The invention relates to a treatment appliance for a human or animal body or body part, having a field coil arrangement which is connected to a mains-operated, low-frequency power pulse current generator and in which a small magnetic plate is resiliently mounted, causing the plate to oscillate in the low-frequency magnetic field of the field coil arrangement.

One such treatment appliance is already known from DE-A-3 335 018 However, this appliance has two field coils, each energising the patient's body and each connected at a respective power pulse current generator. These pulse generators operate at very varied frequencies, namely a low fundamental frequency and a high modulation frequency of more than 10 kHz. This is expensive and in each case requires the adjustment of the two generators to the particular treatment requirements to be appropriately matched. The small permanent magnetic plate is held movably in the field range of the two field coils and by its oscillation only exerts an electromagnetic effect on the body spaced apart from it.

Furthermore, from FR-A-2 585 579 a treatment appliance is known of which the coils are only connected to the frequency generator and insulated with one another one one side, and are not insulated towards the body, but only protected from direct contact by a protective veil. Rather, in this instance the not fully insulating barrier results in an electrically conductive connection to the patient's body via the coil-type conductor arrangement, with a microcurrent supplied from a microbattery passing through the patient's body when two such electrodes are applied, and each of the electrodes being linked to a pole of the frequency generator. The permanent magnets are held in the inner portion of the coil-type conductor arrangements and not directly in contact with the body. The microcurrent - a higher one is not tolerated by a body - passes through the conductor structure only to a limited extent since distributed over the conductor it leaves the latter sideways. Such a microcurrent cannot generate a magnetic alternating field capable of producing vibrational motion in the permanent magnets. Moreover, a mechanical magnetic vibration would only be transmitted to a limited extent to the body through the surrounding conductor arrangement. Furthermore, the body is arranged externally to the coil-type conductor, with the result that only a small fraction of the very weak magnetic field generated by the microcurrent hits the body.

Furthermore, from EP-A-0 005 713 a solenoid arrangement is known which is powered by low-frequency current and in which a human body is to be arranged, a small high-permeability plate being arranged on the body to concentrate the low-frequency magnetic field.

It is the object of the invention to improve on the appliance mentioned at the beginning and to increase the efficacy of the low-frequency therapy and extend its field of application.

The solution to this task consists in arranging a plurality of small magnetic plates so as to be able swivel relative to one another in a magnetic cover or a magnetic apron shaped to fit the body, and in embedding between the magnetic plates elastic material through which seams are sewn, and in making the field coil arrangement from a single hollow cylindrical or flattened hollow cylindrical field coil or a plurality of coil sections arranged alongside one another and linked to the single power pulse current generator so as to operate in the same direction.

In accordance with the invention, the body or part of the body is to be placed in the coil arrangement and the swivelling magnetic plates are to be arranged with the cover or apron directly against the body or part of the body. The coil made up of insulated conductors is connected by each of its two ends to complementary terminals of the low-frequency current source, which is mains-operated on the incoming side. The low-frequency flow of current is so calculated that the small magnetic plates produce vibrations in the low-frequency magnetic field of the coils constituting the field coils and these vibrations massage the body.

Advantageous embodiments are indicated in the subsidiary claims.

The appliance of the invention is very useful in physical medicine and for rehabilitating people. This innovation brings an improvement in the conventional method of using a low-frequency electromagnetic field, known as low-frequency therapy. The small magnetic plates advantageously consist of permanent magnet material and are spaced apart in a cover or dressing and able to swivel relative to one another, making them easy to arrange and hold on the subject for treatment, yet they execute swivelling movements in the electromagnetic field by the interaction of the magnetic fields, said swivelling movements advantageously producing a therapeutic massaging action to complement the therapeutic effect of the magnetic fields.

In one advantageous embodiment of the overall appliance, the coil arrangement which is used to generate the low-frequency field and which surrounds the subject for treatment and the permanent magnet assembly, i.e. the cover or dressing holding the magnets, is made up of flexible coils, thereby simplifying the transportation and handling of the arrangement.

One advantageous embodiment of the appliance is powered by a low-frequency pulse generator with definable frequency and amplitude.

Medical studies using the novel appliance have demonstrated its advantages over the prior art appliance. The trials conducted on humans and animals demonstrated far greater efficacy in the treatment of post-traumatic conditions in comparison to conventional pure low-frequency therapy. The trials were conducted with two designs of electromagnetic low-frequency pulse generator: in the first place generating pulses having a frequency definable in a range between 0.5 and 30 Hz, and the pulses of which consisted of sinusoidally or half-sinusoidally shaped waves with a fundamental frequency of 60 Hz, and in the second place with square-wave pulses having a definable frequency in the 1 and 1000 Hz range. The field coil arrangement was configured in conventional manner in these trials.

Part of the novel appliance is a specially designed magnetic cover. This consists of many small permanent magnets arranged relative to one another in a particular orientation and separated from one another in a particular manner. In an electromagnetic low-frequency field this produces very fine vibration in the rigid, movably mounted magnets which brings about micromassage of the vessels covered with said cover. The principal effect of this micromassage is to dilate the small blood vessels and bring about improved flow in the lymphatic system, in other words improved lymphatic drainage. Moreover, this type of massage has a recuperative effect on the skeletal muscles concerned. These effects overlap with the known positive effects of magnetic and low-frequency therapy and produce a synergistic effect. The effect of the massage can already be appreciated after only a few minutes, and the resulting relaxation and increased circulation makes it possible for the low-frequency therapy, the benefits of which can only be appreciated long term, to better develop its effect.

In advantageous manner it has been shown that dressings fitted with the permanent magnets and used to exert pressure on limbs with injuries, e.g. strains or muscle lacerations, when said limbs have been stimulated in the low-frequency field for massage vibration, can be used to avoid the adverse lymphatic and vascular congestion usually found with dressings in the distant area of the extremity behind the dressing, thereby bringing about a more rapid healing of the injury without pain and follow-up treatment.

Figures 1 to 9 depict advantageous embodiments and applications:

Fig. 1 shows a circuit of a pulse generator of the appliance;

Fig. 2 shows a top view onto a detail from a magnet assembly in a cover;

Fig. 2a shows a cross-section corresponding to Fig. 2;

Fig. 3 shows an apron-type cover with another magnet assembly;

Fig. 4 shows a field coil arrangement in part opened and in part schematically in a top view;

Fig. 4a shows a cross-section corresponding to Fig. 4;

Fig. 5 shows an electrical circuit of the field coil arrangement corresponding to Fig. 4;

Fig. 6 shows another field coil arrangement;

Fig. 6a shows a cross-section corresponding to Fig. 6 in an enlarged detail;

Fig. 6b shows a cross-section corresponding to Fig. 6;

Fig. 7 shows an electrical circuit of the field coil arrangement corresponding to Fig. 6;

Fig. 8 shows a block diagram of a complete appliance;

Figs. 9 a - d show various arrangements of the appliance in use on a patient.

Fig. 1 shows a diagram of the electrical pulse generator. This is powered from the a.c. mains supply (60 Hz, 110 V) when the switch (SWA) is in the ON position. Protection is provided by the fuse (F1), and operation is indicated by the tell-tale (B1). The service mode selector (SW3) is used to switch between one service mode in which mains frequency is used, and in its OFF position signals with a pulse frequency between 0.5 and 30 Hz are generated and signals with a sinusoidal or half-sinusoidal characteristic are produced. Power is supplied to the first oscillator (IC1) via the mains transformer (TR2), a mains rectifier, a second fuse (F2) and a contact assembly of a first relay (R1). The integrated first oscillator (IC1) then generates a respective defined frequency between 0.5 and 30 Hz, in response to the capacities matched with a frequency range switch (P2). The oscillator signal is amplified by the transistor (T1), the signal from which activates a triac (TR1) which supplies the a.c. voltage input signal, suitably timed, to a signal transformer

(TR1). The latter's secondary windings are selected using the power selector (P1), and the selected signal is supplied via a switch (SW2), depending on the position of the latter, either direct to the output or via a half-wave rectifier (D). Accordingly, either full-wave or half-wave output signals are generated periodically in accordance with the oscillator frequency. The output signal emitted at the sockets (CO) is rectified and filtered and then supplied to a level meter (MA). The scale of the latter is advantageously calibrated according to the strength of the magnetic field of the field coil. A tell-tale (LB2) shows the operating status. When the range selector (P2) is in a particular limit position (6), the first relay (R1) is switched over, causing the first oscillator (IC1) to be disconnected and the mains frequency fed direct to the transformer (TR1), said frequency then being emitted directly or as half-waves, depending on the position of the switch.

When the service mode selector (SW3) is in the ON position, the second generator (B), shown in an area delimited by broken lines, is operated instead of the first generator (A) already described, which is situated in the other area delimited by broken lines. The second generator (B) delivers square-wave pulses having a frequency between 1 and 1000 Hz, depending on what has been set. Three relays (R1, - R3) are then actuated. The second integrated oscillator (IC2) is supplied by a transformer (TR3) via a rectifier and a fuse (F3). The second oscillator (IC2) is set in a range between 1 and 1000 Hz via the respective capacity linked to the selector (P3). The oscillator signal is sent to a monostable pulse generator (IC3), which emits complementary square-wave pulses at a corresponding frequency, said pulses being amplified in Darlington transistor pairs (TS) the output signals from which are sent to two electronic switch or thyristor assemblies (TY) comprising parallel high-output thyristors. Direct voltage is supplied to these thyristors (TY) via a rectifier (G) connected downstream of the power selector (P1). Operating mode pilot lamps (B3, B4) are connected downstream of each of the two thyristor assemblies (TY) whose outputs lead to contacts on the sockets (CO) into which the cable for field coils is to be plugged.

Figs. 2 and 2a show a detail from a top view and a cross-section of a magnetic cover. This consists of small permanent magnets (PM). These magnets may be different shapes and sizes. The number of magnets depends on the size of the cover. They are held alongside one another in a textile fabric envelope (SA), e.g. made of linen, with an elastic filler material (RF) such as rubber interposed between them, said filler material being sewn together with the fabric envelope (SA) along the edges of the

magnets, as indicated by the seam (SE) shown in broken lines. This design of magnetic cover has a square grid structure. All the magnets are orientated in the same direction, as Fig. 2a shows, and their magnetic axis is perpendicular to the expanse of the cover.

Fig. 3 shows an alternative arrangement of the magnets (PM) in the form of a magnetic apron filled with a large number of small circular magnetic discs which are sewn in. The interstices between them are filled with rubber (RF). Tapes (BE) are fastened to the sides of the apron for securing it to a patient's body.

The magnetic cover or apron generates the micromassage in the electromagnetic alternating field. When this is switched on, the alternating magnetomechanical forces produced cause the permanent magnets to oscillate and gently massage the covered body part. This exerts a beneficial effect on the living tissue, e.g. improved microcirculation and pain relief.

Fig. 4 shows a first, flat, flexible field coil arrangement of the appliance which can be manufactured in various sizes and consists of a large number of adjacent conductor bundle sections (FA, FB, FC) each in the form of rectangular spirals. An overall coil arrangement is preferably constituted by two separate field coil arrangements (FS1, FS2).

Fig. 4a shows a cross-section and Fig. 4 a partly opened area of the field coil arrangement. The flexible, insulated conductor bundles (W) which make up the coil sections are joined together and held alongside one another by a sheath (LB), with the result that they form the flat rectangular spiral. The three coil sections are connected in series. They are enclosed and held between a two-sided textile cover (LS).

Advantageously a thin layer of foamed material (SP) and a plastic cover (SK) are placed around the textile cover (LS).

The two coil arrangements (FS1, FS2) are so energised and arranged over and alongside one another that their magnetic fields are cumulatively overlapped, as shown schematically in Fig. 5. The terminals (A1, A2; B1, B2) are connected to the socket (CO); Fig. 1.

Fig. 6 shows a hollow cylindrical field coil design in which the two coil arrangements (FS1', FS2') are laid directly on one another from the stranded conductor (W). The internal construction can be seen from the partly open view, from the cross-section in Fig. 6b and from the enlarged cross-section in Fig. 6a. The cables (W) are

provided with a sheath (LB), e.g. made of linen tape, which gives the coil its hollow cylindrical or flat hollow cylindrical shape and gives it flexibility. The entire cylindrical coil is surrounded by a textile sheath (LS), thereon a layer of foam or sponge (SP), and by an envelope (SK) of plastic or natural material. The flexible design of the coil is very convenient to handle and transport, as its shape can be adapted to individual requirements.

Fig. 7 shows the electrical wiring diagram and the additive magnetic field position.

Fig. 8 shows a purely schematic summary of the pulse generator (IG) with the field coil arrangements (FS1, FS2; MZ) which are connectable as required, and the magnetic cover (MD) or the magnetic apron (MS).

Fig. 9a shows the arrangement of a magnetic apron (MS) on a patient (P); the magnetic coil is provided by the flexible assemblies (FS1, FS2), which is laid on the magnetic cover (MD).

Fig. 9b shows the arrangement of a dressing (BM) with a magnetic cover (MD) on a lower leg (US) and the surrounding cylindrical coil (MZ).

Fig. 9d shows a magnetic cover (MD) loosely arranged on a thigh (OS); the field coil is not shown.

Figs. 9a to 9d are merely examples of applications and embodiments. Expert adaptation to specific applications and to animal bodies is possible. In place of the flexible coils, which are particularly pleasant to use, it is also possible to employ solid coils. The coils can also be incorporated into items of clothing, as can the magnets. The permanent magnets used for the massage apron or massage cover can also be electromagnets comprising coils which are in themselves rigid but held flexibly relative to one another, through which direct current flows; these do then, however, need a flow of current for operation.

A further embodiment of the permanent magnet cover or apron involves making the latter from a magnetised magnetic rubber plate impressed with a grid. This may for example be provided with a textile and/or elastic envelope. Ideal dimensions for the magnetic plates have been found to be in the range 0.5 to 5 cm in terms of the lengths of their edges or of diameter. The swivelling movement of the plates in the low-frequency field of the cylindrical coil, the field of which is orientated perpendicular to the magnetisation of the plates, or the axial movement of the plates, if the fields thereof are directed parallel to the low-frequency field of the flexible coil

arrangement, acts in conjunction with the directionally orientated walls of the vascular and lymphatic vessels like a hose pump, in the manner of a peristaltic wave, to promote blood circulation and drainage, with the result that advantageous effects are also found in sports training applications.

Claims

1. Treatment appliance for a human or animal body (P) or body part (US, OS), comprising a field coil arrangement (FS1, FS2; MZ) which is connected to a mains-operated, low-frequency power pulse current generator (IG) and in which a small magnetic plate (PM) is resiliently mounted, causing the plate to oscillate in the low-frequency magnetic field of the field coil arrangement (FS1, FS2; MZ),
characterised in that a plurality of small magnetic plates (MP) are held swivellable relative to one another in a magnetic cover (MD) or a magnetic apron (MS) shaped to fit the body and interposed between the magnetic plates (MP) is elastic material through which seams (SE) are sewn, and in that the field coil arrangement (FS1, FS2; MZ) consists of only one hollow cylindrical or flattened hollow cylindrical field coil (MZ) or of a plurality of coil sections (FA, FB, FC; FS1, FS2) which are arranged alongside one another and are linked to the single power pulse current generator (IG) so as to operate in the same direction.

2. Treatment appliance according to claim 1, characterised in that the coil sections (FA, FB, FC) are designed in spiral form and arranged alongside one another.

3. Treatment appliance according to claim 1 or 2, characterised in that the field coil (MZ) or field coil sections (FA, FB, FC; FS1, FS2) consist of conductors (W) surrounded by a flexible sheath (LB) which fixes them in position.

4. Treatment appliance according to claim 3, characterised in that the flexible sheath (LB) is surrounded by a textile layer (LS) on which a layer of foamed material (SP) rests, over which is laid a flexible envelope (SK) of plastic or natural material.

5. Treatment appliance according to one of the preceding claims, characterised in that the power pulse current generator (IG) contains an oscillator (A) which at a definable repetition rate of 0.5 to 30 Hz emits sinusoidal or half-sinusoidal a.c. supply voltage at a frequency of, for example, 60 Hz.

6. Treatment appliance according to one of the preceding claims 1 to 4, characterised in that the pulse generator (IG) contains an oscillator (A) which delivers square-wave voltage pulses at a definable frequency of 1 - 1000 Hz.

7. Treatment appliance according to one of claims 5 or 6, characterised in that the output voltage of the pulse generator (IG) is adjustable.

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8. Treatment appliance according to claim 5, characterised in that the a.c. supply voltage is supplied, under the control of a triac (TRI) in phase with the first oscillator (A), to a variable transformer (TR1) the output of which passes via a diode (D) or a switch contact (SW2) to the output (CO) of the pulse generator (IG).

9. Treatment appliance according to claim 6, characterised in that the a.c. supply voltage is supplied via a tapped transformer (TR1) to a rectifier (G) and the direct voltage there produced is sent, pulsed by electronic switch assemblies (TY), to the output (CO) of the pulse generator (IG), the switch assembly (TY) comprising two switch groups activated in chronologically complementary manner by a second oscillator (IC2) via a square-wave generator (IC3).

10. Treatment appliance according to claims 5 to 9, characterised in that the pulse generator (IG) contains the two oscillators (A, B), which can be switched on as required using an operating mode selector (SW3).

* C L M S *