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(54) Title: HARNESSING THE DIFFERENTIAL IN GRAVITY ACCELERATION TO PRODUCE CLEAN ENERGY USING REVOLVING WEIGHTS

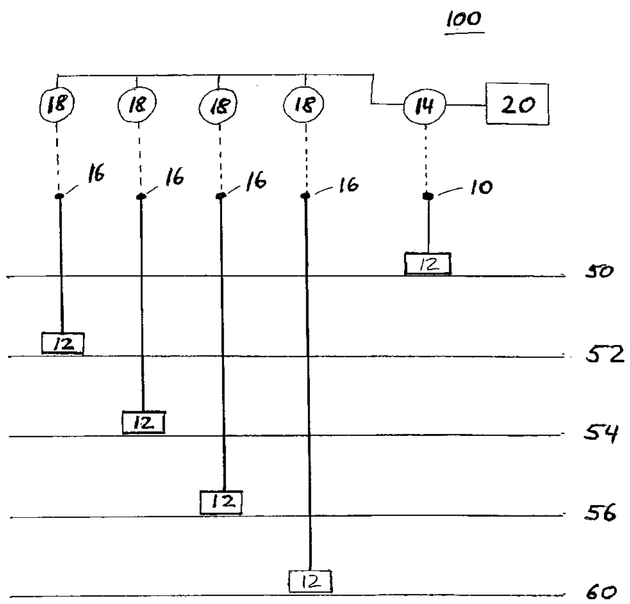

Fig. 1

(57) Abstract: The invention relates to a system, comprising a plurality of weights (12); a first lifting unit (10) configured to lower a weight of the plurality of weights (12) from a first height (50) down to a second height (60) at a first rate; a plurality of second lifting units (16), wherein each second lifting unit (16) is configured to lift a weight of the plurality of weights (12) from the second height (60) up to the first height (50) at a second rate; and an energy storage device (20), wherein the plurality of second lifting units comprises N lifting units, wherein the system is configured to operate in a closed cycle having N steps, wherein N is an integer being equal to the ratio of the first rate to the second rate and wherein the lifting units (10, 16) are coupled to the energy storage device (20) and configured to exchange energy therewith. The invention further relates to a process, comprising N steps, each step comprising lowering a weight of a plurality of weights from a first height down to a second height at a first rate and lifting N weights of the plurality of weights up towards the first height at a second rate; wherein N is an integer larger than 1 and equal to the ratio of the first rate to the second rate.

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Harnessing the differential in gravity acceleration to produce clean energy using revolving weights

The invention relates to a process for harnessing differences in potential energy and a corresponding system.

A system using differences in potential energy to store energy during off-peak electricity periods and release energy during peak electricity periods has been described in WO 2009/056519.

Systems using the difference in elevation between an upper elevation (e.g. at the top of a mountain) and a lower one (e.g. at or near the bottom of the mountain) are also known from US 6,422,016 B2, US 6,009,707, or US 5,873,249. An exemplary system is described in US 5,873,249, wherein a system is provided for generating energy using the difference in elevation between a relatively high elevation and a relatively low elevation, the system comprising: a first container; a first lifting device for lifting the first container from the relatively low elevation to the relatively high elevation and for enabling lowering of the first container from the relatively high elevation to the relatively low elevation; a second container; a second lifting device for lifting the second container from the relatively low elevation to the relatively high elevation and for enabling lowering of the second container from the relatively high elevation to the relatively low elevation; a first generator associated with the first lifting devices; first conversion means for converting energy produced during lowering of the first container into a driving force for the first generator; a first electric motor for driving the first lifting device during lifting of the first container; a second generator associated with the second lifting device; second conversion means for converting energy produced during lowering of the second container into a driving force for the first generator; a second electric motor for driving the second lifting device during lifting of the second container; and means for supplying weight augmenting matter to the containers at the relatively high elevation for discharge from the containers at the relatively low elevation. In a first embodiment of US 5,873,249, the weight augmenting matter comprises a liquefied gas which is converted to a lower pressure gas at said relatively low elevation, and the system further comprises a first pipe system for piping the lower pressure gas, after discharge from said containers, from the relatively low elevation to the relatively high elevation, a compressor, located at the relatively high elevation and connected to the first pipe system for compressing gas supplied from the first pipe system to produce the liquefied gas, and a second pipe system connected to the compressor for supplying the liquefied gas from the compressor to said containers.

Said system thus relies on the presence of weight augmenting matter, which may, however, not be present in many locations in which energy is required. Further, even if such matter may be present in a desired location, the operation of the system according to US 5,873,249 may rapidly deplete the supply of such matter.

There is thus a need in the prior art for a simplified system which can be used regardless of location as well as regardless of the presence of weight augmenting matter.

The present invention relates to a system comprising a plurality of weights, a first lifting unit configured to lower a weight of the plurality of weights from a first height down to a second height at a first rate, a plurality of second lifting units, wherein each second lifting unit is configured to lift a weight of the plurality of weights from the second height up to the first height at a second rate, and an energy storage device.

The plurality of second lifting units comprises N lifting units, wherein the system is configured to operate in a closed cycle having N steps, wherein N is an integer which is equal to the ratio of the first rate to the second rate and wherein the lifting units are coupled to the energy storage device and configured to exchange energy therewith.

Using the system according to the present invention, energy and power are harnessed equalling the difference between the potential energy gained by lowering weights by means of the first lifting unit and said energy difference divided by the time it takes to lower said weight at the first rate, respectively. The energy/power thus generated is then available to be used at least partly to lift weights back up towards the first height by means of the second lifting units and/or to be supplied and stored to the energy storage device, which, in one particularly preferred embodiment may be the national/regional power grid or coupled therewith.

Further, since N is larger than or equal to two, the ratio of the first rate to the second rate thus being larger than one, the first rate is always greater than the second rate. Thus, lowering a weight at the first rate will generate a larger amount of power per unit of time compared to lifting a corresponding weight at the second, smaller rate. This difference may be harnessed by means of the system according to the present invention.

The first and second lifting units may be of equal or at least similar construction. In a preferred embodiment, each of said lifting units may be configured to raise and lower weights to different positions or levels.

In a preferred embodiment of said system the plurality of weights comprises discrete weights having equal mass. In a particularly preferred embodiment, each step is of equal duration.

In a preferred embodiment, each step of the cycle comprises lowering a weight from the first height to the second height by means of said first lifting unit.

Each step of the cycle may further comprise lifting N weights towards the first height by means of the second lifting units, each of the N weights being lifted up by a fraction of 1/N of the height difference between the first height and the second height in each step.

Said system preferably further comprises a first transfer mechanism configured to transfer weights located at the first height between the plurality of second lifting units and the first lifting unit and a second transfer mechanism configured to transfer weights located at the second height between the first lifting unit and the plurality of second lifting units.

The first and second transfer mechanisms may be configured to transfer weights between the first lifting unit and the plurality of second lifting units at the end of each step to ensure closed cycle operation of the system.

Likewise, the present invention relates to a process, comprising N steps, each step comprising

lowering a weight of a plurality of weights, preferably of equal mass, from a first height down to a second height at a first rate and lifting N weights of the plurality of weights up towards the first height at a second rate, wherein N is an integer $N > 1$ and is equal to the ratio of the first rate to the second rate. The first rate is thus always greater than the second rate.

The energy gained and the energy required by lowering and lifting weights, respectively, may be exchanged with an energy storage device, which may, in turn, be coupled to the grid.

In a preferred embodiment, the process operates in steps of equal duration.

Preferably, the process establishes a closed cycle after N steps.

In a particularly preferred embodiment, each step of the cycle comprises lifting N weights up towards the first height, each of the N weights being lifted up by a fraction of 1/N of the height difference between the first height and the second height in each step.

Other features and advantages of the present invention will be set forth in or apparent from the detailed description of the preferred embodiment of the invention.

Brief description of the drawings

Figure 1 is a schematic diagram of a system at the beginning of an operating cycle in accordance with an embodiment of the invention;

Figure 2 is a schematic diagram of the system of figure 1 at a different stage of the operating cycle; and

Figure 3 is a schematic diagram of the system of figure 2 at yet another stage of the operating cycle

Detailed description

Referring to figure 1, there is shown a schematic diagram of a system 100 according to an embodiment of the invention.

System 100 comprises a first lifting unit 10 from which a first weight 12 is suspended, wherein said lifting unit 10 is capable of lifting and lowering weights.

Said first weight 12 is located at a first height 50, as shown in figure 1. The first lifting unit 10 is configured to lower said first weight 12 from said first height 50 down to a second height 60 at a first rate/speed within a time interval delta t. The potential energy released in the process of lowering said first weight 12 from height 50 to the lower height 60 is converted into electrical energy using generator 14 which is suitably coupled to the first lifting unit 10 on the one hand and to an energy storage device 20 on the other hand. Energy storage device 20 could, for instance, be a battery of some kind, a local power network, or the national/regional grid.

Depending on the time interval delta t, the power generated in the process of lowering said first weight 12 from height 50 to height 60 can vary between a low value for a large delta t and a high value for a small delta t. Thus, while the energy generated in the process of lowering said first weight 12 merely depends on the height difference between height 50 and height

60, the power generated during time interval delta t, besides being proportional to said energy, is inversely proportional to delta t itself.

As can be taken from figure 1, system 100 further comprises four lifting units 16 from each of which a weight 12 is suspended. The weights 12 shown in figure 1 are all similar in shape and have equal masses.

The second lifting units 16 are configured to each lift a weight 12 from the second, lower height 60 to the first height 50 at a second rate/speed. The energy and power which is required to lift the four weights 12 from the lower height 60 to the height 50 is provided by motors 18, wherein each second lifting unit 16 is coupled to a motor 18 converting electrical energy into mechanical/potential energy. Motors 18, in turn, are coupled to generator 14 and/or energy storage device 20.

During time interval delta t, each of the four second lifting units 16 lifts a weight 12 by a quarter (i.e. the ratio of the number of first lifting units 10 to the number of second lifting units) of the height difference between the first height 50 and the second height 60. In the staggered arrangement of weights according to figure 1, the first weight 12 on the left hand side of figure 1 is thus lifted from height 52 (located at three quarters of the height difference above lower height 60, i.e. one quarter of the height difference between heights 50, 60 down from height 50) to upper height 50. The second weight 12 from the left is lifted from height 54 (located at two quarters of the height difference above height 60) to height 52. The third weight 12 from the left is lifted from height 56 (located at one quarter of the height difference above height 60) to height 54, and the fourth weight 12 from the left is lifted from height 60 to height 56.

By means of the lowering and lifting actions described above during time interval delta t, the system reaches the state having a distribution of weights 12 as shown in figure 2. The surplus energy/power generated by lowering the weight 12 suspended from the first lifting unit 10 is transferred to energy storage device 20, which may be a battery or a power network. At the same time or subsequently, the energy thus generated can at least partly be used to supply energy to motors 18.

Once the state shown in figure 2 has been reached, weight 12 suspended from the first lifting unit 10 is detached therefrom and subsequently transferred using a transfer mechanism 22, indicated by an arrow in figure 2, to a position at height 60 in which said weight 12 can be attached to the second lifting unit 16 on the left hand side in figure 2. Similarly, the weight 12 which has been lifted to height 50 by said second lifting unit 16 on the left hand side in figure 2, is detached therefrom and transferred to a position at height 50 in which it can be attached to the first lifting unit 10 using another transfer mechanism 24, similarly indicated by an arrow in figure 2.

The distribution of weights 12 in the system 100 after the described transfer has taken place is shown in figure 3.

The system 100 is now ready for the next process step. In the next process step the weight 12 suspended from the first lifting unit 10 is lowered from height 50 down to height 60 during time interval delta t, whereas the four weights 12 suspended from the second lifting units 16 are all lifted by a quarter of the height difference between heights 50, 60 during the same time interval delta t.

Thus, an energy generating system is provided which generates energy and power by lowering weights along a large height difference. Upper height 50 may, for instance, be located at or near the top of a mountain, whereas height 60 of the system may be located at or near the bottom of the mountain. A suitable candidate location for the system is the Sarawat mountain range on the Western coast of the Arabian peninsular rising above 2000 meter.

Details of the first and second transport mechanisms 22, 24 are not described but will be apparent to the skilled person. For example, the weights can be equipped with wheels and the first and second transfer mechanisms may be implemented in the form of rail tracks at heights 50 and 60, respectively.

The lifting units 10, 16 of system 100 may all be implemented in the same way, for instance, in the form of heavy-lift cranes or pulley mechanisms.

The extent of the protection conferred by the present application shall be determined by the appended claims. Nevertheless, the description and drawings shall be used to interpret the claims.

Claims

1. System, comprising
a plurality of weights (12);
a first lifting unit (10) configured to lower a weight of the plurality of weights (12) from a first height (50) down to a second height (60) at a first rate;
a plurality of second lifting units (16), wherein each second lifting unit (16) is configured to lift a weight of the plurality of weights (12) from the second height (60) up to the first height (50) at a second rate; and
an energy storage device (20),
wherein the plurality of second lifting units comprises N lifting units,
wherein the system is configured to operate in a closed cycle having N steps,
wherein N is an integer being equal to the ratio of the first rate to the second rate and
wherein the lifting units (10, 16) are coupled to the energy storage device (20) and configured to exchange energy therewith.

2. System according to claim 1, wherein the plurality of weights (12) comprises discrete weights having equal mass.

3. System according to one of the preceding claims, wherein each step is of equal duration.

4. System according to one of the preceding claims, wherein each step of the cycle comprises lowering a weight from the first height (50) to the second height (60) by means of said first lifting unit (10).

5. System according to one of the preceding claims, wherein each step of the cycle further comprises lifting N weights towards the first height (50) by means of the second lifting units (16), each of the N weights being lifted up by a fraction of 1/N of the height difference between the first height (50) and the second height (60) in each step.

6. System according to one of the preceding claims, the system further comprising
a first transfer mechanism (24) configured to transfer weights (12) located at the first height (50) between the plurality of second lifting units (16) and the first lifting unit (10); and

a second transfer mechanism (22) configured to transfer weights located at the second height (60) between the first lifting unit (10) and the plurality of second lifting units (16).

7. System according to one of the preceding claims, wherein the first and second transfer mechanisms are configured to transfer weights between the first lifting unit (10) and the plurality of second lifting units (16) at the end of each step to ensure closed cycle operation of the system (100).

8. Process, comprising N steps, each step comprising
lowering a weight of a plurality of weights from a first height down to a second height at a first rate and
lifting N weights of the plurality of weights up towards the first height at a second rate;
wherein N is an integer larger than 1 and equal to the ratio of the first rate to the second rate.

9. Process according to claim 8, wherein the weights are of equal mass.

10. Process according to one of the preceding claims, wherein the process operates in steps of equal duration.

11. Process according to one of the preceding claims, wherein the process establishes a closed cycle after N steps.

12. Process according to one of the preceding claims, wherein each step of the cycle comprises lifting N weights up towards the first height (50), each of the N weights being lifted up by a fraction of 1/N of the height difference between the first height (50) and the second height (60) in each step.

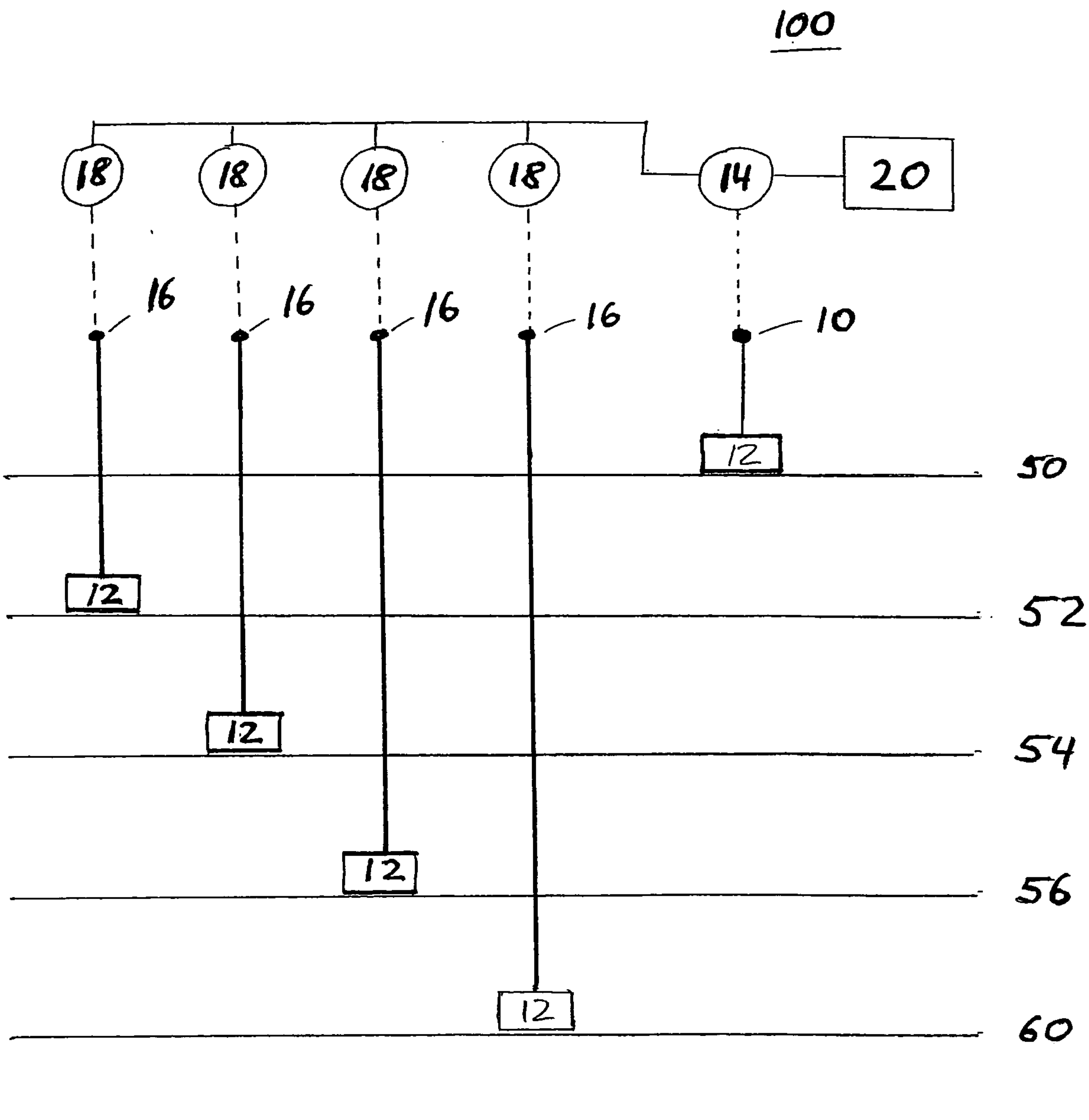

Fig. 1

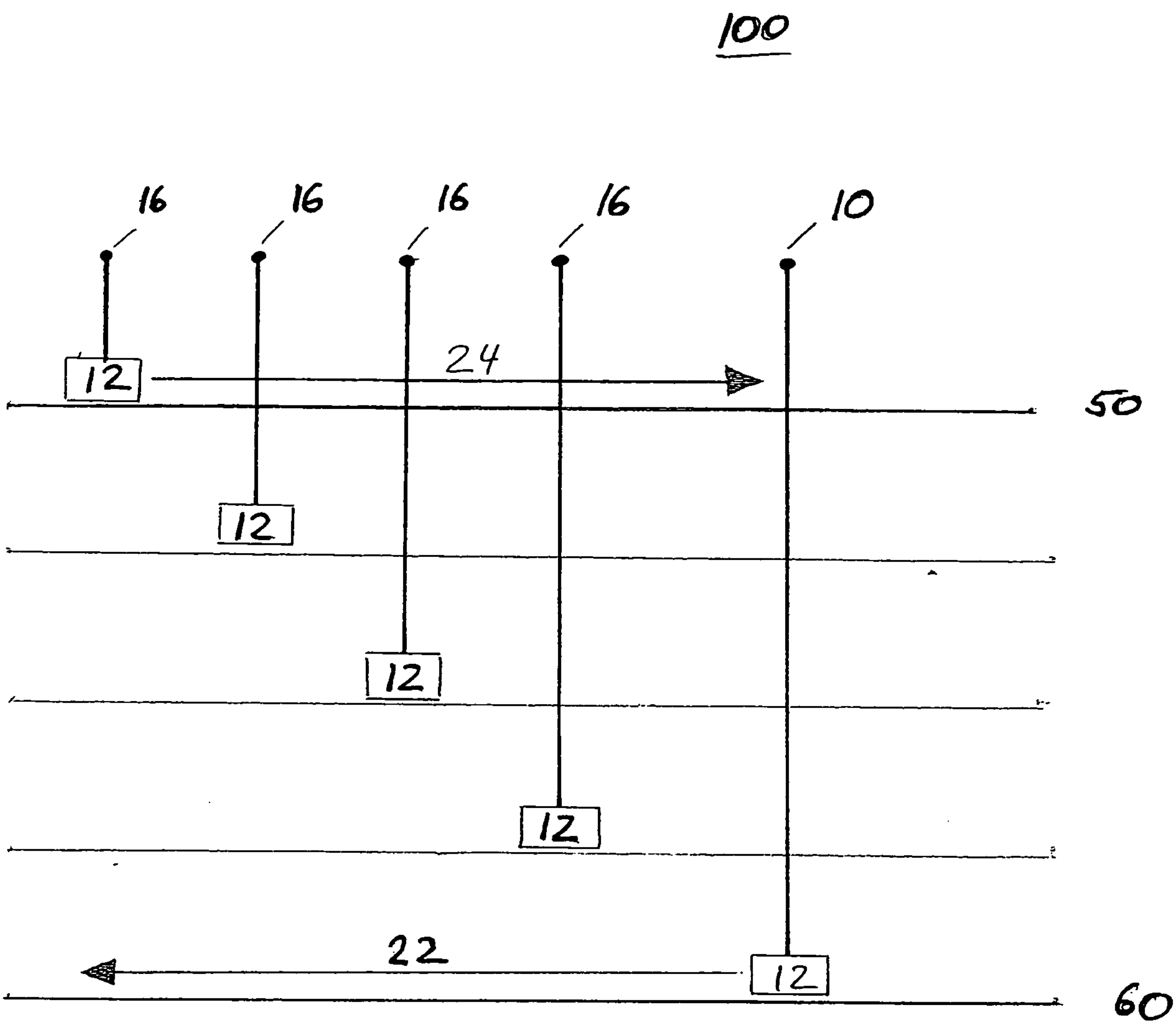

Fig. 2

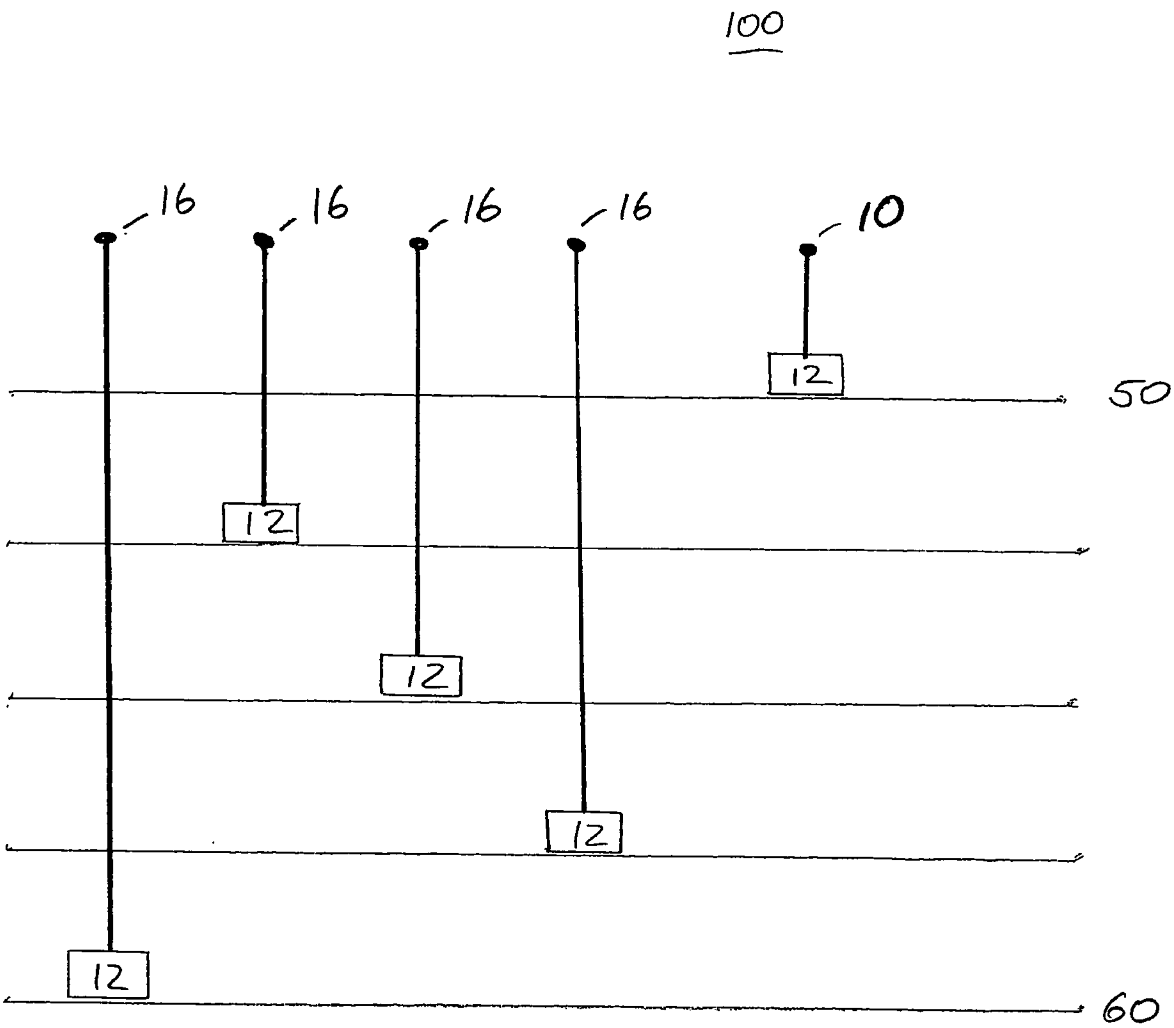

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/004518

A. CLASSIFICATION OF SUBJECT MATTER
INV. F03G3/00 F03G7/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F03G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 224 807 A (HARE JAMES JACKSON; HARE JAMES GEORGE ARMSTRONG) 16 May 1990 (1990-05-16) the whole document	1-12
X	DE 10 2005 038615 A1 (WEISBRODT FRANK [DE]) 10 May 2007 (2007-05-10) the whole document	1-12
A	US 2002/005042 A1 (ALKHAMIS MOHAMMED [SA]) 17 January 2002 (2002-01-17) the whole document	1
A	EP 0 931 930 A (ALKHAMIS MOHAMMAD A [SA]) 28 July 1999 (1999-07-28) the whole document	1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2009	17/08/2009

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2009/004518

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