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(54) Title: MACHINE FOR THE POWER EXERCISE OF A USER

(57) Abstract: A machine for the power exercise of a user, comprising a rocker (20) movable by a user to make a work and a load (30) connected thereto to oppose the user's work. Control means are provided (50, 51) for the monitoring of the user's work (V1; F0) and the comparison thereof with at least one reference value (V2; F1) manually or automatically settable. The machine further includes regulating means (60) operatively connected to the control means (50, 51) and acting on the load (30) to automatically increase it in case the detected work is greater than the reference work, and to automatically decrease the load (30) in case the detected work is lower than the reference work.
MACHINE FOR THE POWER EXERCISE OF A USER

DESCRIPTION

Field of invention

The present invention generally relates to the technical field of the machines for the power exercise, for sport as well as for medical purpose, and particularly relates to a machine for the power exercise of a user.

The invention further relates to a modification kit and a method for obtaining such machine starting from a standard existing machine for power exercise.

The invention further relates to a method and a software product for controlling the machine.

Background of the invention

The known machines for the power exercise of a user, for simply sport or for medical purpose, generally comprise a rocker movable by a user to make a work and a load connected to the rocker suitable to oppose the work of the user. The rocker is moved by the user along predetermined paths, defined by the machine.

The load against which the user works is fix, and generally preset by the user before the exercise. This involves the need of a trainer who follows the exercise, so as to verify its correct execution and efficacy, and a high level of risks of physical damages, as distortions, muscular strains or the like, due to excessive loads.

From the Japanese patent JP2185272 a machine for the rehabilitation of a user following a physical damage is known. This known machine has blocking means of the load in case the user exceeds a safety load threshold.

From the international patent application WO2009107904 a machine for the power exercise of a user is known, which allows to set on a display several training programs, exclusively of isokinetic or isotonic type.

From the European patent EP-B1-1252915 an apparatus for the power exercise of a user is known, comprising a device to increase or decrease the load even during the exercise. In particular, the user is provided with a control panel having a series of controls, to be voluntarily operated by the hands or the feet, to increase or decrease the weight to lift.

This known machine is to be used by trained users or in any case with a trainer, because the variation of the lifted weight is subordinate to the user's will. For the same reason, this known machine does not eliminate the range of physical damages for the user.

Summary of the invention

A main object of the present invention is to overcome, at least in part, the above drawbacks, by providing a machine for the power exercise of a user simple to manufacture and relatively cheap.
Another object of the invention is to provide a machine for the power exercise of a user which can be used by everybody, even without the help of a trainer.

Another object of the invention is to provide a machine for the power exercise of a user which minimizes or totally eliminates the dangers of physical damages for its users.

These and other objects, as better explained hereafter, are fulfilled by the machine for the power exercise of a user having one or more of the features herein disclosed and/or claimed.

Essentially, the machine may comprise a rocker movable by a user to make a work and a load connected to the rocker to oppose the work of the user. In other words, the user, acting on the rocker, makes a work against the load in a given time.

As used herein, the expression "rocker" or derivates thereof is intended to indicate an element, or an assembly of elements connected to one another, with which a user interacts directly or indirectly to make a muscular work.

As used herein, the expression "load" or derivates thereof is intended to indicate an element, or an assembly of elements connected to one another, suitable to generate the force against which the user makes the work.

As used herein, the expression "work of a user" or derivates thereof is intended to indicate the work made by the user in the time unit against the load to move the rocker. In other words, the work of the user defines the power by which the user opposes the load.

The rocker and/or the load may be installed on a load bearing support structure, or not.

The machine may be designed to monitor the work of the user and to automatically adjust the resistant load according to the detected work.

In particular, the machine according to the invention is suitable to automatically increase the load in response to the detection of the increase of the work and vice versa.

With this aim, the machine comprise means to detect at predetermined time intervals, which may have any size, at least one first value of at least one parameter corresponding to the muscular work made by the user against the load.

The detected parameter may be, for example, the speed, or the acceleration of the execution of the exercise, or the force with which the user carries it out.

On the other hand, the work of the user may be monitored by controlling his physical parameters, for example his heart-beat or the frequency of muscular contraction/decontraction.

Of course, the detecting means may change according to the parameter to detect.

Possibly, a plurality of parameters may be detected, simultaneously or not, for example force and speed.
The machine may further include at least one logical control unit settable with at least one second value of at least one parameter corresponding to a training reference work for the user.

Similarly to what above mentioned, the parameter to set may be, for example, the "ideal" performance speed or acceleration of the exercise, or the "ideal" force by which the user has to perform the exercise to train at best.

These values, which change from one user to another, may for example be determined in a per se known manner from the so-called "force-speed curve", which indicates for each user the muscular performances in terms of force and speed of execution of the exercises in a given moment.

On the other hand, also the "ideal" heart-beat may be set, which can be obtained by means of an electrocardiogram.

Furthermore it is possible to set also the frequency of muscular contraction/decontraction, which can be determined by means of an electromyography.

The setting may be made manually, for example by means of a touch-screen type display, or automatically.

The automatic setting may be made by means of a software program which reads from a memory unit, which may be integrated in the machine, one or more values of one or more parameters of the user, possibly preloaded into the memory unit by having the same user worked in standard conditions, and so sets the first logical unit, according to a predetermined algorithm.

For example, the machine may be programmed in such a way that, before the exercise or anyway with predetermined periodic rate, it determines the values of interest, for example those of the force-speed curve, or the heartbeat, or the muscular contraction/decontraction frequency, by having the user worked in predetermined standard conditions suitable to detect such parameters.

These data may be then loaded into the memory of the machine, and may be used by a software program which analyses and employs them to determine the "ideal" reference value or values to which the user has to strive during the exercise. The determination of these values may take place by means of one or more predetermined algorithms, incidentally selectable by the user on the basis of his needs.

For example, it may be possible to select a program for the development of the muscular mass, rather than another program for the development of the explosive force.

This way, the machine is completely automatic as well as extremely safe for the user.

 Appropriately, the first logical control unit may be operatively connected with the detecting means to compare the work detected by these last ones with the reference work.
Of course not necessarily the first detected value has to be coherent with the second set value. If, for example, the detecting means are configured to detect the force with which the user makes the exercise, for example by means of a load cell, it is possible to set a second value of ideal speed of performance. In this case, the first logical control unit provides to translate, by means of the values of the above mentioned force-speed curve, the set "ideal" speed value in an "ideal" force value, so as to compare with one another coherent quantities.

Preferably, the machine may comprise regulating means, which may be operatively connected to the first logical control unit, acting on the load for automatically increase it in case the work detected by the detecting means is greater than the set reference work, and to automatically decrease it in case the detected work is lower than the set reference work.

Thanks to such features, the machine may be used in complete safety by anyone, even without the help of a trainer. Every instant, in fact, the muscular work of the user tends towards the "ideal" training muscular work.

For the user it is sufficient to set the correct "ideal" work, which may be previously determined as above mentioned, and to start to train. In the case of the automatic setting, the user has simply to follow the instruction of the machine, because the machine itself sets for him the "ideal" parameter towards which he has to tend during the exercise.

Differently from the traditional isotonic or isokinetic machines, in fact, the machine according to the present invention adapts itself to the work of the user every instant.

This particular "adaptive" configuration of the machine, moreover, minimizes or completely eliminates the dangers of physical damages for whom uses it, and allows an extremely efficient training.

Appropriately, the "ideal" work values may be two, so as to define an "ideal interval" within which the user can train. In this case, the machine automatically "adapts" the load in case the user works outside the ideal work interval, that is below the minimum work or above the maximum work.

Advantageously, the machine may comprise a unit for the electro-magnetic stimulation of human muscles, which includes at least one inductor positionable close to at least one muscle of the user, at least one power supply connected to the inductor for the generation of at least one electromagnetic field and a generator of pulse current for the emission of current impulses having predetermined frequency and duration towards the inductor to cause the involuntary contraction and decontraction of the human muscle in proximity of which the inductor is put.

Preferably, the first logical control unit may be operatively connected to the electromagnetic stimulation unit to automatically disconnecting the power supply in case the
work detected by the detecting means coincides with a value of at least one parameter corresponding to a dangerous set work.

In this case, the machine may be lacking in the above described regulating means, or not.

Preferred but non-exclusive embodiments of the invention are defined by the dependent claims.

Brief description of the drawings

Further features and advantages of the invention will appear more evident upon reading the detailed description of some preferred, non-exclusive embodiments of a machine according to the invention, which are described as non-limiting examples with the help of the annexed drawings, in which:

FIG. 1 is a schematic view of a first embodiment of the machine 1;
FIG. 2 is a schematic view of a second embodiment of the machine 1;
FIG. 3 is a schematic view of some details of the machine 1 illustrated in FIGS. 1 and 2;
FIG. 4 is a schematic view of a third embodiment of the machine 1;
FIG. 5 is a schematic view of a fourth embodiment of the machine 1;
FIG. 6 is a schematic view of some details of the machine 1 illustrated in FIGS. 4 and 5;
FIG. 7 is a schematic view of a fifth embodiment of the machine 1;
FIG. 8 is a schematic view of a sixth embodiment of the machine 1;
FIG. 9 is a schematic view of a seventh embodiment of the machine 1.

Detailed description of some preferred embodiments

Referring to the above mentioned figures, the machine according to the invention, which is generally designated by the reference number 1, is particularly suitable for the performance of a power exercise by a user, for sport as well as for medical/ rehabilitative purpose.

FIGS. 1, 2, 4, 5, 7, 8 and 9 illustrate seven embodiments of the machine.

The first embodiment illustrated in FIG. 1 is suitable to train the muscles of the upper part of the user's body, and particularly the pectoral muscles, whereas the second embodiment illustrated in FIG. 2 is suitable to train the muscles of the legs of the user.

The embodiments illustrated in FIGS. 4 and 5 are similar to those in FIGG, 1 and 2, and differ from them in the manner in which the machine 1 continuously adapts the load to the work of the user.

The fifth embodiment illustrated in FIG. 7 is suitable to train the muscles of the user's legs, and is conceptually similar to a classical "gym bike" which continuously adapts the load to the user's work.

The sixth embodiment illustrated in FIG. 8 is suitable to train the muscles of the upper
part of the user's body, in particular the pectoral muscles, and differs from the embodiment of FIG. 1 because it includes a unit for the electromagnetic stimulation of human muscles 90.

The seventh embodiment illustrated in FIG. 9 is suitable to train the muscles of the upper part of the user's body, in particular the pectoral muscles, and differs from the embodiment of FIG. 1 because it lacks in the regulating means 60.

Where not differently specified, features common to all embodiments of the machine are indicated with the same number.

The machine 1 may comprise a support structure, in particular a load bearing frame 10 with a base 11 to be laid on the floor G, on which are mounted a rocker 20, movable by a user to make a work, connected to a load 30, suitable to oppose to the work of the user.

In the illustrated embodiments, the movement of the rocker 20 is guided. In particular, the latter may comprise a slider 21 slidably mounted along a slide bar 22, which defines the axis X along which the movement of the rocker takes place, in the two senses indicated by the arrows F1 and F2. On the other side, the rocker 20 may also be free, provided that it is connected to the load 30, without departing from the scope of the invention defined by the appended claims.

In particular, the bearing frame 10 of the first, third, sixth and seventh embodiment of the machine, illustrated in FIGS. 1, 4, 8 and 9, may include a bench 12, which may be plane or inclined, on the upper surface 13 of which the user may lie down to grasp and move the slider 21 upward or downward. For this purpose, the rocker 20 may comprise a substantially horizontal barbell 23, graspable by the user to make the exercise, rigidly connected to the slider 21.

On the other hand, the rocker 20 of the second and fourth embodiment of the machine, illustrated in FIGS 2 and 5, may comprise a seat 24, on which the user may sit to move the slider 21 along the bar 22. With this aim, the bearing frame 10 may comprise a footrest plate 14, against which the user sitting on the seat 24 may push his feet to train.

Moreover, the rocker 20 of the fifth embodiment of the machine, illustrated in FIG. 7, may comprise a group of pedals-pedalcrank 25, which the user may set into rotatory motion around the axis Y. With this aim, the bearing frame may include a gym bike, not illustrated in figure because per se known, on which the user may sit to train.

The machine 1 is so configured as to automatically adapt itself to the user's work, to almost totally eliminate any risk of physical damages during the exercise.

For this purpose, control means may be provided, which may include detecting means 50 suitable to monitor the work of the user at predetermined time intervals, by detecting one or more parameters directly or indirectly connected to the same work, and a logical control unit 51 suitable to compare the detected value with one or more "ideal"
reference training values manually set by the user, for example by means of a display, or automatically set by a software.

Regulating means 60 may be operatively connected to this logical control unit 51, which act on the load 30 for the automatic regulation thereof in response to the detection of a variation of the detected value from the preset or predetermined value or values.

Advantageously, the regulating means 60 may be designed to automatically increase the load 30 in case the work detected by the detecting means 50 is greater than the "ideal" reference work set on the logical control unit 51 and to automatically decrease the load 30 in case the detected work is lower than the set reference work.

This way, the machine continuously urges the muscular work of the user towards the training muscular work, adapting itself to the user's work instant by instant.

The machine furthermore minimizes the risks of physical damages for the user, because if the work detected by the detecting means 50 is lower than the reference one, the machine automatically decreases the load.

 Appropriately, the machine 1 may comprise motor means, generally indicated with 31, suitable to generate a torque which defines the load 30.

In the first, second, fifth, sixth and seventh embodiment of the machine, illustrated in FIGS. 1, 2, 7, 8 and 9, the user, acting on the rocker 20, works directly against the torque generated by the motor means 31.

The latter may comprise a brushless motor of the step type, so as to generate a torque also when not in motion without any danger of damages or breakings.

In order to rigidly and integrally transfer the motion between the rocker 20 and the motor means 31, motion transmission means of the closed ring type may be provided.

The latter may comprise a ring shaped motion transmission 40, for example a rope, a belt, a band or a chain or the like, connected to the motor 31 by means of a toothed-wheel 42 keyed on the axis 32 thereof and to the rocker 20 by means of connecting means 41, for example a couple of clamps welded to the slider 21. One or more returning idle pulley 43 may be provided, too.

In the first, second, fifth, sixth and seventh embodiment of the machine, illustrated in FIGS. 1, 2, 7, 8 and 9, the parameter monitored by the control means for controlling the work of the user may be the speed and/or the acceleration imparted on the rocker 20 as a result of the user's work.

With this aim, the detecting means 50 may be operatively connected to the rocker 20 to control the movement thereof determined by the user's work against the load 30, that is against the torque generated by the motor 31.

For this purpose, such detecting means may comprise an encoder 50'; or an
accelerometer, keyed on the axis 32 of the motor 31 to detect the speed \( v_b \), or the acceleration, of the rocker 20 in response to the work of the user.

While the present description, for simplicity reasons, is always referred to the encoder 50 and to the monitoring of the speed of the rocker 20, it shall be understood that the same is valid also for the control of the acceleration thereof by means of the accelerometer.

Advantageously, as visible in FIG. 3, the control means may also include a first logical control unit 51, operatively connected to the encoder 50, manually or automatically settable with at least one reference speed value \( V_r \), and susceptible to compare at predetermined time intervals the speed value \( V_b \) detected by the encoder 50 with the reference value \( V_r \), to generate a first error signal 52 in case the two values do not coincide.

The embodiments illustrated in FIGS. 1, 2, 3, 7 and 8 refer to a control made by two logical units 51, 60, operatively connected each other. The logical units 51, 60 may interact with a software, which may be a single software program 100 suitable to interact with both these units 51 and 60. In particular, the first logical unit may interact with the software subroutine 101 and the second logical unit may interact with the software subroutine 102. Equivalently, each logical unit 51, 60 may have a single software program implemented thereon.

It shall however be understood that in these embodiments the control of the machine may take place also by means of a single logical unit 51, as happens in the embodiments illustrated in the FIGS. 4, 5 and 6, without departing from the scope of the invention expressed by the annexed claims.

The first logical unit 51 may be furthermore susceptible to incorporate in the first error signal 52 a first information 53 concerning the deviation \( V_\Delta \) between the detected speed \( V_b \) and the reference speed \( V_r \), in other words whether and how much the speed imparted by the user to the rocker 20 is higher or lower than the ideal one.

The regulating means may comprise a second microprocessor logical unit 60 operatively connected to the first unit 51 and to the motor 31, actionable by the first error signal 52 and susceptible to elaborate the first piece of information 53 to generate a second error signal 61, to be transmitted to the motor 31.

The second error signal 61 may incorporate a second information 62 concerning the deviation torque \( C_\Delta \), calculated by the second logical unit 60 on the basis of the deviation speed \( v_\Delta \), to be added to or to be subtracted from the speed presently delivered by the motor 31. In other words, the second error signal 61 indicated whether and how much power has to be delivered or subtracted to the motor 31 to increase or decrease the load 30.

In a preferred but non-exclusive embodiment, the first and the second logical units 51 and 60 may belong to a single control unit PLC 70. On the other hand, the first logical unit 51
and the regulating means 60 may belong to a single control card.

This way, every instant, the machine adapts the load 30 to the work made by the user, in such a manner to increase it if the user makes a work greater than the ideal one and to decrease it if the user is making a work lower than the ideal one.

To do this, in the moment when the performance speed of the exercise \( V_b \) deviates from the ideal reference speed \( V_r \), the machine automatically acts on the load 30, so as to subtract power from the motor 31 if \( v_\Delta=V_b-V_r \) is negative, because the user is getting tired and so the load is decreased to allow him a correct exercise, and to add power to the motor 31 if \( v_\Delta \) is positive, because the user is working above the ideal work and so the load is increased to allow a correct exercise.

Consequently the performance speed of the exercise by the user varies every instant on the basis of the regulating of the load made by the machine.

This way, the risks of uncontrolled and dangerous works due to incorrect behaviours of the user are minimized, if not completely eliminated. In particular, the dangers of muscular damages at the end of the exercises, when the user is more tired because of the initially made work, are minimized.

The speed values to set are individual parameters of the user, and vary depending from the training. For example, they may be fixed on the basis of an equivalence given by the "speed-force" curve after having let the user to work on the basis of a standard curve, according to techniques known by person skilled in that art.

As already said before, this set may be defined manually, for example by means of a touch-screen display, or automatically, as above mentioned.

In particular, the value \( V_r \) may be determined so as to correspond to the ideal work value for the development of the muscular mass and/or of the explosive force of the user.

After determining this value, the PLC has to be set with such reference value \( V_r \), so that the system adjusts the load every time the user deviates from this value.

 Appropriately, it is possible to set the PLC unit 70 with a plurality of reference values, for example two, so to be able to choose every time the exercise type which is most suitable to one's needs.

In particular, on the PLC 70 may be set two reference speed values, a first value corresponding to the ideal work value \( V_{r_{\text{max}}} \) for the development of the muscular mass and a second value corresponding to the ideal work value for the development of the explosive force \( V_{r_{\text{max}}} \) of the user. The machine will adjust at every time the load so as to let the user work around one of these two values.

On the other side, it is possible to program the PLC 70 so as to induce the user to work in the speed interval between these two values \( V_{r_{\text{max}}}, V_{r_{\text{min}}} \), or anyway in an interval
between two ideal speed values so calculated that the exercise is effective for the user, decreasing the load 30 if the performance speed of the exercise detected by the encoder 50' is lower than the lower reference value $V_{\text{ref,}\min}$ between the two and increasing it if the detected speed $V_b$ is higher than the higher reference value $V_{\text{ref,}\max}$.

In fact, in this last case, the user makes a work greater than the maximum work to be made by the user so that the exercise is effective, whereas in the first case the user makes a lower work than the minimum ideal work. Also in this case, therefore, the machine adjusts the load to induce the user to work within the work interval which is ideal for the efficacy of the exercise, avoiding at the same time any muscular damages.

Advantageously, it is also possible to set the first logical unit 51 with at least one dangerous speed value $V_s$, corresponding to a limit value of work that the user can made in safe conditions. Also this value may be determined according to techniques known by the person skilled in that art. Advantageously, means 80 may be provided to block the rocker 20, operatively connected with the logical unit 51, if the speed value $V_b$ detected by the encoder 50' is equal to the value $V_s$.

Even if in the embodiments illustrated in the FIGS. 1, 2, 3, 7 and 8 the control on the danger speed $V_s$ is made by the first logical unit 51, which controls the reference speed $V_r$, too, this control may be made also by a third logical unit, connected with the blocking means 80 and subsequent to the first unit 51, or by a software program 100, as shown for the embodiments of the FIGS. 4, 5 and 6, without departing from the scope of the invention defined by the appended claims.

The blocking means 80, in response to the detection by the encoder 50' of a speed value $V_b$ equal to the value $V_s$, may act on the motor means 31 to brake them, incidentally in a progressive way to avoid damages to the user. For this purpose, the blocking means 80 may comprise a braking unit 81 susceptible to elaborate the error signal 82 coming from the first logical unit 51, generated in response to the detection of a speed value $V_b$ equal to the value $V_s$, and transmits a signal 83 of a possible progressive brake to the motor means 31.

On the other hand, the blocking means 80 may comprise alarm means 84 susceptible to elaborate the signal 82 coming from the first logical unit 51 and transmits a signal 85 for activating an alarm 86, for example of acoustic and/or visual type, so to warn the user of the danger.

Further, the blocking means 80 may include restoration means to bring the rocker 20 back to its rest position. With this aim, such restoration means may comprise a unit 87 susceptible to elaborate a signal 88 coming from the braking unit 81 and transmit to the motor means 31 a signal 89 to drive the automatic placing of the rocker 20.

The signal 88 is transmitted by the braking unit 81 after a time $t$, for example 1-2
seconds, from the transmission of the braking signal 83 to the motor means 31.

In order to have the machine 1 memorize the pause position of the rocker 20, it is possible to perform, before the exercise, a movement followed by a voluntary pause of the user, at first with the compressed muscle and then with the elongated muscle. The rest position may therefore correspond to the position of the elongated muscle, and may be voluntarily or automatically memorized in the PLC 70.

This movement of the user corresponds to the maximum stroke of the slider 21, and is variable from one user to another one. A couple of mechanical locks may be also provided, which are repositionable along the bar 22 in correspondence with the beginning and the end stroke of the slider 21.

The signal 89 then commands the motor 31 the reposition of the rocker 20 in the rest position preset on the PLC 70.

In a first preferred but non-exclusive embodiment, the danger speed value $V_s$ settable on the PLC 70 may be the minimum danger speed value $V_{s_{\text{min}}}$ corresponding to the minimum work to be safely made by the user, below which physical damages may occur to the user. On the other hand, it is possible, alternatively or together with the value $V_{3_{\text{min}}}$ to set the PLC 70 with a maximum danger speed value $V_{s_{\text{max}}}$, corresponding to the maximum work to be safely made by the user.

 Appropriately, the first logical unit 51 may carry out a double control on the speed $V_b$ detected by the encoder 50, a first control to verify whether the speed $V_b$ is equal to the value $V_{s_{\text{min}}}$ or $V_{3_{\text{max}}}$ and incidentally to command to the blocking means 80 the blocking of the rocker 20 in the positive case and a second control to verify the deviation from the reference value $V_b$, and incidentally to command to the regulating means 60 the adjustment of the load 30.

On the other hand, the PLC 70 may carry out two safety controls, the first one to verify whether the performance speed of the exercise is equal to $V_{s_{\text{min}}}$ and the second one to verify whether it is equal to $V_{s_{\text{max}}}$, blocking the rocker 20 by means of the means 80 in the positive case.

The choice between the instantaneous or progressive stop commanded by the signal 83 to the motor 31 depends from different factors, and may be preset in the unit 81. In a first preferred but non-exclusive embodiment, it is possible to set the instantaneous or progressive braking independently from the detected value $V_b$.

On the other hand, it is possible to set the braking according to whether the detected value $V_b$ is equal to $V_{s_{\text{min}}}$ or to $V_{s_{\text{max}}}$.

In fact, if $V_b$ is equal to $V_{s_{\text{min}}}$, it is possible to immediately brake the motor, because the performance speed of the exercise by the user is per se low, and an instantaneous
braking cannot cause him any damages.

If, on the contrary, \( V_b \) is equal to \( V_{s,m} \), it is possible to carry out a progressive braking, because performance speed of the exercise by the user is per se high, and an instantaneous braking may cause him some damages.

In order to progressively brake the motor 31 the signal 83 may command a braking ramp having more or less slope to the motor 31 itself, according to techniques known to the person skilled in that art.

Appropriately, the speed may be progressively reduced, for example at first one tenth, then one fifth of the preceding value and so on, until it corresponds to the value \( V_{s,m,in} \), after which the unit 81, after the time \( t \) has passed, transmits the signal 88 to the unit 87 to bring the rocker 20 back to the rest position, at the same speed \( V_{s,m} \), in.

In the third and fourth embodiment of the machine 1, illustrated in the FIGS. 4 and 5, the user, acting on the rocker 20, does not directly work against the torque generated by the motor means 31.

With this aim, for the transmission of the motion between the motor 31 and the rocker 20 an endless screw 45 may be provided, which is keyed on the axis 32 of the motor 31. The endless screw 45 is operatively connected to a pinion 46, which is rigidly connected to the rocker 20 by means of the metal bar 47.

This way, the user works against the friction generated between the pinion 46 and the endless screw 45, that is against a mechanical force.

In this case, the parameter monitored by the control means for controlling the work of the user may be the force the user exerts against the rocker 20.

For this purpose, the detecting means may comprise a load cell 50", which may be connected to the rocker 20, or not. In fact, in the embodiment of FIG. 4 the load cell 50" is connected to the rocker 20, whereas in the embodiment of FIG. 5 the load cell 50" is not connected to the rocker 20.

As illustrated in FIG. 6, differently from the first and second embodiment illustrated in FIG. 1 and 2, the regulation of the load 30 is carried out on the basis of force values and not of speed or acceleration values.

The control, then, is carried out by means of a single logical unit 51 which interacts with the software program 100.

Apart from these differences, the running of these embodiments is equivalent to those illustrated in FIGS. 1 and 2.

Advantageously, therefore, the first logical control unit 51, operatively connected to the load cell 50", may be automatically or manually settable with at least one reference force value \( F_r \) and susceptible to compare at predetermined time intervals the force value \( F_b \).
detected by the load cell $50^\circ$ with the reference value $F_R$ to activate the regulating means $60$, defined by a subroutine $102$ of the computer program $100$, in case the two values do not coincide.

The subroutine $102$ calculates the deviation $F_{\Delta}$ between the detected force $F_B$ and the reference force $F_R$, in other words, whether and how much the force exerted by the user on the rocker $20$ is greater or lower than the ideal one.

The subroutine $102$ further calculates the deviation torque $C_{\&}$, incorporating it in a second error signal $61$ destined to the motor $31$.

In the moment when the performance force of the exercise $F_B$ deviates from the ideal reference force $F_R$, the software $100$ automatically acts on the load $30$, so as to provide to subtract power from the motor $31$ if $F_{\Delta} = F_B - F_R$ is negative, as the user is getting tired and therefore the load is decreased to allow him a correct exercise, and to add power to the motor $31$ if $F_{\Delta}$ is positive, because the user is working above the ideal work and therefore the load is increased to allow him a correct exercise.

Also in the third and fourth embodiment of the machine $1$, illustrated in the FIGS. 4 and 5, it is possible to set the PLC unit $70$ with a plurality of reference values, for example maximum and minimum reference force $F_{R_{\text{max}}}$, $F_{R_{\text{min}}}$, and to set the machine so that the user works within that interval.

It is also possible to set the first logical unit $51$ with at least one danger force value $F_s$, and to set the blocking means $80$ to block, incidentally in a progressive way, the rocker $20$, operatively connected to the logical unit $51$, if the force value $F_B$ detected by the load cell $50^\circ$ is equal to the value $F_s$.

Even if in the first and second embodiment illustrated in the FIGS. 1 and 2 the regulation of the load $30$ is carried out by means of the two logical control units $51$ and $60$ and in the third and fourth embodiment illustrated in the FIGS. 4 and 5 the regulation is carried out by means of a single logical unit $51$, it is understood that for all the embodiments of the machine $1$ the regulation of the load $30$ may be carried out in any manner without departing from the scope of the invention as defined in the appended claims.

In particular, in the embodiments illustrated in the FIGS. 1 and 2 it may be possible to adjust the load $30$ by means of the software program $100$ which interacts with a single control unit $51$, or in the embodiments shown in the FIGS. 4 and 5 it may be possible to adjust the load $30$ by means of the software program $100$ which interacts with the two logical control units $51$ and $60$.

The running of the fifth embodiment of the machine $1$ illustrated in FIG. 7 is similar to the running of the first and second embodiment, illustrated in FIGS 1 and 2. Also in this case, in fact, the machine adjusts the load on the basis of the speed values detected by the
encoder 50 keyed on the axis of the motor 31, against which the user directly works.

The only difference is that, in this case, the rocker 20 is put into rotatory motion around the axis Y, and not in sliding motion along the axis X. The running of the detecting means 50, of the first logical unit 51 and of the regulating means 60 is identical, as visible in FIG. 7.

Appropriately, the machine 1 may include a unit for the electromagnetic stimulation of the human muscles 90.

In FIG. 8 is illustrated, as a non-limiting example, an embodiment of the machine 1 similar to the embodiment illustrated in FIG. 1, which includes the unit 90. It is however understood that the unit 90 may be coupled to any configuration of the machine 1, and in particular to those according to the FIGS. from 2 to 7, without departing from the scope of the invention expressed by the annexed claims.

In an alternative embodiment, illustrated in FIG. 9, the machine which includes the unit 90 may not comprise the regulating means 60. In other words, the machine which includes the unit 90 may be not configured to adjust the user's work to the ideal work. In this case, the reference work to set, automatically or manually, on the logical unit 51 is the dangerous work.

The unit 90 may comprise at least one inductor 91, positionable in proximity of at least one muscle of the user, at least one power supply 92, connected to the inductor for the generation of at least one electromagnetic field and a generator of pulse current 93 for the emission of current impulses having predetermined frequency and duration to the inductor 91 to cause the involuntary contraction and decontraction of the human muscle in proximity of which is put the inductor 91.

For example, the unit 90 may be arranged according to the teachings of the US patent US6652443 and/or of the International application WO0225675, to which it is referred for consultation.

This way, it is possible to have the user train with the maximum efficiency.

By means of an electromyography, in fact, it is possible to know the current frequency and intensity suitable to contract and decontract one or more muscles of interest. Placing the inductor 91 close to the muscle or to the group of muscles of interest, it will be therefore possible to induct contraction and decontraction even beyond the user's will, making the training particularly efficient.

In order to avoid damages to the user, the first logical control unit 51 is operatively connected to the electromagnetic stimulation unit 90 for automatically disconnecting the power supply 92 if the work detected by the detecting means 50 coincides with the dangerous set work, whether it is $V_s$ or $F_s$. 

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It is also possible to set the unit 90 so that to have the generator of pulse current 93 generates current impulses having different frequency and durations according to whether the user is lifting the rocker 20, or whether he is letting it down.

According to a further aspect of the invention, a method for the control of the load 30 in the machine 1 is provided, which may be carried out by a software product, in particular by a software program 100.

The software product may include one or more memory supports, which may be fixed, for example one or more hard disk, or removable, for example one or more floppy disks, CD or DVD, on which the program 100 is fixed. These memory supports may interact with the logical control unit 51 to control the load 30.

The software product may further comprise one or more integrated circuits belonging to the logical control unit 51.

In the case of a machine with two logical units 51, 60, the software program 100 may interact with both these units, or each unit 51, 60 may have implemented its own software program.

The program 100 may include a first subroutine 101 susceptible to interact with the detecting means 50 to read the first value \( v_b \) or \( F_b \) detected by the detecting means 50 and to compare this first value \( v_b \) or \( F_b \) with the second reference value \( v_r \) or \( F_r \).

The program 100 may further comprise a second operative subroutine 102, actionable by the first operative subroutine 101 if the compared values do not coincide. The second operative subroutine may be designed to generate the first information 53, concerning the deviation \( v_\Delta \) or \( F_\Delta \) between the first value \( V_b \) or \( F_b \) and the second value \( V_r \) or \( F_r \).

The second operative subroutine 102 may further elaborate the first information 53 and generate the second information 62 concerning the deviation \( C_\Delta \) to be added to or to be subtracted from the load 30.

In particular, the second information 62 may comprise a positive deviation \( C_\Delta \) if the first information 53 includes a positive deviation \( V_\Delta \) or \( F_\Delta \), that is if the detected work is greater than the reference one, and a negative deviation \( C_\Delta \) if the first piece of information 53 includes a negative deviation \( V_\Delta \) or \( F_\Delta \), that is if the first piece of information 53 includes a negative deviation, that is if the detected work is lower than the reference one.

The second operative subroutine 102 may furthermore elaborate the second information 62 to cause the increase of the load 30 if the second information 62 includes a positive deviation \( C_\Delta \) and to cause the decrease thereof if the second information 62 includes a negative deviation \( C_\Delta \).

In the case of a machine with a single logical unit 51 the second operative subroutine
102 practically defines the regulation means 60. In other words, the regulation means 60 may be constituted by the subroutine 102.

It is understood that, in the case of a control made with the two logical units 51 and 60, as for the embodiments illustrated in the FIGS. 1, 2, 3, 7 and 8, the first subroutine 101 may interact with the logical unit 51, or it may be implemented therein, whereas the second subroutine 102 may interact with the second logical unit 60, or it may be implemented therein.

Advantageously, the software program 100 may further include a third subroutine 103 susceptible to compare the first value \( V_b \) or \( F_b \) detected by the detecting means 50 with the third value \( V_s \) or \( F_s \) corresponding to the dangerous work for the user.

The third operative subroutine 103 may furthermore interact with the blocking means 80 to activate them if the two compared values do not coincide.

According to another aspect of the invention, a kit is provided, for obtaining the machine 1 through the modification of an existing standard machine for the power exercise which includes a rocker, a load, usually including a series of plates of predetermined weight, and a motion transmission element, usually of the rope or belt type, having a first end connected to the rocker and the other end connected to the load.

The kit may include the motor 31, which may substitute the existing load, means for the rigid connection of the existing rocker to the motor 31, for the substitution of the existing transmission element, the detecting means 50, the first logical control unit 51 and the regulation means 60.

The modification of the existing machine may further provide the connection thereto of the detecting means 50, of the first logical control unit 51 and of the regulating means 60.

Advantageously, in a preferred but non-exclusive embodiment, the first logical unit 51 and, if present, the second logical unit 60 may belong to a single control unit PLC 70.

The kit may advantageously comprise the computer program 100.

By means of the above described kit it is possible to simply and quickly modify one or more existing standard machines for the power exercise, for example the standard machines present in a gymnasium or in a fitness center.

The above disclosure clearly shows that the invention fulfils the intended scopes, and in particular the one of providing a machine for the power exercise which can be used by any user, even the less expert one, in total safety.

A further advantage of the machine according to the invention is the simplicity of manufacturing.

A further advantage of the machine according to the invention is the extreme training efficacy.
The invention is susceptible to many changes and variants, all falling within the inventive concept expressed in the annexed claims. All particulars may be replaced by other technically equivalent elements, and the materials may be different according to the needs, without departing from the scope of the invention defined by the appended claims.
CLAIMS

1. A machine for the power exercise of a user, comprising:
   - a rocker (20) movable by a user in order to make a muscular work;
   - a load (30) connected to said rocker (20) to oppose the muscular work of the
     user;
   - detecting means (50) for detecting at predetermined time intervals at least one
     first value of at least one parameter \((V_b; F_b)\) corresponding to the muscular work made
     by the user against said load (30);
   - at least one logical control unit (51) operatively connected with said detecting
     means (50) to compare said at least one first value \((V_b; F_b)\) detected by the latter with
     at least one second value \((V_i; F_i)\) of at least one parameter corresponding to a
     reference work which is training for the user;
   - regulating means (60) operatively connected with said at least one logical
     control unit (51) and acting on said load (30) for the automatic increasing thereof in
     case the work detected by said detecting means (50) is greater than the reference
     work;

   wherein said regulating means (60) are further designed for automatically reducing
   said load (30) in case the work detected by said detecting means (50) is lower than the
   reference work.

2. Machine according to claim 1, wherein said at least one logical control unit (51) is
   susceptible to activate said regulating means (60) in case the work detected by said
   detecting means (50) is different from the reference work.

3. Machine according to claim 2, wherein said at least one logical control unit (51) is
   susceptible to calculate the first deviation \((V_\Delta; F_\Delta)\) between the work detected by said
   detecting means (50) and the reference work, said regulating means (60) being configured to
   calculate on the basis of said first deviation \((V_\Delta; F_\Delta)\) a second deviation \((C_\Delta)\) to be added or
   to be subtracted to said load (30) for the increasing or the reducing thereof, said second
   deviation \((C_\Delta)\) being positive in case said first deviation \((V_\Delta; F_\Delta)\) is positive and being
   negative in case said first deviation \((V_\Delta; F_\Delta)\) is negative.

4. Machine according to claims 1, 2 or 3, wherein said at least one logical control unit
   (51) is configured to compare said at least one first value \((V_b; F_b)\) detected by said detecting
   means (50) with a couple of second values \((V_{\text{rmax}}, V_{\text{rmin}}; F_{\text{rmax}}, F_{\text{rmin}})\) of said at least one
   parameter corresponding to a maximum and minimum reference training work for the user,
   said regulating means (60) being designed to automatically increase said load (30) in case
   the work detected by said detecting means (50) is equal to or higher than the maximum
   reference work and to automatically decrease said load (30) in case the work detected by
said detecting means (50) is equal to or lower than the minimum reference work.

5. Machine according to any of the preceding claims, wherein said at least one logical control unit (51) is further designed to compare said at least one first value \((V_b; F_b)\) detected by said detecting means (50) with at least one third value \((V_s; F_s)\) of at least one parameter corresponding to a work which is dangerous for the user, blocking means (80) being provided operatively connected with said at least one logical control unit (51) and acting on said rocker (20) and/or on said load (30) for the automatic blocking thereof in case the detected work is equal to the dangerous work, so as to allow the user to continuously work in a safe manner.

6. Machine according to the preceding claim, wherein said at least one logical control unit (51) is designed to compare said at least one first value \((V_b; F_b)\) detected by said detecting means (50) with a couple of third values \((V_{s,max}, V_{s,min}; F_{s,max}, F_{s,min})\) of at least one parameter corresponding to the maximum and minimum safely practicable work, said blocking means (80) being configured for automatically blocking said rocker (20) and/or said load (30) in case the work detected by said detecting means (50) is equal to or greater than the maximum safety work, said blocking means (80) being further designed to automatically block said rocker (20) and/or said load (30) in case the work detected by said detecting means (50) is equal to or lower than the minimum safety work.

7. Machine according to one or more of the preceding claims, wherein said load (30) comprises motor means (31) configured to generate a torque susceptible to oppose to the work of the user to define said load (30), said rocker (20) and said motor means (31) being mutually connected.

8. Machine according to claims 5 and 7 or 6 and 7, wherein said blocking means (80) comprise a braking unit (81) operatively connected with said at least one logical control unit (51) for the activating thereof in response to said third error signal (82) and acting on said motor means (31) for the braking thereof.

9. Machine according to claims 5 and 7 or 6 and 7, wherein said detecting means (50) are operatively connected with said rocker (20) to detect its movement imparted by the user as a result of the work against said load (30).

10. Machine according to the preceding claim, further comprising movement transmission means (40, 41, 42) of the closed ring type for the reciprocal connection of said detecting means (50), said motor means (31) and said rocker (20).

11. Machine according to the claim 9 or 10, wherein said detecting means comprise an encoder (50'), respectively an accelerometer, operatively coupled to said motor means (31) to detect the speed \((V_b)\), respectively the acceleration, of said rocker (20) as a result of the work of the user.
12. Machine according to the preceding claim, wherein said at least one second value is a reference speed, respectively acceleration, value (V_b), said at least one first logical control unit (51) being operatively connected to said encoder (50'), respectively to said accelerometer, to compare said detected speed, respectively acceleration, value (V_b) with said second reference speed, respectively acceleration, value (V_r).

13. Machine according to the preceding claim, wherein said regulating means (60) are designed to automatically increase said load (30) in case said detected speed, respectively acceleration, value (V_b) is greater than said second reference speed, respectively acceleration, value (V_r) and to automatically reduce said load (30) in case said detected speed, respectively acceleration, value (V_b) is lower than said second reference speed, respectively acceleration value (V_r).

14. Machine according to the preceding claim, wherein said first deviation (V_d) is calculated on the basis of the difference between said detected speed, respectively acceleration values (V_b) and said reference speed, respectively acceleration values (V_r), said second deviation (C_d) being a torque value calculated on the basis of said deviation speed, respectively acceleration, value (V_d) to be added to or subtracted from the torque delivered by said motor means (31) to increase or decrease said load (30).

15. Machine according to any of the preceding claims, wherein said third value is a dangerous speed, respectively acceleration, value (V_d), said blocking means (80) being designed to act on said rocker (20) and/or said motor means (31) to the automatic blocking thereof in response to the detection of a speed (V_d), respectively acceleration, value substantially equal to said dangerous speed, respectively acceleration, value (V_d).

16. Machine according to one or more of the claims 1 to 8, wherein said detecting means (50) are designed to detect the force by which the user moves said rocker (20).

17. Machine according to the preceding claim, wherein said detecting means (50) are connected to said rocker (20).

18. Machine according to the claim 16 or 17, comprising an endless screw (45) keyed on the axis of said motor means (31) and operatively connected to a pinion (46), this latter being rigidly connected to said rocker (20) for the motion transmission between the rocker and said motor means (31).

19. Machine according to the claim 17, 18 or 19, wherein said detecting means comprise a loading cell (50") to detect the force (F_b) by which the user moves said rocker (20).

20. Machine according to the preceding claim, wherein said at least one second value is a reference force value (F_b), said at least one first logical control unit (51) being operatively connected to said loading cell (50") to compare said detected force value (F_b)
with said reference force value \( (F_i) \).

21. Machine according to the preceding claim, wherein said regulation means \( (60) \) are designed to automatically increase said load \( (30) \) if said detected force value \( (F_b) \) is greater than said second reference force value \( (F_r) \) and to automatically decrease said load \( (30) \) if said detected force value \( (F_b) \) is lower than said second reference force value \( (F_r) \).

22. Machine according to the preceding claim, wherein said first deviation \( (F_A) \) is calculated on the basis of the difference between said detected force value \( (F_b) \) and said reference force value \( (F_r) \), said second deviation \( (C_A) \) being a torque value calculated on the basis of said first deviation force value \( (F_A) \) to be added to or to be subtracted from the torque delivered by said motor means \( (31) \) to increase or reduce said load \( (30) \).

23. Machine according to any of the preceding claims, wherein said third value is a dangerous force value \( (F_A) \), said blocking means \( (80) \) being configured to act on said rocker \( (20) \) and/or said motor means \( (31) \) for automatically blocking it in response to the detection of a force value \( (F_b) \) substantially equal to said at least one dangerous force value \( (F_A) \).

24. Machine according to one or more of the preceding claims, comprising a unit for the electromagnetic stimulation \( (90) \) of human muscles which includes at least one inductor \( (91) \) positionable in proximity of at least one muscle of the user, at least one power supply \( (92) \) connected to said inductor \( (91) \) for the generation of at least one electromagnetic field and a generator of pulse current \( (93) \) for the emission of current impulses having predetermined frequency and duration to said inductor \( (91) \) for causing the involuntary contraction and decontraction of the human muscle in proximity of which said inductor \( (91) \) is placed.

25. Machine according to the preceding claim, wherein said at least one first logical control unit \( (51) \) is operatively connected with said electromagnetic stimulation unit \( (90) \) to automatically disconnect said at least one power supply \( (92) \) if the work detected \( (V_b; F_b) \) by said detecting means \( (50) \) coincides with the dangerous work \( (V_a; F_a) \).

26. Machine according to the claims 25 o 26, wherein the machine does not include said regulation means \( (60) \), said at least one first logical control unit \( (51) \) being designed to compare said at least one first value \( (V_b; F_b) \) detected by said detecting means \( (50) \) exclusively with said third value \( (V_3; F_3) \) corresponding to the dangerous work and not with said at least one second value \( (V_r; F_r) \) corresponding to the training work.

27. Machine according to one or more of the preceding claims, wherein said at least one second value \( (V_r; F_r) \) of at least one parameter corresponding to a reference training work for the user is manually settable by the user, respectively automatically set by a computer program interacting with said at least one first logical unit \( (51) \).

28. A method for adjusting the load \( (30) \) in the machine \( (1) \) for the power exercise of
a user according to one or more of the preceding claims, the method comprising the following steps:

- detection at predetermined time intervals of at least one first value of at least one parameter \((V_b; F_b)\) corresponding to the muscular work exerted by the user against the load \((30)\);

- comparison of said at least one first detected value \((V_b; F_b)\) with at least one second value \((V_r; F_r)\) of at least one parameter corresponding to a reference training work for the user;

- calculation of a first deviation \((\nu_\Delta; F_\Delta)\) between said first value \((V_b; F_b)\) and said at least one second value \((V_r; F_r)\) if said at least one first value \((V_b; F_b)\) is different from said at least one second value \((V_r; F_r)\);

- calculation on the basis of said first deviation \((\nu_\Delta; F_\Delta)\) of a second deviation \((C_\Delta)\) to be added to or to be subtracted from the load \((30)\) of the machine \((1)\) for the increase or the decrease thereof, said second deviation \((C_\Delta)\) being positive if said first deviation \((\nu_\Delta; F_\Delta)\) is positive and being negative if said first deviation \((\nu_\Delta; F_\Delta)\) is negative,

- regulation of said load \((30)\) on the basis of said second deviation \((C_\Delta)\)

wherein said regulation step of the load \((30)\) comprises the increase thereof if said second deviation \((C_\Delta)\) is positive and the decrease thereof if said second deviation \((C_\Delta)\) is negative.

29. Method according to the preceding claim, further comprising the steps of:

- comparison of said at least one first detected value \((V_b; F_b)\) with at least one third value \((V_s; F_s)\) of at least one parameter corresponding to a dangerous work for the user,

- blocking of the load \((30)\) and/or of the rocker \((20)\) of the machine \((1)\) if said at least one first detected value \((V_b; F_b)\) is substantially equal to said at least one third value \((V_r; F_r)\).

30. Method according to claim 29, wherein said comparison step of said at least one first value \((V_b; F_b)\) with said at least one third value \((V_s; F_s)\) is carried out before the comparison of said at least one first value \((V_b; F_b)\) with said at least one second value \((V_r; F_r)\).

31. Method according to claim 28, 29 or 30, wherein said detecting step comprises a step of interaction with the detecting means \((50)\) of the machine, said step of adjustment of the load \((30)\) including an interaction step with the motor means of the machine \((31)\).

32. An software product controllable in the memory of at least one logical control unit
(51) of a machine for the power exercise of a user, the software product comprising portions of software code for carrying out the method according to any of the claims from 28 to 31 when said software product is run by the at least one logical control unit (51) of the machine (1) according to one or more claims from 1 to 27.

33. Software product according to claim 32, comprising one or more fix or removable memory support interacting with said logical control unit (51).

34. Software product according to claim 32, comprising one or more integrated circuits belonging to said logical control unit (51).

35. A modification kit for obtaining a machine for the power exercise of a user according to any of the claims from 1 to 27 starting from an existing machine for the power exercise which includes a rocker, a load and a motion transmission element having a first end connected to the rocker and the other end connected to the load, the kit comprising:
   - motor means (31) for the substitution of the existing load;
   - means for the rigid connection of the existing rocker to said motor means for the substitution of the existing transmission element;
   - detecting means (50) to detect at predetermined time intervals at least one first value of at least one parameter corresponding to the muscular work made by the user against the load defined by said motor means (31);
   - at least one first logical control unit (51) operatively connectable with said detecting means (50) to compare the work detected by these last ones with a reference training work for the user;
   - regulating means (60) operatively connectable with said at least one first logical control unit (51) and acting on the load defined by said motor means (31) for the automatic increase thereof if the work detected by said detecting means (50) is greater than the reference work, said regulating means (60) being further designed to automatically decrease the load defined by said motor means (31) in case the detected work is lower than the reference work;

wherein said detecting means (50), said at least one first logical control unit (51) and said regulating means (60) are connectable to the existing machine.

36. Kit according to the preceding claim, further comprising an software product according to the claim 32, 33 or 34.

37. A method for obtaining a machine for the power exercise of a user according to any of the claims from 1 to 27 starting from an existing machine for the power exercise which includes a rocker, a load and a motion transmission element having a first end connected to the rocker and the other end connected to the load, the method comprising the steps of:
   - providing the modification kit according to the preceding claim;
- substitution of the existing load on said existing machine with said motor means (31);
- elimination of the existing transmission element on said existing machine;
- rigid connection of said existing rocker with said motor means (31);
- reciprocal operative connection of said detecting means (50) and said at least one first logical control unit (51);
- reciprocal operative connection of said at least one first logical control unit (51) and said regulating means (60);
- reciprocal operative connection of said regulating means (60) and said motor means (31);
- operative connection of said detecting means (50), said at least one first logical control unit (51) and said regulating means (60) with the existing machine.
FIG. 9
**INTERNATIONAL SEARCH REPORT**

**International application No**

PCT/IB2011/050061

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**A. CLASSIFICATION OF SUBJECT MATTER**

INV. A63B21/005 A63B24/00

ADD.

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

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**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

A63B

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

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**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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<td>US 4 765 613 A (VORIS HARV [US]) 23 August 1988 (1988-08-23)</td>
<td>1, 2, 5, 7, 9, 10, 16, 17, 27</td>
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<td>Y</td>
<td>column 3, line 46 - column 9, line 36; figures 1-4</td>
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<td>A</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

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Jekabsons, Armands
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