(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 194 018 A2

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.04.2002 Bulletin 2002/14

(51) Int Cl.^{7}: **H05H 1/48**

(21) Application number: **01123094.3**

(22) Date of filing: **27.09.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **29.09.2000 JP 2000298308**

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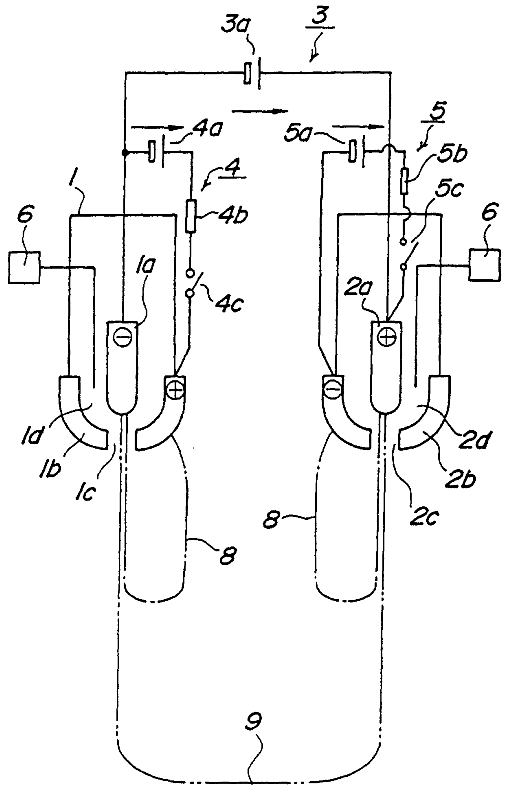
(54) **Inter-torch plasma transfer device**

(57) A plasma device is provided to be used upon furnaces for smelting metal or detoxifying burnt ash by melting, to perform effective heating or melting regardless whether the targeted melting object is conductive or non-conductive, and further, to provide higher efficiency and satisfactory activation and maneuverability.

The plasma transfer device **A** comprising: a primary torch 1 and a secondary torch 2 having an internal electrode 1a, 2a of different polarity, and an external electrode 1b, 2b; a main power source circuit 3 shared by the primary torch 1 and the secondary torch 2; a pilot power source circuit 4, 5 formed to each of the torches 1,2 and electrically discharged between internal electrode and the external electrode for generating a pilot arc; wherein each of the torches 1, 2 forms and emits a pilot arc 8; and wherein the main power source circuit 3 is activated for forming an inter-torch transfer plasma 9 between the internal electrodes 1a, 2a of both torches when the pilot arc of both torches become substantially conducting.

FIG.1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] This invention relates to a device for transferring plasma between torches by switching from a pilot arc to a main arc through a pair of torches having electrodes of opposite polarity, and, more particularly, to an inter-torch plasma transfer device for effectively melting a non-conductive object.

2. Description of Related Art

[0002] Among furnaces such as a melting furnace for smelting metal, a melting furnace for melting glass, or a melting furnace for detoxifying burnt ash, there are furnaces where a plasma formed gas (plasma arc or plasma jet) is emitted inside the furnace, and a targeted melting object is melted by the radiation heat of the emitted plasma arc. When a plasma arc is used, a targeted melting object could be rationally melted in a short time since the plasma arc is of extreme high temperature.

[0003] As for methods of forming a plasma arc, there are for example: a method of electrical discharge by arranging a pair of electrodes with opposite polarity at a prescribed distance apart from each other, and applying a large current simultaneously with supplying plasma gas comprised of nitrogen gas, argon gas or the like, upon each of the electrodes (Japanese Publication No. Kokai Hei 9-4836); a method of electrical discharge by arranging one electrode above a furnace while arranging the other electrode at a bottom surface of the furnace, and applying a large current between both electrodes simultaneously with supplying plasma gas to the above arranged electrode (Japanese Publication No. Kokai Hei 5-253557); and a method of electrical discharge by applying a small current simultaneously with supplying plasma gas between a pair of electrodes being arranged close to each other; wherein the methods are selected and used according to circumstance, for example, according to the characteristic of the targeted melting object.

[0004] Regarding the foregoing methods shown in each of the publications, the targeted melting object comprises part of the circuit during the electrical discharge between the pair of electrodes. That is, the targeted melting object is required to he conductive; this results to a problem of being unable to perform efficient melting when the targeted melting object is non-conductive causing difficulty in electrical discharge between the electrodes.

[0005] Further, when performing electrical discharge between a pair of electrodes being arranged close to each other, a plasma arc could be formed regardless of whether or not the targeted melting object is conductive. However, such case raises a problem in which the energy of the formed plasma arc would be low and would be time-consuming for heating the targeted melting object.

[0006] It is an object of this invention to provide an inter-torch plasma transfer device being highly efficient, providing satisfactory activation and maneuverability, and being advantageous as a heat source for effectively heating or melting a conductive or non-conductive targeted melting object.

SUMMARY OF THE INVENTION

[0007] An inter-torch plasma transfer device of the present invention for solving the foregoing problem comprises: a primary torch being of a positive polarity, and having an internal electrode applied with a negative voltage and an external electrode faced toward the internal electrode; a secondary torch being of a negative polarity, and having an internal electrode applied with a positive voltage and an external electrode faced toward the internal electrode; a main current power source circuit being shared by the primary torch and the secondary torch; a pilot current power source circuit being formed for each the primary torch and the secondary torch, and electrically discharging between the internal electrode and the external electrode for forming a pilot arc; wherein the pilot current power source circuit for the primary torch and the secondary torch is activated to form and emit a pilot arc at each of the primary torch and the secondary torch; and wherein the main current power source circuit is activated and electrically discharged between the internal electrode of the primary torch and the internal electrode of the secondary torch for forming a main arc and for stopping the pilot current power source circuits for the primary torch and the secondary torch respectively, when the pilot arc of the primary torch and the pilot arc of the secondary torch become substantially conducting.

[0008] With the foregoing inter-torch plasma transfer device (hereinafter simply referred as "plasma transfer device"), since each of the primary torch and the secondary torch have a pilot current power source circuit (hereinafter referred as "pilot power source circuit") for maintaining a pilot arc formed from a prescribed internal discharge between the internal electrode and the external electrode, the pilot power source circuit is activated to perform electrical discharge between both electrodes for forming the pilot arc, and emitting the pilot arc outward from an orifice at the tip portion of each torch.

[0009] When the pilot arc emitted from the primary torch and the secondary torch are directly in electrical communication, or in electrical communication via a conductive targeted melting object, the internal electrode for the primary torch and the secondary torch becomes substantially in electrical communication via the pilot arc; in this state, by activating a main current power source circuit (hereinafter referred as "main power source circuit") and by electrically discharging between both internal electrodes, a main arc transferred between the primary arc and the secondary arc could be formed. Subsequently, after the main arc is formed, the pilot power source circuit is stopped to stop the pilot arc so that an inter-torch transfer plasma serving as the main arc could be formed solely.

[0010] Accordingly, conductivity of the targeted melting object would not become a requirement, and activating the pilot power source circuit followed by the activating of the main power source circuit enables the pilot arc to transfer to the inter-torch transfer plasma for heating the targeted melting object.

[0011] In respect of the foregoing plasma transfer device, it is preferable for the pilot power source circuit formed for each the primary torch and the secondary torch to have the internal electrode and the external electrode connected in series to each direct current power source, and to have a circuit breaker and a serial resistor connected in series.

[0012] Further, included in the pilot power source is a pilot arc initiating circuit (not shown) of a high frequency multi-layer type, a contact type, or the like for forming a pilot arc between the internal electrode and the external electrode.

[0013] In respect of the thus structured plasma transfer device, a pilot arc could be independently formed at each torch without changing the polarity of the internal electrode of the primary torch and the secondary torch. Further, the pilot power source circuit could be cut off from the main power source circuit after the transferring of the inter-torch transfer plasma.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The above and other objects and features of the invention are apparent to those skilled in the art from the following preferred embodiments thereof when considered in conjunction with the accompanied drawings, in which:

FIG. 1 is a block diagram for schematically explaining an inter-torch transfer plasma regarding the first embodiment;

FIG.2 is a block diagram for schematically explaining an inter-torch transfer plasma regarding the second embodiment; and

FIG.3 is a schematic view for explaining a structure of a melting furnace arranged with a plasma transfer device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] An embodiment of the plasma transfer device regarding this invention will hereinafter be described with reference to the drawings. FIG.1 is a block diagram for schematically explaining an inter-torch transfer plasma regarding the first embodiment. FIG.2 is a block diagram for schematically explaining an inter-torch transfer plasma regarding the second embodiment. FIG.3 is a schematic view for explaining a structure of a melting furnace arranged with a plasma transfer device.

[0016] A structure of a melting furnace to allow preferable use of the plasma transfer device regarding this invention will be simply explained with reference to FIG. 3. In the drawing, a plasma transfer device **A** is comprised of: a primary torch 1 and a secondary torch 2; a main power source 3a forming a main power circuit 3 in which an internal electrode 1a and an internal electrode 2a (See FIG.1) for each of torches 1, 2 are connected thereto; a pilot circuit 4, 5 for each of the torches 1, 2; a plasma gas supply device 6 for supplying plasma gas to each of the torches 1, 2; and a cooling device (not shown) for cooling each of the torches 1,2.

[0017] The primary torch 1 and the secondary torch 2 comprising the plasma transfer device **A** are connected to a driving device 7 respectively and are structured to move in a direction away from or toward each other, or to move in a direction away from or toward a targeted melting object 12, or to be capable of changing angle, by driving the driving device 7.

[0018] The thus structured plasma transfer device **A** is arranged at an upper portion of a furnace 11 and is structured to apply heat from a radiation heat of an inter-torch transfer plasma from above the targeted melting object 12 contained inside the furnace 11 and from a thermal conduction of a high temperature plasma stream. Further, arranged at a prescribed position of the furnace 11 are a takeout port 11a for taking out a melted targeted melting object and an exhaust gas processing device 13 for absorbing and processing internal gas.

[0019] After the targeted melting object 12 is contained within the thus structured furnace 11, a pilot arc 8 (see FIG. 1) is formed and emitted from each of the primary torch 1 and the secondary torch 2, and then, after the pilot are 8 become substantially conducting, the pilot arc 8 is transferred to an inter-torch transfer plasma 9 between the torch 1 and the torch 2 so that the targeted melting object 12 could be rationally melted from a radiation heat of the inter-torch plasma 9 and from a thermal conduction of high temperature plasma stream.

[0020] Next, a structure of a plasma transfer device **A** and a procedure of activating the plasma transfer device **A** and forming the inter-torch transfer plasma 9 will be explained in detail with reference to FIG.1.

[0021] The primary torch 1 and the secondary torch 2 shown in the drawing is structured with a cooling medium flow path (not shown) for effectively removing the heat created at each internal electrode 1a, 2a, at each external electrode 1b, 2b and at an internal structural body of the torch, and the heat applied upon a structural body of the torch from exposure to an operational high temperature atmosphere.

[0022] The internal electrode 1a subject to negative voltage of the main power source 3a is arranged at a center axis of the primary torch 1, and the external electrode 1b having an orifice 1c at an axis same as that of the internal electrode 1a is arranged in a manner surrounding or facing toward the internal electrode 1a. More particularly, an insulating material (not shown) is placed between the internal electrode 1a and the external electrode 1b, and when a plasma gas such as nitrogen gas or argon gas is supplied to a chamber 1d formed between the internal electrode 1a and the external electrode 1b from a plasma gas supplying device 6, the plasma gas is emitted out of the primary torch 1 from the orifice 1c.

[0023] Other than the fact that an internal electrode 2a and an external electrode 2b are of opposite polarity, the secondary torch 2 and the primary torch 1 are structured in a same manner. That is, the internal electrode 2a subject to positive electric voltage of the main power source 3a is arranged at a center axis of the secondary torch 2, and the external electrode 2b having an orifice 2c at an axis same as that of the internal electrode 2a is arranged in a manner surrounding or facing toward the internal electrode 2a. Further, a plasma gas is supplied from the plasma gas supplying device 6 to a chamber 2d formed between the internal electrode 2a and the external electrode 2b so that the plasma gas is emitted out of the secondary torch 2 from the orifice 2c.

[0024] The primary torch 1 and the secondary torch 2 are structured with pilot power source circuit 4, 5 respectively. The pilot power source circuit 4 of the primary torch 1 is comprised of: a pilot power source 4a for applying negative voltage to the internal electrode 1a of the primary torch 1 and for applying positive voltage to the external electrode 1b; a serial resistor 4b arranged in series for a circuit comprised of electrodes 1a, 1b and the pilot electric source 4a; and a circuit breaker 4c. In the same manner, the pilot power source circuit 5 of the secondary torch 2 is comprised of: a pilot power source 5a for applying a positive voltage to the internal electrode 2a of the secondary torch 2 and for applying negative voltage to the external electrode 2b; a serial resistor 5b; and a circuit breaker 5c.

[0025] At the primary torch 1 and the secondary torch 2, the pilot power source 4a, 5a and the circuit breaker 4c, 5c are activated by a signal from a control device (not shown) ordering the forming of a pilot arc, and then, by activating a pilot arc initiating circuit (not shown), the plasma gas having been supplied from the chambers 1d, 2d formed between the internal electrodes 1a, 2a and the external electrodes 1b, 2b of the torches 1,2 is ionized, so as to form an electrical current path between the internal electrodes 1a, 2a and the external electrodes 1b, 2b and to form a pilot arc 8 having each pilot power source 4a, 5a serve as an electric power source.

[0026] The plasma gas ionized by the pilot arc and being of a high temperature is emitted out from each of the orifices 1c, 2c of each of the torches 1, 2, as a high temperature and high speed ionized stream with a high directivity for forming an ionized area (pilot arc 8) protruding from each of the orifices 1c, 2c. Such state is typically called a plasma jet. In such case, the flow of the electrons within the ionized space of the plasma jet for the primary torch 1 and for that of the secondary torch 2 are faced in a direction opposite from each other.

[0027] When the torches 1,2 are sufficiently apart from each other, each of the ionized area (pilot arc 8) of each plasma jet for the primary torch 1 and the secondary torch 2 comprise a portion of an independent pilot electrical circuit. In this state, the main power source circuit 3 is in an open-circuit state between a front tip of the ionized area (pilot arc 8) of the plasma jet for the primary torch 1 and a front tip of the ionized area (pilot arc 8) of the plasma jet for the secondary torch 2.

[0028] When the primary torch 1 and the secondary torch 2 are arranged close each other, or when the ionized area (pilot arc 8) of the plasma jet emitted from each of the torches 1, 2 are arranged close to each other in correspondence with an increase of plasma gas supply so that a portion thereof is in a state contacting or intersecting to each other, the main power source circuit 3 becomes a closed-circuit state having the pilot arc 8 of the primary torch 1 and that of the secondary torch 2 serve as an electric current path; further, an inter-torch transfer plasma 9 serving as a main arc with the main power source 3a as an electric power source is formed between the internal electrode 1a of the primary torch 1 (cathode) and the internal electrode 2a of the secondary torch 2 (anode).

[0029] The electric power source 3a is comprised with a power source circuit of constant current characteristics having a high output voltage high sufficient for maintaining an electric discharge during an extension of discharge distance after the forming of the inter-torch transfer plasma 9, that is, the actual distance of a discharge current path between the internal electrode 1a of the primary torch 1 and the internal electrode 2a of the secondary torch 2. Further, the pilot power source 4a, 5a formed at each of the torches 1, 2, are comprised with a power source circuit of constant current characteristics having an output voltage enough to sufficiently, lastingly, and steadily form a plasma jet (pilot arc 8) for the primary torch 1 and for the secondary torch 2.

[0030] Next, a case of forming the inter-torch transfer plasma 9 into a preferable state will be described. The primary torch 1 and the secondary torch 2 are arranged in a V-letter shape by driving the driving device 7 so that a center axis of each of the torches 1, 2 would intersect in a state extended from the torches.

[0031] In the foregoing state, the pilot arc 8 is formed at the primary torch 1 and at the secondary torch 2. In such case, an intersecting point of the center axis for each of the torches 1, 2 is located extending from the pilot arc 8, and in such state, the pilot arc 8 is formed for the primary torch 1 and for the secondary torch 2.

[0032] Next, a relative distance between the primary torch 1 and the secondary torch 2 is shortened by the driving device 7. Accordingly, the intersecting point of the center axis for each of the torches 1, 2 shifts toward a front end tip of the torches, and a portion of the pilot arc 8 for the primary torch 1 and the secondary torch 2 contacts or overlaps to form a current path of the inter-torch transfer plasma 9. The relative distance between the torches in such case is maintained to provide a sufficient short current path enabling initiation of the inter-torch transfer plasma 9.

[0033] Next, by activating the main power source circuit 3, an output voltage is supplied between the internal electrode 1a of the primary torch 1 and the internal electrode 2a of the secondary torch 2, and the inter-torch transfer plasma 9 is formed between the internal electrode 1a and the internal electrode 2a. In such state, before the activation of the main power source circuit 3, a current path is already formed between the internal electrode 1a and the internal electrode 2a by the pilot arc 8 of the primary torch 1 and of the secondary torch 2, and at the same time of the activation of the main power source circuit 3, the inter-torch transfer plasma 9 is formed. Accordingly, the output voltage of the main power source circuit 3 during the initiation of the inter-torch transfer plasma 9 would not reach the maximum load voltage of the main power source circuit 9 and would be restrained to an output voltage substantially equal to a load voltage of the inter-torch transfer plasma 9. Since the actual discharge current path is short, the inter-torch transfer plasma 9 in such state is of a relatively low load voltage, and is restricted to a relatively low output.

[0034] After a forming of a steady inter-torch transfer plasma 9 between the internal electrodes 1a, 2a for the primary torch 1 and for the secondary torch 2 is detected, the pilot electric source 4a, 5a of the pilot electric circuit 4,5 for the primary torch 1 and the secondary torch 2 is stopped so as to stop the pilot arc 8; subsequently, the circuit breaker 4c, 5c is cut off. Accordingly, the pilot electric circuits 4, 5 could be cut off from the main power source circuit 3, and could protect the pilot electric circuits 4, 5 from the high main power circuit output voltage generated afterwards during normal execution of heating and melting.

[0035] In a case immediately after the forming of the inter-torch transfer plasma 9 where the pilot arc 8 is also formed, the serial resistors 4b, 5b being inserted in series to the pilot electric circuit 4, 5 of the primary torch 1 and the secondary torch 2 are effective for enabling the pilot electric circuit 4,5 to maintain an electric potential higher than that of the main power source circuit 3 and to prevent the creation of a series arcing.

[0036] Subsequently, the driving device 7 is driven to move the front tip for each of the primary torch 1 and the secondary torch 2 in a separating direction, and to extend the actual distance of the discharge current path of the inter-torch transfer plasma 9. Accordingly, the load voltage of the inter-torch transfer plasma 9 as well as the output increases.

[0037] A shape of the discharge current path of the inter-torch transfer plasma 9 is controlled depending on the position of the plasma torch, the relative distance between the primary torch 1 and the secondary torch 2, the type, flowing amount of plasma gas, and the current of the inter-torch transfer plasma. In the area where a sufficient flow speed of the inter-torch transfer plasma 9 emitted from the orifice 1c, 2c for the primary torch 1 and for the secondary torch 2 is secured, a straight lined discharge current path is formed, and ends in a arc-like manner internally contacting to the straight lined discharge current path in the area where the flow speed is low.

[0038] The inter-torch transfer plasma 9 forming a long discharge current route between the primary torch 1 and the secondary torch 2 is capable of heating a targeted melting object in a wide area with a high output, and capable of providing a plasma generating device with a high heat efficiency.

[0039] A method of initiating the inter-torch transfer plasma 9 is not to be limited to the aforementioned example, but also, the pilot arc 8 of the primary torch 1 and the secondary torch 2 could be initiated by arranging beforehand the pilot arc 8 of the primary torch 1 and the secondary torch 2 in a overlapping position and arrangement. Further, a no-load voltage could be applied between the internal electrodes 1a, 2a of the primary torch 1 and the secondary torch 2 simultaneously with the initiation of the pilot arc 8 or beforehand after the main power 3a is activated. As for a method for overlapping the pilot arc 8 of the primary torch 1 and the secondary torch 2, such method could be performed by changing the angle of each of the torches 1, 2.

[0040] As for other examples for initiating the inter-torch transfer plasma 9, each center axis for the primary torch 1 and the secondary torch 2 could be arranged facing and being sufficiently distanced from each other, and then the pilot arc 8 for the primary torch 1 and the secondary torch 2 could be initiated so that the pilot arc 8 could be formed for each of the torches 1, 2.

[0041] Next, by shortening the relative distance between the primary torch 1 and the secondary torch 2 with the driving device 7, a portion of the pilot arc 8 would be in a contacting or overlapping state, and a current path of the inter-torch transfer plasma 9 could be formed. In such case, the relative distance between the torches 1, 2 are maintained to provide a sufficient short current path for initiating the inter-torch transfer plasma 9.

[0042] Next, by activating the main power source circuit 3, an output voltage is applied between the internal electrode 1a of the primary torch 1 and the internal electrode 2a of the secondary torch 2, and an inter-torch transfer plasma 9 having a straight lined discharge current path between the internal electrodes 1a, 2a for each of the torches 1, 2 is formed. In such state, a current path is already formed between the internal electrode 1a and the internal electrode 2a by the pilot arc 8 of the primary torch 1 and the secondary torch 2 before the starting of the main power circuit 3, and the inter-torch transfer plasma 9 is formed simultaneously with the activation of the main power source circuit 3. Accordingly, the output voltage of the main power source circuit 3 during the initiation of the inter-torch transfer plasma would not reach the maximum no-load voltage of the main power source circuit 3, but would be restrained to an output voltage substantially equal to the load voltage of the inter-torch transfer plasma 9. The inter-torch transfer plasma 9 in such state would have a relatively low load voltage due to the shortness of the actual discharge current route, and the output would be restrained to a relatively low value.

[0043] After a forming of a steady inter-torch transfer plasma 9 between the internal electrodes 1a, 2a for the primary torch 1 and for the secondary torch 2 is detected, the pilot electric source 4a, 5a of the pilot electric circuit 4,5 for the primary torch 1 and the secondary torch 2 is stopped so as to stop the pilot arc 8; subsequently, the circuit breaker 4c, 5c is cut off. Accordingly, the pilot electric circuits 4, 5 could be cut off from the main power source circuit 3, and could protect the pilot electric circuits 4, 5 from the high main power circuit output voltage generated afterwards during normal execution of heating and melting.

[0044] In a case immediately after the forming of the inter-torch transfer plasma 9 where the pilot arc 8 is also formed, the serial resistors 4b, 5b being inserted in series to the pilot electric circuit 4, 5 of the primary torch 1 and the secondary torch 2 are effective for enabling the pilot electric circuit 4,5 to maintain an electric potential higher than that of the main power source circuit 3 and to prevent the creation of a series arcing.

[0045] Subsequently, the driving device 7 is driven to move the front tip for each of the primary torch 1 and the secondary torch 2 in a separating direction, and to extend the actual distance of the discharge current path of the inter-torch transfer plasma 9. Accordingly, the load voltage of the inter-torch transfer plasma 9 as well as the output increases.

[0046] Next, another procedure for forming an inter-torch transfer plasma 9 will be described with reference to FIG.2. Even if the targeted melting object 12 were a non-conductive material in a solid state, the targeted melting object 12 generally becomes conductive when temperature has risen to make the targeted melting object 12 into a liquid state.

[0047] When a non-conductive targeted melting object 12 is heated with the inter-torch transfer plasma 9, the targeted melting object 12 being in a solid state is heated to cause a rise in temperature from the radiation heat of the inter-torch transfer plasma 9 and from a thermal conduction of a plasma stream. When a surface temperature of the targeted melting object 12 reaches the melting point to begin melting, a conductive portion is formed at the surface of the targeted melting object 12.

[0048] When the inter-torch transfer plasma 9 is contacted upon the targeted melting object 12 with a melted surface, a part of the electric current for the inter-torch transfer plasma 9 would flow via a melted layer of the targeted melting object 12. The divided flow component of the inter-torch transfer plasma current flowing through the melted surface of the targeted melting object 12 generates a joule heat within the melted layer, and the temperature of the melted surface would further rise to provoke an expansion of the melting area and to form a melting pool at the surface of the targeted melting object 12. The expansion of the melting pool and the rise of temperature would provoke a further decrease in the impedance of the melting pool forming the melting pool resistor 16; subsequently, the divided flow component would acceleratingly increase, and consequently, all the electric currents for the main power source circuit 3 would steady to a state of flowing through the targeted object.

[0049] The electric discharge arrangement of the main power source circuit 3 comprises a discharge circuit arrangement where: a positive electrode transfer plasma 15a formed between the internal electrode 1a of the primary torch 1 (cathode) and a pseudo anode electrode 14a formed at the melting pool surface; a melting pool resistor 16; and a reverse polar transfer plasma 15b formed between the internal electrode 2a of the secondary torch 2 (anode) and a pseudo cathode electrode 14b formed at the melting pool surface, are connected to the main power source circuit 3 as a serial load.

[0050] With the foregoing discharge arrangement, the resistance exothermic reaction of the arc column of the positive electrode transfer plasma 15a for the primary torch 1 and the resistance exothermic reaction of the arc column of the reverse polar transfer plasma 15b for the secondary torch 2 would indirectly affect the heating of the targeted melting object 12 via the radiation heat and the plasma stream, and in addition, the resistance exothermic reaction of the melting pool and the exothermic reaction from a peak drop at the pseudo anode electrode 14a and the pseudo cathode electrode 14b formed on a surface of the melting pool would directly affect the melting pool, so that a heat-melting of extremely high thermal efficiency could be performed upon the targeted melting object 12.

[0051] The foregoing discharge arrangement for the inter-torch transfer plasma 9 is not only effective for heat-melting upon non-conductive objects, but is also extremely effective for heat-melting the targeted melting object 12 being a mixture of a conductive material and a non-conductive material.

[0052] Although a non-conductive material or a mixture of a conductive material and a non-conductive material is described as the targeted melting object 12 for the other discharge arrangement of the inter-torch transfer plasma 9, the same discharge arrangement could be structured when applying upon a conductive material as well. In such case, the targeted melting object 12 is conductive from the beginning, and at the same time the inter-torch transfer plasma 9 contacts the surface of the conductive material, a portion of the electric current for the inter-torch transfer plasma would flow via a conductive resistor. The divided flow component of the inter-torch transfer plasma 9 flowing through the conductive material is determined by the impedance of the conductive material and the impedance of the discharge path of the inter-torch transfer plasma. Accordingly, by adjusting the relative distance of the primary torch 1 and the secondary torch 2 and the relative distance between the conductive material, the impedance of the discharge route of the inter-torch transfer plasma 9 would be overwhelmingly higher than the impedance of the conductive material, and consequently, all the electric currents for the main power source circuit 3 would steady to a state of flowing through the conductive material.

[0053] With the foregoing discharge arrangement, the resistance exothermic reaction of the arc column of the positive electrode transfer plasma 15a for the primary torch 1 and the resistance exothermic reaction of the arc column of the reverse polar transfer plasma 15b for the secondary torch 2 would indirectly affect the heating of the targeted melting object 12 via the radiation heat and the plasma stream, and in addition, the resistance exothermic reaction of the melting pool and the exothermic reaction from a peak drop at the pseudo anode electrode 14a and the pseudo cathode electrode 14b formed on a surface of the melting pool would directly affect the melting pool, so that a heat-melting of extremely high thermal efficiency could be performed upon the targeted melting object 12.

[0054] With the foregoing example of the inter-torch transfer plasma device, the pilot arc 8 for the primary torch 1 and the secondary torch 2 is stopped after the forming of the inter-torch transfer plasma 9 so as to perform heating of the targeted melting object 12 with use of solely the inter-torch transfer plasma 9; nevertheless, the pilot arc 8 for the primary torch 1 and the secondary torch 2 could continue to run even after the forming of the inter-torch transfer plasma 9 so as to make positive use of the heat generated from the pilot arc 8 for heating the targeted heating object 12.

[0055] As described above, with the plasma shifting device of the present invention, a pair of torches having opposite polarity are arranged, and a pilot electric circuit formed at each of the torches is activated to form a pilot arc respectively, and when the pilot arc are being directly contact or contact via the targeted melting object, the main electric source circuit is activated to form the inter-torch transfer plasma.

[0056] In such case, the portion between the internal electrode for the primary torch and the internal electrode for the secondary electrode becomes a closed circuit state owing to a current path of the pilot arc for the primary torch and for the secondary torch, and an inter-torch transfer plasma could be easily and steadily initiated even if the output voltage of the main power source circuit is in a low state. Accordingly, the maximum no-load voltage of the main power source circuit could be set to a low voltage, which is the maximum no-load voltage when heating the targeted melting object in a stationary state.

[0057] Although the pilot arc is stopped after the steady forming of the inter-torch transfer plasma is detected, the serial resistor inserted in series at the pilot power source circuit allows the pilot power source circuit to effectively maintain an electrical potential higher than that of the main power source circuit, and also serves to effectively prevent the creation of a series arcing.

[0058] By stopping the pilot arc after the steady forming of the inter-torch transfer plasma is detected, and then by cutting off the circuit breaker, the pilot power source circuit could be cut off from the main power source circuit, and the pilot power source circuit could be protected from the high main power source circuit output voltage of the inter-torch transfer plasma generated afterwards during normal execution of melting and heating.

[0059] More particularly, even if the targeted melting object is a non-conductive material, the inter-torch transfer plasma could be formed between a pair of torches for achieving rational melting. Further. when the targeted melting object is a non-conductive material being in a solid state, the targeted melting object could be heated and partially melted by the thermal conductivity from the radiation heat of the inter-torch transfer plasma and the plasma stream; by allowing electricity to flow through such melted portion, the targeted melting object could be included in the circuit and heated for achieving rational heating with a high thermal efficiency.

[0060] The foregoing description of a preferred embodiment of the invention has been presented for purposes of illustration and description, and is not intended to be exhaustive or to limit the invention to the precise form disclosed. The description was selected to best explain the principles of the invention and their practical application to enable others skilled in the art to best utilize the invention in various embodiments and various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention not be limited by the specification, but be defined by the claims set forth below.

Claims

1. An inter-torch plasma transfer device comprising:

a primary torch being of a positive polarity, and having an internal electrode applied with a negative voltage and an external electrode faced toward the internal electrode;
a secondary torch being of a negative polarity, and having an internal electrode applied with a positive voltage and an external electrode faced toward the internal electrode;
a main current power source circuit being shared by the primary torch and the secondary

torch;
a pilot current power source circuit being formed for each the primary torch and the secondary torch, and electrically discharging between the internal electrode and the external electrode for forming a pilot arc;

wherein the pilot current power source circuit for the primary torch and the secondary torch is activated to form and emit a pilot arc at each of the primary torch and the secondary torch;

and wherein the main current power source circuit is activated and electrically discharged between the internal electrode of the primary torch and the internal electrode of the secondary torch for forming a main arc and for stopping the pilot current power source circuits for the primary torch and the secondary torch respectively, when the pilot arc of the primary torch and the pilot arc of the secondary torch become substantially conducting.

2. The inter-torch plasma transfer device according to claim 1, wherein the pilot current power source circuit formed for the primary torch and for the secondary torch comprises the internal electrode and the external electrode being connected in series to each direct current power source, and comprises a serial resistor and a circuit breaker connected in series.

FIG.1

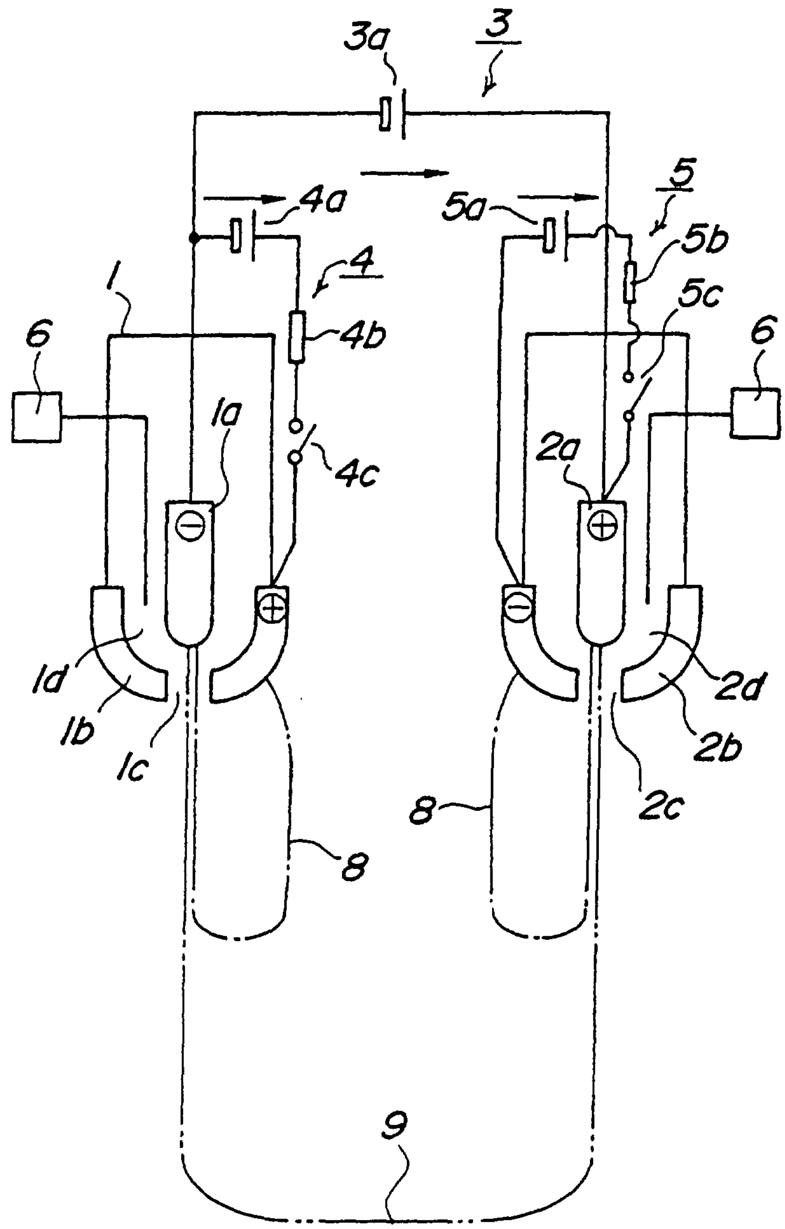

FIG.2

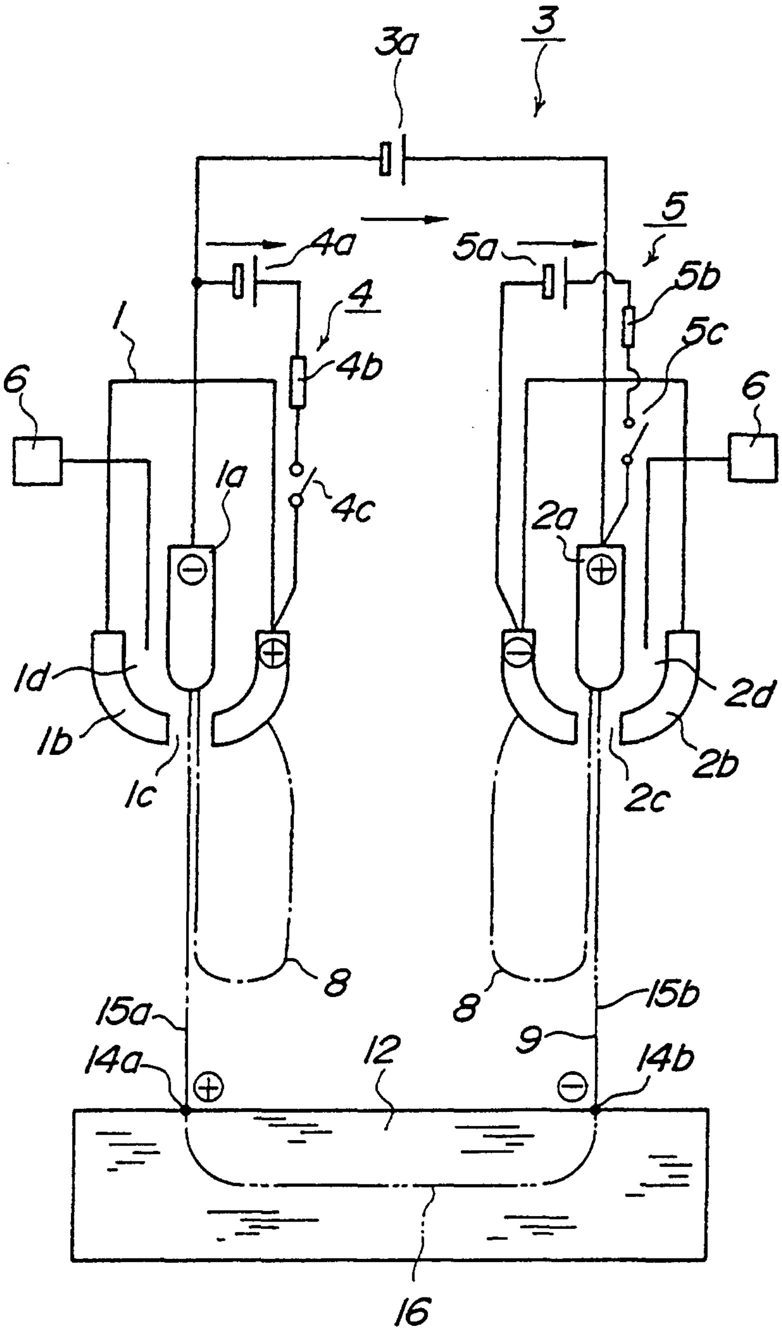
3a
3
5
4a
5a
5b
4
4b
5c
1
6
6
1a
4c
2a
1d
1b
1c
2d
2b
2c
8
8
15a
15b
14a
9
14b
12
16

FIG.3