

Aug. 24, 1943.

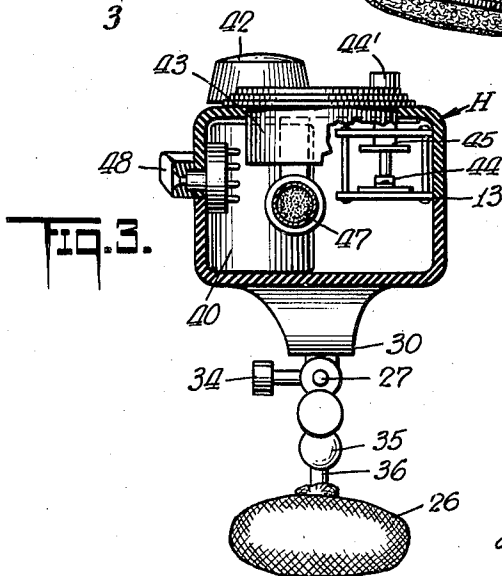
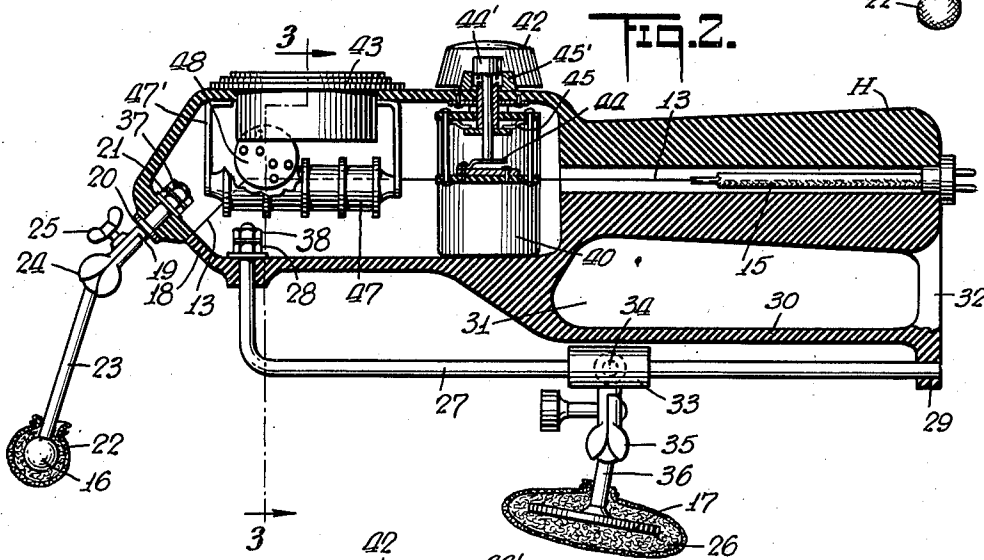
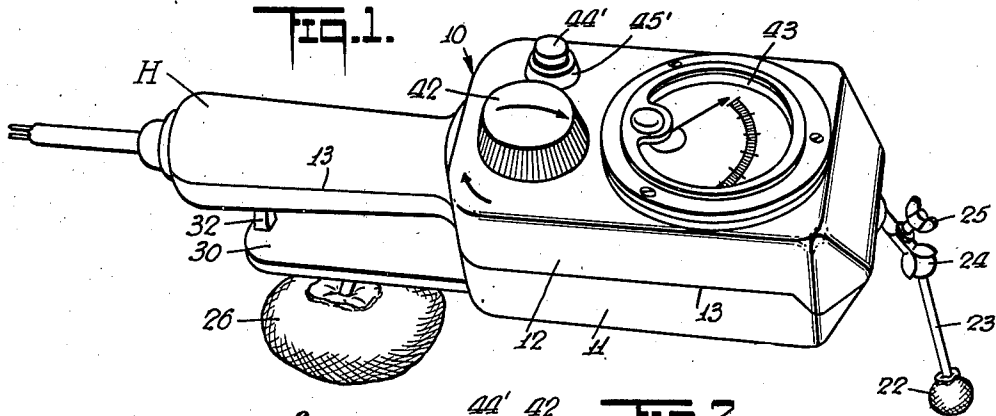
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2,327,874

PORTABLE ELECTROMEDICAL APPARATUS

Filed April 16, 1942

2 Sheets-Sheet 1



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FIG. 4.

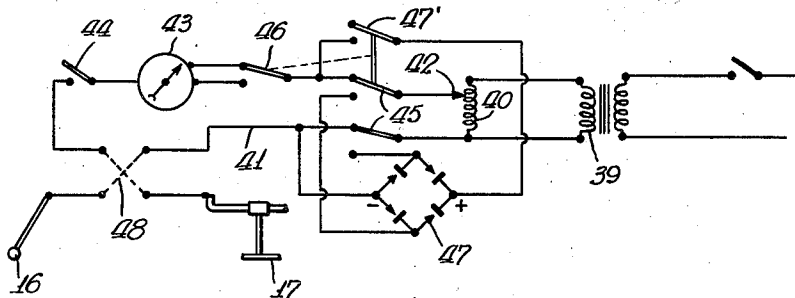


FIG. 5.

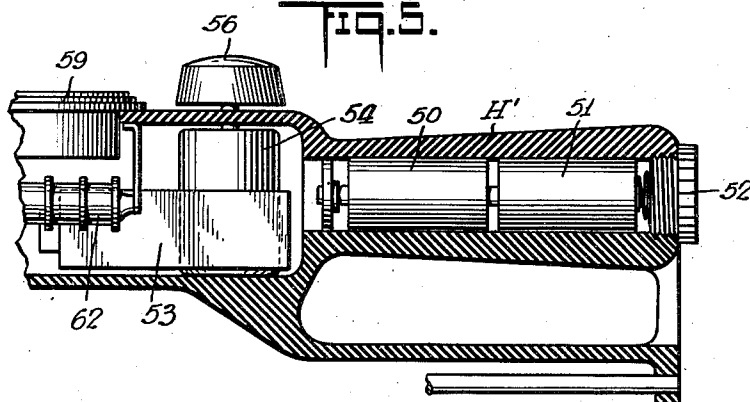
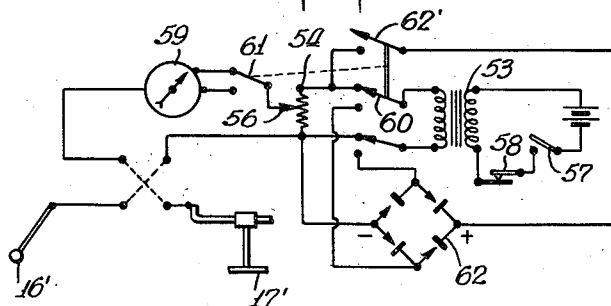


FIG. 6.



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PORTABLE ELECTROMEDICAL APPARATUS

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14 Claims. (Cl. 128-405)

The present invention is concerned with electro-medical apparatus of the type used for diagnostic and for therapeutic purposes in connection with degeneration in peripheral nerves and muscles following nerve lesion, inflammation and the like.

As conducive to a clear understanding of the invention, it is noted that where a peripheral nerve lesion is inflicted, as for instance, by shrapnel in warfare, the prompt location and therapeutic treatment of such lesion will in many cases result in complete restoration of the nerve and muscle, while delay might lead to chronic paralysis. Known equipments in use for treating such injuries are costly and bulky in that they involve a cabinet which encloses the various electrical control and metering units, from which wires or cables lead to separate electrodes that are to be applied to the human body. Such instruments are also difficult to use, because the switch control cannot conveniently be operated, without distracting the attention of the physician from the physiological response to the electrical stimulation, so that the services of a skilled assistant are required in addition to those of the physician for effective use of the instrument.

It is accordingly an object of the invention to provide a small, light, compact, portable equipment which incorporates various electrical control and metering elements as well as the electrodes to enable the ready application of the electrodes, the adjustment of the controls and the reading of the instrument by a single operator, for both diagnostic and therapeutic purposes.

In the accompanying drawings in which are shown one or more of various possible embodiments of the several features of the invention,

Fig. 1 is a perspective view of the complete apparatus,

Fig. 2 is a longitudinal sectional view thereof,

Fig. 3 is a transverse sectional view taken on line 3—3 of Fig. 2,

Fig. 4 is a circuit diagram of the apparatus of Figs. 1 to 3,

Fig. 5 is a fragmentary sectional view of a modification, and

Fig. 6 is a circuit diagram of the modified form shown in Fig. 5.

Referring now to the drawings, the device shown in Fig. 1 may comprise a casing unit 10, which includes a handle H unitary and rigid therewith. The casing and handle unit is preferably of insulating material, desirably of two

complementary casing parts 11 and 12 connected together in rim to rim engagement at 13 by cement or fastening screws (not shown) in manner conventional with electrical shavers, for instance. In the interior of the casing are various electrical control elements operable from the exterior and a metering device exposed to view at the exterior of the casing as will be hereinafter described. The handle H accommodates the conductors 15 that lead to the electrical elements within the casing.

The electrodes 16 and 17 are both mounted, desirably adjustably, upon the casing unit. For this purpose, the stimulation electrode 16 is affixed to the forward portion of the casing, desirably to the inwardly inclined lower section of the forward wall 18 thereof. To this end a metal stud 19 is clamped at its base 20 against said wall 18 by nut 21 at the interior of the casing. The small ball-shaped outer end of stimulation electrode 16 is preferably embraced by a moist fabric wrapper 22. The rod 23 of said electrode is mounted by a universal ball and socket joint 24 at the extremity of stud 19, said universal joint being tightened in adjusted clamped position by a thumb nut 25.

The second or so-called indifferent electrode 17 is desirably a disk much larger than the stimulation electrode 16 and is enclosed in a moistened lens shaped fabric cover 26. It is affixed not only for adjustment in angularity, but also for adjustment in its distance from the stimulation electrode. To this end a metal mounting bar 27 is affixed at its forward end by means of a nut 28 to the lower part 11 of the casing from which its foot extends downward and thence its length rearward along the length of and at a distance from the casing. The rear end of said bar 27 is supported in a lug 29 on the outer end of an arm 30 molded as an integral part of the casing bottom and spaced from the handle as at 31 to afford room for the fingers in grasping the device. For reinforcement, the outer end of the arm 30 is connected by a unitary bridge piece 32 to the outer end of the handle H.

The electrode 17 is mounted on a metal block 33 slidable upon the bar 27, affixed in any position of adjustment by a set screw 34 and carrying the universal joint 35, which mounts the ball end of the rod 36 that carries the electrode 17. Electrical connection to the respective electrodes is made at binding posts 37 and 38 at the inner ends of their mounts within the casing. It is thus seen that the electrode 17 may be slidably adjusted to any distance from electrode 16 with-

in the limitations of the overall length of the device, and the electrodes may be angularly displaced to any extent for ready application along the nerve tract to be tested or treated.

In the embodiment of Figs. 1 to 4 is shown an arrangement operable from an external source of alternating current to apply at will either alternating current or direct current to the body for diagnosis or therapy.

Referring to the circuit diagram of Fig. 4 the alternating current is stepped up through a transformer to the desired voltages, usually in the order of 150 volts, the secondary 39 of which transformer feeds its output to an auto-transformer 40. One terminal of the auto-transformer is connected to terminal 16 by way of conductor 41. The adjustable terminal 42 of said auto-transformer leads through meter 43 and manually operated treatment switch 44 to the other electrode 17, the circuit between the electrodes being, of course, closed through the body to which the electrodes are applied.

For direct current diagnosis or treatment the alternating current is rectified. To this end a changeover switch 45 is used which places rectifier 47 in circuit. Switch 45 is interconnected with meter switch 46 to change its reading scale or range from A. C. to D. C. The rectifier 47 may be of any conventional dry type, such as a selenium or a cuprous oxide rectifier. When the switch 45 is thrown, the output of the auto-transformer is rectified by passing through said rectifier 47 and otherwise the circuit is exactly as in the alternating current operation. Switch 45 is desirably interlinked with switch 47 completely to disconnect rectifier 47 from the circuit in alternating current operation.

A reversing switch 48 is desirably also provided to reverse the polarity of the electrodes 16 and 17 at will in the direct current operation.

The various electrical elements referred to are compactly disposed within the casing 10 and the adjustments thereof are readily effected from the exterior of the casing. Referring to Figs. 2 and 3, the milliammeter is shown at 43 mounted in the cover of the casing with its dial exposed thereabove. The auto-transformer is shown at 40 resting on the bottom of the casing and its operating knob is shown at 42 adjacent handle H. A suitable calibrated scale (not shown) may be associated with the knob 42. The treatment switch or circuit closer is shown at 44 and is operated from a push-button 44' accessible through the casing cover.

The switch 45 for shifting from A. C. to D. C. and conversely is desirably operated from a turn knob 45' that may be coaxial with the push-button 44. The rectifier 47 is shown affixed to the cover by a bracket 47'. The electrode reversing switch 48 is desirably accessible from the side of the casing as shown. The neat and compact arrangement of the elements within the small casing, and the ready accessibility of the operating parts are manifest from the foregoing.

In use, the electrodes, properly moistened with tap water or other electrolyte, are applied to the selected parts of the body, their angularity and distance being readily adjustable as previously described. The device is plugged into an outlet box and the physician holding the instrument by its handle H, may apply its electrodes to the region of the body to be tested or treated. Since the electrode supports are relatively rigid, the instrument may, if desired, be applied to the patient and the adjustment thereof may be con-

trolled by one hand. Thus, the push-button switch 44' may be depressed and released at will, and the meter read, all with as great facility and convenience as in the use of the conventional sphygmomanometer. By turning knob 45', the operation may readily shift from alternating to direct current output as required. In direct current operation, turning of the lateral switch 48 permits reversal of polarity.

The device is thus seen to be a simple portable equipment for effectively determining the location of peripheral nerve lesions caused by shrapnel, for instance, and enables speedy classification of casualties and distribution to proper centers of treatment, contributing considerably to the rehabilitation of casualties.

The invention is by no means limited in its utility to the particular purpose set forth above. Among the diagnostic uses to which the device may readily be put are to determine:

(a) Whether or not a peripheral nerve has been injured, severed or inflamed, for the condition of the nerve is measured by the conductivity of direct or alternating current therethrough, as determined by the meter,

(b) The particular type of degeneration of muscles evidenced by wormlike contraction thereof on stimulation with galvanic current,

(c) Such conditions as tetany in children which is measured by increased excitability of muscles and nerves to the galvanic current, and,

(d) Chronic degeneration of nerves and muscles measured by decreased excitability by galvanic current.

Among the therapeutic uses to which the device may be readily put are:

(a) The stimulation of muscles and nerves in peripheral lesions in order to prevent muscular atrophy by application of direct or alternating current through the nerve;

(b) Anodic stimulation by galvanic current in the cases of irritation of the sensory nerves;

(c) Iontophoresis, that is, the introduction of drugs into the tissues by means of weak galvanic currents applied through the device, and

(d) The electrical stimulation in so-called functional disorders such as shell-shock, by resort to direct or alternating current.

In the embodiment of Figs. 5 and 6 the power is derived from a dry battery, illustratively shown as two series connected cells 50 and 51 mounted in the hollow handle H', and retained in place by removable screw plug 52. The equipment within the casing is generally similar to that of Figs. 2 and 3. In Fig. 6 the induction coil 53 and the associated potentiometer 54 replace the auto-transformer of Fig. 4 and the potentiometer is operated from a knob 55 similar to that used for operating the auto-transformer in the embodiment of Figs. 2 and 3. As appears from the circuit diagram of Fig. 6, the treatment switch 57 when closed, causes the induction coil to step up the voltage greatly in the interruptions of the primary circuit at the interrupter 58. The stepped-up voltage is stepped down to desired extent by the potentiometer 54.

In the alternating current setting shown in full lines in the drawings, the impulses imparted in the closing and opening of the induction coil circuit are passed through the potentiometer 54, the meter 59 to the electrode 17' through the body to the electrode 16' returning to the other terminal of the induction coil secondary.

In the direct current reading the impulses incurred in the opening of the induction coil alone

are imparted to the body and those in the closure are suppressed. This operation is effected by turning the switch 60 to the opposite setting and with it the associated meter switch 61, so that the current from the secondary of the induction coil passes through the rectifier 62, thence to the potentiometer 54, the meter 59 and by way of the electrodes back to the rectifier and to the secondary. Switch 62' is interlocked with switch 60 for the same purpose as in the circuit of Fig. 4.

It will be understood that in each of the embodiments disclosed the treatment switch might be locked in a closed position for continuous treatment whenever desired.

The apparatus in each of its embodiments is so simple, inexpensive and easily operated that it may be standard equipment in the office of general practitioners and surgeons and as above noted, it is especially useful to army doctors in the field. The electrodes, as well as the controls are immediately accessible to the operator who can observe the physiological responses and the corresponding reading of the instrument at the same time.

It is obvious that suitable circuit elements, such as condensers and chokes (not shown) in the elementary circuit diagrams of Figs. 4 and 6 could be incorporated in the apparatus, to attain specialized wave forms for particular applications.

It will be understood that the instrument may be energized by any suitable source of current of any desired frequency or wave form, and operation is by no means limited to the conventional sources of power diagrammatically shown in the drawings. For instance, a motor generator set, or a rotary convertor, operated from any suitable source of mechanical or electrical power could be used. Also an electronic generator may be used to advantage. Instead of the dry cells, used in the embodiment of Figs. 5 and 6, an external battery primary or secondary of any desired voltage or an electronic power supply could be used, as well understood by those skilled in the art.

As many changes could be made in the above construction, and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A portable electro-medical apparatus comprising a combined casing and a handle unit, an electrode near the forward end of said unit having a universal joint mount and a second electrode having a sliding mount along said casing and a universal joint between said sliding mount and the electrode for adjustment in position and inclination of the latter, said electrodes in adjusted position being substantially rigid with said casing, whereby the apparatus held by the handle may be positioned with its electrodes against the patient.

2. An electro-medical apparatus comprising a combined casing and handle unit, a pair of electrodes mounted on said unit in spaced relation, one of said electrodes being slidable along the casing to permit adjustment of the distance between the electrodes and electrical control apparatus in said casing leading to the respective electrodes, said electrodes in adjusted position

being substantially rigid with said casing, whereby the apparatus, held by the handle, may be positioned with its electrodes against the patient.

3. An electro-medical apparatus comprising a combined casing and handle unit, a stimulation electrode affixed to the forward part of said unit, a metal bar extending along said unit and affixed at its ends to said casing, a second electrode having a mounting sleeve slidable along said bar for adjustment in the position thereof and means within said casing connected respectively to said stimulation electrode and to said bar for energizing said electrodes in all positions of adjustment thereof.

4. An electro-medical apparatus comprising a combined casing and handle unit, a stimulation electrode having a rod unitary therewith, a universal joint affixed to the forward end of said casing for accommodating said rod and permitting adjustment in the position of the electrode, a bar affixed at its ends to said casing and handle unit, and extending longitudinally thereof, a second electrode having a rod unitary therewith, a universal joint mounting said rod, and a sleeve mount for said universal joint encompassing said bar to permit adjustment in the distance of the second electrode from the first, and control and indicating apparatus in said casing connected near the forward end of the casing to the electrodes and through the respective mounts of the latter.

5. A portable electro-medical equipment comprising a casing unit having terminals for a source of applied voltage and including a handle, a pair of electrodes protruding in longitudinally spaced relationship from said unit, each of said electrodes having a current lead to the interior of said casing, whereby the electrodes may serve to position the apparatus against the patient, control apparatus within said casing including a device for stepping up the voltage applied to said terminals, means including a knob accessible at the exterior of the casing unit for adjusting the voltage, a switch also accessible from the exterior for closing and opening circuit with respect to said electrodes, and indicating means exposed at the front of said casing for showing the physiological response to the electrical impulse.

6. A portable electro-medical apparatus comprising a casing and handle unit, electrodes adjustably affixed in spaced relation upon said unit, said electrodes having conducting means terminating in the interior of said casing, means encompassed by said handle for delivering current to said casing, means in said casing to vary the applied voltage, a knob upon said casing for adjusting said means, manually operated means accessible at the exterior for opening and closing circuit to said electrodes, and a meter for indicating the current supplied to the electrodes.

7. A portable electro-medical device adapted to be operated from an alternating current source comprising a casing and handle unit, electrodes mounted in longitudinally spaced relation upon said unit and adjustable in relative position for adaptation to the body portions to which said electrodes are to be applied, said casing having therein an auto-transformer supplied from a source of alternating current, a knob upon the casing for setting the auto transformer and determining the applied voltage and a manually operated switch for opening and closing circuit to said electrodes, said switch being accessible to the hand by which the device is held.

8. A portable electro-medical device for ap-

plying direct current from an alternating current source, said apparatus comprising a casing and handle unit, a pair of electrodes mounted at longitudinally spaced positions upon said unit and adjustable in position for adaptation to the parts of the body to which they are to be applied, an auto-transformer in the casing supplied from such source of alternating current, a knob on the casing for determining the voltage delivered by said auto-transformer, a rectifier connected to said auto-transformer and in turn connected to one of said electrodes, and a meter in the circuit to indicate the current through the electrodes.

9. The combination recited in claim 8 in which a reversing switch is accessible from the side of the casing.

10. A portable electro-medical apparatus adapted at will for alternating or direct current use comprising a casing and handle unit, a pair of electrodes mounted exteriorly of said unit at points spaced longitudinally thereof, apparatus in said casing including an auto-transformer, a dry rectifier and a treatment switch, means accessible at the exterior of said casing including a knob for setting the auto-transformer, a push button for operating the treatment switch, a meter for indicating the current passed through the electrodes, and a switch for selectively setting the device for alternating or direct current operation, said switch in the alternating current setting cutting the rectifier out of circuit, and a reversing switch for determining the polarity of the electrodes in the direct current setting.

11. A portable electro-medical apparatus comprising a combined casing and handle unit, electrodes mounted on said casing in longitudinally spaced relation, a battery mounted in the handle element of said unit, electrical control and indicating apparatus in said casing connected to the electrode means, said apparatus including an

induction coil, a potentiometer adjustable from the exterior of the casing, a treatment switch for opening and closing circuit with respect to said electrodes and an indicating meter.

12. A portable electro-medical apparatus comprising a combined casing and handle unit, electrodes mounted on said casing in longitudinally spaced relation, a battery mounted in the handle element of said unit, electrical control and indicating apparatus in said casing connected to the electrode means, said apparatus including an induction coil, a potentiometer operable from the exterior, a treatment switch for opening and closing circuit with respect to said electrodes, a rectifier and a switch for selectively cutting the rectifier into and out of circuit.

13. A portable electro-medical apparatus comprising a casing unit, a pair of electrodes mounted upon said unit, said unit being adapted to be held by the physician to position the apparatus upon the body of the patient with its electrodes in contact with the patient, and energizing means for said electrodes lodged within said casing unit, said casing unit including control apparatus for determining the electrical impulse applied through said electrodes and indicating means for reading the magnitude of said impulse.

14. A portable electro-medical apparatus comprising a combined casing and handle unit, a pair of electrodes mounted upon said unit, said unit serving to position the apparatus upon the body of the patient with its electrodes in contact with the patient, and energizing means for said electrodes extending through the handle length to said casing, said casing unit including control apparatus for determining the electrical impulse applied through said electrodes and indicating means for reading the magnitude of said impulse.

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