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(12) # EUROPEAN PATENT SPECIFICATION

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(54) **Method and apparatus for adjusting the spark gap of a non-invasive lithotriptor.**

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FR-A- 2 593 382
FR-A- 2 605 874
US-A- 3 418 510

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Description

The present invention relates to a method and arrangement for adjusting the position of tips of a spark gap of a generator of shock waves of a non-invasive lithotriptor and to arrangements for execution of said method.

Such a lithotriptor is known for example from FR-A-2 593 382.

The electrodes of such a device are subject to the passage of impulse currents of high amplitudes required for the generation of shock waves. These currents wear out the tips of the electrodes, thus increasing the length of the spark gap, so that it has to be readjusted frequently. Spark gaps with adjustable tips are as a rule controlled mechanically, the method of their adjustment is, however, an empirical one and depends on the experience of the attendants. The major part of regulation methods bases therefore on the picking-up of distances or positions of tips of the spark gap and is capable to compensate roughly the reduction of electrodes. The change of geometry of the surface of electrodes which substantially influences the distribution of the electric field in the neighbourhood of tips of the spark gap and thus also the magnitude of the arc voltage can however not be taken into account by this method.

FR-A-2 593 382 discloses a lithotriptor whose spark gap is continuously readjusted depending on the number of discharges executed and/or the discharge voltage of the spark gap. Although this method of readjustment allows an automatic operation of the lithotriptor, it suffers from the same problems as described above, as it cannot take account of irregular use of the tips, and, as will be shown in the following, the relation between discharge voltage and spark gap width is not unique, so that the direction of the necessary readjustment cannot be concluded with certainty from the discharge voltage.

It is the object of the present invention to eliminate to a high degree said drawbacks and to provide a method and an arrangement which provide means for maintaining a correct operation of generators of shock waves for the mentioned purpose.

This object is achieved with a method and an arrangement respectively, as claimed. Dependent claims are directed on features of preferred embodiments of the invention.

According to the present invention the time interval from the start of charging or from a charged condition of a functional capacitor of the generator up to the moment of discharge within the aqueous spark gap is determined and basing on this obtained time interval, the adjustment of tips of the spark gap of the generator is accomplished.

The respective arrangement for execution of said method comprising two adjustable electrodes has both tips of electrodes situated within a housing provided with slots which determine a spatial angle for propagation of the shock wave, whereby the upper guiding means of the tip of the electrode has a conical shape with an apex angle corresponding to the angle of opening of the reflector. According to an alternative embodiment the arrangement can be provided with a mobile tip of the shape of a wire, opposite to which the upper guiding means of the tip of the other electrode of the shape of a cone with an apex angle corresponding to the angle of opening of the reflector is situated.

The main advantage of the method according to this invention and of the corresponding arrangement is the prolongation of the life time of the spark gap to a multiple of the life periods of existing spark gaps while securing a good capability of reproduction of individual shocks and thus achieving improvements of efficiency of healing. The spark gap with adjustable tips can be provided with means for picking-up their mutual position, with a proper regulation unit and with a working unit, for instance with an electro-mechanical transducer for adjustment of the position of tips of the spark gap. In case the indication from the pick-up device, determining the position of tips of the spark gap is transmitted to a display, it is possible to regulate the position of tips also manually. Against an arrangement described in DE-C- 3,543.881 the spark gap is designed slidable and against another known arrangement the spark gap is coaxial.

The method and the arrangement according to the present invention will be in the following described in detail with reference to the drawings, wherein

Fig. 1 shows a diagram of the voltage course of a spark gap for shock waves versus the time,

Fig. 2 and 3 indicate diagrammatically elevations of two embodiments of respective arrangements.

With reference to Fig. 1 which shows the voltage course of a spark gap for shock waves with indicated time intervals utilized for regulation, whereby U indicates the voltage on the spark gap, t the time in μs, we see that after an impulse charging of the functional capacitor, the voltage is slowly decreasing due to leakage over the resistance of the water of the spark gap. So far the time interval between the start of charging and the discharging over the aqueous spark gap is smaller than t_{min}, the discharge occured prior than the functional capacitor has been sufficiently charged and the distance of electrodes has to be increased. If the time interval between the start of impulse charging and the discharge is larger than t_{max}, corresponding to the variability of the discharge voltage U, or in case

no discharge is experienced, the distance of electrodes has to be reduced.

The regulation thus proceeds as follows. At the start of charging of the functional capacitor or from another defined condition of charging the time interval up to the moment of discharge is measured within the aqueous spark gap, or up to another moment connected directly to the discharge of the aqueous spark gap. This time information is utilized for an adjustment of the distance of the electrodes. If a short time interval between start of charging and discharging, where no full charging of the functional capacitor took place, the distance of tips of electrodes has to be increased. In case of a long time interval between start of charging and discharging of the spark gap where already a partial discharge of the functional capacitor took place, the distance of tips has to be reduced.

Example:

During the verification examinations of the arrangement a minimum time interval t_{min} of 40 µs and a maximum time interval of 300 µs has been determined. For up to 120 expositions of the shock wave the measured time interval did not depart beyond the time limit t_{min} - t_{max}. The distance of electrodes has been thereafter reduced by 0,2 mm. A following regulation has been subsequently accomplished only after 30 shocks.

The verification examinations have been performed at a capacity of the discharge capacitor 1 µF at a voltage 10 kV. At these conditions 300 shocks have been needed for crushing a large bilestone.

The arrangement for execution of the method according to the present invention as shown in Fig. 2 comprises a reflector 1, to which a functional capacitor 2 is joined. The proper spark gap comprising an upper tip 3 and a lower tip 4, enclosed in a housing 5, which beyond its supporting function also supplies current to the upper tip 3, is situated in the focus of the ellipsoid of the reflector 1. The housing 5 is provided with slots 6 which determine the spatial angle for propagation of shock waves generated by the discharge in the spark gap. The upper guiding means 7 of the tip 3 of the electrode has the shape of a cone with an apex angle corresponding to the angle of opening of the reflector 1. At least one of electrodes of the arrangement is provided with shifting means (not shown).

Fig. 3 shows an alternative embodiment of the spark gap. The spark gap is situated in the reflector 1 and comprises a mobile tip 8 of wire shape opposite to which an upper guiding means 7 is situated having a conical shape with an apex angle corresponding to the opening angle of the reflector 1. The mobile tip 8 is provided with a shifting device (not shown).

The arrangements shown in Fig. 2 and 3 operate as follows. After the reflector 1 is filled with water and the patient is brought in contact with its upper part, the place for healing is properly adjusted whereafter between tips 3, 4 a discharge is generated by means of the functional capacitor 2, the power therefrom is transmitted by the focussed shock wave to the place where the healing of the patient has to be performed. In case of wear of the spark gap or of tips 3, 4 respectively, their adjustment is accomplished by the shifting device (not shown).

Claims

1. Method of adjusting the position of tips of a spark gap of a generator of shock waves for non-invasive lithotrypsis,
characterized in that
a time interval from the start of charging or from a charging condition of a functional capacitor is measured up to the discharge of the aqueous spark gap, whereafter the adjustment of tips of the spark gap is accomplished on the basis of the thus determined time interval.

2. Arrangement for execution of the method according to claim 1, comprising a reflector ellipsoid (1) and two movable electrodes, the spark gap defined by the tips (3, 4) of the electrodes being situated in the focus of the ellipsoid (1),
characterized in that
it comprises a means for determining a time interval from the start of charging or of the charged condition of the functial capacitor up to the discharge of the aqueous spark gap, in that both tips (3, 4) of electrodes are enclosed in a housing situated in the focus of the ellipsoid of the reflector, said housing (5) being provided with slots (6) determining a spatial angle in which the shock wave is propagated, in that an upper guiding means (7) of the tip of the electrode (3) has a conical shape with an apex angle corresponding to the angle of opening of the reflector (1) and in that at least one of both electrodes is provided with a shifting device.

3. Arrangement according to claim 2,
characterized in that
it is provided with a mobile tip (8) of wire shape, opposite to which the upper guiding means (7) of the tip of the electrode (3) is provided, and in that the mobile tip (8) is provided with a shifting device.

Patentansprüche

1. Verfahren zum Anpassen der Position von Spitzen einer Funkenstrecke eines Stoßwellengenerators für berührungsfreie Lithotripsie,
dadurch gekennzeichnet,
daß ein Zeitintervall vom Beginn des Ladens oder von einem Ladezustand eines Funktionskondensators bis zur Entladung der wassergefüllten Funkenstrecke gemessen wird, wonach die Anpassung der Spitzen der Funkenstrecke auf Grundlage des so gemessenen Zeitintervalls durchgeführt wird.

2. Anordnung zur Durchführung des Verfahrens nach Anspruch 1, mit einem Reflektorellipsoid (1) und zwei beweglichen Elektroden, wobei die durch die Spitzen (3, 4) der Elektroden definierte Funkenstrecke im Fokus des Ellipsoids (1) liegt,
dadurch gekennzeichnet,
daß sie ein Mittel zur Bestimmung eines Zeitintervalls vom Beginn des Ladens oder des Ladezustands des Funktionsgenerators bis zur Entladung der wassergefüllten Funkenstrecke umfaßt, daß beide Spitzen (3, 4) der Elektroden in einem im Fokus des Ellipsoids des Reflektors angeordneten Gehäuse eingeschlossen sind, welches Gehäuse (5) mit Schlitzen (6) versehen ist, die einen Raumwinkel definieren, in dem die Stoßwelle sich ausbreitet, daß ein oberes Führungsmittel (7) für die Spitze der Elektrode (3) Kegelform mit einem Scheitelwinkel entsprechend dem Öffnungswinkel des Reflektors (1) hat, und daß wenigstens eine der beiden Elektroden mit einer Verschiebevorrichtung versehen ist.

3. Anordnung nach Anspruch 2,
dadurch gekennzeichnet,
daß sie mit einer beweglichen Spitze (8) in Form eines Drahtes versehen ist, der gegenüber das obere Führungsmittel (7) der Spitze der Elektrode (3) vorgesehen ist, und daß die bewegliche Spitze (8) mit einer Verschiebevorrichtung versehen ist.

Revendications

1. Procédé de réglage de la position des extrémités d'un pont d'allumage d'un générateur d'ondes de choc pour un lithotriteur extra-corporel, caractérisé en ce qu'un intervalle de temps à partir du début de la charge ou à partir d'une condition de chargement d'une capacité fonctionnelle est mesuré jusqu'à la décharge du pont d'allumage aqueux, et ensuite, le réglage des extrémités du pont d'allumage est réalisé sur la base de l'intervalle de temps ainsi déterminé.

2. Dispositif pour la mise en oeuvre du procédé selon la revendication 1, comportant un réflecteur ellipsoïdal (1) et deux électrodes déplaçables, le pont d'allumage défini par les extrémités (3, 4) des électrodes étant situé au foyer de l'ellipsoïde (1), caractérisé en ce qu'il comporte des moyens pour déterminer un intervalle de temps depuis le début de la charge ou une condition de charge de la capacité fonctionnelle, jusqu'à la décharge du pont d'allumage aqueux, en ce que les deux extrémités (3, 4) des électrodes sont logées dans un logement situé au foyer de l'ellipsoïde du réflecteur, ce logement (5) étant muni de fentes (6) déterminant un angle spatial dans lequel l'onde de choc se propage, en ce que des moyens de guidage supérieurs (7) de l'extrémité de l'électrode (3) ont une forme de cône avec un angle au sommet correspondant à l'angle d'ouverture du réflecteur (1) et en ce que l'une au moins des deux électrodes est munie d'un dispositif de déplacement.

3. Dispositif selon la revendication 2, caractérisé en ce qu'il est muni d'une extrémité mobile (8) en forme de fil, en vis-à-vis de laquelle les moyens de guidage supérieurs (7) de l'extrémité de l'électrode (3) sont prévus, et en ce que l'extrémité mobile (8) est munie d'un dispositif de déplacement.

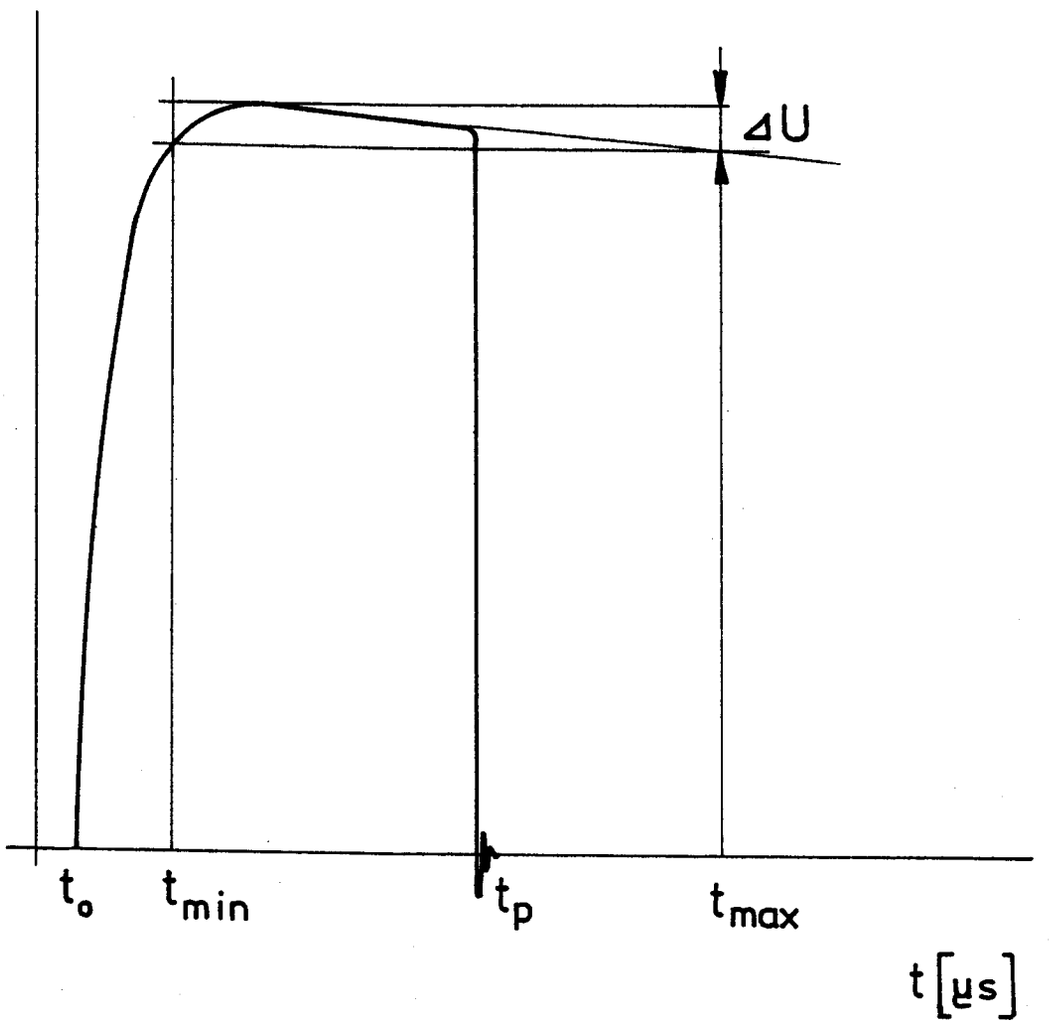

FIG. 1

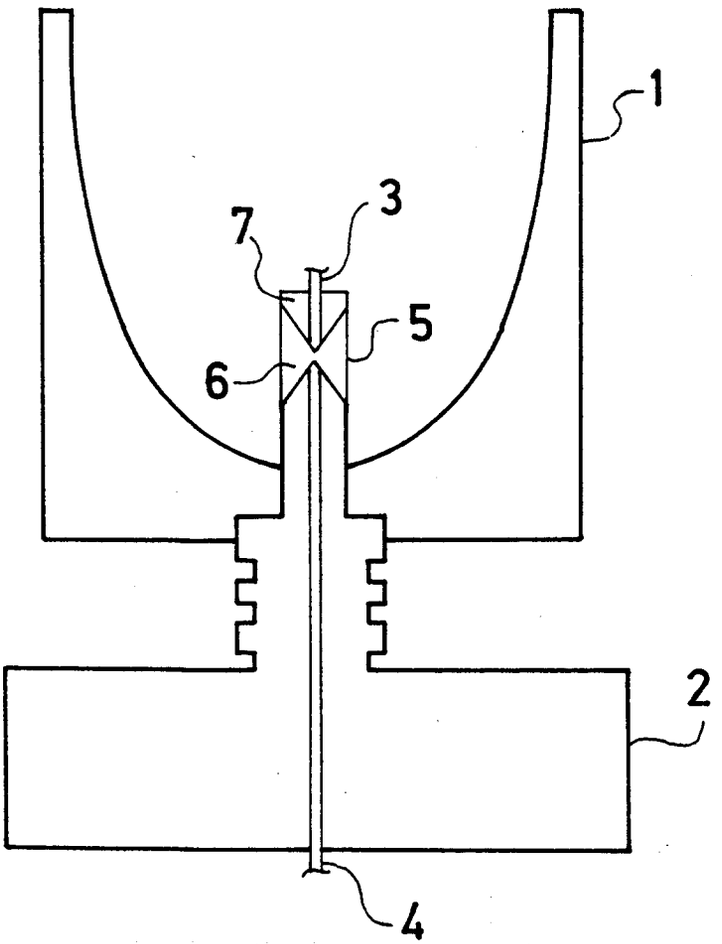

FIG. 2

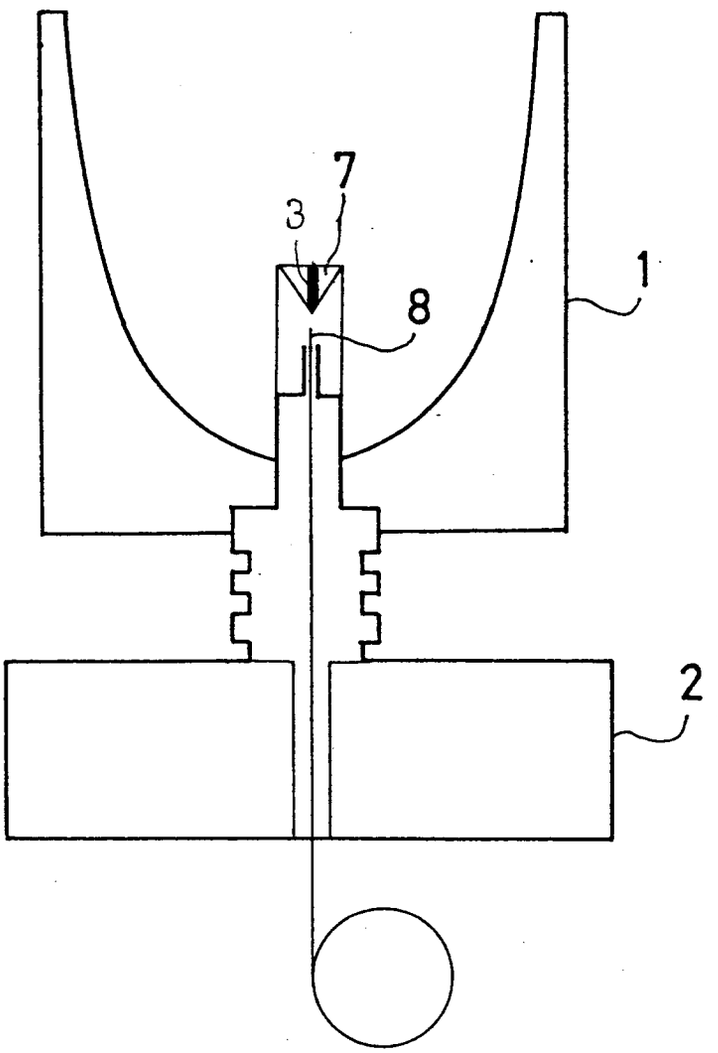

FIG. 3