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(54) **STATIONARY EXERCISE DEVICE**

(57) A stationary exercise device with a driving assembly with a driving wheel rotating around a driving axle, a first and a second crank each connected to the driving wheel and two pedals, each connected to one of the cranks, a flywheel connected to the driving assembly by at least one gear mechanism, a brake assembly for applying a braking force to the flywheel, at least one measuring device for measuring the position of the first and second crank is provided, wherein a detection device detects several time intervals, in each of which the flywheel is displaced a predetermined angle, said detection device further detects time differences between at least two of the time intervals, wherein a control device determines, through dependence of the time differences between at least two of the time intervals, a torque at the driving wheel or a value dependent on the torque at the driving wheel.

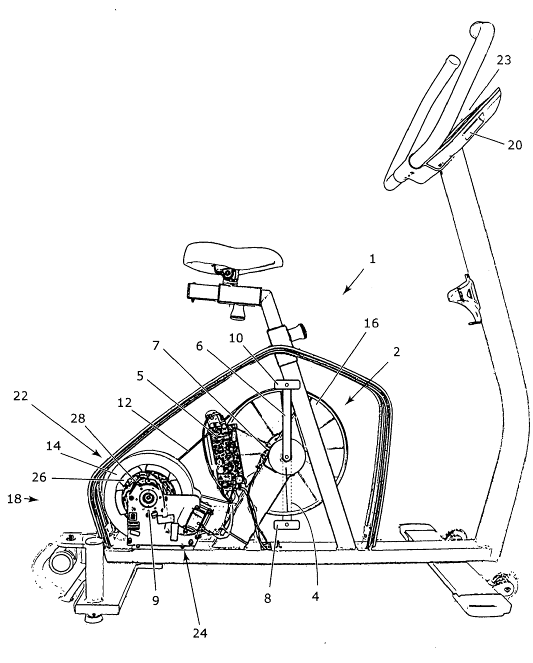

Fig. 1

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Description

[0001] The present invention relates to a stationary exercise device according to the preamble of claim 1 and a method for measuring a torque at the driving wheel or a value dependent on the torque at the driving wheel according to the precharacterizing part of claim 10.

[0002] Stationary exercise devices are known which have a driving assembly with a driving wheel rotating around a driving axle, a first and a second crank each connected to the driving wheel and two pedals, each connected to one of the cranks. Further a flywheel is provided which is connected to the driving assembly by at least one gear mechanism. The stationary exercise devices normally further comprise a brake assembly for applying a braking force to the flywheel and may also comprise at least one measuring device for measuring the position of the first and second crank.

[0003] The stationary exercise device can be used in the field of physiotherapy. With stationary exercise devices the torque balance between the left and the right limbs can be determined. However, in the stationary exercise device known in the prior art this is very difficult and additional external sensors are used in order to measure the torque balance. For example, strain gauges can be attached to the cranks or to the axle between the cranks or the tension in the drive chain can be measured.

[0004] The object of the present invention is to provide a stationary exercise device or a method for measuring a torque at the driving wheel or a value dependent on the torque at the driving wheel which is very easy and cost-effective.

[0005] The present invention is solved by the features according to claims 1 and 10.

[0006] According to the present invention a detection device detects several time intervals, in each of which the wheel is displaced a predetermined angle, said detection device further detects time differences between at least two of the time intervals, wherein a control device determines through dependence of the time differences between at least two of the time intervals, a torque at the driving wheel or a value dependent on the torque at the driving wheel.

[0007] The present invention has the advantage that no additional sensors at the driving assembly are needed and the torque at the driving wheel or a value dependent on the torque at the driving wheel can be easily determined.

[0008] The control device correlates a determined torque at the driving wheel or the value dependent on the torque at the driving wheel to the first or second crank dependent on the position of the first and second crank.

[0009] The first and the second crank can also be understood as left and right crank.

[0010] A display can be provided, on which the torque at the driving wheel or a value dependent on the torque at the driving wheel correlated with the first crank and the torque at the driving wheel or the value dependent on the torque at the driving wheel correlated with the second wheel is shown, so that the difference between the torque at the driving wheel correlated with the first crank and the torque at the driving wheel correlated with the second crank can be seen.

[0011] For example, the first crank can be the left crank and the second crank can be right crank. For example, for the left limb the torques can be correlated to the left limb between the position where the left crank or pedal is at its highest point and where it is at its lowest point. On the other hand, the right limb can be correlated to the torques when the right crank would be between a position where the right crank or pedal is at its highest point there it is at its lowest point.

[0012] For example, the average torque for the first or the second crank can be estimated from the average torque of all sectors of the half rotation associated with that respective crank. Alternatively, also only the peak torque in the rotation can be used. As a further alternative every torque which is calculated for each interval can be shown on the display.

[0013] In this way the balance between the limbs or legs can be determined.

[0014] The value dependent on the torque at the driving wheel correlated with a first or second crank can be for example the percentage of the torque at the driving wheel correlated with the first crank related to total torque at the driving wheel and/or the percentage of the torque at the driving wheel correlated with the second crank related to total torque at the driving wheel.

[0015] It is also possible that at a balance index, preferably a Watt balance index can be calculated which is a value which show the relationship between the torque at the driving wheel correlated with the first crank and the torque at the driving wheel correlated to a second crank.

[0016] The brake assembly can comprise a generator for electrical power generation and an eddy magnetic resistance.

[0017] The brake assembly comprising a generator for electrical power-generation and an eddy-current magnetic resistance are already known in the prior art and e.g. described in the patent US 6,084,325.

[0018] The generator produces an AC current, wherein the change in current is used to detect the time intervals in each of which a flywheel is displaced a predetermined angle.

[0019] The generator can use magnets and a set of coils to produce a n-phase AC power, wherein the detection device detects the zero crossing of 1 or more of the phases, so that time intervals between the zero crossing can be determined, in each of which the flywheel is displaced a predetermined angle.

[0020] The detection device can produce a rectangular wave when the zero crossing of one of the phases is detected and wherein the detection device captures the time of rising and/or falling edge of each wave in order to determine the time intervals between the edge of the waves.

[0021] The detection device can comprise a comparator which detects the zero crossing and produce a rectangular wave and further also a monitor which capture the time of the rising edge of each pulse. The detection device can be part of the braking device of part of the control device.

[0022] The generator can use 6 magnets a 3 sets of coils to produce a three-phase AC power.

[0023] The magnets and the set of coils are evenly spaced from each other so that the zero crossing takes place when the flywheel is displaced a predetermined angle. In case of a three-phase AC power there are six edges of the rectangular waves which are spaced from each other at every 60° of the revolution of the flywheel.

[0024] The control device can preset the torque of the brake assembly.

[0025] The torque at the crank can be determined dependent on the time intervals, the time differences between the at least two of the time intervals and the torque of the brake.

[0026] The torque of the brake assembly can be calibrated once for each stationary exercise device. The calibration can be done with external torque sensors and an external motor which drives the crank axle. A constant current in the brake coil gives a torque which is largely independent of the rotational speed of the brake.

[0027] The torque at the crank can be calculated with the following formula:

$$\text{Torque at the flywheel} = \text{angular momentum x angular acceleration}$$

$$\text{angular acceleration a} = \frac{(\frac{\Delta\varphi}{T2} - \frac{\Delta\varphi}{T1})}{T1} = \frac{\Delta\varphi(\frac{T2-T1}{T1T2}}{T1}$$

[0028] Further $\Delta\varphi$ is a constant predetermined angle. T2 and T1 are the time intervals for the rotation of the flywheel of the predetermined angle $\Delta\varphi$. T2-T1 $=\Delta t$ which is the time difference between the time intervals.

$$\text{Torque at the flywheel} = \text{torque of the brake - torque of the crank}$$

$$\text{Torque at the flywheel} = \text{torque of the brake - torque of the crank} =$$

$$\text{angular momentum x} \frac{\Delta\varphi(\frac{\Delta t}{T1T2})}{T1}$$

[0029] The angular momentum can be determined when using a roll down test. A roll down test is made by spinning the brake above the highest required speed then allowing it to decelerate at constant brake torque. In this case the torque of the crank is zero since no force is applied to the pedals. As already mentioned, the brake torque is known and therefore a momentum can be determined once for each exercise device.

[0030] The torque at the crank can be calculated with the above mentioned formula.

[0031] According to the present invention there is also a method for measuring a torque at the driving wheel or value dependent on the torque at the driving wheel of an exercise device comprising a driving assembly with a driving wheel rotating around a driving axel, first and a second crank each connected to the driving wheel and two pedals, each connected to one of the cranks, a flywheel connected to the driving assembly by at least one gear mechanism, a brake assembly for applying a brake force to the flywheel and at least one measuring device for measuring the position of the first and second crank. The method comprises a step of

- detecting several time intervals by a detecting device, in each of said time intervals the flywheel is displaced a predetermined angle, wherein further the time differences between the at least two of the time intervals are determined,

- determining in dependence of the time differences between at least two of the time intervals a torque at the driving wheel or a value dependent on the torque at the driving wheel.

[0032] The determined torque at the driving wheel or the value dependent on the torque at the driving wheel is correlated to the first or second crank dependent on the position of the first and second crank.

[0033] The torque at the driving wheel or the value dependent on the torque at the driving wheel correlated with the first crank and the torque at the driving wheel or the value dependent on the torque at the driving wheel correlated with the second wheel are shown on a display so that the difference between the torque at the driving wheel correlated with the first crank and the torque at the driving wheel correlated with the second wheel can be seen.

[0034] The brake assembly comprises a generator which produces a n-phase AC power, wherein the zero crossing of each of the phases is detected, so that the time intervals between the zero crossing can be determined in each of which the flywheel is displaced a predetermined angle.

[0035] A rectangular wave is produced when the zero crossing of one of the phases is detected and wherein the time of the rising edge of each pulse is captured in order to determine the time intervals between the edges of each pulse.

[0036] The torque of the brake assembly is preset and wherein the torque at the driving wheel or the value dependent on the torque at the driving wheel determined in dependence of the time differences between at least two of the time intervals. The torque of the brake assembly can also be determined in dependence of the time intervals.

[0037] In the following the present invention is described with respect to schematic drawings.

Fig. 1 shows a stationary exercise device,

Fig. 2 shows a schematic driving wheel with a crank and a pedal,

Fig. 3 shows a display showing the torque at the crank,

Fig. 4 shows a display with an alternative representation for the torque.

[0038] In Fig. 1 a stationary exercise device 1 is shown. A stationary exercise device 1 comprising a driving assembly 2 with a driving wheel 16 rotating around a driving axle 3, a first and a second crank 4, 6 connected to the driving wheel 16 and two pedals 8, 10, each connected to one of the cranks 4, 6. A flywheel 14 is connected to the driving assembly 2 by at least one gear mechanism 12. In the present invention the gear mechanism 12 is a drive belt.

[0039] Further, a brake assembly 18 is provided for applying a braking force to the flywheel 14. At least one measuring device 7 is arranged at the driving assembly 2 for measuring the position of the first and second crank 4, 6. A detection device 5 is provided which detects several time intervals, in each of which the flywheel 14 is displaced a predetermined angle.

[0040] Said detection device further detects the time differences between at least two of the time intervals, wherein a control device 20 determines in dependence of the time differences between at least two of the time intervals a torque at the driving wheel or a value dependent on the torque at the driving wheel. Further, a display 23 is provided. On the display the torque at the driving wheel correlated to the first or second crank or a value dependent on the torque at the driving wheel for the first or the second crank can be shown as explained below.

[0041] The brake assembly 18 comprises a generator 22 and eddy current brake coil 24 which is used as eddy current magnetic resistance for the flywheel 14. When a current is applied to an eddy current coil 24, a braking torque is applied to a flywheel. The braking torque is calibrated, so that a preset braking torque can be applied to the flywheel.

[0042] A generator uses magnets 26 and a set of coils 28 to produce an AC power. In the present case the generator uses 6 magnets and 3 sets of coils to produce the three-phase AC power. The detection device 5 detects the zero crossing of one of the phases, so that time intervals between the crossing can be determined, in each of which the flywheel is displaced a predetermined angle. In the present case there are coils evenly spaced from each other. The predetermined angle is 60°. The detection device 5 can produce a rectangular wave and the zero crossing of one of the phases is detected and the detection device and/or the control device 20 can capture the time of the rising edge of each pulse in order to determine the time intervals between the edges of each pulse.

[0043] The measuring device 7 measures the position of the first and second crank 4, 6.

[0044] The driving wheel is also schematically shown in Fig. 2. Since the position is known from the measuring device 7 the torque which is calculated can be correlated to the position of the first and/or second crank 4,6. Furthermore, half of the rotation of the crank can be associated with the right leg and half of the rotation of the crank can be associated with the left leg. E.g. as shown in Fig. 2 the second crank is in the highest position. Between this position when the crank is in the highest position and between the position when the crank is in the lowest position (as shown in dotted lines) the torques which are determined in this time can be associated to the right leg and vice versa with the left leg or first crank.

[0045] The torques determined which are associated with the first and/or a second crank can be shown in a display as shown in Figs. 3 and 4. E.g. in Fig. 3 a percentage of the torque of the first 40 and a percentage of the second crank 42 with respect to the overall torque of the crank is shown. E.g. in the display in the bottom on the left a percentage of the torque 40 associated with the first crank is shown and on the right hand the percentage of the torque 42 associated with the second crank is shown. As an alternative also only a graphical representation can be shown as shown in Fig.

4. Each vertical bar in the graphic 44, 46 presents a torque measurement of the crank or an average of e.g. two torque measurements.

[0046] Furthermore, since six time intervals are determined per each revolution of the flywheel and because of the gear mechanism, the ratio between the rotation of the crank or the rotation of the flywheel is 10:1, 60 torque measurements are made e.g. per rotation of the crank.

Claims

1. A stationary exercise device with a

   - driving assembly with a driving wheel rotating around a driving axle, a first and a second crank each connected to the driving wheel and two pedals, each connected to one of the cranks,
   - a flywheel connected to the driving assembly by at least one gear mechanism,
   - a brake assembly for applying a braking force to the flywheel,
   - at least one measuring device for measuring the position of the first and second crank,

   characterized in that,
   a detection device detects several time intervals, in each of which the flywheel is displaced a predetermined angle, said detection device further detects time differences between at least two of the time intervals,
   wherein a control device determines, through dependence of the time differences between at least two of the time intervals, a torque at the driving wheel or a value dependent on the torque at the driving wheel.

2. The stationary exercise device according to claim 1, wherein the control device correlates the determined torque at the driving wheel or the value dependent on the torque at the driving wheel to the first or second crank dependent on the position of the first and second crank.

3. The stationary exercise device according to claim 2, wherein a display is provided, on which the torque at the driving wheel or the value dependent on the torque at the driving wheel correlated with the first crank and the torque at the driving wheel or the value dependent on the torque at the driving wheel correlated with the second wheel is shown, so that the difference between the torque at the driving wheel correlated with the first crank and the torque at the driving wheel correlated with the second crank can be seen.

4. The stationary exercise device according to claim 2 or 3, wherein the control device determines the percentage of the torque at the driving wheel correlated with the first crank related to total torque at the driving wheel and/or the percentage of the torque at the driving wheel correlated with the second crank related to total torque at the driving wheel.

5. The stationary exercise device according to one of the claims 1 to 4, wherein the brake assembly comprises a generator for electrical power generation and an eddy current magnetic resistance.

6. The stationary exercise device according to claim 5, wherein the generator produces a current, which is used to detect the time intervals, in each of which the flywheel is displaced a predetermined angle.

7. The stationary exercise device according to claim 5 or 6, wherein the generator uses magnets and a set of coils to produces a n-phase AC power, wherein the detection device detects the zero crossing of each of the phases, so that time intervals between the zero crossing can be determined, in each of which the flywheel is displaced a predetermined angle.

8. The stationary exercise device according to claim 7, wherein the detection device produces a rectangular wave when the zero crossing of one of the phases is detected and wherein the detection device captures the time of the rising and/or falling edge of each pulse in order to determine the time intervals between the edges of each pulse.

9. The stationary exercise device according to one of the claims 1 to 8, wherein the control device presets the torque of the brake assembly, wherein the torque at the driving wheel or a value dependent on the torque at the driving wheel is determined dependent from the the time intervals, the time differences between at least two of the time intervals and the torque of the brake assembly.

10. A method for measuring a torque at the driving wheel or a value dependent on the torque at the driving wheel of an exercise device comprising a driving assembly with a driving wheel rotating around a driving axle, a first and a second crank each connected to the driving wheel and two pedals, each connected to one of the cranks, a flywheel connected to the driving assembly by at least one gear mechanism, a brake assembly for applying a braking force to the flywheel and at least one measuring device for measuring the position of the first and second crank, the method comprises the steps of:

- detecting several time intervals by a detection device, in each of said time intervals the flywheel is displaced a predetermined angle, wherein further the time differences between at least two of the time intervals are determined,
- determining in dependence of the time differences between at least two of the time intervals a torque at the driving wheel or a value dependent on the torque at the driving wheel.

11. The method according to claim 10, wherein the determined torque at the driving wheel or the value dependent on the torque at the driving wheel is correlated to the first or second crank dependent on the position of the first and second crank.

12. The method according to claim 10 or 11, wherein the torque at the driving wheel or the value dependent on the torque at the driving wheel correlated with the first crank and the torque at the driving wheel or the value dependent on the torque at the driving wheel correlated with the second wheel are shown on a display, so that the difference between the torque at the driving wheel correlated with the first crank and the torque at the driving wheel correlated with the second wheel can be seen.

13. The method according to one of the claims 10 to 12, wherein the brake assembly comprises a generator which produces a n-phase AC power, wherein the zero crossing of each of the phases is detected, so that the time intervals between the zero crossing can be determined, in each of which the flywheel is displaced a predetermined angle.

14. The method according to one of the claims 10 to 13, wherein a rectangular wave is produced when the zero crossing of one of the phases is detected and wherein the time of the rising edge of each pulse is captured in order to determine the time intervals between the edges of each pulse.

15. The method according to one of the claims 10 to 14, wherein the torque of the brake assembly is preset and wherein the torque at the driving wheel or a value dependent on the torque at the driving wheel is determined from the time differences between at least two of the time intervals and the torque of the brake assembly.

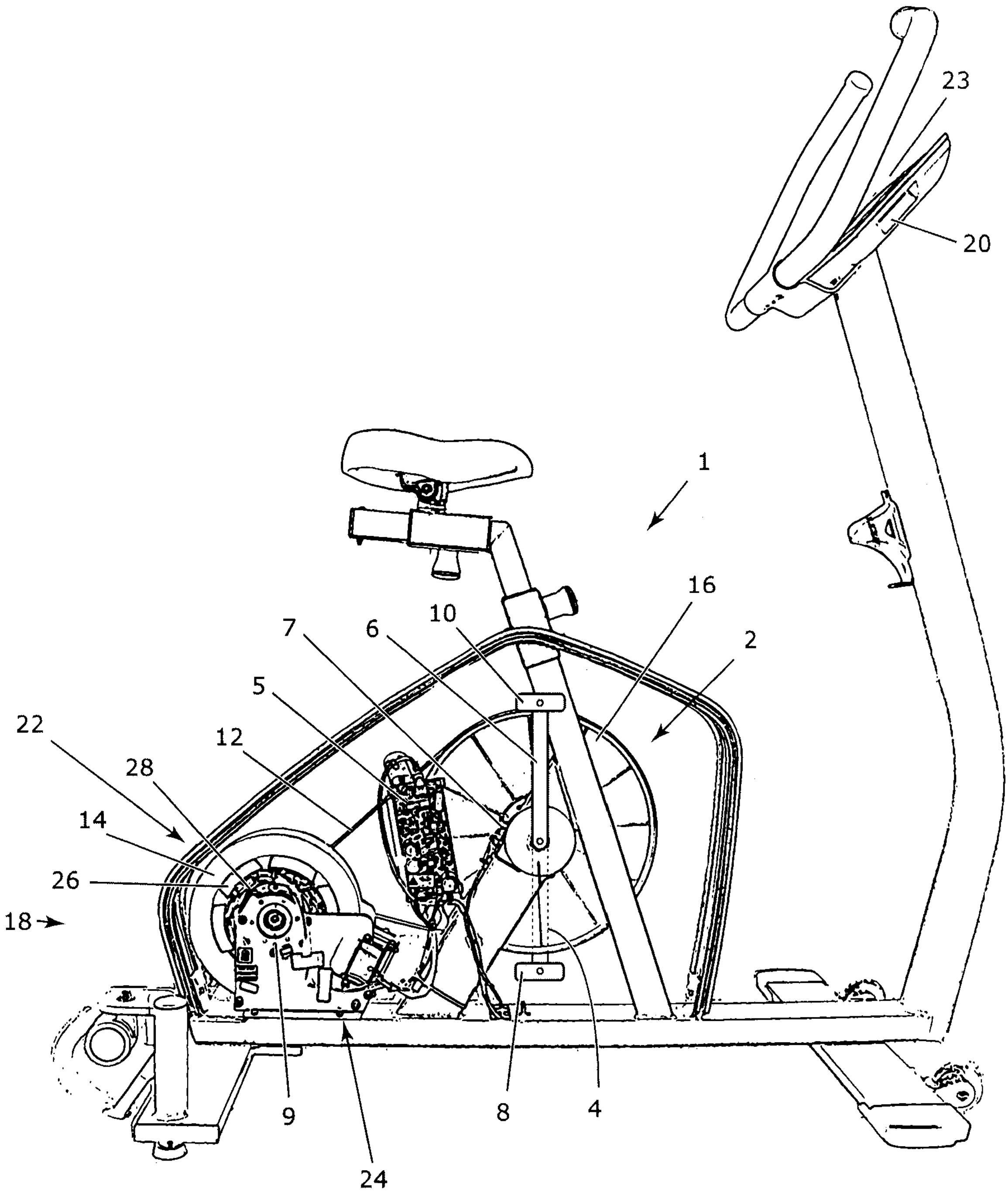

Fig. 1

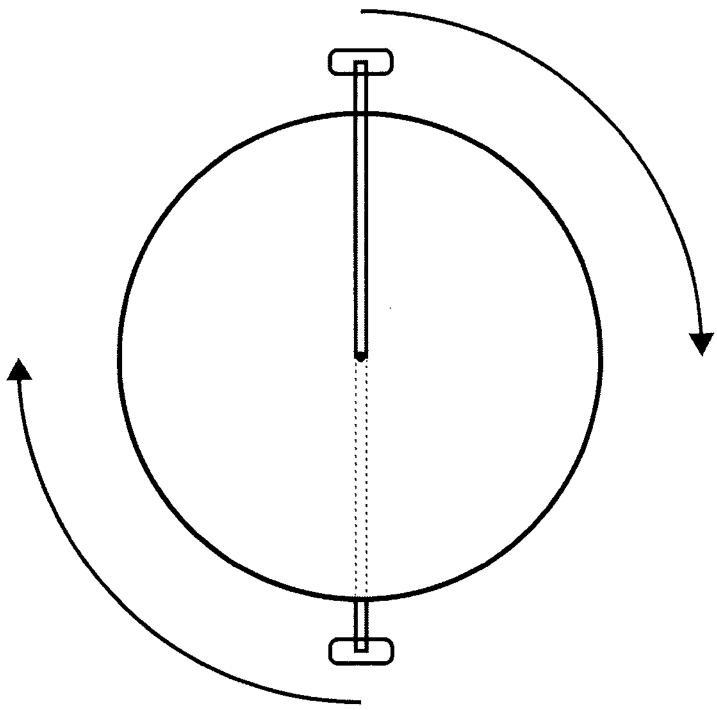

Fig. 2

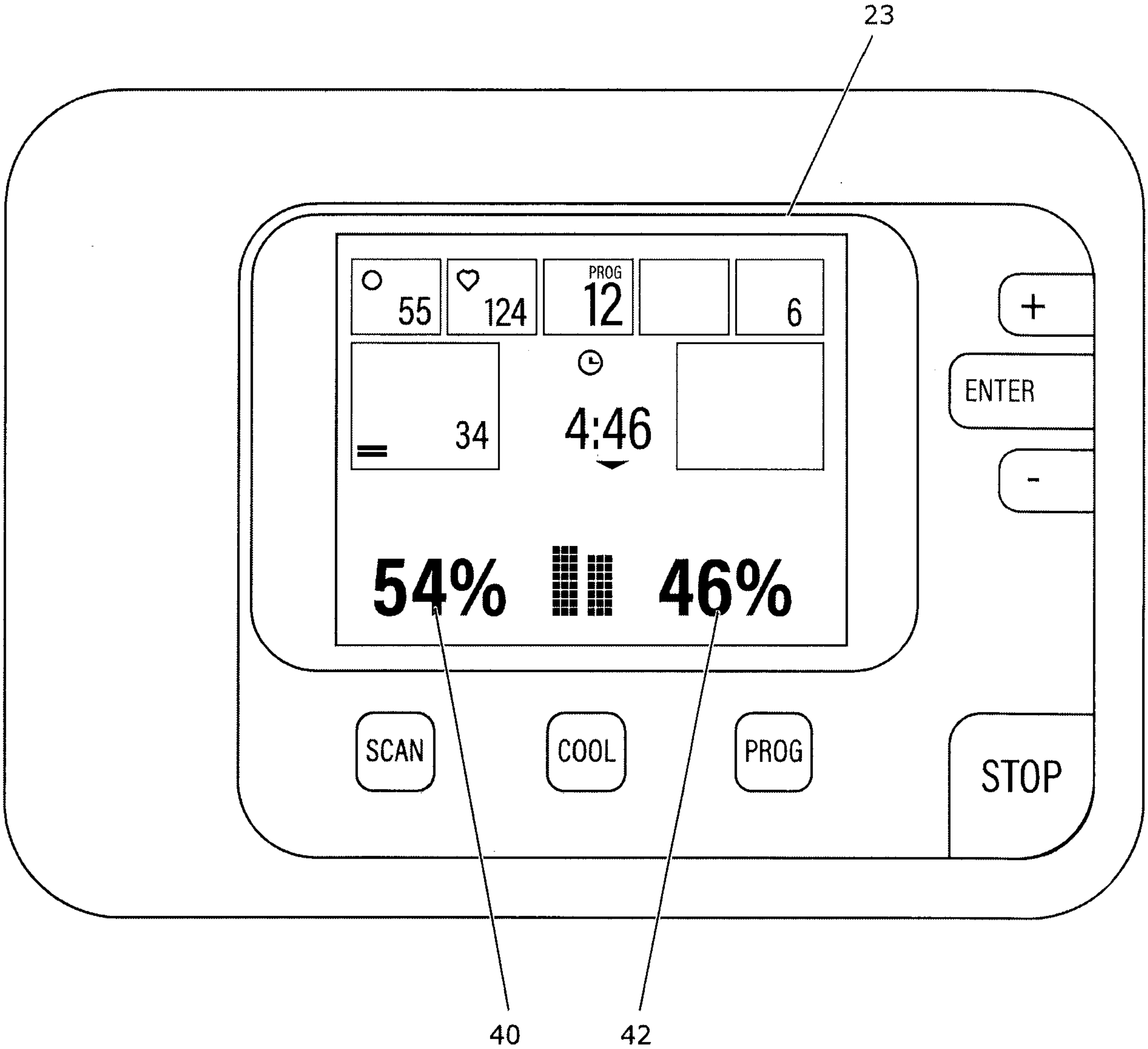

Fig. 3

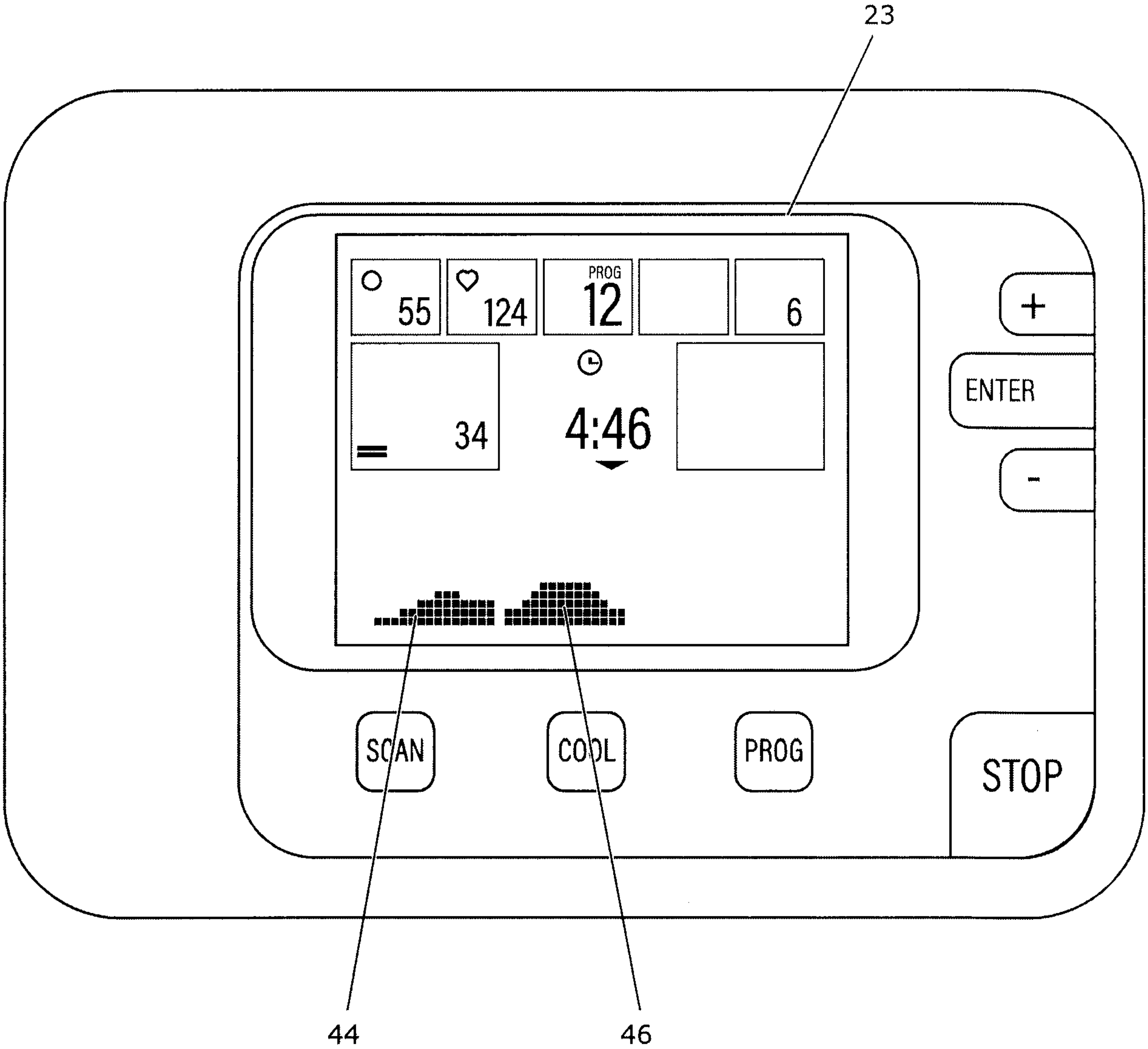

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 19 15 1626

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 July 2019	Vesin, Stéphane

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

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