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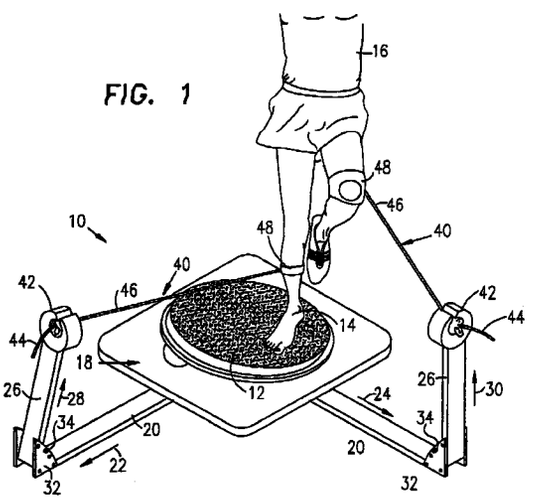
## (54) Rehabilitation exercise apparatus

(57) Rehabilitation exercise apparatus (10) including a support platform (12) adapted for supporting a foot (14) of a patient (16), and variable tilt load-bearing apparatus (18) upon which the support platform (12) is supported, the load-bearing apparatus (18) being operable to selectively statically support the support platform (12) at a desired, fixed angle selected from a range of angles and to selectively dynamically support the support platform (12) whereby the support platform (12) angularly moves about at least one pivot.

FIG. 1

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## Description

### FIELD OF THE INVENTION

**[0001]** The present invention relates generally to exercise apparatus for rehabilitation of the ankle and the knee, with adaptation for the lumbar spine and shoulder.

### BACKGROUND OF THE INVENTION

**[0002]** There are an estimated 27,000 new ankle injuries daily in the United States, or approximately one in 10,000 of the population. Rehabilitation of the ankle involves exercising and strengthening ligaments and restoring ability of the patient to balance and support himself upon the ankles.

**[0003]** Apparatus for ankle rehabilitation exists. Generally such apparatus includes a rigid support platform placed upon one or more hemispherical supports. For example, one hemispherical support may be placed underneath the center of the platform. The platform thus wobbles about its center upon the hemispherical support. A patient standing on the platform thus exercises the ligaments at the ankle, i.e., performs inversion, eversion, plantarflexion and dorsalflexion. Other combinations of hemispherical supports may be used underneath the platform so as to provide different dynamic effects of an unstable platform. In all cases, the platform is dynamic and not static.

### SUMMARY OF THE INVENTION

**[0004]** The present invention seeks to provide improved ankle rehabilitation apparatus that is useful in rehabilitation therapy of the knee as well, with adaptation for the lumbar spine and shoulder. The present invention provides several features not found in the prior art. The present invention provides a support platform whose texture can be selectively changed to suit the needs of the therapy. For example, the surface can comprise hard foam, soft foam, angled foam, wood, angled wood, artificial grass, water, sand, and/or imbedded stones, just to name a few.

**[0005]** Unlike the prior art, the support platform of the present invention may be *statically* maintained at any desired angle, as well as being dynamically supported, such as wobbling upon a support.

**[0006]** Extending from the sides of the support platform are poles which may be vertical (i.e., generally perpendicular to the floor) or which may be positioned at any angle with respect to the floor. The poles may be of varying heights, and their arrangement about the support platform is also variable. Attached to the poles are one or more elongate connecting members which can be strapped to, or otherwise attached to, a limb of the patient, such as the ankle, knee, femur, waist, humerus, forearm, wrist and/or hand. As the patient performs different maneuvers in accordance with the therapeutic plan on the support platform, he is tethered by the elongate connecting member(s) to the pole(s). The elongate connecting members are preferably constructed of an elastic material, such as rubber or springs or flexible rope, which offers a certain resistance to stretching thereof, thereby forcing the patient to exercise one or more muscle groups upon pulling the elongate connecting member. Depending on the type of therapeutic plan, the elongate connecting member may either make the therapeutic exercise harder or easier, i.e., either increase or decrease the physical effort in performing maneuvers on the support platform.

**[0007]** Thus, the apparatus of the present invention makes possible a progressive rehabilitation therapeutic plan for one or more parts of the body, wherein the patient selectively progresses from static exercises to dynamic exercises, all the while selectively changing the resistance to his maneuvers.

**[0008]** There is thus provided in accordance with a preferred embodiment of the present invention rehabilitation exercise apparatus including a support platform adapted for supporting a foot of a patient, and variable tilt load-bearing apparatus upon which the support platform is supported, the load-bearing apparatus being operable to selectively statically support the support platform at a desired, fixed angle selected from a range of angles and to selectively dynamically support the support platform whereby the support platform angularly moves about at least one pivot.

**[0009]** In accordance with a preferred embodiment of the present invention the apparatus includes at least one extension arm extending from the load-bearing apparatus in a first direction and at least one pole extending from the at least one extension arm in a second direction, the first and the second directions forming an angle therebetween in a range of 0° to 180°.

**[0010]** Further in accordance with a preferred embodiment of the present invention the apparatus includes a plurality of the poles wherein at least one of the poles has a height different from another the pole. Preferably a placement of the at least one extension arm relative to the support platform is selectively variable.

**[0011]** Still further in accordance with a preferred embodiment of the present invention the apparatus includes at least one elongate connecting member connected to the at least one pole, the elongate connecting member being attachable to a portion of the patient. Preferably the at least one elongate connecting member is constricted of an elastic material.

**[0012]** Additionally in accordance with a preferred embodiment of the present invention the load-bearing apparatus includes at least one generally hemispherically-shaped support element.

**[0013]** In accordance with a preferred embodiment of the present invention the load-bearing apparatus includes a ball and socket joint wherein the support platform articulates about the joint.

**[0014]** In accordance with another preferred embodi-

ment of the present invention the load-bearing apparatus includes a plurality of props arranged in a pattern underneath the support platform, and an actuator which selectively raises at least one of the props so as to selectively tilt the support platform.

**[0015]** In accordance with yet another preferred embodiment of the present invention the load-bearing apparatus includes a fluid bed.

**[0016]** In accordance with still another preferred embodiment of the present invention the load-bearing apparatus includes a moving plate that moves the support platform in at least one of translatory and rotational movement. Preferably the moving plate is programmed to move in a predetermined sequence. Preferably the support platform includes sensors for sensing movement of the patient on the support platform and wherein the moving plate receives sensed information from the sensors and moves the support platform in accordance with the sensed information.

**[0017]** Further in accordance with a preferred embodiment of the present invention the support platform includes a support surface with a selectively changeable texture.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0018]** The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

Fig. 1 is a simplified pictorial illustration of rehabilitation exercise apparatus constructed and operative in accordance with a preferred embodiment of the present invention;

Figs. 2 and 3 are simplified top view and side view illustrations, respectively, of the rehabilitation exercise apparatus of Fig. 1;

Fig. 4 is a simplified pictorial illustration of selectively placing a hemispherically-shaped support element on load-bearing apparatus of the rehabilitation exercise apparatus of Fig. 1;

Fig. 5 is a simplified pictorial illustration of load-bearing apparatus comprising a ball and socket joint, constructed and operative in accordance with a preferred embodiment of the present invention;

Fig. 6 is a simplified pictorial illustration of load-bearing apparatus comprising a plurality of props arranged in a pattern underneath a support platform, constructed and operative in accordance with a preferred embodiment of the present invention, and wherein the load-bearing apparatus includes a computer-controlled moving plate;

Fig. 7 is a simplified, partially sectional illustration of load-bearing apparatus comprising a fluid bed, constructed and operative in accordance with a preferred embodiment of the present invention; and

Fig. 8 is a simplified pictorial illustration of rehabilitation exercise apparatus with adaptation for the lumbar spine and shoulder, constructed and operative in accordance with another preferred embodiment of the present invention.

## DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

**[0019]** Reference is now made to Figs. 1-3 which illustrates rehabilitation exercise apparatus 10 constructed and operative in accordance with a preferred embodiment of the present invention. Apparatus 10 includes a support platform 12 adapted for supporting a foot 14 of a patient 16. Variable tilt load-bearing apparatus 18 is provided upon which support platform 12 is supported. As will be described with reference to Figs. 4-7, load-bearing apparatus 18 can either statically support platform 12 at a desired, fixed angle selected from a range of angles, or instead, can dynamically support platform 12 so that platform 12 angularly moves about at least one pivot. Thus, unlike the prior art, apparatus 10 provides a progressive rehabilitation therapeutic apparatus, wherein the patient can selectively progress from static exercises to dynamic exercises.

**[0020]** As seen in Fig. 1, one or more extension arms 20 extend from load-bearing apparatus 18 in a first direction, such as indicated by arrows 22 and 24. One or more poles 26 extend from extension arms 20 in a second direction, such as indicated by arrows 28 and 30, respectively. First and second directions 22 and 28, or 24 and 30, form an angle therebetween in a range of 0° to 180°, this angle being selectively variable, such as by means of a hinged connector 32. Connector 32 may be provided with a positive locking device, such as a pin 34 fixed in a hole, so as to fix pole 26 at a desired angle with respect to arm 20. Poles 26 may be of varying heights.

**[0021]** As seen particularly in Fig. 2, the placement of extension arms 20 relative to support platform 12 is preferably selectively variable. For example, arms 20 may be pinned to mounting holes 36 at a variety of angles and positions.

**[0022]** Referring particularly to Fig. 1, it is seen that one or more elongate connecting members 40 are connected to poles 26. Preferably each pole 26 is provided with a slitted disc 42 and an end 44 of elongate connecting member 40 is fixedly slipped through the slit of disc 42. It is of course appreciated that elongate connecting member 40 may be connected to pole 26 in any other suitable manner. An opposite end 46 of elongate connecting member 40 is attached to a portion of patient 16. For example, a connector 48, such as a VELCRO® strap, may be wrapped around a knee of patient 16, as shown in Fig. 1. The elongate connecting member is preferably constructed of an elastic material, such as rubber, springs or flexible rope, which offers a certain resistance to stretching thereof, thereby forcing patient 16 to exercise one or more muscle groups upon pulling

elongate connecting member 40. Depending on the type of therapeutic plan, elongate connecting member 40 may either make the therapeutic exercise harder or easier, i.e., either increase or decrease the physical effort in performing maneuvers on support platform 12.

**[0023]** It is a particular feature of the present invention that support platform 12 preferably includes a support surface with a selectively changeable texture, i.e., various support materials may be placed upon support platform 12. For example, the support surface may initially be a hard foam, which may then be replaced in the progressive therapeutic plan with a soft foam. The support surface may include artificial grass, such as a sheet of ASTROTURF®. Artificial grass may be particularly useful in rehabilitating athletes who are used to playing on grass playing fields. Other materials may include angled foam, wood, angled wood, and/or sand, with or without imbedded stones, for example. It is appreciated that other materials and textures are within the scope of the present invention.

**[0024]** Referring again to Fig. 2 it is seen that optionally a track 47 may be placed at least partially around load-bearing apparatus 18. Track 47 may be provided with another rehabilitation device 49, such as a ball, moving disc or any other structure suitable for placing a foot thereupon and performing other rehabilitation exercises.

**[0025]** Reference is now made to Figs. 4-7 which illustrate different preferred embodiments of load-bearing apparatus 18. In Fig 4, load-bearing apparatus 18 includes one or more generally hemispherically-shaped support elements 50 which may be inserted or threaded into mounting holes 52 on a base 54 of load-bearing apparatus 18. Elements 50 may be made of an elastomer, such as rubber or neoprene, and may have any desired hardness.

**[0026]** In Fig. 5, load-bearing apparatus 18 includes a ball 56 which articulates with a socket 58 attached to an underside of support platform 12. An adjustment screw 60 may be provided for fixing socket 58 with respect to ball 56. By tightening screw 60, support platform 12 may be statically fixed at any desired angle with respect to the horizontal. If instead screw 60 is not tightened, then support platform 12 will dynamically wobble about ball 56. Biasing devices 61, such as springs, may be provided for tensioning movement of support platform 12 about ball 56.

**[0027]** In Fig. 6, load-bearing apparatus 18 includes a plurality of props 62 arranged in a pattern underneath support platform 12. An actuator 64, such as a hydraulic device or a solenoid, selectively raises one or more props 62, so as to selectively tilt support platform 12. Alternatively or additionally, load-bearing apparatus 18 includes a moving plate 66 that moves support platform 12. Moving plate 66 may be an X-Y-Z positioner or a turntable, or a combination thereof, for example. For example, moving plate 66 may translate support platform 12 along any of three mutually orthogonal axes X, Y and Z, or may rotate support platform 12 about any of those axes. Preferably a computer 68 is in communication with moving plate 66 and/or actuator 64. Moving plate 66 may be thus programmed to move in a predetermined sequence. Support platform 12 may be provided with one or more sensors 70, such as pressure sensors or electrical contacts, for example, for sensing movement of the patient on support platform 12. Sensors 70 send the sensed information to computer 68 which the commands moving plate 66 to move support platform 12 in accordance with the sensed information.

**[0028]** In Fig. 7, support platform 12 is supported by a fluid bed 72, such as a tank of water. In this case, the patient can move about the surface of the fluid in any desired manner.

**[0029]** Reference is now made to Fig. 8 which illustrates another preferred embodiment of rehabilitation exercise apparatus 10 with adaptation for the lumbar spine and shoulder. This embodiment is particularly useful for a variety of balance and strengthening exercises, such as, for example, rehabilitation exercises for improving shoulder girdle strength, endurance and proprioreception. In this embodiment, poles 26 are longer than in the previously described embodiments and are preferably anchored to one or more walls or ceiling. Elongate connecting members 40 are connected to different parts of the arms or torso by means of connectors 48, and a wide variety of rehabilitation exercises may be planned and performed.

**[0030]** It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of the features described hereinabove as well as modifications and variations thereof which would occur to a person of skill in the art upon reading the foregoing description and which are not in the prior art.

## Claims

1. Rehabilitation exercise apparatus (10) comprising:

   a support platform (12) adapted for supporting a foot (14) of a patient (16); and
   characterized by variable tilt load-bearing apparatus (18) upon which said support platform (12) is supported, said load-bearing apparatus (18) being operable to selectively statically support said support platform (12) at a desired, fixed angle selected from a range of angles and to selectively dynamically support said support platform (12) whereby said support platform (12) angularly moves about at least one pivot.

2. Apparatus (10) according to claim 1, further comprising at least one extension arm (20) extending

from said load-bearing apparatus (18) in a first direction and at least one pole (26) extending from said at least one extension arm (20) in a second direction, said first and said second directions forming an angle therebetween in a range of 0° to 180°.

3. Apparatus (10) according to claim 2, further comprising a plurality of said poles (26) wherein at least one of said poles (26) has a height different from another said pole (26).

4. Apparatus (10) according to claim 2, wherein a placement of said at least one extension arm (20) relative to said support platform (12) is selectively variable.

5. Apparatus (10) according to claim 2, further comprising at least one elongate connecting member (40) connected to said at least one pole (26), said elongate connecting member (40) being attachable to a portion of said patient (16).

6. Apparatus (10) according to claim 5, wherein said at least one elongate connecting member (40) is constructed of an elastic material.

7. Apparatus (10) according to claim 1, wherein said load-bearing apparatus (18) comprises at least one generally hemispherically-shaped support element (50).

8. Apparatus (10) according to claim 1, wherein said load-bearing apparatus (18) comprises a ball and socket joint (56, 58) wherein said support platform (12) articulates about said joint.

9. Apparatus (10) according to claim 1, wherein said load-bearing apparatus (18) comprises a plurality of props (62) arranged in a pattern underneath said support platform (12), and an actuator (64) which selectively raises at least one of said props (62) so as to selectively tilt said support platform (12).

10. Apparatus (10) according to claim 1, wherein said load-bearing apparatus (18) comprises a fluid bed (72).

11. Apparatus (10) according to claim 1, wherein said load-bearing apparatus (18) comprises a moving plate (66) that moves said support platform (12) in at least one of translatory and rotational movement.

12. Apparatus (10) according to claim 11, wherein said moving plate (66) is programmed to move in a predetermined sequence.

13. Apparatus (10) according to claim 1, wherein said support platform (12) comprises sensors for sensing movement of said patient (16) on said support platform (12).

14. Apparatus (10) according to claim 11, wherein said support platform (12) comprises sensors for sensing movement of said patient (16) on said support platform (12) and wherein said moving plate receives sensed information from said sensors and moves said support platform (12) in accordance with the sensed information.

15. Apparatus (10) according to claim 1, wherein said support platform (12) comprises a support surface with a selectively changeable texture.

16. Apparatus (10) according to claim 15, wherein said support surface is selected from the group consisting of hard foam, soft foam, angled foam, wood, angled wood, artificial grass, water, sand, and imbedded stones.

17. Apparatus (10) according to claim 5, wherein said at least one elongate connecting member (40) is attachable to an upper portion of said patient (16) so as to permit exercise of at least one of a lumbar spine and a shoulder.

FIG. 1

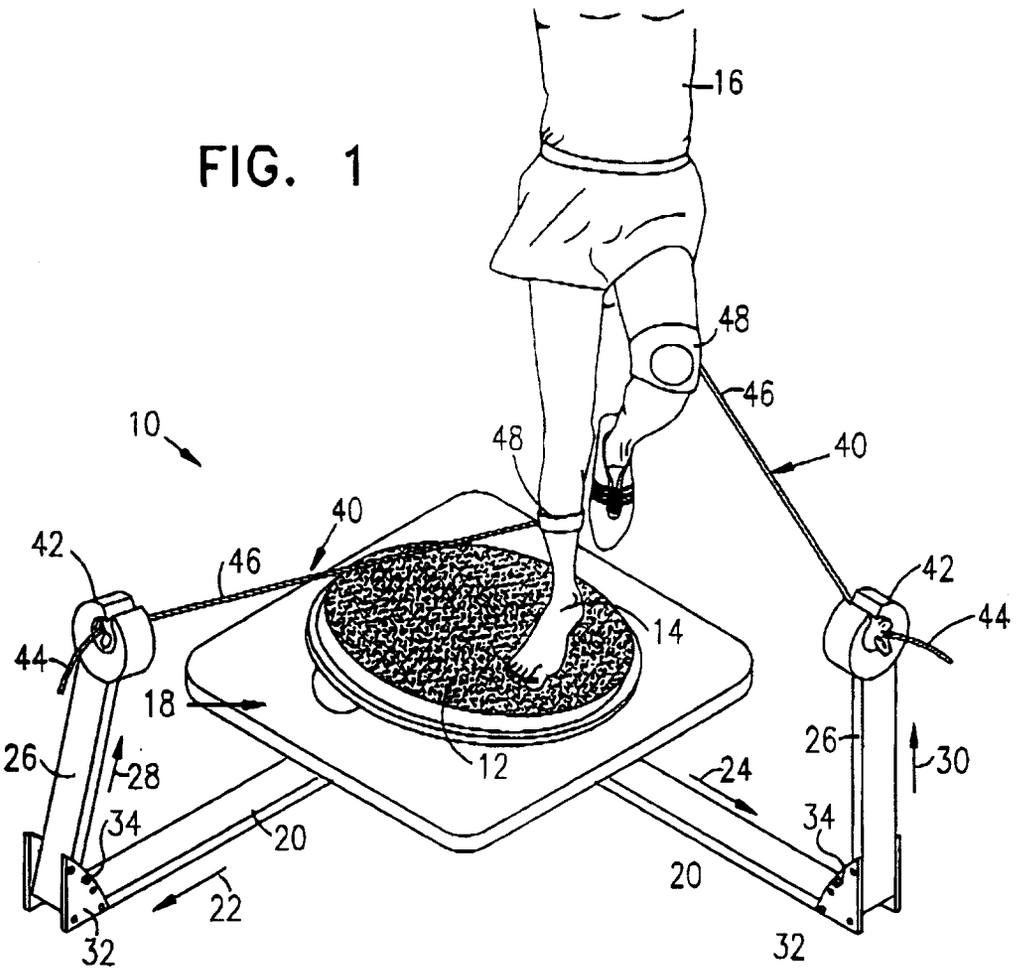
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FIG. 2

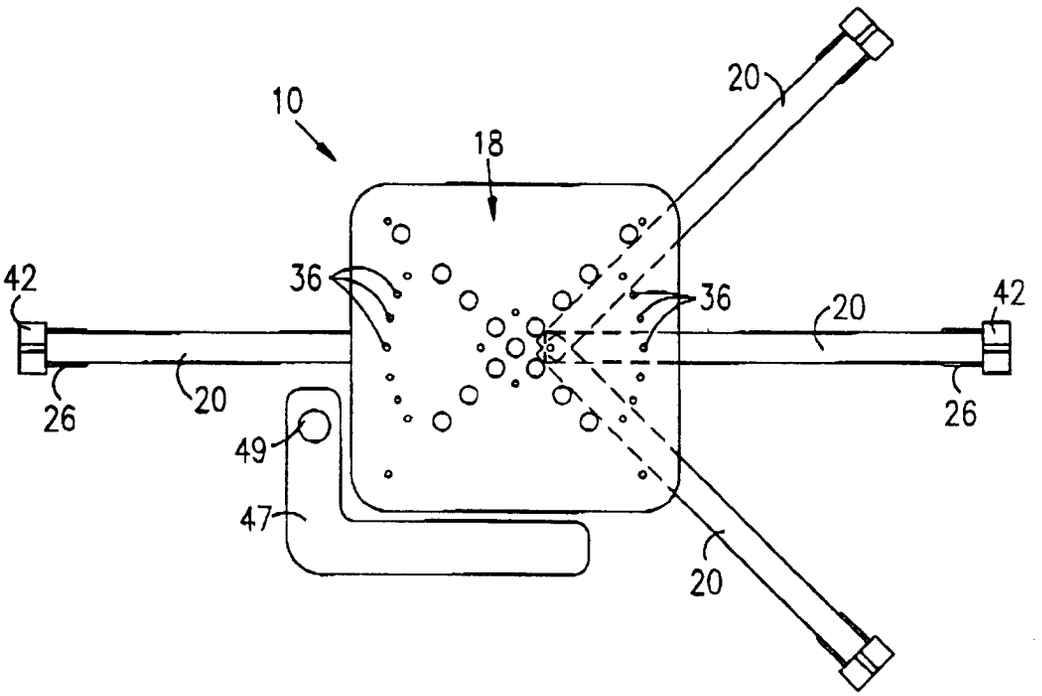
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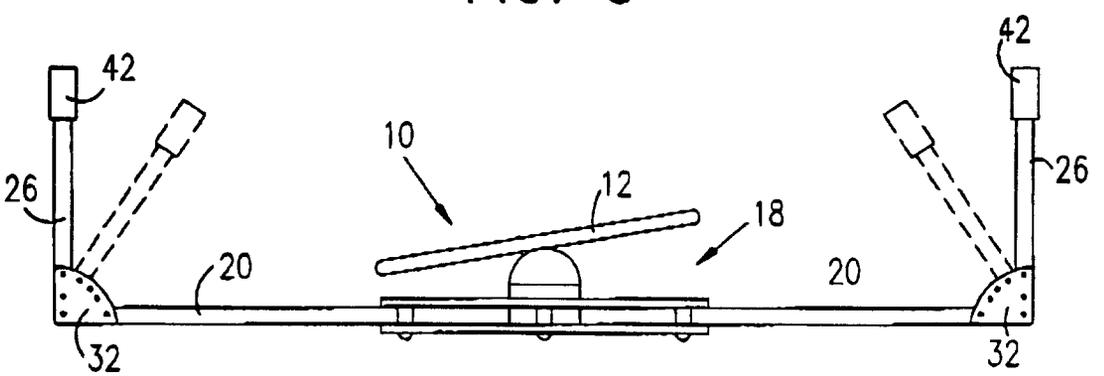
FIG. 3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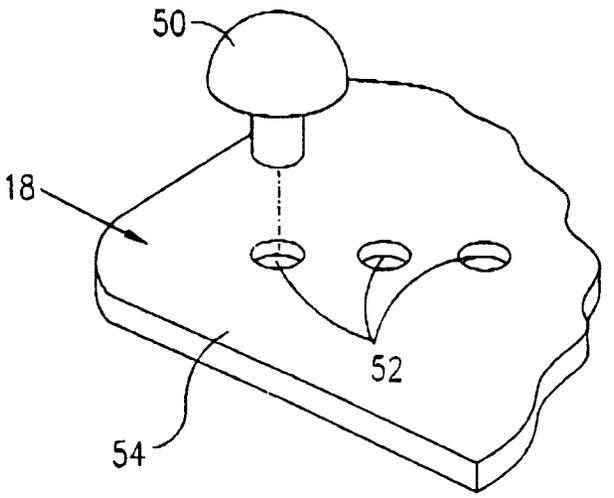


FIG. 5

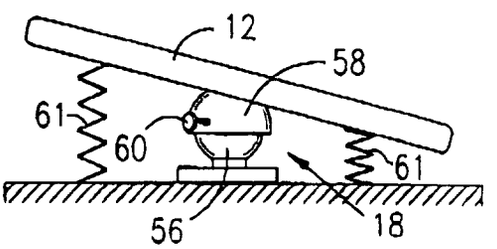

FIG. 6

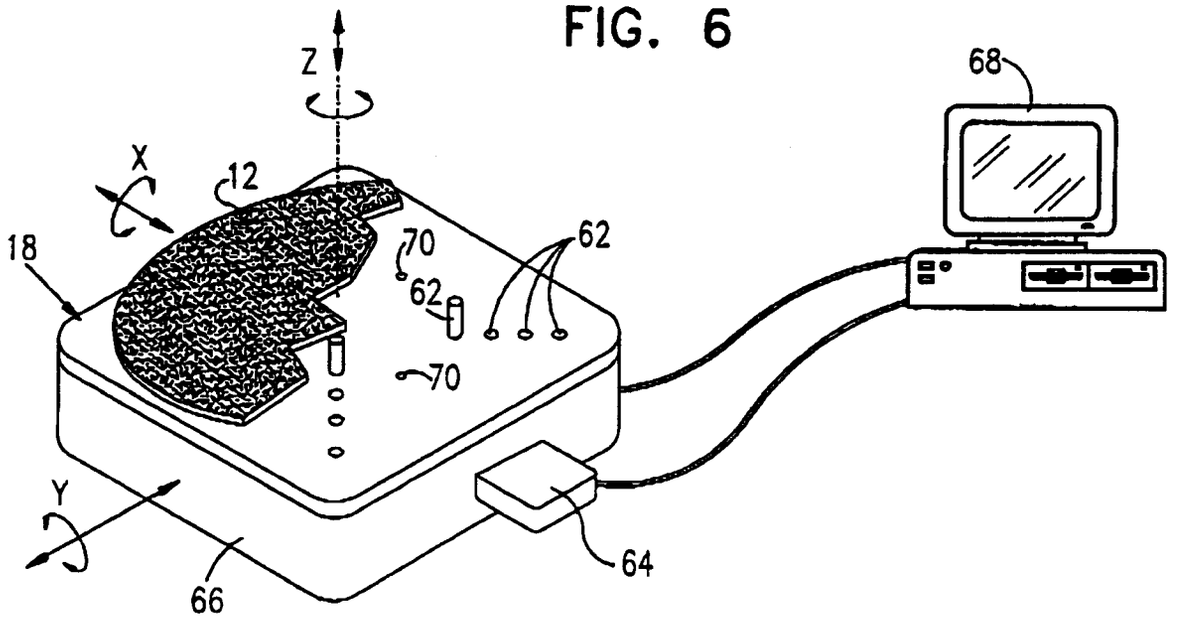


FIG. 7

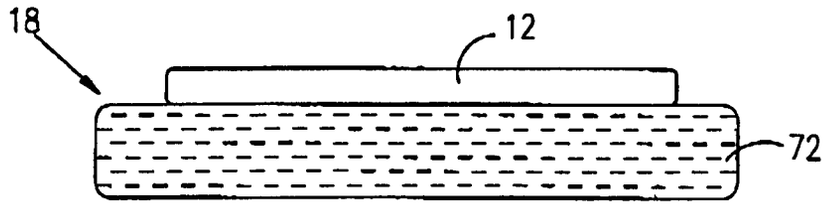

FIG. 8