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Remarks:
The references to the drawing no. 6 are deemed to be deleted (Rule 56(4) EPC).

(54) Anti-bedsore mattress

(57) The present invention relates to an anti-bedsore mattress. The position of the different body support areas are adjusted by means of the use of magnetorheological fluids in mattresses as a result of the variation occurring in the viscosity of this type of fluids due to the selective application of a magnetic field. According to the invention, the mattress has actuation units (4) through which a magnetorheological fluid flows, such units integrating a magnetic field generating element (8) that may act on the magnetorheological fluid, modifying its viscosity and accordingly the pressure that the actuation unit (4) exerts on the user support section.

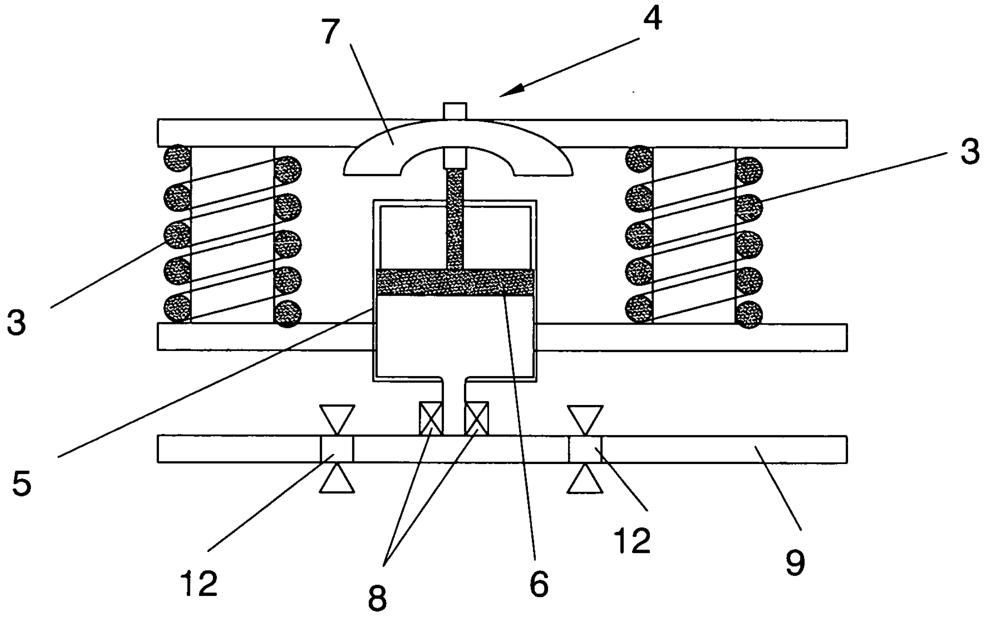

FIG. 1

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Description

OBJECT OF THE INVENTION

[0001] The present invention relates to an anti-bedsore mattress used to prevent the occurrence of ulcers on a patient's skin resulting from prolonged bed rest without eliminating other possible, more general applications.

[0002] The object of the invention essentially relates to the implementation of the use of magnetorheological fluids in mattresses to regulate the stiffness of the different body support areas as a result of the variation occurring in the viscosity of this type of fluids given the selective application of a magnetic field.

BACKGROUND OF THE INVENTION

[0003] Patients who are bedridden for long time periods may experience the occurrence of bedsores or ulcers on their skin, especially in those areas of the body that are in permanent contact with the mattress.

[0004] Different systems have been developed to prevent these ulcerations from occurring, fomenting blood circulation by means of the alternating application of pressures over time on different areas of the body in contact with the mattress.

[0005] Pneumatic systems alternately inflating and deflating different areas of the mattress are specifically known, modifying the contact pressure with different parts of the body. These areas are defined as compartments having several possible shapes, either conical, pyramidal, cylindrical or having a similar geometry.

[0006] Like pneumatic systems and with the same philosophy, hydraulic systems have compartments, in this case filled with water, which are filled to a greater or lesser degree, thus regulating their firmness according to the patient's contact pressure map.

[0007] On the other hand, mechanical, preferably electromechanical, systems are also known which articulate moving parts, such as rollers, which allow generating certain pressure alternation in different areas of the resting surface.

[0008] All these systems must function slowly enough so that suitable alternation of pressures is obtained, such that lesions are not caused due to friction or shearing on the skin. The speed must be even slower than that used in a massage movement since the skin of these patients is usually weaker.

[0009] The need to modify pressures with a controlled slow pace results in the use of new materials; for example, metallic nickel titanium alloy tensors (also known as muscle wire or shape memory alloys) are known that allow modifying the length thereof due to a heating that is generated by the Joule effect due to the application of an electric pulse. These tensors are introduced in the mattress and act on occasions, modifying the pressure of a padded surface.

[0010] Magnetorheological fluids are additionally known, the application of which has essentially been focused on the development of different devices belonging to the field of machinery in general, and in the automotive field in particular, especially for their installation in braking and shock absorbing systems and in gear systems.

[0011] This type of fluids increase their viscosity in a controlled manner due to the application of a magnetic field, acquiring a quasi-solid state in a reversible manner, since the removal of the magnetic field determines the recovery of the initial state of the fluid.

DESCRIPTION OF THE INVENTION

[0012] The anti-bedsore mattress described by this invention proposes the use of magnetorheological fluids as the actuation element for the selective variation of contact pressure in different areas of the mattress on which the user's body is supported.

[0013] It has been verified that magnetorheological fluid provides a fast response to small magnetic field variations, allowing the very precisely controlled application of very small fields to the fluid enabling a slow and smooth response, therefore being very useful for the required features of an anti-bedsore mattress.

[0014] The reversible rheological nature of the fluid likewise allows constructing reproducible and repetitive effects systems, and the change of the rheological properties with the magnetic field is done in a completely silent manner, making these fluids ideal for being applied in this type of mattresses.

[0015] The anti-bedsore mattress incorporates actuation units where the magnetorheological fluid flows distributed in correspondence with the user support sections, such units including a magnetic field generating element which can act on the magnetorheological fluid, modifying its viscosity, subsequently determining a variation in the pressure that the actuation unit exerts on the user's body.

[0016] The actuation units are formed by a cylinder in which a piston moves, said piston being in contact with the magnetorheological fluid which is likewise associated to a vertically shiftable actuator, preferably of a padded material, forming the contact element that transmits pressure to the support surface of the mattress on which the user is resting, and they also incorporate the previously described magnetic field generating element, which may consist of a permanent magnet or an electromagnet acting on the magnetorheological fluid.

[0017] The mattress is preferably divided into at least one upper padded area forming the support surface and a lower structural area where these actuation units will preferably be located, usually in an intercalated arrangement with respect to the mattress springs or the structural foam in the case of special foam mattresses.

[0018] The actuation units are distributed in places defined by the usual pressure map of a body at rest, i.e. in sections of the mattress corresponding with the head, shoulders, lumbar area, hips, buttocks and ankles, and they are preferably connected to one another by a series of closed circuit conduits through which the magnetorheological fluid under pressure flows, each of the units having connectors which allow their individual disassembly for repair or replacement.

[0019] There is also an adjustable pressure compensation diaphragm, the position of which can be adjusted according to the weight of each user, and which can be located inside or outside the structural area. The initial system pressure parameters can be adjusted to the patient's weight by means of this diaphragm, and during the subsequent adjustment it allows changing the pressure of the fluid in the circuit to control the flow direction of the fluid in the actuation units.

[0020] The fluid will or will not flow depending on the filed intensity generated in the magnetic field generating element, and the flow direction will be determined by the pressure balance existing in the circuit and the pressure exerted by the weight at that point of the mattress.

[0021] In the event that there is no magnetic field, the fluid will behave as it does in known hydraulic or pneumatic systems, following the laws of communicating vessels. The actuators supporting more weight will sink lower and those subjected to less weight will tend to lift up until the internal pressure is held in equilibrium.

[0022] The control of each of the actuation units is done individually and as needed. When a magnetic field is applied in an actuation unit, the viscosity of the fluid located in the cylinder increases until canceling the fluid flow, which means that the actuator is immobilized, accordingly defining a rigid area in the padded area.

[0023] The sinking and lifting of different areas of the mattress can therefore be selectively controlled by means of this system, which adjustment can be done or not in collaboration with the pressure compensation diaphragm acting on the pressure of the circuit.

[0024] According to the features set forth above and by way of example, it is possible to obtain response rates in the change of the viscosity of the fluid from minimum to maximum viscosity in the order of less than 10 milliseconds. The field applied to the magnetic valves is in the order of 0.3 teslas, meaning that the actuation distance is a maximum of 5 cm, the patient's magnetic field therefore being null.

[0025] The incorporation of a microprocessor managing the electric pulses feeding the system is complementarily contemplated, such microprocessor acting selectively and in a programmed manner on the actuation units distributed in different areas according to a determined sequence and quick response speed.

[0026] The possibility of integrating a control system in combination with the magnetorheological fluid circuit associated to the microprocessor is also considered, such system being responsible for sensing parameters such as temperature, pressure and moisture, and being able to generate signals which activate forced ventilation and heating systems.

[0027] The data can be shown on a computer display, the program, execution and data management being carried out with the *in situ* reading of the parameters in real time.

DESCRIPTION OF THE DRAWINGS

[0028] To complement the description being made and for the purpose of aiding to better understand the features of the invention according to a preferred practical embodiment thereof, a set of drawings is attached as an integral part of said description which shows the following with an illustrative and non-limiting character:

Figure 1 shows a schematic view of an actuation unit according to the invention located between two springs.

Figure 2 shows a schematic view in which a series of actuation units forming part of a closed circuit has been depicted.

Figure 3 shows a perspective view of the mattress in which the actuation units between springs in the structural area of the mattress have been depicted.

Figure 4 shows a schematic view in which the situation where the sinking and lifting of areas of the mattress occurs without changing the position of the diaphragm has been depicted.

Figure 5 shows a schematic view in which the situation where actuation on a specific part of the mattress and on the general adjustable pressure diaphragm has occurred has been depicted.

Figure 6 shows a schematic view of the mattress with an integrated control system.

PREFERRED EMBODIMENT OF THE INVENTION

[0029] In view of the discussed figures a preferred embodiment of the anti-bedsore mattress forming the object of this invention is described below.

[0030] As shown in Figure 3, the anti-bedsore mattress usually has an upper padded area (1) and a lower structural area (2) integrating a series of springs (3).

[0031] According to the invention, as shown in Figure 1, the anti-bedsore mattress has actuation units (4) comprising a cylinder (5) in which a piston (6) moves, said piston being in contact with the magnetorheological fluid which is likewise associated to a vertically shiftable actuator (7) that transmits pressure to the support surface of the mattress on which the user is resting, and it also comprises a magnetic field generating element (8).

[0032] As shown in Figure 2, the actuation units (4) are connected to one another by means of a series of conduits (9) forming a closed circuit through which the magnetorheological fluid under pressure circulates. The complementary incorporation of an adjustable pressure compensation diaphragm (10) can also be observed in this circuit, this diaphragm allowing the initial system pressure parameters to be adjusted to the patient's weight as well as allowing control of the pressure and fluid flow direction in the actuation units (4), as shown in Figure 5.

[0033] Figure 2 shows the actuation units (4) arranged in the structural area (2), as does Figure 3, which also shows these actuation units (4) surrounded by springs (3).

[0034] Independent connectors (12) of each of the actuation units (4) allowing the disassembly of said actuation units (4) with respect to the remaining conduits (9) of the closed circuit have been depicted in Figure 1.

[0035] In Figure 6 it is seen that the mattress integrates the actuation units (4) as previously described, and has a microprocessor (13) managing the feed of the magnetic field generating elements (8) of the actuation units (4) according to the readings of input signals and the system operating criteria.

[0036] Figure 6 also complementarily shows that the mattress may further incorporate temperature sensors (14), pressure sensors (15) and moisture sensors (16) integrated in the padded area (1) sending input signals to a data acquisition card (11) that are treated by the microprocessor (13) and converted into output signals through the program, which emit through an output (17) orders to act on a possible heating system (18) and a ventilation system (19) integrated in the structural area (2) of the mattress.

Claims

1. An anti-bedsore mattress having an upper padded area (1) and a lower structural area (2), **characterized in that** it comprises actuation units (4) distributed in correspondence with the user support sections, a magnetorheological fluid flowing through such units, which integrate a magnetic field generating element (8) acting on the magnetorheological fluid, modifying its viscosity, accordingly determining a variation of the pressure that the actuation unit (4) exerts on the user support section.

2. An anti-bedsore mattress according to claim 1, **characterized in that** the actuation units (4) additionally comprise a cylinder (5) in which a piston (6) moves, said piston being in contact with the magnetorheological fluid which is likewise associated to a vertically shiftable actuator (7) that transmits pressure to the support surface of the mattress on which the user is resting.

3. An anti-bedsore mattress according to claims 1 or 2, **characterized in that** the actuation units (4) are connected to one another by means of a series of conduits (9) forming a closed circuit through which the magnetorheological fluid under pressure circulates.

4. An anti-bedsore mattress according to claim 3, **characterized in that** the closed circuit additionally comprises an adjustable pressure compensation diaphragm (10) allowing the initial system pressure parameters to be adjusted to the patient's weight as well as allowing control of the pressure and fluid flow direction in the actuation units (4).

5. An anti-bedsore mattress according any of claims 1 to 3, **characterized in that** the actuation units (4) are arranged in the structural area (2).

6. An anti-bedsore mattress according to claim 3, **characterized in that** each of the actuation units (4) has independent connectors (12) allowing the disassembly of said actuation units (4) with respect to the remaining conduits (9) of the closed circuit.

7. An anti-bedsore mattress according to claim 1, **characterized in that** it has a microprocessor (13) managing the feed of the magnetic field generating elements (8) of the actuation units (4) according to the pressure readings and associated control.

8. An anti-bedsore mattress according to claim 7, **characterized in that** it incorporates temperature sensors (14), pressure sensors (15) and moisture sensors (16) integrated in the padded area (1) sending input signals to a data acquisition card (11) that are treated by the microprocessor (13) and converted into output signals through a program, which signals emit through an output (17) orders to act on a heating system (18) and a ventilation system (19) integrated in the structural area (2) of the mattress.

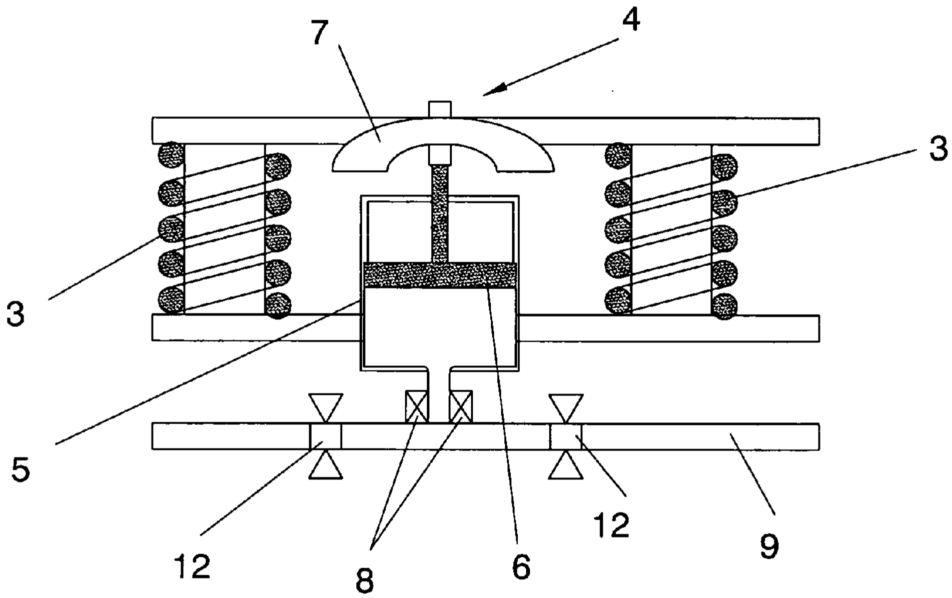

FIG. 1

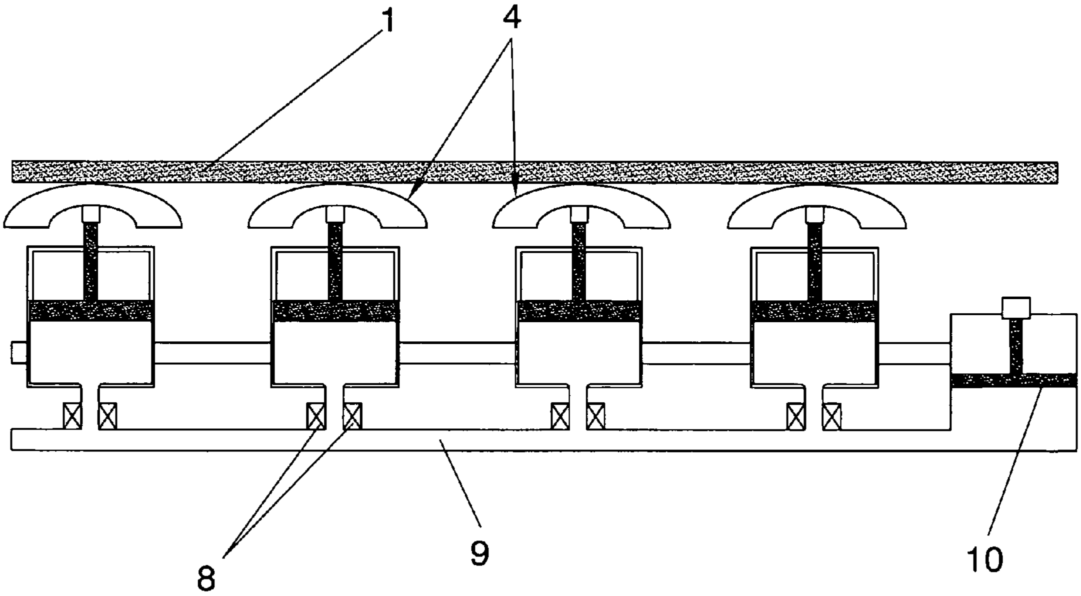

FIG. 2

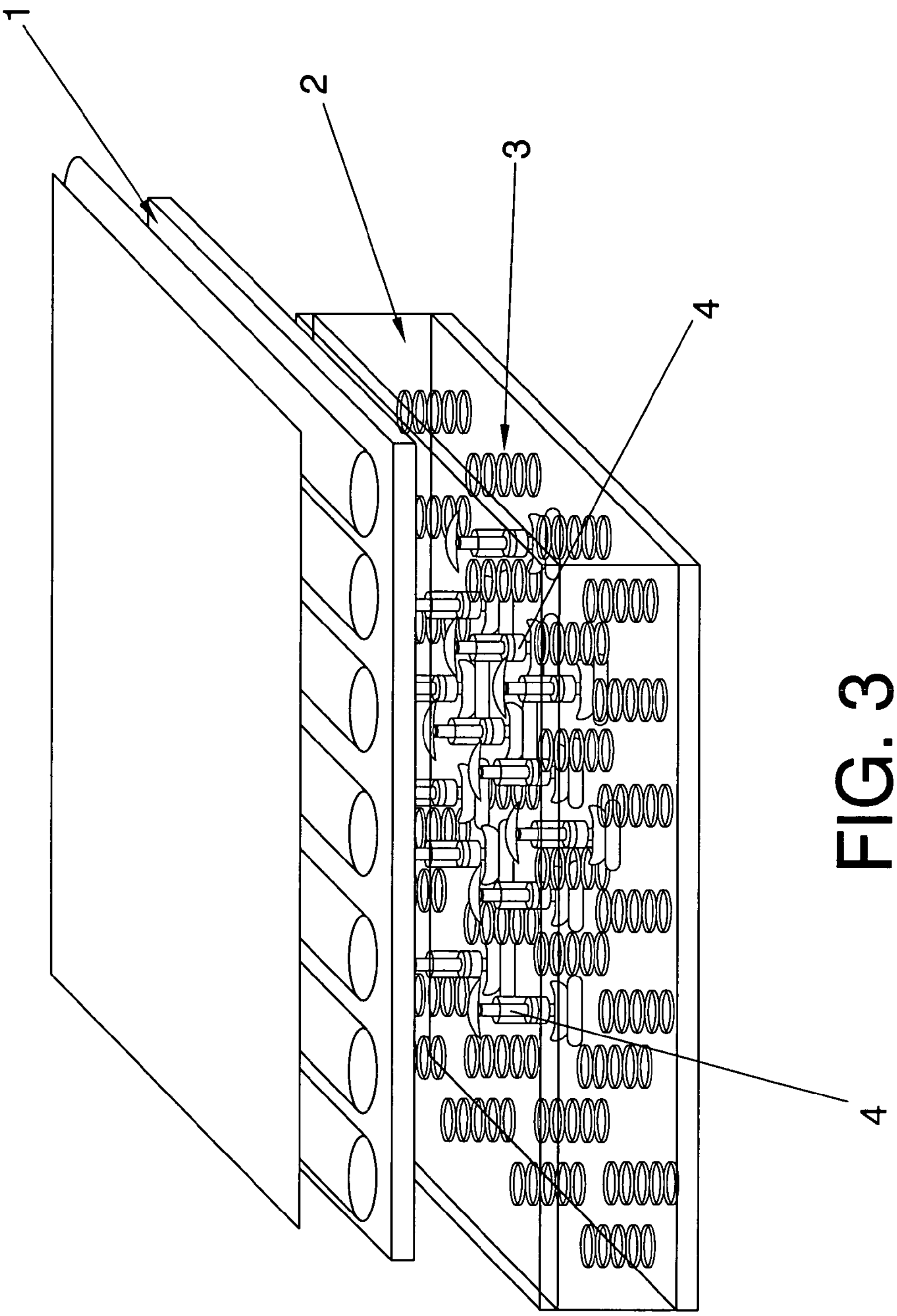

FIG. 3

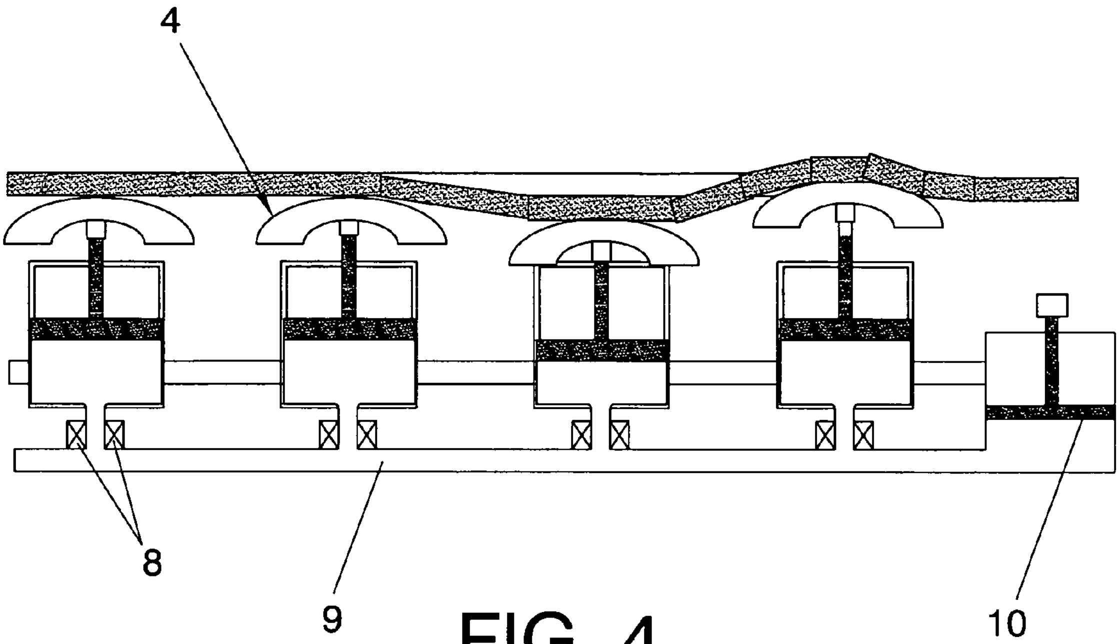

FIG. 4

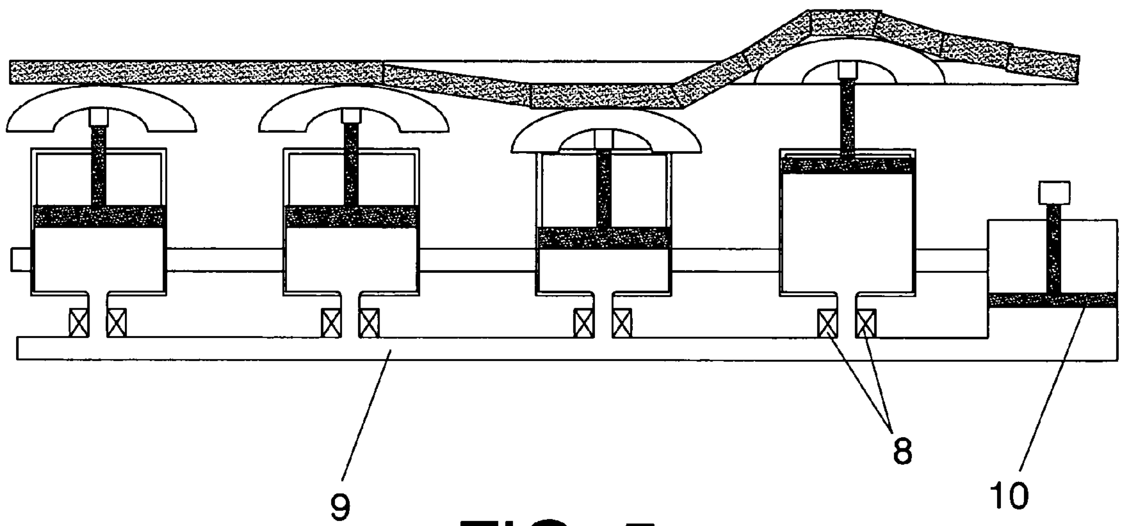

FIG. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 38 0049

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	US 2006/226289 A1 (ROBBINS JODY G [US] ET AL) 12 October 2006 (2006-10-12) * paragraph [0064] - paragraph [0068]; figure 4 * -----	1,5,6	

TECHNICAL FIELDS SEARCHED (IPC)

A61G
A47C
F16F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11 February 2008	Kus, Slawomir

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 38 0049

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11-02-2008

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82