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(54) APPARATUS FOR THERAPEUTIC TREATMENT AND STIMULATION OF MUSCLES BY LOW-FREQUENCY OSCILLATING ELECTRIC CURRENT

(71) We, HAKUJU INSTITUTE FOR HEALTH SCIENCE CO. LTD., a Japanese company organised under the laws of Japan, of Senpakushinko Building No. 35, Shibakoto-hira-cho, Minato-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to apparatus for the therapeutic treatment and stimulation of muscles by low frequency, that is to say: 1 Hz to 100 Hz, oscillating electric currents.

Low-frequency therapeutic apparatus hitherto used for treating muscles of the human body has been primarily for the remedy of pain and fatigue in the muscles and not to effect the positive treatment of the muscles by means of stimulation. Although physical exercise or training of muscles is recognised as important so as to keep the health and strength of the body, such exercise or training is extremely limited in modern social life. It is known that physical action of the body mostly derives from muscle movement of the body frame as well as of its internal organs and, if one neglects physical exercise or training, the muscle portions of the body will tend to atrophy.

It is also known that stimulation of muscles with electricity from a low-frequency oscillating circuit may cause excitation and contraction of muscles which then slacken as the electric supply is interrupted. Thus by repeating intermittent electric excitation it is possible to tone up the muscles.

According to the present invention we provide apparatus adapted to provide a low frequency variable oscillating electric current for therapeutic treatment and or stimulation of a muscle or muscles of the muscular system of the body, said apparatus comprising a housing containing as hereinbefore defined a low-frequency oscillatory electric circuit operable from a dry cell as the electric power source, exposed spaced plural electrodes each being electrically connectable to the said low-frequency oscillatory circuit by means of a plug and socket and each electrode able to be, in use, applied to a surface of the human body to cause said electric current to flow and thereby to effect said therapeutic treatment and or stimulation, at least one of the electrodes being made of metal covered by a sponge member of a shape conforming to the outer configuration of the metal sheet, said sponge being secured thereto.

The apparatus is preferably constructed to be of a compact size, whereby therapeutic and or stimulating treatment may be applied to the muscles with the electrode section contacted to muscle portions so as to remedy pain and fatigue in the muscles and strengthen the muscles by stimulation.

The invention will now be described by way of example only of various embodiments referred to in the figures of the accompanying drawings in which:—

Figures 1 and 2 respectively are a top plan view and a front elevation of one embodiment of an apparatus of the invention comprising a housing and an electrode member;

Figure 3 shows the apparatus of Figure 1 with the electrode member removed from the housing of the apparatus;

Figures 4*a*, 4*b* respectively are a plan view and a front elevation of a part of the electrode member;

Figures 5*a*, 5*b* are respectively a plan view and a front view of a sponge member;

Figure 6 is a circuit diagram of a low-frequency oscillating circuit used in the apparatus of the invention;

Figure 6*a* is a circuit diagram of a low-frequency oscillating circuit of another embodiment of apparatus of the invention;

Figure 7 shows the form of one of the output waves of the oscillating circuits shown in Figure 6 and Figure 6*a*;

Figures 8*a* to 8*h* are diagrams illustrating various uses of an embodiment of the apparatus of the invention in relation to parts of the human body;

Figure 9 is a side view in part perspective of an alternative electrode member used in

an apparatus in accordance with the invention;

Figures 10*a*, 10*b* are respectively a plan view and a front elevation of an alternative electrode member; and

Figure 11 is a view in oblique perspective of yet another alternative electrode member.

In Figures 1 and 2 a low-frequency electrical therapeutical apparatus shown generally at 1 comprises a housing 2 and a mating electrode member 8 containing two electrodes. The housing 2 includes a part 3 able to accept at least one dry cell and a cover plate 4 for the cell part 3. The housing 2 also includes a low-frequency oscillating circuit a slide switch 5 for intermittent switching, a variable resistor 6 with an output switch, and a variable resistor 7 for adjustment of the frequency of the electric current.

The electrode member 8 has two arms 9*a*, 9*b* and two electrodes 10*a*, 10*b*. The arms 9*a*, 9*b* are positioned such that they make an oblique angle α between each other and an angle β with a line representing a plane that contains the bottom of the housing 2. The electrodes 10*a*, 10*b* each consist of an electrode base 11 covered by a sponge member 12. The electrode member 8 can be removed from and replaced with the housing 2 (see Figure 3). Set screws 13 are provided to connect the electrode member 8 to the housing 2.

The electrode member 8, has an insert base 14 formed with a square cross-section having four sides sloping towards its end. The insert base 14 has at its end a plug 15 the base and the plug being insertable respectively into a fitting hole 14^1 and socket 15^1. The plug 15 is provided with a guide groove 16 thereon. A slot 17 is formed in the insert base 14. In the housing 2 the fitting hole 14^1 and the socket 15^1 are shown in dotted lines. When the housing 2 and the electrode member 8 are assembled, the insert base 14 with the plug 15 are pressed into the fitting hole 14^1 and socket 15^1 in the housing 2. As the electrode member 8 is completely fitted to the housing 2, the slot 17 engages with a projection (not shown) in the fitting hole. The electrode member 8 may be securely engaged to the housing, thereby forming a complete electric connection therebetween.

As shown in Figures 4*a* and 4*b*, the electrode base 11 may have a rectangular form in plan view and a dome shape in front elevation. The electrode base 11 may be provided with an electrode terminal 11^1 projecting from the bottom of the electrode base.

Figures 5*a* and 5*b* show a sponge member 12, which is similar in shape to the electrode base as shown in Figures 4*a* and 4*b*. The sponge member 12 is made of a sponge moulding produced from a sponge plate pressed into a shape fitted to the outer configuration of the electrode base. The sponge member 12 has a hollow space 12*a* to contain the electrode base 11 and also a peripheral lip portion 12*b* around the space 12*a*. For example, at four points on the lip portion 12*b* of the sponge member are provided an adhesive 12*c* which may be permeable, water-proof and rapid-curing. As the adhesive 12*c* on the lip portion 12*b* cures, the sponge member 12 is made non-collapsible even when it contains water. The sponge member 12 thus receives the above electrode base 11 for insertion into the hollow space 12*a* as shown by dotted lines on Figure 5*b* to form the electrode 10.

The circuit of the low-frequency oscillating circuit included in the housing 2 is shown in Figure 6. Layer-built cells E1 and E2 each supply a voltage of nine volts and acts as the electrical power source for the apparatus. The circuit contains in connection capacitors C1—C5; resistors R1—R5; transistors Tr1—Tr5; a germanium diode D; an oscillating transformer T1; an output transformer T2; variable resistors VR1 and VR2; switches SW1 and SW2; a lead relay Ry with normally-closed contact S; and output terminals t1 and t2. In Figure 6, the switch SW1 and the variable resistor VR2 are associated in operation. These correspond to the variable resistor 6 with the output switch (Figures 1 and 2). The variable resistor VR1 corresponds to the variable resistor 7 for frequency adjustment as shown in Figure 1. Also the switch SW2 in Figure 6 corresponds to the slide switch 5 in Figure 1.

In operation, the switch SW1 (variable resistor 6 with the output switch) is set ON, then oscillation is produced in the transistor Tr1 and oscillating transformer T1, the output of which sets the transistor Tr2 ON or OFF. Accordingly, electric current in the capacitor C1 loaded by the series of cells E1 and E2 on the primary side of the output transformer T2 instantly flows in the circuit and produces a large output on the secondary side. This output is taken off the variable resistor VR2 and fed to the output terminals t1 and t2 connected respectively to the electrodes 10*a*, 10*b*. Therefore, if the variable resistor VR2 (variable resistor 6 with output switch) is properly adjusted, a desired output can be obtained. The frequency of the current may be adjusted by turning the variable resistor VR1 (variable resistor 7 for frequency adjustment). When the output is to be supplied intermittently, the switch SW2 is closed. Then, as the transistors Tr3 and Tr4 form a nonstable multivibrator, the transistors are alternately set ON or OFF in repetition. Therefore, the transistor Tr5 is set ON or OFF, the lead relay Ry following to set the normally-closed contact S ON or OFF, and output of the output transformer T2 is fed for connection or disconnection through the lead relay Ry.

In Figure 6*a* oscillating transformer T1 and an output transformer T2 are united into one unit as shown at T. In this alternative circuit the cells E1 and E2 are connected in series serving as a power source for the whole circuit. In the circuit, D2 is a protection diode for the transistor Tr2. With the relay Ry in Figure 6 replaced with a transistor Tr6, it is possible to reduce the power consumption and stabilize the operation of the whole circuit. R6 is a bias resistance for the transistor Tr6.

An example of an output wave suitable for favourably affecting the muscles is shown in Figure 7. In this Figure, the positive output wave is relatively small compared to the negative one, which is effected from the diode D or D1 in the circuits.

An example of a manner of using the apparatus of the invention will now be described. The sponge members 12 of electrodes 10*a*, 10*b* in the electrode member 8 may initially be soaked with water. The electrode member 8 with the sponge members containing water is pressed against the body surface. With the switch of the variable resistor 6 set at ON, it may be gradually turned in the arrowed direction as shown in Figure 1. The variable resistor 6 may be turned round until the user senses the stimulus most adapted for the musculature of the body to be treated. Electric current is then applied to the muscles producing the desired effect. When the slide switch 5 is turned in the opposite direction relative to the position shown in Fiigure 2, there is produced an intermittent charge of electricity to the muscles. In order to obtain a much stronger stimulus in the muscles, the variable resistor 6 may be turned in the arrowed direction. The frequency of the electric current may also be increased as desired by turning the variable resistor 7 in the arrowed direction as shown in Figure 1.

Figures 8*a* to 8*h* illustrate manners of application of the apparatus shown in Figure 1 to various anterior and posterior muscle of the human body. Figure 8*a* shows an application to the muscles of the lower jaw. Figure 8*b* shows an application to the facial muscles on both sides of the nose. Figure 8*c* shows an application to the musculature of the throat. Figure 8*d* shows an application to the ocular musculature of the left orbit. Figure 8*e* shows an application to the musculature of the cervical vertebrae at the lower back of the head. Figure 8*f* shows an application to the musculature of the abdomen. Figure 8*g* shows an application to the musculature of the arm and Figure 8*h* an application to the dorsal musculature of the upper vertabrae. In Figure 8*h* above, the apparatus can be used by one person for the benefit of another. Application of the apparatus is not limited only to such parts of the body as described but it can be for any suitable part of the body for similar treatment of the musculature.

In Figure 9, the electrode section 8A is formed in a bar-shape, at the end of which is provided an electrode 10 having a sponge member 12 and in the middle of which is a metallic electrode 10^1 (this portion is gripped by hand). As the electrode 10 is applied to the muscles of the body, electric current is supplied to the body through a hand holding the metallic electrode 10^1. This manner of application is suitable to provide stimulus in localized areas of the body.

In Figures 10*a* and 10*b*, electrodes 8B are shown which are suitable for treatment of the muscles adjacent to the backbone. From the base 18 of the electrode member are formed two elevations 19 to which are secured the electrodes 10*a*, 10*b*. This type of the apparatus is used more effectively on the dorsal side of the body when the user lies with his back upon the floor.

The electrodes 10*a*, 10*b* in the electrode members 8A, 8B in Figures 9 and 10 are similar to the electrodes 10*a*, 10*b* in Figure 1.

Figure 11 shows two electrodes 10*a*, 10*b* each in the form of a metal plate defined by square frames 20_1 20_2 which are made of conductive rubber to be convenient for use due to its flexibility. These electrodes have surfaces made of sheets of sponge 12^1a, 12^1b capable of containing water to obtain suitable flexibility and electric conductivity. These electrodes $10^{11}a$, $10^{11}b$ may be made of a conductive rubber which is well known in the art.

It will be seen that the electrode members 8A, 8B and 8C are provided with an electrical cord connection 21 with a plug 15 that can be readily inserted into the housing 2.

WHAT WE CLAIM IS:—

1. Apparatus adapted to provide a low frequency variable oscillating electric current for therapeutic treatment and or stimulation of a muscle or muscles of the muscular system of the body, said apparatus comprising a housing containing as hereinbefore defined a low-frequency oscillatory electric circuit operable from a dry cell as the electric power source, exposed spaced plural electrodes each being electrically connectable to the said low-frequency oscillatory circuit by means of a plug and socket and each electrode able to be, in use, applied to a surface of the human body to cause said electric current to flow and thereby to effect said therapeutic treatment and or stimulation, at least one of the electrodes being made of metal covered by a sponge member of a shape conforming to the outer configuration of the metal sheet, said sponge being secured thereto.

2. Apparatus as claimed in claim 1, wherein the plural electrodes are arranged

In Figure 6*a* oscillating transformer T1 and an output transformer T2 are united into one unit as shown at T. In this alternative circuit the cells E1 and E2 are connected in series serving as a power source for the whole circuit. In the circuit, D2 is a protection diode for the transistor Tr2. With the relay Ry in Figure 6 replaced with a transistor Tr6, it is possible to reduce the power consumption and stabilize the operation of the whole circuit. R6 is a bias resistance for the transistor Tr6.

An example of an output wave suitable for favourably affecting the muscles is shown in Figure 7. In this Figure, the positive output wave is relatively small compared to the negative one, which is effected from the diode D or D1 in the circuits.

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In Figure 9, the electrode section 8A is formed in a bar-shape, at the end of which is provided an electrode 10 having a sponge member 12 and in the middle of which is a metallic electrode 10^1 (this portion is gripped by hand). As the electrode 10 is applied to the muscles of the body, electric current is supplied to the body through a hand holding the metallic electrode 10^1. This manner of application is suitable to provide stimulus in localized areas of the body.

In Figures 10*a* and 10*b*, electrodes 8B are shown which are suitable for treatment of the muscles adjacent to the backbone. From the base 18 of the electrode member are formed two elevations 19 to which are secured the electrodes 10*a*, 10*b*. This type of the apparatus is used more effectively on the dorsal side of the body when the user lies with his back upon the floor.

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It will be seen that the electrode members 8A, 8B and 8C are provided with an electrical cord connection 21 with a plug 15 that can be readily inserted into the housing 2.

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2. Apparatus as claimed in claim 1, wherein the plural electrodes are arranged

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on outwardly extending arms arranged in a V-shaped configuration, and forming an oblique angle with respect to each other.

3. Apparatus as claimed in claim 1, wherein the plural electrodes are placed one at the end and the other in the middle of an elongated bar.

4. Apparatus as claimed in any preceding claim wherein the electrode is dome shaped.

5. Apparatus as claimed in any preceding claim wherein the sponge is adhesively secured to the metal electrode.

6. Apparatus constructed and arranged substantially as herein described and shown in Figures 1, 2, 4*a*, 4*b*, 5*a*, 5*b*, 6, 6*a* of the accompanying drawings.

7. Apparatus constructed and arranged substantially as herein described and shown in Figures 3, 4*a*, 4*b*, 5*a*, 5*b*, 6, 6*a* of the accompanying drawings.

8. Apparatus constructed and arranged substantially as herein described and shown in Figure 9 of the accompanying drawings.

9. Apparatus constructed and arranged substantially as herein described and shown in Figures 10*a*, 10*b* of the accompanying drawings.

10. Apparatus constructed and arranged substantially as herein described and shown in Figure 11 of the accompanying drawings.

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