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(19) **United States**(12) **Patent Application Publication**
Joutras(10) **Pub. No.: US 2012/0142416 A1**(43) **Pub. Date: Jun. 7, 2012**(54) **SIMULATED RECREATIONAL, TRAINING
AND EXERCISE SYSTEM****Publication Classification**(76) Inventor: **Frank E. Joutras, Lincoln, NE
(US)**(51) **Int. Cl.**
A63F 9/24 (2006.01)(21) Appl. No.: **13/150,987**(52) **U.S. Cl.** **463/36**(22) Filed: **Jun. 1, 2011**(57) **ABSTRACT****Related U.S. Application Data**(60) Provisional application No. 61/350,347, filed on Jun.
1, 2010.

Controlled resistance to movement of body parts of a person is provided based on the person's body position and related to an activity depicted in a visual image provided to the person. The resistance is controlled by a sensor input and a visual input provided to a microprocessor and a software program based on the sensing of the position of at least one part of the person's body.

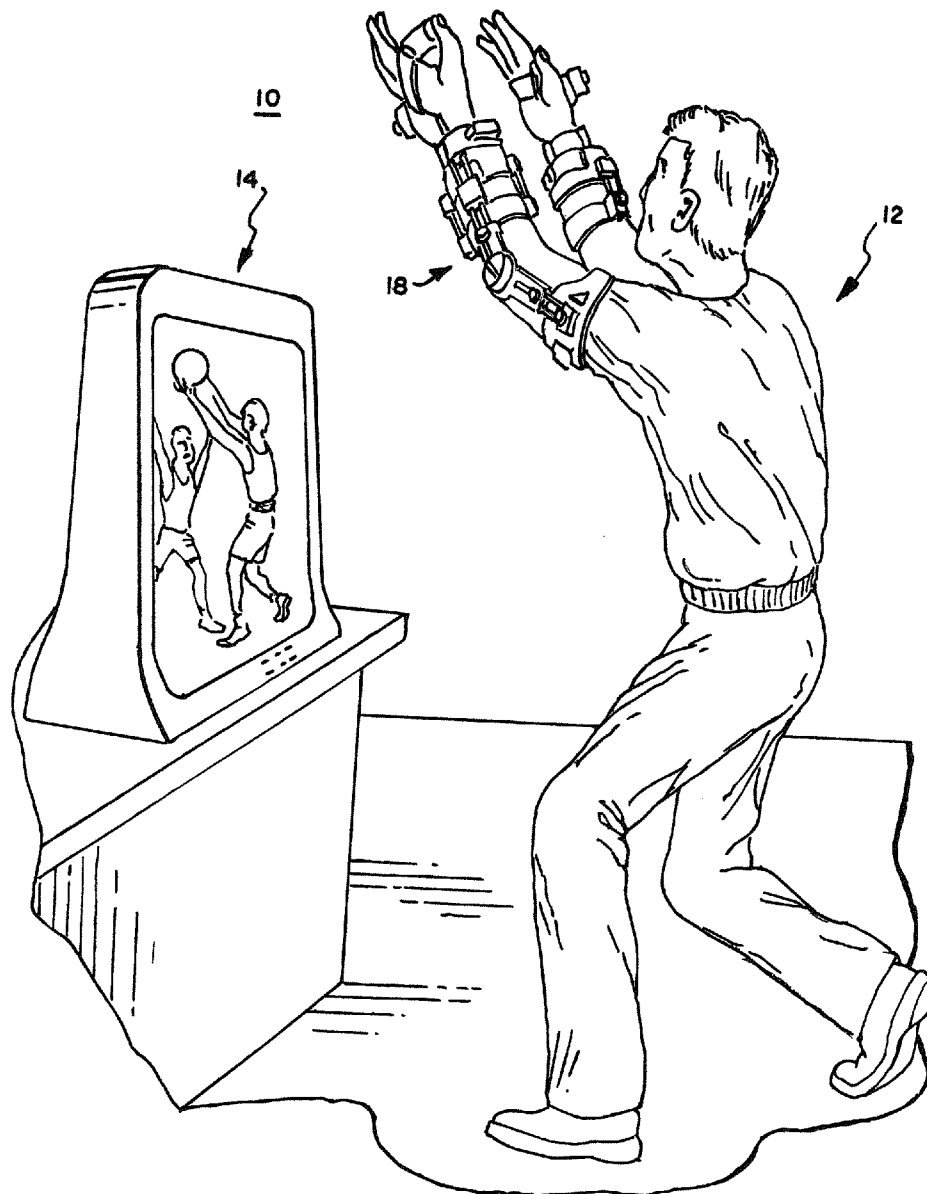


FIG. 1

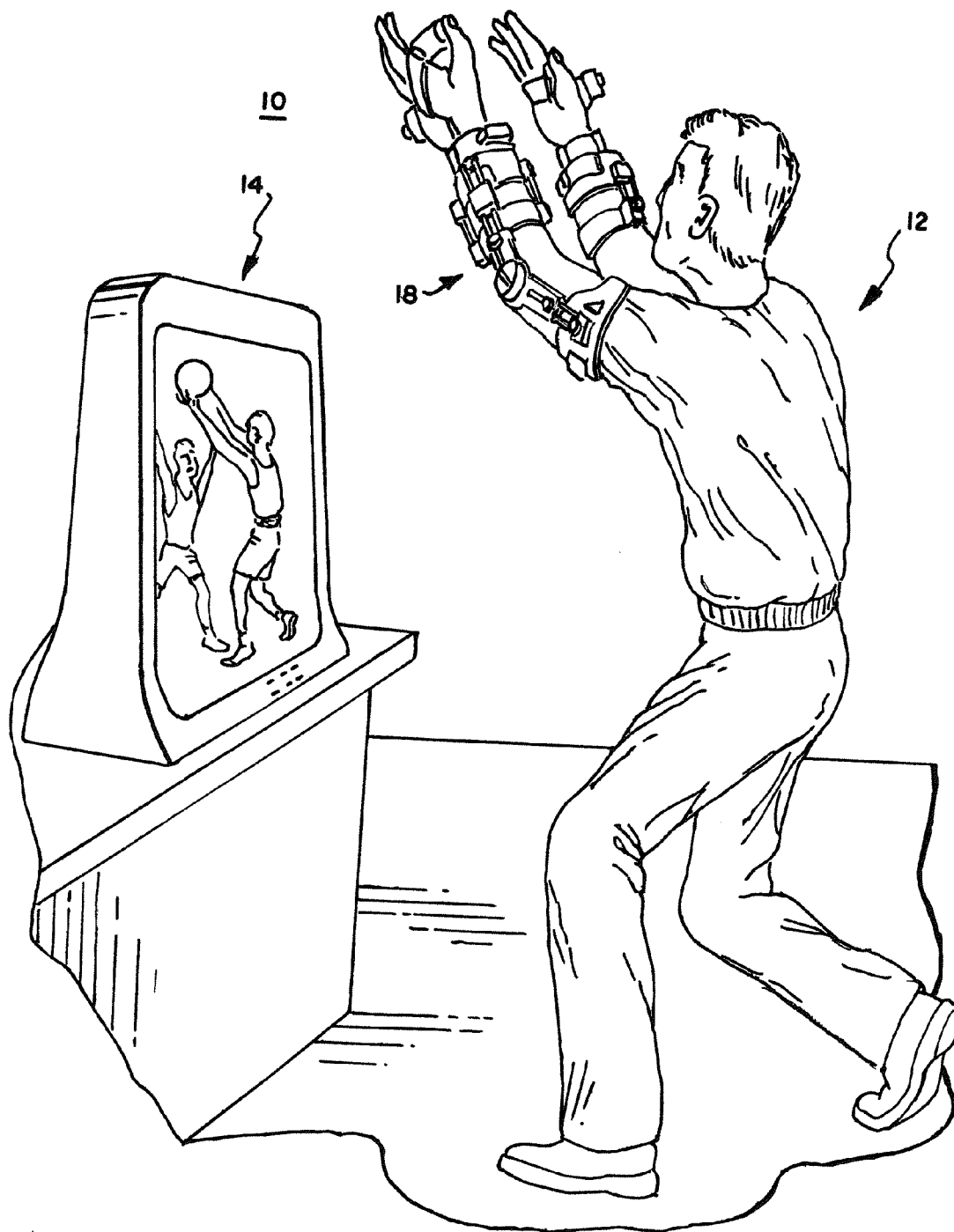


FIG. 2

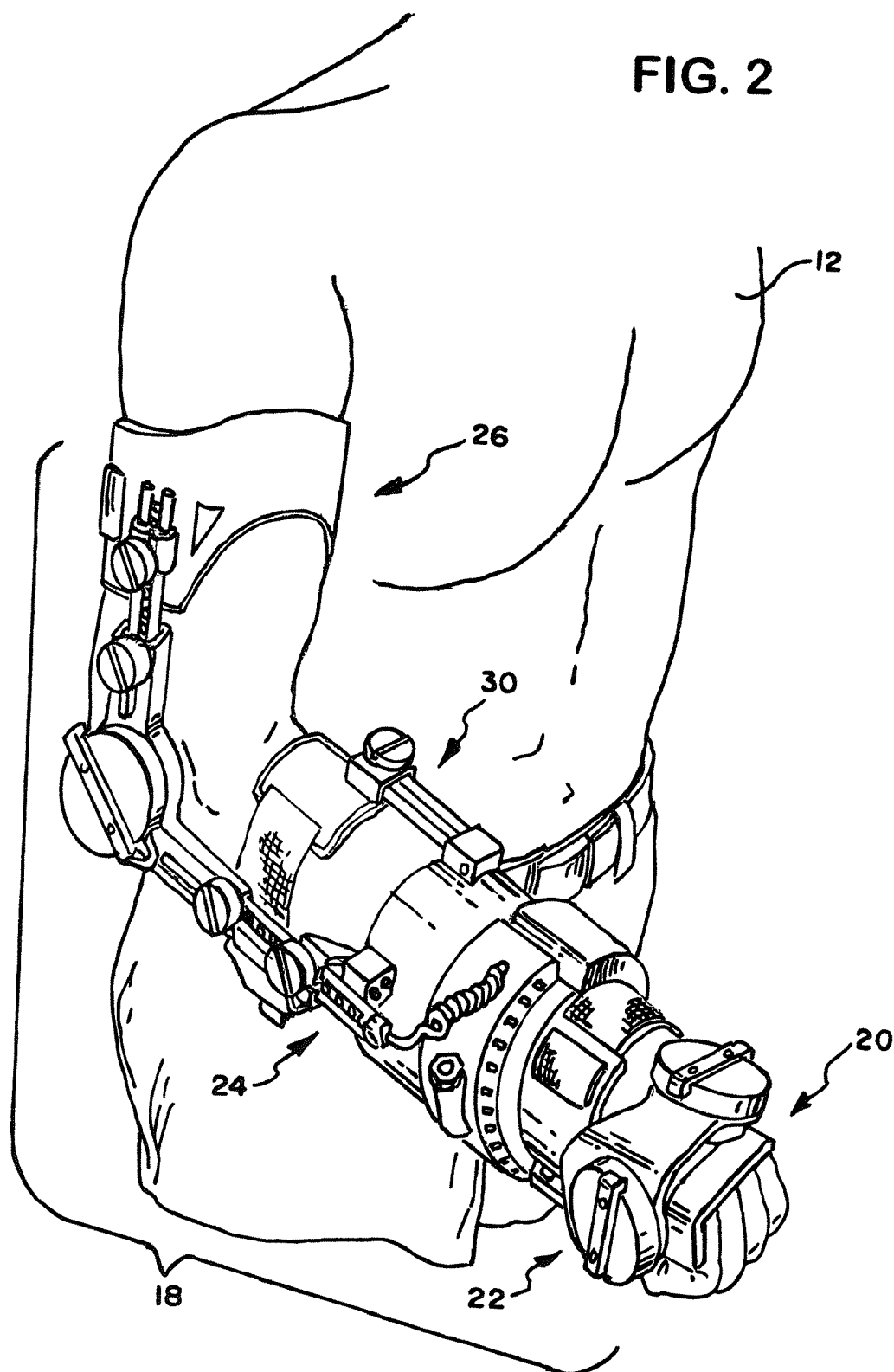
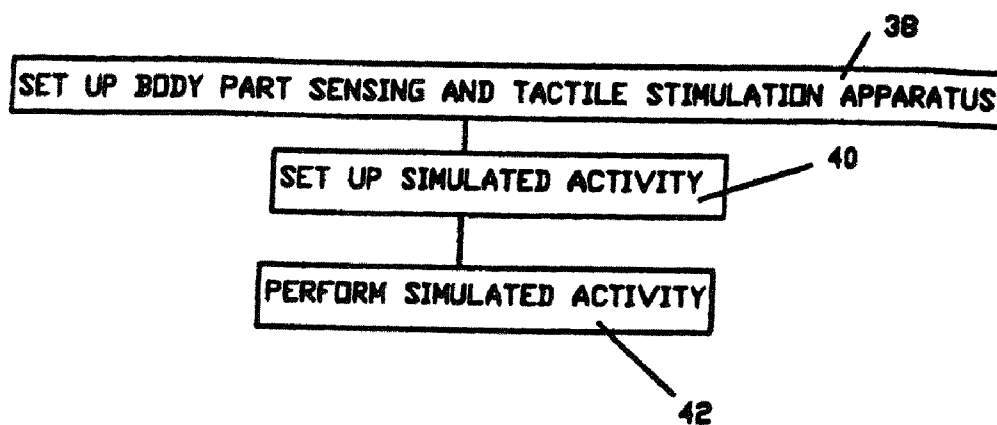
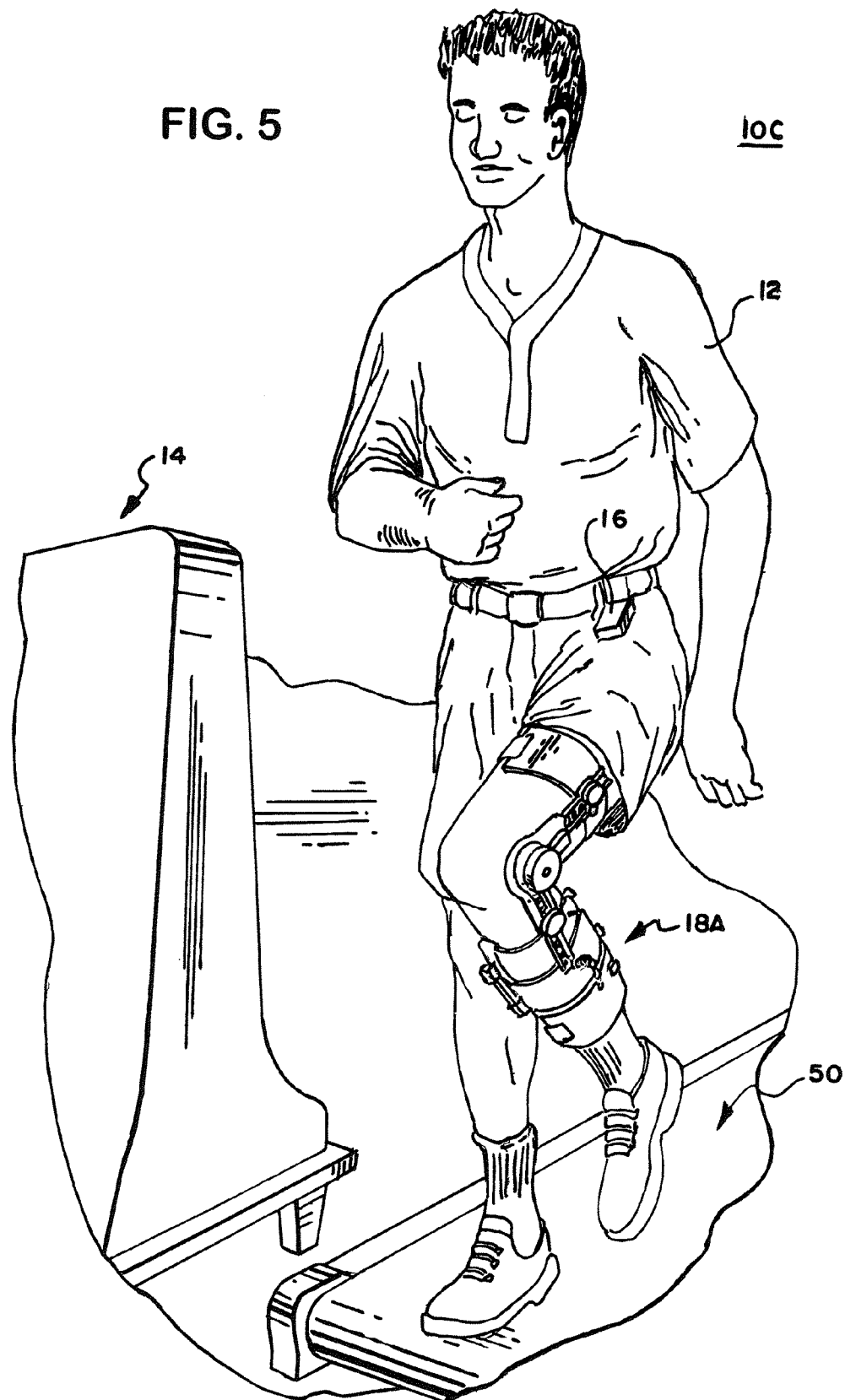


FIG. 3 illustrates a person (12) wearing a motion-tracking suit (10B) interacting with a virtual basketball game displayed on a monitor (14). The suit includes sensors (18, 18A, 22, 26) and a head-mounted display (32). The monitor shows a basketball player (12) shooting a ball. A cable (34) connects the suit to the monitor.

FIG. 4

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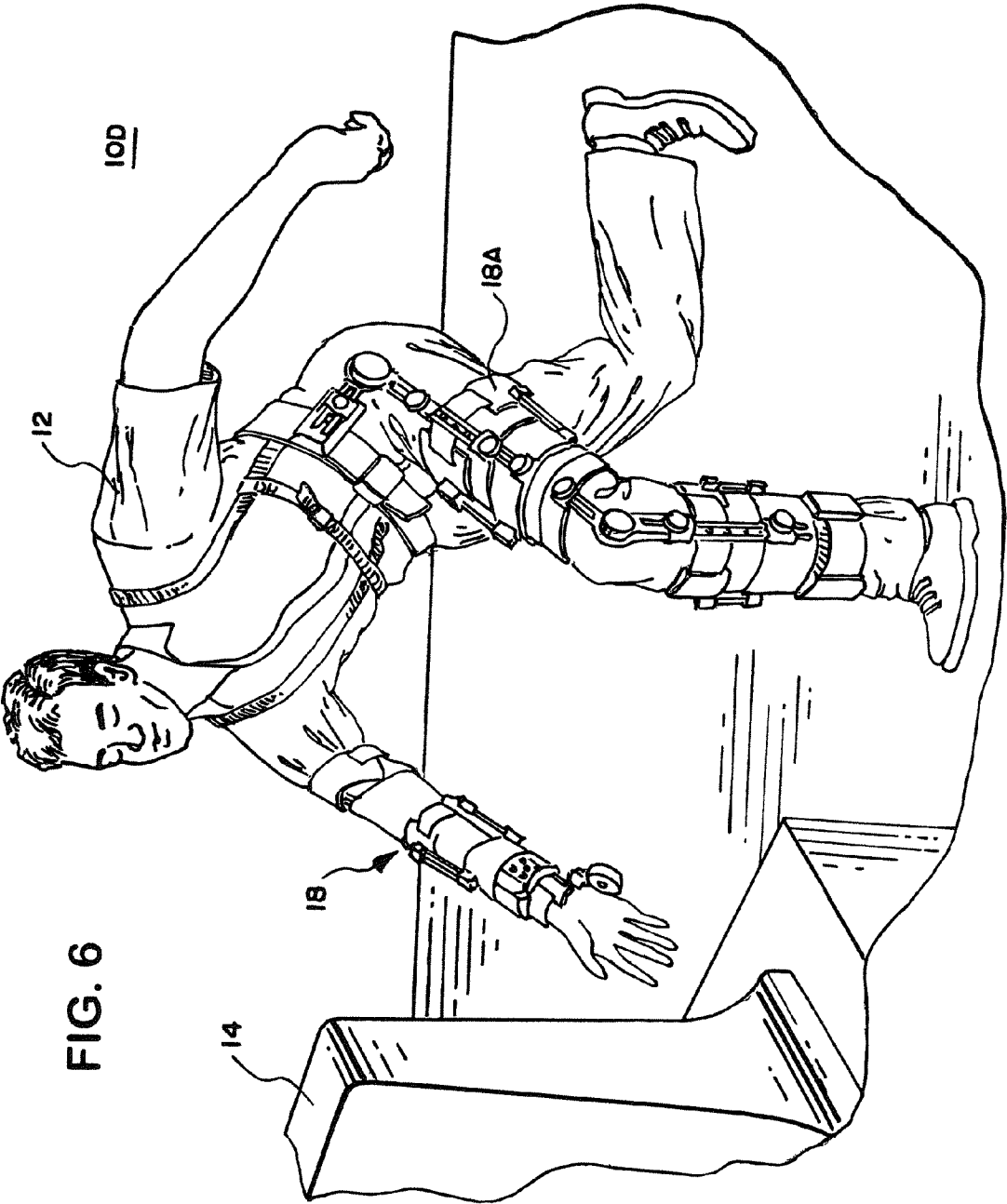


FIG. 6

FIG. 7

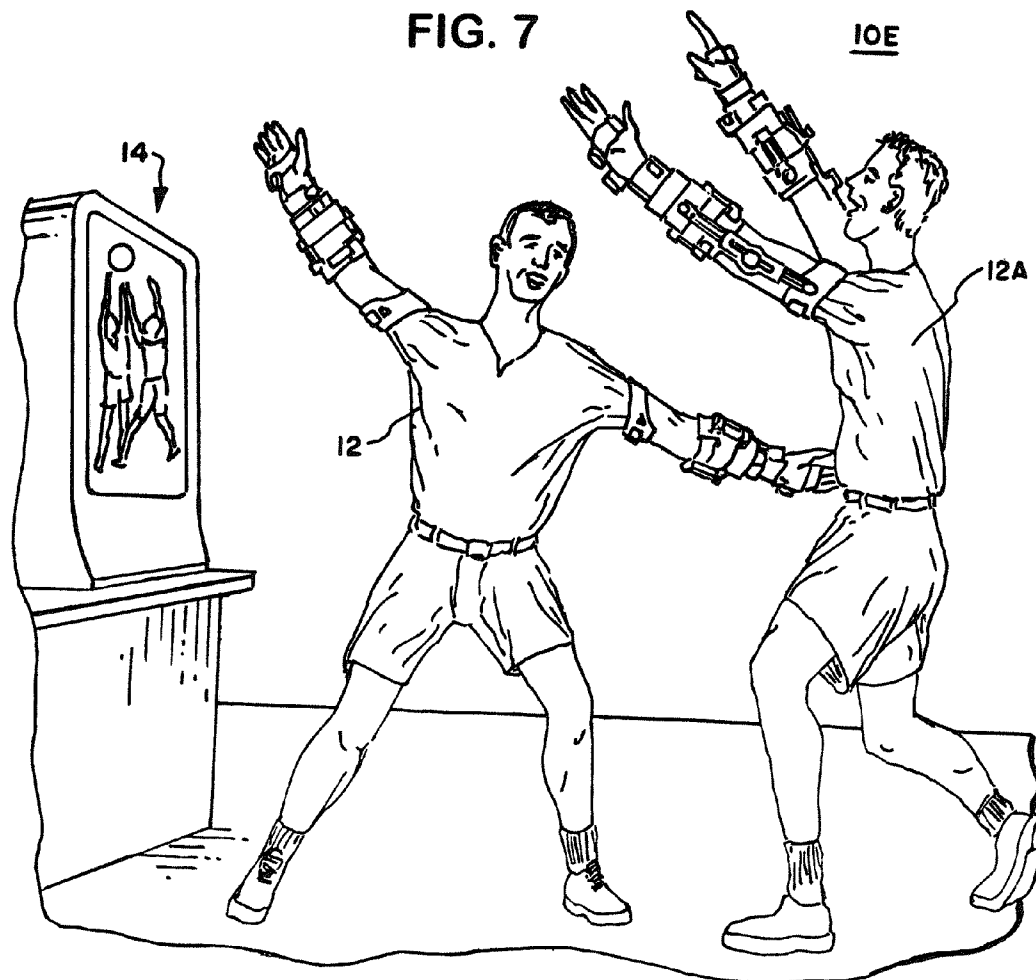
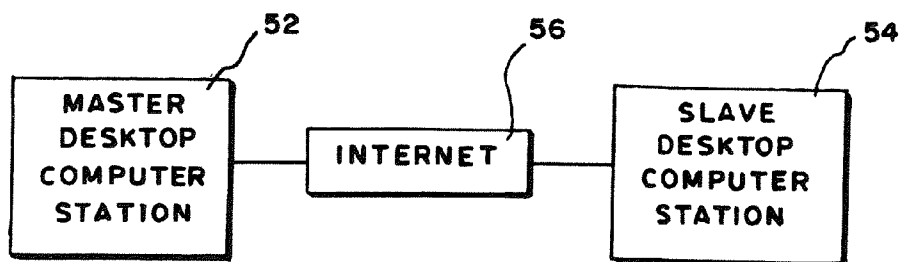
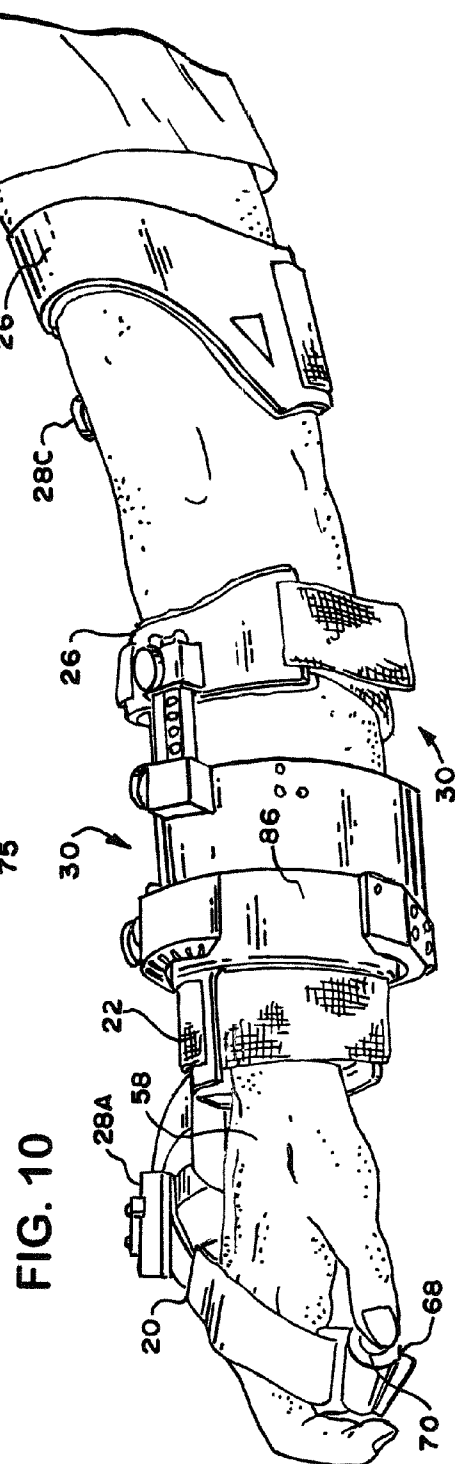
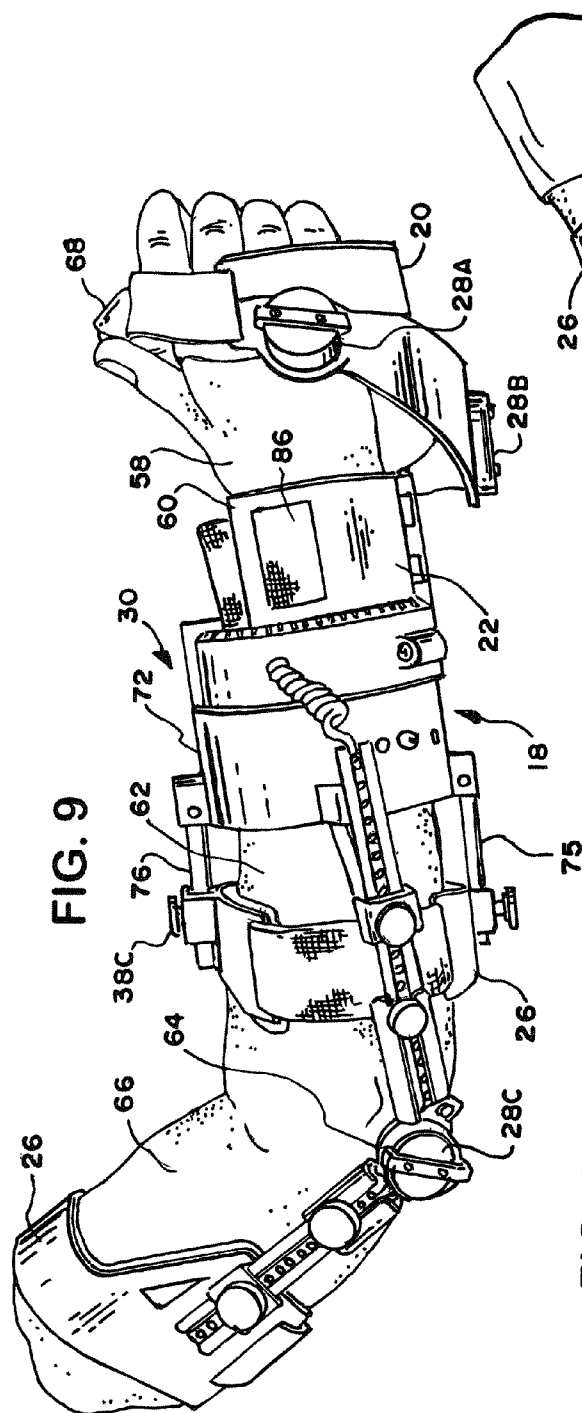
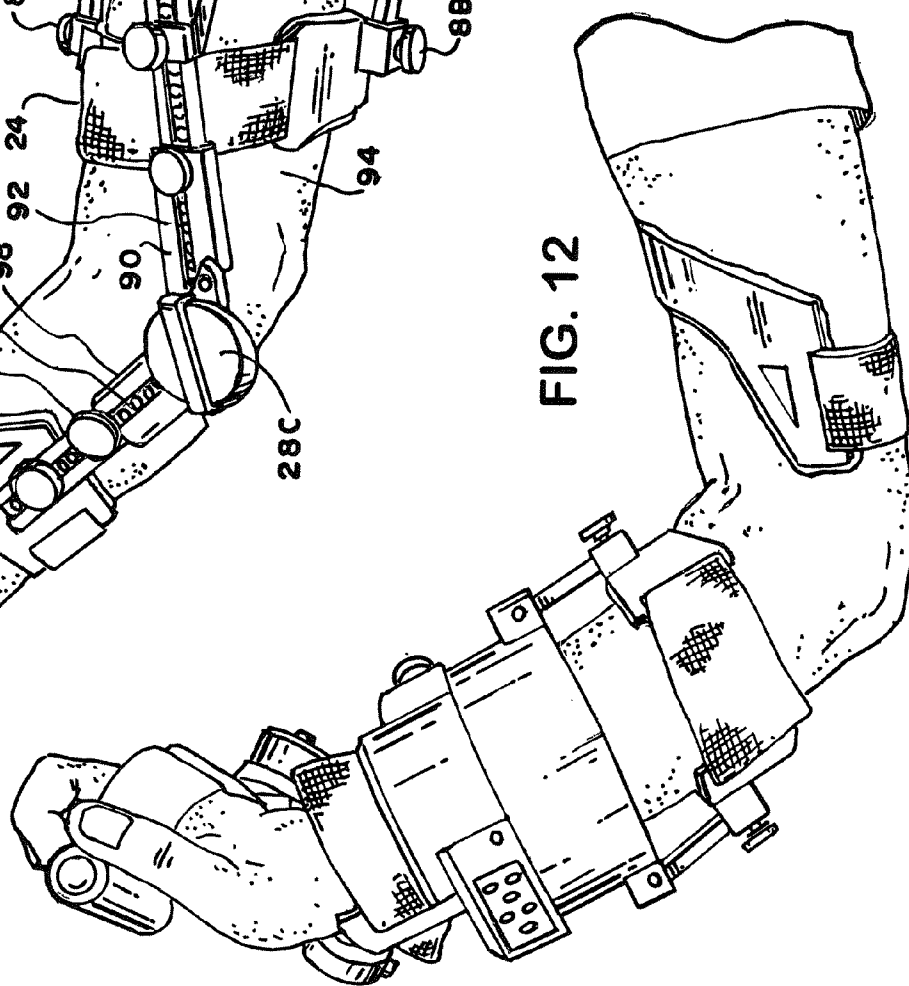
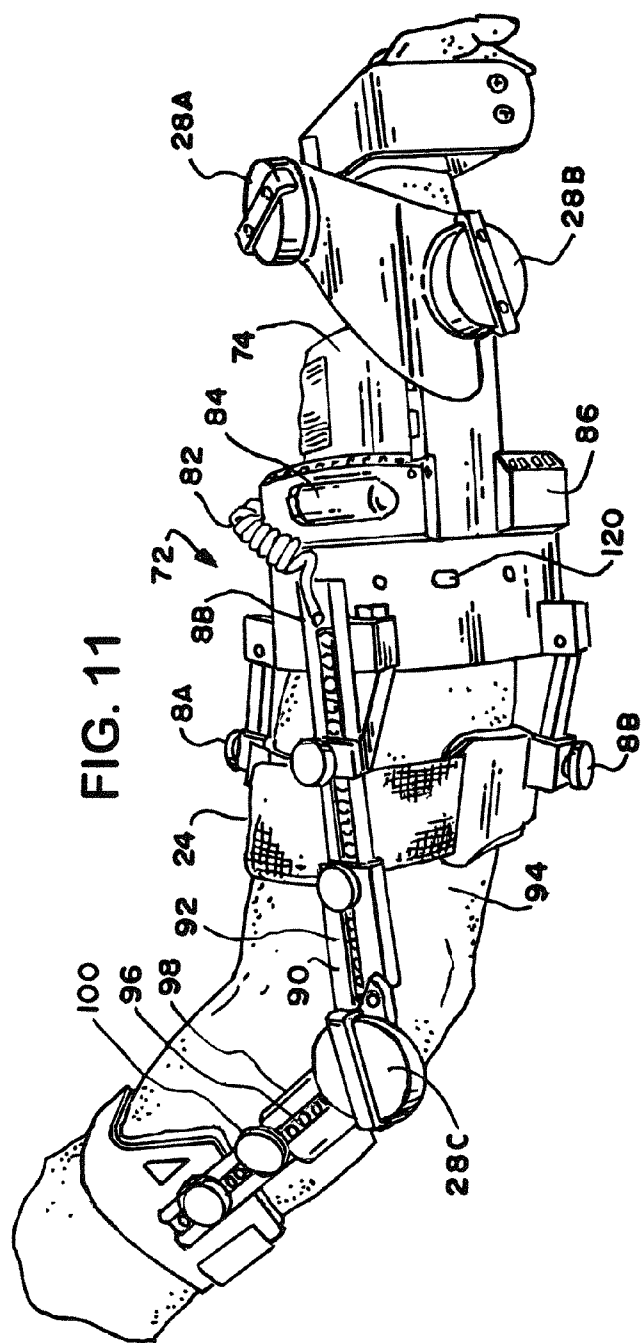


FIG. 8







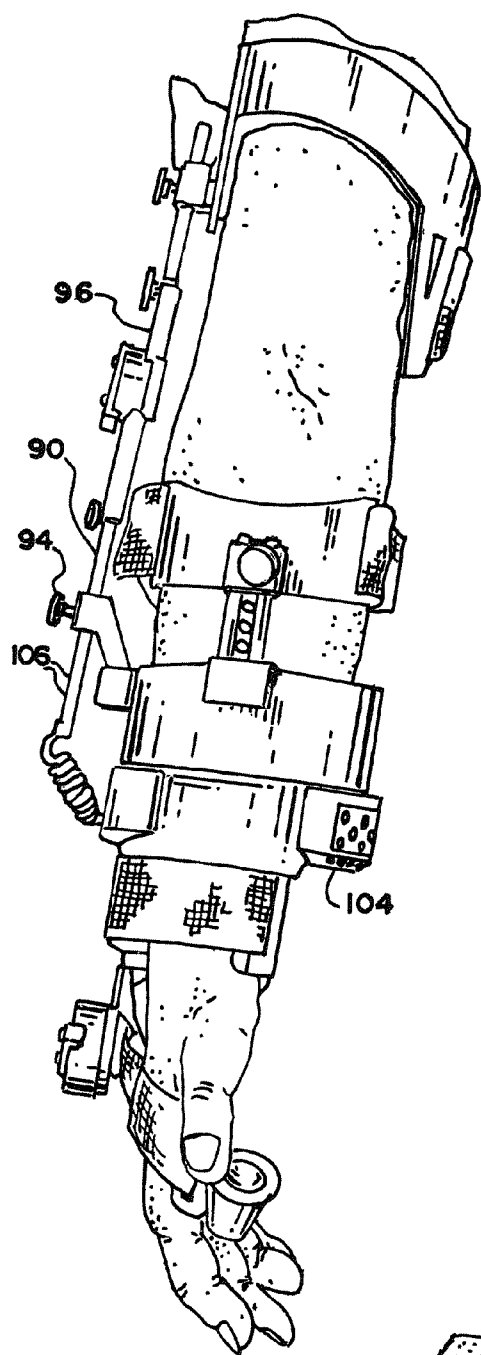


FIG. 14

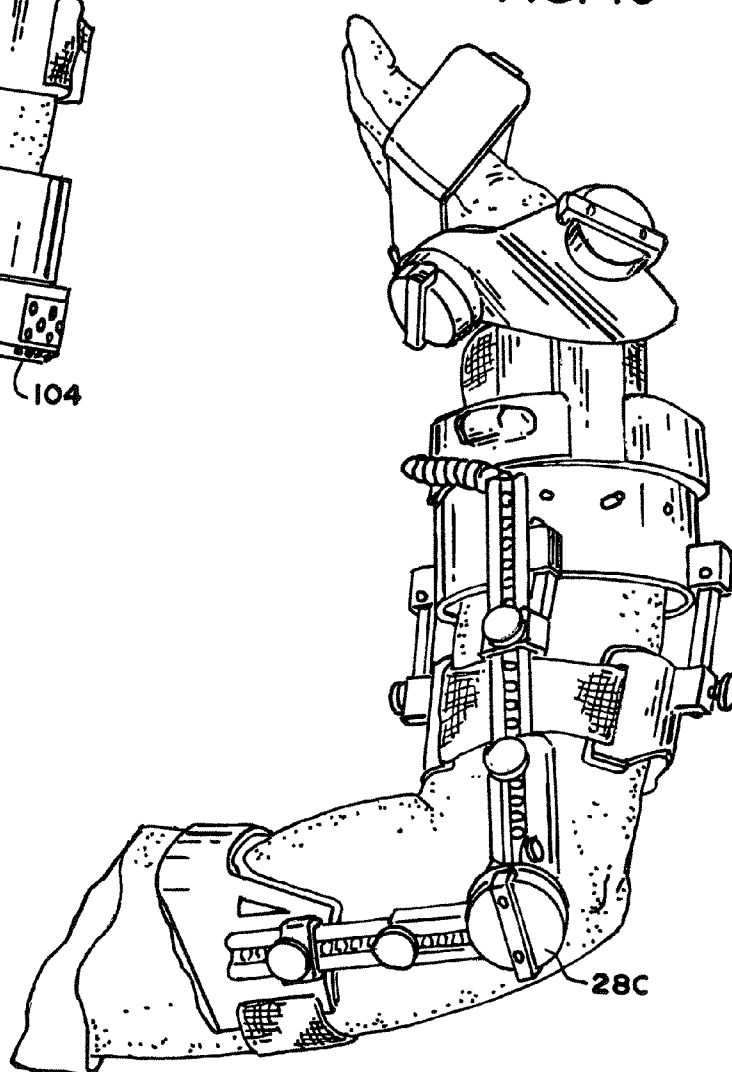


FIG. 13

FIG. 15

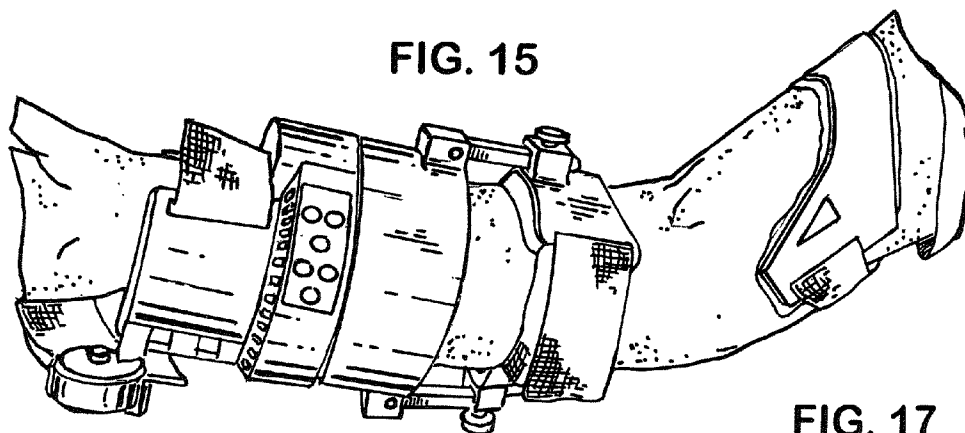
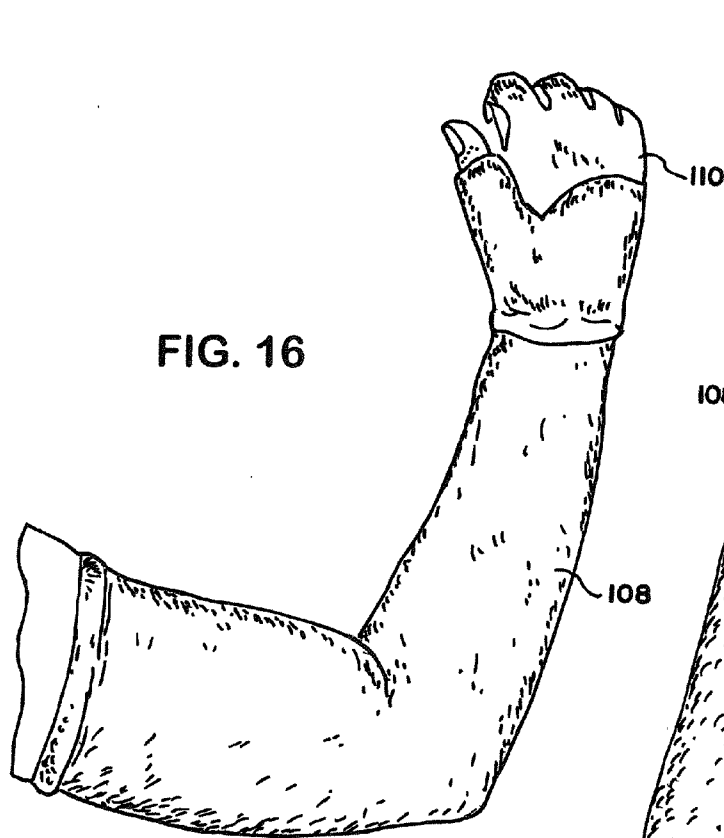


FIG. 17



FIG. 16



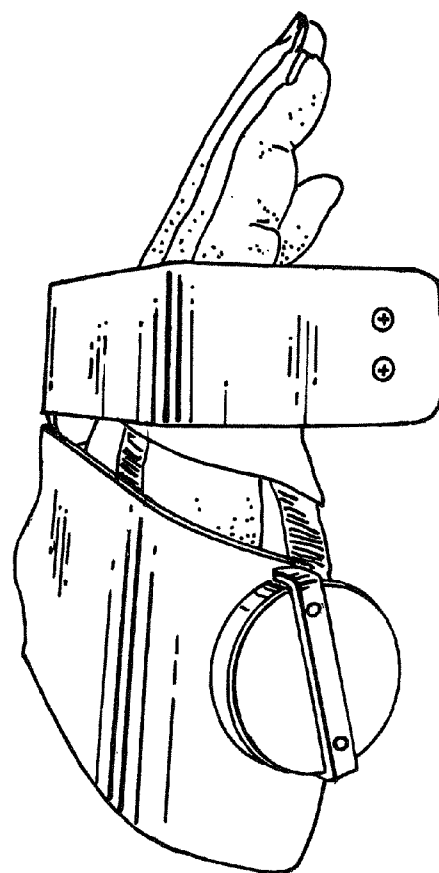
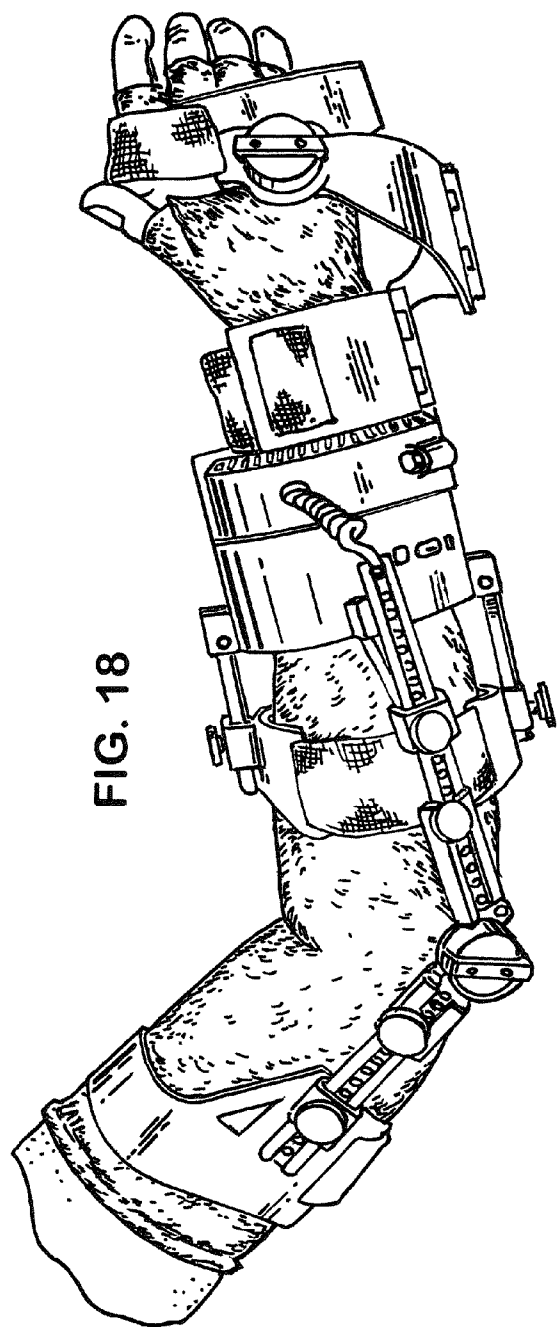


FIG. 20

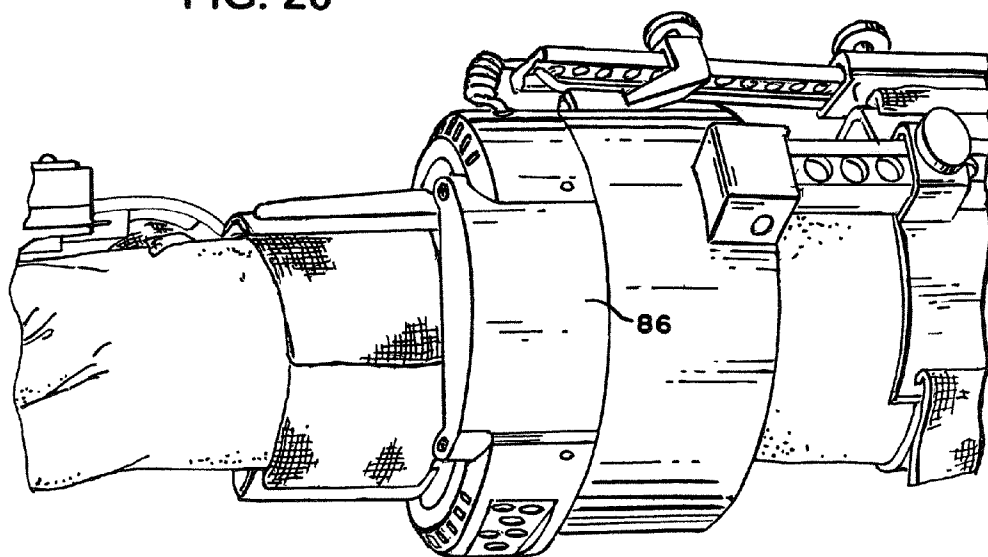


FIG. 21

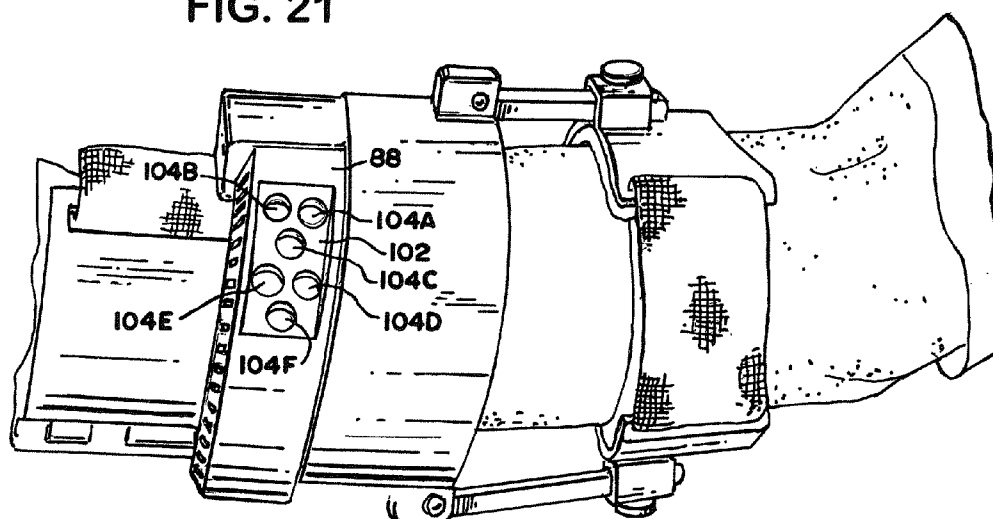


FIG. 22

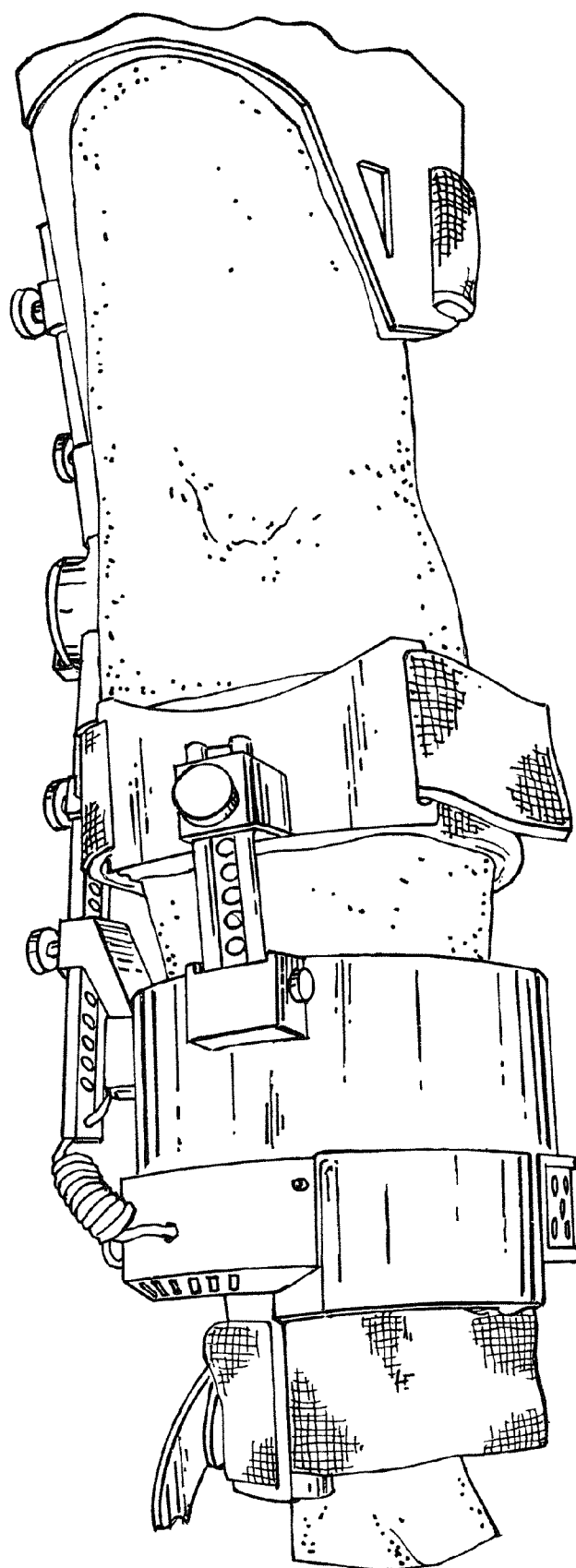


FIG. 23

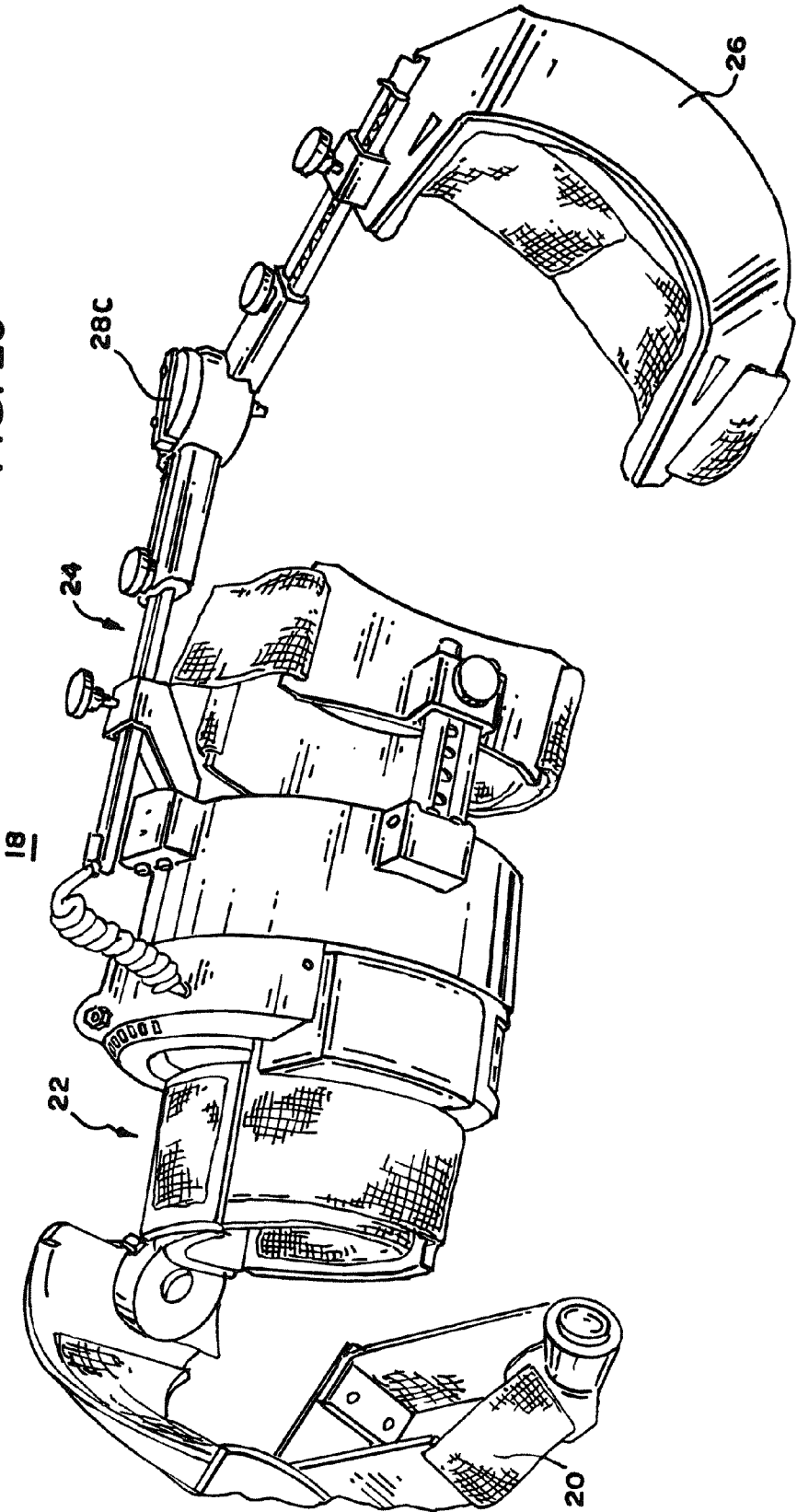


FIG. 24

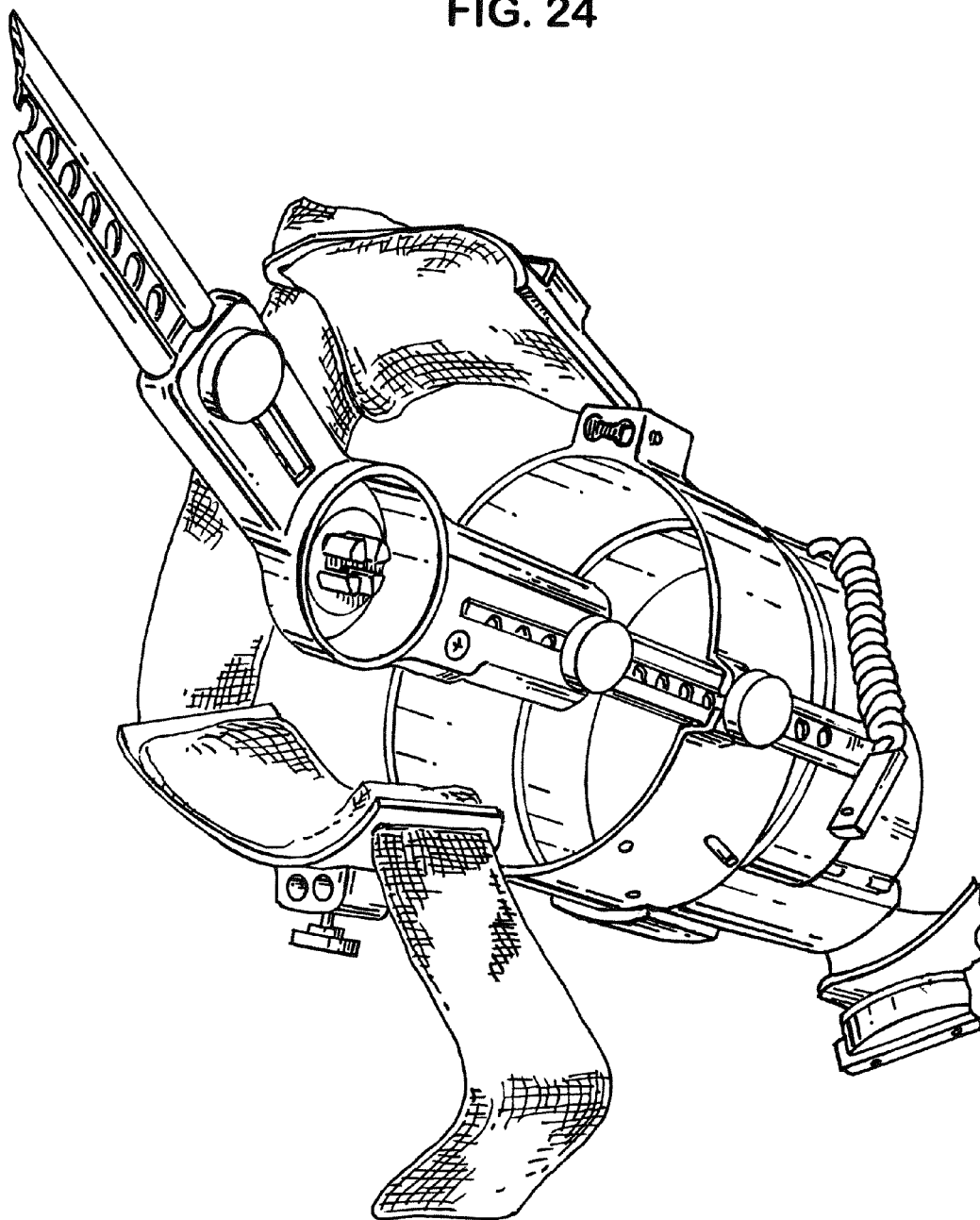


FIG. 25

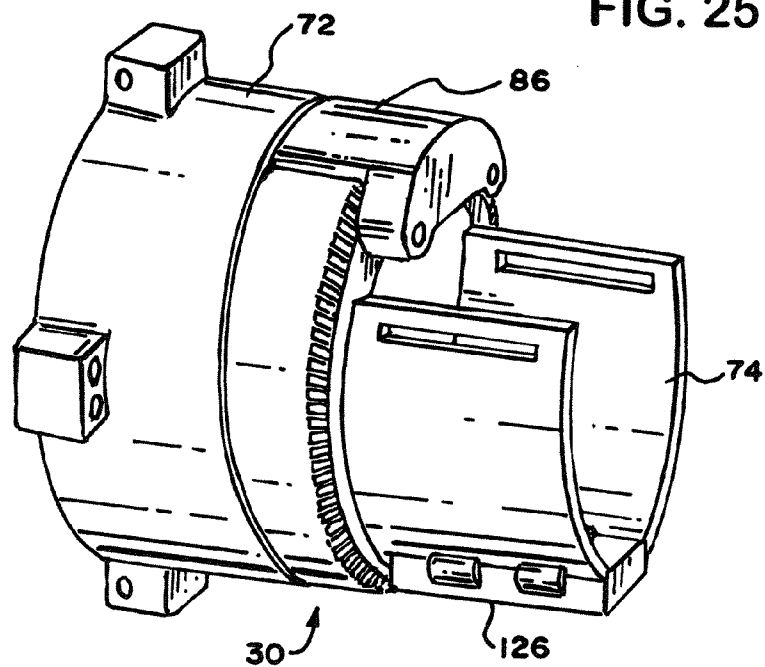


FIG. 26

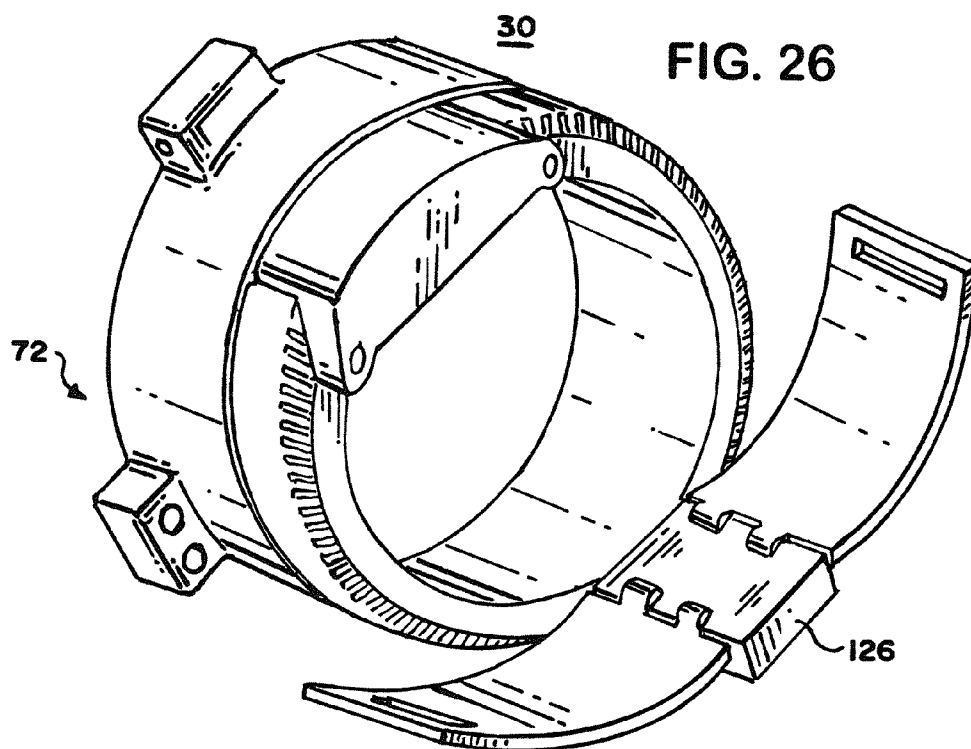


FIG. 27

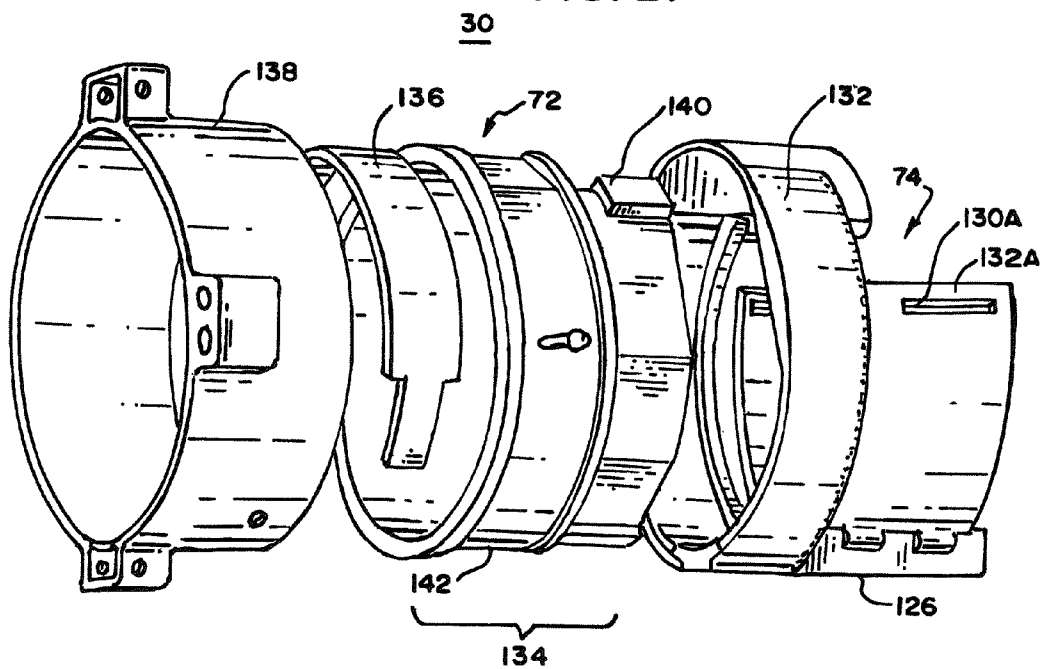


FIG. 28

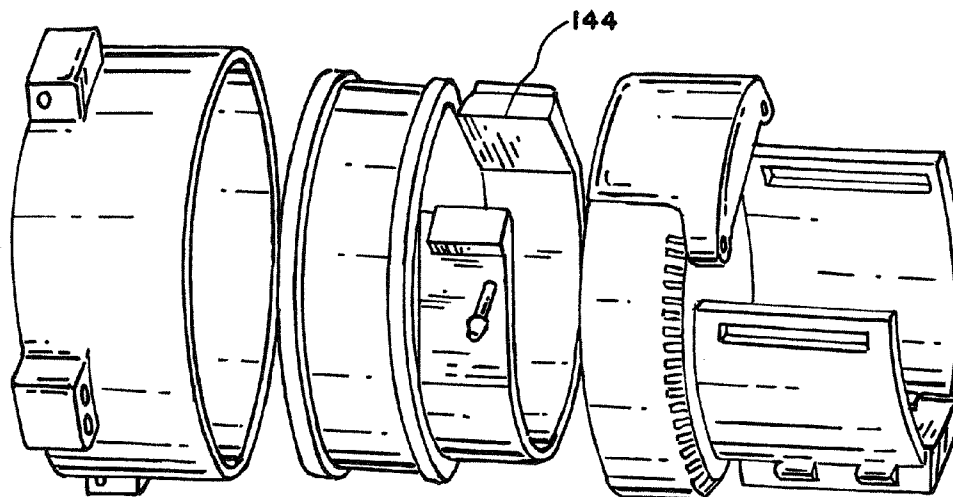


FIG. 29

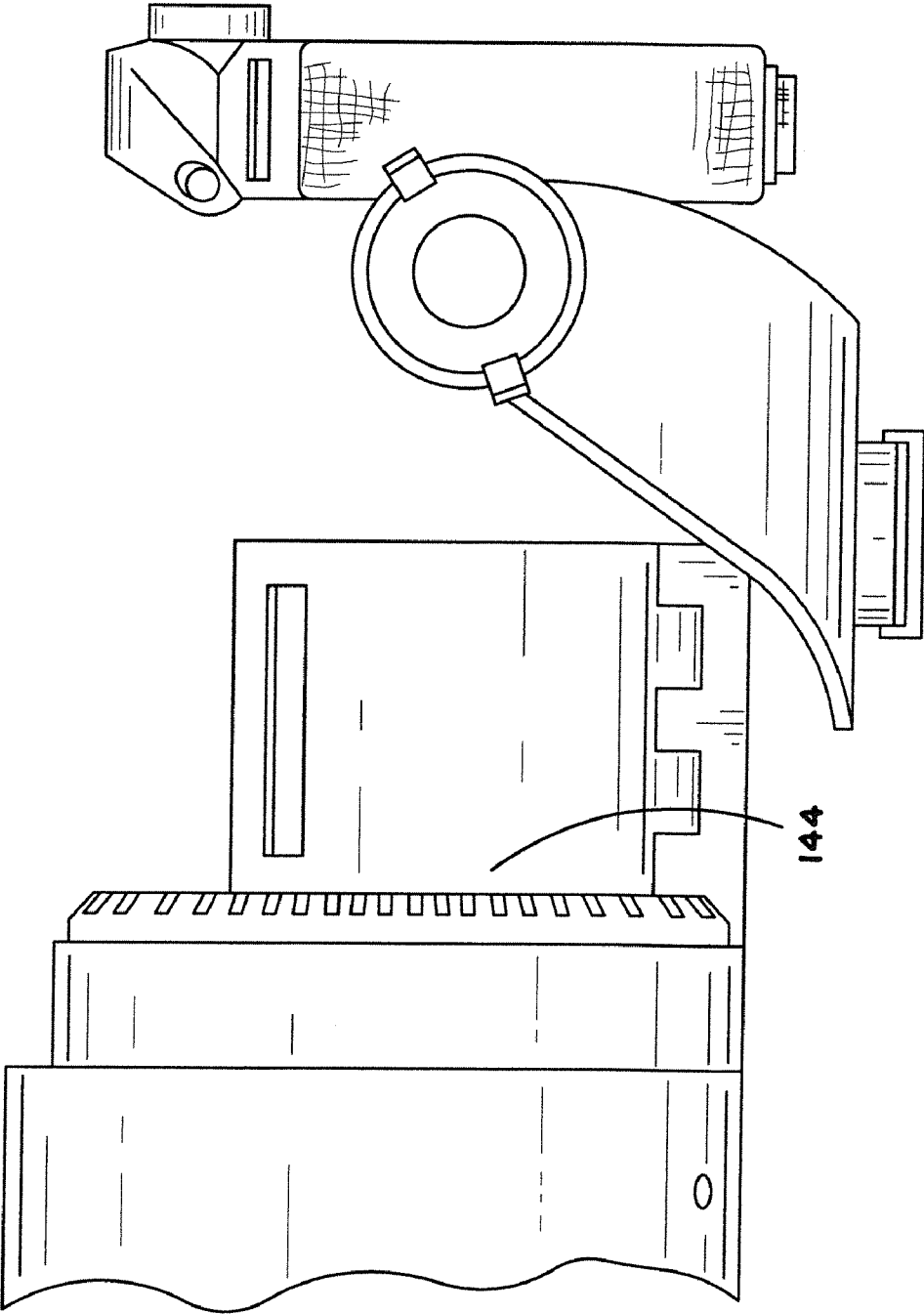
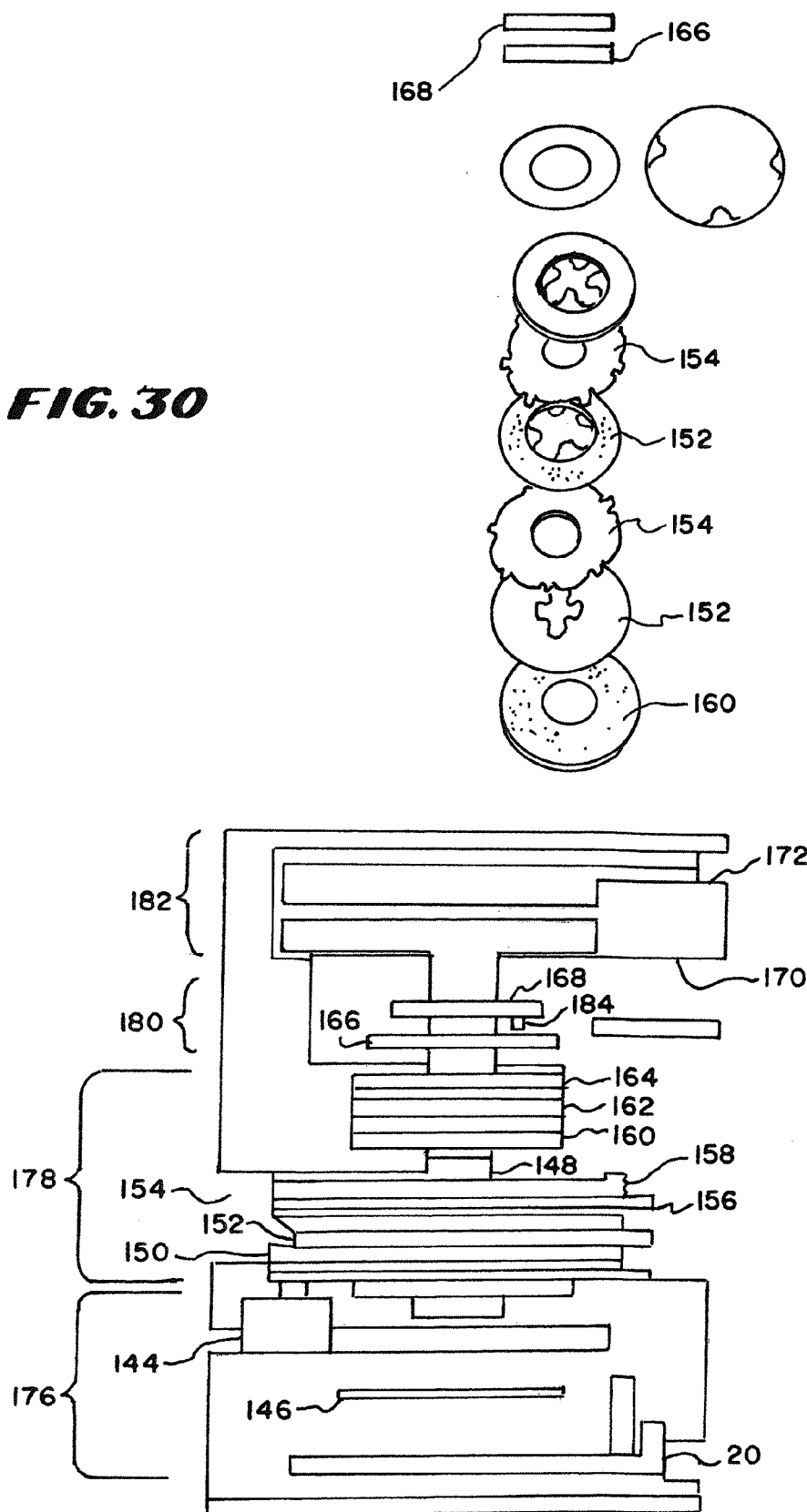


FIG. 30



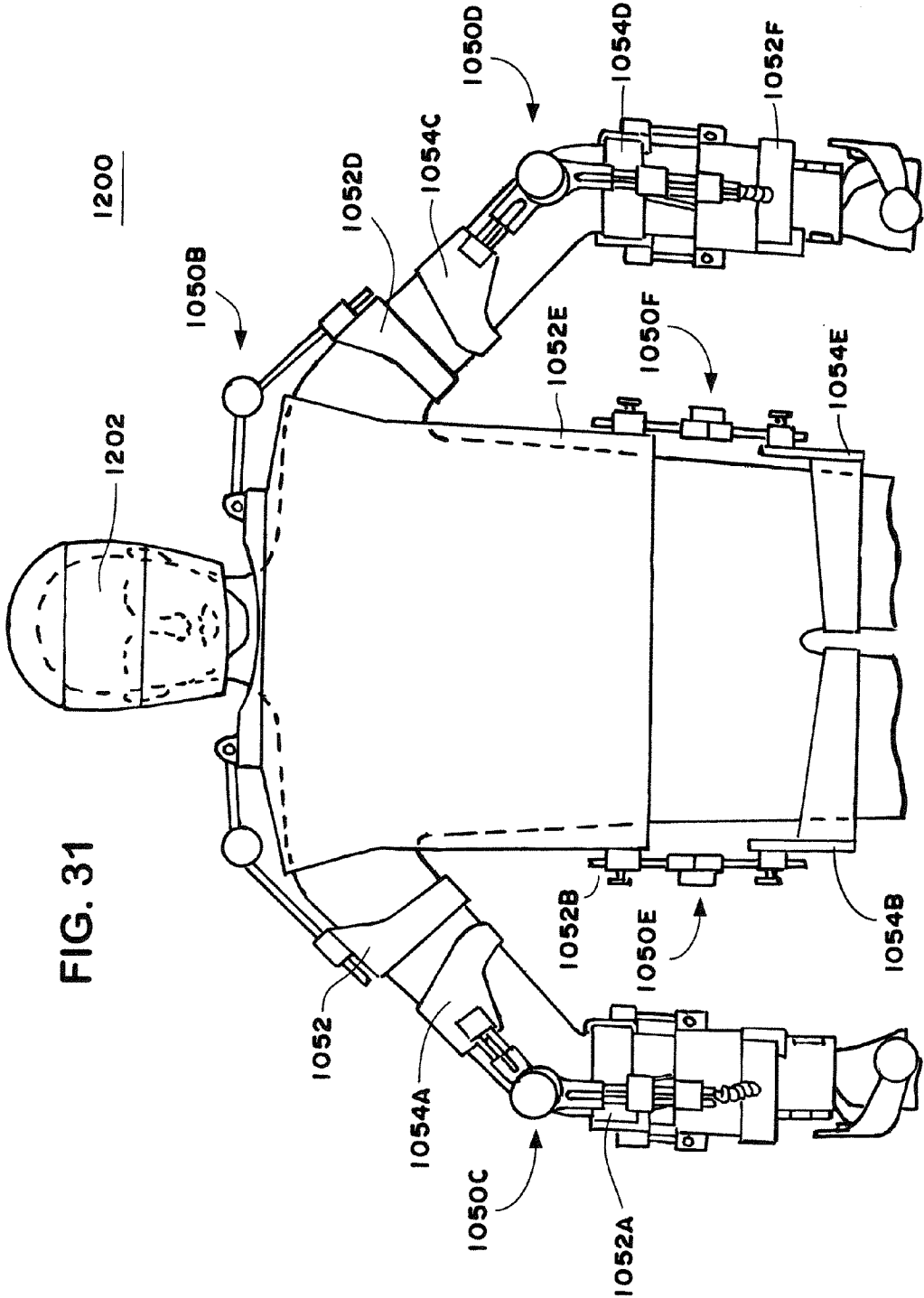


FIG. 32

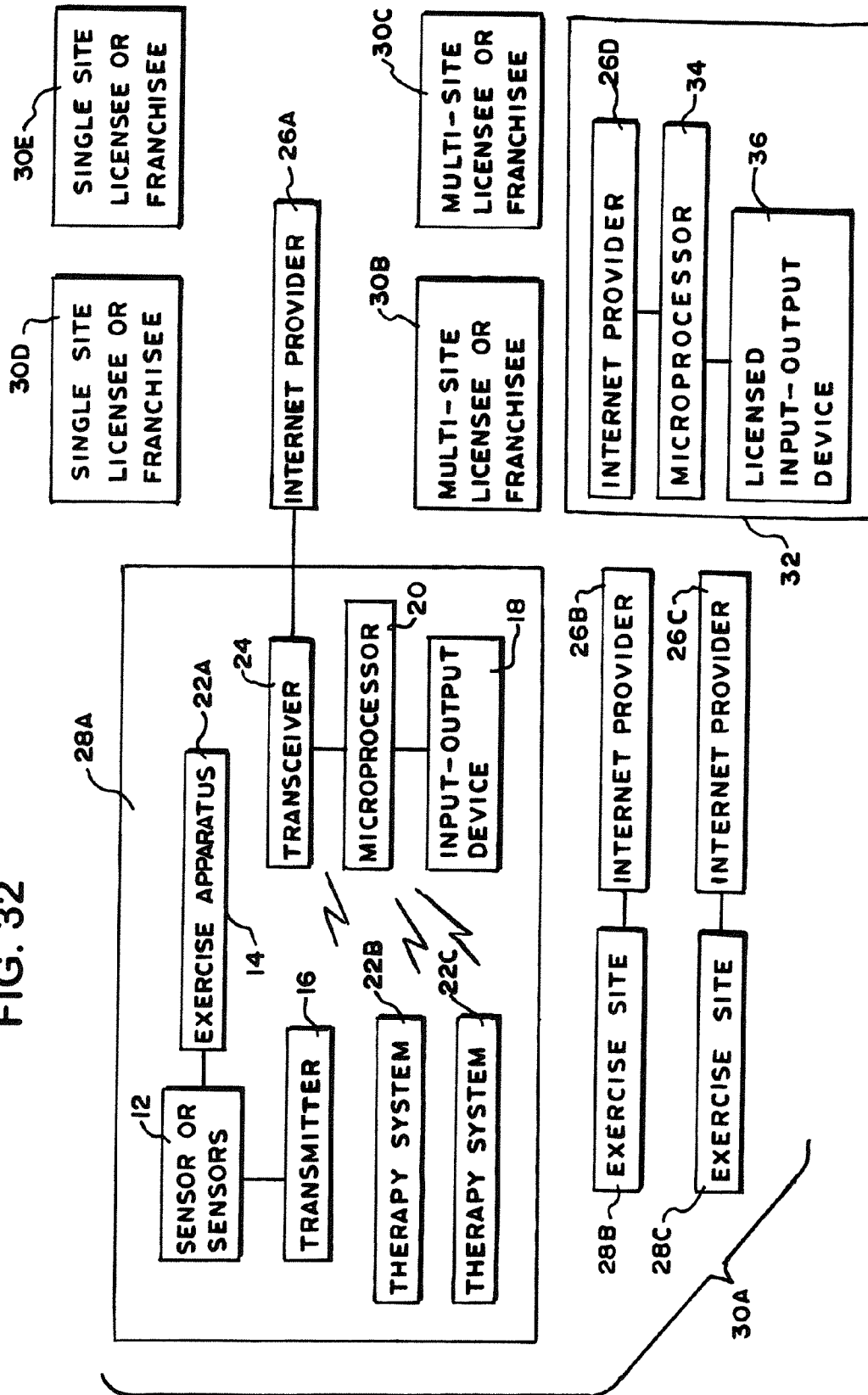


FIG. 33

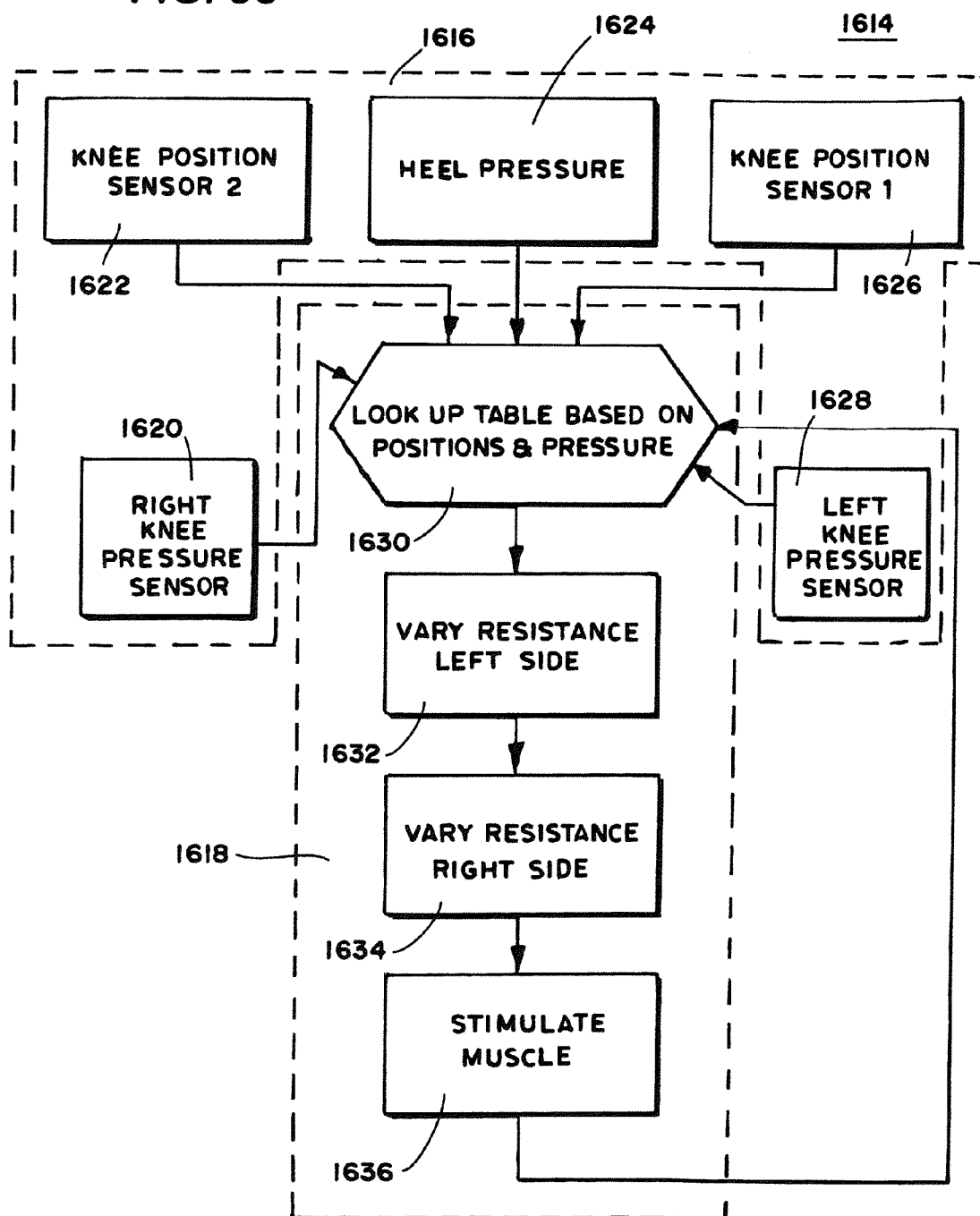


FIG. 34

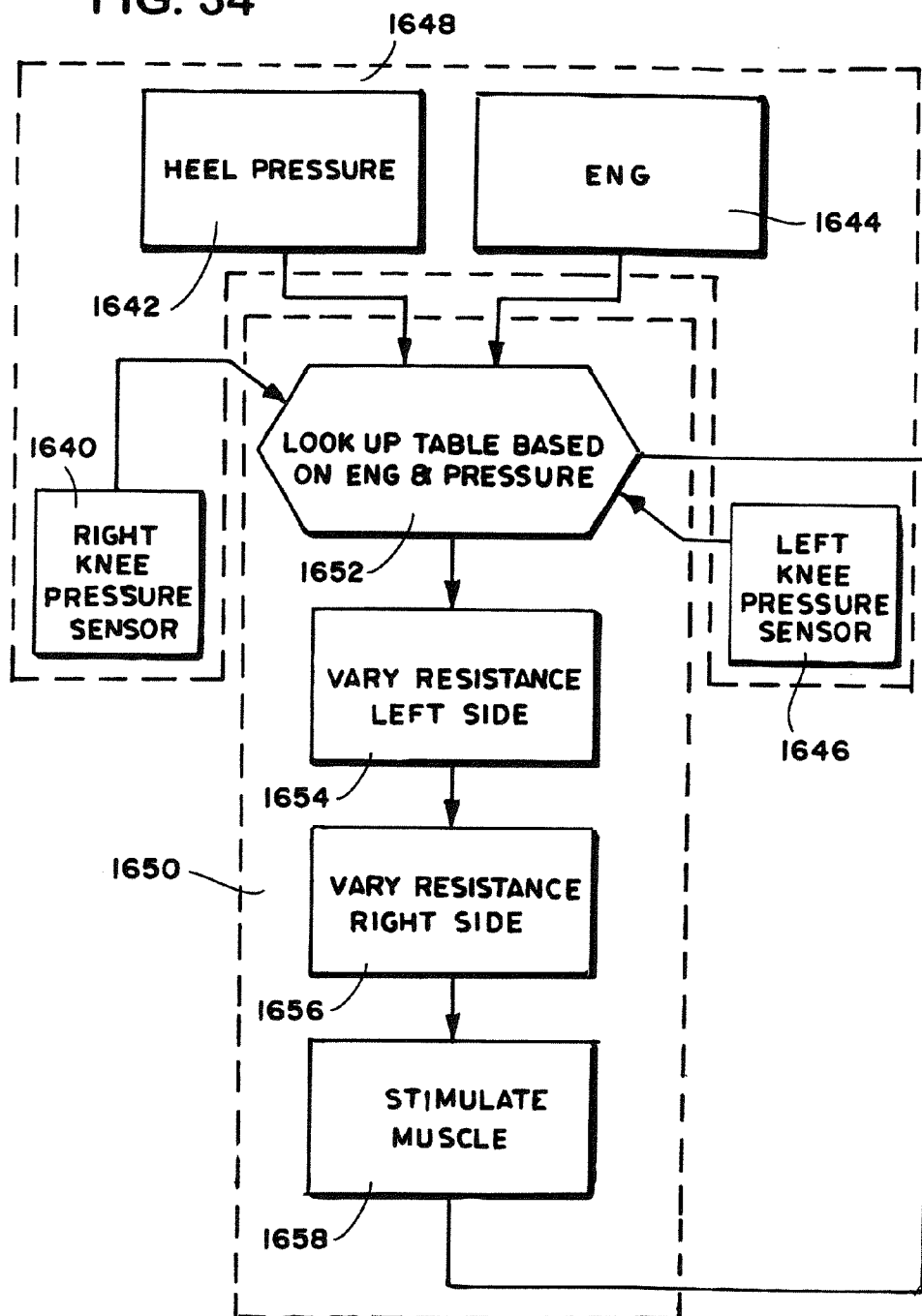
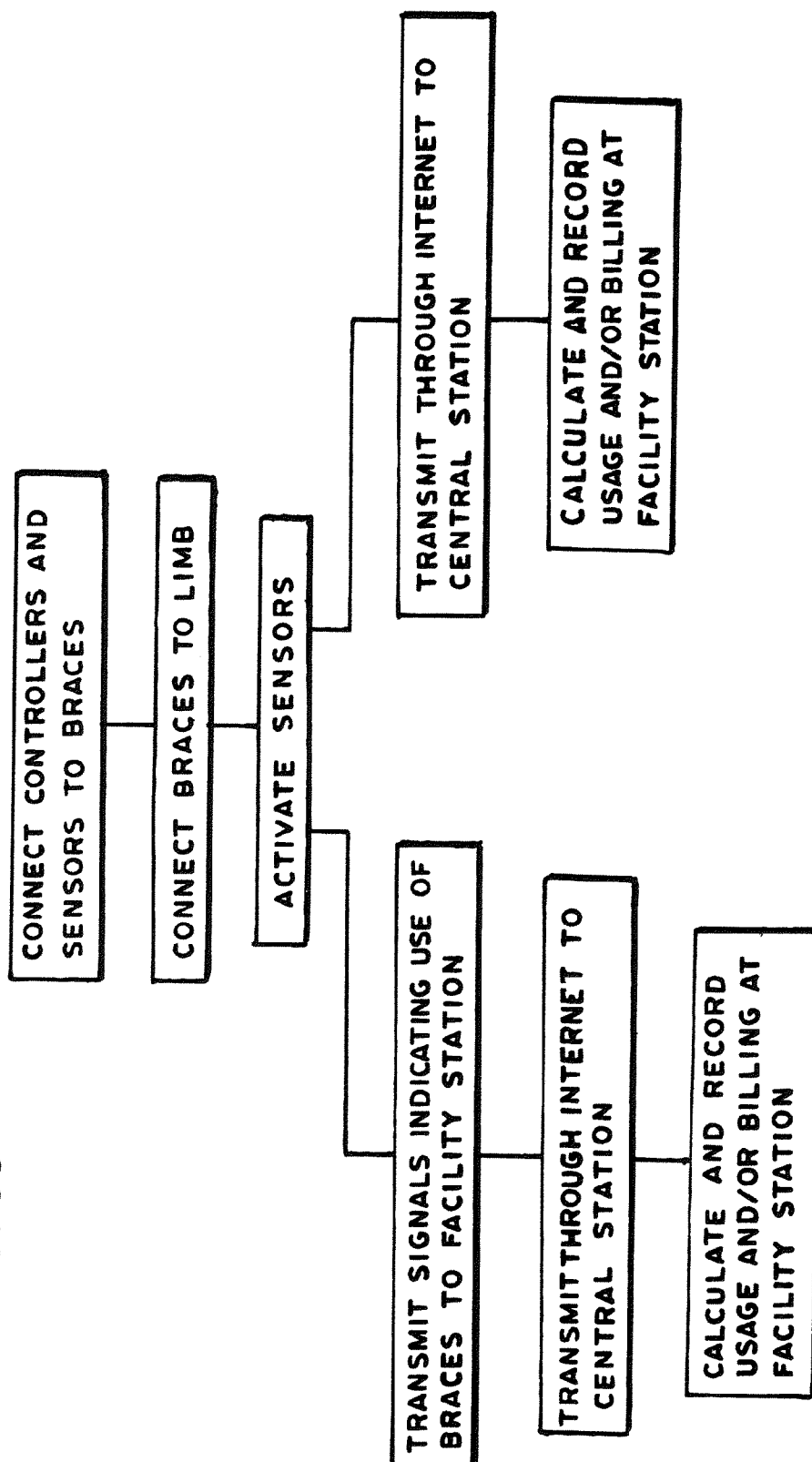
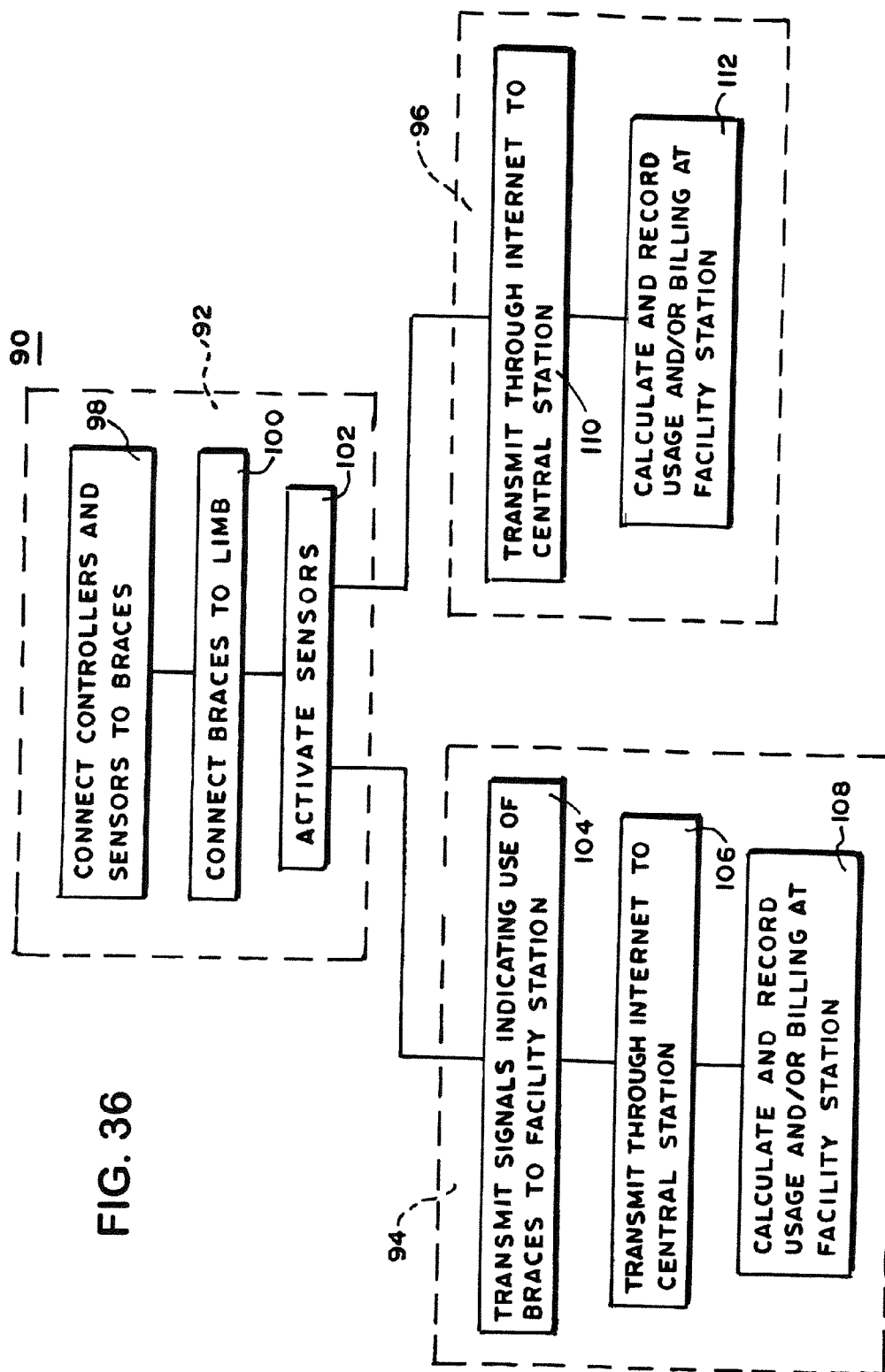


FIG. 35

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SIMULATED RECREATIONAL, TRAINING AND EXERCISE SYSTEM

RELATED CASES

[0001] This application is a continuation-in-part patent application of provisional patent application 61/350,347 filed Jun. 1, 2010. The benefit of the filing date of provisional patent application 61/350,347 is claimed.

BACKGROUND OF THE INVENTION

[0002] This invention relates to apparatuses and methods for providing simulated activities using visible images such as for conditioning exercises or recreational activities or body part repositioning exercises or training. The training may be for activities in unusual environmental conditions such as in space or under water. More particularly, the invention relates to the application of forces in simulated activities using visible images.

[0003] It is known from U.S. Pat. Nos. 5,954,621; 5,976,063 and 5,980,435 to Joutras et al to provide resistance to motion of body parts independent of the velocity of motion with a correlation to sensory stimulation such as visual and/or audio and/or temperature and/or pressure type sensations including ultrasonic vibrations. In this prior art a sensed event such as a visual display is presented to the user and the user may react such as by moving body parts. For example, the images on the visual may be correlated with skiing and the visual display may show a change in terrain. In this example, the user adjusts his or her position to the terrain in the manner of a skier and the resistance to the motion of the user in adjusting is determined by the position of the body parts of the user.

[0004] While this prior art apparatus and method works well, it is limited functionally in that the resistance to movement of the user is determined by the position of the body parts with respect to each other with no variation and cannot be changed by other forces such as programs related to stimuli such as visual/audio stimuli, or by another person such as an opponent in a game of tennis or by the user in response to changes in the stimuli.

[0005] Exercise apparatus are also known from the above patents that provide resistance to motion in multiple planes independent of velocity of the motion. The resistance to motion is provided by friction and response to pressure against surfaces that move with respect to each other as the body parts of the user move. However, the prior art mechanisms are not subject to external control nor is there a range of motion desired for some applications. Moreover, there is a lack of precision and easy feedback.

[0006] The prior art apparatuses and methods of this type lack adequate repeatable coordination between the user's actions and the images. Because of this lack of adequate repeatable coordination, they are not easily adapted for training. For example they cannot be adapted for different levels of skills.

[0007] It is also known to provide exercise and training for weightlessness such as occurs under water or in space but the methods and apparatuses for such exercises and training are on the one hand extremely expensive and complicated or not coordinated with visual images for effectiveness.

[0008] Games using audio/visual stimuli through consoles such as those sold under the trademarks PlayStation or Wii are

known. However, the games do not provide realistic responses to the uses movement such as resistance to movement or other stimuli.

SUMMARY OF THE INVENTION

[0009] Accordingly, it is an object of the invention to provide novel apparatuses and methods for simulating activities.

[0010] It is a further object of the invention to provide a novel exercise and training mechanism and technique.

[0011] It is a still further object of the invention to provide a novel exercise and training device that is coupled to images or other sensed programs so that the user can correlate muscle activity with sensed events.

[0012] It is a still further object of the invention to provide a novel apparatus and method for maintaining proper joint alignment during movement.

[0013] It is a still further object of the invention to provide a novel apparatus and method that is coordinated with images to provide training for maintaining proper joint alignment during activities.

[0014] It is a still further object of the invention to provide a novel apparatus and method for reducing arthrokinetic joint movement dysfunction during training using visual displays.

[0015] It is a still further object of the invention to provide a novel exercise device and technique that provides resistance to movement that is related in a pre-programmed manner to the position of the part being exercised but is applied independently of speed.

[0016] It is a still further object of the invention to provide a novel exercise device and technique that permits tailored exercise programs for a wide variety of purposes, such as to strengthen principally the fast twitch muscle or the slow twitch muscle or to strengthen only certain portions of an injured muscle.

[0017] It is a still further object of the invention to provide a novel exercise technique and apparatus which does not provide a force when the person doing the exercise stops attempting to move but which is nonetheless independent of speed of motion by the person doing the exercising.

[0018] It is a still further object of the invention to provide novel equipment and methods that use virtual reality techniques to provide recreational exercise and training.

[0019] It is a still further object of the invention to provide novel equipment and methods that use virtual reality techniques to develop physical skills

[0020] It is a still further object of the invention to provide novel equipment and methods that use virtual reality techniques to rehabilitate injured patients.

[0021] It is a still further object of the invention to provide novel equipment and methods that use virtual reality for occupational and physical therapy.

[0022] It is still further object of the invention to provide novel equipment and methods that use virtual reality techniques to rehabilitate patients from sports injuries.

[0023] It is a still further object of the invention to provide a device and method that enables equipment such as ski boots or the like to have useful amounts of motion with resistance to movement in controlled directions so as to be less likely to cause injury.

[0024] It is a still further object of the invention to provide a novel exercise device and technique in which the resistance to movement is related in a manner programmed by a therapist to correspond to the position of the part being exercised

but not necessarily proportional to an average motor performance curve throughout the range of motion but instead constructed for specific purposes.

[0025] It is a still further object of the invention to provide a versatile exercise device that can be conveniently applied to either open kinetic chain exercise or closed kinetic chain exercise.

[0026] It is a still further object of the invention to provide a technique and equipment for combining resistance to movement that is related in a precontrolled manner to the position of the part being moved with electrical muscle stimulation to aid movement or prevent undesired movement.

[0027] It is a still further object of the invention to provide an exercise device and technique that provides resistance to movement that is related in a pre-programmed manner to the position of the part being moved and/or provides electrical muscle stimulation at least partly controlled by electrical myography (EMG) and/or other biofeedback measurement (e.g. force plate).

[0028] In accordance with the above and further objects of the invention, one embodiment of exercise or training device simulates characteristics of a physical activity by making sensory stimuli available to at least one person. The sensory stimuli corresponds to the movement of the person in performing the physical activity. Thus, the person associates the physical activity with the stimuli. Both non-tactile stimuli available representing at least one aspect of the activity and tactile stimuli are made available. The position of at least one body part of the person is coordinating with the non-tactile stimuli to begin the activity. The most common non-tactile stimuli are visual or sound stimuli and the most common tactile stimuli is typically resistance to movement of the person or persons.

[0029] The resistance to movement and the non-tactile stimulation are synchronized under at least part control of a program recorded in a microprocessor representing the one aspect of the activity. The non-tactile stimuli is altered in response to the movement of a part of the body of the at least one person. The process includes the step of selecting a physical activity for at least one person to perform and a corresponding resistance program. A time delay is programmed to accommodate the depiction of an aspect of the visual image based on the activity and a velocity of action. A sensor provides signals to the microprocessor so that image depicts multiple actions caused by movement of limbs at multiple joints and sets individual friction control with respect to a direction of movement. The movement of parts of the exoskeleton with respect to each other are sensed and in the preferred embodiment represented by a code. The code or an EMG signal may change the frictional resistance between the parts or otherwise exert a force sensed by the user when moving the parts. A therapist may monitor the audio/visual devices while exercise is being performed and in one embodiment may change the program.

[0030] More specifically, at least a first exoskeleton member is attached to a first body part on a first side and a second exoskeleton member to a second body part on a second side of at least one body joint of the person. At least one adjustable resistance is attached to at least one of said first and second exoskeleton members. With this arrangement, the at least one of said first and second exoskeleton members provides a controlled resistance to movement of the first and second body parts of the person with respect to each other.

[0031] During performance of an activity, positions of at least the first body part with respect to at least the second body part are sensed and a first signal is provided in response thereto. A second signal is generated from a second signal source wherein the second signal source is one of a second person or a microprocessor programmed to generate signals. A video display, sound or touch sensation relating to a relationship between the first and second signals is provided, whereby an activity of the person interacting with an actual person or programmed person is simulated. The movement of the person is resisted with a resistance controlled by a sensor input and a visual input provided to a microprocessor and a software program based on the sensing of the position of at least one part of said person's body. In one embodiment the sensing a position of at least one part of said person's body is from a remote location and it is transmitted to the microprocessor.

[0032] In one embodiment, the joint is the joint between the hand and the forearm and the exoskeleton generates one code representing yaw of the hand with respect to the forearm and a signal representing pitch of the hand with respect to the forearm said yaw and pitch being about orthogonal axes. However, one of the joints may be the elbow and the exoskeleton generates a signal representing the rotation of the forearm with respect to the arm.

[0033] A person with weakened or damaged muscle may be aided in recovery by providing resistance to movement in a direction of natural forces, wherein the natural forces are offset using a value of resistance that varies in magnitude in accordance with a program in which said resistance is independent of velocity of movement. In this embodiment, images are provided depicting the physical activity to the person under the control of the program and coordinating one position of the body with a corresponding position in the image to synchronize the program. The program varies the images and the resistance to movement in accordance with the position of body parts of the person.

[0034] A person may be trained for and aided in adjusting to changes in gravity by simulating the characteristics of a physical activity in a gravity altered environment. This may be done by making sensory stimuli available to at least one person corresponding to the movement of the person in performing the physical activity in a gravity altered environment, whereby the at least one person associates the physical activity in the gravity altered environment with the stimuli. The sensory stimuli is made available by making non-tactile stimuli available representing at least one aspect of the activity in the gravity altered environment, making tactile stimuli available; and coordinating the position of at least one body part of the at least one person with the non-tactile stimuli to begin the activity. The exoskeleton joint may be a universal joint for multiple joint action simulation and may be used with accelerometers or other motion or location sensing apparatuses.

[0035] In one embodiment, the resistance to movement of the at least one person is coordinated to a pattern representing the motion against the result of the activity t in the actual activity. The pattern representing the movement as related to the result in the actual activity is determined by generating a code representing the motion of the body parts during the actual activity and recording the code and the result, wherein a data base is generated correlating the actual motion with the result is obtained. From a number of such data bases taken with a number of different user, a data base is compiled

representing the average motion of multiple users and is provided as a default program. A first data program is prepared in which the coordination between the users motion and the result of the activity provides a first large margin of error and a second program is prepared in which the coordination between the users motion and the result of the activity provides a second margin of error, said second margin of error being smaller than the first margin of error.

[0036] From the above summary of the invention, it can be understood that the simulated recreational, training and exercise method and apparatus of this invention has several advantages, such as: (1) it enables recreational, exercise and training programs to be coupled to images or other sensed events so that the user can correlate muscle activity with sensed events; (2) it provides a program coordinated with images to for maintaining proper joint alignment during activities. (3) it provides recreational, training and exercise devices and techniques that permit tailored programs for a wide variety of purposes, such as to strengthen principally the fast twitch muscle or the slow twitch muscle or to strengthen only certain portions of an injured muscle; (4) it provides equipment and methods that use virtual reality techniques to provide recreation, exercise and training using coordinated images and resistance to movement; (5) it provides a technique and equipment for combining resistance to movement that is related in a precontrolled manner to the position of the part being moved with electrical muscle stimulation to aid movement or prevent undesired movement coordinated with images and sounds; (6) it provides an apparatus and method for reducing arthrokinetic joint movement dysfunction during training using visual displays; and (7) it provides an exercise, training and recreational device and technique that provides resistance to movement related in a pre-programmed manner to the position of the part of the users body performing the activity.

SUMMARY OF THE DRAWINGS

[0037] The above noted and other features of the invention will be better understood from the following detailed description when considered with reference to the accompanying drawings, in which:

[0038] FIG. 1 is a perspective view of a single person using the simulated recreational, training and exercise system in accordance with an embodiment of the invention;

[0039] FIG. 2 is a fragmentary perspective view of a person wearing a body part sensing and tactile stimulation apparatus in accordance with an embodiment of the invention;

[0040] FIG. 3 is another perspective view of a person using another embodiment of simulated recreational, training and exercise system;

[0041] FIG. 4 is a flow diagram of the general operation of the simulated recreational training and exercise system;

[0042] FIG. 5 is a fragmentary perspective view of a person using another embodiment of simulated recreational, training and exercise system;

[0043] FIG. 6 is another embodiment of a person using another embodiment of simulated recreational, training and exercise system in accordance with another embodiment of the invention;

[0044] FIG. 7 is a simplified perspective view of two persons interacting with the same simulated recreational, training and exercise system;

[0045] FIG. 8 is a block diagram illustrating a manner in which different persons or groups of persons may use a simulated recreational, training and exercise system while located remotely from each other;

[0046] FIG. 9 is a perspective posterior view of a hand, forearm, elbow and arm wearing a sensing and tactile stimulation apparatus in accordance with an embodiment of the invention;

[0047] FIG. 10 is a perspective anterior view of a hand, forearm, elbow and arm wearing the sensing and tactile stimulation apparatus in accordance with an embodiment of the invention;

[0048] FIG. 11 is a perspective side view of a hand, forearm, elbow and arm wearing from the right side wearing the sensing and tactile stimulation apparatus in accordance with an embodiment of the invention;

[0049] FIG. 12 is another perspective, anterior view of a hand, forearm, elbow and arm wearing the sensing and tactile stimulation apparatus with the forearm and hand raised;

[0050] FIG. 13 is a perspective side view of a hand and a posterior view of a forearm, elbow and arm wearing the sensing and tactile stimulation apparatus with the forearm raised;

[0051] FIG. 14 is a side view of a hand and an anterior view of a forearm, elbow and arm wearing the sensing and tactile stimulation apparatus;

[0052] FIG. 15 is an anterior view of a hand, forearm, elbow and arm wearing the sensing and tactile stimulation apparatus;

[0053] FIG. 16 is a posterior perspective view of a hand and arm wearing a decorative and protective glove and sleeve used with an embodiment of the invention;

[0054] FIG. 17 is a perspective view of the sleeve and glove of FIG. 16 shown separately;

[0055] FIG. 18 is a posterior perspective view of a hand, forearm, elbow and arm wearing the glove and sleeve of FIG. 17 and the sensing and tactile stimulation apparatus;

[0056] FIG. 19 is a perspective view of a hand and wrist wearing the sensing and tactile stimulation apparatus in accordance with an embodiment of the invention;

[0057] FIG. 20 is a perspective side view of a hand, forearm and elbow wearing the sensing and tactile stimulation apparatus in accordance with an embodiment of the invention;

[0058] FIG. 21 is a fragmentary enlarged side view of a hand and anterior view of a wrist and forearm wearing the sensing and tactile stimulation apparatus;

[0059] FIG. 22 is a perspective side view of a hand and anterior view of a forearm wearing the sensing and tactile stimulation apparatus;

[0060] FIG. 23 is a perspective view of the sensing and tactile stimulation apparatus without a person wearing it;

[0061] FIG. 24 is another perspective view of the sensing and tactile stimulation apparatus without the arm;

[0062] FIG. 25 is a simplified perspective view of the twist sensing and resistance module;

[0063] FIG. 26 is a simplified perspective view of the twist sensing and resistance module;

[0064] FIG. 27 is an exploded view of the twist sensing and resistance module;

[0065] FIG. 28 is another perspective view of the twist sensing and resistance module;

[0066] FIG. 29 is a fragmentary perspective view of the wrist band and a portion of the forearm band.

[0067] FIG. 30 is a perspective exploded view of a body part tactile stimulation apparatus with a yaw or pitch sensing and resistance module;

[0068] FIG. 31 is a simplified fragmentary elevational view of two body part tactile stimulation apparatuses.

[0069] FIG. 32 is a block diagram of a simulated recreational training and exercise system providing for central billing and control.

[0070] FIG. 33 is a block diagram of a position sensing apparatus.

[0071] FIG. 34 is a block diagram of another embodiment of a position sensing apparatus.

[0072] FIG. 35 is a flow diagram a subprocess of setting up the body part sensing and tactile stimulation apparatus.

[0073] FIG. 36 is a flow diagram of a system for coordinating the body part sensing and tactile stimulation apparatus with the simulated recreational, training and exercise system software.

DETAILED DESCRIPTION

[0074] In FIG. 1, there is shown a perspective view of a person 12 using a simulated recreational training and exercise system comprising a viewing screen 14 and a body part sensing and tactile stimulation apparatus 18. Images on the viewing screen 14 are considered non-tactile stimulation in this specification and claims, the words “tactile stimulation” or “tactile sensing” or equivalent words means stimulation or sensing when there is physical contact such as resistance to force applied by the user or electrical shock or vibrations applied to the person. The words “non-tactile stimulation” or “non-tactile sensing” or the like means stimulation or sensing without physical contact such as be a visible display or by a sound.

[0075] The viewing screen 14 may be mounted a separate console or may be a virtual reality mask or be the viewing screen of a personal computer or a game console such as Play Station. Similarly, sounds may be transmitted by ear phones in contact with the ear or through a speaker but in both cases the stimulation or sensing is considered non-tactile stimulation because the stimulation may be transmitted through a virtual reality mask in contact with the user or from a remote viewing screen and the sound may be transmitted through remote speakers or earphones. Tactile stimulation, in contrast, cannot be imparted to the user except through intimate positioning such as directly against the skin or more probably through an exoskeleton. In such cases the In the preferred embodiment it is the viewing screen of a personal computer. In this specification and claims, the work “exoskeleton” means a hard external supporting structure such as the members of a leg brace.

[0076] In the embodiment of FIG. 1, the body part sensing and tactile stimulation apparatus 18 is connected wirelessly to the console containing the viewing screen 14. Other control apparatus may be connected to a belt holder 16 which may also contain the battery for powering the apparatus. In the alternative, these circuits and power sources may be composed within the body part sensing and tactile stimulation apparatus 18.

[0077] The person 12 may select any of several activities. In FIG. 1, the operator 12 has selected a basketball game simulation. When this program has been selected, the person 12 will view a screen showing the position of a player, on the screen. The person 12 will position his hands in his same manner and push a button on the hand document which will

synchronize the program with the operator. The program then proceeds with a basketball game with the person 12 as a player. Thus the person 12 viewing the screen may perform operations shown by his figure on the screen such as blocking passes or shooting passes or the like and the software program within the personal computer or elsewhere with different apparatuses will show his operation and the progress of the game with him as a player.

[0078] The person 12 may also set an amount of resistance at each of the joints controlled by the body part sensing and tactile stimulation apparatus. Modules control the resistance to motion in accordance with a program so as to simulate not only visually but with a tactile sensation the playing of the game. Thus the person 12 in throwing a basket feels resistance in his joints similar to that that the weight of the basketball would provide. Laboratory provision may be provided to impact the hand when the person 12 receives a pass so as to simulate the catching of the basketball.

[0079] While a basketball game is the program illustrated in FIG. 1, any other sport or activity including exercise routines and training exercises such as might be used to train a person to compensate for weightlessness in water or in space and still perform certain activities. The person 12 may also utilize an accelerometer as will be described later for other functions and may be connected by a wire instead of wirelessly to the personal computer 14 and to the program circuits and power circuits 16 if they are mounted on the belt of the person 12.

[0080] FIG. 2, there is shown a fragmentary perspective view of a person 12 with the body part sensing and tactile stimulation apparatus 18 mounted to the arm of the person. In this view, the anterior and right side portion of the arm, forearm and hand are shown illustrating the positioning of a hand band 20, a wrist band 22, a forearm band 24 and an arm band 26 of the body part sensing and tactile stimulation apparatus. These bands mount the body part sensing and tactile stimulation apparatus 18 to the person 12 in a functional position. Three yaw or pitch sensing and resistant modules 28A, 28B and 28C are respectively positioned to sense rotation and supply resistance to rotation about a pitch axis and a yaw axis of the wrist so as to sense and control resistance to movement of the hand and to sense and apply resistance to bending of the arm at the elbow. A twist sensing and resistance module 30 is mounted to sense twisting of the forearm with respect to the elbow and arm. While four sensing and resisting devices are shown in FIG. 2, other such devices may be used such as for example on the other arm and between the shoulder and the arm or at the waist or knee or any other place where motion occurs. An actuator is also located at the hand of the person 12 so as to trigger action manually when desired.

[0081] In FIG. 3, there is shown a person 12 using another embodiment of simulated recreational training and exercise system 10A which has in a manner similar to the embodiment of FIG. 10 a personal computer 14 with programming and viewing screen to cooperate with a body part sensing and tactile stimulation apparatus 18A differing in only minor respects with the embodiment of FIG. 10. In this embodiment an accelerometer 32 is held by the person 12 so that acceleration may be utilized as well as changes in positions of the limbs about the joints. In the embodiment of FIG. 3, the body part sensing and tactile stimulation apparatus is shown on only one arm, which is suitable for some games, but for basketball as shown in FIGS. 1 and 3, both arms would contain the apparatus. In the embodiment of FIG. 3, the

battery and programming is within the body part sensing and tactile stimulation apparatus **18** and is electrically connected by a cord **34** to the personal computer **14**.

[0082] In FIG. **4**, there is shown a flow diagram **36** of the general operation of the simulated recreational training and exercise system **10** having the step **38** of selecting a program, the step **40** of synchronizing image body parts with person body parts, the step **42** of selecting tactile stimulation program, the step **44** of initiating the program for the activity, the step **46** of generating signals indicative of the angle of the body parts with respect to each other at the joints and the step **48** of using the generated code to select routines in the activity program and in the program to set resistance to movement. In the step **38**, there are a variety of programs that may be selected. The programs can be of any type including recreational program, training program and exercise programs. The step **40** of synchronizing image body parts with person body parts includes the movement to a navigation program or routine for the particular selected program. In the navigation mode, an image on the screen is used to synchronize the body parts of a player. The player assumes the position of the image on the screen and upon initiating a trigger, the program is synchronize so that movements of the person playing the game will result in movements of the image on the screen. The step of selecting the tactile stimulation program sets the resistance to movement so as to be suitable to the person for the purpose intended. For example, in the case of therapy, it may compensate for gravity and enable repositioning of a body part. In a basketball game it may simulate the weight of the basketball and, with vibrations, simulate the basketball being caught.

[0083] When the synchronization is complete the step **44** of initiating the program for the activity starts. As the activity progresses, signals are generated that are indicative of the angle between body parts with respect to each other at the joints as shown in the step **46**. As indicated in the step **48**, this code may select routines that would guide the weight of the basketball in accordance in the manner of which it is thrown by the person playing the game in a game of basketball or set the resistance so as to properly reflect the inertia of the basketball as it is being thrown.

[0084] In FIG. **5**, there is shown another embodiment **10C** of a simulated recreational training and exercise system having a person **12** running on a treadmill **50** while the body part sensing and tactile stimulation apparatus **18** is mounted to one or both legs. The program controls the resistance so as to compensate for gravity on an injured leg and enable the person **12** to run normally. The image on the personal computer or other viewing device **14** may be of a race between a programmed person and the person **12** or may merely show a race track or some other terrain as selected. In the embodiment **10E** of this invention the code generated by the body part sensing and tactile simulation apparatuses also energizes resistance programs described in greater detail hereinafter so as to provide the correct resistance for the arms. Apparatuses for generating resistance in response to a code are disclosed in U.S. Pat. No. 5,980,435, the disclosure of which are incorporated by reference.

[0085] In FIG. **6**, there is shown still another embodiment **10D** of simulated recreational training and exercise system in which the person **12** is practicing bowling. The PC or other viewing device **14** will show the ball and its action with the pins. The body part sensing and tactile sensing apparatus **18** on the right arm of the person **12** provides resistance to

simulate the weight of the bowling ball and the inertia to move it. These are synchronized in accordance with a code generated by the body part sensing and tactile stimulation apparatus in response to the movement of the joints of the arm. Similarly, the foot action is simulated by the apparatus **18A** which also bears the load of the bowling ball and the changed resistance simulates it by providing resistance to straightening the knee while the ball is being carried, changing the resistance in accordance the movement of the center of gravity of the person and ball and releasing it when the ball is released.

[0086] In FIG. **7**, there is shown still another embodiment **10E** of simulated recreational training and exercise system adapted for two players **12** and **12A**. The player **12** is shown shooting the ball. The code generated by the two body part sensing and tactile simulating apparatuses **18** controls the computer program which may be in the PC or other viewing device so that the ball will have a projectory appropriate for the motion of the arms of the player **12**. The other player **12A** is shown attempting to block the ball and the code generated by the body part sensing and tactile communication apparatus indicates the position of his arms. If appropriately positioned the program will indicate the ball as being blocked and move it to the side. Otherwise, it may go on and if the player **12** has properly moved his arms, a basket may be scored. Of course all of this has to be preprogrammed and tested so that the codes generated by the body sensing and tactile simulation apparatus result in a reasonably accurate presentation on the PC. This may be done in a manner known in the art and practiced in conjunction with other games on the market.

[0087] In FIG. **8**, there is shown a block diagram of a master computer desktop station **52**, a slave desktop computer station **54** and an internet connection shown at **56**. The master desktop computer station is of the type commercially available for interconnecting conference callers which are able to view the computer desktop of the initiator. Both of the computers have the necessary software for simulated recreational training and exercise systems and there are players equipped with the body part sensing and tactile simulation apparatus shown in the prior figures. With this arrangement, players at two remote locations may play the same game or engage in the same exercises or the like.

[0088] In FIG. **9**, there is shown a perspective view of the posterior of a hand **58**, wrist **60**, forearm **62**, elbow **64** and arm **66** with a body part sensing and tactile simulation apparatus **18** mounted to it. The body part sensing and tactile simulation apparatus **18** includes a hand band **20**, wrist band **22**, forearm band **24** and arm band **26**. The hand band also has mounted to it an actuator **68** which the person may use to actuate program steps or the like with his thumb while holding the hand band **20**. In the vicinity of the hand band and wrist band **22** are two yaw or pitch sensing and resistance modules **28A** and **28B**. These modules may be used to either manually or electronically or automatically set resistance and sense the movement between the hand and wrist about the respective yaw and the pitch axis. The yaw or pitch sensing and resistance module **20B** controls the pitch movement and the yaw or pitch sensing and resistance module **28B** controls the yaw movement so as to completely define the movement of the hand with respect to the forearm. They also provide programmed resistance to that movement.

[0089] A third yaw or pitch sensing and resistance module **28C** senses and controls resistance to the bending of the arm.

A twist sensing and resistance module **30** senses the twisting motion of the forearm with respect to the arm.

[0090] With this arrangement, the hand band **20**, wrist band **22**, forearm band **24** and arm band **26** hold the body part sensing and tactile stimulation apparatus respectfully to the hand, wrist, forearm and arm. Similarly, the yaw or pitch and resistance modules **28A-28C** and the twist sensing and resistance module **30** sense motion of the hand, wrist, forearm, elbow and arm and provide resistance to such motion so as to simulate activities that otherwise would be load bearing or resisting force.

[0091] In the embodiment of FIG. **9**, the yaw or pitch sensing and resistance modules **28A-28C** are manually adjustable and similar to the friction modules disclosed in U.S. Pat. No. 5,980,435. However, in other embodiments, the adjustable top that, in the embodiment of FIG. **9**, are manually turned have geared teeth on them that mesh with the geared teeth of a motor. The motor may be remotely controlled so as to adjust the resistance from a remote location and to adjust the resistance from the personal computer or other program storage facility **14**.

[0092] The twist sensing and resistance module **30** may be a conventional membrane potentiometer. Such potentiometer are available under the trademark SENSOFIL[®] membrane potentiometer sold by Hoffmann and Krippner, Inc., 277 Highway 74N (Suite 306), Peach Tree City, Ga. 30269. While a membrane potentiometer is used in the preferred embodiment, other types of potentiometers are readily available such as for example the outer sheath having lack teeth on it to engage geared teeth on a twist potentiometer.

[0093] The twist sensing and resistance module **30** includes a stationary portion **72** and rotary portion **74**. The rotary portion **74** is mounted to the forearm to rotate with the forearm and the stationary portion **72** is mounted to the forearm band **28** and remains stationary. The potentiometer membrane moves with the rotary portion **74** of the twist sensing and resistance module **30**. In some embodiments, the battery and mother boards may be also housed within the stationary portion **72** of the twist sensing and resistance module **30**. Pressure from rotation is obtained by adjustment of the distance between the stationary portion and twist portion so as to change the friction between the two. Friction pads are provided for that purpose.

[0094] The distance between the twist sensing and resistance module **30** and the arm band **26** is adjusted by two apertured arms **76** and **78** that fit within fixtures so that the distance apart is adjusted by moving the apertured arms **76** and **78** and connecting different apertures in them through the fixtures.

[0095] In FIG. **10**, there is shown an anterior view of the arm and forearm **66** and **62** together with an anterior view of the hand **58** holding the body part sensing and tactile stimulation apparatus **18**. As shown in this view, the arm band **26** is connected to the stationary portion **72** of the twist sensing and resistance module **30** by the elongated apertured plate **76A** fitting in between the fixtures **78A** and **80A**. Similarly, not shown in FIG. **10** but shown in FIG. **9** on the opposite side are corresponding elongated aperture plate **76B** fitting in with the fixtures **78B** and **80B**. Conductive wires connecting the battery source and mother boards may be fastened to the elongated aperture plates so as not to be pushed together as the arm band and twist sensing and resistance module move

closer together or further apart with the adjustment of the arm band and twist sensing and resistance module with respect to each other to fit an individual.

[0096] In FIGS. **11-15**, there is shown a side view of the person's hand **58**, wrist **60**, forearm **62**, elbow **64** and arm **66** with the body part sensing and tactile stimulation apparatus **18** in place. As shown in this view, electrical connection between the rotary portion **74**, a twist sensing and resistance module **30** and the stationary portion **72**. The fixtures **78A** and **80A** are pinned to the elongated apertured plates **78A** and **78B**. The fixtures **80A** and **80B** include corresponding spring loaded plungers **88A** and **88B** that fit between selected apertures so as to adjust the resistance between the arm band **26** and the twist sensing and resistance module **30**. The cable **82** is connected to the circuit board housing **88**.

[0097] The forearm band **24** is connected to the elbow at the yaw or pitch sensing and resistance module **28C** by a slotted elbow-forearm linkage **90**. The elbow-forearm linkage **90** is a flat plate with a slot **92** extending along a portion of the length of the elbow-forearm linkage and with a threaded pressure member within the slot whereby by threading the treaded pressure member inwardly friction may be applied to the elbow-forearm linkage. Similarly, a slotted arm-elbow linkage **96** connects the yaw or pitch sensing and resistance module **28C** to the arm band **26**. It has an elongated slot **98** engaged with the threaded pressure member **100** to adjust tension therein. These members permit adjustment in the positioning of the arm band and forearm band and permit the two to move closer together as the elbow is bent. It should be noted that there is only one linkage connecting the arm and the forearm and that linkage is located at an axis of rotation of the arm and forearm at the elbow through the two slotted linkages.

[0098] In FIGS. **16** and **17** there are shown perspective views of a sleeve **108** and a glove **110** with FIG. **16** illustrating the sleeve and glove as positioned on the arm of a person who may use the simulated recreational training and exercise system **10** and FIG. **17** showing the parts laid out on a table. The sleeve and glove may be of any decorative design and besides improving the appearance of the body part sensing and tactile stimulation apparatus **18** serve as padding between the body part sensing and tactile stimulation apparatus **18** and the skin of the person **12**.

[0099] In FIG. **18** there is shown a perspective view of the sleeve and glove on a person's hand, wrist, forearm, elbow and arm with the body part sensing and tactile stimulation apparatus **18** on top of it. Since considerable areas of sleeve are visible, any particular design can be utilized including a costume design that might be appealing to certain classes of uses such as particularly children.

[0100] In FIG. **19**, there is shown an enlarged view of a person's hand and wrist with a portion of the body part sensing and tactile stimulation apparatus **18** in place over it. As shown in this view, the hand band **20** includes a metal frame **112** in the form of a clip with inside padding and a fabric portion **114** looped through openings on the two ends of the clip so as to provide a comfortable grip firmly in the hand and to accommodate the actuator (not shown in FIG. **18**). The wrist band **22** includes a similar metal clip **116** hinged at **118** so the two sides may be opened or closed. The hinge is connected to a metal connecting member **120** which is fastened to the metal clip **112** by the yaw or pitch sensing and resistance module **28B** (yaw module) so as to permit adjustment of resistance in the yaw direction between the hand and

the forearm and to sense the angle between the hand and the forearm at the wrist joint. A belt **122** provides padding between the hand and the hinged member **118**. The tube **84** and the compartment **86** are the input connection for charging the battery and the compartment which includes the battery and control circuitry in one embodiment of the invention. In another embodiment of the invention, the control circuitry including a transceiver and the circuit boards are mounted to the belt as shown at **16** and the input port for charging the battery may also be included thereon. Instead of a battery, power may be generated on the body part sensing and tactile stimulation apparatus **18** by including a generator on any of the moving parts. Similarly, because the body part sensing and tactile stimulation apparatus is low in power consumption, power may be transmitted to it to power the circuitry and transceivers by radio or the like. While radio transmission is preferred in the embodiment of FIGS. 9-24, infrared transmission or any other suitable transmission may be used.

[0101] Panel **102** houses switches actuated by the button **104A-104F**.

[0102] The buttons **104A-104F** are illuminated and actuate switches within the switch compartment **102** which in turn control the circuitry in the compartment or circuit board housing **88**.

[0103] In FIG. 23, there is shown a perspective view of the posterior side of the forearm, part of the hand and part of the arm with a corresponding portion of the body part sensing and tactile stimulation apparatus **18** mounted thereon. As shown in this view, a slotted hand-forearm pitch linkage **120** rotatably and slidably connects the pitch yaw or pitch sensing and resistance module **28B** within a slot **124** so as to permit movement for adjustment during motion and when fitting to an individual.

[0104] In FIG. 23, there is shown a perspective view of the body part sensing and tactile stimulation apparatus **18** having a hand band **20**, wrist band **22**, a forearm band **24** and an arm band **26** as shown in prior figures mounted to a person. As best shown in this view, the arm band **26** and the forearm band **24** are connected by a single link in which the yaw or pitch sensing and resistance module **28C** permits pivoting and can apply tactile sensations.

[0105] As shown in this view, the parts are integrally connected together, easy to ship and to put on by a player.

[0106] In FIG. 24, there is shown another view of the body part sensing and tactile stimulation apparatus **18** with the yaw or pitch sensing and resistance module **28C** open illustrating the seating for friction disks and sensing apparatus for generating a code indicating the position of body parts about a limb.

[0107] In FIG. 25, there is shown an exploded perspective view of the twist sensing and tactile stimulation apparatus. In the preferred embodiment, this apparatus is not utilized to provide tactile stimulation and only senses the twisting motion of the arm about the elbow. For this purpose it includes an analog sensing strip that senses position and circuitry for coding that analog signal to a position indicating code.

[0108] In FIG. 26, there is shown another simplified perspective view of the twist sensing and resistance module **30** showing the inner surface of the stationary module **72** against which the membrane potentiometer rests with the rotary portion **74** fitting still further inside of it so as to move with respect to a twisting forearm and generate a signal relating to the amount of twist.

[0109] In FIG. 27, there is shown an exploded view of the twist sensing and resistance module **30** being the rotary portion **74** and **72**. the rotary portion **74** includes the hinge **126** and the two side gripping members **128A** and **128B** (**128B** not being shown in FIG. 27). The gripping members **128A** and **128B** each have a corresponding one of the slots **130A** and **130B** (**130B** not being shown in FIG. 27). These slots receive a fabric belt for aiding in the gripping of a forearm. Attached to the hinge **126** is an enlarged outer member for fitting over the stationary portion **72** of the twist sensing and resistance module **30**. The stationary portion **72** includes an inner member **134**, a potentiometer membrane **136** and an outer member **138**. The sensing membrane **136** fits over a first portion **140** of the inner member **134**.

[0110] In FIG. 28, there is shown another perspective view of the twist sensing and resistance module **30** showing the battery compartment mounted to the rotary portion so as to fit over the inner ring **140** of the stationary portion **72** to form the complete battery compartment. An opening **144** permits entry to and is overlaid by the battery compartment.

[0111] In FIG. 29, there is shown a fragmentary perspective view of the wrist band and a portion of the forearm band. The wrist band the rotary portion of the forearm band rotate as described above within the stationary portion **74**. In the embodiment of **29**, programmed resistance is provided by a motor driven friction element **144** as described hereinafter. In response to an electrical signal the element **144** exerts pressure against the rotary portion when it moves with respect to the stationary portion **72** thus creating realistic resistance to twisting such as might be appropriate when bowling to train the bowler for the proper amount of twist when releasing the bowling ball.

[0112] In FIG. 30, there is shown an exploded perspective view of a yaw or pitch sensing and resistance module **28A-28C**. In FIG. 30, the module **28A** is shown specifically but the other yaw or pitch sensing and resistance modules are of similar construction.

[0113] As shown in FIG. 30, the yaw sensing and resistance module **28A** includes a position member assembly **176**, a motion resistance assembly **178**, a position housing assembly **180** and an adjustment and housing assembly **182**.

[0114] The position member assembly **170** includes the hand band **20**, a polyethylene washer **146** and a hand-wrist linkage **144**. The polyethylene washer **146** is positioned between the hand-wrist linkage **144** and the hand band **20** that yaw movement of the hand changes the angle between the hand-wrist linkage **144** and the hand band **20**. The motion resistance assembly resists motion with a force adjusted and dependent upon the angle between the hand band **20** and the hand-wrist linkage **144**. For this purpose, it includes the spring disk **164**, the baring disk **162**, a steel washer **160**, a steel washer **158**, a friction disk **156**, a steel washer **154**, a friction disk **152**, a steel washer **150**. With this arrangement, the pressure between the washers controls the friction exerted by the friction disks and thus, the resistance to motion.

[0115] To sense the position between the hand band **20** and the hand-wrist linkage **144**, the position sensing assembly **180** includes a potentiometer seat **166** and a sensing membrane **168** positioned within the housing **166** and having a pressure member **184** that changes the pressure in accordance with position. The member **184** may exert pressure by testing the pressure sensitive membrane or, a membrane may be utilized which is sensitive to a magnetic field and the member **184** may be a permanent magnet.

[0116] The adjustment and housing assembly **182** includes a tactile threaded adjustment **172**, a force resistance threaded adjustment **174** and a housing **170**. The tactile threaded adjustment **172** may be threaded inwardly to control the position between the resistance control member **184** and the pressure sensitive or magnetic sensitive membrane and the force resistance threaded adjustment adjusts the pressure between the friction disks and the steel washers in a perpendicular direction.

[0117] While a specific potentiometer and resistance creating device have been disclosed, there are many other types of potentiometers which may be used. Moreover, while a constant adjustable pressure has been used, the pressure could change with the angular position between the hand band **20** and the hand-wrist linkage **144** rather than being constant. Similarly, the potentiometer may be linear or non-linear or programmed for different values.

[0118] Another embodiment of yaw or pitch sensing and resistance module **186** comprises a cylindrical potentiometer housing **188** and a resistance housing **190**. The resistance housing includes within it programmable friction disks as described in greater detail in U.S. Pat. No. 5,980,435. In this module, an upper portion **192** and a lower portion **194** includes programs for varying the resistance with either an enlarged angle between the first and second levers or a narrowed angle. The upper lever **196** mounts the potentiometer housing **188** which has a shaft extending through it and the lower lever **198**. A gear connected to the shaft from the potentiometer **188** indicated at **200** engages a similar pinion portion **202** connected for rotation with the lower housing of the resistance module **190**. With this arrangement, as pitch or yaw of two limbs occurs with respect to each other, an analog signal is generated by the pot **188** and appropriate programmed resistance is supplied by the resistance module **190**.

[0119] In FIG. 31, there is shown a simplified fragmentary elevational view of a person **12** wearing two arm body part sensing and tactile stimulation apparatuses **18** and **18C**, two shoulder body part sensing and tactile stimulation apparatuses **18D** and **18F** and a abdomen body sensing and tactile stimulation apparatus **18F**. The person **12** also includes a virtual imaging mask which displays the image similar to a television monitor **2004**, as more fully described in the aforementioned U.S. Pat. No. 5,980,435.

[0120] In FIG. 32, there is shown a block diagram of a simulated recreational training and exercise system **10** having the body part sensing and tactile stimulation apparatus used by one user to characterize his or her role in the activity (hereinafter referred to as personalized apparatus) and interface **208**, a display **14**. The interface communicates with each of the plurality of personalized apparatuses **206A-206B** being shown in FIG. 32 and more specifically with the body part sensing and tactile stimulation apparatuses **18A**, **18C** being shown in FIG. 32. While samples of the body part sensing and tactile stimulation apparatus **18A**, **18C** and personalized apparatus **200A** and **200B** are shown in FIG. 32, any required number of personalized apparatus and body part sensing and tactile stimulation apparatuses may be part of the simulated recreational training and exercise system **10** depending on the number of players and the number of sensing apparatuses necessary to characterize the motions used in the activity.

[0121] As shown in the simulated recreational training and exercise system **10**, each body part sensing and tactile stimulation apparatus such as the one shown at **18A** in detail includes a resistance to motion generator **212**, an interface

210, control circuitry **16**, position sensing apparatus **214** and program selection section **216**. In the preferred embodiment, the interface includes a transceiver permitting signals to be sent from the control circuitry **16** to the system interface **208** for the display **14**. The position sensing apparatus sends such signals to the control circuitry **16** and to the resistance to motion generators **212** as described above to control the resistance to motion in accordance with the program that is part of the position sensing apparatus **214** as described above. The program selection section **216** selects the program that is energized by the position sensing apparatus **214** at selected positions of the limbs about a joint.

[0122] In FIG. 33, there is shown a block diagram of the position sensing apparatus **214** having a potentiometer **230** and an analog-to-digital converter **232**. The potentiometer **230** is a sensing membrane type of potentiometer having a wiper or tap **228** which is electrically connected to the analog-to-digital converter **232** to apply a digital signal to the conductors **226** indicating the twist position or from the twist sensing and resistance module or the yaw or pitch sensing and resistance modules. The analog-to-digital converter **232** receives power from the battery **222A**.

[0123] In FIG. 34, there is shown a block diagram of the interface **210** and battery control mother board and transceiver **16** connected together in the manner shown in FIG. 32 as a portion of the body part sensing and tactile stimulation apparatus **18A**. As shown in this view, the interface **210** includes a transceiver **238** and a signal processor **246**. The signal processor **246** receives signals indicating the position of the body part sensing and tactile stimulation apparatuses **16** on conductors **218**, shapes the pulses and transfers them to the transceiver **238** which transmits them to the interface **208** (FIG. 32) for the personal computer with a viewing screen **14** (FIG. 1). The battery controlled mother board and transceiver **16** includes as its principle parts a digital-to-analog converter **242**, a microprocessor **244**, a power supply **246** which in the preferred embodiment is a battery or a power supply directly connected to the plug for the main supply to convert ordinary **120** ac to low voltage dc for operation of the body part sensing and tactile stimulation apparatus **16**. The power supply **246** supplies power to the microprocessor **244**, the digital-to-analog converter **242** through conductors **222**. The digital-to-analog converter receives a digital signal from the microprocessor **244** indicating the position of the body parts and supplying them to the resistance to motion generators **212** for programmable control of resistance to motion.

[0124] In FIG. 35, there is shown a flow diagram of the subprocess **38** of setting up the body part sensing and tactile stimulation apparatus **18** comprising the step **248** of attaching and energizing the body part sensing and tactile stimulation apparatus on a user, the step **250** of attaching and energizing the computer transceiver to establish communication between the computer and body part sensing and tactile stimulation apparatus and the step **252** of coordinating the body part sensing and tactile stimulation apparatus with the simulated recreational, training and exercise system software. While the setup process described specifically here refers to a computer as maintaining the visual image and the containing the software, other devices such as commercial gaming devices sold under trademarks such as XBOX (XBOX is a registered trademark of Microsoft Corporation). Moreover, instead of using a transceiver to transmit from the

body part sensing and tactile stimulation apparatus to an additional transceiver or receiver in a computer 14, hard wiring circuits can be used.

[0125] In FIG. 36, there is shown a flow diagram 252 of coordinating the body part sensing and tactile stimulation apparatus 18 with the simulated recreational, training and exercise system software comprising the step 254 of selecting the default profile or the individual profile from a list of recorded profiles or using the profile program to develop a new user profile and the step 256 of using the default tactile stimulation program or selecting a pre-recorded tactile stimulation program or setting a new tactile stimulation program. These steps are used to enable the software within the computer to develop and display a image that is performing the same activity as the user and to also advance the software for background such as train or the like in the case of a support that is coordinated with the motion of the user. It can also be used to establish different levels of skill in the case of a training or game playing activity so that the user may start with a beginning activity which is relatively easy such as skiing on a beginners down slope and advance to more advanced activities requiring greater skill such as skiing on an advanced slope entailing faster speed and turning on steep slopes. It also permits the selection of stimuli appropriate for the game and causing the resistance to movement to be adaptable to the individual. In the case of exercises, the amount of resistance may be set in accordance with a user to begin with and increased as the user's strength increases.

[0126] There is a program 40 for setting up the simulated activity. This is software developed in connection with a stimulated activity. For example, a commercial game may be installed in accordance with the instructions with the game for use of playing the game in a computer.

[0127] The process 40 includes the step 256 of selecting the activity and installing the software for the activity in the computer or other display device and the step 258 of navigating through the start-up menu of the selected activity. For example, in the case of a commercial game, the navigation system is provided in the software for the game and the computer or a transceiver connected to the computer activated by the body part sensing and tactile stimulation apparatus 18 may be used to set up of the game in accordance with the program for the game.

[0128] The process includes the step 42 of performing the simulated activity (see FIG. 4) comprising the substep 262 of performing the motions appropriate for the activity, the substep 264 of transmitting signals indicating the user's position and/or speed of movement and/or button push information and/or other senses data from the body part sensing and tactile stimulation apparatus to the personal computer with view screen or monitoring device 14, the step 266 of stepping through the program following subroutines indicated by signals from the body part sensing and tactile stimulation apparatus and the step 268 of displaying images to the user as determined by the program for the activity being used at that time. With this arrangement, the user may use commercial games or tailored activities such as physical therapy activities or exercise routines or the like. Where a skill is being developed, the skill may be developed with a realistic feel for the activity such as in the case of dart throwing, the motion of the arm plus the force needed to obtain the desired target with the dart. Moreover, the difficulty of the game may be changed in accordance with selection.

[0129] A process 270 for obtaining a profile for a new user comprises the step 272 of displaying a menu for profiling body part sensing and tactile stimulation apparatus, the step 280 of selecting new user profile and the step 274 of moving body part sensing and tactile stimulation apparatus into a series of different yaw and pitch positions and twist positions for each joint and transmitting position code to software for the system within the computer to establish a table of positions and corresponding codes within the software. Once encoded, when the profile of the new user is selected or the initial use, codes are transmitted for each position to the software which may control subroutines based on the body part position.

[0130] From the above description of the invention, it can be understood that the simulated recreational, training and exercise method and apparatus of this invention has several advantages, such as: (1) it enables recreational, exercise and training programs to be coupled to images or other sensed events so that the user can correlate muscle activity with sensed events; (2) it provides a program coordinated with images to for maintaining proper joint alignment during activities. (3) it provides recreational, training and exercise devices and techniques that permit tailored programs for a wide variety of purposes, such as to strengthen principally the fast twitch muscle or the slow twitch muscle or to strengthen only certain portions of an injured muscle; (4) it provides equipment and methods that use virtual reality techniques to provide recreation, exercise and training using coordinated images and resistance to movement; (5) it provides a technique and equipment for combining resistance to movement that is related in a precontrolled manner to the position of the part being moved with electrical muscle stimulation to aid movement or prevent undesired movement coordinated with images and sounds; (6) it provides an apparatus and method for reducing arthrokinetic joint movement dysfunction during training using visual displays; and (7) it provides an exercise, training and recreational device and technique that provides resistance to movement related in a pre-programmed manner to the position of the part of the users body performing the activity.

[0131] While a preferred embodiment has been described in considerable detail, many modifications and variations in the preferred embodiment are possible. Therefore, it is to be understood that within the scope of the appended claims, the invention may be practiced other than as specifically described.

What is claimed:

1. A method of simulating characteristics of a physical activity, comprising the steps of:

making sensory stimuli available to at least one person corresponding to the movement of the person in performing the physical activity, whereby the at least one person associates the physical activity with the stimuli; the step of making sensory stimuli available to the at least one person including the substep of making non-tactile stimuli available representing at least one aspect of the activity and the substep of making tactile stimuli available; and

coordinating the position of at least one body part of the at least one person with the non-tactile stimuli to beginning the activity.

2. A method in accordance with claim 1 wherein the substep of making non-tactile stimuli available representing at least one aspect of the activity includes the substep of making

at least one of visual stimuli depicting at least one aspect of the activity available to the at least one person and audible stimuli associated with the aspect of the activity.

3. A method in accordance with claim 1 wherein the substep of making tactile stimuli available to the at least one person includes the substep of controlling the resistance to movement of the at least one person.

4. A method in accordance with claim 3 wherein:

the substep of making tactile stimuli available to the at least one person includes the substep of controlling the resistance to movement of the at least one person either through a preset resistance to joint movement or in synchronization with at least one aspect of the non-tactile stimuli under at least part control of a program recorded in a microprocessor representing the one aspect of the activity; and

altering the non-tactile stimuli in response to the movement of a part of the body of the at least one person.

5. A method in accordance with claim 1 further including the step of selecting a physical activity for at least one person to perform.

6. A method in accordance with claim 1 further including the step of selecting a resistance program.

7. A method in accordance with claim 1 further including the step of programming a time delay in a depiction of an aspect of the visual image based on the activity and a velocity measurement.

8. A method in accordance with claim 7 wherein at least one sensor provides signals to the microprocessor wherein the image depicts multiple actions caused by movement of limbs at multiple joints and sets individual friction control with respect to a direction of movement.

9. A method in accordance with claim 4 wherein the substep of controlling the resistance to movement of the at least one person includes the step of controlling the resistance by electrically generated forces.

10. A method in accordance with claim 9 wherein the electrical forces are applied by one of varying electromagnet resistance to movement and electromagnets forcing frictional surfaces together and by an electric motor turning a screw drive to force frictional surfaces together.

11. A method in accordance with claim 1 further including the step of generating an electrical code indicating the positions of two exoskeleton members with respect to each other wherein the exoskeleton members are connected to opposite sides of a joint of a person whereby the code indicates the position of the exoskeleton members with respect to each other about the joint.

12. A method in accordance with claim 11 wherein the code energizes a program to control the resistance and provide interactive images representing an activity to the person and being displayed on a monitor.

13. A method in accordance with claim 12 in which the images are at least one of terrain, athletic activities, and games.

14. A method in accordance with claim 12 wherein a therapist may monitor the audio/visual devices while exercise is being performed.

15. A method of providing controlled resistance to movement of body parts of a person with respect to each other based on the person's body position and related to an activity depicted in a visual image provided to the person, comprising the steps of:

attaching at least a first exoskeleton member to a first body part on a first side of at least one body joint of the person and a second exoskeleton member to a second body part on a second side of at least one body joint of the person; attaching at least one adjustable resistance to at least one of said first and second exoskeleton members wherein said at least one of said first and second exoskeleton members provides a controlled resistance to movement of the first and second body parts of the person with respect to each other;

sensing positions of at least the first body part with respect to at least the second body part during performance of an activity and providing a first signal in response thereto; generating a second signal from a second signal source wherein the second signal source is one of a second person or a microprocessor programmed to generate signals;

providing a video display, sound or touch sensation relating to a relationship between the first and second signals, whereby an activity of the person interacting with an actual person or programmed person is simulated; and resisting movement of the person with a resistance controlled by a sensor input and a visual input provided to a microprocessor and a software program based on said sensing of the position of at least one part of said person's body.

16. A method in accordance with claim 15 wherein the step of sensing a position of at least one part of said person's body comprises the step of sensing a position of at least one part of said person's body from a remote location and transmitting it to the microprocessor.

17. A method in accordance with claim 16 wherein the step of initiating a program includes the step of displaying the program for a therapist wherein the therapist may change the program.

18. A method in accordance with claim 17 wherein the step of initiating a program includes the step of:

generating an electrical code in response to at least one of a position of the body parts with respect to each other and an EMG signal; and

transmitting the code to the microprocessor storing the program, wherein the program is initiated.

19. A method in accordance with claim 16 wherein the at least one part of said person's body is at least one of a foot, an arm, a forearm, a leg or a shoulder.

20. A method of simulating characteristics of a physical activity, comprising the steps of:

selecting the physical activity;

making sensory stimuli available to at least one person corresponding to the movement of the person in performing the physical activity, whereby the at least one person associates the physical activity with the stimuli;

the step of making sensory stimuli available to the at least one person including the substeps of making non-tactile stimuli available representing at least one aspect of the activity in accordance with a preset program;

coordinating the position of at least one body part of the at least one person with the non-tactile stimuli to begin the physical activity.

the step of generating an electrical code indicating the positions of two exoskeleton members with respect to each other wherein the exoskeleton members are connected to opposite sides of a joint of a person whereby

the code indicates the position of the exoskeleton members with respect to each other about the joint; and the step of providing sensory stimuli including the step of varying the sensory stimuli in accordance with the generated code whereby the activity is varied partly by the person and partly by the recorded program.

21. A method in accordance with claim 20 in which the program is within a microprocessor.

22. A method in accordance with claim 20 further including the step of generating an electrical code indicating the positions of two exoskeleton members with respect to each other wherein the exoskeleton members are connected to opposite sides of a joint of a person whereby the code indicates the position of the exoskeleton members with respect to each other about the joint.

23. A method in accordance with claim 20 wherein the joint is the joint between the hand and the forearm and the exoskeleton generates one code representing yaw of the hand with respect to the forearm and a signal representing pitch of the hand with respect to the forearm said yaw and pitch being about orthogonal axes.

24. A method in accordance with claim 20 wherein the joint is the elbow and the exoskeleton generates a signal representing the rotation of the forearm with respect to the arm.

25. A method of aiding a person in physical activity, wherein the person has weakened or damaged muscle, comprising the steps of:

- providing resistance to movement in a direction of natural forces, wherein the natural forces are offset;
- the step of providing resistance to movement comprising the step of applying a resistance which varies in magnitude in accordance with a program in which said resistance is independent of velocity of movement;
- providing images depicting the physical activity to the person under the control of the program;
- coordinating one position of the body with a corresponding position in the image, wherein the program is synchronized;
- said program varying the images and the resistance to movement in accordance with the position of body parts of the person.

26. A method in accordance with claim 25 in which the program is within a microprocessor.

27. A method in accordance with claim 25 in which the resistance is controlled by electrical forces.

28. A method in accordance with claim 26 further including the step of generating an electrical code indicating the positions of two levers with respect to each other wherein the levers are connected to opposite sides of a joint of a person whereby the code indicates the position of the levers with respect to each other about the joint.

29. A method in accordance with claim 28 wherein the code energizes a program to control the resistance and provide interactive images representing an activity to the person.

30. A method in accordance with claim 29 in which an operator may control the selection of the program being generated for a person exercising.

31. A method in accordance with claim 30 wherein a therapist may monitor the audio/visual devices while exercise is being performed.

32. A method of simulating an activity requiring movement of body parts of a person, comprising the steps of:

- generating signals representing a position of at least two body parts with respect to each other;

- generating resistance to movement in response to the signals;

- generating at least one of visual presentations, audible presentations, heat, cold, wind, ultrasonic vibrations and EMS muscle stimulation in response to the signals, wherein the at least one of visual presentations, audible presentations, heat, cold, wind, ultrasonic vibrations and EMS muscle stimulation relate to the activity and to the resistance to movement;

- synchronizing the signals and the position of the body parts at the start of the activity.

33. A method according to claim 32 in which a visual presentation received by a person is varied by changes in body position of the person and the visual presentation is provided by one of a video monitor and a virtual reality headset.

34. A method according to claim 30 in which the person's body position is determined by sensing the position of one side of a body joint in relation to the opposite side of the same body joint.

35. A method in accordance with claim 30 wherein the step of generating signals comprises the step of generating an electrical code indicating the positions of two levers with respect to each other wherein the levers are connected to opposite sides of a joint of a person whereby the code indicates the position of the levers with respect to each other about the joint; and the step of generating the at least one of visual presentations, audible presentations, heat, cold, wind, vibrations and EMS muscle stimulation comprises the step of sequencing the steps of a program in response to the electrical code to provide at least one of the visual presentation and the audible presentation representing an activity to the person.

36. A method in accordance with claim 30 further including the step of creating resistance to movement of the limb about the joint that is independent in resisting force of the velocity of movement of the limb and stops when force applied by the patient to cause motion stops wherein the exercise device does not exert force except when providing a resisting force to motion said step of creating resistance including the steps of creating frictional resistance during an activity corresponding to a sequence of steps in a program stored in the microprocessor depicting the activity by varying electromagnet resistance to movement or adjusting the pressure between frictional members surfaces that move with the limb about the joint by controlling one of a magnetic attraction forcing the surfaces together and by controlling a motor driven screw that tightens and loosens the surfaces under the control of the microprocessor or by cam surfaces.

37. A method, comprising the steps of:

- generating an electrical code indicating the positions of two levers with respect to each other wherein the levers are connected to opposite sides of a joint of a person whereby the code indicates the position of the levers with respect to each other about the joint;

- energizing a program in response to the code to provide at least one of interactive images and sounds representing an activity to the person;

- said step of energizing a program including the steps of selecting a position of at least one body part and the similar depiction of an image of the body part;

- synchronizing the program with the positions of the body part based on the selection of the position of the at least one body part and the similar depiction of an image of the body part.

38. A method in accordance with claim **37** wherein the at least one of interactive images and sounds includes images and the images are displayed on a monitor.

39. A method in accordance with claim **37** wherein a therapist may monitor the audio/visual devices while exercise is being performed.

40. A method, comprising the steps of:

attaching at least one lever to each side of at least one body joint of the person;

sensing a position of at least one part of said person's body in relation to at least one different body part; and

providing a video display relating the visual image to the sensing of the position of at least one part of said person's body, whereby an activity of the person is simulated.

41. A method in accordance with claim **40** wherein the step of sensing a position of at least one part of said person's body comprises the step of sensing a position of at least one part of said person's body from a remote location and transmitting it to the microprocessor.

42. A method in accordance with claim **40** further including a step of generating at least one of visual and audible presentations in response to signals wherein the at least one of visual and audible presentations relate to the activity and includes a step of generating images of a ski slope that change with the movement to simulate snowboarding, skiing, or snowmobiling.

43. A method in accordance with claim **40** wherein the step of generating at least one of visual and audible presentations in response to the signals wherein the at least one of visual and audible presentations relate to the activity includes a step of initiating a program within the microprocessor in response to the signals.

44. A method of training a person to adjust to changes in gravity, comprising the steps of:

simulating characteristics of a physical activity in a gravity altered environment, comprising the steps of:

making sensory stimuli available to at least one person corresponding to the movement of the person in performing the physical activity in a gravity altered environment, whereby the at least one person associates the physical activity in the gravity altered environment with the stimuli;

the step of making sensory stimuli available to the at least one person including the substeps of making non-tactile stimuli available representing at least one aspect of the activity in the gravity altered environment and the substep of making tactile stimuli available; and

coordinating the position of at least one body part of the at least one person with the non-tactile stimuli to beginning the activity.

45. A method in accordance with claim **44** wherein the substep of making non-tactile stimuli available representing at least one aspect of the activity includes the substep of making at least one of visual stimuli depicting at least one aspect of the activity available to the at least one person and audible stimuli associated with the aspect of the activity.

46. A method in accordance with claim **44** wherein the substep of making tactile stimuli available to the at least one person includes the substep of controlling the resistance to movement of the at least one person.

47. A method of compensating for altered gravity environment during a physical activity, comprising the steps of:

making sensory stimuli available to at least one person corresponding to the movement of the person in performing the physical activity in a, whereby the at least one person associates the physical activity with the stimuli;

the step of making sensory stimuli available to the at least one person including the substeps of making non-tactile stimuli available representing at least one aspect of the activity and the substep of making tactile stimuli available; and

coordinating the position of at least one body part of the at least one person with the non-tactile stimuli to beginning the activity.

48. A method in accordance with claim **47** wherein the substep of making non-tactile stimuli available representing at least one aspect of the activity includes the substep of making at least one of visual stimuli depicting at least one aspect of the activity available to the at least one person and audible stimuli associated with the aspect of the activity.

49. A method in accordance with claim **47** wherein the substep of making tactile stimuli available to the at least one person includes the substep of controlling the resistance to movement of the at least one person.

50. A multiple plane action simulation apparatus, comprising:

a first exoskeleton member adapted to be attached to a first side of a body joint;

a second exoskeleton member adapted to be attached to a second side of the body joint;

an adjustable module moveably connected to said first and second exoskeleton members for movement in at least two planes;

said first and second exoskeleton members being connected for rotary movement and linear movement in at least two planes

said adjustable module including an encoder that generates a code indicating the position of said first and second exoskeleton members with respect to each other; wherein a position of the first side of a person's body is sensed in relation to the second side of said person's body;

a microprocessor;

a video display;

at least one program within said microprocessor providing images to said video display and signals to said adjustable resistance in response to a position of at least one part of said person's body wherein said first and second exoskeleton members provide a controlled resistance to movement of the body parts with respect to each other and a visual image, whereby an activity of the person is simulated.

51. A multiple plane action simulation apparatus in accordance with claim **50** wherein the adjustable resistance serves as a universal joint.

52. A multiple plane action simulation apparatus in accordance with claim **52** wherein the first and second exoskeleton members are portions of a boot.

53. A multiple plane action simulation apparatus in accordance with claim **50** wherein the first and second exoskeleton members are portion of either a weapon, golf club, tennis racket, bat, steering wheel, stick control, snowboard or skis.

54. A multiple plane action simulation apparatus in accordance with claim **52** wherein the boot is a ski boot or snowboard boot and a video signal is an image of ski terrain.

55. A multiple plane action simulation apparatus in accordance with claim **50** further including a modem, wherein a position of at least one part of said person's body is transmitted from a remote location to the microprocessor.

56. A multiple plane action simulation apparatus according to claim **50** in which a visual input is provided by one of a video monitor and a virtual reality headset.

57. Apparatus for aiding a person in physical activity, comprising:

- a microprocessor containing at least one program;
- at least a first and second exoskeleton members;
- said first exoskeleton member being adapted to be mounted to a limb on a first side of a joint of the person;
- said second exoskeleton member being adapted to be mounted to a limb on a second side of the joint of the person, whereas the first exoskeleton member and the second exoskeleton member change position with respect to each other as the limbs move with respect to each other;

- a friction control module;

- said friction control module being attached to said first and second exoskeleton members and including friction members that change in position with respect to each other to resist movement of said first and second exoskeleton members, whereby motion of the limbs with respect to each other is resisted by said exoskeleton members;

- at least one position sensor that senses the position of the first and second exoskeleton members with respect to each other and transmits signals to the microprocessor representing the position, wherein the microprocessor initiates a program to provide at least one of a visual signal, an audio signal, temperature sensation or touch sensation relating to the activity;

- at least a first input device externally controlled by an entity other than the person and a second input device controlled by the person whereby the activity is varied partly by the person and partly by the externally controlled entity.

58. Apparatus for aiding a person in physical activity, comprising:

- a microprocessor containing at least one program;
- at least a first and second levers;
- said first lever being adapted to be mounted to a limb on a first side of a joint of the person;
- said second lever being adapted to be mounted to a limb on a second side of the joint of the person, whereas the first lever and the second lever change position with respect to each other as the limbs move with respect to each other;

- a friction control module;

- said friction control module being attached to said first and second levers and including friction members that change in position with respect to each other to resist movement of said first and second levers, whereby motion of the limbs with respect to each other is resisted by said levers;

- at least one position sensor that senses the position of the first and second levers with respect to each other and transmits signals to the microprocessor representing the position, wherein the microprocessor initiates a program

- to provide at least one of a visual signal relating to an activity and an audio signal relating to the activity.

59. Apparatus for providing controlled resistance to movement of body parts of a person with respect to each other based on the person's body position and a visual image provided to the person, comprising:

- a first lever adapted to be attached to a first side of a body joint of the person's body;

- a second lever adapted to be attached to a second side of the body joint of the person's body; wherein a position of the first side of said person's body is sensed in relation to the second side of said person's body;

- an adjustable resistance connected to said first and second levers wherein said first and second levers provide a controlled resistance to movement of the body parts with respect to each other;

- a microprocessor;

- a video display relating the visual image to a position of at least the first side of said person's body, whereby an activity of the person is simulated; and

- a software program within said microprocessor providing said video display in response to the position of at least one part of said person's body.

60. A method, comprising the steps of:

- simulating characteristics of a physical activity, comprising the steps of:

- making sensory stimuli available to at least one person corresponding to the movement of the person in performing the physical activity, whereby the at least one person associates the physical activity with the stimuli;
- the step of making sensory stimuli available to the at least one person including the substeps of making non-tactile stimuli available representing at least one aspect of the activity and the substep of making tactile stimuli available; and

- coordinating the position of at least one body part of the at least one person with the non-tactile stimuli to beginning the activity.

61. A method in accordance with claim **60** wherein the substep of making tactile stimuli available to the at least one person includes the substep of controlling the resistance to movement of the at least one person in a pattern representing the force against movement in the actual activity.

62. A method in accordance with claim **61** wherein the pattern representing the force against movement in the actual activity is determined by generating a code representing the motion of the body parts during the actual activity and recording the code and the result, wherein a data base is generated correlating the actual motion with the result.

63. A method in accordance with claim **2** wherein a data base is compiled representing the average motion of multiple users and provided as a default program.

64. A method in accordance with claim **63** wherein a first data program is prepared in which the coordination between the users motion and the result of the activity provides a first large margin of error and a second program is prepared in which the coordination between the users motion and the result of the activity provides a second margin of error, said second margin of error being smaller than the first margin of error.

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