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[Continued on next page]

(54) Title: FREE WEIGHT INCLUDING A SYSTEM FOR MEASURING AND ASSESSING REPETITIONS

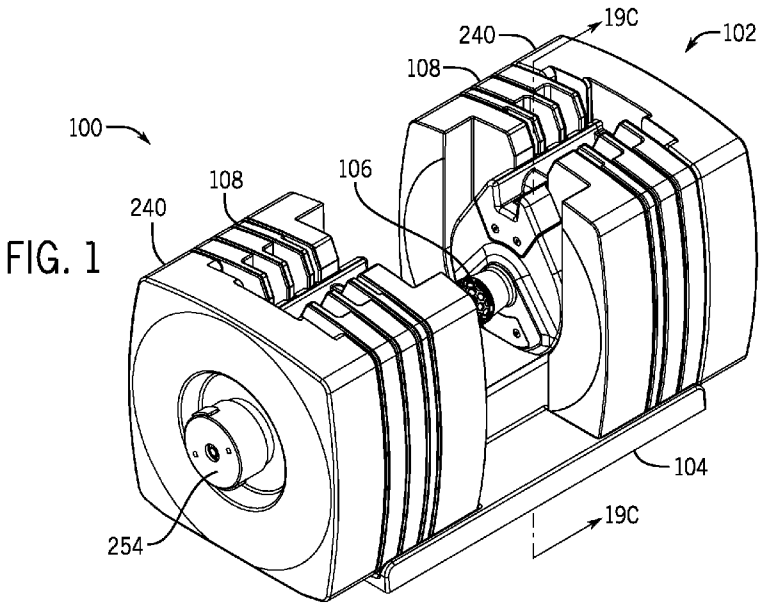


FIG. 1

(57) Abstract: A free weight may include at least one sensor and a computing device in communication with the at least one sensor. The at least one sensor may be connected to the free weight. The computing device may be configured to assess whether or not to count an exercise repetition based upon information received from the at least one sensor. The free weight may include an audio output device, and the computing device may be configured to cause the audio output device to produce an audible sound based upon information received from the at least one sensor. The free weight may include a display device, and the computing device may be configured to cause the display device to indicate a position of the free weight based upon information received from the at least one sensor.

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FREE WEIGHT INCLUDING A SYSTEM FOR MEASURING AND ASSESSING REPETITIONS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Patent Application No. 14/311,228, filed June 20, 2014, and entitled "Adjustable Dumbbell System Having A Weight Sensor", the entire contents of which are hereby incorporated by reference herein for all purposes.

FIELD

[0002] The present disclosure relates generally to a free weight, and more specifically to a free weight with a system for measuring and assessing repetitions.

BACKGROUND

[0003] Free weights are widely used exercise devices for providing resistance training in a wide variety of exercises such as bicep curls, bench presses, shoulder presses, triceps extensions, and the like. Free weight users often perform an exercise routine including multiple repetitions of one or more exercises. The quality of an exercise performed with free weights depends on the use of proper form and thorough repetitions. It can be difficult for a free weight user to properly assess whether proper form has been used, or whether the repetitions were performed well.

SUMMARY

[0004] Examples of the disclosure may include a free weight including a system for measuring and assessing repetitions. In one example, the free weight includes at least one sensor and a computing device. The at least one sensor is connected to the free weight. The computing device is in communication with the at least one sensor. The computing device is configured to assess whether or not to count an exercise repetition based upon information received from the at least one sensor.

[0005] In some examples, the computing device is configured to use a first repetition as a basis in assessing whether or not to count subsequent repetitions.

[0006] In some examples, the computing device is configured to dynamically adjust the first repetition in assessing subsequent repetitions to account for data drift of the at least one sensor.

[0007] In some examples, the computing device is configured to not count the exercise repetition unless the free weight is moved to a pre-determined position. The pre-

determined position may be a location near an upper position of a repetition that comprises moving the free weight between the upper position and a lower position.

[0008] In some examples, the computing device is configured to analyze a rate of motion of the free weight in assessing whether or not to count the exercise repetition.

[0009] In some examples, the free weight is one of the following: a barbell, a dumbbell, or a kettlebell.

[0010] In some examples, the at least one sensor is at least one of the following: an accelerometer, a magnetometer, or a gyroscope.

[0011] In some examples, the free weight includes another sensor operatively associated with the free weight and configured to sense a weight of the free weight.

[0012] In one example, the free weight includes at least one sensor connected to the free weight, an audio output device, and a computing device in communication with the at least one sensor and the audio output device. The computing device is configured to cause the audio output device to produce an audible sound based upon information received from the at least one sensor.

[0013] In some examples, the computing device causes the audio output device to produce the audible sound upon determining the user has completed a valid repetition with the free weight.

[0014] In some examples, the computing device causes the audio output device to produce the audible sound upon determining the user has moved the free weight to a pre-determined position. The pre-determined position may be a location near an upper position of a repetition that comprises moving the free weight between the upper position and a lower position.

[0015] In some examples, the computing device causes the audio output device to produce the audible sound upon determining that the at least one sensor is ready to measure repetitive motion of the free weight.

[0016] In some examples, at least one of the computing device and the audio output device are connected to the free weight.

[0017] In some examples, the free weight is one of the following: a barbell, a dumbbell, or a kettlebell.

[0018] In some examples, the at least one sensor comprises at least one of the following: an accelerometer, a magnetometer, or a gyroscope.

[0019] In some examples, the free weight includes another sensor operatively associated with the free weight and configured to sense a weight of the free weight.

[0020] In one example, the free weight includes at least one sensor connected to the free weight, a display device, and a computing device in communication with the at least one sensor and the display device, the computing device configured to cause the display device to indicate a position of the free weight based upon information received from the at least one sensor.

[0021] In some examples, the computing device causes the display device to display a representative image of the free weight moving on the display in connection with the position of the free weight.

[0022] In some examples, the computing device causes the display device to display a target rate of motion. The computing device may cause the display device to display a pacing feature that moves on the display to indicate the target rate of motion.

[0023] In some examples, the free weight comprises one of the following: a barbell, a dumbbell, or a kettlebell.

[0024] In some examples, the at least one sensor comprises at least one of the following: an accelerometer, a magnetometer, or a gyroscope.

[0025] In some examples, the free weight includes another sensor operatively associated with the free weight and configured to sense a weight of the free weight.

[0026] In one example, the free weight includes a repetition counting system including at least one sensor connected to the free weight, and a computing device including a processor in communication with the at least one sensor and configured to assess whether or not to count an exercise repetition based upon information received from the at least one sensor.

[0027] In one example, a system for counting exercise repetitions performed by a user is provided. The system includes at least one sensor connected to a free weight or the user, and a computing device in communication with the at least one sensor and configured to assess whether or not to count an exercise repetition based upon information received from the at least one sensor.

[0028] In some examples, the computing device is configured to use a first repetition as a basis in assessing whether or not to count subsequent repetitions. The computing device may be configured to dynamically adjust the first repetition in assessing subsequent repetitions to account for data drift of the at least one sensor.

[0029] In some examples, the computing device is configured to not count the exercise repetition unless the free weight or the user is moved to a pre-determined position. The pre-determined position may be a location near an upper position of a repetition that

comprises moving the free weight or the user between the upper position and a lower position.

[0030] This summary of the disclosure is given to aid understanding. Each of the various aspects and features of the disclosure may advantageously be used separately in some instances, or in combination with other aspects and features of the disclosure in other instances. Accordingly, while the disclosure is presented in terms of examples, individual aspects of any example can be claimed separately or in combination with aspects and features of that example or any other example.

[0031] This summary is neither intended nor should it be construed as being representative of the full extent and scope of the present disclosure. The present disclosure is set forth in various levels of detail in this application and no limitation as to the scope of the claimed subject matter is intended by either the inclusion or non-inclusion of elements, components, or the like in this summary.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate examples of the disclosure and, together with the general description given above and the detailed description given below, serve to explain the principles of these examples.

[0033] FIG. 1 is an isometric view of an adjustable dumbbell system in accordance with an example of the present disclosure.

[0034] FIG. 2 is a partially exploded, isometric view of the adjustable dumbbell system of FIG. 1.

[0035] FIG. 3 is an isometric view of a handle assembly of the adjustable dumbbell system of FIG. 1.

[0036] FIG. 4 is top plan view of the handle assembly of FIG. 3.

[0037] FIG. 5 is a lengthwise cross-sectional view of the handle assembly of FIG. 3 taken along line 5-5 of FIG. 4.

[0038] FIG. 6 is an isometric view of a portion of the handle assembly of FIG. 3.

[0039] FIG. 7 is a proximal isometric view of an inner cover of the handle assembly of FIG. 3.

[0040] FIG. 8 is a distal isometric view of the inner cover of FIG. 7.

[0041] FIG. 9 is a proximal isometric view of an indexing disc of the handle assembly of FIG. 3.

[0042] FIG. 10 is a distal isometric view of the indexing disc of FIG. 9.

[0043] FIG. 11 is a proximal isometric view of a first separator disc of the handle assembly of FIG. 3.

[0044] FIG. 12 is a distal isometric view of the first separator disc of FIG. 11.

[0045] FIG. 13 is a proximal isometric view of a first selector disc of the handle assembly of FIG. 3.

[0046] FIG. 14 is a distal isometric view of the first selector disc of FIG. 13.

[0047] FIG. 15 is a proximal isometric view of a second selector disc of the handle assembly of FIG. 3.

[0048] FIG. 16 is a distal isometric view of the second selector disc of FIG. 15.

[0049] FIG. 17 is a proximal isometric view of an end cap of the handle assembly of FIG. 3.

[0050] FIG. 18 is a distal isometric view of the end cap of FIG. 17.

[0051] FIG. 19A is an enlarged cross-sectional view of a locking mechanism of the handle assembly of FIG. 3 taken along line 19A-19A of FIG. 5 with the locking mechanism in a first or locked position that prevents rotation of the discs.

[0052] FIG. 19B is an enlarged cross-sectional view of the locking mechanism of FIG. 19A with the locking mechanism in a second or unlocked position that permits rotation of the discs.

[0053] FIG. 19C is a transverse cross-sectional view of the adjustable dumbbell system of FIG. 1.

[0054] FIG. 19D is an enlarged cross-sectional view of the locking mechanism of FIG. 19A taken along line 19D-19D of FIG. 19C.

[0055] FIG. 20 is a proximal isometric view of a first weight of the adjustable dumbbell system of FIG. 1.

[0056] FIG. 21 is a distal isometric view of the first weight of FIG. 20.

[0057] FIG. 22 is a proximal isometric view of a second weight of the adjustable dumbbell system of FIG. 1.

[0058] FIG. 23 is a distal isometric view of the second weight of FIG. 22.

[0059] FIG. 24 is a proximal isometric view of a third weight of the adjustable dumbbell system of FIG. 1.

[0060] FIG. 25 is a distal isometric view of the third weight of FIG. 24.

[0061] FIG. 26 is a proximal isometric view of a fourth weight of the adjustable dumbbell system of FIG. 1.

[0062] FIG. 27 is a distal isometric view of the fourth weight of FIG. 26.

[0063] FIG. 28 is a proximal isometric view of a weight for the adjustable dumbbell system of FIG. 1.

[0064] FIG. 29 is a distal isometric view of the weight of FIG. 28.

[0065] FIG. 30 is a partially exploded, distal isometric view of a selection assembly of the weight of FIG. 28.

[0066] FIG. 31 is a partially exploded, proximal isometric view of the selection assembly of FIG. 30.

[0067] FIG. 32 is a proximal elevation view of a portion of the selection assembly of FIG. 30.

[0068] FIG. 33 is a cross-sectional view of a portion of the selection assembly of FIG. 30 taken along line 33-33 of FIG. 32.

[0069] FIG. 34 is a distal elevation view of a base of the selection assembly of FIG. 30.

[0070] FIG. 35 is an isometric view of the base of FIG. 34.

[0071] FIG. 36 is another isometric view of the base of FIG. 34.

[0072] FIG. 37 is an enlarged, isometric, longitudinal cross-sectional view of the adjustable dumbbell system of FIG. 1 with the selection assembly of FIG. 30 in an unselected or disengaged state.

[0073] FIG. 38 is another enlarged, isometric, longitudinal cross-sectional view of the adjustable dumbbell system of FIG. 1 with the selection assembly of FIG. 30 in an unselected or disengaged state.

[0074] FIG. 39 is another enlarged, isometric, longitudinal cross-sectional view of the adjustable dumbbell system of FIG. 1 with the selection assembly of FIG. 30 in a selected or engaged state.

[0075] FIG. 40 is yet another enlarged, isometric, longitudinal cross-sectional view of the adjustable dumbbell system of FIG. 1 with the selection assembly of FIG. 30 in a selected or engaged state.

[0076] FIG. 41 is an enlarged, isometric, longitudinal cross-sectional view of one end of the adjustable dumbbell system of FIG. 1.

[0077] FIG. 42 is another enlarged, isometric, longitudinal cross-sectional view of the end of the adjustable dumbbell system shown FIG. 41.

[0078] FIG. 43 is a top plan view of an adjustable dumbbell having an on-board computing device.

[0079] FIG. 44 is an alternative configuration of an adjustable dumbbell having an on-board computing device.

[0080] FIG. 45 is an isometric view of the on-board computing device associated with the adjustable dumbbell of FIG. 44.

[0081] FIG. 46A is a block diagram of the on-board computing device of FIG. 42-44.

[0082] FIG. 46B is a block diagram of a system for measuring and accessing repetitions.

[0083] FIG. 47 is a top plan view of mobile device that may be used in connection with the on-board computing device of FIG. 42-45.

[0084] FIG. 48 is a side elevation view of an example of the adjustable dumbbell shown in FIG. 43.

[0085] FIG. 49 is an enlarged view of the sensor board shown in FIG. 48.

[0086] FIG. 50 is a side elevation view of the modified separator disc shown in FIG. 48.

[0087] FIG. 51 is a side elevation view of another example of the adjustable dumbbell shown in FIG. 43.

[0088] FIG. 52 is an enlarged view of the sensor board shown in FIG. 51.

[0089] FIG. 53 is a side elevation view of the modified separator disc shown in FIG. 51.

[0090] FIG. 54A through FIG. 54C are side elevation views of an alternative example for the mechanical sensors shown in FIG. 51 and FIG. 52.

[0091] FIG. 55 is a side elevation view of another example of the adjustable dumbbell shown in FIG. 43.

[0092] FIG. 56 is an enlarged view of the sensor board shown in FIG. 55.

[0093] FIG. 57A is a side elevation view elevation view of the modified separator disc shown in FIG. 55.

[0094] FIG. 57B is a cross section of the indexing disc shown in FIG. 10.

[0095] FIG. 57C is a cross section of the first selector disc shown in FIG. 13.

[0096] FIG. 57D is a cross section of the first selector disc shown in FIG. 14.

[0097] FIG. 57E is a cross section of the second selector disc shown in FIG. 16.

[0098] FIG. 58 is a side elevation view a modified separator disc that includes an accelerometer.

[0099] FIG. 59A is perspective view of a sensor configuration that includes a potentiometer.

[00100] FIG. 59B is a perspective view of an alternative sensor configuration having a potentiometer.

[00101] FIG. 60 is perspective view of a sensor configuration that includes a capacitive and/or inductive sensor.

[00102] FIG. 61A-B is perspective view of a sensor configuration that includes a magnetic sensor.

[00103] FIG. 62 is a block diagram of a signal processing method.

[00104] FIG. 63 is a block diagram of a repetition counting method.

[00105] FIG. 64 is a graph of an annotated position signal of a dumbbell.

[00106] FIG. 65 is a schematic of a graphical user interface on a user's mobile device.

[00107] FIG. 66 is a schematic of a computing device associated with a barbell.

[00108] FIG. 67 is a schematic of a computing device associated with a kettlebell.

[00109] FIG. 68 is a schematic of a computing device attached to a user.

[00110] The drawings are not necessarily to scale. In certain instances, details unnecessary for understanding the disclosure or rendering other details difficult to perceive may have been omitted. In the appended drawings, similar components and/or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a letter that distinguishes among the similar components. If only the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label. The claimed subject matter is not necessarily limited to the particular examples or arrangements illustrated herein.

DETAILED DESCRIPTION

[00111] The present disclosure provides an adjustable dumbbell system which allows a user to select a dumbbell weight. Referring to FIGS. 1 and 2, an adjustable dumbbell system 100 may include an adjustable dumbbell 102 and a base 104. To change the weight of the dumbbell 102, the user may place the dumbbell 102 in the base 104, turn a handle 106 of the dumbbell 102 to engage a desired combination of weights 108, and remove the dumbbell 102 from the base 104 to perform a desired exercise. The desired combination of weights may be coupled to the handle 106, and unused weights may remain in the base 104. Should the user desire a different dumbbell weight, the user may place the dumbbell 102 back in the base 104, turn the handle 106 to engage the desired weights 108, and remove the dumbbell 102 from the base 104 with the desired weight. When the adjustable dumbbell 102 is not in the

base 104, for example during exercise-type use, the adjustable dumbbell 102 may be configured such that it is difficult to add or remove weights 108.

[00112] The base 104 may receive the dumbbell 102 and may allow a user to adjust the weight of the dumbbell 102. During use of the dumbbell 102, the base 104 may hold the weights 108 that are not attached to the dumbbell 102. Before using the dumbbell 102, the user may first determine the weight to be lifted and turn the handle 106 while the dumbbell 102 is in the base 104, causing no weights or one or more weights 108 to be fixedly connected to a handle assembly 114. The user may then lift the dumbbell 102 out of the base 104. Any weight 108 not fixedly connected with the adjustable dumbbell 102 remains in the base 104.

[00113] The base 104 may include a bottom wall 109, one or more positioning walls 110, and a pair of lock features 112. The bottom wall 109 may support the adjustable dumbbell 102 and the weights 108. The positioning walls 110 may ensure that the adjustable dumbbell 102 is properly aligned when it is inserted into the base 104. The positioning walls 110 may hold the weights 108 upright and in the proper location relative to the handle assembly 114 so that the adjustable dumbbell 102 may be inserted into and removed from the base 104. The positioning walls 110 may be spaced so as to fit between adjacent weights 108 when the dumbbell 102 rests in the base 104 and to keep any weight 108 not attached to the dumbbell 102 upright when the dumbbell 102 is removed from the base 104.

[00114] The lock features 112 may be formed from a relatively rigid metal, plastic, or other suitable material. Each lock feature 112 may extend upwardly from the base 104. In some embodiments, each lock feature 112 may include a plate-like vertical portion that extends upwardly from the base 104 with a plate-like horizontal portion that extends substantially perpendicular from an end portion of the vertical portion that is distal from the base 104. The arrangement of the vertical and horizontal portions of each lock feature 112 may resemble an L-shaped profile for the portion of the lock feature 112 extending above the base 104. The lock features 112 may be positioned on the base 104 to extend into a cavity formed in the adjustable dumbbell 102 when the dumbbell 102 is placed in the base 104. The lock features 112 may deactivate a locking mechanism, as described further below, to allow selection of different weights when the adjustable dumbbell 102 is in the base 104.

[00115] Referring to FIGS. 3-5, the adjustable dumbbell 102 may include the handle assembly 114. The handle assembly 114 may include the handle 106, a shaft 127, a pair of inner covers 118, a pair of indexing discs 120, one or more separator discs 121, one or more selector discs 122, a pair of end caps 124, and a pair of bridges 126. Opposing end regions of

the adjustable dumbbell system 100 may be, except as where otherwise described, generally identical to one another. Thus, when reference is made to one or more parts on one side of the adjustable dumbbell 102 or base 104, it is to be understood that corresponding or similar part(s) may be disposed on the other side or end region of the adjustable dumbbell 102 or the base 104.

[00116] Referring to FIG. 6, the handle 106 of the adjustable dumbbell 102 may include a grip portion 128 and a rotatable member 132, such as a sleeve or the like. The grip portion 128 may be mounted onto the rotatable member 132 and may be slightly bulged to provide a comfortable and ergonomic surface to grasp to facilitate a user securely gripping the adjustable dumbbell 102. The grip portion may be generally symmetrical about the midpoint of the rotatable member 132.

[00117] The shaft 127 may be received through a generally circular passage defined by the rotatable member 132. Each end portion 130 of the shaft 127, one on either end of the rotatable member 132, may extend beyond a respective end of the rotatable member 132. The rotatable member 132 may be rotatable about a longitudinal axis of the shaft 127 to allow a user to select a desired dumbbell weight by rotating the handle 106. In some embodiments, the rotatable member 132 may rotate relative to the shaft 127. In other embodiments, the rotatable member 132 and the shaft 127 may rotate in unison about the longitudinal axis of the shaft 127.

[00118] The rotatable member 132 may include engagement features 134 formed in opposing ends of the rotatable member 132. Each engagement feature 134 may engage a respective indexing disc 120 so that the indexing discs 120 rotate in unison with the rotatable member 132. The end portions 130 of the shaft 127 may include a pair of retaining features 136, such as wave spring washers and retaining rings, disposed adjacent outer or terminal ends of the end portions 130. The retaining features 136 may extend beyond the outer periphery of the end portions 130 and may apply an axial force transferred through any interposed separator and selector discs 121, 122 to the indexing discs 120 to ensure the indexing discs 120 remain engaged with the engagement features 134 of the rotatable member 132. As used herein, the terms inner and proximal refer to a direction toward the grip portion 128 of the handle 106, and the terms outer and distal refer to a direction toward the terminal ends of the end portions 130 of the shaft 127.

[00119] FIG. 5 shows a cross-sectional view of the adjustable dumbbell 102 taken along the longitudinal centerline of the handle 106, without any weights 108 attached to the handle assembly 114. The indexing discs 120, the separator discs 121, and the selector discs

122 may be mounted on the end portions 130 of the shaft 127 and arranged distally from the inner covers 118. The handle 106, the indexing discs 120, the separator discs 121, and the selector discs 122 may be rotationally interlocked to one another. By grasping and turning the handle 106, the indexing discs 120, the separator discs 121, and the selector discs 122 may be rotated in unison relative to the inner covers 118 and the weights 108. In some implementations, the rotatable member 132, the indexing discs 120, the separator discs 121, the selector discs 122, or a combination thereof are interference fit onto the shaft 127, resulting in the shaft 127 rotating in unison with the handle 106 during weight selection. The dumbbell may also allow the selection of the desired combination of weights without requiring the handle to be turned. For instance, in one example, the selector discs at either or both ends of the dumbbell may be sleeved over the handle to allow them to be rotated independently of the handle to allow the desired weights to be selected.

[00120] With reference to FIGS. 3-5, 7, and 8, each inner cover 118 may be mounted on the shaft 127 adjacent to ends of the rotatable member 132. The inner covers 118 each may define a generally centrally-formed aperture 138 for receiving a respective end portion 130 of the shaft 127 there through. Each inner cover 118 may be mounted onto opposing respective end portions 130 of the shaft 127 and may be abutted against a radially-extending shoulder of the rotatable member 132 to axially locate the inner covers 118 along the shaft 127. When the dumbbell 102 is positioned in the base 104, the inner covers 118 may be non-rotatably seated in the base 104. An underside of the inner covers 118 may abut against the bottom wall 109 of the base 104.

[00121] With reference to FIGS. 7 and 8, the inner covers 118 may include a detent 140, such as a spring loaded ball or pin, that engages an indicator feature 156 of the indexing discs 120 to provide an indication to a user that the rotatable member 132 is in a proper rotational position to permit the adjustable dumbbell 102 to be removed from the base 104. The detent 140 may be biased to extend from the inner covers 118 toward the indexing discs 120. The inner covers 118 may include a pair of detents 140 oriented to extend generally parallel to a longitudinal axis of the handle 106. The detents 140 may be biased generally to a distal or outer position and extend partially through openings formed in a distal or outer surface of the inner cover 118 in confronting relationship to the indexing discs 120 (see FIG. 19C). The detents 140 may be engaged with a distal end of a biasing member, such as a spring (leaf, coil, and so on), which may be seated within a recess of the inner covers 118. The detents 140 may be disposed radially outward of the central aperture 138.

[00122] Referring to FIGS. 7, 8, and 19A-19D, the inner covers 118 may include a locking mechanism 142 that permits or prevents rotation of the handle 106. The locking mechanism 142 may include a locking member 144, such as a spring-loaded button. The locking member 144 may include a interference feature 145, such as a protrusion or a projection, that extends in a distal direction parallel or generally parallel to a longitudinal axis of the handle 106 or the shaft 127 and toward the indexing discs 120. The locking member 144 may be vertically movable relative to the inner covers 118 and may be laterally restrained in directions oriented transversely (e.g., orthogonally) to the direction of movement.

[00123] Turning to FIG. 19A, the locking member 144 may be downwardly biased toward an opening 148 by a lock bias member 146, such as a spring, which may be arranged along a vertically-oriented axis. The opening 148 may be defined by the inner cover 118. The opening 148 may be downwardly extending to expose a lower surface of the locking member 144 to permit a portion of the base 104 to engage and vertically displace the locking member 144 against the bias of the lock bias member 146. The locking member 144 may be vertically displaced within a cavity 150 defined by the inner cover 118. The inner covers 118 may include cover plates 152, which may be removably attached to the inner or proximal surface of the inner covers 118 to provide access to the locking members 144 and the lock bias members 146. The cover plates 152 may also provide a bearing surface for the locking members 144 to slide along during vertical displacement of the locking members 144 relative to the inner covers 118.

[00124] Referring to FIGS. 3 and 5, the indexing discs 120 may be mounted onto the handle 106 immediately distal or outside of the inner covers 118. FIG. 9 illustrates an isometric view of the inner or proximal surface of an indexing disc 120, and FIG. 10 illustrates an isometric view of the outer or distal surface of the indexing disc 120. The indexing disc 120 may include one or more of the following: a lock feature 154, an indicator feature 156, a weight selection feature 157, an axially-extending sleeve 158, and a generally centrally located aperture 160 defined by the sleeve 158 and configured to receive a portion of the shaft 127. The lock feature 154, the indicator feature 156, the sleeve 158, and the aperture 158 may be arranged concentrically on the indexing disc 120. A proximal end of the sleeve 158 may include an engagement feature 162 configured to engage the engagement feature 134 of the rotatable sleeve 132 so that the indexing disc 120 rotates in unison with the rotatable sleeve 132 relative to the inner cover 118 and the weights 108. A distal end of the

sleeve 158 may include an engagement feature 164 configured to engage an adjacent separator disc 121 so that the separator disc 121 rotates in unison with the indexing disc 120.

[00125] The lock feature 154 may be positioned proximate to the periphery of the indexing disc 120. In some embodiments, the lock feature 154 may be castellated teeth arranged around the perimeter 161 of the indexing disc 120. Each tooth may extend towards the inner covers 118 in a direction parallel, or generally parallel, to a longitudinal axis of the handle 106 and/or a longitudinal axis of the shaft 127.

[00126] Referring to FIG. 10, the weight selection feature 157 may be configured to either engage a weight 108 to fixedly join the weight 108 to the handle assembly 114 or to not engage a weight 108 to allow it to remain in the base 104 depending upon the rotational orientation of the indexing disc 120. The weight selection feature 157 may take the form of one or more flanges that protrude distally from the distal or outer surface of the indexing disc 120. The flanges may extend along an arcuate or curved path, which may be defined by a single radius originating at a center of the indexing disc 120. The number of flanges may be based on the desired rotational positions of the indexing disc 120 relative to the weight 108 for engagement of the weight selection feature 157 with the weight 108. While one flange is shown in Fig. 10, two or more flanges may also be used. The weight selection feature 157 may be positioned radially between the periphery of the indexing disc 120 and the sleeve 158. Further, in embodiments in which the lock feature 154 is positioned proximate the periphery of the indexing disc 120, the weight selection feature 157 may be positioned radially between the lock feature 154 and the sleeve 158.

[00127] With reference to FIGS. 9 and 10, the indexing disc 120 may include indicator markings 166 arranged on the perimeter 161 of the indexing disc 120. In some implementations, the indicator markings 166 may be formed as raised numbers protruding outwardly from the perimeter 161 of the indexing disc 120. In embodiments in which the locking feature 154 includes teeth, the indicator markings 166 may be positioned angularly between the teeth. The indicator markings 166 may provide a visual indication to the user of the amount of weight selected on the adjustable dumbbell 102. Referring to FIGS. 4 and 19C, the markings 166 may be individually viewable through an opening or window 168 of the bridge 126 to indicate the selected amount of weight.

[00128] Referring to FIG. 9, the indicator feature 156 of the indexing disc 120 may be detent recesses. When the lock feature 154 includes teeth, the detent recesses may be spaced radially inwardly and angularly offset from the teeth. The detent recesses may receive at least portions of the detents 140. The detent recesses may be angularly disposed on the indexing

discs 120 so that the detents 140 engage the detent recesses upon a predetermined level of engagement of one or more of the weights 108 with respective indexing or selector discs 120, 122. The engagement of the detents 140 with the indicator feature 156 may provide audible, tactile, or other sensory feedback to the user indicating that the selected weights 108 are adequately engaged with the handle assembly 114 and that the dumbbell 102 is ready for removal from the base 104.

[00129] Referring to FIGS. 19A-19D, the locking mechanism 142 of the inner cover 118 may be biased to engage an associated lock feature 154 to prevent the indexing discs 120, and hence the separator discs 121 and the selector discs 122, from rotating about the longitudinal axis of the shaft 127 and/or relative to the weights 108 when the handle assembly 114 of the dumbbell 102 is removed from the base 104. Upon removal of the handle assembly 114 from the base 104, each locking member 144 interferes with a respective indexing disc 120 to prevent rotation of the indexing discs 120. This interference may occur by each locking member 144 engaging the lock feature 154 on a respective indexing disc 120. In some implementations, such as implementations in which the lock feature 154 is two or more teeth and the interference feature 145 is a protrusion, upon removal of the dumbbell 102 from the base 104, lock bias members 146 bias respective locking members 144 into a locking position in which each locking member's protrusion is disposed between adjacent teeth of respective indexing discs 120, thereby preventing rotation of the indexing discs 120, and hence rotation of the separator discs and the selector discs 122, relative to the weights 108.

[00130] Referring to FIGS. 19B-19D, when the dumbbell 102 is placed in the base 104, the locking mechanism 142 may be moved into a disengaged or unlocked position. Upon placement of the dumbbell 102 onto the base 104, the lock feature 112 of the base 104 disengages the locking mechanism 142 from the lock feature 154 of the indexing disc 120 to allow rotation of the indexing disc 120 about the longitudinal axis of the shaft 127 and/or relative to the weights 108. In some embodiments, the lock feature 112 of the base 104 may extend upwardly through the opening 148 of the inner cover 118 and may drive the locking mechanism 142 upwardly. The lock feature 112 may move the locking member 144 upwardly a sufficient distance to displace the interference feature 145 (e.g., a protrusion, projection, or the like) from the rotational path of the lock feature 154 (e.g., teeth or the like) of the indexing disc 120 so that the indexing disc 120 and the selector discs 122 may be turned to adjust the weight of the adjustable dumbbell 102. Thus, when the dumbbell 102 is seated in the base 104, the weight of the adjustable dumbbell 102 may be adjusted by turning

the rotatable member 132 of the handle 106 to selectively engage or disengage the weights 108 with the indexing discs 120 and the selector discs 122.

[00131] The adjustable dumbbell 102 may not be removed from the base 104 unless the weights 108 have a predetermined level of engagement or disengagement with the indexing discs 120 and the selector discs 122. The removal of the adjustable dumbbell 102 from the base 104 may be prevented when the base's lock feature 112 engages the indexing disc's lock feature 154 with the lock features 112, 154 engaged based on a rotational orientation of the indexing disc. In some implementations of this locking system, the lock feature 154 for each indexing disc 120 may rotate beneath an upper portion 167 of a respective lock feature 112 when the dumbbell 102 is placed in the base 104. For embodiments in which the lock feature 154 is teeth, the teeth may be circumferentially spaced apart sufficiently to allow the upper portion 167 of the lock feature 112 to pass between adjacent teeth when the indexing discs 120 and selector discs 122 are positioned at predetermined rotational positions relative to the weights 108 to permit removal of the dumbbell 102 from the base 104. Additionally, the teeth may be circumferentially spaced apart sufficiently to inhibit the upper portion 167 of the lock feature 112 from passing between adjacent teeth 154 when the indexing discs 120 and selector discs 122 are not positioned at predetermined rotational positions relative to the weights 108 to prevent removal of the dumbbell 102 from the base 104, thus effectively locking the dumbbell 102 to the base 104. The predetermined rotational positions may be selected so that any weight 108 that is intended to be fixedly joined to the handle assembly 118 based on the relative rotational positions of the indexing and selector discs 120, 122 to the weights 108 is sufficiently engaged with its respective indexing or selector disc 120, 122.

[00132] When the weights 108 are not engaged with or disengaged from the indexing discs 120 and the selector discs 122 as desired, a tooth of the indexing disc 120 may engage the upper portion 167 of the lock feature 112 and prevent the lock feature 112 from exiting through the opening 148 of the inner cover 118, thus locking the dumbbell 102 to the base 104. When the indexing discs 120 and the selector discs 122 are properly aligned rotationally, the upper portion 167 of the lock feature 112 may pass between adjacent teeth 154, and the dumbbell 102 may be removed from the base 104. During removal of the dumbbell 102 from the base 104, the lock bias member 146 may bias the locking member 144 downwardly such that the interference feature 145 interacts with the indexing disc's lock feature 154 to prevent the indexing discs 120 and the selector discs 122 from rotating relative to the inner covers 118 and the weights 108. Thus, when removed from the base 104, the

weight of the dumbbell 102 may be fixed until the dumbbell 102 is repositioned onto the base 104 to select a different combination of weights.

[00133] When the dumbbell 102 is set into the base 104, the lock feature 112 may engage the locking member 144 to disengage the locking member 144 from the indexing discs 120. The handle 106 may then be rotated to rotate the indexing discs 120 and the selector discs 122 to select the desired number of weights 108. The detents 140 may help the user identify when the dumbbell 102 is at a secure location rotationally and not between locations for selecting weights 108. The markings 166 on the indexing disc 120 may be visible through the window 168 of the bridge 126 to indicate that the desired weight is selected (see FIGS. 4 and 19C). In between weight selection locations, the lock feature 154 on the indexing discs 120 may engage the lock feature 112 on the base 104 to prevent the dumbbell 102 from being removed from the base 104. When the indexing discs 120 are in a proper rotational orientation, the base's lock feature 112 does not engage the indexing disc's lock feature 154, thus allowing the dumbbell 102 to be removed from the base 104.

[00134] As the dumbbell 102 is removed from the base 104, the base's lock feature 112 ceases to engage the locking member 144, thus allowing the locking member 144 to be biased into a locking position in which the interference feature 145 interacts with the indexing disc's lock feature 154 to keep the indexing discs 120 from rotating relative to the weights 108. The locked nature of the indexing discs 120 may prevent independent rotation of the selector discs 122 since the selector discs 122 may be keyed to the rotation of the indexing discs 120. Thus, when the dumbbell 102 is removed from the base 104, the indexing discs 120 and selector discs 122 are not rotatable to change the weight selection or cause the weights 108 on the dumbbell 102 to become dislodged.

[00135] Referring to FIGS. 5, 11, and 12, the separator discs 121 may be mounted onto the shaft 127 distal or outside of the indexing discs 120. The separator discs 121 may be positioned along the shaft 127 so as to fit between adjacent weights 108 when the dumbbell 102 rests in the base 104. The separator discs 121 may prevent or substantially prevent axially movement of weights 108 positioned alongside the separator discs 121 and attached to the dumbbell 102 when the dumbbell 102 is removed from the base 104. FIG. 11 illustrates an isometric view of the inner or proximal surface of the separator disc 121, and FIG. 12 illustrates an isometric view of the outer or distal surface of the separator disc 121. Although one pair of separator discs 121 is shown in FIG. 5, the dumbbell 102 may include more or less than one pair of separator discs 121 depending on the specific implementation of the

dumbbell. For example, the dumbbell 102 may include additional pairs of separator discs 121 for implementations where the dumbbell 102 has a heavier weight capability, and vice versa.

[00136] A separator disc 121 may include an axially-extending sleeve 170, which may define a generally centrally located aperture 172 configured to receive the shaft 127 there through. A proximal end of the sleeve 170 may include an engagement feature 174 configured to engage the engagement feature 164 of the indexing disc 120 so that the separator disc 121 rotates in unison with the indexing disc 120 relative to the inner cover 118 and the weights 108. The sleeves 158, 170 may extend distally from the outer surface of the indexing disc 120 and proximally from the inner surface of the separator disc 121, respectively, to axially separate the separator disc 121 from the indexing disc 120 and form a space between the separator disc 121 and the indexing disc 120 configured to receive one or more of the weights 108. A distal end of the sleeve 170 may include an engagement feature 176 configured to engage the selector disc 122 so that the separator disc 121 rotates in unison with the selection disc 122.

[00137] Referring to FIGS. 5 and 13-16, the selector discs 122 may be mounted onto the shaft 127 distal or outside of the separator discs 121. The selector discs 122 may be positioned along the shaft 127 so as to fit between adjacent weights 108 when the dumbbell 102 rests in the base 104. The selector discs 122 may selective engage weights 108 positioned along both sides of the selector discs 122. By engaging multiple weights 108, the selector discs 122 may shorten the overall length of the dumbbell 102. Although two pairs of selector discs 122 are shown in FIG. 5, the dumbbell 102 may include more or less than two pairs of selector discs 122 depending on the specific implementation of the dumbbell. For example, the dumbbell 102 may include additional pairs of selector discs 122 for implementations where the dumbbell 102 has a heavier weight capability, and vice versa.

[00138] FIG. 13 illustrates an isometric view of the inner or proximal surface of a first selector disc 122a, and FIG. 14 illustrates an isometric view of the outer or distal surface of the first selector disc 122a. The first selector disc 122a may include an axially-extending sleeve 178, which may define a generally centrally located aperture 180 configured to receive a portion of the shaft 127 there through. A proximal end of the sleeve 178 may include an engagement feature 182 configured to engage the engagement feature 176 of the separator disc 121 so that the first selector disc 122a rotates in unison with the separator disc 121 relative to the inner cover 118 and the weights 108. The sleeves 170, 178 may extend distally from the outer surface of the separator disc 121 and proximally from the inner surface of the first selector disc 122a, respectively, to axially separate the first selector disc 122a from the

separator disc 121 and form a space between the first selector disc 122a and the separator disc 121 configured to receive one or more of the weights 108. A distal end of the sleeve 178 may include an engagement feature 184 configured to engage the second selector disc 122b so that the second selector disc 122b rotates in unison with the first selector disc 122a.

[00139] With continued reference to FIGS. 13 and 14, the first selector disc 122a may include first and second weight selection features 186, 190 protruding from the proximal and distal faces, respectively, of the first selector disc 122a. The first weight selection feature 186 may be one or more flanges that may protrude proximally from the inner or proximal surface 188 of the first selector disc 122a. The second weight selection feature 190 may be one or more flanges that may protrude distally from the distal or outer surface 192 of the first selector disc 122a. The flanges for both the first and second weight selection features 186, 190 may each extend along an arcuate or curved path, which may be defined by a single radius originating at a center of first selector disc 122a. The first and second weight selection features 186, 190 may each be disposed proximate to a periphery of the inner and outer surfaces 188, 192, respectively, of the first selector disc 122a.

[00140] The first and second weight selection features 186, 190 may be configured to either engage a weight 108 to fixedly join the weight 108 to the handle assembly 114 or to not engage a weight 108 and allow it to remain in the base 104 depending upon the rotational orientation of the first selector disc 122a. The first weight selection feature 186 may be configured to selectively engage a weight 108 received in a space between the first selector disc 122a and a proximally-adjacent separator disc 121, and the second weight selection feature 190 may be configured to selectively engage a weight 108 received in a space between the first selector disc 122a and a distally-adjacent second selector disc. When utilizing flanges for the first and second weight selection features 186, 190, some of the flanges on the distal side of the first selector disc 122a may angularly overlap the flanges on the proximal side of the first selector disc 122a so that in some rotational orientations the first selector disc 122a may simultaneously engage weights 108 disposed along the opposing faces 188, 192 of the first selector disc 122a. Further, at least some portions of the flanges on the distal side of the first selector disc 122a may not angularly overlap the flanges on the proximal side of the first selector disc 122a, or vice versa, so that in some rotational orientations the first selector disc 122a engages only one of the weights 108 disposed along the opposing faces 188, 192 of the disc 122a. Yet further, the flanges may be positioned on respective sides of the first selector disk 122a such that no weights on either side of the first selector disc 122a are engaged for some rotational orientations of the first selector disc 122a.

[00141] FIG. 15 illustrates an isometric view of the inner or proximal surface of a second selector disc 122b, and FIG. 16 illustrates an isometric view of the outer or distal surface of the second selector disc 122b. The second selector disc 122b may include an axially-extending sleeve 194, which may define a generally centrally located aperture 196 configured to receive a portion of the shaft 127. A proximal end of the sleeve 194 may include an engagement feature 198 configured to engage the engagement feature 184 of the first selector disc 122a so that the second selector disc 122b rotates in unison with the first selector disc 122a relative to the inner cover 118 and the weights 108. The sleeves 178, 194 may extend distally from the outer surface 192 of the first selector disc 122a and proximally from the inner surface 200 of the second selector disc 122b, respectively, to axially separate the second selector disc 122b from the first selector disc 122a and form a space between the second selector disc 122b and the first selector disc 122a configured to receive one or more of the weights 108. A distal end of the sleeve 194 may include an abutment feature 202 configured to abut against the retaining feature 136 of the handle assembly 114 (see FIGS. 5 and 6).

[00142] Referring to FIG. 15, the second selector disc 122b may include a weight abutment feature 204 protruding axially from the proximal face 200 of the disc 122b. The weight abutment feature 204 may be an annular rim that protrudes proximally from the inner or proximal surface 200 of the disc 122b, that is spaced radially outward of the sleeve 194, and that extends continuously around a periphery of the proximal face 200 of the disc 122b. The weight abutment feature 204 may abut against a distal surface of a weight 108 positioned between the first and second selector discs 122a, 122b to prevent or substantially prevent lateral movement of the weight. In some implementations, a separator disc may be positioned between the first and second selector discs 122a, 122b, in which case the weight abutment feature 204 may be replaced with a weight selection feature that may similar to the weight selection features 186, 190 for the first selector disc 122a and that may be used to selectively engage a weight positioned between the separator disc and the second selector disc 122b.

[00143] Referring to FIG. 16, the second selector disc 122b may include a weight selection feature 208 positioned on the distal face 206 of the second selector disc 122b to selectively engage a weight 108 received in a space between the second selector disc 122b and the distally-adjacent end cap 124 depending upon the rotational orientation of the disc 122b. The weight selection feature 208 may be similar to the weight selection features 186, 190 of the first selector disc 122a.

[00144] Referring to FIGS. 5, 6, and 9-16, rotation of the rotatable member 132 may cause rotation of the indexing discs 120, the separator discs 121, and the selector discs 122 relative to the weights 108, which may be located between adjacent indexing discs 120, separator discs 121, and selector discs 122. The weights 108 may be selectively engaged by the respective weight selection features 157, 186, 190, 208 of the indexing discs 120 and the selector discs 122 depending upon the angular orientation of the discs 120, 122 relative to the weights 108. The engagement features of the sleeves 158, 170, 178, 194 of the indexing discs 120, the separator discs 121, and the selector discs 122 may be keyed such that the discs 120, 121, 122 may be assembled in only one particular order along the shaft 127 and in only one particular rotational orientation with respect to one another. In some implementations, the engagement features 162, 164, 174, 176, 182, 184, 198 of the discs 120, 121, 122 include corresponding tabs and receiving indentations that are keyed so that adjacent discs 120, 121, 122 may be interconnected in only one rotational orientation. For example, some of the tabs and indentations may be wider than the other tabs and indentations so that the discs 120, 121, 122 may be connected only in a particular orientation. This orientation feature may facilitate assembly of the dumbbell 102 while ensuring the markings 166 of the indexing disc 120 match the weight selection of the dumbbell 102.

[00145] Referring back to FIGS. 3-5, the end caps 124 may be mounted onto the shaft 127 distal or outside of the selector discs 122. The end caps 124 may be fixedly secured to the bridges 126, which may be fixedly secured to the inner covers 118. As such, the end caps 124 may remain stationary during rotation of the indexing discs 120, the separator discs 121, and the selector discs 122 during selection of the dumbbell weight. In other words, the indexing discs 120, the separator discs 121, and the selector discs 122 may rotate relative to the end caps 124.

[00146] FIG. 17 illustrates an isometric view of the inner or proximal surface 210 of the end cap 124, and FIG. 18 illustrates an isometric view of the outer or distal surface 212 of the end cap 124. The end cap 124 may define a generally centrally located aperture 214 configured to receive the end portion 130 of the shaft 127. The aperture 214 may be at least partially defined by an inwardly-extending wall 216 that defines an axially-extending, non-circular surface 218. The non-circular surface 218 may define at least a portion of the aperture 214, and thus at least a portion of the aperture 14 may be non-circular. The non-circular portion of the aperture 214 may receive therethrough a correspondingly-shaped portion of the shaft 127 that is located proximate an end of the shaft 127 and that may further be disposed distally of the retaining features 136 (see FIG. 6) to prevent or substantially

prevent rotation of the end cap 124 relative to the shaft 127. A fastener (see FIG. 5) may be partially inserted through the aperture 214 and secured with the end portion 130 of the shaft 127 by threads, adhesives, press fit, sonic welds, any other known way to join fasteners to other parts, or any combination thereof to prevent or substantially prevent axial displacement of the end cap 124 relative to the shaft 127 and the discs 120, 121, 122.

[00147] Referring to FIG. 17, a bracket 222 may be attached to and extend proximally from the proximal surface 210 of the end cap 124. The bracket 222 may be configured to attach the end cap 124 to the bridge 126. The bracket 222 may define one or more through-holes for receiving fasteners that attach the bracket 222, and thus the end cap 124, to the bridge 126. The bracket 222 may be located above the generally centrally-located aperture 214.

[00148] Referring to FIG. 18, a weight attachment feature 224 may extend axially from the distal surface 212 of the end cap 124. The weight attachment feature 224 may include an end face 226, which may be offset distally from the distal surface 212 of the end cap 124 by opposing lateral side walls 228. The end face 226 may be planar and may be oriented parallel to the distal surface 212 of the end cap 124. The side walls 228 may taper toward one another as the side walls 228 extend downwardly from a top wall 230 of the weight attachment feature 224 to a bottom wall 232 of the weight attachment feature 224. Additionally, the side walls 228 may taper toward one another as the side walls 228 extend proximally from the end face 226 of the weight attachment feature 224 to the distal surface 212 of the end cap 124. The aperture 214 may extend through a central region of the weight attachment feature 224.

[00149] Referring to FIGS. 3-5, the bridge 126 attaches the end cap 124 to the inner cover 118. An outer end of the bridge 126 is attached to the end cap 124, and an inner end of the bridge 126 is attached to the inner cover 118. A middle portion of the bridge 126 spans the axial distance between the end cap 124 and the inner cover 118. The bridge 126 may include downwardly extending wings 234, which may be positioned above the separator discs 121 and the selector discs 122 so as to not interfere with the rotation of the discs 120, 121, 122. The wings 234 may be generally axially aligned with the separator discs 121 and the selector discs 122. Opposing internal side walls of weights 108 and opposing faces of the weights 108 may be positioned between adjacent wings with the opposing internal walls abutting against the bridge 126 and the opposing faces abutting against the wings 234. Abutment of the internal side walls of the weights 108 against the bridge 126 prevents the weights from rotating about the shaft 127 during use of the dumbbell 102, and abutment of

the opposing faces of the weights 108 against the wings 234 prevents the weights 108 from sliding along or rocking about the shaft 127 during use of the dumbbell 102.

[00150] Example weights 108 of the adjustable dumbbell system 100 are illustrated in FIGS. 20-27. FIGS. 20 and 21 are proximal and distal isometric views, respectively, of a first weight 108a. FIGS. 22 and 23 are proximal and distal isometric views, respectively, of a second weight 108b. FIGS. 24 and 25 are proximal and distal isometric views, respectively, of a third weight 108c. FIGS. 26 and 27 are proximal and distal isometric views, respectively, of a fourth weight 108d. The dumbbell system 100 may include more or less weights depending on the desired weight capability of the dumbbell system.

[00151] Referring to FIGS. 20-27, the weights 108a-108d may have a generally rectangular shape. Each weight 108a-108d may form a channel or slot 236 for receiving the sleeve of one of the indexing discs 120, the separator discs 121, or the selector discs 122. The channel 236 may extend through the periphery of the respective weight 108a-108d and may terminate in a semi-circular arc disposed about a longitudinal centerline of the respective weight. The channel 236 may have a constant width equal to the diameter of the semi-circular arc. The channel 236 may be sized to allow the sleeves of the discs 120, 121, 122 to rotate within the channel 236 and to only move the weight incidentally through friction. The bridge 126 may extend longitudinally through the channels 236 of the weights 108 to prevent the weights from rotating relative to the inner covers 118 and the end caps 124 during weight selection and exercise-type use. Additionally or alternatively, the wings 234 of the bridge 126 may seated within and abut against opposing internal side walls 237 of the weights 108-108d to prevent the weights from rotating relative to the inner covers 118 and the end caps 124 during weight selection and exercise-type use.

[00152] With continued reference to FIGS. 20-27, each weight 108a-108d may include an engagement feature 238, such as a tab, configured to engage a respective weight selection feature 157, 186, 190, 208 of one of the indexing or selector discs 120, 122. When the dumbbell 102 is placed in the base 104, the first weight 108a (see FIGS. 20 and 21) may be positioned between the indexing disc 120 and the separator disc 121 (see FIG. 5). The weight selection feature 157 of the indexing disc 120 (see FIG. 10) may be spaced radially outwardly of the engagement feature 238 of the weight 108a (see FIG. 20). In rotational orientations of the indexing disc 120 where the weight selection feature 157 is positioned beneath the engagement feature 238 of the weight 108a, the weight 108a may be fixedly joined or otherwise secured to the dumbbell handle assembly 114. In this secured position, the weight selector feature 157 of the indexing disc 120 combined with the sleeve 158 of the indexing

disc 120, the sleeve 170 of the immediately distal separator disc 121, or both may restrict vertical motion of the first weight 108a relative to the indexing disc 120. The bridge 126 may restrict lateral and rotational motion of the weight 108a relative to the indexing disc 120. The opposing distal and proximal surfaces of the indexing disc 120 and the separator disc 121, respectively, and/or a wing 234 of the bridge 126 may restrict axial motion of the weight 108a relative to the indexing disc 120. As such, when the weight selector feature 157 of the indexing disc 120 is positioned beneath the engagement feature 238, the first weight 108a may be axially, laterally, vertically, and rotationally secured to the dumbbell 102. In rotational orientations of the indexing disc 120 where the weight selector feature 157 is not positioned beneath the engagement feature 238 of the first weight 108a, the weight 108a may remain in the base 104 supported by the positioning walls 110 of the base 104 as the dumbbell 102 is removed from the base 104.

[00153] When the dumbbell 102 is placed in the base 104, the second weight 108b (see FIGS. 22 and 23) may be positioned between the separator disc 121 and the first selector disc 122a (see FIG. 5). The first weight selection feature 186 of the first selector disc 122a (see FIG. 13) may be spaced radially outwardly of and overlap the engagement feature 238 of the second weight 108b (see FIG. 23). In rotational orientations of the first selector disc 122a where the first weight selection feature 186 is positioned beneath the engagement feature 238 of the weight 108b, the weight 108b may be retained on the dumbbell 102. In this retained position, the first weight selection feature 186 of the first selector disc 122a combined with the sleeve 178 of the first selector disc 122a, the sleeve 170 of the immediately proximal separator disc 121, or both may restrict vertical motion of the second weight 108b relative to the indexing disc 120. The bridge 126 may restrict lateral and rotational motion of the weight 108b relative to the first selector disc 122a. The opposing proximal and distal surfaces of the first selector disc 122a and the separator disc 121, respectively, and/or a wing 234 of the bridge 126 may restrict axial, lateral, and rotational motion of the weight 108b relative to the first selector disc 122a. As such, when the first weight selection feature 186 of the first selector disc 122a is positioned beneath the engagement feature 238, the second weight 108b may be axially, laterally, vertically, and rotationally secured to the dumbbell 102. In rotational orientations of the first selector disc 122a where the first weight selection feature 186 is not positioned beneath the engagement feature 238 of the second weight 108b, the weight 108b may remain in the base 104 supported by the positioning walls 110 of the base 104 as the dumbbell 102 is removed from the base 104.

[00154] When the dumbbell 102 is placed in the base 104, the third weight 108c (see FIGS. 24 and 25) may be positioned between the first and second selector discs 122a, 122b (see FIG. 5). The second weight selection feature 190 of the first selector disc 122a (see FIG. 14) may be spaced radially outwardly of and overlap the engagement feature 238 of the third weight 108c (see FIG. 24). In rotational orientations of the first selector disc 122a where the second weight selection feature 190 is positioned beneath the engagement feature 238 of the third weight 108c, the weight 108c may be retained on the dumbbell 102. In this retained position, the second weight selection feature 190 of the first selector disc 122a combined with the sleeve 178 of the first selector disc 122a, the sleeve 194 of the second selector disc 122b, or both may restrict vertical motion of the third weight 108c relative to the first selector disc 122a. The bridge 126 may restrict rotational and lateral motion of the weight 108c relative to the first selector disc 122a. The opposing distal surface 192 and annular rim 204 of the first and second selector discs 122a, 122b, respectively, and/or a wing 234 of the bridge 126 may restrict axial motion of the weight 108c relative to the first selector disc 122a. As such, when the second weight selection feature 190 of the first selector disc 122a is positioned beneath the engagement feature 238, the third weight 108c may be axially, vertically, laterally, and rotationally secured to the dumbbell 102. In rotational orientations of the first selector disc 122a where the second weight selection feature 190 is not positioned beneath the engagement feature 238 of the third weight 108c, the weight 108c may remain in the base 104 supported by the positioning walls 110 of the base 104 as the dumbbell 102 is removed from the base 104.

[00155] When the dumbbell 102 is placed in the base 104, the fourth weight 108d (see FIGS. 26 and 27) may be positioned between the second selector disc 122b and the end cap 124. The weight selection feature 208 of the second selector disc 122b (see FIG. 16) may be spaced radially outwardly of and overlap the engagement feature 238 of the fourth weight 108d (see FIG. 27). In rotational orientations of the second selector disc 122b where weight selection feature 208 is positioned beneath the engagement feature 238 of the fourth weight 108d, the weight 108d may be retained on the dumbbell 102. In this retained position, the weight selection feature 208 of the second selector disc 122b combined with the sleeve 194 of the second selector disc 122b may restrict vertical motion of the fourth weight 108d relative to the second selector disc 122b. The bridge 126 may restrict lateral and rotational motion of the weight 108d relative to the second selector disc 122b. The opposing distal and proximal surfaces of the second selector disc 122b and the end cap 124, respectively, and/or a wing 234 of the bridge 126 may restrict axial motion of the weight 108d relative to the

second selector disc 122b. As such, when the weight selection feature 208 of the second selector disc 122b is positioned beneath the engagement feature 238, the fourth weight 108d may be axially and rotationally secured to the dumbbell 102. In rotational orientations of the second selector disc 122b where one of the distal flanges 208 is not positioned beneath the engagement feature 238 of the fourth weight 108d, the weight 108d may remain in the base 104 supported by the positioning walls 110 of the base as the dumbbell 102 is removed from the base 104. Various orientations of the rotatable sleeve 132, and thus of the indexing discs 120 and the selector discs 122, may cause none or one or more of the weight selection features 157, 186, 190, 208 of the discs 120, 122 to engage the engagement features 238 of the weights 108a-108d to allow the user to select a desired amount of dumbbell weight.

[00156] For dumbbells in which the weight selection features 157, 186, 190, 208 are flanges or the like, the number of incremental weight selections available on the dumbbell 102 may be altered by varying the arc length of the flanges and/or by varying the radial location of the flanges. For example, if the arc length of the flanges is decreased, the number of peripheral flanges that may be placed around a constant radius is increased, thus increasing the number of incremental weight selections that may be made. By increasing the radius of the flanges from the center of the discs 120, 122, the number of flanges that may be arranged on the discs 120, 122 is increased, thus increasing the potential number of incremental weight selections that may be made. Although the peripheral flanges are preferably located along the periphery of the selection discs 122 so that the radius available to position the flanges is maximized, the flanges may be located at any radial distance along a face of the discs 122.

[00157] The dumbbell 102 may include weights 108 having different weight amounts to provide numerous dumbbell weight options. In some implementations, the handle assembly 114 weighs about five pounds, the first weight 108a weighs about fifteen pounds, the second weight 108b weighs about two and one-half pounds, the third weight 108c weighs about five pounds, and the fourth weight 108d weighs about five pounds. In these implementations, the weights 108 may provide the dumbbell 102 with a weight range between about five and sixty pounds, with numerous weight increments. The weights 108 may be constructed of a single weight plate or multiple weight plates attached together (e.g., clipped, glued, riveted, welded, or other suitable attachment elements/methods). In implementations where the weights 108 are constructed of multiple weights plates attached together, the weight plates may be coated with an over-mold material. Example over-mold materials may be nylon, Polypropylene, Kraton, or other suitable materials.

[00158] The adjustable dumbbell 102 may include one or more weights that utilize another type of selection mechanism to accommodate heavier dumbbells. For ease of reading comprehension, these weights may be referred to as an "additional weight" or an "add-on weight." The terms "additional" or "add-on" before weight are not intended to be limiting and are merely used within the specification to help distinguish the following described weights from other weights described herein.

[00159] As described in more detail below, the add-on or additional weights may include a selection assembly, which may include selection member. In some implementations, a selector may rotate in a plane of rotation to linearly move the selection member back and forth between a selected position in which the weight is fixedly connected to the handle assembly and an unselected position in which the weight is not fixedly connected to the handle assembly, and the selection member may linearly move along a line of motion not parallel to the plane of rotation. In some implementations, the selection member may be axially movable back and forth between a selected position in which the weight is fixedly connected to the handle assembly and an unselected position in which the weight is not fixedly connected to the handle assembly.

[00160] Figs. 1 and 2 among other figures show a first embodiment of an add-on weight 240. When not coupled to the dumbbell 102, the add-on weighs 240 may be seated onto the base 104 using a mechanical coupling technique, such as a dovetail joint. Turning to FIGS. 2 and 28, a proximal surface 242 of the add-on weight 240 may define a trapezoidal recess 244 configured to receive a complementary trapezoidal projection 246 of the base 104. Referring to FIG. 28, opposing side walls 248 defining the trapezoidal recess 244 may diverge away from one another as the side walls 248 extend downwardly toward a bottom wall 247 of the add-on weight 240. The side walls 248 may converge toward one another as the side walls 248 extend proximally toward the proximal face 242 of the add-on weight 240. The trapezoidal recess 244 may be downwardly opening so that the recess 244 receives the trapezoidal projection 246 when the dumbbell 102 is lowered vertically onto the base 104. The trapezoidal projection 246 may be located distally of the positioning walls 110 and may be oriented in an upright position. The trapezoidal projection 246 of the base 104 may include side walls configured to complement the side walls 248 of the add-on weight 240 to prevent axial, lateral, and rotational movement of the add-on weight 240 relative to the base 104 when the add-on weight 240 is seated onto the trapezoidal projection 246 of the base 104.

[00161] With continued reference to FIGS. 1 and 2, the add-on weights 240 may be situated on opposing ends of the dumbbell 102 distally of the end caps 124. Referring to FIGS. 2 and 28, the add-on weights 240 may include a weight attachment feature 250 configured to interconnect with the weight attachment feature 224 of the end cap 124. In some embodiments, the weight attachment feature 250 of the add-on weigh 240 may be an inverted trapezoidal recess configured to receive the weight attachment feature 224 of the end cap 124. The inverted trapezoidal recess may be disposed vertically above the trapezoidal recess 244. Referring to FIG. 28, opposing side walls 252 defining the inverted trapezoidal recess may diverge away from one another as the side walls 252 extend upwardly toward a top wall 253 of the add-on weight 240. Additionally, the side walls 252 may converge toward one another as the side walls 252 extend proximally toward the proximal face 242 of the add-on weight 240. The trapezoidal recess may be upwardly opening so that the recess receives the weight attachment feature 224 of the end cap 124 when the dumbbell 102 is lowered vertically onto the base 104. The side walls 252 of the inverted trapezoidal recess 250 may be complementary to the side walls 228 of the weight attachment feature 224 of the end cap 124 (see FIG. 18) to prevent axial, lateral, and rotational movement of the add-on weight 240 relative to the end cap 124 when the add-on weight 240 is seated onto the weight attachment feature 224 of the end cap 124.

[00162] While the weight attachment feature 224 of the end cap 124 is shown as a generally dovetail shaped projection or pin and the weight attachment feature 250 of the add-on weight 240 is shown as a correspondingly shaped recess or groove, these weight attachment features 224, 250 may be any suitable shape or structure that restricts one or two translation degrees of rigid body motion freedom (e.g., axial and lateral translation) between the handle assembly 114 and the add-on weight 240 when interconnected. Additionally, the weight attachment features 224, 250 of the end cap 124 and the add-on weight 240 may restrict one or more rotation degrees of rigid body motion freedom between the handle assembly 114 and the add-on weight 240. In some embodiments, five of the six degrees of rigid body motion freedom between the add-on weight 240 and the handle assembly 114 are restrained when the add-on weight 240 is joined to the handle assembly 114 via only the weight attachment features 224, 250. In such embodiments, the add-on weight 240 may move relative to the handle assembly 114 along an unrestrained translation degree of rigid body motion freedom so that the add-on weight 240 may be disconnected from the handle assembly 114. In some embodiments, the weight attachment feature 224 of the end cap 124 may take the form of a suitably shaped recess, groove, slot or the like, and the weight

attachment feature 250 of the add-on weight 240 may include a correspondingly shaped projection, pin, tongue, rail or the like.

[00163] Referring to FIGS. 1, 2, and 29, the dumbbell system 100 may include a selection assembly 254 to selectively fixedly connect the add-on weight 240 to the dumbbell 102. The selection assembly 254 may be attached to the add-on weight 240 and may be substantially disposed on a distal side of the add-on weight 240. The selection assembly 254 may be axially aligned with a longitudinal axis of the dumbbell 102 and may be partially received within an aperture 260 of the add-on weight 240 (see FIG. 28). The aperture 260 may be positioned within a central region of the add-on weight 240. To shorten the overall length of the dumbbell 102 when the add-on weights 240 are selected, the selection assembly 254 may be disposed at least partially within a recess 256 defined in a distal face 258 of the add-on weight 240. The recess 256 may define an annular space around the selection assembly 254 to accommodate a user's fingers during engagement or disengagement of the add-on weight 240 to or from the dumbbell 102.

[00164] Referring to FIGS. 30-33, the selection assembly 254 may include one or more of the following: a selector 262, a base 264, a selection member 266, a pair of retaining clips 268, and a biasing member 270, such as a helical spring. With reference to FIGS. 30-33, the selector 262 may include a knob 272, a selector lock assembly, and a cover plate 310. The knob 272 may be formed into the shape of a cup or a cap.

[00165] The knob 272 may include a base plate 274 and an annular side wall 276 attached to a periphery of the base 274. The base plate 274 may define a centrally-located aperture 278, which may receive a portion of the selection member 266. The side wall 276 may extend axially away from the base plate 274 and may define an interior space 277. The knob 272 may be oriented so that the side wall 276 extends proximally from the base plate 274 toward the distal face 258 of the add-on weight 240.

[00166] Referring to FIGS. 31-33, a pair of diametrically-opposed cam followers or posts 280 may be attached to and extend proximally from the base plate 274. The posts 280 may be located radially between the side wall 276 and the aperture 278. Each post 280 may include a proximal free end 282, which may include two angled surfaces 284 that intersect along an apex 286 (see FIGS. 32 and 33). The apex 286 may be substantially axially aligned with a proximal end face 288 of the side wall 276 (see FIG. 33).

[00167] With continued reference to FIGS. 30-33, the selector lock assembly may include a pair of movable members 290, such as depressible buttons or push tabs, and one or more bias members 294. The movable members 290 may be received within apertures 292

formed in the side wall 276 of the knob 272 and may diametrically oppose each other. When received in the apertures 292, the movable members 290 may be disposed angularly between the posts 280. Referring to FIG. 33, a portion of the movable members 290 may be located exterior of the side wall 276 for manipulation by a user.

[00168] Referring still to FIG. 33, the movable members 290 may be biased radially outwardly by the one or more bias members 294, such as springs. The bias members 294 may be oriented perpendicularly to a longitudinal axis of the cap assembly 262 and may be disposed between the movable members 290 and a hollow stub shaft 296 of the knob 272, which may extend axially away from the base plate 274 in a distal direction. A radially-inward end 294a of the bias members 294 may be seated against the stub shaft 296, and a radially-outward end 294b of the bias members 294 may be seated against the respective movable members 290. A portion of the bias members 294 may be received within an inner cavity 298 of the movable members 290, which may open to the stub shaft 296.

[00169] Referring to FIGS. 32 and 33, a latch feature 300 may be attached to and extend in a distal direction from the movable members 290. The latch feature 300 may be disposed radially between the stub shaft 296 and the side wall 276 and may move in unison with the movable members 290. The latch feature 300 may be configured to selectively engage the base 264 based on the axial position of the knob 272 relative to the base 264. When engaged with the base 264, the latch feature 300 may prevent axial and/or rotational movement of the cap 272 relative to the base 264 until the latch feature 300 is released by actuation of the movable members 290.

[00170] With continued reference to FIGS. 32 and 33, the latch feature 300 may include a hook 302 attached to each movable member 290. The hooks 302 may move in unison with the movable members 290. The hooks 302 may be formed generally in the shape of a 'J'. Each hook 302 may include a free end defining a barb 304 directed radially outwardly. The barb 304 may include a distal surface 306 oriented orthogonally or substantially orthogonally to the side wall 276 and a proximal surface 308 oriented obliquely to the side wall 276.

[00171] With continued reference to FIGS. 32 and 33, the cover plate 310 may be removably attached to the knob 272. The cover plate 310 may be disposed radially inward of the side wall 276 and may be oriented orthogonally or substantially orthogonally to the side wall 276. The cover plate 310 may be attached to a proximal end of the stub shaft 296 and may define a centrally-located aperture 312 aligned axially with the aperture 278 of the knob 272 and configured to receive a portion of the selection member 266. The cover plate 310

may be oriented parallel or substantially parallel to, and axially offset from, the base plate 274 to define, along with guides 314 that extend in a chord-like manner between points on the side wall 276 (see FIG. 32), respective sliding channels 316 for the movable members 290 (see FIG. 33). In this configuration, the movable members 290 may be constrained in a lateral direction between the guides 314 and may be restrained in an axial direction between the base plate 274 and the cover plate 310. The sliding channels 316 may be oversized in a radial direction to permit movement of the movable members 290 in the radial direction toward and away from the stub shaft 296.

[00172] Referring to FIGS. 30, 31, and 34-36, the base 264 of the weight selection assembly 254 may be at least partially received within the interior space 277 of the knob 272. The base 264 may include a base wall 317 and a side wall 318 extending axially from a periphery of the base wall 317. The base wall 317 may define a centrally-located aperture 319, which may receive a portion of the selection member 266. The side wall 318 may include an outer surface 320, which may be cylindrical or substantially cylindrical. The side wall 276 of the knob 272 may slidably bear against the outer surface 320 of the base 264 during movement of the knob 272 relative to the base 264. When the selection assembly 254 is assembled, the base 264 may be oriented so that the side wall 318 extends distally from the base wall 317 toward the base plate 274 of the knob 272.

[00173] Referring to FIGS. 34-36, the base 264 may define a pair of diametrically-opposed cam surfaces or ramps 322 configured to interface with the posts 280 of the knob 272. The ramps 322 may be disposed radially between the side wall 318 and the aperture 319. A first parking position 324 may be disposed at a distal end of the ramps 322 and may be configured to receive the proximal free end 282 of a respective post 280 when the selection assembly 254 is in a disengaged position. A second parking position 326 may be disposed at a proximal end of the ramps 322 and may be configured to receive the proximal free end 282 of a respective post 280 when the selection assembly 254 is in an engaged position. Distal portions of the ramps 322 may form dwell surfaces 328, which may define rounded transitions from the first parking positions 324 to steepened portions of the ramps 322.

[00174] With continued reference to FIGS. 34-36, the base 264 may define a catch feature 330 that interfaces with the latch feature 300 of the movable members 290 when the weight selection 254 is in an engaged position. The catch feature 330 may be defined in the side wall 318 of the base 264 and may be disposed angularly between the diametrically-opposed ramps 322. Once engaged, the corresponding latch and catch features 300, 330 may prevent axial movement of the knob 272 relative to the base 264, thereby ensuring the

selection assembly 254 remains in an engaged or selected position. To permit movement of the knob 272 relative to the base 264, the movable member 290 may be depressed by a user to disengage the corresponding latch and catch features 300, 330.

[00175] With continued reference to FIGS. 34-36, the catch feature 330 of the base 264 may include a pair of diametrically-opposed apertures 332 extending through the side wall 318 of the base 264. The apertures 332 may be located axially between a distal end face 334 of the side wall 318 and the base wall 317. The apertures 332 may be located proximally of a portion of the distal end face 334 that includes a rounded or chamfered inner edge 336. The apertures 332 may be sized to receive the barbs 304 of the hooks 302 when aligned with one another.

[00176] Referring to FIGS. 31, 35, and 36-40, the base 264 may be fixedly secured to the add-on weight 240. The base 264 may include an axially-extending sleeve 338 attached to and projecting proximally from the base wall 317. The sleeve 338 may be received within the centrally-located aperture 260 of the add-on weight 240. The sleeve 338 may be interference fit within the aperture 260 such that the base 264 is fixedly joined to the add-on weight 240 (see FIGS. 37-40). Other mechanical coupling techniques may be used to secure the base 264 to the add-on weight 240 in lieu of or in addition to interference fitting the base 264 to the add-on weight 240, including, but not limited to, using fasteners, adhesives, welds, or some combination thereof. The aperture 319 of the base wall 317 may extend axially through the sleeve 338 and may be configured to receive the biasing member 270 and a proximal portion of the selection member 266.

[00177] Referring to FIGS. 30 and 31, the selection member 266 may include an elongate shaft 340 and a head 342 attached to a proximal end of the shaft 340. The shaft 340 may be attached to the selection assembly 262 so that the selection member 266 moves in unison with the selection assembly 262 along a longitudinal axis of the shaft 340. The shaft 340 may define first and second annular grooves 344, 346 in an outer surface of the shaft 340. The grooves 344, 346 may be spaced axially apart from one another along the length of the shaft 340 and may be configured to receive the retaining clips 268. Referring to FIGS. 37-40, one of the retaining clips 268 may be disposed distally of the base plate 274 of the cap 272 and may be snap fit into the first annular groove 344. The other of the retaining clips 268 may be disposed proximally of the cover plate 310 of the selection assembly 262 and may be snap fit into the second annular groove 346. The retaining clips 268 may abut against the base plate 274 and the cover plate 310 of the selection assembly 262, thereby securing the selection member 266 to the selection assembly 262 so that the selection member 266 moves

in unison with the selection assembly 262 in an axial direction relative to the dumbbell 102. Other mechanical coupling techniques may be used to secure the selection member 266 to the selection assembly 262 in lieu of or in addition to utilizing retaining clips 268, including, but not limited to, using fasteners, adhesives, welds, or some combination thereof.

[00178] Referring back to FIGS. 30 and 31, the head 342 of the selection member 266 may have a larger outer diameter than the shaft 340, thereby defining a shoulder 348 (see FIG. 30) extending transversely between the outer surfaces of the shaft 340 and the head 342. The head 342 may define a recess or socket 350 opening through a proximal end face of the head 342. The socket 350 may be configured to receive a suitably shaped add-on weight engagement feature 220 secured to the handle assembly 114 when the selection assembly 254 is in an engaged or selected position (see FIGS. 39 and 40). In some embodiments, the add-on weight engagement feature 220 may be a head 220a of the fastener. The head 220a may be snugly received within the socket 350 to prevent or substantially prevent relative vertical and/or lateral movement between the selection member 266 and the add-on weight engagement feature 220. However, the add-on weight engagement feature 220 may be any suitably shaped projection, protrusion, or the like that is joined to the handle assembly 114 and that is configured to prevent relative vertical and/or lateral movement between the selection member 266 and the add-on weight engagement feature 220. Additionally, the socket 350 could be omitted from the head 342, and the add-on weight engagement feature 220 could be formed into a socket or the like that is configured to receive the head 342 therein to restrict vertical and/or lateral movement between the selection member 266 and the add-on weight engagement feature 220.

[00179] With continued reference to FIGS. 30, 31, and 37-40, the biasing member 270 may bias the selection member 266 toward an engaged or selected position in which the head 342 of the selection member 266 is positioned around the add-on weight engagement feature 220 (see FIGS. 39 and 40). In some embodiments, such as when the biasing member 270 is a coil spring, the biasing member 270 may be disposed about the shaft 340 of the selection member 266 and may be received within the aperture 319 defined by the base 264. The biasing member 270 may be disposed axially between the base wall 317 of the base 264 and the shoulder 348 of the selection member 266. The biasing member 270 may act against a proximal surface of the base 264 and against the shoulder 348 of the selection member 266. The biasing member 270 may exert an axial force on the head 342 of the selection member 266 in a proximal direction, thereby biasing the selection member 266 toward the engaged or selected position (see FIGS. 39 and 40).

[00180] Referring to FIGS. 37 and 38, the selection assembly 254 is depicted in a disengaged or unselected position. In the disengaged or unselected position, the selection member 266 may be disposed in a distal position that locates the selection member 266 distally of the separation plane 352 defined between the proximal surface 242 of the add-on weight 240 and the distal end face 226 of the end cap 124, thereby allowing the handle assembly 114 (see FIG. 5) to be removed from the base 104 without the add-on weight 240. In the disengaged or unselected position, the head 342 of the selection member 266 may be housed within the sleeve 338 and the shoulder 348 may abut against a corresponding internal wall of the sleeve 338 to allow the handle assembly 114 to be removed from the base 104 without the selection member 266 interfering with handle assembly 114. In the unselected or disengaged position, the posts 280 of the knob 272 may be seated in the first parking position 324 of the base 264 to maintain the selection assembly 254 in the disengaged or unselected position. The side wall 276 of the knob 272 may overlap the side wall 318 of the base 264 to ensure proper axial alignment of the knob 272 and the base 264. The proximal end face 288 of the side wall 276 may be spaced axially apart from the distal face 258 of the add-on weight 240 to allow axial movement of the knob 272 toward the add-on weight 240 once the posts 280 are unseated from their first parking positions 324. The biasing member 270 may be axially compressed between the shoulder 348 of the selection member 266 and the base plate 317 of the base 264.

[00181] Referring to FIGS. 39 and 40, the selection assembly 254 is depicted in an engaged or selected position. In the engaged or selected position, the selector 262 may be disposed in a proximal position such that the selection member 266 spans across the separation plane 352, thereby preventing relative vertical movement between the add-on weights 240 and the handle assembly 114 (see FIGS. 5, 39, and 40). As previously discussed, when the handle assembly 114 and the add-on weight 240 are placed onto the base 104, the side walls 252 of the inverted trapezoidal recess 250 of the add-on weight 240 may engage the side walls 228 of the weight attachment feature 224 of the end cap 124 to prevent axial, lateral, and rotational movement of the add-on weight 240 relative to the end cap 124. Thus, upon extension of the selection member 266 across the vertical separation plane 352, the weight engagement assembly 254 prevents or substantially prevents vertical movement of the end cap 124 relative to the add-on weight 240, and vice versa, resulting in the add-on weight 240 being fixedly secured to the handle assembly 114.

[00182] Referring to FIG. 39, when the selection assembly 254 is in the engaged or selected position, the posts 280 of the knob 272 may be disposed in the second parking

position 326 of the base 264 and may be biased into this position by the biasing member 270. Referring to FIG. 40, the hooks 302 of the movable members 290 may be received within the apertures 332 of the base 264 to secure the selection assembly 254 in the engaged or selected position. The distal surfaces 306 of the hooks 302 (see FIG. 33) may engage a portion of the side wall 318 surrounding the apertures 332 to secure the selector 262 to the base 264.

[00183] To select the add-on weight 240, the user may place the dumbbell 102 in the base 104, move the selector 262 into the engaged or selected position, and remove the dumbbell 102 from the base 104 to perform a desired exercise. To move the selector 262 between the engaged or selected position and the disengaged or unselected position, or vice versa, the user may rotate or twist the selector 262 via the knob 272 about an axis of rotation with the rotation occurring in a plane of rotation that is perpendicular to the axis of rotation. The axis of rotation may be parallel and/or coincident to a central longitudinal axis of the shaft 127 of the dumbbell 102.

[00184] Rotation of the selector 262 in a first rotational direction unseats the posts 280 of the knob 272 from the first parking positions 324 of the base 264. Once the posts 280 are unseated, the selector 262 linearly moves the selection member 266 towards the end caps 124. Thus, rotational motion of the selector 262 is converted into linear motion of the selection member 266. The linear movement of the selection member 266 may occur along a line of motion that is (1) parallel, substantially parallel, or coincident to the axis of rotation, (2) perpendicular, substantially perpendicular, oblique, or otherwise not parallel to the plane of rotation, and/or (3) parallel, substantially parallel, or coincident to a longitudinal axis of the shaft 127 of the dumbbell 102. In some embodiments, the movement of the selection member 266 between the engaged or selected position and the disengaged or unselected position, and vice versa, may be considered, or referred to, as an "axial movement" (or as "axial motion," "axially movable," "axially move," or "axially moved") with this being understood as linear movement or motion of the selection member 266 that occurs along a line that is parallel, or substantially parallel, to a longitudinal axis of the shaft 127.

[00185] As the selection member 266 is driven toward the end caps 124 by rotation of the selector 262, the selector 262 also moves towards the end caps 124 in a direction similar to the direction of the selection member 266. During this motion of the selector 262, the posts 280 may initially ride along the dwell surfaces 328 and subsequently may ride along the steepened slope portion of the ramp 322 at a faster rate of speed relative to the dwell surfaces 328. As such, the selector 262 may initially move at a first, slower rate of speed, followed by a second, faster rate of speed. The selector 262 may move proximally and rotationally

relative to the base 264 and the add-on weight 240 during movement of the selector 262 from the disengaged or unselected position of FIGS. 37 and 38 to the engaged or selected position of FIGS. 39 and 40. At a proximal end of the ramps 322, the posts 280 may be seated in the second parking position 326 of the base 264 under the bias of the biasing member 270, in which position the hooks 302 may be received within the apertures 332 of the side wall 318 to secure the selector 262 in the engaged or selected position.

[00186] The slower rate of speed provided by the dwell surfaces 328 may result in lower impact forces between the hooks 302 of the selector 262 and the side wall 318 of the base 264 during movement of the selector 262 from the disengaged or unselected position of FIGS. 37 and 38 to the engaged or selected position of FIGS. 39 and 40. As previously discussed, the hooks 302 may be biased radially outwardly by the bias members 294 (see FIGS. 33 and 40). The hooks 302 may be nominally positioned relative to the side walls 318 such that at least a portion of the barbs 304 are positioned in interfering relationship with the side walls 318 to ensure the hooks 302 engage the apertures 332 of the side walls 318 when the selector 262 is in the engaged or selected position. As such, during movement of the selection assembly 262 from the disengaged or unselected position to the engaged or selected position, the hooks 302 may contact the side walls 318, which may drive the hooks 302 and thus the movable members 290 radially inwardly, thereby compressing the bias members 294 and permitting the hooks 302 to slidably pass along an inner surface of the side walls 318. The hooks 302 may initially contact the distal end face 334 of the side wall 318 when the posts 280 are moving along the dwell surfaces 328, thereby resulting in lower impact forces due to the slower speed. To further reduce the impact forces, the obliquely-angled proximal surfaces 308 of the hooks 302 may contact the rounded edge 336 of the distal end face 334 of the side wall 318 of the base 264, thereby facilitating inwardly movement of the hooks 302 relative to the side wall 318 with lower impact forces.

[00187] Should the user desire a dumbbell weight without the add-on weight 240, the user may place the dumbbell 102 back in the base 104, move the selector 262 into the disengaged or unselected position, and remove the dumbbell 102 from the base 104 with the desired weight, without the add-on weight 240. To move the selector 262 into the disengaged or unselected position, the user may actuate the movable members 290 by pushing radially inwardly on the movable members 290, thereby moving the hooks 302 radially inwardly and disengaging the hooks 302 from the side wall 318 of the base 264. Once the hooks 302 are disengaged from the side wall 318, the user may move the selector 262 distally away from the add-on weight 240 by rotating or twisting the selector 262 via the knob 272 relative to the

base 264 about the axis of rotation in a second rotation direction that is opposite the first direction to seat the posts 280 of the knob 272 in the first parking position 324 of the base 264. As the selector member 266 moves away from the end plates 124, the selection member 266 linearly moves away from the end caps 124 along a line of motion that is (1) parallel, substantially parallel, or coincident to the axis of rotation, (2) perpendicular, substantially perpendicular, oblique, or otherwise not parallel to the plane of rotation, and/or (3) parallel, substantially parallel, or coincident to a central longitudinal axis of the shaft 127 of the dumbbell 102.

[00188] The arrangement of the selection assembly 254 may be altered so that the biasing member 270 biases the selection member 266 into a disengaged or unselected position (see FIGS. 37 and 38) and the user pushes the selector 262 against the force of the biasing member 270 to move the selection member 266 into the engaged or selected position (see FIGS. 39 and 40). In this alternative implementation, the biasing member 270 may be positioned axially between the cover plate 310 of the selector 262 and the base wall 317 of the base 264. Further, the selection assembly 254 may be modified so that the selector 262 may be rotated continuously in the same rotational direction to move the selector member 266 between the engaged or selected position and the disengaged or unselected position, or vice versa.

[00189] FIGS. 41 and 42 are longitudinal cross-sectional views of one end of the adjustable dumbbell system 100 showing the weights 108, among other components, in cross-section. The weights 108 may be constructed of one or more weight plates 354 attached together (e.g., clipped, glued, riveted with rivets 356, welded, or other suitable attachment elements/methods). In implementations where the weights 108 are constructed of multiple weights plates 354 attached together, the weight plates 354 may be coated with an over-mold material 358 (see FIG. 41). Example over-mold materials may be nylon, Polypropylene, Kraton, or other suitable materials. In FIGS. 41 and 42, the selection assembly 254 is disposed in a disengaged or unselected position in which the selection member 266 is positioned entirely distally of the separation plane 352 to permit vertical movement of the handle assembly 114 relative to the add-on weight 240.

On-Board Computing Device

[00190] Referring to FIG. 43, an adjustable dumbbell 102 may include an on-board computing device 502. The on-boarding computing device 502 may be generally configured to record information and to provide output to a user of the dumbbell system 100. In one

respect, the computing device 502 outputs visual information to the user through a display device 504. In some cases, the display device 504 may be a touch screen that additionally provides a mechanism for the user to input information. With reference to FIG. 43, the computing device 502 may be positioned such that the display device 504 faces upward when the adjustable dumbbell 102 sits in the support base 104. Thus, when the adjustable dumbbell 102 sits in the support base 104, the display device 502 will be in the direct line of sight of a user looking down on the adjustable dumbbell 102 from above.

[00191] Referring to FIGS. 43, 44, 48, 51 and 55, the computing device 502 may be mounted in a bridge 126. While it is possible to mount a computing device 502 in each of the bridges 126 of the dumbbell, or elsewhere on the handle assembly, the dumbbell 102 will typically have one computing device 502 mounted on one bridge 126. The computing device 502 may be positioned within a cavity of the bridge 126 so to protect the computing device 502 from damage. The top surface 540 of the bridge 126, or a portion thereof, may be transparent so that the display device 504 is visible. Alternatively, the display device 504 may form at least a portion of the top side of the bridge 126, or may extend above the top surface of the bridge 126. In the top plan view of FIG. 43, the entire upward facing surface of the computing device 502 is visible through the top surface of the bridge 126. The bridge 126, however, may not necessarily provide this same visibility. In some cases, the top surface 540 may have a transparent region 544 adjacent to the display device 504 and an opaque region 542 adjacent to the remainder of the computing device 502. In this way, the display device 504 is visible, while other components of the computing device 502 are hidden from view.

[00192] In some cases, the dumbbell 102 features a display device 504 that is removable from the remainder of the computing device 502. The computing device 502 may include a circuit board 501 having a dock in which the display device 504 sits when the display device 504 is physically connected to the remainder of the computing device 502. The dock may include a locking mechanism that holds the removable display device 504 in place while the dumbbell is in use. The depth of the dock may correspond to a thickness of the display device 502 so that the upward facing surface of the display device 504 is flush with the top surface 540 of the bridge 126 when the display device 502 is seated in the dock. In this way, the upward facing surface of the display device 504 forms a portion of the top surface 540 of the bridge 126. The computing device 502 and the display device 504 may communicate over a wireless connection so that the computing device 502 may continue to provide output through the display device 504 when the display device 504 is removed from

the dock. When the display device 504 is in the dock, the computing device 502 and the display device 502 may communicate over a wireless connection and/or a wired connection that may be provided through the dock.

[00193] FIG. 44 and FIG. 45 show alternative examples for the on-board computing device 502a. The on-board computing device 502a may be part of an alternative configuration for the adjustable dumbbell 102. The on-board computing device 502a may include a display device 504 that is visible through a transparent region 544 region of a top surface 540 of the on-board computing device 502a. The top surface 540 may also include an opaque region 542 region that obscures the underlying circuit board 501. A button 503 may be positioned within an aperture formed in on-board computing device 502a. The button 503 may be positioned proximate to the display device 504 and may include an engagement surface that is approximately flush with the top surface 540. The button 503 may be used to implement various functions. In accordance with various examples, the button 503 may be a power button, a reset button, a help button, and so on. The on-board computing device 502a may also include a battery pack 505 or other power source that is disposed on the underside of the circuit board 501.

[00194] FIG. 46 is a block diagram of various components that may be included in the computing device 502. The computing device 502 may include one or more of the following: a processor 508, a memory 510, an input/output interface 507, a sensor port 512, a wireless interface 514, and an accelerometer 516. The processor 508 may be configured to support the various operations of the computing device 502. The processor may communicate with the memory 510 that operates to store data and/or computer readable code that is executable by the processor 508. The input/output interface 507 is generally configured to send and receive data to and from the user. Generally, the input/output interface 507 may be configured to send data to various output devices that generate output perceptible to a user. Various output devices that may be associated with the computing device 502 may generate output that is visible, audible, tactile, olfactory, and so on. Additionally, the input/output interface 507 may be configured to receive data from various input devices that sense user input. Various input devices that may be associated with the computing device 502 may receive sensor data that is visible, audible, tactile, olfactory, and so on. By way of example, the input/output interface 507 may send data to the display device 504 shown in FIG. 44. If the display device 504 includes touch screen capabilities, the input/output interface 507 may also receive data generated by these inputs. By way of further example, the input/output interface 507 may send audio output to audio devices that may be associated with the

computing device 502, such as a speaker, a beeper, a buzzer, a tone generator, or the like. Similarly, the input/output interface 507 may receive audio input through a microphone or the like.

[00195] The computing device 502 may also feature a wireless interface 514, such as a Bluetooth transceiver. As alluded to above, if the dumbbell features a removable display device 502, the computing device 502 may communicate with the display device 502 through the wireless interface 514 so that the computing device 502 may continue to provide output through the display device 504 when the display device 504 is removed from the dock. The computing device 504 may also use the wireless interface to communicate with other electronic devices. For example, the computing device may communicate data to and from a smart phone, electronic tablet, laptop or desktop computer, and so on.

[00196] The computing device 502 may also feature an accelerometer 516, which is generally configured to be responsive to changes in velocity of the accelerometer 516 itself or objects to which the accelerometer is fixedly attached. The accelerometer 516 is fixedly attached to the circuit board 501 of the computing device 502, and thus fixedly attached to the dumbbell 102 itself. Accordingly, the accelerometer 516 is responsive to changes in the velocity of the dumbbell. The computing device 502 may track and record use of the dumbbell 102 through acceleration signals generated by the accelerometer 516. Specifically, when a user lifts the dumbbell 102 and moves the dumbbell through an exercise movement, the dumbbell 102 will experience a number of accelerations. For example, the dumbbell 102 may experience accelerations due to the initial movement of the dumbbell 102 off of the base 104, changes in speed and/or direction of the dumbbell 102 during the exercise movement, and the dumbbell coming to rest as it is again placed on the base 104. The computing device 502 may receive and record signals from the accelerometer 516 responsive these accelerations as part of an operation of tracking use of the dumbbell 102.

[00197] The computing device 502 may also feature a weight sensor port 512, which is configured to receive sensor signals that indicate amount of weight selected by the user. When the user turns the handle 106 to select a desired combination of weights 108, this action may actuate one or more sensors that are configured to sense the user's selection. More specifically, the sensors may be configured to be responsive to the angular displacement of the handle assembly 114. By receiving these sensor signals, the computing device 502 may determine the amount of weight on the adjustable dumbbell 102. In this way, the computing device 502 may track the amount of weight that the user is lifting during his or her workout. The computing device 502 may track the weight used as part of programmed

training routine executed by the computing device. Specifically, the user may download a training program into the computing device 502, which then outputs various prompts or information that guide the user through the workout. As part of the training program, the computing device 502 may track the weight used during the routine so as to track compliance with program specifications or to record the used to track progress over time.

[00198] With reference to FIGS. 46 and 47, the computing device 502 may communicate with a user's mobile device 518. In some examples, the computing device 502 may transmit data related to use of dumbbell to the user's mobile device 518. The computing device 502 may transmit data such as recorded workout information, weight amounts used, compliance with certain training programs and the like. The user also may transmit data to the computing device 502 through his or her mobile device 518. For example, the user may download a certain work program to the computing device 502 through a wireless communication sent from the mobile device 518.

Weight Sensors

[00199] An adjustable dumbbell 102 may include one or more sensors that are configured to detect handle assembly 114 or add-on weight attributes that indicate whether or not selection members associated with the handle assembly 114 or the add-on weight are engaged or not engaged. For example, an adjustable dumbbell 102 may include one or more sensors that are configured to detect certain handle assembly 114 attributes that indicate the rotational position of the handle 106 or the rotational position of an indicator member, such as a disc, that may or may not rotate with the handle. An adjustable dumbbell 102 may also include a linearly moving selector provided in association with a sensor that detects attributes that indicate the linear position of the selection member. One example of such a linearly moving selector is a sensor that detects the linear position of a selection member associated with the add-on weight.

[00200] The one or more sensors may be further configured to communicate or transmit this positional information to the computing device 502. Because certain combinations of weights 108 are retained on the handle assembly 114 when the handle 106 is rotated into particular rotational positions, the computing device 502 may use the rotational position information detected by the one or more sensors to calculate or otherwise determine the amount of weight retained on the handle assembly 114. In this way, the one or more sensors and the computing device 502 may together form a sensing mechanism that is

adapted to detect the amount of weight that a user has configured the handle assembly 114 to retain.

[00201] An adjustable dumbbell 102 may incorporate various types of handle assembly 114 attributes that indicate the rotational position of the handle 106 of the handle assembly 114. In some implementations, an indicator member, such as a disc (also referred to as an indicator disc) of the handle assembly 114 that rotates with handle 106 may include a rotational position encoding feature that encodes each of a plurality of disc sectors with a unique binary number. Here, each disc sector may correspond to a particular rotational position of the handle 106 and thus to a specific weight 108 combination retained on the handle assembly 116. The rotational position encoding feature may encode each disc sector with a unique binary number by encoding each of a plurality of sector subdivisions with either a first binary digit or a second binary digit. To sense each of the sector subdivision encoding, the handle assembly 114 may include a plurality of sensors, one for each sector subdivision. Various adjustable dumbbell 102 implementations are discussed below beginning with those that include a rotational position encoding feature that encodes each of a plurality of disc sectors with a unique binary number. While the examples below are described with reference to a single indicator member (a "disc" in the examples below), more than one indicator member may be implemented for use with the described weight sensor examples. Further, the indicator member may have a circular shape, or may have a geometric or non-geometric shape.

Sensing Weight Amounts with Optical Interrupt Sensors

[00202] FIG. 48 is a side elevation view of the adjustable dumbbell 102 shown in FIG. 43. As shown in FIG. 48 and FIG. 49, an adjustable dumbbell 102 may include a sensor board 604. The sensor board 604 may be configured to provide positional information to the computing device 502, which positional information the computer device 502, in turn, uses to determine the amount of weight retained on the handle assembly 114 of the adjustable dumbbell 102. The sensor board 604 may sense the rotational position of, for example, a separator disc 621 that is modified to include a rotational position encoding feature. A modified separator disc 621 is discussed herein by way example and not limitation. In accordance with other embodiments, other discs, such as one or more of the selector discs 122, may be modified to include a rotational position encoding feature.

[00203] Once the sensor board 604 senses the rotational position of the modified separator disc 621, the sensor board 604 may then output this positional information to the

computing device 502. Because the separator disc 621 is rotationally interlocked with the indexing disc 120 and the selector discs 122, the rotational position of the separator disc 621 corresponds to a specific amount of weight retained on the handle assembly 114. The computing device 502 may be programmed with a look-up table or other data structure that correlates the rotational position of the separator disc 621 with specific weight amounts. The computing device 502 may determine the amount of weight being retained on the handle assembly 114 by referencing the rotational position information received from the circuit board 604 against this look-up table. Alternatively, the computing device 502 may calculate the amount of weight retained on the handle assembly 114 by using equations that specify mathematical relationships between sensor data values and specific weight amounts.

[00204] Thus, generally, the separator disc 621 or other disc may be modified with a rotational position encoding that allows the disc to work with some type of binary sensor or sensors. The binary sensor or sensors register either an "on or "off" state and these states can be interpreted as binary "0" or "1". The number of binary sensors used in a particular implementation is typically chosen to allow for enough unique binary codes for the number of weight combinations that can be retained on the dumbbell. The unique combination of codes provides information about the rotational orientation of the handle 106 relative to a pre-determined initial position, thus allowing for the number of weights retained on the handle to be inferred via a look-up table, an equation, or so on.

[00205] FIG. 50 is a side elevation view elevation view of a separator disc 621 that has been modified to include a particular rotational position encoding. The separator disc 621 is modified from that of the separator disc 121 shown in FIG. 11 by the inclusion of two or more tabs 608 that encode the rotational position of the separator disc 621. The tabs 608 are arranged around the perimeter 612 of the separator disc 621 and extend axially outward from the perimeter 612. The tabs 608 have approximately the same or a smaller width as the remainder of the separator disc 621. The separator disc 621 can be considered as having sixteen equally sized sectors 616. The tabs 608 encode the rotational position of the separator disc 621 by having a unique pattern for each of the sixteen disc sectors 616. The sensor board 604 is arranged to sense which pattern of tabs 608 is present at the 12 o'clock position 620 shown in FIG. 50. Because each of the disc sectors 616 has a unique pattern of tabs 608, the sensor board 604 detects which of the sixteen sectors 616 is present at the 12 o'clock 620 position by sensing which pattern of tabs 608 is present at the 12 o'clock position 620. Thus, the tabs 608 encode sixteen discrete rotational positions that can be sensed by the sensor board 604.

[00206] Unique tab 608 patterns are formed for each sector 616, by dividing each sector 616 into four equally sized sector subdivisions here referred to as subsectors 624. Each subsector 624 either includes or does not include a tab 608 or tab 608 portion. In this way, the subsectors 624 are organized as a binary symbol system where the presence of a tab 608 corresponds to one symbol and the absence of a tab 608 corresponds to the other symbol. Viewed as binary numbers, the presence of a tab 608 may correspond to a "1" and the absence of a tab 608 may correspond to a "0." With four subsectors 624, there are 2^4 or sixteen possible binary numbers. Because there is a total of sixteen sectors 616, an encoding may be defined where each sector 616 is assigned a unique binary number. In the example separator disc 621 shown in FIG. 50, the sector 616 in the 12 o'clock 620 position is assigned binary 0000. Moving clockwise, the sectors 616 are assigned binary 0001, 0010, 0110, 0011, and so on. The encoding of FIG. 50 is shown by way of example and not limitation. Alternative encodings may be used depending on the implementation.

[00207] In some implementations, the separator disc 612 or other disc could be divided into more or less than sixteen sectors. For example, the separator disc 612 or other disc could be divided into eight sectors with 3 subsectors. Alternatively, the separator disc 612 or other disc could be divided into ten sectors with 4 subsectors with some of the binary codes not utilized (e.g., six of the 16 possible codes remaining unused). The number of sectors may generally correspond to the number of weight combinations that can be attached to the dumbbell. Thus, the number of sector subdivisions or subsectors may correspond to the minimum number of binary codes required for the number of sectors/weight combinations (e.g., 2 sub-sectors for 3 to 4 sectors, 3 sub-sectors for 5 to 8 sectors, 4 sub-sectors for 9 to 16 sectors, and so on). Additionally, the subdivisions could be created along a radial line by aligning the sensors vertically. Here, the separator disc 612 or other disc may be provided with sufficiently large holes, for example, formed along radial lines of the discs in binary patterns to determine the angular position of handle 106 or other rotatable member.

[00208] FIG. 49 is an enlarged view of an example sensor board 604 that may be used in combination with the modified separator disc 621 of FIG. 50. The sensor board 604 may include a plurality of optical interrupt type sensors 628 that each has a transmitter 632 and an opposing receiver 636. The sensors 628 are arranged to sense the pattern of tabs 608 that are present in the 12 o'clock position 620 shown in FIG. 50. The number of sensors 628 disposed on the sensor board 604 corresponds to the number of subsectors 624 in an individual disc sector 616. Thus, for the example separator disc 621, the sensor board 604 includes four sensors 628. Each sensor 628 is associated with a particular subsector 624 and,

in connection with that particular subsector 624, the sensor 628 is arranged to detect the presence or absence of a tab 608.

[00209] The sensor 628 detects the presence or absence of a tab 608 by emitting a light beam from the transmitter 632 towards the opposing receiver 636. The light beam may include visible light or non-visible light, such as infrared radiation. By way of example, four light beams 640 corresponding to the four sensors 628 are shown in cross section in FIG. 50. Greater or lesser numbers of sensors may be used depending upon the number of possible weight combinations in a particular implementation. If the path of the light beam 640 is obstructed by a tab 608, the corresponding sensor 628 registers the presence of the tab 608 because the light beam 640 does not reach the receiver 636. If the path of the light beam 640 is not obstructed by the tab 608, the corresponding sensor 628 registers the absence of a tab 608 because the light beam reaches the receiver 636. In the implementation shown in Fig. 50, the sensor 628 registers the absence of a tab 608 when the light beam passes between the gaps in the pattern of tabs. In order to prevent sensor pair light beam pollution, other implementations may encode rotational position information using holes rather than tabs 608. Here, the sensor 628 may register an absence when the light beam passes through a hole.

[00210] The sixteen sectors 616 are arranged such that each sector 616 corresponds to one of the sixteen possible weight 108 combinations that can be retained on the handle assembly 114. Specifically, the sectors 616 are arranged such that when the detents 140 engage respective indicator features 156 to indicate that a desired combination of weights 108 is adequately engaged with the handle assembly 114, a single disc sector 616 is in the 12 o'clock position 620 shown in FIG. 50. Thus, the particular pattern of weights 108 retained on the handle assembly 114 can be determined by detecting which of the sixteen disc sectors 616 is in the 12 o'clock position 620. As mentioned, the particular disc sector 616 that is in the 12 o'clock position 620 can be determined by the positional information that is encoded by the tabs 608. Here, the sensor board 604 senses the presence or absence of a tab 608 for each subsector 624 and transmits this encoded positional information to the computing device 502. The computing device 502, in turn, determines the amount of weight retained on the handle assembly by comparing the encoded information against a stored look-up table or other data structure. The following is an example look-up table that is based on the adjustable dumbbell 102 shown in FIG. 43 encoding of FIG. 50:

Binary Code	Weight (lbs)
0000	10
0001	15
0010	20
0011	25
0100	30
0101	35
0110	40
0111	45
1000	50
1001	55
1010	60
1011	65
1100	70
1101	75
1110	80
1111	85

Table (1)

[00211] As an alternative to a look-up table, the amount of weight retained on the handle assembly 114 may be calculated using one or more equations in some implementations. For example, using known weight amount for individual weights (i.e. weight #1 weighs 5 lbs, weight #2 weighs 10 lbs, and so on), an equation may be used that takes the binary number sensed by an individual sensor (1 or zero) and multiplies this binary number by the weight associated with the individual sensor. This multiplication may be repeated for each sensed value and weight amount pair and then the total added together along with the fixed weight of the handle assembly 114 to arrive at the total weight.

Sensing Weight Amounts with Mechanical Sensors

[00212] FIG. 51 is a side elevation view of an additional adjustable dumbbell 102 implementation. As mentioned, the adjustable dumbbell 102 may include a sensor board 704 configured to provide positional information to a computing device 502 that determines the amount of weight retained on the handle assembly 114. Specifically, the sensor board 704 senses the rotational position of, for example, a separator disc 721 that has been modified to include a rotational position encoding. The separator disc 721 is rotationally interlocked with the indexing disc 120 and the selector discs 122. Thus, the rotational position of the separator disc 721 corresponds to a specific amount of weight being retained on the handle assembly 114. Accordingly, the computing device 502 may determine the amount of weight being retained on the handle assembly 114 by referencing the rotational position information received from the circuit board 704 against this look-up table or by inputting this information into an appropriate equation.

[00213] FIG. 53 is a side elevation view elevation view of a separator disc 721 that has been modified to include a particular rotational position encoding. The separator disc 721 is modified from that of the separator disc 121 shown in FIG. 11 by the inclusion of a plurality of surface features, such as grooves 708, that encode the rotational position of the separator disc 708. Grooves 708 are described as surface features by way of example and not limitation. Alternative surface features include projections, tracks, mounds, bumps, dimples, and so on. The grooves 708 are arranged as recesses in the inner surface of the separator disc 721. The separator disc 721 can be considered as having sixteen equally sized sectors 716. The grooves 708 encode the rotational position of the separator disc 721 by having a unique pattern for each of the sixteen disc sectors 716. The sensor board 704 is arranged to sense which pattern of grooves 708 is present at the 12 o'clock position 720 shown in FIG. 53. Because each of the disc sectors 716 has a unique pattern of grooves 708, the sensor board 704 detects which of the sixteen sectors 716 is present at the 12 o'clock 720 position by sensing which pattern of grooves 708 is present at the 12 o'clock position 720. Thus, the grooves 708 encode sixteen discrete the modified positions that can be sensed by the sensor board 704.

[00214] Unique groove 708 patterns are formed for each sector 716 by arranging the grooves 708 along four sector subdivisions, here referred to as concentric tracks 724, on the inner surface of the separator disc 721. Along each track 724, a groove 708 is either present or not present. In this way, the tracks 724 are organized as a binary symbol system where the presence of a groove 708 corresponds to one symbol and the absence of a groove 708 corresponds to the other symbol. Viewed as binary numbers, the presence of a groove 708

may correspond to a "0" and the absence of a groove 708 may correspond to a "1." With four grooves 708, there are 2^4 or sixteen possible binary numbers. Because there is a total of sixteen sectors 716, an encoding may be defined where each sector 716 is assigned a unique binary number. In the example separator disc 721 shown in FIG. 53, the sector 716 in the 12 o'clock 720 position is assigned binary 0000. Moving clockwise, the sectors 716 are assigned binary 0001, 0010, 0110, 0011, and so on. The encoding of FIG. 53 is shown by way of example and not limitation. Alternative encodings may be used depending on the implementation. As previously mentioned, other implementations may include an alternative number of sectors, sector subdivisions, and so on.

[00215] FIG. 52 is an enlarged view of an example sensor board 704 that may be used in combination with the modified separator disc 721 of FIG. 53. The sensor board 704 may include a plurality of mechanical switch type sensors 728 that each has a base 734 and a moveable tip 738. The sensors 728 are arranged to sense the pattern of grooves 708 that are present in the 12 o'clock position 720 shown in FIG. 53. The number of sensors 728 disposed on the sensor board 704 corresponds to the number of tracks 724 on the inner surface of the separator disc 721. Thus, for the example separator disc 721, the sensor board 704 includes four sensors 728. Each sensor 728 is associated with a particular track 724, and in connection with that particular track 724, the sensor 728 is arranged to detect the presence or absence of a groove 708.

[00216] The sensor 728 detects the presence or absence of a groove 708 by the action of the moveable tip 738 portion of the sensor 728. The sensor 728 may include a spring or other biasing mechanism that urges the tip 738 to an unactuated position, such as outward from the base 734. A mechanical force can be applied to the tip 738 such that the tip 738 moves to an actuated position, such as partially or completely withdrawn into the base 734. The sensor 727 may also include metallic or other conductive contacts that form an electrical switch that is open when the tip 738 is in the unactuated position and that is closed when the tip 738 is in the actuated position. The circuit board 704 may be arranged such that the moveable tips 738 of the four sensors 728 engage the tracks 724 on the inner surface of the separator disc 721 at the four contact points 740 shown in FIG. 53. The circuit board 704 is disposed at a distance from the separator disc 721 such that, if a track 724 contains a groove 708 at a contact point 740, the depth of the groove 708 allows the corresponding tip 738 to move into the unactuated position under the action of the biasing mechanism. Similarly, if a track 724 does not contain a groove 708 at a contact point 740, the inner surface of the

separator disc 721 acts to maintain the moveable tip 738 in the actuated position against the action of the biasing mechanism.

[00217] The sixteen sectors 716 are arranged such that each sector 716 corresponds to one of the sixteen possible weight 108 combinations that can be retained on the handle assembly 114. Specifically, the sectors 716 are arranged such that when the detents 140 engage the indicator feature 156 to fully engage the weights 108 with the handle assembly 114, one and only one disc sector 716 is in the 12 o'clock position 620 shown in FIG. 53. When the weights 108 are fully engaged with the handle assembly 114, a specific pattern of weights 108 is retained on the handle assembly 114. Thus, the particular pattern of weights 108 that is retained on the handle assembly 114 can be determined by detecting which of the sixteen disc sectors 716 is in the 12 o'clock position 720. As mentioned, the particular disc sector 716 that is in the 12 o'clock position 720 can be determined by the positional information that is encoded by the grooves 708. Here, the sensor board 704 senses the presence or absence of a groove 708 for each track 624 and transmits this encoded positional information to the computing device 502. The computing device 502, in turn, determines the amount of weight retained on the handle assembly by comparing the encoded information against a stored look-up table or other data structure. The example look-up table given in Table (1) may be used in connection with encoding of FIG. 53. Alternatively, the computing device 502 may calculate the amount of weight being retained on the handle assembly 114 by using equations that specify mathematical relationships between sensor data values and specific weights amounts.

[00218] FIG. 54A through FIG. 54C are side elevation views of an alternative example for the mechanical sensors 728. As shown, the sensors 728 may include two electrical switches 742a-b that may be separately closed by a mechanical force being applied to the movable tip 738. The particular switch 742a-b that is closed by the movable tip 738 depends on the direction in which force is applied to the movable tip 738. FIG. 54A shows the orientation of the moveable tip 738 when no force is applied. Here, the tip 738 is maintained in the unactuated position by the action of the bias mechanism. Neither of the two electrical switches 742a-b is closed. FIG. 54B shows the orientation of the moveable tip 738 when a force 746 is applied from the right. Here, the tip 738 closes the left switch 742a, but leaves the right switch 742b unaffected. FIG. 54C shows the orientation of the moveable tip 738 when a force 750 is applied from the left. Here, the tip 738 closes the right switch 742b, but leaves the left switch 742a unaffected. Based on which of the two electrical switches 742a-b is closed, the sensor board 704 may be able to determine which direction a user is turning the

handle assembly 114. The computing device 502 may use this information for various purposes, such as determining whether the user is increasing or decreasing the amount of weight that is retained on the handle assembly 114.

[00219] Grooves are discussed above in connection with a rotational position encoding by way of example not limitation. In other implementations, other mechanisms may be used to encode positional information. For example, in some implementations, projections may be used to encode positional information. In this implementation, mechanical sensors may be used that incorporate levers that are switched back-and-forth by projections disposed on a surface of a rotating disc or other handle component.

Sensing Weight Amounts with Reflective Optical Sensors

[00220] FIG. 55 is a side elevation view of the adjustable dumbbell 102 implementation. As mentioned, the adjustable dumbbell 102 may include a sensor board 804 configured to provide positional information to a computing device 502 that determines the amount of weight retained on the handle assembly 114. Specifically, the sensor board 804 senses the rotational position of, for example, a separator disc 721 that has been modified to include a rotational position encoding, as well as the rotational position of the indexing disc 120 and selector discs 122. Because the specific combination of weights 108 retained on the handle assembly 114 corresponds to specific angular positions for the discs 821, 120, 122, the computing device 502 can use the positional information received from the sensor board 804 to determine the amount of weight retained on the handle assembly 114. Accordingly, the computing device 502 may determine the amount of weight being retained on the handle assembly 114 by referencing the rotational position information received from the circuit board 704 against this look-up table or by inputting this information into an appropriate equation.

[00221] FIG. 57A is a side elevation view elevation view of a separator disc 821 that has been modified to include a partial rotational position encoding. The separator disc 821 is modified from that of the separator disc 121 shown in FIG. 11 by the inclusion of a plurality of cut-outs 808 that partially encode the rotational position of the separator disc 908. The cut-outs 808 are arranged such that the separator disc 821 has a reduced radius R1 at certain angular positions, where the radius R1 is smaller than the radius R2 of the remainder of the separator disc 821. An outer concentric ring 812a can be defined on the separator disc 821 that includes portions of the separator disc 821 disposed at radial distances greater than R1, but less than or equal to R2. Within the concentric ring 812a, material that forms the

separator disc 821 is absent at those angular positions having cut-outs 808. Similarly, material that forms the separator disc 821 is present at those angular positions not having cut-outs 808. As shown in FIG 57B through FIG. 57E, concentric rings similar to the concentric ring 812a of the separator disc 821 can be defined for the indexing disc 120 and selector discs 122.

[00222] FIG. 57B is a cross section of the indexing disc 120 shown in FIG. 10. The cross section of FIG. 57B is set-off from the outer surface of the indexing disc 120 so as to intersect with the weight selection feature 157. An outer concentric ring 812b can be defined for the separator disc 821 that includes portions of the separator disc 821 disposed at radial distances greater than R1, but less than or equal to equal to R2, where R1 and R2 are defined in connection with FIG. 57A. Within the concentric ring 812b, material that forms the indexing disc 120 is absent at those angular positions where the weight selection feature 157 is absent. Similarly, material that forms the indexing disc 120 is present at those angular positions where the weight selection feature 157 is present.

[00223] FIG. 57C is a cross section of the first selector disc 120a shown in FIG. 13. The cross section of FIG. 57C is set-off from the inner surface of the selector disc 120a so as to intersect with the weight selection feature 186. A first outer concentric ring 812c can be defined for the selector disc 120a that includes portions of the selector disc 120a disposed at radial distances greater than R1, but less than or equal to equal to R2, where R1 and R2 are defined in connection with FIG. 57A. Within the concentric ring 812c, material that forms the selector disc 120a is absent at those angular positions where the weight selection feature 186 is absent. Similarly, material that forms the selector disc 120a is present at those angular positions where the weight selection feature 186 is present.

[00224] FIG. 57D is a cross section of the first selector disc 120a shown in FIG. 14. The cross section of FIG. 57D is set-off from the outer surface of the selector disc 120a so as to intersect with the weight selection feature 190. A second outer concentric ring 812d can be defined for the selector disc 120a that includes portions of the selector disc 120a disposed at radial distances greater than R1, but less than or equal to equal to R2, where R1 and R2 are defined in connection with FIG. 57A. Within the concentric ring 812d, material that forms the selector disc 120a is absent at those angular positions where the weight selection feature 190 is absent. Similarly, material that forms the selector disc 120a is present at those angular positions where the weight selection feature 190 is present.

[00225] FIG. 57E is a cross section of the second selector disc 120b shown in FIG. 16. The cross section of FIG. 57D is set-off from the outer surface of the selector disc 120b so as

to intersect with the weight selection feature 208. An outer concentric ring 812e can be defined for the selector disc 120b that includes portions of the selector disc 120b disposed at radial distances greater than R1, but less than or equal to equal to R2, where R1 and R2 are defined in connection with FIG. 57A. Within the concentric ring 812e, material that forms the selector disc 120b is absent at those angular positions where the weight selection feature 208 is absent. Similarly, material that forms the selector disc 120a is present at those angular positions where the weight selection feature 208 is present.

[00226] The concentric rings 812a-e can each be considered as having sixteen equally sized sectors 816. The concentric rings 812a-e encode the rotational position of the discs 821, 120, 122 by forming a unique pattern for each rotational position using adjacent disc sectors 716 that are grouped across all of the concentric rings 812a-e. The sensor board 804 is arranged to sense the ring patterns that are present at the 12 o'clock positions 820 shown in FIG. 57A through FIG. 5E. Because each group of adjacent disc sectors 816 forms a unique pattern, the sensor board 804 detects which of the sixteen groups of adjacent sectors 816 is present at the 12 o'clock 820 position by sensing which pattern of rings 812a-e is present at the 12 o'clock position 820. Thus, the rings 812a-e encode sixteen discrete rotational positions that can be sensed by the sensor board 804.

[00227] As mentioned, unique ring 812a-e patterns are formed for each group of adjacent disc sectors 816. In this way, the rings 812a-e form a binary symbol system where the presence of a material in the ring 812a-e corresponds to one symbol and the absence of material in the ring 812a-e corresponds to the other symbol. Viewed as binary numbers, the absence of material in the ring 812a-e may correspond to a "0" and the presence of a material in the ring 812a-e may correspond to a "1." With five rings 812a-e, there are 2^5 or thirty-two possible binary numbers. Because there are a total of sixteen groups of adjacent disc sectors 816, the rings 812a-e define an encoding may where each group of adjacent disc sectors 816 corresponds to a unique binary number. However, because thirty-two is greater than sixteen, not every binary number in the system corresponds to a group of adjacent disc sectors 816.

[00228] FIG. 56 is an enlarged view of the sensor board 804. The sensor board 804 may include a plurality of optical reflective type sensors 828a-e. The sensors 828a-e are arranged to sense the pattern of rings 812a-e that is present in the 12 o'clock position 820 shown in FIG. 57A through FIG. 5E. The number of sensors 828 disposed on the sensor board 804 corresponds to the number of rings 812a-e defined by the discs 821, 120, 122. Thus, for the rings shown in FIG. 57A through FIG. 5E, the sensor board 804 includes five sensors 828a-e. Each sensor 828a-e is associated with a particular ring 812a-e and; in

connection with that particular ring 828a-e, the sensor 828a-e is arranged to detect the presence or absence of a material within the ring 812a-e.

[00229] The sensors 828 detect the presence or absence of material within the rings 828a-e by emitting light beams toward the rings 828a-e. If there is material within the ring 828a-e and thus in the path of the light beam, the corresponding sensor 828 registers the presence of the material because a light beam that is transmitted by a transmitter portion of the sensor 828 is reflected back and received by a receiver portion of the sensor 828. If there is not material within the ring 828a-e and thus not in the path of the light beam, the corresponding sensor 828 registers the absence of the material because the light beam is not reflected back to the sensor 828.

[00230] The sixteen groups of adjunct sectors 816 are arranged such that each group of adjacent sectors 816 corresponds to one of the sixteen possible weight 108 combinations that can be retained on the handle assembly 114. Specifically, the groups of adjunct sectors 816 are arranged such that when detents 140 engage the indicator feature 156 to fully engage the weights 108 with the handle assembly 114, one and only group of adjunct sectors 816 is in the 12 o'clock position 820 shown in FIG. 57A through FIG. 5E. When the weights 108 are fully engaged with the handle assembly 114, a specific pattern of weights 108 is retained on the handle assembly 114. Thus, the particular pattern of weights 108 that is retained on the handle assembly 114 can be determined by detecting which of the groups of adjunct sectors 816 is in the 12 o'clock position 820. As mentioned, the particular group of adjunct sectors 816 that is in the 12 o'clock position 820 can be determined by the positional information that is encoded by the rings 828a-e. Here, the sensor board 804 senses the presence or absence of material within the ring 828a-e and transmits this encoded positional information to the computing device 502. The computing device 502, in turn, determines the amount of weight retained on the handle assembly by comparing the encoded information against a stored look-up table or other data structure. Alternatively, the computing device 502 may calculate the amount of weight being retained on the handle assembly 114 by using equations that specify mathematical relationships between sensor data values and specific weights amounts.

Sensing Weight Amounts with an Accelerometer

[00231] Referring to FIG. 58, in an alternative example, the computing device 502 may determine the amount of weight that is retained on the handle assembly 114 based on acceleration measurements made by an accelerometer. FIG. 58 is a side elevation view a modified separator disc 921. The separator disc 621 is modified from that of the separator

disc 121 shown in FIG. 11 by the inclusion of an accelerometer 904. The accelerometer 904 may be configured to sense accelerations and to send acceleration data to the computing device 502. The computing device 502 may then use this data to determine an angular change that indicates a rotational position of the handle. Here, gravity (which is a form of acceleration measured by the accelerometer 904) is measured on various axes of the accelerometer 904 to determine the orientation of the disk 921 relative to gravity. The angular change relative to gravity that indicates rotational position is calculated by the computing device 502 from the direction gravity is acting on the accelerometer 904. Because the separator disc 821 is rotationally interlocked with the indexing disc 120 and the selector discs 122, the rotational position of the separator disc 821 corresponds to a specific amount of weight being retained on the handle assembly 114. Thus, by sensing accelerations and calculating angular changes in a gravity vector of the modified separator disc 821, the accelerometer 904 and computing device 502 can derive data that the computing device 502 can use to determine the amount of angular displacement and thus the rotational position of the handle. With the rotational position of the handle known, the computing device 502 can determine the amount of weight retained on the handle assembly 114. Positional sensing through an accelerometer is an example of a sensing mechanism that detected movement. In other implementations, other sensors such as gyroscopes and magnetometers may be used.

Alternative Weight Sensor Implementations

[00232] In some implementations, an adjustable dumbbell includes at least one sensor that is configured to detect the rotational position of an indicator member, such as a disc or the like, by detecting a sensible parameter having a substantially continuous range of possible values. A sample value is then passed from the sensor to the computing device, which determines which of the plurality weights are fixedly connected to the handle assembly by determining in which of two or more sub-ranges of the continuous range the sensed parameter is detected. As described below, the continuous range of sensible values may be the displacement of a mechanical linkage, the capacitance or inductance of a material arranged on the indicator member or disc, the direction of a magnetic field, and so on.

[00233] Referring to FIG. 59A and FIG. 59B, an adjustable dumbbell system includes a disc 1004 having a perimeter 1008 with a varying surface shape or profile. In one example, as shown in FIG. 59A, the perimeter 1008 is a spiral-shaped perimeter. Generally, as shown in FIG. 59B, the perimeter 1008 is such that at least some of the points along at least a portion of the perimeter 1008 are disposed at different distances from a center of the disc

1004. The disc 1004 having the varying perimeter 1008 may be provided in association with a sensor 1012 that includes a potentiometer 1016 having a mechanical linkage 1020. The potentiometer 1016 could be any potentiometer having a suitable mechanical structure such as a linear potentiometer, a rotary potentiometer, and so on. A first end 1024 of the mechanical linkage 1020 may be in contact the perimeter 1008 of the disc 1004. In operation, the perimeter 1008 of disc 1004 may move the mechanical linkage 1020 when the disc 1004 rotates due to the varying shape of the perimeter 1008. Here, the disc 1004 may move the mechanical linkage 1020 against the action of a bias mechanism that urges the linkage 1020 in a downward direction. The sensor 1012 may be configured to detect a displacement of the mechanical linkage 1020 that occurs as the disc 1004 rotates. In this way, the sensor 1012 may detect the rotational position of the disc 1004 and thus the amount of weight retained on the handle assembly based on the displaced of the mechanical linkage 1020.

[00234] Referring to FIG. 60, an adjustable dumbbell system includes a disc 1104 having a concentric ring 1108 of material positioned on a surface of the disc 1104. The material in the ring 1108 may have an electrical property that has a different magnitude at each angular position along the ring 1108. For example, the material in the ring 1108 may exhibit a capacitance or inductance of varying magnitude. The ring 1108 of material may be provided in association with a sensor 1112 that includes an electrical sensing portion 1116 adjacent to the ring 1108 of material. The electrical sensing portion 1116 may be configured to detect the magnitude of the electrical property of the ring 1108 of material as the disc 1104 rotates. In this way, the sensor 1112 may detect the rotational position of the disc 1104 and thus the amount of weight retained on the handle assembly based on the detected magnitude of the electrical property. As shown in FIG. 60, material could be placed on a face of the disc 1104. Alternatively, material could be placed on other areas of the disc 1104, such as on the edge of the disc.

[00235] Referring to FIG. 61A and FIG. 61B, an adjustable dumbbell system includes a wheel 1204 positioned on the handle assembly adjacent to a disc 1208 that rotates with the handle. The wheel 1204 may have a plurality of teeth 1212 arranged along a perimeter of the wheel 1204 and a magnet 1216 positioned on a surface of the wheel 1204. The magnet 1216 may be formed in the shape of strip, circle, oval, or any suitable shape. The magnet1216 may be arranged such that a magnetic field direction of the magnet 1216 varies with a rotational position of the wheel 1204. Further, the disc 1208 may include plurality of teeth 1220 arranged along a perimeter of the disc 1208. The teeth 1220 of the disc 1208 may be

arranged to intermesh with the teeth 1212 of the wheel 1204 such that the rotation of the disc 1208 causes a corresponding rotation of the wheel 1204. The wheel 1204 may be provided in association with a sensor 1224 that includes a magnetic sensing portion 1228 adjacent to the magnet 1216 disposed on the wheel 1204. The magnetic sensing portion 1228 may be configured to detect a direction of the magnetic field of the magnet 1216 as the wheel 1204 rotates due to the rotation of the disc 1208. In this way, the sensor 1224 may detect the rotational position of the disc 1208 and thus the amount of weight retained on the handle assembly based on the detected direction of the magnetic field of the magnet 1216. In an alternative implementation, magnetic sensing could be done without a disc and a wheel having intermeshing teeth. Specifically, a magnet may be located at the end of the handle and a magnetic sensor located over the magnet.

Sensing the Add-on Weight

[00236] The computing device 502 may additionally be configured to determine if the add-on weights 240 are retained on the handle assembly 114. In this regard, the adjustable dumbbell may include an add-on weight sensor that determines if the add-on weights 240 are engaged with the handle assembly 114 so as to be retained by the weight attachment feature 224 when the dumbbell 102 is lifted out of the support base 104. As shown in FIG. 18, the add-on weight sensor 1004 may be attached to a portion of the end cap 124 in a position that allows the sensor 1004 to detect the position of the plunger 266 that is associated with the add-on weight engagement assembly 254. The add-on sensor 1004 may be configured to detect that an add-on weights 240 is engaged by sensing that the selection member 266 spans across the separation plane 352 to engage the handle assembly 114. Similarly, the add-on sensor 1004 may be configured to detect that an add-on weights 240 is not engaged by sensing that the selection member 266 does not span across the separation plane 352.

[00237] The add-on weight sensor 1004 may be implemented using any mechanism capable of sensing the position of the selection member 266, such as optical sensing or mechanical sensing. If implemented as an optical sensor, the add-on weight sensor 1004 may function my emitting a light beam that reflected or interrupted in the event that the selection member 266 spans across the separation plane 352 and that is not reflected or not interrupted in the event that the selection member 266 does not span across the separation plane 352. If implemented as a mechanical sensor, the add-on weight sensor 1004 may an actuator that moves to one position in the event that the selection member 266 spans across the separation plane 352 and moves to another position in the event that the selection member 266 does not

span across the separation plane 352. Regardless of the form taken by the add-on weight sensor 1004, the sensor 1004 may be configured to sense the position of the selection member 266 and to covey this information to this computing device 502, which, in turn, uses this information in calculating the amount of weight retained on the handle assembly 114.

Sensing a Position of the Dumbbell

[00238] Referring to FIG. 46B, a repetition counting system 550 may be configured to measure and assess one or more repetitions of the dumbbell 102. To measure and assess a repetition, the repetition counting system 550 may include a computing device 552 and at least one sensor 554. The computing device 552 may be the computing device 502, 502a (see FIGS. 43-46A), a user's mobile device 518, 1600 (see FIGS. 47 and 65), or any other electronic device capable of processing data. The user's mobile device 518, 1600 may be a laptop computer, a smart phone, a smart watch, a tablet, or other types of mobile electronic devices. The sensor 554 may be an accelerometer, a magnetometer, a gyroscope, or any other suitable sensor for detecting positional information of the dumbbell 102. Referring to FIG. 46A, the sensor 554 may include the accelerometer 516, the magnetometer 519, the gyroscope 521, or any combination thereof.

[00239] The computing device 552 may process data received from the sensor 554. The computing device 552 may include at least one processor 556, at least one memory 558, and at least one communication interface 560. The memory 558 may be in communication with the sensor 554, the processor 556, or both. The memory 558 may store raw data received from the sensor 554, processed data received from the processor 556, one or more applications 562, other information, or any combination thereof. The memory 558 may be the memory 510, a memory of a user's mobile device 518, 1600, or any other memory capable of storing data.

[00240] The processor 556 may execute instructions stored by the memory 558. For example, the processor 556 may execute instructions of the application 562. The application 562 may be a repetition counting application including instructions for measuring and accessing repetitions for execution by the processor 556. The processor 556 may be the processor 508 of the computing device 502, 502a (see FIGS. 43-46A), a processor of a user's mobile device 518, 1600 (see FIGS. 47 and 65), or any other processor capable of executing one or more instructions. The communication interface 560 may provide an interface for the computing device 552 to communicate with the sensor 554. The communication interface 560 may be a wired interface, a wireless interface (such as a Bluetooth® interface), a network

interface, or any other communication interface capable of supporting data transfer between the computing device 552 and the sensor 554. The communication interface 560 may be the I/O interface 507 of the computing device 502, 502a (see FIGS. 43-46A), the wireless interface 514 of the computing device 502, 502a (see FIGS. 43-46A), a communication interface of a user's mobile device 518, 1600, or any other communication interface capable of transmitting data between the computing device 552 and the sensor 554.

[00241] The computing device 552 may be located on the dumbbell 102 or located remotely from the dumbbell 102. The computing device 552 may be permanently or removably attached to the dumbbell 102. In some implementations, the computing device 552 is the on-board computing device 502, 502a. In some implementations, the computing device 552 is a remote electronic device, such as a user's mobile device 518, 1600.

[00242] The sensor 554 may be located on a moving body, such as the dumbbell 102 or a user. In some implementations, the sensor 554 may be mounted onto the dumbbell 102 so that the sensor 554 moves in unison with the dumbbell 102 during use of the dumbbell 102. The sensor 554 may be part of the computing device 502, 502a (see FIGS. 43-46A) or separate from the computing device 502, 502a. In some implementations, the sensor 554 may be mounted to the handle assembly 114 of the dumbbell 102. In some implementations, the sensor 554 may be mounted within the bridge 126 of the dumbbell 102, on the handle 106 of the dumbbell 102 in a manner to not interfere with the user's hand, or in other suitable locations. In other implementations, the sensor 554 may be located on the user. In these implementations, the sensor 554 may detect repetitious movements of the user during exercise, for example during push-ups or pull-ups. In some implementations, the sensor 554 may be attached to a user by a band, a belt, a clip, or other suitable attachment feature.

[00243] The sensor 554 may communicate with the computing device 552 by a communication interface 564. The communication interface 564 may be located on a moving body, such as the dumbbell 102 or a user, along with the sensor 554. The communication interface 564 may be a wired interface, a wireless interface (such as a Bluetooth® interface), a network interface, or any other communication interface capable of transmitting data between the computing device 552 and the sensor 554. The communication interface 564 may be the I/O interface 507 of the computing device 502, 502a (see FIGS. 43-46A), the wireless interface 514 of the computing device 502, 502a (see FIGS. 43-46A), or any other communication interface capable of transmitting data between the sensor 554 and the computing device 552.

[00244] The processor 556 of the computing device 552 may be attached to the dumbbell 102 or located remotely from the dumbbell 102. If attached to the dumbbell 102, the processor 556 may be mounted onto the dumbbell 102 within the same housing as the sensor 554 or remotely from the sensor 554. In some implementations, the processor 556 and the sensor 554 may be a physical part of the same computing device. For example, referring to FIG. 46A, the processor 508 and the accelerometer 516, magnetometer 519, and/or gyroscope 521 may be housed within the on-board computing device 502. In other implementations, the sensor 554 may be located separately from the computing device 552. For example, the processor 556 may be the processor 508 housed within the on-board computing device 502 and the sensor 554 may be located on the handle assembly 114 of the dumbbell 102 remotely from the on-board computing device 502.

[00245] Regardless of the particular relationship of the sensor 554 and the computing device 552, the sensor 554 may be in communication with the processor 556 of the computing device 552. Regardless of its location, the processor 556 may process data received from the sensor 554. In implementations in which the processor 556 is located remotely from the dumbbell 102, the sensor data may be transmitted (*e.g.*, streamed) to the remote processor for converting the sensor data (*e.g.*, accelerometer data) into repetition data.

[00246] During use of the dumbbell 102, the sensor 554 may detect acceleration of the dumbbell 102 and generate an acceleration signal reflecting changes in the velocity of the dumbbell 102. The computing device 552 may receive the acceleration signal and use it to determine the relative position of the dumbbell 102 during an exercise repetition.

[00247] The computing device 552 may determine the relative position of the dumbbell 102 by performing one or more mathematical operations on the acceleration signal. Instructions for the one or more mathematical operations may be stored in an application 562, such as a repetition counting application (see FIG. 46B). An example of a signal processing method 1300, which may be stored as instructions in the repetition counting application, is provided in FIG. 62. The method 1300 may include multiple signal processing operations performed by the computing device 552 to convert the accelerometer signal generated by the sensor 554 to, for example, a position signal reflecting the relative position of the dumbbell 102 during an exercise routine. The signal processing operations may be executed by the processor 556 (see FIG. 46B).

[00248] In block 1302 of FIG. 62, the computing device 552 may calculate the average value of the acceleration magnitude of the dumbbell 102 based on the acceleration signal, which may vary through the range of motion of the repetition. In block 1304, the computing

device 552 may remove a sensor offset from the magnitude of the acceleration signal so that the signal more accurately reflects the acceleration of the dumbbell 102. The sensor offset may include a sensor bias (*e.g.*, bias of the accelerometer 516), a gravity offset, or both. In block 1306, the computing device 552 may apply an acceleration deadband to the acceleration signal. The deadband may set the measured acceleration to zero if the acceleration magnitude is less than a threshold value and remains within the deadband for multiple samples. By applying the deadband, any small amount of remaining bias may be eliminated.

[00249] In block 1308 of FIG. 62, the computing device 552 may integrate the acceleration signal to yield a velocity signal. In block 1310, the computing device 552 may apply a high-pass filter to the velocity signal. The high-pass filter may remove most of a random walk error from the velocity signal, as this error tends to be a low frequency signal. In block 1312, the computing device 552 may integrate the filtered velocity signal to yield a position signal. In block 1314, the computing device 552 may apply a high-pass filter to the position signal. The high-pass filter may eliminate any signal drift due to velocity offset.

[00250] The filtered position signal may be used by the computing device 552 to assess whether or not to count a repetition during an exercise routing. By performing one or more mathematical operations on the acceleration signal generated by the sensor 554, the resulting position signal may more accurately reflect the relative position of the dumbbell 102 during a repetition. The computing device 552 may assess the filtered position signal real-time during an exercise repetition. Additionally, or alternatively, the filtered position signal may be stored in memory 558 (see FIG. 46B) for later assessment.

Measuring and Assessing a Repetition

[00251] The computing device 552 may be configured to count the number of repetitions of an exercise performed by a user of the dumbbell 102, and/or analyze the repetitive motion of the dumbbell as sensed by the sensor 554 in order to assess the quality or validity of the one or more repetitions of the dumbbell 102. Based on the assessment of the quality or validity of the repetition or motion, the computing device 552 may determine whether the repetition or motion should be counted, and/or may provide a relative value representing the assessment score. In the assessment of the quality or validity of the repetition or motion, the computing device 552 may compare the current repetition to the overall attributes of a reference repetition, or to one or more attributes of a reference repetition as the basis of the assessment. Examples of the various attributes used to assess a repetition include

the relative depth or stroke of the repetition, the speed of the repetition during an upward motion of the repetition, the speed of the repetition during a downward motion of the repetition, the acceleration of the repetition at or near a bottom portion of the repetition, the acceleration of the repetition at or near a top portion of the repetition, the acceleration of the repetition between the top and bottom portions of the repetition, the continuity of motion of the repetition (*e.g.*, motion without extended pauses), and the like.

[00252] The assessment of a sensed repetition allows the computing device 552 to aid a user through feedback to motivate the user, to improve their exercise form, or confirm that the user is maximizing the benefits (or not) from the proper performance of the exercise. The feedback to the user for such messaging may take one of many forms. In one example, after determining that a repetition is considered valid, the computing device 552 may emit an audible signal via an audio output device 566 to provide an indication to the user that the repetition was counted. In hearing the audible feedback, the user gains information not only on the quantity of exercise (as measured by the repetitions), but also the quality of the exercise (*e.g.*, that the exercise has been performed to the standard programmed into the computing device). Additionally, after a valid repetition the computing device 552 may increment a repetition counter on a display of a display device 504, 518. If the current repetition does not satisfy the attributes of a valid repetition, the computing device 552 may not emit an audible signal nor increment the repetition counter upon completion of the repetition. In some implementations, the computing device 552 may emit a different signal, such as blinking or flashing lights, vibration, or other suitable effects to notify the user the repetition was not counted.

[00253] Referring back to FIG. 62, the computing device 552 may use the filtered position signal created in block 1314 to assess the quality of a repetition. For a typical exercise, the filtered positional signal cycles between a first (*e.g.*, lower) relative position of the free weight and a second (*e.g.*, higher) relative position of the free weight. A single repetition may be defined by a cycle from a lower relative position to a higher relative position and back to or near the lower relative position, from a higher relative position to a lower relative position and back to or near the higher relative position, from a first lateral position to a second lateral position and back to or near the first lateral position, or other repetitive (e.g., cyclic or reciprocating) movements. Using the filtered position signal, the computing device 552 may determine the number of valid exercise repetitions performed during the cyclic movements by comparing the movements to a reference repetition, such as the first repetition of the cyclic movement.

[00254] The computing device 552 may be configured to assess whether or not to count an exercise repetition based upon information received from the sensor 554, such as the accelerometer 516. In some implementations, the computing device 552 is configured to count only those repetitions of the dumbbell 102 that pass through a lower threshold position and an upper threshold position, such as is represented in method 1400 shown in FIG. 63. The method 1400 may include one or more calibrating steps and one or more counting steps. The one or more calibrating steps and the one or more counting steps may be stored in memory 558 (*e.g.*, in an application 562) and performed by the processor 556 of the computing device 552.

[00255] The one or more calibrating steps may analyze a full-range repetition of the user to determine the particular motion of the user for that particular exercise. The full-range repetition may be the first repetition of the exercise performed by the user. The computing device 552 may collect and use the position data obtained from the full-range repetition to create a reference repetition, against which subsequent repetitions are compared to determine validity.

[00256] The computing device 552 may provide one or more signals to the user indicating that the repetition measuring system 550 is operable to measure repetitions. When the user is ready to begin an exercise routine, the user may push a button on the dumbbell 102. With reference to FIG. 45, the user may press the button 503 to indicate the start of an exercise. After the button 503 is pressed, the computing device 552 may send a signal to the audio output device 566 (such as a speaker, a beeper, a buzzer, a tone generator, or the like, which may be the audio output device 517). The signal may be sent to the audio output device 517 via the communication interface 560 of the computing device 552 (see FIG. 46B). The audio output device 566 may emit a first audible signal (block 1402 of FIG. 63) in response to depression of the button 503 to indicate to the user that the computing device 552 is operative to initiate tracking of the exercise routine.

[00257] When the user presses the button 503, the dumbbell 102 may be supported by a support surface, such as rack or a floor. Lifting the dumbbell 102 into a ready or start position may require an initial motion that is not part of the exercise. To allow for this initial motion without analyzing the motion for repetition counting, the computing device 552 may be configured to not track the motion of the dumbbell 102 for a fixed period of time after the button 503 is pressed. In some implementations, the fixed period of time is ten seconds or less. In some implementations, the fixed period of time is about three seconds. After the delay period elapses, the computing device 552 may be configured to not analyze the position

or velocity of the dumbbell 102 until the user maintains the dumbbell 102 in a static position for a fixed period of time, further ensuring the computing device 552 does not analyze the initial handling of the dumbbell 102 for repetition counting.

[00258] To determine whether the dumbbell 102 is moving or not moving (block 1404 of FIG. 63), the computing device 552 may be configured to determine whether a sensed acceleration value remains consistent for a fixed period of time after the button 503 is depressed. The computing device 552 may calculate an average value of the acceleration magnitude of the dumbbell 102 (see block 1302 of FIG. 62) and then may continue to calculate average values of the acceleration magnitude of the dumbbell 102 and compare the values to previous average values to determine whether the dumbbell 102 is stabilized. Once the dumbbell is stabilized for a set period of time (*e.g.*, three seconds or less), the computing device 552 may record the stabilized acceleration value in memory 558 (see FIG. 46B). This stored value may be used as a measurement of the sensor offset (see block 1304 in FIG. 62), including sensor bias and gravity offset, and may be used to offset subsequent acceleration readings. The computing device 552 may apply the acceleration deadband (see block 1306 of FIG. 62) to reduce or eliminate any remaining bias and to more easily identify a no-motion condition.

[00259] Once the user maintains the dumbbell 102 in a static position for a sufficient amount of time, the audio output device 566 may emit a second audible signal (block 1406 in FIG. 63) to indicate to the user that the exercise should begin. The second audible signal may be different than the first audible signal. In some implementations, the first audible signal includes a single beep, whereas the second audible signal includes multiple (*e.g.*, two or more) consecutive beeps. By providing an indication to the user when to begin the exercise, the user is notified that the user has successfully maintained the dumbbell 102 in a substantially stationary position for a sufficiently long enough period to allow the sensor 554 (*e.g.*, accelerometer 516) to settle prior to commencing the exercise, thus enhancing the quality of the acceleration data provided to the computing device 552 for assessing whether or not a quality repetition has occurred.

[00260] After emitting the second audible signal (for the user to begin a repetition), the computing device 552 may process the acceleration signal received from the sensor 554 (*e.g.*, accelerometer 516) to create a filtered position signal. As discussed above in connection with FIG. 62, the computing device 552 may integrate the acceleration signal to yield a velocity signal (block 1308), apply a high-pass filter to the velocity signal (block 1310), integrate the filtered velocity signal to yield a position signal (block 1312), and apply a high-pass filter to

the position signal to calculate a filtered position signal. These operations may be stored as instructions in memory 558 and executed by the processor 556. The computing device 552 may analyze the filtered position signal to assess whether or not to count an exercise repetition. As discussed previously, the computing device 552 may store the first repetition, or the attributes of the first repetition, for determining whether to count subsequent repetitions. The first repetition of an exercise may be counted without assessment, whereas subsequent repetitions may only be counted after assessment by the computing device 552.

[00261] Once the filtered position signal has been calculated, the computing device 552 may analyze the filtered position signal to track the position of the dumbbell 102 during an exercise routine. Referring to FIG. 64, a graph 1500 of a filtered position signal 1502 is provided. The filtered position signal 1502 represents the relative position of the dumbbell 102 during four repetitions R1, R2, R3, R4. Each repetition R1, R2, R3, R4 may include a valley or lower position L1, L2, L3, L4 and a peak or upper position U1, U2, U3, U4, respectively. The position of the dumbbell 102 during each repetition R1, R2, R3, R4 generally tracks upwardly from the respective lower position L1, L2, L3, L4 to the respective upper position U1, U2, U3, U4, and then tracks downwardly from the respective upper position U1, U2, U3, U4 to the respective lower position L2, L3, L4, L5 of the next repetition.

[00262] The computing device 552 may compare each repetition of the dumbbell 102 against a quality attribute to determine whether or not to count the repetition. By doing this, the computing device 552 may only count the number of repetitions that satisfy the quality attribute. The quality attribute may include a depth attribute, a rate attribute, a continuity attribute (pauses in the motion), or other suitable attributes.

[00263] The computing device 552 may use a reference repetition to assess whether subsequent exercise repetitions are counted. In some implementations, the first cycle or repetition of the dumbbell 102 may be used as the basis or baseline model for determining whether subsequent repetitions are counted by the computing device 552. By using the first repetition to assess subsequent repetitions, information about the user (height, arm length, etc.) and the type of exercise (curls, extensions, etc.) is not required to assess whether subsequent repetitions are counted by the computing device 552. In other words, whether or not a repetition is counted or is considered valid is independent of the type of exercise and specific user attributes. Therefore, there is no requirement for the user to input any information into the computing device 552 prior to the start of exercising.

[00264] The computing device 552 may assess a repetitive motion based solely on attributes of a first repetition of an exercise, or it may learn enough about the exercise during the first repetition to implement the attributes of a pre-loaded standard repetition. In some implementations, standardized values may be stored in memory 556 for a specific exercise (*e.g.*, a vertical deadlift, a curl, a bent over row, and the like). Once the computing device 552 determines what the basic exercise is, it may apply a pre-determined (*e.g.*, stored) attribute.

[00265] FIG. 64 shows one example of the computing device 552 using the first repetition R1 as a reference repetition to assess whether or not to count subsequent repetitions R2, R3, R4 as valid repetitions. The distance or depth D1 between the lower position L1 and the upper position U1 of the first repetition R1 may be saved in memory 558 (see FIG. 46B) as the repetition reference depth. The computing device 552 may use the repetition reference depth D1 to determine whether or not to count subsequent repetitions. As subsequent repetitions are completed, the depth values of the subsequent repetitions may be averaged in with the stored depth value to provide an adaptive repetition reference depth D1.

[00266] In some implementations, subsequent repetitions may not be counted if the respective repetition does not pass through a certain percentage of the repetition reference depth D1. The computing device 552 may calculate a threshold depth value D2 from the repetition reference depth D1 and use the threshold depth value D2 as a minimum depth that subsequent repetitions must meet or exceed to be counted by the computing device 552. The threshold depth value D2 may be calculated as a percentage of the repetition reference depth D1. In some implementations, the threshold depth value D2 is greater than seventy-five percent of the repetition reference depth D1. In some implementations, the threshold depth value D2 is about eighty percent of the repetition reference depth D1.

[00267] With reference to FIG. 64, the computing device 552 may count the second repetition R2 as a valid repetition since the distance between the lower and upper positions L2, U2, respectively, of the second repetition R2 is greater than the threshold depth value D2. Similarly, the computing device 552 may count the third repetition R3 as a valid repetition since the distance between the lower and upper positions L3, U3, respectively, of the third repetition R3 is greater than the threshold depth value D2. However, the computing device 552 may not count the fourth repetition R4 as a valid repetition since the distance between the lower and upper positions L4, U4, respectively, of the fourth repetition R4 is less than the threshold depth value D2. In some implementations, the threshold value may be programmed to decrease based on time or number of repetitions.

[00268] Additionally, or alternatively, the computing device 502 may assess the quality of a repetition based upon a rate of motion or speed of the dumbbell 102. During exercise, the computing device 552 may calculate the rate of motion of each repetition by dividing the depth of each repetition R1, R2, R3, R4 by the elapsed time between the lower positions L1, L2, L3, L4 and the upper positions U1, U2, U3, U4, respectively. In some implementations, if the rate of movement of the dumbbell 102 from the lower position to the upper position of a respective repetition is too slow or too fast relative to a target rate of motion, then that repetition is not counted. Similarly, in some implementations, if the rate of movement of the dumbbell 102 from the upper position of a respective repetition to the lower position of a subsequent repetition is too slow or too fast relative to the target rate of motion, then that repetition is not counted. The target rate of motion or speed of the dumbbell 102 may be based on the first repetition R1 or may be a predetermined value. In some implementations, the computing device 552 may include a predetermined target rate of motion stored in memory 558 (see FIG. 46B). The target rate of motion may vary dependent on the type of exercise, which may be determined by the sample repetition based on relative movement. A percentage threshold may be applied to an optimal speed for the exercise repetition to define the target rate of motion. In some implementations, the target rate of motion includes a range of acceptable speeds for the repetition.

[00269] The computing device 552 may provide the user feedback if the user completes a valid repetition. The computing device 552 may provide an audio indication to a user when a repetition is counted. At or near the upper position U1, U2, U3, U4 of the respective repetition R1, R2, R3, R4, the audio output device 566 may emit an audible signal to indicate the repetition has been counted by the computing device 552. The audible signal may incentivize the user for a subsequent repetition. As discussed previously, if the user did not lower the dumbbell 102 to the lower position, raise the dumbbell 102 to the upper position, or maintain a threshold rate of speed during the repetition, the computing device 552 may not count the repetition as a valid repetition. If the repetition is not counted by the computing device 552, then the audio output device 566 may provide a unique signal or may not emit an audible signal at or near the upper position of the repetition.

[00270] In order to account for sensor data drift, the computing device 552 may dynamically adjust the reference repetition. During exercise, the positional data determined from the accelerometer data may drift (upwards or downwards) due to noise or inaccuracies in the derivation of position from acceleration. To account for the positional data drift, the computing device 552 may dynamically adjust the reference repetition_based upon

subsequent measured repetitions. As previously discussed in connection with FIG. 62, the computing device 552 may apply a high-pass filter to the velocity signal (block 1310 in FIG. 62), to the position signal (block 1314 in FIG. 62), or both to account for sensor data drift. Additionally, or alternatively, the computing device 552 may calculate an adaptive repetition reference depth as an average of the latest depth value and the previous depth reference value, as discussed previously in connection with FIG. 64. The dynamic adjustment of the reference repetition may ensure the reference repetition serves as a proper basis for assessing whether or not subsequent repetitions are counted by the computing device 552.

[00271] To improve the accuracy of the position signal, the computing device 552 may communicate with one or more sensors in addition, or alternatively, to an accelerometer such as the accelerometer 516. In some implementations, the computing device 552 may communicate with a magnetometer 519 (see FIG. 46A). The magnetometer 519 may be used in conjunction with the accelerometer 516 to improve the accuracy of the determined relative positions of the dumbbell 102 with respect to Earth's magnetic field. The magnetometer 519 may be useful in reducing drift of the position data since the magnetometer 519 may provide a frame of reference for the position. The computing device 552 may communicate with the magnetometer 519 through a wired or wireless connection. With reference to FIGS. 46A and 46B, the computing device 552 may communicate with the magnetometer 519 (which is an example of the sensor 554) through the communication interfaces 560, 564. The communication interface 564 may be the I/O interface 507, the sensor port 512, the wireless interface 514, or any combination thereof. The magnetometer 519 may be attached to the dumbbell 102 so that the magnetometer 519 moves in unison with the dumbbell 102 during use of the dumbbell 102. The magnetometer 519 may be attached to the handle assembly 114 of the dumbbell 102, or other suitable positions, such as embedded in the bridge 126 of the dumbbell 102.

[00272] Additionally, or alternatively, the computing device 552 may communicate with a gyroscope 521 (see FIG. 46A). The gyroscope 521 may improve the accuracy of detecting repetitions with a rotational or angular acceleration component. The gyroscope 521 may be used in conjunction with other sensors in determining repetitions by accounting for rotation of the dumbbell 102 through the exercise movement. This rotational component may be more distinct than the positional data and may be used to characterize the range of movement of the repetition for improved detection. The computing device 552 may communicate with the gyroscope 521 (which is an example of the sensor 554) through the communication interfaces 560, 564. The communication interface 564 may be the I/O

interface 507, the sensor port 512, the wireless interface 514, or any combination thereof. The gyroscope 521, as with the magnetometer above, may be attached to the dumbbell 102 so that the gyroscope 521 moves in unison with the dumbbell 102 during use of the dumbbell 102. It may be attached to the handle assembly 114 of the dumbbell 102 or other suitable location, such as embedded in the bridge 126 of the dumbbell 102.

[00273] The computing device 552 may, as noted above, provide the user with feedback to help the user perform the exercise correctly. The computing device 552 may communicate with a display device, such as display device 504, mobile device 518, or other suitable device operable to display exercise data, via a wired or wireless interface. Referring to FIG. 46B, the computing device 552 may communicate with the display device via the wireless interface 514 or the I/O interface 507. The computing device 552 may stream data to the display device via a suitable communication protocol, such as a Bluetooth® wireless standard. The computing device 552 may transmit relative position data reflecting the current position of the dumbbell 102 to the display device as the dumbbell 102 moves through a repetition. Additionally, or alternatively, the computing device 552 may transmit the number of successful or valid repetitions to the display device during exercise. Additionally, or alternatively, the computing device 552 may transmit a target rate of motion and velocity data to the display device during exercise. The target rate of motion and velocity of the dumbbell 102 may be displayed on the display device during exercise.

[00274] Referring to FIG. 65, the computing device 552 may communicate with a display 1602 on a user's mobile device 1600. The display 1602 may include a first region 1604 displaying the number of valid repetitions 1606. The display 1602 may include a second region 1608 displaying a representative image 1610, such as that of a dumbbell 102. The representative image 1610 may move up and down on the display 1602 of the user's mobile device 1600 in response to movement of the dumbbell 102 during a repetition. The representative image 1610 may generally track the relative position and velocity of the dumbbell 102 during the repetition. In some implementations, the tracking is scaled to fit the size of the screen. In some implementations, the tracking is synchronized with the repetitive exercise motion. In some implementations, an alarm (*e.g.*, noise, flashing colors, or the like) are displayed if the dumbbell 102 is moving too fast or too slow relative to a pacing feature.

[00275] For instance, to generate the motion of the representative image 1610, the computing device 552 may estimate a completion percentage of a current repetition by comparing the instantaneous depth of the current repetition to the repetition reference depth D1 (see FIG. 64). The estimated completion percentage may be transmitted to the user's

mobile device 1600 and may be represented on the display 1602 by moving the representative image 1610 of the dumbbell 102 between upper and lower bounds 1612, 1614 of the second region 1608 of the display 1602 proportionally to the completion percentage. The display 1602 may include a pacing feature (*e.g.*, pacing bar 1616) within the second region 1608 of the display 1602 to indicate to the user how fast the repetition should be performed. The pacing feature 1616 may move up and down on the display 1602 between the upper and lower bounds 1612, 1614 of the second region 1608. The pacing feature 1616 may overlap the representative image 1610 when the speed of the dumbbell 102 during a repetition is within a target speed or rate range. When the pacing feature 1616 is positioned ahead of the representative image 1610 in the direction of movement of the representative image 1610, the user should increase the speed of the dumbbell 102 so that the representative image 1610 overlaps the pacing feature 1616, and vice versa.

[00276] The display 1602 may include a third region 1618 positioned above the first and second regions 1604, 1608. The third region 1618 may include a set number 1620 of the exercise routine and the amount of weight selected 1622. The display 1602 may include a control panel 1624 with selectable icons to switch the display 1602 to a previous or subsequent screen, to pause the display 1602, or to stop the display 1602.

[00277] Referring back to FIGS. 62-65, the computing device 552 may include a calibration mode in which the user does a full range repetition as an example of the correct repetition motion, and the computing device 552 may use the example full range repetition in evaluating the quality of subsequent repetitions. In the calibration mode, the computing device 552 may provide a first signal (*e.g.*, a single beep) that instructs the user to hold the dumbbell 102 in the ready position. After the dumbbell 102 is held steady for a predetermined minimum amount of time (*e.g.*, about two seconds), the computing device 552 may provide a second signal (*e.g.*, two beeps) that informs the user that the dumbbell 102 is ready to count repetitions.

[00278] With continued reference to FIGS. 62-65, the computing device 552 may count how many repetitions of the correct motion are performed. At or near the top point of each repetition, the computing device 552 may provide a third signal (*e.g.*, a beep) to indicate a successful repetition. If the dumbbell 102 is not lowered to or near the starting point (*e.g.*, the bottom point of the repetition), the computing device 552 may not count the next repetition. The computing device 552 may communicate with one or more display devices during exercise. The computing device 552 may provide the one or more display devices with

position data, speed data, repetition data, weight data, or other types of data related to the exercise.

[00279] The repetition counting system 550 may be associated with various types of free weights, including dumbbells, barbells, and kettlebells, and may assess whether or not to count an exercise repetition of the free weight. Referring to FIG. 66, the repetition counting system 550 may be attached to a barbell 1702 with a coupling feature, such as a strap 1704. Referring to FIG. 67, the repetition counting system 550 may be attached to a kettlebell 1802 with a coupling feature, such as an adhesive layer 1804.

[00280] The repetition counting system 550 may measure and assess the quality of the repetitions of various types of exercises, including bicep curls, tricep extensions, shoulder presses, and many other types of exercises utilizing one or more free weights. The repetition counting system 550 may be removable from the free weight. In some implementations, the repetition counting system 550 may be attached to a user, such as a user's clothing, with a coupling feature, such as a clip. When attached to the user, the computing device may assess the quality of repetitions of various exercises not utilizing a free weight, such as push-ups, pull-ups, tricep dips, and the like. Referring to FIG. 68, the repetition counting system 550 may be attached to a user's belt or waistband 1902 with a coupling feature, such as a clip, to measure repetitions during a pull-up exercise routine.

[00281] The foregoing has many advantages. For instance, as described, the dumbbell system may provide a single dumbbell that accommodates lighter weight workouts with relatively small weight increments between weight selections and heavier weight workouts without disassembling the handle assembly. The dumbbell system may include two different types of weight selection methods. One weight selection method may involve rotating a handle about an axis of rotation to join one or more weights to a handle assembly of the dumbbell via rotation of indexing and/or selector discs. Such as selection method may be useful on a lighter weight dumbbell and/or may allow for relatively small incremental weight selections, such as two and one-half pound increments, between lower and upper weight limits for the adjustable dumbbell. The other weight selection method may involve rotating a selector to linearly move a selection member to couple a weight to a handle assembly of the dumbbell. This selection method may be useful to join relatively large weights to the dumbbell to significantly increase the upper weight limit of an existing adjustable dumbbell that uses another selection method to join its other weights to the handle assembly.

[00282] Each add-on weight may be joined to an adjacent add-on weight utilizing one of the selection assemblies described herein and suitably modified as needed. Any such add-

on weights may further be modified to include a weight attachment feature to interact with a corresponding weight attachment features on an adjacent add-on weight. Thus, an adjustable dumbbell with a plurality of weights on each end of the handle assembly could be formed using solely add-on weights that incorporate a selection assembly on the add-on weight.

[00283] As used in the claims with respect to connection between a weight and the handle assembly, the phrases "fixedly connected," "fixedly joined," or variations thereof (e.g., "fixedly connects" or "fixedly joins") refer to a condition in which the connection between the weight and the handle assembly is such that all six degrees of rigid body motion freedom (i.e., translation in three perpendicular axes and rotation about the three perpendicular axes) are restrained between the weight and the handle assembly. In the "fixedly connected" or "fixedly joined" state, the weight is intended to contribute to the total weight of the dumbbell by remaining joined to the handle assembly during use in an exercise by the user. Further, as used in the claims with respect to the weights being connected to the handle assembly, the phrases "not fixedly connected," "not fixedly joined," or variations thereof (e.g., "not fixedly connects" or "not fixedly joins") refer to a condition in which the connection between the weight and the handle assembly is such that at least one of the translation degrees of freedom is not restrained between the weight and the handle assembly. In the "not fixedly connected" or "not fixedly joined" state, the handle assembly is movable relative to the weight along a non-restrained translation degree of freedom so that upon sufficient movement of the handle assembly relative to the weight, the weight is disconnected from the handle assembly as the weight is not intended to contribute to the total weight of the dumbbell during use in the exercise. Further, in the "not fixedly connected" or "not fixedly joined" state, if the weight is not removed from the handle assembly prior to the start of the exercise by sufficiently moving the handle assembly relative to the dumbbell along the non-restrained translation degree of freedom, the weight will become disconnected from the handle assembly (typically by sliding off the handle assembly) when the weight moves sufficiently along the non-restrained translation degree of freedom during the exercise.

[00284] The foregoing description has broad application. The discussion of any embodiment is meant only to be explanatory and is not intended to suggest that the scope of the disclosure, including the claims, is limited to these examples. In other words, while illustrative embodiments of the disclosure have been described in detail herein, the inventive concepts may be otherwise variously embodied and employed, and the appended claims are intended to be construed to include such variations, except as limited by the prior art.

[00285] The foregoing discussion has been presented for purposes of illustration and description and is not intended to limit the disclosure to the form or forms disclosed herein. For example, various features of the disclosure are grouped together in one or more aspects, embodiments, or configurations for the purpose of streamlining the disclosure. However, various features of the certain aspects, embodiments, or configurations of the disclosure may be combined in alternate aspects, embodiments, or configurations. Moreover, the following claims are hereby incorporated into this Detailed Description by this reference, with each claim standing on its own as a separate embodiment of the present disclosure.

[00286] All directional references (e.g., proximal, distal, upper, lower, upward, downward, left, right, lateral, longitudinal, front, back, top, bottom, above, below, vertical, horizontal, radial, axial, clockwise, and counterclockwise) are only used for identification purposes to aid the reader's understanding of the present disclosure, and do not create limitations, particularly as to the position, orientation, or use. Connection references (e.g., attached, coupled, connected, and joined) are to be construed broadly and may include intermediate members between a collection of elements and relative movement between elements unless otherwise indicated. As such, connection references do not necessarily infer that two elements are directly connected and in fixed relation to each other. Identification references (e.g., primary, secondary, first, second, third, fourth, etc.) are not intended to connote importance or priority, but are used to distinguish one feature from another. The drawings are for purposes of illustration only and the dimensions, positions, order and relative sizes reflected in the drawings attached hereto may vary

CLAIMS

What is claimed is:

1. A free weight comprising:

at least one sensor connected to the free weight; and

a computing device in communication with the at least one sensor and configured to assess whether or not to count an exercise repetition based upon information received from the at least one sensor.

2. The free weight of claim 1, wherein the computing device is configured to use a first repetition as a basis in assessing whether or not to count subsequent repetitions.

3. The free weight of claim 2, wherein the computing device is configured to dynamically adjust the first repetition in assessing subsequent repetitions to account for data drift of the at least one sensor.

4. The free weight of any preceding claim, wherein the computing device is configured to not count the exercise repetition unless the free weight is moved to a pre-determined position.

5. The free weight of claim 4, wherein the pre-determined position comprises a location near an upper position of a repetition that comprises moving the free weight between the upper position and a lower position.

6. The free weight of any of claims 1 to 3, wherein the computing device is configured to analyze a rate of motion of the free weight in assessing whether or not to count the exercise repetition.

7. The free weight of any of claims 1 to 3, wherein the free weight comprises one of the following: a barbell, a dumbbell, or a kettlebell.

8. The free weight of any of claims 1 to 3, wherein the at least one sensor comprises at least one of the following: an accelerometer, a magnetometer, or a gyroscope.

9. The free weight of any of claims 1 to 3, further comprising another sensor operatively associated with the free weight and configured to sense a weight of the free weight.

10. A free weight comprising:

at least one sensor connected to the free weight;

an audio output device; and

a computing device in communication with the at least one sensor and the audio output device, the computing device configured to cause the audio output device to produce an audible sound based upon information received from the at least one sensor.

11. The free weight of claim 10, wherein the computing device causes the audio output device to produce the audible sound upon determining the user has completed a valid repetition with the free weight.

12. The free weight of claim 10, wherein the computing device causes the audio output device to produce the audible sound upon determining the user has moved the free weight to a pre-determined position.

13. The free weight of claim 12, wherein the pre-determined position comprises a location near an upper position of a repetition that comprises moving the free weight between the upper position and a lower position.

14. The free weight of claim 10, wherein the computing device causes the audio output device to produce the audible sound upon determining that the at least one sensor is ready to measure repetitive motion of the free weight.

15. The free weight of any of claims 10 to 14, wherein at least one of the computing device and the audio output device are connected to the free weight.

16. The free weight of any of claims 10 to 14, wherein the free weight comprises one of the following: a barbell, a dumbbell, or a kettlebell.

17. The free weight of any of claims 10 to 14, wherein the at least one sensor comprises at least one of the following: an accelerometer, a magnetometer, or a gyroscope.

18. The free weight of any of claims 10 to 14, further comprising another sensor operatively associated with the free weight and configured to sense a weight of the free weight.

19. A free weight comprising:

at least one sensor connected to the free weight;

a display device; and

a computing device in communication with the at least one sensor and the display device, the computing device configured to cause the display device to indicate a position of the free weight based upon information received from the at least one sensor.

20. The free weight of claim 19, wherein the computing device causes the display device to display a representative image of the free weight moving on the display in connection with the position of the free weight.

21. The free weight of claim 19 or 20, wherein the computing device causes the display device to display a target rate of motion.

22. The free weight of claim 21, wherein the computing device causes the display device to display a pacing feature that moves on the display to indicate the target rate of motion.

23. The free weight of any of claims 19 or 20, wherein the free weight comprises one of the following: a barbell, a dumbbell, or a kettlebell.

24. The free weight of any of claims 19 or 20, wherein the at least one sensor comprises at least one of the following: an accelerometer, a magnetometer, or a gyroscope.

25. The free weight of any of claims 19 or 20, further comprising another sensor operatively associated with the free weight and configured to sense a weight of the free weight.

26. A free weight comprising:

a repetition counting system including:

at least one sensor connected to the free weight; and

a computing device including a processor in communication with the at least one sensor and configured to assess whether or not to count an exercise repetition based upon information received from the at least one sensor.

27. A system for counting exercise repetitions performed by a user, the system comprising:

at least one sensor connected to a free weight or the user; and

a computing device in communication with the at least one sensor and configured to assess whether or not to count an exercise repetition based upon information received from the at least one sensor.

28. The system of claim 27, wherein the computing device is configured to use a first repetition as a basis in assessing whether or not to count subsequent repetitions.

29. The system of claim 28, wherein the computing device is configured to dynamically adjust the first repetition in assessing subsequent repetitions to account for data drift of the at least one sensor.

30. The system of any of claims 27 to 29, wherein the computing device is configured to not count the exercise repetition unless the free weight or the user is moved to a pre-determined position.

31. The free weight of claim 30, wherein the pre-determined position comprises a location near an upper position of a repetition that comprises moving the free weight or the user between the upper position and a lower position.

FIG. 1

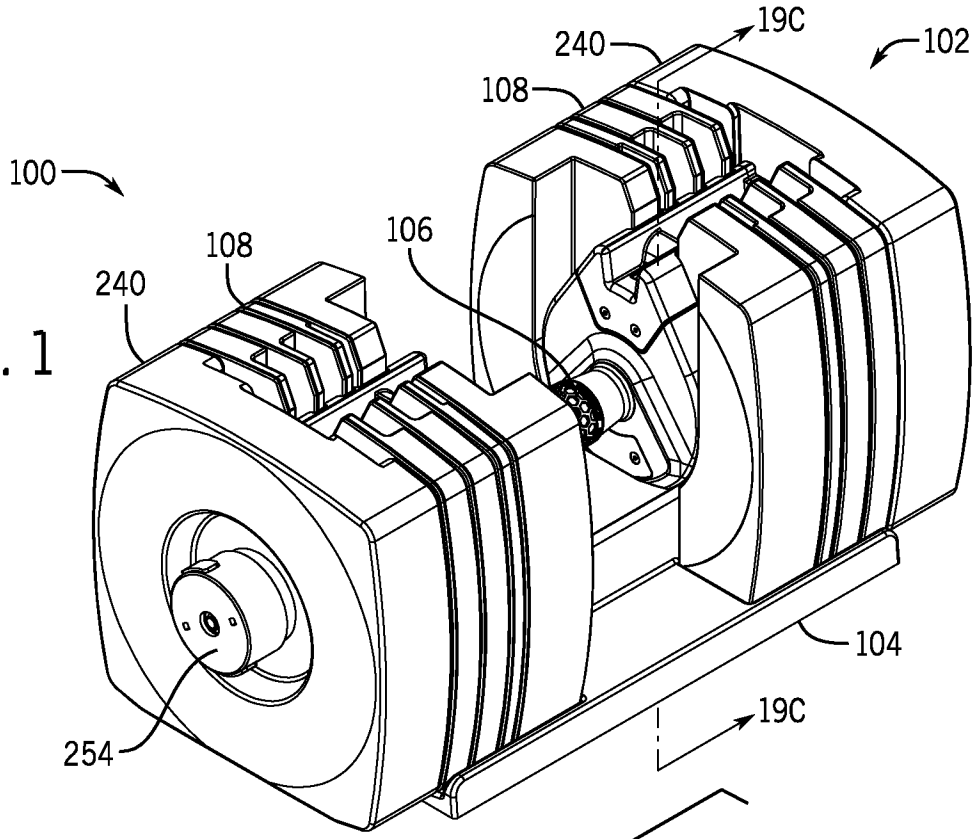
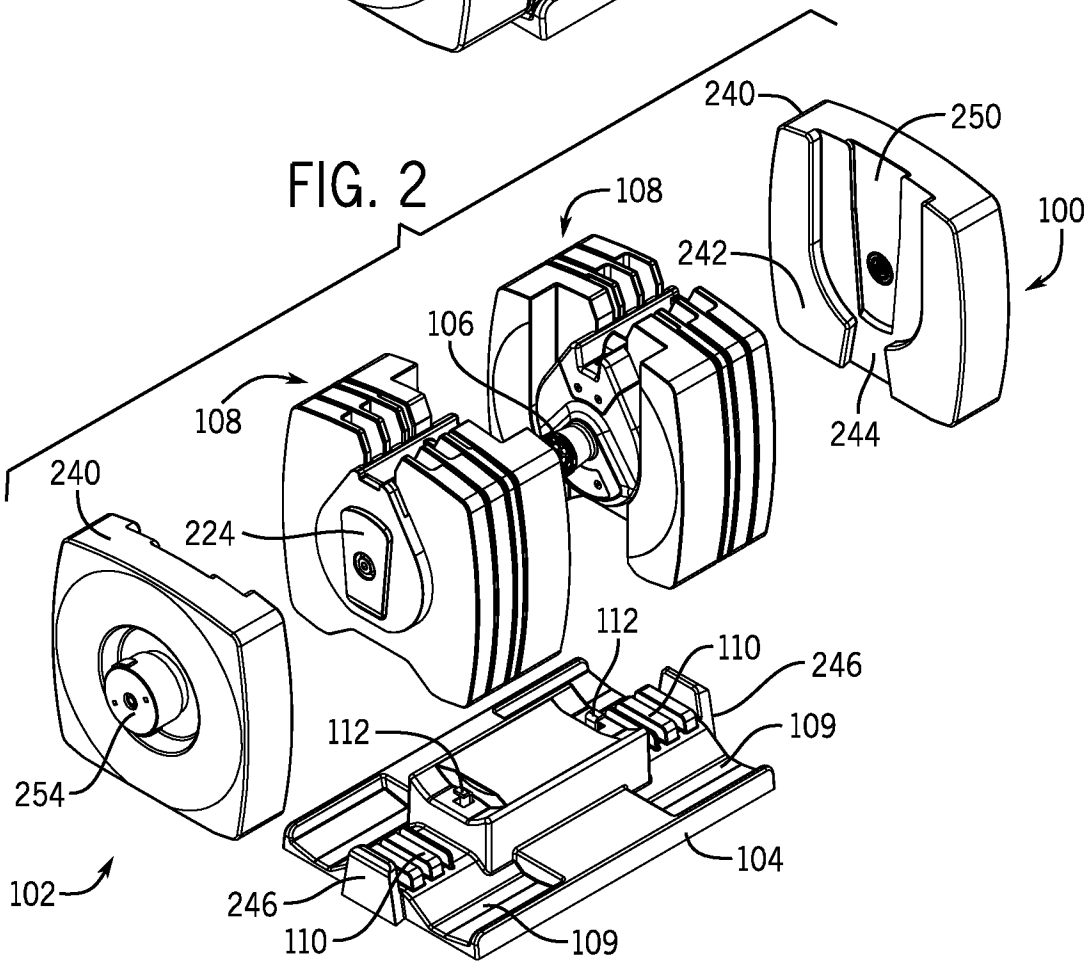

19C
240
102
108
100
106
108
240
104
254
19C

FIG. 2


240
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240
224
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112
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254
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102
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110
109

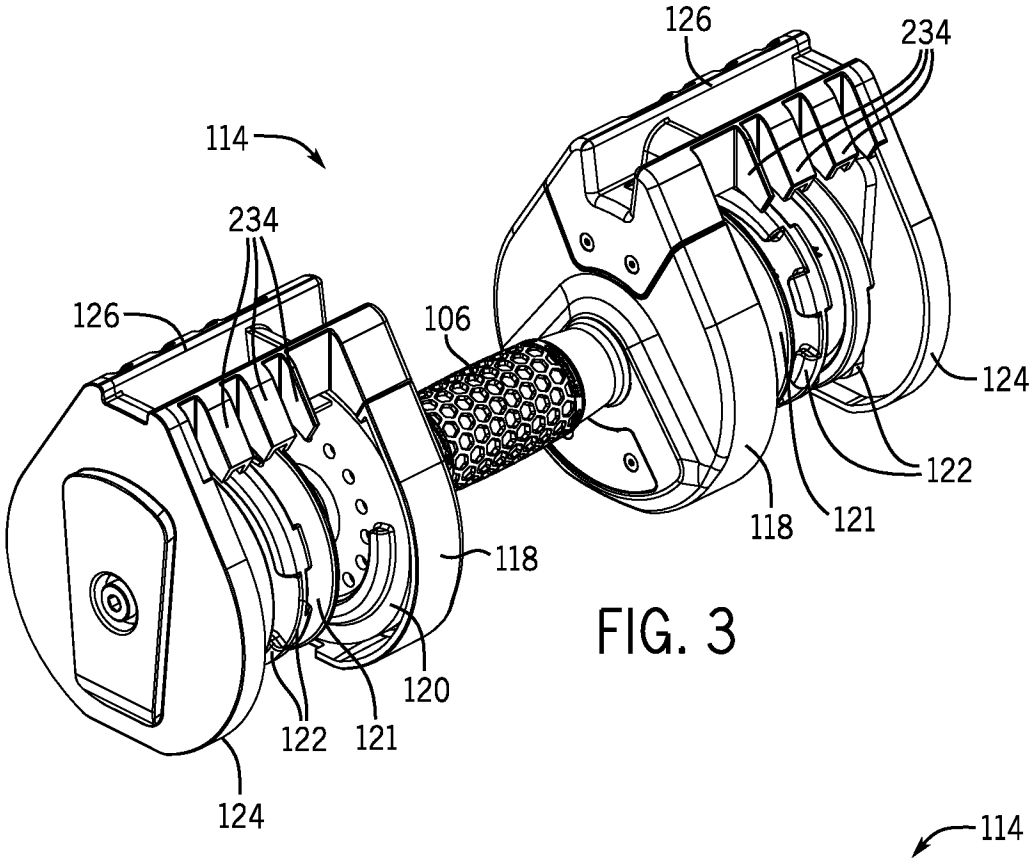

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FIG. 3

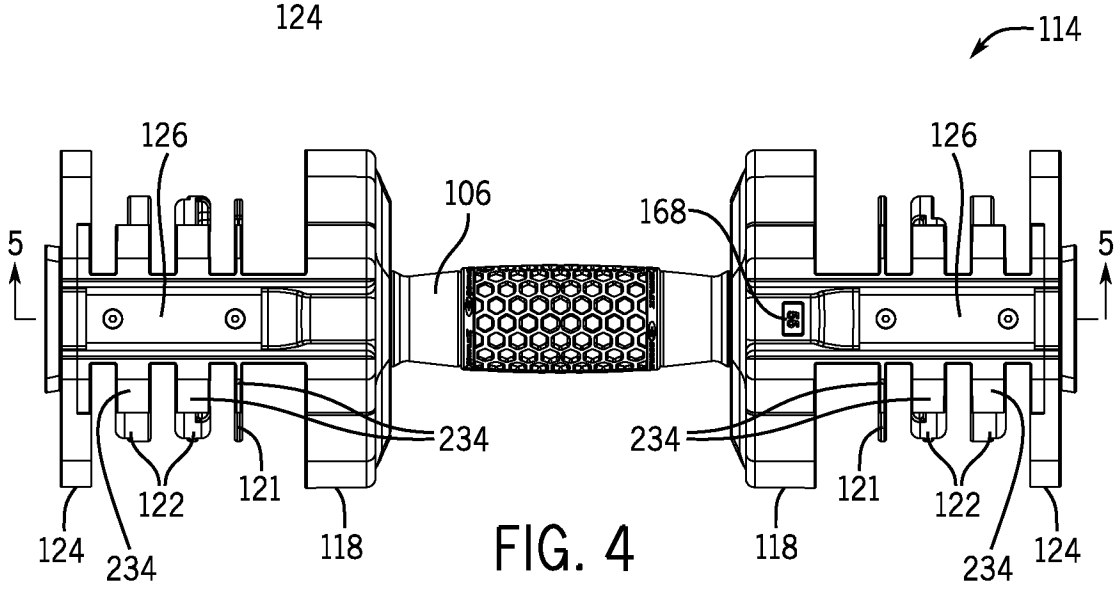

114
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168
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5
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234
121
121
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234
124

FIG. 4

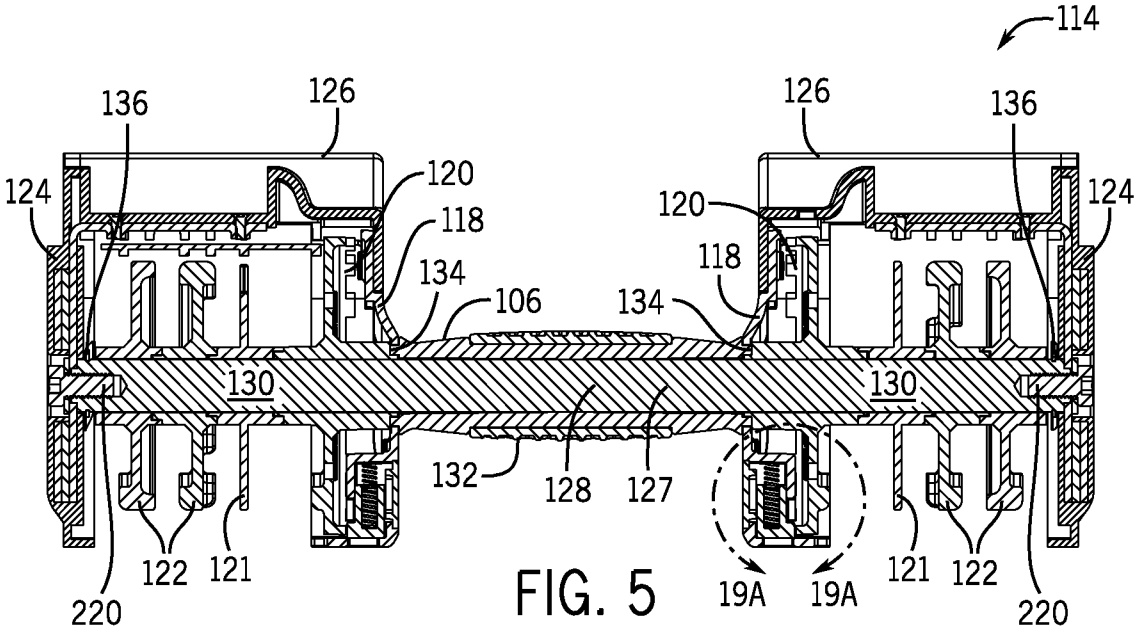

114
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19A
19A
220

FIG. 5

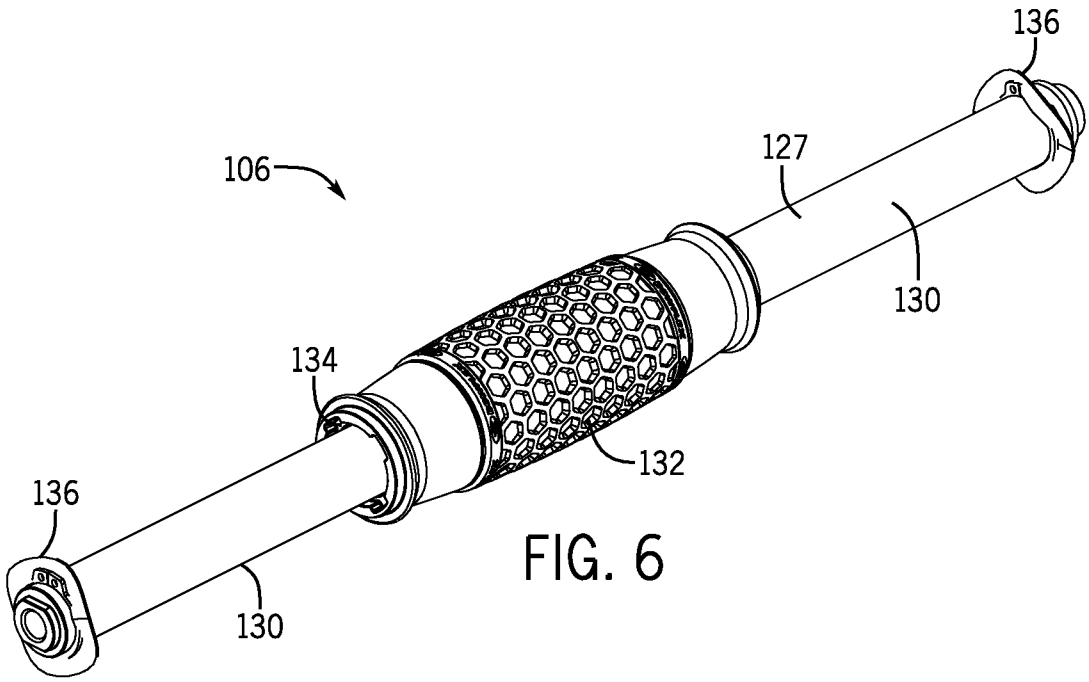

136
106
127
130
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136
130

FIG. 6

FIG. 7

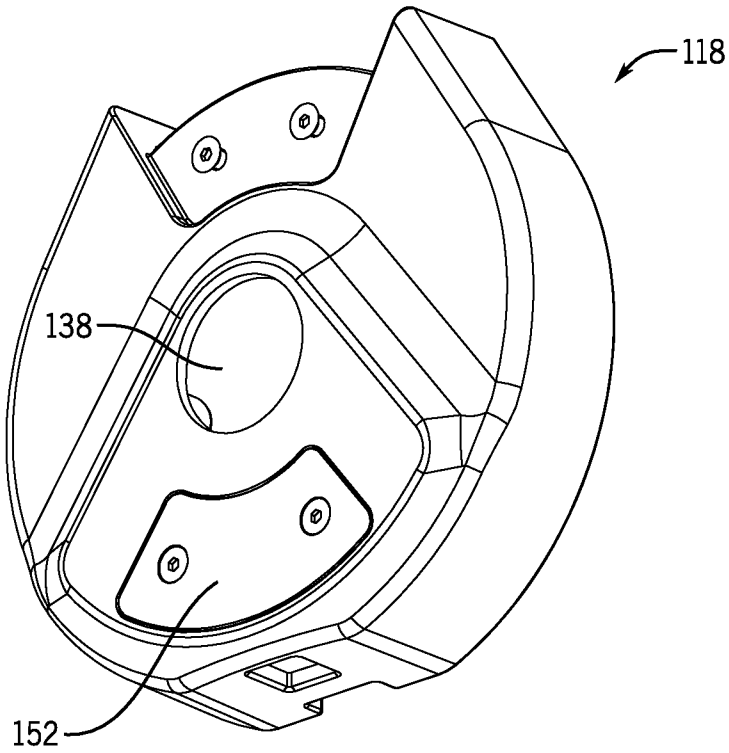


FIG. 8

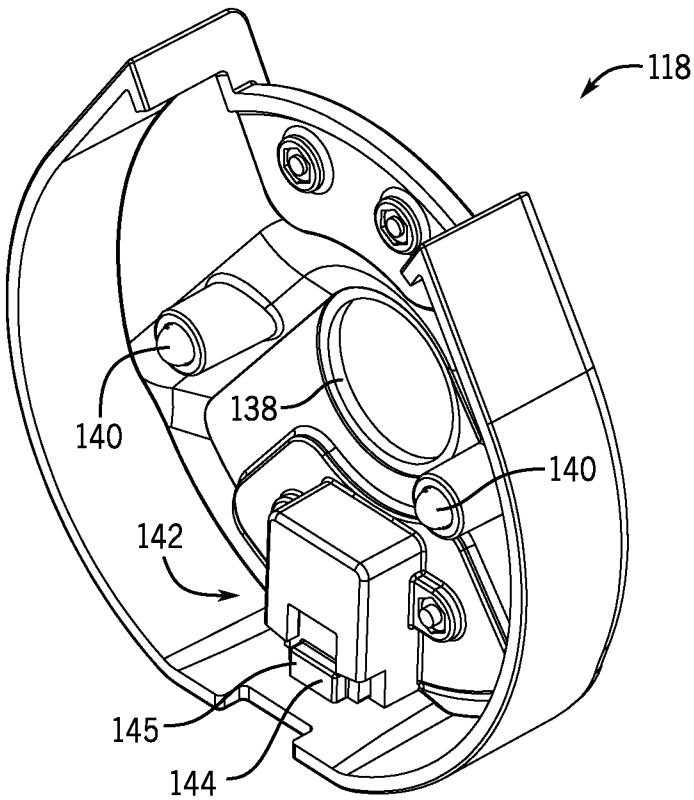


FIG. 9

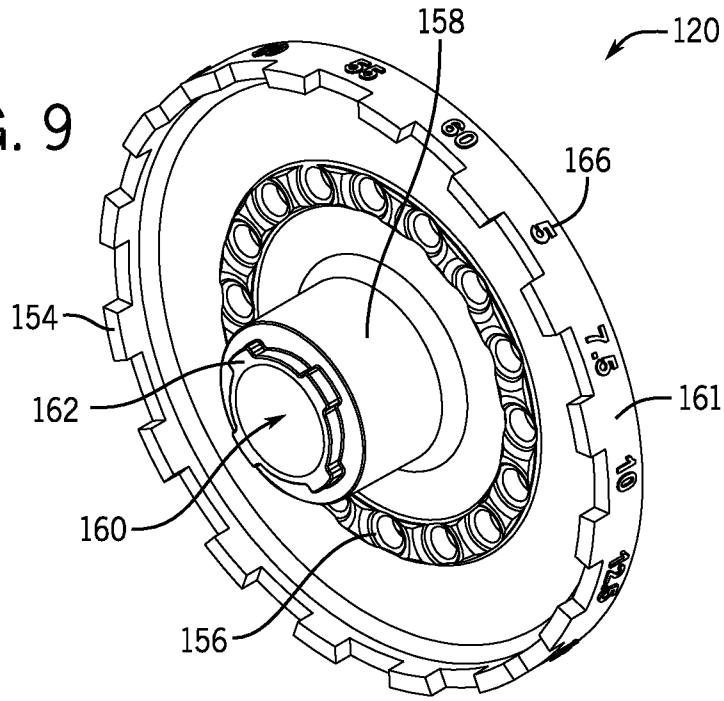

158
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166
154
162
161
160
156

FIG. 10

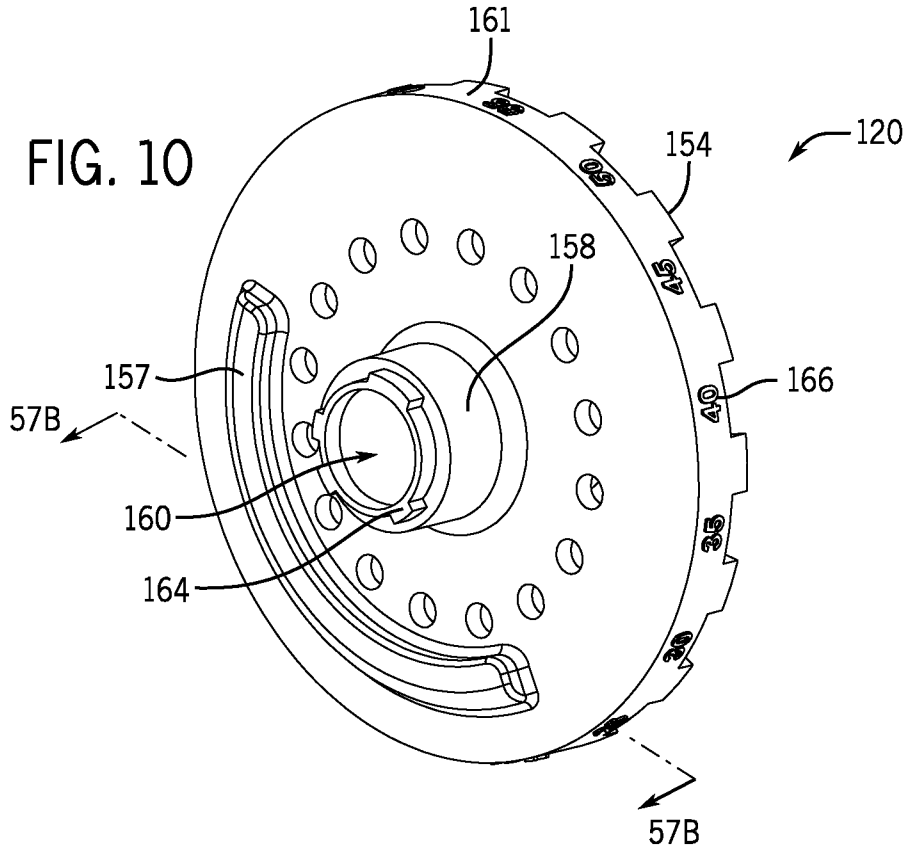

161
154
120
158
157
166
57B
160
164
57B

FIG. 11

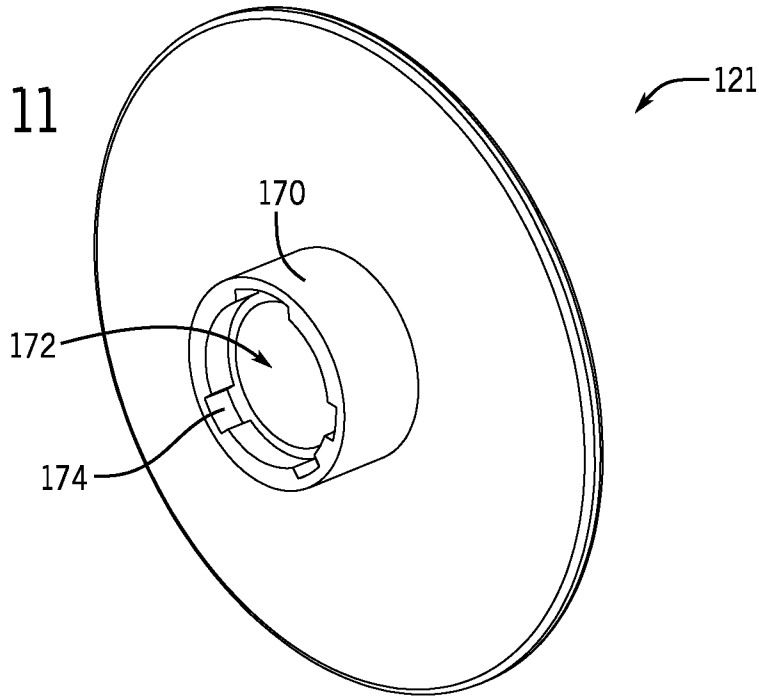
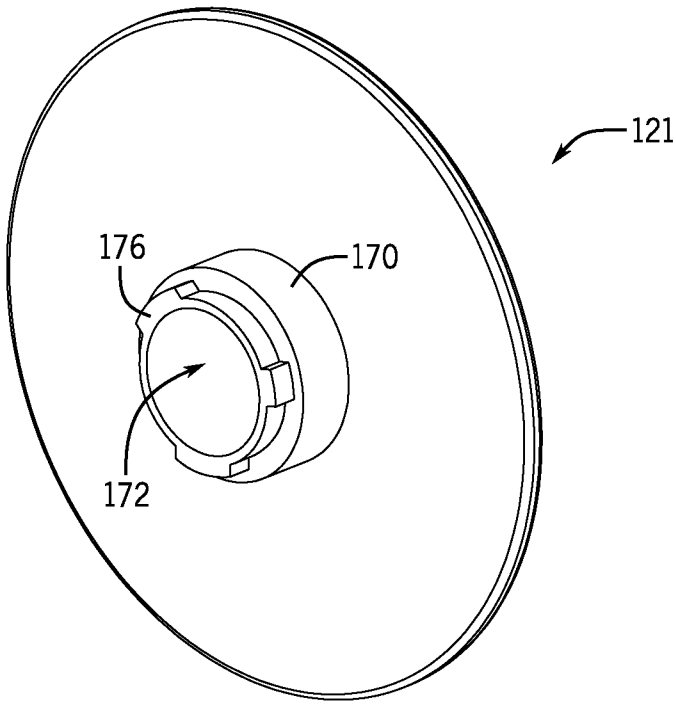


FIG. 12



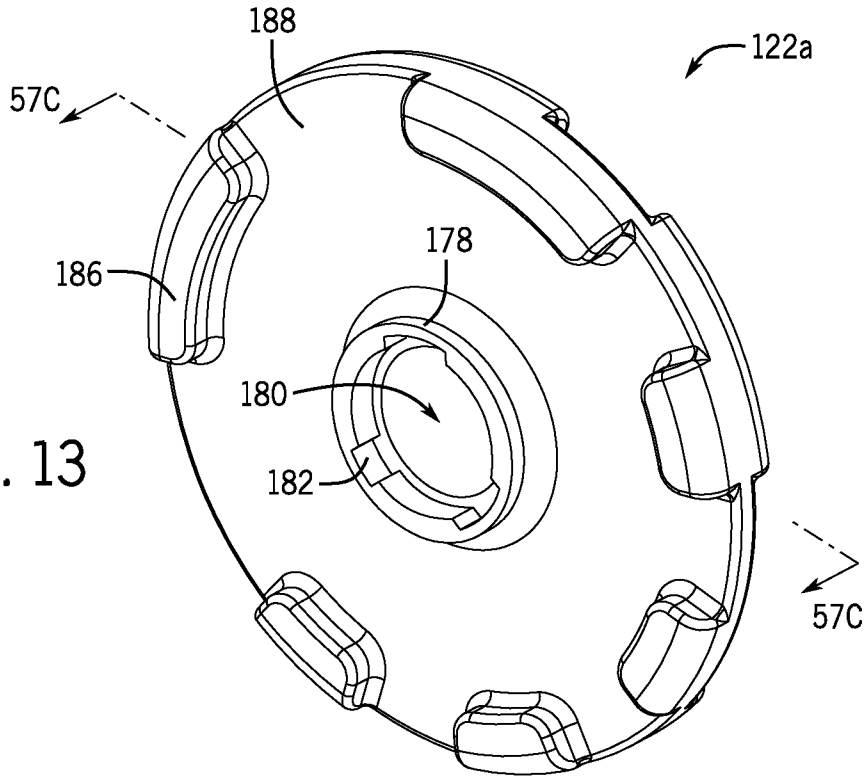

188
122a
57C
178
186
180
182
57C

FIG. 13

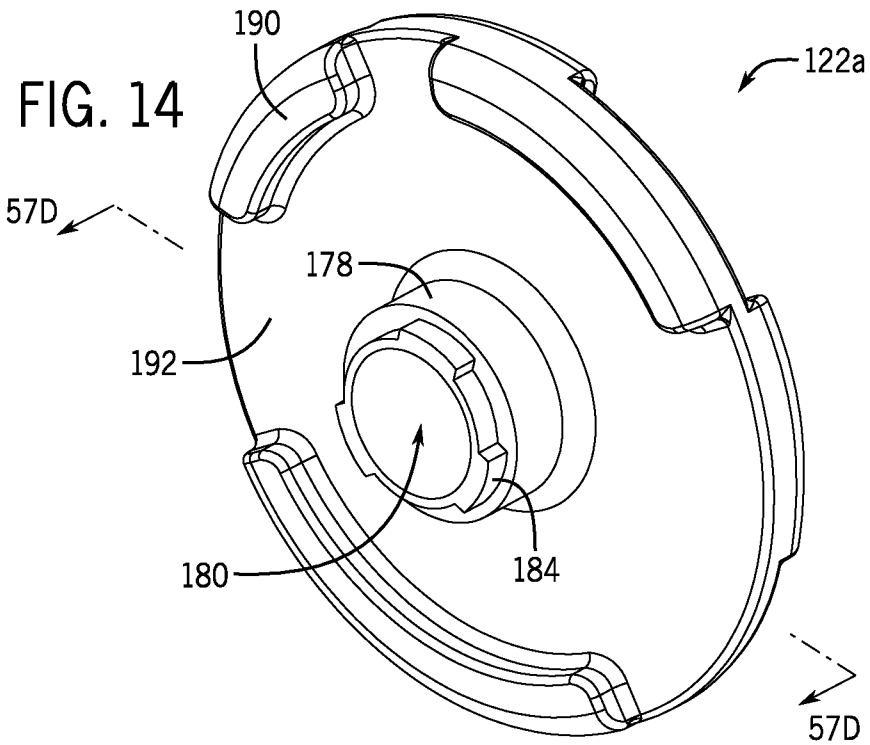

190
122a
57D
178
192
180
184
57D

FIG. 14

FIG. 15

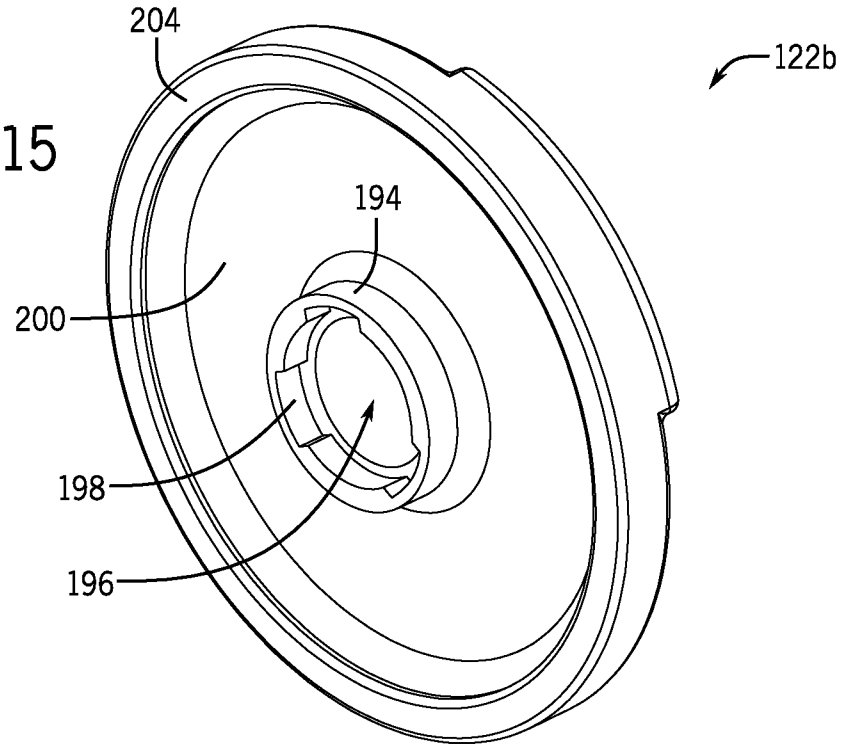


FIG. 16

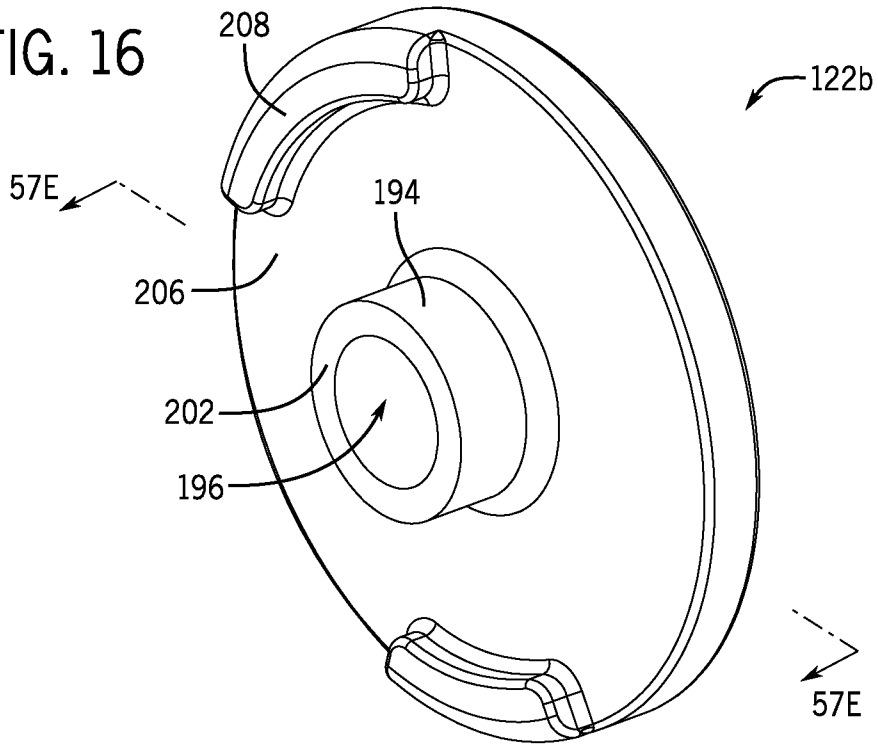


FIG. 17

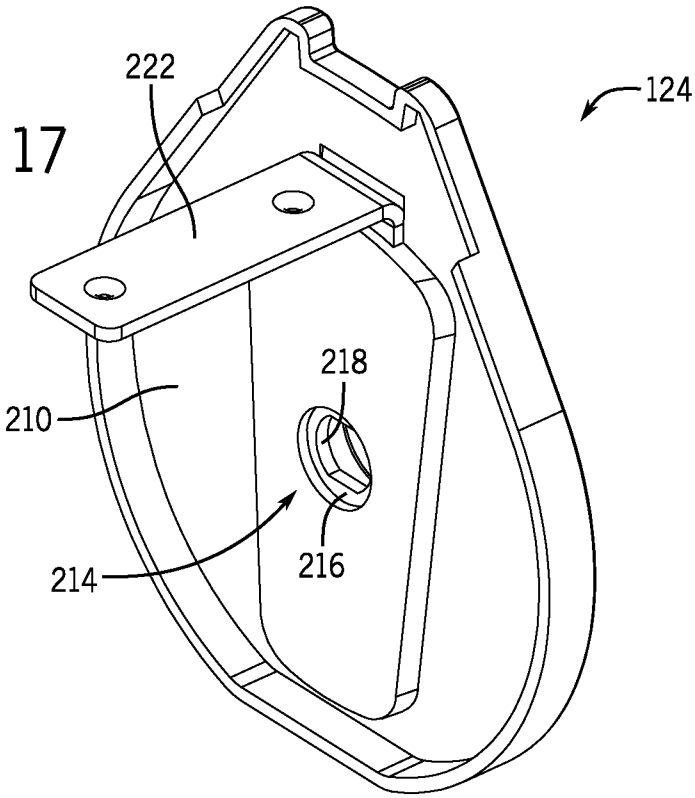

222
124
218
210
214
216

FIG. 18

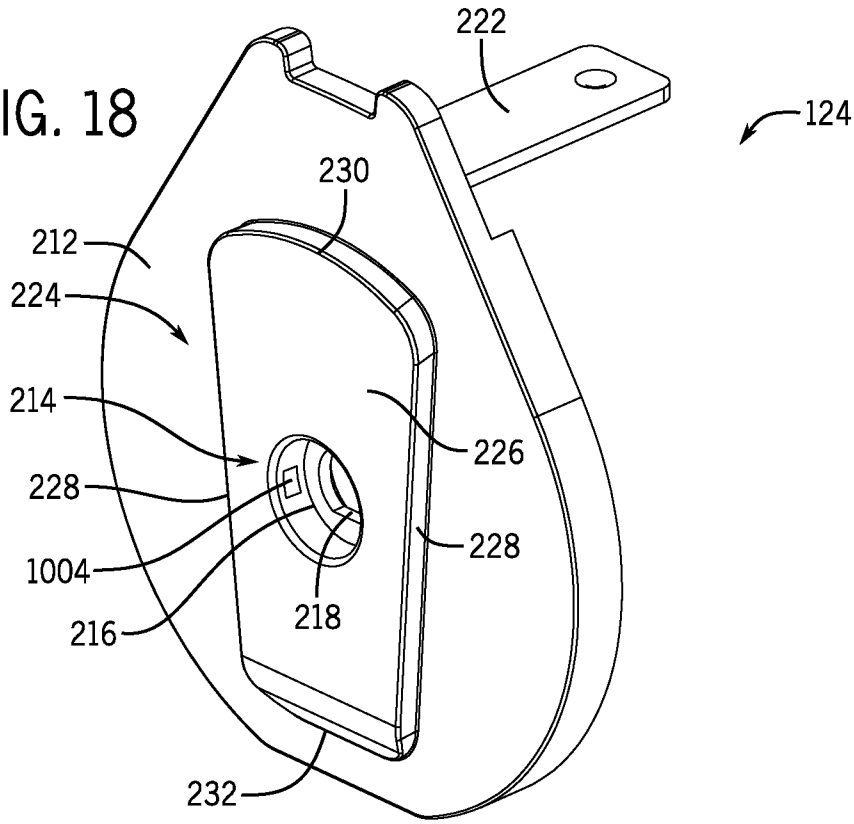
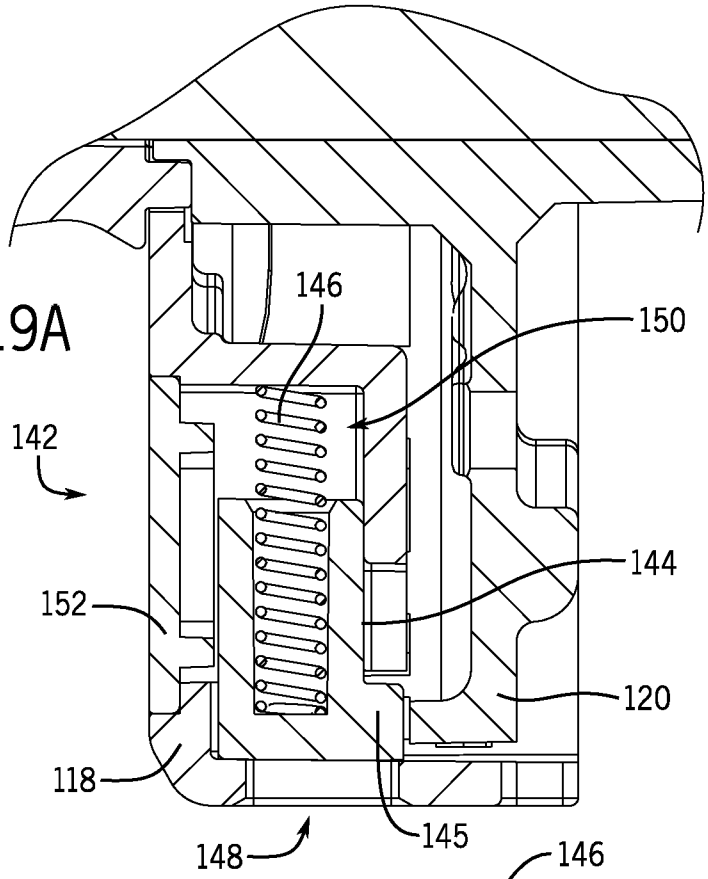

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214
226
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228
1004
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232

FIG. 19A



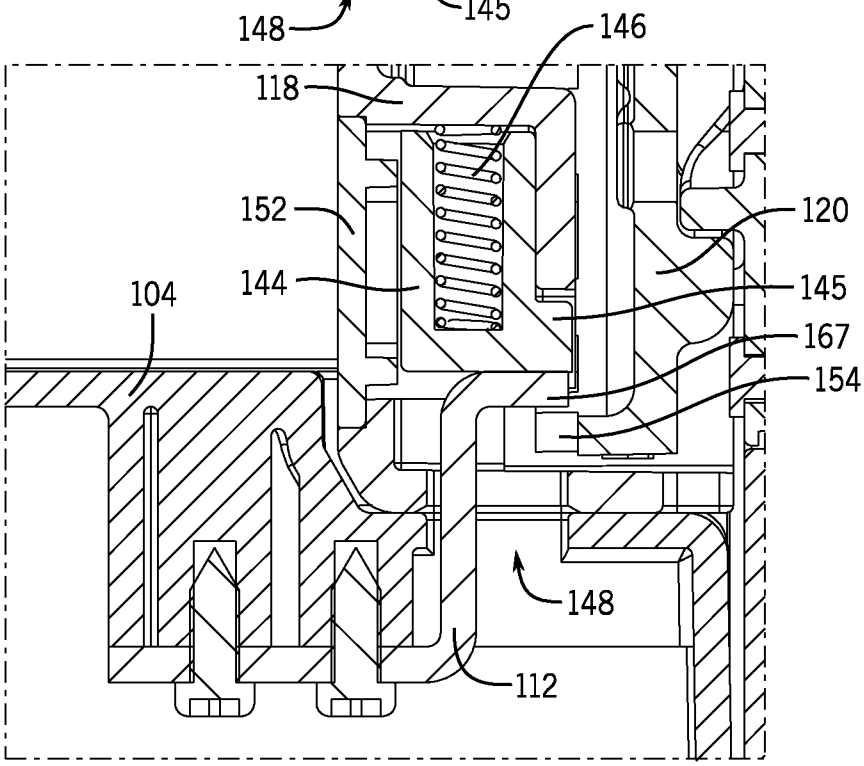


FIG. 19B

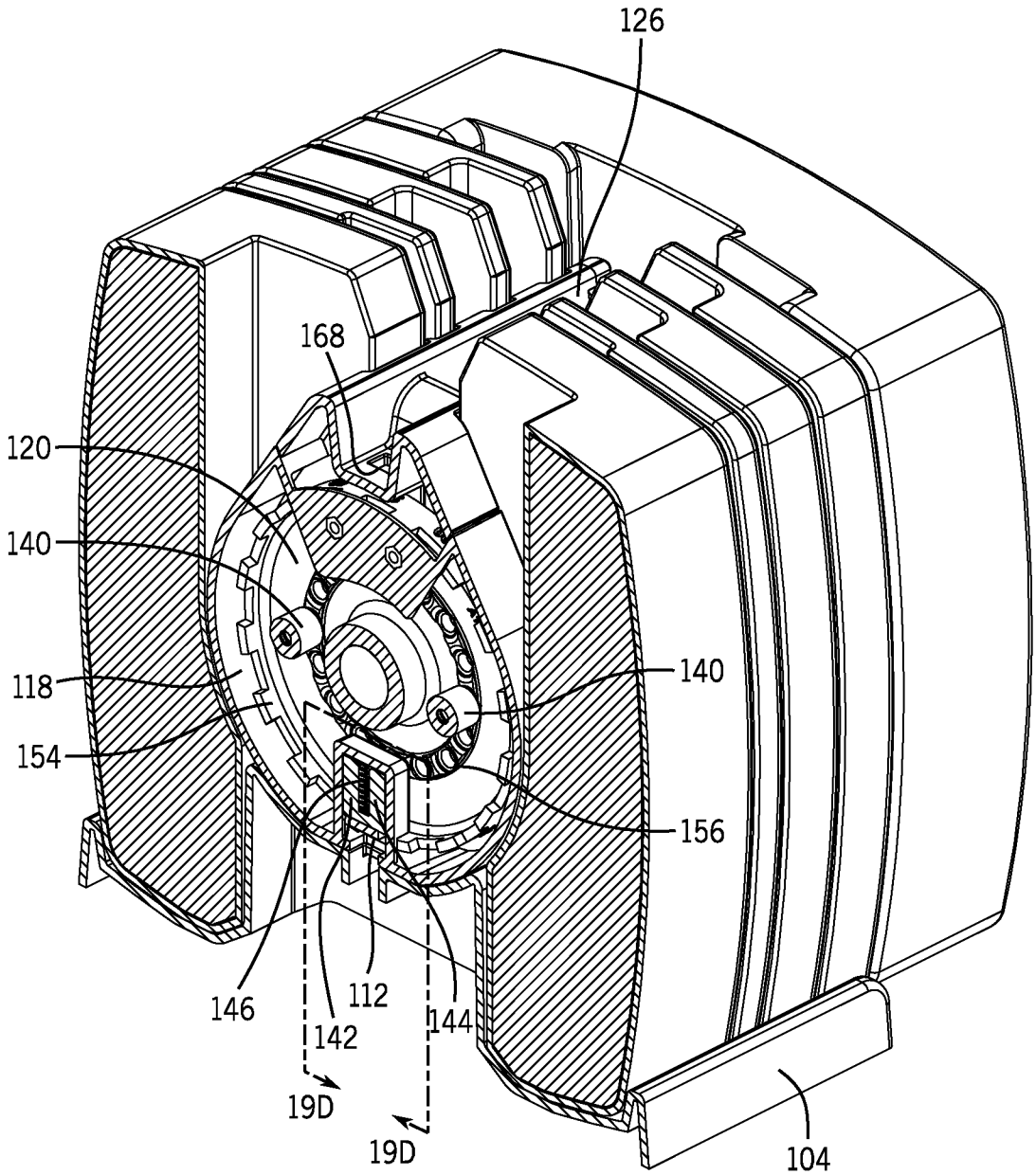


FIG. 19C

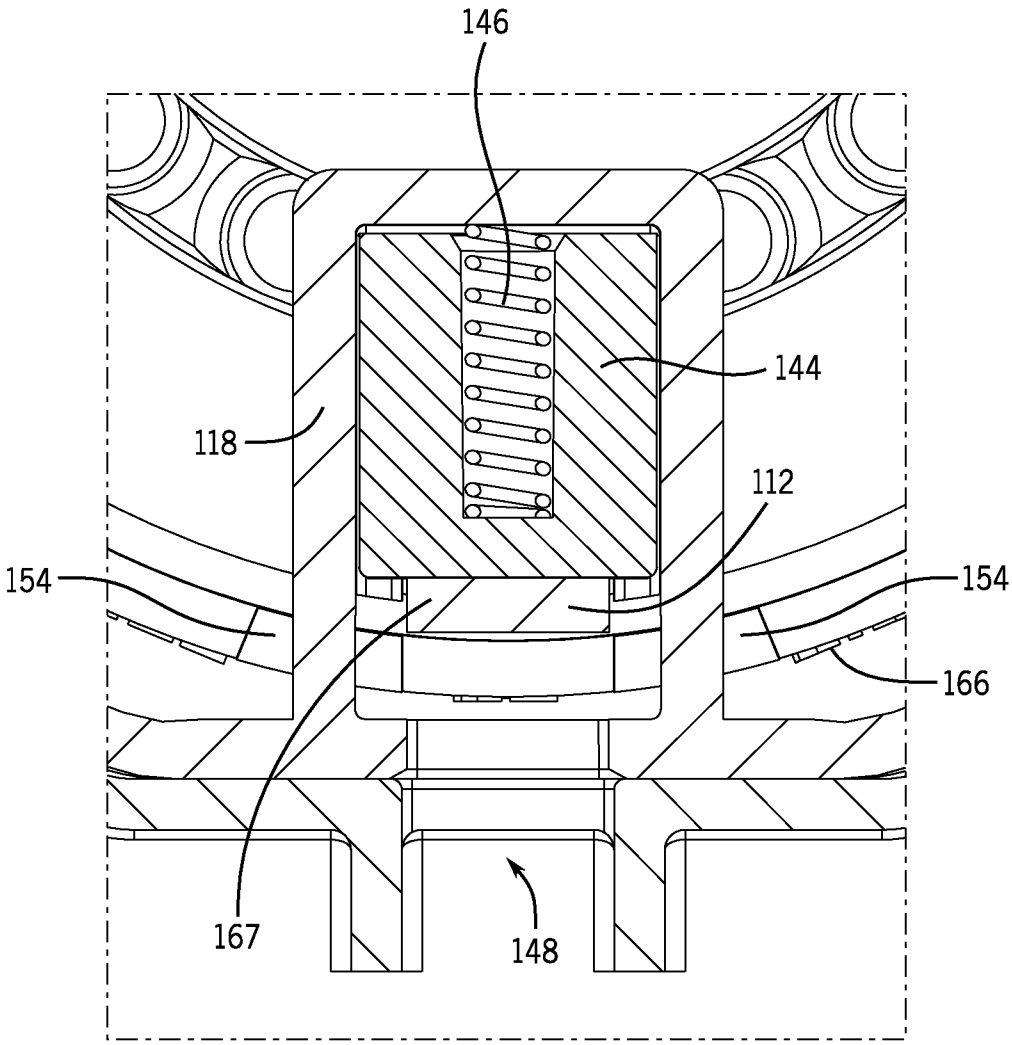


FIG. 19D

FIG. 20

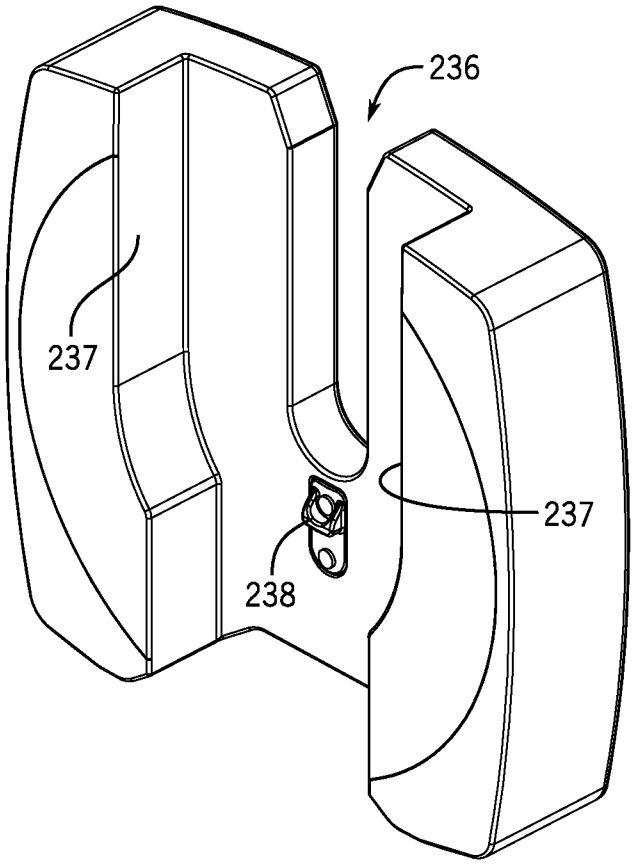


FIG. 21

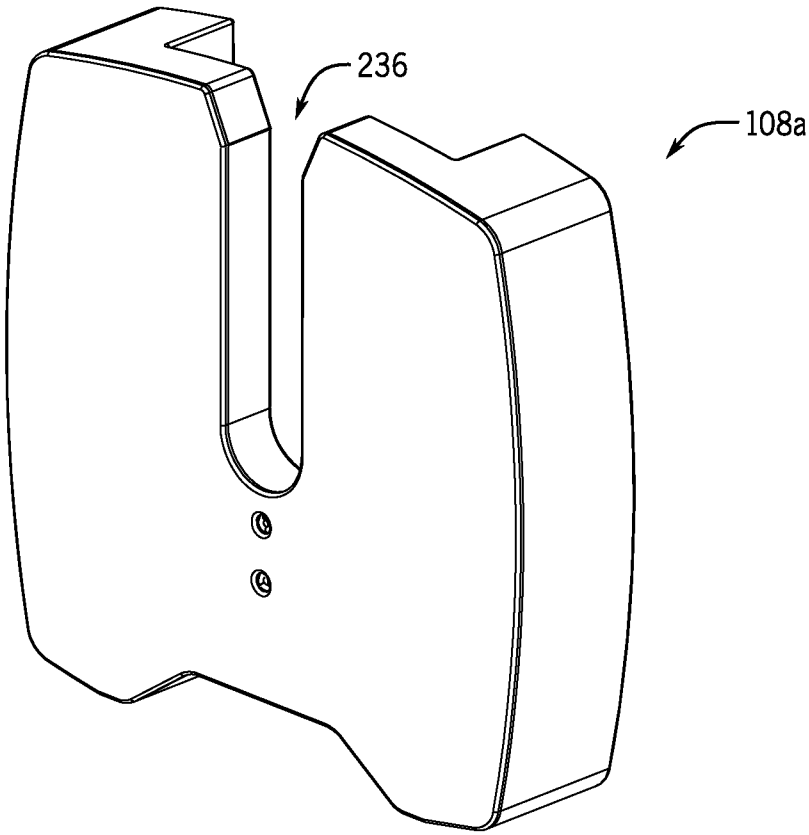


FIG. 22

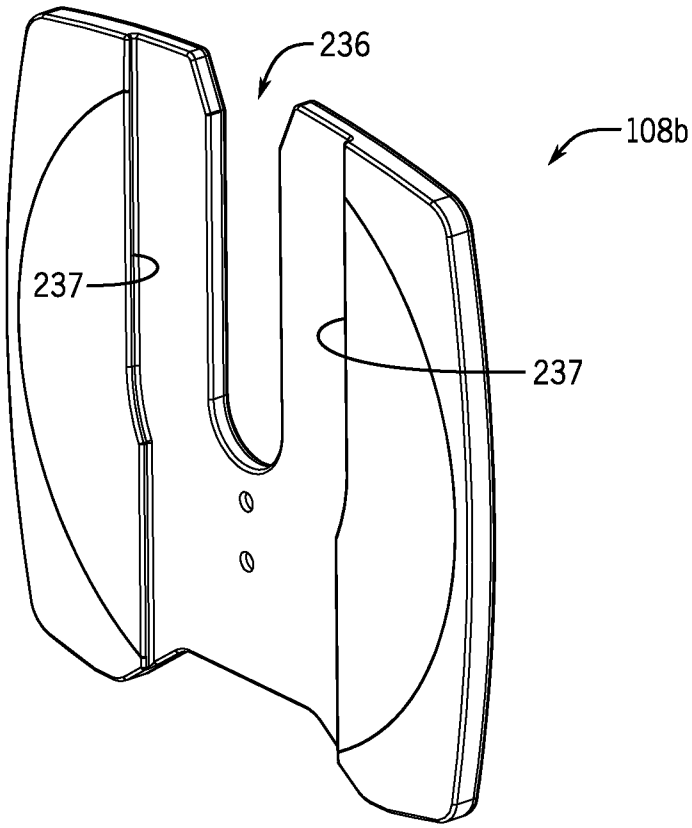


FIG. 23

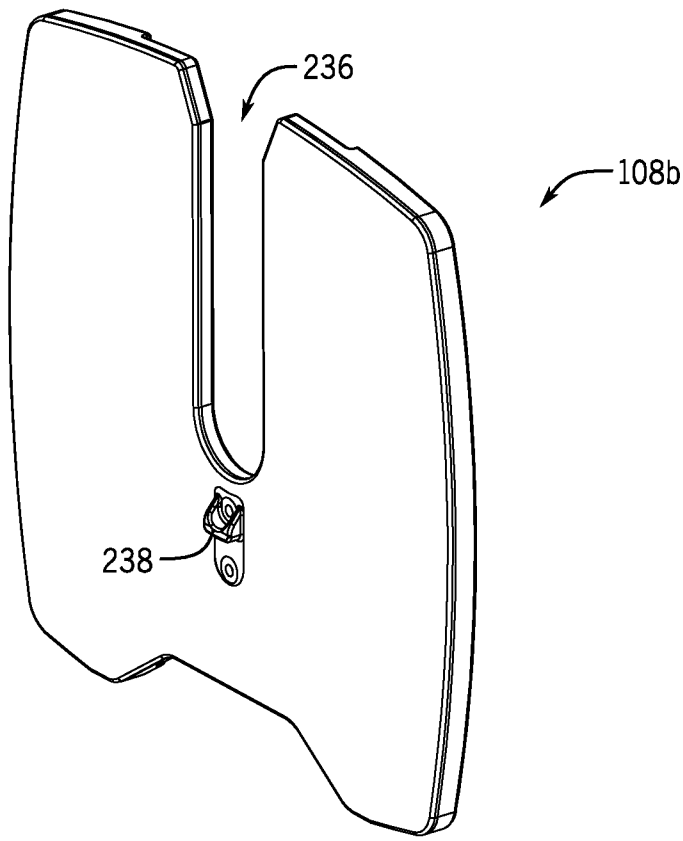


FIG. 24

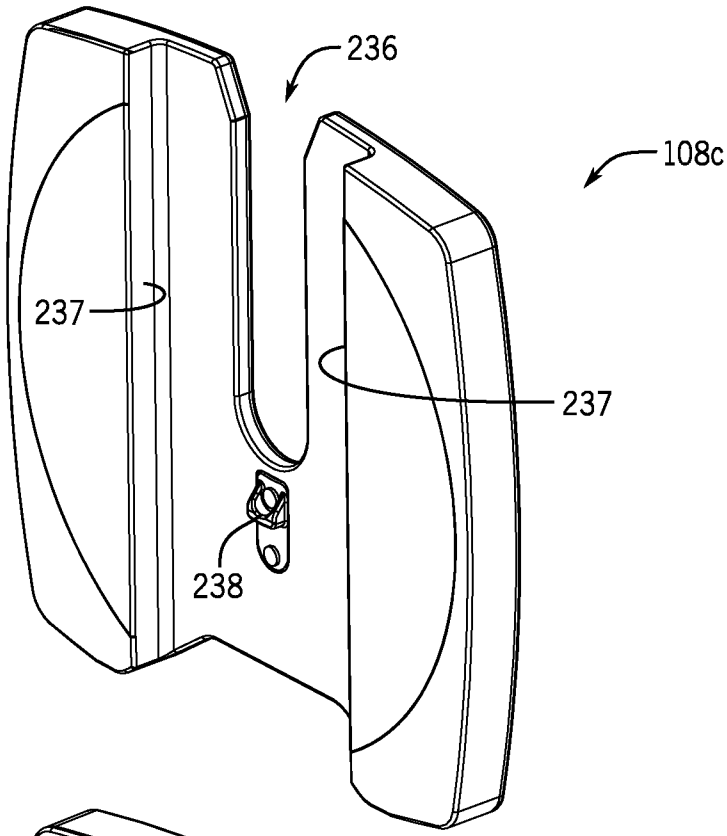


FIG. 25

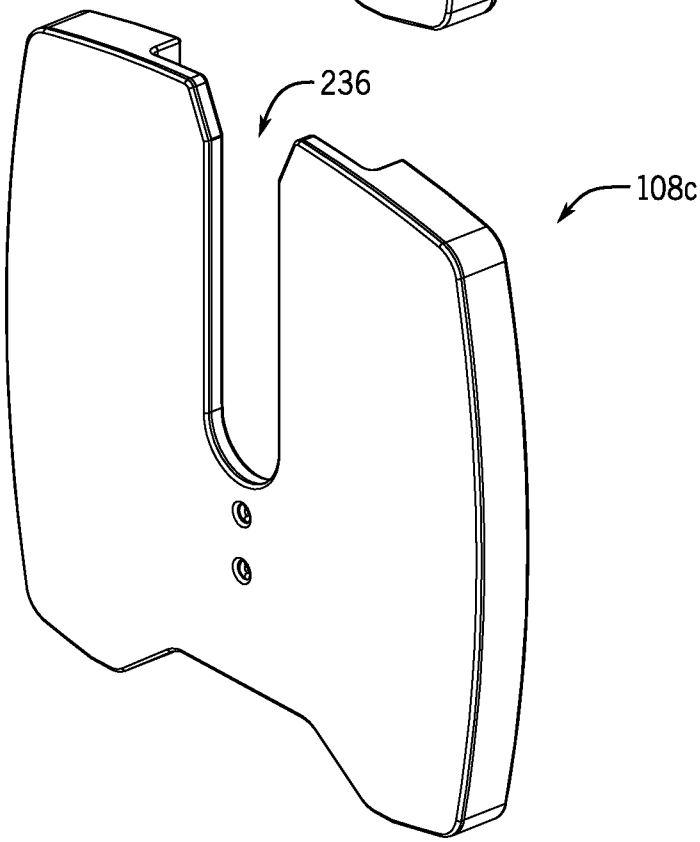


FIG. 26

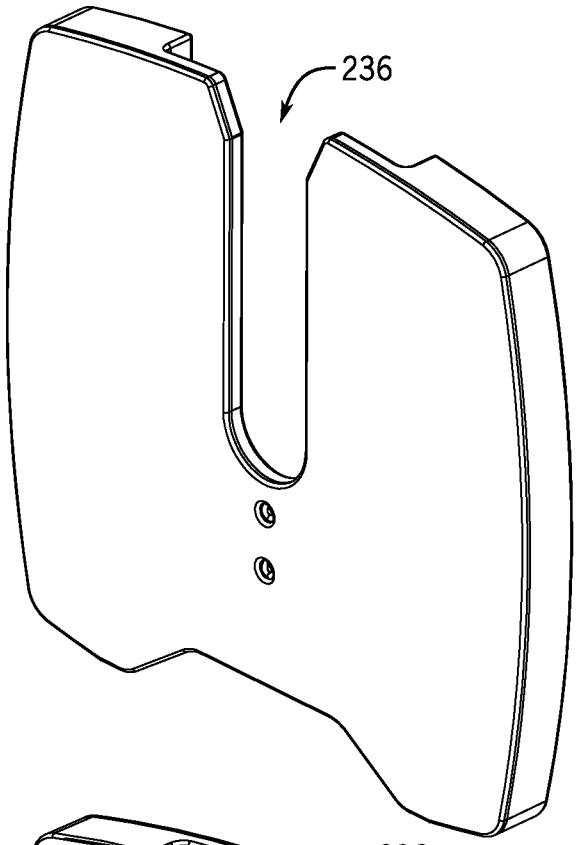


FIG. 27

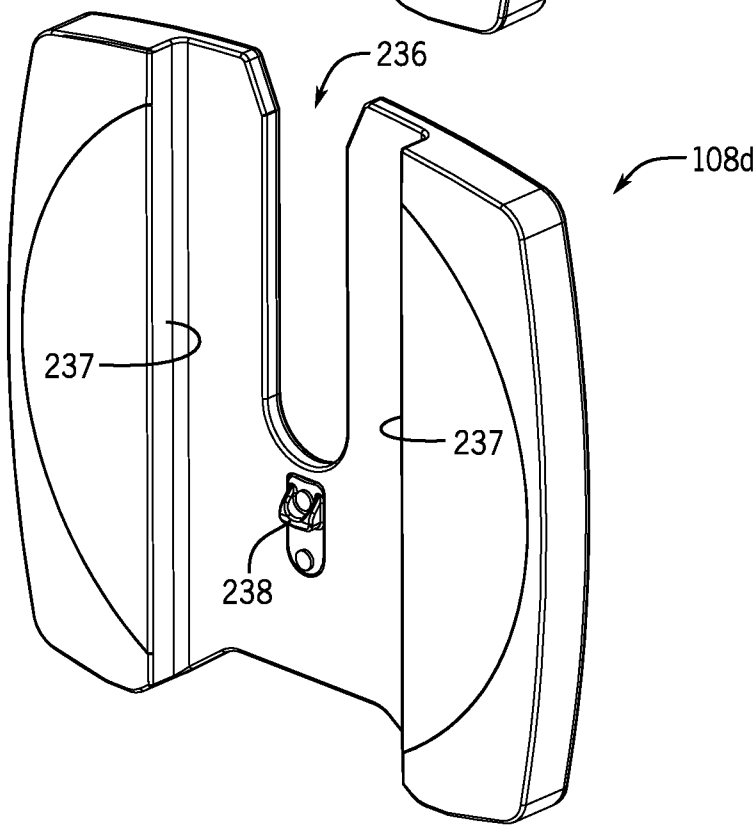


FIG. 28

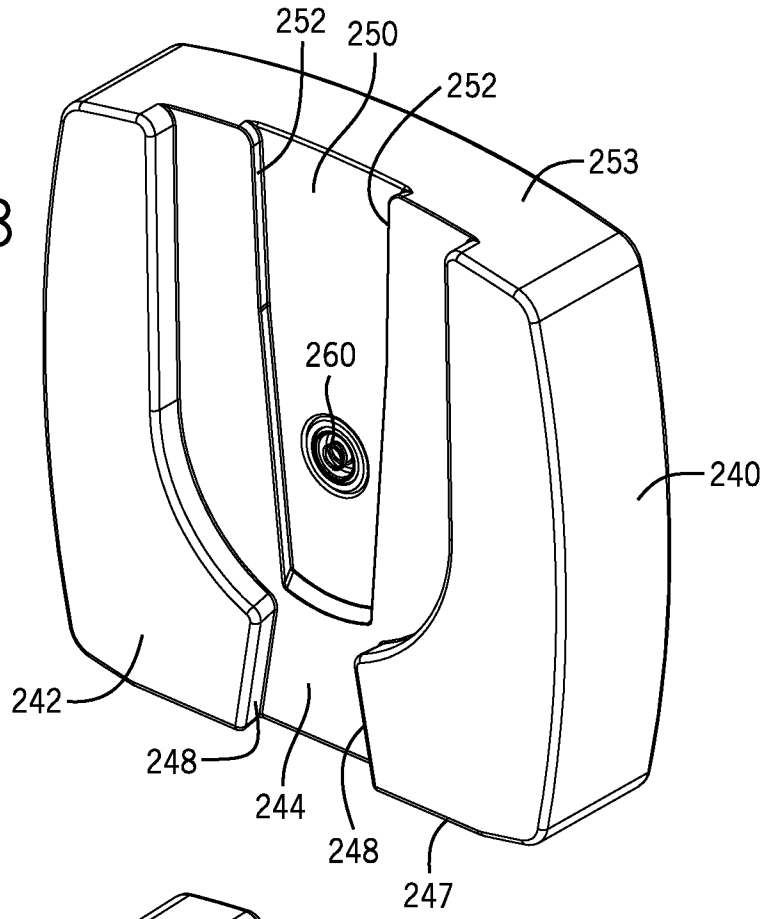
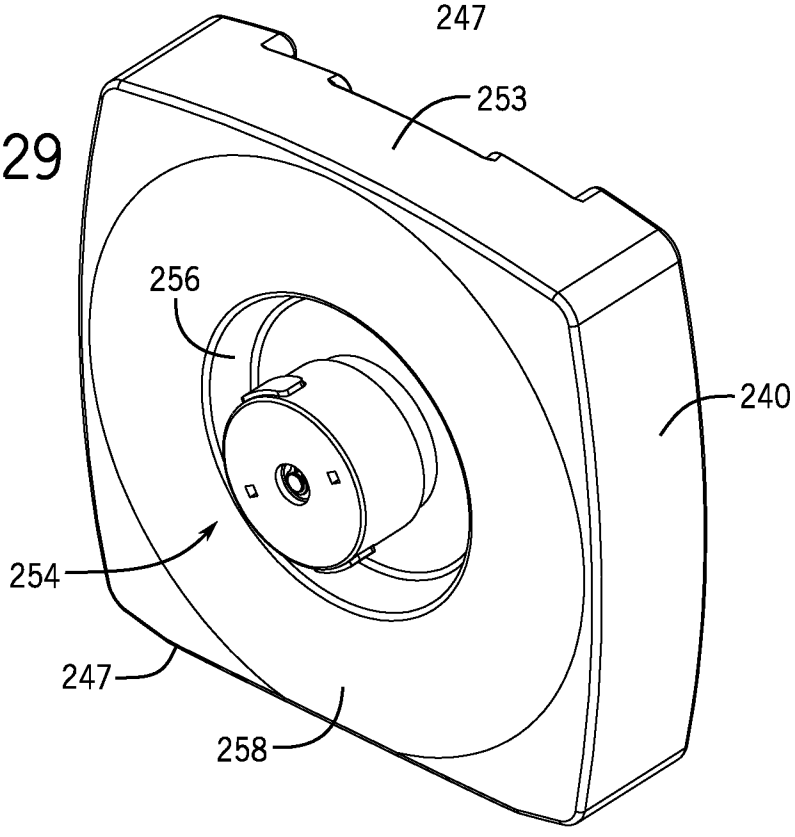

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FIG. 29


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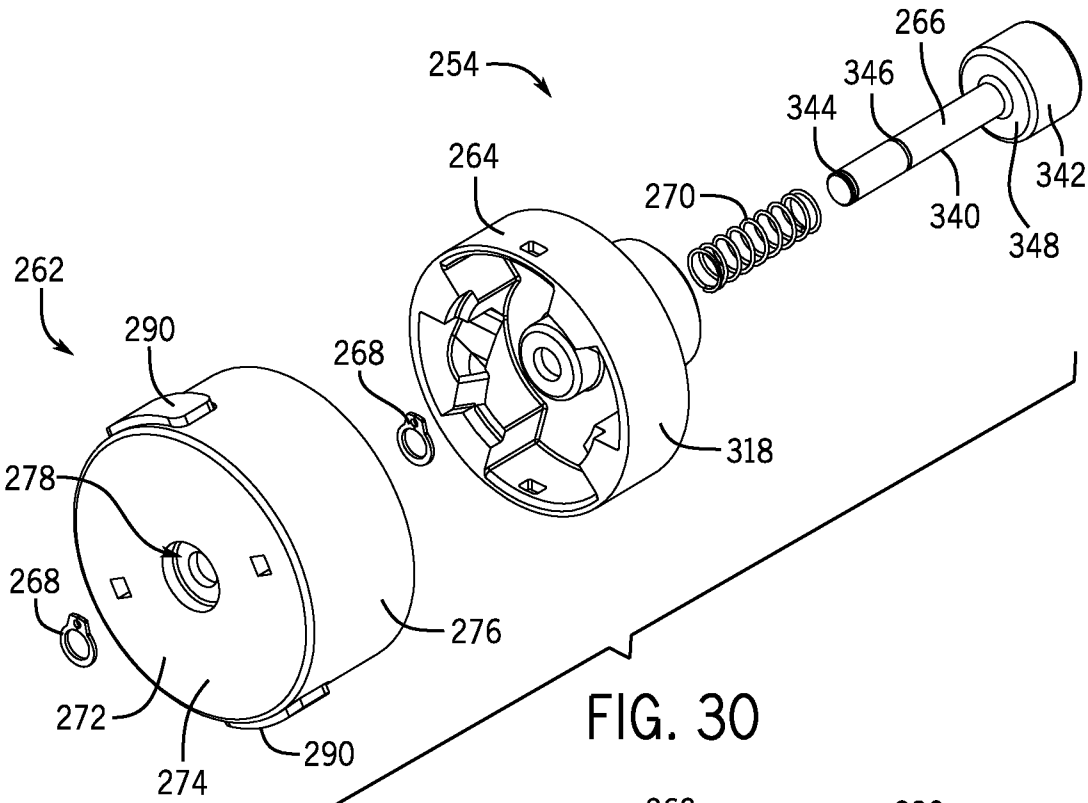

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FIG. 30

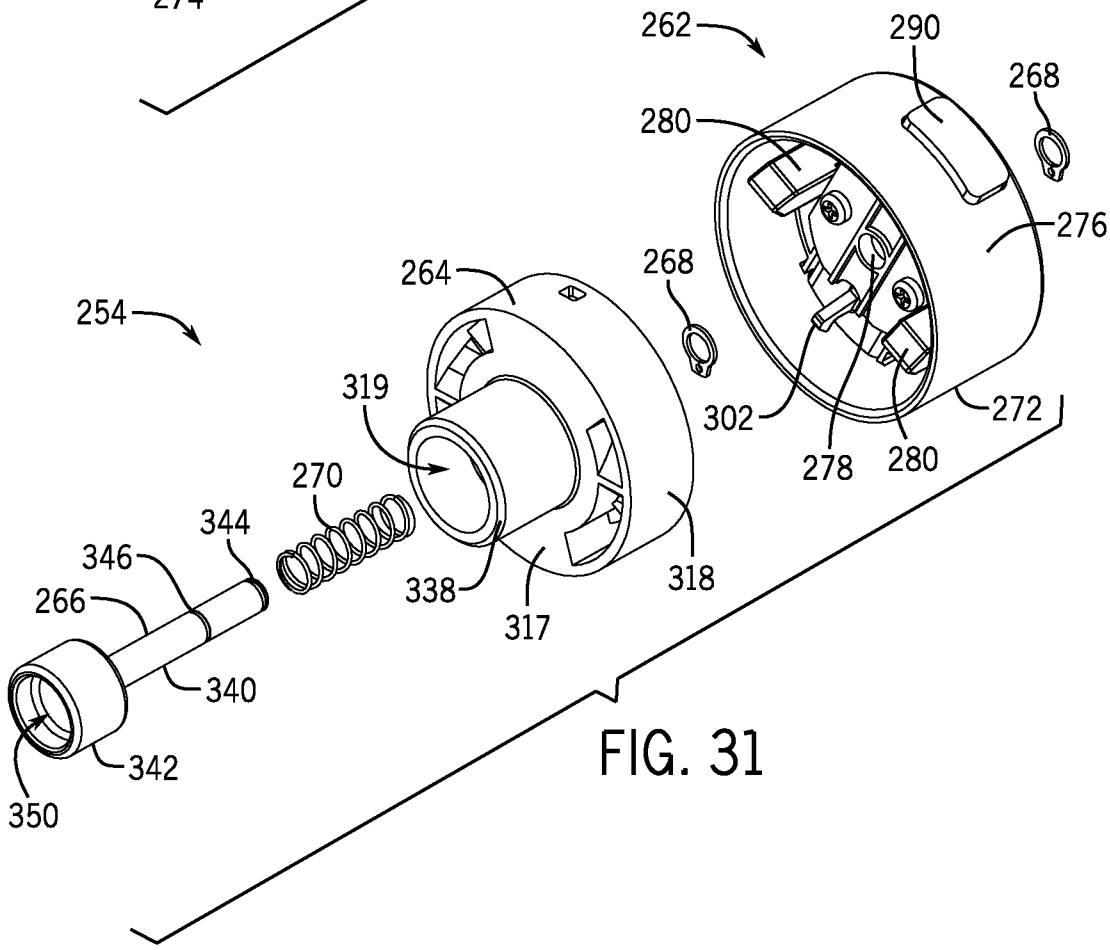

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FIG. 31

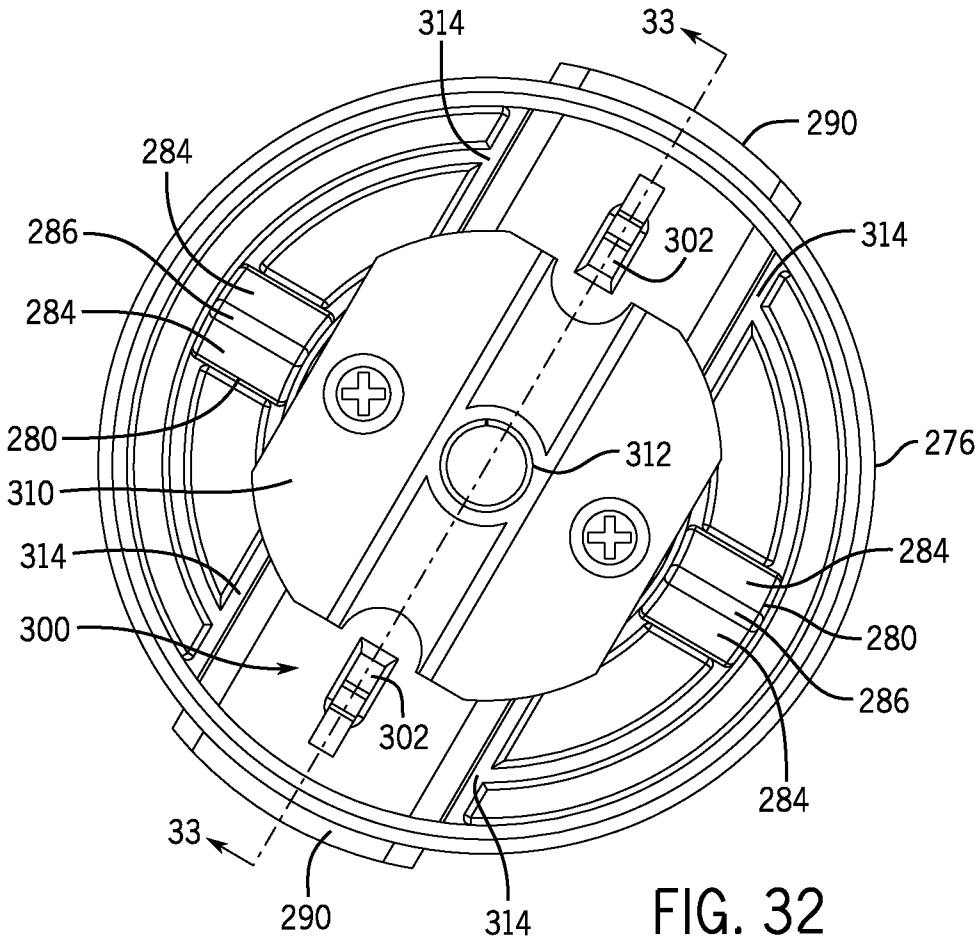

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FIG. 32

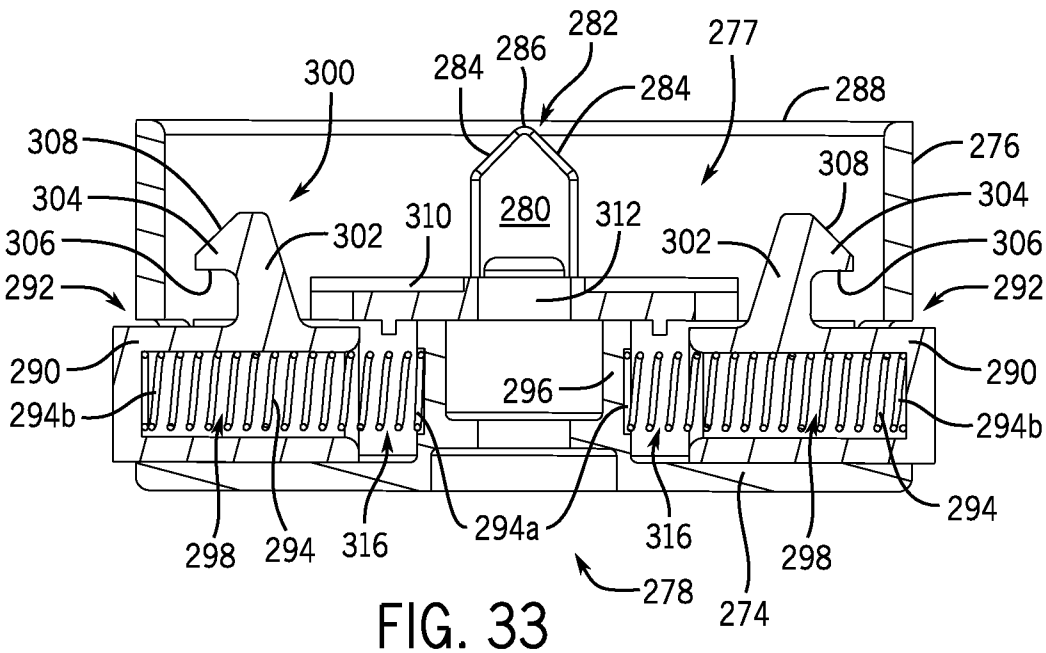
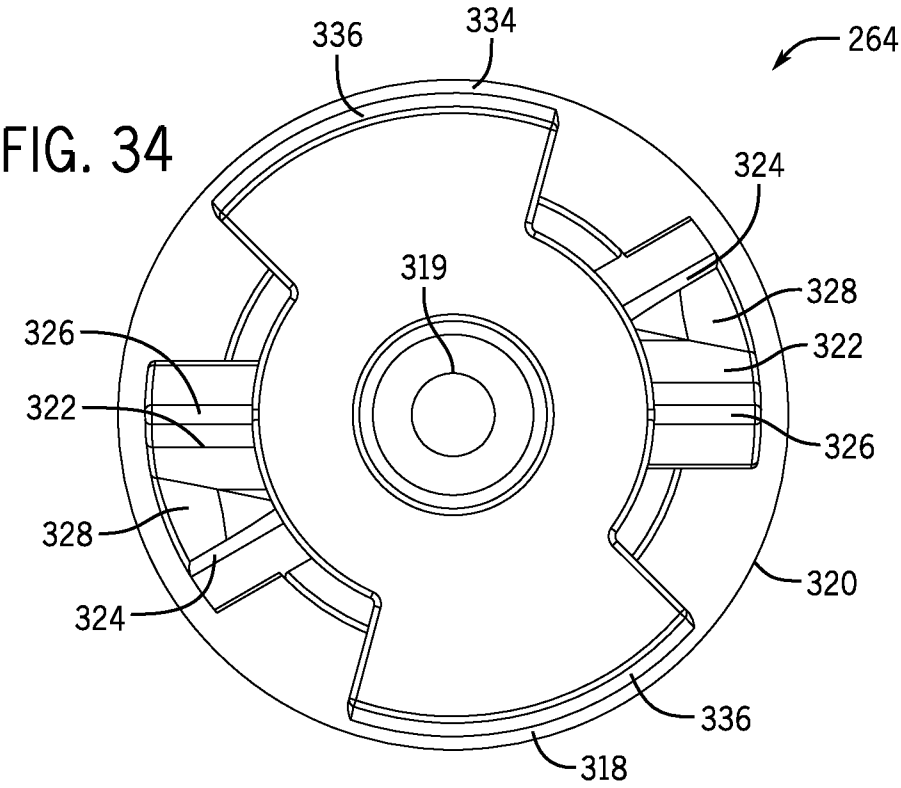

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FIG. 33

FIG. 34



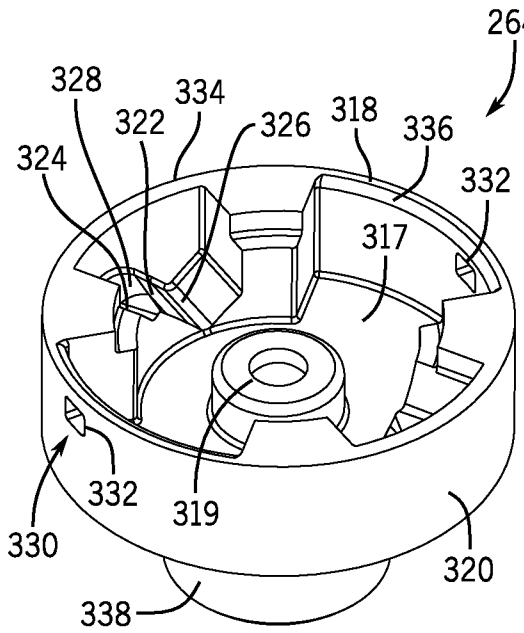


FIG. 35

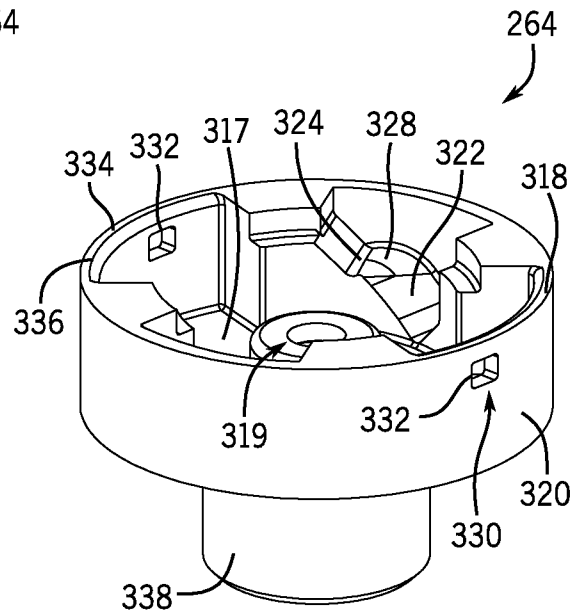


FIG. 36

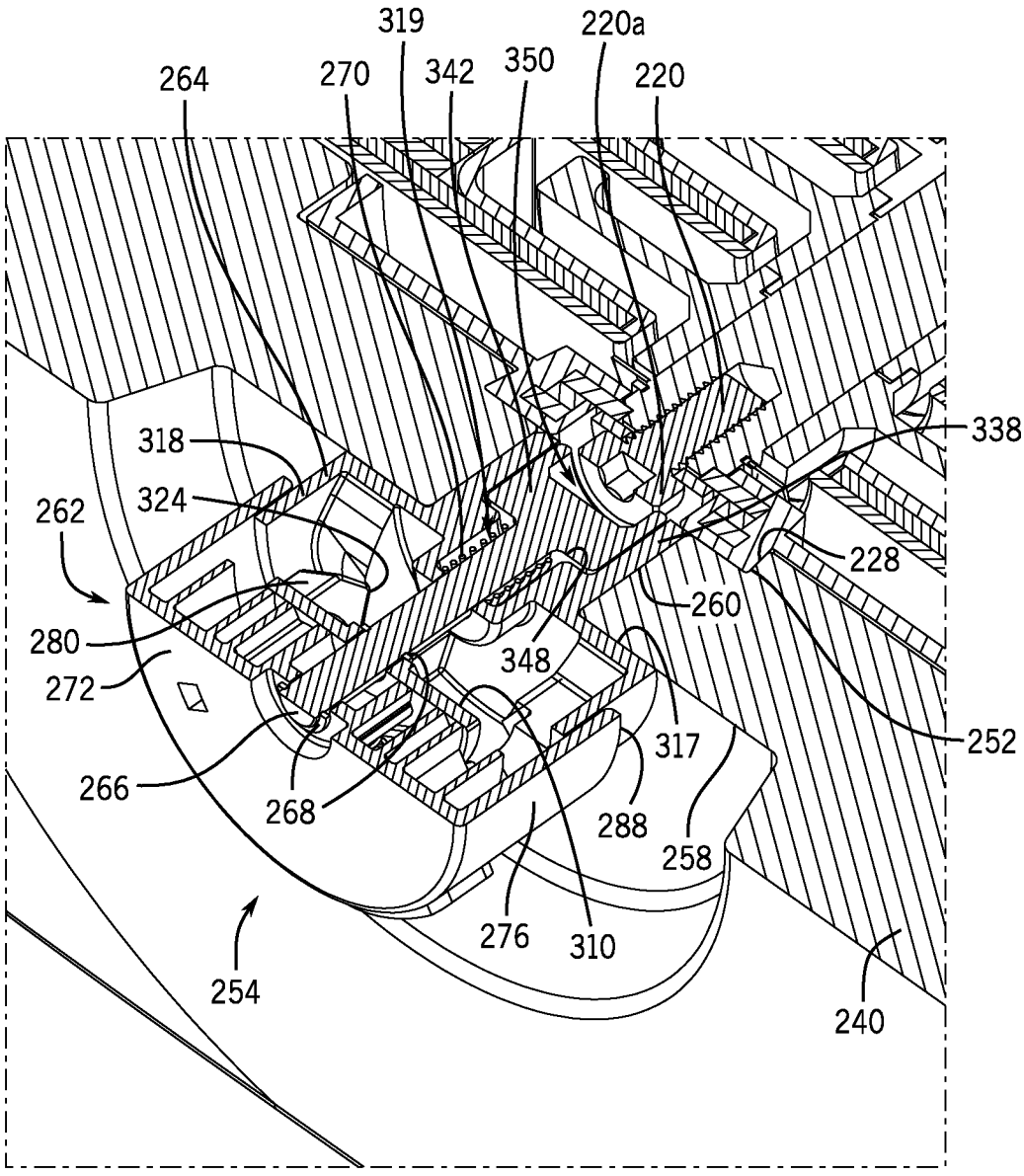

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FIG. 37

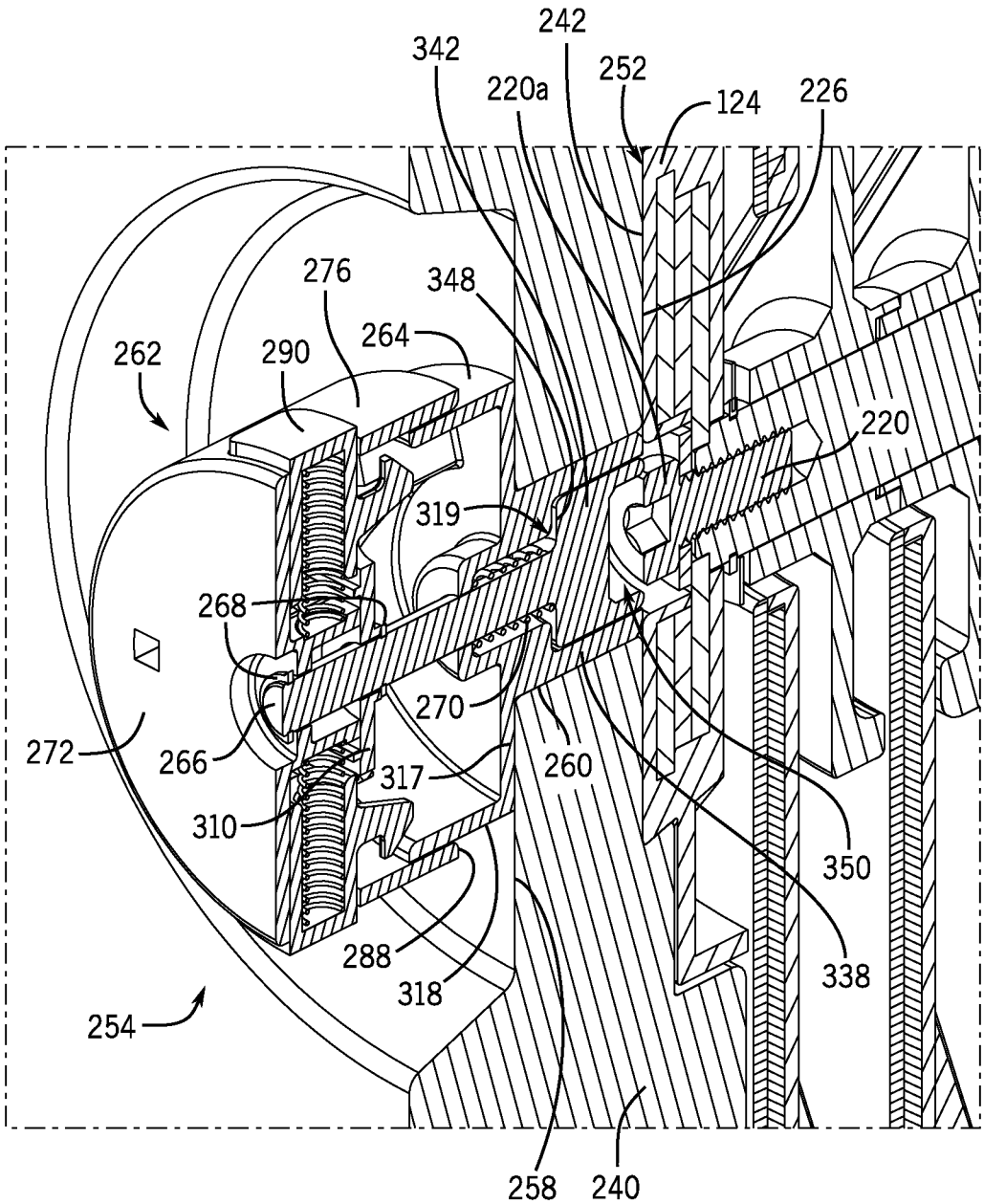

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FIG. 38

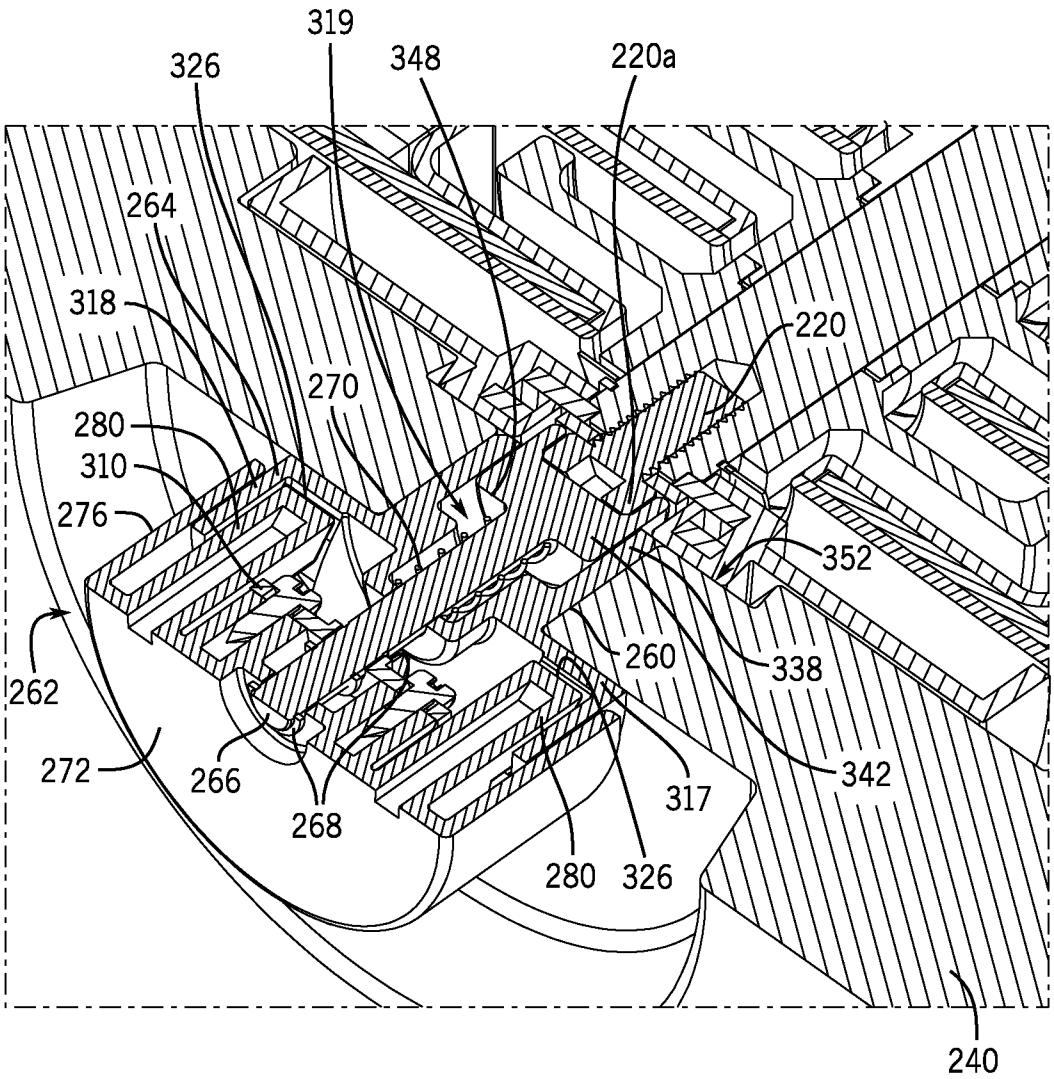

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FIG. 39

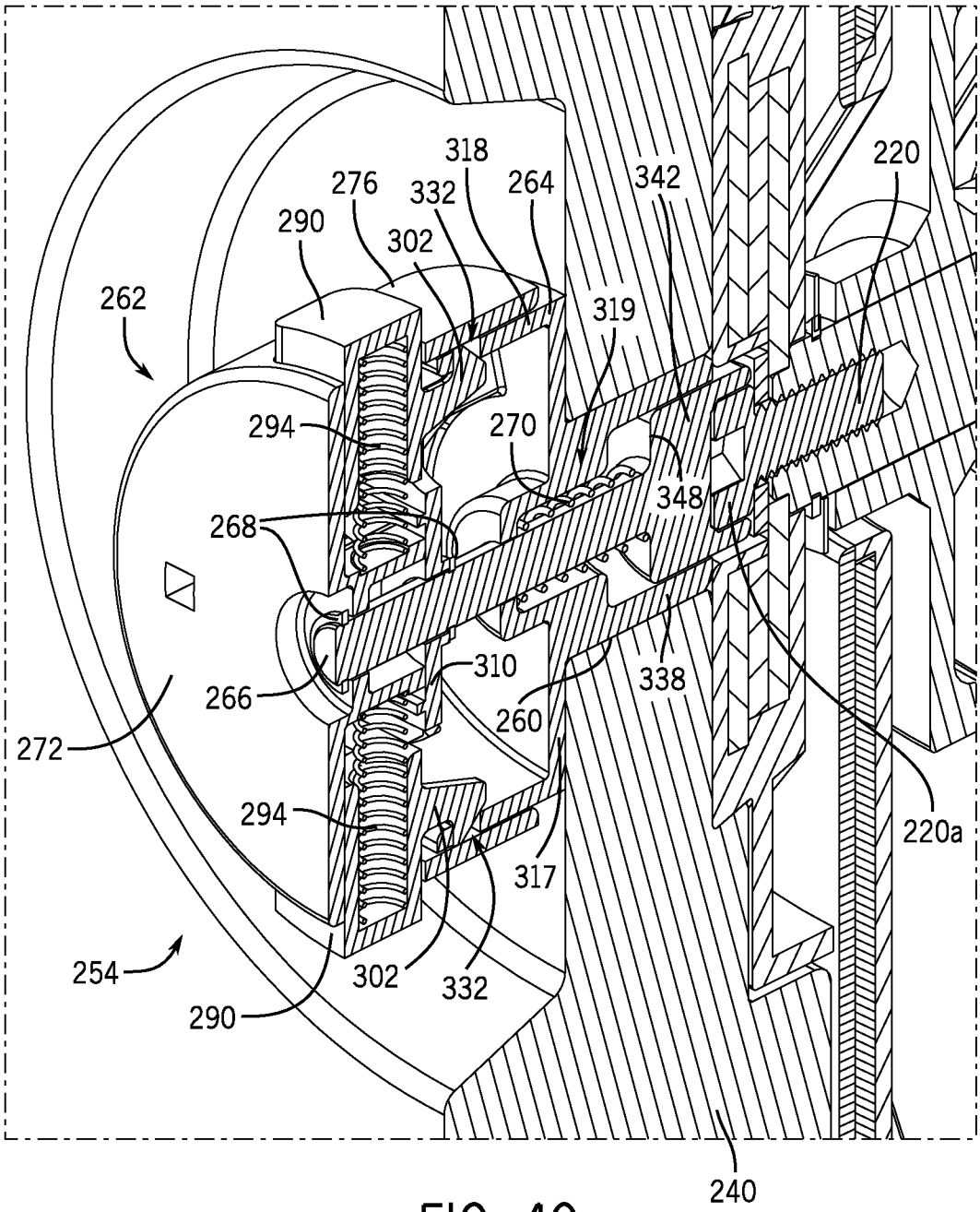

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FIG. 40

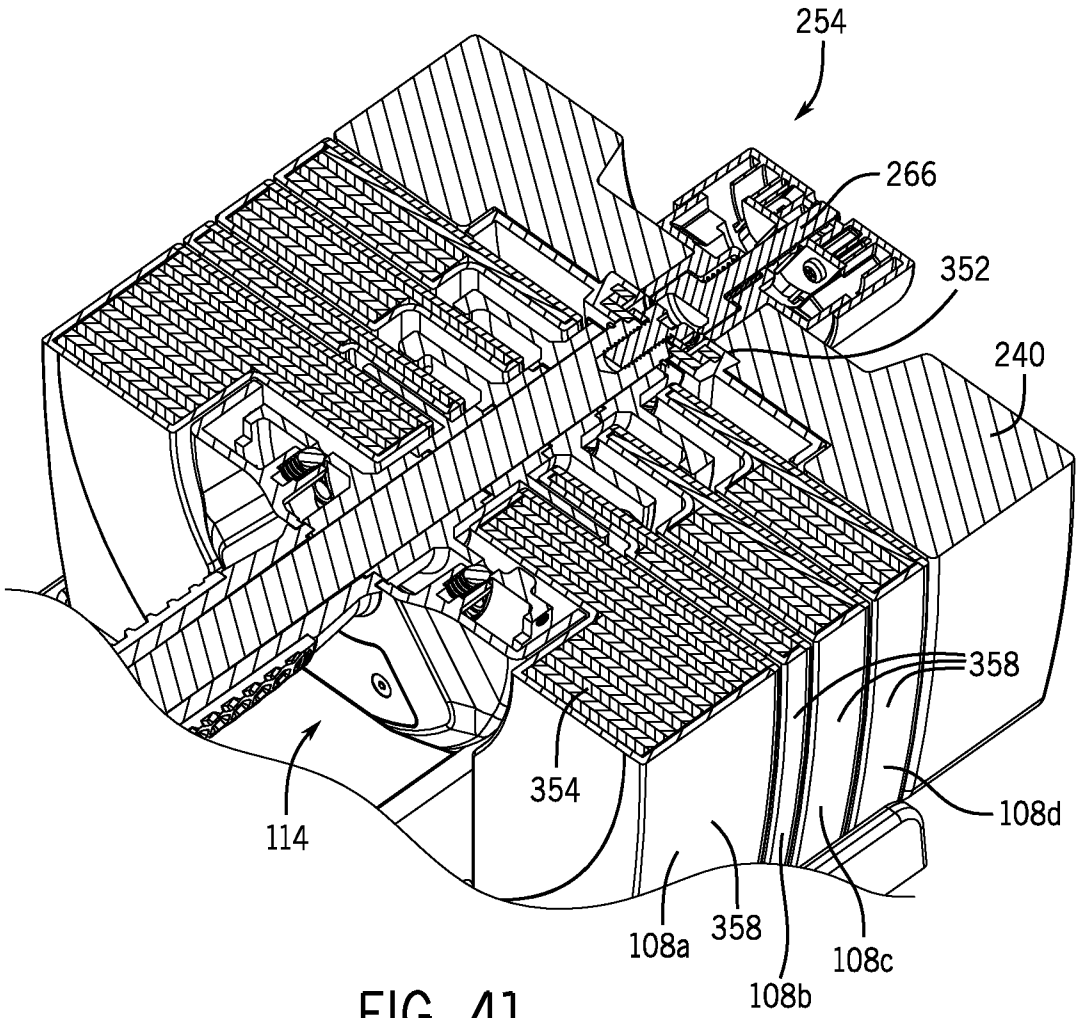


FIG. 41

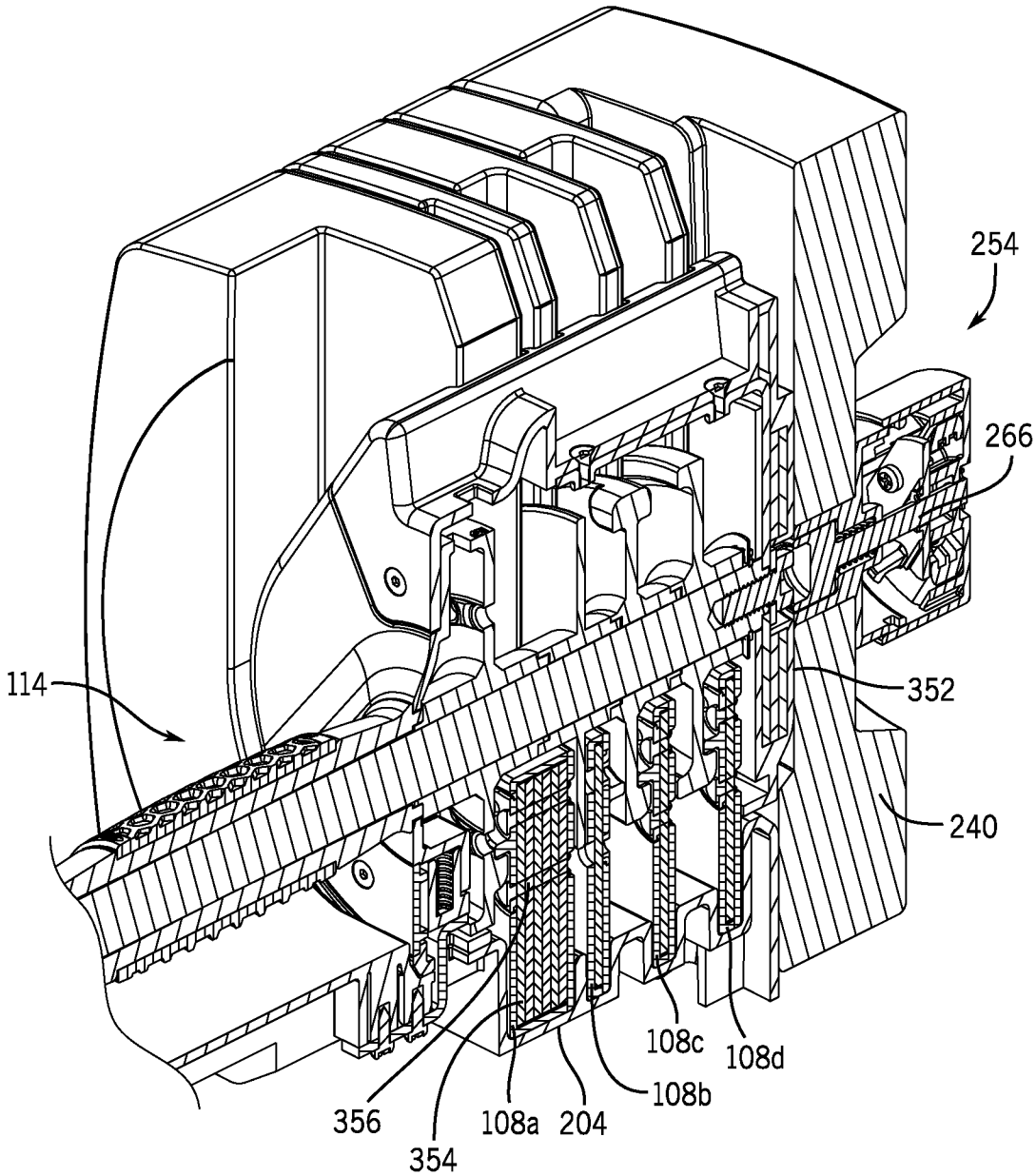
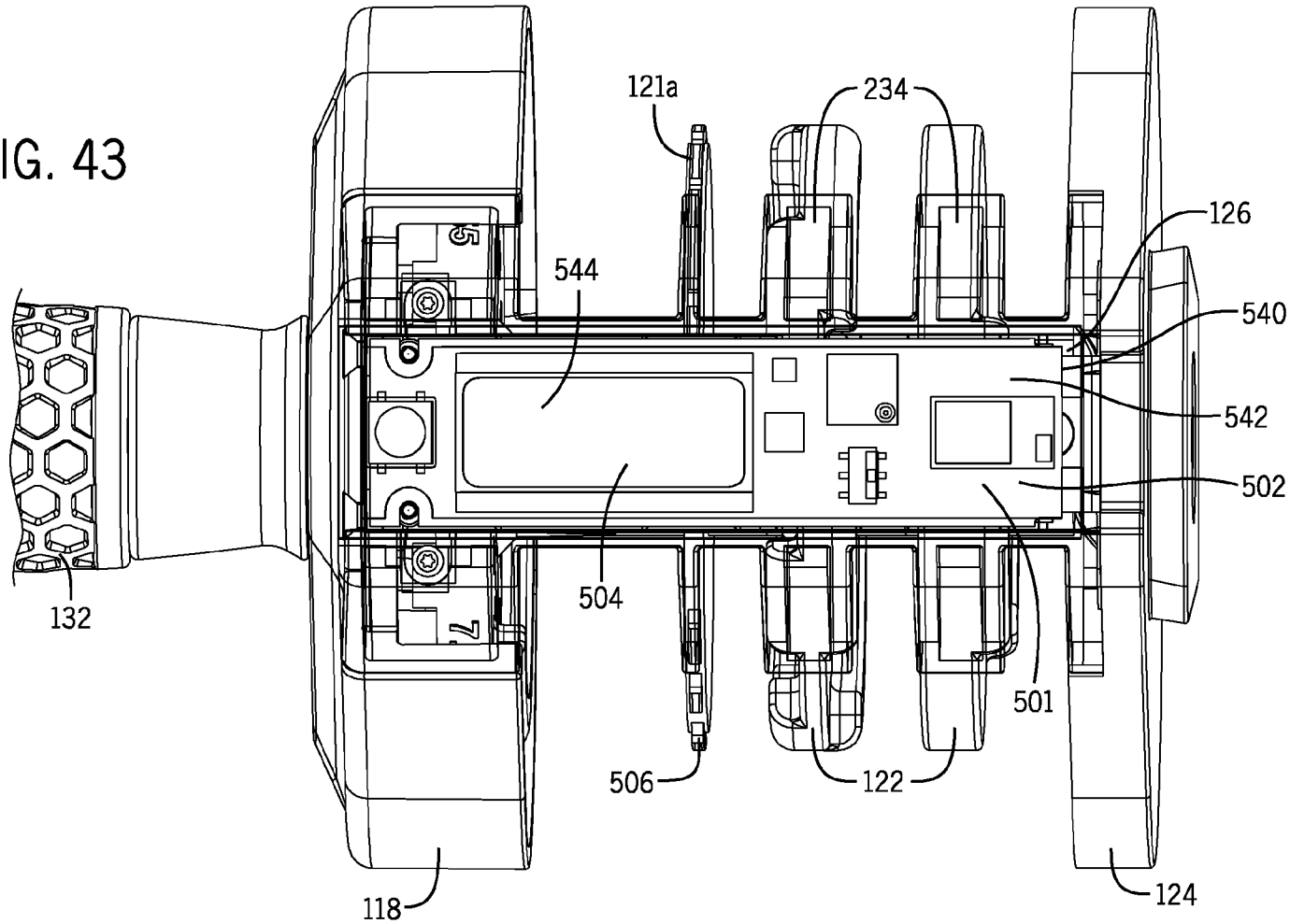


FIG. 42

FIG. 43



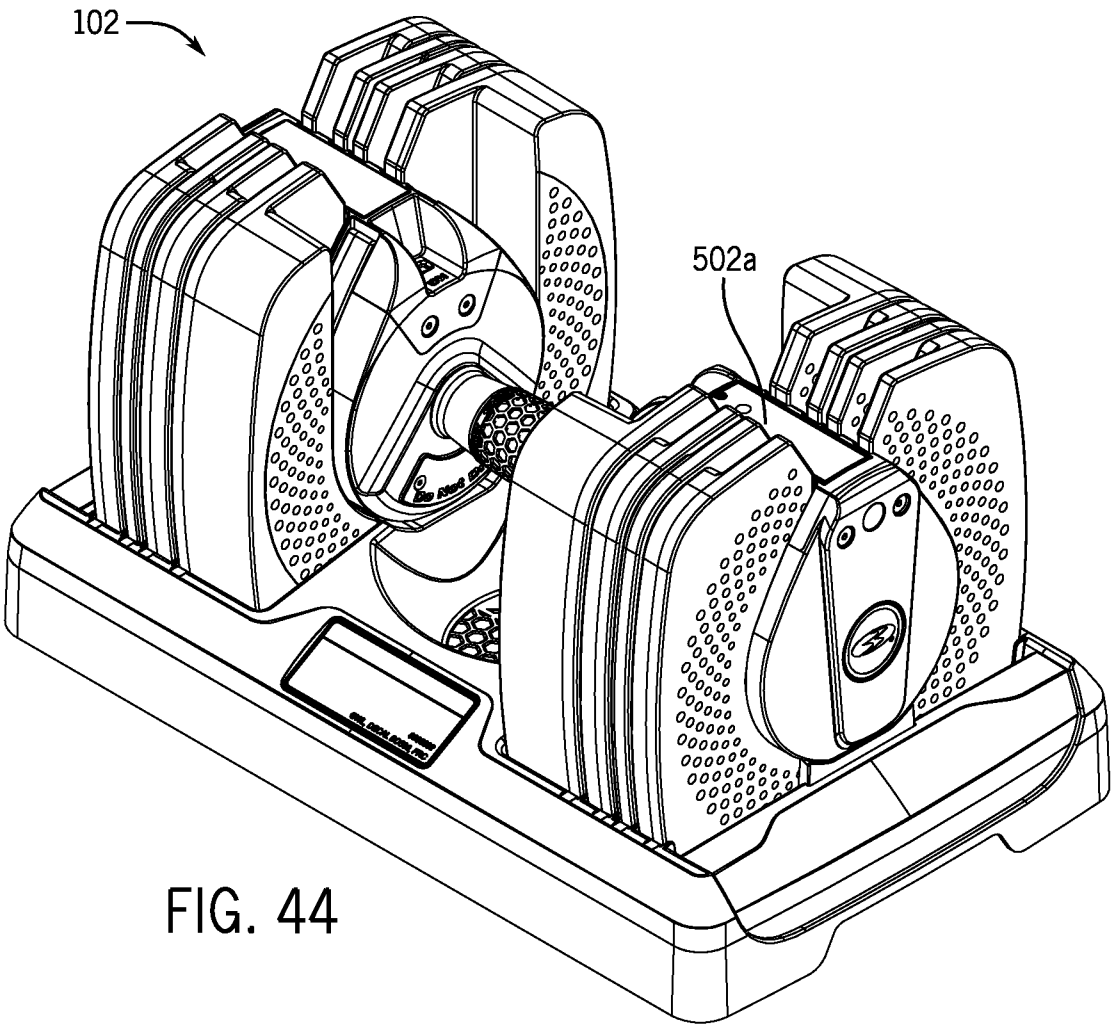


FIG. 44

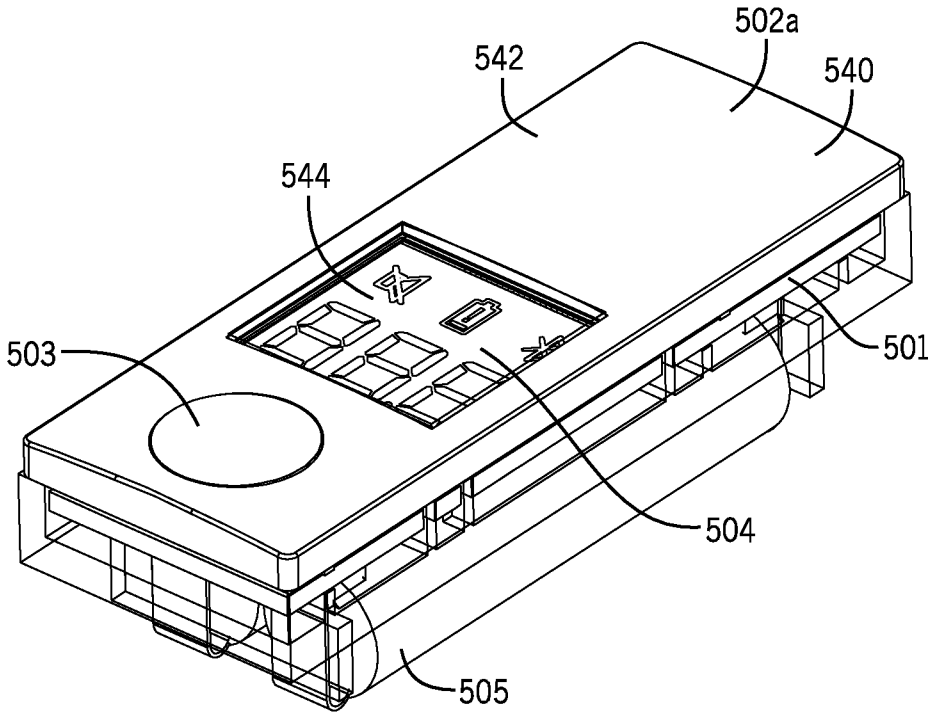


FIG. 45

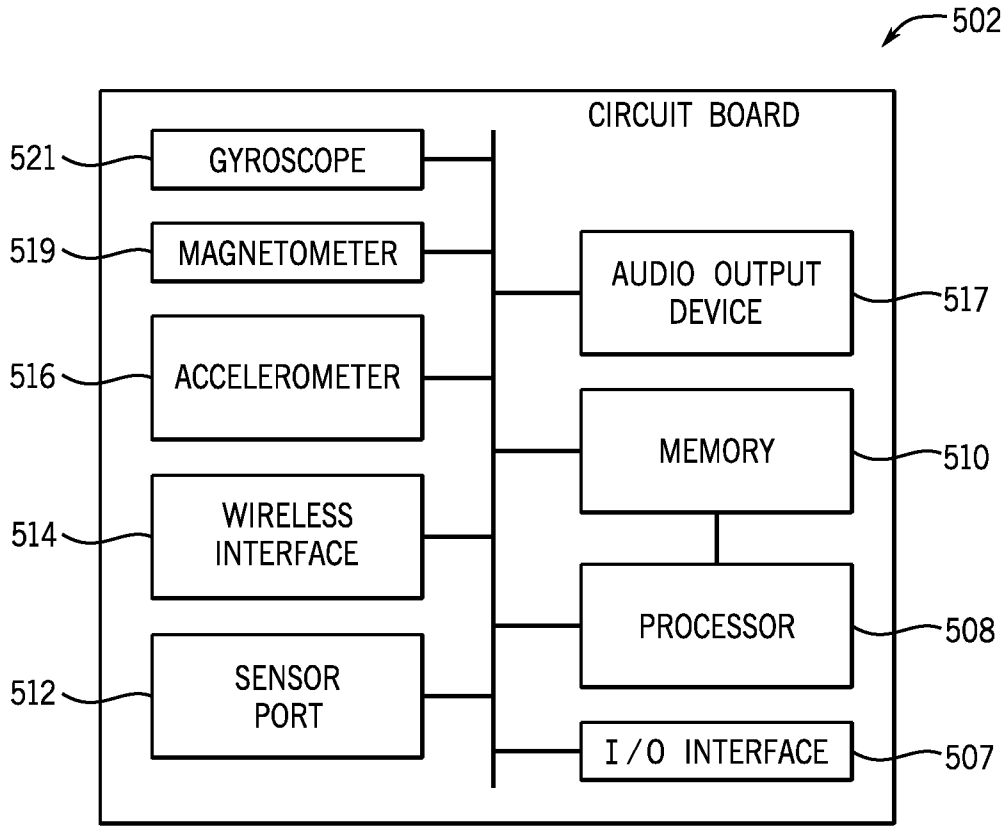


FIG. 46A

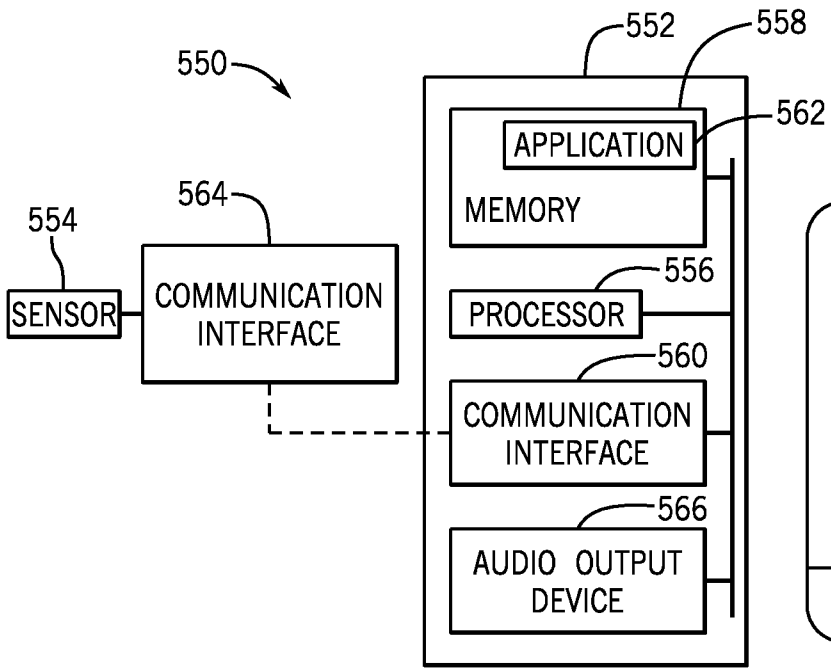


FIG. 46B

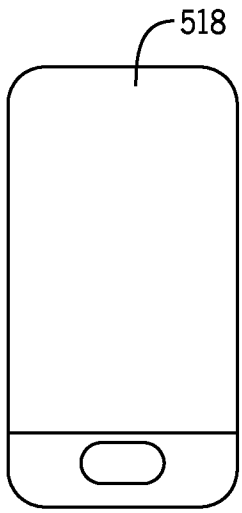


FIG. 47

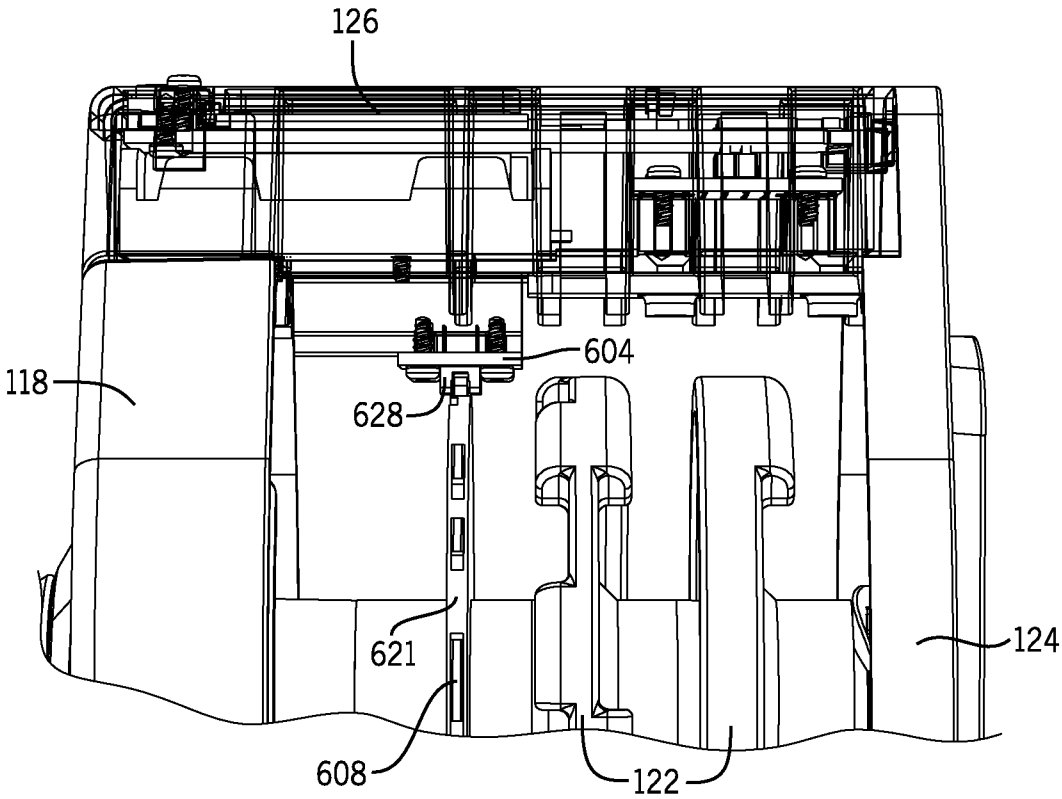


FIG. 48

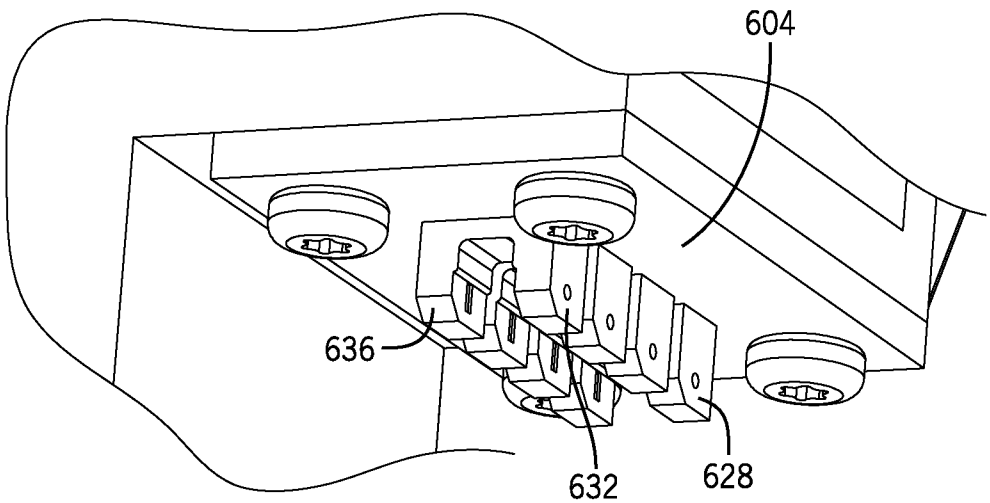


FIG. 49

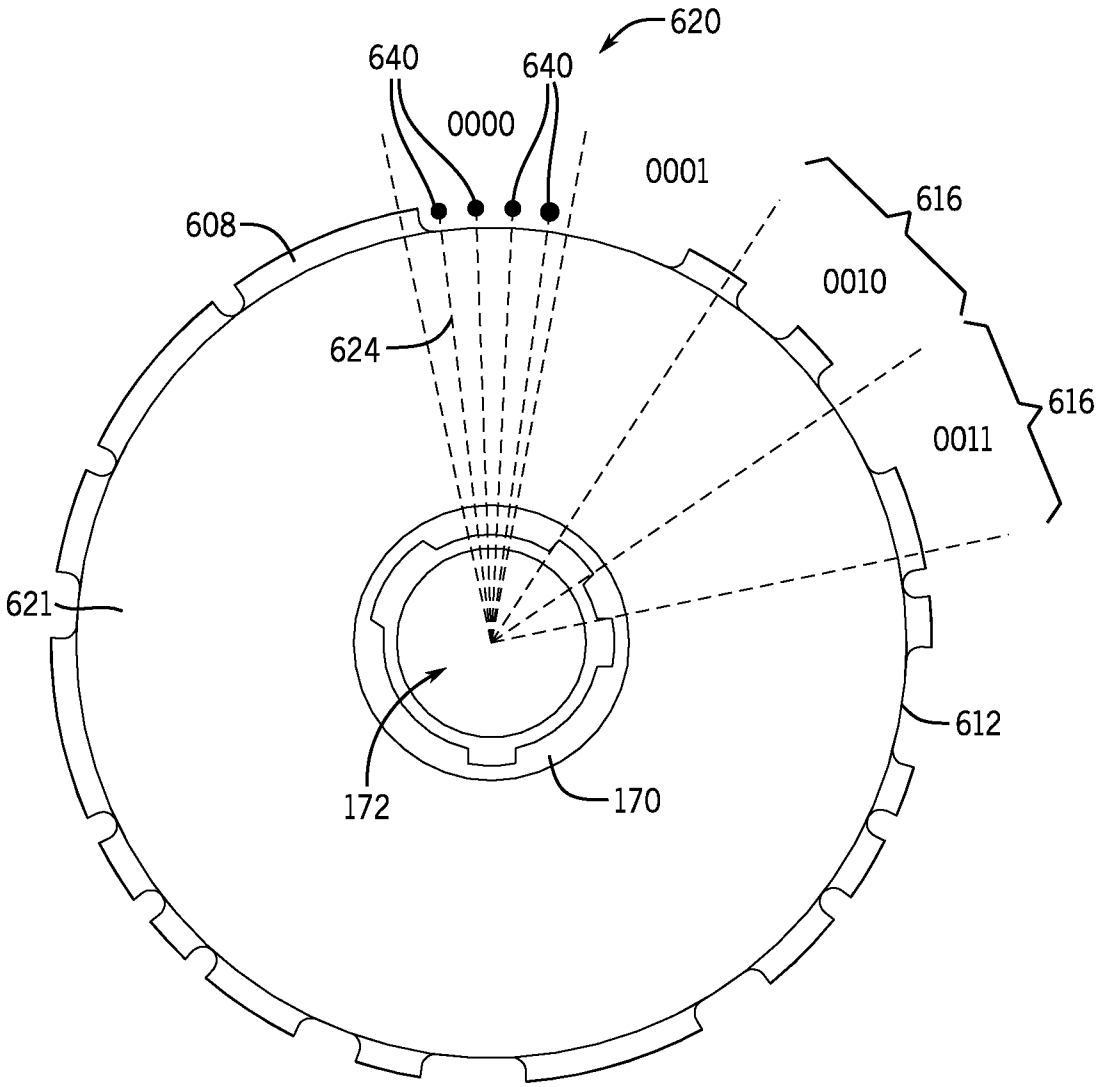


FIG. 50

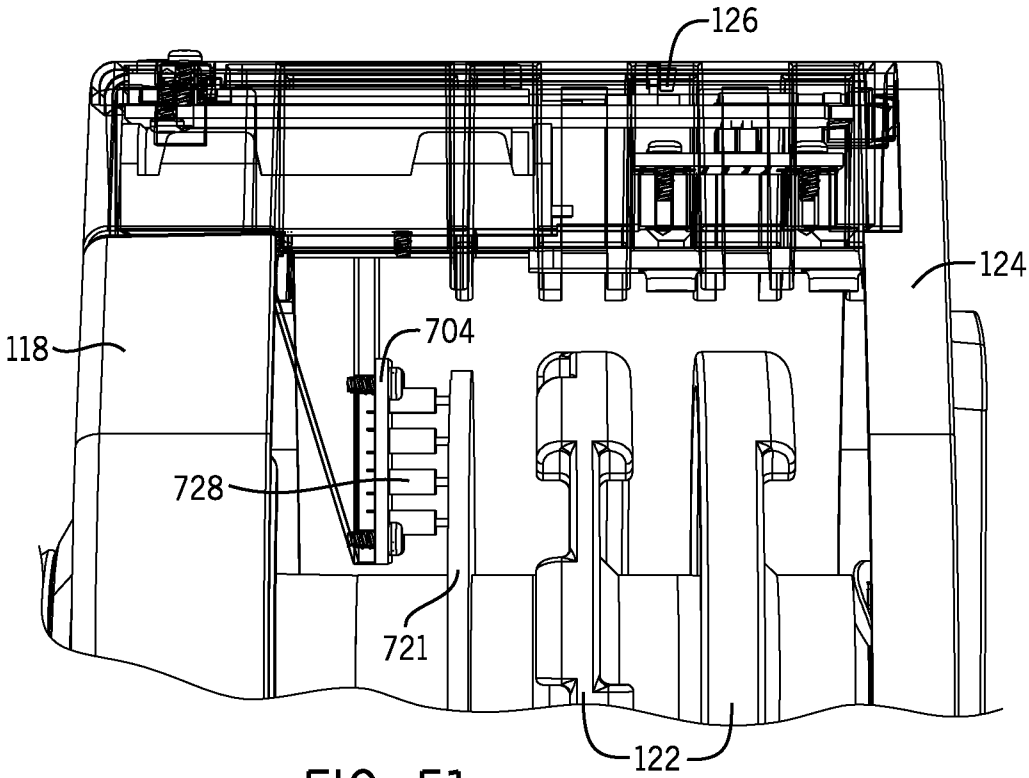


FIG. 51

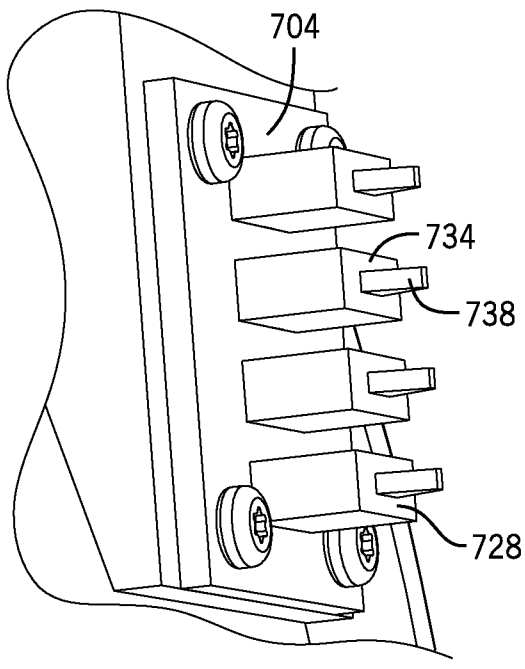


FIG. 52

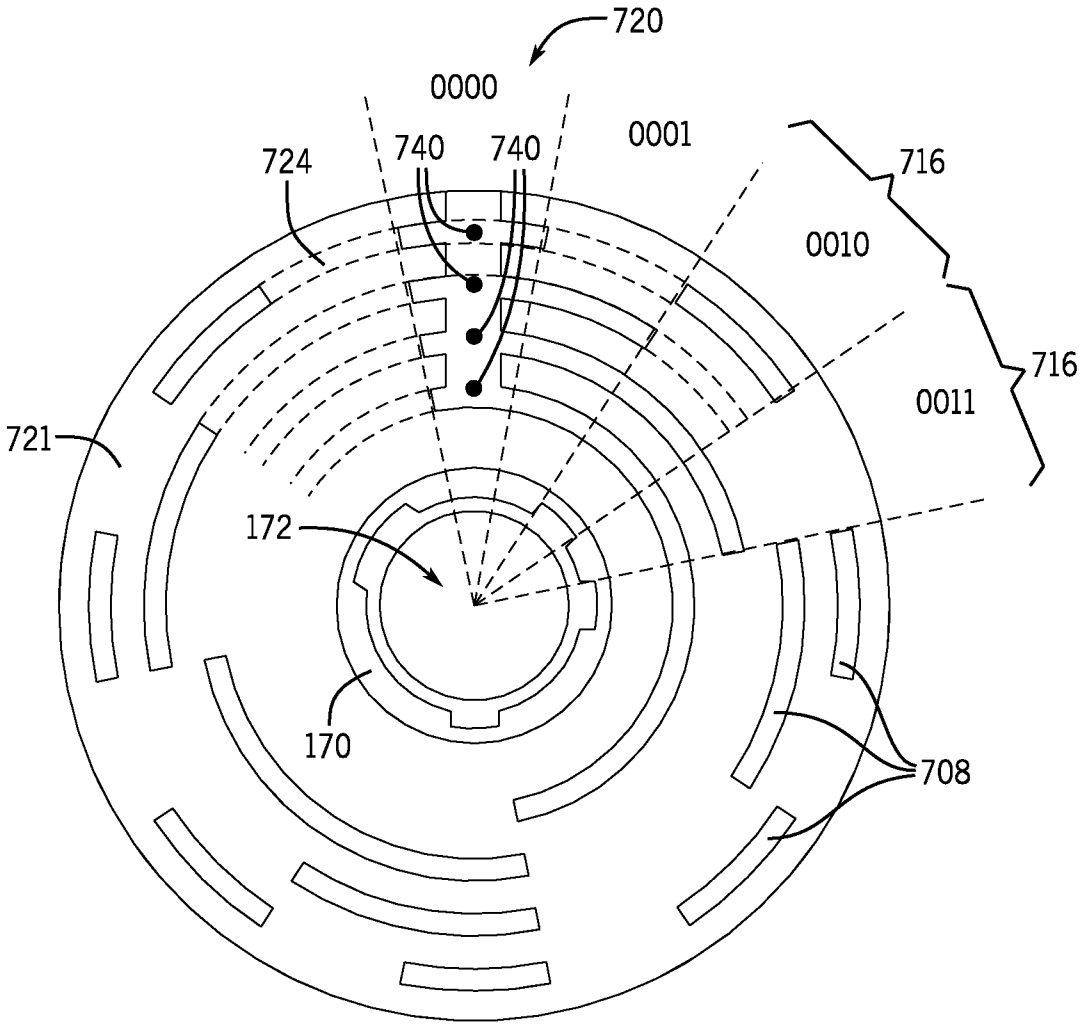


FIG. 53

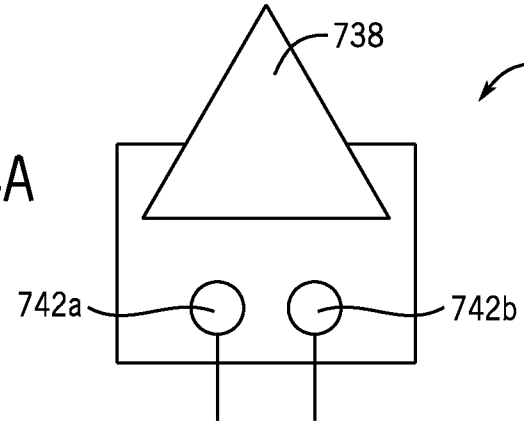


FIG. 54A

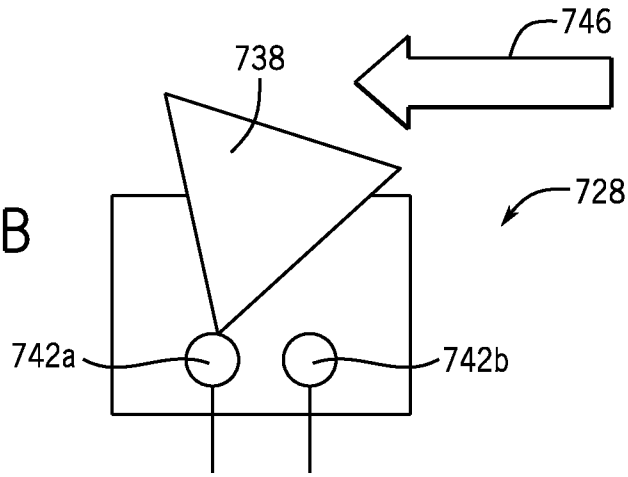


FIG. 54B

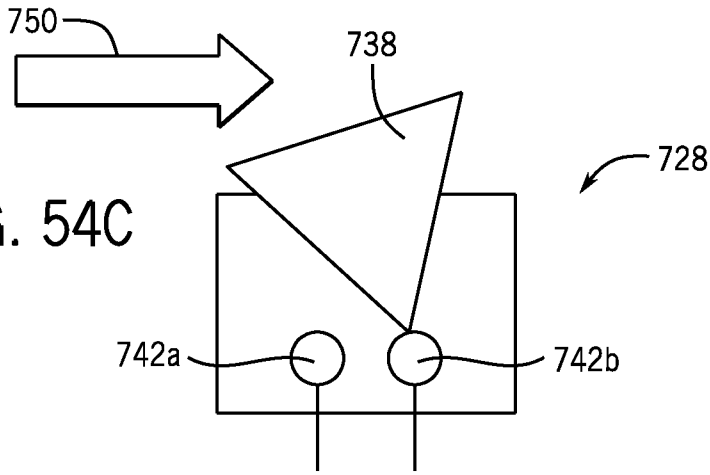


FIG. 54C

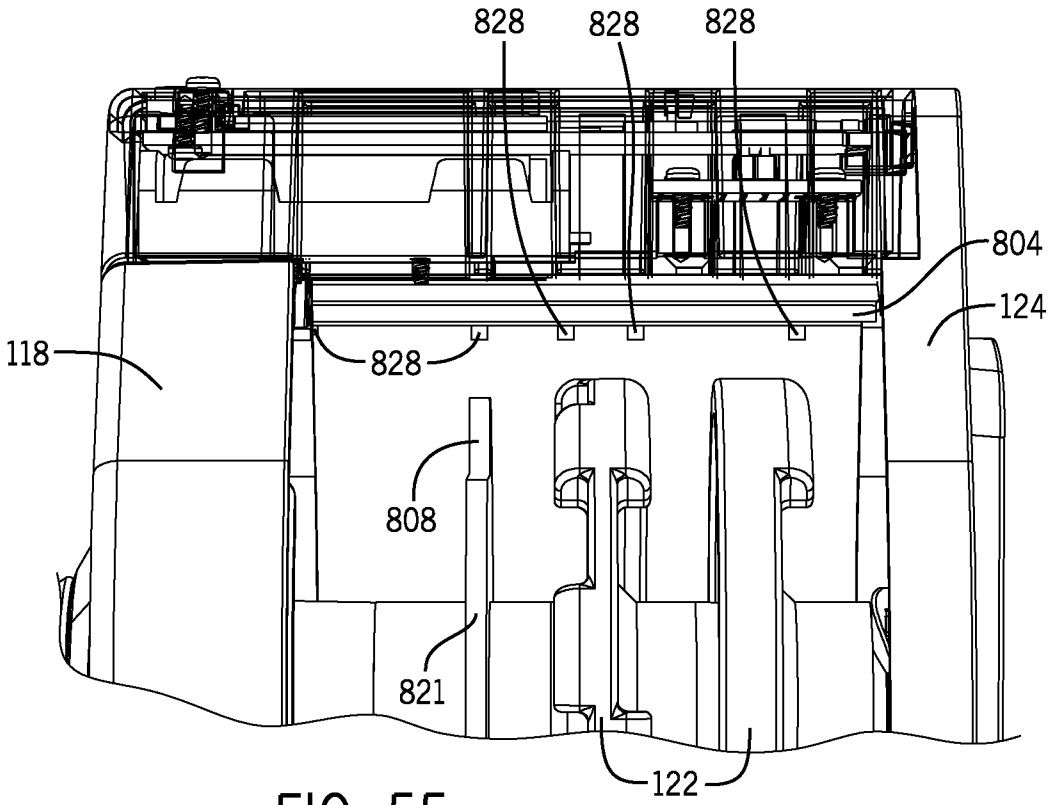


FIG. 55

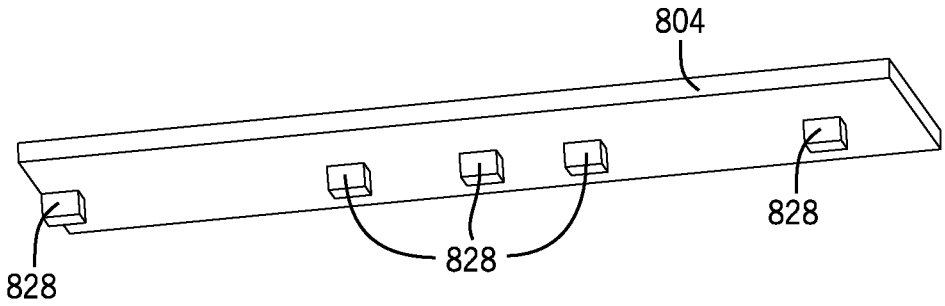


FIG. 56

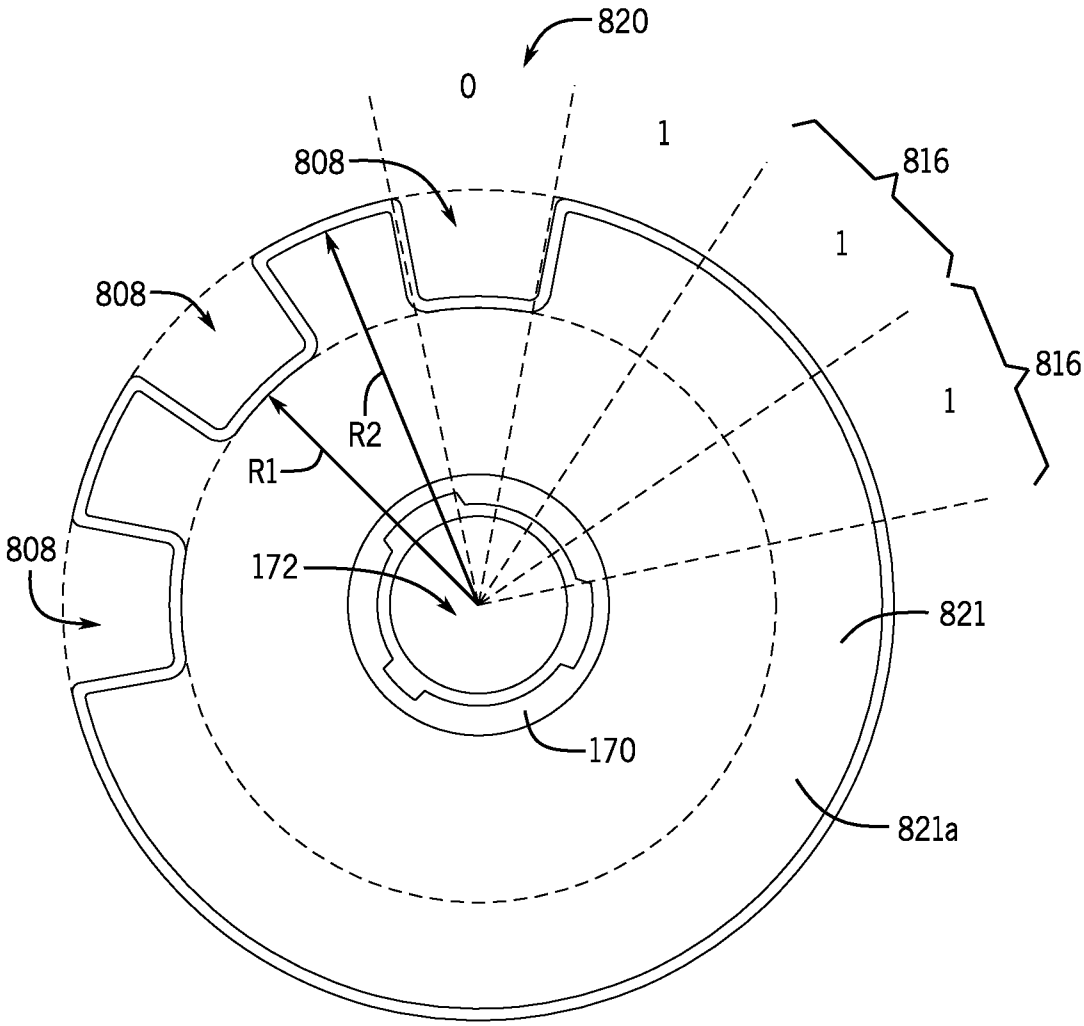


FIG. 57A

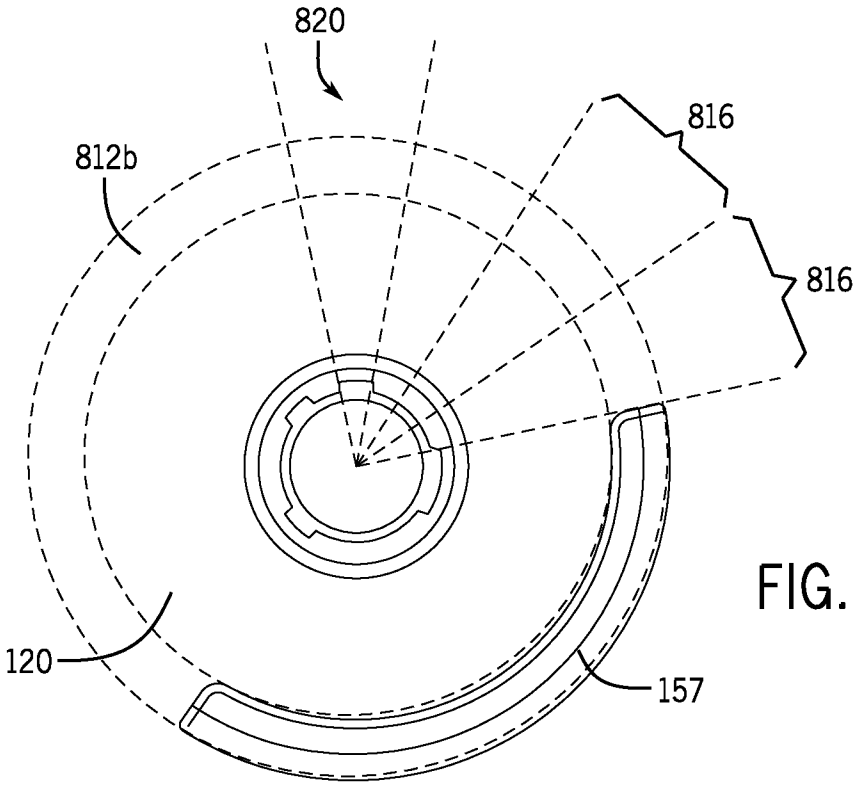


FIG. 57B

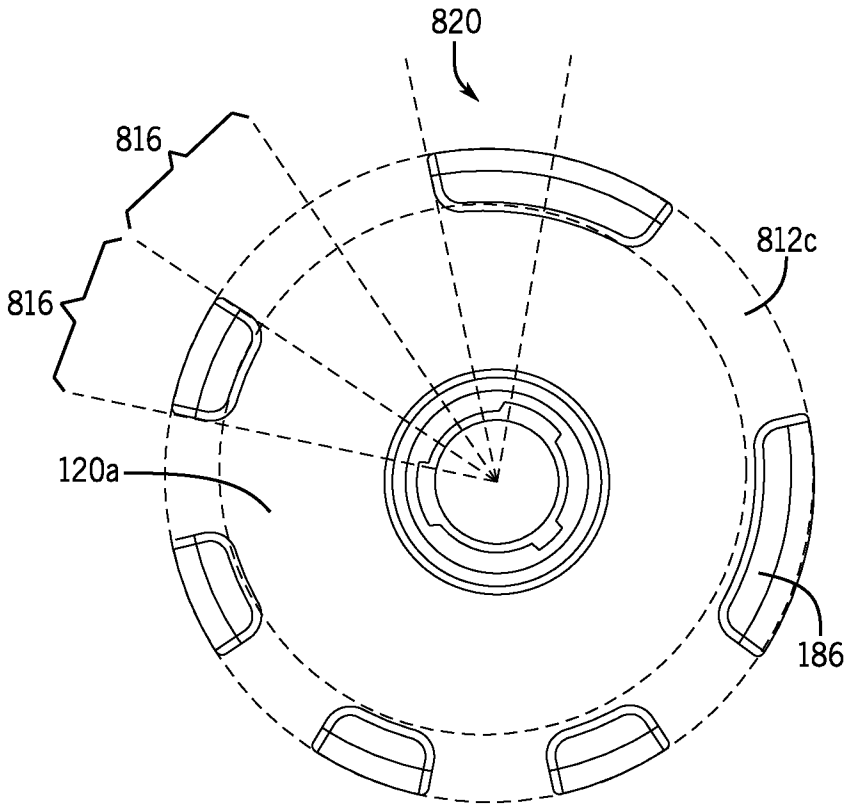


FIG. 57C

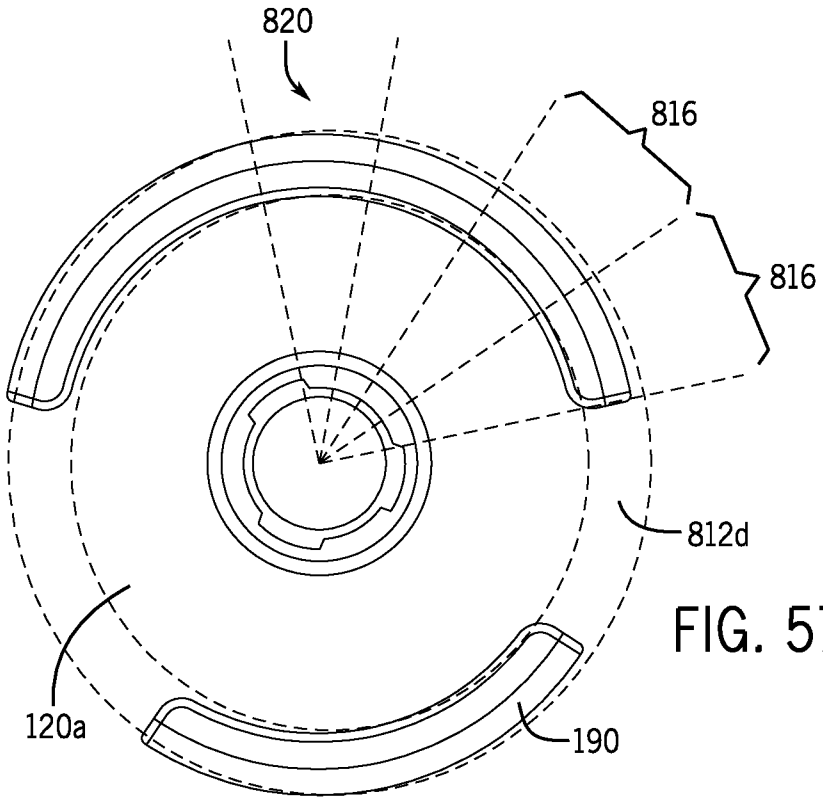


FIG. 57D

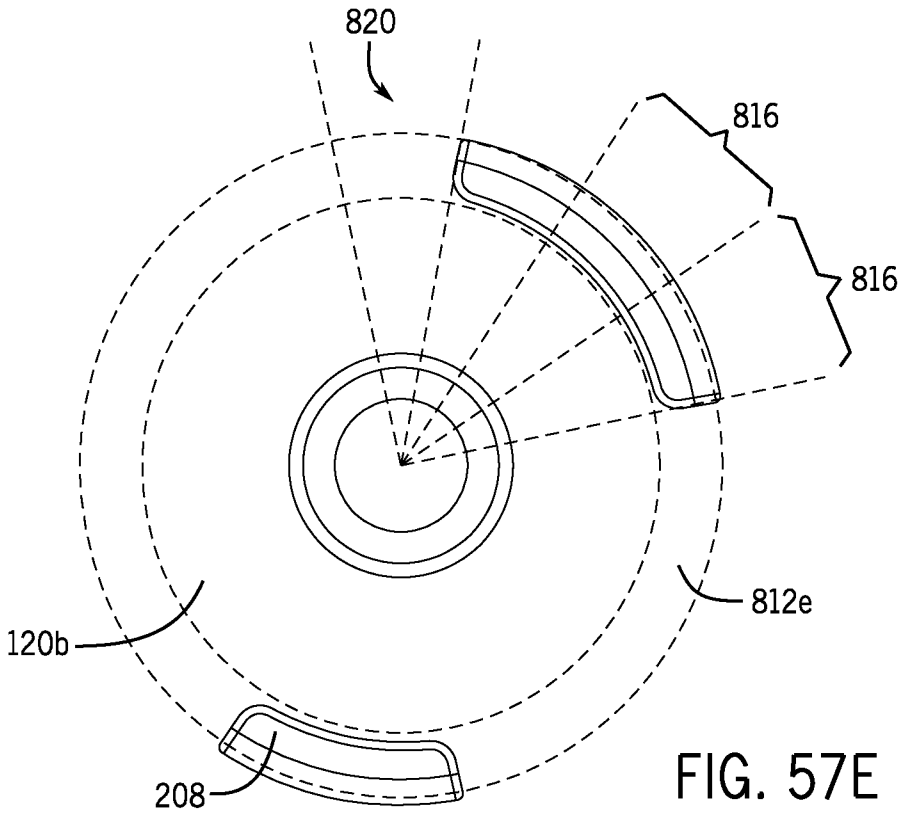


FIG. 57E

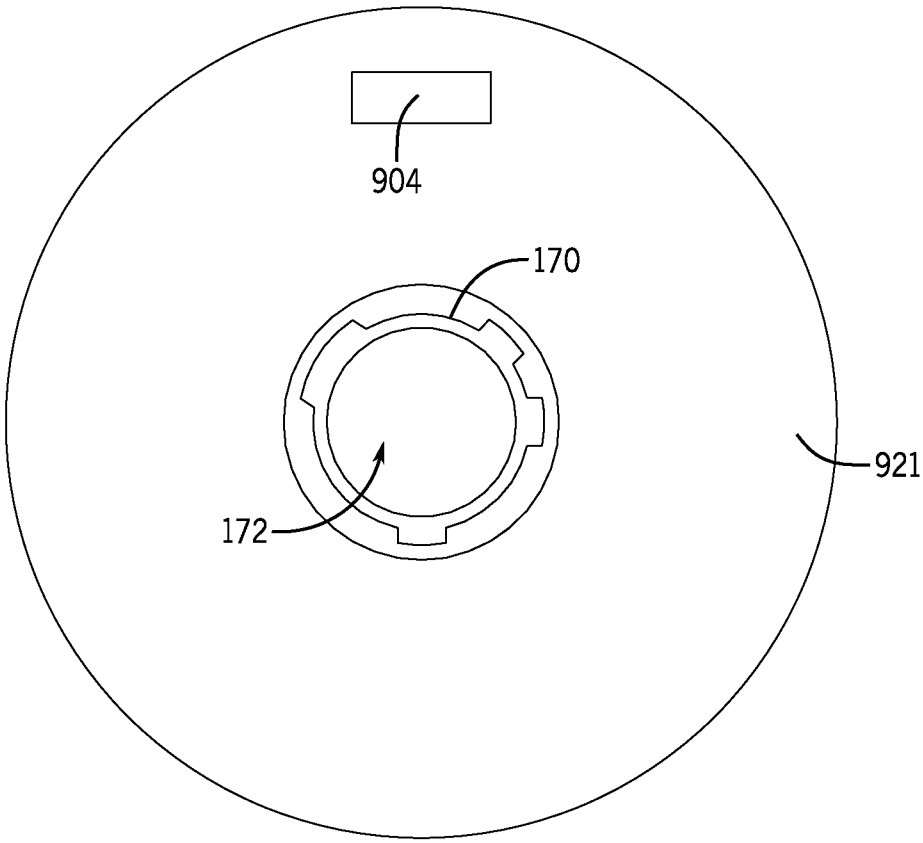


FIG. 58

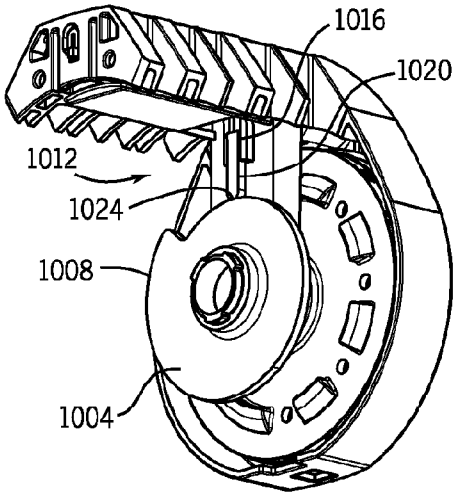


FIG. 59A

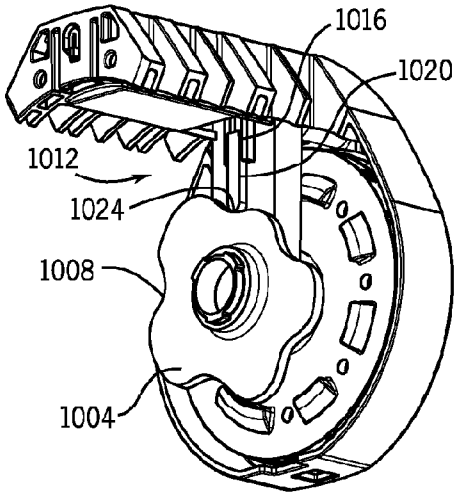


FIG. 59B

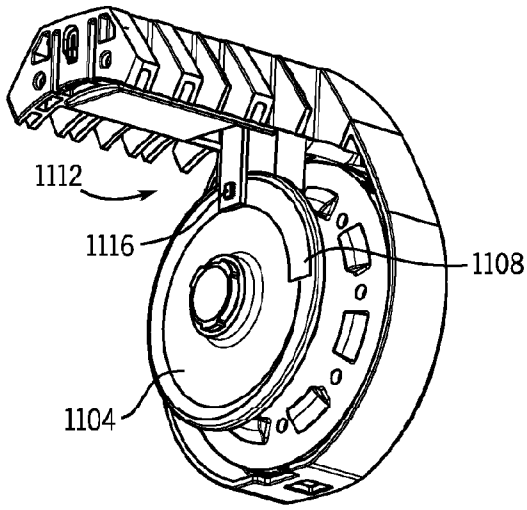


FIG. 60

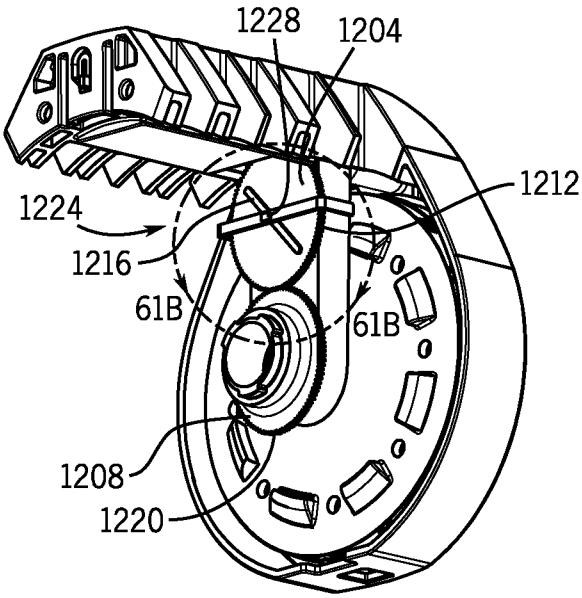


FIG. 61A

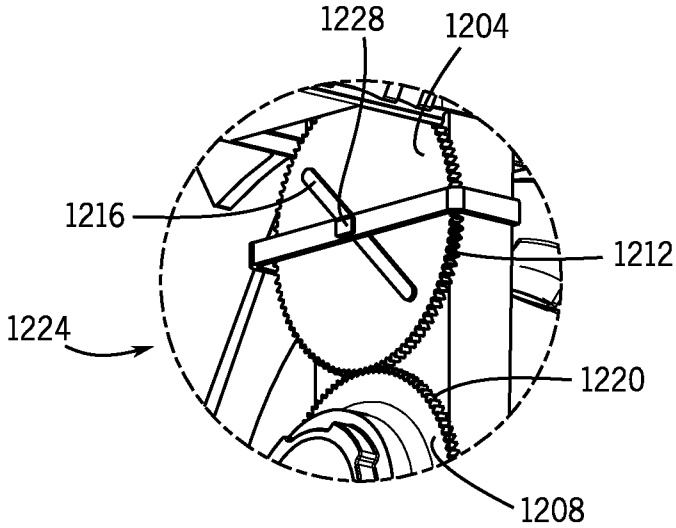


FIG. 61B

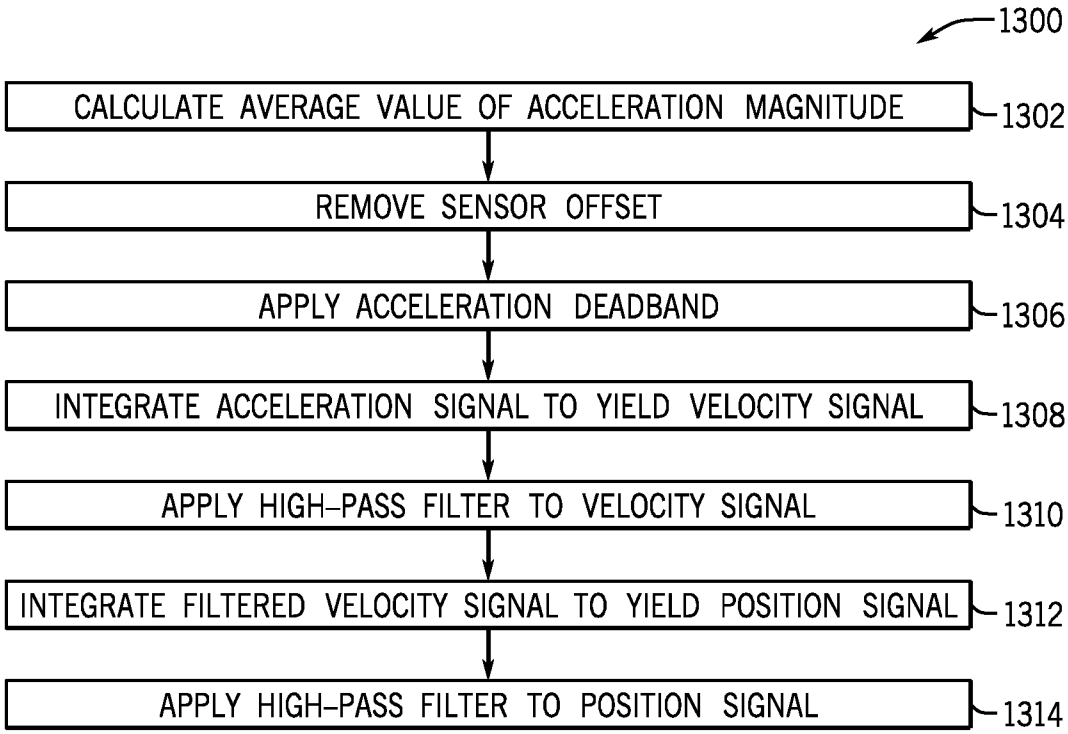

1300
CALCULATE AVERAGE VALUE OF ACCELERATION MAGNITUDE
1302
REMOVE SENSOR OFFSET
1304
APPLY ACCELERATION DEADBAND
1306
INTEGRATE ACCELERATION SIGNAL TO YIELD VELOCITY SIGNAL
1308
APPLY HIGH-PASS FILTER TO VELOCITY SIGNAL
1310
INTEGRATE FILTERED VELOCITY SIGNAL TO YIELD POSITION SIGNAL
1312
APPLY HIGH-PASS FILTER TO POSITION SIGNAL
1314

FIG. 62

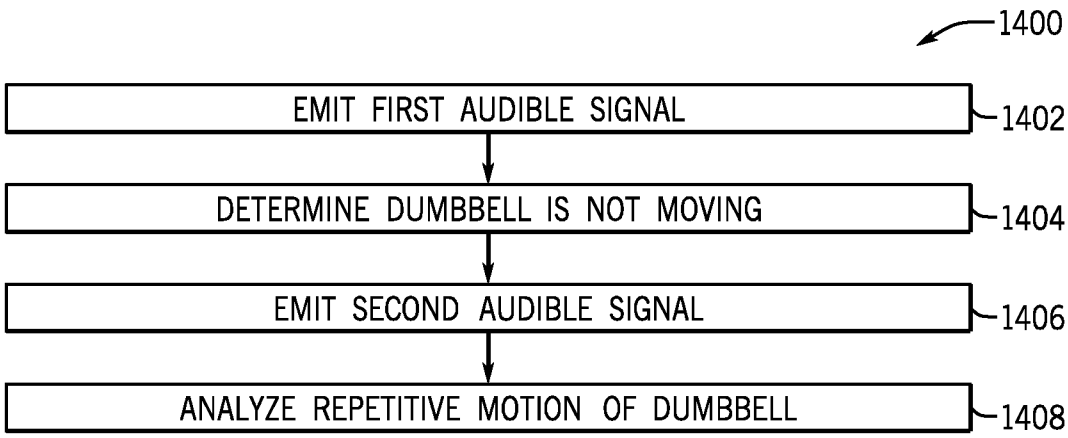

1400
EMIT FIRST AUDIBLE SIGNAL
1402
DETERMINE DUMBBELL IS NOT MOVING
1404
EMIT SECOND AUDIBLE SIGNAL
1406
ANALYZE REPETITIVE MOTION OF DUMBBELL
1408

FIG. 63

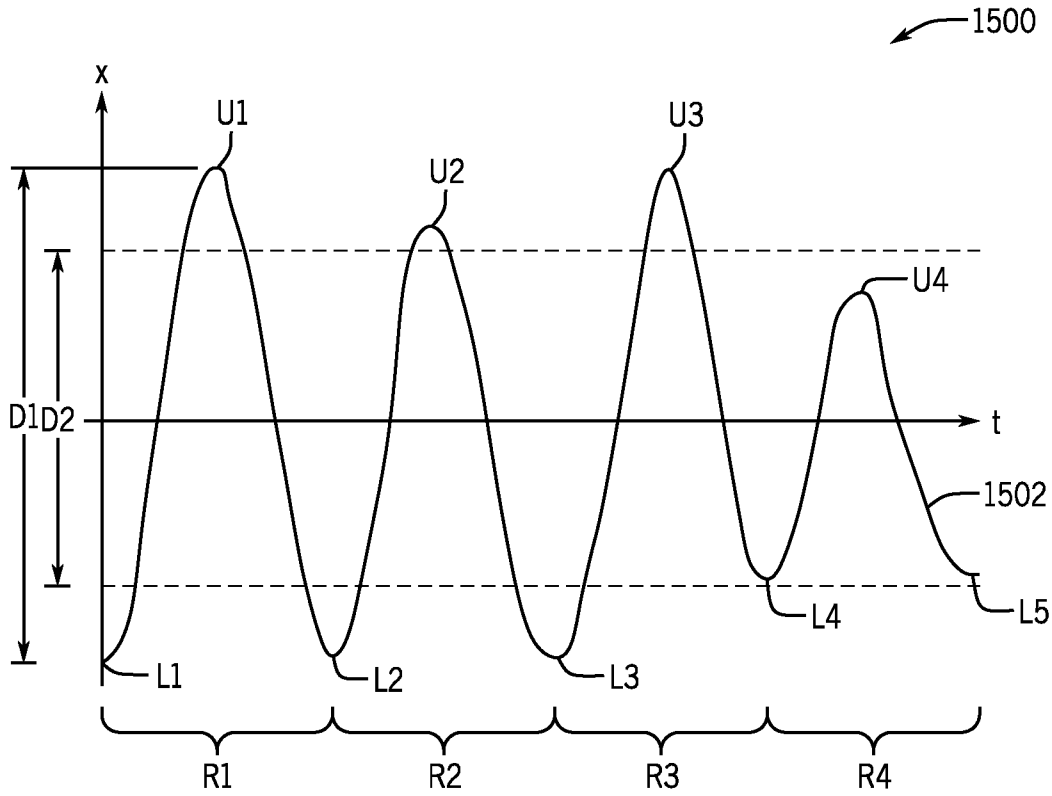

1500
x
U1
U2
U3
U4
D1
D2
t
1502
L1
L2
L3
L4
L5
R1
R2
R3
R4

FIG. 64

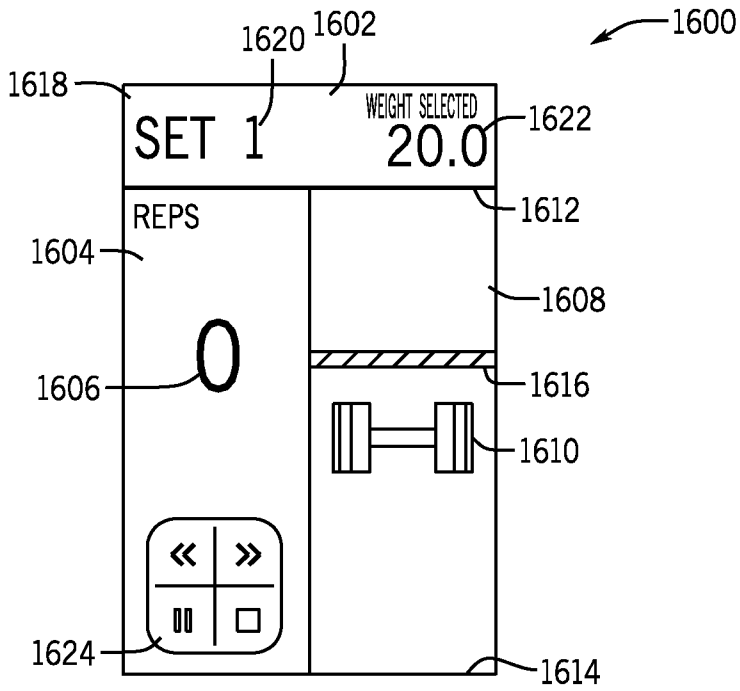

1600
1620
1602
1618
SET 1
WEIGHT SELECTED
20.0
1622
REPS
1612
1604
1608
0
1606
1616
1610
1624
1614

FIG. 65

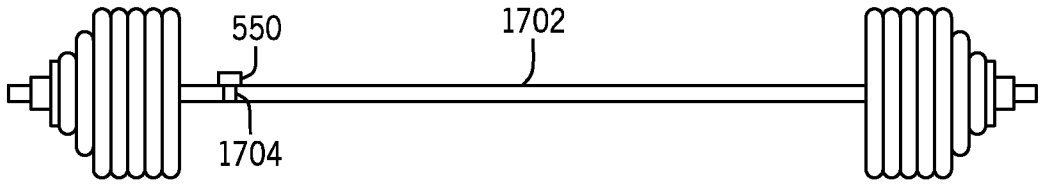


FIG. 66

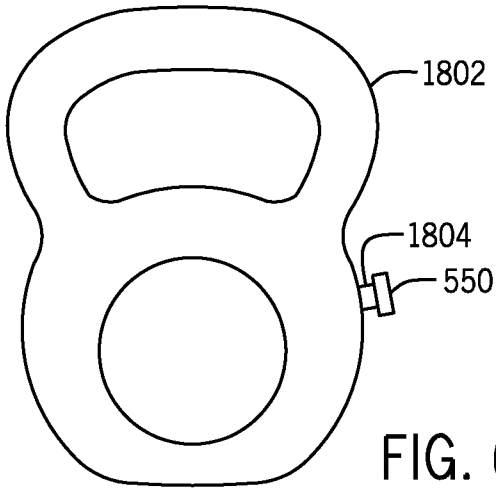


FIG. 67

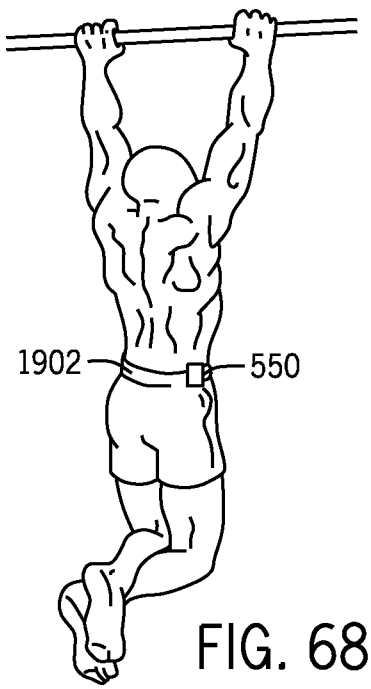


FIG. 68

INTERNATIONAL SEARCH REPORT PCT/US2014/059192 15.01.2015

International application No.
PCT/US 14/59192

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A63B 71/00 (2014.01)
CPC - A63B 24/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 482/8; CPC: A63B 24/00; IPC(8): A63B 71/00 (2014.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 482/1, 482/3; IPC(8): A63B 71/00 (2014.01); CPC: A63B2225/20, A63B24/0062, A63B2225/50, A63B71/0622

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, ProQuest Dialog, Google Web, Google Patents (Search terms: free weight, sensor, accelerometer, magnetometer, gyroscope, detector, repetition, count, audio, audible, sound, visual, display, first repetition, initial, start, ready signal, readiness, indicator, fitness, data drift, target, optimum, preferred, goal, rate, pace, pacing, etc.)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2013/0288859 A1 (Watterson) 31 October 2013 (31.10.2013), para. [0040], [0045]-[0047], [0049]-[0050], [0056]-[0057], [0061], [0063], [0079], and [0087], and Fig. 1.	1, 4/1, (6-9)/1, 19-20, 23-27, 30/27 --- 2-3, 4/(2-3), 5, (6-9)/(2-3), 10-14, 15-18, 21-22, 28-29, 30/(28-29), 31
Y	WO 2009/013679 A2 (Eck et al.) 29 January 2009 (29.01.2009), pg. 6, ln. 3-12, and Figs. 4A-4B.	2-3, 4/(2-3), 5/4/(2-3), (6-9)/(2-3) 13, (15-18)/13, 28-29, 30/(28-29), 31/30/(28-29)
Y	US 6,949,052 B2 (Millington et al.) 27 September 2005 (27.09.2005), col. 3, ln. 36-38, col. 4, ln. 11-57, col. 7, ln. 7-13, and col. 9, ln. 1-14, and Figs. 1A-1B.	10-14, 15-18
Y	US 2013/0171599 A1 (Bleich et al.) 04 July 2013 (04.07.2013), para. [0143], [0183], [0200], and [0229], and Fig. 40.	21-22
Y	WO 2013/151770 A1 (Mokaya et al.) 10 October 2013 (10.10.2013), pg. 14, ln. 1-12.	3, 4/3, 5/4/3, (6-9)/3, 29, 30/29, 31/30/29
Y	US 8,217,797 B2 (Ikoyan) 10 July 2012 (10.07.2012), col. 17, ln. 11-12, and col. 20, ln. 11-16.	14, (15-18)/14

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 December 2014 (12.12.2014)	15 JAN 2015
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774