US Patent & Trademark Office
Patent Public Search | Text View

United States Patent Application Publication	20250262476
Kind Code	A1
Publication Date	August 21, 2025
Inventor(s)	McGregor; Dylan et al.

NOISE ABATEMENT FOR FITNESS MACHINES

Abstract

A fitness machine operable by a user. The fitness machine has a base that extends in a length direction, a width direction, and a height direction that are perpendicular to each other. A mobile portion is configured to support the user during operation of the fitness machine. A resilient body is supported by a frame and configured to provide a resistance against the mobile portion moving towards the base in the height direction. A fastener assembly couples the frame to the base, wherein the fastener assembly is configured to expand to prevent the frame from moving relative to the base during operation of the fitness machine.

Inventors: **McGregor; Dylan (Bonfield, IL), Kanakaris; Peter (Arlington Heights, IL)**

Applicant: **Life Fitness, LLC** (Rosemont, IL)

Family ID: **1000008589382**

Assignee: **Life Fitness, LLC (Rosemont, IL)**

Appl. No.: **19/202847**

Filed: **May 08, 2025**

Related U.S. Application Data

parent US continuation 18179029 20230306 parent-grant-document US 12337208 child US 19202847
parent US continuation 17167184 20210204 parent-grant-document US 11458356 child US 17946295
parent US continuation-in-part 17946295 20220916 parent-grant-document US 12070651 child US 18179029
us-provisional-application US 62976871 20200214

Publication Classification

Int. Cl.: **A63B22/02** (20060101); **A63B71/00** (20060101)

U.S. Cl.:

CPC **A63B22/0228** (20151001); **A63B22/0214** (20151001); A63B2071/0063 (20130101); A63B2225/093 (20130101)

Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of U.S. patent application Ser. No. 18/179,029, filed Mar. 6, 2023, which is a continuation-in-part of U.S. patent application Ser. No. 17/946,295, filed Sep. 16, 2022, which is a continuation of U.S. patent application Ser. No. 17/167,184, filed Feb. 4, 2021, which claims the benefit of U.S. Provisional Patent Application No. 62/976,871, filed Feb. 14, 2020, all of which are incorporated herein by reference in its entirety.

FIELD
[0002] The present disclosure generally relates to fitness machines, and particularly to noise abatement for fitness machines.
BACKGROUND
[0003] The following U.S. Patents provide background information and are incorporated herein by reference in entirety.
[0004] U.S. Pat. No. 8,118,888 discloses a method to support a deck of an exercise treadmill one or more arcuate leaf springs are used in a deck support structure. The leaf springs can be made of a single member of elastomeric material. An adjustment mechanism can be used to change the radius of the leaf springs to vary spring rates of the leaf springs. Where different leaf springs are used, the adjustment mechanism can be used to adjust the spring rates of different springs independently.
[0005] U.S. Pat. No. 5,382,207 discloses a method to improve tracking, whereby an exercise treadmill is provided with a frame including molded plastic pulleys, having an integral gear belt sprocket, an endless belt extending around the pulleys and a motor operatively connected to the rear pulley to drive the belt. The pulleys are molded out of plastic and have a diameter of approximately nine inches. A mold and method for producing large diameter treadmill pulleys having an integrally molded sprocket are also disclosed. A deck underneath the running surface of the belt is supported by resilient members. A positive lateral belt tracking mechanism is used to correct the lateral position of the belt. A belt position sensor mechanism is used in combination with a front pulley pivoting mechanism to maintain the belt in the desired lateral position on the pulleys. The exercise treadmill also includes a lift mechanism with an internally threaded sleeve engaged to vertically aligned nonrotating screws. A user display of foot impact force on the belt is also provided.
[0006] U.S. Pat. No. 7,628,733 discloses a method to provide variable resilient support for the deck of an exercise treadmill via one or more resilient members are secured to the deck and a moveable support member is used to selectively engage the resilient members to provide support for the deck. A user operated adjustment mechanism can be used to move the support member or support members longitudinally along the treadmill thus effectively changing the number of resilient support members supporting the deck.
[0007] U.S. Pat. No. 6,572,512 discloses an exercise treadmill which includes various features to enhance user operation and to reduce maintenance costs. Sound and vibration are reduced in a treadmill by mounting the treadmill belt drive motor on motor isolation mounts that include resilient members. A further feature is a double-sided waxed deck where one side of the deck is

covered by a protective tape.

[0008] U.S. Pat. No. 6,783,482 discloses a microprocessor-based exercise treadmill control system which includes various features to enhance user operation. These features include programs operative to: permit a set of user controls to cause the treadmill to initially operate at predetermined speeds; permit the user to design custom workouts; permit the user to switch between workout programs while the treadmill is in operation; and perform an automatic cooldown program where the duration of the cooldown is a function of the duration of the workout or the user's heart rate. The features also include a stop program responsive to a detector for automatically stopping the treadmill when a user is no longer on the treadmill and a frame tag module attached to the treadmill frame having a non-volatile memory for storing treadmill configuration, and operational and maintenance data. A nother included feature is the ability to display the amount of time a user spends in a heart rate zone.

SUMMARY

[0009] This Summary is provided to introduce a selection of concepts that are further described below in the Detailed Description. This Summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

[0010] One aspect of the present disclosure generally relates to a fitness machine operable by a user. The fitness machine includes a base that extends in a length direction, a width direction, and a height direction that are perpendicular to each other. A mobile portion is configured to support the user during operation of the fitness machine. A resilient body is configured to provide a resistance against the mobile portion moving towards the base in the height direction. A frame is moveable in the length direction relative to the base to adjust the resistance provided by the resilient body. A fastener assembly moveably couples the frame to the base, wherein the fastener assembly is configured to expand in the width direction to prevent the frame from moving in the width direction relative to the base during operation of the fitness machine.

[0011] In another aspect, the fastener assembly is also configured to prevent the frame from moving in the height direction relative to the base during operation of the fitness machine.

[0012] In another aspect, a bushing of the fastener assembly is configured to slide within a slot that extends in the length direction relative to the base when coupling the frame to the base such that the frame is moveable in the length direction. In a further aspect, the fastener assembly includes an expandable bushing that expands in the width direction within the slot to prevent the frame from moving in the width direction relative to the base. In a further aspect, the fastener assembly includes a plunger having a first angled face, wherein the expandable bushing has a second angled face corresponding to the first angled face of the plunger such that operative contact between the first angled face and the second angled face centers the plunger and the expandable bushing about an axis parallel to the height direction. In a further aspect, the slot extends through the frame.

[0013] In another aspect, the fastener assembly includes a plunger and a bushing, wherein the plunger has an angled face that when operatively contacting the bushing causes the bushing to move in the width direction to thereby cause the fastener assembly to expand in the width direction. In further aspect, the fastener assembly further comprises a biasing member that causes the plunger to operatively contact the bushing such that the fastener assembly expands in the width direction.

[0014] In another aspect, the frame is supported by the base.

[0015] In another aspect, the resilient body is supported by the frame and moveable therewith.

[0016] Another aspect according the present disclosure generally relates to a fitness machine operable by a user. The fitness machine includes a base that extends in a length direction, a width direction, and a height direction that are perpendicular to each other. A mobile portion is configured to support the user during operation of the fitness machine. A resilient body is configured to provide a resistance against the mobile portion moving towards the base in the height direction, where a body length of the resilient body changes in the length direction relative to the base when

providing the resistance during operation of the fitness machine. A cushion operatively contacts the resilient body so as to reduce noise generated from contact with the resilient body during operation of the fitness machine.
[0017] In another aspect, the cushion is positioned between the resilient body and the mobile portion to reduce the noise generated from contact therebetween during operation of the fitness machine.
[0018] In another aspect, the cushion is coupled to the resilient body.
[0019] In another aspect, the resilient body comprises a first material, the cushion comprises a second material, and the resilient body and the cushion are integrally formed together. In a further aspect, the resilient body comprises urethane and the cushion comprises plastic.
[0020] In another aspect, the cushion comprises a synthetic web that covers at least a portion of the resilient body.
[0021] In another aspect, the fitness machine further includes an end stop operable to prevent the body length of the resilient body from increasing beyond a set maximum, the end stop being moveable to adjust the set maximum for the body length of the resilient body, where the cushion is positioned between the resilient body and the end stop to reduce the noise generated from contact therebetween during operation of the fitness machine. In a further aspect, the cushion comprises foam. In a further aspect, the cushion is a first cushion and the fitness machine further comprises a second cushion positioned between the resilient body and the mobile portion to reduce the noise generated from contact therebetween during operation of the fitness machine.
[0022] Another aspect according the present disclosure generally relates a fitness machine operable by a user. The fitness machine includes a base that extends in a length direction, a width direction, and a height direction that are perpendicular to each other. A mobile portion is configured to support the user during operation of the fitness machine. A resilient body is configured to provide a resistance against the mobile portion moving towards the base in the height direction, where a body length of the resilient body changes in the length direction relative to the base when providing the resistance during operation of the fitness machine. A cushion operatively contacts the resilient body so as to reduce noise generated from contact with the resilient body during operation of the fitness machine. A frame is moveable in the length direction relative to the base to adjust the resistance provided by the resilient body. A fastener assembly moveably couples the frame to the base, where the fastener assembly is configured to expand in the width direction to prevent the frame from moving in the width direction relative to the base during operation of the fitness machine.
[0023] It should be recognized that the different aspects described throughout this disclosure may be combined in different manners, including those than expressly disclosed in the provided examples, while still constituting an invention accord to the present disclosure.
[0024] Various other features, objects and advantages of the disclosure will be made apparent from the following description taken together with the drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0025] The present disclosure is described with reference to the following drawing.
[0026] FIG. **1** is a rear perspective view of a fitness machine incorporating noise abatement according to the present disclosure.
[0027] FIG. **2** is a side view of a lower portion of a fitness machine similar to that of FIG. **1** depicting an adjustable shock absorption system.
[0028] FIG. **3** is a close-up side view another fitness machine similar to that of FIG. **2**.
[0029] FIG. **4** is a top-down view of the lower portion of the fitness machine of FIG. **2**.
[0030] FIG. **5** is an exploded perspective view depicting an adjustable shock absorption system

similar to that of FIG. **2**.
[0031] FIG. **6** is a close-up view depicting one embodiment of a fastener assembly for assembling a fitness machine such as that shown in FIG. **5**.
[0032] FIG. **7** is a perspective view of an exemplary resilient body such as may be incorporated within an adjustable shock absorbing system similar to that of FIG. **2**.
[0033] FIG. **8** depicts exemplary data for adjustable shock absorption systems according to the present disclosure, particularly the stiffness versus gap size between a resilient body and an end stop.
[0034] FIGS. **9**A-**9**D depict further exemplary data for testing adjustable shock absorption systems according to the present disclosure.
[0035] FIG. **10** depicts an exemplary control system for operating adjustable shock absorption systems according to the present disclosure.
[0036] FIG. **11** is a close-up view perspective view depicting another embodiment of a fastener assembly for assembling a fitness machine such as that shown in FIG. **5**.
[0037] FIG. **12** is a partial exploded view of the fastener assembly of FIG. **11**.
[0038] FIG. **13** is a sectional view taken along the line **13-13** in FIG. **12**.
[0039] FIG. **14** is a sectional view taken along the line **14-14** in FIG. **12**.
[0040] FIG. **15** is a perspective view of an embodiment of a leaf spring assembly according to the present disclosure useable in a fitness machine such as shown in FIG. **5**.
[0041] FIG. **16** is a perspective view of another embodiment of a leaf spring assembly according to the present disclosure useable in a fitness machine such as shown in FIG. **5**.

DETAILED DISCLOSURE

[0042] The present disclosure generally relates to systems and methods for providing noise abatement for fitness machines systems, including fitness machines having adjustable shock absorption. FIG. **1** depicts an exemplary embodiment of a fitness machine **1** incorporating an adjustable shock absorption system **40** according to the present disclosure. In the illustrated embodiment, the fitness machine **1** is a treadmill having a belt **2** that is rotated such that a user may run or walk on the belt **2**. FIGS. **1** and **2** show the belt **2** having a running upper strand **3** and a returning lower strand **4** that continuously cycle about belt rollers **6** in a conventional manner. While the present disclosure principally discusses embodiments in which the fitness machine **1** is a treadmill having a motor that rotates the belt **2**, it should be recognized that the present disclosure equally applies to treadmills in which forces by the user rotate the belt **2**, as well as to fitness machines **1** other than treadmills (e.g., stair climbers).
[0043] The fitness machine **1** of FIGS. **1** and **2** is supported on a base **20** that extends in a length direction LD between a front **21** and rear **22**, in a width direction (extending into the page) between a left **23** and right **24**, and in a height direction HD between a top **25** and bottom **26**. The length direction LD, the width direction, and the height direction HD are each parallel to each other. Operation of the fitness machine **1** is controlled by a console **10** in a manner known in the art, which for example controls the speed of the belt **2**, an incline of the belt **2** relative to a horizontal plane (e.g., via a height adjustment system **30** in a manner known in the art), resistance levels (for example with bicycles, rowers, elliptical trainers, and/or treadmills in which the user rotates the belt), and/or other functions customary for operating fitness machines **1**, as known in the art. The base **20** of the fitness machine **1** is supported on feet **14** and casters **12**. As will be discussed below, manual controls **116** for adjusting the stiffness may be provided. The manual controls **116** may be moveable by the user in a manner similar to systems known in the art (e.g., here, selectable among **4** stiffness settings). However, as will become apparent, the presently disclosed systems and methods effectuate this stiffness adjustment in a completely different manner.
[0044] Fitness machines presently known in the art typically have a fixed or minimally adjustable “stiffness”. In the case of treadmills, this may mean the stiffness of the running surface, for example. Even in fitness machines that do include some degree of adjustable stiffness (for example,

the Life Fitness T5 Treadmill), existing systems do not provide a sufficient range of adjustability for the level of stiffness experienced by the user. Likewise, with systems presently known in the art, some users (e.g., light weight users) have a difficult time detecting changes in stiffness, for example between medium and soft settings. Additionally, some users of fitness machines require an especially “soft” stiffness, for example for ORANGETHEORY FITNESS® and other workout regimens. This is not accomplished by fitness machines that also provide a traditional stiffness, requiring dedicated equipment (and thus increasing the cost for a facility to offer such workout regimens). As such, there is an unmet need for a fitness machine that offers a full range of stiffness settings, for example from a stiffer setting corresponding to running on concrete down to a very-soft setting corresponding to sand, a gymnastics floor, or a pool springboard, for example.
[0045] FIGS. **2-3** depict two exemplary systems **40** for providing shock absorption according to the presently disclosure, and in these examples systems **40** in which the shock absorption is adjustable to provide a range of stiffness selections. In each example the fitness machine **1** includes a base **20** and a mobile portion **42** that is engageable by or otherwise supports the user, which consequently moves relative to the base **20** during operation of the fitness machine **1**. The mobile portion **42** shown is a running deck that supports the belt **2** in a conventional manner, which moves up and down relative to the base **20** from the impact of the user running or walking thereon.
[0046] The system **40** include one or more resilient bodies, for example leaf springs **50**, that resist movement of the mobile portion **42** towards the base **20**, particularly in a height direction HD. In certain embodiments, the leaf spring **50** is made of an elastomeric material, such as rubber, polyurethane, and/or other polymers.
[0047] The embodiments shown in FIGS. **2-4** each include four distinct and separate leaf springs **50** that work independently. These leaf springs **50** are each configured to function in the same or in a similar manner as the others. Thus, for simplicity, the leaf spring **50** and corresponding function are presently discussed singularly. Likewise, the leaf spring **50** described herein may be used in combination with one or more other shock absorbing devices presently known in the art.
[0048] FIG. **7** depicts a close-up view an exemplary leaf spring **50** as incorporated within the system **40** of FIGS. **2-4**. The leaf spring **50** is a resilient body that extends between a first end **51** and second end **52**. A body length L is defined between the first end **51** and the second end **52** that when assembly within the fitness machine extends parallel to the length direction LD. The leaf spring **50** has a parabolic shape that opens downwardly and supports the mobile portion **42** at or near a vertex **54** of the parabolic shape. In the example shown, the mobile portion **42** rests on the leaf spring **50** without being coupled to the mobile portion **42**.
[0049] A first pin hole **55** extends transversely through the leaf spring **50** at the first end **51**, and in certain embodiments a second pin hole **57** also extends transversely through the leaf spring at the second end **52**. The first pin hole **55** (and second pin hole **57** when present) are each configured to receive a pin such as first pin **66** therethrough, as discussed below. The first end **51** and second end **52** have a substantially circular side profile that is thicker in the height direction HD than the resilient body therebetween for added strength. The first pin hole **55** and second pin hole **57** each also have substantially circular side profiles that are approximately centered within the circular profiles of the first end **51** and the second end **52**. However, this is merely an exemplary configuration for the leaf spring **50**, which may be configured to have differing side profiles between the first end **51** and the second end **52** to alter the characteristics of the shock absorption provided by the leaf spring **50**, for example.
[0050] FIGS. **3** and **5-6** depict how these leaf springs **50** may be coupled between the base **20** and the mobile portion **42**, shown here for an adjustable shock absorption system **40** similar to that of FIG. **2**. The first end **51** of the leaf spring **50** is pivotally coupled to the base **20** via a bracket **60**. The bracket **60** includes a plate **62** with a bottom segment **197** extending perpendicularly away from the plate **62**. The plate **62** is coupled to the inside of the base **20**, for example via welding, fasteners (e.g., nuts and bolts), or other methods presently known in the art. Two ears **195** extend

upwardly from the bottom segment **197** and are substantially parallel to the plate **62**. A first pin hole **53** (FIG. **5**) extends through each of the ears **195**, the interiors of the first pin holes **53** being smooth or threaded depending on the type of a first pin **66** to be positioned therein. The first pin holes **53** are configured to receive a first pin **66**, where the first pin **66** is also being received through the first pin hole **55** in the first end **51** of the leaf spring **50** to therefore pivotally couple the leaf spring **50** to the bracket **60**.

[0051] Returning to FIG. **7**, an exemplary first pin **66** is shown extending between a head **143** and tip **141** with a smooth shaft therebetween. An opening **145** is defined near the tip **141** for receiving a cotter pin **147** after the first pin **66** has been received through the bracket **60** (and through the first end **51** of the leaf spring **50**). It should be recognized that the bracket **60** depicted in FIG. **7** is shown as only a partial view so as to not obscure the first pin hole **55**, omitting the ears **195**, for example. Other types of fasteners known in the art may also or alternatively be used as the first pin **66**, including those with set screws, threads (e.g., engaging with a nut **67** as shown in FIG. **3**), or press fits, those integrated with the leaf spring **50** (e.g., via over-molding), those welded to the bracket **60**, and/or those used in conjunction with ears **195** of the bracket **60** that prevent lateral translation of the first pin **66**, for example. These same examples for the first pin **66** also apply to a second pin **82** for the second end **52** of the leaf spring **50**, which is discussed below.

[0052] In this manner, the leaf spring **50** is permitted to freely rotate about the first pin **66**, but the first end **51** is prevented from translating in the length direction LD or in the height direction HD relative to the base **20**.

[0053] As shown in FIGS. **5-6**, the systems **40** further include end stops **70** that are fixable relative to the base **20**, in the present embodiment in an adjustable manner. A separate end stop **70** is shown provided for each leaf spring **50** in a similar manner as the brackets **60**. However, other configurations are also anticipated by the present disclosure. For simplicity, the end stops **70** are principally discussed singularly. In the embodiment of FIGS. **5-6**, each end stop **70** extends from a top **156** to bottom **158** with a vertical segment **162** therebetween. Holes **160** are provided through the bottom **158** of the end stop **70** for mounting the end stop **70** to the base **20**, specifically via a frame **100** to be discussed further below. The holes **160** receive threaded studs **166** that extend upwardly from the frame **100**, in this example four threaded studs **166** for each end stop **70**. Nuts **168** engage the threaded studs **166** to retain the end stops **70** on the frame **100**. It should be recognized that other methods may be used for coupling the end stops **70** to the frame **100**, including welding, other types of fasteners, and/or the like.

[0054] For each end stop **70**, a floor **164** extends perpendicularly from the vertical segment **162**, which intersects at a front end to a stop wall **80** connecting the floor **164** to the top **156**. In the embodiment of FIGS. **5-6**, the stop wall **80** is concaved such that a lip **154** extends rearwardly from the top **156** where the top **156** meets the stop wall **80**. The contour of the stop wall **80** is configured in this manner to correspond with the contour of the second end **52** of the leaf spring **50**, for example having a same approximate diameter. The second end **52** of the leaf spring **50** can thus slide forwardly along the floor **164** of the end stop **70** in the length direction LD until it engages the stop wall **80**. The lip **154** that extends rearwardly from the top **156** is thus configured to prevent the second end **52** of the leaf spring **50** from moving upwardly in the height direction HD upon contacting the stop wall **80**. It should be recognized that the lip **154** is not required and other forces such as the weight of the mobile portion **42** and the user also act to prevent movement of the second end **52** upwardly in the height direction HD.

[0055] Certain embodiments of systems **40** according to the present disclosure provide that the position each end stop **70** is adjustable in the length direction LD relative to the base **20**, which as will become apparent provides adjustability of the stiffness for the fitness machine **1**. As shown in FIGS. **3** and **7**, a gap G exists between the second end **52** of the leaf spring **50** (or in certain embodiments discussed below, a second pin **82** extending therethrough) and the stop wall **80** of the end stop **70**. This gap G is greater when the user is not generating any force on the mobile portion

42, for example when the user is mid-air while running on a treadmill. Since the stop wall **80** limits the forward translation of the second end **52** of the leaf spring **50**, the gap G between the second end **52** and the stop wall **80** can be adjusted to modify the amount and/or characteristics of shock absorption being provided by the leaf spring **50**.

[0056] The position of the stop wall **80** for an end stop **70** is adjustable by moving the support frame **100** to which the end stop **70** is coupled, as described above. As shown in FIGS. **4-5**, the support frame **100** includes cross members **104** extending between a first end **125** and a second end **127** that run perpendicular to the length direction LD, as well as side members **102** extending between a first end **121** and second end **123** and a mid-support **103** extending between a first end **131** and second end **133** that all run parallel to the length direction LD. The cross members **104**, side members **102**, and mid-support **103** may vary in number from that shown and may be coupled together and/or integrally formed, for example. The end stops **70** are coupled to the support frame **100** such that when multiple leaf springs **50** are provided, one or more leaf springs **50** (and therefore the gaps G associated therewith) are adjustable together.

[0057] With reference to FIGS. **4-6**, the support frame **100** is translatable relative to the base **20** in the length direction LD via engagement within a track system **90**. In this embodiment, support beams **196** extend inwardly from the base **20**, each of which having an opening **198** in the height direction HD. A base **188** rests on the top of the support beam **196**. In the example shown, the base **188** includes a plate **190** that rests on the top of the support beam **196**, and wall **192** extending perpendicularly downwardly from the plate **190**. The wall **192** engages with an inside edge of the support beam **196** to prevent rotation of the base **188** relative to the support beam **196**.

[0058] An elongated hole **194** is provided through the plate **190** of base **188**. An elongated standoff **184** having an exterior shape substantially matching the interior shape of the elongated hole **194** is received in part within the elongated hole **194**. A hole **186** is defined through the elongated standoff **184** in the height direction HD, which in the present example has a circular cross section. As shown in FIG. **6**, the elongated standoff **184** is also received in part within a slot **170** defined within the support frame **100**, specifically through the side members **102** in close proximity to the mounting location of each end stop **70**. The exterior shape of the elongated standoff **184** is also configured to have a width **187** corresponding to a width of the slot **170** in the support frame **100**. In the example shown, a top of the elongated standoff **184** is substantially flush with a top for the side member **102** of the support frame **100** when assembled.

[0059] A flanged coupler **172** has a flange top **176** with a barrel **174** extending downwardly therefrom. A hole **178** is defined through the flanged coupler **172**. The barrel **174** is configured to have an outer diameter corresponding to the interior diameter of the hole **186** in the elongated standoff **184** such that the barrel **174** is received therein. When assembled, the underside of the flange top **176** is approximately flush with the top of the side member **102**, preventing movement in the height direction HD. A fastener **180** (e.g., a bolt) having a head **182** is received through the flanged coupler **172**, the elongated standoff **184**, the base **188**, and the opening **198** in the support beam **196** and threadingly engages a nut **183** on the opposite side of the support beam **196**. It should be recognized that alternate methods of fastening known in the art may also be used. Once coupled together in this manner, the support frame **100** is moveable in the length direction LD relative to the base **20** by the elongated standoff **184** sliding within the slot **170**, but prevented from rotating (i.e., due to like-engagement between the support frame **100** and other support beams **196** of the base **20**), moving transversely, or moving in the height direction HD.

[0060] It should be recognized the present disclosure also anticipates embodiments in which there are multiple, separate support frames **100** for changing the positions of one or more leaf spring **50** separately from other leaf springs **50**. For example, leaf springs **50** could be adjusted independently, all together, or in subgroups. In certain embodiments, two support frames **100** may be provided to enable separate adjustment between front and rear pairs of leaf springs **50**. This separation of adjustability enables one set of leaf springs **50** to travel a greater distance than another set of leaf springs **50**, for example.

[0061] The support frame **100** and particularly its position in the length direction LD may be moved and locked in place using various forms of hardware known in the art. For example, a manual adjustment mechanism may be provided, such as a threaded hand crank or fasteners coupling the support frame **100** to discrete openings within the base **20** (e.g., the manual controls **116** of FIG. **1** in a manner known in the art). Alternatively, cam locks as presently known in the art may be used to lock the support frame **100** to the base **20** once in the desired position, for example. The locking hardware may be electrically actuated, including electrically actuated cams.

[0062] With reference to FIG. **3-5**, the support frame **100** is moveable via an actuator **110**, which may be operated via electrical momentary switches, a control system **200** as discussed below (including via the console **10**), or other methods known in the art. The actuator may be an electrical, pneumatic, and/or hydraulically actuator known in the art. For example, a mechanism similar to a conventional height adjustment mechanism **30** (see FIG. **1**) for a treadmill could be employed to move the support frame **100**. One such commercially available height adjustment mechanism is Treadmill incline motor lift actuator 0K 65-01192-0002/CM C-778, produced by P-Tech USA. The actuator **110** may also itself provide the locking function for the positioning of the support frame **100**.

[0063] The actuator **110** is coupled between the base **20** and a front end **101** of the support frame **100** to translate the support frame **100** relative to the base **20** in the length direction LD. Specifically, a first end of the actuator **110** is coupled to a cross member **126** of the base **20** with brackets **119** and fasteners **117**, such as bolts, pins, and/or the like. An opposite end of the actuator **110** is coupled to the support frame **100**, also via a bracket **119** and fastener **117** in a conventional manner, which may be the same bracket **119** and/or fastener **117** provided between the actuator **110** and the cross member **126** as described above. It should be recognized that the actuator **110** may be coupled between the base **20** and support frame **100** in alternate positions as well. Likewise, other types of actuators **110**, including scissor-type actuators, rack and pinion actuators, and/or other configurations known in the art may also be used.

[0064] The exemplary actuator **110** of FIGS. **4-5** includes a motor **112** that rotatably engages with a gearbox **113**. Rotation of the motor **112** extends or retracts a rod **114** relative to a housing **115** of the gearbox **113** in the length direction LD. Specifically, rotation of the motor **112** in a first direction causes rotation of the rod **114** through the gearbox **113**, where a threaded engagement between the outer diameter of the rod **114** and the interior of the housing **115** causes the rod **114** to extend or retract in the length direction LD relative to the housing **115** as the motor **112** rotates. In contrast, rotation of the motor **112** in an opposite direction causes retraction of the rod **114** in the opposite manner. It should be recognized that either the rod **114** or the housing **115** may be coupled to the support frame **100** (with the other to the base **20**), depending on the configuration of the actuator **110**. In this manner, operating the actuator **110** causes movement of the support frame **100** relative to the base **20**. This movement of the support frame **100** consequently adjusts the gap G between the leaf springs **50** and the stop walls **80** of the corresponding end stops **70**, as discussed above. In the example shown, all leaf springs **50** are adjusted simultaneously and equivalently (i.e., a same distance in the length direction LD).

[0065] With reference to FIGS. **3-4**, it should be recognized that the body length L between the first end **51** and the second end **52** of the leaf spring **50** is caused to increase when the mobile portion **42** moves towards the base **20** during operation of the fitness machine **1**. In other words, the parabolic shape of the leaf spring **50** is caused to flatten during use. However, the body length L of the leaf spring **50** may be constrained by engagement between the second end **52** and the stop wall **80** of the end stop **70**. Once the body length L can no longer increase, the leaf spring **50** may further resist movement of the mobile portion **42** towards the base **20**, but now through a different mechanism, namely, compression of its resilient material. Therefore, adjusting the gap G between the leaf spring **50** and the stop wall **80** of the end stop **70** adjusts the allowable body length L of the leaf spring **50**, and thus the profile of resistance provided by the system **40**, which consequently adjusts the stiffness of the fitness machine **1**.

[0066] The resistance provided by the system **40** varies depending upon whether the second end **52** of the leaf spring **50** is engaging the stop wall **80**, creating two or more distinct phases. In an initial phase referred to as first phase P**1** (discussed further below and shown in FIG. **6**), the resistance provided by the leaf spring **50** against movement between the mobile portion **42** and the base **20** is primarily provided via bending deformation of the leaf spring **50**. In other words, the body length L of the leaf spring **50** may change, increasing as the mobile portion **42** moves towards the base **20**. However, once the second end **52** engages with the stop wall **80** of the end stop **70** (or second pin **82** extending therethough for an embodiment discussed further below), which is been fixed relative to the base **20**, a second phase P**2** begins in which a body length L of the leaf spring **50** can no longer change. At this stage, further movement of the mobile portion **42** towards the base **20** is resisted by the leaf spring **50** primarily by compressing the leaf spring **50**, rather than by bending the leaf spring **50** as provide during phase 1 P**1**. In other words, the parabolic shape can no longer get wider longer, and thus the leaf spring **50** starts to compress. In certain embodiments, the term "primarily" with respect to the basis for resistance means the basis has a greater contribution than any other basis (i.e., bending contributing to the resistance more than compressing contributes to the resistance). In certain embodiments, the basis having the greatest contribution provides more than 50% of the total resistance. In certain configurations, approximately 50%, 70%, 80%, 90%, 95%, or other portions of the stiffness is provided in phase 2 P**2**.

[0067] As shown in FIGS. **8** and **9**A-**9**D, the resistance provided by the leaf spring **50**, also referred to as spring stiffness, is thereby provided as a function of whether the resistance is in phase one P**1** or phase two P**2**. Likewise, the selection of when a transition T from phase one P**1** to phase two P**2** occurs (i.e., the position of the mobile portion **42** relative to the base **20**) is based upon the gap G provided between the second end **52** of the leaf spring **50** and the stop wall **80**. In certain embodiments, the leaf spring **50** is selected such that the resistance provided in phase one P**1** is substantially lower than the resistance provided in phase two P**2**. For example, in certain cases the spring stiffness in phase one P**1** is no more than 50 percent of the spring stiffness in phase two P**2**. In further examples, the spring stiffness in phase one P**1** is no more than 10 percent of the spring stiffness in phase two P**2**, or one order lower.

[0068] It should be recognized that while the present disclosure generally refers to the leaf spring **50** providing a resistance in each of the phases, here phase one P**1** and phase two P**2**, the resistance may also be considered a resistance profile. For example, the resistance need not be constant, nor linear within a given phase (such as in phase two P**2** of FIG. **8**). It should also be recognized that the larger the gap G between the second end **52** of the leaf spring **50** and the stop wall **80**, the greater the deflection of the mobile portion **42** relative to the base **20** before phase 2 P**2** is entered. In other words, a larger gap G provides for more deflection within the softer stiffness of phase one P**1**. As discussed above, the systems **40** and methods presently disclosed allow the user to fully configure the stiffness of the shock absorption for the fitness machine **1**, and specifically when this greater resistance of phase two P**2** is felt by the user.

[0069] It should be recognized that additional phases may also be provided by the system **40** according to the present disclosure. For example, instead of pivotally fixing the first end **51** of the leaf springs **50** to the bracket **60**, the first end **51** may also be translatable in the length direction LD in a similar or same manner as the second end **52**. An example of this configuration is shown in FIG. **3**, specifically for the forward-most bracket **60** shown. A stop wall **81** is integral with or coupled to the bracket **60**, which provides a limit for the first end **51** of the leaf spring **50** moving rearwardly. The stop wall **81** thus prevents translation of the first end **51** of the leaf spring **50** without the use of a first pin **66**. Other features may also be included to restrict movement of the first end **51** in the height direction HD, for example, such as the slot **74** discussed for the end stop **70** discussed above. In this embodiment, the first end **51** has a gap G**2** of travel before being constrained by stop wall **81**, thereby changing the overall resistance profile for the system **40** relative to the pivoting embodiment of the rear-most bracket **60** shown. Additional phases or impacts to the overall resistance profile may be provided by controlling one or more leaf springs **50** separately from others, such as having a gap G (and/or gap G**2**) that is greater for rear leaf springs **50** relative to forward leaf springs **50**, for example.

[0070] It will also be understood that the leaf spring **50** need not be shaped as shown in the figures, which may also or alternatively vary in number and/or position relative to the base **20** and mobile portion **42** of the fitness machine **1**. The positions of the leaf springs **50** relative to the base **20** may also be adjustable in ways other than adjusting the gap G between the leaf spring **50** and the stop wall **80** (and/or gap G**2** for stop wall **81**). Similarly, the end stops **70** may be adjustable in the height direction HD in addition to, or in the alternative to in the length direction LD, further modifying the manner in which the adjustments change the resistance profiles of the leaf springs **50**.

[0071] Additional testing results for a fitness machine **1** and system **40** as shown in FIGS. **2-4** are provided in FIGS. **9**A-**9**D, which were tested on a hydraulic MTS® test system in which the leaf springs **50** were compressed for 0.45 inches in the height direction HD in 2 Hz and 5 Hz sinusoidal motion-controlled mode. In the plots, the horizontal axes represent the amount of compression (the same for the four plots), while the vertical axes represent the applied forces to reach the corresponding deformations. The scale of the vertical axes is kip, or 1000 lbf.

[0072] The curves demonstrate that there was little difference between responses under the two tested frequencies. FIG. **9**D depicts the results when the leaf spring **50** was constrained at the original body length L (no gap G to the stop wall **80**), whereby the resultant force reached about 500 lbf at 0.45 inch vertical travel. FIG. **9**C was tested with 25% gap G (the percentage compared to the maximum gap, or equivalently the gap G needed to let the leaf spring **50** free bend into a straight beam. In this case, 25% was about 2.8 mm, where the peak loading reached about 400 lbf. FIG. **9**B was tested at 50% gap G (about 5.6 mm), where about 250 lbf was needed to compress the spring down by 0.45 inch. FIG. **9**A was tested at 75% gap G, with maximum force of about 120 lbf. Collectively these results demonstrate how the stiffness of the fitness machine **1** can be effectively controlled using the system **40** presently disclosed.

[0073] FIGS. **2-3** depict an alternative configuration for an end stop **70**, which may be used alone or in conjunction with the end stop **70** discussed above for the system **40** of FIGS. **5-6**. In this embodiment, the stop wall **80** is formed at the end or termination of a slot **74** defined within the sides of the end stop **70**. Specifically, the end stop **70** has a top **71** with two arms **73** that extend rearwardly from a front **76** to fingertips **77**. In the example shown, the fingertips **77** extend from the front **76** of the end stop **70** approximately the same distance as do base tips **79** such that a slot **74** is formed between the fingertip **77** and base tip **79** on each side of the end stop **70**. As shown in the top-down review of FIG. **4**, providing two arms **73** for each end stop **70** allows the leaf spring **50** to be positioned between the arms **73**, which retains the leaf spring **50** in position relative to the left **23** and right **24** of the fitness machine **1**.

[0074] This embodiment of end stop **70** is configured such that a second pin **82** extending through the second pin hole **57** in the second end **52** of the leaf spring **50** is translatable in the length direction LD within the slot **74**. The second pin **82** is insertable into the slot **74** at least via the open end **75** opposite a stop wall **80** and front **76**. The clearance C of the slot **74** is selected based on the diameter of the second pin **82** such that no movement is permitted in the height direction HD. Forward translation of the second end **52** of the leaf spring **50** may thus be prevented by engagement between the stop wall **80** and the second pin **82** extending through the second end **52**, and/or engagement between the stop wall **80** and the second end **52** itself.

[0075] With continued reference to FIGS. **2-3**, the second pin **82** may be the same or similar to the first pin **66**, or be formed of other hardware known in the art. In certain examples, the second pin **82** and/or first pin **66** are rods retained in place via cotter pins and/or the like. In another example, the second pin **82** and/or first pin **66** are over-molded to be retained on the leaf spring **50** to extend outwardly therefrom, for example. Whether or not first pins **66** and/or second pins **82** are used, the leaf spring **50** may also or alternatively be coupled to the mobile portion **42**, for example at the vertex **54**.

[0076] The present disclosure also anticipates differing configurations for the support frame **100** being translatably moveable relative to the base **20** in the length direction LD. FIG. **3** depicts an embodiment of a system **40** providing this adjustment via engagement via a different track system **90** than discussed above. This track system **90** includes a sliding track **92** that is coupled to the base **20** via track mounts **91**. Specifically, a track riding bracket **94** is coupled to the support frame **100**, for example on the side members **102**. The track riding bracket **94** slideably engages with the sliding track **92**, which may function similarly to a conventional drawer slide having roller bearings, incorporate a rack and pinion engagement, and/or other sliding mechanisms known in the art. The support frame **100** may then be locked relative to the base **20** in a manner known in the art and as discussed above.

[0077] Certain embodiments of system **40** for adjusting the stiffness of fitness machine **1** incorporate the use of a control system **200**. FIG. **10** depicts an exemplary control system **200** for adjusting the stiffness for a fitness machine **1**, which may be manually operated by the user and/or automatically selected or modified according to a given program controlled by the console **10**. The control system **200** in certain embodiments automatically modifies the stiffness according to a changing program or other factors such as user's body weight or fitness levels. For example, the stiffness may be automatically modified when a program for the fitness machine **1**, such as a treadmill, transitions from simulating running on a trail versus running on a road (here, transitioning from soft to firm stiffnesses), for example.

[0078] Certain aspects of the present disclosure are described or depicted as functional and/or logical block components or processing steps, which may be performed by any number of hardware, software, and/or firmware components configured to perform the specified functions. For example, certain embodiments employ integrated circuit components, such as memory elements, digital signal processing elements, logic elements, look-up tables, or the like, configured to carry out a variety of functions under the control of one or more processors or other control devices. The connections between functional and logical block components are merely exemplary, which may be direct or indirect, and may follow alternate pathways.

[0079] In certain examples, such as shown in FIG. **10**, the control system **200** communicates with each of the one or more components of the system **40** via a communication link CL, which can be any wired or wireless link. The control system **200** is capable of receiving information and/or controlling one or more operational characteristics of the system **40** and its various sub-systems by sending and receiving control signals via the communication links CL. In one example, the communication link CL is a controller area network (CAN) bus; however, other types of links could be used. It will be recognized that the extent of connections and the communication links CL may in fact be one or more shared connections, or links, among some or all of the components in the fitness machine **1**. Moreover, the communication link CL lines are meant only to demonstrate that the various control elements are capable of communicating with one another, and do not represent actual wiring connections between the various elements, nor do they represent the only paths of communication between the elements. Additionally, the system **40** may incorporate various types of communication devices and systems, and thus the illustrated communication links CL may in fact represent various different types of wireless and/or wired data communication systems.

[0080] The control system **200** may be a computing system that includes a processing system **210**, memory system **220**, and input/output (I/O) system **130** for communicating with other devices, such as input devices **199** and output devices **201**, either of which may also or alternatively be stored in a cloud **202**. The processing system **210** loads and executes an executable program **222** from the memory system **220**, accesses data **224** stored within the memory system **220**, and directs the system **40** to operate as described in further detail below.

[0081] The processing system **210** may be implemented as a single microprocessor or other circuitry, or be distributed across multiple processing devices or sub-systems that cooperate to execute the executable program **222** from the memory system **220**. Non-limiting examples of the processing system include general purpose central processing units, application specific processors, and logic devices.

[0082] The memory system **220** may comprise any storage media readable by the processing system **210** and capable of storing the executable program **222** and/or data **224**. The memory system **220** may be implemented as a single storage device, or be distributed across multiple storage devices or sub-systems that cooperate to store computer readable instructions, data structures, program modules, or other data. The memory system **220** may include volatile and/or non-volatile systems, and may include removable and/or non-removable media implemented in any method or technology for storage of information. The storage media may include non-transitory and/or transitory storage media, including random access memory, read only memory, magnetic discs, optical discs, flash memory, virtual memory, and non-virtual memory, magnetic storage devices, or any other medium which can be used to store information and be accessed by an

[0083] The present inventors have recognized that some fitness machines known in the art make noises during operation, and particularly noises corresponding to the user's use of the fitness machine. By way of example, these noises may be caused by the user running on the deck of a treadmill. This is in contrast to the sound of a motor running, for example rotate a belt for a treadmill or steps for a stairclimbing fitness machine, or the sounds of the belt and steps consequently moving. Through experimentation and development, the present inventors have identified multiple causes for the noises generated during use of the fitness machine, which each arise from contact between a shock absorption system and other moving or stationary portions of the fitness machine. The fitness machine **1** of FIG. **2** is referenced to describe components of an example of a fitness machine having a shock absorption system **40**. However, it should be recognized that the sources of noises discussed herein may arise in other embodiments of fitness machines, including but not limited to fitness machines other than treadmills and fitness machines not having shock absorption systems. Moreover, while the following description will principally refer to a leaf spring **50** within systems for providing shock absorption, it should be recognized that the teachings apply to resilient bodies more generally.

[0084] In a first case, the present inventors have discovered that some noises are generated by unintended relative movement between elements of the fitness machine, such as movement between the base **20**, the frame **100** supporting the leaf spring **50**, the leaf spring **50**, the mobile portion **42** (e.g., a treadmill deck), and/or the end stop **70** that engages the leaf spring **50**. As discussed above, the frame **100** is moveable in the length direction LD to adjust the amount of shock absorption provided by the leaf spring **50**. However, the present inventors have discovered that any movement in the width direction WD, such as from part to part variation due to tolerances or wear, causes undesirable noises as the user operates the fitness machine. As such, the present inventors have developed an alternative mechanism for coupling the frame **100** and the base **20** so as to prevent these noises during operation of the fitness machine.

[0085] FIGS. **11-12** show an alternative fastener assembly **300** for coupling the frame **100** to the base **20**, which as discussed above prevents the frame from moving in the width direction WD during operation of the fitness machine. Notably, the fastener assembly **300** may be used with embodiments in which the frame **100** remains moveable in the length direction LD relative to the base **20** and is thus compatible with fitness machines having adjustable shock absorption using the techniques discussed above.

[0086] Similar to the discussion above with respect to FIGS. **4-6**, the embodiment of FIGS. **11** and **12** provides that the position of the stop wall **80** for an end stop **70** is adjustable by moving the support frame **100** to which the end stop **70** is coupled, specifically in the length direction LD relative to the base **20**. Support beams **196** extend inwardly from the base **20**, each of which having an opening **198** (FIG. **5**) extending therethrough in the height direction HD. A base **188** rests on the top of each support beam **196**. Each base **188** includes a plate **190** that rests on the top of the corresponding support beam **196**, as well as a wall **192** that extends perpendicularly downwardly from the plate **190**. The wall **192** engages with an inside edge of the support beam **196** to prevent rotation of the base **188** relative to the support beam **196**. An elongated hole **194** is provided through the plate **190** of each base **188**.

[0087] With continued reference to FIGS. **11** and **12**, the support frame **100** (also referred to simply as a frame **100**) is positioned on the bases **188** to thus be supported by the base **20**. As discussed above, a slot **170** is defined within the support frame **100**, specifically through the side members **102** of the frame **100** and specifically in close proximity to the mounting location of each end stop **70**. Therefore, the illustrated example would include 4 slots corresponding to the four end stops **70**.

[0088] Each slot **170** has a width **302** between sides **304** in the width direction WD and a length **306** between ends **308** in the length direction LD. As will be described in further detail, the fastener assembly **300** is configured to expand in the width direction WD when coupling the support frame **100** to the base **20** to maintain contact between the fastener assembly **300** and both the sides **304** of the slot **170** during operation of the fitness machine.

[0089] Referring to FIGS. **12** and **13**, the fastener assembly **300** includes a split bushing **310**, also referred to as an expandable bushing, comprising two bodies **312**, which in the illustrated example are identical to each other for ease of manufacturing. The two bodies **312** may be made of Delrin® or another material presently known in the art. Each of the bodies **312** has a flange **314** that extends along a length between a first side **316** and a second side **318**, along a width between an outer side **320** and an inner side **322**, and along a height between a top **324** and a bottom **326**. The bottom **326** of the flange **314** is configured to be slidably supported on the top of the support frame **100** as shown in FIG. **13**. A leg **328** extends perpendicularly downwardly from the flange **314**, particularly at the inner side **322** thereof. The leg **328** extends along a length between a first side **330** and a second side **332**, along a width between an outer side **334** and an inner side **336**, and along a height between a top **338** and a bottom **340**. In the illustrated example, the first side **330** and the second side **332** of the leg **328** are substantially flush with the first side **316** and the second side **318** of the flange **314**, respectively. Likewise, the top **338** and the inner side **336** of the leg **328** are flush with the bottom **326** and the inner side **322** of the flange **314**, respectively. The outer side **334** of the leg **328** is configured to slidably contact the side **304** of the slot **170** in the support frame **100** as shown in FIG. **13**. A height **342** between the bottom **326** of the flange **314** and the bottom **340** in the height direction HD is less than a height of the slot **170** such that the bottom **340** of the leg **328** does not contact the base **188**, as also shown in FIG. **13**. This allows the split bushing **310** to move in the length direction LD without interference from contacting the base **188**.

[0090] Each body **312** of the split bushing **310** has a tab **344** and a corresponding opening **346** such that when the inner sides **322** and the inner sides **336** of two bodies **312** are brought together, the opening **346** of one body **312** aligns with the tab **344** of the other body **312** so as to align the two bodies **312** with each other. In certain embodiments, the tabs **344** and the openings **346** of the bodies **312** are configured so as to maintain a separation between the inner sides **322** and the inner sides **336** of the two bodies **312** when the tabs **344** are fully positioned within the openings **346**.

[0091] Each body **312** further includes an angled face **348** that extends from the top **324** of the flange **314** downwardly and inwardly towards the bottom **340** and the inner side **336** of the leg **328**, respectively. In the illustrated example, the angled face **348** includes a first face **350** that transitions to a second face **352** each having a partial-cylinder shape, whereby the first face **350** and the second face **352** each extend at different angles relative to the height direction HD. The first face **350** may be any angle greater than 0° and less than 90° (i.e., relative to the height direction HD). It should be recognized that the angle of the first face **350** determines the magnitude of force acting to expand the split bushing **310**. In the illustrated embodiment, the angle of the first face **350** (and likewise the second face **352**) is 45° so that the downward retention force from the coil spring **382** (discussed below) is approximately equal to the outward expansion force for the split bushing **310**, though other angles are also contemplated. It should be recognized that the present disclosure contemplates other configurations of the angled face **348**, including the first face **350** and/or the second face **352** having a variable angle relative to the height direction HD, for example forming a convex or concaved curve. The second faces **352** are shown to be at an angle of 0° relative to the height direction HD.

[0092] In the configuration of FIGS. **12** and **13**, the two bodies **312** of the split bushing **310** are configured such that when the inner sides **322** and the inner sides **336** are brought together, the first faces **350** form a substantially V-shaped opening **354** therebetween and the second faces **352** form a substantially cylindrically-shaped opening **356** therebetween. The V-shaped opening **354** is particularly formed by the two first faces **350** of the two bodies **312** being cylindrically shaped with axes that are angled relative to each other. In the embodiment shown, the first faces **350** are partial-cylinder shaped with the axes extending perpendicularly to each other. This V-shaped opening **354**, formed the two partial-cylinder shapes of the first faces **350**, provides for consistent contact between the plunger **360** (discussed below) and the split bushing **310** as the vertical position of one changes relative to the other. It should be recognized that other shapes of the opening **354** and the plunger **360** (discussed below) are also contemplated, including frustums and other shapes.

[0093] The fastener assembly **300** further includes a plunger **360** that extends from a top **362** to a bottom **364** in the height direction HD (when assembled within the fitness machine), which in the illustrated embodiment is V-shaped and formed by two intersecting partial-cylinders that extend along axes substantially perpendicularly to each other in the same manner as the V-shaped opening **354** discussed above for the split bushing **310**. In particular, an outer surface of the plunger **360** tapers downwardly such that a first diameter **366** at the top **362** of the plunger **360** is greater than a second diameter **368** at the bottom **364**. In the illustrated example, a flange **370** is provided at the top **362** of the plunger **360**, which extends radially outwardly from an angled face **372** extending from the flange **370** to the bottom **364** of the plunger **360**. The angled face **372** is configured to match or generally correspond to the angle of the first face **350** of the two bodies **312** of the split bushing **310**, as discussed above and further below. The present disclosure also contemplates other shapes for the plunger **360** to correspond to other designs for the split bushing **310**, including frustum or conical shapes.

[0094] It should be recognized that the present disclosure also contemplates other configurations in which the plunger **360** does not have a flange **370**, but rather has the angled face **372** extending entirely from the bottom **364** to the top **362** of the plunger **360**. Likewise, the angle of the angled face **372** (i.e., relative to the height direction HD) may vary from that shown, including having concaved or convex curves.

[0095] With continued reference to FIGS. **12** and **13**, tabs **374** extend radially outwardly from the angled face **372** at a first side **376** and at a second side **378** of the plunger **360**. In the illustrated embodiment, the tabs **374** extend perpendicularly downwardly from the flange **370** to the bottom **364** of the plunger **360**. The first side **376** and the second side **378** are substantially flush with the outer diameter of the plunger **360** at the top **362** thereof. The tabs **374** are configured to be positioned between the two bodies **312** of the split bushing **310** in the width direction WD such that operative contact between the two bodies **312** and the tabs **374** prevent the plunger **360** from rotating about an axis parallel to the height direction HD relative to the split bushing **310**.

[0096] An annular groove **380** is provided within the top **362** of the plunger **360**, which extends inwardly toward the bottom **364**. The fastener assembly **300** further includes a biasing member, such as a coil spring **382**. The coil spring **382** extends from a first end **384** to a second end **385**. The annular groove **380** has an inner diameter and an outer diameter configured such that the first end **384** of the coil spring **382** is position therein to thus be axially retained relative to the plunger **360**.

[0097] An opening **386** extends through the plunger **360** from the top **362** to the bottom **364**. The opening **386** has an inner diameter **388** configured so as to accommodate a portion of a cap **390** therein, wherein the cap **390** generally retains the plunger **360** and the coil spring **382** relative to the frame **100** and base **20**, as discussed further below. The cap **390** extends from a top **392** to a bottom **394** having a first section **395***a*, a second section **395***b*, and a third section **395***c* therebetween. The first section **395***a* includes a flange **396** having a first diameter **397***a*. The second section **395***b* includes a collar having a second diameter **397***b* that is less than the first diameter **397***a* and the third section **395***c* has a third diameter **397***c* that is less than the second diameter **397***b*.

[0098] With continued reference to FIGS. **12** and **13**, the third diameter **397***c* of the cap **390** is configured to be positioned within the opening **386** through the plunger **360**, in the illustrated example with the opening **386** having a slightly larger diameter than the third diameter **397***c*. The bottom **394** of the plunger **360** is supported on the base **20** and the plunger **360** is moveable in the height direction HD relative to the cap **390** within the third section **395***c* of the cap **390**. The second diameter **397***b* of the cap **390** is greater than the diameter of the opening **386**, thereby restricting movement of the plunger **360** in the height direction HD past the third section **395***c*. However, the second diameter **397***b* is less than an inner diameter of the coil spring **382**, in the present example generally corresponding to the inner diameter of the annular groove **380** in the top **362** of the plunger **360**. The first diameter **397***a* at the flange **396** is greater than the inner diameter of the coil spring **382** and thus limits the position of the second end **385** of the coil spring **382** in the height direction HD.

[0099] The cap **390** has an opening **400** that extends from the top **392** to the bottom **394** therethrough. The opening **400** is configured to position a fastener **402** therein, such as a bolt or screw. The fastener **402** extends from a head **404** configured to receive a driver (e.g., a Phillips head configured to be driven by a Phillips screwdriver) and a tip **406** opposite the head **404**. A diameter of the fastener **402** is greater at the head **404** than the remainder of the fastener **402** down to the tip **406**. The fastener **402** is threaded along at least a portion of the outer surface, particularly near the tip **406** such that a nut **408** may threadingly engage with the tip **406** in a conventional manner. In the illustrated example, the opening **400** through the cap **390** is smooth configured to position the fastener **402** therein. A chamfered portion **410** is provided in the top **392** of the cap **390** such that the head **404** of the fastener **402** may be flush or recessed into the cap **390**.

[0100] In use, the fastener **402** extends through the cap **390**, through the opening **198** in the base **20**, and into threaded engagement with the nut **408** to attach the cap **390** to the base **20** in the height direction HD (as well as in the width direction WD and length direction LD). The cap **390** also retains the positions of the coil spring **382** and the plunger **360** in the width direction WD and the length direction LD, as discussed above. In other words, the cap **390**, the coil spring **382**, and the plunger **360** remain coaxially aligned parallel to the height direction HD by virtue of the features described above.

[0101] When the cap **390** is coupled to the base **20**, the fastener assembly **300** is configured such that a distance between the flange **396** of the cap **390** and the base **20** causes the coil spring **382** to be compressed between the flange **396** and the annular groove **380** of the plunger **360**, thereby biasing the plunger **360** downwardly away from the flange **396** and towards the split bushing **310**. As discussed above, the plunger **360** has an angled face **372** that generally has a V-shape (i.e., from the perspective of the length direction LD) and the first faces **350** of the split bushing **310** form a substantially V-shaped opening **354** generally corresponds to the angel of the angled face **372**. As the plunger **360** is biased downwardly by the coil spring **382**, two bodies **312** of the split bushing **310** are forced apart, particularly in the width direction WD, by virtue of the operative contact between the angles of the angled face **372** of the plunger **360** and the first faces **350** of the two bodies **312**. Another sectional view of the fastener assembly **300** coupling the frame **100** to the base **20** is shown in FIG. **14**.

[0102] In this manner, the downward force provided by the plunger **360** causes the two bodies **312** to remain in abutting contact with the sides **304** of the slot **170** in the frame **100** in the width direction WD, thereby preventing movement between the fastener assembly **300** and the frame **100** in the width direction WD. This therefore prevents any noises that may be caused by such movement between the frame **100** and the base **20** to which it is coupled via the fastener assembly **300**, providing an improved user experience and reducing wear from lateral movement of the components. This also provides that the plunger **360** and the two bodies **312** of the split bushing **310** remain centered above an axis parallel to the height direction HD by virtue of the angled faces being V-shaped. It should be recognized that the fastener assembly **300** also therefore prevents movement of the frame **100** relative to the base **20** in the height direction HD by virtue of the angled face **372** of the plunger **360** providing a downward force on the first faces **350** of the split bushing **310**. However, the frame **100** remains capable of being moved in the length direction LD relative to the base **20**, which as discussed above allows for adjusting the shock absorption provided by the shock absorption system.

[0103] Another advantage of the presently disclosed fitness machine is that a zero clearance is maintained between all the components even after split bushing **310** begins to wear with repeated cycling of the shock absorption system. This extends the life of the product by not having to replace bearings, or not having to replace them as early, while also reducing the cost of ownership.

[0104] Through further experimentation and development, and with reference to FIG. **6**, the present inventors have identified another cause of a user's engagement with the machine generating undesirable noise, in this case due to contact with the leaf spring **50**. This contact may be between the resilient body (e.g., leaf spring **50**) and the underside of the mobile portion **42** (e.g., a treadmill deck), and/or between the leaf spring **50** and the end stop **70** that limits the body length L of the leaf spring **50** in the manner discussed above. This contact may be a rubbing or sliding type of contact caused by friction due to relative movement in the length direction LD (or width direction WD) between the leaf spring **50** and the mobile portion **42** and/or between the leaf spring **50** and the end stop **70**. This contact may also or alternatively be caused by impact when there is relative movement in the height direction HD between the leaf spring **50** and the mobile portion **42** of the fitness machine. By way of example the treadmill deck may jump during the gait cycle of the user such that the underside is not in continuous contact with the leaf spring **50**. Likewise, contact-type noise may be generated when the second end **52** of the leaf spring **50** repeatedly contacts the wall **80** of the end stop **70** in the length direction LD.

[0105] Through further experimentation and development, the present inventors have found that these noises are effectively abated by incorporating one or more cushions that operatively contact the leaf spring **50** so as to reduce the noises generated from contact with the leaf spring **50** during operation of the machine.

[0106] FIG. **15** illustrates a first embodiment of a leaf spring assembly **500** for reducing noise generated from contact with a resilient body during operation of a fitness machine, such a leaf spring **50** as discussed above. The leaf spring assembly **500** includes a leaf spring **50** similar to those discussed above, which extends from a first end **51** to a second end **52** with a vertex **54** positioned approximately at a midpoint therebetween. The leaf spring **50** has an upper surface **502** and a lower surface **504**. The leaf spring assembly **500** includes a first cushion **506** that is positioned between the upper surface **502** of the leaf spring **50** and the mobile portion **42**, which is shown in part superimposed the leaf spring **50** for reference.

[0107] The first cushion **506** extends along a length between a first end **508** and a second end **510**, along a width between a third end **512** and a fourth end **514**, and has a depth between an outer surface **517** and an inner surface **518**. In the illustrated example, the length between the first end **508** and a second end **510** generally corresponds to a length of the arc of the upper surface **502** of the leaf spring **50** between the first end **51** and the second end **52** thereof. Likewise, the width of the first cushion **506** between the third end **512** and the fourth end **514** generally corresponds to a width of the leaf spring **50** in the width direction WD. The first cushion **506** may be coupled to the leaf spring **50** in a variety of manners, including integral formation, adhesives, or other techniques known in the art. In the illustrated embodiment, bands **516** are provided in one or more locations between the first end **51** and the second end **52** of the leaf spring **50**, which cinch, tie, or clamp the first cushion **506** and the leaf spring **50** to prevent separation thereof. The bands **516** may be zip-ties, rubber bands, metal or synthetic straps that are crimped or otherwise tied in place, or other mechanisms known in the art. In certain embodiments, the elastic nature of the leaf spring **50** permits the bands **516** to partially indent the leaf spring **50** (hidden beneath the band **516**), thereby preventing movement of the bands **516** along the length of the leaf spring **50** in use. The present disclosure also contemplates configurations in which the bands **516** extend through openings through the width of the leaf spring **50**, the use of notches in the upper surface **502** and/or a lower surface **504** of the leaf spring **50**, or other mechanisms for fixing the bands **516** relative to the leaf spring **50** when in use, particularly in the length direction LD.

[0108] The first cushion **506** may comprise many different types of materials, such as nylon webbing, felt, plastic (including rigid or flexible), or other materials known in the art. The present inventors have identified that the first cushion **506** in certain fitness machines principally reduces noise by reducing the friction between the mobile portion **42** and the leaf spring **50** in the length direction LD. Thus, while not required, the first cushion **506** is advantageously comprised of a different material than the leaf spring **50**. In these cases, the first cushion **506** is selected to be robust for this sliding or rubbing type contact, which the present inventors have identified nylon webbing to by particularly suited to handle in a cost-effective manner.

[0109] FIG. **16** shows an alternate embodiment of leaf spring assembly **520** in which the first cushion **522** extends entirely around the leaf spring **50**. In other words, the first cushion **522** completely encircles the leaf spring **50** (though not necessarily the sides **524** of the leaf spring **50** across which the leaf spring **50** extends in the width direction WD. The first cushion **522** may otherwise be the same or similar to the first cushion **506** discussed above. The present inventors have identified that the encircling design of the first cushion **522** of FIG. **16** advantageously avoids the need to align the first cushion **522** between the first end **51** and the second end **52** of the leaf spring **50**, and also avoids any concerns with the first cushion **522** moving in the length direction LD relative to the leaf spring **50**.

[0110] As discussed above, the present inventors have further developed solutions for abating noise caused by contact between the second end **52** of the leaf spring **50** and the end stop **70**. In particular, further discussion will be provided for a second cushion **530** that provides this noise abatement. It should be recognized that the second cushion **530** may be used in addition to, or as an alternative to the first cushion **506** or the first cushion **522** discussed above. FIG. **15** shows an embodiment of the second cushion **530** that is configured to reduce or eliminate noise generated by contact between the second end **52** of the leaf spring **50** and the end stop **70**. The second cushion **530** may comprise a second material distinct from the first material of the first cushion **506**, and/or be distinct from a third material comprising the leaf spring **50**. Since the present inventors have found that the noise generated by contact at the second end **52** of the leaf spring **50** is principally caused by impact or shock, rather than sliding or friction, particularly advantageous material choices for the second cushion **530** include felt, foam, or other compressible materials. In one example, felt of 95% wool (SAE standard F1 felt) was identified to work particularly well in cushioning the operative contact between the second end **52** of the leaf spring **50** and the wall **80** of the end stop **70**, thereby effectively eliminating noise.

[0111] The second cushion **530** extends along a length between a first end **532** and a second end **534**, along a width between a third end **535** and a fourth end **536**, and has a depth between an outer surface **538** and an inner surface **540**. The second cushion **530** overlays a portion of the leaf spring **50**, specifically wrapping around the second end **52** of the leaf spring **50**. The second cushion **530** may be coupled to the leaf spring **50**, including indirectly via the first cushion **506**, in the same or a similar manner as the first cushion **506**. In the illustrated example of FIG. **15**, the second cushion **530** also partially overlaps with the first cushion **506** such that the same band **516** not only secures both the first cushion **506** and the second cushion **530**, but also both the first end **532** and the second end **534** of the second cushion **530**.

[0112] While the present embodiment shows the second cushion **530** as a separate element from the first cushion **506**, it should be recognized that these materials may also be combined as a single material having both friction reducing and shock reducing capabilities. The second cushion **530** may also be provided on only a portion of the first cushion **506** that aligns with the second end **52** of the leaf spring **50**, whether being integrally formed with or subsequently coupled to the first cushion **506**.

[0113] The leaf spring assembly **500** of FIG. **15** also includes an optional plate **542** that can be sandwiched between the leaf spring **50** and the first cushion **506**, the first cushion **522**, and/or the second cushion **530**. The plate **542** extends along a length from a first end **544** to a second end **546**, along a width (illustrated here to be substantially similar to the width of the leaf spring **50**), and has a thickness between an outer surface **548** and an inner surface **550**. The plate **542** is configured to reduce the friction between the leaf spring **50** and the first cushion **506**, the first cushion **522**, and/or the second cushion **530**. The plate **542** may comprise a plastic material, a synthetic webbing material, or a metal alloy (e.g., steel, aluminum), by way of example. In certain configurations, the inner surface **550** is adhered to or integrally formed with the leaf spring **50** (e.g., via injection molding) to be coupled thereto. However, other techniques for coupling the plate **542** to the second end **52** of the leaf spring **50** are also contemplated, including being held in position by virtue of the band **516** and/or being sandwiched between the leaf spring **50** and the first cushion **506**, the first cushion **522**, and/or the second cushion **530**.

[0114] In certain embodiments, the plate **542** may be used without the second cushion **530** being on the leaf spring **50**. In one example, a reduced friction of the plate **542** is well suited to directly contact a second cushion **530** on the end stop **70** (i.e., replacing the element shown as **545** in FIG. **16**). The plate **542** (again, without the second cushion **530** covering it on the leaf spring **50**) may directly contact the plate **545** on the end stop **70** as shown in FIG. **16**. It should be recognized that other combinations of plates and cushions are also contemplated by the present disclosure.

[0115] As shown in FIG. **16**, a similar plate **545** may also or alternatively be provided between the leaf spring assembly **520** and the end stop **70** so as to reduce friction therebetween. In other examples, another cushion such as the first cushion **506**, the first cushion **522**, and/or the second cushion **530** may be coupled to the end stop **70** (in addition to, or as an alternative to being coupled to the leaf spring **50**) to provide the desired effect. For example, the first cushion **506** may be coupled to the leaf spring **50** with the second cushion coupled to the end stop **70**.

[0116] In certain examples of fitness machines, such as the treadmill of FIG. **2**, the present inventors have found it sufficient for the first cushion for reducing friction type contact between the leaf spring **50** and the mobile portion **42** (the deck) to overlay only the uppermost portion of the leaf spring **50**, such as the 20%, 50%, or 75% of the length of the leaf spring **50**. Likewise, in certain configurations only the end wall **80** of the end stop **70** need be cushioned via the second cushion **530**. In other cases, it is advantageous to cover the entire portion of the end stop **70** in which contact is made with the second end **52** of the leaf spring **50** so as to avoid the movement the leaf spring **50** removing the second cushion **530** after extensive use.

[0117] Returning to FIG. **15**, the present inventors have further identified that the friction type contact and the noises therefrom can be reduced or eliminated by treating the upper surface **502** of the leaf spring **50** with a friction reducing material. Similarly, the leaf spring **50** can be formed or fabricated such that the upper surface **502** comprises a separate material than the remainder of the leaf spring **50**, such **2**-shot injection molding that results in the upper surface **502** comprising Delrin® or another low friction material known in the art.

[0118] In addition, or in the alternative, such a friction reducing treatment or material may be applied to the underside of the mobile portion **42** to provide the same effect. The embodiment of FIG. **16** shows such a configuration in which at least a portion of the underside of the mobile

portion **42** comprises Delrin® or another friction material, which is advantageous to incorporate even with the use a first cushion **506** or a first cushion **522** on the leaf spring **50** to reduce friction and thus, noise. The example shown is a plate **552** that is positioned over the leaf spring **50** in the height direction HD, whereby the plate is sized in the length direction LD and the width direction WD to accommodate all movement between the mobile portion **42** and the leaf spring **50**. In other words, the plate **552** is configured such that the leaf spring **50** only touches the plate **552** during operation of the fitness machine, rather than the mobile portion **42** itself. The plate **552** may be coupled to the underside of the mobile portion **42** via integral formation, fasteners, or adhesives, by way of example.
[0119] Certain embodiments further provide for preventing the second end **52** of the leaf spring **50** from moving in the height direction HD. One such embodiment was discussed above and shown in FIG. **3**, whereby a second pin **82** is vertically confined within a slot **74** in the end stop **70**. A nother embodiment is shown in FIG. **11**. In this embodiment, a coil spring **560** is coupled at a first end **562** to the second pin **82** and a second end **564** of the coil spring **564** is coupled to the side of the end stop **70**, such as via a screw or another fastener. The coil spring **560** provides a downward, tensile force in the height direction HD to prevent the second end **52** of the leaf spring **50** from moving in the height direction HD. It should be recognized that other mechanisms may be used to provide this downward force, including gas springs or elastomeric bands, by way of example. In certain further embodiments, rollers **566** are also coupled to the second end **52** of the leaf spring **50**, which allow the second end **52** of the leaf spring **50** to roll along rails **568** of the end stop **70**.
[0120] In this manner, the presently disclosed cushioning concepts and the various combinations thereof provide for reduced noise generation due to contact with the resilient body providing shock absorption for a fitness machine, whether from friction or impact.
[0121] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to make and use the invention. Certain terms have been used for brevity, clarity, and understanding. No unnecessary limitations are to be inferred therefrom beyond the requirement of the prior art because such terms are used for descriptive purposes only and are intended to be broadly construed. The patentable scope of the invention is defined by the claims and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have features or structural elements that do not differ from the literal language of the claims, or if they include equivalent features or structural elements with insubstantial differences from the literal languages of the claims.

Claims

1. A fitness machine operable by a user, the fitness machine comprising: a base that extends in a length direction, a width direction, and a height direction that are perpendicular to each other; a mobile portion configured to support the user during operation of the fitness machine; a resilient body supported by a frame and configured to provide a resistance against the mobile portion moving towards the base in the height direction; and a fastener assembly that couples the frame to the base, wherein the fastener assembly is configured to expand to prevent the frame from moving relative to the base during operation of the fitness machine.
2. The fitness machine according to claim 1, wherein the fastener assembly is configured to prevent the frame from moving in the height direction relative to the base during operation of the fitness machine.
3. The fitness machine according to claim 1, wherein the frame is moveable in the length direction relative to the base to adjust the resistance provided by the resilient body.
4. The fitness machine according to claim 1, wherein the fastener assembly includes an expandable bushing that expands in the width direction and/or in the length direction to prevent the frame from

moving relative to the base.
5. The fitness machine according to claim 4, wherein the expandable bushing expands within a slot that extends in the width direction and/or in the length direction.
6. The fitness machine according to claim 5, wherein the slot extends through the frame.
7. The fitness machine according to claim 4, wherein the fastener assembly includes a plunger with an angled face that when operatively contacting the expandable bushing causes the expandable bushing to expand.
8. The fitness machine according to claim 4, wherein the fastener assembly further comprises a biasing member that biases the expandable bushing towards expanding.
9. The fitness machine according to claim 1, wherein the frame is supported by the base.
10. The fitness machine according to claim 1, wherein the resilient body is supported by the frame and moveable therewith.
11. A fitness machine operable by a user, the fitness machine comprising: a base that extends in a length direction, a width direction, and a height direction that are perpendicular to each other; a mobile portion configured to support the user during operation of the fitness machine; a resilient body that extends along a body length from a first end to a second end and supports the mobile portion at a position therebetween, wherein the resilient body is configured to provide a resistance against the mobile portion moving towards the base in the height direction, wherein the body length of the resilient body changes in the length direction and/or in the width direction relative to the base when providing the resistance during operation of the fitness machine; and a cushion positioned between the resilient body and the mobile portion and/or between the resilient body and the base so as to reduce noise generated by the resilient body during operation of the fitness machine.
12. The fitness machine according to claim 11, wherein the cushion is positioned between the resilient body and the mobile portion to reduce the noise generated from contact therebetween during operation of the fitness machine.
13. The fitness machine according to claim 11, wherein the cushion is coupled to the resilient body.
14. The fitness machine according to claim 11, wherein the resilient body comprises a first material and the cushion comprises a second material.
15. The fitness machine according to claim 11, wherein the resilient body comprises an elastomer.
16. The fitness machine according to claim 11, wherein the cushion covers at least a portion of the resilient body.
17. The fitness machine according to claim 11, further comprising an end stop operable to prevent the body length of the resilient body from increasing beyond a set maximum, the end stop being moveable to adjust the set maximum for the body length of the resilient body, wherein the cushion is positioned between the resilient body and the end stop to reduce the noise generated from contact therebetween during operation of the fitness machine.
18. The fitness machine according to claim 17, wherein the cushion comprises foam.
19. The fitness machine according to claim 17, wherein the cushion is a first cushion, further comprising a second cushion positioned between the resilient body and the mobile portion to reduce the noise generated from contact therebetween during operation of the fitness machine.
20. A fitness machine operable by a user, the fitness machine comprising: a base that extends in a length direction, a width direction, and a height direction that are perpendicular to each other; a mobile portion configured to support the user during operation of the fitness machine; a resilient body configured to provide a resistance against the mobile portion moving towards the base, wherein a body length of the resilient body changes when providing the resistance during operation of the fitness machine; a cushion positioned between the resilient body and the mobile portion and/or between the resilient body and the base so as to reduce noise generated by the resilient body during operation of the fitness machine; a frame moveable relative to the base to adjust the resistance provided by the resilient body; and a fastener assembly that moveably couples the frame

to the base, wherein the fastener assembly is configured to expand to prevent the frame from moving relative to the base during operation of the fitness machine.