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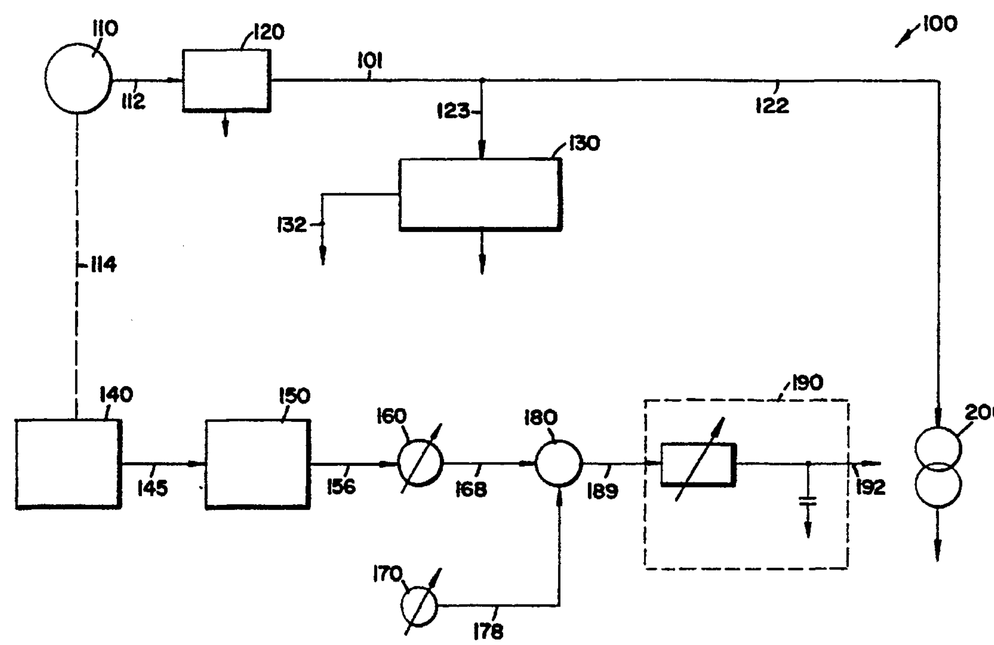

(57) Abstract

The present invention provides an electromechanical resistance device for exercise equipment. Exercise movement drives a motor that dissipates at least twenty percent of the power generated by exercise movement and that powers an electronic circuit which in turn dissipates the remainder of the exercise generated power. The effective inertia and drag resistance of the resistance device are user programmable. The present invention also provides a method of providing resistance to exercise movement using a relatively inefficient motor to dissipate approximately 50 % of the power generated by exercise movement.

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EXERCISE RESISTANCE DEVICE

Field of the Invention

This is a continuation in part of U.S. Patent Application, Serial No. 08/039,898, filed March 30, 1993. The present invention relates to exercise equipment and more particularly, to an electromechanical exercise resistance device.

Background of the Invention

An object of the present invention is to provide a new and improved exercise resistance device.

Another object of the present invention is to provide a new and improved exercise resistance device that can be readily substituted for known resistance devices on exercise equipment currently in production.

Another object of the present invention is to provide a new and improved exercise resistance device that can be used in a wide range of applications.

Another object of the present invention is to provide a new and improved exercise resistance device that is cost effective to manufacture.

Another object of the present invention is to provide a new and improved exercise resistance device that is reliable in operation.

Another object of the present invention is to provide a new and improved exercise resistance device that is capable of simulating a flywheel rotating subject to resistance.

Another object of the present invention is to provide a new and improved exercise resistance device that more accurately simulates the "feel" of cross-country skiing.

Another object of the present invention is to provide a new and improved exercise resistance device that allows a user to program workout parameters such as inertia and drag resistance.

Another object of the present invention is to provide a new and improved exercise resistance device that receives contemporaneous exercise input from multiple sources.

Another object of the present invention is to provide a new and improved exercise resistance device that generates its own power to drive resistance controlling circuitry.

Another object of the present invention is to provide a new and improved exercise resistance device that generates its own power to display workout data to the user.

Another object of the present invention is to provide a new and improved exercise resistance device that uses a motor to dissipate at least 20% of the power generated by exercise movement.

Summary of the Invention

According to one embodiment, the present invention provides a resistance mechanism for exercise equipment. The resistance mechanism includes a variable resistance means for providing variable resistance to exercise movement and a control means for comparing actual force of exercise movement to a threshold force and selecting a relatively high level of resistance when the actual force is greater than the threshold force and a relatively low level of resistance when the actual force is less than the threshold force. In one particular application, the present invention electromechanically simulates a flywheel that rotates subject to drag resistance.

The present invention also provides a method of providing resistance to exercise movement. The exercise movement is linked to a motor, which is operated to dissipate at least 20% of the power generated by the exercise movement. The motor is linked to an electronic circuit, which is operated to dissipate the remainder of the power generated by the exercise movement.

The present invention also provides an exercise resistance device that incorporates structure for cooling the resistance device to prolong its life.

The many advantages of the present invention will become apparent upon a more detailed description of a preferred embodiment.

Brief Description of the Drawing

With reference to the Drawing, wherein like numerals represent like parts and assemblies throughout the several views,

Figure 1 is a schematic diagram of a preferred embodiment exercise resistance device constructed according to the principles of the present invention;

Figure 2 is a sectioned side view of a motor that forms a part of the exercise resistance device shown in Figure 1;

Figure 3 is a sectional top view of the motor shown in Figure 2;

Figure 4 is a perspective view of a Prior Art flywheel resistance device mounted on a treadmill exercise apparatus;

Figure 5 is a perspective view of a Prior Art cross-country skiing exercise machine;

Figure 6a is a graph of torque versus time during operation of the Prior Art skier shown in Figure 5;

Figure 6b is a graph of angular velocity versus time during operation of the Prior Art skier shown in Figure 5;

Figure 7 is a perspective view of an assembly for substituting the resistance device of the present invention in the Prior Art skier shown in Figure 5;

Figure 8 is a top view of a skier incorporating an alternate embodiment of an exercise resistance device according to this invention;

Figure 9 is a bottom view of the skier represented in Figure 8;

Figure 10 is a side view, with portions represented in cross section, of the skier represented in Figure 8;

Figure 11 is a perspective view of a collar member which forms a portion of an alternate embodiment of an exercise resistance device according to the present invention;

Figure 12 is an elevational view of the collar represented in Figure 11;

Figure 13 is a side, cross-sectional view of the collar illustrated in Figure 11;

Figure 14 is an exploded assembly view of an alternate embodiment of an exercise resistance device according to the present invention; and

Figure 15 is an exploded, assembly view of an alternate embodiment of an exercise resistance device according to the present invention.

Detailed Description of a Preferred Embodiment

A preferred embodiment exercise resistance device constructed according to the principles of the present invention is designated as 100 in Figure 1. The resistance device 100 generally includes a motor 110 and a control circuit 101. The motor 110 is connected by a conducting means 112 to a rectifier component 120 and by another conducting means 114 to a velocity sensing component 140. In the preferred embodiment, the conducting means 112 is wire, and the other conducting means 114 is air, as explained below.

The rectifier component 120 is connected by a conducting means 122 to a current sink component 200 and by another conducting means 123 to a voltage regulator component 130. In the preferred embodiment the conducting means 122 and 123 are conducting traces on a circuit board. The output of the voltage regulator component 130 is used to power the other components of the control circuit 101.

The velocity sensing component 140 is connected by a conducting means 145 to a derivation component 150, which in turn, is connected by another conducting means 156 to a variable gain block component 160. The variable gain block component 160 is connected by a conducting means 168 to a summation component 180, and another variable gain block 170 is connected to the summation component 180 by another conducting means 178. The summation component 180 is connected by a conducting means 189 to an optional low pass filter component 190, which in turn, is connected by another conducting means 192 to the current sink component 200.

As shown in Figures 2 and 3, the motor 110 includes a housing 111 in the shape of a cylindrical shell. Four magnets 113 are secured at equally spaced intervals to the inner cylindrical wall of the housing 111, and a pulley 106 is secured to the outer end wall of the housing 111. The housing 111 is rotatably mounted relative to a shaft 118 by means of a bearing assembly 115. A stack 116 of laminations, each having 25 prongs 116a-116y equally spaced at 14.4 degrees, is secured to the shaft 118. Wire is wound around the prongs 116a-116y of the stacked laminations to form the windings 117 of the motor 110. In operation, the housing 111, together with the magnets 113 and the pulley 106, rotates relative to the windings 117 and the lamination stack 116. In other words, the motor 110 functions as a brushless alternator with the magnet bearing housing 111 serving as a rotor and the windings 117 serving as a stator.

The motor 110 is intentionally designed to function relatively inefficiently from a power generation perspective, so that the control circuit is required to consume less power than otherwise would be the case and thus, is less expensive to manufacture. With the motor 110 dissipating fifty percent of the energy generated by exercise movement, the control circuit 101 dissipates only the remaining fifty percent of the energy generated by exercise movement, as opposed to ninety-five percent if a typical state of the art motor were used. In this regard, the present invention provides a method of providing resistance to exercise movement. The exercise movement is linked to a motor, which is operated to dissipate at least 20% of the power generated by the exercise movement. The motor is linked to an electronic circuit, which is operated to dissipate the remainder of the power generated by the exercise movement. In a preferred method, the motor dissipates approximately 50% of the exercise generated power.

The motor 110 is also designed to generate a 3 phase alternating current having overlapping trapezoidal shaped waveforms that are rectified to provide a substantially constant direct current voltage without requiring a filter.

In the preferred embodiment, the velocity sensor component 140 employs known bar code reading technology to optically detect the passage of equally spaced markings 104 on the exterior cylindrical wall of the housing 111 (as shown in Figure 7). In an alternative embodiment, an alternative sensor component detects the zero voltage crossings of the 3 phase alternating current, recognizing that there are six zero voltage crossings per revolution. In either case, the measured velocity is conveyed to the derivation component 150, and the resulting differential value is conveyed to the variable gain block 160, which allows the user to program an "effective inertia" for the resistance system, as explained below.

The other variable gain block 170 allows the user to program an "effective drag" on the resistance system, as explained below. The summation component 180 adds the effective inertial torque and the effective drag torque to arrive at an overall resistance torque, which is conveyed to the optional low pass filter 190. The low pass filter 190 allows the user to program a dampening factor into the resistance system to moderate the severity of resistance variations. With or without the low pass filter 190, an overall resistance torque is conveyed to the current sink 200 to dictate the draw of current from the motor 110. Those skilled in the art will recognize that the torque transmitted through the motor 110 is directly proportional to the current, and more current translates into greater resistance.

The resistance device of the present invention has numerous applications throughout the exercise industry. In one particular application, the resistance device 100 can be used to simulate a Prior Art resistance device having a flywheel that rotates subject to drag resistance, an example of which is designated as 50 in Figure 4. The treadmill exercise apparatus 10 includes a frame 11 and a treadmill belt 12 that rotates relative to said frame 11. The Prior Art resistance device 50 includes a flywheel 51 having an outer cylindrical contact surface 54 that is bordered by right and left peripheral flanges 55a and 55b, respectively. A drag strap 52 wraps around some portion of the outer cylindrical contact surface 54 and is disposed between the left and right flanges 55a and 55b, respectively. Both ends of the drag strap 52 are anchored relative to the exercise apparatus frame 11, and a coil spring 53 is disposed in series with the drag strap 52 to maintain tension in the drag strap 52. As a person walks on the treadmill belt 12, the flywheel 51 rotates subject to frictional resistance created by contact between the drag strap 52 and the outer cylindrical contact surface 54. The resistance level can be adjusted by increasing or decreasing the tension in the spring 53 and hence, the drag strap 52.

The Prior Art flywheel device is currently used on a variety of exercise equipment, examples of which are disclosed in United States Patent Nos. 4,728,102 and 5,072,929. One such device is designated as 20 in Figure 5. The ski machine 20 includes a base 30 having a front leg assembly 31 and a rear leg assembly 32 that are designed to rest upon a floor surface. A pair of simulator skis 40a and 40b are movably mounted relative to the base 30. Each of the skis 40a and 40b extends from a respective front end 41a and 41b to a respective rear end 42a and 42b, and each has a respective toe loop 46a and 46b mounted on a respective intermediate portion therebetween.

Although the simulator skis 40a and 40b are several times longer than a person's foot, those skilled in the art will recognize that the skis need only be long enough to effectively support a person's foot, and the present invention is not limited in this regard. Indeed, many commercially available striding devices have simulator skis or foot members that are significantly shorter than those shown in Figure 5. One such Prior Art cross-country skier is disclosed in United States Patent No. 4,650,077 to Stropkay.

With reference back to the skier 20 shown in Figure 5, the Prior Art resistance device 50 is operatively connected to the base 30 and the skis 40a and 40b, such that the skis 40a and 40b move rearward relative to the base 30 subject to resistance provided by the Prior Art resistance device 50. In a preferred embodiment, the skis 40a and 40b are supported on drive rollers (designated as 45a and 45b in Figure 7) that are connected to a main shaft (designated as 57 in Figure 7) by one-way clutches, so that the drive rollers 45a and 45b rotate the shaft 57 in response to rearward movement of the skis 40a and 40b, but the drive rollers 45a and 45b "free wheel" relative to the shaft 57 during forward movement of the skis 40a and 40b. The Prior Art resistance device 50 includes a flywheel 51 that is mounted on the shaft 57 and rotates together with the shaft 57, subject to frictional forces between an outer cylindrical contact surface of the flywheel 51 and a drag strap 52 secured about the outer cylindrical contact surface of the flywheel 51.

The exercise apparatus 20 further includes a post 60 that is mounted relative to the base 30 and extends in a substantially vertical direction from the base 30 when in an operable position. A clip 56 is slideably mounted relative to the post 60 to releasably secure the drag strap 52 along the post 60 and thereby set the relative tension in the drag strap 52 and the corresponding level of resistance to rotation of the flywheel 51.

The skier 20 further includes a pelvis support 70 that is slideably secured relative to the post 60. The pelvis support 70 is designed to support the pelvis/hips of a person using the apparatus 20, and the elevation of the pelvis support 70 is adjustable along the post 60 to accommodate persons of various heights. A bar 80 is mounted relative to the post 70 and extends in a forward and upward direction from the post 70 when in an operable position, defining an angle of approximately 130 degrees therebetween. A pair of fixed handles 81a and 81b extend laterally from opposite sides of the bar 80.

An arm exercise unit 90 is secured relative to a distal end of the bar 80. The arm exercise unit 90 includes a pair of lines 91a and 91b that are designed to be pulled from a drum 93 in reciprocating fashion, subject to a frictional` resistance force. A pair of free handles 92a and 92b are disposed on respective distal ends of the pair of lines 91a and 91b.

In operating the skier 20 shown in Figure 5, a person faces toward the pelvis support 70, places a foot on each of the skis 40a and 40b, and leans forward slightly to rest his or her pelvis/hips against the pelvis support 70. The person may additionally grasp a free handle 92a or 92b in each hand or simply hold onto the sides of the pelvis support 70 or the fixed handles 81a and 81b. The person then "shuffles" his or her feet back and forth, alternately pushing one of the skis 40a and 40b rearward against the resistance from the flywheel 51 and pulling the other of the skis 40a and 40b forward subject to minimal resistance. The person also has the option of alternately pulling one of the free handles 92a and 92b rearward against resistance from the drum, while the other of the free handles 92a and 92b is reciprocally pulled forward.

In order to initiate rotation of the flywheel, the user must exert an initial force T1 to overcome the force of static friction between the drag strap and the flywheel contact surface. Upon rotation of the flywheel, the user must exert a steady state force T2 to continue driving the flywheel subject to the force of dynamic friction between the drag strap and the flywheel contact surface. The static frictional forces are greater than the dynamic frictional forces, and thus, the steady state force T2 is less than the initial force T1. When the user stops exerting the steady state force T2, the inertia of the flywheel keeps the flywheel rotating until the friction depletes the inertial energy or until the user resumes exertion of the steady state force T2. If the flywheel stops rotating, then the user must again exert the initial force T1 to begin rotation of the flywheel anew.

The flywheel torque and velocity behave substantially as shown in Figures 6a and 6b. In the time interval 0-a, the user pushes one leg rearward to overcome the initial resistance torque T1 and initiate rotation of the flywheel. In the time interval a-b, the user continues to push the one leg rearward subject to the steady state resistance torque T2, and the rotational velocity of the flywheel increases. In the meantime, the user pulls the other leg forward subject to minimal resistance. In the time interval b-c, the user switches the direction of each leg, pulling the one leg forward subject to minimal resistance and pushing the other leg rearward. The speed of the flywheel is such that rearward movement of the other leg does not immediately overtake the inertia of the flywheel, and the rotational velocity of the flywheel decreases as the initial rearward movement of the other leg is subject to minimal resistance. In the time interval c-d, the rearward movement of the other leg overtakes the flywheel inertia, engaging the steady state resistance torque T2 and increasing the rotational velocity of the flywheel. In the meantime, the user continues to push the one leg forward subject to minimal resistance. The process then reverses itself beginning in the time interval d-e, as the user again pulls the one leg rearward and overtakes the inertia of the flywheel.

The resistance device 100 of the present invention can be readily substituted for the Prior Art flywheel resistance device on the skier 20 shown in Figure 5. As shown in Figure 7, the present invention functions with the same drive rollers 45a and 45b and shaft 57 as the Prior Art skier 20. A large pulley 105 is mounted on the shaft 57 in place of the Prior Art flywheel 51, and a ribbed belt 107 links the large pulley 105 to the relatively smaller pulley 106 on the motor 110, establishing a 3:1 gear ratio. The ribs of the belt 107 mate with ridges 108 and 109 on the large pulley 105 and the relatively smaller pulley 106, respectively. A cable 119 connects the motor 110 to the control circuit 101.

In this particular application, the resistance device 100 is capable of providing variable resistance to exercise movement in a manner that simulates the flywheel rotating subject to drag resistance. Higher resistance is encountered when the exercise movement is sufficient to overtake the simulated flywheel inertia, and lower resistance is encountered when the exercise movement is insufficient to overtake the simulated flywheel inertia. In particular, the control circuit 101 compares actual force of exercise movement to a threshold force and selects a relatively high level of resistance (equivalent to T2) when the actual force is greater than the threshold force and a relatively low level of resistance (equivalent to minimal resistance) when the actual force is less than the threshold force. The control circuit 101 computes the threshold force as a function of the actual force of at least one previous exercise movement and the time elapsed since the previous exercise movement.

The present invention provides improvements and options beyond mere simulation of the Prior Art flywheel resistance system. For example, the control circuit 101 can select from among a range of available resistance levels to initial exercise movement, whereas the initial resistance force T1 provided by the Prior Art device was dictated by the static friction between the flywheel and the drag strap. As a result, the present invention can be used to avoid the resistance spike that can occur with the Prior Art device during initial exercise movement. Thus, the present invention facilitates a smoother initial exercise movement.

The control circuit 101 can also provide a transitional level of resistance as the actual force of exercise movement approaches the threshold force. As a result, the present invention can be used to avoid the resistance spike that can occur with the Prior Art device as the exercise movement overtakes the flywheel inertia. Thus, the present invention facilitates a smoother overtaking of the simulated flywheel inertia.

Another advantage of the present invention is that the user can vary the simulated flywheel inertia, as well as the simulated drag resistance. To the contrary, the only resistance adjustment available with the Prior Art device 50 is to change in the magnitude of T1 and T2 by altering the tension in the drag strap. The various adjustment capabilities of the present invention allow for a resistance curve that more accurately simulates the "feel" of cross-country skiing.

Those skilled in the art will recognize that the present invention is not limited to the particular graphs shown in Figures 6a and 6b, but rather, can be used to provide a variety of resistance curves for a variety of applications. The versatility of the present invention also provides an opportunity to combine the work performed by the legs and arms, for example, and use the combined work to drive a single simulated inertia. The measurements and computations used in the circuitry also facilitate calculations of workout data such as total work performed, and the power generating feature of the present invention enables display of such data without the need for a power supply.

Figure 10 illustrates a skier 201, which is similar to the skier 20 shown in Figure 5. Skier 201 incorporates an alternate embodiment of an exercise resistance device 205. The skier 201 includes a pair of simulator skis 207a and 207b which are mounted for movement relative to a base 208. Exercise resistance device 205 provides resistance to the movement of the skis 207a and 207b. More specifically, skis 207a and 207b rest on drive rollers 210 and 211, visible in Figure 9. Exercise resistance device 205 provides resistance to the rotation of drive rollers 210 and 211, thereby creating resistance to movement of the skis 207a and 207b relative to the base 208.

In the alternate embodiment for the exercise resistance device 205, a variable resistance device 220 is directly linked to the drive rollers 210 and 211. This is illustrated in Figure 14. A shaft 215 is provided on which drive rollers 210 and 211 are mounted. The shaft 215 is illustrated in cut-away form in Figure 14. The shaft 215 extends through a housing 218 which substantially encloses a variable resistance device 220.

The resistance device 220 functions substantially the same as the resistance device discussed above with respect to Figures 2 and 3. That is, it includes a motor 221 which functions as a brushless alternator, with a rotor 222 and a stator 223. The resistance device 220 is constructed and arranged such that the rotor 222 is able to rotate with respect to the stator 223. The stator 223, as illustrated in Figure 15, is a coil hub and includes wire-wrapped prongs forming windings, in the manner discussed above with respect to the motor 110.

The stator 223 is mounted on a bearing hub 225 which in turn is mounted on shaft 215, such that shaft 215 is able to rotate about its axis with respect to bearing hub 225. That is, while shaft 215 rotates, bearing 225 allows for stator 223 to remain stationary.

As illustrated in Figures 11-13, collar member 228 is provided to which are mounted magnets 229 which act as the rotor 222. More specifically, collar member 228 includes a generally cylindrical innersurface 231 against which magnets 229 are disposed. Preferred magnets 229, when arranged in collar member 228, define a cylindrical cavity 235 which receives stator 223.

Collar member 228 is constructed and arranged to be fixed to shaft 215, such that rotation of shaft 215 simultaneously causes rotation of collar member 228. In this manner, when shaft 215 is rotated, collar member 228 rotates, thereby causing rotation of magnets 229 with respect to coil hub 223 to generate resistance to rotation of the shaft 215.

Collar member 228 includes a recess 237 for receiving shaft 215. Preferable, recess 237 is located along the longitudinal or symmetrical axis 238 of collar 228.

Additionally, the exercise resistance device 205 of the present invention includes cooling structure for dissipating heat generated by the motor 221. As illustrated in Figures 11 and 12, a plurality of fins 240 are provided on collar member 228. In a preferred embodiment, the fins are generally curved in cross-section, and are disposed in a circular path, spaced radially from shaft 215. The fins extend in a generally radial direction. In this manner, rotation of collar member 228 about shaft 215, causes fins 240 to create an air current which cools the motor 221. The Applicant has found that this is a particular elegant way to create resistance to movement of shaft

215, while at the same time cooling the resistance device 220 to prolong its life.

As illustrated in Figure 14, housing 218 envelops collar 228, so that exposed moving parts are minimized.

Electronic circuit board 250 is positioned within housing 218 such that the air stream generated by the rotation of fins 240 passes over the electronic circuit board 250. In this manner, the electronic circuit board 250 is cooled as a result of the rotation of the fins 240. As shown in Figure 15, a preferred manner of positioning the circuit board 250 in the housing is to mount the circuit board 250 to a plate 245 which forms a wall of housing 218. It should be understood that electronic circuit board 250 could be mounted to or supported in some other manner within the housing to 218, within the spirit of this invention.

The control circuit on circuit board 250 performs in the manner discussed above with respect to control circuit 101.

In a preferred embodiment, the electronic controls 250 include a heating coil for dissipating energy from the circuit board.

The present invention has been described with reference to a preferred embodiment and method. However, those skilled in the art will recognize a variety of alternative embodiments and additional applications that fall within the scope of the present invention. Accordingly, the present invention is to be limited only by the appended claims.

IN THE CLAIMS

1. An exercise resistance device, comprising:

(a) variable resistance means for providing variable resistance to exercise movement;

(b) control means for comparing actual force of exercise movement to a threshold force and selecting a relatively high level of resistance when said actual force is greater than said threshold force and a relatively low level of resistance when said actual force is less than said threshold force.

2. An exercise resistance device according to claim 1, further comprising:

(a) first cooling means for dissipating heat generated by said resistance means;

(b) linking means for linking said exercise movement to said variable resistance means, wherein said linking means includes a rotatable shaft on which is mounted a drive roller which rotates in response to exercise movement, and said cooling means includes fins mounted on said rotatable shaft, such that said fins rotate about said shaft during exercise movement.

3. An exercise resistance device, according to claim 2, wherein said cooling means dissipates greater than 40% of energy generated by said variable resistance means.

4. An exercise resistance device according to claim 2, wherein said variable resistance means includes a stator and a rotor, one of said stator or rotor being mounted on said shaft to rotate relative thereto, and the other of said stator or said rotor being fixably mounted to said shaft.

5. An exercise resistance device according to claim 2 wherein said variable resistance means include a stator mounted on said shaft to rotate relative thereto, and a rotor fixably mounted on said shaft, such that upon rotation of said shaft, said rotor rotates relative to said stator thereby generating a force that resists movement of said shaft.

6. An exercise resistance device according to claim 5 wherein said rotor includes magnets fixed to a collar member, and said fins are fixed to said collar member.

7. An exercise resistance device according to claim 1, said device further comprising second cooling means for dissipating heat generated by said control means.

8. An exercise resistance device according to claim 2 further comprising second cooling means for dissipating heat generated by said control means.

9. An exercise resistance device according to claim 8 wherein said second cooling means includes a wire coil positioned in a stream of air generated by rotation of said fins about said shaft.

10. An exercise resistance device according to claim 2 wherein said control means is positioned in a stream of air generated by rotation of said fins about said shaft.

11. An exercise resistance device according to claim 2 wherein said drive roller rotates about its axis once for every rotation of said shaft about its axis.

12. An exercise resistance device according to claim 1 further comprising cooling means constructed and arranged to be operated by movement during exercise.

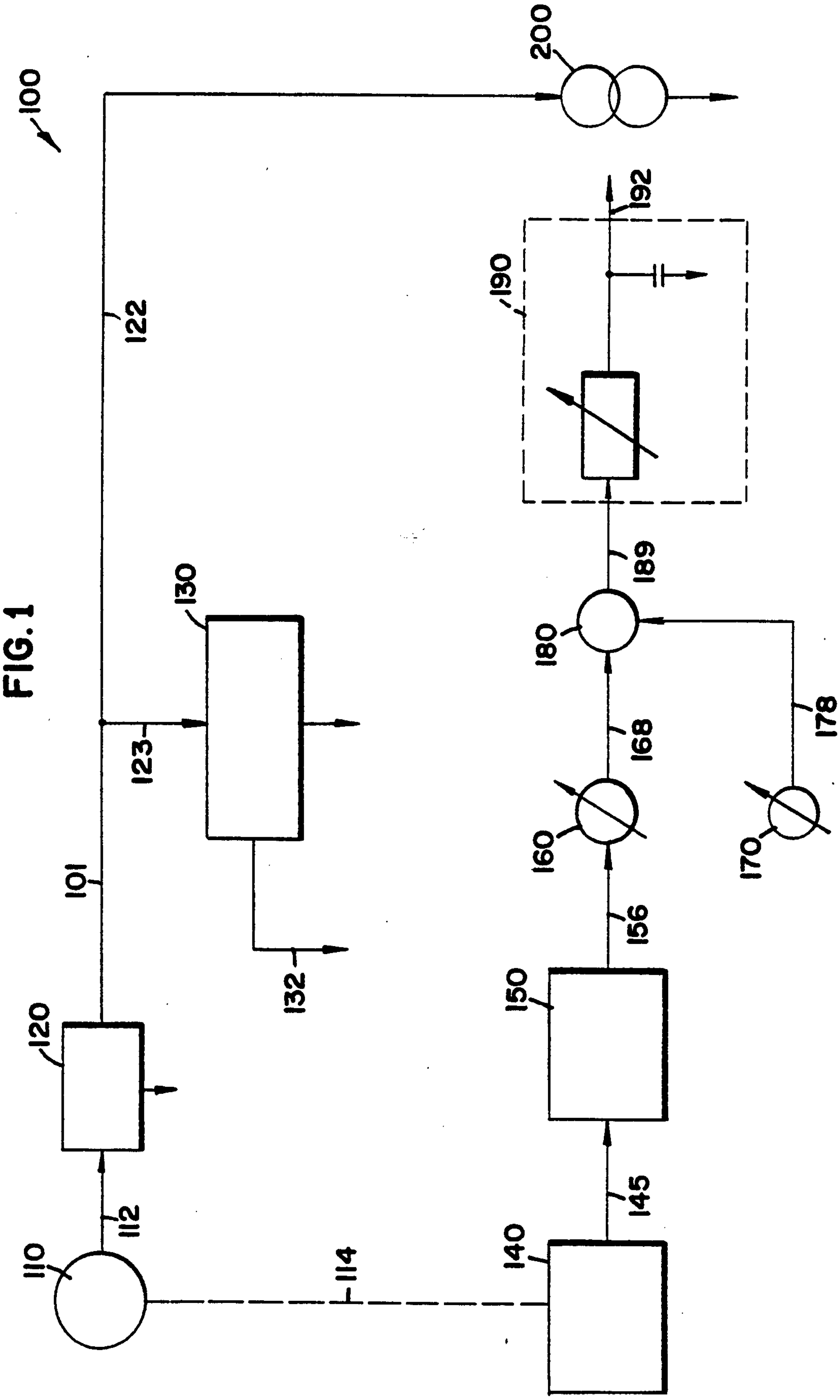
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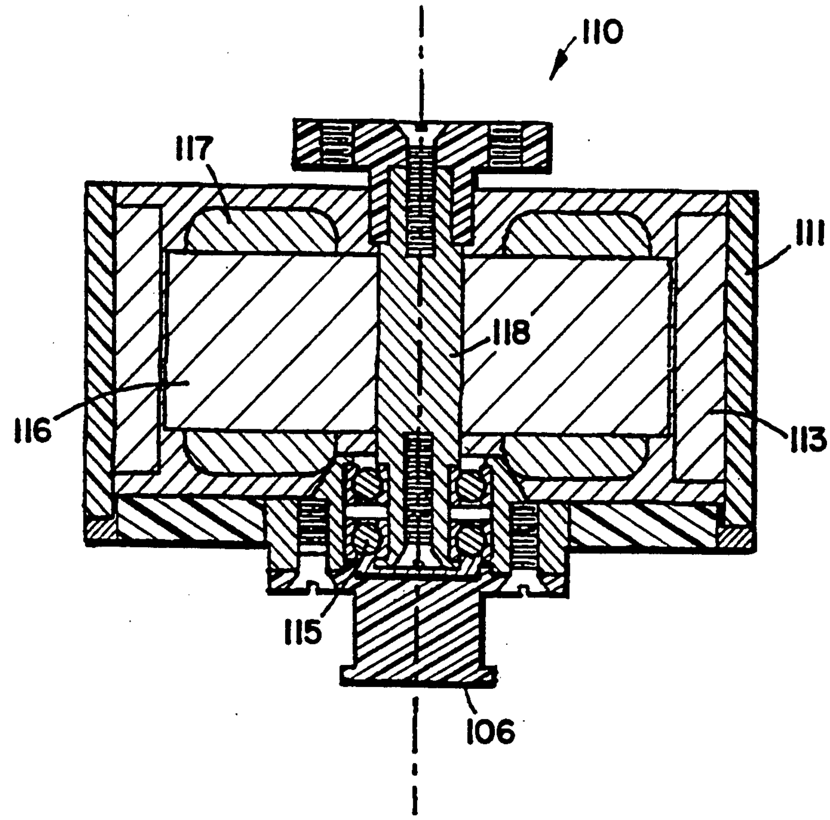
FIG. 1

FIG. 2



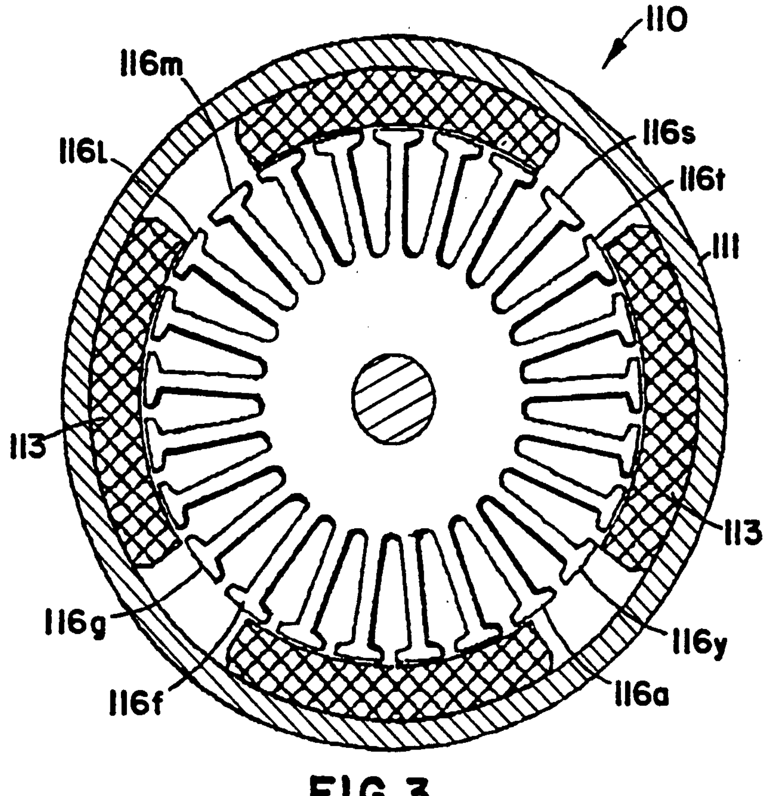


FIG. 3

SUBSTITUTE SHEET (RULE 26)

FIG. 4
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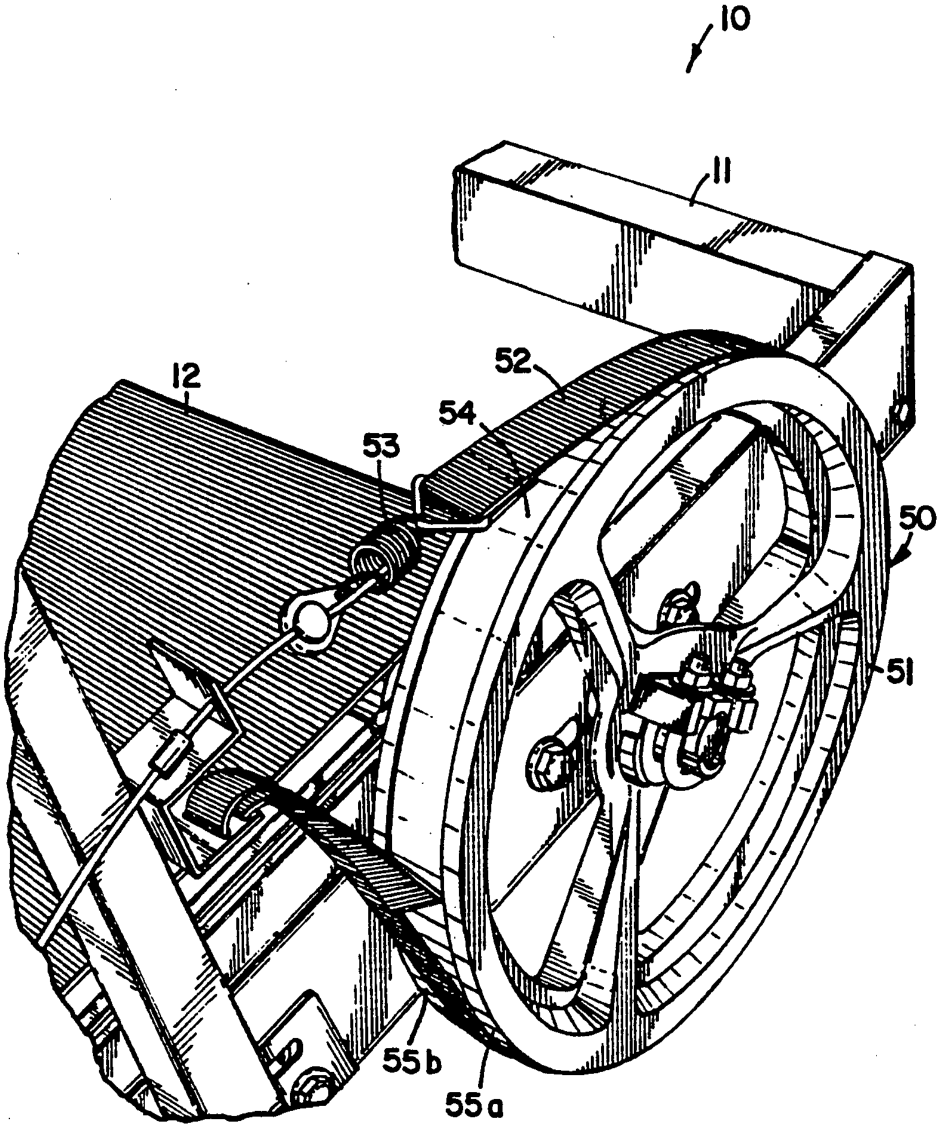
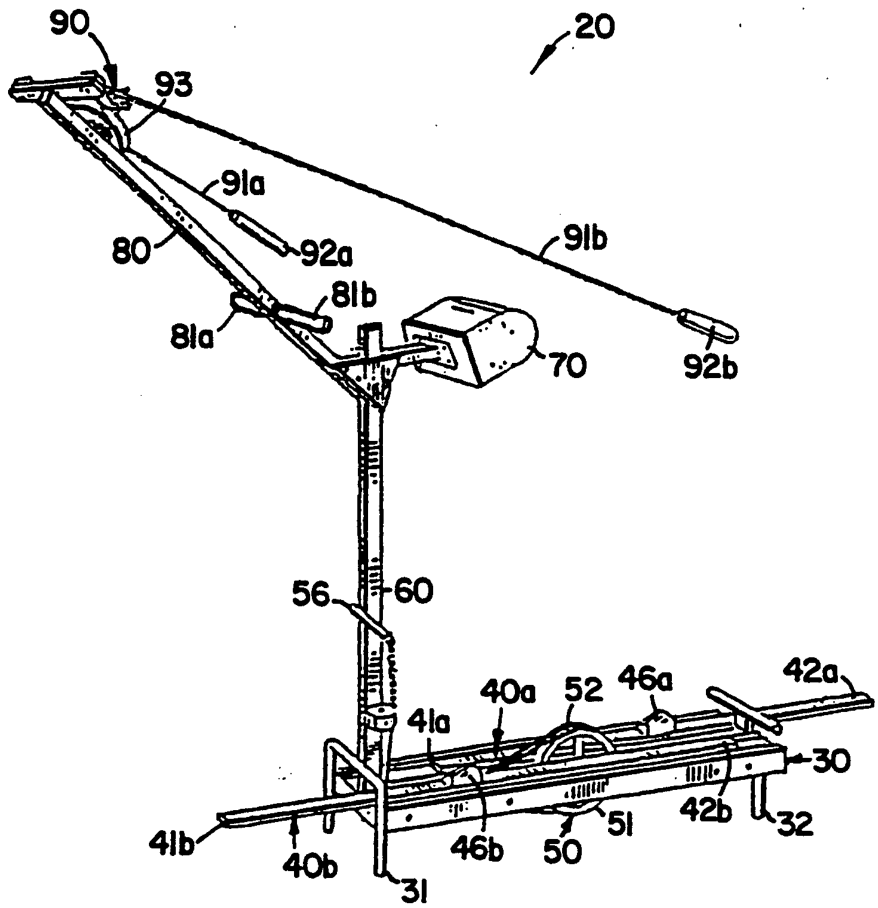


FIG.5
PRIOR ART



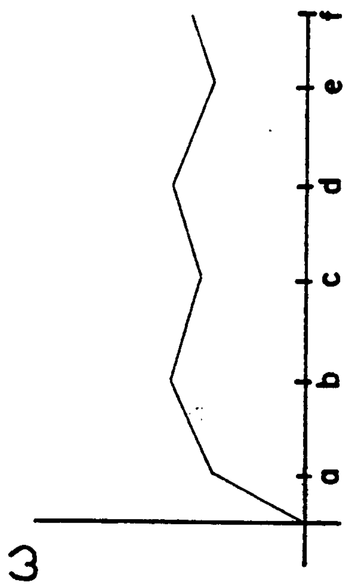


FIG.6b

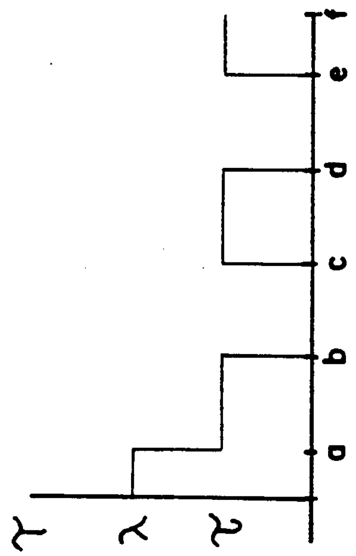


FIG.6a

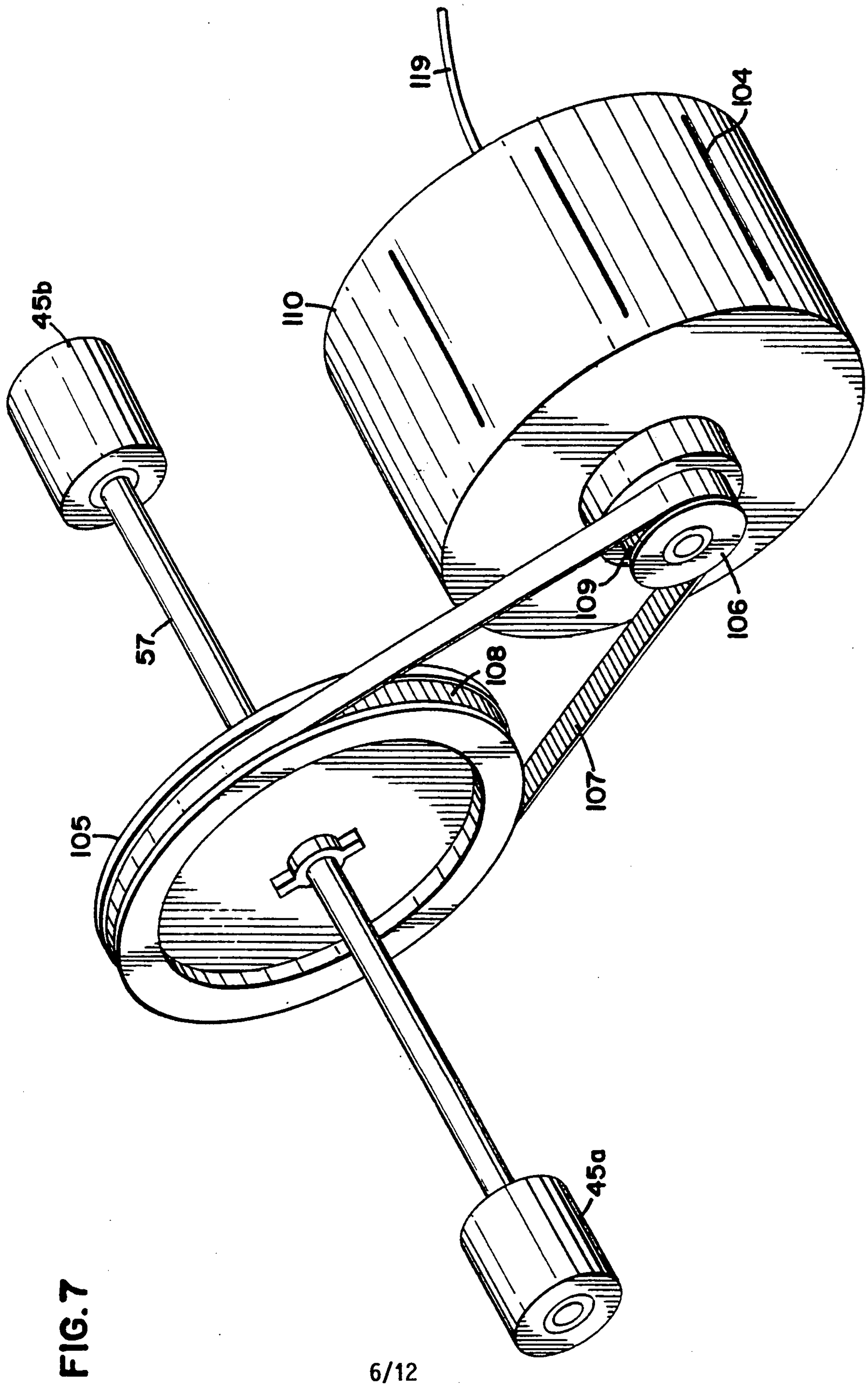


FIG. 7

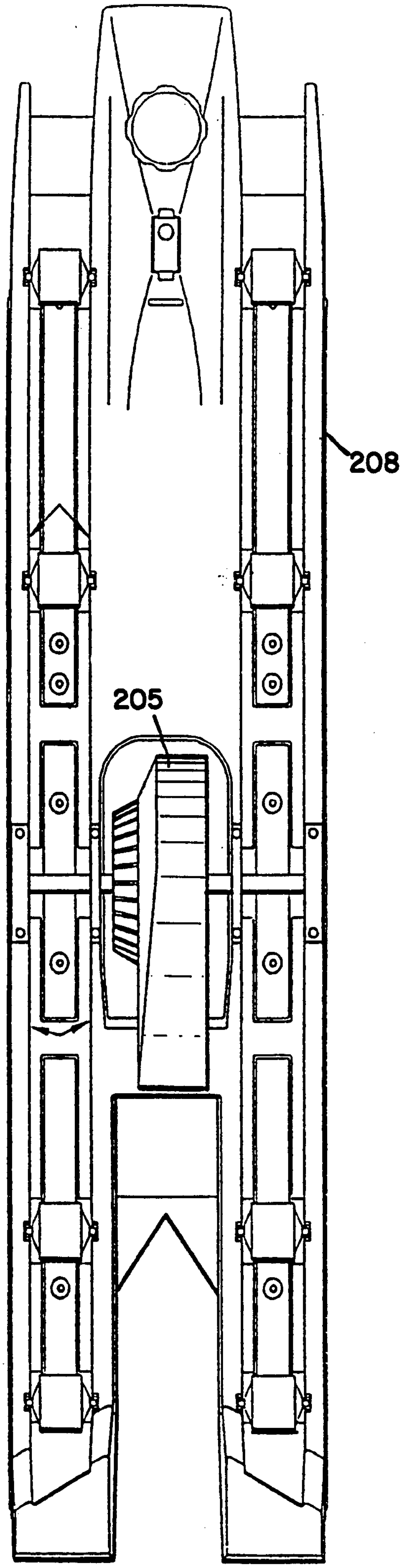


FIG. 8

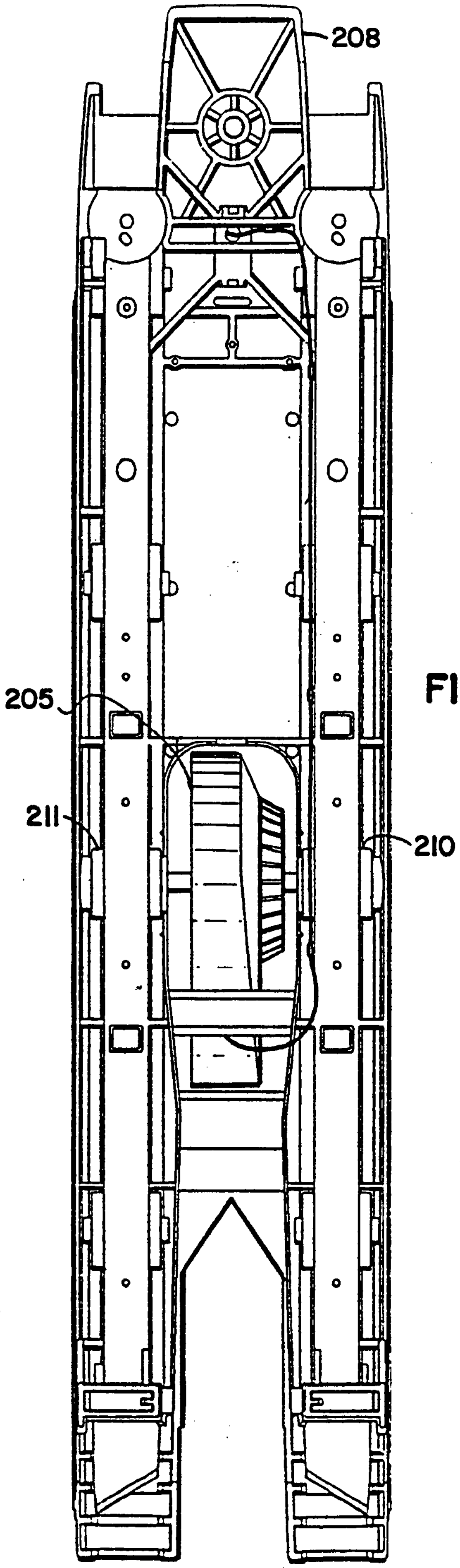


FIG. 9

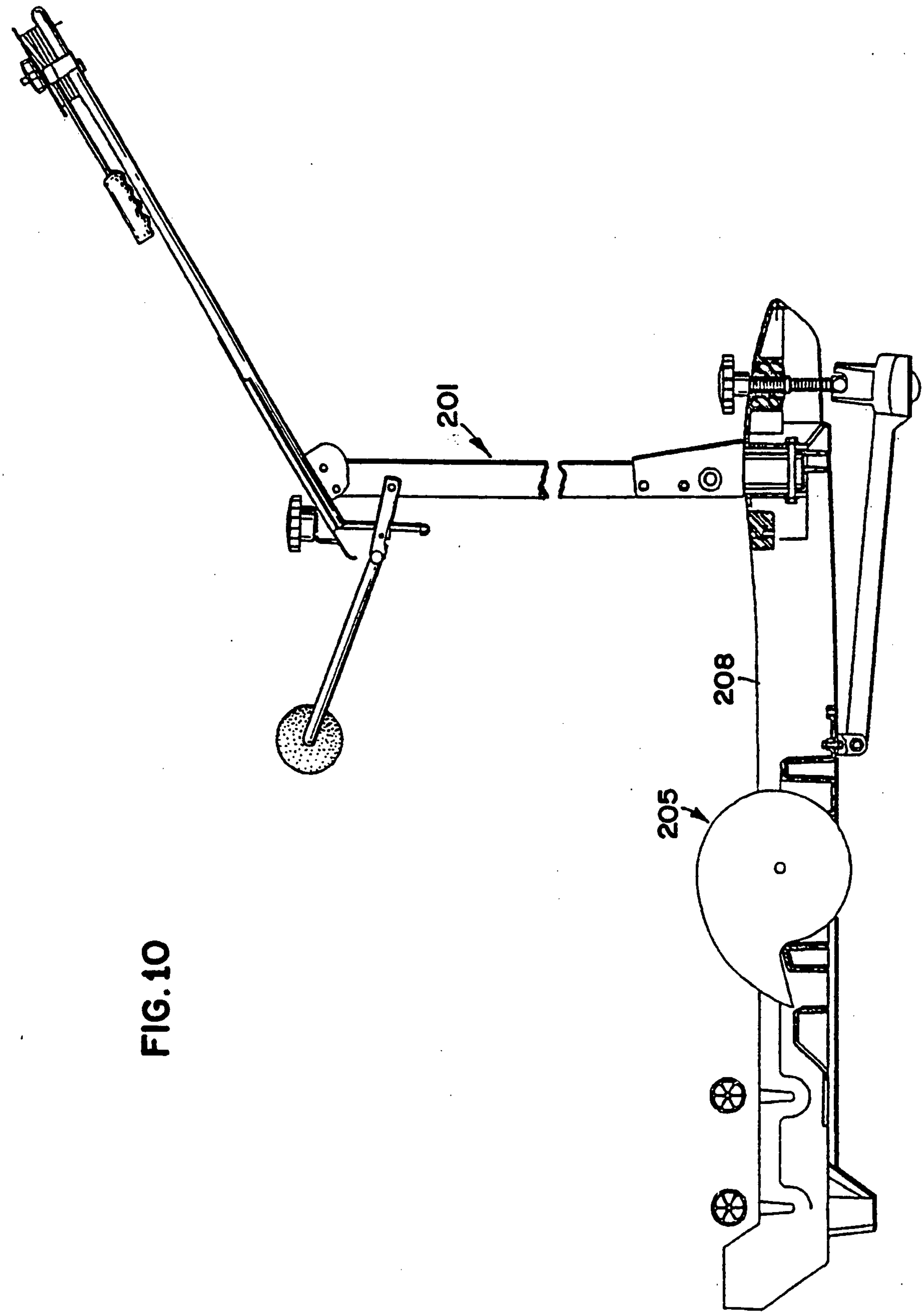


FIG.10

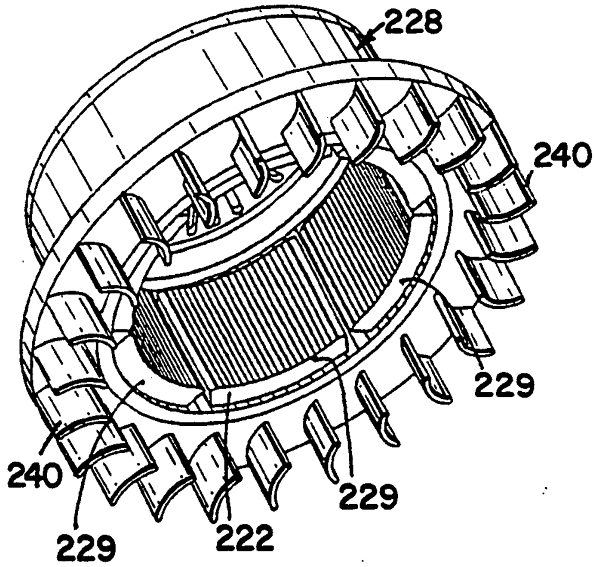


FIG. 11

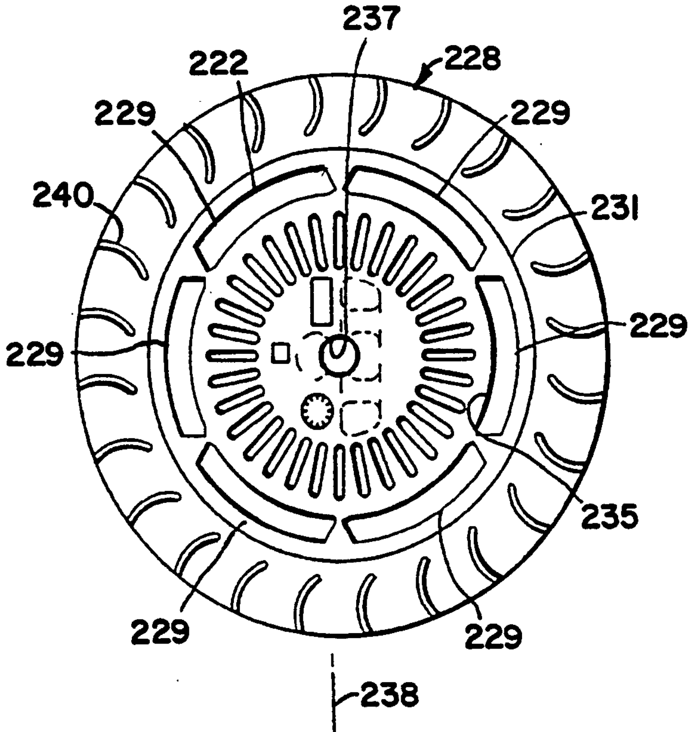


FIG.12

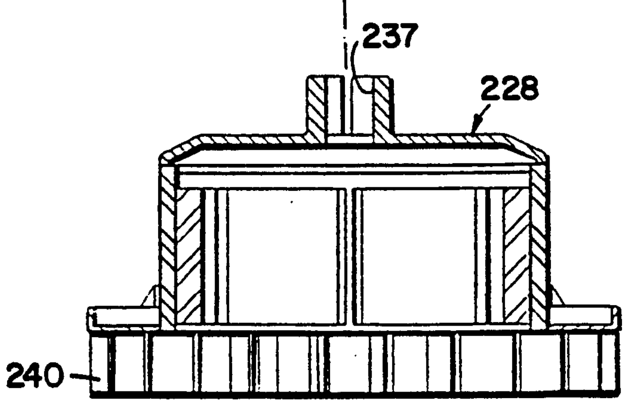


FIG.13

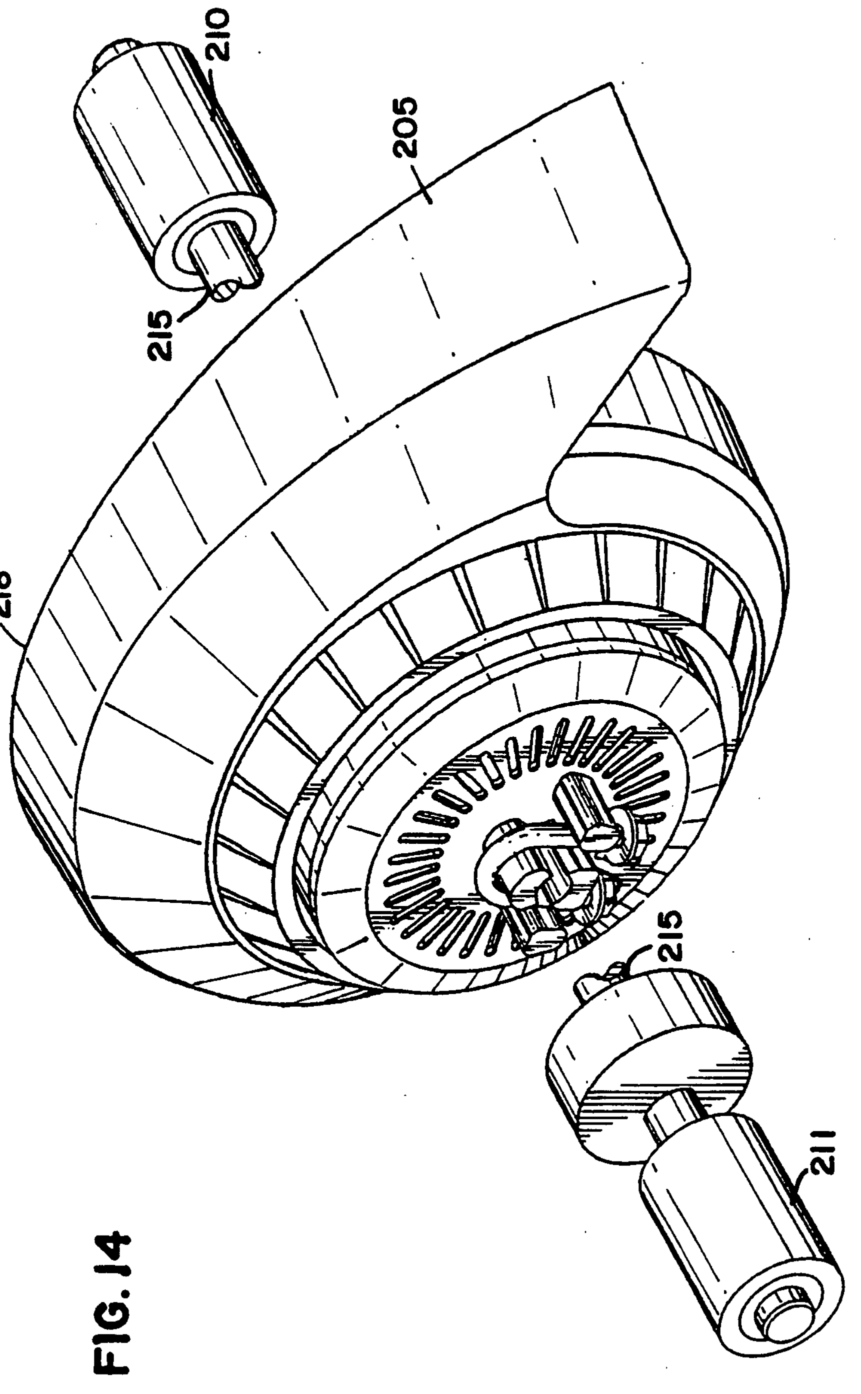


FIG. 14

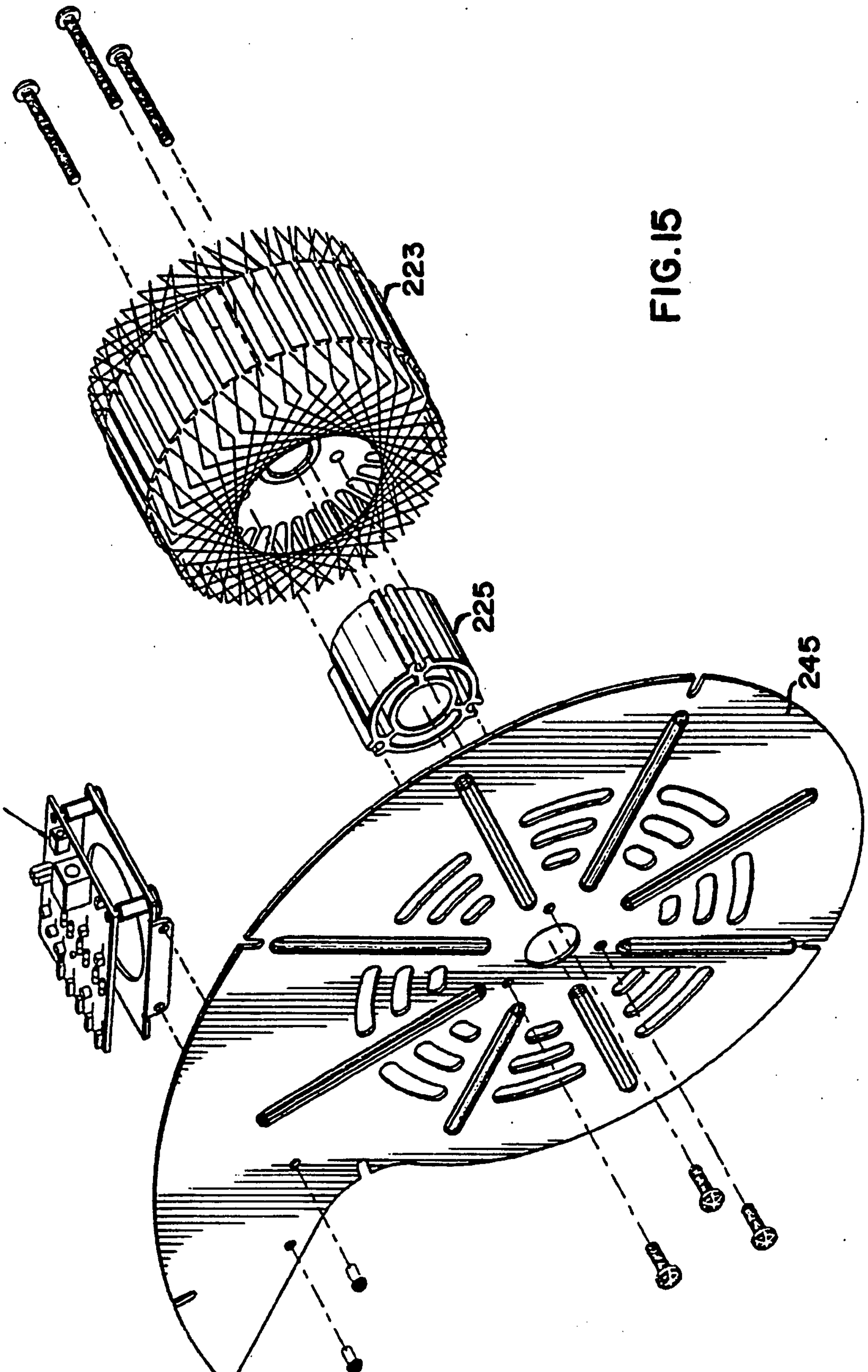


FIG.15