

[54] **HYDRAULIC ADJUSTING APPARATUS
FOR HOSPITAL BEDS OR THE LIKE**

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60/97 P, DIG. 2; 91/412, 459

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[57] **ABSTRACT**

The head and foot ends of a mattress supporting frame or operating table are articulately connected with the piston rods of two hydraulic motors whose double-acting cylinders are articulately connected to a shiftable bottom frame. The lower chambers of the cylinders can be connected with a supply conduit for pressurized fluid by way of discrete working conduits and discrete solenoid operated directional control valves. The upper chambers of the two cylinders are connected to each other by a first control conduit and the first control conduit is connected with the working conduit for the cylinder at the head end by means of a second control conduit. The supply conduit receives pressurized fluid from a single pump and each valve is further connected with a return conduit for spent fluid. The valve members of the two valves are movable independently of each other between first or neutral positions in which they seal the supply conduit and the return conduit from the respective working conduits, second positions in which they connect the supply conduit with the respective working conduits, and third positions in which they connect the return conduit with the respective working conduits. A solenoid operated shutoff valve can be installed in the working conduit for the cylinder at the head end to seal the lower chamber of such cylinder from the supply and return conduits as well as from the respective working conduit and both control conduits when the foot end is to be raised or lowered without any changes in the level of the head end. The single pump can supply pressurized fluid to the motors for one or more additional frames or tables as well as to auxiliary cylinders which can move the head rest and/or the foot rest of a frame or table between different levels and/or different positions of inclination.

15 Claims, 3 Drawing Figures

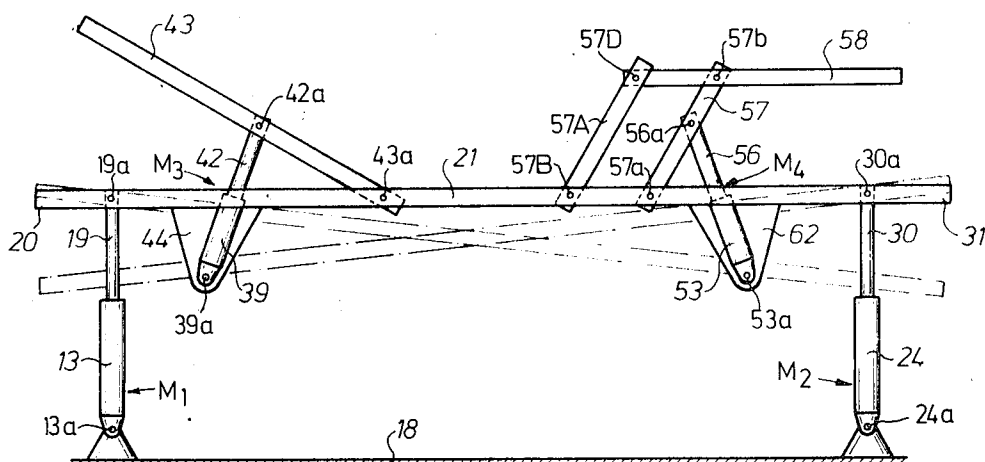


Fig. 2

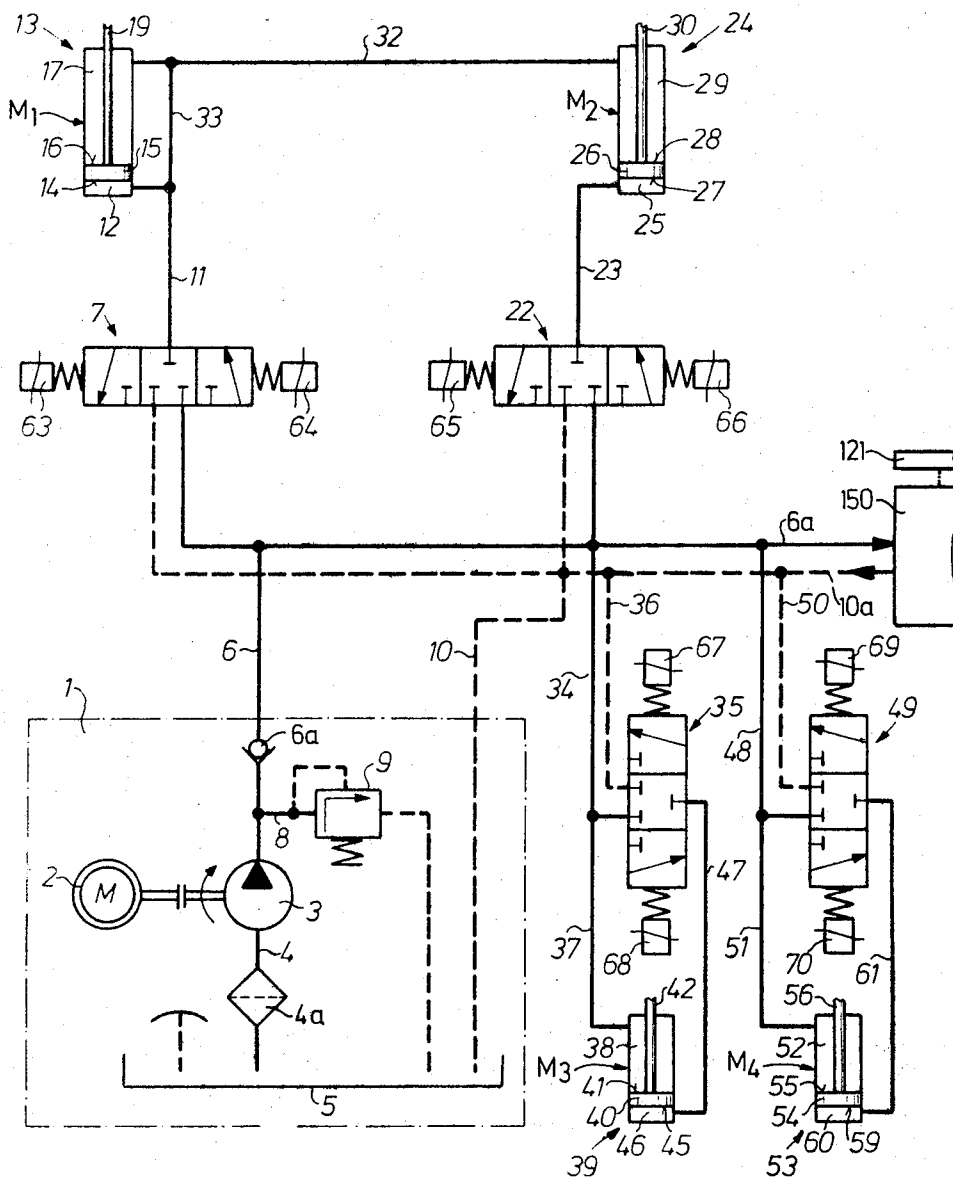
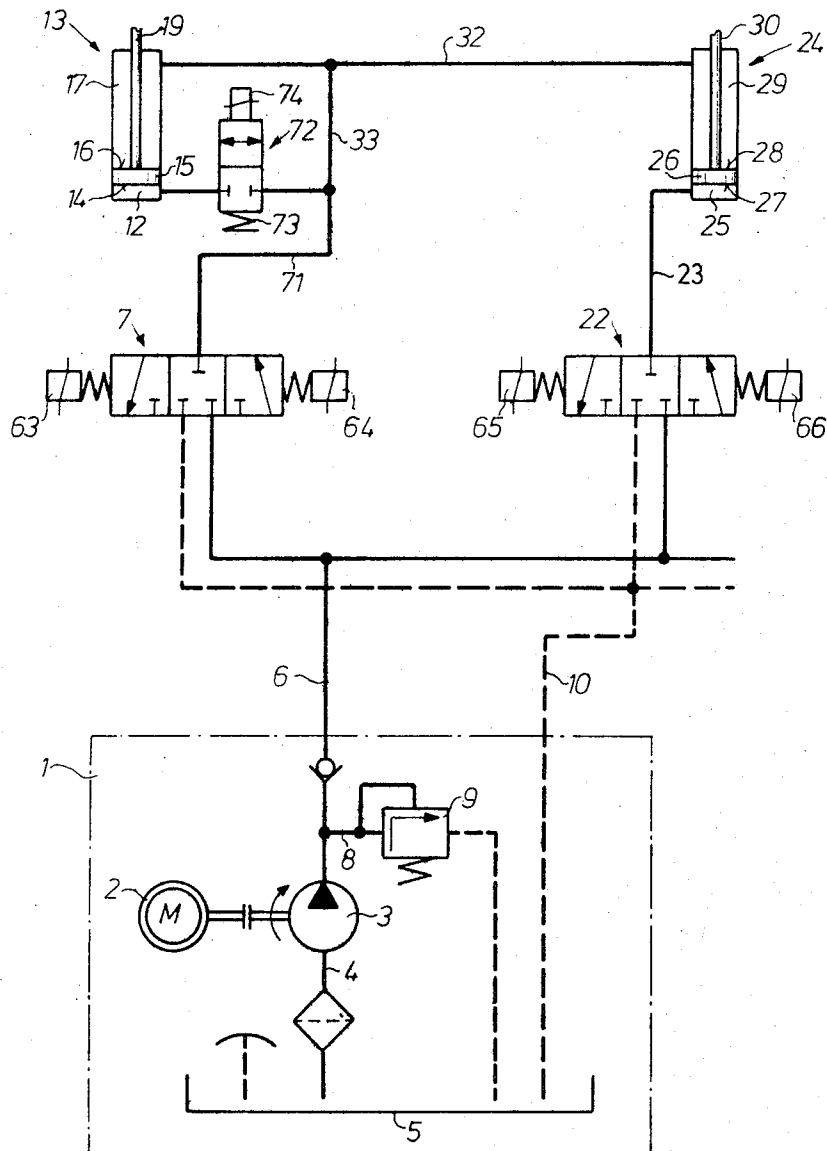


Fig. 3



HYDRAULIC ADJUSTING APPARATUS FOR HOSPITAL BEDS OR THE LIKE

BACKGROUND OF THE INVENTION

The present invention relates to hydraulic adjusting apparatus for hospital beds or analogous structures wherein a mattress frame or another component is to be moved between several levels and/or different positions of inclination.

It is already known to mount the mattress supporting frame of a hospital bed or an operating table on a pair of hydraulic motors each of which employs a double-acting cylinder and which are respectively connected to the head end and foot end of the frame or table. In order to move the frame or table up or down without excessive changes in inclination, the presently known adjusting apparatus which include such motors employ twin or tandem pumps which supply pressurized fluid to the cylinders. However, such pumps are likely to deliver different amounts of pressurized fluid so that one of the motors is likely to raise or lower the frame or table to a different extent than the other motor. Therefore, such known adjusting apparatus must employ additional control equipment which insures more uniform admission or evacuation of fluid for the purpose of effecting a predetermined displacement of the table or frame, either up and down or to a different position of inclination. The additional equipment is costly, expensive and bulky.

SUMMARY OF THE INVENTION

An object of the invention is to provide a novel and improved hydraulic adjusting apparatus which is capable of changing the inclination and/or the level of a component (such as the mattress supporting frame of a hospital bed or an operating table) with a high degree of accuracy and reproducibility as well as with a relatively small outlay for valves, pumps and/or other control equipment.

Another object of the invention is to provide an adjusting apparatus which can insure that a component can be moved to any desired position of inclination and/or to any desired level by necessitating the manipulation of a small number of simple actuating elements such as buttons, knobs, levers or the like.

A further object of the invention is to provide an adjusting apparatus which can be used to change the level and/or the inclination of two or more mattress supporting frames, operating tables or other components, either simultaneously or independently of each other.

An additional object of the invention is to provide an adjusting apparatus which, in addition to being capable of effecting controlled movement of a given main component, can also serve to effect controlled movements of one or more auxiliary components which are attached to and share the movements of the main component, e.g., a head rest and/or a foot rest which is articulately connected to a mattress supporting frame or to an operating table.

Still another object of the invention is to provide an adjusting apparatus which is capable of effecting controlled movements of one or more main components and/or one or more auxiliary components even though it employs a single pump.

The invention is embodied in a hospital bed or the like which comprises an adjustable component having

spaced first and second portions (e.g., an operating table or a mattress supporting frame having a head end and a foot end), and an adjusting apparatus for moving the first and second portions of such component together with and/or relative to each other. The adjusting apparatus comprises a source of pressurized hydraulic fluid (preferably a single pump which can be driven by an electric motor to draw oil or another suitable hydraulic fluid from a tank or the like), a pair of hydraulic motors, one for each portion of the adjustable component and each comprising a double-acting cylinder member, a piston reciprocable in the cylinder member and dividing its interior into a first chamber and a second chamber, and a piston rod member connected with the piston and extending through and beyond the second chamber, one of the members (e.g., the piston member) being preferably articulately connected with the respective portion of the adjustable component, supply conduit means connected with the source, a pair of working conduits each connected with a different first chamber, control conduit means connecting the second chambers of the two cylinders with each other and with one of the working conduits, evacuating or return conduit means for spent fluid, and a pair of directional control valves each connected between the supply conduit means and the evacuating conduit means on the one hand and a different one of the two working conduits on the other hand. The valve member of each directional control valve is movable between a first or neutral position in which the respective working conduit is sealed from the supply conduit means as well as from the evacuating conduit means, a second position in which the respective working conduit is connected with the supply conduit means, and a third position in which the respective working conduit is connected with the evacuating or return conduit means.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved adjusting apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic side elevational view of a hospital bed and of a portion of a hydraulic adjusting apparatus for the mattress supporting frame, head rest and foot rest of the bed, the adjusting apparatus being constructed and assembled in accordance with a first embodiment of the invention;

FIG. 2 is a circuit diagram of the adjusting apparatus for the hospital bed shown in FIG. 1; and

FIG. 3 is a similar diagram of a modified adjusting apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIGS. 1 and 2, there is shown a hydraulic adjusting apparatus for a hospital bed including an adjustable main component in the form of a mattress supporting frame 21 having a first portion or head

end 20 and a spaced second portion or foot end 31. The adjusting apparatus comprises a housing 1 which accommodates at least some elements of the hydraulic circuit. As shown in FIG. 2, the housing 1 contains an oil tank 5 or an analogous container for a supply of hydraulic fluid, a single hydraulic pump 3 which can be driven by an electric motor 2 and can draw fluid from the tank 5 by way of a conduit 4 containing a strainer or oil filter 4a, a supply conduit 6 for pressurized hydraulic fluid which is connected with the outlet of the pump 3 and contains a check valve 6a, and a branch conduit 8 which communicates with the supply conduit 6 and contains an adjustable pressure relief valve or safety valve 9 serving to return the output of the pump 3 into the tank 5 when the fluid pressure in the supply conduit 6 reaches a predetermined value. The elements 2, 3 together constitute a source of pressurized hydraulic fluid.

The supply conduit 6 is connected with the inlet of a solenoid-operated directional control valve 7 having a reciprocable valve member which is illustrated in its neutral or sealing position. A first outlet of the valve 7 is connected with a return conduit or evacuating conduit 10 which can discharge fluid into the tank 5. A second outlet of the valve 7 is connected with a working conduit 11 which communicates with the lower chamber 12 of a double-acting hydraulic cylinder 13 forming part of a first hydraulic motor M_1 . The cylinder 13 accommodates a reciprocable piston 15 having a piston rod 19 which is articulately connected (as at 19a) with the head end 20 of the frame 21. The piston 15 is reciprocable in the cylinder 13 with minimal clearance and the area of its lower end face 14 is larger than (preferably twice the area of) the upper end face 16 which surrounds the lower end of the piston rod 19. The upper chamber of the cylinder 13 is denoted by the reference character 17, and the lower end of the cylinder 13 is articulately connected with a bottom frame or base 18, as at 13a. The bottom frame 18 is preferably shiftable along the floor in an operating room or in a patient room. The means for limiting the pivotal movements of the cylinder 13 with reference to the bottom frame 18 is not shown in the drawing.

The supply conduit 6 is further connected with the inlet of a second solenoid-operated directional control valve 22 which has a first outlet connected with the return conduit 10 and a second outlet connected with a working conduit 23 communicating with the lower chamber 25 of a second double-acting hydraulic cylinder 24 which is articulately connected with the bottom frame 18, as at 24a. The cylinder 24 forms part of a second hydraulic motor M_2 and accommodates a piston 26 which is reciprocable therein with minimal clearance and separates the lower chamber 25 from an upper chamber 29. The ratio of the area of the lower end face 27 to the area of the upper end face 28 of the piston 26 is preferably identical with the ratio of the areas of the end faces 14, 16 on the piston 15. The piston rod 30 of the piston 26 is articulately connected with the foot end 31 of the frame 21, as at 30a. It will be noted that the cylinders 13 and 24 are connected in parallel. The upper chambers 17, 29 of these cylinders are connected with each other by a control conduit 32, and a further control conduit 33 connects the conduit 32 (i.e., the chambers 17, 29) with the working conduit 11 (i.e., with the chamber 12).

The solenoids for the valves 7 and 22 are respectively shown at 63, 64 and 65, 66. When the solenoid 63 is energized in response to actuation of a lever, button, knob or an analogous actuating member on a control panel, not shown, the valve member of the valve 7 is moved in a direction to the left to leave the illustrated first or neutral position and to assume a second position in which it connects the supply conduit 6 with the working conduit 11. The energization of solenoid 64 results in a rightward movement of the valve member in the valve 7 to a third position in which the working conduit 11 is connected with the return conduit or evacuating conduit 10. Analogously, the solenoid 65 is energizable to move the valve member of the valve 22 in a direction to the left so as to establish a connection between the supply conduit 6 and the working conduit 23. When the solenoid 66 is energized, the valve member of the valve 22 moves in a direction to the right and connects the working conduit 23 with the return conduit 10.

The dimensions of the cylinder 13 are preferably identical with the dimensions of the cylinder 24.

The supply conduit 6 is further connected with a conduit 34 which communicates with the inlet of a first auxiliary directional control valve 35 having two solenoids 67 and 68. A first outlet of the valve 35 is connected with the return conduit 10 by a conduit 36 and a second outlet of the valve 35 is connected with the lower chamber 46 of a first auxiliary double-acting hydraulic cylinder 39 by a working conduit 47. The cylinder 39 forms part of a third hydraulic motor M_3 . A piston 40 which is reciprocable in the cylinder 39 with minimal clearance separates the lower chamber 46 from an upper chamber 38 which communicates with the supply conduit 6 by way of the conduit 34 and a further conduit 37. The area of the lower end face 45 of the piston 40 is larger than the area of the upper end face 41 which surrounds the lower end of a piston rod 42 articulately connected with a pivotable head support or head rest 43, as at 42a. The head rest 43 is pivoted to an intermediate portion of the mattress frame 21 by pins 43a. The frame 21 is provided with a bracket 44 or an analogous support for a pivot pin 39a at the lower end of the auxiliary cylinder 39.

A conduit 48 connects the supply conduit 6 with the inlet of a second auxiliary directional control valve 49 having two solenoids 69 and 70. A first outlet of the valve 49 is connected with the return conduit 10 by a conduit 50 and a second outlet of the valve 49 is connected with the lower chamber 60 of a second auxiliary double-acting hydraulic cylinder 53 by a working conduit 61. The cylinder 53 forms part of a fourth hydraulic motor M_4 . The upper chamber 52 of the cylinder 53 is connected with the supply conduit 6 by the conduit 48 and a further conduit 51. A piston 54 which is reciprocable in the cylinder 53 has a piston rod 56 which is articulately connected (as at 56a) with a brace 57 for a foot support or foot rest 58. The end portions of the brace 57 are articulately connected with an intermediate portion of the frame 21, as at 57a, and with an intermediate portion of the foot rest 58, as at 57b. A second brace 57A is parallel with the brace 57 and is articulately connected with the foot rest 58 (at 57D) and with the frame 21 (at 57B). The braces 57, 57A insure that the foot rest 58 remains at least substantially parallel with the foot end 31 of the frame 21 but is

movable toward and away from the frame in response to movement of the piston rod 56.

The area of the lower end face 59 of the piston 54 in the cylinder 53 exceeds the area of the upper end face 55. A pivot pin 53a at the lower end of the cylinder 53 is articulately connected with a bracket 62 of the frame 21.

The motor 2 can be started by a pressure-responsive switch or by a mechanically operated switch (not shown) only when at least one of the solenoids 63 to 70 has caused the valve member of the respective directional control valve 7, 22, 35 or 49 to leave its first or neutral position. Thus, a prerequisite for delivery of pressurized hydraulic fluid by the pump 3 into the supply conduit 6 is that the motor 2 be started in response to such adjustment of at least one of the valves 7, 22, 35, 49 that at least one of the working conduits 11, 23, 47, 61 can receive pressurized fluid or that at least one of the working conduits is connected with the conduit 10. FIG. 2 illustrates the valve members of the four directional control valves in the first or neutral positions in which the supply conduit 6 is sealed from the working conduits and the working conduits are also sealed from the return conduit or evacuating conduit 10.

The conduits 6 and 10 can be connected with the directional control valves of adjusting apparatus for one or more additional hospital beds, as at 6a and 10a. The reference character 150 denotes schematically the adjusting apparatus (without the housing 1) for a second frame 121.

The operation:

If an attendant (or the patient himself) wishes to lift the mattress supporting frame 21 without any changes in the inclination of the frame, the valve member of the valve 7 remains in its neutral position and the solenoid 65 is energized (in response to depression of a knob or the like, not shown) so that the valve member of the valve 22 moves to its left-hand end position (lifting) and connects the supply conduit 6 with the working conduit 23. Thus, the working conduit 11 remains sealed from the supply conduit 6 and from the return conduit 10, and the latter remains sealed from the working conduit 23. The motor 2 is started simultaneously or substantially simultaneously with energization of the solenoid 65 so that the pump 3 delivers pressurized hydraulic fluid into the working conduit 23 and hence into the lower chamber 25 of the double-acting cylinder 24 for the foot end 30 of the frame 21. The piston 26 rises in the cylinder 24 and expels fluid from the chamber 29 into the control conduits 32, 33 and the working conduit 11, i.e., into the lower chamber 12 of the cylinder 13 for the head end 20 of the frame 21. The fluid which is expelled from the chamber 29 cannot enter the chamber 17 of the cylinder 13 because the area of the lower end face 14 of the piston 15 exceeds the area of the upper end face 16. Since the dimensions of the cylinders 13, 24 are identical and since the amount of fluid which is expelled from the chambers 17 and 29 into the chamber 12 equals the amount of fluid which enters the chamber 25, the two ends 20, 30 of the frame 21 are lifted at the same rate for as long as the solenoid 65 remains energized. FIG. 1 shows the frame 21 in a position of substantial parallelism with the bottom frame 18; therefore, the energiza-

tion of solenoid 65 results in such lifting of the frame 21 that the latter remains in a substantially horizontal position. The electric motor 2 is arrested in response to or at the time of deenergization of the solenoid 65 so that the pump 3 ceases to deliver pressurized fluid into the supply conduit 6 as soon as the frame 21 is arrested at the desired level above the bottom frame 18. The check valve 6a prevents return flow of fluid from the supply conduit 6 toward the pump 3.

If the frame is to be lowered without changing its inclination, the solenoid 66 is energized to move the valve member of the valve 22 to its right-hand end position so that the working conduit 23 communicates with the return conduit 10. The lower chamber 25 of the cylinder 24 discharges fluid into the tank 5 by way of the conduits 23 and 10 due to the pressure exerted by the piston 26 under the weight of the frame 21. If desired, the chamber 29 of the cylinder 24 may accommodate a spring (not shown) which urges the piston 26 downwardly and whose bias is readily overcome when the supply conduit 6 is connected with the working conduit 23. The piston 15 in the cylinder 13 descends at the same rate as the piston 26 because the fluid is caused to flow from the chamber 12, through the conduits 11, 33, 32, and into the chambers 17 and 29 under the weight of the mattress frame 21. When the frame 21 descends to the desired level, the solenoid 66 is deenergized and the valve member of the valve 22 reassumes its neutral position in which the working conduit 23 is sealed from the conduits 6 and 10.

If a patient, a physician or an attendant wishes to raise the foot end 31 of the frame 21, the solenoid 64 is energized to move the valve member of the valve 7 in a direction to the right so that the working conduit 11 communicates with the return conduit 10. At the same time, the solenoid 65 is energized to move the valve member of the valve 22 in a direction to the left so that the supply conduit 6 communicates with the working conduit 23. The chamber 25 of the cylinder 24 receives pressurized fluid from the supply conduit 6 and the chambers 29, 17, 12 are connected with the return conduit 10 by way of the conduits 32, 33, 11 and valve 7. The piston 26 moves upwardly and its piston rod 30 lifts the foot end 31. At the same time, the return conduit 10 receives fluid which is expelled from the chambers 29 and 12 so that the head end 20 descends to insure a more rapid change in the inclination of the frame 21. When the foot end 31 is lifted to the desired level or when the frame 21 assumes the desired position of inclination, the solenoids 64 and 65 are deenergized so that the working conduits 11, 23 are sealed from the conduits 10 and 6 whereby the frame 21 remains in the selected position.

If the foot end 31 of the frame 1 is to be moved to a lower level, the solenoid 63 is energized to connect the supply conduit 6 with the working conduit 11, and the solenoid 66 is also energized to connect the working conduit 23 with the return conduit 10. The chamber 25 of the cylinder 24 is connected with the return conduit 10 and the piston rod 30 moves downwardly to entrain the foot end 31 toward the bottom frame 18. The expulsion of fluid from the chamber 25 takes place under the weight of the frame 21 as well as in response to admission of pressurized fluid into the chamber 29 by way of the valve 7, working conduit 11 and control conduits

33, 32. The working conduit 11 also admits pressurized fluid into the chamber 12 and, since the area of the end face 14 exceeds the area of the end face 16, the piston 15 is caused to move upwardly so that the head end 20 of the frame 21 rises while the foot end 31 descends. This insures that the frame 21 rapidly assumes that angular position in which the foot end 31 is located a desired distance below the level of the head end 20. As the piston 15 rises, it expels fluid from the chamber 17 and such fluid flows into the chamber 29 and/or into the chamber 12. When the frame 21 assumes the desired angular position (with the level of the head end 20 located at a desired distance above the level of the foot end 31), the solenoids 63 and 66 are deenergized so that the valve members of the valves 7, 22 seal the working conduits 11, 23 from the conduits 6, 10.

In order to lift the head end 20 of the frame 21, it is necessary to energize the solenoid 63 so that the valve 7 connects the supply conduit 6 with the working conduit 11. The valve member of the valve 22 remains in the neutral position. The fluid which is furnished by the pump 3 enters the lower chamber 12 of the cylinder 13 and, because the area of the end face 14 exceeds the area of the end face 16, the piston 15 rises and moves the piston rod 19 upwardly so that the head end 20 moves above the level shown in FIG. 1. The fluid which is expelled from the chamber 17 flows into the chamber 12; such fluid cannot enter the chamber 29 because the fluid which is entrapped in the chamber 25 is sealed from the return conduit 10 by the valve 22. Once the head end 20 reaches the desired level, the solenoid 63 is deenergized and the frame 21 thereupon remains in the selected angular position because the working conduit 11 is sealed from the conduits 6 and 10.

If the head end 20 is to be moved downwardly, i.e., below the position shown in FIG. 1, the solenoid 64 is energized to connect the working conduit 11 with the return conduit 10. The valve member of the valve 22 remains in the neutral position. The return conduit 10 communicates with the chambers 12, 17 and 29 by way of the conduits 11, 33, 32 so that the piston 15 moves downwardly and entrains the piston rod 19, i.e., the head end 20 descends to a level below the foot end 31. The solenoid 64 must be deenergized when the head end 21 reaches the desired lower level. The chambers 12, 17, 25, 29 are then again sealed from the conduits 6 and 10.

If it should become necessary to change the inclination of the frame 21 by lowering or raising the head end 20 or the foot end 31 and to thereupon move the frame up or down without any change in its inclination, the patient or another person first changes the inclination of the frame 21 in one of the afordescribed manners and thereupon energizes the solenoid 65 (lift) or 66 (lower) of the valve 22 whereby the frame 21 moves up or down in the same way as described above.

If the head rest 43 is to be pivoted in a clockwise direction, as viewed in FIG. 1, i.e., to increase the inclination of the head rest 43, the upper solenoid 67 of the auxiliary valve 35 is energized to connect the supply conduit 6 with the lower chamber 46 of the cylinder 39 by way of the conduit 34, valve 35 and working conduit 47. The supply conduit 6 is in permanent communication with the upper chamber 38 of the cylinder 39 by way of the conduits 34 and 37. Since

the area of the lower end face 45 of the piston 40 exceeds the area of the upper end face 41, the piston rod 42 moves upwardly and pivots the head rest 43 in a clockwise direction. Once the head rest 43 assumes the desired position of inclination with reference to the frame 21, the solenoid 67 is deenergized and the valve 35 seals the working conduit 47 from the conduits 34 and 6. Thus, the fluid which is entrapped in the chamber 46 prevents the piston 40 from moving downwardly even though the chamber 38 is connected with the supply conduit 6. Of course, the electric motor 2 is preferably arrested in response to deenergization of the solenoid 67. In the absence of such stoppage of the motor 2 simultaneously or nearly simultaneously with deenergization of the solenoid 67, the fluid delivered by the pump 3 after the valve 35 seals the conduit 34 from the working conduit 47 would open the relief valve 9 and would be returned into the tank 5.

If the head rest 43 is to be pivoted in a counterclockwise direction, as viewed in FIG. 1, the solenoid 68 is energized so that the valve 35 connects the working conduit 47 with the return conduit 10 by way of the conduit 36. The piston 40 expels fluid from the chamber 46 by way of the conduit 47, valve 35 and conduits 36, 10 so that the head rest 43 pivots in a counterclockwise direction. The electric motor 2 is started in response to energization of the solenoid 68 so that the pump 3 delivers fluid into the chamber 38; this assists the weight of the head rest 43 in rapidly expelling a requisite amount of fluid from the chamber 46. The starting of pump 3 in response to energization of the solenoid 68 is desirable in order to prevent the generation of vacuum in the chamber 38. The solenoid 68 is deenergized when the head rest 43 assumes the desired position of inclination with reference to the frame 21. The valve 35 then seals the working conduit 47 from the conduits 6, 10 and the pump 3 ceases to deliver fluid into the chamber 38.

If the foot rest 58 is to be adjusted with reference to the frame 21, the solenoid 69 (lifting) or the solenoid 70 (lowering) is energized and the motor M_4 including the cylinder 53 raises or lowers the foot rest 58 in substantially the same way as described for the cylinder 39 and head rest 43. Thus, when the solenoid 69 is energized, the pump 3 delivers pressurized fluid into the chamber 60 so that the piston 54 lifts the piston rod 56. When the solenoid 70 is energized, the contents of the chamber 60 are caused to flow into the return conduit 10 and the pump 3 delivers fluid into the chamber 52.

As mentioned before, the extensions 6a, 10a of the conduits 6, 10 can be connected with one or more additional sets of cylinders for a desired number of hospital beds. The frames, head rests and/or foot rests of two or more beds can be adjusted simultaneously and/or independently of each other. It is further clear that the frame 21 can constitute an operating table or any other component whose level and/or inclination is to be changed to a controlled extent.

Referring to FIG. 3, there is shown a portion of a modified adjusting apparatus wherein all such parts which are identical with or clearly analogous to the corresponding parts of the apparatus shown in FIGS. 1-2 are denoted by similar reference characters. The working conduit 11 of FIG. 2 is replaced with a working conduit 71 which contains a solenoid operated shutoff

valve 72. The solenoid is shown at 74 and the reference character 73 denotes a spring which normally maintains the valve member of the valve 72 in the illustrated neutral or closing position in which the valve 72 seals the lower chamber 12 of the cylinder 13 from the control conduits 33, 32 as well as from the upper outlet of the valve 7. When the solenoid 74 is energized, the valve member of the valve 72 moves against the opposition of the spring 73 and establishes communication between the chamber 12 and the control conduit 33.

The purpose of the shutoff valve 72 is to insure that, when necessary, the head end 20 of the component 21 shown in FIG. 1 remains in an unchanged position. This is particularly important in connection with operating tables. Thus, the valve 72 insures that, if the physician or the nurse desires, the foot end 31 of the component 21 can be raised or lowered while the head end 20 remains at the same level as prior to adjustment of the foot end (excepting, of course, for such minor changes in the level of the outermost part of the head end 20 which are due to pivoting of the component 21 about the axis of the pivot member 19a when the cylinder 24 causes the foot end 31 to move up or down). The valve 72 can perform such function irrespective of whether the level of the foot end 31 is to be changed at a time when the component 21 dwells in a horizontal position, in an inclined position, at a greater distance from the bottom frame 18 or closer to the bottom frame.

If the component 21 is to be raised or lowered without any changes in its inclination with reference to the bottom frame 18, the operator (e.g., the patient, a visitor a physician or a nurse) energizes the solenoid 65 or 66 in the same way as described in connection with FIG. 2. The valve member of the valve 7 remains in the neutral position shown in FIG. 3. The solenoid 74 is also energized so that the shutoff valve 72 allows a fluid to flow between the chamber 12 and the chambers 17, 29 (by way of the working conduit 71 and control conduits 33, 32). The lifting or lowering of the component 21 takes place in the aforescribed manner since, when the shutoff valve 72 is open, the conduit 71 is a functional equivalent of the working conduit 11 shown in FIG. 2.

If it is necessary to merely lift the foot end 31 of the component 21 with reference to the head end 20, the solenoid 64 is energized so that the valve member of the valve 7 moves to its right-hand end position and connects the working conduit 71 with the return conduit 10. At the same time, the solenoid 65 is energized to move the valve member of the valve 22 to its left-hand end position whereby the valve 22 connects the supply conduit 6 with the working conduit 23. The solenoid 74 remains in deenergized condition so that the shutoff valve 72 seals the chamber 12 from the return conduit 10 and control conduits 33, 32. The electric motor 2 in the housing 1 is started in response to energization of the solenoid 65 and the pump 3 causes pressurized fluid to flow into the chamber 25 of the cylinder 24. The piston 26 rises and expels fluid from the upper chamber 29 whereby such fluid flows by way of the control conduits 32, 33 working conduit 71, valve 7, return conduit 10 and back into the tank 5. The fluid which is entrapped in the chamber 12 prevents any changes in the axial position of the piston rod 19 so that the component 21 merely pivots at 19a

and the level of the head end 20 remains substantially unchanged. The foot end 31 rises because the piston 26 moves the piston rod 30 upwardly. The solenoids 64, 65 are deenergized to arrest the electric motor 2 and to terminate the inflow of pressurized fluid into the chamber 25 when the foot end 31 is raised to the desired level.

If the foot end 31 is to be moved to a lower level, the shutoff valve 72 remains closed while the operator energizes the solenoid 63 so that the working conduit 71 communicates with the supply conduit 6 and the electric motor 2 starts the pump 3 whereby the latter delivers pressurized fluid into the upper chamber 29 of the cylinder 24. The solenoid 66 is also energized so that the valve 22 connects the working conduit 23 with the return conduit 10. The fluid which flows into the upper chamber 29 causes the piston 26 to move downwardly and to expel fluid from the chamber 25. Therefore, the foot end 31 descends while the level of the head end 20 remains substantially unchanged. The main purpose of fluid which is pumped into the chamber 29 is to prevent the generation of vacuum because the piston 26 can descend exclusively under the weight of the foot end 31 as soon as the valve 22 allows the working conduit 23 to communicate with the return conduit 10. When the foot end 21 descends to the desired level, the solenoids 63, 66 are deenergized so that the working conduits 71, 23 are again sealed from the conduits 6, 10.

If the head end 20 is to be raised by the piston rod 19, the solenoid 63 is energized to connect the working conduit 71 with the supply conduit 6 and to start the motor 2 for the pump 3. The solenoid 74 is also energized so that the valve 72 establishes communication between the chamber 12 and the supply conduit 6 (via conduit 71 and valve 7). The pressurized fluid flows into the chamber 12 and lifts the piston 15 because the area of the end face 14 exceeds the area of the end face 16. The fluid which is expelled from the chamber 17 cannot flow into the chamber 29 because the chamber 25 is sealed from the return conduit 10; therefore, such expelled fluid flows in the control conduits 32, 33, working conduit 71 and into the chamber 12. When the head end 21 rises to the desired level, the solenoids 63, 74 are deenergized so that the valve 72 prevents the outflow of fluid from the chamber 12 and the valve 7 seals the working conduit 71 from the supply conduit 6.

If the head end 20 is to be moved to a lower level, the solenoid 64 is energized to connect the working conduit 71 with the return conduit 10. The solenoid 74 is also energized to open the valve 72 whereby the piston 15 is free to descend and the piston rod 19 lowers the head end 20. Some of the fluid which is expelled from the chamber 12 flows into the upper chamber 17 to prevent the generation of vacuum. The head end 20 is arrested at the desired level in response to deenergization of the solenoids 64 and 74.

It is clear that the conduits 6, 10 of FIG. 3 can be connected with one or more auxiliary cylinders (such as the cylinders 39, 53 of FIG. 2) and/or with the cylinders of adjusting apparatus for one or more additional beds, not shown.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for

various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

We claim:

1. In a structure of the character indicated, particularly in a hospital bed, a combination comprising an adjustable component having spaced first and second portions; and an adjusting apparatus for moving said portions of said component together with and relative to each other, said apparatus including a source of pressurized hydraulic fluid, a pair of hydraulic motors, one for each of said portions, each of said motors comprising a double-acting cylinder member, a piston reciprocable in and dividing the interior of said cylinder member into first and second chambers, and a piston rod connected with said piston and extending through and beyond said second chamber, one of said members being connected with the respective portion of said component, supply conduit means connected with said source, a pair of working conduits each connected with a different one of said first chambers, control conduit means connecting said second chambers with each other and with one of said working conduits, a pair of directional control valves each connected with said supply conduit means and with a different one of said working conduits, and fluid evacuating conduit means connected with said valves, each of said valves having a portion movable between a plurality of positions including a first position in which the respective working conduit is sealed from said supply conduit means and from said evacuating conduit means, a second position in which the respective working conduit is connected with said supply conduit means, and a third position in which the respective working conduit is connected with said evacuating conduit means.

2. A combination as defined in claim 1, wherein said component is the mattress supporting frame of a hospital bed and said first and second portions respectively constitute the head and foot ends of said frame.

3. A combination as defined in claim 2, wherein said one member is said piston rod member and said valves are solenoid-operated directional control valves.

4. A combination as defined in claim 3, wherein said one working conduit is connected with the first chamber of the cylinder member of the motor for said head end of said frame.

5. A combination as defined in claim 1, further comprising third valve means provided in said one working conduit intermediate the respective first chamber and the connection of said one working conduit with said

control conduit means, said third valve means having a portion movable between first and second positions in which said third valve means respectively permits and prevents the flow of fluid between said last mentioned first chamber and said control conduit means.

6. A combination as defined in claim 5, wherein said third valve means is a solenoid-operated valve.

7. A combination as defined in claim 5, wherein said third valve means is a shutoff valve and said portion of said third valve means normally dwells in said second position.

8. A combination as defined in claim 1, further comprising at least one second component and additional adjusting apparatus for said second component, said supply conduit means and said evacuating conduit means forming part of said additional adjusting apparatus.

9. A combination as defined in claim 1, further comprising an auxiliary component movable relative to said first mentioned component, said adjusting apparatus further comprising a third motor for moving said auxiliary component and directional control valve means interposed between said third motor and said supply and evacuating conduit means.

10. A combination as defined in claim 9, wherein said first mentioned component is the mattress supporting frame of a hospital bed and said first and second portions respectively constitute the head and foot ends of said frame, said auxiliary component constituting a head rest which is pivotably connected with said frame in the region of said head end.

11. A combination as defined in claim 9, wherein said first mentioned component is the mattress supporting frame of a hospital bed and said first and second portions respectively constitute the head and foot ends of said frame, said auxiliary component constituting a foot rest articulately connected with said frame in the region of said foot end.

12. A combination as defined in claim 1, wherein said source comprises a pump and electric motor means for driving said pump in response to movement of at least one of said portions of said valves from the respective first position.

13. A combination as defined in claim 1, further comprising a base articulately connected with the other member of each of said motors.

14. A combination as defined in claim 1, wherein each of said pistons has a relatively large end face adjacent to the respective first chamber and a relatively small second end face adjacent to the respective second chamber.

15. A combination as defined in claim 1, wherein said cylinders are mounted in at least substantially upright positions and said first chambers are located below the respective second chambers.

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