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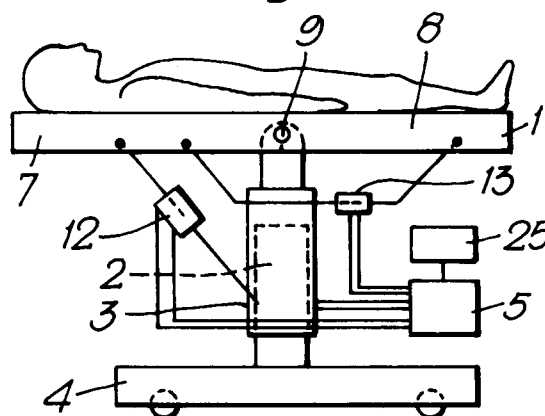
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SMITHS INDUSTRIES PUBLIC LIMITED
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London NW11 8DS(GB)(54) **Patient support tables.**

(57) An hydraulic operating table has two leaves 7 and 8 which support the upper and lower trunk of the patient. One hydraulic actuator 12 is connected between one leaf 7 and the support column 3 whereas another actuator 13 is connected between the two leaves to control the angle between them. The inlet of both actuators 12 and 13 is connected to a pump 50 via a flow divider 55 which controls the flow of fluid from one actuator according to the flow of fluid from the other actuator so that the angle of both leaves relative to the horizontal can be changed by the same amount.

Fig. 1.**EP 0 463 734 A2**

This invention relates to hydraulic patient support tables including two leaves for supporting different parts along the patient, the leaves being hinged relative to one another and relative to the horizontal, a first hydraulic actuator coupled between one of the leaves and a support to effect change in the angle of the leaf relative to the horizontal, a second hydraulic actuator coupled between the two leaves to effect change in the angle between the two leaves, and an hydraulic supply.

Hydraulic patient support table, such as surgical operating tables, have several hydraulic actuators which are supplied with hydraulic fluid from a single source which may be electrically or manually powered. One actuator is used to alter the height of the table above the floor. Another actuator is used to alter the longitudinal, elevation angle of the table, so that the patient's head or feet are raised, in what is called Trendelenberg movement. Two further actuators alter, respectively, the lateral, side-to-side, angle or tilt of the table and the break angle of the table at a lateral joint. This latter, break actuator is used to put the table into either an extension mode, where an obtuse angle is formed between the two leaves of the table on its upper surface, or a flexion mode where an acute angle is formed between the two leaves.

If the table surface is initially horizontal and power is supplied to the break actuator to produce extension, this will cause the outer end of only one leaf to be lowered, that is, the leaf which is not coupled to the Trendelenberg actuator, because the other leaf will be prevented from movement by the Trendelenberg actuator. Similarly, if power is supplied to the break actuator to cause flexion, this will cause the same leaf to be raised. In order to complete the extension or flexion movement, so that both leaves are raised or lowered, it is necessary subsequently to control the Trendelenberg actuator. For example, if the Trendelenberg actuator is coupled to the lower trunk leaf, flexion would be achieved by initially supplying fluid to the break actuator so as to raise the upper trunk leaf. The break actuator would then be locked and fluid supplied to the Trendelenberg actuator so as to raise the lower trunk leaf. However, because the upper and lower trunk leaves are locked relative to one another by the break actuator, the entire table top will pivot around its joint so that the lower leaf is lowered as the upper leaf is raised. The desired position is achieved by making successive corrections to the break actuator and the Trendelenberg actuator. This procedure is difficult, time consuming and can cause unnecessary movement of the patient. The procedure is especially difficult with manually-powered tables.

In some surgical procedures, the patient needs to be moved directly from an extension position

into a flexion position and from there into a horizontal position. It can be appreciated that, to achieve these movements, requires repeated actuation of the different actuators and is very difficult to achieve rapidly and smoothly.

It is an object of the present invention to provide an hydraulic patient support table which can be used to avoid these disadvantages.

According to one aspect of the present invention, there is provided an hydraulic patient support table of the above-specified kind, characterised in that the hydraulic supply, in at least one mode, controls the supply of hydraulic fluid simultaneously to or from both actuators in such a way that when power is supplied to the actuators the angle of both leaves relative to the horizontal changes by substantially the same amount.

The hydraulic supply preferably includes a flow control device that controls the flow of fluid to or from one actuator in response to the flow of fluid to or from the other actuator. The flow control device may be a flow divider device coupled to both actuators such that a desired proportion of fluid can be supplied to or from each actuator. The first actuator may have an inlet and outlet connected via respective valves to an inlet and outlet of an hydraulic pump unit. The second hydraulic actuator may have an inlet and outlet connected to an inlet and outlet of an or the hydraulic pump unit and a valve connected between the second actuator and the pump unit.

The hydraulic supply may include an hydraulic pump unit connected to one end of the first and second actuators via respective parallel arrangements of two flow lines, one of the flow lines being common to the two actuators and including a flow divider device, and the other of the flow lines connected with each actuator including a respective valve so that flow of fluid to or from both actuators can be confined to flow via the flow divider device by closing the valves in the other flow lines.

The common flow line includes a valve which can be closed to prevent flow of fluid through the flow divider. The pump unit may have an inlet and an outlet, one of the inlet and outlet being connected to one end of the first and second actuators via the respective parallel arrangements of two flow lines, and the other of the inlet and outlet of the pump unit being connected to the other end of the first actuator via a valve and to the other end of the second actuator without the interposition of a valve. The pump unit may be reversible. The hydraulic supply preferably locks the table in position when the supply of hydraulic fluid stops.

An hydraulic operating table in accordance with the present invention, will now be described, by way of example, with reference to the accompany-

ing drawings, in which:

Figure 1

is a side elevation view of the table;

Figure 2

is an end view of the table;

Figure 3

shows the hydraulic system of the table schematically;

Figures 4A to 4F

illustrate operation of the table.

With reference first to Figures 1 and 2, the surgical operation table has a top 1 supported at the upper end of an hydraulic actuator or ram 2 within a support column 3 on a base 4. The height of the table top 1 relative to the base 4 is controlled by hydraulic fluid pumped into the ram 2 by an hydraulic power supply 5. The top 1 is divided across its longitudinal axis into two leaves 7 and 8 which support the upper trunk and lower trunk respectively of the patient. The two leaves 7 and 8 are hinged relative to one another and to the upper end of the ram 2 about a horizontal, lateral axis by a joint 9. A second joint 10 (Figure 2) hinges the entire table top 1 about a longitudinal axis so that the table top can be tilted laterally.

The table has three further hydraulic actuators 11, 12 and 13 in addition to the hydraulic ram 2. One of these is a lateral actuator 11 (Figure 2) which is coupled between one side of the table top 1 and the table support column 3 so that, by controlling fluid supply to the actuator, the lateral tilt of the table top 1 can be altered. Another actuator 12 (Figure 1) is coupled between the upper trunk leaf 7 and the support column 3 which enables the elevation angle of the top to be altered; this longitudinal tilting movement is known as Trendelenberg movement. The third actuator 13 (Figure 1) is coupled between the two leaves 7 and 8 and enables the angle between the two leaves to be changed; this actuator is referred to as the break actuator.

With reference now to Figure 3, the hydraulic control system 5 includes an electrical pump unit 50 with an inlet line 51 and an outlet line 52. The pump unit 50 can be operated in a reverse sense so that the inlet line 51 can serve as an outlet line and the outlet line 52 as an inlet. The outlet line 52 is connected to the inlet of the Trendelenberg actuator 12, via a first solenoid-controlled valve 53 in a fluid line 43, and to the inlet of the break actuator 13, via a second solenoid-controlled valve 54 in a fluid line 44. The outlet line 52 is also connected to a flow divider 55 via a third solenoid-controlled valve 56 in a fluid line 46. The flow divider 55 is of "Y" configuration with its common arm connected to the valve 56, one lateral arm connected intermediate the valve 53 and the input of the Trendelenberg actuator 12, and the other

lateral arm connected intermediate the valve 54 and the input of the break actuator 13. Connection of the pump 50 to the inlet of the actuator 13 is, therefore, via a parallel arrangement of lines 44 and 46, whereas connection of the pump to the inlet of the actuator 12 is via a parallel arrangement of lines 43 and 46. The fluid line 46 is common to both connections between the pump 50 and the inlets of the two actuators 12 and 13.

The input line 51 of the pump unit 50 is connected directly to the output of the break actuator 13 without the interposition of any valve and is connected to the output of the Trendelenberg actuator 12 via a fourth solenoid-controlled valve 57.

The different modes of operation will now be described with reference to Figures 4A to 4F.

Trendelenberg motion, Figure 4A, in which the lower trunk end of the table 1 is raised whilst the upper end is lowered, is achieved by putting the first valve 53 and the fourth valve 57 in an open position (1) and by pumping fluid out of the unit 50 in a forward direction (F) into the outlet line 52. Fluid flows into the inlet of the Trendelenberg actuator 12 via the valve 53 and out of the outlet of the actuator, via valve 57 and the inlet line 51 back to the pump unit 50. This causes the actuator to contract. The second valve 54 remains closed (O) so that fluid is prevented from flowing to or from the break actuator 13. The third valve 56 is also closed (O) so that fluid cannot flow out of the flow divider 55. Because the break actuator 13 is locked, there is no relative movement between the two leaves 7 and 8.

If it is desired to produce reverse Trendelenberg motion, that is, to raise the upper trunk end of the table 1 whilst lowering the lower end, Figure 4B, the pump unit 50 is simply reversed (R) with the valves in their Trendelenberg settings. In this way, fluid flows out of the inlet 51 and returns through the outlet line 52 so that the Trendelenberg actuator 12 extends.

A "break up" motion can also be produced in which the lower trunk leaf 8 is raised and the upper trunk leaf 7 remains horizontal, Figure 4C. This is achieved with the pump unit 50 in reverse (R), with the second valve 54 open (1) and with the other valves 53, 56 and 57 closed (O). Fluid flows to the outlet of the actuator 13 causing it to extend, whilst fluid returns to the pump unit 50 via the open valve 54. The upper trunk leaf 7 will be locked in position by the Trendelenberg actuator 12 so that only the lower leaf 8 moves upwardly, in an anti-clockwise sense about the joint 9.

A "break down" motion, Figure 4D, is achieved with the valves in the same setting as for break up, but with the pump unit 50 running in its forward sense (F). Fluid will flow from the pump unit 50 via outlet line 52 to the inlet of the actuator 13, thereby

causing contraction and lowering of the lower trunk leaf 8.

To produce flexion, when both the upper and lower trunk leaves 8 and 7 are raised, Figure 4E, the third and fourth valves 56 and 57 are opened (1), with the other valves 53 and 54 closed (O), and the pump unit 50 run in reverse (R). In this way, fluid will flow simultaneously to the outlet of both actuators 12 and 13 causing both to extend and both leaves 7 and 8 to be raised. Fluid flows out of the inlets of the two actuators 12 and 13 into the arms of the flow divider 55. The flow divider 55 may be of conventional construction and functions such that flow of fluid from one actuator controls the rate at which fluid from the other actuator can flow through the divider. The flow divider 55 is so arranged that the flows from the two actuators 12 and 13 are balanced to produce equal angular rates of movement of the two leaves 7 and 8. Without the flow divider, or some equivalent arrangement, fluid would flow preferentially to the actuator which presents less resistance. Fluid flows from the flow divider 55, via the third valve 56 to the outlet line 52 of the pump unit 50.

When it is desired to produce extension, Figure 4F, by lowering both leaves 7 and 8 about the joint 9, the valves remain in the same setting and the pump unit 50 is set to its forward setting (F). Fluid thereby is pumped through the third valve 56 into the flow divider 55 from where it is supplied, in the appropriate proportions, to the inlets of both actuators 12 and 13. Fluid forced out of the outlet of the Trendelenberg actuator 12 flows back to the inlet 51 of the pump unit 50 via the fourth valve 57, whilst fluid flowing out of the outlet of the break actuator 13 flows directly back to the pump inlet 51.

It can be seen that the table of the present invention enables the table top 1 to be put into an extension or flexion configuration directly from a horizontal configuration without successive different movements. Also, the table top can be moved directly from an extension configuration to a flexion configuration smoothly as a continuous action. The hydraulic circuit is preferably arranged so that, when the pump unit 50 is off, no hydraulic fluid can flow around the circuit. This effectively locks the table in position.

It will be appreciated that the table top could have a greater number of leaves for supporting different parts of the body and which are articulated with respect to one another. The hydraulic control system is only described schematically above and it may take various different forms. In particular, the hydraulic system may be manually powered rather than electrically powered, if desired. The user would not generally need to switch the individual valves independently, this would be

achieved automatically by actuation of a single button or the like marked "Trendelenberg", "Reverse Trendelenberg" and so on.

The invention is not confined to surgical tables but could be used in other patient support tables.

Claims

1. An hydraulic patient support table including two leaves for supporting different parts along the patient, the leaves being hinged relative to one another and relative to the horizontal, a first hydraulic actuator coupled between one of the leaves and a support to effect change in the angle of the leaf relative to the horizontal, a second hydraulic actuator coupled between the two leaves to effect change in the angle between the two leaves, and an hydraulic supply, characterised in that the hydraulic supply (5), in at least one mode, controls the supply of hydraulic fluid simultaneously to or from both actuators (12 and 13) in such a way that when power is supplied to the actuators the angle of both leaves (7 and 8) relative to the horizontal changes by substantially the same amount.
2. An hydraulic patient support table according to Claim 1, characterised in that the hydraulic supply (5) includes a flow control device (55) that controls the flow of fluid to or from one actuator (13) in response to the flow of fluid to or from the other actuator (12).
3. An hydraulic patient support table according to Claim 2, characterised in that the flow control device is a flow divider device (55) coupled to both actuators (12 and 13) such that a desired proportion of fluid can be supplied to or from each actuator.
4. An hydraulic patient support table according to any one of the preceding claims, characterised in that the first actuator (12) has an inlet and outlet connected via respective valves (57 and 53) to an inlet (51) and outlet (52) of an hydraulic pump unit (50).
5. An hydraulic patient support table according to any one of the preceding claims, characterised in that the second hydraulic actuator (13) has an inlet and outlet connected to an inlet and outlet of an or the hydraulic pump unit (50), and that a valve (54) is connected between the second actuator (13) and the pump unit (50).
6. An hydraulic patient support table according to any one of the preceding claims, characterised in that the hydraulic supply (5) includes an

hydraulic pump unit (50) connected to one end of the first and second actuators (12 and 13) via respective parallel arrangements of two flow lines (43 and 46, 44 and 46), that one of the flow lines (46) is common to the two actuators (12 and 13) and includes a flow divider device (55), and that the other of the flow lines (43, 44) connected with each actuator includes a respective valve (53, 54) so that flow of fluid to or from both actuators can be confined to flow via the flow divider device (55) by closing the valves in the other flow lines.

7. An hydraulic patient support table according to Claim 6, characterised in that the common flow line (46) includes a valve (56) which can be closed to prevent flow of fluid through the flow divider (55).
8. An hydraulic patient support table according to Claim 6 or 7, characterised in that the pump unit (50) has an inlet (51) and an outlet (52), that one of the inlet and outlet (52) is connected to one end of the first and second actuators (12 and 13) via the respective parallel arrangements of two flow lines (43 and 46, 44 and 46), and that the other of the inlet and outlet (51) of the pump unit (50) is connected to the other end of the first actuator (12) via a valve (53) and to the other end of the second actuator (13) without the interposition of a valve.
9. An hydraulic patient support table according to any one of Claims 4 to 8, characterised in that the pump unit is reversible.
10. An hydraulic patient support table according to any one of the preceding claims, characterised in that the hydraulic supply (5) locks the table in position when the supply of hydraulic fluid stops.

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Fig. 1.

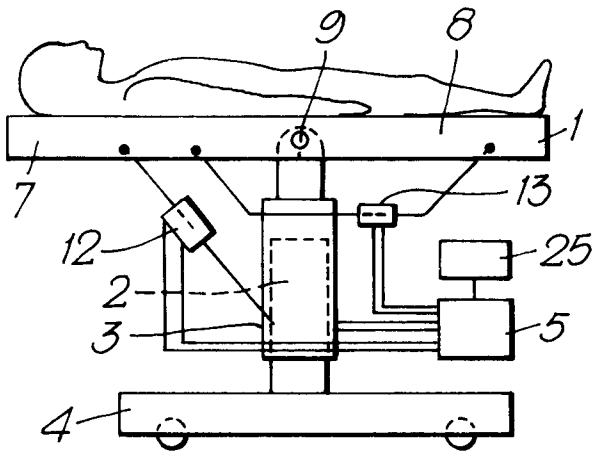


Fig. 2.

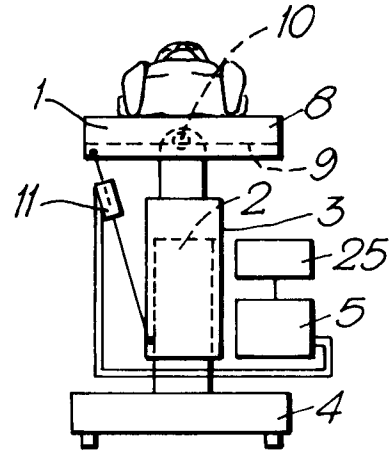
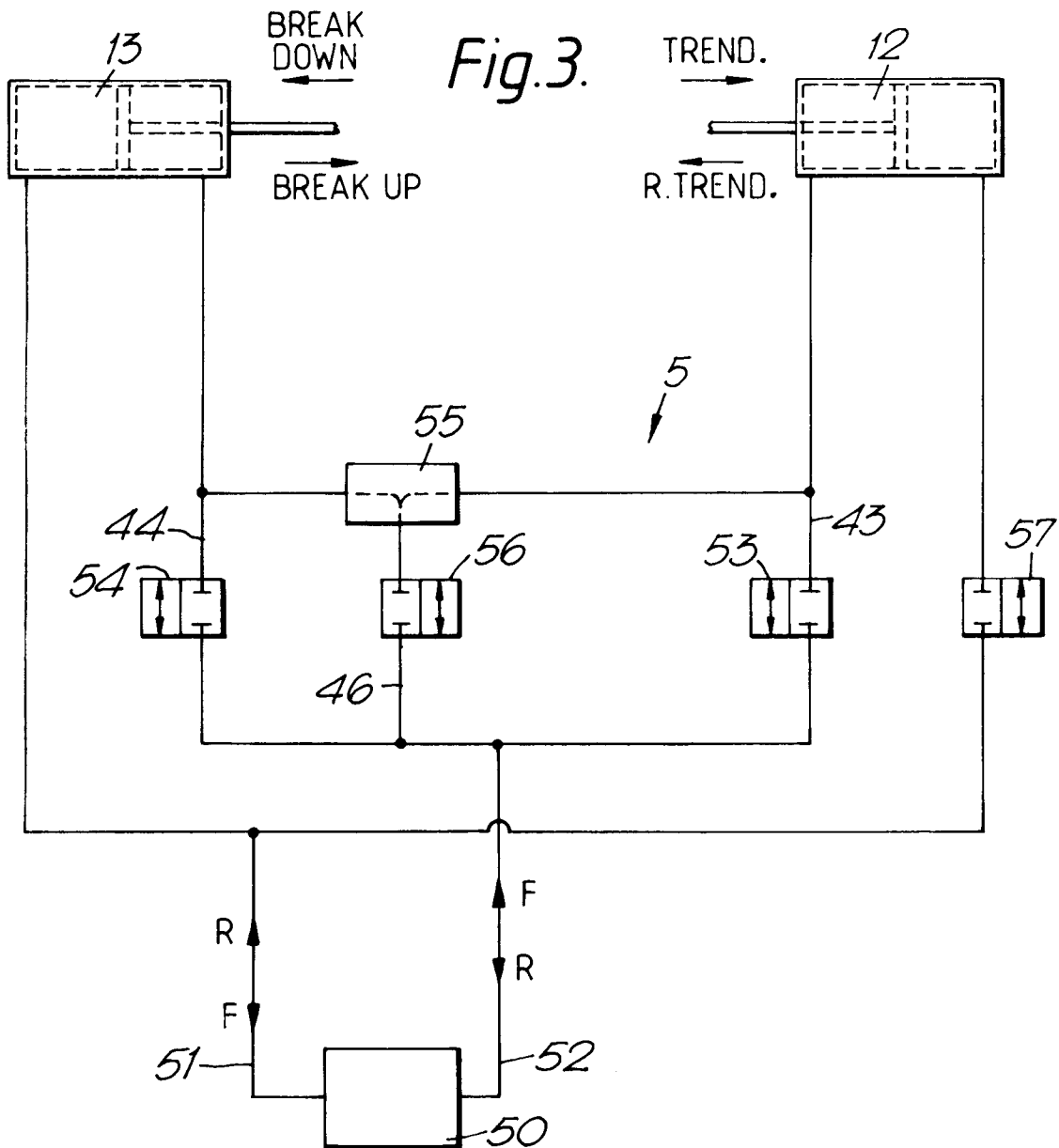
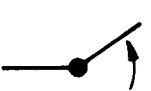


Fig. 3.



	PUMP	VALVES:53	54	56	57
<i>Fig.4A.</i> 	F	1	0	0	1
<i>Fig.4B.</i> 	R	1	0	0	1
<i>Fig.4C.</i> 	R	0	1	0	0
<i>Fig.4D.</i> 	F	0	1	0	0
<i>Fig.4E.</i> 	R	0	0	1	1
<i>Fig.4F.</i> 	F	0	0	1	1