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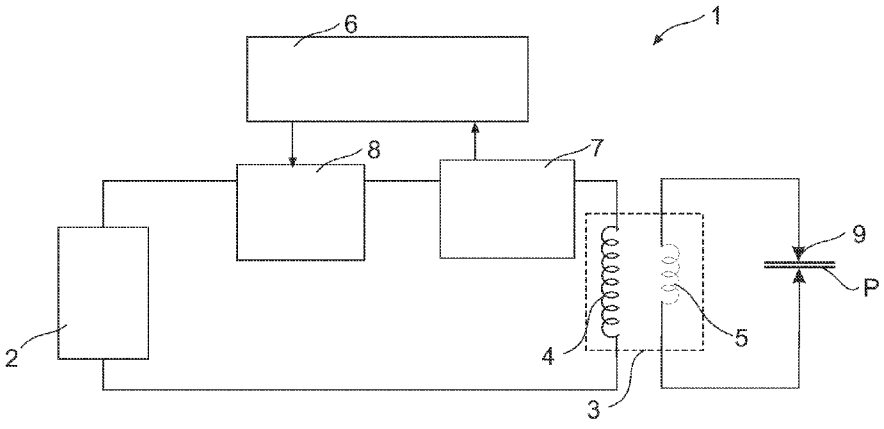
(54) **Title:** A SPOT WELDING MACHINE WITH CONTROL CIRCUIT FOR DETERMINING THE MAGNITUDE OF WELD CURRENT TO BE APPLIED ON LOAD CIRCUIT



(57) **Abstract:** The present invention relates to a spot welding machine (1) . In this welding machine (1) , a constant test current of a very small magnitude is run for a short period of time before the weld current is applied. The load circuit resistance value measured with a measurement circuit (7) in response to this current is compared with the load circuit resistance measured previously and the relative corresponding weld current values recorded in a control circuit (6) to determine the magnitude of the weld current that has to be applied on the said load circuit.

WO 2007/029170 A1

Description

A SPOT WELDING MACHINE WITH CONTROL CIRCUIT FOR DETERMINING THE MAGNITUDE OF WELD CURRENT TO BE APPLIED ON LOAD CIRCUIT

[1] The present invention relates to a spot welding machine.

[2] The spot welding, being a type of resistance welding, is a frequently used method for welding of metal pieces. The high temperature created by the current that is passed through the metal pieces to be joined and the pressure applied on the metals provide the metals to melt and to coalesce. The welding machine used in the application of spot welding, basically provides the low current and high voltage delivered by a power supply to be converted into a low voltage and high current in the secondary side of a transformer. A control circuit triggers the thyristor with a certain phase angle on the primary side of the transformer for a certain period of time to control the magnitude of the welding current on the secondary side. The resulting current is transferred to the pieces to be joined by means of electrodes that apply pressure above and below a spot. However the magnitude of the welding current depends on the load circuit aside from the winding features of the transformer and the losses. The load circuit is made up of the workpiece and resistances resulting from the transitions. These resistances are of significance since the voltage on the secondary side of the transformer is low. Therefore the quality of the welding changes depending on the features of the load circuit.

[3] In state of the art, the welding current is increased as the number of weldings done by the welding machine increases, in order to compensate the surface deteriorations in the electrodes with time. However in this implementation, the quality of the welding cannot be increased as expected since the conditions that affect the quality of the welding like the material, coating and surface variations, changes in resistance in the pieces to be joined by welding, the differences in the pressure applied by the electrodes are not taken into account.

[4] In the welding machine described in the state of the art United States Patent no. US4849601, a current sensor is used on the secondary side of a transformer and the actual welding current measured by this sensor while the welding is carried out is adjusted until the actual current substantially equals the commanded current which is triggered by a thyristor in the primary side of the power supply.

[5] In the welding machine described in another state of the art document, the United States Patent no. US6064029, wherein a voltage is applied to the primary circuit to generate a welding current which is measured by a current sensor to obtain a dynamic resistance curve. The calculation of the nugget size and nugget penetration is based on this curve and the weld current is controlled accordingly by using the dynamic resistance curve.

[6] In the welding machine described in the United States Patent no. US5938947, the current value measured on the primary side is controlled whether it is within a predetermined allowable range. If the detected value of the primary current exceeds the predetermined allowable range, then it is decided that the secondary current is erroneous and the applied current is changed.

[7] In state of the art, changing the weld current values based on the current sensor measurements while the welding process is carried out that takes only milliseconds is not sufficient. However it is not possible to take into account all the factors like material, coating and surface variations, resistance changes, variations in the pressure applied by the electrodes in such a short period of time.

[8] The object of the present invention is to design a welding machine wherein the welding quality is enhanced by determining the weld current based on the resistance of the load circuit.

[9] The welding machine designed to fulfill the object of the present invention is explicated in the attached claims.

[10] In the welding machine of the present invention, there is a measurement circuit on the primary side of the transformer and a control circuit in connection with this measurement circuit. The said control circuit applies a very small sized test current for a very short time while the electrodes are clamped on the workpiece but before the weld current is applied. The measurement circuit measures the resistance of the load circuit on the secondary side that corresponds to this test current. The measured resistance value of the load circuit is compared with the pre-measured load circuit resistances and the corresponding weld current values to determine the magnitude of the weld current that has to be applied for the said resistance. This value is transferred to the thyristor circuit to provide the application of welding with the determined current value. Consequently a constant weld current can be applied that is conformable with the load resistance during the said welding process.

[11] The test current is applied for a time period that can't be perceived by the person applying the weld, for example for a duration of 5 – 50 milliseconds.

[12] In an embodiment of the present invention, the current values recorded in the processor are values determined numerically for certain load resistances.

[13] In another embodiment of the present invention, the current values recorded in the processor are composed of values that correspond to certain load resistances of the quality welds that have been implemented previously.

[14] The welding machine designed to fulfill the object of the present invention is illustrated in the attached figures, where:

[15] Figure 1 – is the schematic view of the welding machine.

[16] Elements shown in the drawings are numbered as follows:

[17] 1. Welding machine

[18] 2. Power supply

[19] 3. Transformer

[20] 4. Primary side

[21] 5. Secondary side

[22] 6. Control circuit

[23] 7. Measurement circuit

[24] 8. Thyristor circuit

[25] 9. Electrode

[26] The welding machine (1) of the present invention comprises:

[27] - a power supply (2),

[28] - a transformer (3) having a primary (4) and a secondary side (5), converting the high voltage and low current electricity applied on the primary side (4) into low voltage and high current electricity on the secondary side (5),

[29] - two electrodes (9) that transmit the weld current formed on the secondary side (5) of the transformer (3) to the workpieces (P),

[30] - a thyristor circuit (8) that controls the energy in conformance with the value of the current to be transmitted to the primary side (4) of the transformer (3),

[31] - a measurement circuit (7) situated on the primary side (4) of the transformer (3), and measuring the load resistance on the secondary side (5),

[32] - a control circuit (6) wherein the load resistance values and the corresponding weld current values determined by the producer are recorded, that applies a very small sized test current before every welding process for a very short time period while the electrodes (9) are clamped on the workpiece (P) but just before the weld current is applied, and compares the resistance value of the load circuit measured by the measurement circuit (7) in relation to this current with the recorded resistance values and transfers the corresponding weld current value to the thyristor (3) to be applied on the workpiece (P).

[33] The load circuit is comprised of all the intermediary parts together with the workpiece (P), through which the weld current passes as well as the electrodes (9). The material, coating and surface features of the workpiece (P) and the deterioration rate of the electrodes (9), the pressure applied after the workpiece (P) is clamped on them are all factors affecting the resistance value of the load circuit. This resistance value varies even with two consecutive welding processes applied by the same person on the same workpieces (P) by the same electrodes (9). The welding machine (1) of the present invention takes into account these factors in determining the weld current by means of applying the test current before each welding.

[34] In this embodiment, the load circuit values derived from previous quality welding

processes or determined by numerical/analytic means and the corresponding weld current values are recorded in the control circuit (6). The control circuit (6) measures the load resistance between the electrodes (9) by the measurement circuit (7) by means of applying the test current just before the start of the welding process and thereafter provides the application of a thus determined constant weld current on the workpieces (P) during the welding process. Furthermore since the features of the load circuit varies due to reasons like the pressure applied by the electrodes (9) in even two consecutive welding processes, the application of the test current before the application of each current provides the possibility of determining a weld current value that takes into account the features of the load circuit.

[35] The test current is applied for a very short time period, for example 5 – 50 milliseconds. The test current is applied for the purpose of measuring the load resistance that is relevant for the conditions of that moment, only on the point of welding, not for making the welding. Since the test current is very small, welding is not done during the testing phase.

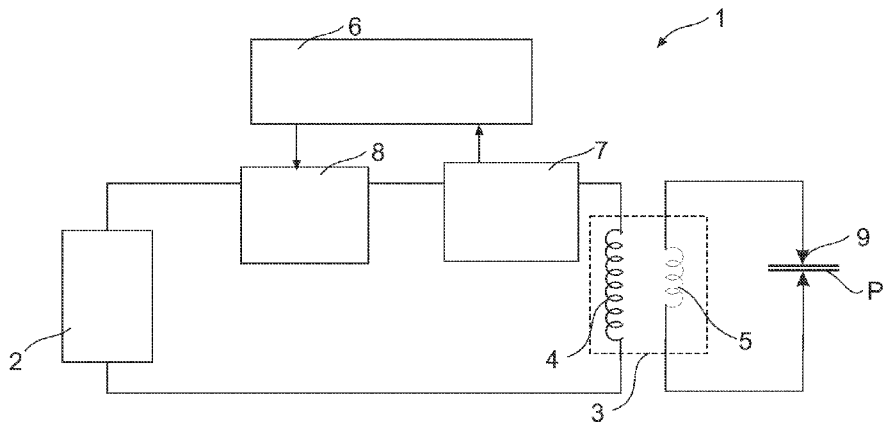
[36] In the welding machine (1) of the present invention, first the electrodes (9) are clamped on the workpieces (P). Afterwards, the control circuit (6) applies a test current. The measurement circuit (7) measures the load circuit resistance that corresp onds to this test current. The weld current value that corresponds to this load circuit resistance in the control circuit (6) is applied on the workpiece (P).

[37] By way of the welding machine (1) of the present invention, a weld current is determined taking into account the features of the effective load circuit at that moment and this weld current is provided to be applied on the workpieces (P) during the welding process without being changed.

Claims

[1] A welding machine (1) comprising a power supply (2), a transformer (3) having a primary (4) and a secondary side (5), converting the high voltage and low current electricity applied on the primary side (4) into low voltage and high current electricity on the secondary side (5), two electrodes (9) that transmit the weld current formed on the secondary side (5) of the transformer (3) to the workpieces (P), a thyristor circuit (8) that controls the energy in accordance with the value of the current to be transmitted to the primary side (4) of the transformer (3), and characterized by a measurement circuit (7) situated on the primary side (4) of the transformer (3), measuring the load resistance on the secondary side (5), and a control circuit (6) wherein the load resistance values and the corresponding weld current values determined by the producer are recorded, that applies a very small sized test current before every welding process for a very short time period while the electrodes (9) are clamped on the workpiece (P) but just before the weld current is applied, and compares the measured resistance value of the load circuit in relation to this current with the recorded resistance values and transfers the corresponding weld current value to the thyristor circuit (3) to be applied on the workpiece (P).

Figure 1



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. B23K11/25 B23K11/11

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

B. FIELDS SEARCHED

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

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

Electronic data base consulted during the international search (name of data base and, where practical, 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	US 4 634 828 A (Y. OKABE ET AL) 6 January 1987 (1987-01-06) column 2, line 67 - column 4, line 59; figures	1
A	JP 56 160885 A (NIPPON ABIONIKUSU KK) 10 December 1981 (1981-12-10) abstract; claims; figures	1
A	JP 07 266059 A (NIPPON AVIONICS CO LTD) 17 October 1995 (1995-10-17) abstract; claims; figures	1
A	US 5 523 541 A (S. ISHIKAWA) 4 June 1996 (1996-06-04)	

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
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