Dec. 22, 1964 M. F. DE BOY ETAL 3,161,968

TASK TRAINER

Filed Feb. 19, 1962 4 Sheets-Sheet 1

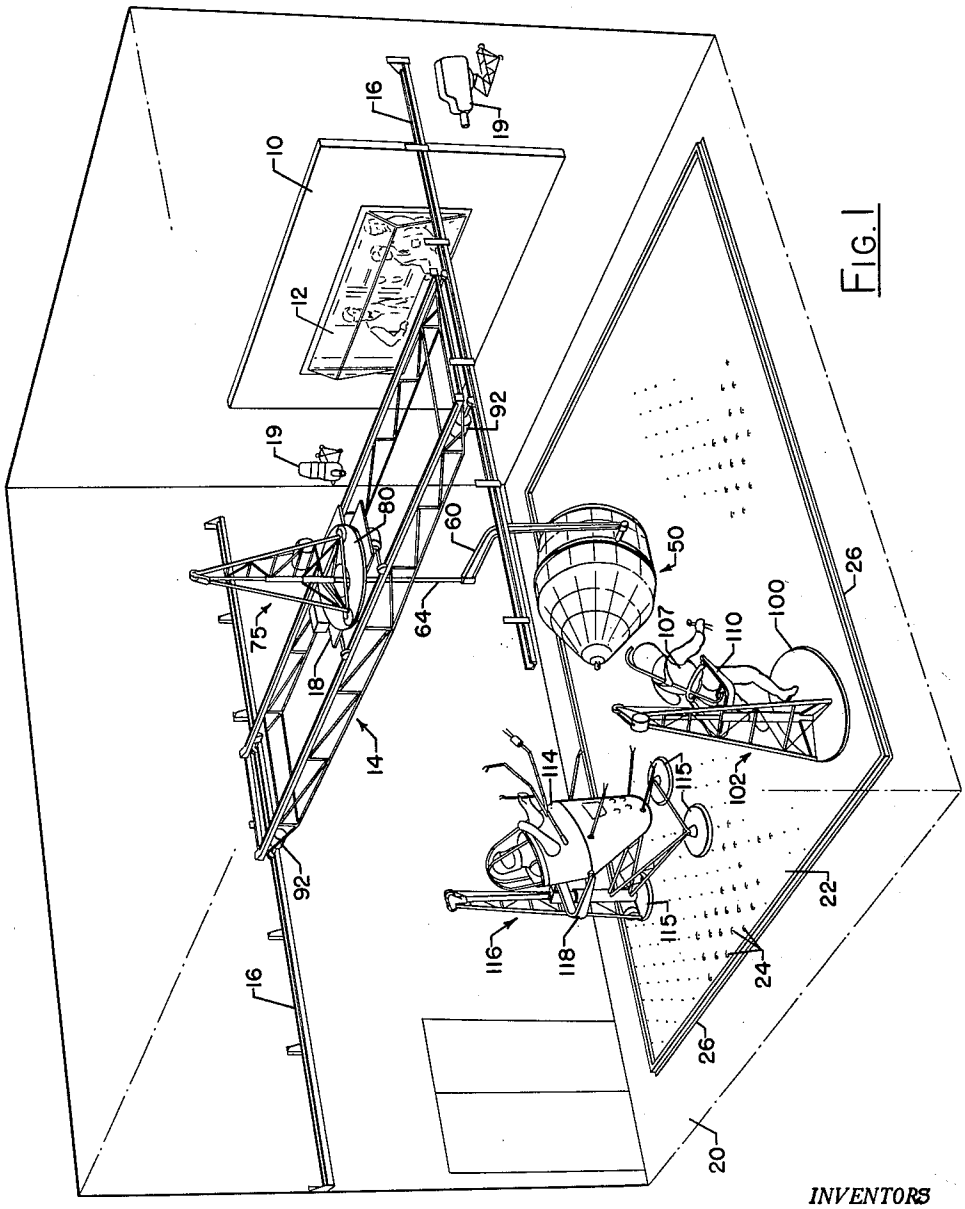


FIG. 1

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TASK TRAINER

Filed Feb. 19, 1962 4 Sheets-Sheet 2

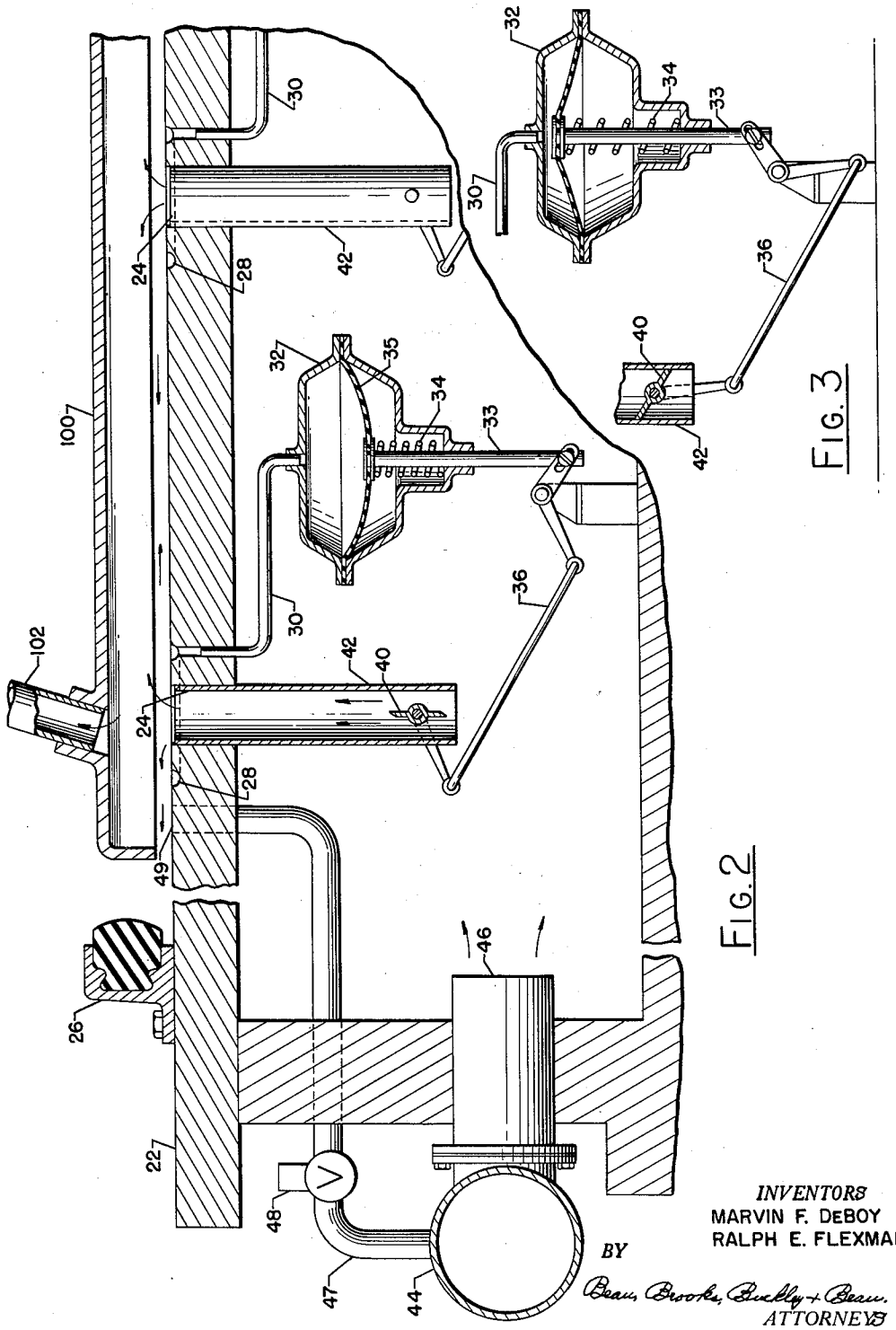


FIG. 3

FIG. 2

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TASK TRAINER

Filed Feb. 19, 1962 4 Sheets-Sheet 3

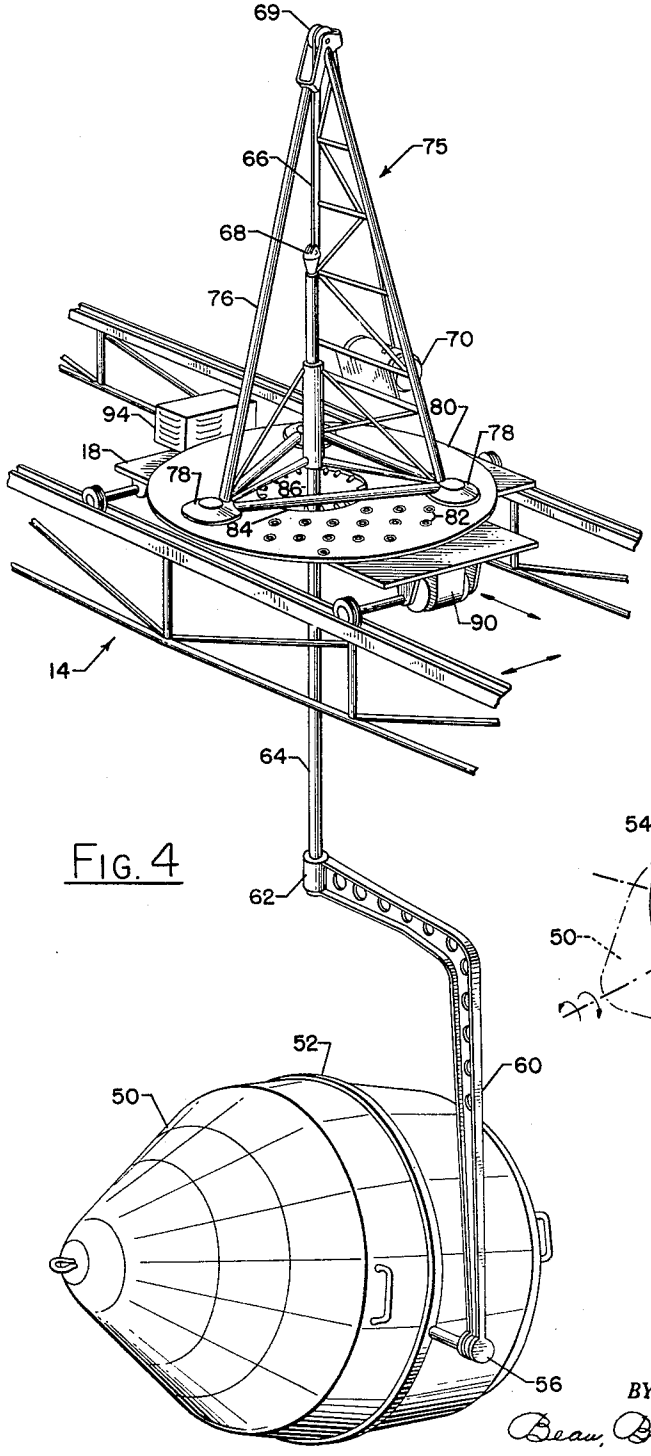


FIG. 4

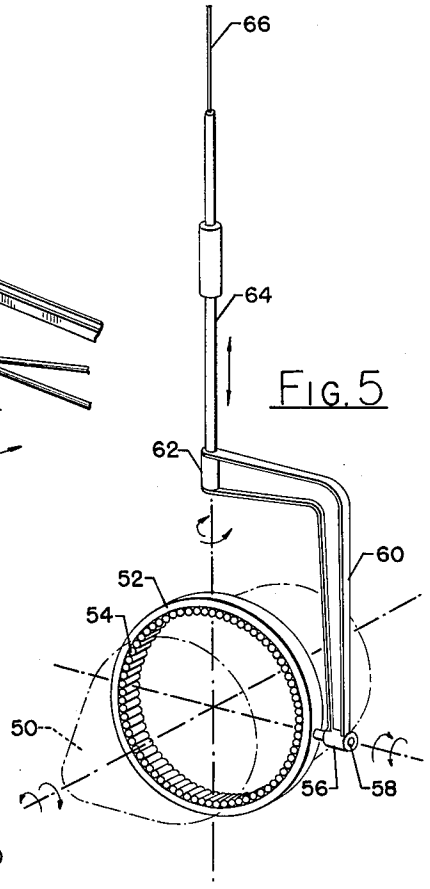


FIG. 5

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TASK TRAINER

Filed Feb. 19, 1962 4 Sheets-Sheet 4

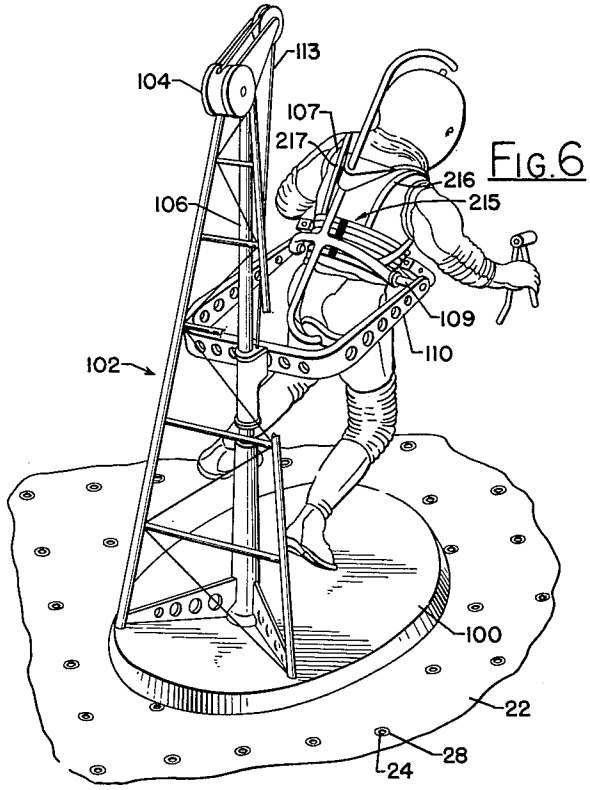


FIG. 6

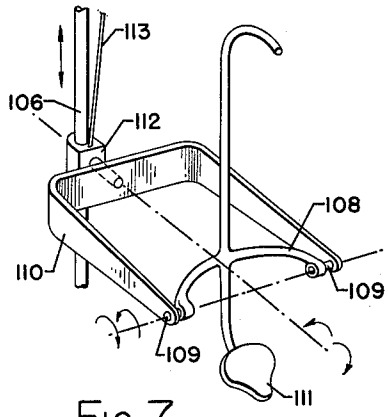


FIG. 7

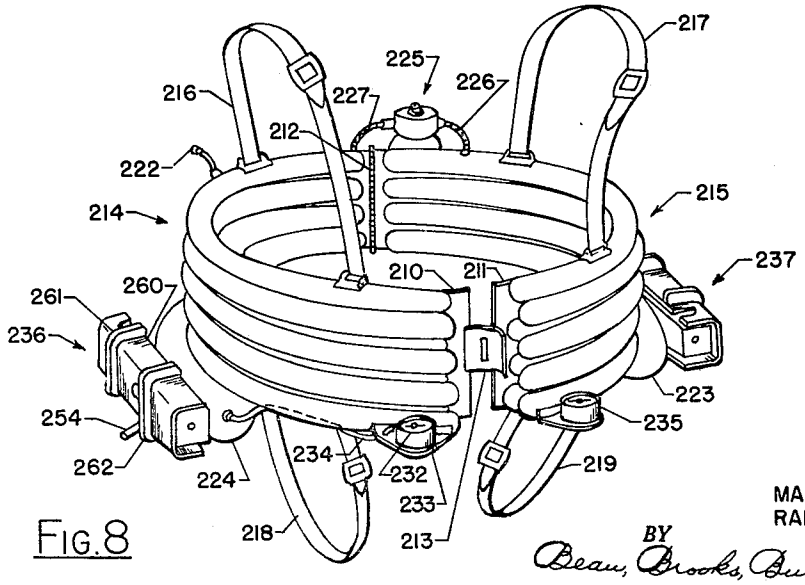


FIG. 8

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United States Patent Office 3,161,968 Patented Dec. 22, 1964

3,161,968

TASK TRAINER

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Filed Feb. 19, 1962, Ser. No. 173,905
8 Claims. (Cl. 35—12)

This invention relates to personnel training devices, and more particularly to equipment for conditioning and/or training personnel for certain work tasks to be performed incidental to explorations in outer space.

It is a principal object of this invention to provide in a training studio, object supporting and gravity force countering devices adapted to alternatively support person and/or objects to be worked upon in such manner as to simulate the substantially weightless working conditions environmental to space task operations.

More specifically, an object is to provide improved mechanisms for the support "in space" of training personnel and for objects to be worked upon; said mechanisms being adapted to "give" in response to forces directed thereon so as to effectively simulate the positionally non-reactive nature of substantially weightless objects in outer space, due to the lack of substantial gravity forces and attendant frictional effects.

Another object is to provide an improved theater for the training of personnel to familiarize them and to condition them to work efficiently under environment conditions anticipated to be encountered in outer space.

Another object is to provide an improved theatre as aforesaid embodying an improved "space" illuminating arrangement.

Another object is to provide a theatre as aforesaid having a novel floor and moving object support mechanism.

Another object is to provide for use in a theatre as aforesaid an improved personnel supporting mechanism.

Other objects and advantages of the invention will appear from the specification and the accompanying drawings wherein:

FIG. 1 is a perspective of a personnel training studio of the invention;

FIG. 2 is an enlarged scale fragmentary sectional view through a portion of the studio floor structure showing parts of the personnel support and levitation control mechanism;

FIG. 3 is a fragmentary view of a valve control portion of FIG. 2, showing the mechanism in valve closed condition;

FIG. 4 is a fragmentary perspective of an object support mechanism of the invention;

FIG. 5 is a disassembled detail of the mechanism of FIG. 4;

FIG. 6 is a close up view of a portion of FIG. 1 showing the mechanism thereof in more detail;

FIG. 7 is a disassembled view of a portion of the mechanism of FIG. 6; and

FIG. 8 is a more detailed frontal perspective view of the personnel support belt and control device of FIG. 6.

As shown in FIG. 1, the training theater may comprise a conventionally shaped room, the walls of which will preferably be of soundproof material and painted with light absorbing paint. One of the walls incorporates a light source as indicated generally at 10 consisting of a bank of high intensity lamps or the like disposed behind a light diffusing panel, so as to project into the theater space a mass of light designed to simulate natural lighting conditions expected to be encountered in space. The instructors booth containing various instructor controls, student response recorders, and monitors and the like will conveniently be located behind an

observation window as indicated at 12 incorporated in the center of the light panel 10.

To support objects to be worked upon during the training procedure so as to simulate a condition of weightlessness, the theater is provided with an overhead crane as indicated generally at 14; the crane being of the horizontal travel type and supported by tracks 16—16 fastened to upper side wall portions of the theater so that the crane may travel the length of the studio. The crane is equipped with a cross carriage 18 mounted on rollers for lateral travel between the room side walls. Movement of the crane parts will of course be effected by suitable electric motors drawing power through conventional bus-bar arrangements. Recording cameras may be mounted on the side walls of the theater as indicated at 19—19, and may be of either the movie or TV type.

The basic floor structure of the theater is indicated at 20 and supports a special test floor as indicated at 22. The floor 22 may be fabricated of any pressure-tight material such as metal sheeting or composition board or the like, and is provided at intervals throughout its area with upwardly directed air outlet openings 24. The floor 22 is margined by a curbing 26 to confine the training maneuvers within the limits of the floor area. As shown in the drawing, each hole 24 is encircled by a groove 28 and a return pressure tube 30 is arranged in communication with each groove (FIG. 2). In each case the tube 30 delivers into a valve control device, which as shown herein may comprise a casing 32 into which a push rod 33 extends in sliding relation. A spring 34 is arranged to bias the push rod in one direction while the inner end of the rod is fastened to a flexible diaphragm 35 separating the casing 32 into two compartments. Thus it will be appreciated that whereas the spring 34 normally operates to displace the push rod into the casing 32 as shown in FIG. 3, whenever an unbalancing fluid pressure force develops against the opposite side of the diaphragm 35 it will cause the push rod to displace toward the position thereof shown in FIG. 2.

The push rod 33 mechanically connects through linkage as indicated generally at 36 to a valve 40 which is disposed interiorly of a conduit 42 controlling passage of air through the floor opening 24. A supply of pressured fluid such as compressed air, may be provided by means of a pipe 44 extending through a side wall portion of the subfloor structure and delivering as indicated at 46 into the plenum chamber formed between the floor members 20, 22. Thus it will be appreciated that whenever the control valve 40 of any one outlet conduit 42 is open, compressed air from within the plenum chamber will flow upwardly through the conduit and out of the associated opening 24.

As will be explained in more detail hereinafter, the personnel undergoing training will be supported relative to the floor 22 by means of special support devices having floor pad portions such as are indicated at 100 (FIGS. 1, 2). Assuming that compressed air from within the plenum chamber is escaping through at least one conduit delivering air against the pad 100, the back pressure developing under the pad 100 will communicate through the tubing 30 to the actuator 32 and will overcome the spring 34 so as to displace the valve control linkage in such manner as to open the associated valve 40. Thus, full supply of compressed air will be delivered through all conduits 42 which are disposed at any one time beneath the pad 100. This creates a levitating pressure force against the pad 100 which assumes the weight of the trainee and the associated support structure. To initiate the levitation operation, a branch supply conduit 47 (FIG. 2) may be arranged in communication with the main supply pipe 44, and is furnished with a control valve

48 which may be remotely controlled from a manual control station by any suitable means (not shown) so that whenever the valve 48 is opened a blast of compressed air will flow out of a floor opening 49 and hence into the space below the pad 100. This air supply will furnish the requisite back pressure required to operate the valve control mechanisms associated with the floor openings which now reside beneath the pad 100.

Thus, the levitation process is initiated as explained hereinabove, and the support pad is now supported upon a continuously flowing film of air, and may now be easily shifted in any direction across the surface of the floor 22. Whenever, the pad 100 is shifted positionally, the valves controlling the conduits which become uncovered by such movement of the pad, will automatically close due to the loss of pneumatic back pressure through the return tube 30 which permits the associated spring to return its valve to closed position. On the other hand, conduits which are newly covered by the pad 100 will automatically assume the load by virtue of the back pressures developing in their associated valve control mechanisms which cause their valves to open. Hence, assuming a condition of levitation, the pad 100 may be shifted laterally in any desired direction and only those ports which are covered by the pad at any one time will be in operation to provide the levitation forces. The floor and compressed air flow control devices illustrated and described hereinabove are of the type disclosed and claimed in our copending patent application Serial No. 165,771 filed January 12, 1962, and now Patent 3,081,886 issued March 19, 1963.

One or more work training objects are provided with the theater, for example as designated generally at 50 in FIGS. 1, 4, 5. As shown herein the object 50 is fabricated and shaped to resemble a typical "space capsule" or like object; but it will be understood that it may be of any other preferred form and will be so built as to present to the training personnel typical handling problems such as are contemplated to be met when working with such objects in space. To provide the capsule 50 with a feeling of weightlessness, it is mounted by means of a carrying ring 52 and roller bearing arrangement as shown at 54, whereby the capsule is free to rotate about its longitudinal axis within the ring 52. The ring 52 is gimbal-mounted by means of a rotatable bearing 56 and an elbow-shaped arm 60 which is in turn mounted by bearing 62 at the bottom of a suspension rod 64. The rod 64 is carried by a flexible cable 66 through connection 68, the cable 66 training over a pulley 69 running to the output pulley of a pneumatic torque motor 70. The motor 70 and pulley 69 are carried by a tripod-shaped pylon 75, including legs 76 and foot pads 78 which rest upon a support plate 80 which corresponds to the floor pad 22 of FIGS. 1, 2.

The plate 80 is carried by the carriage base 18, and both the carriage 18 and the base plate 80 are centrally apertured as indicated at 84 (FIG. 4). Thus, the suspension rod 64 which is slidably held in the pylon frame 75 as by means of a slide bearing 85, is free to move laterally relative to the floor plates 18, 80. The plate 80 carries a plurality of sensing fingers 86 extending radially from the inner periphery of the aperture 84 therein, for the purpose of sensing any lateral movements of the suspension rod 64 which are of such order as to approach the margins of the aperture 84.

Thus, it will be appreciated that the pylon 75 supports the capsule 50 by means of the foot pads 78 resting on the plate 80. As explained, in connection with the floor 22 of FIGS. 1, 2, compressed air under the floor plate 80 will function to support the frame 75 relative to the plate 80 on films of constantly moving air issuing only from those ports which are beneath the foot pads 78. The supply of compressed air for this purpose may of course be arranged in any convenient manner, such as by means of a compressor indicated at 94 mounted on the carriage plate 18. The sensors 86 are operatively connected to control reversible direction electric motors such as are indicated at 90, 92 (FIGS. 1, 4) for displacing the carriage plate 18 and the gantry 14, respectively, on their corresponding tracks in lateral directions as indicated by the double headed arrows of FIG. 4; but only whenever the capsule 50 is displaced by the training personnel sufficiently to cause the suspension rod 64 to contact one or more sensors. The control system then operates to cause the appropriate motor or motors to displace the carriage plate 18 and/or gantry 14 in appropriate direction so as to avoid interference thereof against movement of the suspension rod 64. Thus, the permissible lateral displacements of the suspension rod 64 will not be limited by the diameter of the aperture 84. Consequently, whenever a trainee applies a tool or other source of pressure against the capsule 50 at any surface portion thereof, the capsule will exert no appreciable reactive force and will simply rotate and/or displace in the consonance with the applied forces. Thus, effective simulation of a condition of weightlessness for the capsule is achieved.

The trainees are likewise arranged to be supported in such manner as to simulate conditions of weightlessness. For example, as shown in FIGS. 1, 6–8, a trainee is illustrated as being supported upon a floor pad 100 which in turn mounts a pylon 102. The pad 100 is of hollow bottom form in communication through means of a conduit, such as the hollow center of one of the legs of the pylon, to a pneumatic motor 104 which operates in the manner of the motor 70 referred to hereinabove. The pylon includes a trainee support rod 106 upon which a harness 107 is mounted to be vertically slidable (FIG. 6). The harness includes a suspension belt arrangement which is shown in greater detail in FIG. 8. As shown in FIG. 7 the harness-belt unit (with the trainee therein) is carried by means of a yoke 108 which spans the back of the trainee and pivotally mounts as indicated at 109, 109 upon a U bracket 110. This U bracket is pivotally mounted upon a slide bearing 112 which moves vertically on the support rod 106 referred to hereinabove. A flexible cable 113 tied to the slide bearing 112 and to the motor 104 counterbalances the weight of the trainee as explained hereinabove in connection with the arrangements of FIGS. 4, 5.

The yoke 108 may also include upper and lower extension arms to provide a seat as indicated at 111 and an arm extending behind and above the head of the trainee, as shown in FIG. 6. Thus, motions of the trainee's body are transmitted through the harness to the support system, and it will be appreciated that by virtue of this arrangement the trainee is thereby supported so as to simulate a condition of weightlessness. For example, if he attempts to exert any force, as against the work object 50, the reactions thereto will be shared by the trainee and the workpiece, and they will simply move apart and/or rotate in opposition to the direction of the applied forces. By this arrangement the trainee may bodily move vertically, forward or back, or sidewise; and at all times he is free to rotate about the axes of the bearings 112, 109 and of the support shaft 106. As explained hereinabove, the capsule 50 is similarly free to displace and/or rotate about its corresponding axes; and therefore the training conditions desired are efficiently simulated.

As shown in FIG. 1, trainees may be otherwise supported in accord with the present invention, such as by simply sitting within a cabinet or casing as indicated at 114. The case 114 is supported by a pylon as indicated at 116, as in the manner of the support of the harness of FIG. 6. Thus, a U bracket as indicated at 118 is employed to mount the case 114 relative to the pylon 116, and the pylon is supported relative to the test floor 22 by means of floor pads 115 which function in the manner of the pad 100 of FIG. 6. Thus, the case 114 may be pressurized or otherwise conditioned so as to provide

additional training facilities in simulation of anticipated environmental conditions, such as may require pressurization or other isolation effects for various reasons.

As shown in FIG. 8, the trainee support belt 215 may be of the form disclosed for example in copending patent application Serial No. 27,792, now Patent 3,066,887 issued December 4, 1962, commonly assigned with the present application. As shown therein the support belt unit may include two semi-circular band portions 210–211 relatively hinged as indicated at 212 and provided with a connection clasp 213. The bands 210 and 211 provide mounting means for propellant storage tube bundles indicated generally by the reference characters 214 and 215 and which may be filled with propellant, such as liquefied gas or other high pressure gas. Connected to the top of each tube bundle is an adjustable shoulder strap as indicated generally by the reference characters 216 and 217; and on the lower side thereof are adjustable groin straps 218 and 219. The manner in which the device is fitted to a user is illustrated in FIG. 6 of the drawings. A flexible conduit (not shown) interconnects the two tube bundles, and one of them is provided with a filling nipple 222 as shown in FIG. 8.

The tube bundles are preferably connected to the pressure manifolds through a pressure regulator 225. The pressure regulator is provided with a line 226 leading from the high pressure tube bundles, and on the low pressure side there is a line 227 leading to the two manifolds 223 and 224 through branch conduits. A low pressure gauge 232 is mounted on a suitable bracket 233 at the front of the belt and this gauge is connected through a line 234 to the pressure manifold 224. A further pressure gauge 235 is mounted on a similar bracket at the opposite side of the belt, and this gauge is connected directly to the tube bundle 215. In this manner, the operator can very easily determine the reserve in the tube bundles by reference to the gauge 235, and can ascertain the correct setting of the pressure regular 225 by reference to the gauge 232.

Mounted at either side of the belt directly upon the low pressure manifolds 223 and 224 are valve block assemblies indicated generally by reference characters 236 and 237. Each of these valve block assemblies includes a main body portion suitably secured to its associated manifold, and the manifolds are provided with connections into the body of each associated valve block so as to subject the interior of the bodies to the same pressure as is present in the manifolds 223 and 224.

The bodies are provided with pluralities of orifices on the forward end of the valve body; on the rear wall of the body, on the top wall; and on the bottom wall. Also, an additional orifice with which is associated at least one nozzle as shown at 254 is provided for exerting lateral thrust, as will be presently apparent. The actuating mechanism for the valve in each case includes a channel-shaped member 260 having positioning guards 261 and 262 thereon. As can be appreciated the operator's hands grip the channel member 260, being positioned between the guard or positioning portions 261 and 262.

From the above, it will be clearly apparent that the valve actuating mechanism is extremely practical and efficient, particularly in view of the fact that the motion imparted to the actuating mechanism by the user will effect a corresponding motion to his body. For example, when the two members 260 are moved forwardly, the rearward orifice members are uncovered so that the propellant escapes from the rear of the valve housing, thus imparting a forward motion to the user. Conversely, rearward movement of the actuators uncovers the orifice members at the forward end of the valve bodies, imparting rearward motion. Likewise, lifting up on the actuating mechanism exerts a lifting force and pushing downwardly exerts a lowering force. The nozzles 254, since they are laterally directed, will impart lateral motion to the user and, of course, are utilized only one at a time. For example, should the user wish to move to the left, he opens the right hand valve thus causing a reaction jet to escape on the right side with a resultant motion to the left. It will also be readily appreciated that rotation can be easily effected either by pushing forwardly or rearwardly on only one actuator, or pushing in opposite directions on both. A lateral rotating motion of the user's body may be effected similarly by either lifting up or pushing down on only one actuator or imparting opposite such directions to both. Also, compound motion is easily effected by skillful manipulation of the actuating mechanism. For example, lifting up and moving forwardly will impart an upwardly angled motion. In this fashion, it will be readily apparent that the operator may very easily move in any direction in which he chooses.

It will further be appreciated that the propellant may be any suitable substance. For example, it may be simply compressed air or similar propellant, or it could be hydrogen peroxide-catalyst, lithium-water or other reaction type propellants. Also, alternate designs or variations within the scope of this invention could utilize storage tanks or spheres on the back or elsewhere instead of the tube bundles. Also, it will be readily appreciated that this mechanism may be incorporated practically in conjunction with a capsule containing an individual, in which case, the man would be inside the capsule and the fundamental thrust-controller device would then merely be attached to the outside with the manual grips or levers protruding inside and suitably positioned to be operated by the hands or feet, as desired.

Thus it will be understood that in accordance with the present invention the objects to be worked upon will be supported in such manner as to simulate weightlessness, and that the trainees are similarly supported as though "in space" and are provided with means for propelling themselves and guiding their motions in the manner of proposed space exploratory work. Hence, the trainees may be tested as to aptitudes and/or conditioned for efficient performances under the supervision of instructors prior to any actual exploratory work.

We claim:

1. In a training theater for personnel prior to space exploratory work, a floor, means for supporting an object simulating a workpiece in a universally displaceable and rotatable condition and at an elevation above said floor, carriage means for supporting a trainee against gravity forces while being vertically displaceable thereon and universally rotatable, pneumatic cushion means reacting against said floor and said carriage means for maintaining said carriage means free from said floor without restraint of movement of said carriage means in directions parallel to said floor, and jet thrust means adapted to be attached to a trainee's body under control by the trainee for effecting movement of said carriage means to approach the object simulating a workpiece and for controlling vertical and universally rotatable motions of the trainee.

2. In a training theater for personnel prior to space exploratory work, a floor, means for supporting an object simulating a workpiece in a universally displaceable and rotatable condition at an elevation above said floor, carriage means including a base and a harness vertically displaceable thereon and universally rotatable with respect thereto and means for counterbalancing gravity forces acting upon the trainee, pneumatic cushion means reacting against said floor and said carriage means for lifting and maintaining said carriage means free from said floor without restraint of movement of said carriage means in directions parallel to said floor, and manually controlled power means carried by said harness for effecting movement of said carriage means to approacch the object simulating a workpiece and for controlling vertical and universally rotatable motions of the trainee.

3. A training theater for personnel to be aptitude-tested and/or preconditioned for space exploratory work comprising, in combination,

personnel carriage means,

means supporting said carriage means for substantially frictionless movement in a horizontal plane,

said carriage means including personnel support structure and mechanism supporting such structure for free rotation about orthogonal axes contained within a horizontal plane,

workpiece simulating structure,

means supporting said workpiece simulating structure for substantially frictionless movement in a horizontal plane and including mechanism supporting the workpiece simulating structure for free rotation about orthogonal axes contained within a horizontal plane,

and personnel-controlled means for moving said carriage means in a horizontal plane to approach said workpiece simulating structure and for controlling rotational motions of said personnel support structure.

4. A training theater for personnel to be aptitude-tested and/or preconditioned for space exploratory work comprising, in combination,

a supporting floor,

personnel-carrying means including a base,

means for generating and maintaining an air film between said base and said floor so that said personnel-carrying means is levitated relative to said floor for free translation and pivoting about a vertical yaw axis relative to the floor,

said personnel-carrying means also including a personnel-carrying harness mounted on said base for free pivotal motion about orthogonal pitch and roll axes parallel to said floor.

and personnel-controlled reaction means having a plurality of reaction outlets for selectively effecting translation of said base as well as pitch, roll and yaw motions of said harness.

5. The assembly as defined in claim 4 wherein said harness is also mounted for vertical motion relative to said base,

and means for counterbalancing the weight of personnel supported by said harness.

6. A training theater for personnel to be aptitude-tested and/or preconditioned for space exploratory work comprising, in combination,

a supporting floor,

personnel-carrying means including a base,

means for generating and maintaining an air cushion between said base and said floor so that the base is free to translate and pivot about a vertical yaw axis relative to the floor,

said personnel-carrying means also including a personnel-supporting harness mounted on said base for vertical motion and for pitch and roll rotation relative thereto, and means for counterbalancing said harness and a trainee against the action of gravity forces,

an object simulating a workpiece,

means for freely supporting said object in universally displaceable and rotatable condition at an elevation above said floor,

and jet thrust means adapted to be attached to a trainee's body and including a plurality of selectively controllable jets under trainee control for effecting fore and aft and lateral motions to said personnel-carrying means for trainee approach to said object and for controlling vertical, pitch, roll and yaw motions of said harness.

7. The assembly as defined in claim 6 wherein said means for supporting the object includes an overhead crane having freedom of movement along orthogonal axes parallel to said floor, power means for moving said crane along said orthogonal axes, carrier means supported by a cushion of air for directly carrying said object for limited displacement relative to said crane, and sensor means for actuating said power means in response to approach of said carrier means to its limits of displacement relative to said crane.

8. A training theater for personnel to be aptitude-tested and/or preconditioned for space exploration comprising, in combination,

personnel-carrying means including a base,

means for supporting said personnel-carrying means for substantially frictionless movement in a horizontal plane,

said personnel-carrying means also including a personnel-carrying harness mounted on said base for free pivotal motion about orthogonal pitch and roll axes parallel to said floor,

and personnel-controlled reaction means having a plurality of reaction outlets for selectively effecting translation of said base as well as pitch, roll and yaw motions of said harness.

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