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(54) REMOTE MEASURING DEVICE FOR AN EXERCISE MACHINE WITH COUNTERWEIGHTS

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(57) **ABSTRACT**

A device for measuring at least one current mechanical state parameter of a mobile counterweight on an exercise machine with counterweights, in which the counterweight comprises a plurality of weights placed one on top of another, whose number can be selected using a selection pin, which can be attached as required to one of the weights, so as to define a counterweight with a predetermined weight. The device comprises means for generating a signal that indicates the instantaneous position of the pin relative to a predetermined reference part and means for detecting the signal. The generation means and the detector means are directly opposite one another and separated by the distance which the signal covers only once so that the length of the signal path is minimized.

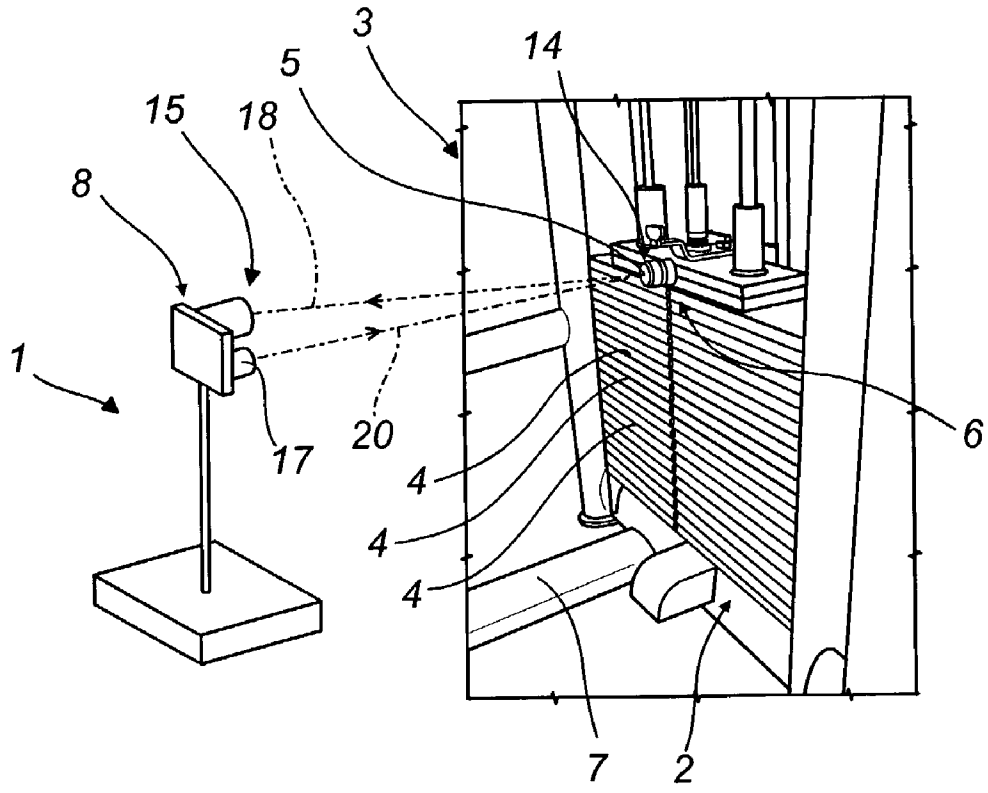


FIG. 1

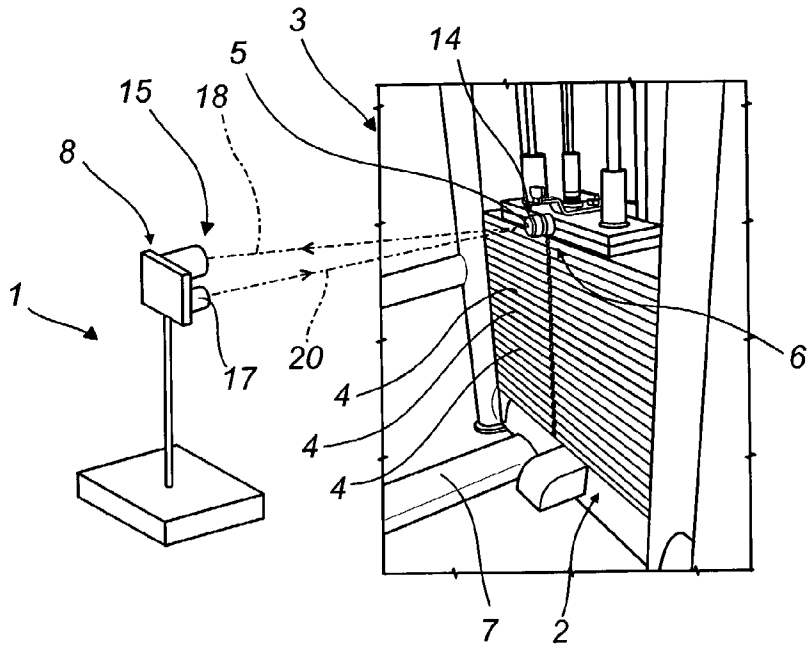


FIG. 2

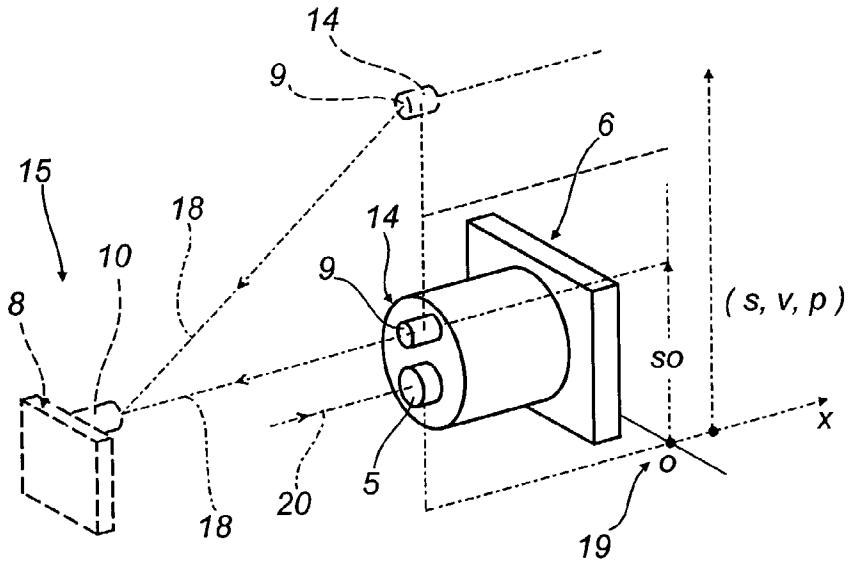


FIG. 3

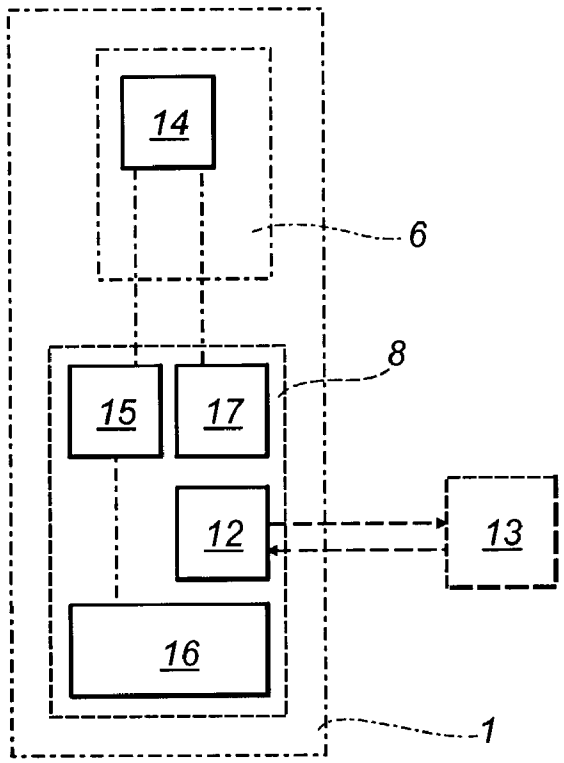
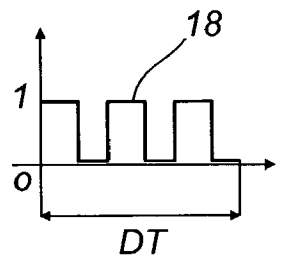


FIG. 4



REMOTE MEASURING DEVICE FOR AN EXERCISE MACHINE WITH COUNTERWEIGHTS

BACKGROUND OF THE INVENTION

[0001] The present invention relates to the sector of exercise machines with counterweights, in which the counterweights consist of a vertical stack of plates positioned one on top of another, which the machine user can select as required, using a selection pin and in proportion to the desired counterweight load.

[0002] The present invention relates in particular to a remote measuring device, designed to measure several important parameters relating to the mechanical state of the counterweight—such as the static load applied and the intensity of the kinematic speed and displacement parameters of the counterweights during the exercise.

[0003] In the aforementioned sector of devices for the measurement of parameters, devices are known which can substantially be classed as electromechanical systems, and combined electromechanical and optical systems.

[0004] The latter include in particular a device—described in document BO2000A000389 in the name of the same Applicant—which, to measure the aforementioned mechanical parameters, uses a laser unit positioned in a fixed location relative to the machine and equipped with: an emitter part; a laser beam receiver part; and a laser beam reflector part attached to the counterweight plate selector means, the reflector part being opposite and at a given distance from the laser unit emitter part. Depending on the instantaneous position assumed by the stack selector means, both in the weights static selection condition, and relative to the movement of the counterweight as a result of the exercise being performed, the length of the flight path covered by the laser beam: between the emitter part, the reflector part and the receiver part, is normally variable relative to a reference distance predetermined according to a given positional relationship initially predetermined for the various device components.

[0005] The definition on each occasion of the difference between the actual path of the laser beam and the reference path allows the evaluation of: the number of plates selected, that is to say, the load applied to the counterweight; the displacement of the selector means relative to the reference position; and, by relating this displacement to the time required to complete it, the speed of the counterweight as the exercise is performed.

[0006] The aforementioned device provided completely satisfactory practical results. However, some factors, including the high level of power needed for device operation, the different resolution obtainable for measuring the distance, with the various types of lasers; and the high device production costs, prompted interest in investigating measuring systems which, although based on the time-of-flight of a signal, are alternatives to the laser.

[0007] Basically, a possible alternative system may be obtained using ultrasound, that is to say, with a device which for a short period of time sends a suitable ultrasonic frequency to a reflector part attached to the selector means. Since the speed of sound in a given means is known, a simple calculation including the interval of time between the pulse sent and the echo returned gives an evaluation of the distance between the device and the reflective surface.

[0008] However, given the short distance to be traveled, whose size varies in practice (approximately) from 20 cm to around 200 cm, and given the presence of many mechanical devices normally located close to or in the exercise machine's physical space, (for example: the weight stack; the guard; various types of brackets and supports, etc.) such a device has operating problems, since reflected echoes which cannot be eliminated overlap with the signal emitted by the emitter part, making the data associated with the measurement of the signal which reaches the receiver part unreliable, and so compromising the overall reliability of the measuring device.

[0009] The aim of the present invention is, therefore, to overcome such disadvantages using a device which activates the weight stack plate selector means, that is to say, which allows the selector means, with a suitable remote control, to autonomously generate an ultrasonic signal which is then conveniently directed towards the outside.

SUMMARY OF THE INVENTION

[0010] Accordingly, the present invention achieves this result using a detector device for at least one current mechanical state parameter of a mobile counterweight on an exercise machine with counterweights. The counterweight comprises a plurality of weights placed one on top of another, whose number can be selected using a selection pin, which can be attached as required to one of the weights, so as to define a counterweight with a predetermined weight. The device comprises means which generate a signal indicating the instantaneous position of the pin relative to a predetermined reference part; means which detect the signal. In the device according to the invention, the generation and detector means are directly opposite one another, separated by a distance which the signal covers only once to minimize the length of its path.

[0011] The present invention also relates to a measuring method, which conforms to device operation.

[0012] The aforementioned device and method allow the important result of making detection of the selection pin position insensitive to the interference around the device, the machine as a whole and/or its component parts.

[0013] Since the receiver means are directly opposite the generator means, the first sign on the receiver means of the ultrasonic signal emitted by the generator means, indicating that the signal has covered the shortest flight path, that is to say, that the distance between the generation and detector means has been covered only once, is sufficient to determine the position of the selection pin. Any echoes or signal distortion which follow do not disturb or modify the measurement already taken in any way.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The technical features of the present invention, in accordance with the aforementioned aims, are set out in the claims herein and the advantages more clearly illustrated in the detailed description which follows, with reference to the accompanying drawings, which illustrate a preferred embodiment of the invention without limiting the scope of the inventive concept, and in which:

[0015] **FIG. 1** is a schematic perspective assembly view of a detector device applied to a generic exercise machine with counterweights;

[0016] **FIG. 2** illustrates the operating principle of the device;

[0017] **FIG. 3** is a block diagram illustrating the device; and

[0018] **FIG. 4** is an example of a possible waveform of a signal generated by the device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] With reference to **FIG. 1** in the accompanying drawings, the numeral **1** denotes as a whole a device for measuring one or more current mechanical state parameters of a counterweight **2** on an exercise machine **3** with counterweights.

[0020] More specifically, the counterweight **2** of the exercise machine **3** opposes the muscular force generated by the user during the exercise and consists of a vertical stack of weights **4**, whose number may be selected on each occasion as required by the user, relative to the exercise requirement and using customary selector means, equipped with a selection pin **5** designed to allow the user to set the number of weights **4** to be picked up from the top of the stack and applied to the machine **3** as the resistant force.

[0021] The counterweight **2** mechanical parameters of practical interest for machine **3** operation may be the most diverse. However, some which deserve special mention are the total weight "P" of the counterweight **2** applied to the machine **3** each time,—**FIG. 2**—and the movement "s" and instantaneous speed "v" of the vertical stack of weights **4** relative to a suitable, predetermined fixed reference part **19**.

[0022] Such mechanical parameters can advantageously be detected with reference to the current position of the selection pin **5**. For this reason, the device **1** basically comprises:

[0023] a mobile element **6**, attached to the selection pin **5** and fitted with self-contained means **14** for generating a signal indicating the instantaneous position of the selection pin **5** relative to the fixed reference part **19**;

[0024] a fixed apparatus **8**, remote from the mobile element **6**, which is in turn fitted with means **15** for detecting the signals from the mobile element **6**; and

[0025] processing means **16**—preferably consisting of an electronic control unit—interfacing with the detector means **15**, which are designed to process the data received in the form of the aforementioned signals **18** so as to identify the instantaneous position of the selection pin **5** relative to the reference part **19**.

[0026] The generation means **14** are preferably designed to include an ultrasonic transmitter **9** able to generate and emit to the fixed apparatus **8** directly opposite, a pulsed ultrasonic signal **18** with appropriate frequency, wavelength and duration "DT"—**FIG. 4**—following a remote activation command supplied from outside the machine **3**.

[0027] The command which activates the signal **18** generation means **14** is preferably provided by remote control means **17** (generic remote control means of the type with—preferably—or without, wires), operating at a distance from the generation means **14**, attached to a fixed apparatus **8** together with the detector means **15** and the processing means **16**—**FIG. 3**. The remote control means **17** which issue the command that switches the mobile element **6** generation means **14** on and off are designed to also switch the fixed apparatus **8** detector means **15** on and off. These means consist of a suitable ultrasonic receiver **10**.

[0028] The fixed apparatus **8** illustrated in **FIG. 1** has a self-contained structure independent of the exercise machine **3** structure **7**. However, this does not restrict the scope of application of the present invention, since, obviously the fixed apparatus **8** may equivalently be attached to and/or built into the exercise machine **3** structure **7**.

[0029] The measuring device **1** may also incorporate a calibration device **12** designed to compensate any variations in the speed of propagation of the signal **18** ultrasound waves due to external interference, caused for example by temperature changes. It also has a monitoring system **13** for the mechanical parameters of the stack of weights **4**, detected and/or calculated.

[0030] In practice, the device **1** operates as follows: the remote control means **17**—for example a radio transmitter, or an optical transmitter controlled by the machine control unit which controls its operation—send an activation pulse **20** to the ultrasonic signal **18** generation means **14**, fitted on the mobile element **6**.

[0031] Simultaneously with the activation of the ultrasonic signal generation means **14**, the remote control means **17** enable the detector means **15** to receive the ultrasonic signal **18** and enable the processing means **16** to process the data relevant to the signal. The flight time of the control pulse **20**—however it is issued, whether by radio wave or light pulse—is negligible, since the distance between the generation means **14** and the signal **18** detector means **15** is only covered once, and therefore, with the minimum length of the total distance. Thus, it may be assumed that the generation means **14** and the detector means **15** of the signal **18** generated by the generation means **14** are activated the moment the pulse **20** is transmitted. At this point, the selection pin **5** transmits the ultrasonic signal **18** to the detector means **15**. If the speed of propagation of the ultrasound signals in the air is known, the time which elapses between the pulse **20** being issued by the control means and the ultrasonic signal **18** arriving at the detector means **15** allows the calculation of a distance which is correlated to the position of the selection pin **5** on the stack, that is to say, to the number of weights selected, and that is, the weight "P" selected. As the exercise is performed, the length of the ultrasonic signal **18** path, that is to say, the distance between the selection pin **5** and the detector means **15** is detected as often as possible, being reiterated many times in the unit of time at cyclical intervals, for example at least ten times per second. This is done in order to achieve a suitable signal resolution for the measurement or measurements during the exercise with the machine moving.

[0032] The measuring device **1** therefore allows the expected results to be achieved in a simple, reliable and relatively economical way, without being affected by inter-

ference caused by reflection of the ultrasonic waves by any obstacles constituted by the machine **3**, its component parts and/or other objects near the machine. These reflections or interference, when the sound emission has been switched off, are exhausted and only reproduced after renewed activation, but always in such a way that they do not affect the precision of the measurement. Although in the preferred embodiment of the invention described above specific reference is made to the use of ultrasonic signals **18**, such an embodiment is provided by way of example only. By operating in an equivalent way, different types of signals **18** may be used, for example signals with a wavelength within the range of frequencies and wavelengths typical of radio waves; or light waves operating both in the visible light spectrum and in the infrared electromagnetic radiation spectrum.

[**0033**] The invention described has evident industrial applications and can be subject to modifications and variations without thereby departing from the scope of the inventive concept. Moreover, all the details of the invention may be substituted by technically equivalent elements.

What is claimed:

1) a device for measuring at least one current mechanical state parameter of a mobile counterweight on an exercise machine with counterweights; the counterweight comprising a plurality of weights placed one on top of another, whose number can be selected using a selection pin, which can be attached as required to one of the weights, so as to define a counterweight with a predetermined weight; the device comprising means for generating a signal that indicates the instantaneous position of the pin relative to a predetermined reference part; and means for detecting the signal; and wherein the generation means and the detector means are directly opposite one another, separated by a distance which the signal covers only once so that the length of the signal path is minimized.

2) The device according to claim 1, comprising remote control means designed to enable the exchange of the signal between the generation means and the detector means.

3) The device according to claim 2, wherein the remote control means are designed to switch off the generation means after the emission of the position signal.

4) The device according to claim 2 or **3**, wherein the remote control means are designed to switch on the generation means.

5) The device according to claim 4, wherein the remote control means are designed to switch also the detector means on and off.

6) The device according to any of the claims from **1** to **5**, wherein the generation means are integral with the selection pin.

7) The device according to claim 6, wherein the reference part is positioned below the selection pin, and is rigidly connected to an apparatus which is fixed relative to a machine frame.

8) The device according to claim 6, wherein the reference part is positioned above the selection pin, and is rigidly connected to a given apparatus which is fixed relative to a machine frame.

9) The device according to at least one of the foregoing claims, wherein the generation means are designed in such a way as to emit pulsed signals activated and/or deactivated for predetermined intervals.

10) The device according to at least one of the foregoing claims, wherein the generation means comprise a signal transmitter which emits the signals with predetermined characteristics, the detector means comprising a receiver designed to receive the signals from the transmitter.

11) The device according to claim 10, wherein each signal emitted has wavelength and frequency in the ultrasonic spectrum.

12) The device according to claim 10, wherein each signal emitted has wavelength and frequency in the radio wave spectrum.

13) The device according to claim 10, wherein each signal emitted has wavelength and frequency in the light spectrum.

14) The device according to claim 10, wherein each signal emitted has wavelength and frequency in the infrared spectrum.

15) The device according to claim 7 or **8**, wherein the fixed apparatus is directly connected to the machine frame.

16) The device according to claim 7 or **8**, wherein the fixed apparatus is independent of the exercise machine frame.

17) The device according to claim 11, further comprising a calibration device for compensating variations in the speed of propagation of the ultrasound waves due to external interference.

18) The device according to any of the foregoing claims, in which the exercise machine with counterweights comprises processing means interfacing with the detector means, for receiving and processing the signal so as to identify the instantaneous position of the pin, the device further comprising a system for monitoring at least one of the mechanical parameters of the pack of weights interfaced with the processing means to supply data correlated to at least one of the selection pin mechanical parameters.

19) A method for measuring at least one current mechanical state parameter of a mobile counterweight on an exercise machine with counterweights; the counterweight comprising a plurality of weights placed one on top of another, whose number can be selected using a selection pin, which can be attached as required to one of the weights, so as to define a counterweight with a predetermined weight; the method comprising a step of exchanging a signal between the generation means and the detector means; the signal indicating the instantaneous position of the pin relative to a predetermined reference part; the generation means and detector means being opposite one another and separated by a distance which the signal they exchange covers only once so as to minimize the length of the signal path.

20) The method according to claim 19, wherein the step of exchanging a signal between generation means and detector means in turn comprises the steps of: activating the signal generation means, indicating the instantaneous position of the selection pin relative to a predetermined reference part; activating the means which detect the signals emitted by the generation means, located in a fixed apparatus, remote from the generation means; and identifying the current position of the selection pin, relative to the reference part, according to the change in the distance between the selection pin and the fixed apparatus, calculated with reference to given signal propagation parameters between the generation means and the detector means.

21) The method according to claim 20, wherein the aforementioned steps are reiterated many times, at cyclical intervals, in a given space of time.

22) The method according to claim 21, wherein the cyclical intervals involve sequential repetition of the steps at least ten times per second.

23) The method according to any of the foregoing claims from **20** to **22**, wherein the instantaneous position of the selection pin is indicated by ultrasound signals.

24) The method according to any of the foregoing claims from **20** to **22**, wherein the instantaneous position of the selection pin is indicated by light signals.

25) The method according to claim 24, wherein the light signals are within the visible light spectrum.

26) The method according to claim 24, wherein the light signals are within the infrared spectrum.

27) The method according to claim 23, further comprising a step of calibrating the signal, compensating variations in the speed of propagation of the ultrasound waves caused by external interference.

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