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(54) **PNEUMATIC MASSAGE APPARATUS FOR TREATMENT OF EDEMA**

PNEUMATISCHE MASSAGEVORRICHTUNG ZUR BEHANDLUNG VON ÖDEMEN

APPAREIL DE MASSAGE PNEUMATIQUE POUR LE TRAITEMENT DE L'OEDEME

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Description

Technical Field

5 **[0001]** The present invention relates to a pneumatic massage apparatus. More particularly, the present invention relates to a pneumatic massage apparatus suitable for use in treatment of various types of edema (swelling), including lymphedema in the legs and arms.

Background Art

10 **[0002]** If lymphatic vessels are depressed in function or occluded by cancer treatment or the like, the lymph fluid does not flow smoothly. Consequently, the lymph fluid, which should normally be absorbed into the lymphatic vessels, may accumulate in spaces in the cellular tissues, resulting in swelling mainly in the arms and legs. Such swelling resulting from obstruction of the circulation of lymph fluid is known as lymphedema. Edema may also occur in the arms and legs
15 owing to some disease in the blood vessels.

[0003] Manual lymphatic drainage is known as a method of treating such edema. The manual lymphatic drainage is effective in treating not only lymphedema but also vascular edema. With the manual lymphatic drainage, a body fluid such as lymph fluid accumulated in spaces in the cellular tissues is urged toward normally-functioning lymphatic vessels and blood vessels by massage performed with the human hands, thereby resolving the swelling. The manual lymphatic
20 drainage needs to be performed almost daily, which is a heavy burden whether the patient oneself performs the massage or a nurse or the like massages the patient.

[0004] To lighten the load of carrying out manual lymphatic drainage, it is becoming common practice to perform lymphatic drainage using a pneumatic massage apparatus as an auxiliary of manual lymphatic drainage. A pneumatic massage apparatus used for this purpose has a plurality of air chambers disposed in series in a proximal direction from
25 a distal position of an arm or a leg of a patient's body toward the center of the patient's body. Each air chamber is inflated with compressed air supplied thereinto to compress the patient's arm or leg by pneumatic pressure, thereby performing massage. Basically, a body fluid such as lymph fluid needs to be urged from the distal part of a patient's arm or leg toward the center of the patient's body. Therefore, usually, the air chambers are pressurized sequentially from a distal
30 end air chamber located at the periphery side toward successively proximal air chambers to promote the flow of body fluid by the action of compressing the patient's arm or leg during pressurization, as for example described in the Catalog "Physical Medomer PM-8000", of Nitto Kohki Co., Ltd. (Tokyo, JP).

[0005] Further, reference is made to WO 2009 049 103 A2, which relates to a blood clot prevention device, having an adjustable pressure cuff device for the arm or leg of a user for stimulating blood flow and preventing blood clots. The pressure cuff contains a number of bladders which wrap in the direction of the cuff and which are arranged in succession
35 down the arm or leg of a user. An air compressor is connected to the bladders via a multiplicity of tubes, each of which contain a valve. A control module runs the air compressor and sequentially opens the valves to provide air pressure to the bladders in succession along the arm or leg of a user. Further, between the bladders and the valves, additional tubes containing valves are provided to equalize pressure between bladders before exhausting the air from a previously pressurized bladder to save power and allow for increased patterns of bladder pressure. Said WO 2009 049 103 A2
40 discloses a pneumatic massage apparatus comprising: a massage device to be fitted to wrap around one of an arm and a leg of a patient and having air chambers disposed in series in a proximal direction from a distal position of the one of the arm and the leg toward a center of a body of the patient when the massage device is fitted around the one of the arm and the leg; and a compressed air control unit supplying and discharging compressed air into and from the plurality of air chambers of the massage device; the compressed air control unit having a means for pressurizing each of the air
45 chambers by supplying compressed air thereinto, a means for depressurizing each of the pressurized air chambers by discharging compressed air therefrom, and a means for maintaining a pressurized state of each pressurized air chamber; wherein the means for pressurizing are configured to pressurize all air chambers; the means for maintaining a pressurized state of each pressurized air chamber are configured to maintain the pressure for a predetermined period of time after completion of pressurization of all air chambers by the means for pressurizing; and the means for depressurizing are
50 configured to depressurize the pressurized air chambers after completion of pressurization of all the air chambers in such a manner that a proximal air chamber first starts to be depressurized, and then a distal air chamber starts to be depressurized; the means for pressurizing, the means for maintaining a pressurized state and the means for depressurizing are configured to repeat the cycle of pressurization, maintaining and depressurization.

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Summary of Invention:

Technical Problem:

5 **[0006]** The above-described conventional pneumatic massage apparatus offers certain advantageous effects as an auxiliary of manual lymphatic drainage. It is, however, desirable to be able to promote the flow of body fluid even more efficiently. The present invention has been made in view of these circumstances, and provides a pneumatic massage apparatus making it possible to perform even more efficient drainage.

10 Solution to Problem

[0007] That is, the present invention provides a pneumatic massage apparatus as set forth in claim 1 or claim 2. Further embodiments are inter alia disclosed in the dependent claims. The massage apparatus inter alia includes a massage device to be fitted to wrap around an arm or leg of a patient and having at least four air chambers disposed
15 in series in a proximal direction from a distal position of the arm or leg toward the center of the patient's body when the massage device is fitted around the arm or leg, and a compressed air control unit supplying and discharging compressed air into and from the plurality of air chambers of the massage device. The compressed air control unit has a means for pressurizing each air chamber by supplying compressed air thereinto, and a means for depressurizing each pressurized
20 air chamber by discharging compressed air therefrom. The apparatus is configured to first pressurize all air chambers, maintain the pressurized state and then depressurize the pressurized air chambers in accordance with a specific depressurization pattern in such a manner that, for at least one pair of mutually adjacent air chambers, a proximal air chamber of the pair first starts to be depressurized, and then a distal air chamber of the pair starts to be depressurized.

[0008] In the pneumatic massage apparatus of the present invention, when the pressurized air chambers are to be depressurized, a proximal (closer to the center of the patient's body) air chamber of any pair of mutually adjacent air
25 chambers first starts to be depressurized. Therefore, at the time when the depressurization of the proximal air chamber is started, the distal (closer to the periphery of the patient's body) air chamber is still in a pressurized state. Consequently, a pressure difference is produced between a patient's body part having been compressed by the proximal air chamber until depressurization thereof and another patient's body part being compressed by the distal air chamber still being
30 pressurized. As a result, the body fluid flows in the proximal direction from the distal body part toward the proximal body part. In this way, it is possible to urge the body fluid to flow in the proximal direction not only during pressurization but also during depressurization and hence possible to perform even more efficient drainage. As has been stated above, with the conventional pneumatic massage apparatus, the air chambers are pressurized sequentially from a distal end air chamber located at the periphery side toward successively proximal air chambers to promote the flow of body fluid mainly by the action of compressing the patient's arm or leg during pressurization. Further, in the conventional pneumatic
35 massage apparatus, the air chambers are sequentially depressurized from the distal air chamber pressurized first, or alternatively, all the air chambers are simultaneously depressurized. Thus, the depressurization of the massage chambers is performed solely to repeatedly promote the flow of body fluid by pressurization. The pneumatic massage apparatus according to the present invention is, as has been stated above, configured to urge the body fluid to flow toward the center of the patient's body also by the depressurization of the air chambers.

40 **[0009]** Preferably, the means for depressurizing may be configured to start depressurizing at least one of the pressurized air chambers except a distal end air chamber disposed at the distal-most position of the pressurized air chambers before depressurization of the distal end air chamber.

[0010] Specifically, the means for depressurizing may be configured such that, when the pressurized air chambers are numbered sequentially in the proximal direction so that the distal end air chamber is given number one, the even-
45 numbered air chambers first start to be depressurized in descending order of the given numbers, and then the odd-numbered air chambers start to be depressurized in descending order of the given numbers.

[0011] Alternatively, the means for depressurizing may be configured such that, when the pressurized air chambers are numbered sequentially in the proximal direction so that the distal end air chamber is given number one, the odd-
50 numbered air chambers first start to be depressurized in descending order of the given numbers, and then the even-numbered air chambers start to be depressurized in descending order of the given numbers.

[0012] Alternatively, the means for depressurizing may be configured such that, when the pressurized air chambers are numbered sequentially in the proximal direction so that the distal end air chamber is given number one, the air
chambers start to be depressurized in descending order of the given numbers.

55 **[0013]** The results of exhaustive studies conducted by the present inventors have proved that particularly efficient drainage can be performed by the above-described depressurization patterns.

[0014] Specifically, the means for pressurizing may be configured such that, when the air chambers are numbered sequentially in the proximal direction so that the distal end air chamber is given number one, the air chambers start to be pressurized in ascending order of the given numbers.

[0015] The means for pressurizing may be configured to start pressurizing the plurality of air chambers simultaneously.

[0016] Preferably, the plurality of air chambers may be disposed so that the mutually adjacent air chambers overlap each other.

[0017] Because the mutually adjacent air chambers are disposed to overlap each other, the area of the patient's body that is not to be pressurized by the air chambers reduces, and pressure can be applied all over the arm or leg. It is therefore possible to perform even more efficient drainage.

[0018] Preferably, the compressed air control unit may further have a means for maintaining a pressurized state of each air chamber for a predetermined period of time after completion of pressurization of the air chamber by the means for pressurizing.

[0019] An embodiment of a pneumatic massage apparatus according to the present invention will be explained below with reference to the accompanying drawings.

Brief Description of Drawings:

[0020]

Fig. 1 is a general view showing a pneumatic massage apparatus according to the present invention.

Fig. 2 is an illustration of a massage device of the pneumatic massage apparatus shown in Fig. 1.

Fig. 3 is a schematic view showing an outline of an experiment.

Fig. 4 is a diagram showing a driving sequence of electromagnetic valves of a conventional pneumatic massage apparatus.

Fig. 5 is a diagram showing a driving sequence of electromagnetic valves of the pneumatic massage apparatus according to the present invention.

Fig. 6 is a graph showing the results of a first experiment.

Fig. 7 is a graph showing the results of a second experiment.

Description of Embodiments:

[0021] As shown in Fig. 1, a pneumatic massage apparatus 1 according to an embodiment of the present invention has tubular massage devices 2 to be fitted to wrap around the legs of a patient, and a compressed air control unit 4 connected to the massage devices 2 through air tubes 3. Each massage device 2 has, as shown in Fig. 2, first to sixth air chambers 5a-5f arranged in series from a periphery-side portion of the massage device 2 covering a patient's foot from the tow to the heel to a center-side portion of the massage device 2 covering the patient's thigh. The six air chambers 5a-5f are disposed so that the mutually adjacent air chambers overlap each other. The air tubes 3 respectively connect between the air chambers 5a-5f of each massage device 2 and the compressed air control unit 4. The compressed air control unit 4 is provided therein with an air pump (not shown) delivering compressed air, six electromagnetic valves (not shown) disposed between the air pump and the air tubes 3, respectively, six pressure sensors (not shown) for measuring the pressure in the air chambers 5a-5f, and a control circuit (not shown) controlling the drive of the six electromagnetic valves. Each of the electromagnetic valves is a three-way valve having a first opening communicating with the air pump, a second opening communicating with the associated air chamber through the associated air tube 3, and a third opening communicating with the atmosphere. When the electromagnetic valve is in an OFF state, the first opening is closed, and the second and third openings are communicated with each other. Thus, the electromagnetic valve is in a compressed air discharge state. When the electromagnetic valve is in an ON state, the third opening is closed, and the first and second openings are communicated with each other. Thus, the electromagnetic valve is in a compressed air supply state. That is, when the electromagnetic valve is turned ON by the control circuit while the air pump is operating, the electromagnetic valve is brought into a compressed air supply state, so that compressed air from the air pump is supplied into the associated air chamber. Consequently, the air chamber is pressurized and thus inflated. When turned OFF, the electromagnetic valve is brought into a compressed air discharge state, so that the compressed air in the associated air chamber is discharged into the atmosphere. Consequently, the air chamber is depressurized and thus deflated.

[0022] The operating sequence of the electromagnetic valves, i.e. the order in which the air chambers 5a-5f are pressurized and depressurized, can be set as desired with the control circuit. In the pneumatic massage apparatus 1, the electromagnetic valves are turned ON in a sequence set by a pressurization program (means for pressurizing) of the control circuit, and after completion of pressurization of all the air chambers, each air chamber is allowed to maintain the pressurized state for a predetermined period of time (5 seconds) by a pressurized state maintaining program (means for maintaining a pressurized state). Thereafter, the electromagnetic valves are turned OFF in a sequence set by a depressurization program (means for depressurizing), and thus all the air chambers 5a-5f are depressurized. After completion of depressurization of all the air chambers 5a-5f, the pressurization program starts again. In this way, pres-

surization and depressurization are performed in sequences similar to the above. This cycle is repeated thereafter.

[0023] Typical pressurization patterns used in the pneumatic massage apparatus 1 include a first pressurization pattern in which all the electromagnetic valves are simultaneously turned ON to pressurize all the air chambers 5a-5f simultaneously, and a second pressurization pattern in which the first to sixth electromagnetic valves are sequentially turned ON to start pressurizing the air chambers sequentially in the proximal direction from the first air chamber, which is the distal-most air chamber, to the sixth air chamber, which is the proximal-most air chamber. However, pressurization patterns usable in the present invention are not limited to those described above. The first to sixth electromagnetic valves may be driven to pressurize the air chambers 5a-5f in any sequence.

[0024] Depressurization patterns used in the pneumatic massage apparatus 1 are, basically, such that, of any pair of mutually adjacent air chambers, a proximal air chamber of the pair first starts to be depressurized, and then a distal air chamber of the pair starts to be depressurized. By performing depressurization in this way, a pressure gradient is produced between a patient's body part having been compressed by the proximal air chamber until depressurization thereof and another patient's body part being compressed by the distal air chamber. Consequently, it is possible to urge the body fluid to flow from the body part being compressed by the distal air chamber toward the body part having been compressed by the proximal air chamber until depressurization thereof. Typical depressurization patterns used in the pneumatic massage apparatus 1 include first, second and third depressurization patterns. Only the first and the second depressurization patterns are covered by the claims. In the first depressurization pattern, the sixth air chamber 5f first starts to be depressurized, and thereafter, the fourth air chamber 5d, the second air chamber 5b, the fifth air chamber 5e, the third air chamber 5c, and the first air chamber 5a start to be depressurized in the order mentioned. In the second depressurization pattern, the fifth air chamber 5e first starts to be depressurized, and thereafter, the third air chamber 5c, the first air chamber 5a, the sixth air chamber 5f, the fourth air chamber 5d, and the second air chamber 5b start to be depressurized in the order mentioned. In the third depressurization pattern, the air chambers start to be depressurized sequentially in the order in which the air chambers are arranged in the distal direction, i.e. from the sixth air chamber 5f to the first air chamber 5a. It should, however, be noted that depressurization patterns usable in the present invention are not limited to the above-described three depressurization patterns, and that the present invention may use any depressurization pattern in which depressurization of each of the air chambers 5a-5f is performed so that the pressure applied to the patient's body decreases from the distal side toward the proximal side.

[0025] To verify the effects of the pneumatic massage apparatus 1 as used for lymphatic drainage, we observed the flow of lymph fluid during massage performed using the pneumatic massage apparatus 1 by ICG (Indo-Cyanine Green) fluorescence imaging. The ICG fluorescence imaging is a technique in which ICG that emits infrared fluorescence having a wavelength of 830 nm when excited with infrared light of 760 nm in wavelength is intracutaneously injected into a patient's body, and fluorescence that the ICG emits when irradiated with infrared excitation light from the outside of the patient's body is observed with an infrared observation camera, thereby observing the ICG flowing with the lymph fluid to inspect the flow of lymph fluid and to identify the position of lymphatic vessels. Infrared light, which has a long wavelength, can penetrate biological tissues relatively easily. Therefore, the ICG fluorescence technique can observe the flow of lymph fluid deep under the skin. In this experiment, a transparent massage device 2 having six air chambers 5a-5f was fitted around a subject's leg as shown in Fig. 3, and ICG was intracutaneously injected between each pair of subject's toes. Thereafter, massage using the pneumatic massage apparatus 1 was started, and the flow of ICG was observed during the massage with an infrared observation camera while irradiating an area around the subject's calf with infrared excitation light. Specifically, the observation area observed with the infrared observation camera was provided with five measurement regions R1-R5 as shown in Fig. 3. An average value of fluorescence intensity in each of the measurement regions R1-R5 was calculated every 0.2 seconds, and the magnitude of the flow of ICG, i.e. the flow of lymph fluid, was evaluated from the change of the average fluorescence intensity.

[0026] The first experiment was carried out to verify the effects of the conventional pneumatic massage apparatus. In the first experiment, as shown in Fig. 4, the first to sixth electromagnetic valves corresponding to the first to sixth air chambers, respectively, were sequentially turned ON from the first electromagnetic valve to the sixth electromagnetic valve, and while doing so, the first to sixth electromagnetic valves were sequentially turned OFF in such a manner that the first electromagnetic valve was first turned OFF at a timing after the third electromagnetic valve was turned ON, and so forth. Consequently, the air chambers were pressurized sequentially in the order in which the first to sixth air chambers were arranged in the proximal direction. When the third air chamber started to be pressurized, the first air chamber, which was the distal-most air chamber, first started to be depressurized, and then the second to sixth air chambers were depressurized sequentially. The pressure in each air chamber during pressurization was 8 kPa.

[0027] The second experiment was carried out to verify the effects of the pneumatic massage apparatus 1 according to the present invention. In the second experiment, the above-described first pressurization pattern and first depressurization pattern were combined, as shown in Fig. 5, to present a typical example of pressurization-depressurization patterns usable in the present invention. That is, the first to sixth electromagnetic valves were controlled as follows. The six air chambers 5a-5f were simultaneously pressurized, and after the pressurized state was maintained for 5 seconds, the sixth air chamber 5f started to be depressurized, and thereafter, the fourth air chamber 5d, the second air chamber

5b, the fifth air chamber 5e, the third air chamber 5c, and the first air chamber 5a started to be depressurized sequentially in the order mentioned. The pressure in each of the air chambers 5a-5f during pressurization was 8 kPa, as in the case of the first experiment.

[0028] Figs. 6 and 7 show the results of the first and second experiments, respectively. Figs. 6 and 7 show the changes of the average fluorescence intensity in the first to fifth measurement regions R1-R5 in a period of time corresponding to about 2 cycles of each pressurization-depressurization pattern. In the graphs of Figs. 6 and 7, at points where there is an increase in fluorescence intensity, the air chambers 5a-5f were pressurized, and at points where there is a decrease in fluorescence intensity, the air chambers 5a-5f were depressurized. It will be understood that the amount of change in fluorescence intensity of ICG during massage using the pneumatic massage apparatus 1 of the present invention, which is shown in Fig. 7, is larger than the amount of change in fluorescence intensity of ICG during massage using the conventional pneumatic massage apparatus, which is shown in Fig. 6. The amount of change in fluorescence intensity is correlated with the change in amount of ICG. Therefore, it is considered from the above-described results that a larger amount of ICG passed through the measurement regions R1-R5 in the second experiment than in the first experiment. In other words, it is considered that a larger amount of lymph fluid passed through the measurement regions R1-R5 in the second experiment using the present invention. In addition, the fluorescence intensity decreases more sharply, particularly, during depressurization in the second experiment, which is shown in Fig. 7, and it is inferred from the results of the second experiment that the lymph fluid flowed more rapidly in the second experiment. These experimental results suggest that the massage using the pneumatic massage apparatus 1 according to the present invention allows a larger amount of lymph fluid to flow more rapidly than the massage using the conventional pneumatic massage apparatus.

[0029] According to the present invention, the order in which the air chambers 5a-5f are depressurized, in particular, is appropriately set to form inside the patient's body such a pressure gradient that the pressure decreases in the proximal direction from the periphery toward the center of the patient's body, thereby urging the lymph fluid to flow not only during pressurization but also during depressurization. Although the first to third depressurization patterns have been shown above specifically as examples of a depressurization pattern for forming the above-described pressure gradient, other depressurization patterns are also disclosed. Examples of other usable depressurization patterns will be shown below, together with the above-described first to third depressurization patterns.

Table 1:

First Depressurization Pattern	6 → 4 → 2 → 5 → 3 → 1
Second Depressurization Pattern	5 → 3 → 1 → 6 → 4 → 2
Third Depressurization Pattern	6 → 5 → 4 → 3 → 2 → 1
Fourth Depressurization Pattern	6 → 3 → 5 → 2 → 4 → 1
Fifth Depressurization Pattern	(6, 4, 2) → (5, 3, 1)
Sixth Depressurization Pattern	(5, 3, 1) → (6, 4, 2)
Seventh Depressurization Pattern	(6, 5) → (4, 3) → (2, 1)
Eighth Depressurization Pattern	(6, 5, 4) → (3, 2, 1)
Ninth Depressurization Pattern	(6, 3) → (5, 2) → (4, 1)

[0030] In Table 1, each arrow means that, after an air chamber designated by the number on the left side of the arrow has started to be depressurized, an air chamber designated by the number on the right side of the arrow starts to be depressurized. Air chambers designated by the numbers in each set of parentheses simultaneously start to be depressurized. It should be noted that the timing of starting depressurization may be either of the following: a next air chamber may start to be depressurized after completion of depressurization of the preceding air chamber; a next air chamber may start to be depressurized in the middle of depressurization of the preceding air chamber.

[0031] Although all the air chambers 5a-5f of the massage device 2 are used in the above-described pressurization-depressurization patterns, only necessary air chambers may be used according to each particular situation. For example, when the patient has edema only in the calf portion and drainage of his or her thigh is unnecessary, only the first to fourth air chambers 5a-5d may be used. Further, the pressurizing force may be changed appropriately in accordance with the severity of edema. It is also possible to set a different pressure value for each of the air chambers 5a-5f. These conditions can be changed appropriately in accordance with the condition of the patient.

[0032] Although in the foregoing embodiment each massage device 2 is provided with six air chambers 5a-5f, the number and size of air chambers may be changed appropriately. Lymph flow in vivo is a stream of lymph fluid flowing in small amounts through thin lymphatic vessels having valve structures; therefore, lymph fluid cannot be allowed to

flow over a long distance at a time. Accordingly, it is an effective way to depressurize an air chamber closer to the center of the patient's body by a distance of from several centimeters to 20 centimeters at the most from a patient's body portion from which the lymph fluid is desired to be drained. For this reason, when the pneumatic massage apparatus of the present invention is used for treatment of lymphedema, the number of air chambers may be increased to 8 or 12, with the size of each air chamber being reduced. With this structure, lymphatic drainage may be able to be performed even more efficiently. Alternatively, the massage device 2 may have a reduced number of air chambers, i.e. four air chambers, to form a compact massage device for performing local drainage. Although in the foregoing embodiment the massage device 2 is for massaging a leg, the massage device 2 may also be constructed to massage an arm by modifying the configuration.

Claims

1. A pneumatic massage apparatus comprising:

a massage device (2) to be fitted to wrap around one of an arm and a leg of a patient and having at least four air chambers (5a-5f, 1-6) disposed in series in a proximal direction from a distal position of the one of the arm and the leg toward a center of a body of the patient when the massage device (2) is fitted around the one of the arm and the leg; and

a compressed air control unit (4) supplying and discharging compressed air into and from the plurality of air chambers (5a-5f, 1-6) of the massage device (2); the compressed air control unit (4) having a means for pressurizing each of the air chambers (5a-5f, 1-6) by supplying compressed air thereinto, a means for depressurizing each of the pressurized air chambers (5a-5f, 1-6) by discharging compressed air therefrom, and a means for maintaining a pressurized state of each pressurized air chamber (5a-5f, 1-6); wherein

the means for pressurizing are configured to pressurize all air chambers (5a-5f, 1-6);
the means for maintaining a pressurized state of each pressurized air chamber (5a-5f, 1-6) are configured to maintain the pressure for a predetermined period of time after completion of pressurization of all air chambers by the means for pressurizing;

one or more pairs of mutually adjacent ones of the air chambers (5a-5f, 1-6) can be selected and the means for depressurizing are configured to depressurize the pressurized air chambers (5a-5f, 1-6) after completion of pressurization of all the air chambers (5a-5f, 1-6) in such a manner that, at least one of the pressurized air chambers (5a-5f, 1-6) except a distal end air chamber disposed at a distal-most position of the pressurized air chambers (5a-5f, 1-6) is depressurized before depressurization of the distal end air chamber, and when the pressurized air chambers (5a-5f, 1-6) are numbered sequentially in the proximal direction so that the distal end air chamber is given number one, even-numbered air chambers first start to be depressurized in descending order of numbers given thereto, and after starting to depressurize the lowest even numbered air chamber then odd-numbered air chambers start to be depressurized in descending order of numbers given thereto so that of any said selected pair of mutually adjacent ones of the air chambers (5a-5f, 1-6), a proximal air chamber of the pair first starts to be depressurized, and then a distal air chamber of the pair starts to be depressurized, to in operation urge body fluid of a patient from a body part being compressed by the distal air chamber to flow towards the body part having been compressed by the proximal air chamber until depressurization thereof; and the means for pressurizing, the means for maintaining a pressurized state and the means for depressurizing are configured to repeat the cycle of pressurization, maintaining and depressurization.

2. A pneumatic massage apparatus comprising:

a massage device (2) to be fitted to wrap around one of an arm and a leg of a patient and having at least four air chambers (5a-5f, 1-6) disposed in series in a proximal direction from a distal position of the one of the arm and the leg toward a center of a body of the patient when the massage device (2) is fitted around the one of the arm and the leg; and

a compressed air control unit (4) supplying and discharging compressed air into and from the plurality of air chambers (5a-5f, 1-6) of the massage device (2); the compressed air control unit (4) having a means for pressurizing each of the air chambers (5a-5f, 1-6) by supplying compressed air thereinto, a means for depressurizing each of the pressurized air chambers (5a-5f, 1-6) by discharging compressed air therefrom, and a means for maintaining a pressurized state of each pressurized air chamber (5a-5f, 1-6); wherein

the means for pressurizing are configured to pressurize all air chambers (5a-5f, 1-6);
the means for maintaining a pressurized state of each pressurized air chamber (5a-5f, 1-6) are configured to maintain the pressure for a predetermined period of time after completion of pressurization of all air chambers

by the means for pressurizing;

one or more pairs of mutually adjacent ones of the air chambers (5a-5f, 1-6) can be selected and the means for depressurizing are configured to depressurize the pressurized air chambers (5a-5f, 1-6) after completion of pressurization of all the air chambers (5a-5f, 1-6) in such a manner that, at least one of the pressurized air chambers (5a-5f, 1-6) except a distal end air chamber disposed at a distal-most position of the pressurized air chambers (5a-5f, 1-6) is depressurized before depressurization of the distal end air chamber, and when the pressurized air chambers (1-6) are numbered sequentially in the proximal direction so that the distal end air chamber is given number one, odd-numbered air chambers first start to be depressurized in descending order of numbers given thereto, and after starting to depressurize the lowest odd numbered air chamber then even-numbered air chambers start to be depressurized in descending order of numbers given thereto so that of any said selected pair of mutually adjacent ones of the air chambers (5a-5f, 1-6), a proximal air chamber of the pair first starts to be depressurized, and then a distal air chamber of the pair starts to be depressurized, to in operation urge body fluid of a patient from a body part being compressed by the distal air chamber to flow towards the body part having been compressed by the proximal air chamber until depressurization thereof; and the means for pressurizing, the means for maintaining a pressurized state and the means for depressurizing are configured to repeat the cycle of pressurization, maintaining and depressurization.

3. The pneumatic massage apparatus of claim 1 or 2, wherein the means for pressurizing is configured such that, when the air chambers (1-6) are numbered sequentially in the proximal direction so that the distal end air chamber is given number one, the air chambers start to be pressurized in ascending order of numbers given thereto.
4. The pneumatic massage apparatus of claim 1 or 2, wherein the means for pressurizing is configured to start pressurizing the plurality of air chambers (5a-5f, 1-6) simultaneously.
5. The pneumatic massage apparatus of any one of claims 1 to 4, wherein the plurality of air chambers (5a-5f, 1-6) are disposed so that mutually adjacent ones of the air chambers overlap each other.

Patentansprüche

1. Eine pneumatische Massagevorrichtung, die Folgendes aufweist:

eine Massagevorrichtung (2), die geeignet ist, um um entweder einen Arm oder ein Bein eines Patienten herum gelegt zu werden, und die wenigstens vier Luftkammern (5a-5f, 1-6) besitzt, die in Reihe in einer proximalen Richtung von einer distalen Position entweder des Armes oder des Beines hin zu einer Körpermitte des Patienten angeordnet sind, wenn die Massagevorrichtung (2) entweder um den Arm oder das Bein angebracht ist; und eine Druckluftsteuereinheit (4), die komprimierte Luft in die und aus der Vielzahl von Luftkammern (5a-5f, 1-6) der Massagevorrichtung (2) zuführt bzw. ablässt; wobei

die Druckluftsteuereinheit (4) Mittel zum Druckbeaufschlagen jeder Luftkammer (5a-5f, 1-6) durch Zuführen von Druckluft dahinein besitzt, Mittel zum Druckablassen jeder unter Druck stehenden Luftkammer (5a-5f, 1-6) durch Ablassen komprimierter Luft aus dieser, und Mittel zum Halten eines Druckzustands jeder unter Druck stehenden Luftkammer (5a-5f, 1-6); wobei

die Mittel zum Druckbeaufschlagen konfiguriert sind, um alle Luftkammern (5a-5f, 1-6) unter Druck zu setzen; die Mittel zum Halten eines Druckzustands jeder unter Druck stehenden Luftkammer (5a-5f, 1-6) konfiguriert sind, um den Druck für eine vorbestimmte Zeitdauer nach Vollendung des Druckbeaufschlagens aller Luftkammern durch die Mittel zum Druckbeaufschlagen zu halten;

ein oder mehr Paare zueinander benachbarter der Luftkammern (5a-5f, 1-6) ausgewählt werden können, und die Mittel zum Druckablassen konfiguriert sind, um den Druck aus den unter Druck stehenden Luftkammern (5a-5f, 1-6) nach Vollendung des Druckbeaufschlagens aller Luftkammern (5a-5f, 1-6) in einer solchen Art abzulassen, dass aus wenigstens einer der unter Druck stehenden Luftkammern (5a-5f, 1-6), ausgenommen einer Distalendluftkammer, die an einer am meisten distalen Position der unter Druck stehenden Luftkammern (5a-5f, 1-6) angeordnet ist, Druck abgelassen wird, bevor aus der Distalendluftkammer Luft abgelassen wird, und wenn die unter Druck stehenden Luftkammern (5a-5f, 1-6) fortlaufend in der proximalen Richtung nummeriert sind, so dass die Distalendluftkammer die Nummer eins besitzt, aus den gerade nummerierten Luftkammern zuerst Druck in absteigender Reihenfolge der ihnen vergebenen Nummern abgelassen wird, und nach dem Starten des Druckablassens aus der niedrigsten gerade nummerierten Luftkammer dann aus den ungerade nummerierten Luftkammern Druck in absteigender Reihenfolge der ihnen vergebenen Nummern abgelassen wird, so dass von jedem ausgewählten Paar zueinander benachbarter der Luftkammern (5a-5f, 1-6) aus einer

proximalen Luftkammer des Paares, zuerst Druck abgelassen wird, und dann aus einer distalen Luftkammer des Paares Druck abgelassen wird, so dass im Betrieb bewirkt wird, dass Körperflüssigkeit eines Patienten von einem Körperteil, der durch die distale Luftkammer komprimiert wird, in Richtung des Körperteils fließt, der durch die proximale Luftkammer bis zum Druckablassen in dieser komprimiert wurde; und
 5 die Mittel zum Druckbeaufschlagen, die Mittel zum Halten eines Druckzustands und die Mittel zum Druckablassen konfiguriert sind, um einen Zyklus aus Druckerzeugung, Druckhalten und Druckablassen zu wiederholen.

2. Eine pneumatische Massagevorrichtung, die Folgendes aufweist:

10 eine Massagevorrichtung (2), die geeignet ist, um um entweder einen Arm oder ein Bein eines Patienten herum gelegt zu werden, und die wenigstens vier Luftkammern (5a-5f, 1-6) besitzt, die in Reihe in einer proximalen Richtung von einer distalen Position entweder des Armes oder des Beines hin zu einer Körpermitte des Patienten angeordnet sind, wenn die Massagevorrichtung (2) entweder um den Arm oder das Bein angebracht ist; und
 15 eine Druckluftsteuereinheit (4), die komprimierte Luft in die und aus der Vielzahl von Luftkammern (5a-5f, 1-6) der Massagevorrichtung (2) zuführt bzw. ablässt; wobei
 die Druckluftsteuereinheit (4) Mittel zum Druckbeaufschlagen jeder Luftkammer (5a-5f, 1-6) durch Zuführen von Druckluft dahinein besitzt, Mittel zum Druckablassen jeder unter Druck stehenden Luftkammer (5a-5f, 1-6) durch Ablassen komprimierter Luft aus dieser, und Mittel zum Halten eines Druckzustands jeder unter Druck stehenden Luftkammer (5a-5f, 1-6);
 20 die Mittel zum Druckbeaufschlagen konfiguriert sind, um alle Luftkammern (5a-5f, 1-6) unter Druck zu setzen; die Mittel zum Halten eines Druckzustands jeder unter Druck stehenden Luftkammer (5a-5f, 1-6) konfiguriert sind, um den Druck für eine vorbestimmte Zeitdauer nach Vollendung des Druckbeaufschlagens aller Luftkammern durch die Mittel zum Druckbeaufschlagen zu halten;
 ein oder mehr Paare zueinander benachbarter der Luftkammern (5a-5f, 1-6) ausgewählt werden können, und
 25 die Mittel zum Druckablassen konfiguriert sind, um den Druck aus den unter Druck stehenden Luftkammern (5a-5f, 1-6) nach Vollendung des Druckbeaufschlagens aller Luftkammern (5a-5f, 1-6) in einer solchen Art abzulassen, dass aus wenigstens einer der unter Druck stehenden Luftkammern (5a-5f, 1-6), ausgenommen einer Distalendluftkammer, die an einer am meisten distalen Position der unter Druck stehenden Luftkammern (5a-5f, 1-6) angeordnet ist, Druck abgelassen wird, bevor aus der Distalendluftkammer Luft abgelassen wird,
 30 und wenn die unter Druck stehenden Luftkammern (5a-5f, 1-6) fortlaufend in der proximalen Richtung nummeriert sind, so dass der Distalendluftkammer die Nummer eins besitzt, aus den ungerade nummerierten Luftkammern zuerst Druck in absteigender Reihenfolge der ihnen vergebenen Nummern abgelassen wird, und nach dem Starten des Druckablassens aus der niedrigsten ungerade nummerierten Luftkammer dann aus den gerade nummerierten Luftkammern Druck in absteigender Reihenfolge der ihnen vergebenen Nummern abgelassen wird, so dass von jedem ausgewählten Paar zueinander benachbarter der Luftkammern (5a-5f, 1-6) aus einer proximalen Luftkammer des Paares, zuerst Druck abgelassen wird, und dann aus einer distalen Luftkammer des Paares Druck abgelassen wird, so dass im Betrieb bewirkt wird, dass Körperflüssigkeit eines Patienten von einem Körperteil, der durch die distale Luftkammer komprimiert wird, in Richtung des Körperteils fließt, der durch die proximale Luftkammer bis zum Druckablassen in dieser komprimiert wurde; und
 35 die Mittel zum Druckbeaufschlagen, die Mittel zum Halten eines Druckzustands und die Mittel zum Druckablassen konfiguriert sind, um einen Zyklus aus Druckerzeugung, Druckhalten und Druckablassen zu wiederholen.

3. Pneumatische Massagevorrichtung nach Anspruch 1 oder 2, wobei die Mittel zum Druckbeaufschlagen so konfiguriert sind, dass wenn die Luftkammern (1-6) fortlaufend in der proximalen Richtung nummeriert sind, so dass der Distalendluftkammer die Nummer eins gegeben wird, die Luftkammern beginnen in absteigender Reihenfolge der ihnen vergebenen Nummern unter Druck gesetzt zu werden.
 45

4. Pneumatische Massagevorrichtung nach Anspruch 1 oder 2, wobei die Mittel zum Druckbeaufschlagen konfiguriert sind die Vielzahl von Luftkammern (5a-5f, 1-6) gleichzeitig unter Druck zu setzen.
 50

5. Pneumatische Massagevorrichtung nach einem der Ansprüche 1 bis 4, wobei die Vielzahl von Luftkammern (5a-5f, 1-6) so angeordnet ist, dass zueinander benachbarte der Luftkammern sich gegenseitig überlappen.

Revendications

1. Appareil de massage pneumatique comprenant :

un dispositif de massage (2) destiné à être enroulé autour d'un bras ou d'une jambe d'un patient et comportant au moins quatre chambres à air (5a-5f, 1-6) disposées en série dans une direction proximale à partir d'une position distale du bras ou de la jambe en direction du centre du corps du patient lorsque le dispositif de massage (2) est installé autour du bras ou de la jambe ; et

un module de commande d'air comprimé (4) fournissant et évacuant de l'air comprimé dans et à partir de la pluralité de chambres à air (5a-5f, 1-6) du dispositif de massage (2) ; le module de commande d'air comprimé (4) comportant des moyens pour pressuriser chacune des chambres à air (5a-5f, 1-6) en fournissant de l'air comprimé dedans, des moyens pour dépressuriser chacune des chambres à air (5a-5f, 1-6) pressurisées en évacuant de l'air comprimé à partir de celles-ci, et des moyens pour maintenir un état pressurisé de chaque chambre à air pressurisée (5a-5f, 1-6) ; dans lequel

les moyens pour pressuriser sont agencés pour pressuriser toutes les chambres à air (5a-5f, 1-6) ;

les moyens pour maintenir un état pressurisé de chaque chambre à air (5a-5f, 1-6) pressurisée sont agencés pour maintenir la pression pendant une durée prédéterminée après l'achèvement de la pressurisation de toutes les chambres à air par les moyens pour pressuriser ;

une ou plusieurs paires de certaines chambres mutuellement adjacentes parmi les chambres à air (5a-5f, 1-6) peuvent être sélectionnées et les moyens pour dépressuriser sont agencés pour dépressuriser les chambres à air (5a-5f, 1-6) pressurisées après l'achèvement de la pressurisation de toutes les chambres à air (5a-5f, 1-6) d'une manière telle qu'au moins l'une des chambres à air (5a-5f, 1-6) pressurisées excepté une chambre à air distale disposée à une position la plus distale des chambres à air (5a-5f, 1-6) pressurisées est dépressurisée avant la dépressurisation de la chambre à air distale, et lorsque les chambres à air pressurisées (5a-5f, 1-6) sont numérotées séquentiellement dans la direction proximale de telle sorte que la chambre à air d'extrémité distale reçoive le numéro un, les chambres à air à numéros pairs commencent à être dépressurisées en premier dans l'ordre décroissant des numéros qui leur ont été donnés, et après le commencement de la dépressurisation de la chambre à air de numéro pair le plus faible, alors les chambres à air à numéros impairs commencent à être dépressurisées dans l'ordre décroissant des numéros qui leur ont été donnés de sorte que parmi toutes paires sélectionnées de chambres mutuellement adjacentes parmi les chambres à air (5a-5f, 1-6), une chambre à air proximale de la première paire commence à être dépressurisée, puis une chambre à air distale de la paire commence à être dépressurisée, pour solliciter en fonctionnement le fluide corporel d'un patient provenant d'une partie du corps qui est comprimée par la chambre à air distale pour qu'il s'écoule en direction de la partie du corps ayant été comprimée par la chambre à air proximale jusqu'à sa dépressurisation ; et

les moyens pour pressuriser, les moyens pour maintenir un état pressurisé et les moyens pour dépressuriser sont agencés pour répéter le cycle de pressurisation, de maintien et de dépressurisation.

2. Appareil de massage pneumatique comprenant :

un dispositif de massage (2) destiné à être enroulé autour d'un bras ou d'une jambe d'un patient et comportant au moins quatre chambres à air (5a-5f, 1-6) disposées en série dans une direction proximale à partir d'une position distale du bras ou de la jambe vers le centre du corps d'un patient lorsque le dispositif de massage (2) est installé autour du bras ou de la jambe ; et

un module de commande d'air comprimé (4) fournissant et évacuant de l'air comprimé dans et à partir de la pluralité de chambres à air (5a-5f, 1-6) du dispositif de massage (2) ; le module de commande d'air comprimé (4) comportant des moyens pour pressuriser chacune des chambres à air (5a-5f, 1-6) en leur fournissant de l'air comprimé, des moyens pour dépressuriser chacune des chambres à air (5a-5f, 1-6) pressurisées en évacuant de l'air comprimé à partir de celle-ci, et des moyens pour maintenir un état pressurisé de chacune des chambres à air pressurisées (5a-5f, 1-6) ; dans lequel

les moyens pour pressuriser sont agencés pour pressuriser toutes les chambres à air (5a-5f, 1-6) ;

les moyens pour maintenir un état pressurisé de chaque chambre à air (5a-5f, 1-6) pressurisée sont agencés pour maintenir la pression pendant une durée prédéterminée après l'achèvement de la pressurisation de toutes les chambres à air par les moyens de pressurisation ;

une ou plusieurs paires de chambres mutuellement adjacentes parmi les chambres à air (5a-5f, 1-6) peuvent être sélectionnées et les moyens pour dépressuriser sont agencés pour dépressuriser les chambres à air (5a-5f, 1-6) pressurisées après l'achèvement de la pressurisation de toutes les chambres à air (5a-5f, 1-6) d'une manière telle qu'au moins l'une des chambres à air (5a-5f, 1-6) pressurisées excepté une chambre à air distale disposée à une position la plus distale des chambres à air (5a-5f, 1-6) pressurisées est dépressurisée avant la dépressurisation de la chambre à air d'extrémité distale, et lorsque les chambres à air (1-6) pressurisées sont numérotées séquentiellement dans la direction proximale de telle sorte que la chambre à air d'extrémité distale reçoive le numéro un, les chambres à air à numéros impairs commencent à être dépressurisées en premier dans l'ordre décroissant des numéros qui leur ont été donnés, et après le commencement de la dépressurisation

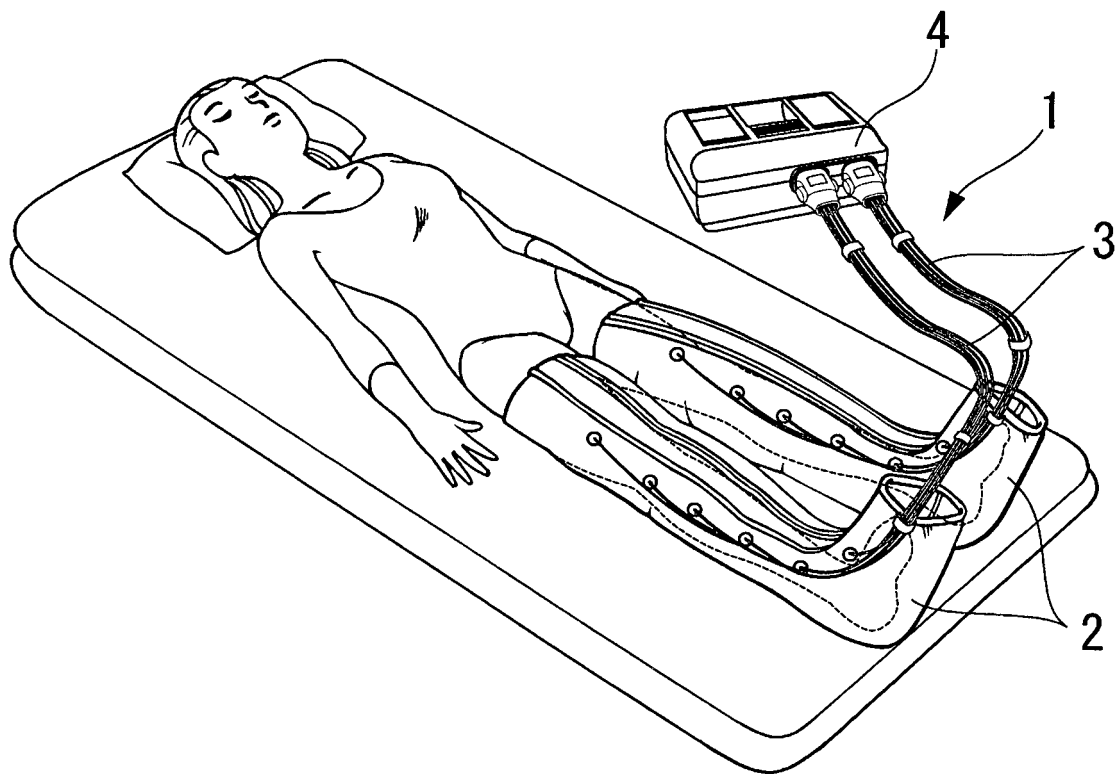
de la chambre à air de numéro impair le plus faible, alors les chambres à air à numéros pairs commencent à être dépressurisées dans l'ordre décroissant des numéros qui leur ont été donnés de sorte que parmi toutes paires sélectionnées de chambres mutuellement adjacentes parmi les chambres à air (5a-5f, 1-6), une chambre à air proximale de la première paire commence à être dépressurisée, puis une chambre à air distale de la paire commence à être dépressurisée, pour solliciter en fonctionnement le fluide corporel d'un patient provenant d'une partie du corps qui est comprimée par la chambre à air distale pour qu'il s'écoule en direction de la partie du corps ayant été comprimée par la chambre à air proximale jusqu'à sa dépressurisation ; et les moyens pour pressuriser, les moyens pour maintenir un état pressurisé et les moyens pour dépressuriser sont agencés pour répéter le cycle de pressurisation, de maintien et de dépressurisation.

3. Appareil de massage pneumatique selon la revendication 1 ou 2, dans lequel les moyens pour pressuriser sont agencés de telle sorte que, lorsque les chambres à air (1-6) sont numérotées séquentiellement dans la direction proximale de telle sorte que la chambre à air d'extrémité distale reçoive le numéro un, les chambres à air commencent à être pressurisées dans l'ordre croissant des numéros qui leur ont été donnés.

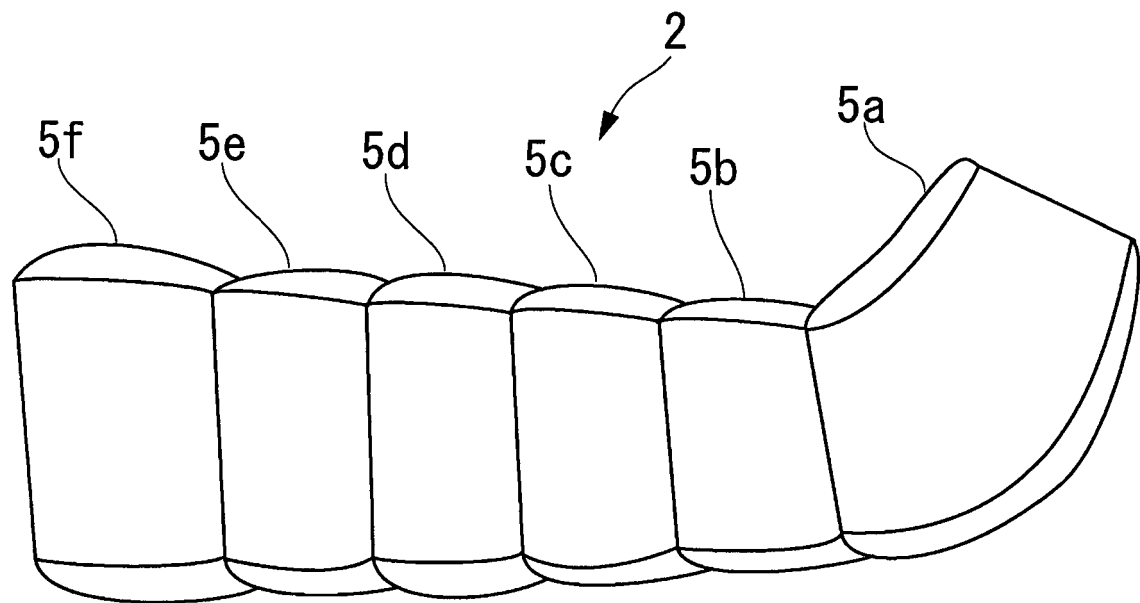
4. Appareil de massage pneumatique selon la revendication 1 ou 2, dans lequel les moyens pour pressuriser sont agencés pour commencer la pressurisation de la pluralité de chambres à air (5a-5f, 1-6) simultanément.

5. Appareil de massage pneumatique selon l'une quelconque des revendications 1 à 4, dans lequel la pluralité de chambres à air (5a-5f, 1-6) est disposée de telle sorte que des chambres mutuellement adjacentes parmi les chambres à air se chevauchent entre elles.

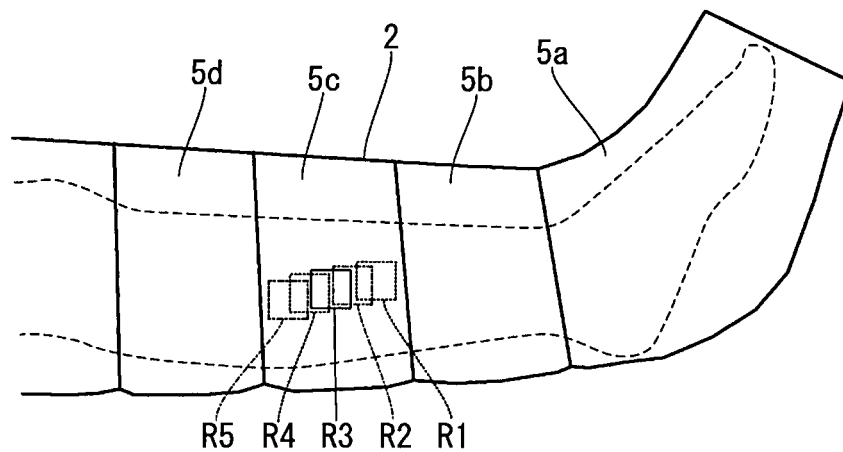
[Fig. 1]



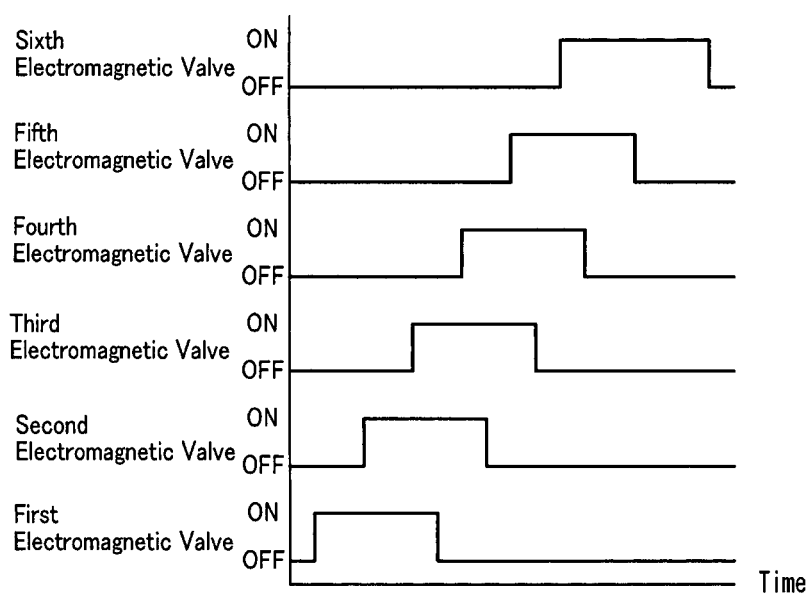
[Fig. 2]



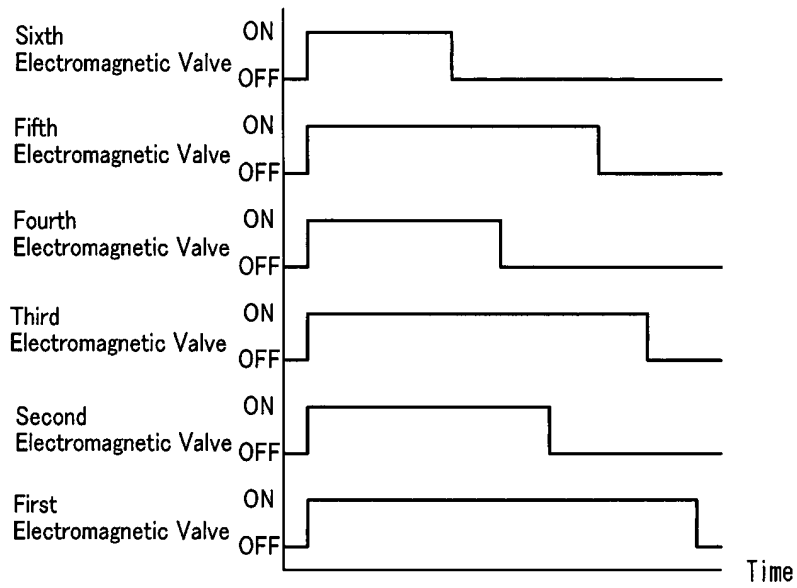
[Fig. 3]



[Fig. 4]

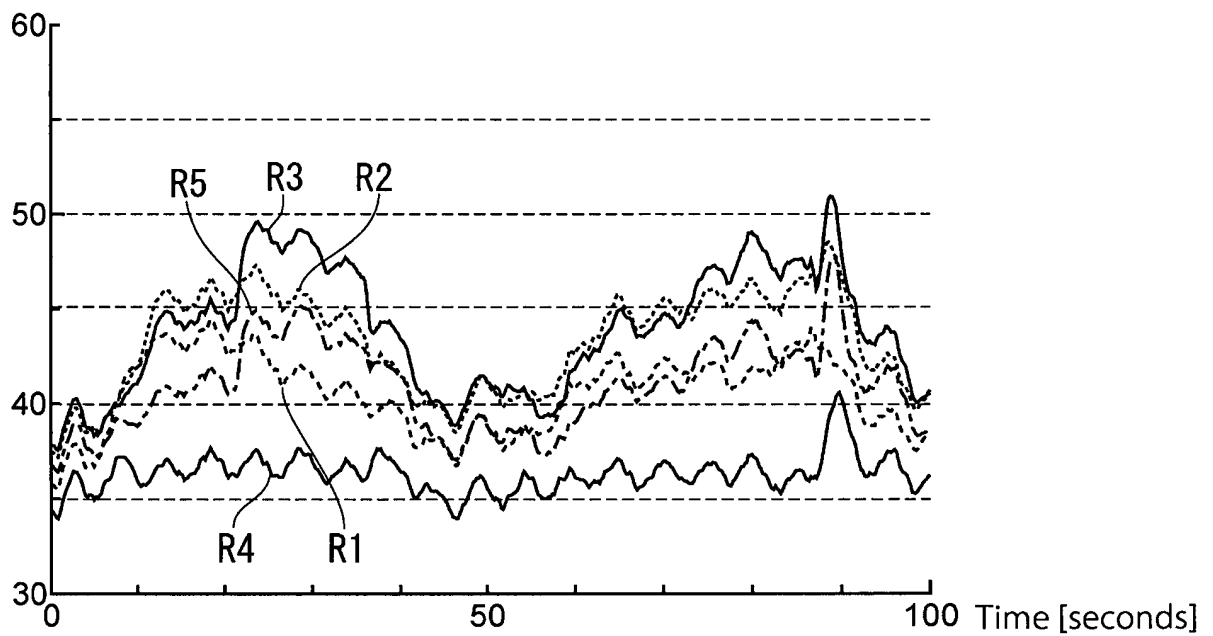


[Fig. 5]



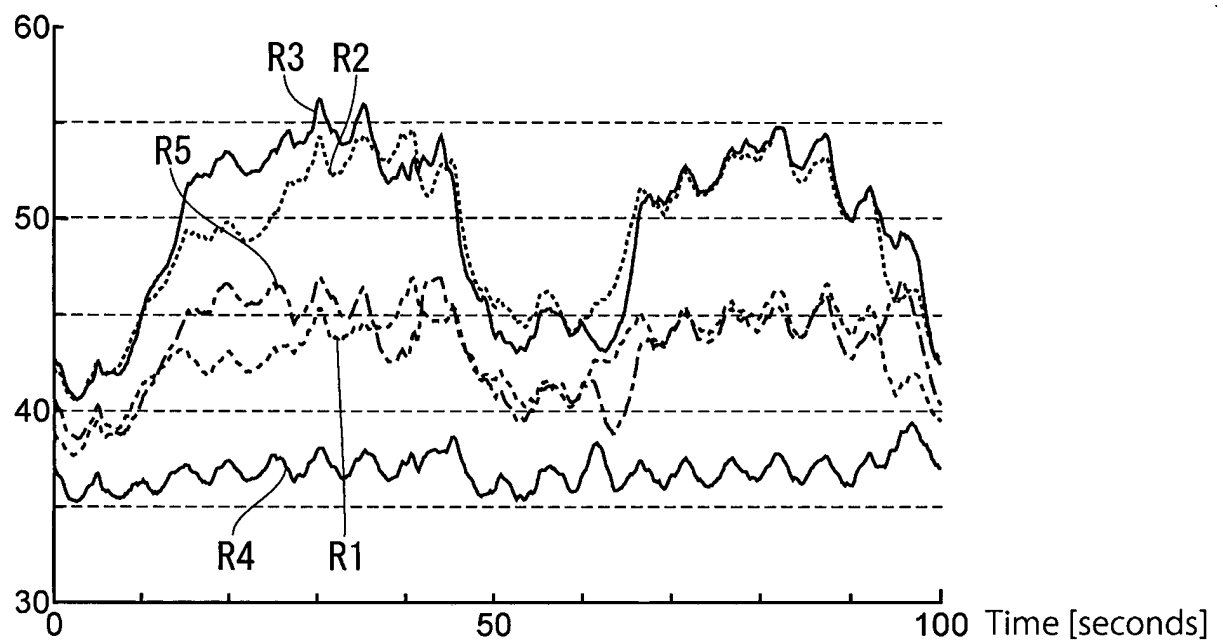
[Fig. 6]

Fluorescence Intensity



[Fig. 7]

Fluorescence Intensity



REFERENCES CITED IN THE DESCRIPTION

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