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(71) Applicant: Shankster, Raymond Edwin
29 Cutler's Road Saltcoates Industrial Estate
South Woodham Ferrers Essex(GB)

(72) Inventor: Shankster, Raymond Edwin
29 Cutler's Road Saltcoates Industrial Estate
South Woodham Ferrers Essex(GB)

(74) Representative: Crouch, David John et al
Bromhead & Co. 19 Buckingham Street
London WC2N 6EF(GB)

(54) An exercise device.

(57) An exercise device comprising a user operated air pump in the form of a piston and cylinder arrangement (20, 28) connected to pump air into an air receiver (22). The connection is made via a non-return valve (32) across which is connected a by-pass valve (36). A control unit (30) is connected to a pressure sensor (38) in the air receiver (22) and an operating member on the by-pass valve (36) so that when the pressure in the air receiver (22) reaches or exceeds a predetermined threshold value, as sensed by the pressure sensor (38), the control unit (30) opens the by-pass value (36) to convert the air pump (20, 28) and air receiver (22) into an air spring.

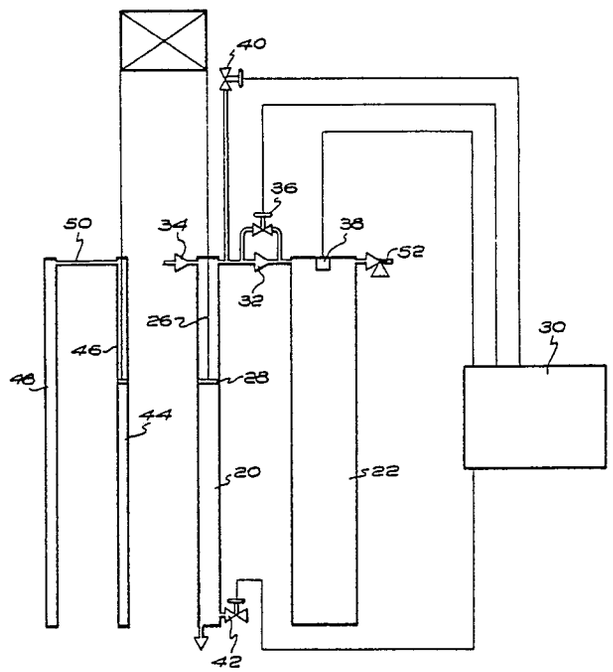

FIG. 2

EP 0 335 616 A2

An Exercise Device

The present invention relates to an exercise device.

Hitherto the most common type of exercise device has utilized a number of selectable weight increments. There are a wide variety of mechanisms employed to raise and lower these increments but all suffer to a similar degree, the effect of inertia which necessitates an "explosive" or greater force being applied to initiate movement and converseley a lesser force corresponding to the speed of the exercise to sustain movement. The repetitive raising and lowering of metal weight increments also produces a significant noise level and produces large dynamic loadings on floors.

Some forms of exercise device have been developed using hydraulic or water filled cylinders and pistons. However because of their inherent nature, variations in speed of exercise cannot be readily accommodated, and the resistance means do not provide a reciprocal returning force. Thus they do not facilitate the important "negative" stage of the exercise during which the same muscles employed in pushing the resistance are used again in resisting the force during movement in the opposite direction.

Pneumatic exercise devices have also been developed which eliminate noise to a large degree and in which the resistance force reacts in a similar way to a stack of weights. These devices do provide resistance during both the positive and negative phases of the exercise and largely overcome the effects of inertia inherent in conventional weight-stack based machines. However these have necessitated a separate source of compressed gas comprising a compressor or a large cylinder of pressurized gas sufficient to raise the pressure of gas in the resistance means to a sufficiently high level many times.

The present invention seeks to provide a remedy.

Accordingly, the present invention is directed to an exercise device comprising a user operated air pump connected to pump air into an air receiver, and means to change operation of the air pump and air receiver into that of an air spring once the air pressure in the air receiver has reached or exceeded a predetermined value.

Such a device may be made to provide the benefits of a pneumatic system but to be a self-contained unit, not requiring the running of air lines and the installation of a compressor. Thus, such a device comprises an air pump which operates when the user moves an operating member during exercise. Air is pumped into a receiver and a control mechanism changes the air pump and air receiver into an air spring, once pressure in the air receiver has reached a predetermined value.

Preferably, the air pump comprises a pneumatic piston and cylinder arrangement. This may be used to pump air into the air receiver via a pneumatic non-return valve, for example. The means to change operation of the air pump and air receiver may comprise a by-pass valve connected across the non-return valve, the by-pass valve having an operative member connected to control means which in turn are connected to a pressure sensor positioned to monitor the pressure of air in the air receiver, so that the by-pass valve is opened when the pressure in the air receiver reaches or exceeds a predetermined value set by the control means. The control means may be adjustable to enable the predetermined pressure to be selectively adjusted. Once the by-pass valve is opened, pressure exerted on the piston is resisted by the air in the cylinder and the air receiver, which are now in communication with one another. The piston and cylinder arrangement and the air receiver now therefore act in combination as an air spring, with the force resisting movement of the piston against the air pressure rising only very little as the piston is moved against that pressure if the volume of the air receiver is large relative to the volume swept by the piston. The resulting air spring may now be used as resistance means to a given exercise movement of a leg or arm, for example.

The resistance to a given exercise movement may be increased if air is exhausted from that side of the piston opposite to the side which is in communication with the air receiver, to create a vacuum in the cylinder on that side of the piston.

An example of an exercise device made in accordance with the present invention is illustrated diagrammatically in the accompanying drawings, in which:-

Figure 1 is a side elevational view of the device; and

Figure 2 shows pneumatic circuitry of the device shown in Figure 1.

The exercise device shown in Figure 1 comprises front and rear supports 10, on which are supported two mutual parallel slide rails 12, (only one of which is visible in Figure 1). A seat 14 straddles the two slide rails 12 and is fixed thereto at a position that can be adjusted by releasing and tightening a hand-operated clamp 16. A foot pedal 18 is mounted on each slide rail 12 in such a manner as to be slideable therealong. An operating cylinder 20 and an air receiver 22 are fixed to and suspended from the slide rails 12 by

means of brackets 24. A rod 26 is connected at one end to a piston 28 within the cylinder 20 and at its other end to the underside of each pedal 18. A user may sit on the seat 14 and rest his feet on the pedals 18 which he can then push forwards along the slide rails 12 to the position indicated in broken lines, against a resistance to such movement owing to the pressure of air in the cylinder 20.

A control unit 30 is mounted on the rear of the device, and is connected pneumatically to the cylinder 20 and the air receiver 22 in a manner which will now be described with reference to Figure 2.

This Figure 2 shows that the interior of the cylinder 20 and the interior of the receiver 22 are connected at the forward ends thereof via a non-return valve 32, oriented to allow passage of air in the direction from the cylinder 20 to the receiver 22, but not in the reverse direction. Also connected to the forward end of the cylinder 20 is a further non-return valve 34 which is oriented to allow air to pass from the outside to the interior of the cylinder 20 but not in the reverse direction. A by-pass valve 36 is connected across the non-return valve 32 so that the latter is by-passed when the valve 36 is opened. A pressure sensor 38 which is in communication with the air receiver 22 to monitor the pressure of air therein is connected to the control unit 30 which is also connected to control operation of the by-pass valve 36. The control unit 30 is also connected to open and close a pressure control valve 40 connected upstream of the non-return valve 32 between that valve and the cylinder 20, and also to an air vent valve 42 which is connected to the interior of the cylinder 20, on the side of the piston 28 which is opposite to the side within which extends the rod 26.

The control unit 30 is constructed in a manner to familiar to those in the art of control circuitry operate the valves 36, 40 and 42 in the following sequence when a user wishes to perform exercises on the device. Initially, it is set to have valve 42 open, and valves 36 and 40 closed. When the user pushes forward the foot pedals 18, valve 34 automatically closes and valve 32 opens so that the user pumps air into the air receiver 22. When the user draws back his foot, the foot pedal 18 is returned to its start position, for example by means of an air spring 44 rigidly connected to the rod 26. This comprises a low piston pressure and cylinder arrangement 46 and a low pressure receiver 48 connected to one another at their forward ends by a connecting pipe 50, but which are otherwise sealed and isolated pneumatically. During the return movement of the pedal 18 and with it the piston 28, the non-return valve 32 is closed, so that the air forced into the air receiver 22 remains trapped, and further air is introduced into the piston rod side of the cylinder 20, via the non-return valve 34, which is now open. This action is repeated by the user to pump up the air pressure in the air receiver 22. When the pressure therein reaches or exceeds a predetermined value defined by the control unit 30 and sensed by the pressure sensor 38, the control unit 30 first automatically opens and after a short delay closes the valve 40 to vent air from the cylinder 20 and enable the piston 28 to complete its travel to the end of the cylinder 20. The control unit 30 then automatically opens the by-pass valve 36. The pressure which has been built up in the receiver 22 is now therefore communicated to the piston rod side of the piston 28. The valve 36 is therefore opened slowly so as not to cause a dangerously sudden increase of return force on the foot pedal 18.

The operating cylinder 20 and the air receiver 22, with the by-pass valve 36 open, now act together as an air spring in much the same way as the low pressure spring 44, but with a very much higher pressure generated by the user during the pump-up stage.

Should the pressure in the air receiver fall too low, this will be detected by the sensor 38 and the control unit 30 will as a result automatically close the valve 36 to put the system back into pump mode.

By adjusting the selected pressure in the control unit, which may, for example, be by means of membrane switches and a digital display well-known in the art, the resistance force to forward movement of the pedal 18 can be adjusted.

A fixed increase in the resistance force may be applied by closing the valve 42, so that a vacuum is created on the side of the piston 28 opposite to the rod 26 when the pedal 18 is urged forwardly.

It will be appreciated that the force required to move the foot pedal 18 forwardly increases with the amount of displacement from its rest position, and that this increase depends on the ratio of the swept volume of the cylinder 20, to the volume of the air receiver, and that the increase can be varied if that ratio is varied. In particular, it can be made very small.

A pressure safety valve 52 may be connected to the interior of the receiver 22 to ensure that the pressure in the air receiver does not become dangerously high.

In the event that the pressure in the system is to be decreased, a lower pressure is selected on the control unit 30, which then opens the valve 40 to vent air from the system accordingly, until the new lower pressure is reached. A selection of a higher pressure will naturally require the full operating sequence already described to be executed by the user.

Provided good seals are used and the valves of the system do not leak, a high pressure may be retained in the exercise device for some time so that when a user next comes to the device for an exercise session, it may take very few strokes to pump up the pressure back to the desired value.

An exercise device made as illustrated with a swept cylinder volume to air receiver volume of 1:4 and with an effective piston area of 7 square inches (3 inch diameter) affords the following absolute piston pressure, gauge pressure, and actual load created for the system after the given number of pump-up strokes.

Compression Strokes		Piston Pressure		Load lbs. Maximum
		lbs.	Gauge	
One	14.7 x 5/4	18.375	3.675	25.725
Two	6/4	22.05	7.35	51.45
Three	7/4	25.725	11.025	77.175
Four	8/4	29.4	14.7	102.9
Five	9/4	33.075	18.375	128.625
Six	10/4	36.75	22.05	154.35
Seven	11/4	40.425	25.725	180.075
Eight	12/4	44.1	29.4	205.8
Nine	13/4	47.775	33.075	231.525
Ten	14/4	51.45	36.75	257.25

The maximum pressure generated in this manner is less than 40 p.s.i.g.

Thus it will be seen that the resistance force to forward movement of the foot pedal 18 varies from 103 lbs. at the start of the stroke to 128.6 lbs. at the end of the stroke after five pump-up strokes, although the minimum and maximum values after ten strokes are 205.8 and 257.25 respectively, so that the load variation is generally 25%.

The minimum and maximum values after five pump-up strokes with the valve 42 shut are about 203 and 228 respectively and after 10 strokes about 305 and 357 respectively. Thus the load variation after 5 pump-up strokes is about 12% and after 10 strokes it is about 17%. (After one pump-up stroke it is about 5%).

Numerous variations and modifications will readily occur to the reader familiar with art of exercise devices without taking the device outside the scope of the present invention. In particular, the operating cylinder 20 may be vertically oriented for use in an exercise device in which the user pushes a resisting member upwards with his arms, for example. The control unit 30 is shown mounted at the rear of the device, but an arrangement is possible in which the control unit 30 is positioned at the front of the device.

The connection between the main piston and each pedal or other operating member does not have to be rigid: links and rods could be used, or even a flexible connection.

Control of the valves may be pneumatic, electro magnetic, manual, or by cams and levers, for example.

In addition, display means may be provided to indicate to the user pressure values built up in the device. The display means may take the form of dial gauges, bar graples, or liquid crystal displays, for example.

A further adaptation could encompass a single air receiver servicing a plurality of exercise stations.

Instead of having an operating cylinder to which both foot pedals are connected, there could be respective operating cylinders, one for each foot pedal, connected to one and the same air receiver, or possibly to respective air receivers.

Although the illustrated machine resists the horizontal movement of the feet in a leg exercise motion, it could be re-oriented for vertical movement of the hands, for example, in an arm exercise machine, in which case handlebars would replace the foot pedals.

Claims

1. An exercise device characterised in that it comprises a user operated air pump (20, 28) connected to pump air into an air receiver (22), and means (30, 36, 38) to change operation of the air pump (20, 28) and air receiver (22) into that of an air spring once the air pressure in the air receiver (22) has reached or exceeded a predetermined value.

2. An exercise device according to claim 1, characterised in that the air pump (20, 28) comprises a pneumatic piston and cylinder arrangement (20, 28).

3. An exercise device according claim 2, in which the piston and cylinder arrangement (20, 28) is connected to pump air into the air receiver (22) via a pneumatic non-return valve (32).

4. An exercise device according to any preceding claim, characterised in that the means (30, 36, 38) to change operation of the air pump (20, 28) and air receiver (22) comprise a by-pass valve (36).

5. An exercise device according to claim 4 read as appendant to claim 3, characterised in that the by-pass valve (36) is connected across the non-return valve (32).

6. An exercise device according to claim 5, characterised in that the by-pass valve (36) has an operative member connected to control means (30) which in turn are connected to a pressure sensor (38) positioned to monitor the pressure of air in the air receiver (22), so that the by-pass valve (36) is opened when the pressure in the air receiver (22) reaches or exceeds a predetermined value set by the control means (30).

7. An exercise device according to claim 6, characterised in that the control means (30) are adjustable to enable the predetermined pressure to be selectively adjusted.

8. An exercise device according to any preceding claim, characterised in that means (42) are provided to exhaust air from that side of the piston (28) opposite to the side which is in communication with the air receiver (22), to create a vacuum in the cylinder (20) on that side of the piston (28).

9. An exercise device according to any preceding claim, characterised in that a low pressure air spring (46, 48) is connected directly or indirectly to the air pump (20, 28) to urge the latter into an intended start position.

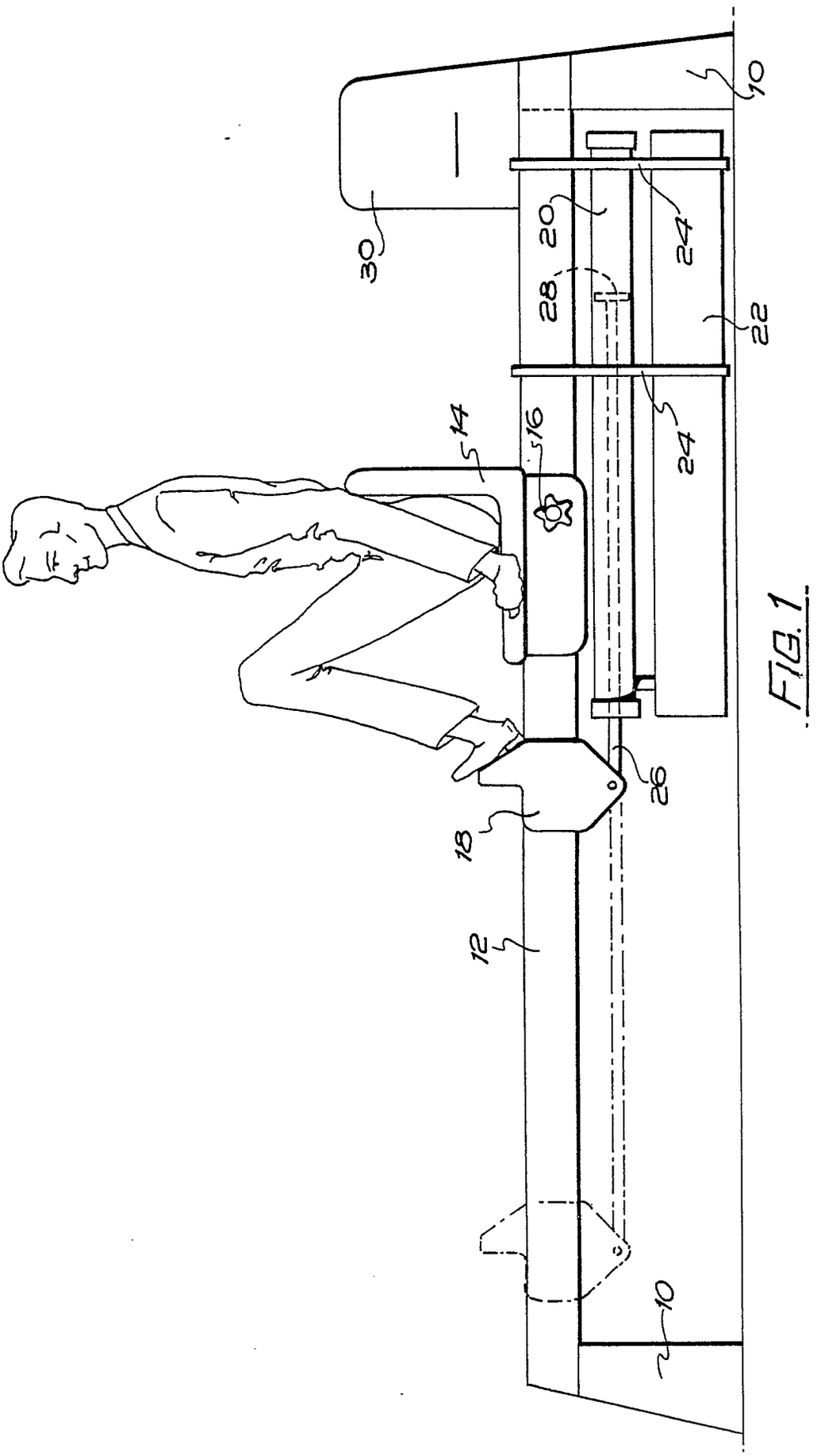

FIG. 1

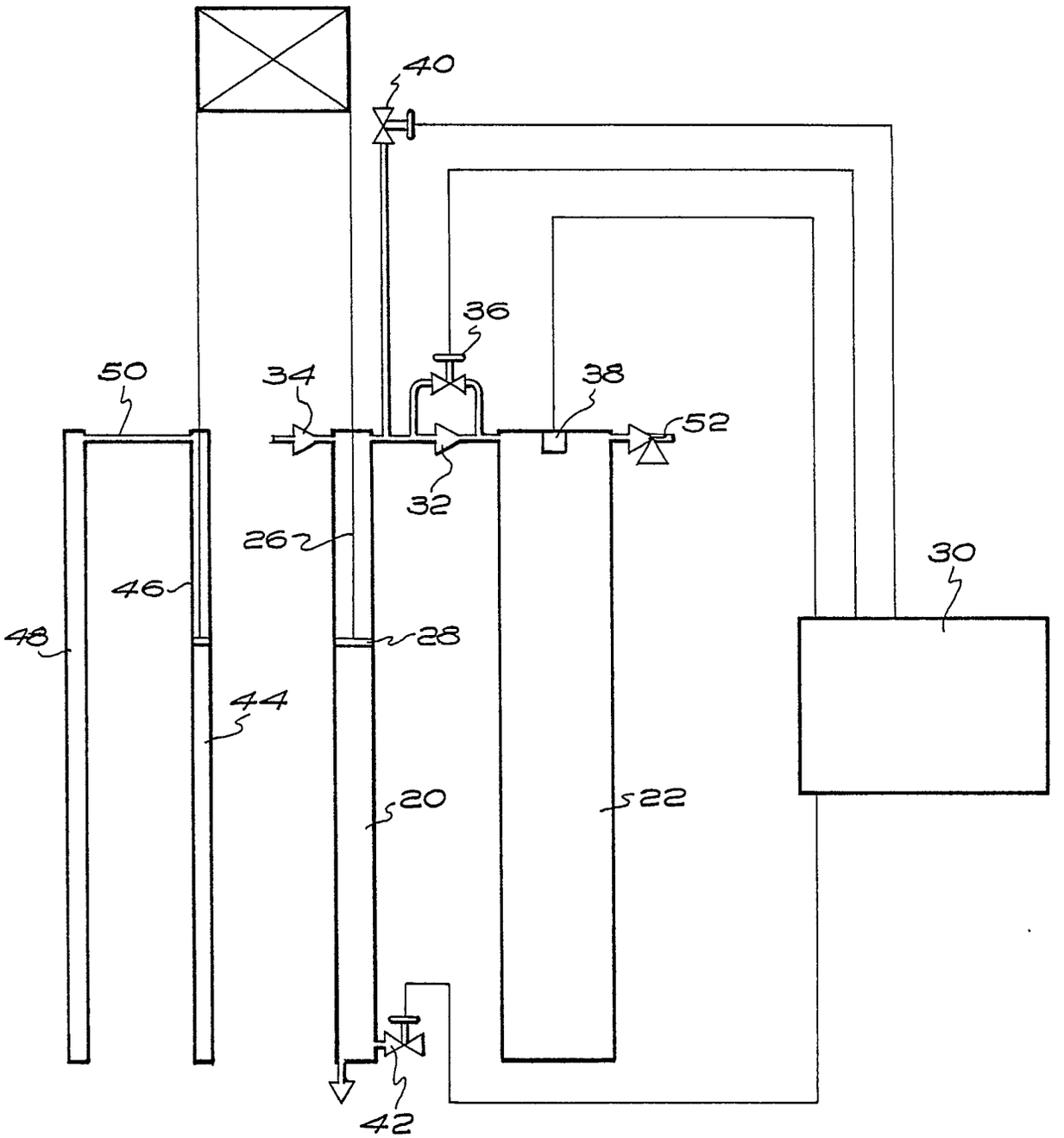

FIG. 2