Feb. 3, 1931. E. S. FLARSHEIM 1,791,464

SPARK GAP

Filed Oct. 26, 1927 2 Sheets-Sheet 1

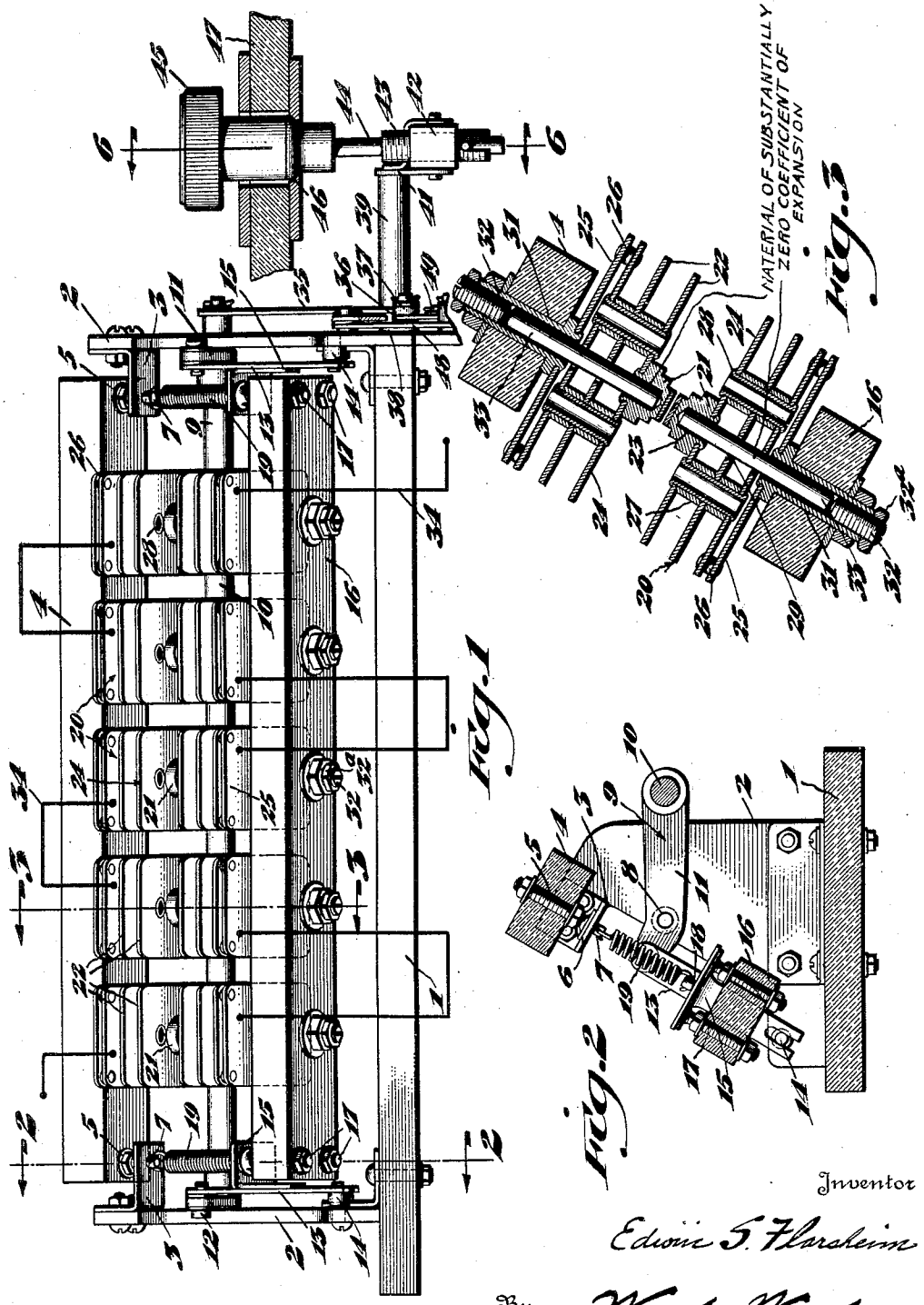

Fig. 1

Fig. 2

Fig. 3

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Fig. 4

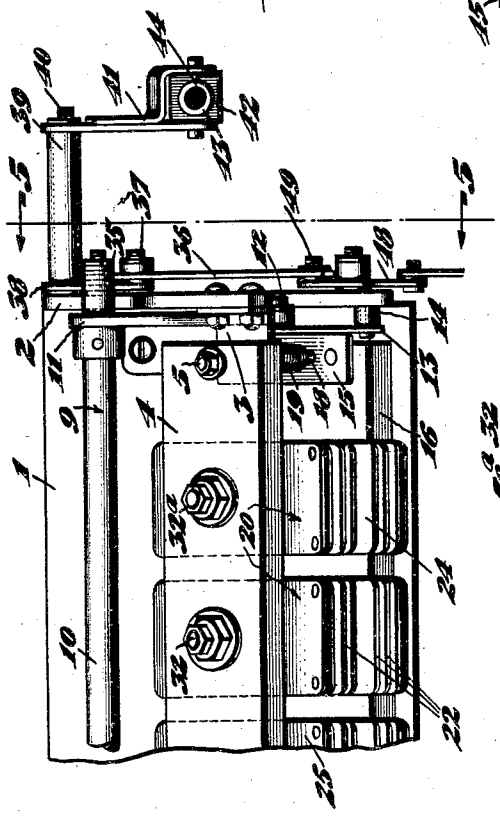


Fig. 6

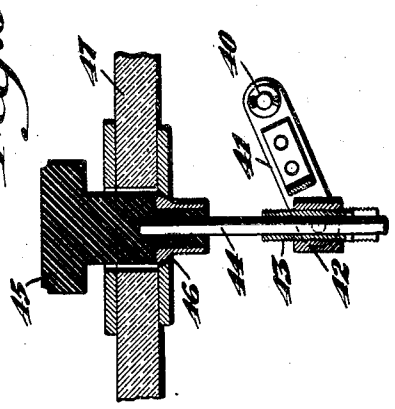
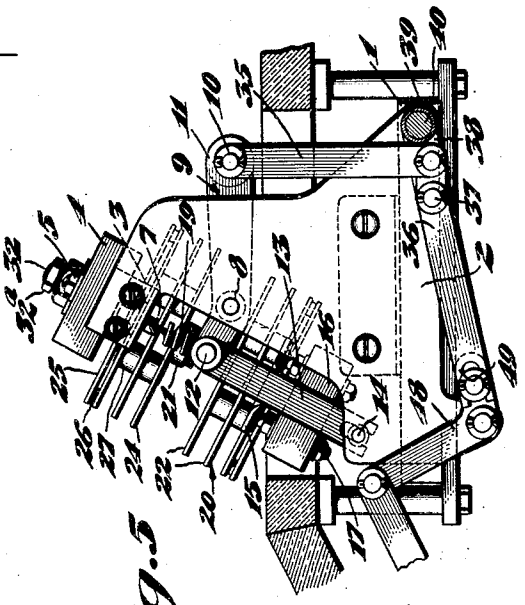


Fig. 5



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Patented Feb. 3, 1931

1,791,464

UNITED STATES PATENT OFFICE

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SPARK GAP

Application filed October 26, 1927. Serial No. 228,964.

This invention relates to spark gaps and especially to spark gap mechanisms for therapeutic machines and the like wherein the spark electrode spacing of the gap controls current characteristics of prime importance. One therapeutic machine of this type is disclosed and claimed by me in co-pending application, Serial No. 215,541.

In the case of a therapeutic machine for the application of high frequency current the spark electrode spacing determines the voltage of the current applied to the patient. It is therefore essential that the gap spacing be not subject to thermal changes which would vary the voltage of the applied current during a treatment.

Therefore, one object of the invention is to provide a spark gap wherein the spark electrode spacing is relatively constant over the temperature range to be encountered in service.

On a therapeutic machine for the application of high frequency currents it is advisable to have a plurality of gaps or opposing spark electrode sets.

Therefore, another object of the invention is to provide a spark gap comprising a plurality of sets of opposing spark electrodes the spacing of each set independently adjustable and all of the sets adjustable as to spacing as a unit, i. e., collectively.

Other objects and certain advantages will appear in the description of the accompanying drawings forming a part of this specification, in which:

Figure 1 is a front view of the spark gap device, showing a control mechanism at one end thereof.

Figure 2 is a sectional view taken on line 2—2, Figure 1.

Figure 3 is an enlarged detail sectional view taken on line 3—3, Figure 1, showing the relation of the radiator plates and the mounting therefor.

Figure 4 is a plan view of one end of the spark gap.

Figure 5 is a sectional view taken on line 5—5, Figure 4, showing the spark gap device in end view.

Figure 6 is a sectional view taken on line 6—6, Figure 1, detailing the control for collective adjustment of the spark gap sets.

This invention comprises opposing spark electrodes and supports therefor, the connection between the supports and spark electrodes preferably being made through flexible radiator plates. Each spark electrode is recessed on the side toward the support or bar which carries it. Spacers are disposed between each spark electrode and its carrying support or bar. One end of each spacer is placed in a spark electrode recess and the other end contacts an adjustable abutment carried by the bar. These spacers are of special alloy of steel or some other material, such as porcelain or fused quartz, possessed of a low or substantially zero coefficient of expansion so that the electrode spacing does not change materially as the gap becomes hot.

More specifically, this spark gap device comprises a base 1, and side standards or supports 2 mounted at either end of the base. At the top of each standard is bolted an inwardly extending bracket 3 to which bracket is attached a stationary gap bar 4 preferably of marble, porcelain or some other insulating material. The connection between the gap bar 4 and brackets 3 is made by means of shoulder screws 5 extending through the bar and through the brackets, the bar being positioned on the shoulder screws by means of nuts and washers on either side of the bar, the shoulders 6 of said screws which rest upon the brackets, being riveted to the brackets on the sides opposite to the shoulders, and provided with eyelets 7 at their ends on the other sides of said brackets. Pivoted to the inner faces of said side standards by means of studs 8 projecting from said faces is a yoke 9. This yoke consists of a rod 10 extending substantially the distance of the standard spacing and arms 11 extending from the ends of the rod 10. It is these arms which are pivoted to the side standards, the pivot points being located near the ends of the arms. Pivoted to the ends of the arms by means of pins 12 extending inwardly from the arm ends are slide bars 13 held in position on the studs by cotter pins. The opposite ends of these slide

bars 13 are slotted and the slots are entered by studs 14 extending inwardly from the side standards. By this construction the swinging of the yoke upon its pivots back and forth reciprocates the slide bars 13 in substantially a straight line. The mechanism for adjusting the yoke will be described further on in the description. On the inner faces of the slide bars 13 are riveted brackets 15 to which a movable gap bar 16 is secured by means of shoulder screws 17 such as used on the stationary gap bar. A stud 18 is provided on each of the brackets 15 having an eyelet disposed in alignment with the eyelet 7 extending below the opposing face of the stationary gap bar retaining brackets. A coil spring 19 under tension is anchored at each end in these eyelets in order to draw the gap bars together.

These gap bars 4 and 16 carry a plurality of opposing sets of spark electrodes 20, five sets as disclosed. Each set of opposing spark electrodes comprises opposing spark electrodes proper 21, each connected to its carrying gap bar by way of a plurality of radiator plates 22 of which one or more are flexible. These spark electrodes 21 are preferably tipped with tungsten or some other substance suitable for spark gap purposes. They are recessed as at 23 on the side opposite to the active face, said recesses extending almost to said active face and leaving but a thin partition of metal between the recess and the active face. The radiator plate 24 adjacent the spark electrode is apertured and the electrode riveted to the plate through said aperture.

As disclosed, four radiator plates 22 are used in connection with each spark electrode. The radiator plate 25 adjacent to the gap bar is riveted to the adjacent radiator plate at the corners by means of shouldered studs 26. This radiator plate 25 is of thinner material than the others to provide spring action. The three radiator plates nearest to the spark electrode are held together by means of spacing washers 27 with an eyelet 28 running through and spread on each end. These spacing washers and eyelets are disposed relatively near the centers of said radiator plates. Due to the disposition of the mounting studs of the radiator plates the three inner radiator plates are substantially rigidly secured together, moving as a unit in relation to or under the flexing of the spring radiator plate 25. All of the radiator plates are provided with apertures 29 aligned with the spark electrode recesses.

In the gap bar behind and in alignment with the apertures is mounted a sleeve 31 flanged on the inner side of the gap bar, threaded on the outer side of the gap bar and secured thereto by means of a nut and washer. In the outer end of this sleeve 31 is a set screw or adjustable abutment 32 for a spacer rod 33 which extends from within said sleeve through the apertures in said radiator plates which are sufficiently large to provide clearance and into the far end of the recess of the spark electrode. The set screw is secured by means of a nut 32ª engaging the outer end of the sleeve. Therefore, by screwing in or out this set screw the spacer rod 33 is moved longitudinally and the distance of the spark electrode from the gap bar carrying it correspondingly adjusted. The requisite amount of motion is permitted by the flexible radiator plate adjacent to the gap bar. It is therefore possible by adjusting this set screw to adjust each spark electrode individually in relation to the gap bar and bring them into proper alignment. The spacer rod is preferably of special alloy of steel or some other material having a substantially zero coefficient of thermal expansion within the temperature range encountered in service. What little expansion there might be in the spacer rod is compensated for by the very slight expansion of the sleeve 31 extending through the gap bar. These spark electrodes are so adjusted that the flexible radiator plate is under tension greater than can be relieved by expansion of the radiator plates and the electrode is thus held firmly against the spacing member so that only the expansion of this spacing member in relation to its adjustable abutment changes or alters the position of the spark electrode in relation to its carrying bar. Therefore a spark gap comprising two of these spark electrodes so mounted is not subject to change or alteration of gap distance as the temperature varies as a result of the heat generated by the spark.

These individual sets of spark electrodes are connected in series by means of flexible connectors 34 (indicated diagrammatically in Figure 5) extending between and secured to the radiator plates.

The mechanism for collectively controlling the plurality of spark gap sets 20 is arranged as follows:

The rod 10 of the adjustment yoke 9 extends out beyond the end bracket 2 and has a link 35 pivotally secured thereto. The other end of the link 35 pivotally connected to the end of a lever 36 fulcrumed at 37. The fulcrum point 37 for the lever 36 is the loose end of an arm 38 attached to the inner end of a sleeve 39 pivotally mounted on a stud 40 extending from the end frame 2. The outer end of the sleeve 39 has an arm 41 secured thereto, the outer end of the arm 41 providing a yoke pivotally mounting a block 42.

The block 42 has an adjustment sleeve 43 threaded therethrough, and a rod 44 extends through the sleeve, the lower end of the rod 44 being provided with a radially disposed pin engaging in a slot at the base end of the sleeve 43, the upper end of the rod 44

provided with a knob 45, this knob 45 being hung or seated on an inclined seat 46 in the frame 47.

Raising or lowering the knob 45 swings the adjustment yoke carrying the movable bar 16 by raising or lowering the fulcrum point of the lever 36. This movement gives a very coarse and rapid adjustment. The arrangement of the pin and slot permits lowering of the knob 45 and rod 44 independently of the linkage and adjustment bar in the event that the gaps are held apart otherwise for cleaning, etc. Rotation of the knob raises and lowers the block 43 through the threaded sleeve providing an intermediate form of adjustment. For a more minute or delicate adjustment a bell crank lever 48 is pivoted to the end frame 2 and has one arm thereof provided with a pin engaging in a slotted end 49 of the lever 36. The bell crank lever may be rocked by any suitable means, this rocking swinging the lever 46 on its fulcrum through a comparatively small range of movement, this being reduced considerably in its application to the link 35 by means of the positioning of the fulcrum point of the lever 36.

By this arrangement of linkage, three means for collectively adjusting the spark gap sets are provided. First, a minute or fine adjustment through the bell crank lever. Second, an intermediate adjustment through rotation of the knob, raising or lowering the block 42, and third, a very rapid adjustment or separation of the spark gap electrodes by raising or lowering the knob.

Claims on this mechanism for collectively adjusting the spark gap are made in a separate application.

Having described my invention, I claim:

1. A spark gap mechanism, comprising, two gap bars, opposing spark electrodes carried by said gap bars, said spark electrodes recessed each on the side toward the carrying bar, each recess extending almost to the spark discharge face leaving only a thin partition of metal between the recess and the face, and spacers possessed of substantially zero coefficient of expansion extending between each spark electrode and its carrying bar each spacer being disposed within the recess of the spark electrode which it spaces from the bar.

2. A spark gap mechanism, comprising, two gap bars, opposing spark electrodes carried by said gap bars, flexible heat radiating plates connecting said spark electrodes to said bars, and spacers possessed of substantially zero coefficient of expansion between the spark electrodes and the bars, each spacer being adjustably mounted in the bar at one end and in a recess of a spark electrode at the other end to space said bars and electrodes any distance desired.

3. A spark gap mechanism, comprising, two side supports, a gap bar secured to said side supports, a yoke pivoted to said side supports, a slide bar pivoted to said yoke arms, a second gap bar secured to said slide bars and adapted to be adjusted in relation to said first gap bar by movement of the yoke, and opposing spark electrodes carried by said gap bars.

4. A spark gap mechanism, comprising, two side supports, a gap bar secured to said side supports, a yoke pivoted to said side supports, slide bars pivoted to said yoke arms, guides on the side supports for said slide bars, a second gap bar secured to said slide bars and adapted to be adjusted in relation to said first gap bar by movement of the yoke, and opposing spark electrodes carried by said gap bars.

5. A spark gap mechanism, comprising, opposing spark electrodes, supports for said spark electrodes, flexible radiator plates securing said spark electrodes to their supports, and steel spacing members having substantially zero coefficient of expansion determining the distances of said electrodes from their supports, said spacing members passing loosely through said radiator plates and shielded thereby from the spark heat.

6. A spark gap mechanism, comprising, two side supports, a gap bar secured to said side supports, a yoke pivoted to said side supports, slide bars pivoted to said yoke arms, guides on the side supports for said slide bars, a second gap bar secured to said slide bars and adapted to be adjusted in relation to said first gap bar by movement of the yoke, opposing spark electrodes carried by said gap bars, and means maintaining the spark electrode spacing constant despite thermal changes.

7. A spark gap mechanism, comprising, a plurality of sets of opposing rearwardly recessed spark electrodes, supports for said spark electrodes, flexible radiator plates securing said spark electrodes to their supports, spacing members entering the spark electrode recesses, said members determining the distances of said electrodes from their supports, said spacing members passing loosely through said radiator plates and shielded thereby from the spark heat, means for altering the spacing of each opposing set of electrodes, and means for altering the spacing of said sets collectively.

8. A spark gap mechanism, comprising, a base, two side supports mounted on said base, a stationary gap bar secured to said side supports, a second gap bar movable relative to the said stationary gap bar, slide bars guided on the side supports and supporting said movable gap bar, a yoke having its arms pivoted to said side supports and to said slide bars, said yoke adapted to adjust the relative position of the gap bars by its own pivotal movement, opposing spark electrodes carried by said gap bars, heat radiating plates

securing said electrodes to said bars, sleeves in said gap bars, one positioned behind each electrode, set screws in the outer ends of said sleeves, deep recesses in the backs of each of said spark electrodes, leaving but a thin partition of metal between the recess and the spark electrode face, and steel spacing members having substantially zero coefficient of expansion extending between the gap bars and the spark electrodes, one end of each spacing member being disposed in a spark electrode recess and the other end in a sleeve carried by a gap bar, said end abutting the set screw carried by the sleeve to provide individual spark electrode adjustment.

9. The spark gap mechanism, comprising, spark electrodes opposingly disposed to constitute a spark gap, supports for said spark electrodes, a spacing member possessed of substantially zero coefficient of expansion between each spark electrode and its support, said spacing member adapted to determine the minimum distance between the electrode and its support, and flexible means connecting each spark electrode to its support said means adapted to insure that this minimum distance be not exceeded.

10. A spark gap mechanism, comprising, two relatively movable bars, a plurality of opposing spark electrodes flexibly secured to said bars, and adjustable members possessed of substantially zero coefficient of expansion disposed between each spark electrode and the supporting bar, said members adapted to determine the spacing of the spark electrode from its supporting bar.

11. A spark gap mechanism, comprising, two opposing supports, two opposing spark electrodes, each flexibly attached to one of the supports, and two spacing members possessed of a substantially zero coefficient of expansion, each spacing member mounted between a spark electrode and its support, and means located in said supports for adjusting said spacing members to and from said supports to determine the distance of each spark electrode from its support.

12. A spark gap mechanism, comprising, two relatively movable bars, spark electrodes carried by said bars and arranged to constitute a plurality of spark gaps, spacing members having substantially zero coefficient of expansion disposed between each spark electrode and the bar carrying it to determine the distance of the spark electrode from the bar, and means remote from the zone of heat created by the action of the spark gaps for regulating the distance between the bars supporting the electrodes.

In witness whereof, I hereunto subscribe my name.

EDWIN S. FLARSHEIM.