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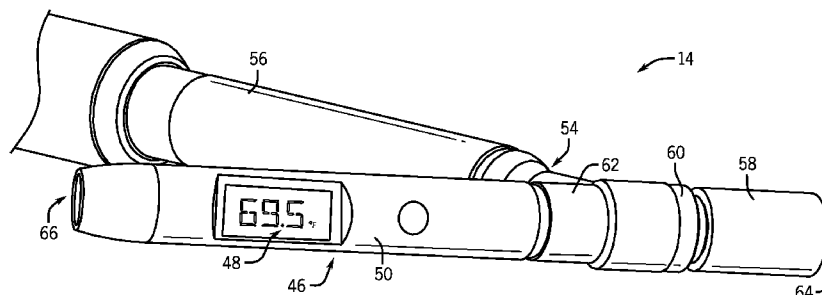
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(57) Abstract: [0042] Various welding systems including a welding torch assembly (14) are provided. The welding torch assemblies may include a welding torch adapted to be utilized in a welding operation to establish a welding arc between the welding torch and a workpiece. The welding torch assemblies may also include a temperature sensing system (46) integral with the welding torch and adapted to sense a temperature of the workpiece.

WELDING TORCH WITH A TEMPERATURE MEASUREMENT DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] *This application is a Non-Provisional Patent Application of U.S. Provisional Patent Application No. 61/621,439, entitled “Welding Torch with a Temperature Measurement Device”, filed April 6, 2012, which is herein incorporated by reference.*

BACKGROUND

[0002] The invention relates generally to welding systems, and more particularly to welding torch assemblies having temperature sensing systems.

[0003] Welding is a process that has become increasingly ubiquitous in all industries. While such processes may be automated in certain contexts, a large number of applications continue to exist for manual welding operations performed by skilled welding technicians. Traditional process welding systems support a variety of processes, such as metal inert gas (MIG) welding, tungsten inert gas (TIG) welding, stick welding, and so forth, which may operate in different modes, such as constant current or constant voltage. These power sources provide conditioned power for the welding application, and features of this provided power are governed by one or more settings input by a welding operator. Many welding applications, such as welding of aerospace parts, require the operator to utilize a TIG process, typically for finer or more intricate welds. Such intricate forms of welding a desired part may be sensitive to weld conditions and parameters, and, accordingly, it may be desirable to monitor these processes throughout the various stages of a welding operation, including before, during, and after establishment of a welding arc. In some cases, monitoring of the parameters of these processes may require use of an auxiliary device and/or interruption of the welding arc for measurements to be obtained, thus reducing the efficiency and accuracy of the welding process. Accordingly, there exists a need for systems that enable an operator to measure parameters of a welding operation with

minimal inconvenience for the welding operator, particularly in environments where the welding operation is intricate.

BRIEF DESCRIPTION

[0004] In one embodiment, a welding system includes a welding torch assembly. The welding torch assembly includes a welding torch adapted to be utilized in a welding operation to establish a welding arc between the welding torch and a workpiece. The welding torch assembly also includes a temperature sensing system integral with the welding torch and adapted to sense a temperature of the workpiece.

[0005] In another embodiment, a welding system includes a welding power source including power conversion circuitry adapted to receive primary power and to convert the primary power to a weld power output for use in a welding operation. The welding power source also includes a temperature sensing system integral with a welding torch. The temperature sensing system includes a temperature probe adapted to sense a temperature of a workpiece and a display adapted to display the sensed temperature of the workpiece.

[0006] In a further embodiment, a welding system includes a welding torch assembly. The welding torch assembly includes a welding torch adapted to be utilized in a welding operation to establish a welding arc between the welding torch and a workpiece. The welding torch assembly also includes a temperature sensing system reversibly coupled to the welding torch in a tool-less engagement and adapted to sense a temperature of the workpiece.

DRAWINGS

[0007] These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0008] FIG. 1 is a block diagram illustrating an embodiment of a welding system that includes a welding power supply and a welding torch assembly having a temperature sensing system;

[0009] FIG. 2 is a perspective view of an embodiment of the welding torch assembly of FIG. 1;

[0010] FIG. 3 is a block diagram illustrating an embodiment of a welding system that includes a welding power supply and a welding torch assembly having an infrared sensing system;

[0011] FIG. 4 is a perspective view of an embodiment of the welding torch assembly of FIG. 3;

[0012] FIG. 5 is an exploded view of an embodiment of the infrared sensing and mounting system of FIG. 4;

[0013] FIG. 6 illustrates use of a temperature sensing system to sense a temperature of a workpiece along a weld bead in accordance with a presently disclosed embodiment; and

[0014] FIG. 7 illustrates use of a temperature sensing system to sense a workpiece temperature in a plurality of positions about a welding area in accordance with a presently disclosed embodiment.

DETAILED DESCRIPTION

[0015] As discussed in detail below, various embodiments of welding systems having temperature sensing systems capable of sensing a temperature of a weld bead and/or a workpiece are disclosed. Some embodiments may integrate the temperature sensing system with the welding torch, thus reducing or eliminating the need for auxiliary temperature sensing devices, such as handheld thermometers. For example, in one embodiment, a digital temperature probe may be disposed on a back portion of a tungsten inert gas (TIG) torch such that an operator may rotate the TIG torch to conveniently position the digital temperature probe for temperature acquisition. For

further example, in another embodiment, an infrared sensor system may be mechanically coupled to a welding torch and capable of measuring the desired temperature during a welding operation without the establishment of physical contact between the sensor system and the workpiece. The temperature sensing capabilities provided by the disclosed welding torches and their respective integrated temperature sensing systems may be particularly advantageous when performing intricate welds that are sensitive to temperature changes, such as welds performed utilizing tungsten inert gas (TIG) welding. However, presently disclosed embodiments are compatible with a variety of suitable welding processes, such as metal inert gas (MIG) welding, stick welding, and so forth, or any particular welding process or regime. That is, it should be noted that although the illustrated embodiments are described in the context of TIG welding systems and the illustrated temperature sensing systems are shown coupled to TIG welding torches, the presently disclosed embodiments are also compatible with a variety of other welding systems and devices.

[0016] Turning now to the drawings, FIG. 1 illustrates a welding system 10 that powers, controls, and provides supplies for a welding operation. In the illustrated embodiment, the welding system 10 includes a welding power supply 12 and a welding torch assembly 14, and examples of suitable internal components included in the welding power supply 12 and the welding torch assembly 14 are shown. However, it should be noted that the particular components included in the welding power supply 12 and the welding torch assembly 14 of the welding system 10 are subject to implementation-specific variations that are within the scope of presently disclosed embodiments. That is, more or fewer components may be included in other embodiments, depending on features of the given application.

[0017] In the illustrated embodiment, the welding power supply 12 includes power conversion circuitry 16 that receives input power from an alternating current power source 18 (e.g., the AC power grid, an engine/generator set, a battery, or a combination thereof). The power applied to the power conversion circuitry 16 may originate in a power grid, although other sources of power may also be used, such as power generated by an engine-driven generator, batteries, fuel cells or other alternative sources. After receiving the input power, the power conversion circuitry

16 conditions the input power, and provides output power via lead 20 to the cable 22 to power one or more welding devices (e.g., welding torch assembly 14) in accordance with demands of the system 10. Accordingly, in some embodiments, the power conversion circuitry 16 may include circuit elements, such as transformers, rectifiers, switches, and so forth, capable of converting the AC input power to a direct current electrode positive (DCEP) or direct current electrode negative (DCEN) output, as dictated by the demands of the system 10. Additionally, a lead cable 24 terminating in a clamp 26 couples the power conversion circuitry 16 to a workpiece 28 and closes the circuit between the power supply 12, the workpiece 28, and the welding torch assembly 14.

[0018] The welding power supply 12 also includes control circuitry 30 that is configured to receive and process a plurality of inputs regarding the performance and demands of the system 10. The control circuitry 30 includes processing circuitry 32 and memory 34. The memory 34 may include volatile or non-volatile memory, such as read only memory (ROM), random access memory (RAM), magnetic storage memory, optical storage memory, or a combination thereof. Furthermore, a variety of control parameters may be stored in the memory 34 along with code configured to provide a specific output (e.g., initiate wire feed, enable gas flow, etc.) during operation. The processing circuitry 32 may also receive one or more inputs from an operator interface 36, through which the user may choose a process and input desired parameters (e.g., voltages, currents, particular pulsed or non-pulsed welding regimes, and so forth). The processing circuitry 32 is also coupled to gas control valving 38, which regulates the flow of shielding gas from a gas cylinder 40 to the torch 14. In general, such gas is provided at the time of welding, and may be turned on immediately preceding the weld and for a short time following the weld.

[0019] Based on such inputs received from the operator, the control circuitry 32 operates to control generation of welding power output for carrying out the desired welding operation, for example, via control signals transmitted to the power conversion circuitry 16. Based on such control commands, the power conversion circuitry 16 is configured to create the output power that will ultimately be applied to the welding wire at the torch 14. To this end, as noted above, various power

conversion circuits may be employed, including choppers, boost circuitry, buck circuitry, inverters, converters, and so forth.

[0020] As shown, the welding power supply 12 provides power, control signals, and gas to the welding torch assembly 14 via leads 20, 42, and 44, respectively. In the illustrated embodiment, the leads 20, 42, and 44 combine into lead assembly 22 that couples the welding power supply 12 to the welding torch assembly 14. The illustrated welding torch assembly 14 includes a temperature sensing system 46 that may be utilized to sense a temperature of the workpiece 28. To that end, the depicted temperature sensing system 46 includes a display 48, a temperature probe 50, and an energy storage device 52. In certain embodiments, components of the temperature sensing system 46 may be integrated into the welding torch assembly 14. For example, in one embodiment, the temperature probe 50 including the display 48 may be coupled to a TIG welding torch of the welding torch assembly 14 and may be configured for use while attached to the TIG welding torch, as described in more detail below.

[0021] During operation, the temperature sensing system 46 may be utilized to measure the temperature of the workpiece 28, and the measured temperature may be displayed on the display 48. Further, in some embodiments, when the temperature sensing system 46 acquires such data regarding the temperature of the workpiece 28, this data is communicated to the control circuitry 30 located in the welding power supply 12 via lead assembly 22. In certain embodiments, once the acquired data is communicated to the control circuitry 30, the temperature may be communicated to the operator, for example, via the operator interface 36. However, in other embodiments, the temperature probe 50 may acquire the data and display the measurements on the display 48 to communicate the temperature of the workpiece to the operator.

[0022] In the illustrated embodiment, the energy storage device 52 is provided, for example, to produce power for operation of the temperature probe 50. The energy storage device 52 may be any suitable device capable of storing and discharging energy, such as a battery. In some embodiments, the energy storage device 52 may be

removable from the temperature sensing system 46 to facilitate replacement or recharging of the device 52. However, in other embodiments, the energy storage device 52 may be irremovable and configured for charging while remaining integrated with the temperature sensing system 46.

[0023] Again, it should be noted that the temperature sensing system 46 may be provided as an integral part of the welding torch assembly 14 in some embodiments. That is, the temperature sensing system 46 may be integrated into the torch assembly 14, for example, during manufacturing of the torch. However, in other embodiments, the temperature sensing system 46 may be provided as a retrofit kit that may endow existing torch assemblies with the temperature sensing capabilities described herein. To that end, such retrofit kits may be configured as wired or wireless devices capable of communicating with one or more controllers of the weld system. For example, in one embodiment of the retrofit kit, the temperature sensing system 46 may be configured to mount to the welding torch and be programmable to communicate with the desired controller (e.g., control circuitry 30 located in the welding power supply) or to communicate directly with the operator via a display. In such an embodiment, the retrofit kit may be the temperature sensing system 46.

[0024] FIG. 2 illustrates an embodiment of the welding torch assembly 14 having the temperature sensing system 46. The illustrated embodiment includes a TIG welding torch 54 having a handle 56, a shielding cone 58, a heat shield 60, a back cap 62, and a tungsten electrode 64. As shown, in this embodiment, the temperature probe 50 is mounted to the back cap 62 of the TIG welding torch 54. The temperature probe 50 is depicted in an attached position with respect to the back cap of the welding torch 54. In some embodiments, the temperature probe 50 may be integrated with the welding torch 54 such that tools are required for the removal of the temperature probe 50 from the welding torch 54. However, in other embodiments, the temperature probe 50 may be reversibly coupled to the back cap 62 of the welding torch 54 in a tool-less engagement such that the temperature probe 50 may be attached and detached from the back cap 62 without the use of tools.

[0025] While the temperature probe 50 is shown mounted to the back cap 62 of the welding torch 54 in the illustrated embodiment, it should be noted that in other embodiments, the temperature probe 50 may be coupled to the welding torch 54 in a variety of other locations. Indeed, in embodiments in which the temperature sensing system 46 is provided as a retrofit kit for existing welding torches, the temperature sensing system 46 may include implementation-specific features that facilitate the coupling of the temperature probe 50 to existing welding torches. For example, the temperature probe 50 may include recesses or protrusions designed to receive or insert into portions of existing welding torches.

[0026] During operation, the TIG welding torch 54 may be utilized by a welding operator to perform a welding process. That is, the welding power supply 12 provides power and shielding gas to the welding torch 54 for use at the weld location. The shielding gas is directed toward the weld area with the shielding cone 58, and the tungsten electrode 64, which is typically non-consumable, is utilized to produce the weld. It may be desirable to monitor the temperature of the workpiece 28 at various time points before, during, and after the welding operation. For example, in some instances, it may be desirable to preheat the workpiece 28 to a desired temperature before beginning the welding operation. Further, in some instances, it may be desirable to maintain the temperature of the workpiece 28 below a predetermined level during the welding operation to remain in accordance with welding guidelines for the particular part that is being welded.

[0027] The temperature sensing system 46, whether integral with the welding torch 54 or removably coupled to the welding torch 54, is configured to sense the temperature of the workpiece when a temperature measurement is desired by the operator. For example, in embodiments in which the temperature probe 50 is integral with the welding torch 54, the operator may rotate the welding torch to position an end portion 66 of the temperature probe 50 in proximity to the workpiece 28. In other embodiments, the operator may remove the temperature probe 50 from the back cap 62 of the welding torch 54 without the use of tools, position the end portion 66 of the temperature probe near or on the workpiece 28 for the temperature reading, and reattach the temperature probe 50 to the welding torch 54. However, regardless of the

attachment between the temperature probe 50 and the welding torch 54, in the illustrated embodiment, the temperature probe 50 may display the measured temperature on the display 48 to communicate the workpiece temperature to the operator at the weld location. In other embodiments, the temperature probe 50 may communicate the measured temperature to the operator through other interfaces, such as the operator interface 36 located on the welding power supply 12.

[0028] FIG. 3 illustrates an alternate embodiment of a welding system 68 including the welding power supply 12 and the welding torch assembly 14. As before, the welding power supply 12 includes the power conversion circuitry 16, the control circuitry 30, and the operator interface 36 that operate as previously described. However, the welding power supply 12 also includes interface circuitry 70 that facilitates communication between the control circuitry 30 of the welding power supply 12 and components of the temperature sensing system 46. Additionally, in this embodiment, the welding power supply 12 also includes a connection to another gas cylinder 72, which may contain a gas (e.g., argon) suitable for cleaning or cooling of one or more components of the temperature sensing system 46.

[0029] In the depicted embodiment, the welding torch assembly 14 includes an alternate embodiment of the temperature sensing system 46. The temperature sensing system 46 includes interface circuitry 74, gas control valving 76, and an radiation thermometer 78. The radiation thermometer 78 includes signal processing circuitry 80, a sensor 82, a lens 84, and a spectral filter 86. The sensor 82 may be any of a variety of suitable sensors capable of measuring the temperature of the workpiece 28. For example, in certain embodiments, the sensor 82 may be an optical pyrometer capable of detecting infrared radiation from the workpiece 28 to determine the temperature of the workpiece without coming into contact with the workpiece 28. That is, in some embodiments, the sensor 82 may be capable of measuring the temperature of the workpiece 28 via a non-contact method. Additionally, the sensor 82 may be formed from a variety of suitable materials, such as lead selenide, lead sulfide, gallium indium arsenide, fiber optics, and so forth.

[0030] During operation, the radiation thermometer 78 is controlled to measure the workpiece temperature, for example, at a location outside of a gas shielding area existing about the weld area. That is, as thermal radiation is emitted from the workpiece 28, the infrared sensing system 46 measures the temperature of the workpiece 28 by converting the radiant power contained in the emitted heat into an electrical signal corresponding to the amount of detected heat. Specifically, in one embodiment in which the sensor 82 is an optical pyrometer, the thermal radiation may be focused onto a detector with a suitable optical system to determine the temperature of the workpiece 28.

[0031] In the depicted embodiment, the sensor 82 detects the thermal radiation being emitted by the workpiece 28, and the thermal radiation is converted into an electrical signal that is communicated to the signal processing circuitry 80. The signal processing circuitry 80 processes the electrical signals from the sensor 82, for example, by filtering the received signals to remove noise introduced from the welding environment. Additionally, the signal processing circuitry 80 may be configured to communicate the received temperature measurements to the control circuitry 30 located in the welding power supply 12. For example, the signal processing circuitry 80 may communicate the temperature measurements to the control circuitry 30 via the interface circuitry 74, the lead assembly 22, and the interface circuitry 70. The control circuitry 30 may further process or store the received temperature measurements, for example, in order to track the temperature of the workpiece 28 throughout the welding operation or to monitor the workpiece temperature to ensure that the temperature does not exceed a predetermined threshold.

[0032] Still further, the welding system 68 includes a protective and/or cooling circuit 88 capable of circulating fluid to components of the radiation thermometer 78 for protection and/or cooling of such components. In one embodiment, the circuit 88 may include the gas cylinder 72, the gas control valving 38, the gas lead 90, and the gas control valving 76. In one embodiment, the circuit 88 may be configured to circulate a gas (e.g., argon) suitable for cleaning of the lens 84 from the gas cylinder 72 to the lens 84. In another embodiment, the circuit 88 may be configured to

circulate a gas (e.g., argon) suitable for cooling of the sensor 82 from the gas cylinder 72 to the sensor 82.

[0033] FIG. 4 is a perspective view of an embodiment of the welding torch assembly 14 including a TIG welding torch 92 having the temperature sensing system 46 mounted thereon. In the illustrated embodiment, the temperature sensing system 46 includes an assembly 94 capable of coupling to the welding torch 92 and measuring a temperature of the workpiece 28 without directly contacting the workpiece 28. The assembly 94 includes a torch mount 96, an adjustable coupling device 98 (e.g., a gooseneck), a mounting assembly 100, a sensor assembly 102, and a targeting assembly 104. The torch mount 96 is utilized to couple the assembly 94 to the welding torch 92, and the adjustable coupling device 98 is utilized to position the sensor assembly 102 in the desired position with respect to a weld bead on a workpiece.

[0034] More specifically, during operation, the adjustable coupling device 98 is adjusted to position the sensor assembly 102 such that the sensor assembly 102 is located in a position suitable for obtaining temperature measurements of the workpiece 28 without contacting the workpiece 28. In some embodiments, the adjustable coupling device 98 may be manually adjusted by an operator or may be automatically adjusted to the desired position by a suitable controller, such as control circuitry 30 located in the welding power supply 12. Once positioned, the sensor assembly 102 and the targeting assembly 104 cooperate to obtain a measurement of the temperature of the workpiece via a non-contact method. These temperature measurements may be obtained continuously throughout the welding operation, for example, to monitor the workpiece temperature throughout the operation, or at desired time intervals, for example, to check that the workpiece temperature does not exceed a desired threshold.

[0035] Embodiments of the components of the mounting assembly 100, the sensor assembly 102, and the targeting assembly 104 are shown in more detail in the exploded view of FIG. 5. As shown in FIG. 5, the mounting assembly 100 includes mounting device 106. The mounting device 106 includes an extension 108 capable of

receiving and securing a body 110 of the targeting assembly 104. Further, the mounting device 106 also includes a coupling device 113 that couples the mounting device 106 to the adjustable coupling device 98. Additionally, the mounting device 106 includes an aperture 112 disposed in a bottom portion 114 of the mounting device 106 and shaped to receive components of the sensor assembly 102.

[0036] In the illustrated embodiment, the sensor assembly 102 includes an air purge jacket having a first portion 116 and a second portion 118 and a pyrometer 120 adapted to be received between the air purge jacket portions 116 and 118. The air purge jacket portion 116 includes an extension 122. In the illustrated embodiment, the extension 122 is dimensioned to be received by the aperture 112 in the mounting device 106 such that a bottom portion 124 of the air purge jacket portion 116 contacts the bottom portion 114 of the mounting device 106.

[0037] FIG. 6 is a schematic illustrating operation of the welding torch assembly 14 and the temperature sensing system 46 shown in FIG. 4. As illustrated, the schematic includes a weld bead 126 during formation on the workpiece 28 as a welding operation proceeds along the length of the workpiece 28. A welding arc 128 is established between the tungsten electrode 64 and the workpiece 28, thereby forming a weld pool 130. The weld pool 130 is located in a welding area 132 established by the boundaries of a shielding gas cone 134. A laser 136 originating from the targeting assembly 104 targets a temperature detection zone 138 in which the temperature of the workpiece 28 is measured.

[0038] In some embodiments, the temperature detection zone may be located at a position that is outside of the weld pool 130. For example, in certain embodiments, the temperature detection zone 138 may be located outside of the welding area 132 defined by the shielding gas cone 134 or may be located along the periphery of the shielding gas cone 134. Indeed, the temperature detection zone 138 may be positioned at any desired location in a heat affected zone 140 extending outward along the workpiece from the weld bead 126 and the weld pool 130.

[0039] During operation, as the welding operation proceeds in the direction indicated by arrow 142, the temperature sensing system 46 acquires data corresponding to the temperature of the workpiece 28 in the temperature detection zone 138. The temperature sensing system 46 may then process the received data or may transfer the data to a suitable controller before communicating the detected temperature to the operator. Because the temperature sensing system 46 is capable of acquiring data corresponding to the temperature of the workpiece 28 during the welding operation, presently disclosed embodiments may reduce or eliminate the need for an operator to stop welding in order to determine the workpiece temperature. The foregoing feature may offer advantages over systems that do not have an integrated temperature sensing system and may require an operator to stop welding in order to verify that the workpiece temperature has not exceeded a predetermined threshold.

[0040] FIG. 7 is a schematic illustrating operation of an alternate embodiment of the temperature sensing system 46 capable of detecting the temperature of the workpiece 28 at a plurality of locations. That is, the temperature sensing system 46 of FIG. 7 is configured to utilize a non-contact method to measure data corresponding to the temperature of the workpiece 28 in the plurality of temperature detection zones 138. In the illustrated embodiment, the temperature detection zones 138 are disposed about the perimeter of the shielding gas cone 134. However, in other embodiments, the temperature detection zones 138 may be located anywhere within the heat affected zone 140. Therefore, as compared to traditional systems, presently disclosed embodiments may enable monitoring of the workpiece temperature at a plurality of locations instead of a single location. In certain embodiments, this feature may enable a suitable processor, such as signal processing circuitry 80, to identify which locations in the heat affected zone 140 are hotter than others, thus enabling the temperature sensing system with the ability to identify hot spots during the welding operation.

[0041] While only certain features of the invention have been illustrated and described herein, many modifications and changes will occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

CLAIMS:

1. A welding system, comprising:
a welding torch configured to be utilized in a welding operation to establish a welding arc between the welding torch and a workpiece; and
a temperature sensing system integral with the welding torch and configured to sense a temperature of the workpiece.
2. The welding system of claim 1, wherein the welding torch is a tungsten inert gas welding torch configured to establish the welding arc between a tungsten electrode and the workpiece.
3. The welding system of claim 2, wherein the temperature sensing system comprises a digital temperature probe integral with a cap portion of the tungsten inert gas welding torch.
4. The welding system of claim 3, wherein the temperature sensing system further comprises a digital display configured to display the sensed temperature of the workpiece.
5. The welding system of claim 1, wherein the temperature sensing system is reversibly coupled to the welding torch in a tool-less engagement.
6. The welding system of claim 1, wherein the temperature sensing system is coupled to the welding torch in an engagement that is configured to be irreversible without the use of tools.
7. The welding system of claim 1, wherein the temperature sensing system comprises a non-contact sensor configured to sense the temperature of the workpiece without establishment of physical contact between the non-contact sensor and the workpiece.

8. The welding system of claim 1, wherein the temperature sensing system comprises a contact sensor configured to sense the temperature of the workpiece via physical contact between the contact sensor and the workpiece.

9. The welding system of claim 8, wherein the contact sensor comprises a thermocouple, a resistance thermometer, a thermistor, or a combination thereof.

10. The welding system of claim 1, comprising a welding system, wherein the temperature sensing system is configured to communicate data relating to the sensed temperature to the welding system, and the welding system is configured to store the communicated data.

11. A welding system, comprising:
a welding power source comprising power conversion circuitry configured to receive primary power and to convert the primary power to a weld power output for use in a welding operation; and
a temperature sensing system integral with a welding torch and comprising a temperature probe configured to sense a temperature of a workpiece; and a display configured to display the sensed temperature of the workpiece.

12. The welding system of claim 11, wherein the temperature probe comprises a thermocouple, a resistance thermometer, a thermistor, an optical pyrometer, or a combination thereof.

13. The welding system of claim 11, wherein the welding power source comprises control circuitry configured to control operation of the power conversion circuitry to provide the weld power output and an auxiliary power output configured to power to the temperature sensing system.

14. The welding system of claim 11, wherein the temperature sensing system comprises an energy storage device configured to provide energy to power operation of the temperature sensing system.

15. The welding system of claim 14, wherein the energy storage device comprises a battery configured to be removed from the temperature sensing system.

16. The welding system of claim 11, comprising gas control valving configured to regulate the flow of gas to the welding torch.

17. The welding system of claim 11, wherein the welding torch comprises a tungsten inert gas torch configured to establish the welding arc between a tungsten electrode and the workpiece.

18. The welding system of claim 11, comprising a welding system, wherein the temperature sensing system is configured to communicate data relating to the sensed temperature to the welding system, and the welding system is configured to store the communicated data.

19. A welding system, comprising:
a welding torch configured to be utilized in a welding operation to establish a welding arc between the welding torch and a workpiece; and
a temperature sensing system reversibly coupled to the welding torch in a tool-less engagement and configured to sense a temperature of the workpiece.

20. The welding system of claim 19, wherein the temperature sensing system comprises a temperature probe configured to sense the temperature and a display configured to display the sensed temperature.

21. The welding system of claim 19, wherein the temperature sensing system comprises a removable energy storage device configured to provide energy to power operation of the temperature sensing system.

22. The welding system of claim 19, comprising a welding power source configured to provide welding power to the welding torch for establishment of the welding arc.

23. The welding system of claim 19, comprising a welding system, wherein the temperature sensing system is configured to communicate data relating to the sensed temperature to the welding system, and the welding system is configured to store the communicated data.

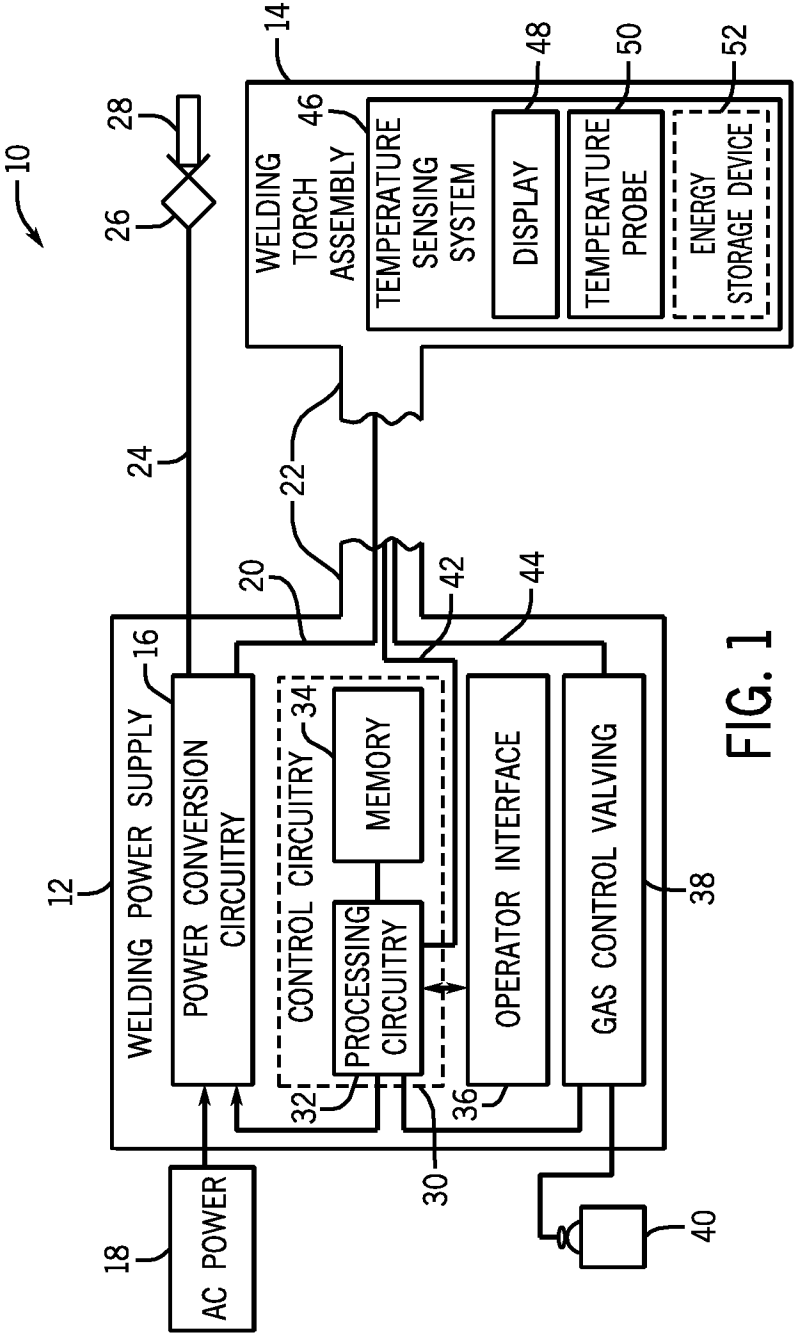
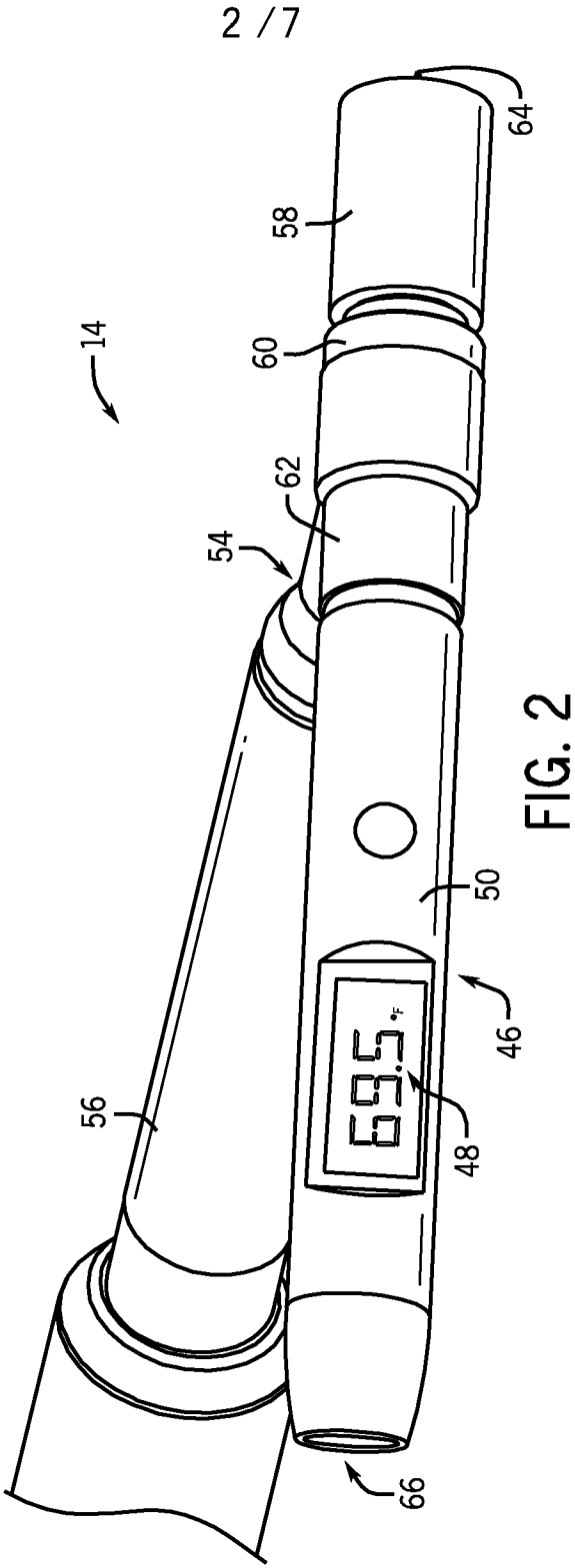


FIG. 1



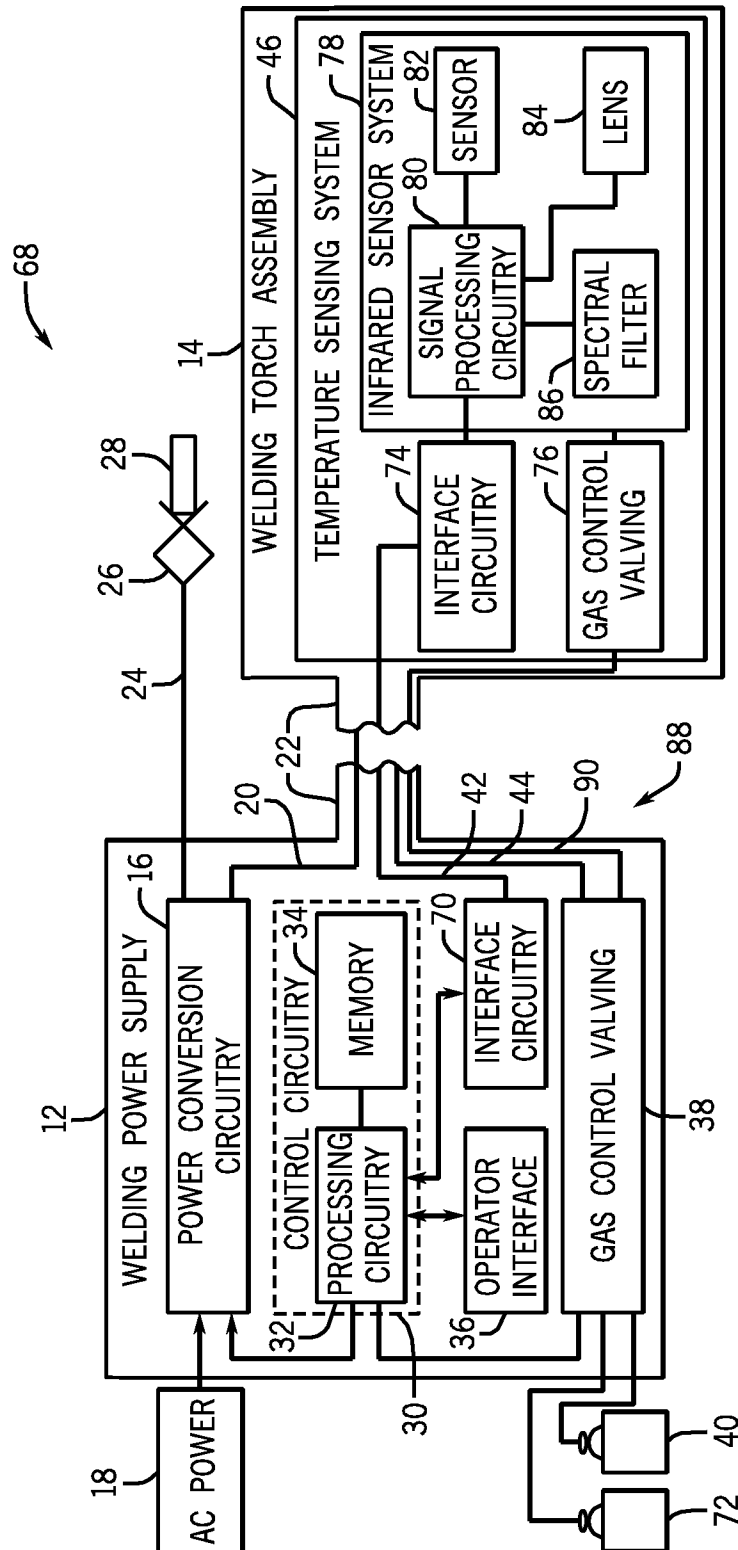
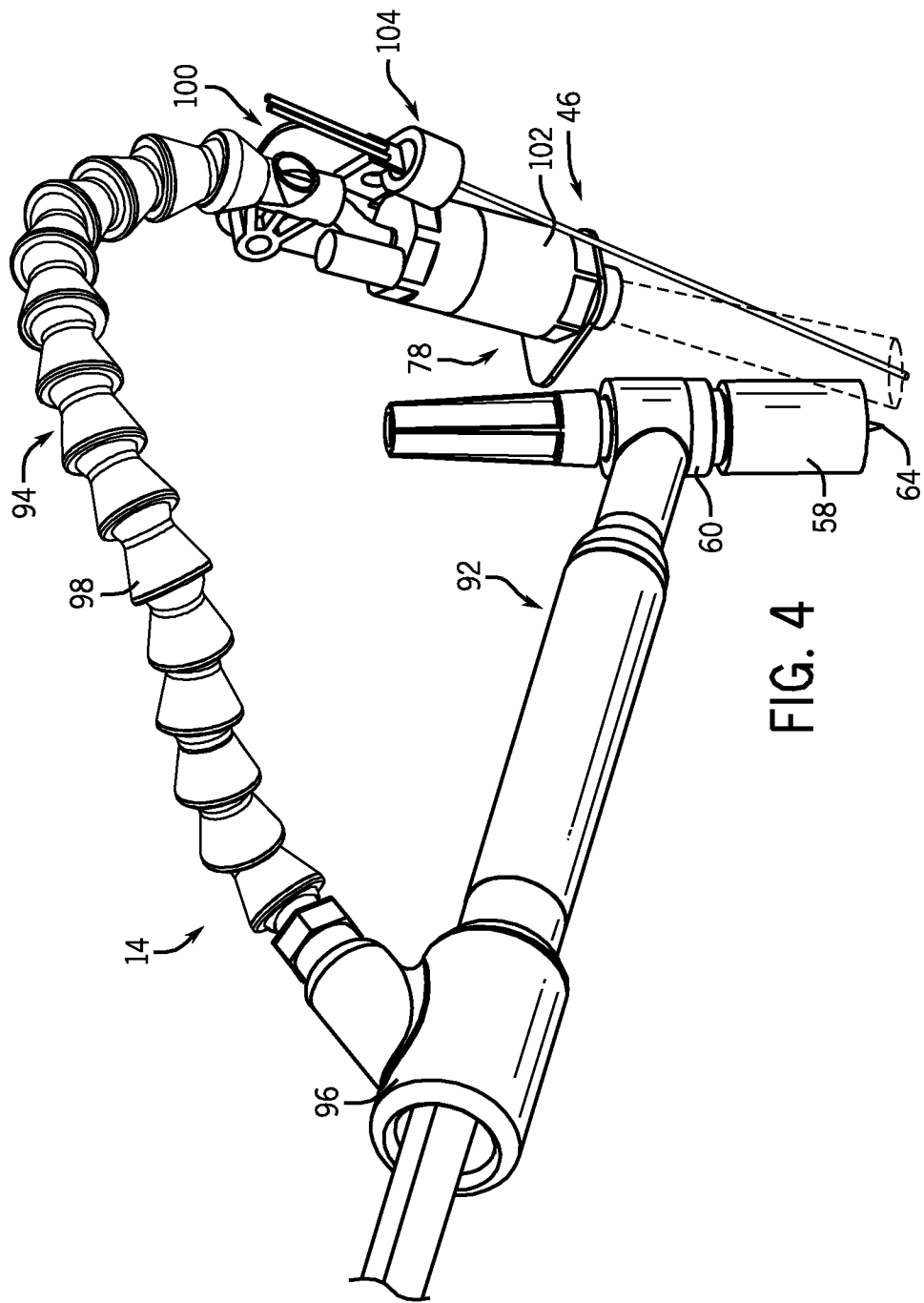
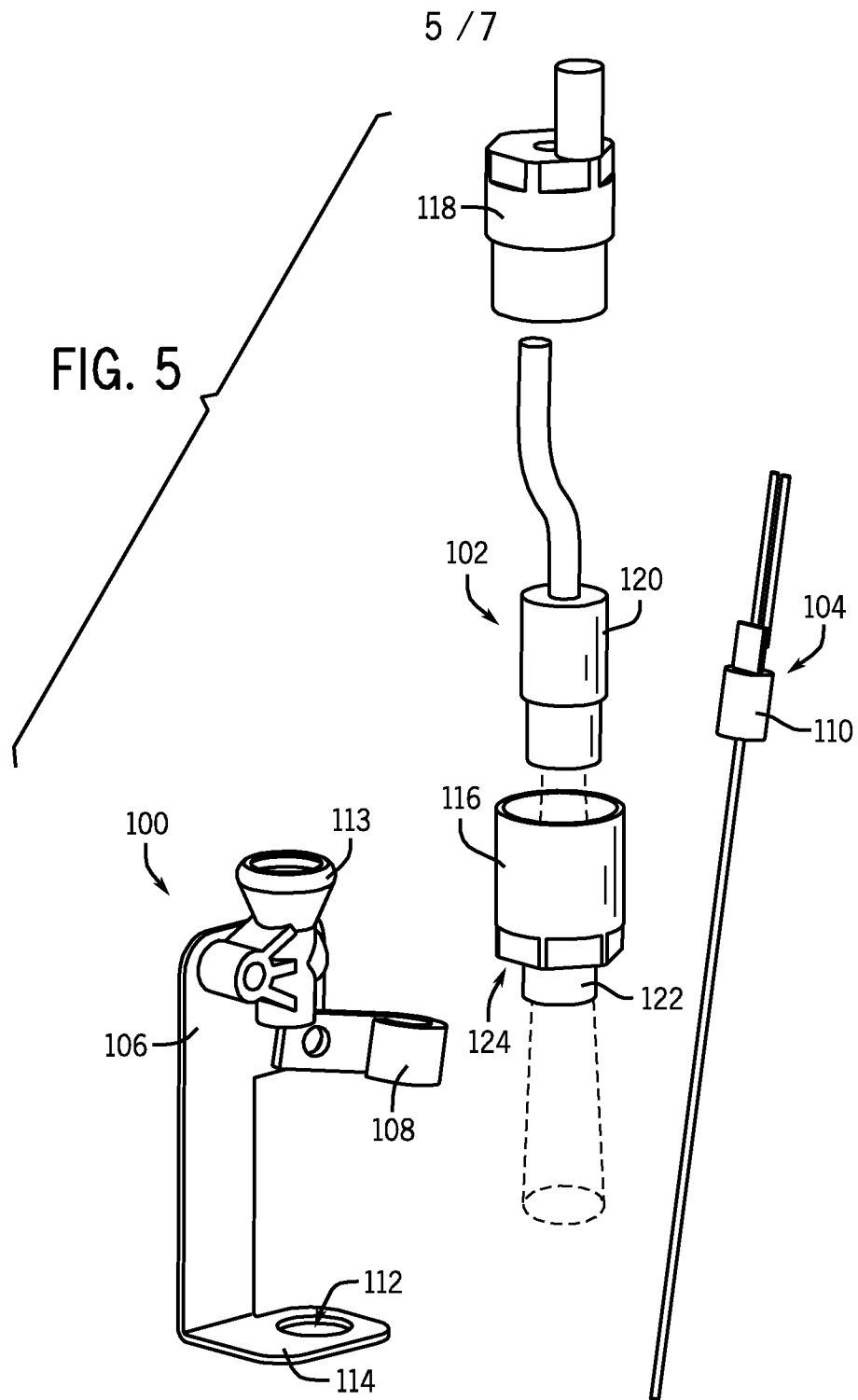


FIG. 3





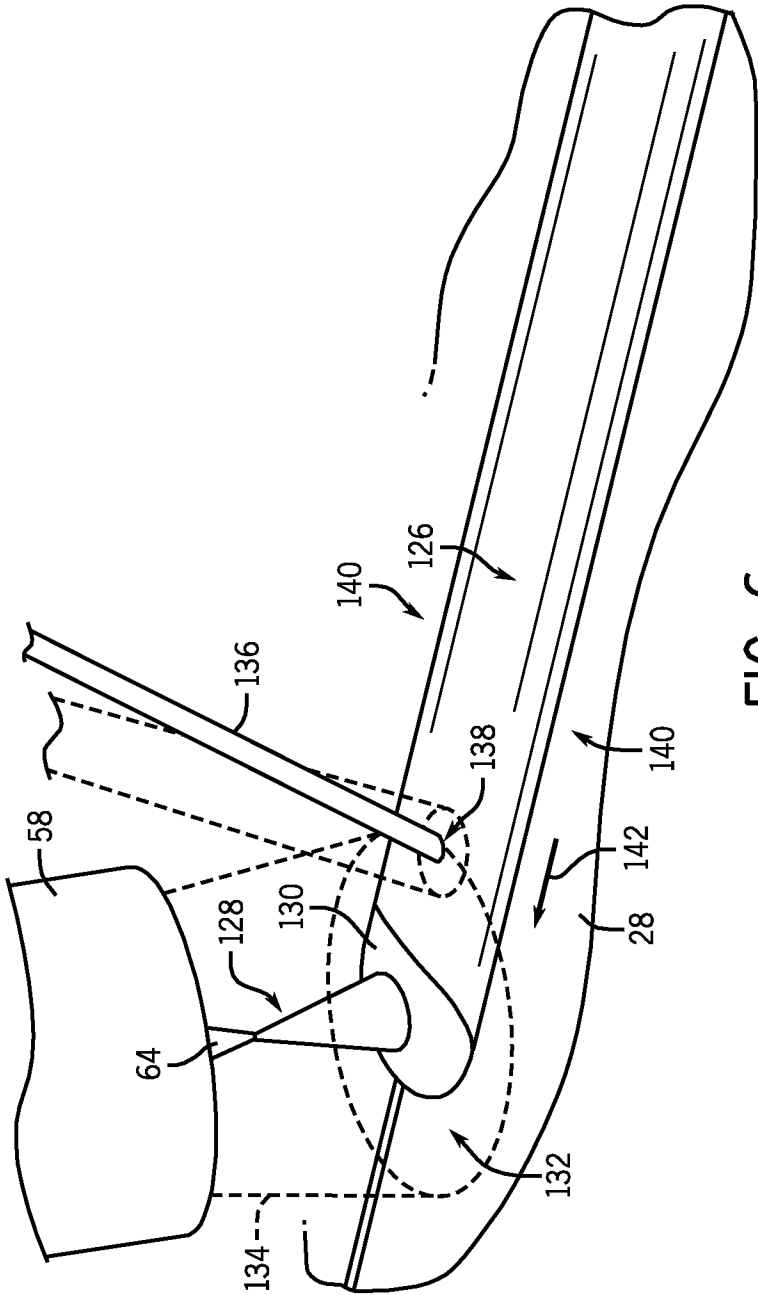
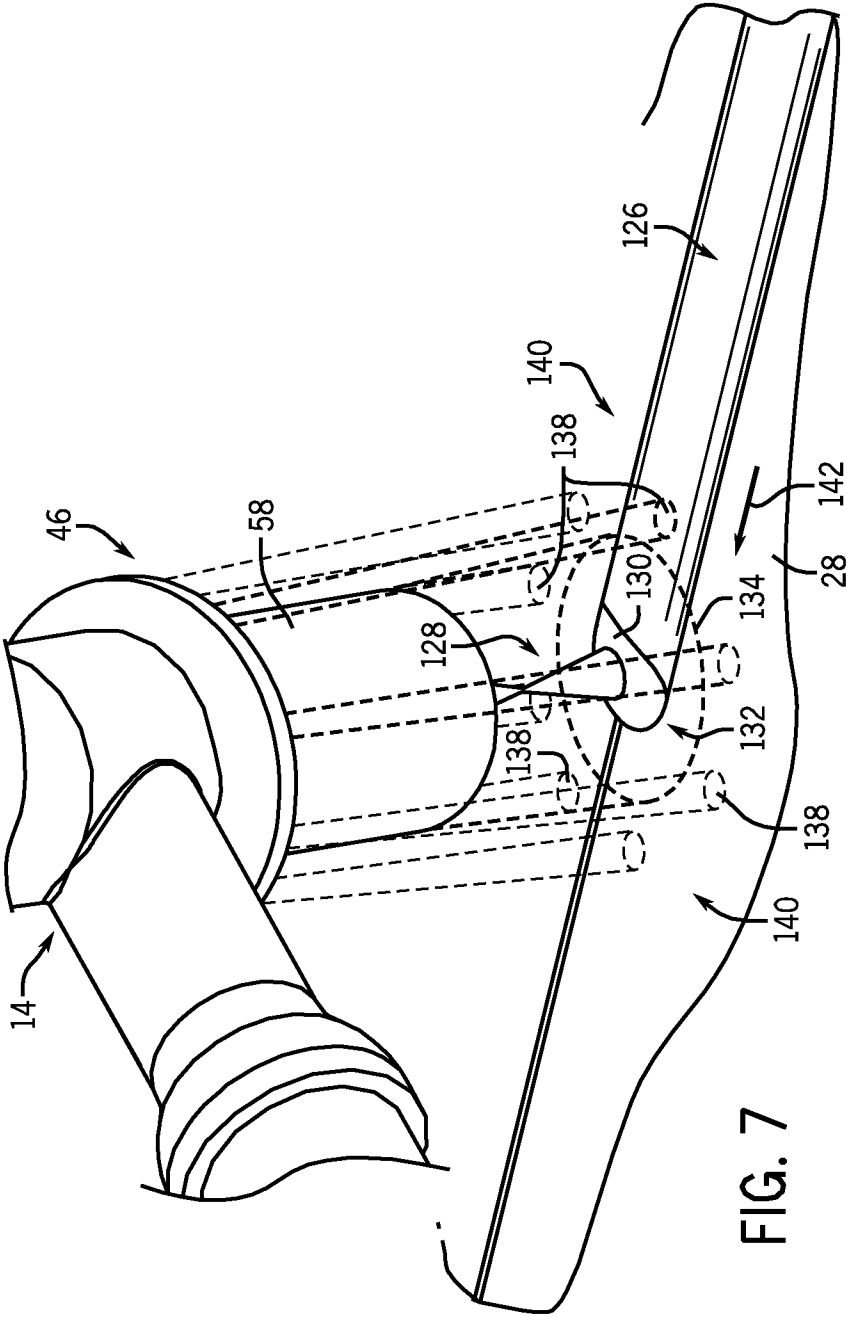


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/035196

A. CLASSIFICATION OF SUBJECT MATTER

INV. B23K9/095 B23K9/32
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 092 753 A2 (GEN ELECTRIC [US]) 2 November 1983 (1983-11-02) page 7, line 3 - page 11, line 14; figures -----	1-7, 10-23
X	US 5 811 055 A (GEIGER MICHAEL B [US]) 22 September 1998 (1998-09-22) column 14, line 27 - column 20, line 3; figures -----	1-4,7, 10-23
A	WO 01/58400 A1 (NEKP SWEDEN AB [SE]; ERIKSSON INGEMAR [SE]) 16 August 2001 (2001-08-16) the whole document -----	1-7, 10-23



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

11 July 2013

Date of mailing of the international search report

23/07/2013

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/035196

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 8, 9(completely); 12(partially)
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2013/035196

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0092753	A2	02-11-1983	CA 1204839 A1 20-05-1986
			DE 3378405 D1 15-12-1988
			EP 0092753 A2 02-11-1983
			IL 67892 A 31-01-1986
			JP S6239070 B2 20-08-1987
			JP S58212873 A 10-12-1983
			US 4484059 A 20-11-1984

US 5811055	A	22-09-1998	NONE

WO 0158400	A1	16-08-2001	AU 3255001 A 20-08-2001
			SE 515707 C2 01-10-2001
			SE 0000432 A 12-08-2001
			US 2003001950 A1 02-01-2003
			WO 0158400 A1 16-08-2001

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 8, 9(completely); 12(partially)

The feature of claims 8, 9 and 12 related to contact sensing, is not referred to in the description. Claim 8, 9 and 12 (part) are therefore not supported by the description as required by Article 6 PCT.

Moreover,
the skilled person cannot derive the necessary information from the application and from his own knowledge, that would enable him to construct a temperature contact sensor adapted to sense the temperature of a workpiece, while being moved together with the torch, in the same manner as the contact-less sensors described in the application. The invention claimed in claims 8, 9 and partially claim 12 is therefore not described in a manner sufficiently clear and complete for a skilled person to perform it, Article 5 PCT.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.