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(54) **CONTACT START PLASMA TORCH AND METHOD OF OPERATION**

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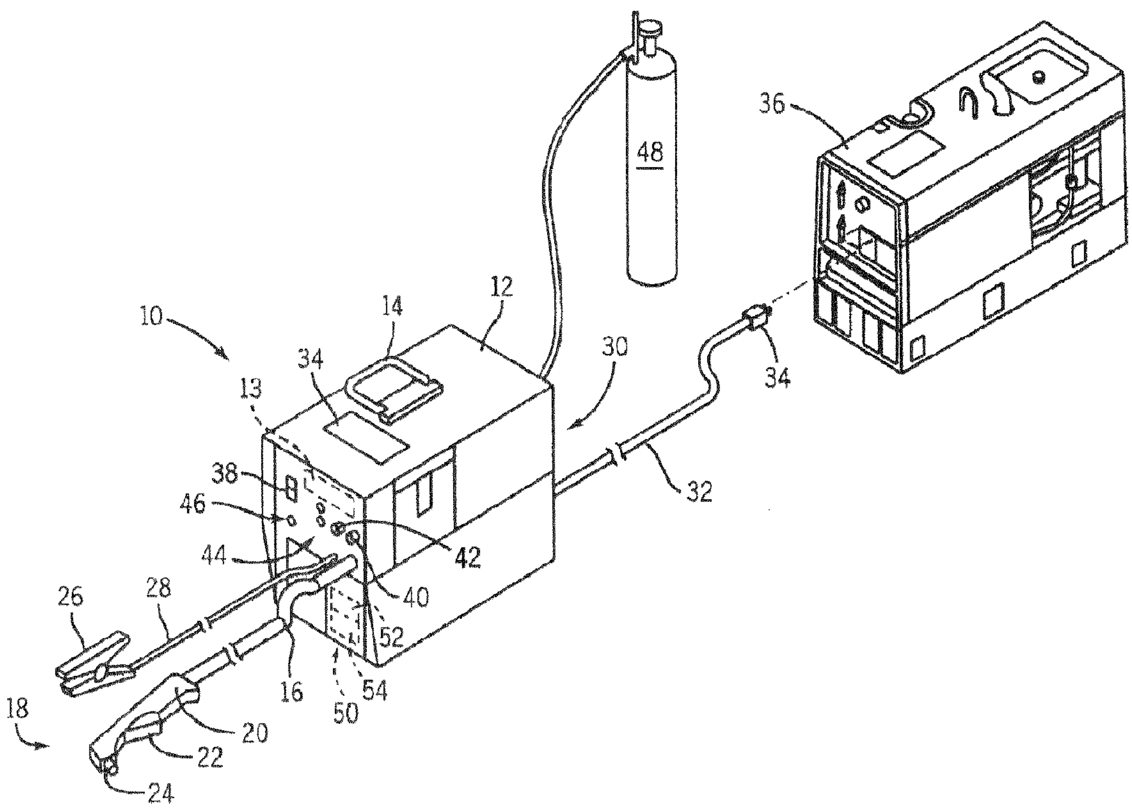
(57) **ABSTRACT**

A contact start plasma torch has a shuttle element disposed between a cathodic component and an anodic component. The shuttle element is movable between a first position and a second position and is maintained in the first position during an idle mode and a cutting mode. When the shuttle element is in the first position, a separation is maintained between the cathodic component and the anodic component of the plasma torch. The shuttle element momentarily bridgingly connects the cathodic component and the anodic component when it is located in the second position and initiates a plasma arc therebetween as it returns to the first position.



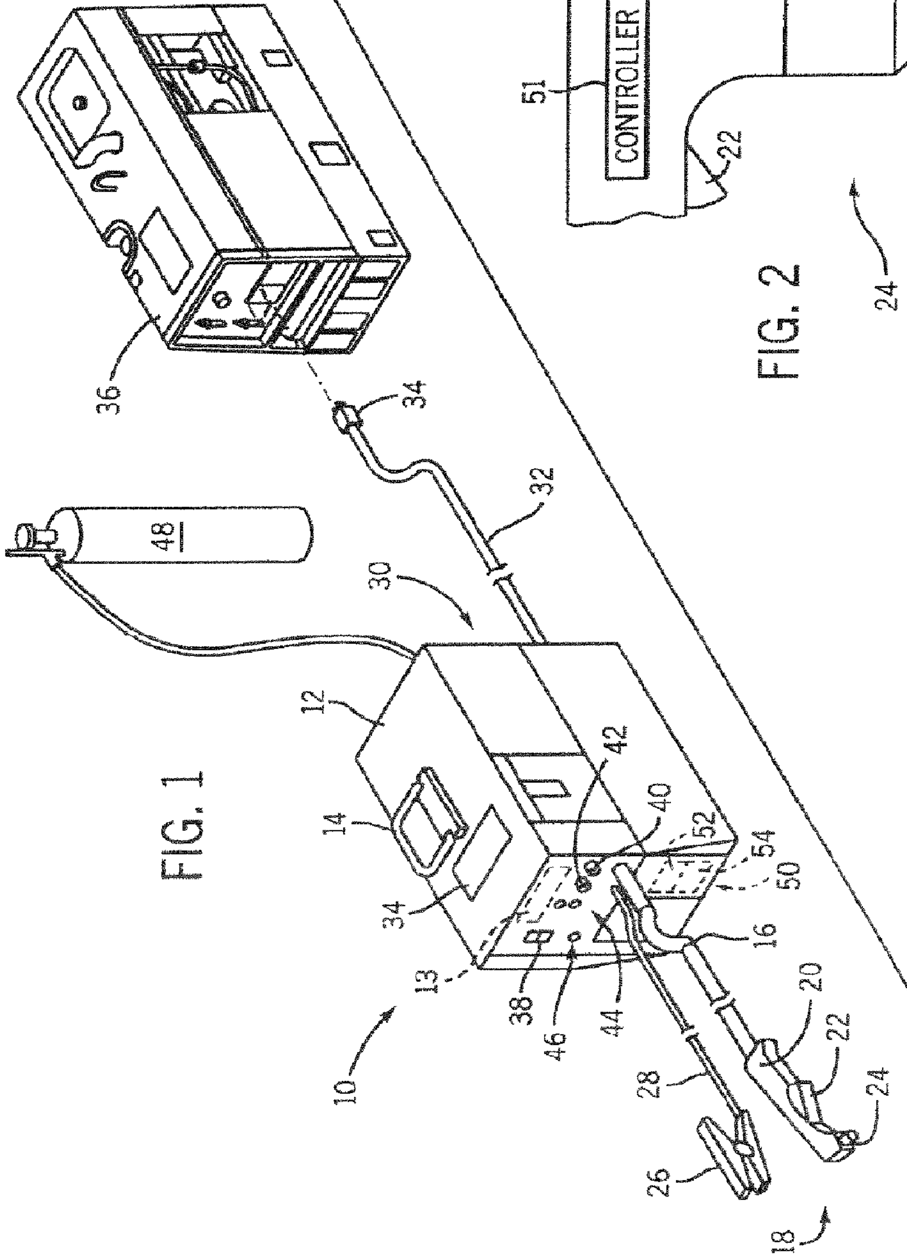


FIG. 1

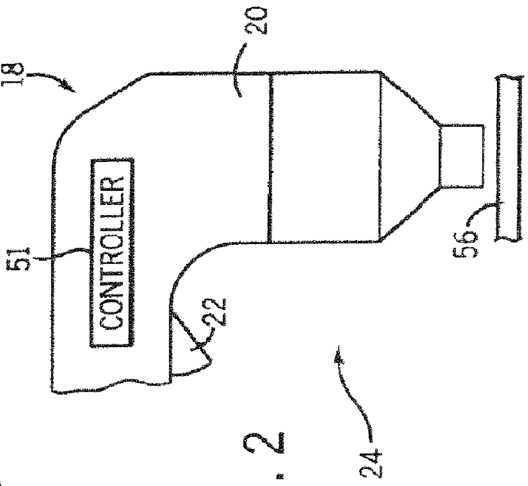
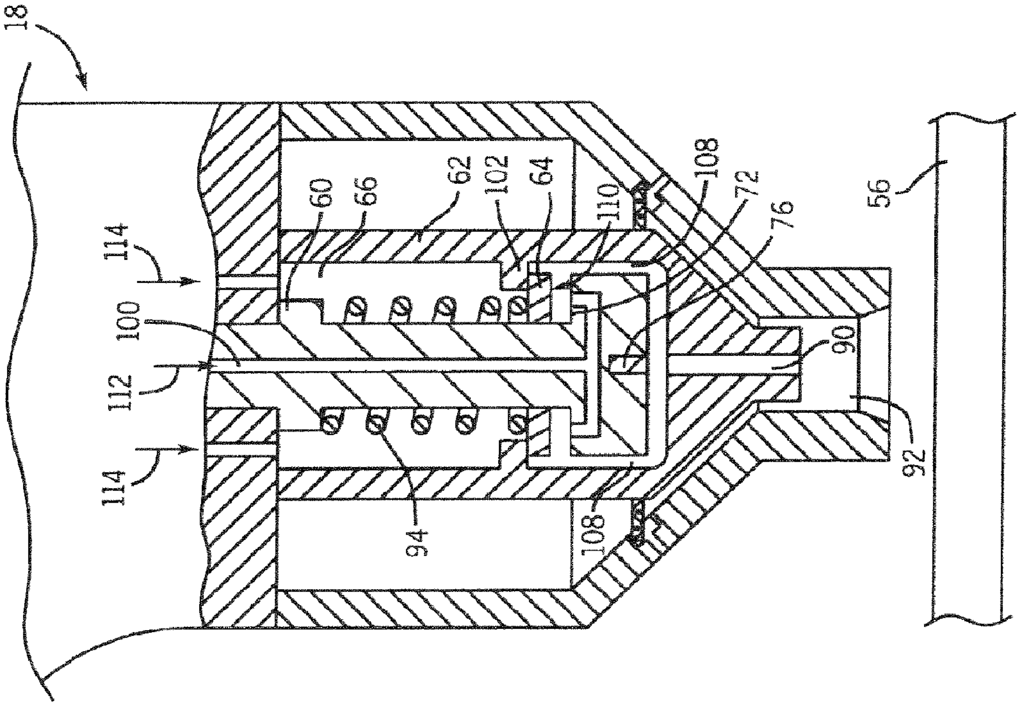


FIG. 2


18
114
100
112
114
60
66
62
102
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110
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72
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94
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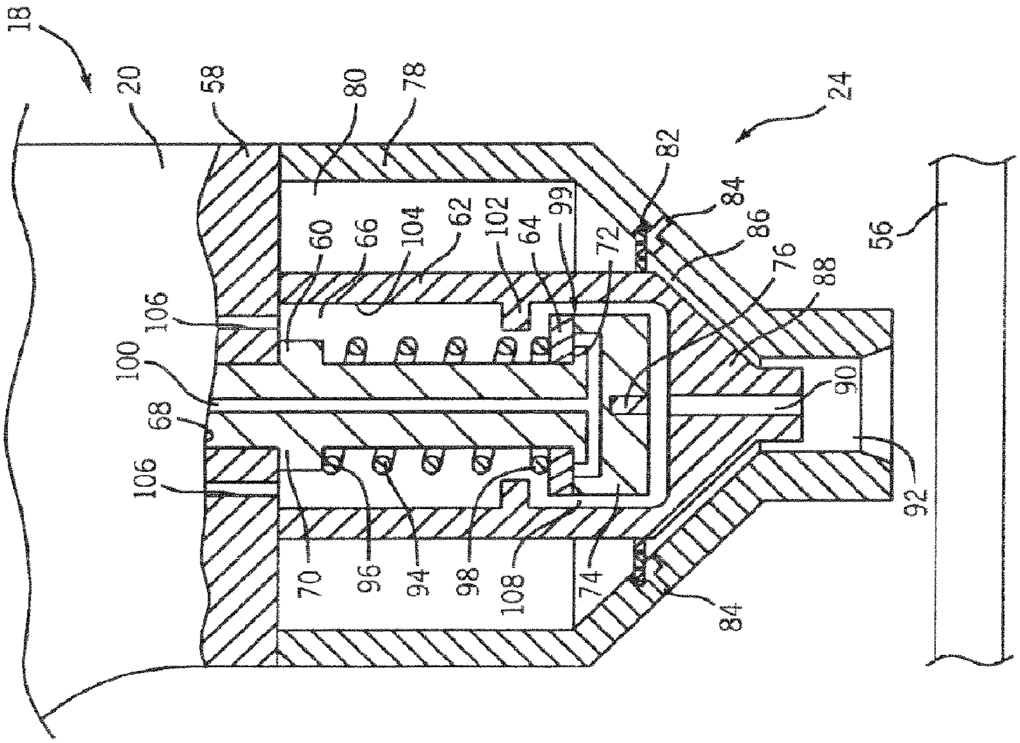
56
90
92

FIG. 4


18
20
58
80
78
24
106
100
68
106
60
66
104
62
102
64
99
72
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84
86
76
88
56
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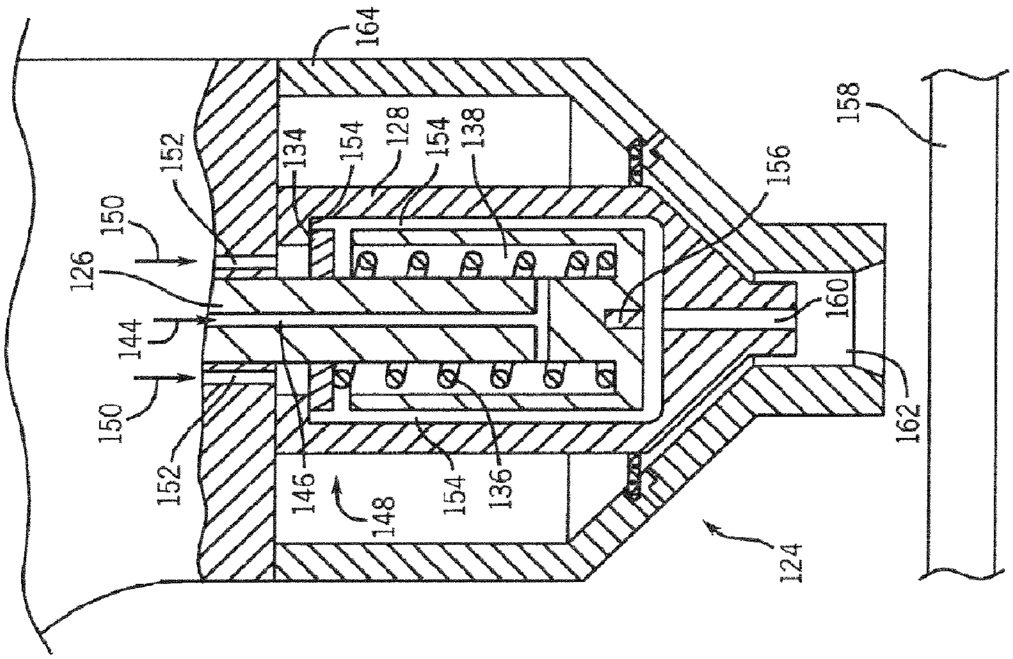
70
96
94
98
108
74
84

FIG. 3


164
158
152
134
154
128
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126
144
160
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152
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148
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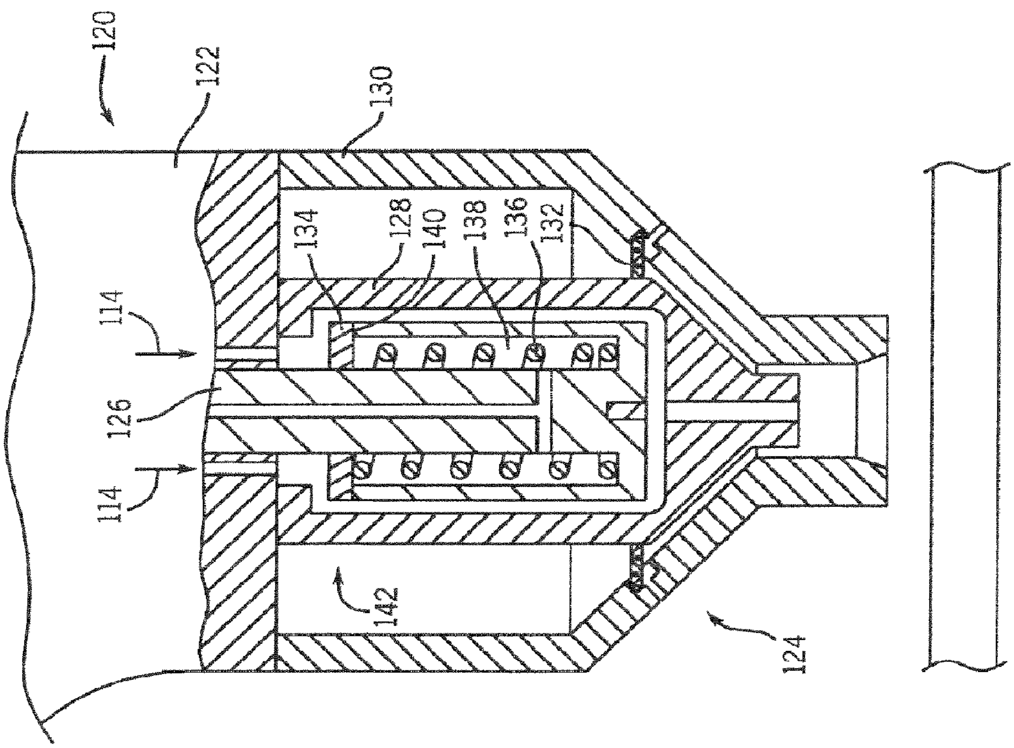
136
162
124

FIG. 6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122
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132
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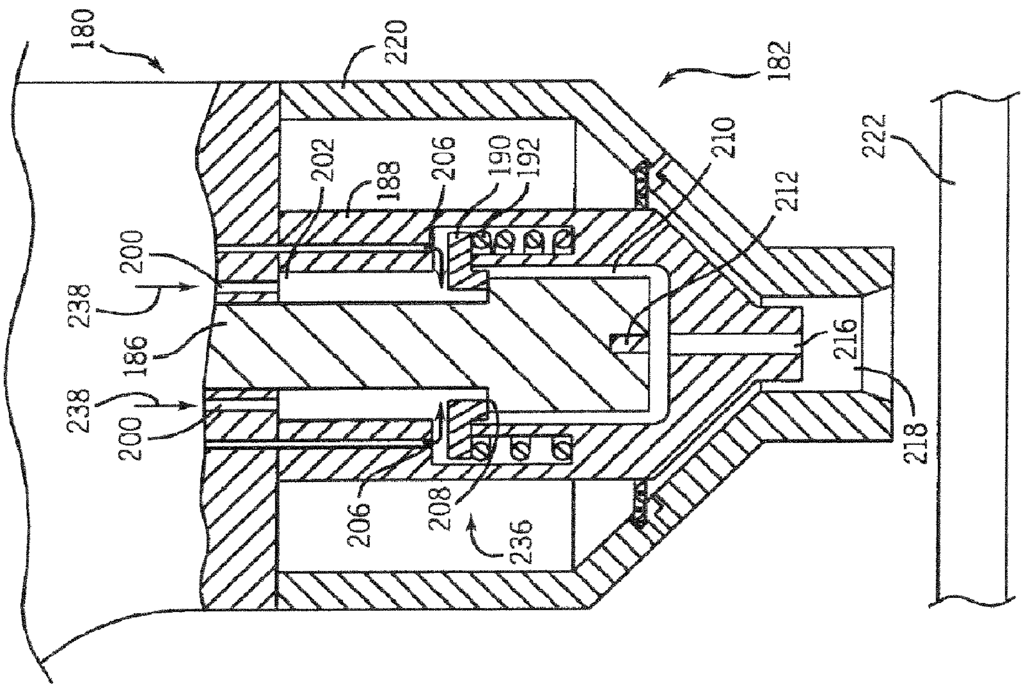
142
124

FIG. 5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220
182
202
188
206
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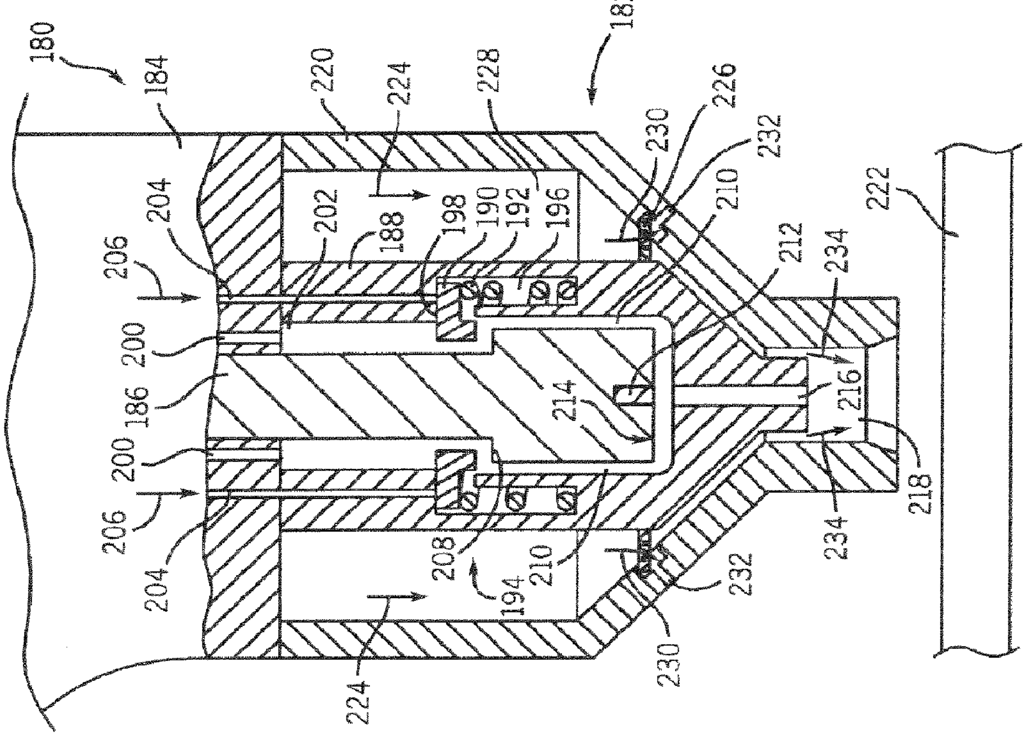
192
210
212
222
200
238
186
216
218
208
236

FIG. 8


180
184
220
224
228
182
230
226
232
204
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202
198
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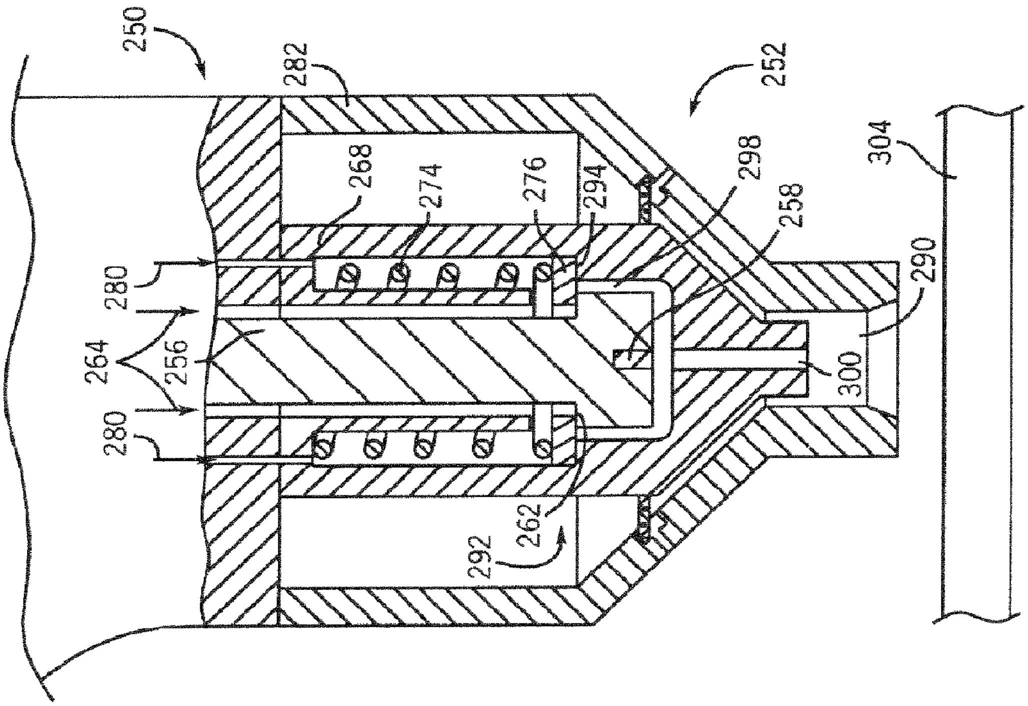
186
214
216
218
208
194
224

FIG. 7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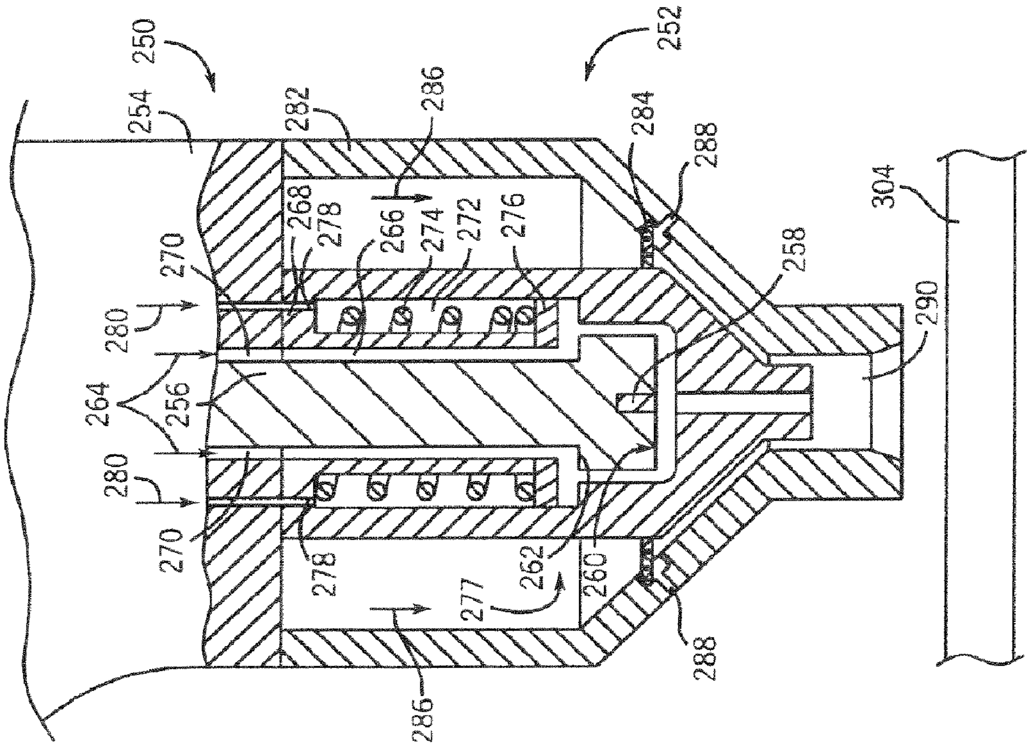
268
274
276
294
298
258
304
280
264
256
300
290
280
262
292

FIG. 10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268
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266
274
272
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286

FIG. 9

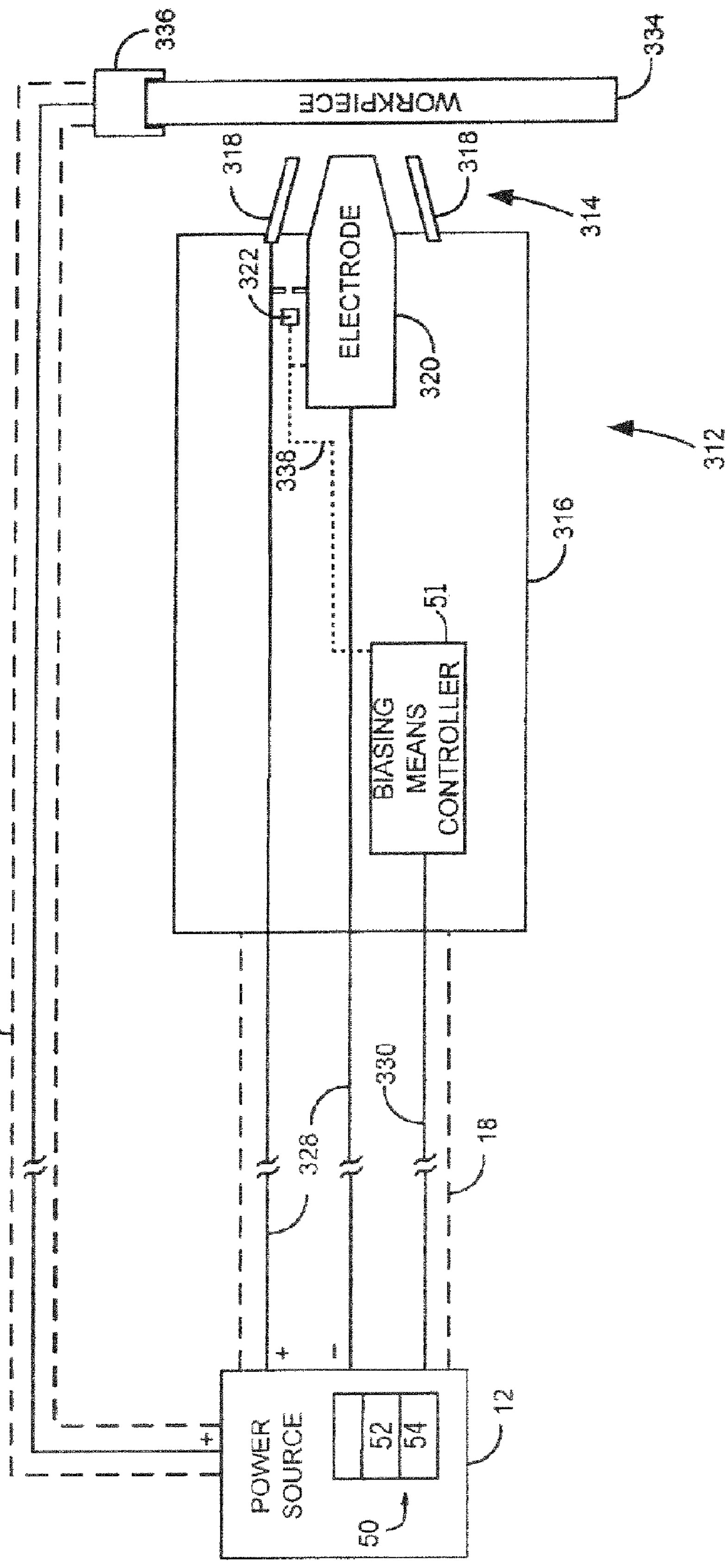
310
336
334
WORKPIECE
318
318
314
322
ELECTRODE
320
312
338
316
51
BIASING
MEANS
CONTROLLER
332
330
328
18
+
-
+
POWER
SOURCE
52
54
50
12

FIG. 11

CONTACT START PLASMA TORCH AND METHOD OF OPERATION

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to plasma cutting systems and, more particularly, to a plasma torch for use with such systems.

[0002] Plasma cutting is a process in which an electric arc and plasma gas are 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 receptacle or generator and provides output power to a pair of output terminals, one of which is connected to the plasma torch and the other of which is connected to the workpiece. An air supply is used with most plasma cutters to carry and propel the arc from the tip assembly of the plasma torch to the workpiece and also helps cool the torch.

[0003] The cutting process is typically initiated through one of contact starting, high frequency starting, or high voltage starting. Generally, in contact start plasma cutters, a movable or fixed electrode or consumable serves as a cathode and a fixed or movable nozzle or tip serves as an anode. The cathodic and the anodic component are biased to remain in contact until an arc is desired. Biasing of the components into contact ensures that the components of the torch are in the appropriate position when a pilot arc is desired. When an arc is desired, a pilot arc power is introduced across the moveable components and when a separation is created therebetween, a pilot arc is generated. As the pilot arc is established, air is forced past the pilot arc whereby it is heated and ionized to form a plasma jet that is forced out of the torch through an opening in the nozzle. The air aids in extending the arc to the workpiece thereby forming a cutting arc and initiating the cutting process.

[0004] Generally, the separation of the components is achieved by overcoming a bias that retains the components in contact with one another. Once the anodic and cathodic components have been separated and a pilot arc has been achieved, the components remain separated for the duration of a particular cutting process. When the plasma torch is positioned in close proximity to a work piece, the pilot arc transfers to the workpiece and establishes the cutting arc. During a cutting process, the contact bias remains overcome such that the cathodic and anodic components remain separated for the duration that the torch maintains any arc. Once a cutting process has been completed, the components are returned to an idle position wherein the cathodic and anodic components are in contact with one another.

[0005] It would be advantageous to design a plasma cutting system having a contact start plasma torch which does not have a tip or nozzle in contact with an electrode and only momentarily electrically connects the cathodic and anodic components of the plasma torch as required to generate a pilot arc.

BRIEF DESCRIPTION OF THE INVENTION

[0006] The present invention provides a system and method that overcomes the aforementioned drawbacks. Specifically, a plasma torch has an anodic component, a cathodic component, and a contactor moveably disposed therebetween. The contactor is biased to a rest position wherein the contactor maintains physical separation of the cathodic and anodic components. To initiate a pilot arc, the contactor is moved, against the bias, into bridging contact with the cathodic component and the anodic component. The contactor then returns to the rest position thereby generating a pilot arc.

[0007] Therefore, in accordance with one aspect of the present invention, a plasma torch having an electrode, a nozzle, and a shuttle element is disclosed. The nozzle is positioned about the electrode and the shuttle element is disposed therebetween. The shuttle element is movable between a first position and a second position. When located in the first position, the shuttle element is separated from at least one of the nozzle and the electrode and, when momentarily located in the second position, the shuttle element contacts the nozzle and the electrode. The plasma torch includes a biasing means constructed to bias the shuttle element to the first position during an idle mode and a cutting mode of the plasma torch. The shuttle element is momentarily movable to the second position when generation of a pilot arc is desired.

[0008] According to another aspect of the present invention, a plasma cutting system is disclosed. The plasma cutting system has a plasma torch connected to a power source constructed to generate a power signal suitable for plasma cutting applications. The plasma torch has a cathodic component having a fixed-position, an anodic component having a fixed-position, and a separator movably disposed between the cathodic component and the anodic component. A first biasing means is connected to the plasma torch and is constructed to bias the separator out of mutual contact with the cathodic component and the anodic component. A second biasing means is connected to the plasma torch and is constructed to overcome the first biasing means and move the separator into mutual contact with the cathodic component and the anodic component.

[0009] According to a further aspect of the present invention, a method of initiating a plasma arc is disclosed that includes the steps of biasing a shuttle element housed in a plasma torch to maintain a separation between a cathode and an anode, overcoming the bias to connect the shuttle element to the cathode and the anode, and returning the shuttle element to the biased position to generate a plasma arc.

[0010] Various other features and advantages of the present invention will be made apparent from the following detailed description and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The drawings illustrate four alternate embodiments presently contemplated for carrying out the invention.

[0012] In the drawings:

[0013] FIG. **1** is a perspective view of a plasma cutting system incorporating the present invention.

[0014] FIG. **2** is an elevational view of the torch tip assembly shown in FIG. **1**.

[0015] FIG. **3** is a cross-sectional view of one embodiment of the torch tip assembly shown in FIG. **2** and shows a shuttle element in a first position.

[0016] FIG. **4** shows the torch tip assembly shown in FIG. **3** with the shuttle element moved to a second position.

[0017] FIG. **5** shows a cross-sectional view of another embodiment of the torch tip assembly shown in FIG. **2** and shows a shuttle element in a first position.

[0018] FIG. **6** shows the torch tip assembly shown in FIG. **5** with the shuttle element moved to a second position.

[0019] FIG. **7** shows a cross-sectional view of a further embodiment of the torch tip assembly shown in FIG. **2** and shows the shuttle element in a first position.

[0020] FIG. **8** shows the plasma torch shown in FIG. **7** with the shuttle element moved to a second position.

[0021] FIG. **9** shows a cross-sectional view of yet another embodiment of the torch tip assembly shown in FIG. **2** and shows a shuttle element in a first position.

[0022] FIG. **10** shows the torch tip assembly shown in FIG. **9** with the shuttle element moved to a second position.

[0023] FIG. **11** shows an exemplary plasma cutting system according to which each of the plasma torches shown in FIGS. **2-9** is operated.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0024] FIG. **1** shows a plasma cutting system **10** according to the present invention. Plasma cutting system **10** is a high voltage system with open circuit output voltages that typically range from approximately 230 Volts Direct Current (VDC) to over 300 VDC. Plasma cutting system **10** includes a power source **12** to condition raw power and generate a power signal suitable for plasma cutting applications. Power source **12** includes a processor **13** that receives operational feedback and monitors the operation of a plasma cutting system **10**. Power source **12** includes a handle **14** to effectuate transportation from one site to another. A cable **16** connects a torch assembly **18** to power source **12**. Cable **16** provides torch **18** with power and compressed air or gas, and also serves as a communications link between torch **18** and power source **12**. Torch **18** includes a torch body, or handle portion **20** having a trigger **22** thereon and a tip assembly **24** extending therefrom. Although shown as attached to torch **18**, it understood and within the scope of the claims that trigger **22** be connected to power source **12** or otherwise remotely positioned relative to torch **18**.

[0025] Also connected to power source **12** is a work clamp **26** designed to connect to a workpiece (not shown) to be cut and provide a grounding or return path. A cable **28** connects work clamp **26** to power source **12** and provides the return path, or grounding path, for the cutting current from torch **18** through the workpiece and work clamp **26**. Extending from a rear portion **30** of power source **12** is a power cable **32** having a plug **34** for connecting power source **12** to either a portable power supply **36** or a transmission line power receptacle (not shown). Power source **12** includes an ON/OFF switch **38** and may also include amperage and air pressure regulation controls **40**, **42**, indicator lights **44**, and a pressure gauge **46**.

[0026] To effectuate cutting, torch **18** is positioned in close proximity to the workpiece connected to clamp **26**. A user then activates trigger **22** on torch **18** to deliver electrical power and compressed air to tip assembly **24** of torch **18** to initiate a pilot arc and plasma jet. Shortly thereafter, a cutting arc is established as the user moves the torch to the workpiece and at least a portion of the pilot arc extends between torch **18** and a workpiece. The arc transfers from an electrode to the workpiece through tip assembly **24**. The user may then cut the workpiece by moving torch **18** across the workpiece. 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 **18** from a pressurized gas source **48** connected to power source **12**. Alternatively, gas could be supplied to torch **18** from an internal or an external air compressor or gas source.

[0027] Power source **12** includes a controller **50** electrically connected to plasma cutting torch **18**. Controller **50** includes a pilot arc circuit **52** and a cutting arc circuit **54**. Controller **50** is electrically connected to trigger **22** of cutting torch **18** and processor **13**. Initial actuation of trigger **22** enables pilot arc circuit **52**. Pilot arc circuit **52** instructs power source **12** to provide a power signal sufficient for tip assembly **24** to generate a pilot arc. After generation of a pilot arc, cutting arc circuit **54** enables communication of cutting arc power from power source **12** to tip assembly **24** of torch **18** and therefrom to a workpiece **56**. Understandably, although controller **50**, pilot arc circuit **52**, and cutting arc circuit **54** are shown attached to power source **12**, other locations such as torch assembly **18** are envisioned and within the scope of the claims.

[0028] Referring now to FIG. **2**, tip assembly **24** is removeably attached to handle portion **20** of plasma cutting torch **18**. A biasing means controller **51** is attached to plasma cutting torch **18** and communicates with controller **50** of power source **12**. As described further with respect to FIG. **11**, biasing means controller **51** controls operation of a shuttle element of plasma torch **18**. It is further understood that biasing means controller **51**, rather than being integrated into plasma torch **18**, could be located in other positions such as power source **12**.

[0029] FIG. **3** shows a partial cross-sectional view of one embodiment of tip assembly **24** according to the present invention. As shown in FIG. **3**, tip assembly **24** removably engages an end **58** of torch body **20**. Tip assembly **24** includes a cathodic component, or electrode **60**, an anodic component, or nozzle **62**, and a shuttle element **64** disposed therebetween. Electrode **60** is centrally disposed within a gas chamber **66** and has a base **68** that electronically communicates with power source **12** through handle portion **20** of torch assembly **18**. Electrode **60** has a shoulder **70** formed proximate base **68** and a ledge **72** formed proximate a tip **74** of electrode **60**. Tip **74** of electrode **60** includes an insert **76** generally centrally disposed therein. Preferably, insert **76** is formed of a hafnium or zirconium material. Insert **76** supports a cutting arc and is resistive to deterioration associated with the support of the cutting arc.

[0030] A cup or cap **78** is positioned about nozzle **62** and defines a plasma/cooling gas chamber **80** therebetween. A swirl ring **82** is positioned in gas chamber **80** and directs a flow of gas helically about nozzle **62**. Cap **78** preferably includes a plurality of bleed ports or vents **84** formed radially therethrough. However, such vents are not necessary to practice the invention. A gas passage **86** extends between cap **78** and a tapered end **88** of nozzle **62**. An orifice **90** is centrally positioned through tapered end **88** of nozzle **62** and generally aligned with insert **76**. An opening **92** is formed through cap **78** and is generally aligned with orifice **90** of nozzle **62**. During operation of plasma torch **18**, a cutting arc and plasma gas exits torch assembly **18** through orifice **90** of nozzle **62** and opening **92** of cap **78** and is directed to workpiece **56**.

[0031] Electrode **60** and nozzle **62** have fixed relative positions. A biasing means, or spring **94**, extends between shoulder **70** and ledge **72** of electrode **60**. A first end **96** of spring **94** engages shoulder **70** of electrode **60** and a second end **98** of spring **94** engages shuttle element **64**. Spring **94** biases shuttle element **64** to a first position **99** wherein shuttle element **64** contacts ledge **72**. A gas path **100** is formed through electrode **60** and is in fluid communication with gas source **48**. Gas path **100** terminates at ledge **72** of electrode **60**. Passage of gas through gas path **100** overcomes the bias of spring **94** and momentarily forces shuttle element **64** into contact with a ridge **102** formed about an interior surface **104** of nozzle **62**. A plurality of gas tubes **106** extend through torch assembly **18** and fluidly connect gas chamber **66** to gas source **48**. When the flow of gas through gas path **100** is suspended, shuttle element **64** moves away from ridge **102** forming a pilot arc therebetween. Gas in gas chamber **66** flows through an arc passage **108** formed between electrode **60** and nozzle **62** and carries the pilot arc therewith. The pilot arc continues to travel through arc passage **108** until it reaches insert **76**. Once the pilot arc has reached insert **76**, a cutting arc can be established when opening **92** of cap **78** is positioned in relatively close proximity to workpiece **56**.

[0032] FIG. **4** shows shuttle element **64** moved to a second position **110** with the introduction of a gas flow (indicated by arrow **112**) through gas path **100**. Gas flow **112** overcomes the bias of spring **94**, which biases shuttle element **64** into contact with ledge **72**, and also overcomes any gas pressure bias that may exist in gas chamber **66**, and forces shuttle element **64** into contact with ridge **102**. A pilot arc power is communicated between electrode **60** and nozzle **62** via shuttle element **64** when pilot arc circuit **52**, as shown in FIG. **2**, is enabled and shuttle element **64** is momentarily located in second position **110**. Suspending gas flow **112**, or increasing gas flow, indicated by arrows **114**, through gas tubes **106**, returns shuttle element **64** to first position **99** shown in FIG. **3**. The return of shuttle element **64** to first position **99** from second position **110** creates a pilot arc between shuttle element **64** and nozzle **62**. Gas flow **114** carries the pilot arc through arc passages **108** and toward insert **76**. The arc heats the gas passing therealong and generates a plasma gas. When torch assembly **18** is positioned proximate workpiece **56**, the pilot arc extends thereto through orifice **90** and opening **92** and forms a cutting arc between workpiece **56** and insert **76**. The combination of the cutting arc and the plasma gas cooperate to perform a cutting-type process. As such, during idle and cutting operation of plasma torch **18**, shuttle element **64** is biased out of contact with nozzle **62** thereby forming an "open" circuit condition between electrode **60** and nozzle **62**.

[0033] FIGS. **5** and **6** show an alternate embodiment of a plasma torch assembly according to the present invention. As shown in FIG. **5**, a plasma torch assembly **120** includes a torch body or handle portion **122**. Plasma torch assembly **120** includes a tip assembly **124** having an electrode **126**, a nozzle **128** positioned about electrode **126**, a cap **130**, and a swirl ring **132** positioned between cap **130** and nozzle **128**. A shuttle element **134** is movably disposed between electrode **126** and nozzle **128**. The positions of electrode **126** and nozzle **128** are fixed relative to one another. Electrode **126** and nozzle **128** are electrically connected to power source **12** through torch body **122**. A biasing means **136** is disposed in a cavity **138** of electrode **126** and secured to shuttle element **134** and electrode **126**. Biasing means **136** biases shuttle element **134** against a ledge **140** of electrode **126**. Shuttle element **134** maintains a first position **142** during non-operation of torch assembly **120** and during cutting operation of plasma torch assembly **120**.

[0034] As shown in FIG. **6**, when a flow of gas, indicated by arrow **144**, is introduced to a gas path **146** formed through electrode **126**, shuttle element **134** moves axially along electrode **126** to momentarily maintain a second position **148**. Gas flow **144** enters cavity **138** and is sufficient to overcome biasing means **136**. When flow of gas **144** is suspended, or a flow of gas, indicated by arrows **150**, is introduced to a pair of gas tubes **152**, shuttle element **134** returns to first position **142** and a pilot arc is generated between shuttle element **134** and a ledge **154** of nozzle **128**. Gas flow **150** carries the pilot arc along an arc passage **154** between electrode **126** and nozzle **128** to an insert **156**. When torch assembly **120** is positioned in close proximity to a workpiece **158**, the pilot arc extends thereto. The pilot arc passes through an orifice **160** formed in nozzle **128** and an opening **162** formed in a cap **164** positioned about nozzle **128** and establishes a cutting arc between workpiece **158** and insert **156**. As such, shuttle element **134** is located in first position **142** during non-use and cutting use of plasma torch assembly, and is momentarily located in second position **148** only when a pilot arc is desired. As such, during initial arc generation, shuttle element **134** moves from first position **142** to second position **148** and returns to first position **142** in a shuttle-type fashion.

[0035] FIGS. **7** and **8** show another alternate embodiment of a plasma torch assembly according to the present invention. As shown in FIG. **7**, a plasma torch assembly **180** includes a tip assembly **182** removably connected to a torch body, or handle portion **184**. An electrode **186** is electrically connected to power source **12** through handle portion **184**. A nozzle **188** is positioned about electrode **186** and includes a shuttle element **190** slideably attached thereto. A biasing means, or spring **192** biases shuttle element **190** to a first position **194** and out of contact with electrode **186**. Spring **192** is disposed in a cavity **196** of nozzle **188** and biases shuttle element **190** into contact with a ridge **198** of nozzle **188**.

[0036] A pair of gas tubes **200** fluidly connect a gas chamber **202** of tip assembly **182** with a gas source through handle position **184**. A plurality of gas paths **204** extend through nozzle **188** and are fluidly connected to a gas source through handle portion **184**. Gas paths **204** terminate at ridge **198** of nozzle **188** and a gas flow, indicated by arrows **206**, overcomes the bias of spring **192** and momentarily forces shuttle element **190** into contact with a ledge **208** of electrode **186**. An arc passage **210** is formed between electrode **186** and nozzle **188**. Termination of gas flow **206** allows shuttle element **190** to return to first position **194** and initiates a pilot arc between shuttle element **190** and ledge

208. The pilot arc is carried with the flow of gas from gas chamber **202** through arc passage **210** and toward an insert **212** disposed in an end **214** of electrode **186**.

[**0037**] The pilot arc passes through an orifice **216** formed in nozzle **188** and an opening **218** formed in a cap **220** positioned about nozzle **188**. When tip assembly **182** is positioned in close proximity to a workpiece **222**, the pilot arc extends between insert **212** and workpiece **222** and establishes a cutting arc therebetween. A gas flow, indicated by arrow **224**, passes through a swirl ring **226** from a gas cavity **228** formed between cap **220** and nozzle **188**. A first portion **230** of gas flow **224** exits cap **220** at a plurality of bleed ports or vents **232** and a second portion **234** of gas flow **224** passes to opening **218** and generally surrounds a cutting arc passing therethrough.

[**0038**] As shown in FIG. **8**, shuttle element **190** is movable to a second position **236** as gas flow **206** passes into gas chamber **202**. Shuttle element **190**, when located in second position **236**, electrically connects nozzle **188** and electrode **186** via shuttle element **190**. The suspension of gas flow **206** allows spring **192** to return shuttle element **190** to first position **194** shown in FIG. **7** and initiates a pilot arc between shuttle element **190** and ledge **208** of electrode **186**. A gas flow, indicated by arrows **238**, from gas tubes **200** enters gas chamber **202** between electrode **186** and nozzle **188**. When shuttle element **190** returns to first position **194**, gas flow **238** carries the pilot arc formed between ledge **208** and shuttle element **190** through arc passage **210** and toward insert **212**. The pilot arc formed about insert **212** extends from tip assembly **182** through orifice **216** of nozzle **188** and opening **218** of cap **220** thereby establishing a cutting arc with workpiece **222**. Shuttle element **190** remains in first position **194** during idle and cutting operation of plasma torch assembly **180** and is momentarily located in second position **236** only when initiation of a pilot arc is desired.

[**0039**] FIGS. **9** and **10** show yet another embodiment of a plasma torch assembly according to the present invention. As shown in FIG. **9**, a plasma torch assembly **250** includes a tip assembly **252** removably connected to a torch body or handle portion **254**. An electrode **256** is electrically connected to power source **12** and includes an insert **258** disposed in an end **260** thereof. A ledge **262** is formed on electrode **256** proximate end **260**. A gas flow, indicted by arrows **264**, fluidly connects a gas chamber **266** formed between electrode **256** and a nozzle **268** to a gas source via a plurality of gas tubes **270**. Nozzle **268** includes a cavity **272** formed therein. A biasing means or spring **274** is disposed in cavity **272** and secures a shuttle element **276** to nozzle **268**. Spring **274** biases shuttle element **276** to a first position **277**. A plurality of gas paths **278** pass through nozzle **268** and fluidly connect cavity **272** to a gas source. A flow of gas, indicated by arrows **280**, through gas paths **278** pressurizes cavity **272** when gas is introduced thereto. A cap **282** is positioned about nozzle **268** and includes a swirl ring **284** positioned therebetween. A gas flow, indicated by arrows **286**, flows between cap **282** and nozzle **268** and through swirl ring **284**. Gas flow **286** exits cap **282** at a plurality of ports **288** and an opening **290** formed through cap **282**.

[**0040**] As shown in FIG. **10**, shuttle element **276** is movable to a second position **292**. When temporarily located in second position **292**, shuttle element **276** overcomes the bias of spring **274** and moves into contact with a ridge **294** of nozzle **268** and ledge **262** of electrode **256**. Gas flow **280** is sufficient to allow shuttle element **276** to stretch spring **274** and engage ridge **294** and ledge **262**. As gas flow **280** is suspended, spring **274** returns shuttle element **276** to first position **277** and a pilot arc is established between shuttle element **276** and ledge **262** of electrode **256**. As shuttle element **276** returns to first position **277**, gas flow **264** passes between shuttle element **276** and electrode **256** and carries the pilot arc through an arc passage **298** and towards insert **258**. The pilot arc passes through an orifice **300** formed in nozzle **268** and exits plasma torch assembly **250** through an opening **290** formed in cap **282**. The pilot arc extends between insert **258** and a workpiece **304** thereby establishing a cutting arc therebetween. Such a construction provides a plasma torch assembly having a shuttle element which shuttles between a position out of mutual contact with both the electrode and nozzle during cutting operation and idle, or non-use, operation of the plasma torch assembly, and a momentary position of bridging contact between the nozzle and electrode for pilot arc generation.

[**0041**] Each embodiment includes a nozzle and an electrode having a relatively fixed location. The embodiments shown in FIGS. **3**-**6** provide a plasma torch assembly having a shuttle element biased into contact with the electrode during non-use and cutting operation of the plasma torch. Biasing means **94** of torch assembly **18**, shown in FIGS. **3** and **4**, is preloaded in compression to bias shuttle element **64** into contact with electrode **60**. Comparatively, biasing means **136** of torch assembly **120**, shown in FIGS. **5** and **6**, is preloaded in tension to bias shuttle element **134** into contact with electrode **126**. The embodiments shown in FIGS. **7**-**10** provide a plasma torch assembly having a shuttle element biased into contact with the nozzle during non-use and cutting operation of the plasma torch. Biasing means **192** of torch assembly **180**, shown in FIGS. **7** and **8**, is preloaded in compression to bias shuttle element **190** into contact with nozzle **188**. Comparatively, biasing means **274** of torch assembly **250**, shown in FIGS. **9** and **10**, is preloaded in tension to bias shuttle element **276** into contact with nozzle **268**. Regardless of which embodiment is practiced, the shuttle element is biased out of mutual contact with the cathodic and anodic component of the torch assembly during both non-use of the torch assembly and during cutting operation of the torch assembly. Additionally, although each embodiment includes a spring as the biasing means, understandably other biasing means, such as a gas pressure, solenoid control, or other mechanical actuators are envisioned and within the scope of the claims. Similarly, although each embodiment has a gas flow as the overcoming bias means, a spring, solenoid control, or other mechanical actuator could equally perform this overcoming bias means and are also within the scope of the claims.

[**0042**] FIG. **11** shows a graphic representation of an exemplary plasma cutting system usable with any of the above torch tip assembly embodiments. Plasma cutting system **310** includes a power source **12** electrically connected to a plasma torch assembly **312**. A tip assembly **314** is removably connected to a torch body or a handle portion **316** and has a nozzle **318** disposed about an electrode **320**. A shuttle element **322** is disposed between electrode **320** and nozzle **318** and can be electrically connected to one of the electrode and the nozzle, or to neither as shown in FIG. **11**. Controller **50** communicates with plasma torch assembly

312 and includes pilot arc circuit **52** and cutting arc circuit **54**. Controller **50** also communicates with biasing means controller **51** of plasma torch assembly **312**. Controller **50** is connected to plasma torch assembly **312** by a plurality of cables **328** and a hose **330**. Cables **328** communicate pilot arc power and cutting arc power to torch assembly **312**. Additionally, cables **328** can be configured to communicate operational feedback from torch assembly **312** to power source **12**. Hose **330** communicates a gas to torch assembly **312** for operation of shuttle element **322**, gas for the generation of plasma for a cutting process, and provides cooling gas when desired. A cable **332** electrically connects a workpiece **334** to power source **12** through clamp **336**.

[**0043**] Upon trigger actuation, biasing means controller **51** initiates a flow of gas **338** to momentarily bias shuttle element **322** into mutual contact with both nozzle **318** and electrode **320**. Controller **50** enables pilot arc circuit **51** and communicates a power signal sufficient to generate a pilot arc to electrode **320** and nozzle **318** via shuttle element **322**. Biasing means controller **51** then suspends flow of gas **338** allowing shuttle element **322** to return to a first position wherein the shuttle element is not in mutual contact with electrode **320** and nozzle **318**. The return of shuttle element **322** to the first position generates a pilot arc between the electrode/nozzle and the shuttle element. A flow of gas is directed through torch assembly **312** and carries the pilot arc to workpiece **334**. Operational feedback communicated to power source **12** or controller **50** indicates the extension of the pilot arc to workpiece **334**. Controller **50** then enables a cutting arc circuit **54** and communicates a cutting arc power from power source **12** to electrode **320**.

[**0044**] Therefore, one embodiment of the present invention includes a plasma torch having a nozzle positioned about an electrode. A shuttle element is disposed between the nozzle and the electrode and movable between a first position and a second position. The shuttle element is separated from at least one of the nozzle and the electrode when in the first position and contacts the nozzle and the electrode when in the second position. The plasma torch includes a biasing means constructed to bias the shuttle element to the first position during an idle mode and a cutting mode of the plasma torch.

[**0045**] Another embodiment of the present invention includes a plasma cutting system having a plasma torch connected to a power source constructed to generate a power signal suitable for plasma cutting applications. The plasma torch includes a cathodic component having a fixed-position and an anodic component having a fixed-position. A separator is movably disposed between the cathodic component and the anodic component. A first biasing means is connected to the plasma torch and is constructed to bias the separator out of mutual contact with the cathodic component and the anodic component. A second biasing means is connected to the plasma torch and constructed to overcome the first biasing means and move the separator into mutual contact with the cathodic component and the anodic component.

[**0046**] A further embodiment of the present invention includes a method of initiating a plasma arc comprising the steps of biasing a shuttle element housed in a plasma torch to maintain a separation between a cathode and an anode, overcoming the bias to connect the shuttle element to the cathode and the anode, and returning the shuttle element to the biased position to generate a plasma arc.

[**0047**] As one skilled in the art will fully appreciate, the heretofore description of a plasma cutting system is one example of a plasma cutting system according to the present invention. It is understood that torches having constructions other than those shown are envisioned and within the scope of the claims.

[**0048**] 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.

1. A plasma torch comprising:

an electrode;

a nozzle positioned about the electrode;

a shuttle element disposed between the nozzle and the electrode and movable between a first position and a second position, the shuttle element separated from at least one of the nozzle and the electrode when in the first position and contacting the nozzle and the electrode when in the second position; and

biasing means constructed to bias the shuttle element to the first position during an idle mode and a cutting mode of the plasma torch.

2. The plasma torch of claim 1 further comprising an overcoming means constructed to overcome the biasing means and move the shuttle element to the second position upon a trigger actuation.

3. The plasma torch of claim 2 wherein at least one of the biasing means and the overcoming means is at least one of a gas flow, a spring, and a solenoid.

4. The plasma torch of claim 1 wherein the biasing means is further defined as a spring and the spring is fixedly connected to the shuttle element and at least one of the electrode and the nozzle.

5. The plasma torch of claim 1 further comprising a power source connectable to the plasma torch and constructed to provide a plasma cutting power to the plasma torch and a gas source constructed to provide a plasma/cooling gas to the plasma torch.

6. The plasma torch of claim 1 further comprising a control having a pilot arc circuit and a cutting arc circuit, the pilot arc circuit constructed to provide a power signal sufficient to generate an electrical arc between the shuttle element and one of the nozzle and electrode when the shuttle element moves from the second position to the first position.

7. The plasma torch of claim 1 wherein the idle mode is further defined as the plasma torch being arc-less and the cutting mode is further defined as the plasma torch communicating an arc to a workpiece.

8. The plasma torch of claim 1 wherein the shuttle element is electrically isolated from the nozzle when located in the first position.

9. A plasma cutting system comprising:

a power source constructed to generate a power signal suitable for plasma cutting applications;

a plasma torch connected to the power source and having a cathodic component having a fixed-position, an anodic component having a fixed-position, and a separator movably disposed between the cathodic component and the anodic component;

a first biasing means connected to the plasma torch and constructed to bias the separator out of mutual contact with the cathodic component and the anodic component; and

a second biasing means connected to the plasma torch and constructed to overcome the first biasing means and move the separator into mutual contact with the cathodic component and the anodic component.

10. The plasma cutting system of claim 9 wherein the first biasing means is at least one of a solenoid, a spring, and a gas flow.

11. The plasma cutting system of claim 9 wherein the second biasing means is at least one of a solenoid, a spring, and a gas flow.

12. The plasma cutting system of claim 9 wherein the first biasing means is a spring, the spring electrically connecting the separator and one of the anodic component and the cathodic component.

13. The plasma cutting system of **12** wherein the spring is housed in a recess formed in the one of the anodic component and the cathodic component.

14. The plasma cutting system of claim 9 further comprising a first gas passage formed through the plasma torch and constructed to supply a plasma forming gas and a second gas passage formed through the plasma torch and constructed to provide the second biasing means to the plasma torch.

15. The plasma cutting system of claim 9 wherein the separator bridgingly connects the anodic component and cathodic component during an arc requested mode and electrically separates the cathodic component and the anodic component during an arc-less mode and a cutting mode.

16. The plasma cutting system of claim 9 further comprising a trigger attached to the plasma torch and constructed to initiate the second biasing means automatically upon each actuation of the trigger, the second biasing means configured to be overcome by the first biasing means after the separator has established mutual contact with the cathodic component and the anodic component.

17. The plasma cutting system of claim 9 wherein the separator is electrically isolated from the anodic component when the separator is out of contact therewith.

18. A method of initiating a plasma arc comprising the steps of:

positioning a shuttle element substantially about a circumference of an electrode in a plasma torch;

biasing the shuttle element housed in a plasma torch to maintain a separation between a cathode and an anode;

overcoming the bias to connect the shuttle element to the cathode and the anode; and

returning the shuttle element to the biased position to generate a plasma arc.

19. The method of claim 18 wherein the step of biasing the shuttle element is achieved with at least one of a spring, a gas flow, and a solenoid.

20. The method of claim 18 wherein the step of overcoming the bias is achieved with at least one of a spring, a gas flow, and a solenoid.

21. The method of claim 18 further comprising the step of actuating a trigger to initiate the step of overcoming the bias.

22. The method of claim 18 further comprising connecting the cathode and the anode to a power source constructed to generate a plasma cutting power.

23. The method of claim 18 wherein the step of biasing the shuttle element further comprises electrically separating the shuttle element and the anode.

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