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Reswick

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[54] FLOTATION BED

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[52] **U.S. Cl.** .... **5/348 WB,** 4/185 L
[51] **Int. Cl.** **A47c 27/08**
[58] **Field of Search** .... 5/348, 349, 350, 348 WB; 4/185 L

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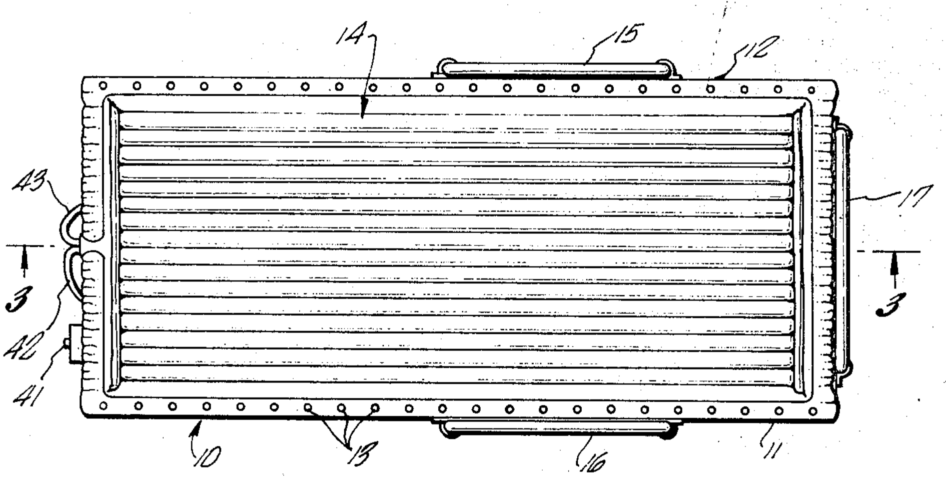
[57] **ABSTRACT**

A flotation bed is disclosed which utilizes a supporting fluid held in a container and covered by a flexible, fluid-impervious layer. The supporting fluid has a specific gravity substantially greater than 1 and in a preferred embodiment has a specific gravity of about 2. An inflatable bladder may be located in the bottom of the container and inflation of this bladder results in a raising of the supporting fluid level.

6 Claims, 7 Drawing Figures



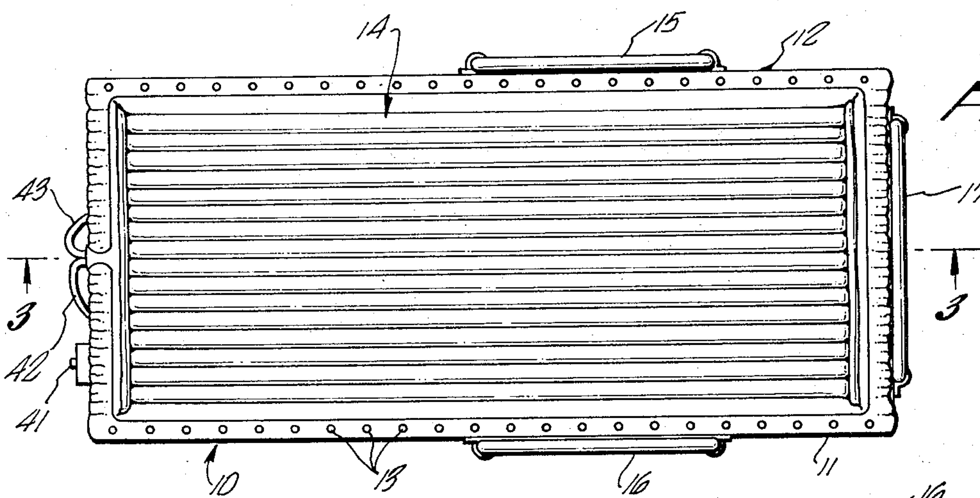


FIG-1

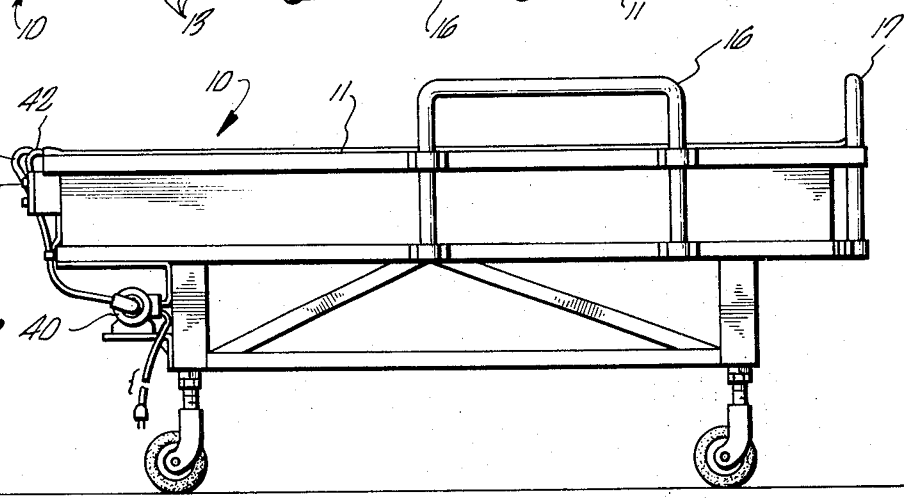


FIG-2

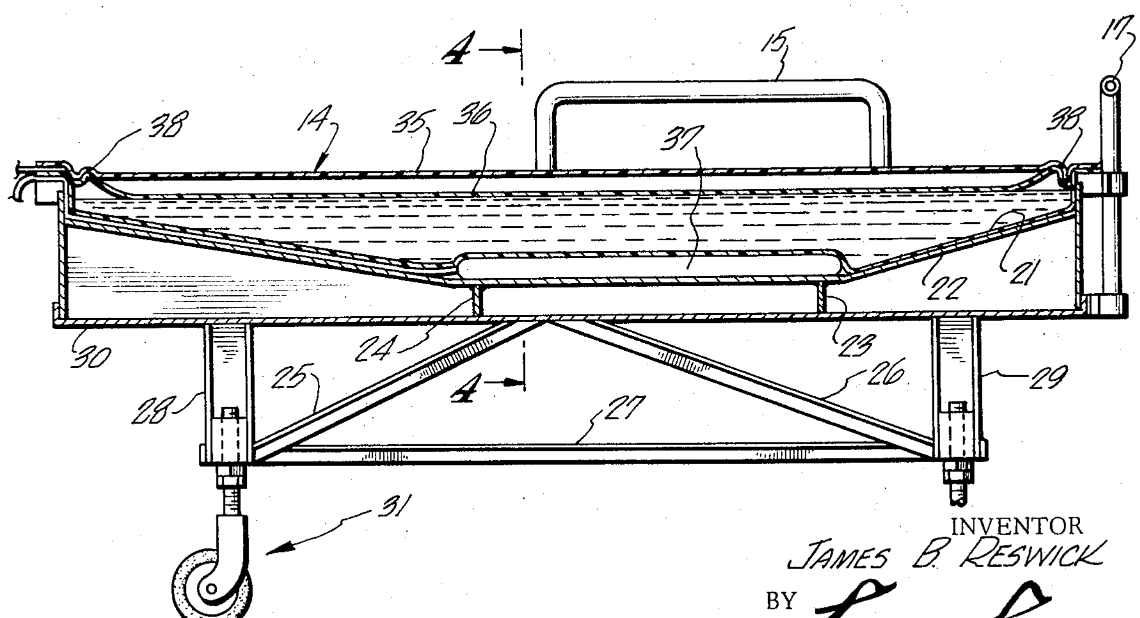


FIG-3

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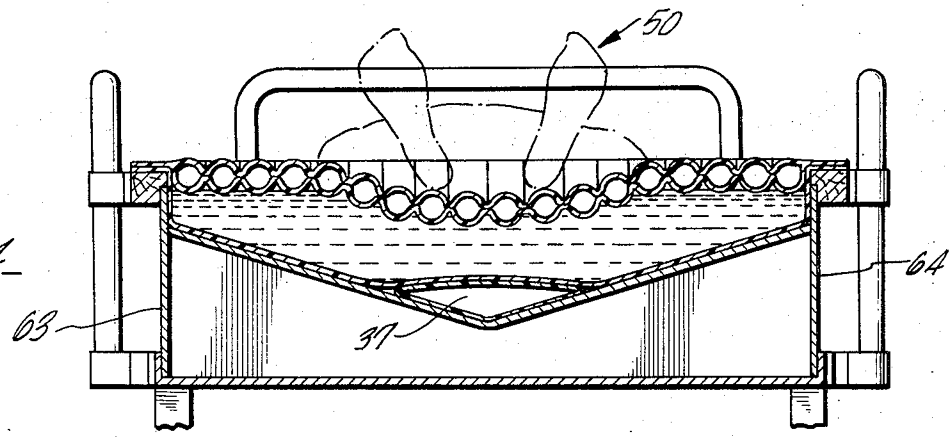
FIG. 4



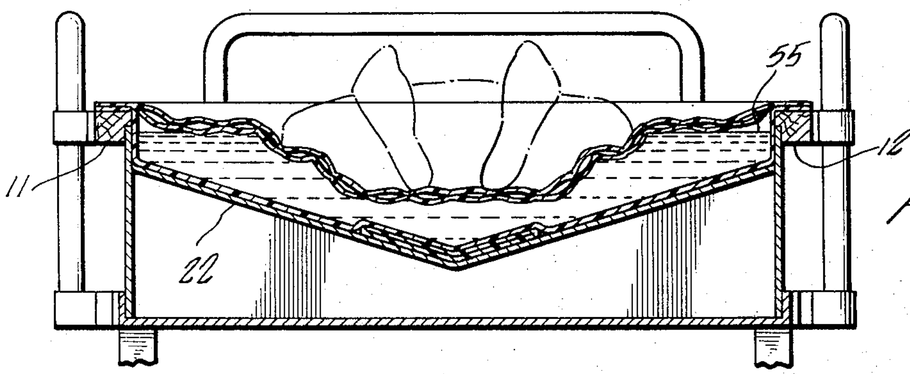


FIG. 5

FIG. 6

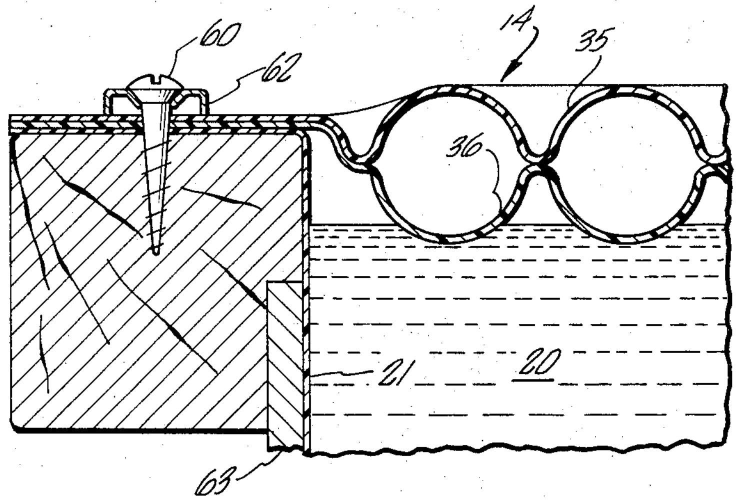
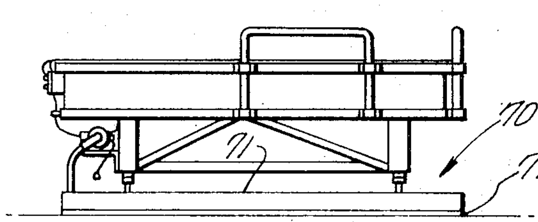


FIG. 7



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FLOTATION BED

BACKGROUND OF THE INVENTION

Beds utilizing fluid filled mattresses such as air mattresses and water-filled mattresses have found growing acceptance as a result of their comfort and their ability to provide a more uniform support than the conventional stuffed mattress. Recently, flotation beds have been used to overcome the propensity of paralyzed and long-term care patients to suffer decubitus ulcers (pressure sores) when confined in hospital beds for extended periods of time. A pressure sore results when the local pressure of any part of the human body is maintained above the value which closes off peripheral capillary blood flow for a period of over a few hours. For this reason, it is common practice in hospitals to turn such patients every two hours to relieve pressure areas. However, in many hospitals, because of crowding and understaffing, the necessary manpower to perform this task is unavailable. It is therefore of great importance that means be devised to prevent the formation of pressure sores and to cure any that do form. The means should not require increased manpower.

Many attempts have been made to control pressure areas by means of pneumatic mattresses which may or may not pulsate from one part to the other; "air flotation beds" which use silicon particles in a porous bag; sheep's wool and water beds. These systems are capable of reducing maximum pressure to some extent but such systems either are not capable of reducing pressure sufficiently to prevent the formation of pressure sores or have other inherent shortcomings which have limited their usefulness.

Several articles have appeared in the American Journal of Nursing on the treatment of decubitus ulcers by flotation therapy and the following two articles are incorporated by references herein in order to illuminate the background of the present invention: American Journal of Nursing, Volume 68, No. 11, November, 1968 pgs. 2351–2355 and pgs. 2356–2358. It is estimated in the former of these articles that the average cost of treating a decubitus ulcer is 5,000 dollars and that the course of these ulcers often determines the future of the afflicted person. The ulcers are caused as a result of reduced circulation of blood. In a normal person such reduced circulation creates "pins and needles" which will cause the person to change his position to relieve the pressure. Where, however, there is sensory loss or paralysis, the person may not move and skin breakdown results. Still further, the heavy weight-bearing prominences that are covered with only a limited padding of muscles and fat poorly tolerate compromised circulation and are thus particularly susceptible to these pressure sores. Shearing forces, produced by muscle spasm or abrupt changes in body position while the body is still in contact with a bed or chair, may be as detrimental as direct pressure.

A greater understanding of the cause of pressure sores has led to the development of a number of devices to reduce or eliminate pressure. Water beds have shown a great deal of promise because of their ability to float the patient with a pressure more evenly distributed than heretofore possible. Several problems, however, have been associated with such water beds, including the mental and physical discomfort of being largely submerged and surrounded by the bed. Hallucinations and nightmares have resulted, due in part to the

instability of the patient while in the bed as well as his largely enveloped condition. In order to overcome these problems a certain amount of "hammocking" has been combined with flotation, but this reintroduces increased pressure of weight-bearing prominences and the possibility of shearing forces.

SUMMARY OF THE INVENTION

It is thus a primary object of the present invention to provide a flotation bed which will reduce the maximum contact pressure on the user.

Another important object of the present invention is to provide a flotation bed which results in greater stability and comfort of the user while at the same time does not introduce points of abnormally high pressure or the possibility of shearing forces.

It is still another object of the present invention to provide a flotation bed which is capable of lowering or raising a patient.

Another object of the present invention is to provide a low-cost, reliable pressure support system for use by hospital patients which is capable of conforming to the shape of different patients.

These and other objects of the present invention are brought about by the provision of a flotation bed utilizing a supporting fluid which has a specific gravity substantially greater than water. Since the human body has a specific gravity of approximately **1** (that of water), the body must be totally submerged if it is to be supported only by hydrostatic pressure in water. A "water bed" operating on flotation alone would be unsatisfactory because of the surrounding of the patient by the plastic film which separates him from the water. Furthermore, the patient would be unstable and would tend to double up and would find it difficult to remain in a comfortable position. By the provision of a supporting fluid with a specific gravity substantially greater than **1**, the patient is supported with a substantial amount of his body held above the surface level of the supporting fluid. For instance, if the supporting fluid has a specific gravity of **2**, then only one half of the body need be submerged to support the total body weight. Thus, a condition of stability results in which the limbs tend to stay above the bed and tend to support the body in a comfortable and stable position.

It is significant to the success of the invention that the maximum hydrostatic pressure on the user does not tend to increase with increasing specific gravity until the specific gravity nears about **2**. This is evident from a consideration of the hydrostatic pressure exerted on a 1-foot diameter cylinder which is floating in water. If the cylinder itself has a specific gravity of **1**, it will not be totally supported by the water until it is completely submerged. The maximum hydrostatic pressure on the cylinder will be at least the pressure exerted by one foot of water. Now, if this same cylinder is floating in a liquid having a specific gravity of **2**, it will float with one half of its surface above the water. The maximum hydrostatic pressure will be that exerted by one-half foot of a liquid having a specific gravity of **2**. It is evident that the pressure exerted by one-half foot of a liquid having a specific gravity of **2** is exactly the same as the pressure exerted by one foot of water.

The relationship between maximum hydrostatic pressure and specific gravity is dependent upon the shape of the supported body. The closer the cross-sectional shape approaches a rectangle, the less the effect of specific gravity on maximum pressure. For the human body a specific gravity of 1½ and preferably near 2 has been found particularly comfortable and results in a maximum pressure of 20 to 25 millimeters of mercury. The specific gravity should not exceed about 3, however, as significant increased pressure may result. A fluid-impervious film is provided between the patient and the supporting fluid and it is preferable that this film be large enough so that it is incapable of causing any tension or "hammocking" effect.

By the term "a specific gravity substantially greater than water" it is intended to convey a specific gravity greater than about 1½ and preferably near 2. The supporting fluid should have low toxicity to human tissue in case of leakage, It should also be relatively low in cost and noncorrosive with respect to the surfaces which it contacts. Solutions of inorganic salts have been found useful and concentrated solution of zinc chloride ($ZnCl_2$) in water has been found particularly useful. Organic liquids such as trichlorotrifluoroethane and tetrachlorodifluoroethane may also be used. Furthermore, suspensions such as an aqueous suspension of barytes (barium sulfate ore) permit a wide range of specific gravities and have a low order of toxicity and corrosiveness.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of the flotation bed of the present invention.

FIG. 2 is a side elevation of the flotation bed of FIG. 1.

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 1.

FIG. 4 is a cross-sectional view taken along lines 4—4 of FIG. 3.

FIG. 5 is a cross-sectional view taken along lines 4—4 of FIG. 3 with the air mattress deflated.

FIG. 6 is an enlarged view of a portion of the rail section of FIG. 4.

FIG. 7 is a side elevation showing the flotation bed of FIG. 1 having an alternate base configuration.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to FIG. 1, a flotation bed generally indicated as 10 has two sides 11 and 12 into which a series of screws 13 are inserted. Screws 13, in cooperation with sides 11 and 12 serve to locate air mattress 14 on the surface of a supporting fluid. Conventional side rails 15 and 16 and head rail 17 are located along the edges of the bed as shown in FIG. 1.

The operation of the flotation bed may be understood by reference to FIG. 3 where a supporting fluid 20 is shown contained in a flexible sheet 21 which is supported by a tub 22. Tub 22 should be fabricated from a material having substantial physical strength such as steel, polyester-fiberglass or plywood. Alternatively, tub 22 could be formed from a hollowed-out portion of a foamed material such as a rigid or flexible polyurethane foam. Braces 23 and 24 help support the weight of the fluid which may weigh as much as 1000 to 1500 pounds.

The supporting fluid is placed in the tub 22 below the upper flexible layer or air mattress 14 and is filled to within about 1½ inches of the top of the sides 11 and 12. It may be desirable to provide a heating unit for the supporting fluid in order to control the temperature of the bed and a thermostatically controlled electrical heater located in the fluid provides a dependable temperature control system. However, it has also been found that the simple provision of a radiant heater under the bed pointing upwardly will serve this purpose. The relatively large amount of water creates a large heat sink and thus the temperature of the fluid has been found to be very stable for long periods of time. For instance, it requires about 1500 BTU's to increase 1500 pounds of water 1°F.

Leg braces 25, 26 and 27 help support legs 28 and 29 which are attached to base 30. Legs 20 and 29 are in turn supported by conventional caster assemblies shown on leg 28 and identified by reference character 31.

Air mattress 14 is shown in an inflated state in FIG. 3 and comprises an upper layer 35 and a lower layer 36 which are joined at a multiplicity of locations as shown best in FIGS. 4 and 6. An inflatable bladder 37 is located at the bottom of tub 22 and below an optional flexible sheet 21. The inflation of bladder 37 serves to raise the surface level of the supporting fluid 20 and thus raises the level of air mattress 14. The use of bladder 37 is optional and may be eliminated if a change in fluid level is not necessary or when the lower sheet 21 is eliminated. Also, other means of changing fluid level may be used such as adding or removing fluid. Air mattress 14 is of a greater length (and width when deflated) than flotation bed 10, causing folds. This intentional oversizing prevents any "hammocking" and causes the air mattress to conform easily to the body when deflated without any tension or friction.

Turning now to FIG. 2, an air pump 40 is operated by controls 41 and is adapted to feed a source of air into air mattress 14 or bladder 37. The air is fed through tubes 42 and 43 and the means for controlling air flow in conventional and will not be described herein.

Turning now to FIG. 4 a patient 50 is shown in phantom lines resting on the upper surface of air mattress 14 while mattress 14 is in its inflated condition. Bladder 37 is also in its inflated condition and with this combination of conditions the flotation bed easily provides a relatively firm support which facilitates entry and egress from the bed. Furthermore, in this condition the patient may be readily turned or otherwise positioned and have his clothes changed.

After the patient has been placed on the bed as shown in FIG. 4, the air is slowly expelled from bladder 37 and air mattress 14 and the patient is allowed to slowly become totally supported by the supporting fluid. Note that the deflation of air mattress 14 results in an increase in its width of about 50 per cent. This helps to prevent any "hammocking" effect from the sides without requiring excess film to be provided along the longitudinal sides of the air mattress. Of course, other means may be provided to prevent hammocking caused by side support such as providing excess flexible material along the sides of the air mattress.

The specific gravity and composition of the supporting fluid forms an important aspect of the present invention and will be discussed in detail below. For purposes of depicting the invention in drawings, however, it will be assumed that the supporting fluid has a specific gravity of 2 (twice that of water). In this way, the patient may be supported as shown in FIG. 5 with about half of his body below the supporting fluid level indicated as 55 in FIG. 5. If the supporting fluid was, instead, water as disclosed in the prior art, then the patient would be further submerged or lowered with respect to the supporting fluid level and in fact would have to be almost totally below the water level. The higher support level afforded by the use of a fluid having a specific gravity substantially greater than one greatly improves the stability and comfort of the patient. Since the body is roughly symmetrical about a longitudinal axis, the patient's spine is kept straight whether supine, side lying or prone as long as the specific gravity is no more than about 3. Also, note that the increase in specific gravity of the supporting fluid does not necessarily proportionally increase the weight of the flotation bed. This comes about from the higher level of support therefor causing the patient to not protrude as far below the fluid surface. In this way, the tub 22 can be closer to the surface of the fluid without touching the patient and this permits less fluid to be used.

The details of the support of air mattress 14 are shown in FIG. 6. A screw 60 is held in wooden side 11 and serves to force washer 62 against the two layers 35 and 36 of air mattress 14. It further secures flexible sheet 21 to side 11. Steel sides 63 and 64 are shown in FIGS. 4 and 5 and are secured to sides 11 and 12 by conventional means such as screws threaded from the inside of sides 63 and 64 outwardly into sides 11 and 12 and countersunk so they do not protrude to damage flexible sheet 21. Sides 63 and 64 are welded to base 30.

FIG. 7 shows an alternative means for supporting the flotation bed. Here, the air pump 40 is utilized to feed air to a flotation base generally indicated at 70. Flotation base 70 comprises an upper plenum chamber 71 having a flexible skirt 72. In this way a relatively low pressure permits the flotation bed to be moved over flat surfaces.

While an air mattress is shown at the upper surface of the supporting fluid, the use of this particular patient support system is not necessary for the practice of the present invention. Any flexible film which is impervious to the supporting fluid may be utilized. Examples of satisfactory films include 0.010-inch thick polyvinyl chloride or polyurethane.

It is advantageous to provide some means for temporarily firming the flotation bed surface to facilitate movement to and from the bed, but this need not be created by inflation of an air mattress. For instance, a padded shelf could be provided within the supporting fluid and raised to permit firm support. Other means of providing support include the provision of a canvas-like layer either above or below the flexible, fluid-impervious layer on the top of the supporting fluid. This canvas could be rolled over rollers at each end and provisions included for the lateral or longitudinal tightening of this layer to form the desired temporary support.

Another advantage of the flotation concept is the ability of the bed to support and conform to patients with bulky surgical dressings or casts. These objects merely protrude into the fluid rather than pressing painfully against a wound or in the case of a cast causing local points of pressure. This is particularly important where following plastic surgery shear or friction on wounds could be painful and retard healing.

Turning now to the important considerations going into the choice of supporting fluid, several fluid types are satisfactory. In addition to an appropriate specific gravity, the fluid is preferably low in toxicity to human tissue, relatively low in cost, easily available, has good long-term stability at body temperatures, is noncorrosive and low in odor. It has also been discovered that patient comfort may be increased for certain types of injuries by providing a fluid with a high viscosity. Several types of supporting fluids have been found useful in the practice of the present invention. Aqueous solutions of inorganic salts such as zinc chloride possess most of the above-listed requirements. Solutions or gels of sodium silicate ($Na_2 + 2.06\ SiO_2$) also provide most of the above requirements, including an ability to increase viscosity. Other inorganic salts which are less desirable because of their relatively higher level of toxicity include aqueous solutions of silver nitrate ($AgNO_3$). Inorganic liquids such as zinc bromide ($ZnBr_2$) and zinc iodide (ZnI_2) may be used but are less advantageous because of their toxicity and cost.

A particularly effective supporting fluid results from an aqueous suspension of barytes (barium sulfate ore). Such suspensions are commonly used in oil well drilling fluids and additives are available to increase the thixotropic nature of the suspensions if desired. The specific gravity of such suspensions may be widely varied and the order of toxicity, odor, cost and high potential viscosity are highly desirable characteristics of this fluid. In practice it has been found that the normal movement of the patient is sufficient to keep the barytes in suspension. If the bed has been unused for several days, it is merely necessary to push down on the upper surface of the mattress and any baryte which has settled is resuspended.

It is not necessary that the supporting fluid contain water and organic or inorganic liquids may be used. Particularly effective organic liquids include trichlorotrifluoroethane and tetrachlorodifluoroethane. All of the above-discussed fluids are capable of exhibiting a specific gravity of greater than 1.5 and some have specific gravities as high as 2.4.

Although the present invention has been discussed with an emphasis toward the treatment of hospital patients, the uses of the bed are not so limited. The bed has been found exceptionally comfortable for normal persons and promotes a deep sleep, providing more than the usual amount of rest in any given amount of time. It is possible that the use of such beds will increase the productive life of users by a substantial per cent.

The present embodiments of this invention are to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims therefore are intended to be embraced therein.

What is claimed is:

1. A flotation bed useful for prevention and treatment of decubitus ulcers comprising

a base;

a fluid-impervious tub supported by said base;

a supporting fluid contained in said tub, and supporting fluid having a specific gravity of at least 1.5 and less than 3.0 to provide uniform support to a patient; and an inflatable bladder attached to said tub and below the surface of said fluid whereby the inflation of said bladder causes the raising of said supporting fluid; and

a flexible, fluid-impervious layer having an upper surface overlying said supporting fluid, said flexible layer being large enough to prevent the hammocking effect when the patient is placed on said upper surface.

2. The flotation bed of claim **1** wherein said base is an air flotation base comprising a plenum having a flexible skirt at its lower extremity and air inlet means attached to said plenum.

3. The flotation bed of claim **1** wherein said supporting fluid is an aqueous suspension of barytes.

4. A flotation bed useful for the prevention and treatment of decubitus ulcers comprising

a base;

a support member held above said base;

a first flexible, fluid-impervious sheet overlying said support member and forming a container;

a supporting fluid within said container, said supporting fluid having a specific gravity of at least 1.5 and less than 3.0 to provide uniform support to a patent; and

a second flexible, fluid-impervious sheet overlying said supporting fluid,

said second flexible sheet comprising an inflatable air mattress having an upper surface large enough, when deflated, to prevent the hammocking effect when the patient is placed on said upper surface, and said air mattress, when inflated, causing a firming of said upper flotation surface thereby facilitating movement to and from the flotation bed by the patient, said flotation bed further including an inflatable bladder resting between said support member and said first flexible sheet whereby the inflation of said bladder raises the surface of said air mattress thereby facilitating movement to and from the flotation bed by the patient.

5. The flotation bed of claim **4** wherein said supporting fluid is an aqueous suspension of barytes.

6. A flotation bed comprising

a base;

a fluid-impervious tub supported by said base;

a supporting fluid within said tub,

said supporting fluid being an aqueous suspension of barytes having a specific gravity of at least 1.5 and less than 3.0 to provide uniform support to a patient; and

a flexible fluid-impervious layer overlying the upper surface of said supporting fluid,

said flexible layer comprising an inflatable air mattress having an upper surface large enough, when deflated, to prevent the hammocking effect when a patient is placed on said upper surface, and said flotation bed including an inflatable bladder resting in said supporting fluid, whereby the inflation of the bladder and the inflation of said air mattress causes the firming of said upper surface of said air mattress thereby facilitating movement to and from the flotation bed by the patient.

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