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(54) **PLASMA TORCH HAVING A QUICK-CONNECT RETAINING CUP**

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B23K 10/00 (2006.01)

(52) **U.S. Cl.** **219/121.4**; 219/121.48; 219/121.51; 219/121.39

(58) **Field of Classification Search** 219/121.48, 219/121.39, 121.5, 121.51, 121.52, 74, 75
See application file for complete search history.

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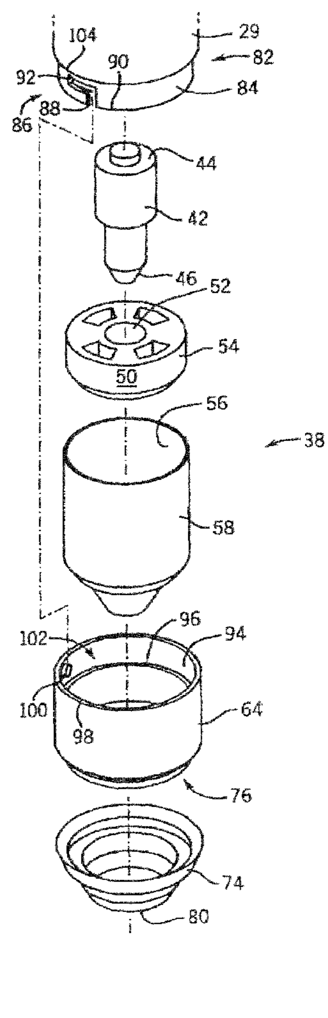
(57) **ABSTRACT**

A plasma torch assembly having a quick-connect retaining cup is disclosed. The plasma torch has a torch body constructed to receive an electrode therein. A retaining cup secures the electrode to the torch body by rotating the retaining cup less than approximately 360 degrees relative to the torch body.

29 Claims, 3 Drawing Sheets



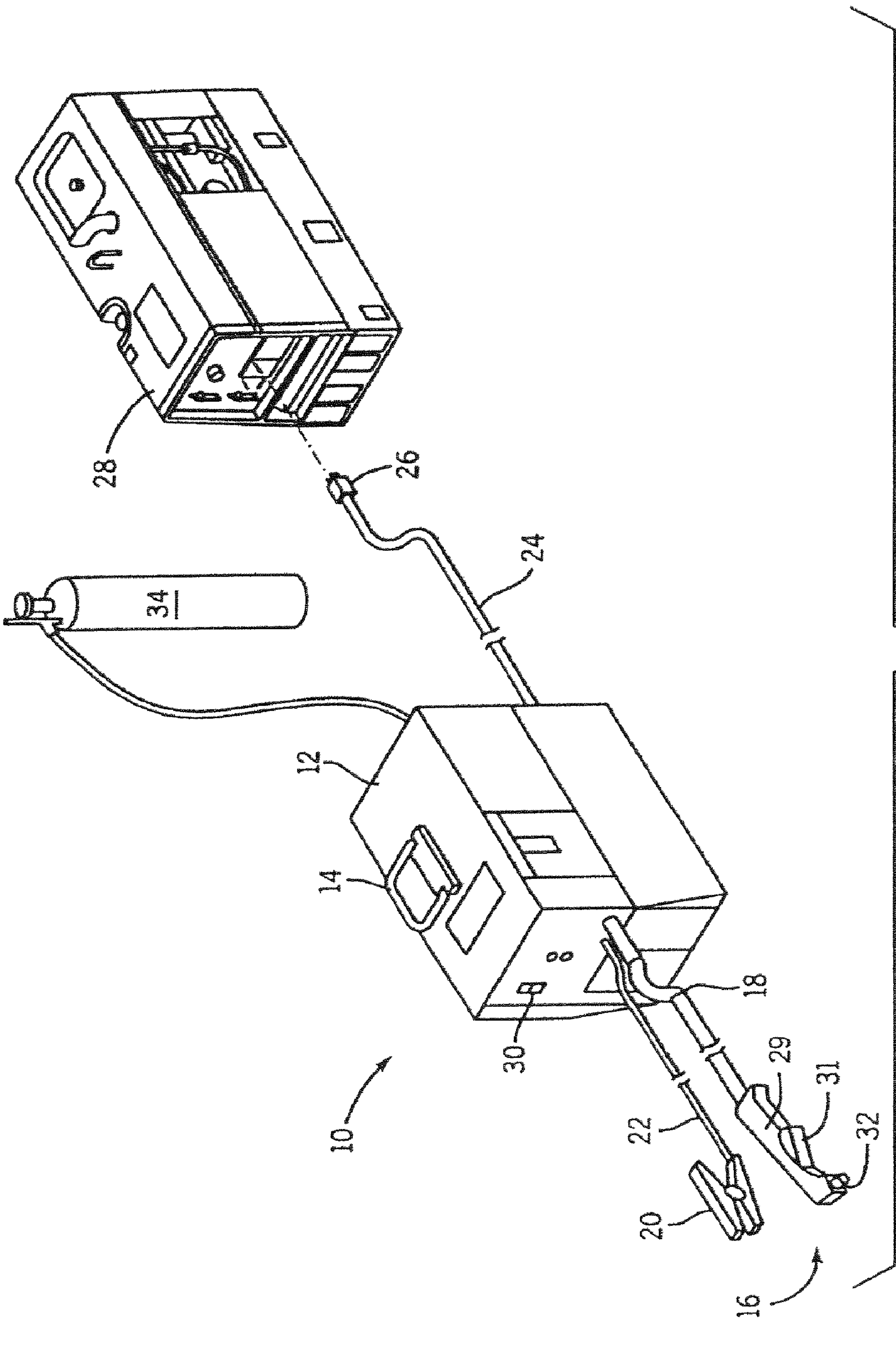


FIG. 1

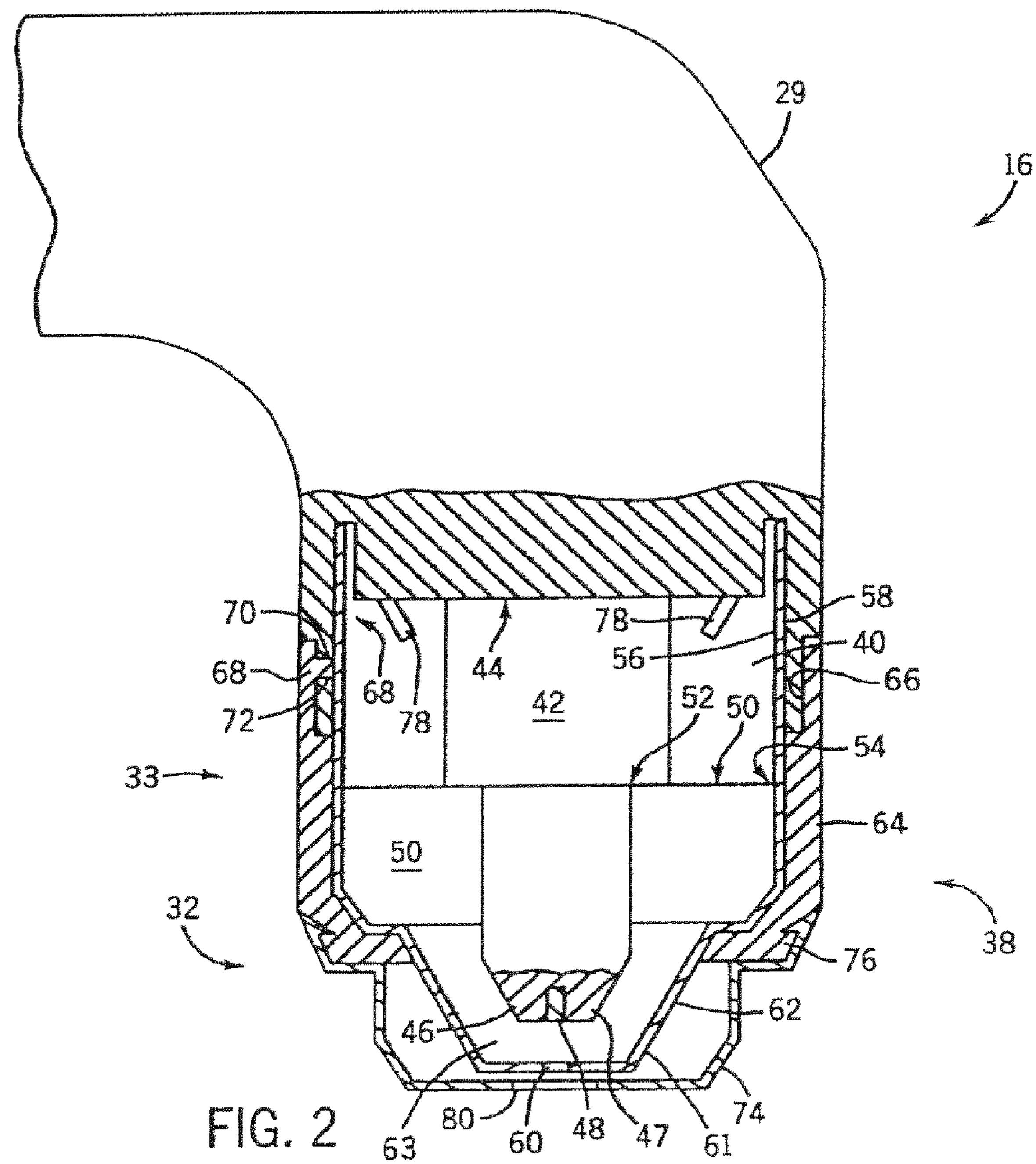

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FIG. 2

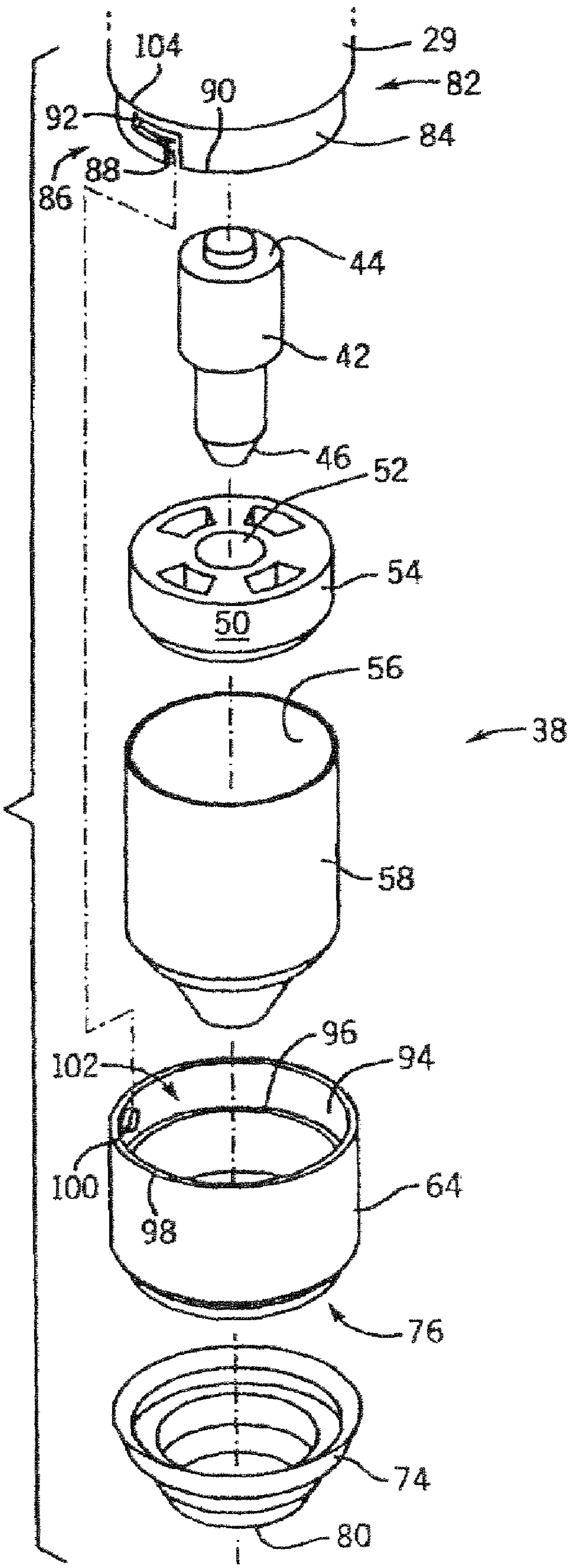
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FIG. 3

PLASMA TORCH HAVING A QUICK-CONNECT RETAINING CUP

BACKGROUND OF INVENTION

The present invention relates generally to plasma cutting systems and other high power output welding-type systems such as welding and induction heating systems and, more particularly, to a quick-connect retaining cup for use with such systems.

Plasma cutting is a process in which an electric arc is used for cutting a workpiece. Plasma cutters typically include a power source, an air supply, and a torch. The torch, or plasma torch, is used to create and maintain the plasma arc that performs the cutting. A plasma cutting power source receives an input voltage from a transmission power line or generator and provides output power to a pair of output terminals, one of which is connected to an electrode and the other of which is connected to the workpiece.

An air supply is used with most plasma cutters to help start the arc, provide the plasma gas to the torch, and cool the torch. A movable or fixed electrode or consumable serves as a cathode and a fixed or moveable nozzle or tip serves an anode. In some units, the air supply is used to force a separation of the electrode and tip to create an arc. The arc initiates a plasma jet that is forced out through the opening in the nozzle by the compressed air. The plasma jet causes the arc to transfer to the workpiece, and thus initiates the cutting process. In other plasma cutting systems, a high frequency starter can be used to initiate the arc, and still others can employ high voltage to initiate the arc. In either arrangement, the spaced relationship or the range of movement of the cathodic component and the anodic component are considerations to be addressed for the generation of a pilot arc and maintaining of a cutting arc.

During the generation of the pilot arc and the cutting process, the proper alignment and positioning of the components of the torch affect arc generation and proper torch operation. Improper alignment of the components of the torch can result in premature wear of the components or, if unaddressed, can result in inoperability of the torch. Additionally, as the arc transfers from the electrode to the workpiece in the plasma, substantial heat is generated. The level of heat generated is partially determined by the type of material being worked, the power output required to work the material, and the type of consumable required to effectuate the desired work. Due to the high operating temperatures, the remaining working life of certain components, called consumables, is reduced during cutting. Improper consumable alignment can result in the components of the consumable assembly being subjected to elevated temperatures during torch operation. Cutting with an overheated or overused consumable can result in poor cut quality or reduced cutting speeds. As such, operating life of the components of the consumable assembly is partly dependent on operating conditions and, if unaddressed, may require replacement of the consumable assembly in the middle of a cutting job.

Known plasma torches generally have a cup or cap that threadingly connects to the torch. The cup secures the consumable components, such as the tip and electrode, to the torch and determines the relative position of the components to the torch. After extended periods of operation, the electrode, cup, and other consumables can become worn. A worn consumable electrode should be replaced to maintain cut integrity and desirable cutting speeds. Replacing these consumables requires an operator to remove and replace the electrode and cap assembly. Replacing threaded components consumes time from the cutting process and reduces efficiency. Also, overtightening or cross-threading of the cap during replacement of the tip and electrode can result in improper alignment of the components within the torch. Such misalignments can detract from cut quality, increase component wear, and can ultimately result in torch inoperability—requiring total replacement.

It would, therefore, be desirable to design a cup that can be quickly and repeatably connected to a plasma torch.

BRIEF DESCRIPTION OF INVENTION

The present invention provides a plasma torch assembly that solves the aforementioned problems by providing a plasma torch assembly that includes a quick-connect retaining cup that is quickly and repeatably connectable to a plasma torch. The quick-connect retaining cup orients the consumable components to the plasma torch and assures proper alignment of the components therewith.

Therefore, in accordance with one aspect of the present invention, a plasma torch assembly is disclosed that includes a torch body having a handle portion and a tip portion. An electrode is disposed in the tip portion of the torch body. The assembly also includes a retaining cup constructed to encircle the electrode in the torch body and connect to the tip portion with less than approximately 180 degrees rotation relative to the torch body.

In accordance with another aspect of the present invention, a plasma cutter is disclosed that includes a power source configured to condition power into a form usable by a plasma cutting process. The plasma cutter also includes a torch connected to the power source and configured to effectuate the plasma cutting process. An electrode is disposed in the torch, and a cup having a twist-lock quick-connect mechanism removably connects the cup to the torch and is constructed to maintain an operable position of the electrode and prevent overtightening of the cup to the torch.

In accordance with an alternate aspect of the present invention, a plasma torch assembly is disclosed that includes a torch body, an electrode, and a means for connecting the electrode to the torch body. The connecting means having a fully engaged position with less than one complete rotation of the means from an unlock position to a lock position.

In accordance with yet another aspect of the present invention, a plasma torch consumable is disclosed that includes a quick connect cup having a partial-turn engagement mechanism engageable with another engagement mechanism of a plasma torch.

Various other features, objects, and advantages of the present invention will be made apparent from the following detailed description and the drawings.

BRIEF DESCRIPTION OF DRAWINGS

The drawings illustrate one preferred embodiment presently contemplated for carrying out the invention.

In the drawings:

FIG. **1** is a perspective view of a plasma cutting system incorporating the present invention.

FIG. **2** is a partial cross-sectional view of the torch assembly shown in FIG. **1**.

FIG. **3** is an exploded perspective view of the torch assembly shown in FIG. **2**.

DETAILED DESCRIPTION

FIG. **1** shows a plasma cutting system **10** according to the present invention. The plasma cutting system is a high voltage system with open circuit output voltages ranging from approximately 230 Volts Direct Current (VDC) to over 300 VDC. The plasma cutting system **10** includes a power source **12** to condition raw power and regulate/control the cutting process. Specifically, the power source **12** includes a processor that receives operational feedback and controls the plasma cutting system **10** accordingly. Power source **12** includes a lifting means **14**, such as a handle, which effectuates transportation from one site to another. Connected to the power source **12** is a torch **16** via cable **18**. The cable **18** provides the torch **16** with power and compressed air, and also serves as a communications link between the torch **16** and power source **12**. Torch **16** includes a handle portion, or torch body **29** having a trigger **31** thereon and work tip **32** extending therefrom.

Also connected to power source **12** is a work clamp **20** which is designed to connect to a workpiece (not shown) to be cut and provides a grounding path. Connecting work clamp **20** to the power source **12** is a cable **22** designed to provide a return path, or grounding path, for the cutting current from the torch through the workpiece and the work clamp **20**. Extending from a rear portion of power source **12** is a power cable **24** having a plug **26** for connecting the power source **12** to either a portable power supply **28** or a transmission line power receptacle (not shown). Power source **12** includes an ON/OFF switch **30** and may also include amperage and air pressure regulation controls, indicator lights, and a pressure gauge.

To effectuate cutting, torch **16** is placed in close proximity to a workpiece connected to clamp **20**. A user may then activate trigger **31** on torch **16** to deliver compressed air and power to work tip **32** of torch **16** to initiate a pilot arc and plasma jet. Shortly thereafter, a cutting arc is generated as the user moves the torch to the workpiece. The arc transfers from the electrode to the workpiece through the tip. The user may then cut the workpiece by moving the torch thereacross. The user may adjust the speed of the cut to reduce spark splatter and provide a more-penetrating cut by adjusting amperage and/or air pressure. Gas is supplied to torch **16** from a pressurized gas source **34**, from an internal air compressor, or an external air compressor.

Referring now to FIG. **2**, a head portion **33** of the plasma cutting torch **16** is shown in partial cross-section. Plasma torch **16** is defined by torch body **29** that is connected to head portion **33** of torch **16**. A consumable assembly **38** is positioned in head portion **33** and is quick-connectable to torch body **29** by a cup **64**. Consumable assembly **38** is connected to head portion **33** so as to define a gas chamber **40** that, as will be described in greater detail below, allows for the charging of the gas into a plasma and passage of the gas therefrom. Centrally disposed within gas chamber **40** is an electrode **42**. Electrode **42** has a base **44** that electronically communicates with power source **12** through torch body **36**. Electrode **42** includes an electrode tip **46** at an opposite end **47** from the base **44** of the electrode **42**. Electrode tip **46** has an insert **48** formed therein that exhibits certain preferred electrical, thermal, and chemical properties. Insert **48** is preferably formed of hafnium or zirconium, the importance of which is well known in the art.

Electrode **42** has a swirl ring **50** positioned thereabout. Optionally, electrode **42** may be press-fit into an opening **52** formed generally in the center of swirl ring **50**. An outer diameter **54** of swirl ring **50** engages an inner surface **56** of a tip **58**. Tip **58** generally encircles electrode **42** and swirl ring **50** and includes an orifice **60** at an end **61** thereof. Orifice **60** is positioned generally adjacent to insert **48** of electrode **42** and is constructed to allow the passage of an electrical arc therethrough. Tip **58** also has a nozzle portion **62** formed about orifice **60** and end **47** of electrode **42**. Nozzle portion **62** is constructed to direct the plasma flow from a plasma chamber **63** into a concentrated, highly charged, plasma flow. Plasma chamber **63** is formed in the space between electrode **42** and nozzle portion **62** of tip **58**. During a cutting process, the pilot arc is generally formed in plasma chamber **63** between electrode **42** and tip **58** to cause generation of the plasma gas.

A cup **64**, or retaining cup/cap, passes over nozzle portion **62** of tip **58** and engages an end **66** of torch body **29**. Cup **64** is constructed to snuggly engage tip **58** and quick-connectable to torch body **29**. Cup **64** has a torch end **68** with a tab **70** formed thereat. Tab **70** of cup **64** engages a channel **72** formed in end **66** of torch body **29** and allows consumable assembly **38** to be quickly connected and disconnected from torch body **29**. Such a construction quickly orients the components of consumable assembly **38** with torch body **29** for repeatable alignment of the components of consumable assembly **38** with torch body **29** and thereby proper torch operation. Additionally, it is understood that swirl ring **50** is not necessary for certain plasma cutting processes and/or that the swirl ring is sometimes integrally connected to the torch body **29**.

A shield **74** is connected to cup **64** about an end **76** thereof and is constructed to maintain an appropriate arc distance between insert **48** of electrode **42** and a workpiece. In operation, gas is injected into chamber **40** via a plurality of passages **78**. The gas passes through swirl ring **50** and into plasma chamber **63** where it is heated to a plasma state. The plasma is then forced out of plasma chamber **63**, through nozzle portion **62**, and out tip **58** via orifice **60**. The plasma exits consumable assembly **38** at an opening **80** in shield **74**. Nozzle portion **62** is designed to focus the velocity as well as the heat of an arc that is created between a workpiece (not shown) and insert **48** of electrode **42**. A cutting arc swirls about insert **48** and travels to a workpiece in the plasma flow through torch **16**. Insert **48** is constructed to be conductive and to resist deterioration associated with the high temperature arc which swirls thereabout. Proper alignment of the components of the consumable assembly with torch **16** ensures proper pilot arc generation, cutting arc operation, and consumable component operational longevity.

The components of consumable assembly **38**, as shown in FIG. **3**, are removably connected to torch body **29**. As shown in FIG. **3**, torch body **29** has an end **82** with a flange **84** extending thereabout. A channel **86** is formed in an L-shape about a portion of flange **84** and includes a first section **88** extending from an edge **90** of torch body **29** to a second section **92** of channel **86**. Second section **92** of channel **86** is oriented generally transverse to first section **88** of channel **86**. Shield cup **64** includes an inner surface **94** extending from a shoulder **96** to an edge **98** of shield cup **64**. A pin **100** extends from inner surface **94** of cup **64** between shoulder **96** and edge **98**. Pin **100** is constructed to engage channel **86** formed in flange **84** of torch body **36** with tip **58**, swirl ring **50**, and electrode **42** disposed therebetween.

Cup **64** is axially translatable relative to torch body **36** as pin **100** passes through first section **88** of channel **86**. Second section **92** of channel **86** allows partial rotation of cup **64** relative to torch body **36** and engages pin **100** therein thereby securing cup **64**, tip **58**, swirl ring **50**, and electrode **42** within the space between cup **64** and torch body **36**. As shown, approximately 45 degrees of rotation of cup **64** relative to torch body **36** secures the components of consumable assembly **38** to torch body **29**. Cup **64** is rotatable from an unlocked position, wherein pin **100** engages first section **88** of channel **86**, to a locked position as pin **100** passes along second section **92** of groove **86** thereby forming a twist-lock quick-connect mechanism. Such a construction forms a consumable assembly that is quickly and easily associated with torch body **29**. Accordingly, plasma torch **16** is constructed to provide complete engagement between cup **64** and torch body **29** within a single-grip rotation of cup **64** relative to torch **16**. As such, an operator need only grip cup **64** once and fully engage cup **64** with torch **16** within a typical wrist rotation.

During assembly, electrode tip **46** passes through opening **52** formed in swirl ring **50**. Electrode **42** and swirl ring **50** are disposed within the inner surface **56** of tip **58** which is disposable within opening **102** of cup **64**. When connected to torch body **36**, shoulder **96** of cup **64** abuts edge **90** of torch body **29** and edge **98** of cup **64** abuts a shoulder **104** formed about end **82** of torch body **29**. During certain cutting operations shield **74** can be connected about end **76** of cup **64** to prevent contact of tip **58** with a workpiece. As shown, cup **64** rotates approximately 45 degrees relative to torch body **36** to fully engage the consumable assembly therewith. Although shown as having approximately 45 degrees of relative rotation to torch body **29**, it is understood that other degrees of rotation and orientations other than pin **100** and channel **86** are within the scope of the claims. Additionally, it is equally understood to form a quick-connect consumable assembly wherein the cup and torch are connectable with twist-lock mechanisms other than those shown, such as a DINSE-style partial-turn engagement mechanism.

The heretofore description of a welding apparatus, or plasma cutter, illustrates just one embodiment in which the present invention may be implemented. The present invention is equivalently applicable with many high power systems, such as cutting and induction heating systems or any similar systems.

Therefore, the present invention includes a plasma torch assembly including a torch body having a handle portion and a tip portion. An electrode is disposed in the tip portion of the torch body. The assembly also includes a retaining cup constructed to encircle the electrode in the torch body and connect to the tip portion with less than approximately 180 degrees rotation relative to the torch body.

In another embodiment of the present invention, a plasma cutter includes a power source configured to condition power into a form usable by a plasma cutting process. The plasma cutter also includes a torch connected to the power source and configured to effectuate the plasma cutting process. An electrode is disposed in the torch, and a cup having a twist-lock quick-connect mechanism removably connects the cup to the torch and is constructed to maintain an operable position of the electrode and prevent overtightening of the cup to the torch.

An alternate embodiment of the present invention has a plasma torch assembly that includes a torch body, an electrode, and a means for connecting the electrode to the torch body. The connecting means has a fully engaged position with less than one complete rotation of the means from an unlock position to a lock position.

In yet another embodiment of the present invention, a plasma torch consumable is disclosed that includes a quick connect cup having a partial-turn engagement mechanism engageable with another engagement mechanism of a plasma torch.

The present invention has been described in terms of the preferred embodiment, and it is recognized that equivalents, alternatives, and modifications, aside from those expressly stated, are possible and within the scope of the appending claims.

What is claimed is:

1. A plasma torch assembly comprising:

a torch body having a handle portion and a tip portion;

an electrode disposed in the tip portion of the torch body; and

a retaining cup constructed to encircle the electrode in the torch body and connect to the tip portion with less than approximately 180 degrees rotation relative to the torch body.

2. The plasma torch assembly of claim **1** further comprising an L-shaped groove formed in at least one of the retaining cup and the tip portion of the torch body.

3. The plasma torch assembly of claim **2** further comprising a pin extending from at least one of the retaining cup and the tip portion of the torch body and constructed to engage the groove.

4. The plasma torch assembly of claim **1** further comprising a shield connectable to the retaining cup generally opposite the tip portion of the torch body.

5. The plasma torch assembly of claim **4** wherein the shield is at least one of a drag shield and a gouging shield.

6. The plasma torch assembly of claim **1** further comprising a swirl ring disposed generally between the electrode and the tip portion of the torch body.

7. The plasma torch assembly of claim **1** wherein the retaining cup is fully connectable to the tip portion of the torch body by approximately 90 degrees of rotation therebetween.

8. The plasma torch assembly of claim **1** wherein the plasma torch assembly is any one of a contact start plasma torch, a high-frequency start plasma torch assembly, and a high voltage start plasma torch assembly.

9. The plasma torch assembly of claim **1** further comprising a cable having a first end connected to the plasma torch assembly and a second end connectable to a power source.

10. A plasma cutter comprising:

a power source configured to condition power into a form usable by a plasma cutting process;

a torch connected to the power source and configured to effectuate the plasma cutting process;

an electrode disposed in the torch; and

a cup having a twist-lock quick-connect mechanism removably connecting the cup to the torch and constructed to maintain an operable position of the electrode and prevent overtightening of the cup to the torch.

11. The plasma cutter of claim **10** further comprising a pin and channel engagement between the cup and torch constructed to limit rotation therebetween to less than approximately 360 degrees.

12. The plasma cutter of claim **10** further comprising a swirl-ring disposed between the electrode and the torch and constructed to direct a flow of gas therethrough.

13. The plasma cutter of claim **10** further comprising a shield connected to the cup.

14. The plasma cutter of claim **10** wherein the twist-lock mechanism is constructed to provide complete engagement within a single-grip rotation.

15. The plasma cutter of claim **10** further comprising a pin extending from one of the cup and the torch and constructed to engage a groove formed in another of the cup and the torch.

16. The plasma cutter of claim **10** wherein the torch is one of a contact start torch, a high-frequency start torch, and a high-voltage start torch.

17. A plasma torch assembly comprising:

a torch body;

an electrode;

means for connecting the electrode to the torch body having a fully engaged position with less than one complete rotation of the means from an unlock position to a lock position.

18. The plasma torch assembly of claim **17** wherein the fully engaged position of the connecting means is approximately 90 radial degrees from the initial position.

19. The plasma torch assembly of claim **17** wherein at least one of the torch body and the connecting means includes a groove constructed to engage a pin on another of the torch body and the connecting means.

20. The plasma torch assembly of claim **19** wherein the pin and groove cooperate to prevent overtightening of the connecting means to the torch body.

21. The plasma torch assembly of claim **17** further comprising a cable connecting the plasma torch assembly to a power source configured to generate a power signal applicable to a plasma process.

22. A plasma torch consumable comprising a quick connect cup having a partial-turn engagement mechanism engageable with another engagement mechanism of a plasma torch.

23. The plasma torch consumable of claim **22** wherein the partial-turn engagement mechanism of the quick connect cup is a twist-lock mechanism.

24. The plasma torch consumable of claim **23** wherein the twist-lock mechanism is one of a DINSE-style connector and includes a pin and groove engagement.

25. The plasma torch consumable of claim **23** wherein the twist-lock mechanism prevents overtightening of the quick connect cup to the torch.

26. The plasma torch consumable of claim **22** wherein the partial turn engagement mechanism is defined to have a rotation less than 360 degrees when moved from a disengaged position to an engaged position.

27. The plasma torch consumable of claim **22** wherein the partial turn engagement mechanism is a half-turn engagement mechanism wherein rotation of the quick connect cup relative to the plasma torch fully connects the quick connect cup thereto.

28. The plasma torch consumable of claim **22** wherein the partial-turn engagement mechanism includes one of a groove and a pin and another engagement mechanism is another one of a groove and pin.

29. The plasma torch consumable of claim **22** wherein the partial-turn engagement mechanism includes a thread on each of the quick connect cup and the torch having a stop mechanism preventing rotation past a partial turn of the cup with respect to the torch.

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