March 29, 1949. P. D. BERNARD 2,465,838

ELECTRONIC VALVE APPARATUS FOR ELECTROTHERAPY

Filed July 18, 1945

Fig. 1

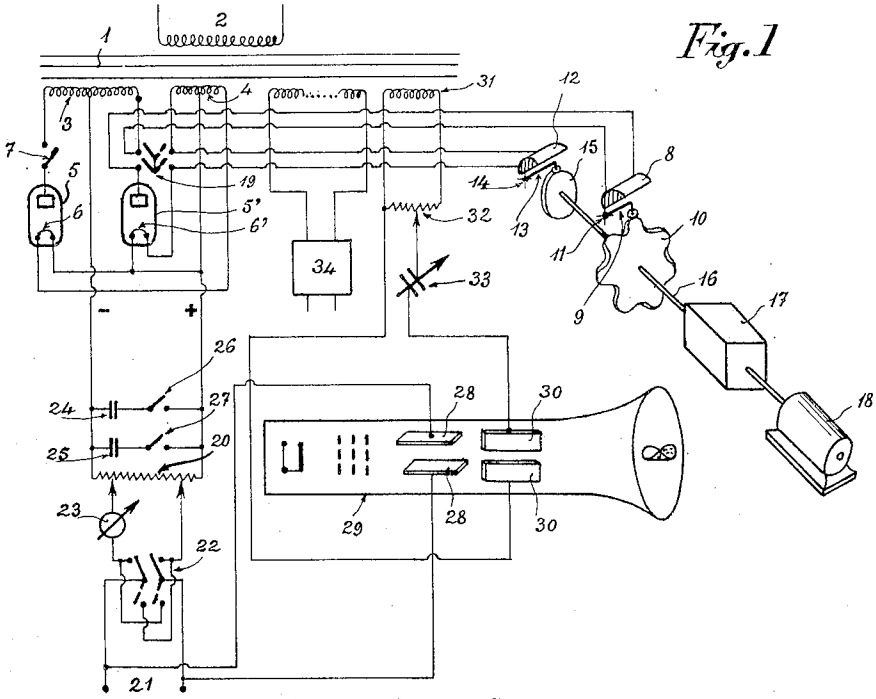


Fig. 2

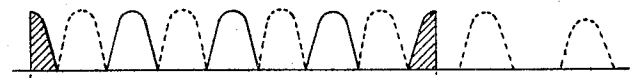


Fig. 3

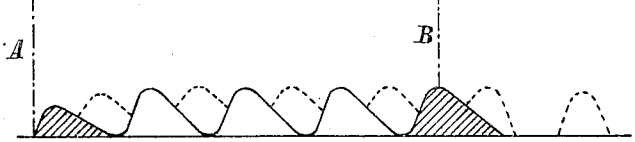


Fig. 4

Fig. 5

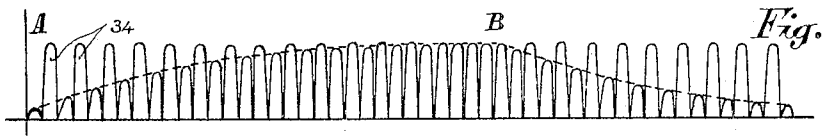


Fig. 6

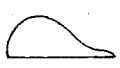


Fig. 7

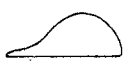


Fig. 8

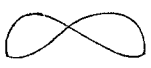
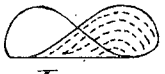


Fig. 9



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ELECTRONIC VALVE APPARATUS FOR ELECTROTHERAPY

Pierre Denis Bernard, Clermont-Ferrand, France

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4 Claims. (Cl. 175—363)

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As is known, electrotherapeutics use electric currents defined by curves the shapes of which vary to suit the medical purpose which is sought in each particular instance. Thus it was discovered amongst other findings that a current modulated at a cadence equal to several seconds is required for certain medical treatments such for example as the treatment of pains commonly designated by algies, while for certain other medical treatments, particularly the treatment of atonies and for the diagnosis of neuro-muscular states, currents syncopated at a short cycle rhythm are to be preferred.

The present invention has for its object to provide a novel apparatus incorporating electronic valves and utilisable in electrotherapy, said apparatus having such an improved construction as to permit selectively to obtain either of the currents having the aforesaid characteristic curve shapes to suit the required healing treatments.

Another object of the invention is to provide an apparatus as aforesaid having such an improved construction as to enable a change over from single undulatory frequency to undulatory frequency having twice the value of the former frequency, thereby enhancing the therapeutical effects by doing away with any accustoming of the patient to any given stationary frequency.

A further object of the invention is to provide an apparatus as aforesaid wherein variations obtained by the action of primary switch means are comparatively rapid and suitable for the treatment of atonies, while the actions obtained by secondary switch means are comparatively slow and appropriate for healing algies.

A still further object of the invention is to provide an apparatus as aforesaid including oscillographic means permitting the shape of curve of the delivered current to be visualized, thereby greatly facilitating the use of the apparatus while increasing its handiness.

With these and such other objects in view as will incidentally appear hereafter, the invention comprises the novel construction and combination of parts that will now be described in detail with reference to the accompanying diagrammatic drawing exemplifying the same and forming a part of the present disclosure.

In the drawing:

Fig. 1 is a view of the apparatus represented in its entirety, some parts being shown diagrammatically, others being shown isometrically.

Figs. 2, 3, 4 and 5 are curves showing several current shapes which are obtainable by means of an oscillograph of usual construction embodied

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in the apparatus and providing constant direction wiping action.

Figs. 6, 7, 8 and 9 are curves obtainable with the apparatus shown in Fig. 1 and fitted with an alternating wiping oscillograph.

1 designates a transformer having a primary winding 2 and a pair of secondary windings 3, 4 having middle tapping leads. The winding 3 feeds two electronic valves 5, 5' whose cathodes 6, 6' are heated by the winding 4. A hand controlled switch 7 is connected to the anode line for the valve 5. The anode of the valve 5' is fed through a switch 8 supported by a carrier 9 operable by a cam 10 for rocking action about a pivotal joint 11. Another switch 12 is connected to the heating leads for the cathode 6' of the valve 5', said switch 12 being supported by a carrier 13 capable of performing a rocking motion about a pivotal joint 14 under the influence of a cam 15.

The cams 10, 15 may be mounted either on separate pins or (as shown by the drawing) on a common shaft 16 actuated through a speed-reducing gear 17 by a motor 18. The shape of these cams is selected for enabling the switch 8 to perform a quicker rocking motion than the switch 12. The showing presupposes that the ratio of frequencies of these rocking motions is 1 to 7, the switch 8 effecting say one rocking motion per second.

A two-pole reversing switch 19 permits selectively to short-circuit either the switch 8 (position of switch 19 shown in full lines on the left hand side) or both switches simultaneously for obtaining a non-interrupted current.

The rectified current is delivered to a potentiometer 20 which supplies output terminals 21 with a regulatable current whose polarity may be selected by means of a reversing switch 22 while its intensity may be controlled following the indications furnished by an ammeter 23.

In parallel with the potentiometer 20 are arranged any suitable number of condensers such as 24, 25 which may be put into action or out of action by means of a pair of switches 26, 27.

The horizontal plates 28 of a cathodic oscillograph 29 are connected to the output terminals 21 while the vertical wiping plates 30 are connected to one of the secondary windings 31 of the general feeding transformer through a potentiometer 32 permitting the voltage to be adjusted and a variable condenser 33 allowing of regulation of phase shifting.

The operation takes place as follows:

The transformer winding 3 and the electronic

valves 5, 5' build up a rectifier which supplies a current whose rectified shape may be altered in the following manner: Opening of the switch 7 permits one half-wave of the rectified current to be cancelled. When, however, the reversing switch 19 is brought to its right hand side position (shown in dotted lines) the switch 12 is short-circuited, thereby starting permanent heating of the cathode 6', while the switch 8 is inserted into the anode line for the valve 5' which cuts off the anode current of the valve 5' at a rhythm or cadence which responds to the shape and rotating speed of the cam 10. Under such conditions, the anode current is either cut off or started at any moment of the phase. When such current cutting or starting actions take place at phase maximum, a sudden current variation ensues or in other words a variation having a much steeper gradient than that of the sinusoidal variation of the initial current (Fig. 2).

However, as will be understood, such rapid variations produce fairly painful effects on the patient, also brutal neuro-motive effects which must be avoided wherever possible.

In order to obviate such disadvantages, the condenser 24 (which has a relatively low capacity) is set into operation by means of a contactor 26. Therefore even if the current is switched in at the peak moment of the half-wave, it grows in accordance with an exponential function (side A of Fig. 3) and decreases exponentially (side B of Fig. 3) when, responsive to the action of the cam 10, the switch 8 establishes or cuts off the anode line. During the A—B interval, the half-wave shape is no longer exactly sinusoidal but exponential.

This shape of syncopated current is particularly suitable for treating and healing atonies.

When the reversing switch 19 is brought to its left hand side position, it short circuits the switch 8 but inserts the switch 12 into the heating line for the cathode 6'. Owing to the action of the cam 15, the heating current is thereby cut off at a certain frequency which, however, is substantially different from the cutting off frequency of the switch 8 owing to the difference of shape between the cams 10 and 15 or to the difference in the revolving speeds if said cams are mounted on different axes. The assembly is so adjusted as to cause the switch 12 to effect approximately a cutting off action every five to fifteen seconds. Following interruptions performed by the switch 12 and due to the thermal inertia of the cathode 6', the shape of delivered current represented in Fig. 4 is obtained, still assuming the switch 7 to remain open. During the interval A—B when the switch 12 closes the heating circuit, the current grows but fairly slowly owing to the thermal inertia of the cathode 6'. As soon as the switch 12 cuts off the heating current (point B) the current begins to decrease slowly.

The curve 5 represented in Fig. 5 shows another current shape such as obtainable following the action of the automatic switch 12 by opening the switches 26, 27 but closing the switch 7. The slow varying current shape supplied by the valve 5' shown in Fig. 4 is completed by the current from the valve 5 which in each period or cycle supplies maximum power as indicated at 34. Therefore the current comprises a pair of components one of which is supplied by the valve 5 and remains invariably at its peak value, while the other one is modulated by the action of the switch 12 and slowly increases or decreases as the case may be.

It will be understood from the foregoing that the periodical change over from a simple undulatory frequency to an undulatory frequency having a double value increases the therapeutical effects by doing away with any possibility for the patient to become accustomed to any given invariable frequency. Furthermore, variations obtained by the action of the switch 8 are comparatively rapid and suitable for treating atonies, while modulations obtained by the action of the switch 12 are comparatively slow and suitable for treating algies.

The apparatus also comprises an oscillographic device by means of which the shape of the supplied current may be visualized. This device comprises either an oscillograph of any known type capable of giving currents connoted by the curves shown in Figs. 2 to 5 or preferably (as shown in the embodiment illustrated in Fig. 1) an oscillographic tube in which the horizontal wiping action takes place alternately and provides currents whose representative curves belong to the "Lissajou" type as shown in Figs. 6 to 9. In such case, as above stated, the voltage fed at the terminals 21 is supplied to the horizontal plates 28 of the cathodic oscillograph tube, while the vertical plates 30 (for the horizontal wiping action) are subjected to an alternating voltage tapped from the feeding transformer. An adjustable or invariable phase shifting action of this voltage may be obtained by customary processes so as to obtain a characteristic curve connoting the general shape of the current as used.

In Fig. 6 is shown the shape of the current curve when using one half-wave. In Fig. 7 is shown the shape of the current curve when using the other half-wave. In Fig. 8 is shown the case where, by means of a remanent screen, the nature of the phase progression (whether rapid or slow, increasing or decreasing) is visualized.

The complete manner of fitting the oscillograph fed as shown from the secondary winding tapping terminals 34 is not fully illustrated in Fig. 1, this being purposely done for the sake of clearness of this drawing because such fitting may be of any known type as used in the art and is not characteristic of the invention. The only showing given is that of the particular way of connecting the wiping plates with the source of alternating voltage.

Minor constructional details may be varied without departing from the scope of the appended claims.

What is claimed is:

1. An electrotherapeutical apparatus adapted particularly for the treatment of differentiated pains of the human body comprising a rectifier including two electronic tubes arranged in parallel, anode feeding circuits therefor, cathode-heating circuits for said tubes, switches inserted respectively in the anode feeding circuit and the cathode heating circuit associated with one of the tubes, power means, two cams controlled by said power means and adapted to operate said switches at different rhythms and a hand controlled change over switch inserted in the last mentioned anode feeding circuit and cathode heating circuit and adapted to provide selective short circuiting of at least one of the last mentioned switches and a further hand controlled switch inserted in the anode circuit of the tube other than that submitted to the action of the two rhythmically controlled switches.

2. An electrotherapeutical apparatus adapted

particularly for the treatment of differentiated pains of the human body comprising a rectifier including two electronic tubes arranged in parallel, anode feeding circuits therefor, cathode-heating circuits for said tubes, switches inserted respectively in the anode feeding circuit and the cathode heating circuit associated with one of the tubes, power means, two cams controlled by said power means and adapted to operate said switches at different rhythms, a hand controlled change over switch inserted in the last mentioned anode feeding circuit and cathode heating circuit, and adapted to provide selective short circuiting of at least one of the last mentioned switches, a further hand controlled switch inserted in the anode circuit of the tube other than that submitted to the action of the two rhythmically controlled switches, a transformer including a primary and three secondaries two of which are adapted to feed respectively the cathode heating circuits and the anode feeding circuits and provided with medial tappings, output terminals fed by said medial tappings, an oscillographic device adapted to visualize the curves of the rectified currents supplied by the medial tappings, said oscillographic device including spaced horizontal anodes connected with the output terminals and spaced vertical anodes fed by the third secondary winding, and a variable condenser inserted between said vertical plates and said third secondary winding.

3. An electrotherapeutical apparatus adapted particularly for the treatment of differentiated pains of the human body comprising a rectifier including two electronic tubes arranged in parallel, anode feeding circuits therefor, cathode heating circuits for said tubes, switches inserted respectively in the anode feeding circuit and the cathode heating circuit associated with one of the tubes, power means, two cams controlled by said power means and adapted to operate said switches at different rhythms, a hand controlled change over switch inserted in the last mentioned anode feeding circuit and cathode heating circuit, and adapted to provide selective short circuiting of at least one of the last mentioned switches, a further hand controlled switch inserted in the anode circuit of the tube other than that submitted to the action of the two rhythmically controlled switches, a transformer including a primary and three secondaries two of which are adapted to feed respectively the cathode heating circuits and the anode feeding circuits and provided with medial tappings, output terminals fed by said medial tappings, a cathode ray tube adapted to visualize the curves of the rectified currents supplied by the medial tappings, said cathode ray tube including spaced horizontal anodes connected with the output terminals and spaced vertical anodes fed by the third secondary winding, a variable condenser inserted between said vertical plates and said third secondary winding, said cathode ray tube being arranged for reciprocating horizontal scanning and being adapted to produce representative current curves of the Lissajou type.

4. An electrotherapeutical apparatus adapted particularly for the treatment of differentiated pains of the human body comprising a rectifier including two electronic tubes arranged in parallel, anode feeding circuits therefor, cathode heating circuits for said tubes, switches inserted respectively in the anode feeding circuit and the cathode heating circuit associated with one of the tubes, power means, two cams controlled by said power means and adapted to operate said switches at different rhythms, a hand controlled change over switch inserted in the last mentioned anode feeding circuit and cathode heating circuit, and adapted to provide selective short circuiting of at least one of the last mentioned switches, a further hand controlled switch inserted in the anode circuit of the tube other than that submitted to the action of the two rhythmically controlled switches, a transformer including a primary and three secondaries two of which are adapted to feed respectively the cathode heating circuits and the anode feeding circuits and provided with medial tappings, output terminals for the rectifier current, a potentiometer including an input and an output connected respectively with the intermediate tappings of the first two secondaries and with the output terminals and a reversing switch operatively connected between the output of the potentiometer and the output terminals of the apparatus, an oscillographic device adapted to visualize the curves of the rectified currents supplied by the medial tappings, said oscillographic device including spaced horizontal anodes connected with the output terminals and spaced vertical anodes fed by the third secondary winding, and a variable condenser inserted between said vertical plates and said third secondary winding.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,908,688	Call	May 16, 1933
1,946,176	Matscheller	Feb. 6, 1934
1,972,159	Morrison	Sept. 4, 1934
1,992,100	Stein	Feb. 19, 1935
2,028,338	Le Bel	Jan. 21, 1936
2,094,379	Schenkel	Sept. 28, 1937
2,265,025	Brace	Dec. 2, 1941
2,311,935	Dobert	Feb. 23, 1943

FOREIGN PATENTS

Number	Country	Date
535,934	Germany	Oct. 17, 1931