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(54) Title: OPTIMIZATION AND CONTROL OF MATERIAL PROCESSING USING A THERMAL PROCESSING TORCH

(57) Abstract: A consumable component for a thermal processing torch is provided. The consumable component includes a consumable component body and a signal device located on or within the consumable component body for transmitting a signal associated with the consumable component. The signal can be independent of a detectable physical characteristic of the consumable component.

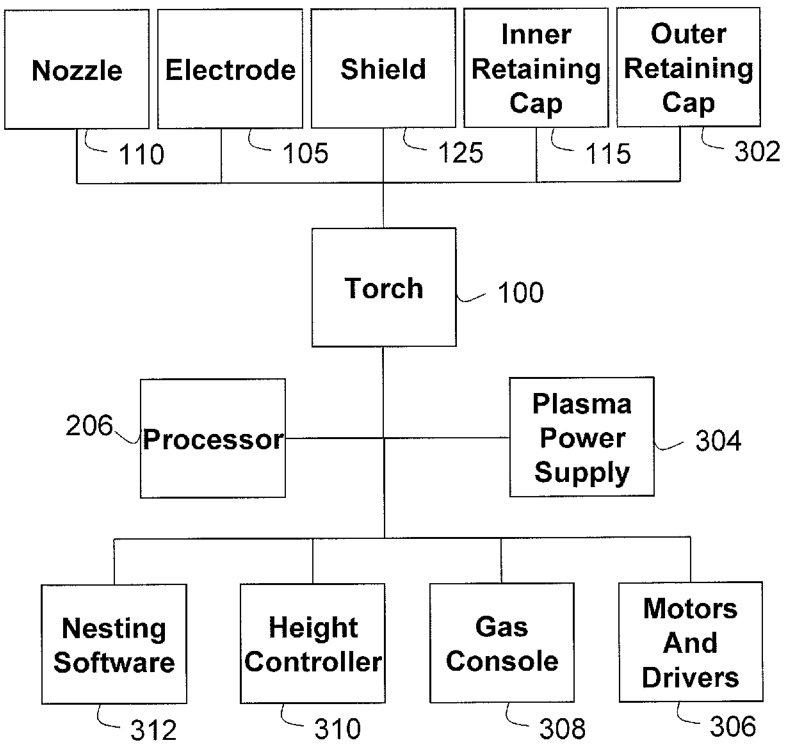

FIG. 4

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Optimization and Control of Material Processing Using a Thermal Processing Torch

FIELD OF THE INVENTION

[0001] The present invention relates generally to controlling and optimizing material processing using signals associated with consumables of a thermal processing torch.

BACKGROUND OF THE INVENTION

[0002] Thermal processing torches, such as plasma arc torches, are widely used in the heating, cutting, gouging and marking of materials. A plasma arc torch generally includes an electrode, a nozzle having a central exit orifice mounted within a torch body, electrical connections, passages for cooling, and passages for arc control fluids (e.g., plasma gas). Optionally, a swirl ring is employed to control fluid flow patterns in the plasma chamber formed between the electrode and the nozzle. In some torches, a retaining cap can be used to maintain the nozzle and/or swirl ring in the plasma arc torch. In operation, the torch produces a plasma arc, which is a constricted jet of an ionized gas with high temperature and sufficient momentum to assist with removal of molten metal.

[0003] Typically, a plasma arc torch includes multiple consumables. Each consumable can be selected to achieve optimal performance (e.g., an optimal current level, maximum lifespan, etc.) in view of specific processing constraints, such as the type of material being cut and/or the cut shape desired. Installing incorrect consumables into a torch can result in poor cut quality and decreased cut speed. In addition, incorrect consumables can reduce consumable life and lead to premature consumable failure. Even when correct consumables are installed in a torch, it can be difficult for an operator to manually configure and optimize torch operating parameters corresponding to the selected consumable set. Moreover, it can be difficult for a torch component manufacturer to guarantee performance if aftermarket consumables are used in a torch system.

SUMMARY OF THE INVENTION

[0004] Thus, systems and methods are needed to detect incompatible consumables in a plasma arc torch. In addition, systems and methods are needed to automatically adjust torch operating parameters to enhance cutting quality and prolong consumable life. Specifically, systems and methods are needed to efficiently convey information among various components of a torch system to facilitate operation control and optimization.

[0005] In one aspect, a consumable component of a thermal processing torch is provided. The consumable component includes a consumable component body and a signal device located on or inside of the consumable component body for transmitting a signal associated with the consumable component. The signal is independent of a detectable physical characteristic of the consumable component.

[0006] In another aspect, a method is provided for conveying information about a consumable component of a thermal processing torch that includes a signal receiver. The method includes installing into the torch the signal receiver and the consumable component. The consumable component has a signal component attached thereto. The signal component is adapted to generate a signal conveying the information about the consumable component. The method also includes passing the signal from the signal component to the signal receiver.

[0007] In another aspect, a system is provided for conveying information about a thermal processing torch. The system includes a signal detector and at least one consumable selected from a group including an electrode, a nozzle, a shield, a retaining cap, a welding tip, and a swirl ring. The system also includes at least one signal device attached to the at least one consumable for conveying information about the at least one consumable to the signal detector. The system further includes a controller coupled to the signal detector for i) receiving the information from the at least one signal device, and ii) transmitting a least a portion of the information to at least one of a processor, a gas console, nesting software, a height controller, and a drive motor. At least one of the processor, the gas console, the nesting software, the height controller, and the drive motor adjusts torch operation based on the information.

[0008] In other examples, any of the aspects above can include one or more of the following features. In some embodiments, the signal device is a radio-frequency identification (RFID) tag for storing information assigned to the consumable component. In some embodiments, the signal is one of a radio signal, a pneumatic signal, a magnetic signal, an optical signal, or a hydraulic signal. In some embodiments, the torch is a plasma arc torch.

[0009] In some embodiments, the signal transmitted by the signal device identifies at least one feature unique to a type of the consumable component. The type of the consumable component can include a nozzle, a shield, an electrode, an inner retaining cap, an outer retaining cap, a swirl ring, a welding tip or a replaceable torch body. The signal transmitted by the signal device can also identify at least one feature unique to the consumable component.

[0010] In some embodiments, the signal device is located at a surface of the body to minimize heat exposure during torch operation. This surface can be adjacent to a cooling mechanism of the torch, remote from a plasma arc of the torch, or in an o-ring channel of the torch, or a combination thereof. The signal device can be shielded by another torch component to minimize exposure of the signal device to at least one of thermal energy, radiation, damaging gases, or high-frequency energy.

[0011] In some embodiments, the signaling device is adapted to transmit the signal before, during or after plasma arc ignition, or a combination thereof. In some embodiments, the signal transmitted by the signal device is readable from inside of the torch after the consumable component is installed in the torch. The signal transmitted by the signal device can also be readable from outside of the torch after the consumable component is installed in the torch.

[0012] In some embodiments, the signal component includes a sensor for measuring a physical modification of the consumable component. The physical modification can include modification of the consumable component to restrict a flow rate of a gas therethrough.

[0013] In another aspect, a method is provided for identifying consumables in a thermal processing system including a torch. The method includes providing a first consumable having a first characteristic and a second consumable having a second characteristic. The second characteristic is different from the first characteristic and at least one of the first or second characteristics is independent of a measured physical property of the corresponding consumable. The method also includes installing at least one of the first and second consumables into the torch. The method further includes communicating information about at least one of the first characteristic of the first consumable or the second characteristic of the second consumable to a controller by a first methodology.

[0014] In some embodiments, the method includes communicating information about the first characteristic of the first consumable and the second characteristic of the consumable to the controller by the first methodology.

[0015] In some embodiments, the method further includes communicating information about the first characteristic of the first consumable to the controller by the first methodology and communicating information about the second characteristic of the second consumable to the controller by a second methodology. The second methodology is different from the first methodology. The first methodology can include using a first signal device coupled to the first consumable to transmit the first characteristic as a first signal. The second methodology can include using a second signal device coupled to the second consumable to transmit the second characteristic as a second signal. The first or second signal includes a pneumatic signal, a radio signal, a light signal, a magnetic signal or a hydraulic signal.

[0016] In some embodiments, the first consumable and the second consumable are substantially the same. In some embodiments, the first methodology includes using a signal device coupled to at least one of the first consumable or the second consumable to communicate the information as a signal. The signal can be a pneumatic signal, a radio signal, a light signal, a magnetic signal or a hydraulic signal.

[0017] It should also be understood that various aspects and embodiments of the invention can be combined in various ways. Based on the teachings of this specification, a person of ordinary skill in the art can readily determine how to combine these various embodiments. For example, in some embodiments, any of the aspects above can include one or more of the above features. One embodiment of the invention can provide all of the above features and advantages.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The advantages of the invention described above, together with further advantages, may be better understood by referring to the following description taken in conjunction with the accompanying drawings. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention.

[0019] FIG. 1 shows a cross-sectional view of an exemplary plasma arc torch.

[0020] FIG. 2 shows an exemplary communication network.

[0021] FIG. 3 shows altered geometry of various consumables.

[0022] FIG. 4 shows an exemplary thermal processing system using the communication network of FIG. 2 to control the operation of a plasma arc torch.

DETAILED DESCRIPTION OF THE INVENTION

[0023] FIG. 1 is a cross-sectional view of an exemplary plasma arc torch 100 including a torch body 102 and a torch tip 104. The torch tip 104 includes multiple consumables, for example, an electrode 105, a nozzle 110, a retaining cap 115, a swirl ring 120, and a shield 125. The torch body 102, which has a generally cylindrical shape, supports the electrode 105 and the nozzle 110. The nozzle 110 is spaced from the electrode 105 and has a central exit orifice mounted within the torch body 102. The swirl ring 120 is mounted to the torch body 102 and has a set of radially offset or canted gas distribution holes 127 that impart a tangential velocity component to the plasma gas flow, causing the plasma gas flow to swirl. The shield 125, which also includes an exit orifice, is connected (e.g., threaded) to the retaining cap 115. The retaining cap 115 as shown is an inner retaining cap securely connected (e.g., threaded) to the nozzle 110. In some embodiments, an outer retaining cap (not shown) is secured relative to the shield 125. The torch 100 can additionally include electrical connections, passages for cooling, passages for arc control fluids (e.g., plasma gas), and a power supply. In some embodiments, the consumables include a welding tip, which is a nozzle for passing an ignited welding gas.

[0024] In operation, plasma gas flows through a gas inlet tube (not shown) and the gas distribution holes 127 in the swirl ring 120. From there, the plasma gas flows into a plasma chamber 128 and out of the torch 100 through the exit orifice of the nozzle 110 and the shield 125. A pilot arc is first generated between the electrode 105 and the nozzle 110. The pilot arc ionizes the gas passing through the nozzle exit orifice and the shield exit orifice. The arc then transfers from the nozzle 110 to a workpiece (not shown) for thermally processing (e.g., cutting or welding) the workpiece. It is noted that the illustrated details of the torch 100, including the arrangement of the components, the direction of gas and cooling fluid flows, and the electrical connections, can take a variety of forms.

[0025] Different operating processes often require different shield and/or plasma gas flow rates, which require different sets of consumables. This leads to a variety of consumables being used in the field. Using the correct consumables and matching them appropriately is necessary to achieve optimal cutting performance. Consumable mismatch (e.g., using a consumable made for operation at 65 Amps in a torch that is being operated at 105 Amps) can result in poor consumable life and/or poor performance of the plasma arc torch.

[0026] FIG. 2 shows an exemplary communication network 200 of the present invention. The communication network 200 includes one or more signal devices 202, each assigned to a consumable of a thermal processing torch, such as the plasma arc torch 100 of FIG. 1. Exemplary consumables include the electrode 105, the nozzle 110, the retaining cap 115, the swirl ring 120, and the shield 125. In some embodiments, a signal device 202 is an electrically writable device configured to transmit information about a consumable in the form of one or more signals. For example, the signal device 202 can be a radio-frequency identification (RFID) tag or card, bar code label or tag, integrated circuit (IC) plate, or the like. In some embodiments, a signal device 202 is a detector (e.g., a sensor) for detecting a physical characteristic of the consumable and transmitting the detected information in the form of one or more signals. The communication network 200 also includes at least one receiver 204 for i) receiving signals transmitted by the signal devices 202, ii) extracting data conveyed by the signals, and iii) providing the extracted data to a processor 206 for analysis and further action. The processor 206 can be a digital signal processor (DSP), microprocessor, microcontroller, computer, computer numeric controller (CNC) machine tool, programmable logic controller (PLC), application-specific integrated circuit (ASIC), or the like.

[0027] In some embodiments, each signal device 202 is encoded with information pertaining to the consumable to which the signal device 202 is assigned. The encoded information can be generic or fixed information such as the consumable's name, trademark, manufacturer, serial number, and/or type. The encoded information, for example, can include a model number to generally indicate that the consumable is a nozzle. In some embodiments, the encoded information is unique to the consumable, such as metal composition of the consumable, weight of the consumable, date, time and/or location at which the consumable was manufactured, personnel responsible for the consumable, and the like. As an example, the encoded information can provide a serial number, which is unique to each torch component manufactured, to distinguish, for example, nozzle Type A, Serial #1 from nozzle Type A, Serial #2.

[0028] In some embodiments, information is encoded to a signal device 202 at the time of manufacture of the corresponding consumable. Information can also be encoded to a signal device 202 during the lifetime of the consumable, such as after each consumable use. Such information can include the date, time and location of consumable use, any abnormalities detected during use, and/or consumable conditions after use so that a log can be created to predict a failure event or end-of-life event associated with the consumable.

[0029] Information encoded to a signal device 202 can also specify operating parameters. For example, for a signal device 202 associated with the shield 125, data encoded to the signal device 202 can indicate the type of shield gas and/or the appropriate gas flow rate for the shield 125. In some embodiments, encoded data of a signal device 202 provides information about other related torch components. For example, encoded data can identify other torch components that are compatible with the assigned consumable, assisting with installation of the entire consumable set in a torch to achieve certain performance metrics.

[0030] In some embodiments, a signal device 202 includes information about the corresponding consumable independent of a detectable physical characteristic of the consumable. Examples of detectable physical characteristics of the consumable include magnetic properties, surface reflectivity, density, acoustic properties and other tactile features of the consumable measured by a detector installed in the torch. Therefore, examples of consumable data independent of a detectable physical characteristic of the consumable can include consumable name, type, manufacturer, manufacturing date, manufacturing location, serial number, or other non-tactile features of a consumable. In some embodiments, the signal device 202 stores pre-collected information of the consumable, including physical characteristics, before it is installed into the torch, but the signal device 202 is not configured to actively measure or detect the physical characteristics. However, the signal device 202 can store physical characteristics about the consumable measured or detected by another device, such as by a sensor. Generally, the signal device 202 is used mainly for data storage purposes.

[0031] In some embodiments, the signal device 202 is located inside or on the torch 100. For example, the signal device 202 can be attached to a surface of a consumable that is ultimately installed inside of the torch tip 104. The signal device 202 can also be attached to a component inside of the torch 100 other than the assigned consumable. For example, while a signal device 202 is assigned to store data about the electrode 105, the signal device 202 can be affixed to a surface of the retaining cap 115. In some embodiments, the signal device 202 is coupled to an external source that is not physically associated with the torch 100. For example, the signal device 202 can be attached to a package used to store the consumable and is remote from the consumable once it is installed in the torch 100. If a signal device 202 is located inside of the torch 100, the surface to which the signal device 202 is attached can be selected to reduce or otherwise minimize heat exposure during operation of the torch 100. For example, the signal device 202 can be located near a cooling mechanism, away from the plasma arc, and/or in an o-ring channel of the torch 100 to reduce or minimize heat exposure. In addition, the signal device 202 can be coated with a heat protective material to prevent the device from overheating during torch operation. Generally, the signal device 202 can be situated, such as being shielded by another torch component, to minimize exposure to thermal energy, radiation, damaging gases (e.g., ozone), and/or high-frequency energy.

[0032] In some embodiments, a signal device 202 is designed to be durable, i.e., functional during and after one or more torch ignitions. In some embodiments, a signal device 202 is disposable after each torch use or after several uses. In some embodiments, a signal device 202 is writable once, for example, to encode information about a consumable when the consumable is first manufactured. In some embodiments, a signal device 202 is writable multiple times, such as throughout the lifespan of the corresponding consumable.

[0033] In the communication network 200, the signal device 202 can wirelessly transmit its stored information to the receiver 204 in the form of one or more signals. The receiver 204 is adapted to process these signals to extract pertinent data about the consumable and forward the data to the processor 206 for analysis. In some embodiments, the receiver 204 is located in or on the plasma arc torch 100. For example, the receiver 204 can be located in the torch body 102. In some embodiments, the receiver 204 is at a location external to the torch 100, such as attached to a power supply module, a gas console, the processor 206, etc.

[0034] In some embodiments, at least one of the signal devices 202 is an RFID tag and the receiver 204 is a reader used to interrogate the RFID tag. In such embodiments, the RFID tag includes a microchip for storing information and an antenna for receiving and transmitting RF signals. The reader can include 1) an antenna for transmitting RF signals to the RFID tag to interrogate the tag and 2) components for decoding a response transmitted by the RFID tag before forwarding the response to the processor 206. The RFID tag can be either active or passive. An active RFID tag includes a battery to produce a stronger electromagnetic return signal to the reader, thereby increasing the possible transmission distance between the RFID tag and the reader. The distance between an RFID tag and a reader can be from less than one inch to 100 feet or more, depending on the power output, the radio frequency used and the type of material through which the RF signals need to travel. In one example, the distance between an RFID tag and an antenna of a corresponding reader can be about 2-4cm. A reader antenna and remaining reader components do not need be in the same packaging. For example, the reader antenna can be located on or inside of the torch body 102 while the remaining reader components are external to the torch 100. Using an RFID tag is advantageous because it does not require direct contact (e.g., via wires) or direct line of sight (e.g., via optical signals) with the reader and is well suited for use in harsh environments.

[0035] In some embodiments, a signal device 202 is a detector (e.g., a sensor) for detecting at least one physical marker of the consumable for uniquely identifying the consumable by its type or individually. The physical marker can be a physical alteration of the consumable, for example. As shown in FIG. 3, identification of a consumable is achieved by altering the geometry of the consumable such that, when it is installed in the torch 100, it affects the wall of an adjacent coolant passageway 402, which in turn alters the rate of a coolant flowing therethrough. Specifically, the altered section of the coolant passageway 402 can restrict the rate of the coolant flow. A signal device 202 can be used to measure the pressure change as a function of the coolant flow rate. Hence, the measured coolant pressure change serves as an identification of the consumable. In another example as shown in FIG. 3, an auxiliary vent line 404 that is connected to a valve and a flow meter is attached to the nozzle 110 to identify the nozzle 110. The valve is opened prior to plasma arc ignition and the auxiliary vent line flow rate is measured by a signal device 202 as a function of plasma pressure during a purge cycle. Therefore, the measured flow rate serves as an identification of the nozzle 110. In another example, one or more uniquely sized metering holes (not shown) can be drilled into the outer retain cap to identify the cap once it is installed in the torch 100. The size of each metering hole is configured to uniquely affect the off-valve pressure and/or the flow rate of the shield gas. Therefore, these measurements, taken by a signal device 202 in a pre-flow routine prior to pilot arc ignition, serve to identify the outer retaining cap.

[0036] In yet another example, the shield 125 can be identified by measuring the consumable's length relative to a reference torch datum. In an exemplary measurement process, a torch height controller is used to determine the height at which a known torch fires and begins to cut a workpiece. This height can serve as the reference torch datum. Then, after installing an unidentified consumable into the torch, the height relative to the reference datum is determined. Therefore, simple calculations involving the two heights can be used to determine the relative length of the unidentified consumable. In turn, the relative consumable length can be used to identify the consumable by, for example, referencing a looking-up table that correlates relative consumable lengths to consumable parts.

[0037] In some embodiments, a signal device 202 is a barcode that provides optical machine-representation of data about the corresponding consumable. A barcode can be read by the receiver 204 in the form of a barcode reader. Generally, a signal device 202 can convey data about a consumable in the form of any machine readable signals, including radio signals, optical or other light-based signals (e.g., infrared signals or ultraviolet signals), magnetic signals, pneumatic signals, or hydraulic signals.

[0038] In some embodiments, a single signal device 202 is assigned to each consumable of a torch to transmit pertinent information about the corresponding consumable. In some embodiments, two or more signal devices 202 are assigned to the same consumable to transmit different information about that consumable. For example, one signal device 202 can transmit information unique to the consumable type, such as the model number and operating parameters for the consumable type, while another signal device 202 can transmit information unique to the consumable itself, such as weight and usage history of the consumable. In some embodiments, the signal devices 202 in the communication network 200 employ different modes of data transmission. For example, while one signal device 202 transmits data as RF signals, another signal device 202 transmits data as optical signals. In some embodiments, the network 200 includes multiple receivers 204. Each receiver 204 is configured (e.g., tuned) to read signals from one or more of the signal devices 202 and transmit the extracted data to the processor 206. In some embodiments, a single receiver 204 is used to read signals from all signal devices 202 in the communication network 200. The processor 206 thus can simultaneously process data associated with multiple consumables.

[0039] FIG. 4 is an exemplary thermal processing system 300 using the communication network of FIG. 2 to control the operation of a thermal processing torch, such as the plasma arc torch 100 of FIG. 1. The plasma arc torch 100 can include one or more consumables including the nozzle 110, the electrode 105, the shield 125, the inner retaining cap 115 and an outer retaining cap 302. At least one signal device 202 is assigned to at least one of the consumables for transmitting information about the corresponding consumable to the processor 206 via the receiver 204. The system 300 also includes a power supply 304 for providing the electrical current necessary to generate plasma arc in the torch 100. Data collected from the signal devices 202 about the respective consumables can be used by the processor 206 to control and optimize the operation of at least one of the plasma power supply 304, the motors and drivers 306, the gas console 308, the height controller 310 and the nesting software 312.

[0040] The processor 206 can be located inside or outside of the plasma arc torch 100. In some embodiments, the processor 206 is housed in the power supply 304. In some embodiments, each of the plasma power supply 304, the motors and drivers 306, the gas console 308, the height controller 310 and the nesting software 312 houses at least one processor for processing data from the signal devices 202 to control the functions of the respective module 304, 306, 308 or 310.

[0041] Based on the information collected from the signal devices 202, the processor 206 can regulate many plasma system functions simultaneously or near simultaneously and in real-time or near real-time. These system functions include, but not limited to, start sequence, CNC interface functions, gas and operating parameters, and shut off sequences. In some embodiments, the processor 206 uses consumable information to automatically set various parameters of the system 300. In some embodiments, the processor 206 uses consumable information to verify whether certain preset parameters of the system 300 are compatible with the consumables inside of the torch 100. As an example, based on the data collected about the multiple consumables of the torch 100, the processor 206 can control and verify one or more of the following system components: i) settings of the power supply 304 for regulating power to the torch 100, ii) settings of the nesting software 312 for processing a workpiece, iii) settings of the gas console 308 for controlling shield and/or plasma gases supplied to the torch 100, iv) settings of the height controller 310 for adjusting the height between the torch 100 and the workpiece, and v) settings of various motors and drivers 306.

[0042] In some embodiments, based on the data collected from one or more signal devices 202, the processor 206 interacts with the nesting software 312 to automatically select a cutting program that sets parameters for processing a workpiece, such as the cutting speed, direction, paths, nesting sequences, etc. The cutting program can also define the gas types, gas pressure and/or flow settings and height control settings for the torch in view of the collected consumable data. Traditionally, when a set of consumables is assembled into a torch, an operator needs to manually configure the nesting software 312 to create the cutting program for the torch by supplying information to the software including the type and thickness of the workpiece material being processed, the type of gas being used, and the current rating of the consumable set. In particular, the operator needs to manually input into the processor 206 the current rating of the consumable set. In the present invention, because the current rating information for each consumable is stored in at least one signal device 202, the processor 206 can electronically collect such information from the one or more signal devices 202 and automatically determine the appropriate current setting without user input.

[0043] In some embodiments, based on the collected consumable data, the processor 206 selects a suitable cutting program from the nesting software 312 by taking into consideration of consumable data from the signal devices 202 and user-input operating parameters, including the characteristics of the workpeice being cut and the desired cut shape. For example, an operator can first send a generic program file to the nesting software 312. The generic program file specifies, for each workpiece thickness, variable cut speeds, gas flows, kerf compensations, torch heights, etc. that change with different consumable parts. Thus, after identifying the consumables using the signal devices 202, the processor 206 interacts with the generic program file to configure a cutting program for the torch. In some embodiments, after a cutting program is created, the processor 206 uses consumable data collected from the signal devices 202 to verify whether correct consumables are installed into the torch that are appropriate for the program. In addition, the processor 206 can instruct the nesting software 312 to automatically set or correct parameters of the program to enhance compatibility with the consumables loaded into the torch. For example, a consumable requiring 400A current has larger kerfs and lead-ins in comparison to a consumable requiring 130A current. Accordingly, the nesting software 312 can select fewer parts to fit on a nest of the program if the 400A consumable is loaded into a torch.

[0044] In some embodiments, based on the data collected from one or more signal devices 202, the processor 206 can manipulate a gas console 308 to control flow of plasma and shield gases to the torch 100 by verifying and adjusting the gas console settings. The gas console 308 houses solenoid valves, flow meters, pressure gauges, and switches used for plasma and shield gas flow control. For example, the flow meters are used to set the pre-flow rates and cut flow rates for the plasma and shield gases. The gas console 308 can also have a multi-inlet gas supply area where the plasma and shield gases are connected. A toggle switch can be used to select the desired gases. The plasma and shield gases are monitored by gas pressure gauges. In one example, a signal device 202 associated with the shield 125 of the plasma arc torch 100 can store information about the type and composition of one or more shield gases suitable for use with the shield 125, along with the optimal flow rate setting of the shield gases. Based on this data, the processor 206 can interact with the gas console 308 to provide the plasma arc torch 100 with the appropriate shield gas at the optimal flow rate.

[0045] In some embodiments, based on the data collected from one or more signal devices 202, the processor 206 manipulates the torch height controller 310, which sets the height of the torch 100 relative to the workpiece. The torch height controller 310 can include a control module to control an arc voltage during cutting by adjusting the standoff (i.e., the distance between the torch 100 and the work piece) to maintain a predetermined arc voltage value. The torch height controller 310 can also include an external control module to control the standoff. The torch height controller 310 can further include a lifter, which is controlled by the control module through a motor or driver 306, to slide the torch 100 in a vertical direction relative to the workpiece to maintain the desired voltage during cutting. In one example, based on the data collected from the consumables of a torch, the torch height controller 310 can automatically determine the height to position the torch relative to the top of a workpiece. Therefore, the torch height controller 310 does not need to perform a height sense in order to set an appropriate pierce height and cut height before beginning arc voltage control.

[0046] In some embodiments, the processor 206 is configured to prevent the thermal processing system 300 from commencing an operation on the workpiece if it determines that the consumables installed in the torch 100 are mismatched with each other, not compatible with the thermal processing system 300 or inconsistent with other pre-selected operating parameters input by an operator. If such a determination is made, the processor 206 can trigger an audio or visual alert indicating to the operator that one or more of the connected consumables are unsupported and that the consumables should be replaced or operator inputs should be revised. Additionally, the processor 206 can prevent initiation of an operation if an alert is triggered. For example, the processor 206 can stop torch operation if the current setting of the shield 125, which is conveyed to the processor 206 by a signal device 202 assigned to the shield 125, is different from the current setting of the nozzle 110, which is conveyed to the processor 206 by a different or the same signal device 202 corresponding to the nozzle 110.

[0047] In some embodiments, the processor 206 is configured to prevent the thermal processing system 300 from operating if it determines that at least one of the consumables installed in the torch 100 is not manufactured or otherwise supported by an accepted manufacturer. For example, the processor 206 can stop torch operation if it does not recognize the manufacturer identification, serial number and/or parts number conveyed by a signal device of a consumable. Hence, the thermal processing system 300 can be used to detect and prevent the use of inferior or counterfeit consumables.

[0048] In some embodiments, the processor 206 recommends one or more remedial actions to the operator to address alarm situations. For example, the processor 206 can suggest one or more consumables to install in the torch 100 to avoid potential mismatch with other components of thermal processing system 300. The processor 206 can suggest suitable types of workpiece for processing based on the ratings of the installed consumable set. The processor 206 can recommend a cutting sequence that reconciles the settings of the installed consumables with settings provided by the operator.

[0049] Generally, the signal devices 204 can store information about torch components other than consumables. For example, the signal devices 204 can store information about the torch body 102 or about one or more leads. Therefore, as one in the art will fully appreciate, the exemplary communication network 200 of FIG. 2 and the configuration of FIG. 3 can be easily adapted to store information about any torch component.

[0050] In addition, as one in the art will fully appreciate, the invention described herein is not only applicable to plasma cutting devices, but also welding-type systems and other thermal processing systems. In some embodiments, the invention described herein is configured to operate with a variety of cutting technologies, including, but not limited to, plasma arc, laser, oxy fuel, and/or water-jet technologies. For example, the signal devices 202 can be coupled to one or more consumables configured to operate with one or more of the cutting technologies. The processor 206, using information transmitted by the signal devices 202, can determine whether the consumables installed in a torch are compatible with the specific cutting technology. In some embodiments, based on the selected cutting technology and the consumable information, the processor 206 can set or adjust operating parameters accordingly, such as the height of the cutting head above the workpiece, which can vary depending on the cutting technology and the consumables.

[0051] As an example, it is known to use water-jet systems that produce high pressure, high-velocity water jets for cutting various materials. These systems typically function by pressurizing water or another suitable fluid to a high pressure (e.g., up to 90,000 pounds per square inch or more) and force the fluid through a small nozzle orifice at high velocity to concentrate a large amount of energy on a small area. An abrasive jet is a type of water jet, which can include abrasive materials within the fluid jet for cutting harder materials. In some embodiments, the signal devices 202 are attached to consumables of a water-jet system, such as to a water-jet nozzle, an abrasive-jet nozzle, a mixing tube used to mix abrasive particles with fluid, and/or one or more valves and filters. A signal device 202 associated with an abrasive-jet nozzle can identify, for example, the types of abrasives suitable for use with the nozzle, the amount of pressure in the pressurized fluid that can be fed to the nozzle, and can also indicate other consumables that are suitable for use with a particular nozzle. Identification of particular consumable set combinations for a given water-jet system can also be performed, to verify compatibility with a given system or to limit operating conditions and parameters, such as maximum pressure or flow settings, or abrasive types or amounts.

[0052] It should also be understood that various aspects and embodiments of the invention can be combined in various ways. Based on the teachings of this specification, a person of ordinary skill in the art can readily determine how to combine these various embodiments. In addition, modifications may occur to those skilled in the art upon reading the specification. The present application includes such modifications and is limited only by the scope of the claims.

CLAIMS

What is claimed is:

1. A consumable component of a thermal processing torch comprising:

   a consumable component body; and

   a signal device located on or within the consumable component body for transmitting a signal associated with the consumable component, the signal being independent of a detectable physical characteristic of the consumable component.

2. The consumable component of claim 1 wherein the signal device comprises a radio-frequency identification (RFID) tag.

3. The consumable component of claim 1 wherein the signal transmitted by the signal device identifies at least one feature unique to a type of the consumable component.

4. The consumable component of claim 3, wherein a type of the consumable component comprises a nozzle, a shield, an electrode, an inner retaining cap, an outer retaining cap, a swirl ring or a welding tip.

5. The consumable component of claim 1 wherein the signal transmitted by the signal device identifies at least one feature unique to the consumable component.

6. The consumable component of claim 1 wherein the signal device is located at a surface of the body to minimize heat exposure during torch operation.

7. The consumable component of claim 6 wherein the surface is adjacent to a cooling mechanism of the torch, remote from a plasma arc of the torch, or in an o-ring channel of the torch, or a combination thereof.

8. The consumable component of claim 6 wherein the signal device is shielded by another torch component to minimize exposure of the signal device to at least one of thermal energy, radiation, damaging gases, or high-frequency energy.

9. The consumable component of claim 1 wherein the signaling device is adapted to transmit the signal before, during or after plasma arc ignition, or a combination thereof.

10. The consumable component of claim 1 wherein the signal transmitted by the signal device is readable from inside of the torch after the consumable component is installed in the torch.

11. The consumable component of claim 1 wherein the signal transmitted by the signal device is readable from outside of the torch after the consumable component is installed in the torch.

12. The consumable component of claim 1 wherein the torch comprises a plasma arc torch.

13. A method for conveying information about a consumable component of a thermal processing torch including a signal receiver, the method comprising:

installing into the torch the signal receiver and the consumable component, wherein the consumable component has a signal component attached thereto, the signal component being adapted to generate a signal conveying the information about the consumable component; and

passing the signal from the signal component to the signal receiver.

14. The method of claim 13 wherein the consumable component comprises one of an electrode, a nozzle, a shield, a swirl ring, a retaining cap or a replaceable torch body.

15. The method of claim 13 wherein the signal component comprises an RFID tag for storing the information assigned to the consumable component.

16. The method of claim 13 wherein the signal component comprises a sensor for measuring a physical modification of the consumable component, the physical modification comprises modification of the consumable component to restrict a flow rate of a gas therethrough.

17. The method of claim 13 wherein the signal comprises one of a radio signal, a pneumatic signal, a magnetic signal, an optical signal, or a hydraulic signal.

18. A system for conveying information about a thermal processing torch, the system comprising:

a signal detector;

at least one consumable selected from a group comprising: an electrode, a nozzle, a shield, a retaining cap, a welding tip, and a swirl ring;

at least one signal device attached to the at least one consumable for conveying information about the at least one consumable to the signal detector;

a controller coupled to the signal detector for i) receiving the information from the at least one signal device, and ii) transmitting at least a portion of the information to at least one of a processor, a gas console, nesting software, a height controller, and a drive motor, wherein at least one of the processor, the gas console, the nesting software, the height controller, and the drive motor adjusts torch operation based on the information.

19. A method for identifying consumables in a thermal processing system including a torch, the method comprising:

providing a first consumable having a first characteristic and a second consumable having a second characteristic, wherein the second characteristic is different from the first characteristic and at least one of the first or second characteristics is independent of a measured physical property of the corresponding consumable;

installing the first and second consumables into the torch; and communicating information about at least one of the first characteristic of the first consumable or the second characteristic of the second consumable to a controller by a first methodology.

20. The method of claim 19 wherein the first methodology comprises using a signal device coupled to at least one of the first consumable or the second consumable to communicate the information as a signal, the signal being a pneumatic signal, a radio signal, a light signal, a magnetic signal or a hydraulic signal.

21. The method of claim 19, further comprising:

communicating information about the first characteristic of the first consumable to the controller by the first methodology; and

communicating information about the second characteristic of the second consumable to the controller by a second methodology, wherein the second methodology is different from the first methodology.

22. The method of claim 21 wherein the first methodology comprises using a first signal device coupled to the first consumable to transmit the first characteristic as a first signal, the second methodology comprises using a second signal device coupled to the second consumable to transmit the second characteristic as a second signal, the first or second signal comprising a pneumatic signal, a radio signal, a light signal, a magnetic signal or a hydraulic signal.

23. The method of claim 19, further comprising:

communicating information about the first characteristic of the first consumable and the second characteristic of the consumable to the controller by the first methodology.

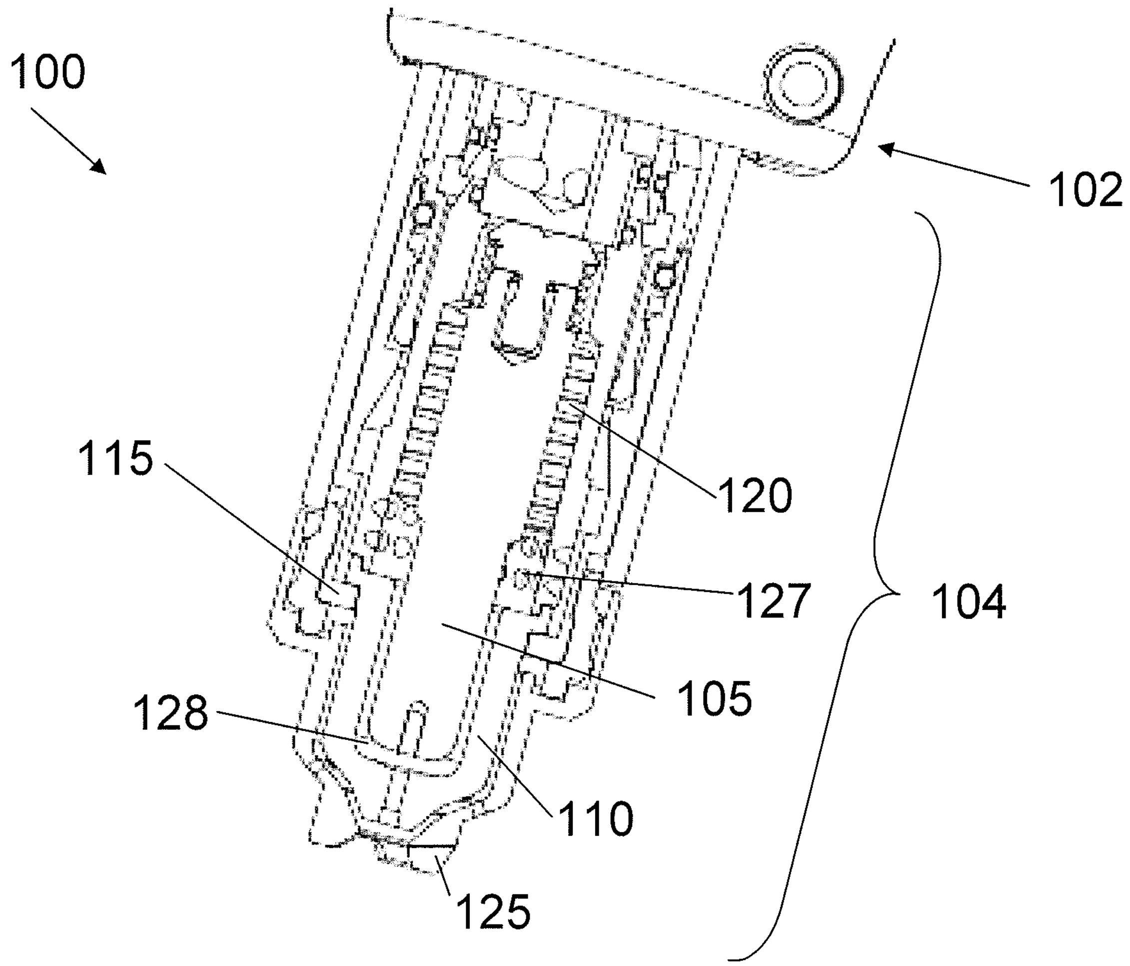

FIG. 1

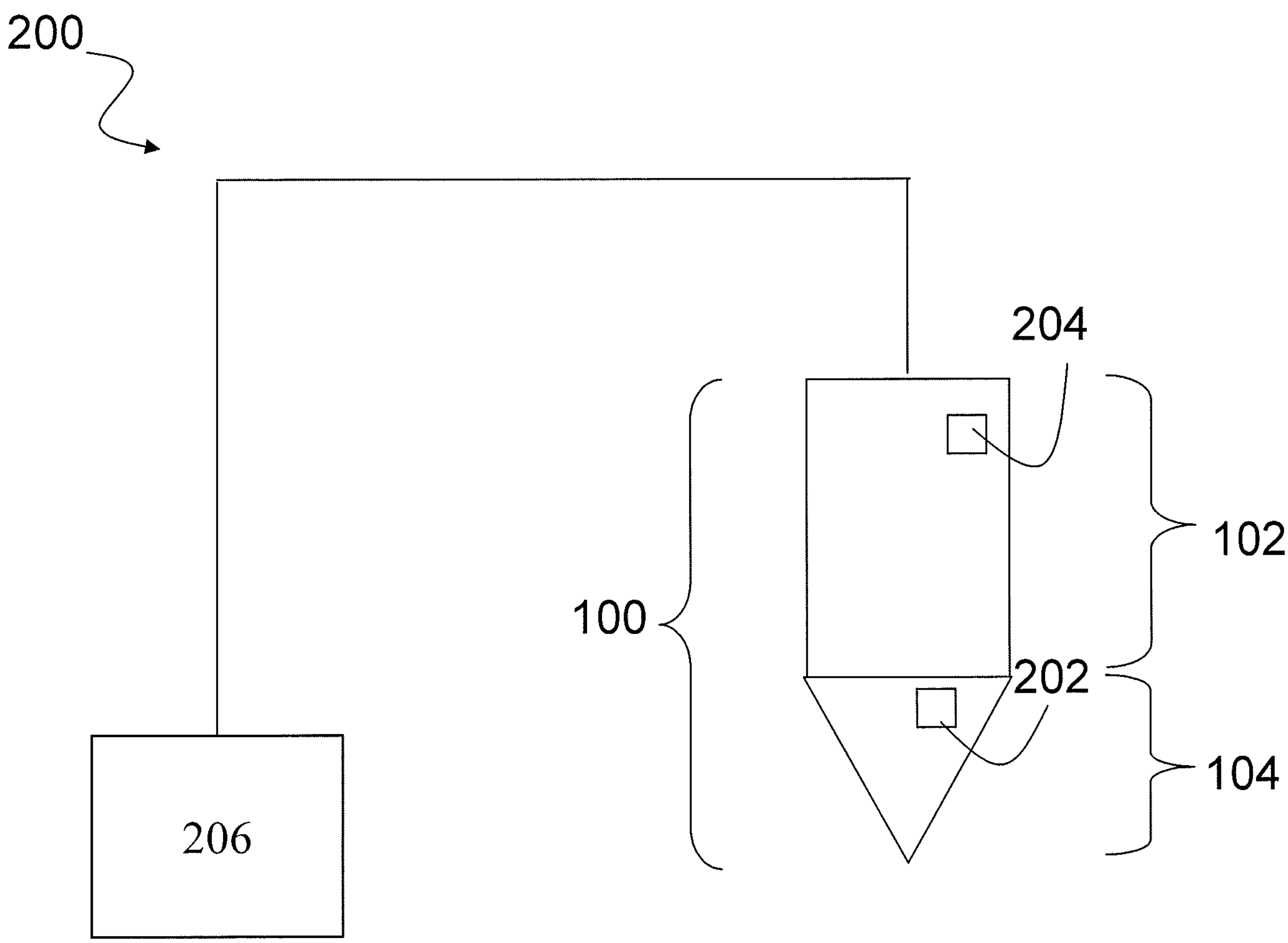

FIG. 2

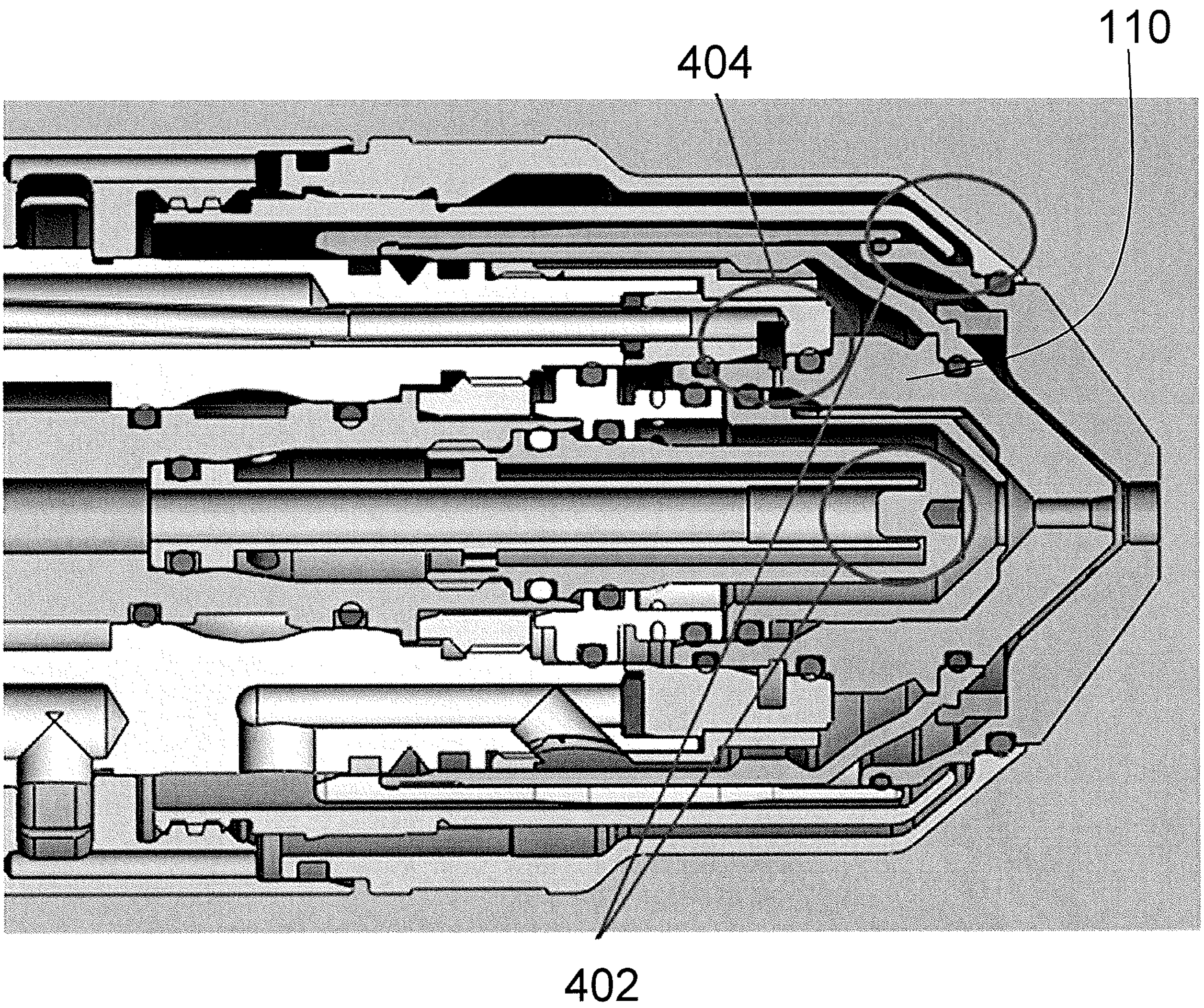

FIG. 3

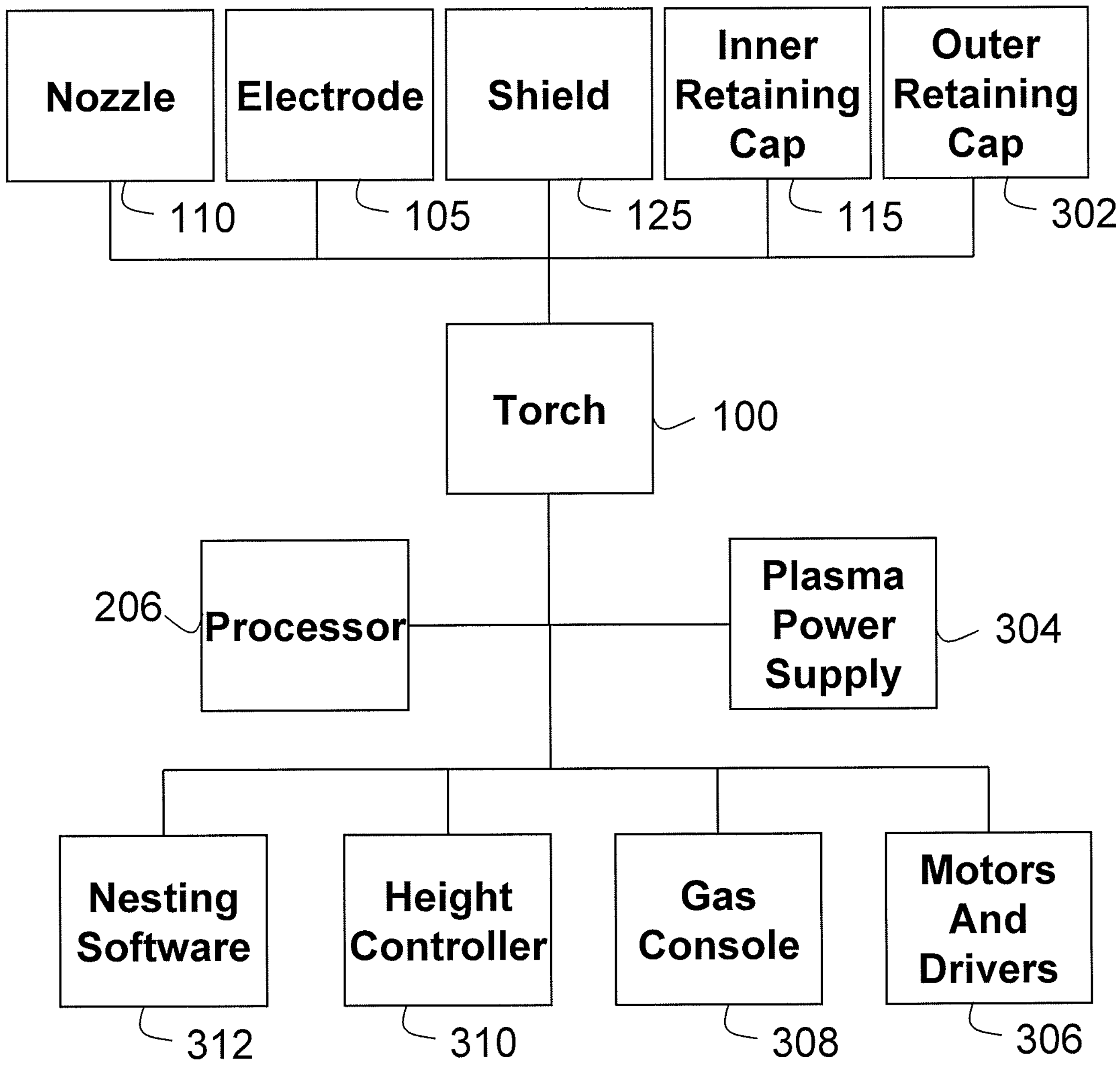
Nozzle
Electrode
Shield
Inner Retaining Cap
Outer Retaining Cap
110
105
125
115
302
Torch
100
206
Processor
Plasma Power Supply
304
Nesting Software
Height Controller
Gas Console
Motors And Drivers
312
310
308
306

FIG. 4