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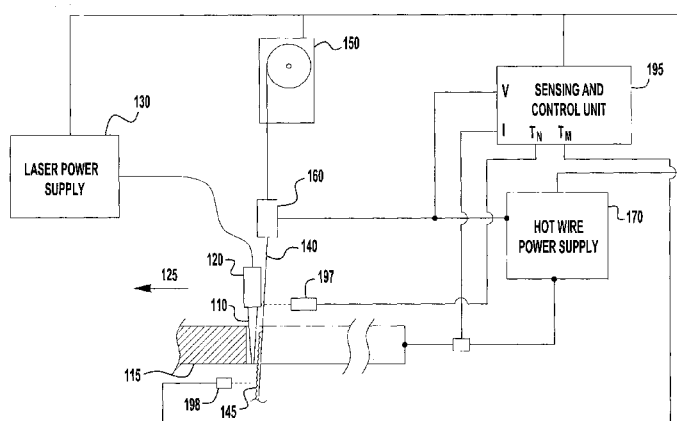


FIG. 1

(57) Abstract: The present application relates to a system (100) for and a method of removing material (145) in a workpiece (115). The system (100) includes a laser system (120, 130) that melts a portion of the workpiece (115) by heating the workpiece (115). The system (100) includes a wire feeder system (150) that feeds a wire (140) to the workpiece (115) to remove molten metal (145) from the workpiece (115) by using the wire (140). The wire (140) is configured such that the molten metal (145) adheres to the wire (140) when the wire (140) makes contact with the molten metal (145). The melting by the laser system (120, 130) includes a cutting or a gouging of the workpiece (115). In some embodiments, the system (100) includes a hot wire power supply (170) that supplies heating current through a length of the wire (140) to heat the length of the wire (140) to a desired temperature. The heating of the wire (140) facilitates the adherence of the molten metal (145) to the wire (140).



METHOD OF AND SYSTEM FOR REMOVING MATERIAL FROM A CUT-JOINT USING A
LASER BEAM AND A WIRE

[001] The present application claims priority to U.S. Provisional Patent Application No. 61/668,859, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[002] The invention is related to a system for removing material in a workpiece according to claim 1 and to a method of removing material in a workpiece according to claim 9. Certain embodiments relate to cutting and gouging applications using a laser. More particularly, certain embodiments relate to a system and method for removing material from a cut using a hot wire in laser cutting and gouging applications.

TECHNICAL BACKGROUND

[003] The traditional method of cutting or gouging is to use plasma, oxyacetylene or air arc. These methods can tend to be messy as the molten material is blown away by using pressurized air or gas. In addition, these methods are limited in how deep they can cut. While laser cutting is known, the traditional method still relies on using pressurized gas to blow the molten metal away from the cutting area, which requires containment.

[004] Further limitations and disadvantages of conventional, traditional, and proposed approaches will become apparent to one of skill in the art, through comparison of such approaches with embodiments of the present invention as set forth in the remainder of the present application with reference to the drawings.

DESCRIPTION OF THE INVENTION

[005] The problem to be solved is to overcome the limitations and disadvantages. This problem is solved by a system for removing material in a workpiece according to claim 1 and by a method of removing material in a workpiece according to claim 9. Further embodiments of the present invention, especially comprising a system and method for removing material from a cut using a hot wire in laser cutting and gouging applications are subject of the subclaims. The system includes a laser system that melts a portion of the workpiece by heating the workpiece. The system includes a wire feeder system that feeds a wire to the workpiece to remove molten metal from the workpiece by using the wire. The wire is configured such that the molten metal adheres to the wire when the wire makes contact with the molten metal. The melting by the laser system includes a cutting or a gouging of the workpiece. In some embodiments, the system includes a hot wire power supply that supplies heating current through a length of the wire to heat the length of the wire to a desired temperature. The heating of the wire facilitates the adherence of the molten metal to the wire.

[006] The method includes melting a portion of the workpiece by heating the workpiece using a laser and feeding a wire to the workpiece to remove molten metal from the workpiece by using the wire. The wire is configured such that the molten metal adheres to the wire when the wire makes contact with the molten metal. In some embodiments, the method further includes supplying a heating current through a length of the wire to heat the length of the wire to a desired temperature. The heated wire facilitates the adherence of the molten metal to the wire. According

to a preferred embodiment of the method according to the invention the wire is knurled to facilitate removal of said molten metal.

[007] These and other features of the claimed invention, as well as details of illustrated embodiments thereof, will be more fully understood from the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[008] The above and/or other aspects of the invention will be more apparent by describing in detail exemplary embodiments of the invention with reference to the accompanying drawings, in which:

[009] FIG. 1 illustrates a functional schematic block diagram of an exemplary embodiment of a system for laser cutting and gouging applications;

[0010] FIG. 2 illustrates an exemplary embodiment of a wire feeder that can be used in the system of Figure 1;

[0011] FIG. 3 illustrates an exemplary embodiment of a wire feeder that can be used in the system of Figure 1;

[0012] FIG. 4 illustrates an exemplary embodiment of a wire feeder that can be used in the system of Figure 1;

[0013] FIGS. 5A and 5B illustrate exemplary embodiments of contact tubes that can be used in the system of Figure 1; and

[0014] FIGS. 6A and 6B illustrate exemplary embodiments of hot wires that can be used in the system of Figure 1.

DETAILED DESCRIPTION OF THE DRAWINGS

[0015] Exemplary embodiments of the invention will now be described below by reference to the attached Figures. The described exemplary embodiments are intended to assist in the understanding of the invention, and are not intended to limit the scope of the invention in any way. Like reference numerals refer to like elements throughout.

[0016] FIG. 1 illustrates a functional schematic block diagram of an exemplary embodiment of a system **100** for performing cutting and gouging applications. The system **100** includes a laser subsystem capable of focusing a laser beam **110** onto a workpiece **115** to heat a portion of the workpiece **115**. The laser subsystem is a high intensity energy source. The laser subsystem can be any type of high energy laser source, including but not limited to carbon dioxide, Nd:YAG, Yb-disk, YB-fiber, fiber delivered or direct diode laser systems. Further, even white light or quartz laser type systems can be used if they have sufficient energy. For example, a high intensity energy source can provide at least 500 W/cm^2 .

[0017] The following exemplary embodiments will be discussed in terms of cutting operations. However, one skilled in the art will understand that the present invention is not limited to just cutting operations and that other operations, including gouging operations, can fall within the scope of the present invention.

[0018] The laser **120** should be of a type having sufficient power to provide the necessary energy density for the desired cutting operation. That is, the laser device **120** should have a power sufficient to melt workpiece **115** throughout the cutting process, and also reach the desired penetration. For example, lasers should have the ability to “keyhole” the workpieces being welded. This means that

the laser should have sufficient power to fully penetrate the workpiece, while maintaining that level of penetration as the laser travels along the workpiece. Exemplary lasers should have power capabilities in the range of 1 to 20kW (1kW = 1.000 W), and may have a power capability in the range of 5 to 20kW. Higher power lasers can be utilized, but can become very costly.

[0019] As shown in Figure 1, the laser subsystem **130/120** includes a laser device **120** and a laser power supply **130** operatively connected to each other. The laser power supply **130** provides power to operate the laser device **120**. The laser beam **110** serves to cut workpiece **115** by melting some of the base metal of the workpiece **115**.

[0020] The system **100** also includes a hot wire feeder subsystem capable of providing at least one wire **140** to make contact with molten material **145** in workpiece **115** in the vicinity of the laser beam **110**. The hot wire feeder subsystem includes a wire feeder **150**, a contact tube **160**, and a hot wire power supply **170**. During operation, the wire **140**, which trails the laser beam **110** as it moves in direction **125**, is heated by the hot wire power supply **170** which is operatively connected between the contact tube **160** and the workpiece **115**. As illustrated in Figure 1, the power supply **170** can supply current to heat wire **140**. In accordance with an embodiment of the present invention, the hot wire power supply **170** is a pulsed direct current (DC) power supply, although alternating current (AC) or other types of power supplies are possible as well.

[0021] The wire **140** is fed from the wire feeder **150** through the contact tube **160** toward the workpiece **115** and extends beyond the tube **160**. The extension portion of the wire **140** is heated such that the extension portion is at or near (in-

cluding above and below) the melting point of workpiece **115** before contacting the molten material **145** on the workpiece **115**. As indicated above, in this exemplary embodiment the hot wire power supply **170** provides a heating current to the wire **140**. The current flows in wire **140** between the contact tip **160** (which can be of any known construction) and the workpiece **115**. This resistance heating current causes the wire **140** between the contact tube **160** and the workpiece **115** to reach a temperature that is at or near (including above and below) the melting temperature of the workpiece **115**. Of course, the melting temperature of the workpiece **115** will vary depending on the size and chemistry of the workpiece **115**. Accordingly, the desired temperature of the wire **140** during cutting will vary depending on the workpiece **115**. In exemplary embodiments, the temperature of the wire **140** is within $\pm 25\%$ of the melting point of workpiece **115**. The desired operating temperature for the wire **140** can be a data input into the cutting system so that the desired wire temperature is maintained during cutting. In any event, the temperature of the wire **140** should be such that the wire **140** is always below its melting point during the cutting operation. In exemplary embodiments, the wire **140** is 5 to 45% below its melting point. The power supply **170** provides a large portion of the energy needed to heat the wire **140**. However, the laser beam **110** may aid in the heating of wire **140**.

[0022] In the above embodiments, the heating current in wire **140** flows between the tip of contact tube **160** and workpiece **115**, where at least a portion of the wire **140** contacts the workpiece during the cutting operation. However, in some exemplary embodiments, as shown in Figure 5A, the wire **140** is routed through two contact tubes **160** and **161**. In these embodiments, the heating current in wire **140**

flows between the contact tubes **160** and **161**. Further, in other exemplary embodiments, as shown in Figure 5B, the contact tube **160** contains an induction coil **165**, which causes the contact tube **160** and the wire **140** to be heated via induction heating. In such an embodiment, the induction coil **165** can be made integral with the contact tube **160** or can be coiled around a surface of the contact tube **160**. Of course, other configurations for heating wire **140** can be used so long as they deliver the needed heating current/power to the wire **140** so that the wire can achieve the desired temperature for the cutting operation.

[0023] During cutting operations, the laser beam **110** will initially melt a portion of workpiece **115** to create a hole or slot in the workpiece **115**. Once the laser beam **110** fully penetrates the workpiece **115**, the wire **140** is fed by wire feeder **150** through the hole or slot created by the laser beam **110**. As the wire **140** moves through the hole or slot, the wire **140** picks up the molten metal **145** and the molten metal **145** is removed from the hole or slot. That is, during cutting the molten material from the workpiece adheres to the surface of the **140** and the wire **140** carries the material out of the cutting area in a controlled fashion. As such, the temperature of the wire should be such that it allows the molten material from the workpiece to adhere to the wire **140**. Thus, in some exemplary embodiments the wire **140** does not have to be heated and can simply be at room or operational temperature. This temperature will allow the molten material to quickly cool and adhere to the surface of the wire **140**. However, to the extent that the material is to be removed from the wire **140**, it can be beneficial to have the wire **140** heated as described herein. This will be discussed further below.

[0024] By using the wire **140** rather than blasting the molten metal **145** using pressurized gas, the work area is kept clear of debris. As the wire **140** draws out the molten metal, the laser **120** and/or the workpiece **115** is moved as desired to cut the remaining portion of workpiece **115**. U.S. Patent Application No. 13/212,025, titled "Method And System To Start And Use Combination Filler Wire Feed And High Intensity Energy Source For Welding" is incorporated by reference in its entirety, provides exemplary robotic systems that may be used for moving workpiece **115**.

[0025] As discussed before, in some exemplary embodiments the wire **140** is preheated to at or near the temperature of the meeting point of workpiece **115**. In these embodiments, by preheating the wire **140**, the wire **140** will not appreciably cool or solidify the molten metal **145** as the wire **140** draws the molten metal **145** out of the cut. However, the temperature of the wire **140** should be such that at least some bonding between the molten metal and the wire surface should occur. Depending on the properties of the workpiece **115** being cut and the wire **140**, in some exemplary embodiments, the temperature of the wire **140** may be kept slightly below the melting point of wire **140**. In such embodiments, the wire has a melting temperature which is higher than that of the workpiece being cut. In some exemplary embodiment, the melting temperature of the wire **140** is at least 5% higher than that of the workpiece being cut. As such, the portion of molten metal **145** that touches wire **140** may solidify and facilitate the adherence of the molten metal **145** to the wire **140** as the metal **145** is being drawn out of the hole or slot. In other embodiments, the removal of the molten metal **145** may be easier if the metal **145** is kept molten on the wire **140**. In such cases, the temperature of wire **140** may be

kept slightly higher than the melting point of workpiece **115**. Because the wire **140** is used to remove the molten metal **145**, as opposed to pressurized air or gas, the workpiece **115** is clear of molten debris.

[0026] In the embodiments discussed above, the wire **140** is pushed through the hole or slot by wire feeder **150**. As such, the wire **140** should be of a sufficient rigidity that it can be forced through the hole or slot without bending or crimping when drawing out the molten metal **145**. Further, the contact tip **160** can be of a configuration that controls the movement and placement of the wire **140** through the cut and keeping the wire **140** in the appropriate positioning. However, the present invention is not limited to wire feeders that push the wire **140** through the hole or slot, and can include wire feeding systems that pull the hot wire through the hole or slot instead of pushing it. The wire **140**, which is initially spooled on spooler **255**, is drawn through the hole or slot by wire feeder **250**. In this case, the wire **140** need not be as rigid as in the above embodiments (but should have the proper tensile strength) and, thus, can be thinner. By using a thinner wire **140**, the slots (or holes) relatively narrower slots and smaller holes can be formed by laser beam **110** in the workpiece **115**. Of course, in the case of a hole or a slot that is initiated in the middle of the workpiece **115** (as opposed to starting from an edge of the workpiece **115**), the wire **140** will first have to be threaded through the hole or slot to wire feeder **250** before it can start its pulling operation.

[0027] In the above embodiments, the wire feeding operations are a once-through process in that the wire **140** is not reused during the same cutting operation. Of course, the metal **145** that has adhered to the wire **140** may be removed from the wire **140** at a later time, and the wire **140** can then be reused. For example, in

some exemplary embodiments, the metal **145** can be removed by heating wire **140** to a point where the metal **145** melts off the wire **140**. This is possible because the melting point of the wire **140** is higher than that of the metal **145** that was removed from the workpiece **115**. In other exemplary embodiments, the metal **145** can be chemically removed using chemicals that react with metal **145** but not with wire **140**. In yet other exemplary embodiments, the metal **145** can be mechanically removed, for example, by scraping or grinding of the metal **145** from the wire **140**. Of course, any combination of the above cleaning methods may be used in the present invention.

[0028] The once-through wire feed process discussed above will require that enough wire **140** is spooled or kept on-site to ensure that the cutting operation is not interrupted. However, the present invention is not limited to just the once-through wire feed process and other wire feed processes may be used. For example, Figure 3 illustrates an embodiment in which the wire **140** is looped between a wire feeder **350** and pulley **355**. In this exemplary embodiment, wire feeder **350** pulls the wire **140** from pulley **355** through the hole or slot in workpiece **115** and then through the wire cleaning unit **360** before the wire **140** is looped back to pulley **355**. In this embodiment, after the wire **140** picks up the molten metal **145** during the cutting operation, the metal **145** is removed from the wire **140** by the wire cleaning unit **360**. The wire **140** is then routed to the pulley **355** by the feeder **350** so that the wire **140** can be reused. The wire cleaning unit **360** can use any combination of the exemplary cleaning methods discussed above to clean the wire **140**. However, in this case, the cleaning is performed during the cutting operation, rather than using the "offline" cleaning method discussed above. Because the wire **140** can be

immediately reused, there is no need to keep a large amount of the wire **140** on-hand for cutting operations.

[0029] For example, the wire cleaning unit **360** can use additional heat which heats the removed material and/or the wire to above the melting temperature of the workpiece so that any solidified material **145** will be in molten form again. Once made molten, the material can then be removed by scraping or other physical means. Additionally, the wire cleaning unit can use a chemical bath to clean the material off of the wire **140**.

[0030] In the above embodiments, the laser beam **110** fully penetrates the workpiece **115** during cutting operations. However, the laser device **120** allows for precise control of the size and depth of the cutting, as it is easy to change the focus and beam intensity on laser **120**. Accordingly, in some embodiments, the laser **120** may be controlled such that the beam **110** does not fully penetrate the workpiece **115** during cutting operations. In such cases, the wire **140** must return to the same side of the workpiece **115** after picking up the molten material **145**, as illustrated in Figure 4. As shown in Figure 4, wire feeder **450** includes extension **455** and pulley **456** that permits the wire **140** to remove the molten material **145** from the cutting area and return it to wire feeder **450** (or send it to some other location). The wire **140** may be heated using methods discussed above. In addition, the wire **140** may be directed to a wire cleaning system similar to that discussed above prior to returning the wire **140** to the wire feeder **450** for reuse. Because the shape and/or intensity of the beam **110** can be adjusted/changed, in some exemplary embodiments the width and depth of the cut may be varied as desired during the cutting process. Of course, wire feeder **450** may also be used in cutting operations that fully pene-

trate the workpiece **115**. For example, in situations where it is impractical to have wire feeder equipment on both sides of the workpiece **115**, wire feeder **450** will be able to remove the molten metal **145** from the cut. These embodiments allow grooves and channels to be cut in a work piece and allows for the simultaneous removal of excess material, allowing for rapid and clean processing of the workpiece.

[0031] In the embodiments discussed above, the wire **140** can be a material that has a higher melting temperature than workpiece **115**. For example, in the case where aluminum is the workpiece **115**, the wire **140** can be a metal alloy, such as steel, that has a higher melting temperature. Of course other wire/workpiece material combinations can be used so long as the melting point of the wire is higher than the melting point of the workpiece **115**.

[0032] In addition, to facilitate the removal of molten metal **145**, the wire **140** may be knurled. A knurled wire will allow the wire **140** to grab and attach to the molten metal **145** more easily. Some exemplary embodiments of such knurled wire **140** are illustrated in Figures 6A and B. That is, the surface of the wire **140** can be textured, have protrusions, grooves, abrasive, etc. which provides additional surface area of the material to be removed.

[0033] In another exemplary embodiment of the present invention, the wire feeders **150**, **250**, **350**, and **450** (or the sensing and control unit **195**) can include or be coupled to a feed force detection unit (not shown). The feed force detection units are known and detect the feed force being applied to the wire **140** as it is being fed to the workpiece **115**. For example, such a detection unit can monitor the torque being applied by a wire feeding motor in the wire feeder **150**, **250**, **350**, and **450**. If the wire **140** encounters obstacles as it passes through the molten metal

145 because of, for example, un-melted areas on workpiece **115**, such contact can cause an increase in the force/torque of the motor that is trying to maintain the desired wire feed rate. This increase in force/torque can be detected and relayed to the control **195** which can utilize this information to adjust the voltage, current and/or power to laser power supply **130** to ensure proper melting of the workpiece **115**, to wire feeder **150, 250, 350, or 450** to ensure proper wire speed, and/or to power supply **170** to ensure proper temperature of the wire **140**. To this end, sensing and control unit **195** may use the temperature feedbacks from sensors **197** (temperature of wire **140**) and **198** (temperature of molten metal **145**) to further adjust the voltage, current and/or power to laser power supply **130**, wire feeder **150, 250, 350, or 450**, and/or power supply **170**. US Patent Application No. 13/212,025, titled "Method And System To Start And Use Combination Filler Wire Feed And High Intensity Energy Source For Welding" and incorporated by reference in its entirety, provides exemplary temperature sensors and control algorithms that may be used in the above exemplary systems for controlling the temperature of the wire **140**.

[0034] In Figure 1, the laser power supply **130**, hot wire power supply **170**, and sensing and control unit **195** are shown separately for clarity. However, in embodiments of the invention these components can be made integral into a single welding system. Aspects of the present invention do not require the individually discussed components above to be maintained as separately physical units or stand alone structures.

[0035] While the invention has been described with reference to certain embodiments, it will be understood by those skilled in the art that various changes may

be made and equivalents may be substituted without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from its scope. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

REFERENCE NUMBERS

100	system	170	(wire) power supply
110	laser beam	195	sensing/control unit
115	workpiece	197	sensor
120	laser	198	sensor
125	direction	250	wire feeder
130	laser power supply	255	spooler
140	wire	350	wire feeder
145	molten material	355	pulley
150	wire feeder	360	wire cleaning unit
160	contact tube / tip	450	wire feeder
161	contact tube	455	extension
165	induction coil	456	pulley

CLAIMS

1. A system (100) for removing material in a workpiece (115), said system (100) comprising:
a laser system (120) that melts a portion of said workpiece (115) by heating said workpiece (115); and
a wire feeder system (150, 250, 350, 450) that feeds a wire (140) to said workpiece (115) to remove molten metal (145) from said workpiece (115) by using said wire (140);
wherein said wire (140) is configured such that said molten metal (145) adheres to said wire (140) when said wire makes contact with said molten metal (145), and
wherein said melting by said laser system (120) comprises a cutting or a gouging of said workpiece (115).
2. The system (100) of claim 1, further comprising:
a hot wire power supply (170) that supplies heating current through a length of said wire (140) to heat said length of said wire (140) to a desired temperature,
wherein said desired temperature facilitates said adherence of said molten metal (145) to said wire (140).
3. The system (100) of claim 2, wherein said desired temperature is $\pm 25\%$ of a melting temperature of said workpiece (115).
4. The system (100) of claim 2 or 3, wherein said desired temperature is above a melting temperature of said workpiece (115), or

wherein said desired temperature is below a melting temperature of said workpiece (115).

5. The system (100) of any of the claims 1 to 4, wherein a melting temperature of said wire (140) is at least 5% above a melting temperature of said workpiece (115).
6. The system (100) of any of the claims 1 to 5, wherein said wire feeder system (150, 250, 350, 450) is a once-through system that does not reuse said wire (140) in a same melting process, or wherein said wire feeder system (150, 250, 350, 450) is a loop-back system that reuses said wire (140) in a same melting process.
7. The system (100) of any of the claims 1 to 6, further comprising:
a cleaning unit (360) that uses one of a mechanical and chemical process to clean said adhered metal from said wire (140) prior to said reuse.
8. The system of any of the claims 1 to 7, wherein said wire (140) is knurled to facilitate removal of said molten metal (145).
9. A method of removing material in a workpiece, said method comprising:
melting a portion of said workpiece by heating said workpiece using a laser;
and
feeding a wire to said workpiece to remove molten metal from said workpiece by using said wire;
wherein said wire is configured such that said molten metal adheres to said wire when said wire makes contact with said molten metal, and
wherein said melting comprises a cutting or a gouging of said workpiece.
10. The method of claim 9, further comprising:

supplying a heating current through a length of said wire to heat said wire to a desired temperature,

wherein said desired temperature facilitates said adherence of said molten metal to said wire.

11. The method of claim 10, wherein said desired temperature is $\pm 25\%$ of a melting temperature of said workpiece.
12. The method of claim 10 or 11, wherein said desired temperature is above a melting temperature of said workpiece, or wherein said desired temperature is below a melting temperature of said workpiece.
13. The method of any of the claims 9 to 12, wherein a melting temperature of said wire is at least 5% above a melting temperature of said workpiece.
14. The method of any of the claims 9 to 13, wherein said wire is not reused in a same melting process, or wherein said wire is reused in a same melting process.
15. The method of any of the claims 9 to 14, further comprising:
cleaning adhered metal from said wire by using one of a mechanical and chemical process prior to said reusing of said wire.

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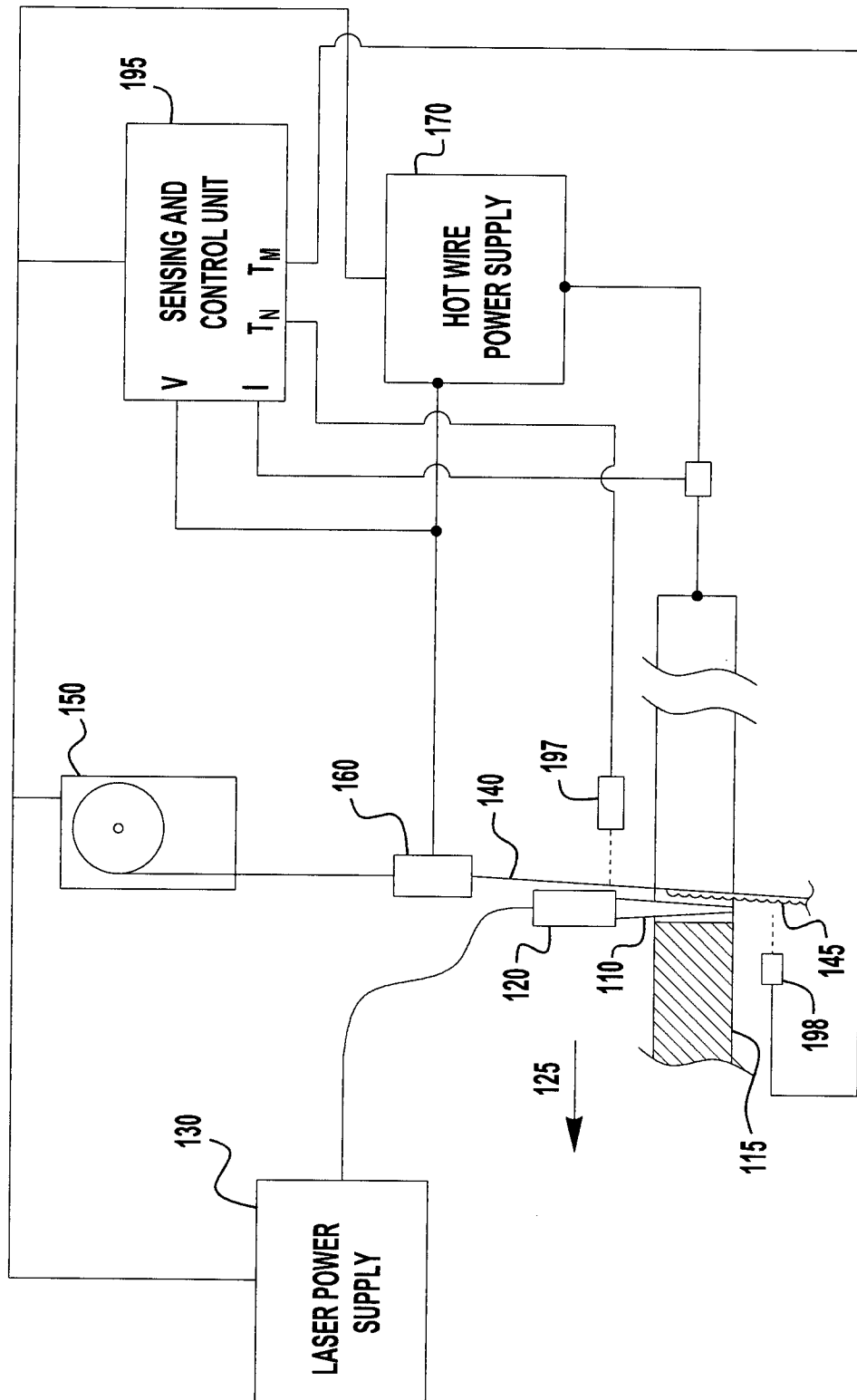


FIG. 1

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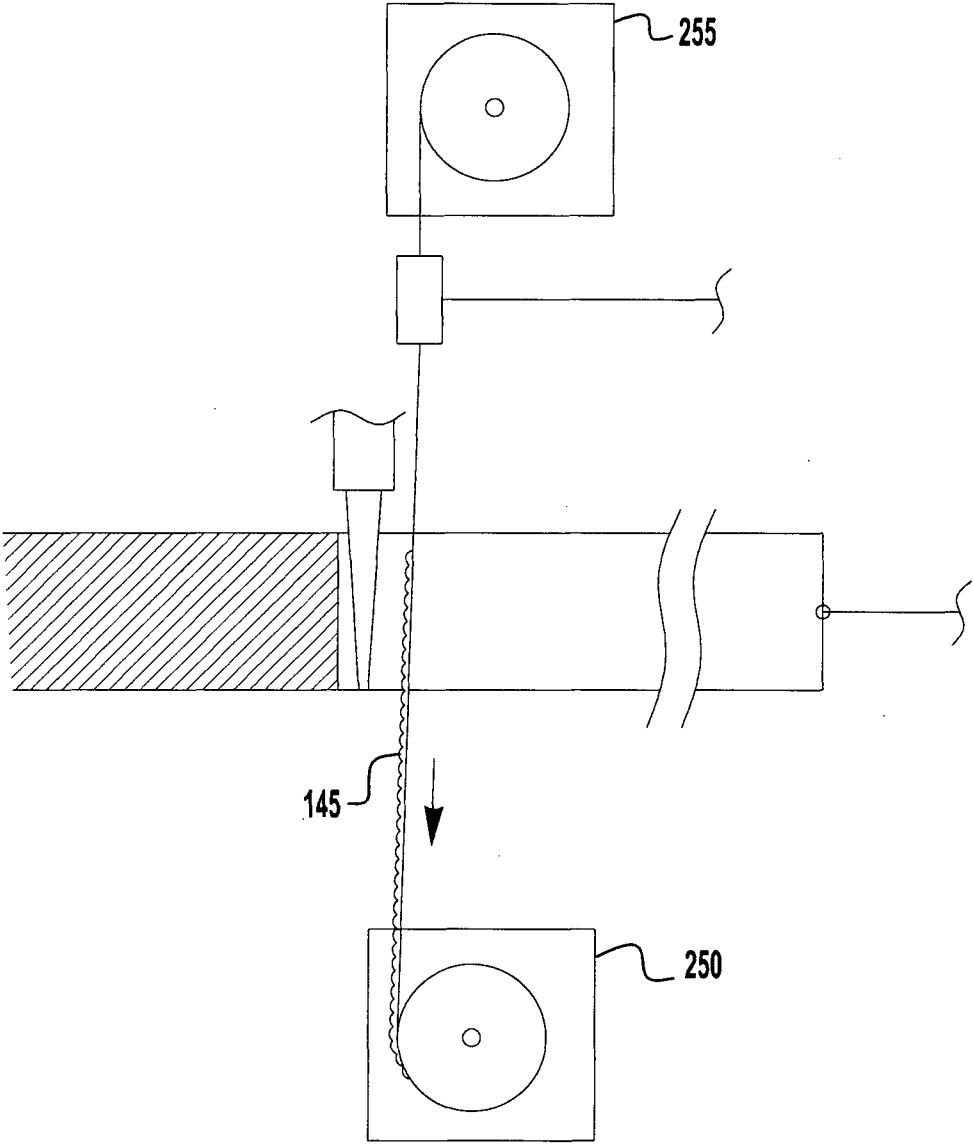


FIG. 2

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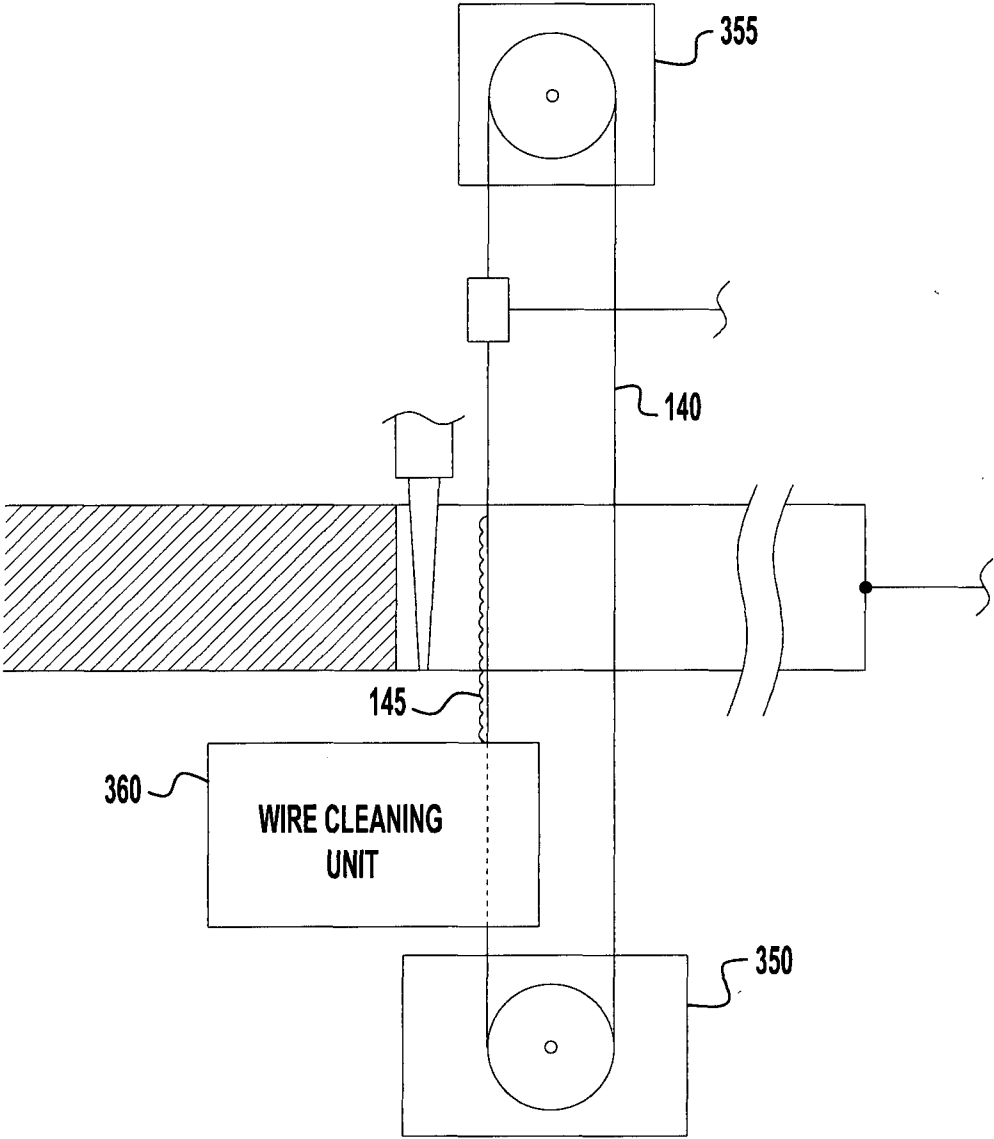


FIG. 3

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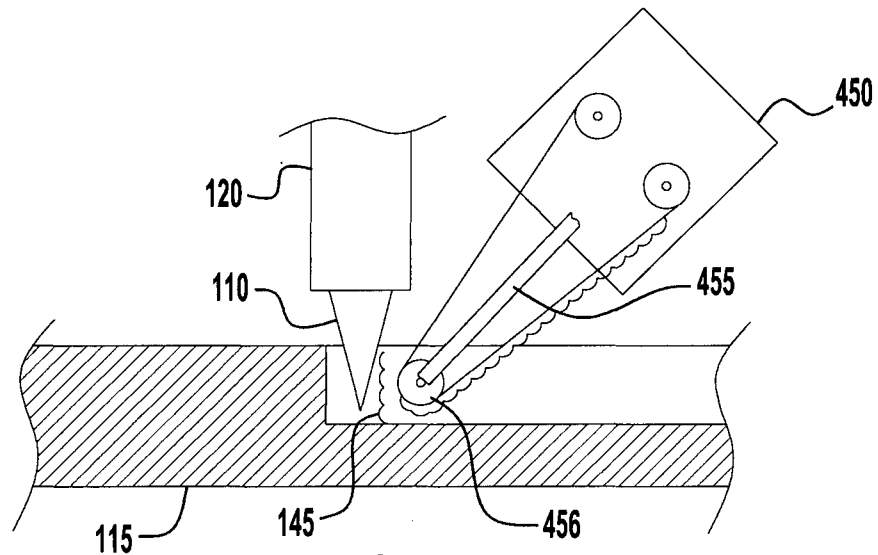


FIG. 4

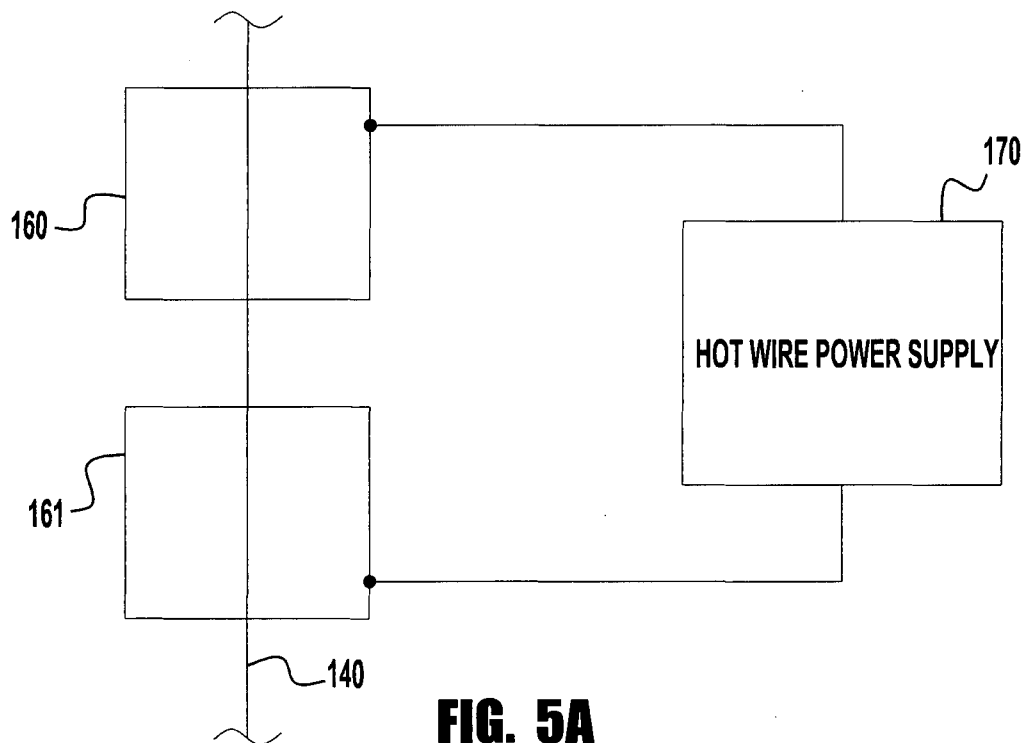


FIG. 5A

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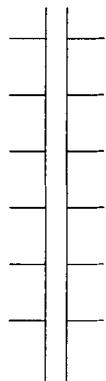
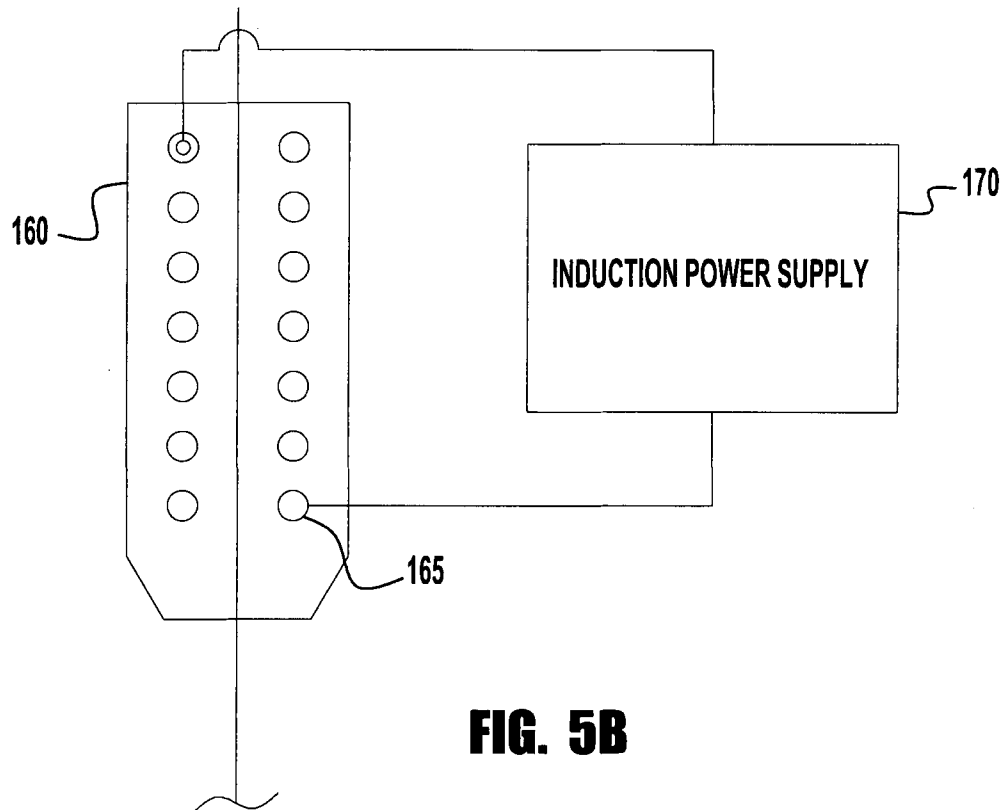


FIG. 6A



FIG. 6B

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2013/001463

A. CLASSIFICATION OF SUBJECT MATTER

INV. B23K26/14 B23H7/02 B23K26/38
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 B23H

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	JP 2012 061478 A (MITSUI SHIPBUILDING ENG) 29 March 2012 (2012-03-29)	1,5-7,9, 13-15
Y	abstract; figures	2-4,8, 10-12
Y	----- US 4 427 870 A (K. INOUE) 24 January 1984 (1984-01-24) column 2, lines 50-59 column 6, line 29 - column 7, line 34; figures	2-4, 10-12
Y	----- US 2004/056003 A1 (B. STELTER) 25 March 2004 (2004-03-25) paragraph [0031]; figures	8
A	----- EP 0 396 759 A1 (FANUC LTD) 14 November 1990 (1990-11-14) page 4, last paragraph - page 5, paragraph 1; figures	1,9



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

25 November 2013

Date of mailing of the international search report

02/12/2013

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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			FR 2485975 A1	08-01-1982
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