(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 November 2017 (23.11.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/201099 A1

(51) International Patent Classification:
*A63B 21/02* (2006.01) *A63B 21/008* (2006.01)

(21) International Application Number:
PCT/US2017/032977

(22) International Filing Date:
16 May 2017 (16.05.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/336,861 16 May 2016 (16.05.2016) US
15/597,027 16 May 2017 (16.05.2017) US

(72) Inventor; and
(71) Applicant: **LIND, Peter** [US/US]; 1707 Lansing Avenue NE, Salem, OR 97301 (US).

(74) Agent: **CROSY, Kevin, P.**; GrayRobinson, P.A., 401 E. Las Olas Blvd., Suite 1000, Fort Lauderdale, FL 33301 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,

(54) Title: MULTI-DEGREE OF FREEDOM RESISTANCE EXERCISE DEVICE

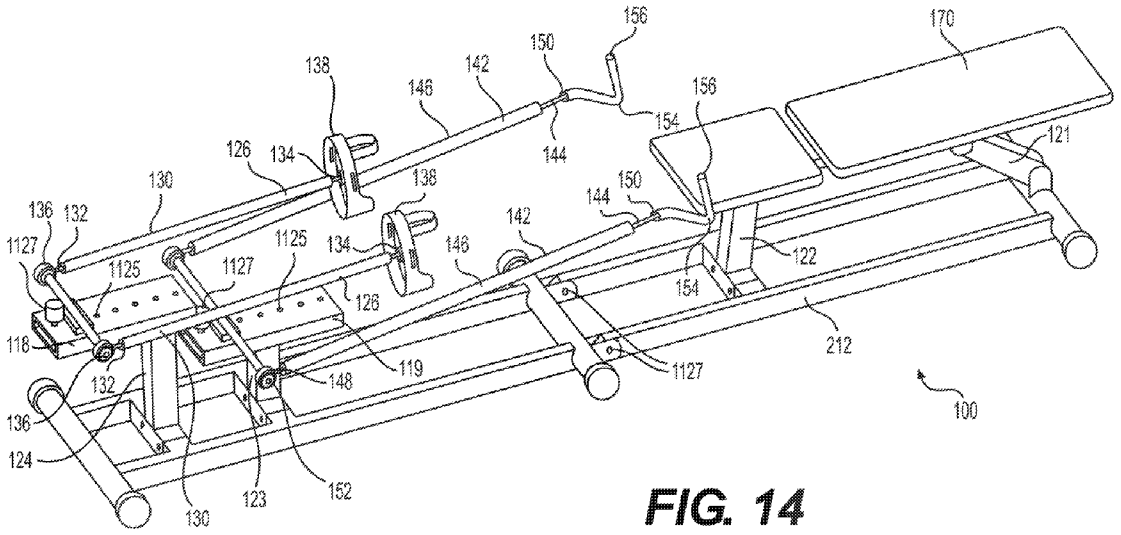



FIG. 14

(57) Abstract: A rehabilitative and/or exercise machine that has a frame with attachments to multiple independent bidirectional resistance devices (pneumatic, hydraulic, spring actuated, pulley system, cam, or any other resistance devices) used by the arms and/or legs to provide resistance against movement of the user's appendages in two substantially opposed directions. The resistance devices may have a mechanism such as one or more valves, brakes, springs, or the like that control bi-directional resistance. The action of the arms and/or legs in bi-directional resistance offers near full body exercise of the agonist/antagonist muscles using flexion and extension action of the larger muscle groups in a gait pattern, simultaneously. Hand engaging members attach to the arm resistance devices and foot engaging members attach to the leg resistance devices. The unit may- include an attached inclined backboard, mat, bench, or cushion to fully or partially support the user, such as for the user to sit or lay on. The unit may have separate adjustment mechanism s for adjusting the height and/or length of the various portions of the unit to adjust the range of motion of the appendages. The unit may have devices to monitor pulse, oxygen flow and other vital signs.

WO 2017/201099 A1

*[Continued on next page]*

UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

**Published:**

— *with international search report (Art. 21(3))*

# MULTI-DEGREE OF FREEDOM RESISTANCE EXERCISE DEVICE

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims the benefit of U.S. Provisional Application No. 62/336,861, filed on May 16, 2016. The disclosure of the provisional applications are expressly incorporated herein by reference as though fully set forth herein.

## BACKGROUND OF THE INVENTION

**[0002]** Field of the Invention

**[0003]** This invention relates to exercise devices, and, more particularly, relates to devices having multiple resistance elements permitting the user to exercise his or her arms and/or legs synchronously in full or nearly full range of motion without the influence of gravity.

**[0004]** Description of the Prior Art

**[0005]** There are two major reasons people don't exercise. The most common objection is the time it takes for a workout, typically at least 45 – 60 minutes, performed three or more times per week. The second most common objection to exercise is the lack of results from engaging in an exercise program.

**[0006]** Safety concerns about exercise in general also limit or altogether preclude many from exercise, including those who: have heart conditions; have balance problems; have dizziness and occasionally lose consciousness; have bone or joint pain made worse by weight-bearing activity; or have neuropathy made worse by weight-bearing activity.

**[0007]** However, the importance of exercise is universally recognized. Moreover, the wider/fuller the range of motion through which a user's appendages are put during exercise,

the more benefit is realized. Some of the benefits of full range of motion during exercise include muscles becoming far stronger, not just in the bottom of the range of motion but throughout the entire range of motion, muscle size increases throughout the entire muscle, fat stores decrease, joints are strengthened throughout the entire range of motion, not in just one particular range of motion, less work (weight and intensity) is needed to strengthen a muscle during a full range of motion, and greater efficient load can be imposed on the muscle(s) (using less weight) during full range of motion.

**[0008]** The best exercise for the body is it to engage the most muscle groups in the highest active intensity for the shortest time, until complete fatigue. The more muscles that are engaged, the more the heart pumps blood, the more the lungs exchange oxygen and carbon dioxide, the greater the volume of oxygen ($VO_2$). The more muscles that are engaged, the less time it takes to reach maximum anaerobic threshold (the point of anaerobic metabolism) and the sooner the striated muscles and cardio-respiratory system reaches fatigue. The most successful cardio-respiratory exercise is one that activates the most muscle groups to reach maximum fatigue as rapidly as possible.

**[0009]** To improve muscle function, tone, strength, and endurance the muscles must be overloaded to the point of fatigue. An overloaded muscle requires more mitochondrial activity, more oxygen consumption, and increased efficient metabolism through anaerobic glycolysis. The longer time spent in muscle overload (past the level of maximum anaerobic threshold), the more oxygen/carbon dioxide is exchanged and the more glucose is used. Therefore, the goal of effective exercise is to bring total cardio-respiratory overload as fast as possible. This can best be done by engaging large muscle mass with bi-directional resistance, through near-complete ranges of motion, while involving both sides of the body synchronously.

**[00010]** In some approaches, such as disclosed in U.S. Patent Nos. 4,750,735, 6,500,099, and 4,949,954, the user is limited in the range of motion provided by the exercise machine. In particular, the exercise machines described in the prior art generally limit the user to extension of one set of limbs during exercise. Other approaches, such as those disclosed in U.S. Patent Nos. 5,104,363 and 4,684,126, require the user to remain in a seated position and still limits the range of motion provided during exercise. There is an unmet need in the art for an exercise machine that allows a user to have a full range of motion in both the arms and the legs at the same time so as to allow for high intensity interval training or equivalent exercise, for which the current art does not provide.

**[00011]** Maximum aerobic capacity is the maximum rate of oxygen consumed and is measured as $VO_2$ Max. $VO_2$ Max reflects the aerobic physical condition of the individual.

**[00012]** $VO_2$ Max is affected by: the ability of the lungs to transfer maximum oxygen through inspiration and maximum carbon dioxide through expiration, the efficiency of oxygen and carbon dioxide exchange in peripheral tissues, the ability of the heart to pump maximum blood volume through the lungs and peripherally through the body, the condition of the circulatory system, the condition of the muscles and peripheral tissues, and the autonomic nervous system control.

**[00013]** Maximum anaerobic capacity is the maximal amount of energy released by anaerobic metabolism. Enhanced anaerobic metabolism causes: improved efficiency of the lactic acid cycle, mobilization and burning of fats, increased metabolic efficiency such that both metabolic rate and caloric burning is more efficient 24 hours per day (not merely while exercising - this is the "after-burn" affect), more efficient use of sugar and glycogen (stored sugar) for energy, maximization of muscular development, maximization of cardiovascular-pulmonary stamina, enhanced regeneration of adenosine triphospate (ATP) and creatine

phosphokinase (CPK) in muscle tissue, and mitochondrial growth throughout muscle cells.

**[00014]** The more muscles that are activated into fatigue the more calories are burned. The more the muscles that are activated the more oxygen is required by them. The more the muscles that are activated the more sugar the body burns as fuel. The more the muscles that are activated the more likely the body moves into anaerobic metabolism, increasing the efficiency of mitochondrial function at the cellular level.

**[00015]** The greater the muscle mass that is activated, the greater will be the caloric burn quantity and rate. The highest muscle activation comes from stretching under resistance. The further the muscle moves through its range of motion, the greater the muscle is activated. The greater the resistance and stretch on the muscle, the greater the muscle strength gained (both in the striated and cardiac muscles) during the anabolic repair phase. The prior art previously only allowed for range of motion in one set of limbs, thereby only allowing for muscle activation in fewer than desired muscle groups.

**[00016]** Exercise is a physical/mechanical stress that causes a catabolic phase (tissue breakdown), followed by a longer anabolic phase (tissue repair), lasting hours or days. Efficient exercise tears down striated muscle and cardiac muscle, forcing the body to rebuild and repair. When exercise is efficient, the body rebuilds tissue such that the functional capacity of the muscle is more efficient than it was before the exercise was performed and the oxygen delivery system is improved ($VO_2$ max).

**[00017]** With proper exercise, body strength is increased and physical stamina improves until a physiological limit is reached at about 32 years of age. After the physiological limit has been reached, no greater gains can be made in physiology. However, with a proper exercise routine, strength and stamina can be maintained for decades as body metabolism and other factors of health are maintained. The greater the catabolic breakdown of the muscle

through proper exercise and the greater the opportunity to complete the anabolic repair cycle, the more efficient the muscles become. Exercising multiple muscle groups at the same time allows for greater catabolic breakdown of the muscles thereby allowed for a greater opportunity to complete the anabolic repair cycle, leading for more efficient muscles.

**[00018]** The complete cycle of exercise begins with a strenuous exercise. Ideally, the catabolic phase begins during the exercise activity and then continues, and then the anabolic phase begins and continues until full recovery and rebuilding from the workout is completed, up to 48 hours later. In an efficient exercise routine, the anabolic phase is not interrupted by an early catabolic phase, but it often is when a person exercises too frequently – a condition known as overtraining. In a high intensity, short duration catabolic exercise phase, the anabolic recovery phase may take up to 48 hours for completion.

**[00019]** High intensity interval training (HIIT) sessions are highly intense, short duration workouts in which a person quickly reaches maximum aerobic capacity ($VO_2$ max) and then approaches their anaerobic threshold, to the point of muscle fatigue and in attempt to satisfy the growing oxygen debt.

**[00020]** HIIT is a short duration exercise (sprint-like bursts of activity). HIIT is the most effective way to condition the physical body, while low intensity, long duration exercise (jogging, treadmill, elliptical, cycling) usually makes a person weak, tired, hungry, irritable and older faster. Consider the health and physique of a sprinter versus that of a long-distance runner.

**[00021]** The most effective high intensity interval training will cause the body to reach its anaerobic threshold quickly. The exercise goal of HIIT is to continue in anaerobic metabolism as long as possible, until complete fatigue. In summary, high intensity interval training (engaging in short bursts of rapid activity (30-90 second bursts)), using the most

muscle mass, to the point of complete fatigue, is the most effective form of exercise. The prior art fails to disclose exercise machines that allow for the most effective high intensive interval training because they generally only use a smaller number of muscle groups at a time.

**[00022]** HIIT produces the greatest hormonal and other metabolic effects that can be derived from any exercise, burns body fat, burns sugar, builds lean body mass, and continues metabolic processes up to 24-48 hours later.

**[00023]** HIIT has at least two novel features: Firstly, unlike walking or moderate intensity aerobic training, efficient HIIT involves the activation of large muscle mass. Secondly, this large muscle mass activation is associated with a very high glycogen breakdown-turnover which means improved muscle glucose uptake.

**[00024]** The principal benefits of HIIT are that: the cardio-respiratory system will be strengthened; the risk of heart attacks and strokes will reduce; circulation will improve; functional muscular strength will improve; weight loss will occur more readily; food cravings will be reduced; hormonal balance will improve; muscles will be toned; fat reserves will be metabolized; energy will improve; aerobic and anaerobic fitness will improve; fasting insulin levels will decrease; insulin sensitivity will increase; abdominal and subcutaneous fat will reduce; and total exercise time will decrease.

**[00025]** As little as six sessions of HIIT over two weeks, or a total of only approximately 15 minutes of very intense exercise (a cumulative energy expenditure of roughly 600 kJ or 143 kcal), has been shown to increase oxidative capacity in skeletal and cardiac muscle and significantly improve performance in activities that rely on aerobic energy metabolism.

**[00026]** Most people who exercise over-train. Because of their exercise routine, people are either in an ongoing catabolic phase or an incomplete anabolic phase. That is, they are stuck

in a catabolic phase and cannot begin the anabolic phase needed to recover and repair, or they are stuck in an anabolic phase in which their body is working desperately in an attempt to complete recovery from the previous catabolic workouts. But they do not complete the anabolic recovery phase before their next workout. In either case, most people over-train and continue exercising while they are not fully recovered.

**[00027]** Overtraining and excessive exercise are metabolic stressors that advance the catabolic damages of aging. More than just a few minutes in a catabolic phase without a complete anabolic repair phase is over-training. A person cannot over-exercise themselves into better health. It takes very little exercise volume to maximize cardio-respiratory fitness, fat loss, strength gain, and metabolic efficiency.

**[00028]** The "plateau" is the phase of exercise when the body approaches the zone of causing greater catabolic stress than anabolic repair. When a person reaches a plateau, exercise should not continue until the anabolic cycle is completed. Objective measurements must be used to determine when the plateau has been reached (heart rate recovery). Continuing to exercise beyond the plateau will only make a person tired, hungry, and irritable, have more pain, waste more time, expose them to injury, and age faster.

**[00029]** In an effective exercise program, a person will just reach plateau but never overdo the exercise routine.

**[00030]** Therefore, the most effective exercise routine is to engage as many muscles, safely, through their complete range of motion, in a synchronized pattern, with adequate resistance, as vigorous as possible, to complete fatigue.

**[00031]** However, there has heretofore not been proposed an exercise machine that can provide such an effective workout. Therefore, it is a principle object of this invention to provide an exercise device adapted to simultaneously, or synchronously, exercise the arms

and legs in near complete range of motion with resistance in the flexion/extension planes.

**[00032]** The main objective is to exercise the arms and legs in near complete range of motion with resistance in the flexion/extension planes. A second objective is to activate the muscles so that muscular fatigue can be reached quickly. A third objective is to allow for a non-weight bearing way to exercise large groups of muscles. A forth objective is to provide a synchronized movement of the arms and legs in a gait-like pattern. A fifth objective is to rehabilitate the arms and leg muscles and joints through near complete range of motion with adjustable resistance. A sixth objective is to offer one of the safest ways to exercise, almost eliminating any risk of injury.

**[00033]** It is also an object this invention to activate the muscles so that muscular fatigue can be reached quickly.

**[00034]** Another object of this invention is to allow for a way to exercise large groups of muscles without the user bearing any weight.

**[00035]** A further object of this is to provide a synchronized movement of the arms and legs in a gait-like pattern, synchronizing the nervous system.

**[00036]** A still further object of this invention is to rehabilitate the arms and leg muscles and joints through near complete range of motion with adjustable resistance.

**[00037]** It is yet a further object of this invention to provide an exercise device which allows for a free, not rigid, range of motion of the limbs.

**[00038]** It is yet a further object of this invention to provide an exercise device which allows for a full body, non-weight bearing exercise.

**[00039]** It is an even further object of this invention to provide an exercise device which offers purely operator-induced exercise because the exerciser is supine and using only muscular action, not gravity, to facilitate exercise.

**[00040]** It is an even further object of this invention to provide an exercise device which offers the greatest effect to the cardio-respiratory systems by utilizing the largest muscle groups in all four limbs in near-complete range of motion through resistance.

**[00041]** It is an even further object of this invention to provide an exercise device which provides high intensity interval training exercise.

**[00042]** It is an even further object of this invention to provide an exercise device through which a user reaches cardio-respiratory fatigue.

**[00043]** It is an even further object of this invention to provide an exercise device which activates more than one muscle group at one time.

**[00044]** It is an even further object of this invention to provide an exercise device which increases cardio-respiratory output.

**[00045]** It is an even further object of this invention to provide an exercise device which increases aerobic metabolism.

**[00046]** It is an even further object of this invention to provide an exercise device which increases anaerobic metabolism.

**[00047]** It is an even further object of this invention to provide an exercise device which offers the shortest time to achieve a full body exercise.

## SUMMARY OF THE INVENTION

**[00048]** The foregoing objectives, among others, are achieved through an exercise apparatus which allows for near-complete joint range of motion in active and resistant movements. An embodiment of the present invention is directed to an exercise machine comprising a base, a first pair of bi-directional resistance elements, each comprising a first end and a second end, the first end of each resistance element of the first pair of resistance elements pivotally attached to a support in such a manner as to imbue each element with a

substantially free range of motion, the second end of each resistance element of the first pair of resistance elements comprising a foot-engagement member, and a second pair of bi-directional resistance elements, each comprising a first end and a second end, the first end of each resistance element of the second pair of resistance elements pivotally attached to the support in such a manner as to imbue each such element with a substantially free range of motion, each resistance element of the second pair of resistance elements comprising a hand-engagement member.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[00049]** FIG. 1 is a right, front perspective view of a first embodiment of the invention showing a user in a first position of use employing the invention.

**[00050]** FIG. 2 is a right, front perspective view of the invention showing a user in a second position of use employing the invention.

**[00051]** FIG. 3 is a rear perspective view of the embodiment of Figs. 1 and 2.

**[00052]** FIG. 4 is a left rear perspective view thereof.

**[00053]** FIG. 5 is a left front perspective view thereof.

**[00054]** FIG. 6 is a right rear perspective view thereof.

**[00055]** FIG. 7 is a top view thereof.

**[00056]** FIG. 8 is a left rear perspective view of a second embodiment of the invention.

**[00057]** FIG. 9 is a right front perspective view of a second embodiment of the invention.

**[00058]** FIG. 10 is a right, rear perspective view of a third embodiment of the invention.

**[00059]** FIG. 11 is a top view of a third embodiment of the invention.

**[00060]** FIG. 12 is a left side view of a fourth embodiment of the invention in an extended position.

**[00061]** FIG. 13 is a left side view of a fourth embodiment of the invention in a folded position.

**[00062]** FIG 14 is a right rear perspective view of a fourth embodiment of the invention in an extended position.

**[00063]** FIG. 15 is a left side view of a fifth embodiment of the invention.

**[00064]** FIG. 16 is a right rear perspective view of a fifth embodiment of the invention.

**[00065]** FIG. 17 is a left side view of a sixth embodiment of the invention in an extended position.

**[00066]** FIG. 18 is a left side view of a sixth embodiment of the invention in a folded position.

**[00067]** FIG. 19 is a right rear perspective view of a sixth embodiment of the invention in an extended position.

## DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENT(S)

**[00068]** The following description is of a preferred and other embodiments presently contemplated for carrying out the invention. This description is not to be taken in a limiting sense, but is made merely for the purpose of describing one or more embodiments of the invention. The scope of the invention should be determined with reference to the claims.

**[00069]** By "substantially free range of motion" is meant freedom to rotatingly move about a connection in any direction of movement brought about by the appendage with which the resistance element is associated while the exercise device is in use.

**[00070]** An embodiment of the present invention is illustrated in Figs. 1-7 shown from various perspectives. In this embodiment, the exercise apparatus **10** is comprised of a frame/base **12** having a first base side **14** and second base side **16,** and an upper platform **18**

having a first platform side **20** and second platform side **22**. The frame/base **12** has one or more supports **24** connecting the lower sides **14, 16** to the platform **18**.

**[00071]** Hingedly attached to frame/base **12** are a first pair of resistance elements **26,** which may be any type of apparatus that presents resistance to the user in both flexion and extension, such as hydraulic or pneumatic rams, spring-like members, frictional resistance mechanisms, pulleys, cams, and/or the like. In the case of a hydraulic or pneumatic ram, the resistance elements may be comprised of an inner rod **28** and outer cylinder **30**.

**[00072]** The first pair of resistance elements (each denoted by the reference numeral "**26**") each have a first end **32** and second end **34**. The first ends **32** of the first pair of resistance elements **26** are attached to the upper platform level side **20** and second platform side **22** through the use of pivot joints **36** such as ball and socket joints or other structure permitting substantially free range of motion. Joints **36** should be constructed and arranged in such a manner as to imbue each such element with a substantially free range of motion in any direction of movement brought about by the user's appendage with which the resistance element is associated while the exercise device is in use. Joints **36** may, in one or more embodiments, be adjustably connected to upper section **16** so as to permit adjustment of the position of resistance element **26** relative to the user, to accommodate different sized users and/or different exercise modalities. By providing such an adjustment of the connection position of joints **36** to base **12** relative to the user, the distance of the connection points of joints **36** from the user can be adjusted. Additional mounting points may be provided on the frame/base **12**. A user may also adjust the resistance provided by the first pair resistance elements **26** through the use of a valve or methods currently known or to be discovered.

**[00073]** Second ends **34** of the first pair of resistance elements **26** have associated therewith foot engaging members **38** adapted to engage the user's feet during use of the

device. Structure for removably securing the user's feet to the foot engaging members **38**, such as straps **40**, may be provided as well.

**[00074]** Hingedly attached to frame/base **12** are a second pair of resistance elements **42,** which may be any type of apparatus that presents resistance to the user in both flexion and extension, such as hydraulic or pneumatic rams, spring-like members, frictional resistance mechanisms, pulleys, cams, and/or the like. In the case of a hydraulic or pneumatic ram, the resistance elements may be comprised of an inner rod **44** and outer cylinder **46**, or vice versa.

**[00075]** The second pair of resistance elements (each denoted by the reference numeral "42") each have a first end **48** and second end **50**. The first ends **48** of the second pair of resistance elements **42** are attached to the lower section **14** through the use of a pivot joints **52** such as ball and socket members or other structure permitting substantially free range of motion. Joints **52** should be constructed and arranged in such a manner as to imbue each such element with a substantially free range of motion in any direction of movement brought about by the user's appendage with which the resistance element is associated while the exercise device is in use. Joints **52** may, in one or more embodiments, be adjustably connected to lower section **14** so as to permit adjustment of the position of resistance element **42** relative to the user, to accommodate different sized users and/or different exercise modalities. Joints **52** should be constructed and arranged in such a manner as to imbue each such element with a substantially free range of motion in any direction of movement brought about by the user's appendage with which the resistance element is associated while the exercise device is in use.

**[00076]** Second ends of the second pair of resistance elements **42** have associated therewith hand engaging members **54** adapted to be engaged by a user's feet during use of the device. Structure for removably securing the user's hands to the foot engaging members (not

shown), such as straps, may be provided as well. As shown in Figs. 1 and 2, the hand engaging member **54** can be a handle **56** or a grip **58,** or any other known or unknown hand engaging configuration or structure.

**[00077]** In the preferred embodiment, each resistance element **26, 42** is independent and bidirectional and can provide resistance in a number of ways, including, but not limited to, pneumatics, hydraulics, springs, and any other apparatus, now known or currently unknown, that resists the pushing or pulling forces exerted by the user. The action of the arms and legs in bi-directional resistance offers near full body exercise of the agonist/antagonist muscles using flexion and extension action of the larger muscle groups in a gait pattern, simultaneously.

**[00078]** The unit may include an attached inclined or horizontal support, mat, cushion or the like for the exerciser to lay on. The unit may have an adjustment mechanism for height of the leg settings and for the length of the arm settings in accord to reach maximal limb range of motion. The unit may include one or more devices to monitor heart rate, blood pressure, oxygen flow (VO2 max), body temperature and the like.

**[00079]** For one version of a rehabilitation use of the invention, a person lays on their back, straps their feet in foot engaging members **38** using the straps **40**, holds onto the hand engaging members **52**, and moves their arms and legs against resistance in near-complete range of motion. In one version of an exercise use of the invention, a person lays on their back, straps their feet in foot engaging members **38** using the straps **40**, holds onto the hand engaging members **52**, and pumps their arms and legs against bi-directional resistance in near-complete range of motion until cardio-respiratory fatigue is reached.

**[00080]** The unit allows for near-complete joint range of motion in active and resistant movements. That is, for example, the following magnitude of movements can be achieved in

the following joints: elbow flexion: 0-150 degree movement, shoulder flexion: 0-180 degree movement, knee flexion: 0-100 degree movement, hip flexion: 0-120 degree movement. These ranges represent what is essentially free range of movement for all four limbs, thereby providing a full body workout engaging multiple muscle groups.

**[00081]** An alternative embodiment is shown in Figs. 8 and 9, in which a base of any configuration/shape is contemplated. By way of example but not by way of limitation, a rectangular-shaped base **112** is shown. Base **112** may be water-fillable or otherwise constructed and arranged to be heavy enough to remain in place while being used by someone exercising, and/or to accommodate some form of removable weight (not shown) such as sand or discrete, removable weight elements. Base **112** provides support for the pair of resistance elements **26** and a solid structure for the exercise apparatus as a whole. The frame/base **112** still has a first, lower, section **14** and second, upper, section **16**. The frame/base **112** also has a top face **60** where the first pair of resistance elements **26** are attached using pivot joint **36**. The second pair of resistance elements **42** are also attached to a lower portion of front face **62** of the frame/base **112** using pivot joints **52**.

**[00082]** The unit may include one or more devices to monitor such things as heart rate, oxygen flow (VO2 max), blood pressure, and temperature or any newly developed health monitoring devices.

**[00083]** In another embodiment, base **12** or **112**, or a base comprised simply of a flat plate or the like (not shown) (e.g., steel), which is heavy enough to remain in place while the device is in use, to which is connected resistance elements **26**, **42**, may be constructed and arranged to be placed on or mounted to a surface such as a wall or floor.

**[00084]** In embodiments, a back support structure may be employed to support the user either on the ground/floor or above the ground/floor. Such a support may be connected to bases **12/112** or be independent thereof.

**[00085]** In another embodiment, the arm or leg resistance elements, or all of them, may be movably connected to the base to permit extended appendage movement by larger (i.e., taller) users. In one embodiment shown in Figs. 10-11, arm resistance elements **42**, through joints **52**, are slideably connected to base **12/112** via tracks **120**. Joints **52** are slideably disposed in tracks **120** such that joint **52** will slide back and forth in response to user movement of elements **42**, giving the user and resistance elements greater range of movement. Alternatively, joints **52** may be releasably locked into place relative to tracks **120** via a suitable locking structure. Any structure for allowing releasable locking of joints **52** may be used, such as aligned holes **125** through which may be passed a removable locking pin **127**. Joints **52** may fit tightly within track **120** to provide resistance to movement by a user but still allow the joint **52** to translate in track **120** to provide additional range of motion.

**[00086]** In another embodiment, as illustrated in Figs. 12-14, the exercise apparatus **100** is comprised of a frame/base **212**, a first pair of resistance elements **126**, a second pair of resistance elements **142**, and a bench **170**. By way of example but not by way of limitation the frame/base **212** is comprised of multiple elongated members. In various other embodiments, the frame/base **212** is comprised of one or more members arranged in a variety of shapes/configurations. In the current embodiment, the frame/base **212** has one or more supports **123**, **124** hingedly connecting the first pair of resistance elements **126**, and the second pair of resistance elements **142**, to the frame/base **212**.

**[00087]** In various embodiments the support **124** extends higher than the support **123**, relative to the frame/base **212**, such that when the first pair of resistance elements **126** is

hingedly connected to the support **124**, and the second pair of resistance elements **142** is hingedly connected to the support **123**, the resistance elements **126**, **142** do not come in contact with one another during use. In the alternative, the resistance elements **126**, **142** may be capable of being switched, in which the first pair of resistance elements **126** are hingedly connected to the support **123**, and the second pair of resistance elements **142** are hingedly connected to the support **124**. In either configuration the difference in height between the support **124** and the support **123** is such that the resistance elements **126**, **142** do not come in contact with one another during use.

**[00088]** The first pair of resistance elements **126**, may be any type of apparatus that presents resistance to the user in both flexion and extension, such as hydraulic or pneumatic rams, spring-like members, frictional resistance mechanisms, pulleys, cams, and/or the like. In the case of a hydraulic or pneumatic ram, the resistance elements may be comprised of an inner rod **128** and outer cylinder **130**.

**[00089]** The first pair of resistance elements (each denoted by the reference numeral "**126**") each has a first end **132** and a second end **134**. When attached to the support **124**, the first ends **132** of the first pair of resistance elements **126** are attached to the first upper platform **118** through the use of pivot joints **136** such as ball and socket joints or other structure permitting substantially free range of motion. Joints **136** may, in one or more embodiments, be adjustably connected so as to permit adjustment of the position of resistance element **126** relative to the user, to accommodate different sized users and/or different exercise modalities. The adjustability of the connection position allows for the distance from the connection points of the joints **136** relative to the user to be altered to the preference of the user. The user may also be able to adjust the resistance provided by the first pair of resistance elements **126**.

**[00090]** The adjustability of the distance of the connection points of the joints **136** relative to the user may be achieved through any suitable locking structure, such as aligned holes **1125** through which may be passed a removable locking pin **1127**. As seen in Figs. 12-14, the removable locking pin **1127** may comprise a spring loaded knob and pin combination, whereas once pulled up, the joints **136** slidingly engage with the aligned holes **1125** in the first upper platform **118**.

**[00091]** The second ends **134** of the first pair of resistance elements **126** have associated therewith foot engaging members **138** adapted to engage the user's feet during use of the device. The foot engaging members **138** are capable of removably securing the user's feet to the foot engaging members **138**. The ability of removably securing the user's feet may be achieve through any suitable securing structure, currently known or unknown, such that when the exercise apparatus **100** is in use the user's feet remain fixed to the foot engaging members **138**. In various embodiments, the securing ability may be provided by at least a portion of the foot engaging member **138** enveloping the user's foot. The foot engaging member **138** may comprise multiple components, of a variety of differing materials, configured in a variety of manners. In one or more embodiments, the foot engaging member **138** may include a base portion, a webbing or strap portion, and a heel portion. In other embodiments, not shown, the foot engaging member **138** may include various other components such as to allow the foot engaging member **138** to removably secure the user's foot. In one or more embodiments, the foot engaging members **138** may be removable and replaceable with a differently configured foot engaging member **138**.

**[00092]** Hingedly attached to the frame/base **212** are a second pair of resistance elements **142**, which may be any type of apparatus that presents resistance to the user in both flexion and extension, such as hydraulic or pneumatic rams, spring-like members, frictional

resistance mechanisms, pulleys, cams, and/or the like. In the case of hydraulic or pneumatic ram, the resistance elements may be comprised of an inner rod **144** and an outer cylinder **146**, or vice versa.

**[00093]** The second pair of resistance elements (each denoted by the reference numeral "**142**") each has a first end **148** and a second end **150**. When attached to the support **123**, the first ends **148** of the second pair of resistance elements **142** are attached to the second upper platform **119** through the use of pivot joints **152** such as ball and socket members or other structure permitting substantially free range of motion. Joints **152** may, in one or more embodiments, be adjustably connected so as to permit adjustment of the position of resistance element **142** relative to the user, to accommodate different sized users and/or different exercise modalities. The adjustability of the connection position allows for the distance from the connection points of the joints **142** relative to the user to be altered to the preference of the user. The user may also be able to adjust the resistance provided by the second pair of resistance elements **142**.

**[00094]** The adjustability of the distance of the connection points of the joints **152** relative to the user may be achieved through any suitable locking structure, such as aligned holes **1125** through which may be passed a removable locking pin **1127**. As seen in Figs. 12-14, the removable locking pin **1127** may comprise a spring loaded knob and pin combination, whereas once pulled up, the joints **152** slidingly engage with the aligned holes **1125** in the second upper platform **119**.

**[00095]** Second ends of the second pair of resistance elements **142** have associated therewith hand engaging members **154** adapted to be engaged by the user's hands during use of the device. The hand engaging members **154** can be a handle **156** or a grip, or any other known or unknown hand engaging configuration or structure. The hand engaging members

**154** may comprise multiple components, of a variety of differing materials, configured in a variety of manners. In one or more embodiments, the hand engaging members **154** may be removable and replaceable with a differently configured hand engaging member **154**. One or more hand engaging members **154** may be of a fixed structure, and one or more hand engaging members **154** may have at least of a portion that is flexible, the flexible structure may include but is not limited to fabric.

**[00096]** In an embodiment, each resistance element **126**, **142**, is independent and bidirectional and can provide resistance in a number of ways, including, but not limited to, pneumatics, hydraulics, springs, pulleys, cams, and any other apparatus, now known or currently unknown, that resists the pushing or pulling forces exerted by the user. The action of the arms and legs in bi-directional movement while being resisted by the resistance elements in both directions offers near full body exercise of the agonist/antagonist muscles using flexion and extension action of the larger muscle groups in a gait pattern, simultaneously.

**[00097]** In the current embodiment, the bench **170** is elevated from the frame/base **212** by one or more supports **121**, **122**. In various other embodiments, the bench **170** may rest on the frame/base **212**. In the current embodiment, one way to use the exercise apparatus **100** allows the person lay their back on the bench **170**, place their feet in the foot engaging members **138**, hold onto the hand engaging members **154**, and move their arms and legs against resistance in near-complete range of motion.

**[00098]** The unit allows for near-complete joint range of motion in active and resistant movements. That is, for example, the following magnitude of movements can be achieved in the following joints: elbow flexion: 0-150 degree movement, shoulder flexion: 0-180 degree movement, knee flexion: 0-100 degree movement, hip flexion: 0-120 degree movement.

These ranges represent what is essentially free range of movement for all four limbs, thereby providing a full body workout engaging multiple muscle groups.

**[00099]** In various embodiments, the frame/base **212** may include one or more removable locking pins **1127**. When utilized, the removable locking pins **1127** may allow for the frame/base **212** to pivotally fold from an extended position, as shown in Fig. 12, to a folded position, as shown in Fig. 13. The removable locking pin **1127** may comprise a spring loaded knob and pin combination, whereas once pulled up, the frame/base **212** is no longer locked in a uniform section, but instead is able to fold upon itself. In other embodiments, the removable locking pin **1127** may be fixed pin and hole variety. By allowing for frame/base **212** to fold up, the exercise apparatus **100** is able to be stored in a more space-efficient manner.

**[000100]** In various embodiments, the supports **121**, **122**, may allow for various portions of the bench **170** to be elevated in various degrees. In the preferred embodiment, the range of degree variation can allow for the bench **170** to form any angle between 90 to 180 degrees. In various other embodiments, the bench **170** may form and an angle greater than 180 degrees. By providing for variation in the angle of the bench **170**, the position of the resistance elements **126**, **142** relative to the user are able to be altered, thus allowing the user to focus of differing muscle groups.

**[000101]** In another embodiment, as illustrated in Figs. 15-16, the exercise apparatus **1000** is comprised of a frame/base **312**, at least one pair of resistance elements **242**, and a bench **270**. By way of example but not by limitation, the frame/base **312** is comprised of multiple elongated members. In various embodiments, such as the embodiment depicted in Fig. 17, the frame/base **312** may include one or more locking pins **1127** to allow for the various members to slidingly-engage with one another so as to allow the frame/base **312** to be

capable of lengthening or shortening. As seen in Figs. 15 and 16, the removable locking pin **1127** may comprise a spring loaded knob and pin combination, whereas once pulled up, the frame/base **312** is able to telescopically elongate. In various other embodiments, the frame/base **312** may be comprised of one or more members comprised in a variety of shapes/configurations. The frame/base **312** has one or more supports **221**, **223**, **224**, hingedly connecting the resistance elements **226**, **242**, to the frame/base **312**.

**[000102]** The resistance elements **226**, **242**, may be any type of apparatus that presents resistance to the user in both flexion and extension, such as hydraulic or pneumatic rams, spring-like members, frictional resistance mechanisms, pulleys, cams, and/or the like. In the case of a hydraulic or pneumatic ram, the resistance elements **226**, **242**, may be comprised of an inner rod **228**, **244**, and outer cylinder **230**, **246**, respectively.

**[000103]** The resistance elements **242** each have a first end **248** and a second end **250**. The first end **248** of the pair of resistance elements **242** are attached to the upper platform **219** through the use of pivot joints **252** such as ball and socket joints or other structure permitting substantially free range of motion. The user may be able to adjust the resistance provided by the pair of resistance elements **242**. In the alternative, the resistance elements **242** are capable of attaching to the lower platform **218**, wherein the connection may be made through the use of pivot joints **236** such as ball and socket or other structure permitting substantially free range of motion.

**[000104]** In this embodiment, as shown in Fig. 16, both the upper platform **219** and the lower platform **218** are located on the same support structure **224**. In various embodiments the support structure **224** may be angled relative to the frame/base **312**, or in the alternative, may be perpendicular to the frame/base **312**. Both the upper platform **219** and the lower platform **218** are capable of attaching resistance elements **226**, **242**. In various versions of

use the upper platform **219** hingedly attaches the first resistance element **226**, where the lower platform **218** hingedly attaches the second resistance element **242**. Whereas, when the upper platform **219** is hingedly attached to the second resistance element **226**, the lower platform **218** may hingedly attach the first resistance element **226**.

**[000105]** In this embodiment, the upper platform **219** and the lower platform **218** are configured in a cross-brace fashion with hinges at either end to attach the resistance elements **226**, **224**. In various embodiments, either one or both of the upper platform **219** and the lower platform **218** may span the entire width of the support structure **224**. For instance, in the embodiment shown in Fig. 16 the upper platform **219** spans across the width of the support structure **224**, where the lower platform **218** is comprised of two independent sections that do not span the width of the support structure **224**.

**[000106]** Second ends **250** of the pair of resistance elements **242** have associated therewith hand engaging members **254** adapted to be engaged by the user's hands during use of the device. The hand engaging members **254** can be a handle **256** or a grip, or any other known or unknown hand engaging configuration or structure. The hand engaging members **254** may comprise multiple components, of a variety of differing materials, configured in a variety of manners. In one or more embodiments, the hand engaging members **254** may be removable and replaceable with a differently configured hand engaging member **254**. One or more hand engaging members **254** may be of a fixed structure, and one or more hand engaging members **254** may have at least of a portion that is flexible, the flexible structure may include but is not limited to fabric.

**[000107]** In another embodiment, as shown in Fig. 17-19, the first end **232** of the resistance elements **226** may be attached under the bench **270**, or, in the alternative, may be attached to the upper platform **218**, in either attachment the connection may be made through

the use of pivot joints **236** such as ball and socket or other structure permitting substantially free range of motion. The user may be able to adjust the resistance provided by the pair of resistance elements **226**.

**[000108]** In the preferred embodiment, the resistance elements **226**, **242**, are independent and bidirectional and can provide resistance in a number of ways, including, but not limited to, pneumatics, hydraulics, springs, pulleys, cams, and any other apparatus, now known or currently unknown, that resists the pushing or pulling forces exerted by the user.

**[000109]** In the current embodiment, the bench **270** is elevated from the frame/base **312** by one or more supports **221**, **222**. In various other embodiments, the bench **270** may rest on the frame/base **212**.

**[000110]** One method of using the exercise apparatus **1000** allows for the person to lay on their back on the bench **270**, place their feet in either a foot engaging member **238**, as shown in Figs. 12-14, on the floor, on the frame/base **312**, on the lower platform **218**, or the upper platform **219**, hold onto the hand engaging members **252**, and move their arms and/or legs against resistance in near-complete range of motion.

**[000111]** The unit allows for near-complete joint range of motion in active and resistant movements. That is, for example, the following magnitude of movements can be achieved in the following joints: elbow flexion: 0-150 degree movement, and shoulder flexion: 0-180 degree movement. These ranges represent what is essentially free range of movement, thereby providing a workout engaging multiple muscle groups.

**[000112]** In differing embodiments, as shown in Figs. 17-19, the frame/base **312** may include one or more removable locking pins **1127** that allow for the frame/base **312** to pivotally fold from an extended position, as shown in Fig. 17, to a folded position, as shown in Fig. 18. The removable locking pin **1127** may comprise a spring loaded knob and pin

combination, where once pulled up, the frame/base **312** is no longer locked in a uniform section, but instead is able to fold upon itself. In other embodiments, the removable locking pin **1127** may be fixed pin and hole variety. By allowing for the frame/base **312** to fold up, the exercise apparatus **1000** is able to be stored in a more space-efficient manner.

**[000113]** In various embodiments, the frame/base **312** may include wheels **223** either fixed, or removably attached. The wheels **223** allow for the exercise apparatus **1000** to be pivotally-lifted and moved without having to fully lift the exercise apparatus **1000**. Thereby allowing the user to move and position the exercise apparatus **1000** on any suitable floor space.

**[000114]** In various embodiments, the supports **224** may allow for various portions of the bench **270** to be elevated to various fixed positions, such as can be seen in Fig. 17. The adjustability of the various portions of the bench **270** may be achieved through any suitable locking structure, such as aligned holes **1125** through which may be passed a removable locking pin **1127**.

**[000115]** The adjustability of the various portions of the bench **270** may help provide comfort for the user by allowing the user to engage the exercise apparatus **1000** in various positions. By enabling the user to engage the exercise apparatus **1000** in various positions, the user is able to position themselves in a suitable position to better focus on differing muscle groups. For instance, if the user wishes to focus on their shoulders, the bench **270** will optimally be flat in a 180 degree position. If the user wishes to focus on their biceps and/or triceps, the bench **270** will optimally be positioned between 90 to 120 degrees. However, the optimal position for various users may vary based upon the individual preference of the user.

**[000116]** In various embodiments, as seen in Figs. 20-22, the resistance elements **700**, **800**, may be any unidirectional or bidirectional resistance apparatus, including, by way of example but not by way of limitation, fluid cylinders, electromechanical devices, pulleys, cam devices, leaf spring, coil spring, brakes, or combination thereof. The cam devices may include but are not limited to spring loaded cams. The resistance elements **700**, **800**, may interchangeably attach to the different support structures **423**, **424**, which hingedly connect the resistance elements **700**, **800**, to the frame/base **412** at the location of the joint **436**, **452**. The joint **436** connects to the support structure **424** on the first upper platform **418**, and the joint **452** connects to the support structure **423** on the second upper platform **419**. In the various embodiments, the resistance elements **700**, **800**, may be interchangeable, in which a resistance element **700**, **800** of one variety (i.e. fluid cylinders, electromechanical devices, pulleys, cam devices, leaf spring, coil spring, brakes, or combination thereof) may be exchanged for a resistance elements **700**, **800**, of a different variety (i.e. fluid cylinders, electromechanical devices, pulleys, cam devices, leaf spring, coil spring, brakes, or combination thereof).

**[000117]** The resistance element **700** is connected to a connecting apparatus **710**, which is itself connected to a foot engaging member **438**. The resistance element **800** is connected to a connecting apparatus **810**, which is itself connected to a hand engaging member **456**. The connecting apparatus **710**, **810**, may be of any suitable structure to connect the foot engaging member **438** or the hand engaging member **456** to resistance element **700**, **800**. In various embodiments the connecting apparatus **710**, **810**, may be either a rigid material, like a metal, plastic, or other suitable bar composition, or may be flexible, like a wire, nylon, or other suitable cable-like structure. Different choice of connection apparatus **710**, **810**, may be suitable dependent on, among other things, the choice of the resistance element **700**, **800**.

For example, when employing pulleys the connection apparatus **710**, **810**, best suited will likely be a flexible structure, such as but not limited to a cable.

**[000118]** The resistance elements **700**, **800**, may be formed through a combination of multiple different varieties of resistance elements. For example, if a pulley is selected the user may also choose to attach a cam device to provide increased resistance for the pulley. The combination of a pulley and cam device may form one unitary resistance element **700**, **800**. By allowing for different variety of resistance mechanisms to be combined to form one unitary resistance element **700**, **800**, the user will be further enabled to vary the level of resistance created.

**[000119]** Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments of the present invention. However, the benefits, advantages, solutions to problems, and any element(s) that may cause or result in such benefits, advantages, or solutions to become more pronounced are not to be construed as a critical, required, or essential feature or element of any or all the claims. The invention is defined solely by the appended claims including any amendments made during the pendency of this application and all equivalents of those claims as issued. While the invention has been described in its preferred form or embodiment with some degree of particularity, it is understood that this description has been given only by way of example and that numerous changes in the details of construction, fabrication, and use, including the combination of structural arrangement and sizes of features, may be made without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. An exercise apparatus comprising:

a base having a first base side and a second base side, and a platform having a first platform side and a second platform side, the base and platform being connected by one or more supports;

a first pair of resistance elements, each having a first end and a second end, the pair of resistance elements pivotally attached to the first and second base sides at the first end and further comprising a foot plate connected to each resistance element at the second end, each resistance element providing resistance against linear movement; and

a second pair of resistance elements, each having a first end and a second end, the resistance elements pivotally attached to the first and second platform sides at the first end and further comprising a hand engaging member attached to the resistance element at the second end, each resistance element providing resistance against linear movement.

2. The exercise apparatus of claim 1 wherein the first and second pair of resistance elements are pneumatic cylinders.

3. The exercise apparatus of claim 1 wherein the first and second pair of resistance elements are hydraulic cylinders.

4. The exercise apparatus of claim 1 wherein the first and second pair of resistance elements are spring actuated.

5. The exercise apparatus of claim 1 wherein the first and second pair of resistance elements comprise a pulley system.

6. The exercise apparatus of claim 1 wherein the first and second pair of resistance elements further comprise a valve to control bi-directional resistance.

7. The exercise apparatus of claim 1 wherein the base is trapezoidal.

8. The exercise apparatus of claim 1 wherein the base is a cube.

9. An exercise apparatus for permitting simultaneous exercise of left and right arms, and left and right legs, of a user, the apparatus comprising:

a frame;

first and second arm resistance elements, each arm resistance element defining a hand engaging member connected to a proximal end thereof, distal ends of the first and second arm resistance elements being connected to a first support structure defined by the frame;

first and second leg resistance elements, each leg resistance element defining a foot engaging member connected to a proximal end thereof, distal ends of the first and second leg resistance elements being connected to a second support structure defined by the frame; and

a bench for supporting the user, the bench being connected to the frame by at least one further support structure.

10. The exercise apparatus of claim 9, wherein the support structure for the bench defines aligned holes with removable locking pin for adjusting the configuration of the bench.

11. The exercise apparatus of claim 9, wherein the first support structure is elevated higher relative to the base than the second support structure.

12. The exercise apparatus of claim 9, wherein the first support structure is farther from the bench relative to the second support structure.

13. The exercise apparatus of claim 9, wherein the frame defines a removable locking pin allowing for folding of the frame.

14. The exercise apparatus of claim 9, wherein the first support structure defines aligned holes for adjusting the distance of the first and second arm resistance elements relative to the bench.

15. The exercise apparatus of claim 9, wherein the second support structure defines aligned holes for adjusting the distance of the first and second leg resistance elements relative to the bench.

16. The exercise apparatus of claim 9, wherein the support structure for connecting the first and second leg resistance elements is the same support structure for supporting the bench.

17. An exercise apparatus for permitting simultaneous exercise of left and right arms, of a user, the apparatus comprising:

a frame;

first and second arm resistance elements, each arm resistance element defining a hand engaging member connected to a proximal end thereof, distal ends of the first and second arm resistance elements being connected to a support structure defined by the frame; and

a bench for supporting the user, the bench being connected to the frame by at least one further support structure.

18. The exercise apparatus of claim 17, wherein the support structure for the bench defines aligned holes and removable locking pin for adjusting the configuration of the bench.

19. The exercise apparatus of claim 17, wherein the frame defines a removable locking pin allowing for folding of the frame.

20. The exercise apparatus of claim 17, wherein the frame includes at least one wheel for pivotally-lifting and moving of the exercise apparatus.

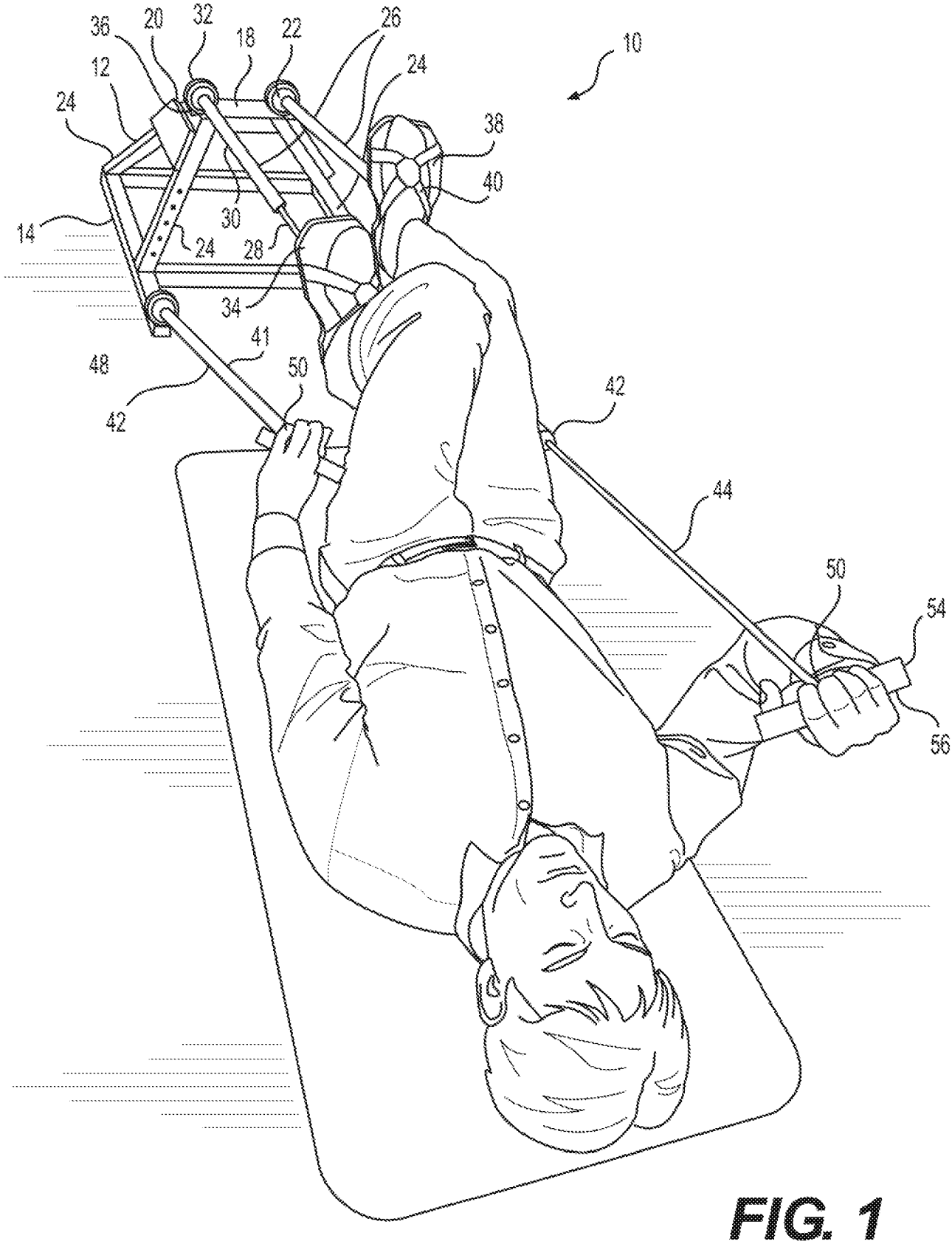



FIG. 1

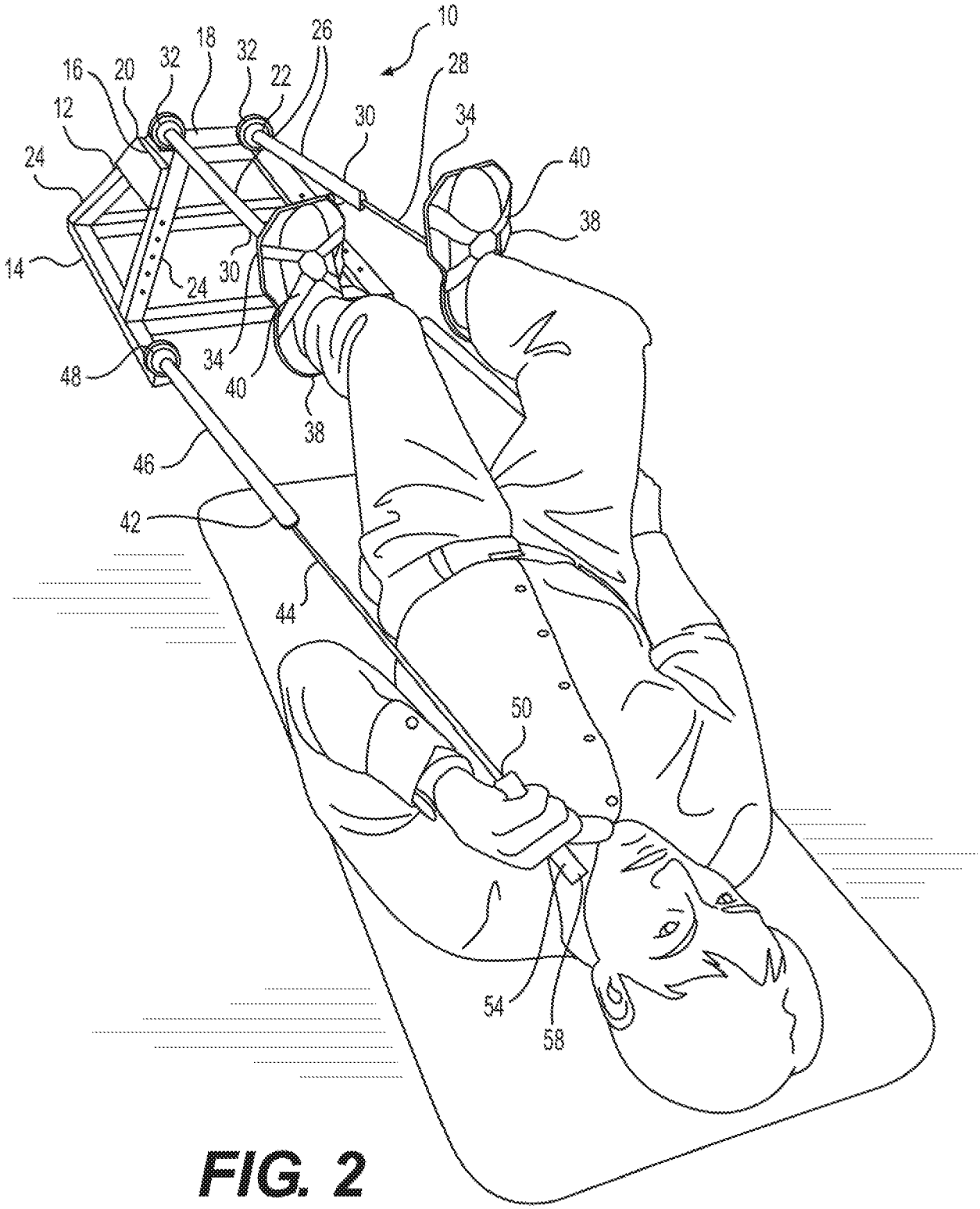

10
16
20
32
18
32
22
26
28
12
30
34
24
40
38
14
24
30
34
40
48
38
46
42
44
50
54
58

FIG. 2

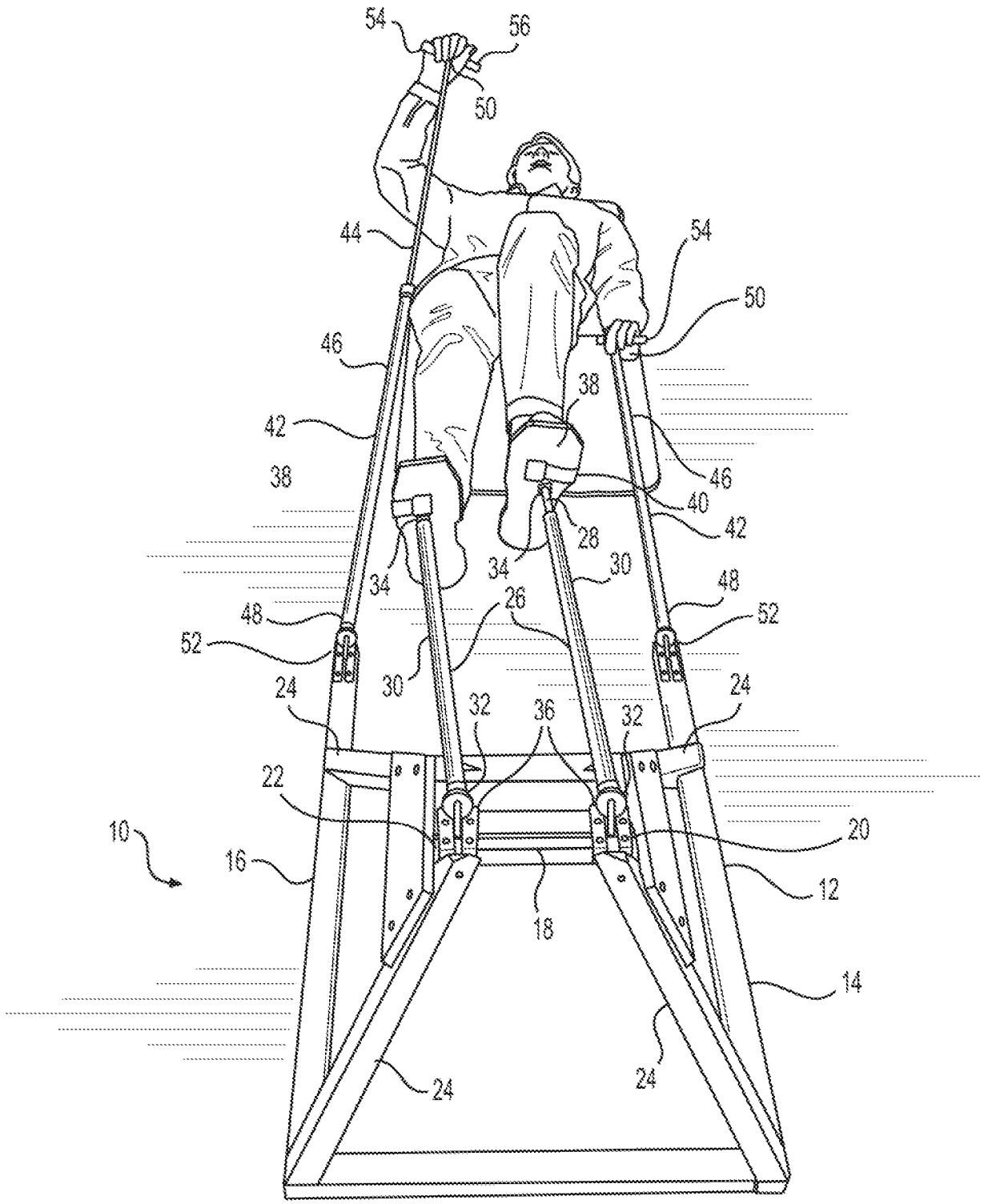

54
56
50
44
54
50
46
38
42
46
38
40
42
28
34
34
30
48
26
48
52
52
30
24
32
36
32
24
22
20
10
16
12
18
14
24
24

FIG. 3

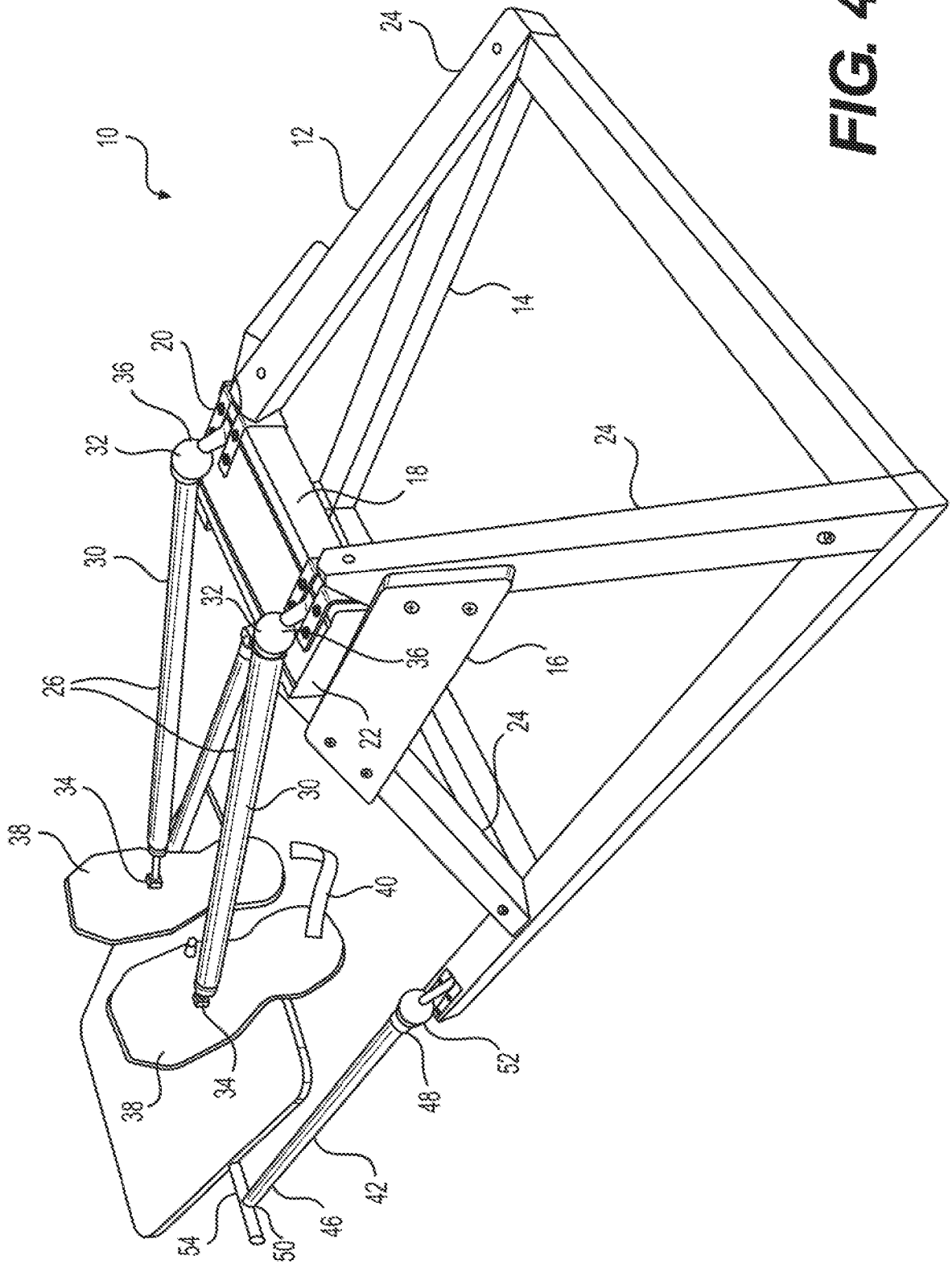



FIG. 4

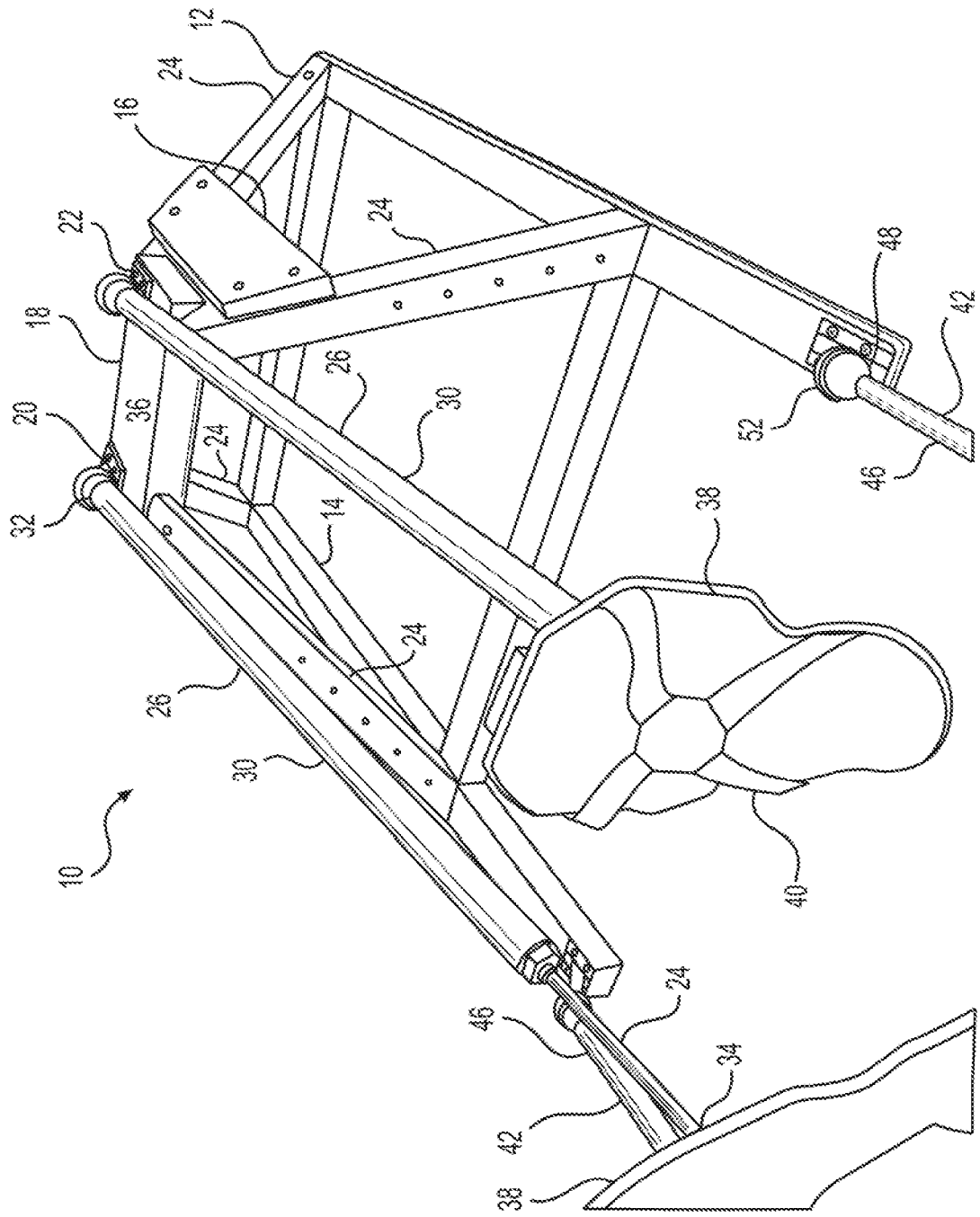

12
24
16
22
18
20
32
36
24
26
30
14
24
26
30
10
24
46
42
38
34
24
26
30
38
40
48
42
52
46

FIG. 5

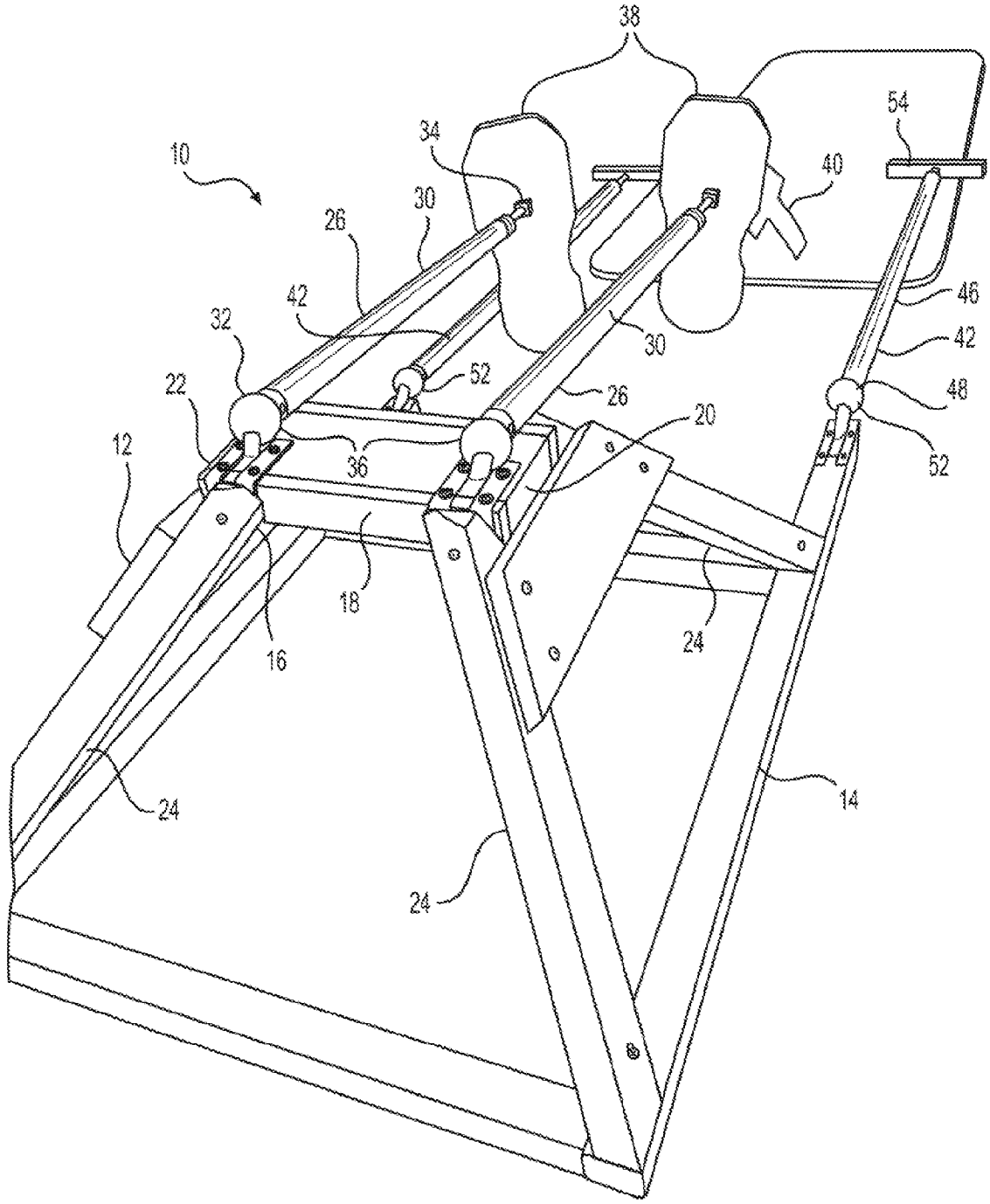

38
54
34
10
40
30
26
46
42
32
30
42
52
48
22
26
20
12
36
52
18
16
24
24
14
24

FIG. 6

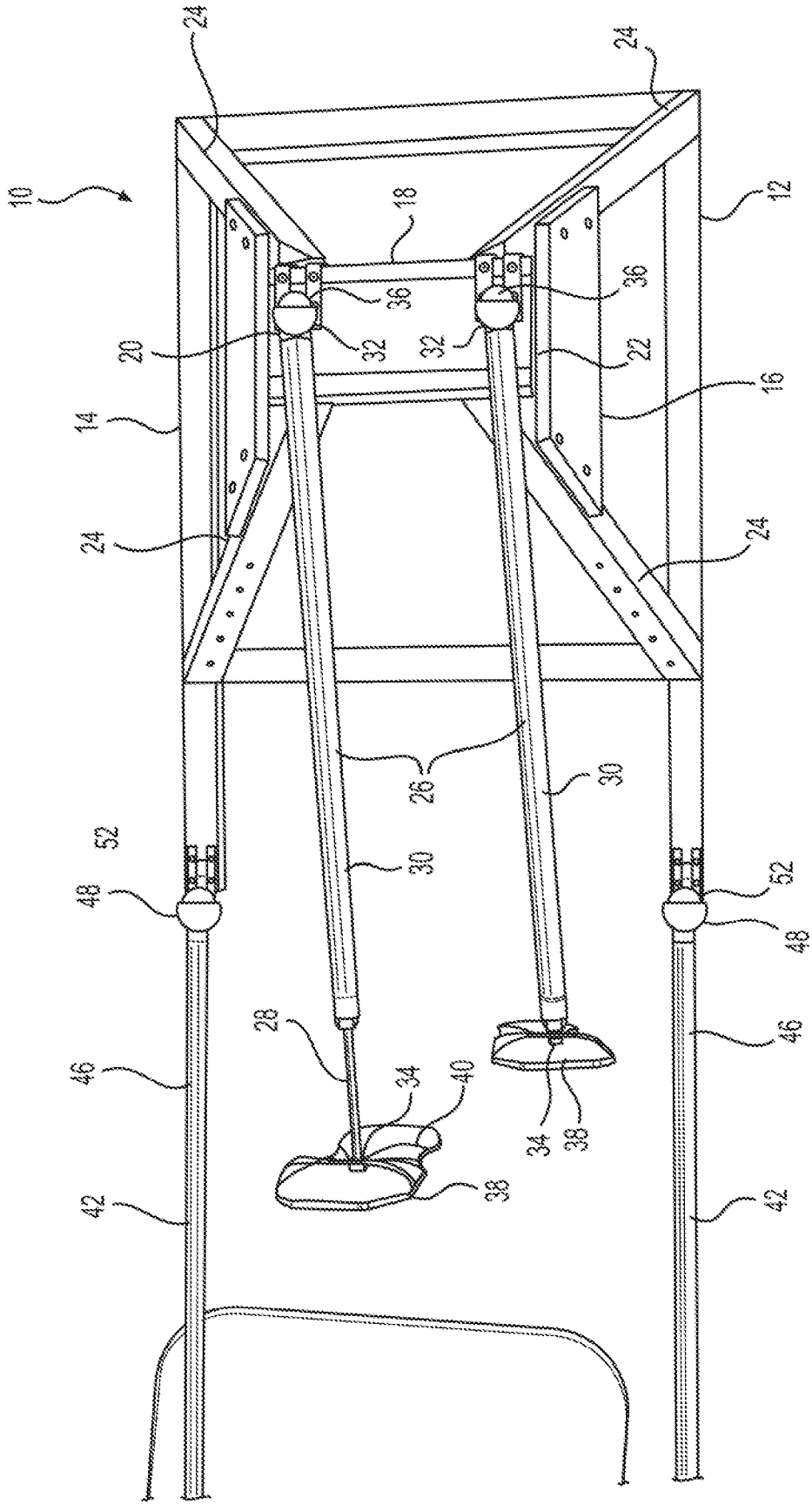
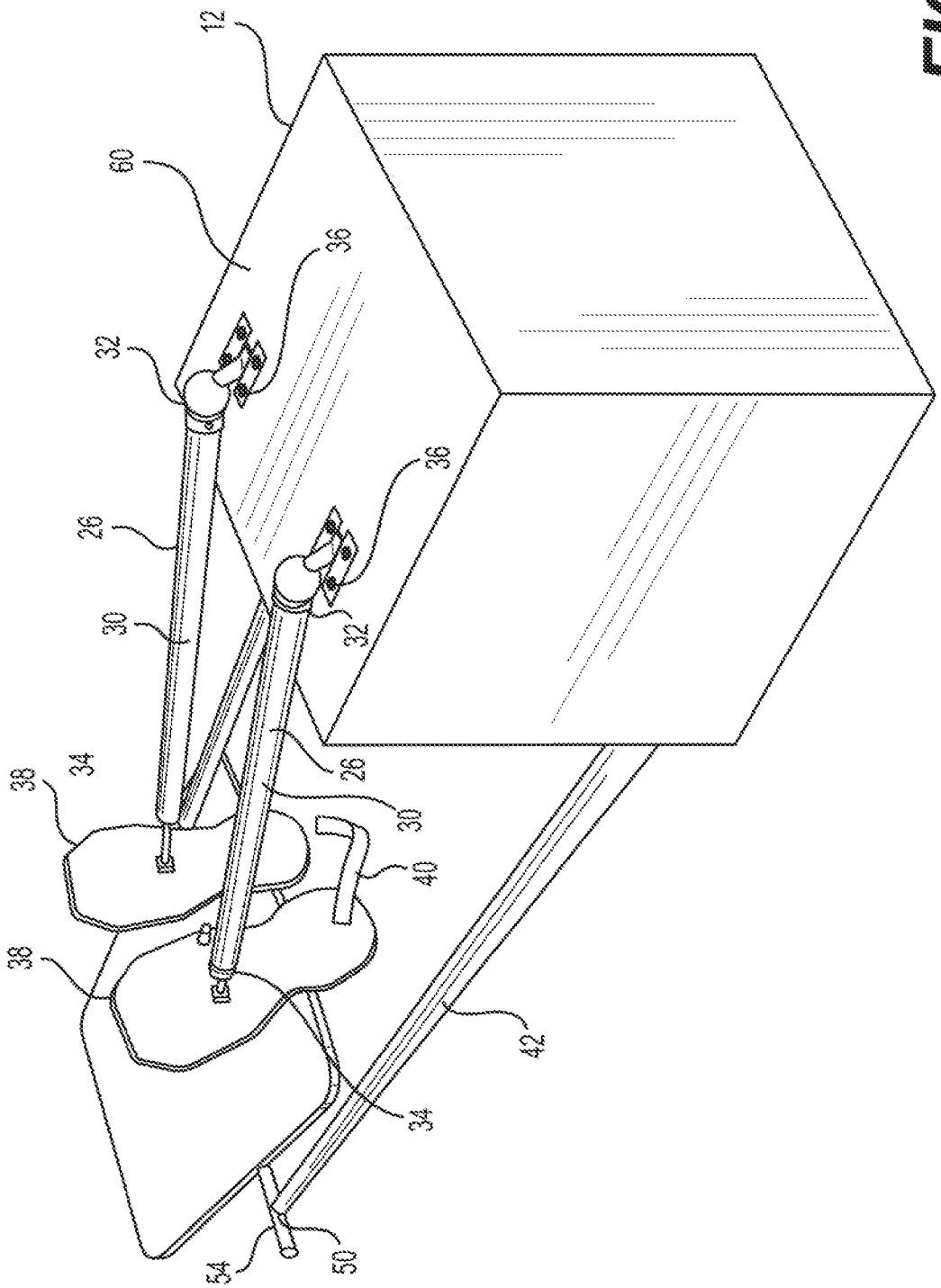



FIG. 7

FIG. 8



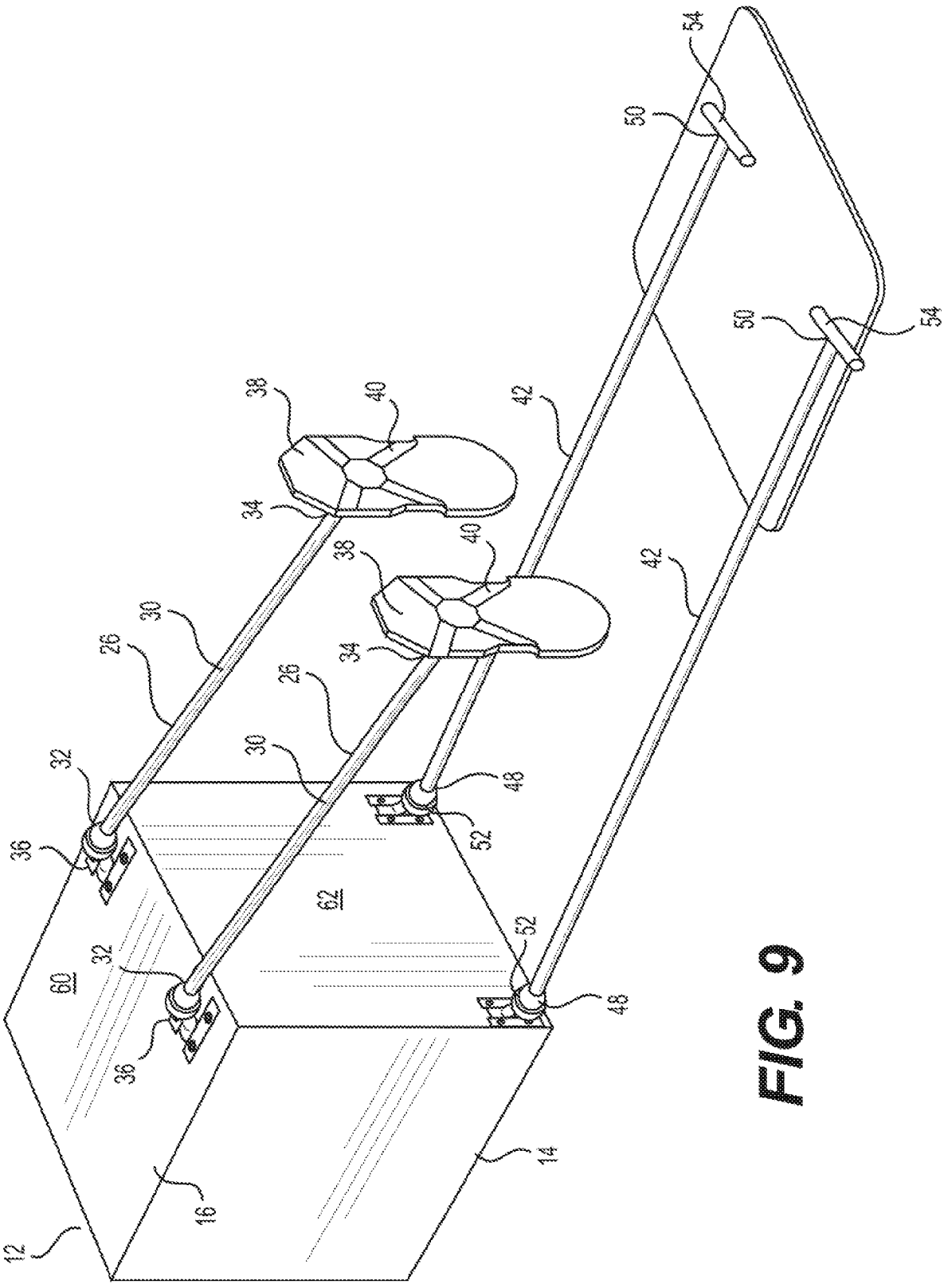



FIG. 9

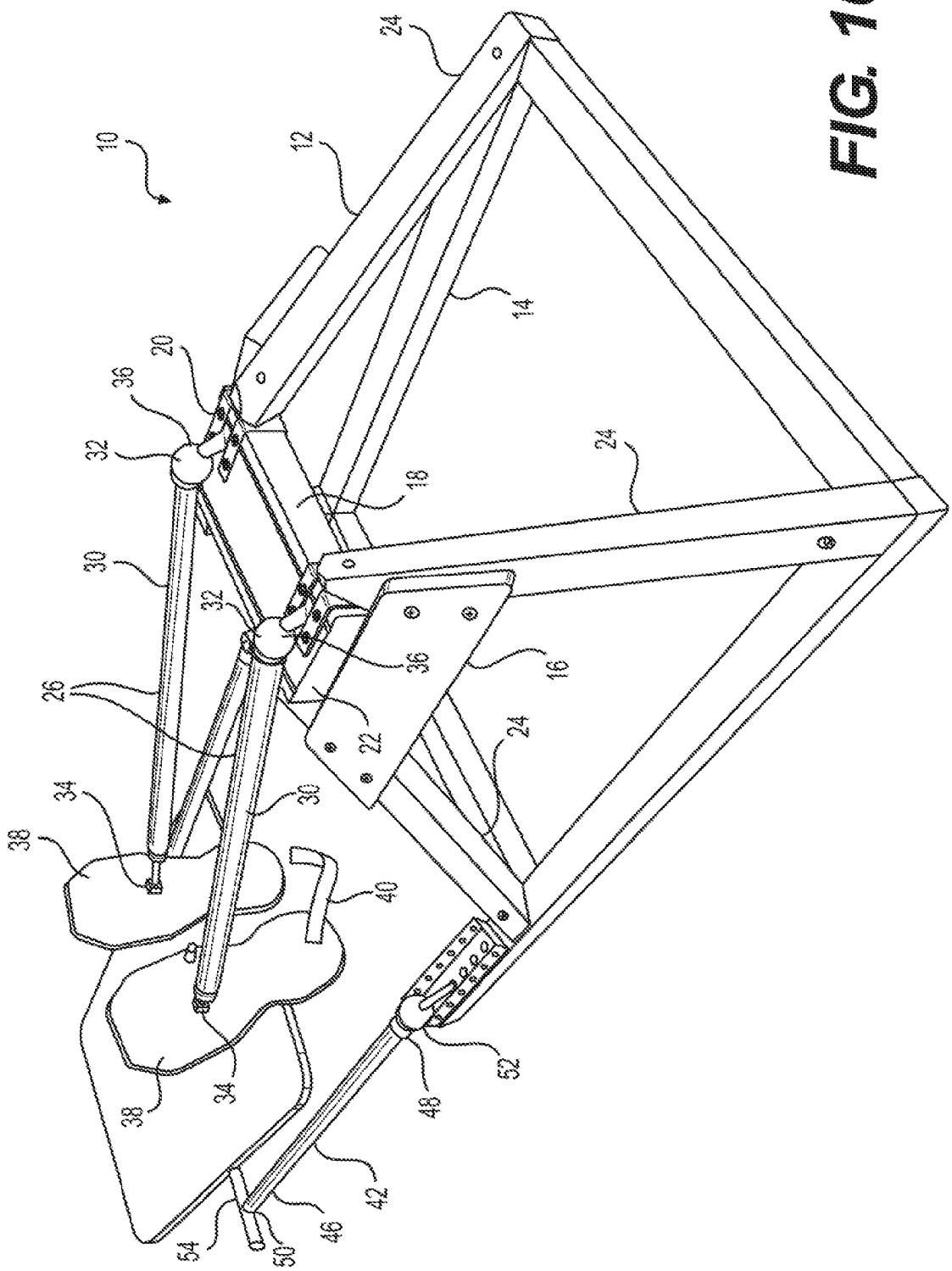



FIG. 10

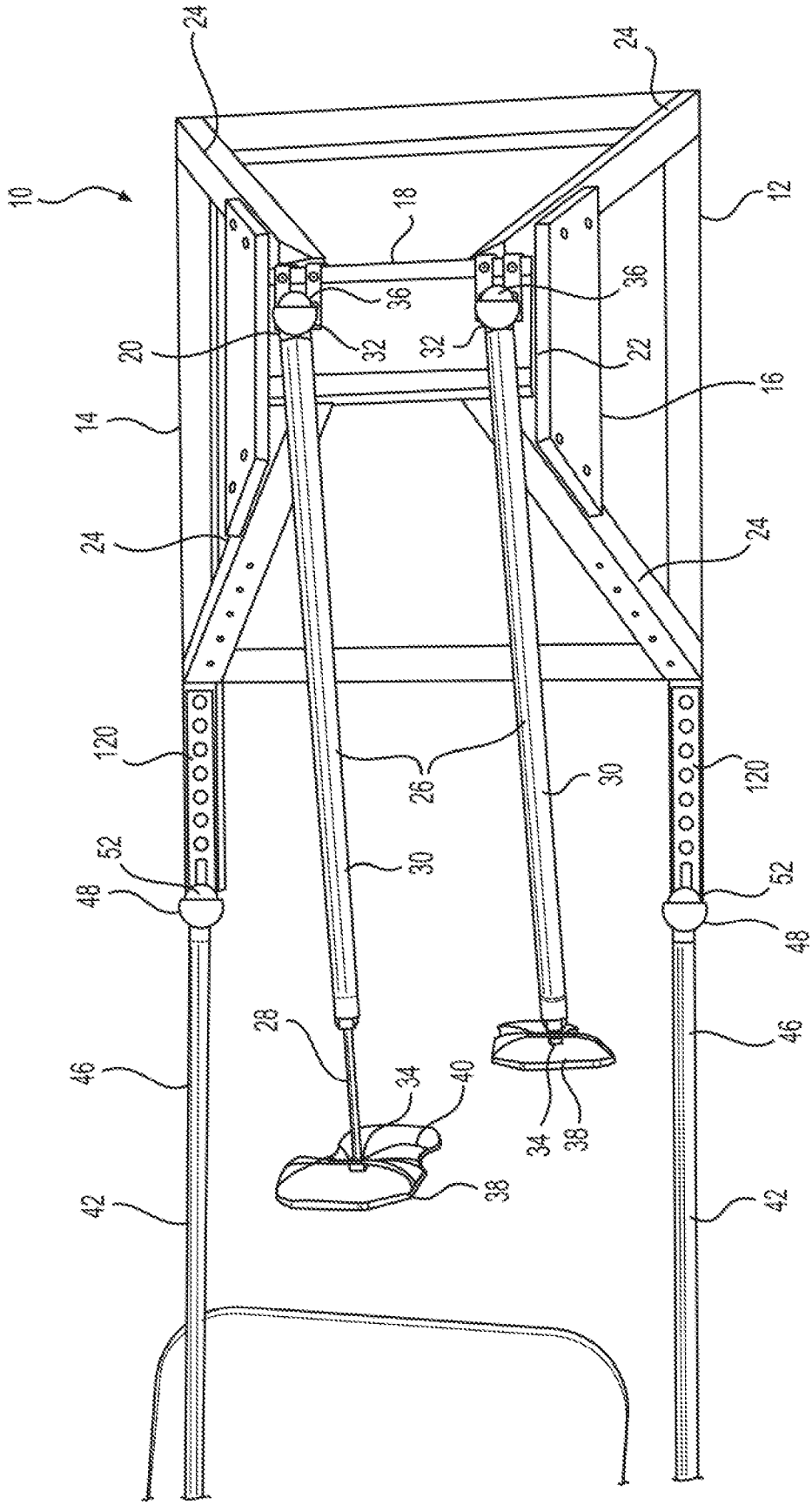



FIG. 11

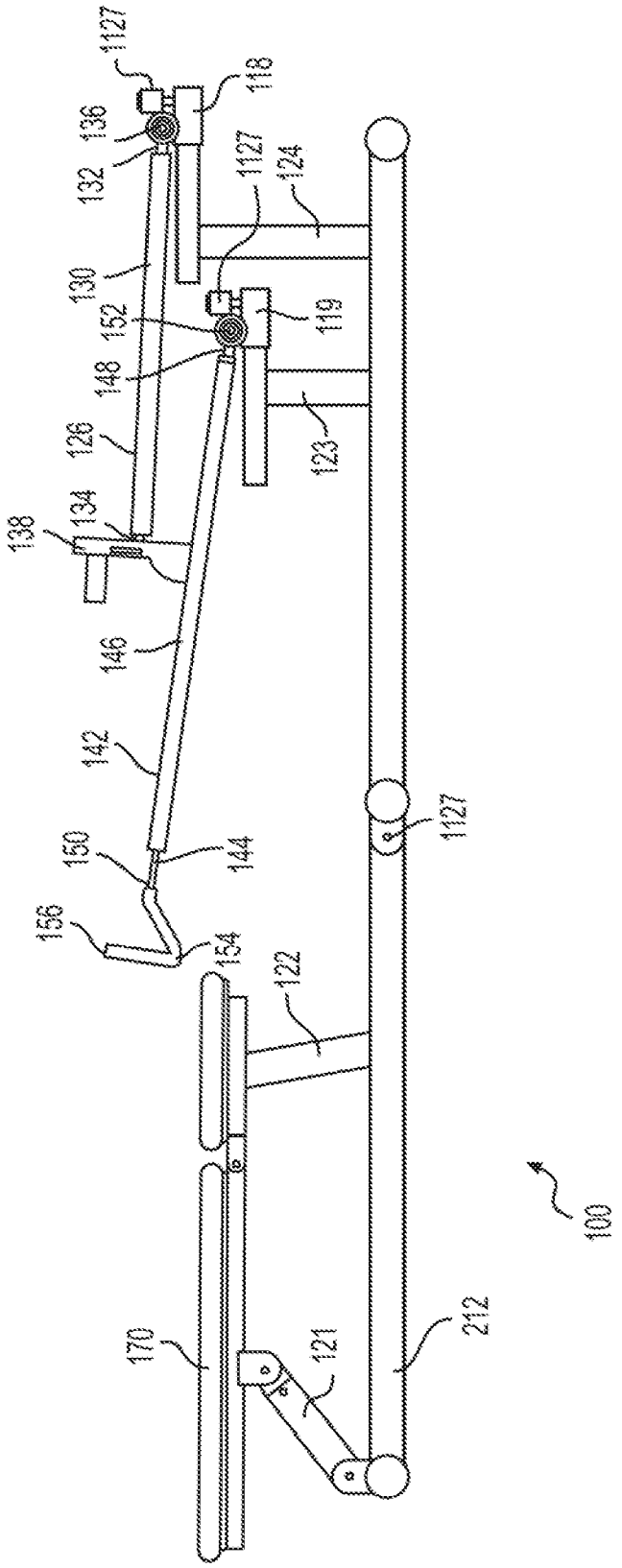

1127
118
136
132
1127
124
130
152
119
148
123
126
134
138
146
142
160
144
156
154
122
1127
100
170
121
212

FIG. 12

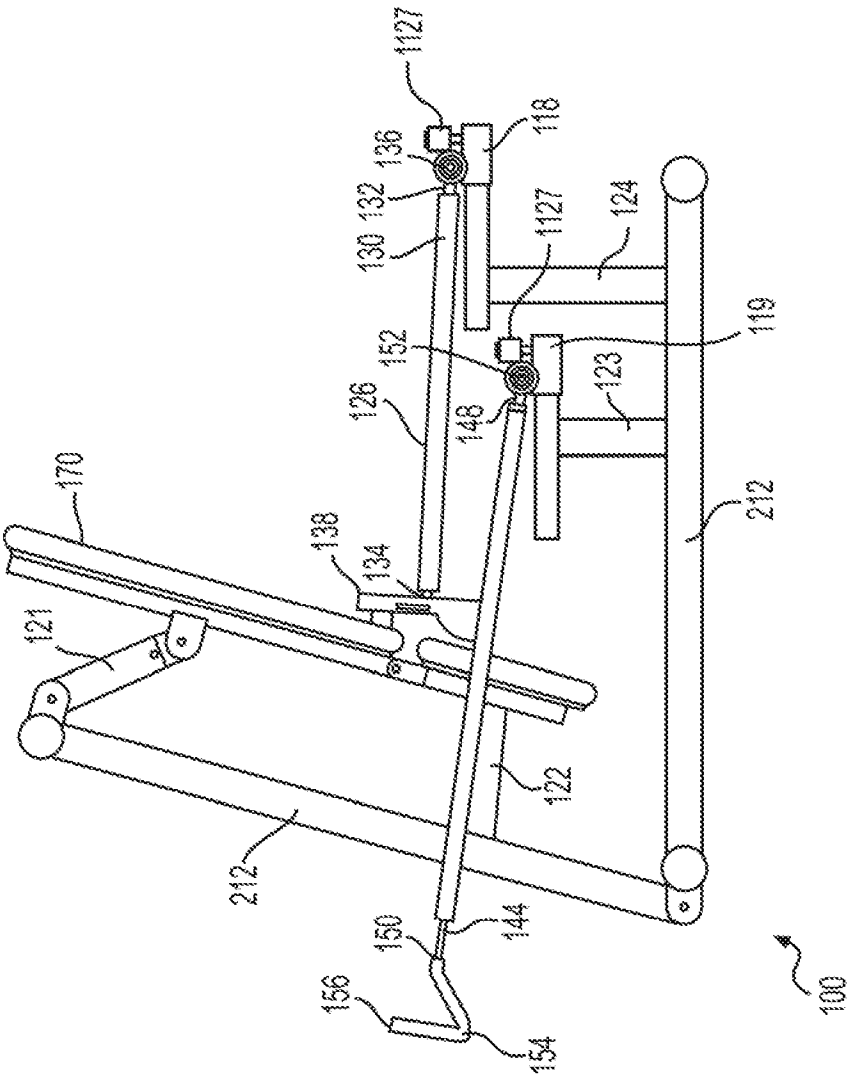

1127
118
136
132
130
1127
124
119
152
123
126
148
170
138
134
212
121
122
212
150
144
156
154
100

FIG. 13

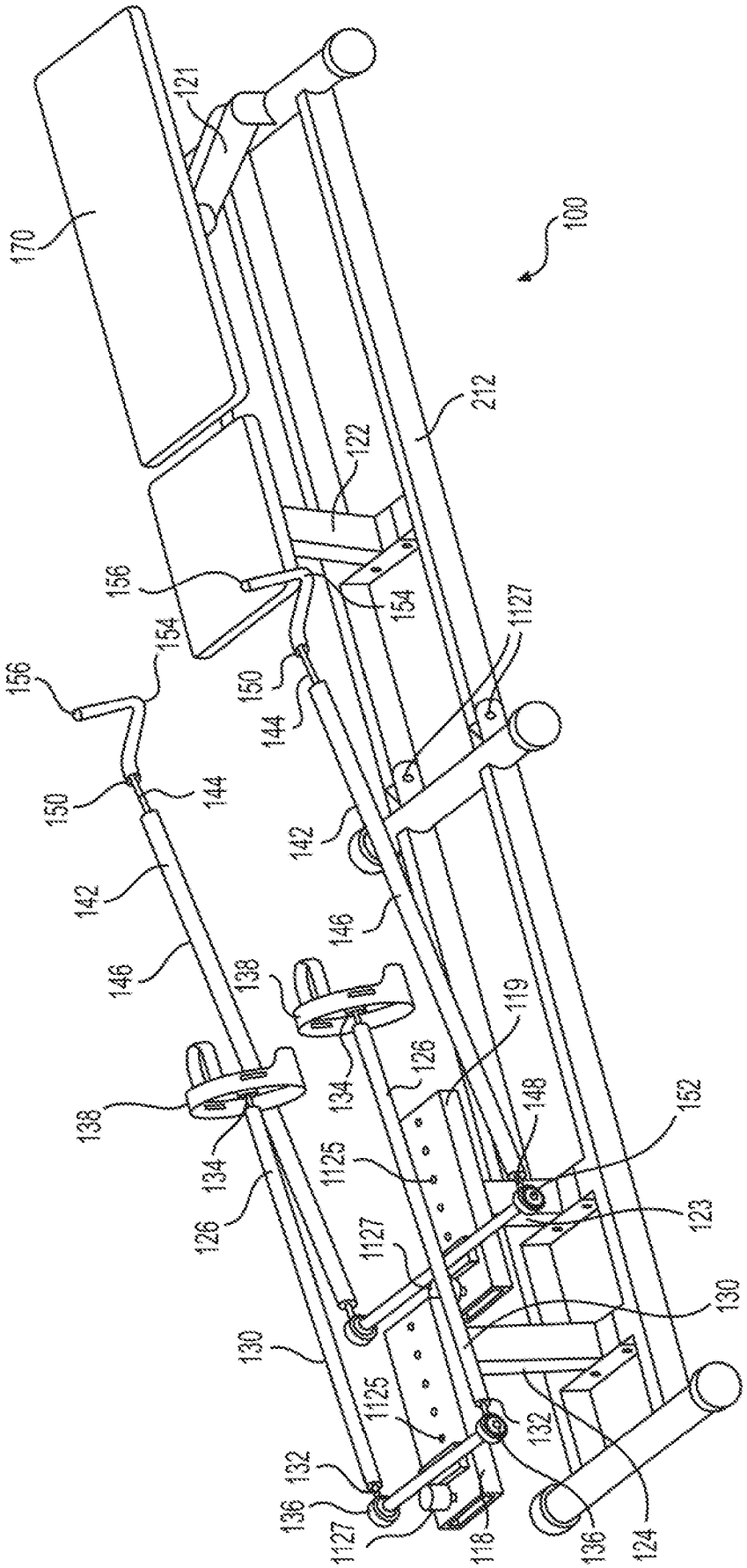

100
121
122
123
124
126
127
130
132
134
136
138
142
144
146
148
150
152
154
156
170
212
118
119
1125
1127

FIG. 14

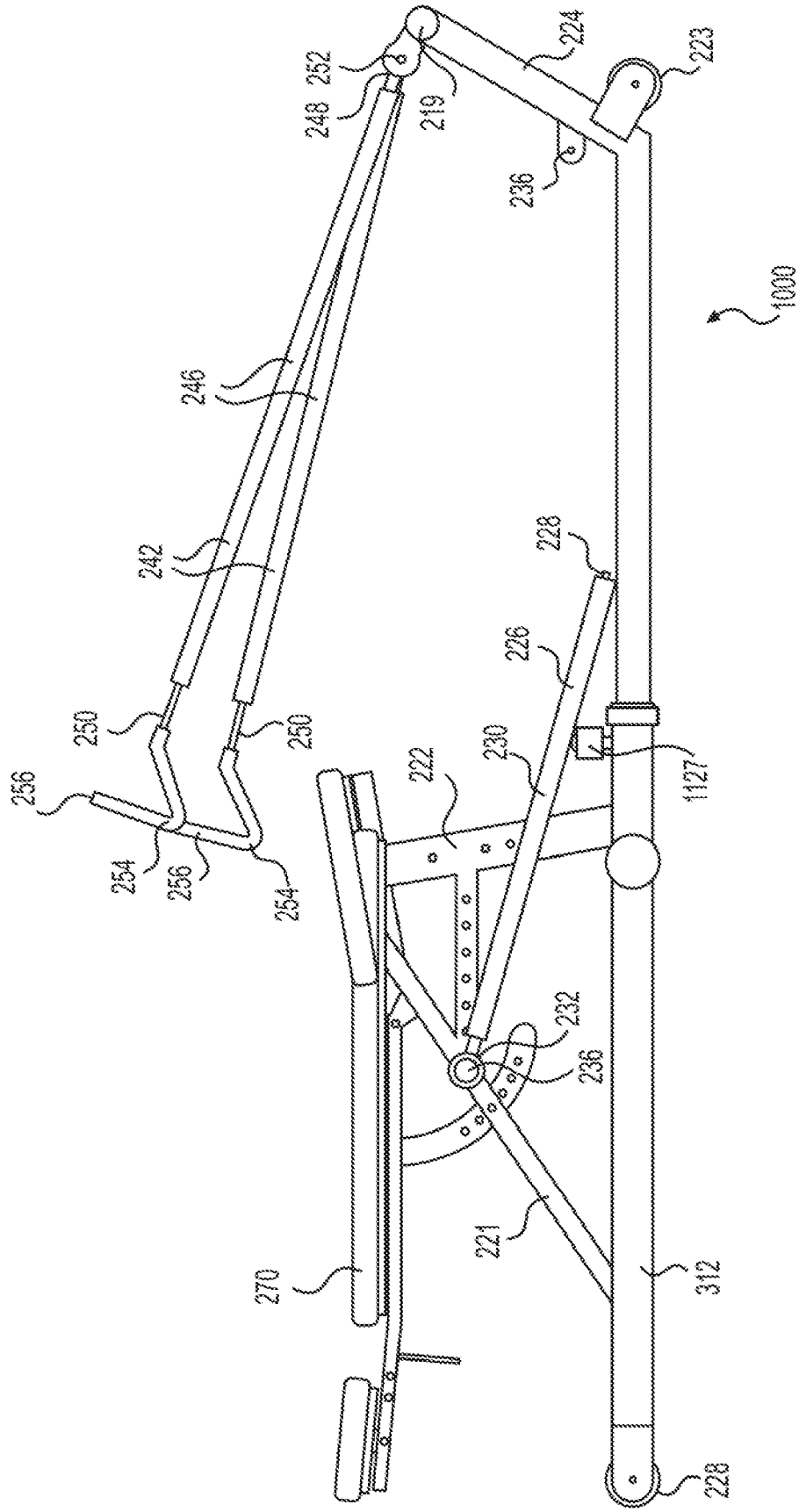

252
248
219
224
223
236
1000
246
242
228
226
250
250
230
222
1127
256
254
256
254
232
236
221
270
312
228

FIG. 15

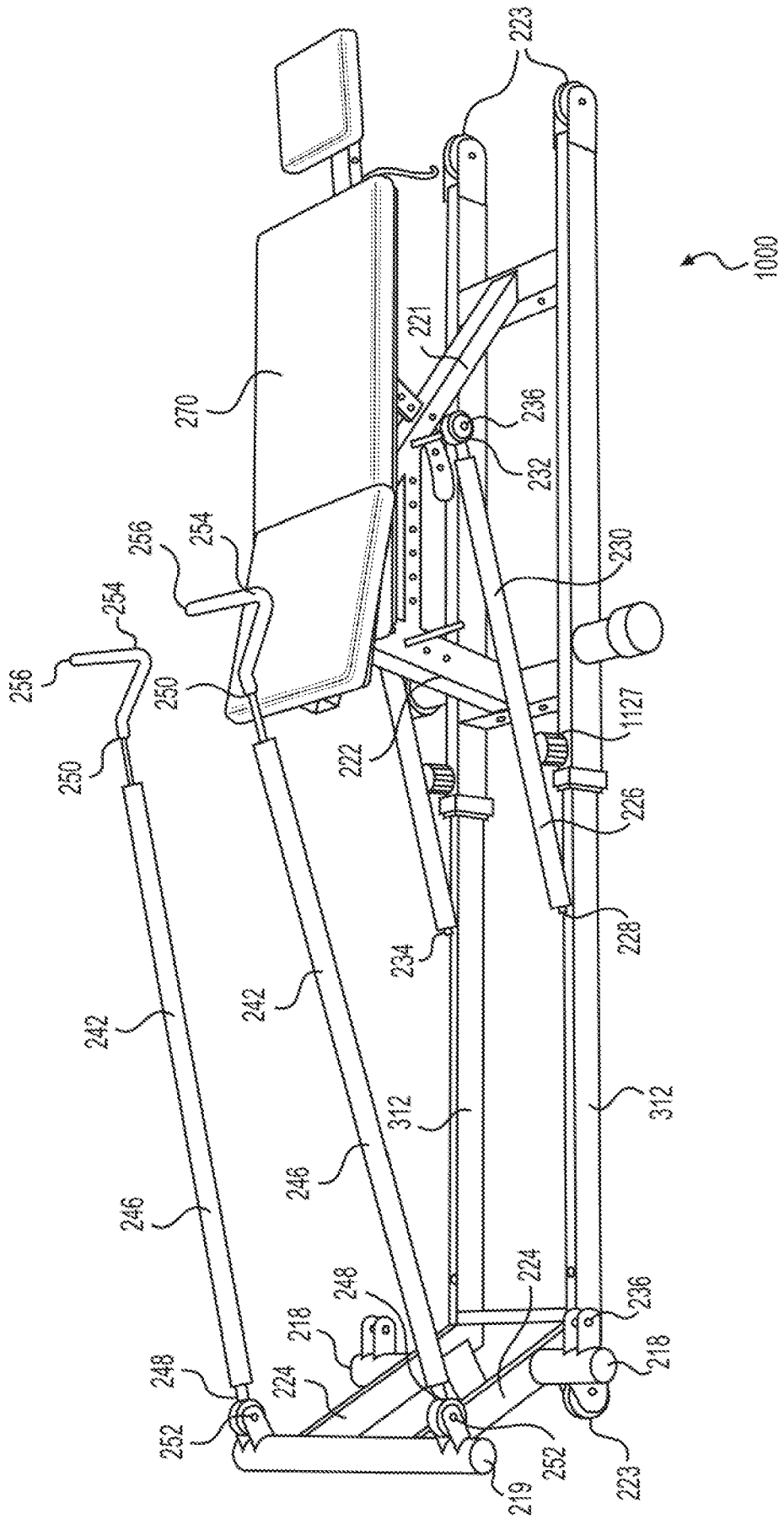

1000
223
221
270
236
232
230
256
254
250
1127
222
226
228
234
242
312
246
224
248
218
252
219

FIG. 16

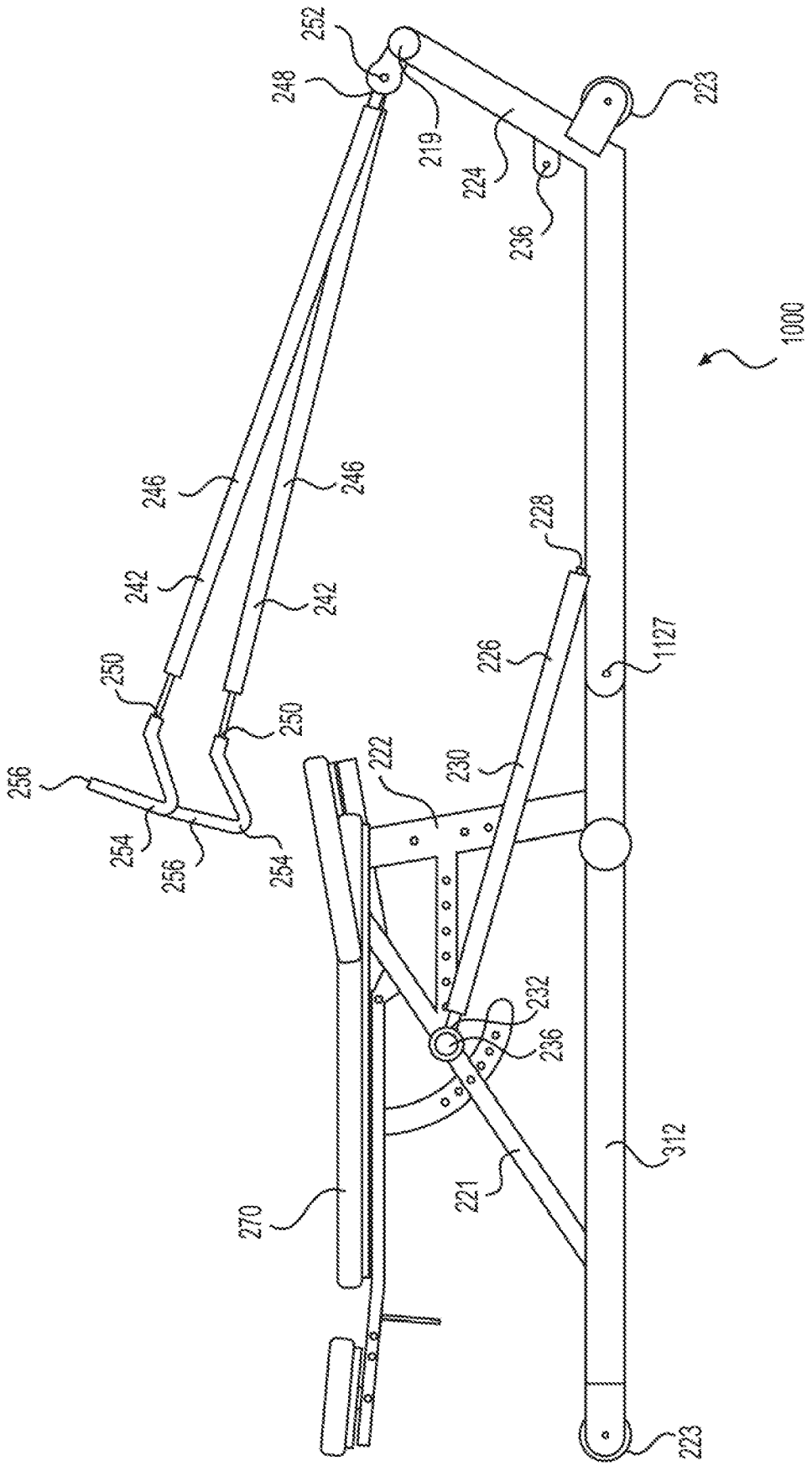

252
248
219
223
224
236
1000
246
246
228
242
242
226
1127
250
250
222
230
256
254
256
254
232
236
312
270
221
223

FIG. 17

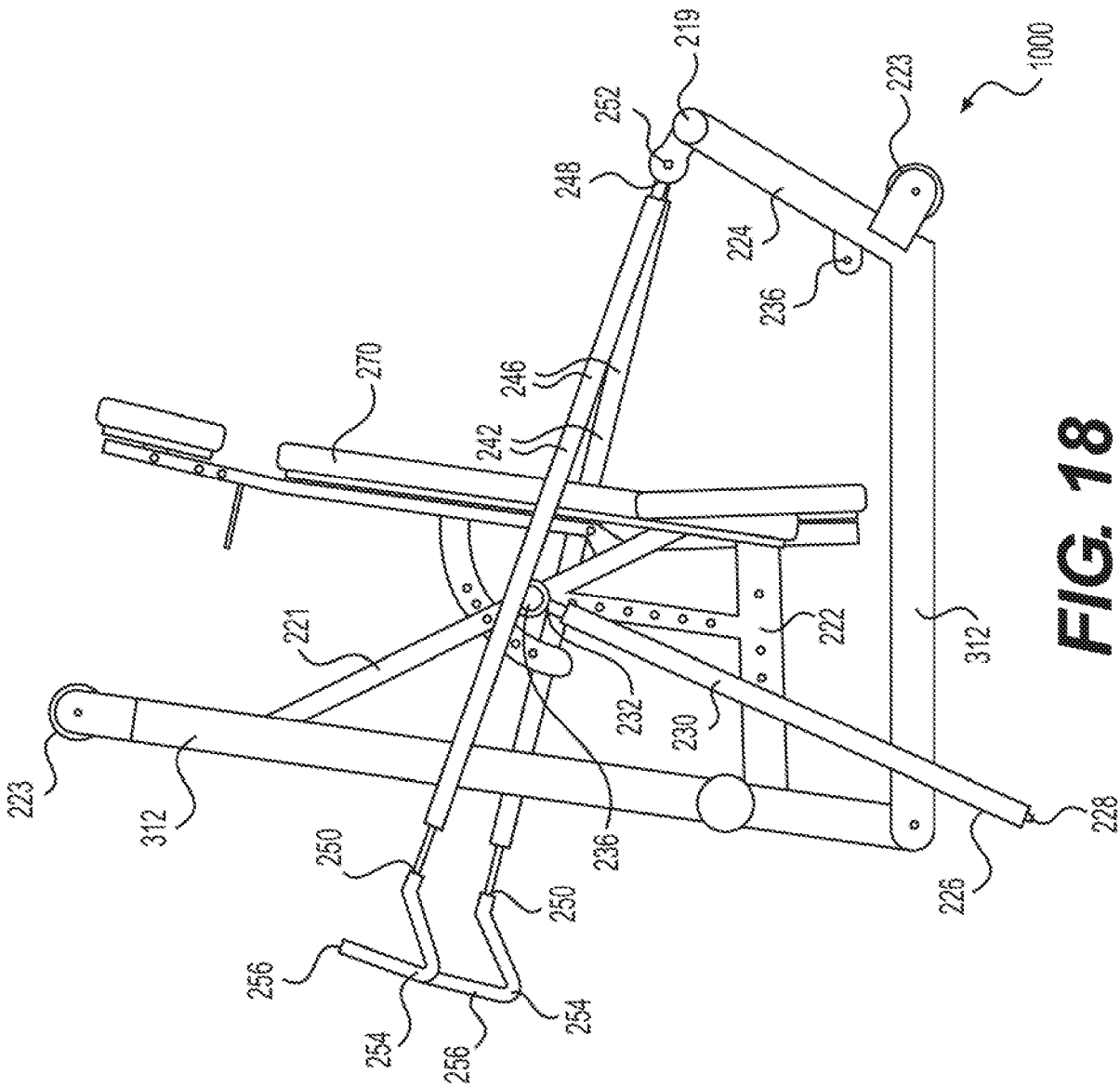

1000
219
252
248
223
224
236
270
246
242
221
222
312
232
230
223
312
250
236
250
228
226
256
254
256
254

FIG. 18

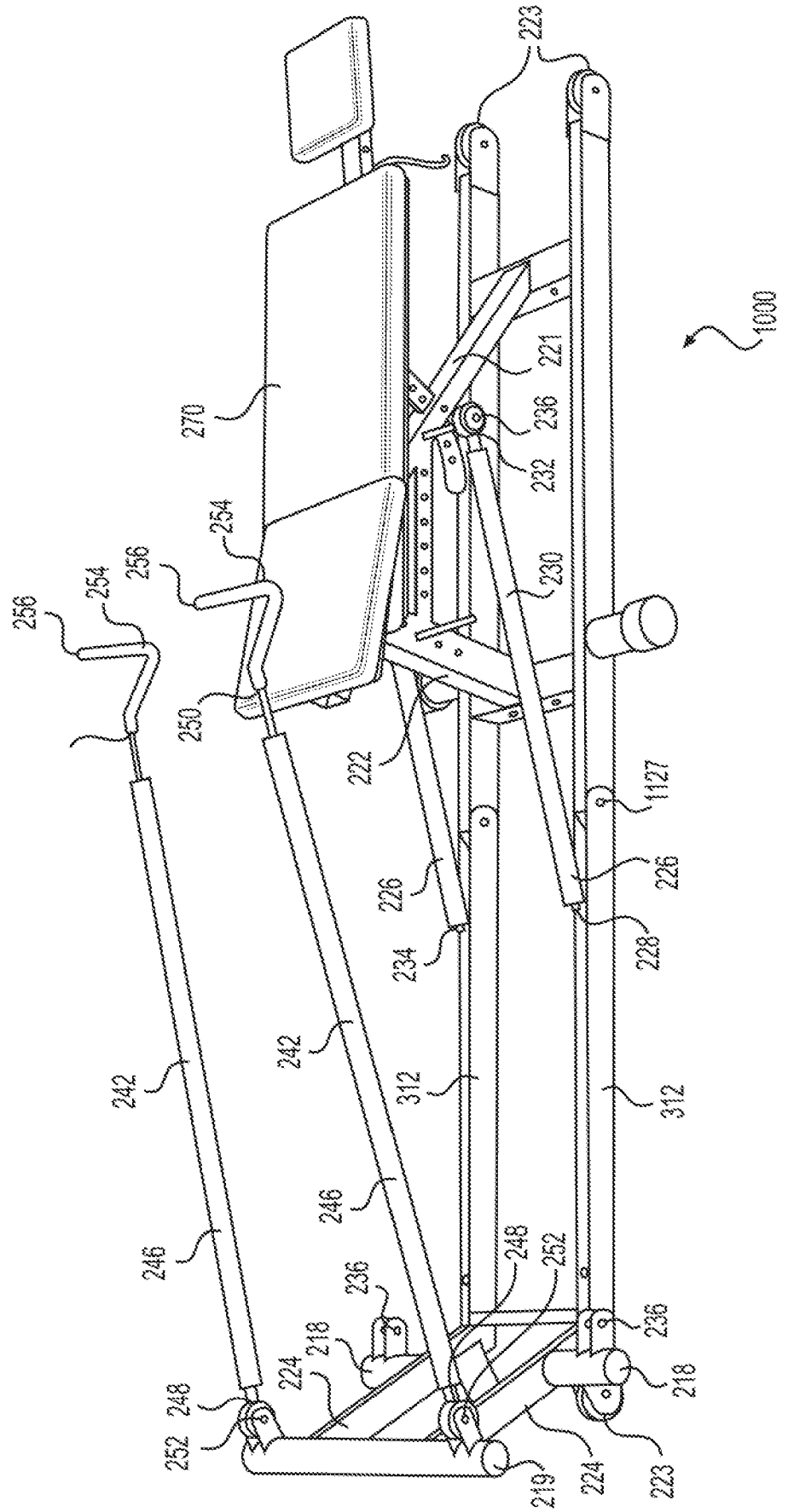

1000
223
221
236
232
270
254
256
230
250
222
1127
226
234
228
242
312
246
248
252
218
224
219

FIG. 19

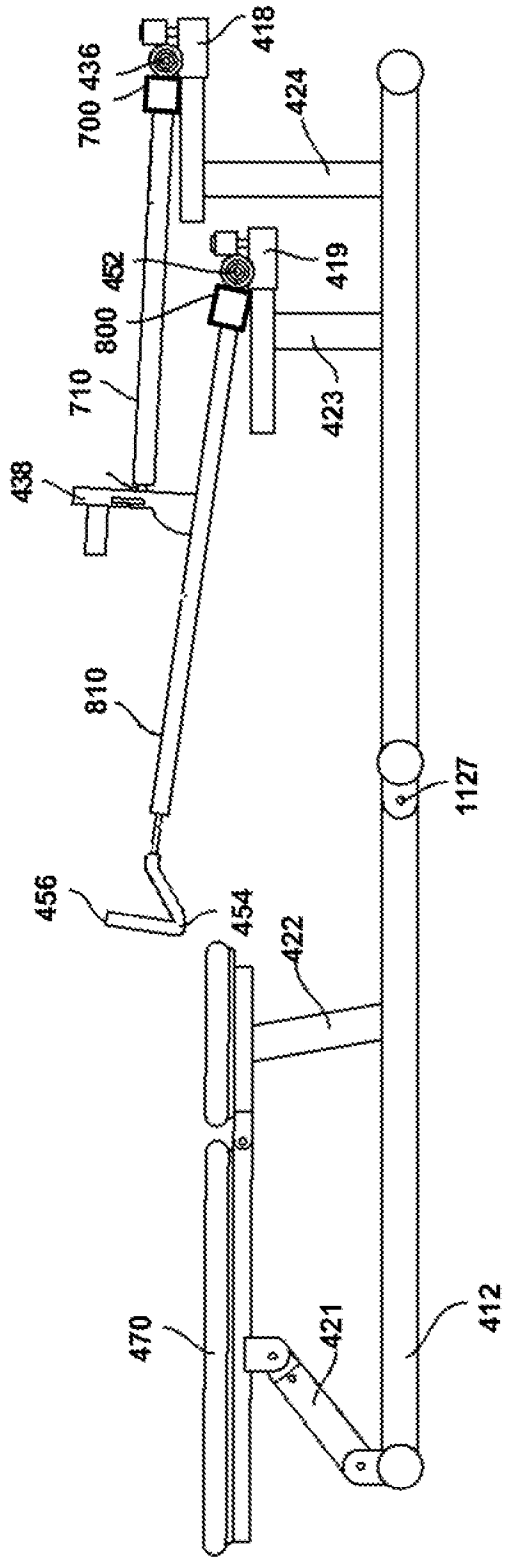

418
436
700
424
452
419
800
710
423
438
810
1127
456
454
422
470
421
412

FIG. 20

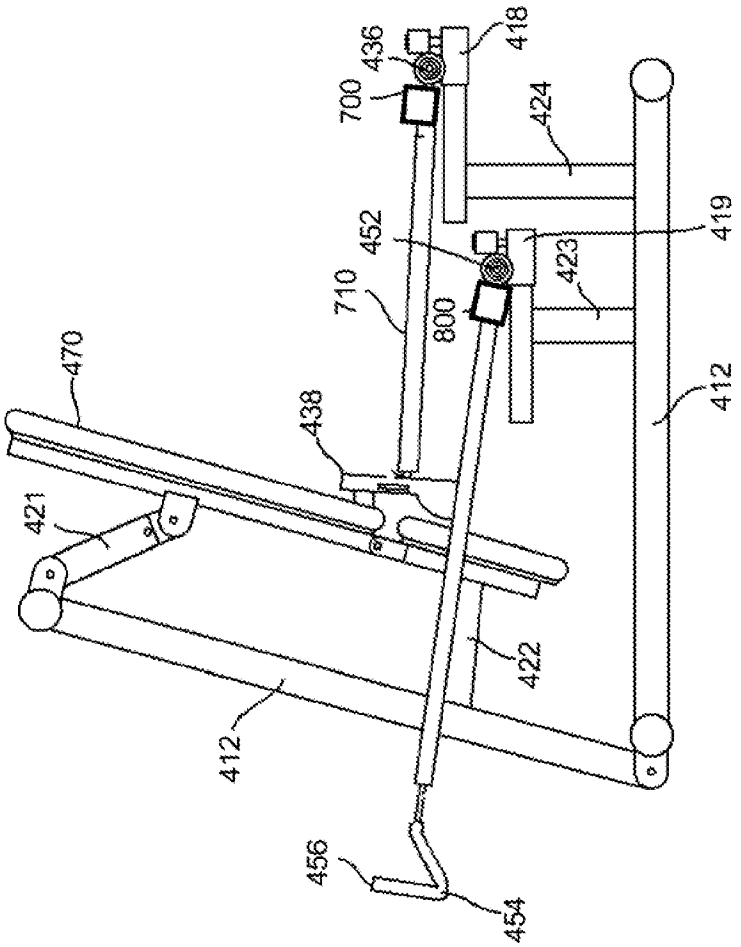

436
418
700
424
452
419
423
710
800
470
438
412
421
422
412
456
454

FIG. 21

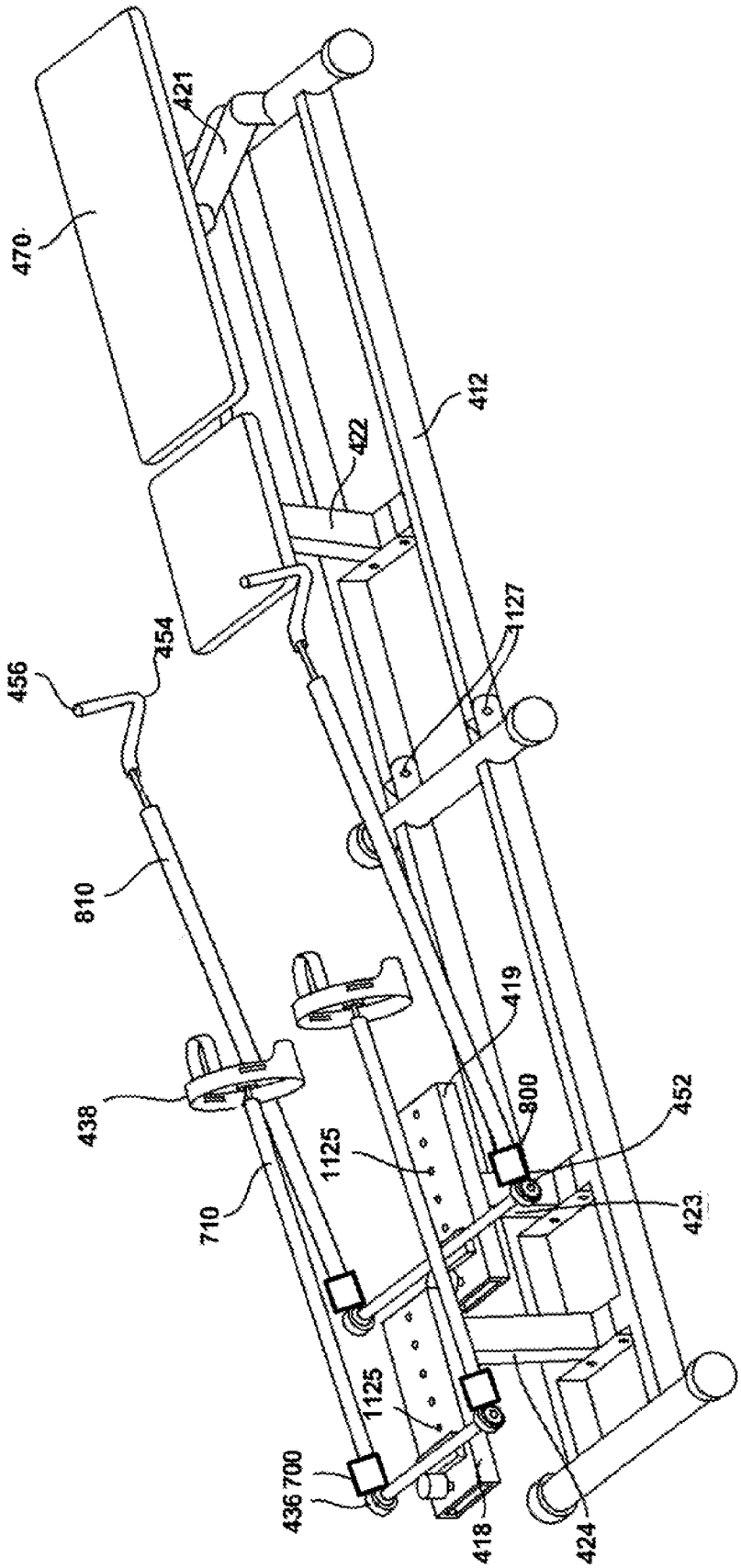

470
421
412
422
127
454
456
810
419
438
800
452
1125
710
423
1125
436
700
418
424

FIG. 22

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/032977

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A63B 21/02; A63B 21/008 (2017.01)
CPC - A63B 21/02; A63B 21/008; A63B 21/0083; A63B 21/0085; A63B 21/0087 (2017.05)

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)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 482/121; 482/122; 482/123; 482/126; 482/128; 482/129; 482/130; 482/133; 482/138; D21/692 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>---<br>Y | US 2003/0050156 A1 (TORNABENE) 13 March 2003 (13.03.2003) entire document | 17-20<br>---<br>13 |
| Y | US 2008/0261781 A1 (YAMAZAKI) 23 October 2008 (23.10.2008) See pg 7 of the ISA/237 | 1-16 |
| Y | US 4,684,126 A (DALEBOUT et al) 04 August 1987 (04.08.1987) entire document | 1-16 |
| Y | US 5,110,118 A (WINEY) 05 May 1992 (05.05.1992) entire document | 3, 5, 6 |
| A | US 2013/0157824 A1 (CHEN) 20 June 2013 (20.06.2013) entire document | 1-20 |
| A | US 2008/0004166 A1 (OREN et al) 03 January 2008 (03.01.2008) entire document | 1-20 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"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 |
|---|---|
| 17 July 2017 | 03 AUG 2017 |
| Name and mailing address of the ISA/US<br>Mail Stop PCT, Attn: ISA/US, Commissioner for Patents<br>P.O. Box 1450, Alexandria, VA 22313-1450<br>Facsimile No. 571-273-8300 | Authorized officer<br>Blaine R. Copenheaver<br>PCT Helpdesk: 571-272-4300<br>PCT OSP: 571-272-7774 |