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(54) **TRAINING METHOD AND DEVICE**

(57) The present invention is directed to a method and apparatus for adaptive training one or more muscle(s) and/or joint(s) of a trainee. The method comprises the step of automatically determining an individual resistance, resistance band, speed and/or speed band of a user during movement of the training device by the user and the further step of automatically adjusting the resistance, resistance band and/or speed band for an actual or a later movement by the user according to the determination step. According to a preferred embodiment the further movement of the user is monitored and the training resistance automatically adapted.

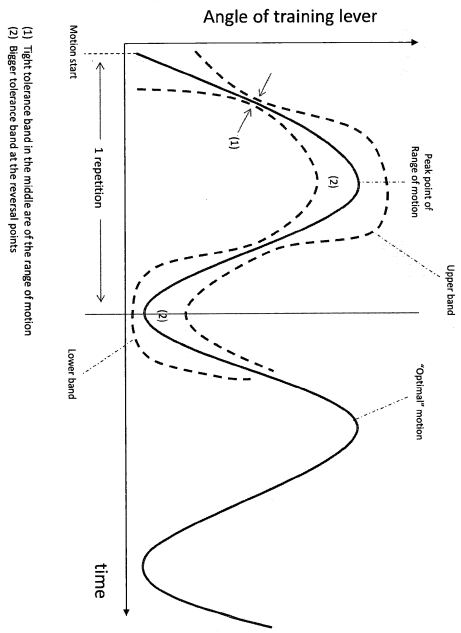

FIG. 6

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Description

Field of the Invention

[0001] The present invention relates to a training or exercise method and respective device that can automatically adapt according to the individual needs or can optimize the training of a user. The method and the apparatus can be used for therapeutic or physical movements in order to exercise or to train at least one muscle or a group of muscles and/or at least one joint or a group of joints in order to keep or improve the abilities or strength of a user, trainee or patient.

Background of the Invention

[0002] Training or exercising clearly positively contributes to the fitness or health conditions of a user. Thus, respective methods and devices for training or exercising are used in sports and hobby institutions, such as gyms, hospitals, clinics, rehab institutions, fitness studios etc. It is generally believed that contraction and distraction (also called concentric movement and excentric movement) of muscles beyond their normal range of capabilities is necessary in order to train them. Thus, in order to stress a muscle, generally contraction and distraction is performed against some sort of resistance, load or weight.

[0003] A variety of training or exercising machines or devices have been proposed in the past that enable an individual or user, such as a sportsman or patient, to exercise or train with an individual load or resistance and/or weight. Among these various training machines, there are machines with a trainee performing repetitive exercises while a load or resistance is applied to certain muscles in order to work the muscles that she or he has targeted. For example, Japanese Examined Utility Model Application No. 87-41083 proposes an apparatus for the purpose of training by performing repetitive exercise. This training apparatus uses a direct drive motor as the power source to provide a load that works against the trainee's muscular force, and comprises a muscle load providing apparatus that adjusts the load by controlling the rotation of the direct drive motor in accordance with its torque and rotational speed.

[0004] The load controlling method disclosed according to US 2006-061528 adjusts the load by controlling the rotation of the direct motor in the same manner for every trainee. However, in actuality, individual trainees have different physiques. Differences in physique result in differences in, for example, the amplitude and the width of the rotation the repetitive exercise. Consequently, the posture taken by each trainee varies when the rotational speed of the direct load is applied uniformly to every trainee in accordance with the torque and the rotational speed of the direct drive motor is a prescribed fixed value. However, if the load is applied uniformly to every trainee in accordance with the torque and the rotational speed of the direct drive motor then the control of the load will be perfect for the trainees who have a standard physique, but the change of the load will be inappropriate for trainees who have a build that is smaller or larger than the standard physique. Consequently, the latter trainees cannot exercise appropriately and cannot, therefore, for example, sufficiently increase the effectiveness of the exercise or are forced into overexertion.

[0005] In view of the above US 2007/219051 A1 tries to provide an improved training apparatus wherein a trainee can exercise with a load that is in accord with his or her build in the forward and return paths of a repetitive exercise, respectively. A motor applies a load to a bar or a moving unit that moves repetitively due to a trainee's exercise. The load that is applied by the motor is not fixed, but rather varies according to individual needs. The width of the repetitive exercise, i.e., the width of the range of motion of the bar, takes into account differences in the physique of individual trainees. Consequently, varying the load in accordance with the width of the range of motion makes it possible to apply a load that is suited to the physique of each individual trainee, thereby enabling each trainee to exercise effectively.

[0006] These prior art methods and devices still have the disadvantages that they make it necessary to train the same movement for a plurality of cycles in order to train in an effective manner and are not capable to change during the training or training stroke or cycle of an individual to the actual needs or conditions or to optimize the training sufficiently.

Summary of the Invention

[0007] It is the object underlying the present invention to provide an improved training or exercising method and device. This object is solved with the present invention and further aspects and embodiments thereof. The present invention is defined in the claims attached.

[0008] The present invention is preferably directed to a method or device for an adaptive training of one or more muscle(s) and/or joint(s) of a user. The method comprises the steps of automatically determining an individual resistance, resistance band, speed and/or speed band of a user during movement of the training device by the user and automatically adjusting the resistance, resistance band and/or speed band for an actual or a later movement by the user according to the determination step. In other words, the invention is able to very quickly or quasi real time adjust, adapt and/or change any training condition during the use of by a user. The training condition can be the resistance against movement by the user or trainee that embraces a load, weight etc. that is changed during a stroke, a cycle or a training unit of a user. In a preferred embodiment or aspect this can be controlled and realized so that a user doesn't notice any increments but rather feels no adjustment steps, almost nothing or a smooth change only.

[0009] Working out with such an optimized resistance

allows the sportsmen to stress their muscles much more intensively than with a constant resistance. Studies show that such an increased muscle stress will lead to greater acute hormonal and neuromuscular responses and thus greater training success. Athlets' maximum force has shown to increase by 50% under similar conditions in comparison to a training with regular resistance.

[0010] The term resistance is intended to embrace any resistance applied to train or exercise a muscle, group of muscles, joint and/or group of joints. This can be a load, weight or resistance as it is applied by an electric motor against one or more movements of a muscle, group of muscles, joint and/or group of joints for their movement, training or exercise. In this respect the disclosure of US 2007/219051 A1 is referred to and herein incorporated by reference.

[0011] The term band used inhere means a nominal value which may change over the movement or angle of movement of a training device, and embraces other neighboring values, a field or a tolerance around the nominal values. This can be a +/- deviation or tolerance of around +/-5 % or can be a deviation or tolerance deviating over the angle of movement of the training device, over time, may change cyclic etc. As a non-limiting example a sinusoid nominal speed curve is given where the respective nominal speed is adapted to the angle of an arm of a training device. The band may then be a 10% tolerance field around each nominal speed or may vary according to the angle of the arm, i.e. the tolerance field at a turning point of the arm may be larger compared to a tolerance field at a point of straight or almost straight movement of the arm to counterbalance the change of the movement direction.

[0012] Thus, the invention is able to make or motivate the user to train with certain resistances or with certain speeds, both being able to change over a stroke, cycle and/or time. In order to make it easier for the user a band is preferably provided which tries to motivate him to meet this band rather than an exact or too precise movement over time.

[0013] In a further aspect or embodiment a plurality or even large number of adaptions, adjustments or changes take place during a cycle or preferably during a single stroke of a user. Preferably the user is constantly or quasi constantly monitored and the resistance, resistance band, speed and/or speed band is automatically re-adjusted.

[0014] In a further aspect or embodiment of the present invention the resistance band, speed and/or speed band is displayed in a monitor or display in the vision field of the user and preferably attached to the training device and further preferably attached on an arm allowing an adaptation to the user needs. In a further preferred aspect also the position of the display for each user can be stored as data accessible when a specific user enters the training device. The authentication of a user can be laid down in a passive or active transponder which can be read by the training device or a control attached to it. The data can be also stored on the transponder or a query for further data in relation to the respective user can be initiated by the transponder. The data queried can be stored on a store attached to the training device or on a server storage which can be accessed by the training device, either via intranet or internet.

[0015] Preferably a motion band is displayed as this is relatively easy to show to the trainee and is it corresponds to the motion of the lever or bar of the training device. A nominal motion and tolerances are shown which result in a motion band. During the operation or training this motion band constantly moves during operation to the left.

[0016] What is actually controlled is more preferably the derivation of this motion and tolerances over time, namely the nominal speed and tolerances resulting in the speed band. This is easier to be controlled while still keeping and providing to the trainee information which are easier to understand and to follow and which correspond rather to her or his actual movement. As said, this can preferably be done in the form of a sinusoidal curve which is moved sidewardly on a display. Additionally the user's actual resistance, resistance band, mostly preferred speed and/or speed band is also displayed. Preferrably a correlation of the actual motion is shown as a dot or spot and the motion band is shown wherein the actual motion dot should be kept in the broader curve moving over the time. This allows the user to control the nominal versus the actual resistance, resistance band, speed and/or speed band and to move the training device accordingly. The user can nevertheless move the training device with any motion or speed that would mean in the above example that the dot would be outside the curve.

[0017] According to a further preferred embodiment the leaving and/or following of the speed band by the user's speed is monitored and evaluated. This can most preferably be done with a counting process that is counting the deviations over time and thereby monitoring the leaving/following of the actual speed by the nominal speed band. Most preferably the time of deviation is measured in tenth of milliseconds and is integrated in real time or close to real time. That is, in case the trainee has moved the device too slow for let's say 90 milliseconds and too fast for let's say 100 milliseconds the integrated value of the increase counter is 90 milliseconds, the integrated value of the decrease counter is 100 Should a dynamic threshold value be exceeded, let's say 150 milliseconds in either direction the resistance, load or weight will then be instantaneously be increased or decreased, respectively. The threshold values can also be different for speeds of movement too fast or too slow, respectively for the increase or decrease counter. In addition to that the profile of deviation over time in a single stroke can be taken into consideration as well and the deviation in time could be weighted accordingly. Thus, a deviation in the past will be weighted lower than an actual deviation. And a deviation of speed which is twice as high as another one with the same time of deviation will

present higher counter value. In other words, in case the actual speed has exceeded the nominal speed band for a certain time more than the threshold, the resistance of the training device is made larger. In case the actual speed has been a certain time slower that the preset speed band the resistance of the training device will be reduced. The thresholds for these two different scenarios can vary over time so that only fewer actual speeds having been slower than the speed band will change the nominal speed band than the actual speed having been faster than the nominal speed band. The counts may also depend on the amount of deviation, that is, an actual speed being 10% slower than the nominal speed band will result in a deduction of 1 count while an actual speed being 15% slower than the nominal speed will result in a deduction of 2 counts and so on. The boundaries of the counter may also be adapted based on the movement phase, excentric movement or concentric movement. Additionally with a linear adjustment with every boundary linearly decreasing, the speed band is defined with a cubicle adjustment with every boundary cubically decreasing and/or the speed band is defined as a given fraction of the previous one, depending on the training status of the user. A linear adjustment is more robust but relatively idle or slow and a cubicle adjustment is more sensitive but not as stable as a linear adjustment. This means that the adjustments can be made more sensitive or idler according to the training effect or skills of the user.

[0018] Additionally or optionally the change of movement direction in the turning points can be accepted by increasing the speed band for a defined amount of time, for example 1s. In case the user leaves the turning point prior the timer is finished, the system can use the original speed band again. This prohibits unwanted adaptations of the weight at the turning points.

[0019] The initial resistance of the training device can be set by a person or preferably automatically according to data stored with respect to the user and/or can be automatically set according to a static and/or dynamic resistance measurement preferably before the training cycle starts. The resistance over time can be preferably adjusted automatically according to a defined part or percentage of the initial resistance.

[0020] In a further preferred aspect of the invention the resistance is automatically increased, preferably according to a pre-defined function.

[0021] In a further aspect of the invention in a concentric phase or movement the resistance is increased if the moving speed by the user is faster than according to the nominal resistance band, decreased if the moving speed is slower than according to the stroke or cycle band, and wherein during an excentric movement the load or resistance is decreased if the moving speed is faster than according to the stroke or cycle band and/or increased if the moving speed is slower than according to the stroke or cycle band. This results in a kind of hysteresis resistance over one full movement of the user.

[0022] The term movement can also be understood as a stroke of the user.

[0023] During a concentric movement the muscle of a trainee contracts and during an excentric movement the muscle expands. According to the present invention there are preferably different resistances or weights and speeds or speed bands adjusted for concentric or excentric movements.

[0024] The resistance band can further be defined initially with higher boundaries or larger tolerance fields than at a later time, the resistance band being further defined may be limited by the starting value and a bottom limit of 20% of the starting value for the concentric phase. The resistance change during a single stroke is limited, to increase the tolerance towards wrong usage of the training device, like changing the movement direction in the middle of a cycle. Experimental defined values allow changes in a single stroke of around 40%. As the excentric phase resistance should usually not be below the concentric phase resistance, the resistance band might have a minimal value being latest concentric resistance. The maximum value may vary based on the user, a typical value might be 130% of the latest concentric resistance. A user having used training devices according to the present invention quite often are usually more familiar with the training devices and better able to provide a more stable actual speed. Should they leave the speed band than this will easier or earlier change the resistance of the training device. The skills and/or training extensity of specific user can be also stored by the training device or in the internet or cloud or a respective transponder communicating with the training device.

[0025] According to a further aspect of the invention the speed boundaries are increased incrementally or step wise after each or a group of strokes or cycles if the user meets the previous speed bands. This will help to optimize the training effect and to shorten the training cycles as will be shown further below.

[0026] In a further aspect of the invention data of a user can be stored and/or be accessible via a network or the internet and also be used for determining or adjusting the individual resistance, resistance band, speed and/or speed band of a user during movement of the training device by the user.

[0027] The present invention is also directed to training devices or apparatuses realizing some or all of the above discussed methods or method steps. Such apparatus is particularly adapted for carrying out such method and has an automatic determinator determining an individual resistance, resistance band, speed and/or speed band of a user during movement of the training device by the user and an automatic adjuster adjusting the resistance, resistance band and/or speed band for an actual or a later movement by the user in response to the determinator.

[0028] A further aspect of the invention involves a monitor or control monitoring the further movement of the user and automatically re adjusting the resistance, resistance band, speed and/or speed band according the

monitoring step.

[0029] The most preferred embodiment of the present invention monitors the actual speed of movement by a user versus a given speed band and adjusts or re-adjusts the resistance against the movement of the user.

[0030] The invention may bear the advantage that the training is optimized according to the natural needs of muscles and/or joints. The training effect is further severely optimized while nevertheless saving considerable training time. Any misuse jeopardizing or overexerting the health or function of muscles and other parts of the body can be avoided.

[0031] The parameters for the training, such as variable resistances and an optimized speeds for the movement by the trainee or user can be set.

Preferred embodiments of the invention

[0032] Preferred but non-limiting embodiments of the present invention are described in the following. The figures show the following:

FIG. 1: An example of a training circle with a plurality of training devices according to the present invention;

FIG.2a: a back trainer according to the present invention;

FIG. 2b: a rowing trainer according to the present invention;

FIG. 2c: a lat pull according to the present invention;

FIG. 2d: a ventral trainer according to the present invention;

FIG. 2e: a gluteus trainer according to the present invention;

FIG. 2f: a leg extensor according to the present invention;

FIG. 2g: a leg bender according to the present invention;

FIG. 2h: a bench press according to the present invention;

FIG. 3: a flow chart of a method or part of the method according to the present invention;

FIG. 4: a graph showing the actual force moved by a user over time in a training device according to the present invention;

FIG. 5: a screen shot of a display in a training device according to the present invention;

FIG. 6: a preferred motion band with perferred tolerances;

FIG. 7: a preferred speed band with preferred tolerances and

FIG. 8: a comparison of a standard training method (top) and a training method according to the present invention (bottom).

[0033] A known arrangement of training devices is called a training circle in order to train at least a plurality or even a majority of the muscles and/or joints of a trainee. A trainee using all of the training devices can rest assured that for a general or specified training he has trained her or his body according the aims or needs. The number and kind of training devices can vary according to the different kinetics and multiple devices or machines known. Such a training circle is shown in FIG. 1 with training devices according to the present invention.

[0034] Here it should be emphasized that the method and apparatus according to the present invention can also be used in other devices than shown with weights, motors, levers, cords etc. or a combination or mixture thereof. Also the design or arrangement of parts can vary considerably as is known in the art. In a training circle according the example shown in FIG. 1 also just one or less than all of the devices can work according to the method according to the invention or can be an apparatus according to the present invention.

[0035] In the circle as exemplified in FIG. 1 several distinct or combined training devices can be arranged, such as a back trainer, a rowing trainer, a lat pull, a ventral trainer, a gluteus trainer, a leg extensor, a leg bender and/or a bench press according to figures 2a to 2h, respectively. Further training devices can be used, such as a leg press, an adduction machine, an abduction machine, a rotator, a calf machine, a butterfly, a butterfly reverse, a biceps machinea shoulder press. Other training or rehab devices for studios or end customers or combined devices for muscles, groups of muscles, joints or group of joints can also work or be equipped according to the present invention.

[0036] FIG. 3 shows a flow chart or part of a flow chart according to a preferred embodiment according to the present invention. At any position, e.g. of a lever or handle or leg bar of the training device, it is realized that the optimum or nominal speed of movement is subtracted from the current differentiated speed. The optimal speed in the concentric phase is therefore defined as

$$v_{opt-conc} = \frac{r_{comp} * conv_{opt}}{t_{conc}}$$

$v_{opt\text{-}conc}$: *Optimal speed in the concentric movement*
r_{comp}: *Complete range of motion defined for the user*
$conv_{opt}$: *Conversion facto to get the optimal range,*

typical around 90%

t_{conc}: *Optimal time of the concentric movement cycle*

[0037] Based on the sign of the deviation, either the increase or the decrease counter is incremented by the amount of the deviation. As this process is repeated at a fixed frequency, the counter integrates the deviation over time. In case the counter is below its defined boundary, the resistance is retained and no adaptation is done. Otherwise if the counter exceeds the defined boundary, the weight is either increased or decreased within the defined resistance band. Opptionally, the boundary may be decreased or increased after each adaptation step.

[0038] In the preferred embodiment shown a deviation in speed is checked or monitored. In the most preferred embodiment the deviation of speed is the difference of the actual speed by the user compared to the nominal speed set earlier by the method or apparatus according to the present invention. Should there be a difference outside the nominal speed and speed band or tolerance field around it, the counter is either increased or decreased.

[0039] Should the counter remain under a preset threshold value, the resistance or weight of the training device remains unanmended. Should it be higher or bigger than the threshold value, either in positive or negative terms, then the resistance or weight is increased or decreased, respectively.

[0040] The threshold value can be pre-set or can grow dynamically depending on the time of the training device used by a certain trainee.

[0041] FIG. 4 shows an example of an actual force/time diagram of a user or trainee over a training cycle. During an excentric movement the force or resistance is higher than during a concentric movement and the actual speed of movement tends to be faster during an excentric movement than during a concentric movement. This is apparent by the graph according to FIG. 4.

[0042] At a time of a bit more than 10 seconds in FIG. 4 the concentric movement is initiated with the least force approximately in the mid of it. Approximately in the mid of this concentric movement a negative adaption of the resistance or force takes automatically place. The excentric movement starts at around 12 seconds and it is shown that until around 15 seconds the force remains relatively stable on an only very slightly increasing plateau irrespective of the different leverages during the excentric part of the cycle. The different leverages are caused by the different angles of the lever between the trainee and the training device, and the trigonometric relations that are generally known. Anyhow, the method and apparatus according to the present invention are able to optimize the training also by compensating such leverage differences by controlling the resistance or force dynamically according to the position of the lever.

[0043] After 15 to 16 seconds according to FIG. 4 the trainee enters the concentric movement and tends to allow the muscle to contract by far more quickly than during the excentric movement. This is also compensated by the method and apparatus according to the present invention as a more uniform concentric movement is suggested to the trainee than she or he would normally allow to happen.

[0044] In the graph according to FIG. 4 the second excentric movement happens from about 17 to 19 seconds. It is apparent that due to the exhaustion by the first concentric movement the resistance or force according to the second concentric is generally lower. The method and apparatus according to the present invention allows for an automatic and quick adaption of the resistance or weight and, therefore, optimizes the training very considerably according to the needs, abilities or training status of the trainee.

[0045] It is further shown in FIG. 4 that in an excentric cycle between around 42 to 43 seconds the speed has been increased by the trainee and therefor the resistance has been increased according to the method and apparatus of the invention accordingly. In the concentric cycle or phase between 43 and 47 seconds the force or resistance is decreased down to a relatively low value of around 28 kg compared to the values before. The trainee has obviously exhausted his muscle(s).

[0046] Up to the end of about 70 seconds the training cycles become more and more disharmonic or unstable which shows the exhaustion and training effect of the muscle(s) involved.

[0047] FIG. 5 shows a preferred example of a screen shot of a display according to the method and apparatus according to the present invention.

[0048] The sinusoid curve corresponds to the preferred motion or speed band set or revealed by the method and apparatus according to the present invention and shown to the user or trainee. As mentioned before, the motion band is a nominal motion over given time with a tolerance field or band around it. Over time this motion band moves continuously to the left corresponding to the nominal speed. Its derivation results in the nominal speed band.

[0049] The dot in the first third of the speed band corresponds to the actual position of the handle, bar or lever of the training device and it will remain in this distance to the left end of the display or screen. In this embodiment only the vertical position of the dot can change according to the actual position of the handle, bar or lever of the training device. While now the sinusoid motion band moves continuously to the left the user should try keeping the dot within the motion band moving, all these parameters then providing the information about the actual speed of movement by the user at any time. In the positive, no deviation between the actual speed and the nominal speed band will happen. In the negative, however, the dot will leave the motion band and under the conditions described herein the resistance will preferably be adjusted or adapted accordingly. As also mentioned before an additional automatic change or adaption of the resistance may be added over time or over a training

cycle in order to obtain a certain training effect.

[0050] At the right end of the display the lower resistance or weight is shown corresponding to the presently set excentric resistance and the higher resistance or weight is shown corresponding to the presently set concentric resistance. At the bottom the overall time used for the training cycle is shown and the status or advice to the trainee as well.

[0051] There are many ways to provide the same or similar control information to the user while making use of different aesthetics or designs of the display.

[0052] FIG. 6 shows a preferred motion band with preferred tolerances, more particularly a motion band of the angle of the lever over time. This is similar to the curve shown to the trainee according to FIG. 5. It is to be kept in mind that the picture on the screen according to FIG. 5 continuously moves to the left over time. Advantageously it shows to the trainee the intended movement of the lever, handle or foot bar she or he has to make during the training. The nominal motion and the tolerances which result in the motion band are actually set differently at the points or sections marked as it is there more difficult for the trainee to meet these parts of the motion band. As mentioned before, the dot shown in FIG. 5 corresponds to the actual motion of the handle or bar of the training device.

[0053] FIG. 7 shows essentially a derivation of the graphs shown in FIG. 6, namely a preferred nominal speed and preferred tolerances resulting in a speed band. These values derived from the nominal motion band are preferably controlled by the method and apparatus according to the present invention.

Comparative examples

[0054] The top part of FIG. 8 shows a training with a constant weight according to a training method as it is generally known with a weight and several cycles of moving the weight. It is apparent that three cycles of weight movements are shown with two breaks inbetween.

[0055] It is apparent that the training method takes 300 seconds time and that 20% of the muscles capacity will remain at the end of the cycles.

[0056] The bottom of FIG. 6 shows a training according to the present invention which is also called adaptive training. Over an overall time of 60 seconds the training is optimized so that no muscle capacity is left.

[0057] This means that in a fraction of the time needed for a standard training method, namely only 20% thereof, the training according to the present invention results in an optimized training effect while nevertheless avoiding any misuse, overloading or overstressing of the muscles and/or joints of the trainee. In other words, 240 seconds can be saved according to the present invention and this just for one of a number of training devices. In a whole circle of training devices the amount of saved time can add up to 30 minutes or even more.

[0058] The above description or below figures are of exemplifying nature and not intended to limit the scope of the invention in any respect.

[0059] The invention is also defined by the following numbered aspects:

1. Method of adaptive training one or more muscle(s) and/or joint(s) of a user with a training device with the following steps:

   a. automatically determining an individual resistance, resistance band, motion, motion band, speed and/or speed band of a user during movement of the training device by the user;

   b. automatically adjusting the resistance, resistance band, movement, movement band, speed and/or speed band for an actual or a later movement by the user according to the determination step.

2. Method according to aspect 1 with the further step of monitoring the further movement of the user and automatically re-adjusting the resistance, resistance band, motion, motion band, speed and/or speed band according the monitoring step.

3. Method according to one or more of the preceding aspects, wherein the resistance, resistance band, motion, motion band, speed and/or speed band is determined and/or re-adjusted according to the actual incremental and/or overall moving speed of the training device by the user.

4. Method according to one or more of the preceding aspectswith the step of displaying to the user the actual resistance, resistance band, motion, motion band, speed and/or speed band and a representation of the resistance, resistance band, motion, motion band speed and/or speed band and correlation so as to allow him to control the actual resistance, resistance band, motion, motion band, speed and/or speed band.

5. Method according to one or more of the preceding aspectswith the step of automatically monitoring the actual moving speed of the user and determining the leaving and/or following of the nominal speed band by the user at a resistance automatically adjusted.

6. Method according to one or more of the preceding aspectswith the step of displaying to the user a nominal motion band and an actual motion of the training device and automatically adjusting the resistance.

7. Method according to aspect6 wherein the motion band is displayed as an essentially sinusoid curve being moved over time and the actual motion is displayed as a dot.

8. Method according to aspects 6 and 7, wherein the nominal speed band is derived from the nominal motion band and the actual speed is derived from the actual motion, and the actual speed versus the nominal speed band is taken for controlling the resistance.

9. Method according to one or more of the preceding aspects, wherein the initial resistance of the training device can be set automatically according to data stored with respect to the user and/or can be automatically set according to a static and/or dynamic resistance measurement.

10. Method according to aspects, wherein the resistance adjusted is automatically set according to a defined part or percentage of the initial resistance.

11. Method according to one or more of the preceding aspects, wherein the resistance is automatically increased, preferably according to a pre-defined function.

12. Method according to one or more of the preceding aspects5 to 11 with the further step of adding or deducting counts for each leaving of the speed band by the user, the counts added or deducted depending on the time and/or amount of deviation between the nominal speed band and actual speed.

13. Method according to one or more of the preceding aspects, wherein during a concentric movement the resistance is increased if the actual moving speed by the user is faster than according to the nominal speed band, decreased if the actual moving speed is slower than according to the nominal speed band, and wherein during an excentric movement the load or resistance is decreased if the actual moving speed is faster than according to the speed band and/or increased if the actual moving speed is slower than according to the speed band.

14. Method according to one or more of the preceding aspects, wherein the speed band is defined initially with higher boundaries or larger tolerance fields than at a later time, the speed band being further defined with a linear adjustment with every boundary linearly decreasing, the speed band being defined with a cubicle adjustment with every boundary cubically decreasing and/or the speed band being defined as a given fraction of the previous one, depending on the training status of the user.

15. Method according to one or more of the preceding aspects, wherein the speed band boundaries are increased incrementally or step wise after each or a group of strokes or cycles if the user meets the previous speed bands.

16. Method according to one or more of the preceding aspects, wherein data of a user is stored and accessible via a network or the internet and also used for determining or adjusting the individual resistance, resistance band, speed and/or speed band of a user during movement of the training device by the user.

17. Training apparatus, particularly adapted for carrying out a method according to any one of the preceding aspects, with

a. an automatic determinator determining an individual resistance, resistance band, speed and/or speed band of a user during movement of the training device by the user;

b. an automatic adjuster adjusting the resistance, resistance band and/or speed band for an actual or a later movement by the user in response to the determinator.

18. Training apparatus according to aspect17 with a monitor monitoring an actual speed of the user versus a speed band adjusted by the apparatus and automatically readjusting the resistance according the monitoring by the monitor.

19. Training apparatus according to aspect18, with a display for displaying to the user a nominal motion band and an actual motion, and a controller deriving both to the nominal speed band and actual speed, respectively.

Claims

1. Method of adaptive training one or more muscle(s) and/or joint(s) of a user with a training device with the following steps:

a. automatically determining an individual resistance for a user during movement of the training device by the user;
b. automatically adjusting the resistance for an actual or later movement by the user according to the determining step;
c. automatically monitoring the actual moving speed of the user and determining the leaving and/or following of a nominal speed band by the user at the resistance adjusted; and
d. automatically re-adjusting the resistance for an actual or a later movement according to the monitoring step,

wherein the speed band comprises a nominal value and a tolerance around the nominal value and wherein the tolerance deviates over the angle of movement of the training device.

2. Method according to claim 1 with the step of Monitoring and evaluating the leaving of the speed band by the user's speed with a counting process that is counting the deviations over time.

3. Method according to claim 1 with the step of controlling the derivation of the nominal speed and tolerances resulting in the speed band.

4. Method according to claim 1 with the step of

increasing the resistance in a concentric movement if the moving speed by the user is faster than according to the nominal resistance band, and
decreasing the resistance if the moving speed is slower than according to the stroke or cycle band, and
decreasing resistance during an excentric movement if the moving speed is faster than according to the stroke or cycle band and
increasing the resistance if the moving speed is slower than according to the cycle band.

5. Method according to claim 1 with the step of Accepting a change of movement direction in the turning points by increasing the speed band for a defined amount of time.

6. Method according to claim 1 with the step of Adapting a nominal speed to an angle of an arm of a training device.

7. Method according to the preceding claim, wherein the band comprises a 10 % tolerance field around each nominal speed.

8. Method according to any of the two preceding claims, wherein the band varies according to the angle of the arm of the training device.

9. Method according to any of the preceding claims, wherein the speed band comprises a smaller tolerance band in the middle of the range of motion and comprises a bigger tolerance band at the reversal points.

10. Method according to one or more of the preceding claims with the step of displaying to the user the nominal speed band and a representation of the moving speed and a correlation between nominal speed band and moving so as to allow him to control the actual resistance.

11. Method according to one or more of the preceding claims with the step of displaying to the user a nominal motion band and an actual motion of the training device and automatically adjusting the resistance.

12. Method according to the preceding claim, wherein the motion band corresponds to the motion of a lever or a bar of the training device is displayed and wherein a nominal motion and tolerance are shown which result in a motion band and wherein during the operation or training this motion band constantly moves during operation to the left.

13. Method according to one or more of the preceding claims, wherein the speed band is defined initially with higher boundaries or larger tolerance fields than at a later time, the speed band being further defined with a linear adjustment with every boundary linearly decreasing, the speed band being defined with a cubicle adjustment with every boundary cubically decreasing and/or the speed band being defined as a given fraction of the previous one, depending on the training status of the user.

14. Method according to one or more of the preceding claims, wherein the speed band boundaries are increased incrementally or step wise after each or a group of strokes or cycles if the user meets the previous speed bands.

15. Training apparatus, particularly adapted for carrying out a method according to any one of the preceding claims, with

a. a determinator automatically determining an individual resistance for a user during movement of the training device by the user;
b. an adjuster automatically adjusting the resistance for an actual or a later movement by the user in response to the determinator.
c. an monitoring device automatically monitoring the actual moving speed of the user and determining the leaving and/or following of a nominal speed band by the user at the resistance adjusted; and
d. a re-adjuster automatically re-adjusting the resistance for an actual or a later movement according to the monitoring step,

wherein the speed band comprises a nominal value and a tolerance around the nominal value and wherein the tolerance deviates over the angle of movement of the training device.

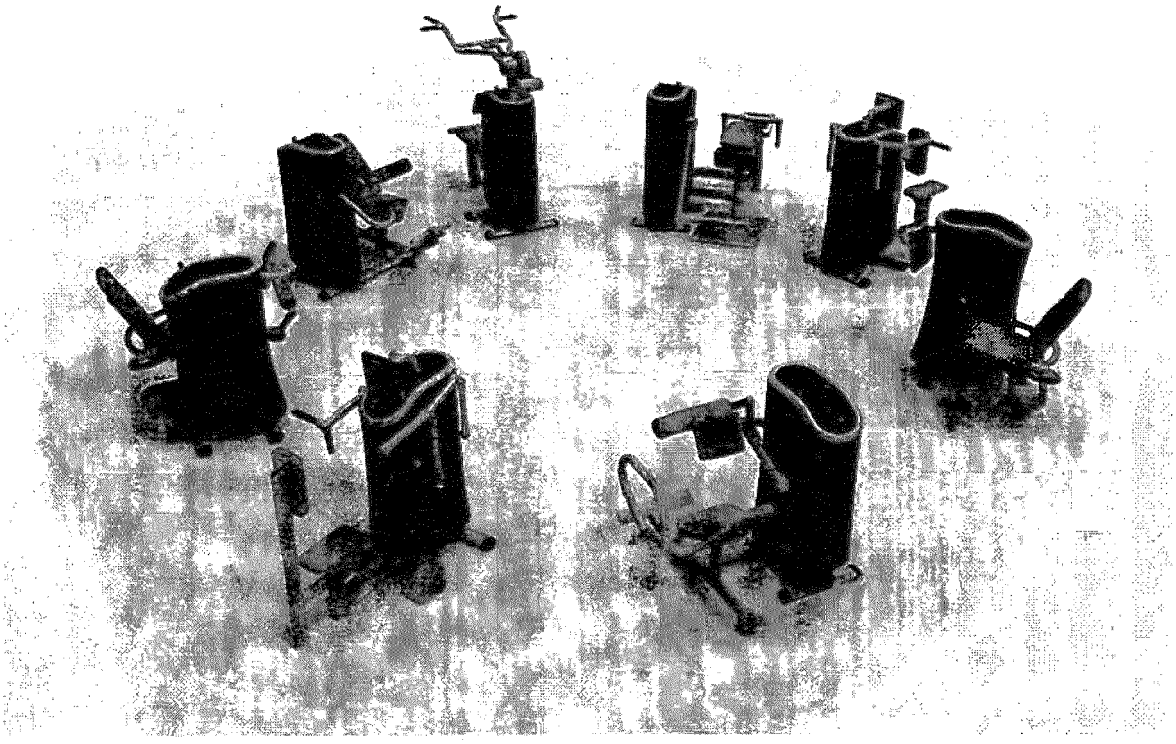


FIG. 1

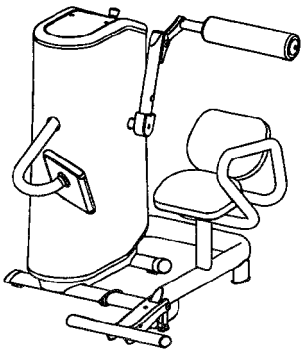


FIG. 2a

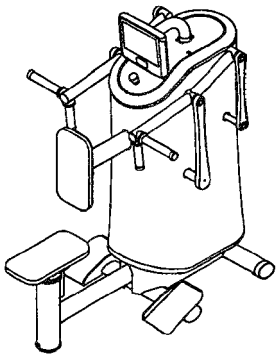


FIG. 2b

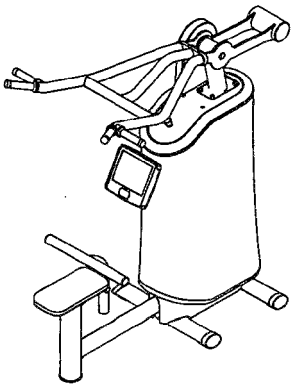


FIG. 2c

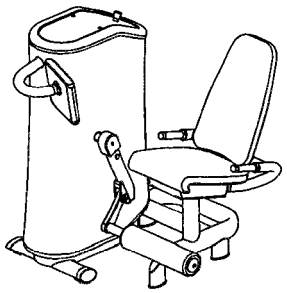


FIG. 2d

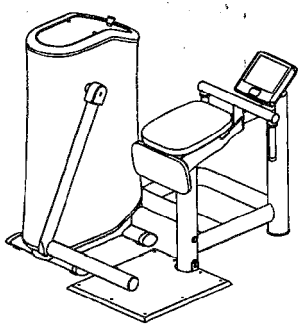


FIG. 2e

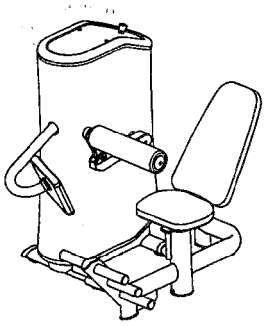


FIG. 2f

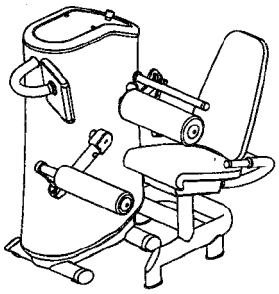


FIG. 2g

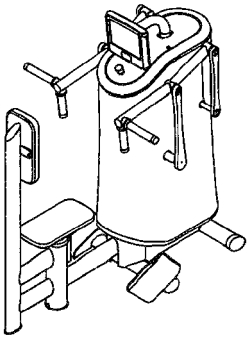


FIG. 2h

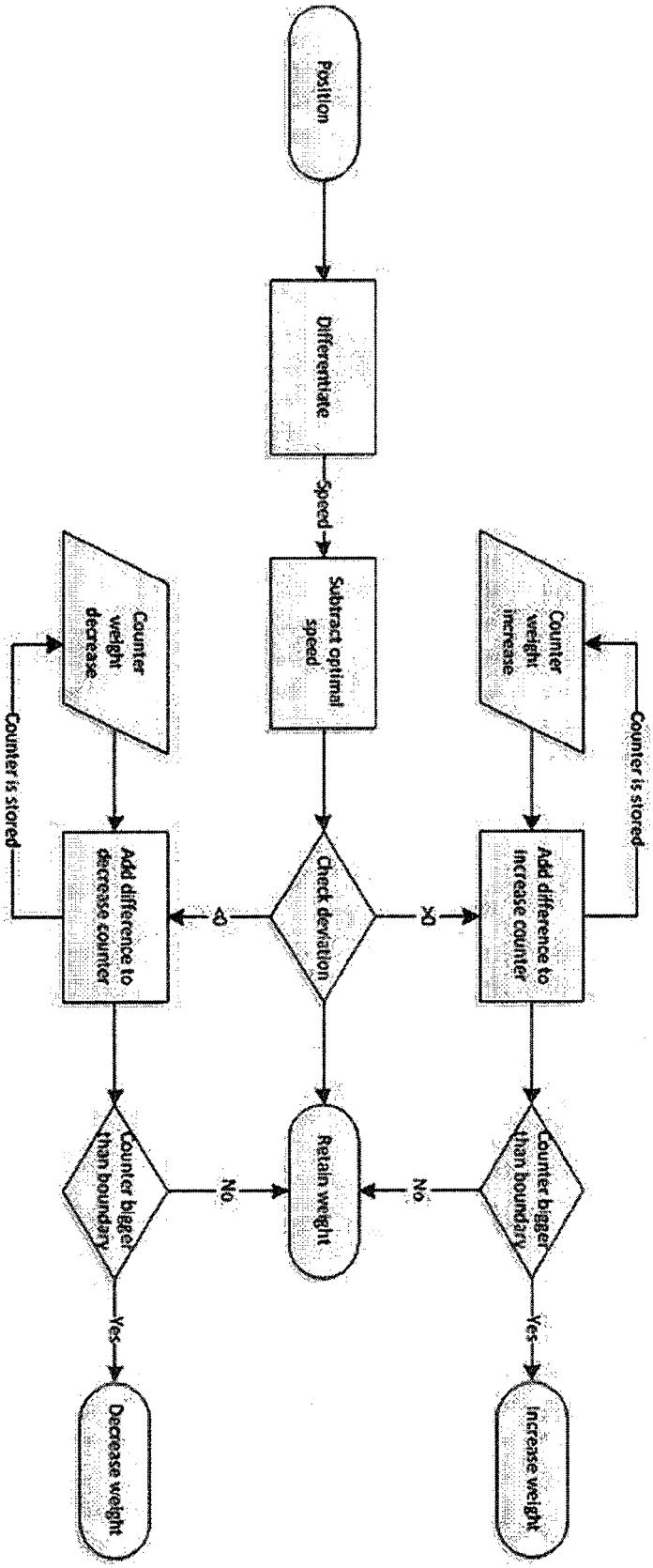

Position
Differentiate
Speed
Subtract optimal speed
Counter weight decrease
Counter weight increase
Counter is stored
Counter is stored
Add difference to decrease counter
Check deviation
Add difference to increase counter
<0
>0
Counter bigger than boundary
No
Retain weight
No
Counter bigger than boundary
Yes
Yes
Decrease weight
Increase weight

FIG. 3

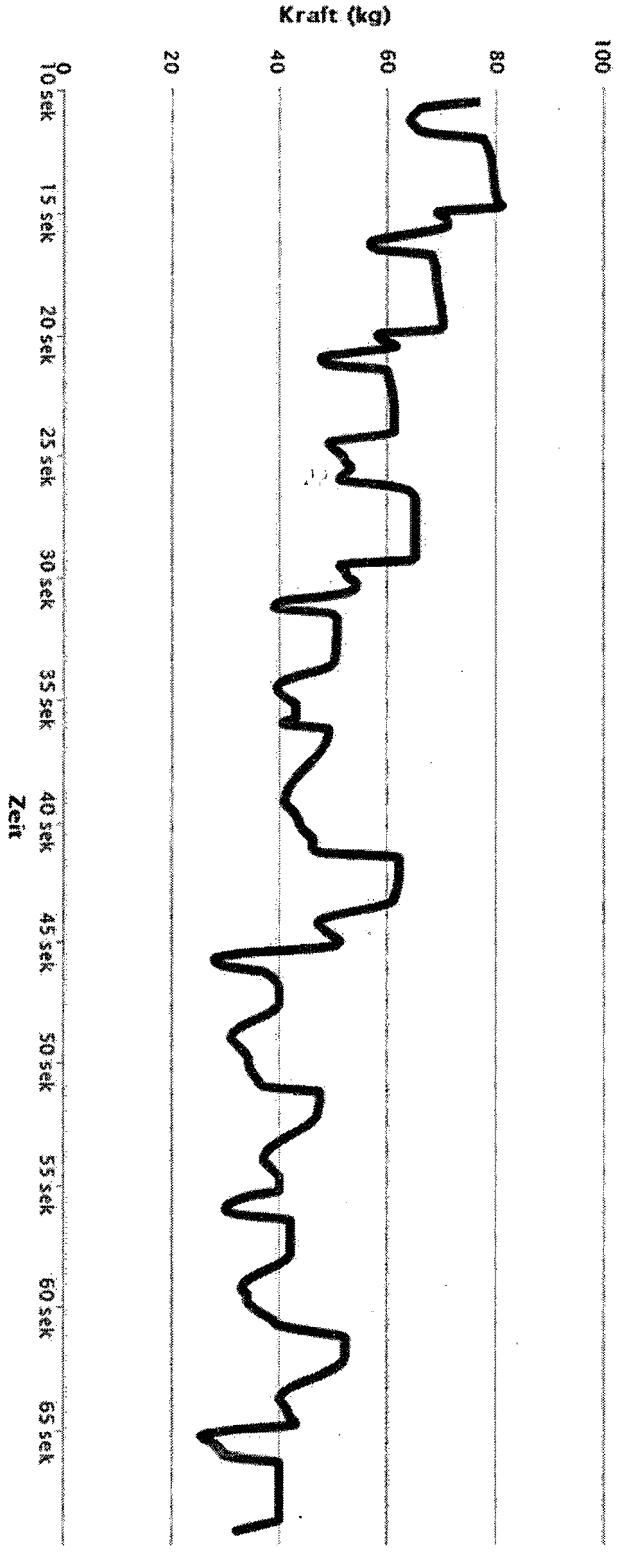

Kraft (kg)
0
20
40
60
80
100
0 sek
5 sek
10 sek
15 sek
20 sek
25 sek
30 sek
35 sek
40 sek
45 sek
50 sek
55 sek
60 sek
65 sek
Zeit

FIG. 4

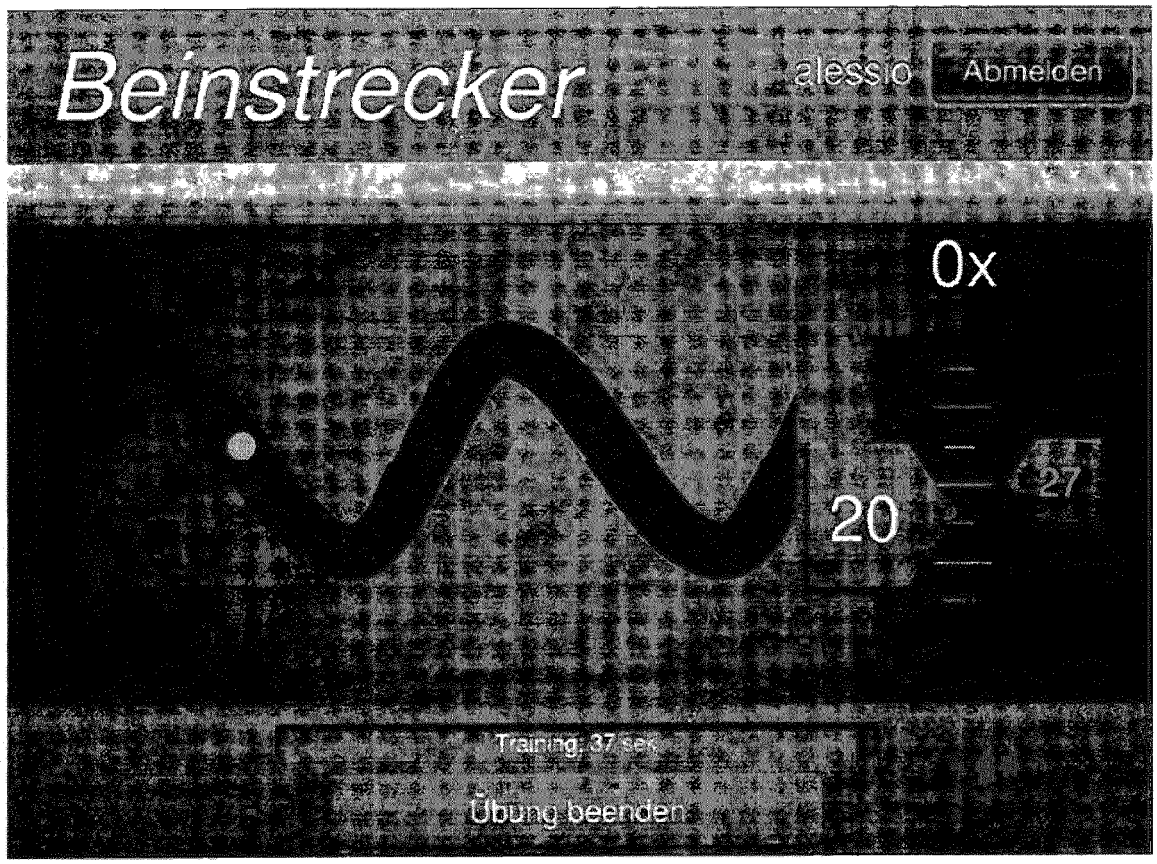

Beinstrecker
alessio
Abmelden
0x
27
20
Training: 37 sek.
Übung beenden

FIG. 5

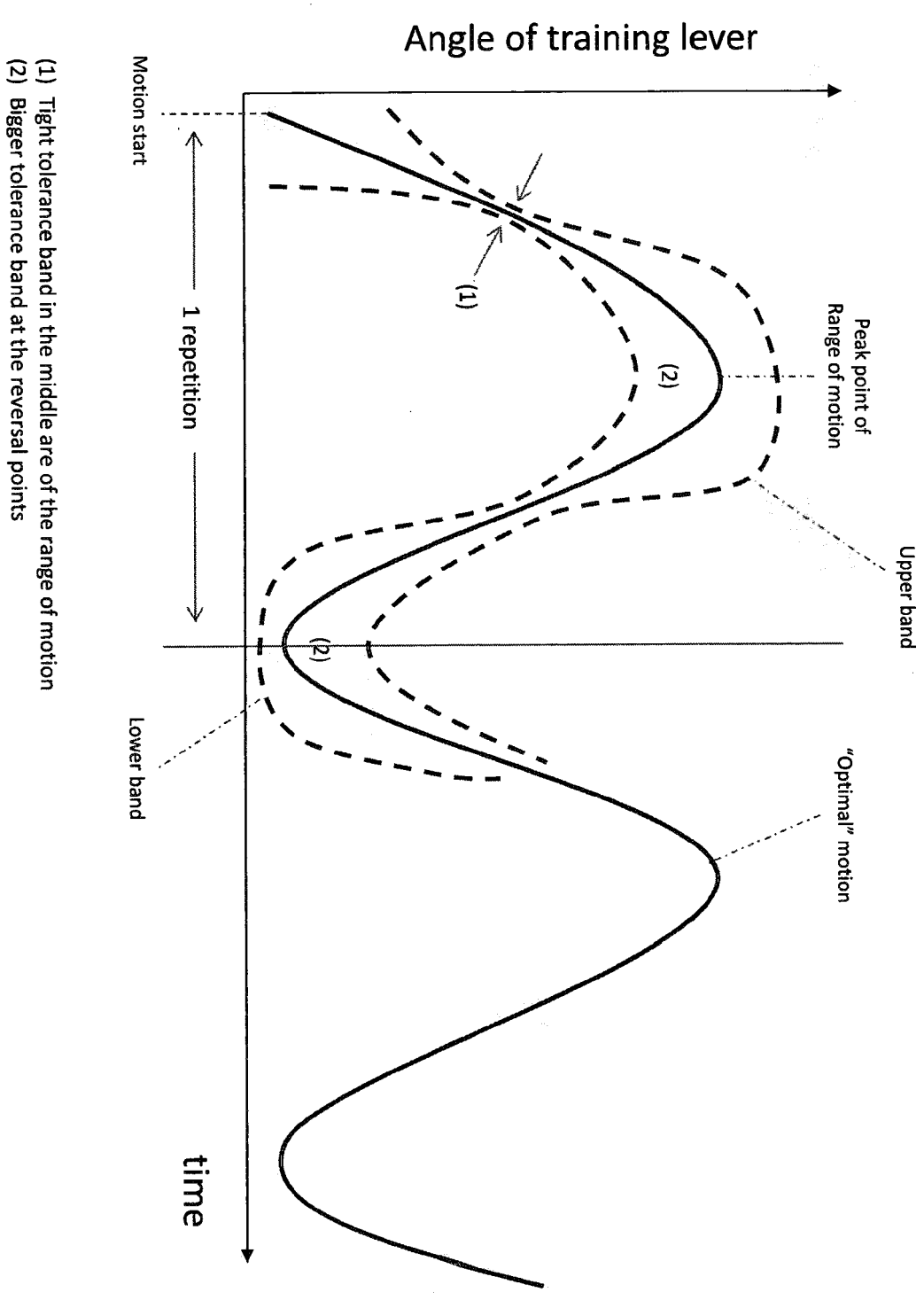
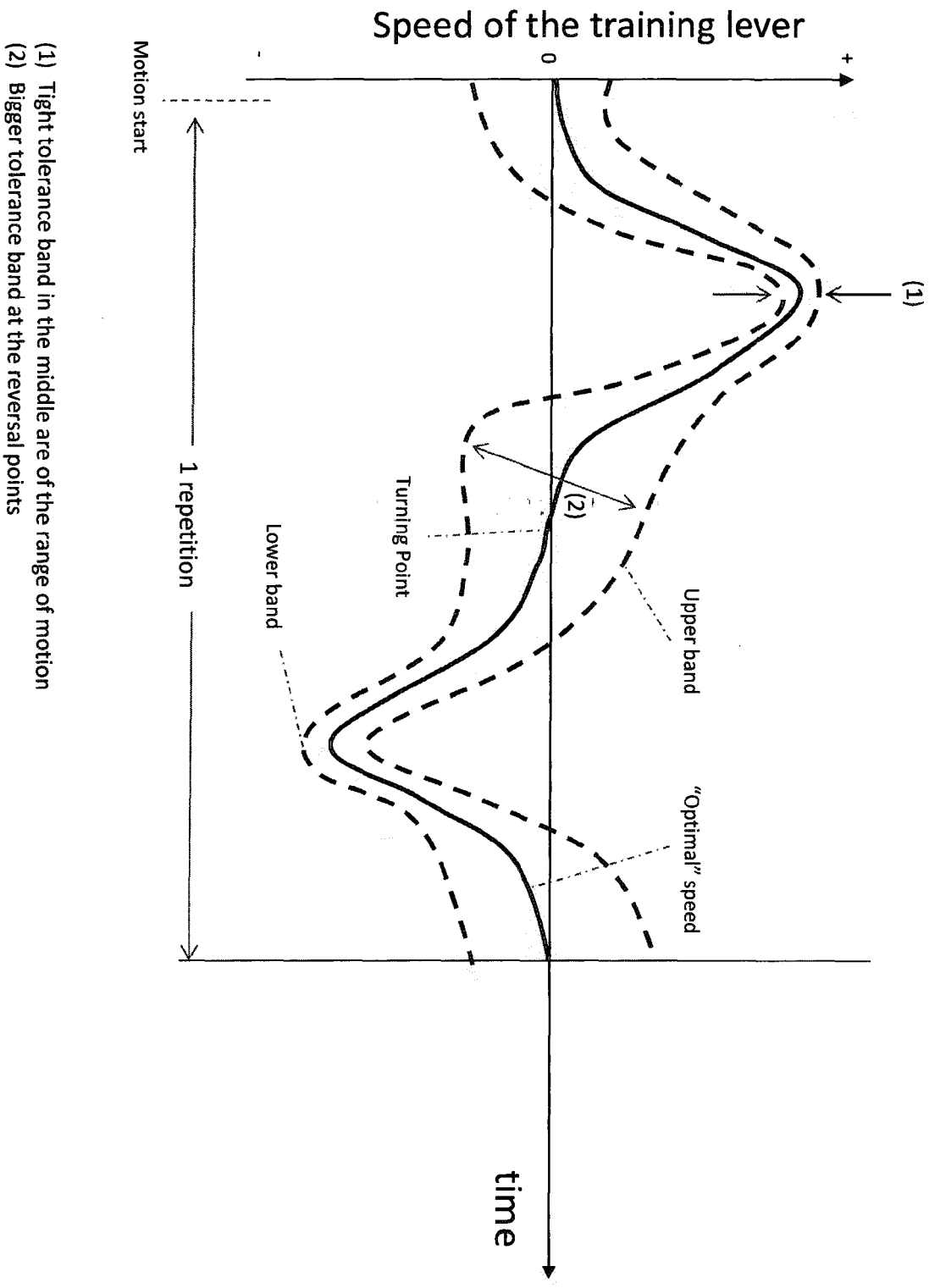

Angle of training lever
Motion start
1 repetition
(1)
(2)
(2)
Peak point of
Range of motion
Upper band
Lower band
"Optimal" motion
time
(1) Tight tolerance band in the middle are of the range of motion
(2) Bigger tolerance band at the reversal points

FIG. 6



(1) Tight tolerance band in the middle are of the range of motion
(2) Bigger tolerance band at the reversal points

FIG. 7

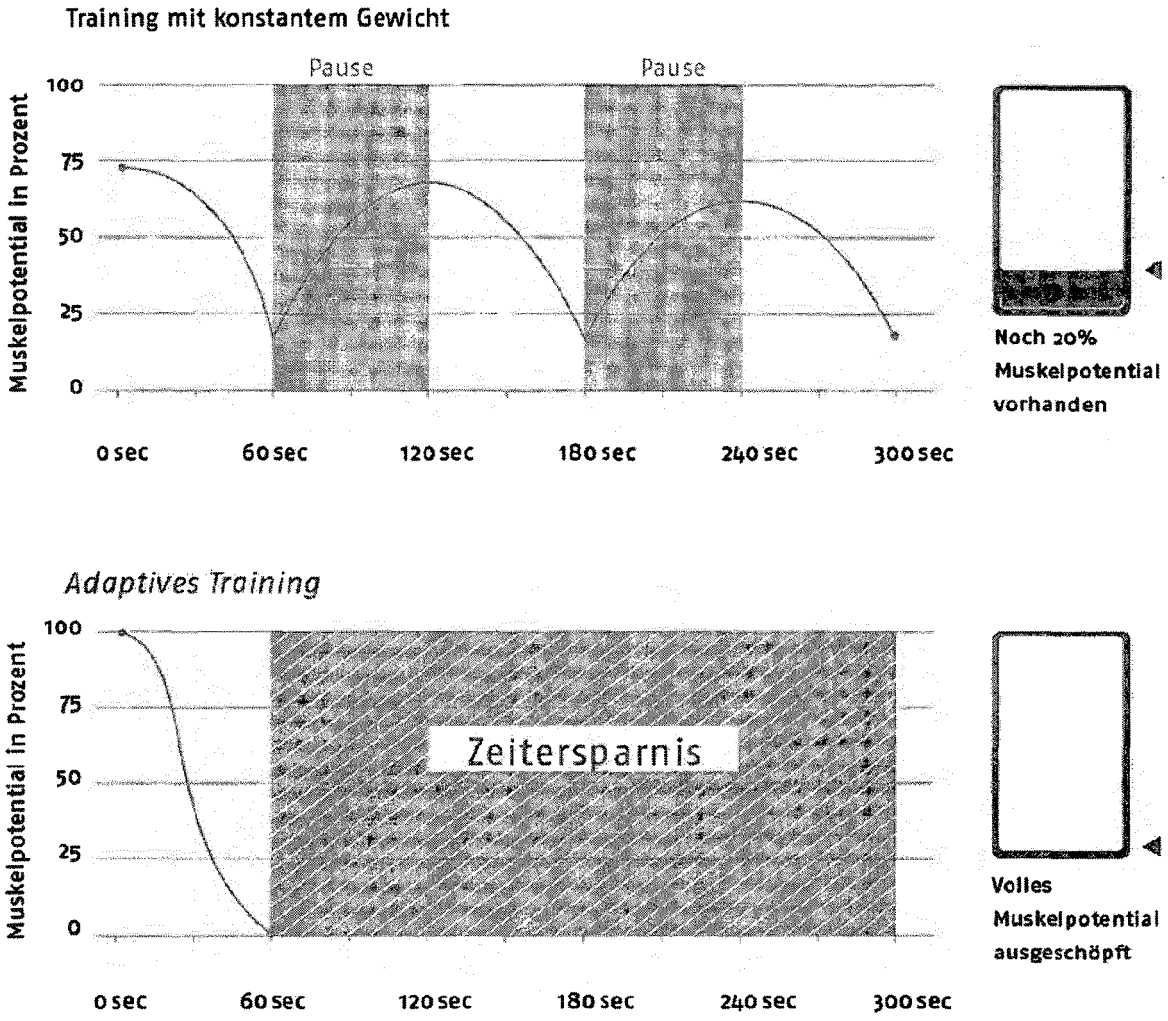

Training mit konstantem Gewicht
Pause
Pause
Muskelpotential in Prozent
100
75
50
25
0
0 sec
60 sec
120 sec
180 sec
240 sec
300 sec
Noch 20% Muskelpotential vorhanden
Adaptives Training
Muskelpotential in Prozent
100
75
50
25
0
Zeitersparnis
0 sec
60 sec
120 sec
180 sec
240 sec
300 sec
Volles Muskelpotential ausgeschöpft

FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 62041083 U **[0003]**
- US 2006061528 A **[0004]**
- US 2007219051 A1 **[0005] [0010]**