

SMART WELDING CONNECTOR AND ASSOCIATED METHOD THEREOF

TECHNICAL FIELD

[0001] The present disclosure generally relates to electrical connectors in the metal fabrication field, and more particularly, to an electrical connector for enabling electrical connection between a welding machine and a plurality of welding tools. Specifically, the present disclosure relates to a welding connector having an in-built mechanism for measuring and recording welding parameters such as current and voltages, weld joint heating temperatures and welding duration in real time while the welding tools are being utilized.

BACKGROUND

[0002] Metal fabrication involves the construction of metal components and structures from iron, steel and a variety of other metals. Typical metal fabrication products include metal parts, frames for buildings and heavy equipment, pressure vessels such as boilers, and structural parts for buildings and marine structures. The metal fabrication processes are usually conducted in a fabrication yard or workshop such as a shipyard and include welding, cutting, forming and machining activities. Metal arc welding is the main activity when joining the iron and steel pieces together. However, other metals such as aluminum and brass for example, can also be welded together. The welding work is usually carried out by skilled welders and involves good dexterity and attention to detail, as well as technical knowledge about the metals being joined and best practices in the field.

[0003] The welding electrode holder is usually the only welding tool connected to a welding machine as illustrated in Fig. 1. However, in a typical fabrication facility such as a shipyard, the welding work may in addition, include other welding accessories such as electrode dryers (also known as quivers) for storing the electrodes near to the welders for reasons of ease and efficiency. Hence, the power supply from a welding machine can be shared by an electrode holder as well as a heated quiver or even a combination of other welding accessories that require a source of power supply for their operation.

[0004] There is currently no industry standard for connecting these welding tools and accessories to the welding machine and different operators may resort to self-improvised connection methods based on individual preferences with perhaps some due considerations on functional ability, convenience, ease of connection and safety.

[0005] Self-improvised connection methods may pose several problems. For example, using a welding electrode holder to connect to a welding accessory such as an electrode dryer prevents the welder from continuing the welding process and results in excessive downtime and loss of productivity for the welders. Improper sealing of cable connections will cause electrocution when a human body comes into contact with exposed wires. The exposed wires may additionally cause sparks due to arcing when in contact with the ground, thereby creating fire hazards. The need to provide additional cables from the welding machine to the supporting welding tool further results in tripping hazards to the welder and other workers within the vicinity of the welding work.

[0006] Suitable connectors such as the T-connector disclosed in Singapore patent application number 10201400863U provide a good and safe connection to connect support tools and accessories to the welding machines. The connection using such a connector is illustrated in Fig. 2. However, provision of such an electrical connection for powering welding accessories is not sufficient to ensure good quality and safe welding operations. In a typical welding operation, it is also important to ensure that welding parameters such as current and voltages are preset and carried out according to approved welding specifications. In addition, preheating of the weld joint up to a specific temperature is also required as part of the welding control parameters as is recording of welding duration or ‘arc-time’ for quality control and/or to measure the productivity of the welding operation. The current method of measuring pre-heat and interpass temperatures of weld joints is by means of temperature indicating sticks or a temperature gun (infrared thermometer). This method requires the welder to carry the devices separately and the temperatures have to be manually taken regularly during the welding operation. For recording of ‘arc-time’, another operator may need to be deployed using conventional stop-watches, and as such the time has to be recorded separately.

[0007] Fig. 3 illustrates how electrical measuring devices such as a clamp meter and a voltmeter are used to measure the current and voltage available to the welding electrode when the welding work is in progress. Such electrical measuring devices are used mainly during quality inspections by the welding inspectors but pose several disadvantages. Measuring current and voltages using a clamp meter or a multi-meter can be invasive and therefore may be hazardous, for example, posing electrocution risks to the user if the devices are not connected properly. In addition, these measuring devices are usually heavy and bulky and require considerable effort to set up before measurements can take place in situ. Another key disadvantage is that these measurements can only be carried out selectively and on an ad-hoc basis according to work requirements and may not be accessible to all welding operations nor can they be carried out on a 'round-the-clock' basis.

[0008] In view of the foregoing, there is therefore a need to provide a multi-functional connector capable of measuring the desired welding parameters in order to overcome or at least ameliorate one or more of the shortcomings described above. The non-limiting exemplary embodiments of this disclosure satisfy such a need by providing an electrical connector with an in-built mechanism for measuring the current, voltage, heating temperature and welding duration available to the welding operator or welding inspector in real time while the welding work is in progress.

SUMMARY

[0009] In view of the foregoing background, it is therefore an object of the non-limiting exemplary embodiments of the present disclosure to provide an electrical connector having an in-built capability for measuring current, voltages, heating temperature and welding duration in real time while the welding tool is being utilized.

[0010] In accordance with one aspect of the present disclosure, there is disclosed an electrical connector for use in conjunction with an electrical power source. The electrical connector may include a unitary sheath for housing a primary and a second conductor and at least one encapsulated mechanism in electrical communication with a processor for measuring welding parameters in real time.

[0011] The encapsulated mechanism may include a mechanism for measuring the primary current available to a first electrical tool; a mechanism for measuring the primary voltage available to the first electrical tool; a mechanism for measuring the heating temperature at the work piece such as a welding joint; a mechanism for measuring the duration of the primary current flow across the work piece; a display for indicating the values of the primary current and voltages available to the first electrical tool, and the heating temperature and duration of primary current flow across the work piece; and a data logging module for capturing and recording the values of the primary current and voltages available to the first electrical tool, and the heating temperature and duration of primary current flow across the work piece. The encapsulated mechanisms may further be operable in simultaneous and independent modes.

[0012] In accordance with one aspect of the present disclosure, the primary conductor may include a first connecting member for electrical communication with a power source and a second connecting member for electrical communication with a first electrical tool.

[0013] In accordance with one aspect of the present disclosure, the electrical conductor may include a second conductor extending outwardly from the primary conductor for electrical communication with a second electrical tool.

[0014] In accordance with one aspect of the present disclosure, the electrical connector may include a secondary circuitry in electrical communication with the primary current for detecting the primary current at the second connecting member of the primary conductor.

[0015] In accordance with one aspect of the present disclosure, the electrical connector may include a DC power source in electrical communication with the secondary circuitry, the processor and the display. Such a DC power source may include one or more rechargeable or non-rechargeable disposable batteries. The DC power source may further be enclosed in a water resistant enclosure formed in the unitary sheath. Such an enclosure may further include a cover to prevent ingress of water.

[0016] In accordance with one aspect of the present disclosure, the display may include a digital LED display having resettable multi-unit readings for indicating current, voltage, heating temperature and time duration of the welding or arc time.

[0017] In accordance with one aspect of the present disclosure, the mechanism for measuring the primary current includes a current transformer disposed at a portion of the second connecting member of the primary conductor. In this way, the current transformer advantageously induces a secondary current electrically communicated to the processor for generating a value of the primary current at the digital LED display.

[0018] In accordance with one aspect of the present disclosure, the mechanism for measuring the primary voltage includes a first measuring point located on the second connecting member and a second measuring point connectable to the work piece. The second measuring point may include a socket in electrical communication with the first measuring point. The socket may further be located on the sheath of the connector for electrical communication with the work piece via a cable.

[0019] In accordance with one aspect of the present disclosure, the mechanism for measuring the heating temperature at the work piece includes a data acquisition device in electrical communication with the processor and a thermocouple detachably engaged to the work piece. The thermocouple may be in electrically communication with the data acquisition device via a cable and further be in electrical communication with the DC power source.

[0020] In accordance with one aspect of the present disclosure, the mechanism for capturing the duration of the primary current flow across the work piece includes an hour meter mounted within the connector and a relay in electrical communication with the processor. The hour meter may further be in electrical communication with the DC power source.

[0021] In accordance with one aspect of the present disclosure, the data logging module may include a user interface for communicating with a computer via wire or wireless connections; and a visual aid located at the display for indication of stored memory capacity. Such a data logging module may further be in electrically communication with the processor.

[0022] In accordance with one aspect of the present disclosure, the power source may include a welding machine.

[0023] In accordance with one aspect of the present disclosure, the first electrical tool may include at least one of a welding electrode holder and the second electrical tool may include at least one of a welding electrode quiver.

[0024] In accordance with one aspect of the present disclosure, the unitary sheath may be in immovable close contact to provide rigid encapsulation of the primary and second conductor, secondary circuitry, the processor and LED display.

[0025] In accordance with another aspect of the present disclosure, there is disclosed a method for measuring and recording welding parameters such as current and voltages, weld joint heating temperatures and welding duration in real time while the welding tools are being utilized on a work piece. Such a method may include the steps of: providing a unitary sheath for housing a primary and a second conductor and providing at least one encapsulated mechanism in electrical communication with a processor for measuring welding parameters in real time.

[0026] In accordance with one aspect of the present disclosure, the method of providing the encapsulated mechanism may include the steps of: providing a mechanism for measuring the primary current available to a first electrical tool; providing a mechanism for measuring the primary voltage available to the first electrical tool; providing a mechanism for measuring the heating temperature at a work piece; providing a mechanism for measuring the duration of the primary current flow across the work piece; providing a display for indicating the values of the primary current and voltages available to the first electrical tool, and the heating temperature and duration of primary current flow across the work piece; providing a

data logging module for capturing and recording the values of the primary current and voltages available to the first electrical tool, and the heating temperature and duration of primary current flow across the work piece. The method may further provide for the mechanisms to be operable in simultaneous and independent modes.

[0027] In accordance with one aspect of the present disclosure, the method may further include the step of providing the mechanism for measuring the primary voltage with a first measuring point located on a second connecting member and a second measuring point connectable to the work piece.

[0028] In accordance with one aspect of the present disclosure, the method may further include the step of providing the mechanism for measuring the heating temperature at the work piece with a data acquisition device in electrical communication with the processor and a thermocouple detachably engaged to the work piece. The thermocouple may further be in electrically communication with the data acquisition device via a cable.

[0029] In accordance with one aspect of the present disclosure, the method may further include the step of providing the mechanism for capturing the duration of the primary current flow across the work piece with an hour meter mounted within the unitary sheath and a relay in electrical communication with the processor.

[0030] In accordance with one aspect of the present disclosure, the methods for measuring the heating temperature and for capturing the primary current across the work piece may further include the step of providing an electrical communication with a DC power source housed within the unitary sheath.

[0031] In accordance with one aspect of the present disclosure, the method for providing the data logging module may further include the steps of: providing a user interface for communicating with a computer via wire or wireless connections; and providing a visual aid located at the display for indication of stored memory capacity; and the step of providing the data logging module with electrical communication with the processor.

[0032] Advantages of the Invention

The invention as disclosed offers several advantages:

[0033] Firstly, the invention allows measurements and display of both the current and voltage flowing through the welding circuitry for the purpose of quality assurance while the welding work is in progress. This capability serves to prevent and deter welders, knowingly or unknowingly, from deviating away from the required welding parameters. For example, setting a high current to increase welding output will inevitably result in the weld having a high porosity. At same time, the invention also allows the heating temperature to be measured in order to ensure that the correct pre-heat and inter-pass heating temperature is achieved before and during the welding operation. (Ref: Per welding standard, the current, voltage pre-heat and inter-pass heating temperature requirements differ for different welding position, root weld, welding process, material thickness, feeder wire/ electrode thickness, etc.). An added advantage includes the recording of the welding duration for quality and productivity monitoring purposes;

[0034] Secondly, in terms of consistency and accuracy, the invention allows the current and voltage measuring points to be consistent and be situated nearest to the welding source thereby reducing measuring errors as the welding machine with the display settings may be placed at a distance away from the work pieces.

[0035] Thirdly, the invention eliminates complicated set-ups as the measuring mechanism is built into the connector such that the external measuring devices (clamp meter/voltmeter) or additional wiring that needs to be connected at different points to measure the current and voltages are not necessary. In addition, the use of external temperature or time monitoring devices for heating temperature and welding duration monitoring, are also eliminated; and

[0036] Lastly, the invention allows current, voltage, heating temperatures and welding duration measurements to be displayed from a digital LED display located on the housing of the welding connector such that during welding operations, the welding operator

or other personnel such as welding supervisors, quality inspectors, and/or owner representatives may monitor and check the welding parameters against the required settings in a convenient manner. The invention also provides for recording and transfer of measured welding parameters to another computer via wire or wireless communications to allow ease of monitoring and progress tracking of all welding operations by third party personnel who may be located off-site such as project supervisors or project planners.

[0037] There has thus been outlined, rather broadly, the more important features of the present invention in order that the detailed description thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are additional features of the present invention that will be described hereinafter and which will form the subject matter of the claims appended hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] The embodiments of the present disclosure are described hereinafter with reference to the following drawings, in which:

[0039] Fig. 1 is a schematic diagram showing a welding machine electrically connected to a metal work piece in a conventional manner;

[0040] Fig. 2 is a schematic diagram showing a conventional T-connector for providing a safe electrical connection between a welding machine and welding tools;

[0041] Fig. 3 is a schematic diagram showing a conventional arrangement using a clamp meter and a voltmeter to measure the current and voltages when the welding work is in progress;

[0042] Fig. 4 is an illustrative diagram showing an electrical connector equipped with the mechanism for measuring current, voltages, temperature and welding duration in accordance with the non-limiting exemplary embodiments;

[0043] Fig. 5 is a schematic diagram showing the mechanism for measuring current in accordance with the non-limiting exemplary embodiments;

[0044] Fig. 5a is a schematic diagram showing an alternative mechanism for measuring current in accordance with the non-limiting exemplary embodiments;

[0045] Fig. 5b is a schematic diagram showing another alternative mechanism for measuring current in accordance with the non-limiting exemplary embodiments;

[0046] Fig. 6 is a schematic diagram showing the mechanism for measuring voltage in accordance with the non-limiting exemplary embodiments;

[0047] Fig. 7 is a schematic diagram showing the configuration of the mechanisms for measuring the temperature and time duration of the welding process in accordance with the non-limiting embodiments; and

[0048] Fig. 8 is a perspective view of the features of the housing showing the primary body, digital LED display, connectors and battery cap in accordance with the non-limiting embodiments; and

[0049] Fig. 9 is a schematic block diagram showing the system configuration in accordance with the non-limiting embodiments.

[0050] Those skilled in the art will appreciate that the figures are not intended to be drawn to any particular scale; nor are the figures intended to illustrate every embodiment of the present invention. This disclosure is not limited to the exemplary embodiments depicted in the figures or the shapes, relative sizes or proportions shown in the figures.

DETAILED DESCRIPTION

[0051] The non-limiting exemplary embodiments will now be described more fully hereinafter with reference to the accompanying drawings, in which a preferred embodiment of the invention is shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, the present disclosure is provided so that this application will be thorough and complete, and will fully convey the true scope of the invention to those skilled in the art.

[0052] The non-limiting exemplary embodiments of the present disclosure relate to an electrical connector 10 for use in conjunction with an electrical power source such as a welding machine 300 or generator, and welding tools and accessories such as welding electrode holders 400 and portable electrode dryers 600. In particular, the electrical connector 10 includes in-built mechanisms for measuring current, voltages, heating temperatures and welding duration available to the electrode in real time while the welding work is in progress.

[0053] Arc welding as aforementioned, is a method of joining metal work pieces 100 together by applying sufficient electrical pressure to a welding electrode 200 (hereinafter referred to as electrode) to maintain a current path (arc) between the electrode 200 and the work pieces 100. As shown in Fig. 1, the current (I_t) flows from the welding machine 300 to the electrode holder 400, then to the electrode 200 and then back to the welding machine 300. The process results in the electrical energy being converted into heat energy, thus bringing the tip of the electrode 200 to a molten state whereby the metal work pieces 100 are joined together.

[0054] The conventional T-connector 500 referred to in Singapore patent application number 10201400863U allows power to be supplied to an electrode dryer 600 (hereinafter referred to as quiver) as electrical power is being tapped from the welding machine 300, thereby allowing current (I_q) to flow from the T-connector 500 to the quiver 600 and then back to the welding machine 300 in parallel with the current flowing to the electrode 200 and work pieces 100 via the electrode holder 400. Thus, current (I_p) will also flow through the electrode 200 as shown in Fig. 2.

[0055] Fig. 3 shows the conventional method of measuring current available to the electrodes 200 using a conventional clamp meter 800 which is clamped around the welding cable. The current flowing through the welding cable produces a magnetic field at the clamp meter 800 which allows the clamp meter 800 to perform the necessary readings and display the current measurements. Fig. 3 also shows the conventional method of measuring the voltage available to the electrodes 200 using a conventional voltmeter 900. The voltmeter 900 is connected in parallel to the welding machine 300. In such a parallel connection, two test points (positive & negative) are required at the welding machine 300. Such an arrangement poses several disadvantages. For example, measuring voltages using a voltmeter requires the probe to be connected at both the positive (+) and negative (–) ends of the welding connection. This method can be invasive, such as for example, poking through a welding cable and therefore is an electrical hazard posing an electrocution risk if the devices are not connected properly as afore mentioned.

[0056] The present invention disclosed herein, replaces the use of the externally connected devices and in addition, is able to measure the current flowing through the electrical connector 10 [hereinafter referred to as connector] to the electrode 200 in real time while the work pieces 100 are being welded together. Other crucial welding parameters such as voltages available to the electrodes, heating temperatures and welding duration are also measured simultaneously with the current measurements.

[0057] Referring to Fig. 4, the connector may include a housing 20 enclosing a primary conductor 2 having a female recess portion 4 at its proximal end and a male portion 6 extending outwardly from its distal end. The primary conductor 2 may be cylindrical in shape or in any other appropriate shape, and sized adequately for quick and fast engagement/disengagement of the connector 10 to/from the welding tools, and capable of being carried around and handled by a user.

[0058] The male portion 6 may be an integral part of the primary conductor 2 or an auxiliary part that is fixedly mated to the primary conductor 2 to provide maximum electrical connectivity. This arrangement ensures that the primary conductor 2 may be manufactured in the most efficient and cost effective manner. The male portion 6 may further include

appropriate cam lock engagement 8 with the female heavy duty cable adaptor (not shown) of a welding electrode holder 400. One skilled in the art understands that there are many types of cam lock designs available for cable adaptors in accordance with user preferences which may be easily configured by persons skilled in the art. The female recess portion 4 extending inwardly from the proximal end of the primary conductor 2 may similarly be shaped to correspond to the male portion of a cable adaptor (not shown) of the welding machine 300.

[0059] Referring again to Fig. 4, a second conductor 3 may extend outwardly from the primary conductor 2. Such a second conductor 3 may be cylindrical in shape and may include sufficient material to enable a recess portion 7 to be cut into its body without reducing its strength. The second conductor 3 may further be suitably spaced from the female recess portion 4 of the primary conductor 2 to prevent any leakage of electrical current across the electrical adaptors without having to increase the size and weight of the connector 10. This arrangement ensures that the connector 10 is kept as small and as compact as possible to provide ease of handling to the user.

[0060] In like manner, the female recess portion 7 of the second conductor 3 extends inwardly from its proximal end. The recess portion 7 may similarly be shaped to correspond to the male portion of the electrical cable adaptor (not shown) of another welding tool or accessory. The arrangement of the electrical connection is well known in the art for enabling fast and easy coupling/uncoupling of electrical cables without undue delays thus reducing downtime for the users. Although the male and female portions are described as such, it should be apparent to those skilled in the art that such male/female coupling configurations may be interchangeable to accommodate the numerous designs of cable adaptors that is available to the welding machine 300 and welding tool/accessory connections. Such interchangeability may be easily configured by those skilled in the art without departing from the essence of this disclosure.

[0061] In another embodiment, the connector 10 may further be extended end to end, for example by coupling the male portions 6 of a first connector to the female recess portions 4 of a second connector and so on, such that a number of connectors 10 can be connected as

determined by the primary current availability of the welding machine 300 to supply to the welding electrodes and tools.

[0062] The mechanisms for measuring the current and voltages may be arranged in a form not unlike that of an electrical measuring device (for example, a multi-meter) with a LED type digital display. It is envisaged that the mechanisms may be enclosed within the connector 10 for measuring the current and voltage available to the welding electrode 200 simultaneously and independently of each other when the welding operation is in progress. Figs. 4 - 7 illustrate the configuration of the mechanisms for measuring the current and voltages. A secondary voltage/current measurement circuitry suitably powered by a DC power source 24 is used to convert the current and voltage detected by the measuring mechanisms into a digital display 12 as shown in the figures. The DC power source 24 may include one or more rechargeable or non-rechargeable disposable batteries, or other power supply means.

[0063] As shown in Figs. 4-7, the DC power source 24 is further in electrical communication with a processor 11 and the digital LED display 12. Such a DC power source 24 may include a set of batteries suitably sized to allow for example, at least one year of continuous operation of the connector 10. As shown in Fig. 4, the batteries may be housed in a separate battery compartment 27 indented into a side portion of the connector housing 20. A suitable cover such as a water resistant battery cap 28 may be detachably mated to the housing 20 over the battery compartment 27 as shown in Fig. 8. Such a cover may conform to Ingress Protection: IP44 specifications to protect the batteries against water splashes and further be protected against solid objects that are bigger than 1.0mm in diameter and to withstand the harsh working environment of the metal fabrication yard. Ideally, the battery compartment 27 and cap 28 may be constructed to allow ease of battery replacement during routine maintenance. The digital LED display 12 may further include multi-unit readings for current, voltage, heating temperature and welding duration, which can be reset through a reset button.

[0064] In one embodiment as shown in Fig. 5, the mechanism 50 for measuring current may include a current transformer 32 having for example a transformer jaw 33 encircling the male portion 6 of the primary conductor 2. As best shown in Figs. 4 and 5, a

coil of wire may be wound around the transformer jaw 33 to provide the magnetic flux necessary to produce the secondary current for computing the current flowing through the primary conductor 2 to the welding electrode 200. It is envisaged that the current transformer 32 will be enclosed within an insulating material such as a polyester (not shown) to provide electrical isolation between the primary conductor 2 and the transformer winding (not shown).

[0065] Figs. 4 and 5 further show the current transformer 32 being positioned at the male portion 6 of the connector 10 to ensure that the current measurement does not include the current flowing to the quiver 600. This unique arrangement is necessary because of the following reasons: Firstly, based on Kirchhoff's current law "At any node (junction) in an electrical circuit, the sum of currents flowing into the node is equal to the sum of current flowing out of the node", i.e., $I_t = I_p + I_q$. Therefore, the current used for welding (I_p) instead of the total current (I_t) used during the welding process should be measured as shown in Fig. 5. Thus by positioning the current transformer 32 at the male portion 6 of the connector, the current measurement will not include the current flowing to the quiver 600. Secondly, the voltage drop from the welding machine 300 is significantly reduced as current moves through the passive elements (such as the welding cable to the welding electrode). In view of the significant distance between the welding machine 300 and the connector 10, the voltage drop will result in energy being lost through the welding cable's electrical resistance. Thus, measuring the current at the male portion 6 of the connector 10 provides a more accurate current reading instead of current measurement taken at the welding machine 300.

[0066] The mechanism 50 for measuring current is thus able to measure and display the magnitude of the current to the electrode 200 in real time during the welding process. Such an arrangement is well known in the art for generating a magnetic flux as a result of current flowing through a conductor. The current flowing through the primary conductor 2 is therefore the current available to the electrode 200 while a secondary current proportional to the current is generated by electromagnetic induction from the current transformer 32. The secondary current is thereafter communicated to the processor 11 for conversion into a digital display reading 55 of the value of the current at the LED display 12.

[0067] As a further illustration, because of the very high current present at the primary conductor 2, the magnitude of the current to be measured has to be suitably reduced in order not to damage the mechanism 50 for measuring the current. For instance, with a maximum current measurement of 400A, it is necessary to step down (reduce) the magnitude of the measured current to a value that can be safely handled by the mechanism 50. As an example, it is envisaged that the present invention may include a current transformer ratio of 400:5.

[0068] Although the current transformer 32 is utilized in this embodiment, one skilled in the art will understand that other types of mechanisms for measuring current, for example, by a magnetic field generation mechanism can be utilized to calculate the current using the voltage drop effect. Thus, a current sensing device 34 may be connected in series with the circuit in which the current to the electrode may to be measured, utilizing the voltage drop across the device 34 as shown in Fig. 5a. Another type of device for measuring current using a magnetic current sensing device 35 may also be utilized to measure the current in the circuit. Such a mechanism 50" includes a sensing device 35 as illustrated in Fig. 5b allows isolation of the current sensing device 35 from the primary circuit as no contact is necessary with the circuit carrying the primary current. In this way, a magnetic field is produced which is at right angles to the flow of current in the primary conductor 2. The magnetic field may then be utilized by the magnetic current sensing device 35 to measure the current available to the electrode 200.

[0069] Referring to Fig. 6, the mechanism 60 for measuring voltage may include a first measuring point 36 suitably located on the male portion 6 of the primary conductor 2 and a second measuring point 38. Upon connecting the second measuring point 38 to the work piece 100, a close circuit is formed from the welding machine 300 to the work piece 100 and back to the welding machine 300 such that the voltage across the primary conductor 2 is detected and communicated to the processor 11 for conversion to a digital display 56 of the value of the voltage at the LED display 12.

[0070] It is envisaged that the connection to the second measuring point 38 (negative test point) is accessed externally via a probe cable 42 with a connecting plug 43 for connection between the circuit ground and the voltage measuring mechanism 60. Provision for the probe cable connection may be made to allow easy and simple connection. The connecting plug 43 may include an embodied “Banana plug” female socket as shown in figure 6, to allow for an easy and simple connection. Thus, the probe cable 42 may include a “Banana” jack at one end and an alligator clip 46 at the other end. With the connection of a positive and negative point, voltage across the primary conductor 2 can be measured and monitored in real time when the welding is in progress. The analog input signal may then be processed digitally into a digital form and when necessary, by discrete-time processing of the converted values by the processor 11. The measurement result may then be presented at the LED Display 12. It is envisaged that alternative embodiments well known in the art for tapping the voltage across the primary conductor 2 such as by utilizing a potentiometer or oscilloscope may also be possible.

[0071] In one embodiment shown in Fig. 7, the invention may include a mechanism 70 for measuring the temperature of the weld joints or work pieces 100. One skilled in the art will understand that in order to produce a good quality weld, preheating is necessary to raise the weld joint or parent steel to a specified predefined temperature. The mechanism 70 may include a thermocouple 47 placed within the perimeter of the preheated steel or work piece 100. The thermocouple 47 may be connected to a data acquisition device 52 by a cable. The data acquisition device 52 may further be embodied in the housing 20 of the connector 10 to allow real time monitoring of the heating temperature readable in digital format 57 as shown in fig. 4 on the display 12. Power supply for the data acquisition device 52 may be tapped from the DC power source 24.

[0072] Although measuring the heating temperature by using a thermocouple 47 is described in this embodiment, one skilled in the art will understand that other types of temperature monitoring devices such as thermometers, resistive temperature devices (RTD), bimetallic devices, change-of-state sensors, infrared sensors and silicon diodes may also be utilized. One skilled in the art will further understand that such a data acquisition device 52 typically convert analogue signals into digital signals for processing. It is envisaged that such a skilled person should be able to configure the features of these types of devices that can be

housed within the connector 10. For example, a sensing device may be placed near the preheated steel and cable connection made available to the data acquisition device 52 which can be placed within the connector housing 20.

[0073] In another embodiment as shown in Fig. 7, the invention may include a mechanism 80 for monitoring the welding duration. The mechanism 80 may include an hour meter 54 which may be mounted within the connector 10 and be energized with the aid of a relay. Power supply for the hour meter 54 may be tapped from the DC power source 24. A relay coil (not shown) may be connected in series to the primary conductor 2. In this way, when welding commences, the relay coil will be energized thus closing the “normally open” contact relay to energize the hour meter 54. Once the hour meter 54 is energized, it will start counting the welding duration. The hour meter 54 may include a resetting provision 59 which is easily accessible for the user to reset an hour counter as shown in Fig. 8.

[0074] In other embodiments, the mechanisms 50, 60 for measuring the current and voltages may include provisions for measuring direct current (DC) and alternating current (AC) ranging for example between 0A to 400A, and voltage measurements ranging for example between 0V to 24V.

[0075] In one embodiment, the processor 11 may be incorporated into the housing 20 of the connector 10 and electrically communicated to the measuring mechanisms 50, 60, 70, 80, DC power source 24 and the digital LED Display 12. The processor 11 may further include a microprocessor or other devices capable of being programmed or configured to perform computations and instruction processing in accordance with the invention. Such a processor 11 may include a memory 13 incorporating programmable software instructions that are executed by the processor 11. It is envisaged that one skilled in the art will be able to configure such a processor 11 accordingly for current/voltage conversions, rectification circuitry, AC/DC conversions for indicating the current and voltage readings at the digital LED Display 12. It is further envisaged that the components of the processor 11 may be in the form of modular kits that can be easily assembled and enclosed in the housing 20 of the connector. For example, the processor 11, sub-systems and components may be located on a circuit board together with a secondary circuitry (not shown) and together with the digital

LED Display 12, be suitably housed in a modular enclosure as illustrated in Fig. 8. A system configuration of such an arrangement is illustrated in Fig. 9.

[0076] In one embodiment, the invention may include a data logging module 62. One skilled in the art understands that recorded welding data such as the current, voltages, heating temperatures and welding duration may be retrieved for analysis in order to improve on welding quality, welder productivity, time and cost reduction. Such a module 62 may eliminate or reduce manual data entry for quality and productivity control purposes. For example, a welding supervisor may make use of the data to monitor the performance of a welder in the course of an entire project for appropriate action to be taken if any abnormality or non-conformance is found. Project supervisors and/or project planners may also make use of the measured welding duration to ensure work output and productivity of welding operations conforms to desired practices and for updating project schedules accordingly. The data logging module 62 may for example, record activities including recorded parameters for a predetermined period of time such as a period of one month (approximately 400hours).

[0077] The data logging module 62 may be communicatively linked to the processor 11 which further includes the memory 13 or a storage device for storing the data retrieved by the measuring mechanisms 50, 60, 70,80, and a suitable user interface 15 for communicating with a computer 90 via wire or wireless connections. The data logging module 62 may additionally include a visual aid for indication of stored memory capacity when it reaches 95% and 98%. The data logger may include functions to override recorded data when it is being utilized beyond the 100% stored data capacity. Activity data to be recorded may further include at least (i) Date and Time (ii) Current (iii) Voltage (iv) Heating temperature and (v) Welding duration.

[0078] As best shown in Fig. 8, the housing 20 may be in the form of a unitary sheath 40 that is molded to enclose the primary conductor 2, the second conductor 3, the processor 11 and the in-built sub-systems and components of the mechanisms 50, 60, 70, 80 for measuring the current, voltage, temperature and welding duration as well as the data logging module 62 and user interface 15. Such a unitary sheath 40 primarily provides an immovable close contact between the primary conductor 2 and the second conductor 3 as well as to provide a rigid encapsulation of the secondary circuitry (not shown), processor 11 and

associated components. This arrangement results in a compact assembly suitable for heavy duty applications. In addition, the sheath 40 may provide good electrical insulation to protect users in case of an electrical short circuit as well as provides an excellent sealing between the connector 10 and the cable adaptors when in the connected state.

[0079] The invention may include a method of for measuring and recording welding parameters such as current and voltages, weld joint heating temperatures and welding duration in real time while the welding tools are being utilized on a work piece. Such a method may include the chronological steps of: providing a unitary sheath 40 for encapsulating a primary and a second conductor 3 and providing at least one mechanism for measuring welding parameters in real time.

[0080] The steps of providing the encapsulated mechanisms may include: providing a mechanism 50 for measuring the primary current and a mechanism 60 for measuring the primary voltage available to the first electrical tool; providing a mechanism 70 for measuring the temperature at a work piece; providing a mechanism 80 for measuring the duration of the primary current flow across the work piece; providing a display 12 for indicating the values of the primary current and voltages available to the first electrical tool, and the temperature and duration of primary current flow across the work piece; and providing a data logging module 62 for capturing and recording the values of the primary current and voltages available to the first electrical tool, and the temperature and duration of primary current flow across the work piece, wherein the mechanisms are operable in simultaneous and independent modes.

[0081] The steps of providing the mechanism 60 for measuring the primary voltage may include providing a first measuring point 36 located on a second connecting member and a second measuring point 38 connectable to the work piece.

[0082] The steps of providing the mechanism 70 for measuring the temperature at the work piece may include providing a data acquisition device 52 in electrical communication with the processor 11 and a thermocouple 47 detachably engaged to the work piece, wherein

the thermocouple 47 is in electrically communication with the data acquisition device 52 via a cable.

[0083] The steps of providing the mechanism 80 for capturing the duration of the primary current flow across the work piece may include providing an hour meter 54 mounted within the unitary sheath 40 and a relay in electrical communication with the processor 11.

[0084] The steps of providing the mechanisms 70 for measuring the temperature and the mechanism 80 for capturing the primary current across the work piece may include providing an electrical communication with a DC power source 24 housed within the unitary sheath 40.

[0085] The steps of providing the data logging module 62 may include: providing a user interface 15 for communicating with a computer 90 via wire or wireless connections; and providing a visual aid located at the display 12 for indication of stored data capacity; wherein the data logging module 62 is in electrically communication with the processor 11.

[0086] While the invention has been described with respect to a certain specific embodiment, it will be appreciated that many modifications and changes may be made by those skilled in the art without departing from the spirit of the invention. It is intended, therefore, by the appended claims to cover all such modifications and changes as fall within the true spirit and scope of the invention. In particular, with respect to the above description, it is to be realized that the optimum dimensional relationships for the parts of the non-limiting exemplary embodiments may include variations in size, materials, shape, form, function and manner of operation.

CLAIMS:

1. A welding connector for measuring welding parameters in real time when used with an electrical power source, comprising:
 - a primary conductor for connecting to a work piece; and
 - a unitary sheath for housing:
 - the primary conductor and provides electrical insulation to the primary conductor;
 - encapsulated mechanisms for measuring a current flow and a voltage at the primary conductor; and
 - a display for indicating values of the current flow and the voltage.
2. The welding connector of claim 1, further comprising:
 - a processor, wherein
 - the encapsulated mechanisms are in electrical communication with the processor; and the encapsulated mechanisms further comprising the following mechanisms:
 - a mechanism for measuring a temperature at the work piece; and
 - a mechanism for measuring a time duration of the current flow to the work piece.
3. The welding connector of claim 2, wherein the encapsulated mechanisms comprise:
 - the mechanism for measuring the current available to a first electrical tool, which electrically connects the primary conductor to the work piece; and
 - the mechanism for measuring the voltage available to the first electrical tool.
4. The welding connector of claim 3, wherein, the display further indicates values of the temperature at the work piece and time duration of the current flow to the work piece; and further comprising:
 - a data logging module for capturing and recording the values of the current, the voltage available to the first electrical tool, the temperature at the work piece and time duration of the current flow to the work piece,wherein the data logging module is also encapsulated in the unitary sheath.
5. The welding connector of claim 4, wherein the primary conductor comprises a first connecting member for electrical communication with the electrical power source and a second

connecting member for electrical communication with the first electrical tool, wherein the first electrical tool is configured to electrically connect the primary conductor to the work piece.

6. The welding connector of claim 5, further comprising a second conductor extending outwardly from the primary conductor for electrical communication with a second electrical tool.

7. The welding connector of claim 5, further comprising a secondary circuitry in electrical communication with the primary conductor for measuring the current at the second connecting member.

8. The welding connector of claim 4, further comprising a DC power source in electrical communication with the processor, the encapsulated mechanisms, the data logging module and the display.

9. The welding connector of claim 8, wherein the DC power source comprises one or more rechargeable or non-rechargeable disposable batteries.

10. The welding connector of claim 8 or claim 9, wherein the DC power source is enclosed in a water resistant enclosure formed in the unitary sheath, with the water resistant enclosure further having a cover to prevent ingress of water.

11. The welding connector of claim 4, wherein the display comprises a digital LED display having resettable multi-unit readings for indicating current, voltage, temperature and time duration.

12. The welding connector of claim 5, wherein the encapsulated mechanism for measuring current is disposed at a portion of the second connecting member.

13. The welding connector of claim 12, wherein the encapsulated mechanism for measuring current is configured to induce a secondary current, and the secondary current is configured to electrically communicate with the processor for generating a value of the current flow at the display.

14. The welding connector of claim 5, wherein the encapsulated mechanism for measuring the voltage comprises a first measuring point located on the second connecting member and a second measuring point connectable to the work piece, with the encapsulated mechanism for measuring the voltage is configured to electrically communicate with the processor for generating a value of the voltage at the display.
15. The welding connector of claim 14, wherein the first measuring point comprises a socket located on the unitary sheath of the welding connector, while the second measuring point is connected to the work piece via a cable.
16. The welding connector of claim 2 or 3, wherein the encapsulated mechanism for measuring the temperature at the work piece comprises a thermocouple detachably disposed on the work piece, wherein the thermocouple is configured to electrically communicate with the processor via a cable to indicate a value of the temperature.
17. The welding connector of claim 2 or 3, wherein the mechanism for measuring the time duration of the current flow to the work piece comprises an hour meter mounted within the welding connector and a relay for electrical communication with the processor.
18. The welding connector of claim 8, wherein the mechanism for measuring the temperature and the mechanism for capturing the current flow to the work piece are configured to electrical communicate with the DC power source.
19. The welding connector of claim 4, wherein the data logging module comprises:
a data acquisition device in electrical communication with the processor;
a user interface for communicating with a computer via wire or wireless connection; and
a visual aid located at the display for indication of a stored memory capacity.
20. The welding connector of claim 1, wherein the electrical power source comprises a welding machine.
21. The welding connector of claim 3, wherein the first electrical tool comprises a welding electrode holder.

22. The welding connector of claim 6, wherein the second electrical tool comprises a welding electrode quiver.
23. The welding connector of claim 6, wherein the unitary sheath is in immovable close contact to provide a rigid encapsulation of the primary conductor, the second conductor, the processor and the display.
24. A system for measuring and recording welding parameters comprising:
an electrical power source;
a welding tool; and
a welding connector connecting the welding tool to the electrical power source for measuring the welding parameters in real time;
wherein the welding connector comprises:
- a primary conductor for connecting to a work piece; and
 - a unitary sheath for housing:
 - the primary conductor and provides electrical insulation to the primary conductor,
 - encapsulated mechanisms for measuring current flow and voltage at the primary conductor; and
 - a display for indicating values of the current flow and the voltage.
25. The system of claim 24, further comprising:
a second conductor extending from the primary conductor and a processor in electrical communication with the encapsulated mechanisms for measuring the welding parameters in real time,
wherein the encapsulated mechanisms further comprise the following mechanisms:
- a mechanism for measuring a temperature at the work piece; and
 - a mechanism for measuring a time duration of the current flow to the work piece.
26. The system of claim 24, wherein the encapsulated mechanisms comprise:
- the mechanism for measuring the current available to a first electrical tool, which electrically connects the primary conductor to the work piece;
 - the mechanism for measuring the voltage available to the first electrical tool;

- a mechanism for measuring temperature at the work piece; and
- a mechanism for measuring time duration of the current flow to the work piece.

27. The system of claim 26, wherein the display further indicates values of the temperature and time duration of the current flow to the work piece; and

further comprising:

a data logging module for capturing and recording the values of the current flow, the voltage available to the first electrical tool, the temperature and time duration of the current flow to the work piece,

wherein the data logging module is enclosed in the unitary sheath.

28. The system of claim 24, wherein the mechanism for measuring current is disposed at a portion of a second connecting member connectable to the primary conductor.

29. The system of claim 28, wherein the mechanism for measuring the voltage comprises a first measuring point located on the second connecting member and a second measuring point connectable to the work piece.

30. The system of claim 25 or 27, wherein the mechanism for measuring the temperature at the work piece comprises a thermocouple detachably disposed on the work piece, wherein the thermocouple is configured to electrically communicate with the processor via a cable to indicate a value of the temperature.

31. The system of claim 25, 26 or 27, wherein the mechanism for measuring the time duration of the current flow to the work piece comprises an hour meter mounted within the unitary sheath and a relay configured in electrical communication with the processor.

32. The system of claim 25, wherein the mechanism for measuring the temperature and the mechanism for measuring the current flow to the work piece are configured to be in electrical communication with a DC power source housed within the unitary sheath.

33. The system of claim 27, wherein the data logging module comprises:

a data acquisition device in electrical communication with a secondary circuitry connected to the primary conductor;

a user interface for communicating with a computer via wire or wireless connection; and

a visual aid located at the display for indication of a stored memory capacity.

34. The system of claim 25, wherein the unitary sheath is in immovable close contact to provide a rigid encapsulation of the primary conductor, the second conductor, the processor and the display.

35. A method for measuring welding parameters comprising:

housing a primary conductor in a unitary sheath;

connecting the primary conductor to a work piece;

measuring a current flow and a voltage in real time with encapsulating mechanisms coupled to the primary conductor, wherein the current flow and the voltage constitute the welding parameters; and

displaying values of the welding parameters on a display;

wherein the encapsulated mechanisms and the display are housed in the unitary sheath.

36. The method of claim 35, further comprising the step of:

extending a second conductor from the primary conductor within the unitary sheath; and

connecting the encapsulated mechanisms in electrical communication with a processor, wherein the step of measuring the welding parameters in real time further comprises:

- measuring a temperature at the work piece; and
- measuring a time duration of the current flow to the work piece.

37. The method of claim 36, wherein:

the step of measuring the welding parameters in real time comprises the steps of:

- measuring the current available to a first electrical tool that electrically connects the primary conductor to the work piece; and
- measuring the voltage available to the first electrical tool.

38. The method of claim 37, further comprising the steps of:

indicating on a display values of the current flow, the voltage available to the first electrical tool, the temperature and time duration of the current flow to the work piece; and capturing and recording values of the current flow, the voltage available to the first electrical tool, the temperature and time duration of current flow to the work piece by a data logging module,
wherein the data logging module is enclosed in the unitary sheath.

39. The method of claim 37, wherein measuring the current flow comprises connecting a current transformer to a portion of a second connecting member, which is connectable to the primary conductor.

40. The method of claim 39, wherein measuring the voltage comprises connecting a first measuring point on the second connecting member and a second measuring point connectable to the work piece.

41. The method of claim 37, wherein measuring the temperature at the work piece comprises connecting a thermocouple detachably located on the work piece, wherein the thermocouple is in electrically communication with the processor via a cable.

42. The method of claim 37, wherein capturing the time duration of the current flow to the work piece comprises connecting an hour meter mounted within the unitary sheath and a relay in electrical communication with the processor.

43. The method of claim 37, wherein measuring the temperature and measuring the current flow to the work piece comprise connecting the encapsulated mechanisms in electrical communication with a DC power source housed within the unitary sheath.

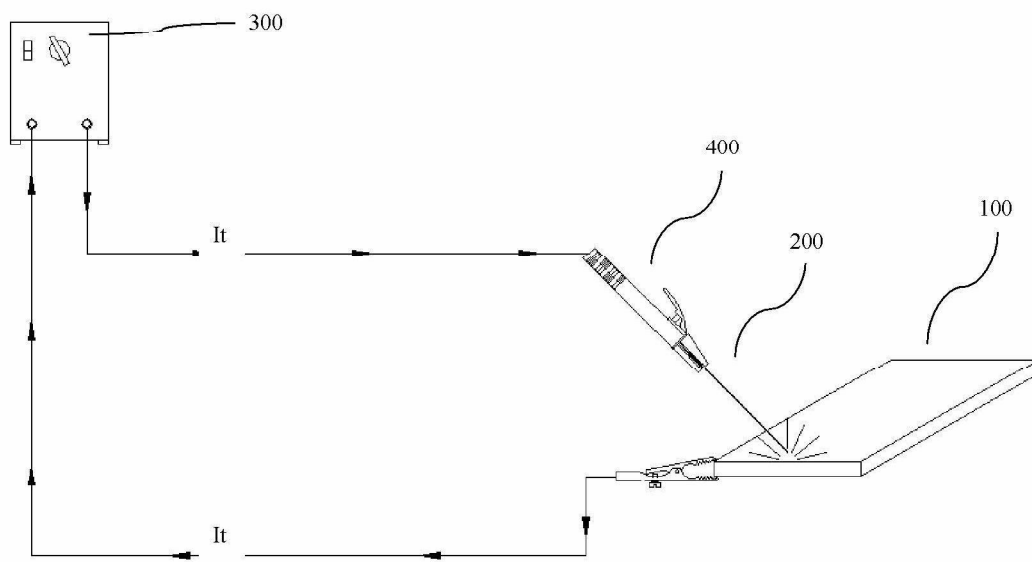
44. The method of claim 38, further comprising:
connecting a data acquisition device in electrical communication with the processor;
connecting the data logging module to the processor for capturing a set of welding parameters;
providing a user interface for communicating with a computer via wire or wireless connection; and
providing a visual aid located at the display for indication of a stored memory capacity.

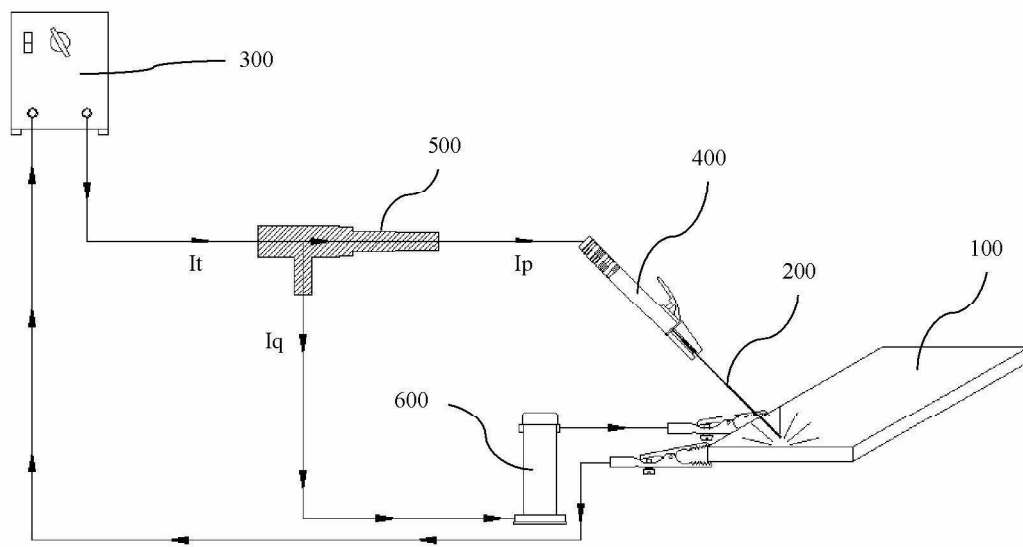
ABSTRACT

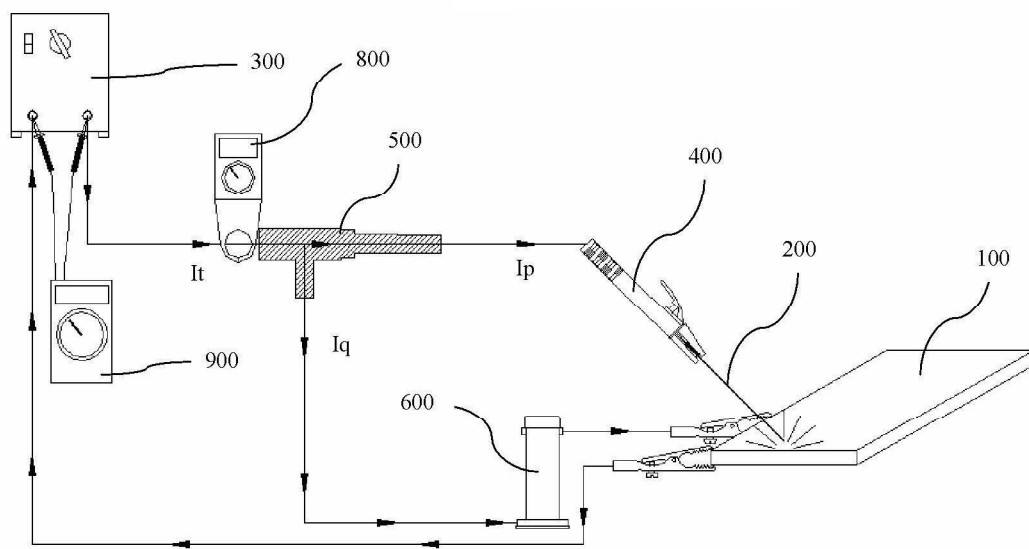
Smart Welding Connector And Associated Method Thereof

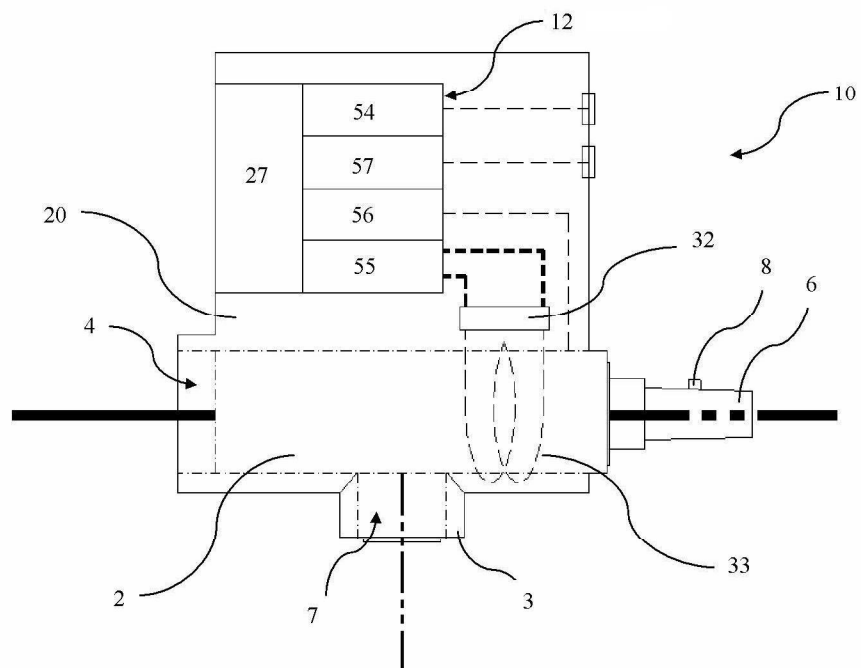
An electrical connector for connecting to a welding machine may include a unitary sheath for housing a primary and a second conductor and at least one encapsulated mechanism in electrical communication with a processor for measuring welding parameters in real time. The encapsulated mechanisms may include mechanisms for measuring the primary current and voltages available to a first electrical tool; measuring the temperature at a work piece; and measuring the duration of the primary current flow across the work piece. The electrical connector may further include a display for indicating the values of the primary current and voltages available to the first electrical tool, the temperature and duration of primary current flow across the work piece. A data logging module may be utilized for capturing and recording the values of the parameters. The encapsulated mechanisms may further be operable in simultaneous and independent modes.

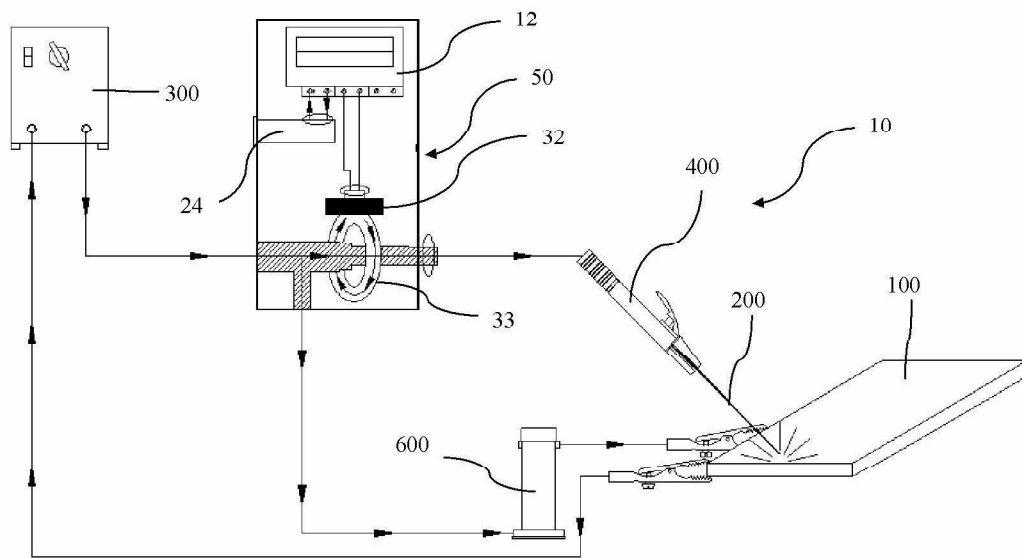
Fig. 4

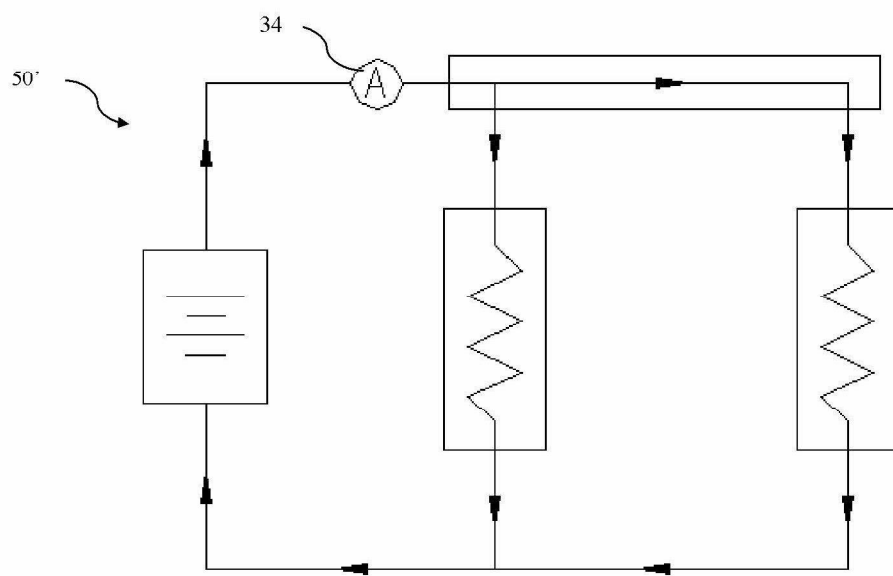
**Fig. 1**

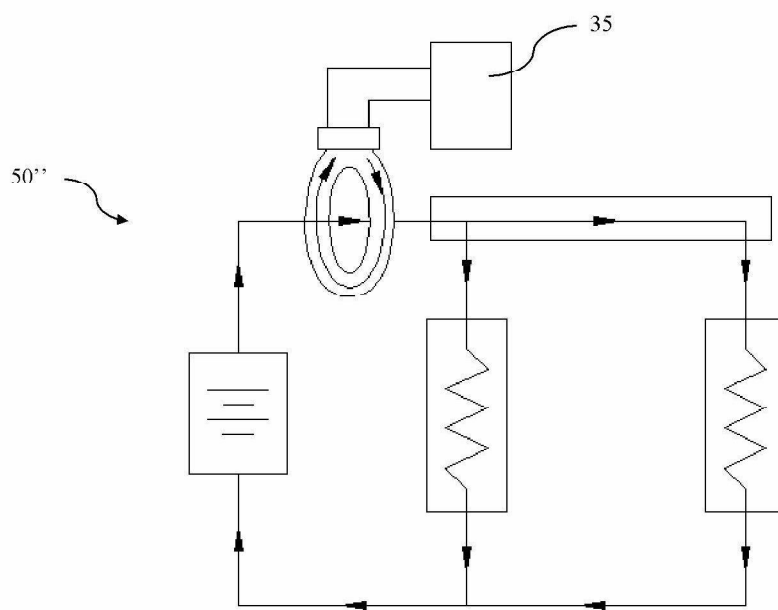
**Fig. 2**

**Fig. 3**

**Fig. 4**

**Fig. 5**

**Fig. 5a**

**Fig. 5b**

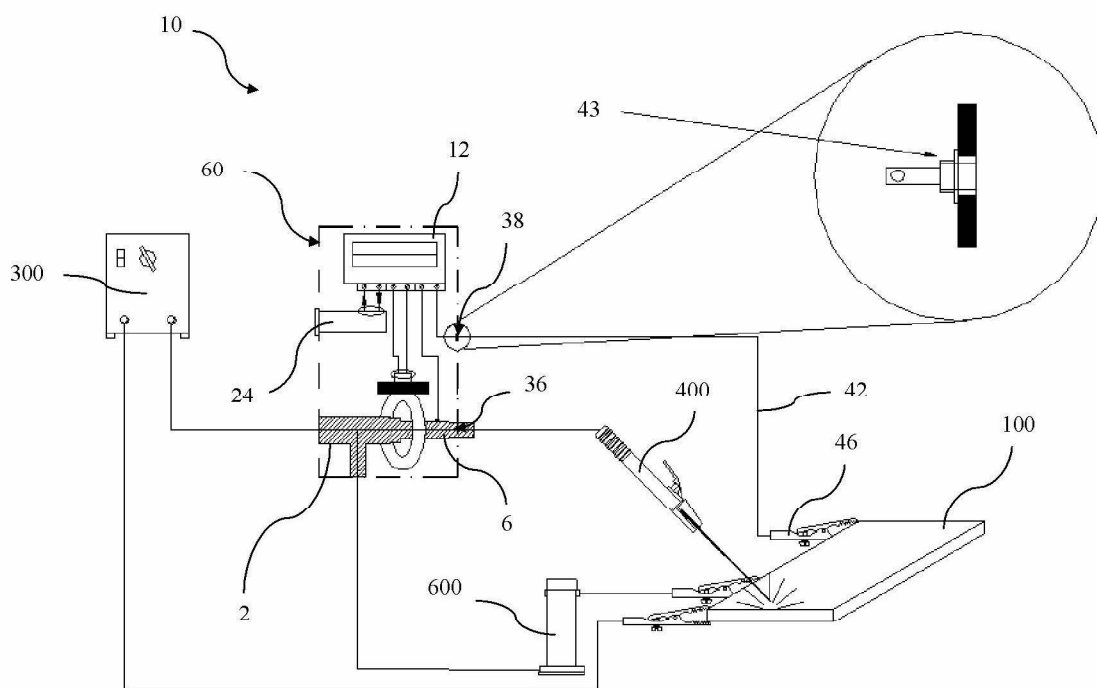
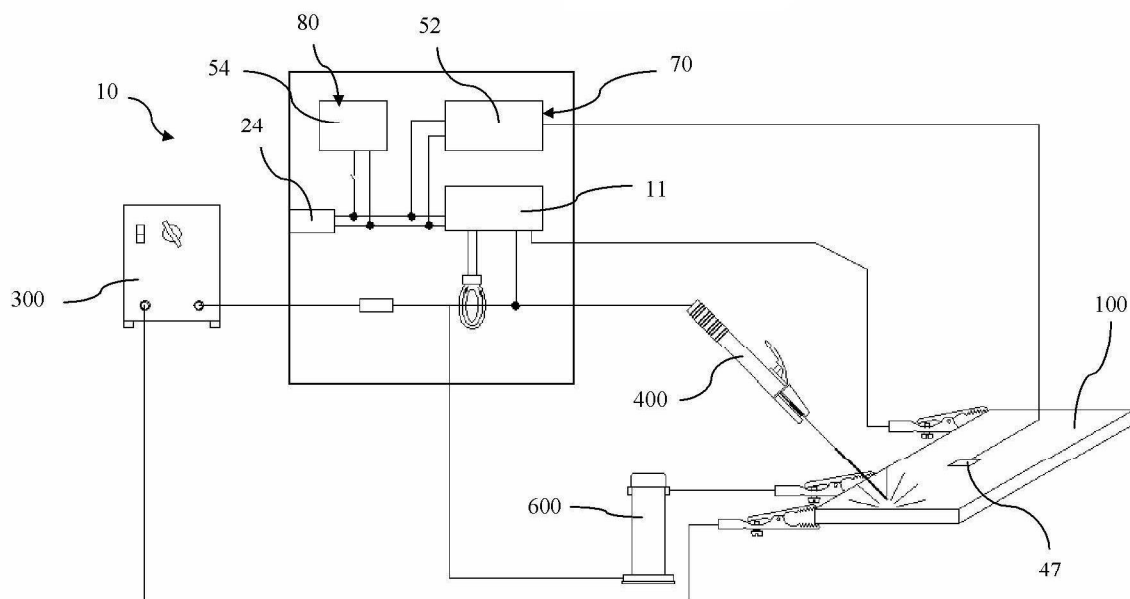


Fig. 6

**Fig. 7**

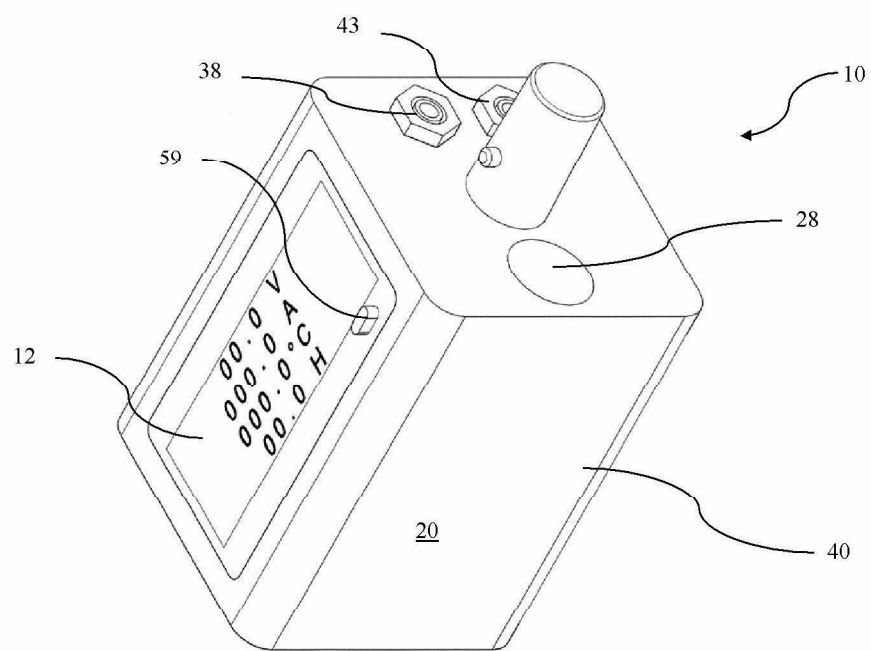
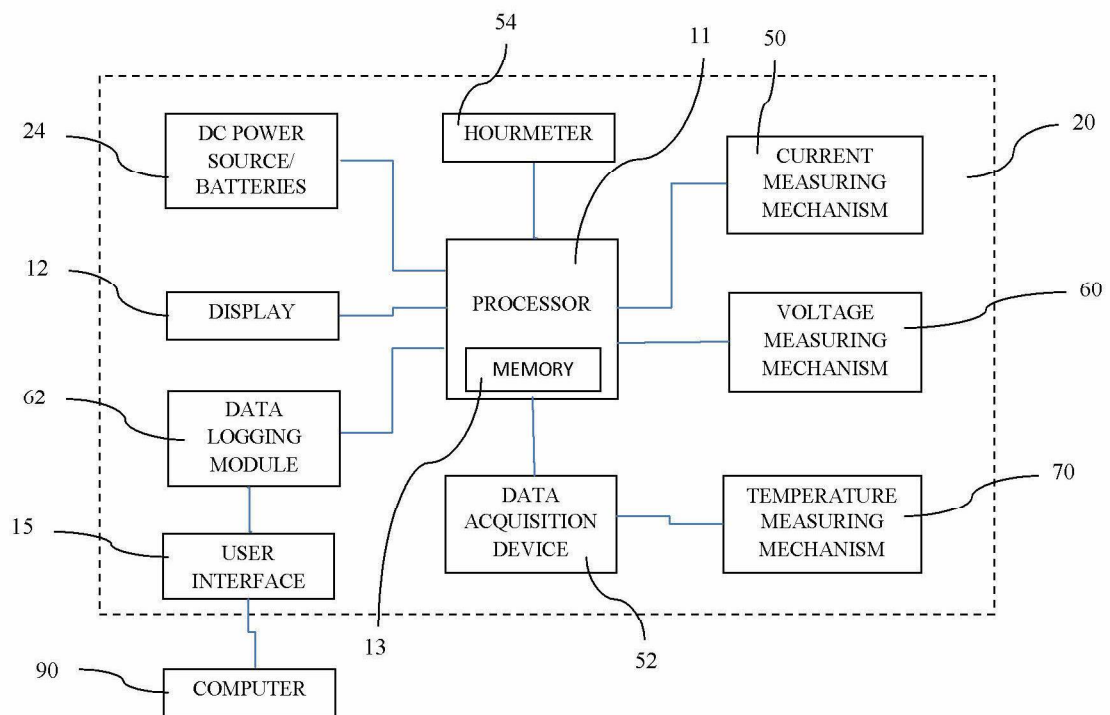


Fig. 8

**Fig. 9**