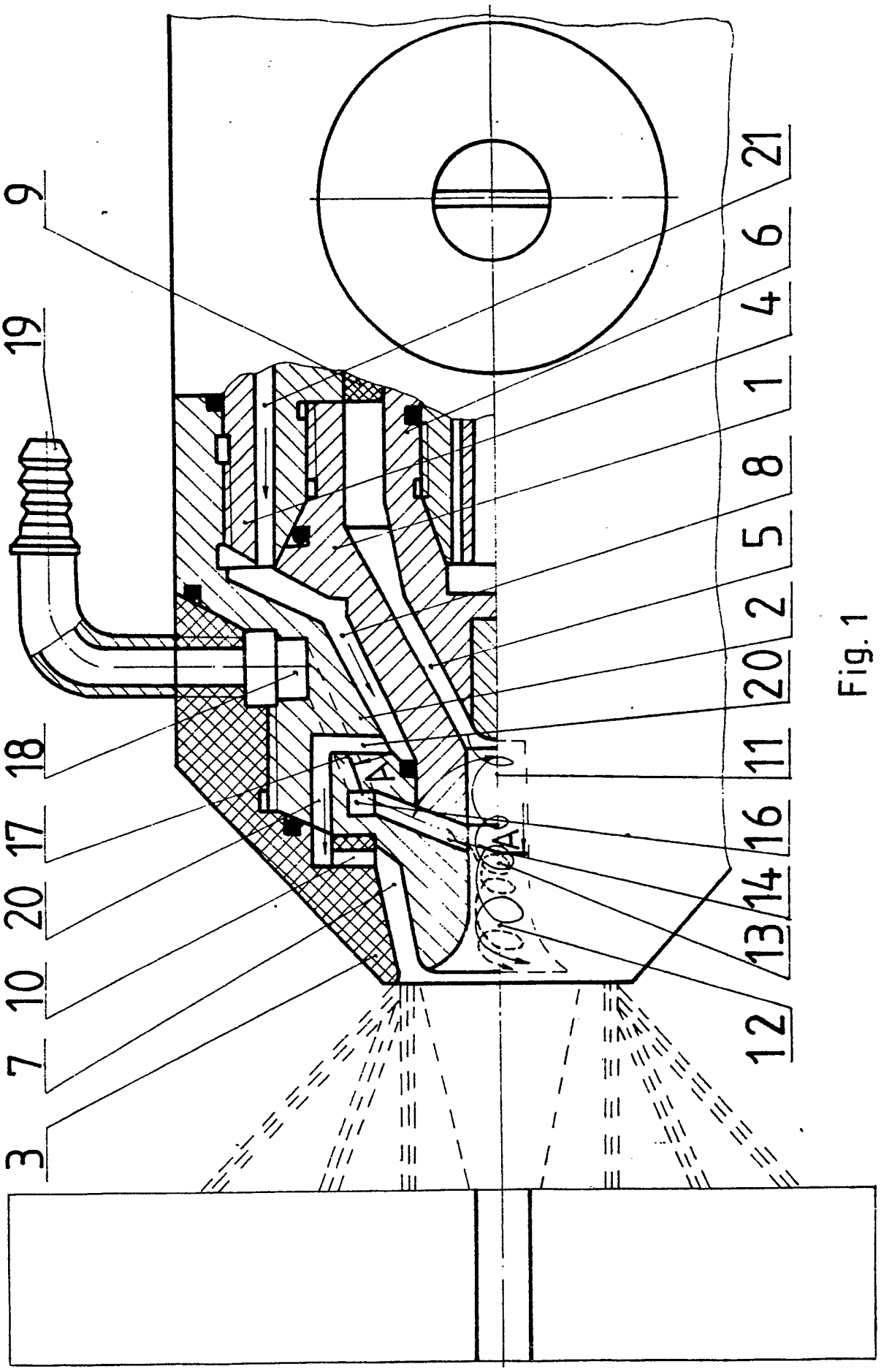

Fig. 1

A - A

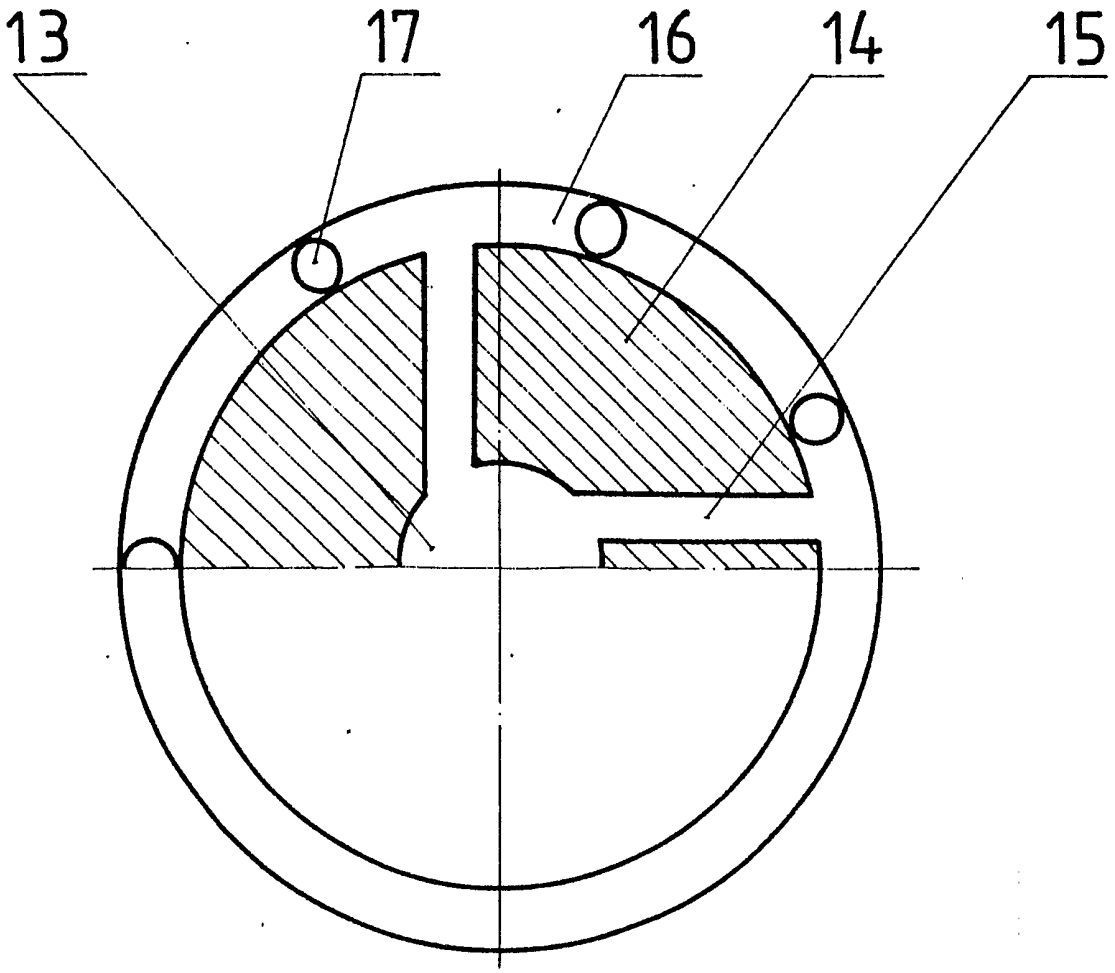

Fig. 2

SPECIFICATION

Plasma arc torch

This invention relates to a plasma arc torch for use in plasma-arc cutting of materials and especially, though not exclusively, for plasma-arc cutting of materials in air or underwater.

It is known to provide a component nozzle for a plasma arc torch, especially for independent feeding of coolant water flow and plasma-forming gas, which includes an external and an internal forming nozzle portion mounted one above the other and fitted to a housing of the torch in such a way as to define two gaps or passages. The first gap is defined between a torch cathode and the internal nozzle portion, designed for feeding plasma-forming gas, and an internal vortex generator is mounted in this first gap. The second gap is defined between the internal and the external nozzle portions, designed for feeding the coolant water flow. The front part of the second gap is in the shape of concentric hole, and its backside is connected with races or ducts machined in the torch housing. An external vortex generator is fitted below the level of the races, along the external surface of the internal forming nozzle portion. A forming race is designed in the front part of the internal forming nozzle.

The disadvantage of this known nozzle arrangement is that it cannot simultaneously and independently feed separate streams of both inert gas and oxygen-containing plasma-forming gas directly and straight into the forming race. Another disadvantage is that the consumption of the inert gas (argon, hydrogen, nitrogen, helium and their mixtures) considerably increases when the thickness of the material to be cut is increased or the depth of sinking, and when the power of the plasma arc nozzle is increased. This makes plasma arc cutting of standard steels over a certain thickness more expensive per linear metre of cut, than by oxyacetylene cutting.

The present invention has therefore been developed primarily, though not exclusively, with a view to provide a nozzle arrangement for a plasma arc torch which permits simultaneous and independent supply of inert gas and oxygen-containing plasma-forming gas directly into a plasma-arc forming chamber, in such a way as to reduce the consumption of the inert gas.

According to the invention there is provided a plasma arc torch comprising a torch housing, a cathode mounted in the housing, and a nozzle arrangement connected to the housing and surrounding the cathode, the nozzle arrangement forming a torch outlet for a plasma arc generated in use by the torch and being arranged to direct streams of inert gas, plasma-forming gas and coolant towards a workpiece which is to undergo treatment by the torch, and in which the nozzle arrangement comprises:

an inner nozzle portion which surrounds the cathode and which defines therewith an inert gas supply passage;

a plasma arc forming chamber communicating with said passage and defined by the inner nozzle portion between a forward discharge end of the cathode and the torch outlet;

an outer nozzle portion which defines with the inner nozzle portion a coolant outlet nozzle which surrounds the torch outlet and which is arranged to direct a shield of coolant to surround the plasma arc emitted through the torch outlet;

an intermediate nozzle portion arranged between the inner and the outer nozzle portions and defining therewith a coolant passage which communicates with said coolant outlet nozzle;

an inlet on the torch for admitting a supply of plasma-forming gas to the torch; and

means extending through the nozzle arrangement to communicate said inlet with said plasma arc forming chamber.

Accordingly, as will become more apparent from the following detailed description of a preferred embodiment of the invention, a nozzle arrangement may be provided for a plasma arc torch which permits simultaneous and independent supply of inert gas and oxygen-containing plasma-forming gas, in such a way as to reduce inert gas consumption, while still enabling satisfactory supply of coolant to the nozzle arrangement and around the plasma arc generated between the torch and a workpiece which is to be treated.

In addition, the embodiment permits cutting of parts of workpieces having substantial thicknesses, both in air and underwater at considerable depths.

A preferred embodiment of plasma arc torch according to the invention will now be described in detail, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a side view, partly in section, of a component nozzle arrangement mounted on one end of a plasma arc torch according to the invention; and

Figure 2 is a section taken on the lines AA in Figure 1.

As will become apparent from the subsequent detailed description of the preferred embodiment of the invention, there is disclosed herein a plasma arc torch which comprises a torch housing 4, a cathode 6 mounted in the housing 4, and a nozzle arrangement connected to the housing and surrounding the cathode, the nozzle arrangement forming a torch outlet for a plasma arc generated in use by the torch and being arranged to direct streams of inert gas, plasma-forming gas and coolant towards a workpiece which is to undergo treatment by the torch. The nozzle arrangement comprises an inner nozzle portion 1 which surrounds the cathode 6 and which defines therewith an inert gas supply passage 5, a plasma arc forming chamber communicating with said passage 5 and defined by the inner nozzle portion 1 between a forward discharge end of the cathode and the torch outlet, an outer nozzle portion 3 which defines with the inner nozzle portion 1 a coolant outlet nozzle 7 which surrounds the torch outlet and which is arranged to direct a shield of coolant to surround the plasma arc emitted through the torch outlet, an intermediate nozzle portion 2 arranged between the inner and the outer nozzle portions 1

and 3 and defining therewith a coolant passage 7, 8 which communicates with the coolant outlet nozzle, an inlet 19, 18 on the torch for admitting a supply of plasma-forming gas to the torch, and means 17, 16, 15 extending through the nozzle arrangement to communicate the inlet 19, 18 with the plasma arc forming chamber.

Referring now to the drawings, the preferred embodiment of plasma arc torch will now be described in detail. Thus, the component nozzle for a plasma arc torch comprises an internal nozzle portion 1, an intermediate portion 2 and an external portion 3, mounted one on top of the other. They are secured to a housing 4 of the plasma arc torch in such a way as to define three gaps or passages. A first gap 5 is defined between a torch cathode 6 and the internal nozzle portion 1. A second gap 7 is defined between the intermediate portion 2 and the external portion 3. A third gap 8 is defined between the internal portion 1 and the intermediate portion 2. An internal vortex generator 9 is mounted in the first gap 5, and an external vortex generator 10 is mounted in the second gap 7, fitted in the middle external part of the intermediate nozzle portion 2.

A plasma-arc forming chamber in the form of a race or conduit 11 is defined in the front part of the internal nozzle portion 1, coaxially connected to a second race 12, so that a common forming race 14 is formed. The above mentioned races 11 and 12 may have different diameters and lengths. An intermediate vortex generator 14 is arranged in the contact surface of gap 2 and the internal nozzle portion 1, having tangentially extending races 15 which may be inclined at different angles relative to the axis of the common forming race 13. The tangentially extending races 15 are connected at one end to the common race or canal 13, and at their other end to an annular passage or race 16 defined on the intermediate nozzle portion 2. In turn, the annular passage 6 is connected via openings 17 to an external circular race 18, which is connected to a pipe connection 19, which forms an inlet for supply of plasma-forming oxygen-containing gas to the torch.

The external annular passage 18 may be machined in the gap 2 and in the external nozzle portion 3. The second gap 7, by means of external vortex generator 10, connecting radially extending ducts or races 20 of the intermediate nozzle portion 2 and the third gap 8, is connected to races 21 machined in the housing 4 of the plasma arc torch. The connecting races 20 are fitted radially outwardly of the intermediate vortex generator 14.

The operation of the plasma arc torch will now be described. Inert gas of a specified quantity is fed tangentially by means of internal vortex generator 9 along the first gap 5 at an accelerating velocity, entering the forming race 11 of the internal nozzle portion 1, and continuing along the common forming race 13 which forms a plasma-arc forming chamber. Cooling water is supplied along conduits 21 in the housing 4 to enter the third gap 8 in order to cool the internal nozzle portion 1 and the intermediate nozzle portion 2. The coolant water then flows along the connecting races 20 and continues to cool the intermediate nozzle portion 2 as it passes to the second gap 7 above the external vortex generator 10.

As the coolant flows through the generator 10, it has imparted thereto rotary and translational motion which continues with the cooling of the intermediate nozzle portion 2 and the external nozzle portion 3. In the second gap 7, the coolant flows at an accelerating velocity directed outwardly towards the coolant outlet nozzle formed by the gap 7. The coolant is directed away from the end of the torch towards a workpiece, in a convergent pattern as shown in Figure 1. Thus, the coolant water flow forms a protecting conical water screen or shield which surrounds the emission of a plasma arc from the outlet end of the torch. The plasma arc generated within the chamber defined by the races 11, 12 and 13 is directed towards the workpiece so as to cut the material thereof, this being initiated by supply of voltage across the component nozzle and the cathode 6. A pilot arc may be ignited by means of a manual starting device, or automatically by an oscillator, or a pneumatic button, and the arc automatically extends out to the workpiece material.

Simultaneously with the increase in energy parameters of the plasma arc, oxygen-containing plasma-arc gas is released automatically through pipe connection 19 with a flow rate considerably exceeding that of the inert gas supply along the first gap 5. This plasma-forming gas enters the plasma-arc forming chamber via the external annular race 18, holes 17 and the internal annular passage 16 of the intermediate vortex generator 14. Thereafter, the plasma-forming gas passes along tangential or substantially radially extended races 15 to enter the common forming race 13 (plasma-arc forming chamber), to mix with the incoming supply of inert gas.

In the plasma-arc generating chamber, an electric arc is generated from the forward discharge end of the cathode 6, and this generates formation of a plasma-arc in the plasma-arc forming gas supplied via inlet connection 19, which imparts enormous increase in the dynamic, energy and heat parameters in the gas sufficient to produce the required cutting action in the workpiece.

CLAIMS

1. A plasma arc torch comprising a torch housing, a cathode mounted in the housing, and a nozzle arrangement connected to the housing and surrounding the cathode, the nozzle arrangement forming a torch outlet for a plasma arc generated in use by the torch and being arranged to direct streams of inert gas, plasma-forming gas and coolant towards a workpiece which is to undergo treatment by the torch, and in which the nozzle arrangement comprises:

an inner nozzle portion which surrounds the cathode and which defines therewith an inert gas supply passage;

a plasma arc forming chamber communicating with said passage and defined by the inner nozzle portion between a forward discharge end of the cathode and the torch outlet;

an outer nozzle portion which defines with the inner nozzle portion a coolant outlet nozzle which surrounds the torch outlet and which is arranged to direct a shield of coolant to surround the plasma arc emitted through the torch outlet;

an intermediate nozzle portion arranged between the inner and the outer nozzle portions and defining therewith a coolant passage which communicates with said coolant outlet nozzle;

an inlet on the torch for admitting a supply of plasma-forming gas to the torch; and

means extending through the nozzle arrangement to communicate said inlet with said plasma arc forming chamber.

2. A torch according to claim 1, including vortex forming means arranged in said chamber to form and to mix swirls of inert gas and plasma-forming gas during generation of a plasma arc.

3. A torch according to claim 2, including an internal vortex generator arranged in said inert gas supply passage.

4. A torch according to any one of the preceding claims, including an external vortex generator arranged in said coolant passage upstream of the coolant outlet nozzle.

5. A torch according to any one of the preceding claims, including an intermediate vortex generator arranged in said communication means.

6. A torch according to any one of the preceding claims, including radially extending ducts defined between the intermediate nozzle portion and the inner nozzle portion and forming part of said coolant passage.

7. A torch according to any one of the preceding claims, in which said communication means includes a passage extending through said intermediate nozzle portion, an annular passage formed in said inner nozzle portion, and at least one connecting passage extending at least partly radially inwardly to communicate with said chamber.

8. A torch according to claim 5, in which the coolant passage is arranged radially outwardly of the intermediate vortex generator.

9. A torch according to claim 1 and substantially as hereinbefore described with reference to, and as shown in the accompanying drawings.

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