

[54] **ENVIRONMENTAL CONTROL APPARATUS**  
 [72] Inventor: **Kurt Grauvogel, Ottweiler, Saar, Germany**  
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[63] Continuation-in-part of Ser. No. 765,605, Oct. 7, 1968.

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 [58] Field of Search.....317/262, 262 AE, 2, 3, 4, 123; 21/74.1; 128/190, 419, 421; 323/7, 9, 63

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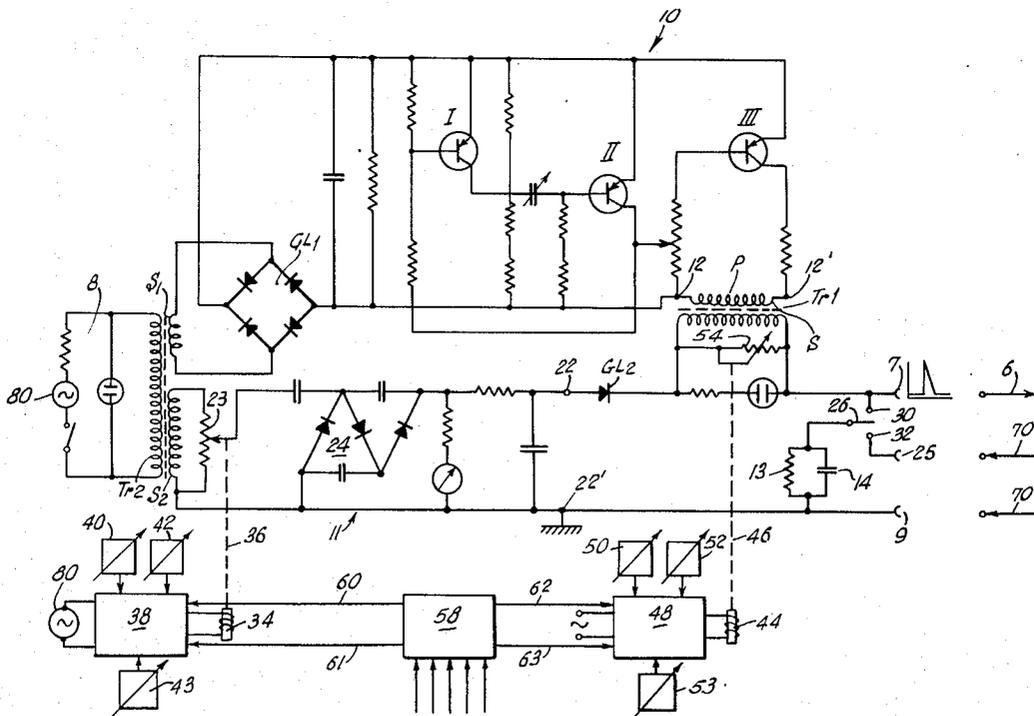
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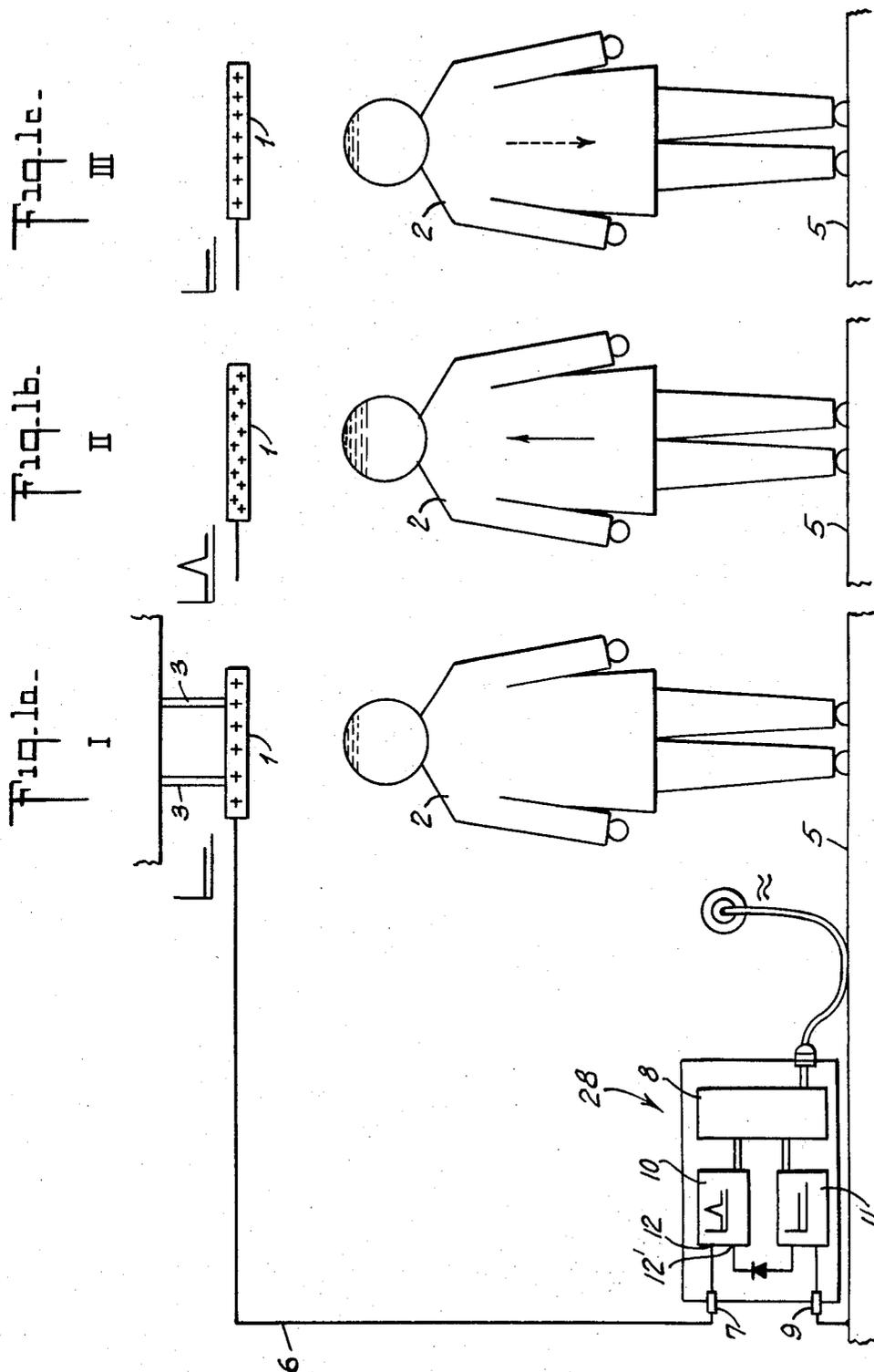
*Primary Examiner*—Lewis H. Myers  
*Assistant Examiner*—U. Weldon  
*Attorney*—Curtis, Morris & Safford

**ABSTRACT**

The apparatus re-creates indoors electric and magnetic fields which occur naturally out-of-doors. A direct current field is created in an enclosure, such as a building, and low-frequency recurring disturbances or pulses are created in the field. The disturbances and/or the direct current field can be varied in time duration and frequency, either in a random manner or a pre-determined pattern, in order to avoid unresponsiveness of the persons in the building to the beneficial effects of the fields.

**14 Claims, 12 Drawing Figures**





INVENTOR:  
KURT GRAUVOGEL

BY  
Curtis, Morris & Stafford  
ATTORNEYS.

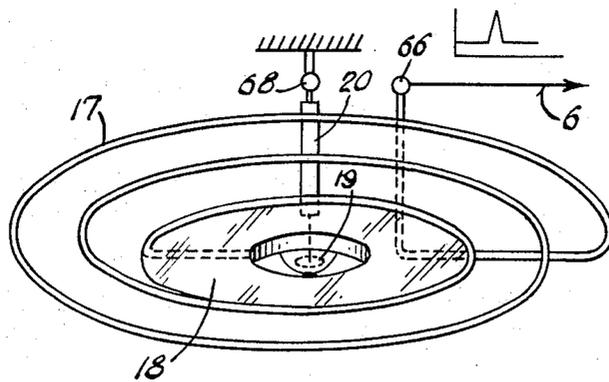
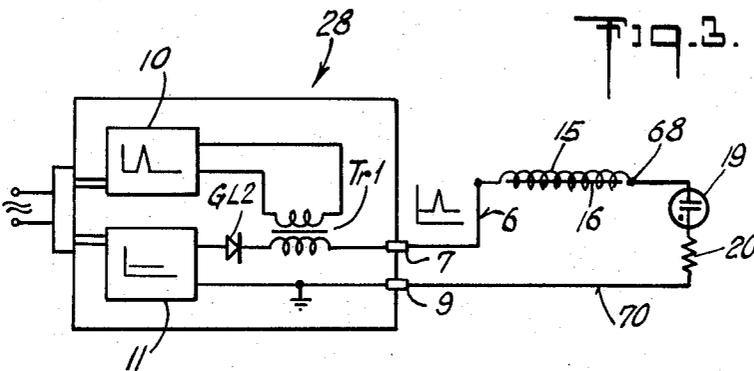
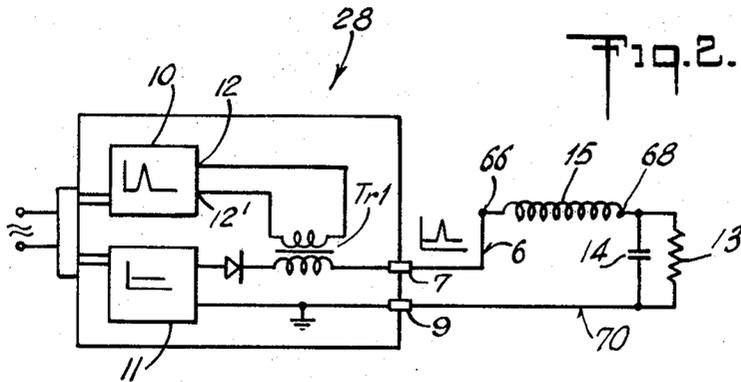


Fig. 19.4.

INVENTOR:  
 KURT GRAUVOGEL  
 BY  
 Curtis, Morris & Safford  
 ATTORNEYS.



Fig. 6a.

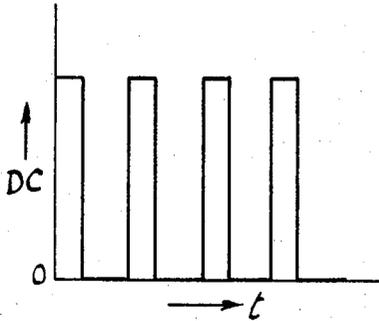


Fig. 6b.

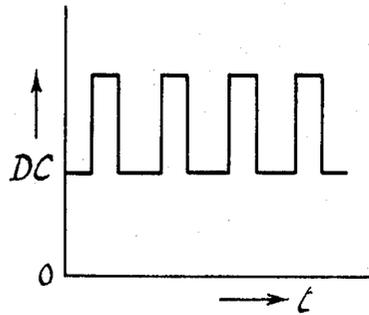


Fig. 6c.

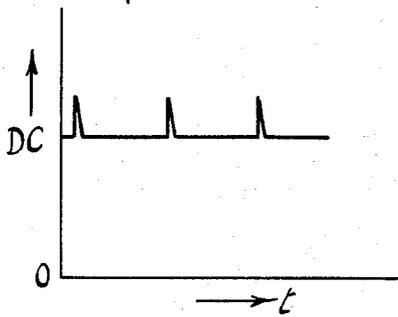


Fig. 6d.

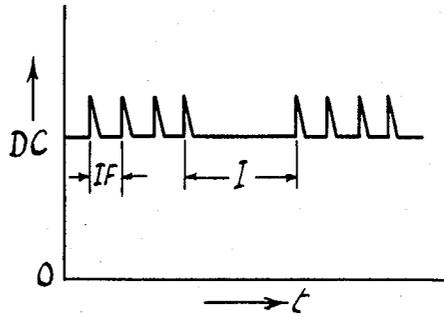
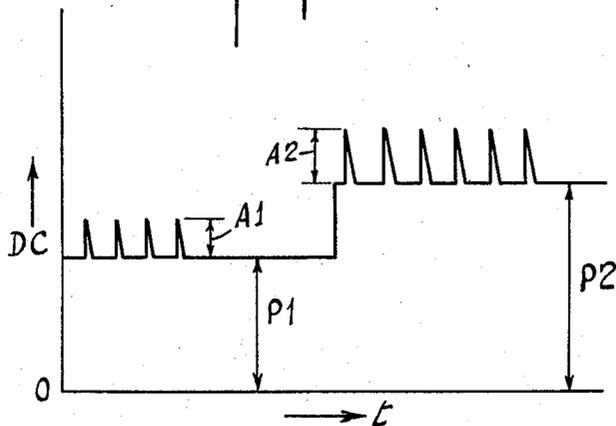


Fig. 6e.



INVENTOR:  
KURT GRAUVOGEL

BY  
Curtis, Morris & Safford  
ATTORNEYS:

## ENVIRONMENTAL CONTROL APPARATUS

This application is a continuation-in-part of U. S. Pat. application Ser. No. 765,605, filed on Oct. 7, 1968.

This invention relates to apparatus for indoor environmental control. More particularly, this invention relates to devices for re-creating indoors electric fields which exist naturally out-of-doors. This application is a continuation-in-part of U. S. Pat. application Ser. No. 765,605, filed on Oct. 7, 1968.

It is believed that naturally-occurring electric fields which exist near the earth affect the physical and mental well-being of living organisms, and especially human beings. It also is believed that when human beings are deprived of such fields, such as when they are working in buildings which shield them from the fields, their well-being is affected adversely. For example, research workers have reported a loss of "internal synchronization"; i.e., changes in physiological parameters of the body, loss of a sense of time, and a corresponding slowing of work efficiency in human test subjects who lived for a length of time in underground bunkers which shielded the subjects from the natural fields outside the bunkers.

It has been proposed to alleviate the foregoing adverse affects of working indoors by creating indoors electric fields which simulate those occurring naturally out-of-doors. The results of tests in which 10 Hz alternating fields were used are reported in the articles entitled: "Principles of Circadian Rhythms in Man, Studied by the Effects of a Weak Alternating Electric Field," *Pflugers Archives* 302, 97-122 (1968) and "The Influence of Weak Electromagnetic fields on the Circadian Rhythm in Man", *Zeitschrift fur Vergleichende Physiologie* 56, 111-128 (1967), both by Rutger Wever. Additionally, the use of direct current fields with superimposed pulses is suggested in German Pat. No. 1,217,576.

It is believed that when a living organism such as a man moves in the earth's electric field, currents are induced in the man's body: Specifically, it is believed that current pulses are induced in a man's body when he walks in the earth's field. These pulses will be named "displacement currents" in this description.

One of the objects of the present invention is to provide environmental control equipment which will simulate natural displacement currents in living organisms such as humans not only when the persons are moving, but also when they are at rest inside buildings.

Certain prior art teachings indicate that the electric field in buildings should be uniform in space and constant with respect to time in order to achieve the best therapeutic effect. However, in accordance with the present invention, it is believed that an organism such as man becomes unresponsive to such fields after long periods of exposure to them. Therefore, it is another object of the present invention to provide environmental control apparatus of the aforementioned type, in which the fields are not likely to cause unresponsiveness after long periods of exposure.

In accordance with the present invention, the foregoing objects are met by the provision of environmental control apparatus which produces constant electric fields with low frequency disturbances. The frequency of the disturbances is close to the frequency of naturally-occurring field components so as to closely simulate natural fields in the rooms of buildings. Also, the field strength is changed at different time intervals of the order of hours or minutes in order to prevent long-term unresponsiveness of the organism to the fields.

Other objects, features and many of the attendant advantages of this invention will be appreciated more readily by reference to the following detailed description, when considered in connection with the accompanying drawings, wherein:

FIGS. 1(a) - 1(c) are diagrammatic representations of one embodiment of the environmental control apparatus of the present invention;

FIG. 2 is an electrical circuit diagram of a portion of the apparatus shown in FIG. 1;

FIG. 3 is an electrical circuit diagram of another embodiment similar to that of FIG. 2;

FIG. 4 is a perspective view of an alternative embodiment of a portion of the system shown in FIG. 1;

FIG. 5 is an electrical circuit diagram of a power supply unit for the system of the invention; and

FIGS. 6(a) through 6(e) are waveforms of voltages to be used in creating electric fields by means of the present invention.

The environmental control apparatus shown in FIG. 1 includes an electrode 1 which preferably is of planar shape and is located in a room near an organism such as a person 2 so that it does not make contact with the person. The electrode 1 is secured to the ceiling 4 of the room by means of supporting insulators 3. The room floor serves as the second electrode and, if necessary, can be provided with a grounded, electrically conductive coating 5.

In movable apparatus of the foregoing type, the first electrode is mounted on a movable support such as a stand formed like a lamp post, and the grounded springs of a chair or a bed, for example, form the other electrode. Such arrangements are well known in the art of conditioning air by the use of electric fields.

Still referring to FIG. 1, the electrode 1 is connected by means of a conductor 6 to one output terminal 7 of a power supply unit 28. Terminal 7 carries d.c. voltage with superimposed voltage pulses. The other output terminal 9 of the unit 28 is connected to ground.

The unit 28 includes a power supply 8, a d-c source 11 and an ungrounded pulse generator 10 with two output terminals 12 and 12'. One terminal, for example, the plus terminal of the d-c source 11, is connected to one output lead 7 of the unit 28 through the secondary winding of a transformer Tr 1 (see FIGS. 2 and 3), whose primary winding is connected between the output leads 12, 12' of the pulse generator 10. The pulses produced by the pulse generator 10 thus are superimposed upon the direct current conducted to the electrode 1. The negative terminal of the d-c source 11 is connected through output lead 9 to ground. Of course, the polarity of the d-c source can be reversed without changing the principles upon which the circuit operates.

The desired frequency range of the pulses produced by the generator 10 is approximately from 1 to 20 Hz, and the preferred frequency is 10 Hz. The strength of the direct current field can be from a very low value (less than one volt per meter) to in the vicinity of 2,500 volts per meter, and the increments in field strength created by the pulses preferably are from 5 to 15 percent of the direct current field strength. The time intervals between changes in the field strength which can be used to prevent unresponsiveness of the organism to the fields preferably are approximately from one half minute to one hour.

In the specific circuit shown in the drawings, the superimposed d-c voltage pulses have a peak voltage of 80 volts. The frequency as well as the time duration of the pulses can be adjusted in the unit 28. The frequency preferably is variable from 1 to 20 Hz.

The roman numerals I, II and III in FIGS. 1(a), 1(b) and 1(c), respectively, indicate the conditions which are believed to exist during three different phases of the voltage applied to the electrode 1.

During phase I, the voltage applied to the electrode 1 is constant, and is, for example, plus 900 volts with respect to ground. In the person 2 standing beneath the electrode 1, displacement currents are believed to occur when the direct voltage first is switched on. However, these currents are believed to diminish rapidly when the person is at rest. For designation of this "built-up" condition, a number of negative signs are drawn in the head of the person 2 represented in FIG. 1, while the electrode carries a positive charge.

During phase II, a direct voltage pulse is supplied to the electrode 1 when pulse generator 10 is turned on. When the positive charge on the electrode 1 increases, the field intensity also increases and this field intensity increase is believed to produce a corresponding displacement current in the person.

This condition is indicated in FIG. 1(b) of the drawings by an

arrow and a greater number of negative signs in the head of the person 2.

Phase III occurs upon the dissipation of the voltage pulse. The electrode has the same constant potential as it had during phase I. The conditions of phases I, II and III are repeated for each successive voltage pulse. In this manner, physiologically favorable displacement currents are believed to be established in living organisms by use of the succession of rhythmic or periodic voltage pulses.

It has been found that the voltage pulses produced in the pulse generator 10 and the corresponding electric field pulses are attenuated under certain conditions. This is believed to result in a corresponding decrease in the currents induced in living organisms, and in the effectiveness of the system.

It is, therefore, a further object of the invention to provide environmental control apparatus for producing in living organisms rhythmic or periodic displacement currents, in which the above-mentioned shortcomings of known devices of this type are avoided.

In view of the fact that magnetic fields also are believed to have a beneficial effect on living organisms, it is another object of this invention to provide apparatus which produces an electrical field having a magnetic field component. Such apparatus is shown schematically in FIGS. 2 and 3. To this end, instead of the planar surface electrode 1 shown in FIG. 1(a), "linear" electrodes, i.e. electrodes made of elongated conductors, are used. Such electrodes have a shape which is adapted to the particular application. For example, they are formed as "point" radiators or as "surface" radiators and preferably consist of a wire bent into a spiral or coiled shape. Examples of such electrodes are shown diagrammatically in FIGS. 2 to 4. Each of the electrodes 15 shown diagrammatically in FIGS. 2 and 3 forms a compact cylindrical coil which acts as "point radiator." For amplifying the desired magnetic field strength; a correspondingly-shaped core 16 of ferromagnetic material is inserted coaxially into the cylindrical coil as is shown in FIG. 3.

FIG. 4 shows an electrode 17 forming a "surface radiator" having substantially the form of a flat coil. In the preferred example shown in FIG. 4, the electrode 17 consists of a wire coiled to a plane spiral. The wire of the electrode 17 is of sufficient diameter so that each of the spiral turns is self-supporting. Also, the spacing of the turns is such that the turns do not touch one another. A disc 18 serves as a support for a lamp housing 21 and is positioned within the innermost turn of the spiral. The lamp housing contains a signal lamp 19 for indicating the operative condition of the electrode. The supporting disc 18 also can be made of ferromagnetic material, whereby, as in the case of the core 16, a greater magnetic field strength will be produced. Such an arrangement is particularly suitable for controlling the electric and magnetic fields in rooms since the effective surface area of the electrode can be large, and the electrode can have a pleasing appearance.

The two terminals 66 and 68 of electrodes 15 and 17 both are connected to the unit 28 in order to produce the magnetic field component. Specifically, the input terminal 66 is connected to the output lead 7 by means of lead 6, and the output terminal 68 is connected to the grounded output lead 9 of the unit 28 through a current-limiting circuit.

In the example shown in FIG. 2, the current-limiting circuit is formed by a resistor 13 and a condenser 14 connected in parallel with the resistor. The resistor 13 has a relatively large resistance, for example 1,000 megohms, so that the electrode 15 holds the desired high potential during operation. The capacitance of the condenser 14 preferably is so chosen that the time constant of the RC circuit formed by the resistor 13 and the condenser 14 is adapted to the frequency of the direct voltage pulses delivered by the pulse generator 10.

In the example of FIG. 3, the current limiting circuit connected in series with the electrode 15 consists of a gas discharge tube 19 connected in series with a current-limiting resistor 20. The discharge tube 19 can be a commercial grade glow-lamp, and can be used both in the current limiting cir-

cuit, and at the same time as a signal lamp to indicate the operating condition of the system.

Referring to FIG. 4, the series circuit consisting of the electrode 17 and one of the current-limiting circuits can be connected to the terminal 7 of the unit 28, while its other end can be connected to ground. In this example, as mentioned already, the lamp casing secured to the support 18 contains a signal lamp which is connected in series with the electrode 17. Due to the design of the electrode as a "linear" electrode and its connection between the output lead 7 and ground, current flows through the electrode 17 so that a pulsed electric field with a magnetic component is formed in the room.

FIG. 5 illustrates a preferred circuit for a power supply unit 28 for producing a d-c potential with superimposed pulses, and including means for time-dependent, abrupt change of the electromagnetic fields.

The circuit shown in FIG. 5 includes a supply transformer Tr2 whose primary winding is connected to a conventional a-c power supply 80, and which has two separate secondary windings S1 and S2. The secondary winding S1 supplies a direct voltage of 5 volts together with a rectifier circuit GL 1, to the transistorized pulse generator 10. The pulse generator 10 is designed for producing direct voltage pulses, preferably having a peak voltage of about 80 to 100 volts and a pulse repetition frequency of 1 to 20 Hz. The generator 10 includes three transistors I, II, III, and a differentiator in a conventional circuit arrangement, so that the output signals at the output terminals 12, 12' of the generator are steep, peaked voltage pulses. The total circuit of the pulse generator has no ground connection. A conventional voltage multiplying circuit 24 comprising rectifier elements and condensers is connected to the secondary windings S2 of the transformer Tr2 through a potentiometer 23. The voltage multiplying circuit supplies a variable direct voltage of e.g. up to 1,000 volts to its output terminals 22, 22'. The output terminal 22' is connected to ground. The ungrounded pulse circuit 10 and the grounded direct voltage circuit 11 are inductively coupled together by the transformer Tr 1. The primary winding P of the coupling transformer Tr1 is connected to the output terminals 12, 12' of the pulse circuit 10. One end terminal of the secondary winding S of the coupling transformer Tr1 is connected through a blocking rectifier GL 2 with the ungrounded output terminal 22 of the direct voltage circuit 11, and the other end terminal of the transformer Tr1 is connected to the output terminal 7 which supplies the direct voltage with superimposed pulses. The blocking rectifier GL 2 has the function of preventing a return flow of current from the pulse circuit 10 to the d-c source 11. The source 11 also can be a battery instead of the a-c to d-c converter shown in the drawing.

The other terminal 9 of the power unit 28 is connected to the grounded output lead 22' of the direct voltage circuit 11. In the circuit shown in FIG. 5, the live terminal 7 is connected to the grounded terminal 9 through a large (e.g. 1,000 megohms) resistor 13 and a parallel-connected condenser 14. This resistor and condenser comprise the current limitation circuit shown in FIG. 2; therefore, both components are designated by the same reference numerals. The time constant of this resistor-condenser circuit is adapted to the frequency of the direct voltage pulses delivered by the pulse generator so as not to distort the pulses.

The electrode 1 shown in FIG. 1 is a single member connected to the live terminal 7. In this type of circuit the electrode produces a direct current field with superimposed pulses without a magnetic component. However, the above-mentioned reduction of displacement current does not occur.

When the connection between the terminals 7 and 9 is interrupted, for example, by opening a switch 26, and the end terminals of the electrode are connected between the terminal 7 and a further terminal 25 connected to the junction between resistor 13 and condenser 14, by means of the switch 26, a connection of the electrode as shown in FIG. 2 is obtained, and a pulse-superimposed direct current field having a magnetic field component is produced by the electrode. Alterna-

tively, an electrode having a series-connected discharge tube 19 and limiting resistor 20 can be connected to the live terminal 7 when the switch 26 is open, as is shown in FIG. 3. The power unit 28 accordingly permits many different modes of operation.

As mentioned above, one feature of the invention is that the danger of acclimatization of the organism to the fields is avoided by an additional device for the time-dependent abrupt variation of the fields in such a way that a state of stimulation is produced constantly in the organism. The time intervals between disturbances of the continuity of the steady field should be the order of hours or minutes, and the time intervals should be adjustable.

The low-frequency disturbance of the continuity of the steady field can be effected in various ways, for example, by a low-frequency device for the temporary interruption of the direct current, so that rectangular pulses with a minimum voltage of 0 volts, as shown in FIG. 6(a), are produced. In order to produce rectangular pulses with a minimum voltage level differing from zero as shown in FIG. 6(b), a low-frequency device for varying the d-c potential is provided.

It is preferred, however, to use a pulse generator for the production of low-frequency pulses as shown in FIG. 6(c), or low-frequency pulse sequences as shown in FIGS. 6(d) and 6(e), and superimpose such pulses upon a direct current signal. With a pulse generator it is also possible to adjust and vary the pulse sequence frequency and the amplitude of the pulses. device

The circuit shown in FIG. 5 includes devices for producing low-frequency disturbances of the steady field, independently of the pulse generator 10. As mentioned above, a potentiometer 23 is connected to the secondary coil S2 of the main transformer Tr 2. This potentiometer 23 can be regulated in the embodiment shown in FIG. 5 not only by hand but also mechanically. For example, the wiper arm of the potentiometer can be moved by means of a solenoid 34 and a magnetic member 36 which is moved longitudinally by the solenoid in accordance with the voltage the solenoid receives from a control device 38. The control device 38 converts line voltage into two different control voltages whose values can be controlled by means of two adjusting devices 40 and 42. A timer 43 delivers signals in adjustable time intervals to the control device 38 and the device 38 switches the voltage delivered to the solenoid 34 between the limiting values preset by means of devices 40 and 42.

If the limiting value of zero is set by means of one of the devices 40, 42, there is developed at the output terminal 22 of the d-c source 11 a rectangular pulse with a minimum level of zero, as is shown in FIG. 6(a). If the minimum level is greater than zero, the field potential alternates between two positive voltage values, as is shown in FIG. 6(b). Thus, it is possible to eliminate the pulse-generator 10 if the adjustable timer 43 gives off its reversing signals at the desired frequency.

If the unit 28 contains the pulse generator 10, however, the above described devices shown in the upper portion of FIG. 5 for the rhythmic variation of the steady field potential should be used for the automatic time-dependent abrupt and essential variation of the fields in order to change the degree of stimulation of the organism so as to prevent "acclimatization." The timer 43 then does not give off low-frequency signals, but very low frequency signals whose time duration is of the order of minutes or hours. This abrupt variation of the characteristic of the fields is shown in FIG. 6(e) by the change of the pulse-superimposed d-c voltage from potential A1 to potential A2.

It should be mentioned that the movement of the potentiometer arm is shown herein only as an example of an electromechanical solution of the problem. Of course, purely electrical, contact-free and low-inertia means for performing the same function are also within the scope of the invention.

A time-dependent abrupt variation of the disturbance of the continuity of the steady field in a room also can be achieved, by variation of the rectangular pulse frequency (e.g. by control of the reversal rate of the timer or interval transmitter 43),

of the pulse duration, of the pulse sequence frequency, or of the amplitude of the pulses.

To this end is provided a control circuit with elements, shown in the lower portion of FIG. 5, which correspond, respectively, to the elements in the upper portion of FIG. 5 having reference numerals each of which is smaller than its counterpart by 10. The lever 46 moves the wiper arm of a potentiometer 54 for the gradual adjustment of the amplitude of the pulses which are transmitted through the transformer Tr 1 and added to the d-c potential applied to the output terminal 22. The potentiometer 54 is connected in parallel with the secondary winding S of the transformer Tr 1.

If the minimum value of zero is set by means of one of the adjusting devices 50, 52, the secondary winding S is short-circuited, and pulses are not added to the direct field current in the time intervals dictated by the timer 53. Such a time interval is indicated in FIG. 6d by the letter I. Thus, a pulse sequence or burst is obtained whose repetition rate can be adjusted by means of the timer or interval transmitter 53. With reference to FIG. 6d, the pulse frequency (equal to 1/IF) from the pulse generator 10 can be relatively high. In this example, the interval I determined by the timer 53 is the low-frequency disturbance of the continuity of the field in the sense of the present invention.

If limiting values differing from zero are preset on both adjusting devices 50, 52, the amplitude of the pulses is varied from A1 to A2, as shown in FIG. 6e. This variation of the amplitude can be accompanied by an abrupt variation of the steady field potential from P1 to P2 in order to produce a new state of stimulation in the organism and to avoid "acclimatization" of the organism. A similar effect can also be achieved if the switch 26 is switched back and forth automatically in intervals of minutes or hours between the contact 30 and the central neutral position. In this manner, a pulsating field with and without magnetic field component is produced.

Instead of the adjusting devices 40, 42, 50, 52, and the timers 43, 53, a storage device 58 can be used. Into the device 58 is stored all data for the time-dependent or gradual programmed movement of the arm of potentiometer 54 and/or of the potentiometer 23 and, if necessary, other switching elements of the pulse generator 10. The instructions to the storage device can be input by means of punch cards or magnetic tape, for example. In the latter case, the control signals are transmitted over the lines 60, 61, 62, 63 to the control devices 38, 48.

What is claimed is:

1. Environmental control apparatus comprising at least one electrode mounted in an habitable enclosure, a direct current source connected to said electrode for producing a direct current electric field in said enclosure, said direct current source having one output connected to ground, the flux lines in said field extending generally between a position adjacent the floor and another position adjacent the ceiling of said enclosure, a pulse generator connected to said direct current source for adding its pulses to the direct current output of said source, said pulses having a relatively low frequency, said pulse generator including means for limiting the increments in field strength created by said pulses to 15 percent of the direct current field strength.

2. Apparatus according to claim 1 including means for setting the frequency of said pulses at from one to twenty pulses per second.

3. Apparatus according to claim 1 including additional means coupled to said direct current source for producing time-dependent, abrupt alterations of the characteristic of said electric field in said enclosure.

4. Apparatus according to claim 3 in which the time interval between successive ones of said alterations is at least 1 minute.

5. Apparatus according to claim 3 including means coupled to said pulse generator for temporarily disabling said pulse generator to create pulse bursts of a pre-determined time duration.

6. Apparatus according to claim 4 in which said time interval is a least 60 times longer than the time duration of one cycle of said pulses.

7. Apparatus according to claim 3 in which said additional means includes a timer.

8. Apparatus according to claim 7 in which said direct current source includes a means for gradually adjusting the direct current potential.

9. Apparatus according to claim 8 comprising a timer for producing time-dependent signals, and means responsive to said signals for controlling said direct current potential adjusting means.

10. Apparatus according to claim 3 including means for adjusting the magnitude of said electric field with respect to time, comprising a means for storing data, producing control signals, and delivering said control signals to said adjusting means to control the adjustments thereof in accordance with time.

11. Environmental control apparatus comprising at least one electrode mounted in an habitable enclosure, a direct current source connected to said electrode for producing a direct current electric field in said enclosure, said direct current source having one output connected to ground, the flux lines in said field extending generally between a position adjacent the floor and another position adjacent the ceiling of said enclosure, and pulse generator means connected to said electrode for causing the strength of said field to vary periodically with respect to time at a relatively low frequency, said electrode having a linear configuration to produce a magnetic field component in said enclosure when current flows through said electrode, said linear electrode having two terminals, one receiving the pulses imposed on the direct current voltage by said

pulse generator, and the other being connected to said grounded output of said direct current source via a current-limiting circuit, said current-limiting circuit comprising a resistor and a condenser connected in parallel with the resistor, the time constant of said circuit being adapted to the frequency of the pulses delivered by said pulse generator.

12. Apparatus according to claim 11 in which said electrode has a coiled shape.

13. Apparatus according to claim 11 in which said electrode consists of a wire coiled to form a plane spiral.

14. Environmental control apparatus comprising at least one electrode mounted in an habitable enclosure, a direct current source connected to said electrode for producing a direct current electric field in said enclosure, said direct current source having one output connected to ground, the flux lines in said field extending generally between a position adjacent the floor and another position adjacent the ceiling of said enclosure, and pulse generator means connected to said electrode for causing the strength of said field to vary periodically with respect to time at a relatively low frequency, said electrode having a linear configuration to produce a magnetic field component in said enclosure when current flows through said electrode, said linear electrode having two terminals, one receiving the pulses imposed on the direct current voltage by said pulse generator, and the other being connected to said grounded output of said direct current source via a current-limiting circuit, said current-limiting circuit comprising a gas discharge tube connected in series with a current-limiting resistor, the time constant of said circuit being adapted to the frequency of the pulses delivered by said pulse generator.

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