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[54] **LIQUID COOLED PLASMA BURNER**

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[52] **U.S. Cl.** ..... **315/111.2,** 219/121 P, 313/231.4, 315/111.8

[51] **Int. Cl.** **H05b 31/26**

[58] **Field of Search** ..... 219/121 P; 313/146, 149, 313/231; 315/111; 328/233; 313/DIG. 6

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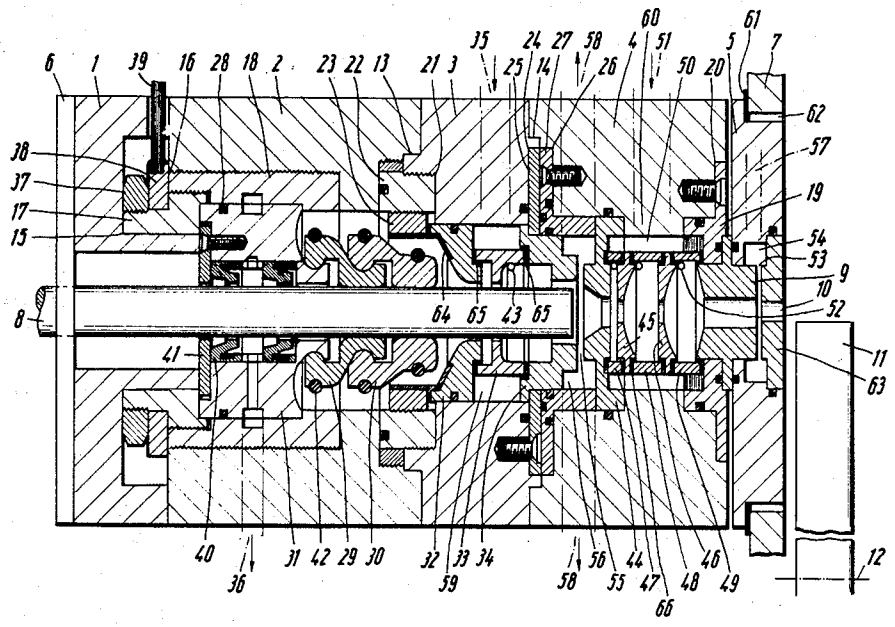
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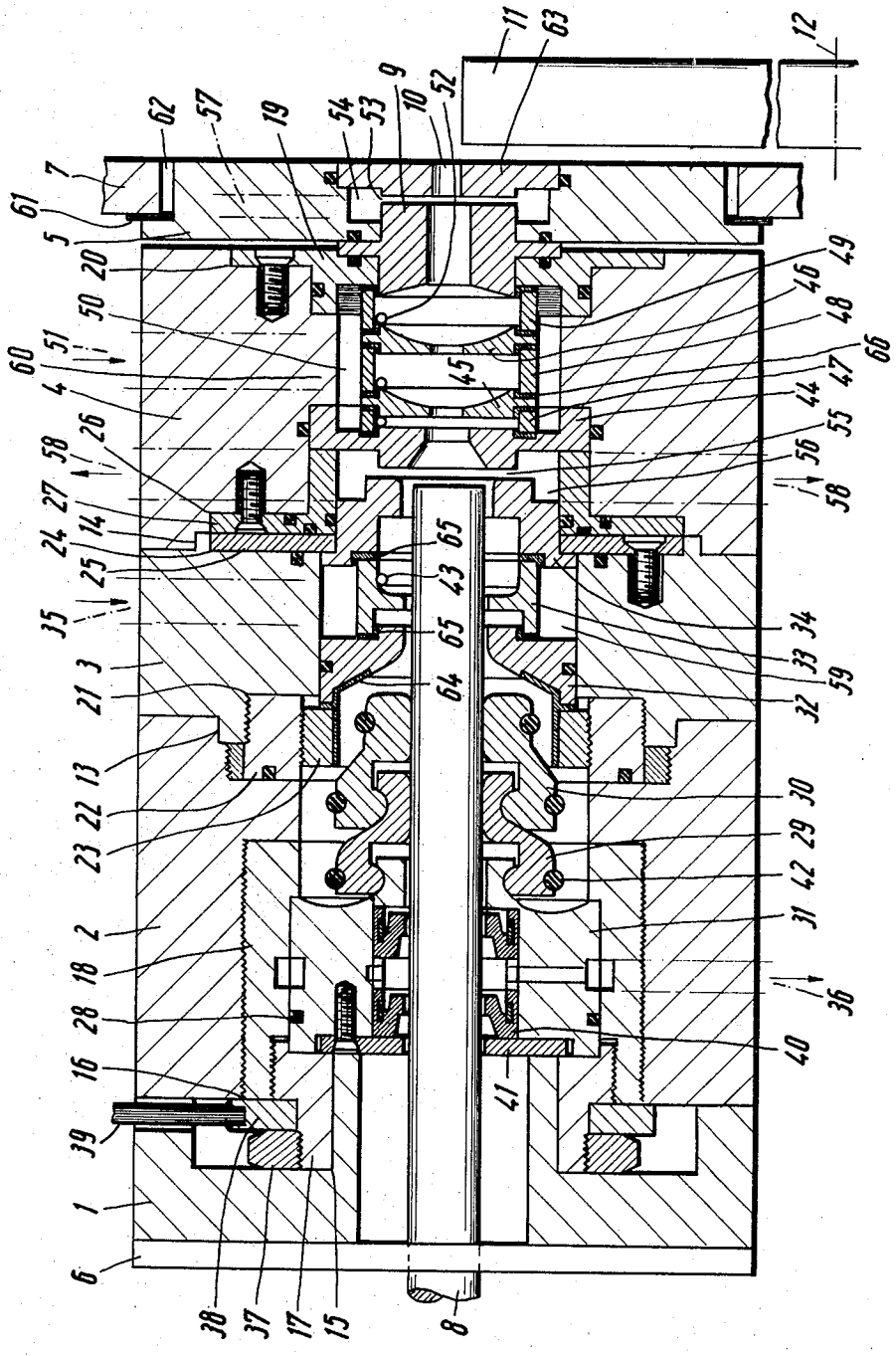
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[57] **ABSTRACT**

A plasma burner consists of an electrode chamber unit and an arc discharge chamber unit. The parts of each unit are detachable from one another and the units are detachably joined together. Each unit has one or more casing rings which are coaxially centered directly or by means of interposed rings. Inserts are associated with the face of at least one casing ring and are centrally and detachably fixed by a retaining ring. At least one further insert is held positively and co-axially between the first mentioned inserts at a distance from the inner wall of the casing.

4 Claims, 1 Drawing Figure




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LIQUID COOLED PLASMA BURNER

The invention relates to a liquid stabilized plasma burner having a hollow cylindrical casing which encloses an electrode chamber with circular, co-axial inserts which are spaced away from the inner wall of the casing and hold a bar electrode and come into contact with, and are washed by, a cooling liquid, and an arc discharge chamber, which contains further circular, coaxial inserts packed closely together and spaced away from the inner wall of the casing, said further inserts constituting orifice plates and intermediate rings provided with tangential passages for stabilizing liquid.

Such a plasma burner is known from U.S. Pat. No. 3,665,244.

Because of the extremely high plasma temperatures, plasma burners are subjected to severe wear and consequently must be frequently taken apart and reassembled to allow for cleaning and replacement of worn-out inserts. It is also necessary for plasma burners to be equipped with various other inserts according to the purpose for which the burner is to be used, in particular the inserts should be changed if the burner is to be used for high-temperature chemical processes. The use of the burner with these other inserts frequently calls for the use of a shorter or longer combustion chamber and thus a shorter or longer burner, and hence a casing of another length. In the case of known plasma burners the taking apart and the changing of inserts is complicated and time-consuming, and in some circumstances the entire casing must be replaced by a shorter or a longer one.

It is an object of the invention to provide a liquid-stabilized plasma burner of the kind initially mentioned which may be quickly and simply broken down and reassembled and consequently is simpler to manufacture and to maintain the casing of which may be adapted to different lengths of burner, and which also can be so formed that it does not have to be completely taken apart for the replacement of parts by new ones, or others, at any time.

This is attained in the plasma burner in accordance with the invention in that the burner consists of an electrode-chamber unit and an arc discharge chamber unit, in that the parts of each unit are detachable from one another and the units are detachably joined together, each unit having one or more casing rings which are positively co-axially centred directly or by means of interposed rings, in that the inserts associated with the face of at least one casing ring are each centrally and detachably fixed through a retaining ring, and in that at least one further insert is held positively and coaxially between the inserts associated with the face of the said one casing ring at a distance from the inner wall of the casing.

One embodiment of the invention is now described, by way of example, with reference to the accompanying drawing. The single FIGURE in the drawing shows a schematic longitudinal section through a plasma burner.

The plasma burner illustrated has a casing consisting of five casing rings **1** to **5** and two end flanges **6** and **7**. the casing rings **1** to **4** are of a form of a polyamide (Trade Name "Delrin"), and the casing ring **5** is of V4A steel and is insulated electrically from the end flange **7** by an insulating ring **61** and an air gap **62**. The casing rings **1** to **5** are clamped together between the

end flanges **6** and **7** through expansion bolts not shown which yield with the heating of the burner. It is, for example, possible for the end plates to be square and an expansion bolt can be provided between each corner of an end flange and the corresponding corner of the other end flange. The hollow space enclosed by the parts **1** to **7** is cylindrical and stepped as shown and contains a cathode **8** in the form of a rod or bar and circular inserts with different profiles. The casing rings **1** to **3** surround the cathode chamber. The casing rings **4** and **5** surround the arc discharge chamber, the end of the cathode **8** penetrating into these and a plasma outlet nozzle **9** which is of V4A steel. In front of an outlet aperture **10** of a copper ring **63** is disposed a cooled, circular disc anode **11** rotating about an axis **12** shown in broken line, so that it has a common tangential plane with the outlet aperture **10**.

The mutually engaging faces of the casing parts **2, 3** and **4** have corresponding steps and recesses **13** and **14** that engage directly in one another. The engaging faces of the casing parts **1** and **2** have steps **15** and **16** in which two profile rings **17, 18,** which are bolted together, seat in engagement partly in one and partly in the other of the two steps **15** and **16.** The ring **18** is screwed into the casing ring **2.** The profile ring **9** constituting the outlet nozzle of the burner engages on the one side in a step of an interposed ring **19** that seats in a step **20** of the casing ring **4** and is screwed onto this, and on the other side in the aperture of the casing ring **5.** In this way the casing rings **1** to **5** are centred in relation to one another.

Screwed into a step **21** of the casing ring **3** is an intermediate ring **22,** in which a threaded ring **23** seats. A flat intermediate ring **25** is also inserted in a step **24** of the casing ring **3** and an intermediate ring **27** with an L-shaped profile is inserted in an opposite step **26** of the casing ring **4.** These intermediate rings **25** and **27** are of V4A steel, they are screwed onto the front faces of the casing rings **3** and **4** respectively concerned. To the extent that the casing rings and these interposed rings (as well as parts mentioned later) enclose a hollow space through which a cooling or stabilising liquid flows, they are sealed by sealing rings (e.g., **28**) seated in circular grooves.

In the casing rings **2** and **3** which surround the cathode chamber are circular inserts **29, 30** of copper, which hold the cathode and serve for the conveyance of current, as do inserts **31** to **34** also. The inserts **32** to **34** are of V4A steel. The insert **32** carries a ceramic coating **64.** The insert **33** is fitted between ceramic interlayers **65.** The inserts **32** and **34** delimit circular spaces which surround the cathode **8.** Through these circular spaces a liquid coolant circulates which is introduced through ducts, one of which is indicated in broken line and identified as **35,** and led away through a duct **36.** A nut **37** screwed onto the ring **17** presses a contact ring **38** to which a current lead **39** is connected against the rings **17** and **18.** The ring **31** seats in a step of each of these rings. This has an inner step in which two lip seals **40** are disposed and retained by a screwed-on ring **41.** The ring **31** and the rings **29** and **30** serving as current conductors engage in one another, the necessary pressure being provided by spring rings **42** and the rings **29** and **30** being built up from segments (not illustrated). The rings **32, 33** and **34** seat in the aperture of the casing ring **3,** with the intermediate rings **23** and **25** constituting outer axial abutments

for the rings 32 and 34 and the ring 33 being held centred between the rings 32 and 34. The ring 33 has tengential drillings 43 and delimits the inner side of a circular space 59, into which the supply duct 35 for the cooling liquid leads.

The arc discharge chamber contains an orifice plate 44 seated in a step of the casing ring 4 and held on an internal protrusion 60 of the casing ring 4 by the intermediate ring 27, and two further orifices 45 and 46. The orifice plates 44, 45 and 46 are of V4A steel. The orifices 45 and 46 are held centralised together with distance rings 47, 48 and 49 and sealing rings interposed between them, e.g., 66, between the orifice plate 44 and the intermediate ring 19, in which a part of the outlet nozzle seats. The sealing rings, one of which is identified with 66, are made of an electrically insulating material. The orifice plates 45, 46 and distance rings 47, 48 and 49 delimit on their outer periphery together with a part of the inner wall of the casing ring 4 an annular space 50 into which a duct 51 for the supply of stabilisation liquid discharges. This liquid flows through tangential drillings, such as 52, of the distance rings 47, 48 and 49 into the spaces formed between these and the orifice plates 44, 45 and 46 respectively of the outlet nozzle 9, encircles there the arc discharge, forms this stabilising liquid swirl thereby and passes through a gap 53 into an annular space 54 and also through a gap 55 into an annular space 56, from which it is led through a duct 57 or through the ducts 58 respectively.

For dismantling, for example for the purpose of cleaning of or for the exchange of internal parts of the burner described, it is possible after loosening the tension bolts mentioned (not illustrated) with which they are clamped together between the flanges 6 and 7 for the assembled casing rings 1 to 5 to be pulled apart at one or more contact points as desired and thus released one from another, when the inner parts can only be withdrawn or knocked out after the screwing out or screwing off of one or more intermediate rings 17, 18, 41, 23, 25, 27, 19, 41. When the internal parts are reinserted, the return to their correct co-axial locations without further provision, as can be seen from the construction described.

In the example described the casing ring 1 (which can be fixed with bolts to the flange 6) constitutes a cathode side sealing unit that can be withdrawn from the rest of the burner, without parts of it being loosened.

The casing rings 2 and 3 with their inserts constitute the actual cathode chamber. This can be divided into a left and a right part through pulling apart the casing rings 2 and 3 when each of these parts forms a unit with the inserts fixed in it.

In the left unit the inserts 29 and 30 are anchored on the ring 31, which is held in the casing ring 2 by the screwed-in rings 17 and 18, and the lipped seals 40 are retained by the screwed-on ring 41.

In the right unit, the inserts 32, 33 and 34 are held co-axially between the screwed-in ring 23 and the screwed-on ring 25.

The casing ring 4 with the inserts fixed in it constitutes an arc discharge chamber unit, in which the orifice plates 44, 45, 46 and distance rings 47, 48, 49 are held co-axially between the screwed-on intermediate rings 27 and 19.

The casing ring 5 constitutes an anode-side sealing unit that can be withdrawn from the rest of the burner, without parts of the same (apart from the outlet nozzle 9) being loosened.

Each unit can be removed from the rest of the burner independent of the others, replaced or dis-assembled, cleaned and assembled again with the same or other inserts and installed in the burner.

The parts of the plasma burner described, the material of which is not quoted above, can be made from copper, copper with an aluminium oxide coating, stainless steel or hard metals (e.g., those sold under the trade name "Hestalloy") according to the thermal loading and the conductivity called for by the particular case.

What we claim is:

1. A liquid stabilized plasma burner assembly comprising, in combination, a hollow cylindrical casing including an inner wall and formed from a plurality of casing rings (1–5) arranged in a coaxially aligned relationship, an electrode chamber defined by at least one (1–3) of said casing rings, first circular inserts (29, 30) coaxially arranged in said electrode chamber and spaced from said inner wall of said casing, a bar electrode (8) arranged to be surrounded by said inserts and contacted thereby, means (35, 58) for passing a cooling fluid into said casing and through said spacing between said inserts and said inner wall of said casing, an arc discharge chamber defined by at least one other (4) of said casing rings in axial alignment with said electrode chamber, said at least one casing ring (1–3) defining said electrode chamber and said at least one casing ring (4) defining said arc discharge chamber being detachably joined together, second circular inserts (45–49), including orifice plates (45, 46) and intermediate rings (47, 48, 49) provided with tangential passages (52), coaxially arranged in said arc discharge chamber, said second inserts being held tightly together and spaced from said inner wall of said casing, inlet means (51) for feeding stabilizing liquid into said spacing between said second inserts and said inner wall of said casing, outlet means (57) for passing said stabilizing liquid out from said spacing, said second inserts including two inserts (47, 49) which are associated each with one face of said at least one ring (4) defining said arc discharge chamber and which are centrally and detachably mounted upon said ring, a pair of annular steps (20, 26) formed in opposite faces of said at least one casing ring (4) defining said arc discharge chamber, and at least two retaining rings (27, 19) seated one each in said annular steps (20–26) to mount thereon said inserts (47, 49) associated with said at least one ring (4) defining said arc discharge chamber, with at least one other (48, 46) of said second inserts being coaxially held between said two inserts (47, 49) associated with said at least one ring (4) defining said arc discharge chamber.

2. An assembly according to claim 1 further including an interposed ring (17, 18, 22, 9) arranged to maintain at least two of said casing rings (1–5) in a coaxially centered relationship.

3. An assembly according to claim 1 wherein at least one of said retaining rings (27, 19) is detachably fixed to one end of said at least one casing ring (4) defining said arc discharge chamber.

4. An assembly according to claim 1 further comprising end flange means (6, 7) arranged to hold together said casing rings defining said electrode chamber and said arc discharge chamber.

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