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(54) **ANTI-SHOCK DEVICE FOR HIGH FREQUENCY WELDING MACHINES**

ANTI-SHOCK-VORRICHTUNG FÜR HOCHFREQUENZSCHWEISSEINRICHTUNG

DISPOSITIF ANTI-CHOC POUR MACHINES DE SOUDURE À HAUTE FRÉQUENCE

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Description

SCOPE OF THE INVENTION

[0001] The present invention falls within the field of high-frequency electronic welding machines and more precisely, it relates to an anti-shock device for said welding machines.

[0002] Electronic presses or welding machines generally comprise a class C oscillator comprising a triode provided with a control electrode (grid) on the supply line.

[0003] The triode supplies a resonant circuit which in turn supplies a user, said user for example consisting of the mold holding plates of a welding press.

PRIOR ART

[0004] Anti-shock devices are known which have the purpose of identifying discharges occurring between the mold holding plates of the press.

[0005] The anti-shock device must block the triode as fast as possible in order to block the supply of high frequency energy thereof:

- once a discharge or
- an abnormal variation of resistance has been identified, or at least
- a resistance between the plates with the material to be welded lower than a predetermined value.

[0006] With this operation, damage to the press molds is avoided.

[0007] When the oscillator is working normally, the grid is traversed by a negative grid current, consisting of a flow of electrons traversing the grid resistance to earth.

[0008] In order to block the triode it is then necessary to apply on the grid itself a negative locking voltage, of the same sign but of greater value than the operating one, so as to prevent it. The locking voltage in fact creates a potential barrier on the negative control electrode so that the electrons are repelled rather than attracted, blocking the triode conduction.

[0009] Then, the contactors that feed a transformer designed to generate the high anode voltage of the triode are disconnected.

[0010] The prior art anti-shock devices, such as the one described in DE 102 22 590, consist of an input device configured to measure the resistance between the electrodes by means of a discharge sensor essentially consisting of a filter connected directly to the mold electrode powered by high frequency energy.

[0011] The discharge sensor measures the continuous resistance between the electrodes during welding and this resistance is compared to a preset sample value on a potentiometer referred to as sensitivity potentiometer. When the resistance on the electrodes becomes lower than the preset (slowly or rapidly) or when a discharge occurs between the plates of the press which tends to short circuit, then the anti-discharge device sends a negative locking voltage to the grid electrode to block the triode and just as quickly break the contactors that give the high voltage.

[0012] In the anti-shock device of known type, the system responsible for generating the locking voltage, consisting of a power supply with a battery of capacitors with diodes for having a continuous voltage, must supply a resistance closed to earth, i.e. the grid resistance, and must be able to maintain this very high voltage for the time it takes for the oscillator to stop oscillating and for as long as the high voltage takes to reach very low or zero values.

[0013] The energy that a known type of power supply must supply is linked to the power of the machine and is also linked to the anodic voltage and therefore to the triode supply system. Therefore, the bigger the power supply, the greater its inertia and therefore the voltage drop takes place more slowly, from this follows a long time transient to lower the values.

[0014] Furthermore, the energy that the power supply must supply is linked to the value of the self-polarization resistance (small resistance, higher circulating current).

[0015] Therefore, high power welding machines with small resistance require an adequate dimensioning of the transformer which feeds the power supply system of the anti-shock device.

[0016] The anti-shock devices of the known type therefore have some drawbacks, among which is therefore that of requiring high power transformers for the power supply system.

[0017] Moreover, the intervention times are high and therefore do not guarantee the sudden ceasing of electrical discharges between the mold holding electrodes, with consequent wear thereof, in addition to the damage of the interposed material to be welded, particularly in high power welding machines for welding of non-high thicknesses and without insulators.

DESCRIPTION AND ADVANTAGES OF THE INVENTION

[0018] An object of the present invention is to provide an improved device, configured to intervene in a much quicker way, when the resistance between the molds of the welding press reaches a value lower than a predetermined value, so as to open the supply circuit of the triode grid and lock the latter, to avoid the formation of arcs or discharges between the molds.

[0019] The above being implemented within a simple and rational solution and with a rather low cost.

[0020] These and other objects are achieved by the features of the invention set forth in the independent claim 1. The dependent claims outline preferred and/or particularly advantageous aspects of the invention.

[0021] In particular, an embodiment of the present invention provides an anti-shock device of high frequency welding machines, wherein said welding machines comprise at least one oscillator in class C and a triode provided with a control electrode (grid) on the supply line; the triode configured to power a resonant circuit which in turn powers the mold holding plates of said welding machine.

[0022] The device comprises:

a. a control unit connectable to a discharge sensor of the mold holding plates of the welding machine; said control unit configured to

i. make a comparison with a preset sample value,
ii. process the data received and when the resistance values between the plates decreases very quickly, send a signal to

b. a triode locking unit of the oscillator of the welding machine acting on the grid of the triode; said triode locking unit comprises a transformer which powers a voltage doubler rectifier bridge which in turn powers a battery of capacitors.

[0023] .The device further comprises at least two bipolar transistors in series and suitable for grounding the positive side of the bridge; the control unit is connected to a contact, for example of the normally open type, connected in series between the grid resistance and the ground.

[0024] In this way, the method for controlling and locking the triode of high-frequency welding machines, by a control unit 11 according to the device of claim 1 provides for:

c. presetting a sensitivity value by means of a setter, according to the product to be welded,
d. starting the welding step so that the material melts and therefore the resistance between the plates decreases, and during this step

i. making a comparison with a preset sample value,
ii. processing the data received and in the event of rapidly decreasing resistance values or if the resistance becomes lower than the preset one, switching to step c)

e. sending a signal to the triode locking unit and

i. controlling the IGBT bipolar transistor arranged in series, applying a negative voltage to the grid,
ii. closing the capacitors supplied by the rectifier bridge to lock the triode,
iii. switching the contact to open the grid resistance circuit.

[0025] With this solution there is a very short intervention time.

[0026] The transistors are in fact configured and designed in series to have greater resistance to the high voltages of the application (1500V). This leads to a greater rapidity of intervention (in the order of microseconds).

[0027] This modification, during the intervention, makes the opening of the NC relay less critical, which opens the circuit called "earth".

[0028] Another aspect of the invention provides for the transistors inserted into the triode locking circuit.

[0029] Another aspect of the invention is that said transistors are supplied by the control unit.

[0030] Another aspect of the invention is that the negative poles of the capacitors supplied by the rectifier bridge are connected to the triode grid through a diode with bridge protective function.

[0031] Another aspect of the invention is that said at least two bipolar transistors in series are of the IGBT type.

[0032] Another aspect of the invention is to provide a third bipolar transistor of the IGBT type to protect the contact.

[0033] Another aspect of the invention is that the contact is configured not to open the current circuit so that, with this

solution, the criticality of the spark effect is avoided.

[0034] Said objects and advantages are all achieved by the anti-shock device, object of the present invention, which is characterized by the following claims.

BRIEF DESCRIPTION OF THE FIGURES

[0035] This and other features will become more apparent from the following description of some of the configurations, illustrated purely by way of example in the accompanying drawing.

- Figure 1: shows a circuit diagram implemented by the anti-shock device for high-frequency welding machines;
- Figure 2: shows the simplified diagram of the anti-shock device according to the present invention.

DESCRIPTION OF THE INVENTION

[0036] The anti-shock according to the present invention is associated with a control unit 11 which can be connected to a discharge sensor 12 of the mold holding plates of the welding machine and adapted to make a comparison with a preset sample value.

[0037] In greater detail and with particular reference to the figure indicated above, reference numeral 1 indicates an anodic plate of a high frequency welding press while reference numeral 2 indicates the cathode plate connected to earth 3.

[0038] The anodic plate, also called hot plate, is fed by a high frequency class C oscillator 4 comprising a valve or triode 5 whose anode 6 is connected to a resonant circuit 7.

[0039] Triode 5 has a cathode 8 connected to earth and a control grid 9 also connected to earth through a self-polarization resistance 10 of the grid.

[0040] A connection 26 for the sectioning of the anionic voltage of triode 5 may be provided, although not necessary.

[0041] Reference numeral 11 indicates the control unit connected to the discharge sensor 12 which detects the resistance value between the two anode 1 and cathode 2 plates.

[0042] The resistance value detected by sensor 12 is compared with a preset value by means of a potentiometer sensitivity setter 13 or of the step selector type.

[0043] Reference numeral 27 indicates a connection for the welding control which supplies the circuit of the control unit 11 when the press begins to weld.

[0044] When the press stops welding, the circuit of the control unit 11 is disabled.

[0045] The control unit 11 processes the data received and, when the resistance values between the plates decrease very rapidly, it sends signals via connections 14 and 15 to a triode locking unit of indicated as a whole with reference numeral 16.

[0046] The triode locking unit 16 comprises a transformer 17 which powers a voltage doubler rectifier bridge 18 which in turn powers a battery of capacitors 30, for example a first and a second capacitor 19 and 20.

[0047] Reference numeral 21 indicates at least two IGBT bipolar transistors in series which are inserted in the triode locking circuit of the anti-shock device and are powered by connection 14 coming from the control unit and whose function is to connect the positive side of bridge 18 to earth.

[0048] The negative poles of capacitors 19 and 20 are connected, through a diode 22, to the grid of triode 5, diode 22 has the function of protecting the bridge.

[0049] Unit 16 further comprises a contact 24, preferably of the normally open type, inserted in series between the grid resistance 10 and earth 3.

[0050] Preferably, a capacitive impedance 25 for holding the pulse is provided in parallel to contact 24.

[0051] In one embodiment there is also a locking relay 23 which can receive an activation command from connection 15 coming from the control unit.

[0052] The operation of the anti-shock device described above will now be described, which results from the combination of the control unit 11 with the triode locking unit 16.

[0053] As soon as the press starts to weld, having preset the sensitivity value through the setter 13, depending on the product to be welded, the material melts and therefore the resistance between the plates decreases.

[0054] If the resistance remains greater than that set in the control unit, nothing happens.

[0055] If the resistance becomes lower than that preset due to a sudden discharge or even for normal reasons, the signals are sent from the control unit to the triode locking unit.

[0056] The signal coming from the control unit, through connection 14, controls the two IGBT bipolar transistors 21, or BJT transistor (bipolar junction transistor); they are arranged in series and arranged in order to input the pulse which closes capacitors 19 and 20 to earth for locking the triode.

[0057] The signal coming from the control unit via connection 15 de-energizes the locking relay 23 which acts as a switch and opens the grid resistance circuit 10.

[0058] As soon as the at least two IGBT bipolar transistors 21 trigger, the negative voltage is applied to the grid.

[0059] Thus a negative potential barrier is created which blocks the electron flow of the triode, which is constantly applied to the grid by the contact of the locking relay 23 for a period of some microseconds.

[0060] To disengage said transistors 21 it is necessary to cancel the anodic current and relay 23 has also this function as it opens in time indicated above (microseconds).

[0061] The locking relay 23 is configured not to open the current circuit so that, with this solution, the criticality of the spark effect is avoided.

[0062] The combination of bipolar transistors 21 and relay 23 allows a locking pulse to be realized for a sufficient time after which the diode is completely defused, i.e. the oscillation is locked.

[0063] According to a further aspect of the invention, illustrated in figure 2, in addition to the IGBT transistors 21 (also indicated with A), there are:

- an ON-OFF contact for galvanic separation 28 (with safety function and also indicated with B),
- a third IGBT bipolar transistor 29 (also indicated with C) in parallel with contact 24 (also indicated with D).

[0064] The indicated components provide for the protection of contact 24.

[0065] In fact, as shown in the sequence in the following table, if during the discharge all the above components A, B, C, D are closed, the final stand-by is reached by first opening the normally open contact 24 in parallel with the third transistor 29, after which the three IGBTs of 21 and 29 and finally contact 28.

	Transistor A	Contact B	Transistor C	Contact D
Set-Welding	OFF	ON	OFF	ON
Discharge	ON	ON	ON	ON
	ON	ON	ON	OFF
	OFF	ON	OFF	OFF
Final stand-by	OFF	OFF	OFF	OFF

[0066] In this way, the contact branch in current can be opened without producing the annoying spark; the presence of the third transistor creates continuity so that the contact opening is not in critical conditions.

Claims

1. Anti-shock device for high frequency welding machines, wherein said welding machines comprise at least one oscillator in class C (4) with a triode (5) provided with a grid (9) on the supply line, the triode (5) being configured to power a resonant circuit (7) which in turn powers mold holding plates (1, 2) of said welding machine; the anti-shock device comprising:

a. a control unit (11) connectable to a discharge sensor (12) of the mold holding plates (1, 2) of the welding machine;
b. a locking unit (16) of the triode (5) of the oscillator of the welding machine acting on the grid (9) of the triode (5); said locking unit (16) of the triode (5) comprising a transformer (17) which powers a voltage doubler rectifier bridge (18) which in turn powers a battery of capacitors (30); said control unit (11) being configured to:

i. make a comparison with a preset sample value,
ii. process the data received and when the resistance values between the plates decreases very quickly send a signal to said locking unit (16) of the triode, said locking unit further comprising:

- at least two IGBT type bipolar transistors (21) in series adapted to connect the positive side of the rectifier bridge (18) to earth;
- a contact (24) inserted in series between a grid resistance (10) and earth (3);

characterized in that said locking unit (16) further comprises:

- an ON-OFF contact for galvanic separation (28) arranged in series between a grid resistance (10) and

said contact (24);
- a third IGBT bipolar transistor (29), in parallel to the contact (24).

2. Device according to claim 1, **characterized in that** said transistors (21) are powered by the control unit (11).

3. Device according to claim 1 or 2, **characterized in that** the negative poles of the capacitors (19, 20) of the battery of capacitors (30) are connected to the grid of the triode (5) by means of a diode (22) with a protective function of the bridge (18).

4. Device according to any one of the preceding claims, **characterized in that** it comprises a locking relay (23) functionally associated with the contact (24) configured not to open the circuit in current, the contact (24) being normally open.

5. Device according to claim 4, wherein said locking relay (23) is connected via a connection (15) to the control unit (11) to receive an activation command.

6. Device according to claim 1, wherein said contact (24) inserted in series between the grid resistance (10) and earth (3) is of the normally open type.

7. Method for controlling and locking the triode of high-frequency welding machines, by a control unit (11) of a device according to one of the preceding claims, which provides for:

a. presetting a sensitivity value by means of a setter (13), according to the product to be welded,
b. starting a welding step so that the material melts and therefore the resistance between the plates decreases, and during this step

i. making a comparison with a preset sample value,
ii. processing the data received from said comparison and in the event of rapidly decreasing resistance values or if the resistance becomes lower than the preset one, switching to step c)

c. sending a signal to the triode locking unit and

i. controlling the IGBT bipolar transistors (21) arranged in series, applying a negative voltage to the grid
ii. closing the capacitors (19, 20) of the battery of capacitors (30) to earth to lock the triode (5)
iii. switching the contact (24) to open the grid resistance circuit.

8. Method for controlling and locking the triode of high-frequency welding machines according to claim 8, further comprising:

i. opening in sequence the IGBT transistors (21, 29) and finally the ON-OFF contact for galvanic separation (28) after switching the contact (24).

Patentansprüche

1. Stoßfeste Vorrichtung für Hochfrequenzschweißmaschinen, bei der die Schweißmaschinen mindestens einen Oszillator der Klasse C (4) mit einer Triode (5) umfassen, die mit einem Gitter (9) auf der Versorgungsleitung versehen ist, wobei die Triode (5) konfiguriert ist um einen Resonanzkreis (7) zu aktivieren, der wiederum die Formbefestigungsplatten (1, 2) der Schweißmaschine aktiviert; wobei die stoßfeste Vorrichtung umfasst:

a. eine Steuereinheit (11), die mit einem Entladesensor (12) der Formbefestigungsplatten (1, 2) der Schweißmaschine verbunden werden kann;
b. eine Verriegelungseinheit (16) der Triode (5) des Oszillators der Schweißmaschine, die auf das Gitter (9) der Triode (5) einwirkt; wobei die Verriegelungseinheit (16) der Triode (5) einen Transformator (17) umfasst, der eine Spannungsverdopplungsgleichrichterbrücke (18) versorget, die wiederum eine Kondensator-Batterie(30) versorgt; wobei die Steuereinheit (11) wird konfiguriert für:

I. einen Vergleich mit einem vorgegebenen Stichprobenwert anstellen,

II. die empfangenen Daten verarbeiten und wenn der Wert des Widerstands zwischen den Platten sehr schnell abnimmt, ein Signal an die Verriegelungseinheit (16) der Triode senden,

wobei die Verriegelungseinheit umfasst ferner:

- mindestens zwei Bipolartransistoren vom IGBT-Typ (21) in Reihe geschaltet, um die positive Seite der Gleichrichterbrücke (18) mit Masse zu verbinden;
- einen Kontakt (24), der in Reihe zwischen einem Widerstand (10) des Gitters und der Erde (3) eingefügt ist;

dadurch gekennzeichnet, dass die Verriegelungseinheit (16) ferner umfasst:

- einen EIN-AUS-Kontakt zur galvanischen Trennung (28), der in Reihe zwischen einem Widerstand (10) des Gitters und dem Kontakt (24) angeordnet ist;
- einen dritter bipolaren IGBT-Transistor (29) parallel zum Kontakt (24).

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Transistoren (21) von der Steuereinheit (11) betrieben werden.

3. Vorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die negativen Pole der Kondensatoren (19, 20) der Kondensator-Batterie (30) mittels einer Diode (22) mit einer Schutzfunktion der Brücke (18) mit dem Gitter der Triode (5) durch eine Diode (22) verbunden sind.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet dass** sie ein dem Kontakt (24) funktionell zugeordnetes Verriegelungsrelais (23) umfasst, das derart konfiguriert ist, um den Stromkreis nicht zu öffnen, wobei der Kontakt (24) normalerweise offen ist.

5. Vorrichtung nach Anspruch 4, wobei das Verriegelungsrelais (23) mittels einer Verbindung (15) mit der Steuereinheit (11) verbunden ist, um einen Aktivierungsbefehl zu empfangen.

6. Vorrichtung nach Anspruch 1, wobei der Kontakt (24), der in Reihe zwischen dem Widerstand (10) des Gitters und der Erde (3) geschaltet ist, vom normalerweise offenen Typ ist.

7. Verfahren zum Steuern und Verriegeln der Triode von Hochfrequenzschweißmaschinen mittels einer Steuereinheit (11) einer Vorrichtung gemäß einem der vorhergehenden Ansprüche, die vorsieht:

a. Im voraus Wählen mit Hilfe eines Wahlschalters (13) einen Empfindlichkeitswert entsprechend dem zu schweißenden Produkt aus
b. Starten einen Schweißvorgang, bei dem das Material schmilzt und folglich der Widerstand zwischen den Platten abnimmt, und während dieses Vorgangs
c. Vergleichen mit einem vorgegebenen Stichprobenwert,
II. Verarbeiten die empfangenen Daten auf der Grundlage dieses Vergleichs und führen im Falle einer raschen Abnahme der Widerstandswerte oder wenn der Widerstand niedriger als der vorgewählte wird, eine Umschaltung in Schritt c) durch
c. Senden eines Signals an die Verriegelungseinheit der Triode; und

I. Ansteuern der in Reihe angeordneten bipolaren IGBT-Transistoren (21) beim Anlegen einer negativen Spannung an den Grill
II. Schließen die Kondensatoren (19, 20) der Kondensator-Batterie (30) in Bezug auf die Erde, um die Triode (5) zu verriegeln.
III. Schalten den Kontakt (24) um, um den widerstandsfähigen Stromkreis der Gris zu öffnen

8. Verfahren zum Ansteuern und Verriegeln der Triode von Hochfrequenzschweißmaschinen nach Anspruch 8, ferner umfassend:

I. sequentielles Öffnen der IGBT-Transistoren (21, 29) und schließlich des EIN-AUS-Kontakts für die galvanische Trennung (28) nach dem Schalten des Kontakts (24).

Revendications

1. Dispositif antichoc pour machines à souder haute fréquence, dans lequel lesdites machines à souder comprennent au moins un oscillateur de classe C (4) avec une triode (5) munie d'une grille (9) sur la ligne d'alimentation, la triode (5) étant configurée de manière à activer un circuit résonnant (7) qui à son tour active les plaques de fixation de moule (1, 2) de ladite machine à souder; le dispositif antichoc comprenant:

   a. une unité de commande (11) pouvant être connectée à un capteur de déchargement (12) des plaques de fixation de moule (1, 2) de la machine à souder;
   b. une unité de verrouillage (16) de la triode (5) de l'oscillateur de la machine à souder, agissant sur la grille (9) de la triode (5); ladite unité de verrouillage (16) de la triode (5) comprenant un transformateur (17), qui alimente un pont redresseur doubleur de tension (18), qui à son tour alimente une batterie de condensateurs (30);

   ladite unité de commande (11) étant configurée pour:

   I. faire une comparaison avec une valeur d'échantillon prédéterminée,
   II. traiter les données reçues et lorsque les valeurs de la résistance entre les plaques diminue très rapidement, transmettre un signal à ladite unité de verrouillage (16) de la triode,

   ladite unité de verrouillage comprenant en outre:

   - au moins deux transistors bipolaires de type IGBT (21) en série, adaptés pour connecter le côté positif du pont redresseur (18) à la masse;
   - un contact (24) inséré en série entre une résistance (10) de la grille et la masse (3);

   caractérisé en ce que ladite unité de verrouillage (16) comprend en outre:

   - un contact ON-OFF pour séparation galvanique (28) disposé en série entre une résistance (10) de la grille et ledit contact (24);
   - un troisième transistor IGBT bipolaire (29), en parallèle avec le contact (24).

2. Dispositif selon la revendication 1, **caractérisé en ce que** lesdits transistors (21) sont actionnés par l'unité de commande (11).

3. Dispositif selon la revendication 1 ou 2, **caractérisé en ce que** les pôles négatifs des condensateurs (19, 20) de la batterie de condensateurs (30) sont reliés à la grille de la triode (5) au moyen d'une diode (22) avec une fonction de protection de pont (18).

4. Dispositif selon l'une des revendications précédentes, **caractérisé en ce qu'**il comprend un relais de verrouillage (23) associé fonctionnellement au contact (24), configuré pour ne pas ouvrir le circuit de courant, le contact (24) étant normalement ouvert.

5. Dispositif selon la revendication 4, dans lequel ledit relais de verrouillage (23) est connecté au moyen d'une connexion (15) à l'unité de commande (11) pour recevoir une commande d'activation.

6. Dispositif selon la revendication 1, dans lequel ledit contact (24) inséré en série entre la résistance (10) de la grille et la masse (3), est du type normalement ouvert.

7. Procédé de commande et de verrouillage de la triode de machines à souder haute fréquence, au moyen d'une unité de commande (11) d'un dispositif selon l'une des revendications précédentes, qui prévoit:

   a. présélectionner une valeur de sensibilité au moyen d'un sélecteur (13), en fonction du produit à souder,
   b. démarrer une opération de soudage par laquelle le matériau fond et par conséquent la résistance entre les plaques diminue, et pendant cette opération

      I. faire une comparaison avec une valeur d'échantillon prédéterminée,
      II. traiter les données reçues sur la base de cette comparaison et en cas de diminution rapide des valeurs de résistance ou si la résistance devient inférieure à celle présélectionnée, effectuer une commutation à

l'étape c).

c. transmettre un signal à l'unité de verrouillage de la triode et

I. commander des transistors IGBT bipolaires (21) disposés en série en appliquant une tension négative à la grille
II. fermer les condensateurs (19, 20) de la batterie de condensateurs (30) par rapport à la masse, afin de bloquer la triode (5)
III. commuter le contact (24) pour ouvrir le circuit de résistance de la grille.

8. Procédé de commande et de verrouillage de la triode de machines à souder haute fréquence selon la revendication 8, comprenant en outre:

I. ouverture en séquence des transistors IGBT (21, 29) et enfin ouverture du contact ON-OFF pour une séparation galvanique (28) après avoir actionné le contact (24).

FIG. 1

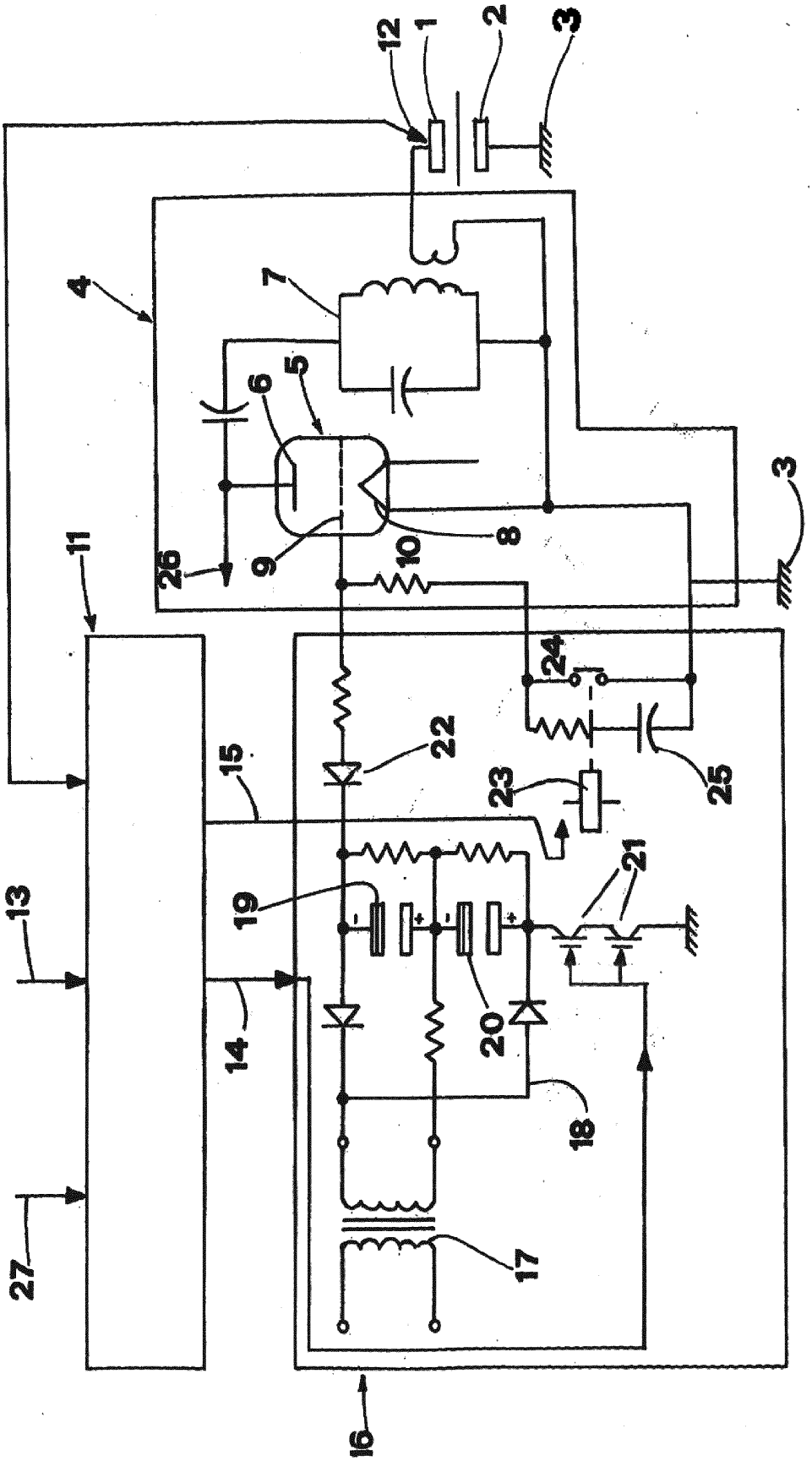

FIG. 2

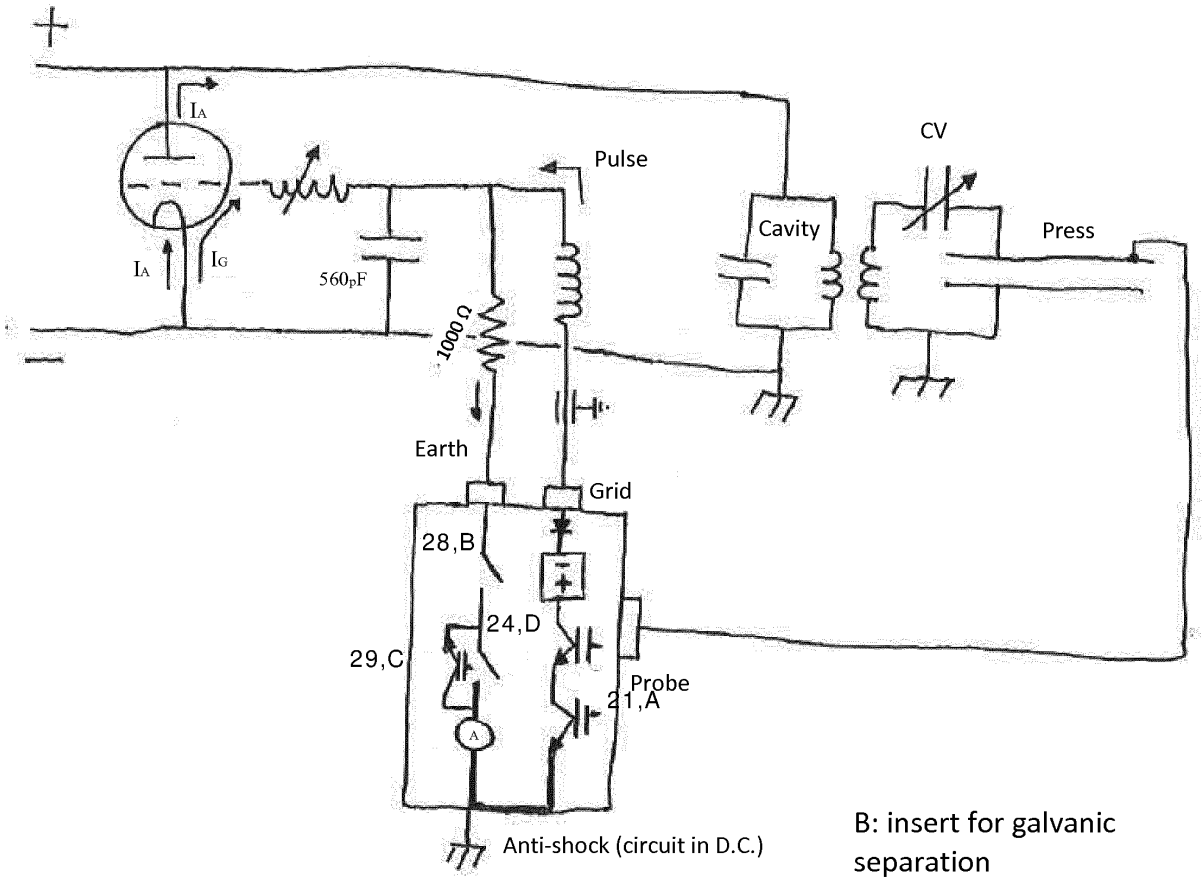

Table of the operating steps

	A	B	C	D
SET-WELDING	OFF	ON	OFF	ON
DISCHARGE	ON	ON	ON	ON
	ON	ON	ON	OFF
	OFF	ON	OFF	OFF
FINAL STAND-BY	OFF	OFF	OFF	OFF

REFERENCES CITED IN THE DESCRIPTION

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