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HYDRAULIC POSITION LOCK

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This invention relates to hydraulic position locks.

It is an object of my invention to provide a hydraulic position lock having a locked and an unlocked condition which in one condition will selectively fix the distance between two associated relatively movable members and which in the other condition will allow comparatively free movement between said members in one direction and comparatively restricted movement in the other direction.

It is a further object of my invention to provide a lock of the character described which in locked condition is capable of being actuated by a comparatively high predetermined force applied in one but not the opposite direction so as to allow unidirectional movement of the lock when excessive force is applied to it.

It is a further object of my invention to provide a lock of the character described which can be readily utilized in a variety of relatively foldable devices designed to receive and support the human body such as erectable beds, tiltable chairs and the like.

My hydraulic position lock is a device which when fastened between two relatively movable associated members will expand or contract in accordance with the desired variable distance between these movable members and which will in locked condition fix the distance between these members. When it is desired to vary this distance, means are provided by forcing hydraulic fluid to flow through selected passageways within my device to allow comparatively restricted movement, say in contraction, and comparatively free movement in expansion between these members.

The uses of such a device are myriad, a few including application to a hospital bed with erectable sections; chairs having tiltable backs as those used in the home; reclining seats in automobiles or in airplanes; and mechanisms used to hold swinging doors in a partly open position. In other words, the instant lock may find application whenever two members are so arranged that it is desirable both to selectively fix the distance between them and to influence the rate at which these members can be relatively moved toward or away from one another. In addition, while carrying out such functions, my device, via its hydraulic fluid flow, tends to provide a smooth constant rate of expansion or contraction between these members. Thus, it serves as a dampening agent, absorbing fluctuations in the expansion or contraction force so as to provide a desirable more constant rate of expansion or closure.

The feature of my invention which allows comparatively freer movement in one direction than another when the lock is in its open condition is a particularly desirable aspect of the instant device. It finds use for example in a chair or a bed having a tiltable back. When a user sits in such a chair and desires to adjust the back, he will lean backwards and actuate the mechanism so as to unlock the normally fixed position of the back and seat members. My hydraulic lock will then allow the chair back to rotate backwards against a return spring at a safe speed until a desired position is attained, when the user will release the mechanism so as to lock the members in this position. When it is desired to return the chair back to a more upright position, the same rate of movement may be unsafe since the return spring may cause the back of the chair to impact the back of the user

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if he is sitting erect while actuating the lock. In this situation, it will be desirable to allow comparatively restricted movement of the lock as it contracts between two members, and comparatively free movement when the lock expands between two members.

The instant device further incorporates a unidirectional overridable valve by which is meant an internal mechanism which allows one movement, either expansion or contraction, at times other than when the mechanism is actuated (unlocked) by the user. This is done to absorb an overload applied in only one direction to the lock, the override allowing movement in the predetermined direction only, thereby preventing damage both to its internal mechanism due to high hydraulic pressures and to the external members. The override valve mechanism is actuated (opened) only as long as the overload force is applied, the override mechanism cutting out and the device locking in place upon removal of such force. This unidirectional override feature finds typical use in a tiltable back chair, wherein a person sitting down suddenly or violently could accidentally overload the lock, the override feature here preventing material damage. However, when a stranger lifts the chair back from the rear the lock cannot be overridden, thus preventing discomfort to the person occupying the chair.

The device in a preferred form also includes a return spring which functions in compression and opposes expansive movement of the instant device. The spring acts to counterbalance the loading of a rotatable member and return it to a contracted, closed or upright position.

The embodiment of the hydraulic position lock presently to be described incorporates all of the above mentioned functions. It will be obvious, however, that a reader of the instant disclosure skilled in the art will be able to readily substitute the desired features within the device to act in expansion or contraction without proceeding beyond the scope of the present invention. Thus, either the expansive or contractive movement of the lock may be checked at a comparatively freer rate; the unidirectional override may be embodied in the device in contraction or expansion as desired; and the return spring may be caused to function in compression or tension. All these variations become obvious within the ambit of the instant device, one embodiment being shown as illustrative of my concept.

This and various other objects and advantages of my invention will become apparent to the reader in the following description.

My invention accordingly consists in the features of construction, combinations of elements and arrangement of parts which will be exemplified in the device hereinafter described and of which the scope of application will be indicated in the appended claims.

In the accompanying drawings, in which I have shown various possible embodiments of my invention,

FIG. 1 is a side view of my hydraulic position lock utilized mounted on a chair having a tiltable back;

FIG. 2 is an enlarged longitudinal axial cross-section of my lock;

FIG. 3 is an enlarged fragmentary view through the piston of the lock shown in FIG. 2; and

FIG. 4 is a transverse cross-section taken along line 4—4 of FIG. 3.

In general, my hydraulic position lock includes an elongated cylinder having end walls. Contained within the cylinder is a piston mounted for reciprocal movement therein and in slidable sealing engagement therewith. The piston hydraulically divides the cylinder into two closed compartments. Each of two piston rods, integral with the piston, slidably and sealingly extends through

its adjacent cylinder end wall. One of the piston rods is tubular.

The piston has a passageway extending through it communicating from one compartment to another. The cylinder and passageway are filled with liquid. The piston may experience movement when liquid flows through the passageway, and, conversely, is immobilized when the passageway is blocked since the liquid is substantially incompressible.

Two valve systems act on this passageway. The first is a lock valve which has a face that can block the passageway. This valve is spring biased to a normally closed position, so that the passageway is normally blocked and so that the piston is normally immobilized thereby. An actuating rod is disposed within the tubular piston rod and is mounted to act against the biasing spring to open the lock valve when desired.

The lock valve face is mounted to oppose pressure from only one compartment, this being done by placing the face across the passageway, spring biasing the face to a closed position, and arranging the valve so that excessive pressure from only said one compartment can move the valve to an open position.

The second valve system comprises a check valve which is associated with a shunt portion within the passageway. The passageway is arranged to include a first portion, a second portion of smaller cross-sectional area than the first portion and in series with the first portion, and a shunt portion of larger cross-sectional area than the second portion and in parallel with the second portion. The check valve, associated with the shunt portion, is mounted so that it will open and unblock the shunt portion when liquid flows in one direction and will close to block the shunt when liquid flows in the other direction.

The principles involved may be summarized briefly. The lock valve normally blocks the passageway, and may be opened by the user by means of an actuating rod and handle or may be opened by excessively high pressure from only one compartment. Only when the lock valve is open allowing some liquid flow through the passageway will the check valve function. With liquid flow in one direction, the check valve is closed blocking the shunt portion and thus allowing somewhat restricted flow through the passageway. When hydraulic fluid flows in the other direction, the check valve opens and liquid may flow through the shunt allowing somewhat freer flow through the passageway.

Referring now in detail to the drawing, the reference numeral 10 indicates my hydraulic position lock. FIG. 1 shows one of the several uses of my device, it here being utilized with a chair 12 having a tiltable back 14 turning about a pivot pin 15. The hydraulic lock includes an elongated cylinder 16 having side walls 18 and end walls 20, 22. The cylinder has a piston 24 within it and two attached aligned piston rods 26, 28. It is convenient to designate several parts of the instant device as "right" members or "left" members, as seen in FIG. 2, this designation being utilized only for the purpose of eliminating undue verbosity in the instant disclosure. The right piston rod 28 extends from a right face 29 of the piston 24 through the right end wall 22 and the left piston rod 26 extends from a left face 31 of the piston through the left end wall 20. Both piston rods are joined to the piston as by means of threads on the proximal ends of the rods screwed into threaded bores in the piston. The piston hydraulically divides the cylinder into two closed compartments, a right compartment 30 and a left compartment 32. The piston 24 has a passageway extending through it, generally designated by reference numeral 34, which communicates between these two compartments.

The piston has its external diameter substantially of the same dimension as the inside diameter of the cylinder 16, and the piston is mounted for sliding reciprocal axial movement within the cylinder between a position adjacent the left end wall 20 and the right end wall

22. An incompressible fluid as oil fills the cylinder compartments and the passageway. The piston has two external annular grooves 38 on its side periphery, in which O-rings 40 are seated to provide sliding sealing engagement of the piston 24 to the cylinder side wall 18, thus providing hydraulic separation of the two compartments 30, 32.

The end walls 20, 22 are identically arranged and constructed, only the left one 20 being structurally described herein for simplicity. A bored cylindrical insert 42 is positioned in the left end of the cylinder and is seated against an outwardly facing shoulder 44 within the cylinder. The insert is held captively in place by a spin-formed converging rim 46 on the left end of the cylinder. The insert is held in sealing engagement against the cylinder wall 18 by O-rings 48 seated in annular grooves 50 in the insert.

The insert has provision for slidable sealing engagement with the piston rod by containing within its inner bore 51 a packing comprising a nylon lining ring 52, a retaining ring 54, O-rings 56 and a spacer 58. This packing is compressed into place by a retaining nut 60 screwed into an internally threaded portion 62 of the bore 51. Those skilled in the art will appreciate many other suitable methods for causing sealing slidable engagement of the mentioned parts.

The piston and piston rods can experience motion relative to the cylinder 16. The cylinder has an external bracket 64 fixedly attached to it, which can be used, for example, to pivotally connect the cylinder to the seat 66 of the chair 12. In this embodiment the right piston rod 28 has a hole 68 through a portion always external to the cylinder, by which the rod may be appropriately fastened as by a pivot pin to the tiltable back 14 of the chair.

Reference will now be made to the valve means and passageway, shown enlarged in FIG. 3. The passageway 34 has several portions including from left to right, a first portion 70 running from a terminal 72 on the left face 31 of the piston through an aperture 74 in a lock valve seat 76, and a second portion 78 having a cross-sectional area smaller than the cross-sectional area of the first portion 70. The first portion and second portion are in series. The passageway 34 further includes a shunt portion 80 bridging the second portion 78, the shunt portion having a larger cross-sectional area than that of the second portion 78. The passageway terminates with a bore 82 terminating in the right compartment 30 after passing through a proximal end of the right piston rod 28 which extends through the right face 29 of the piston 24.

A lock valve, generally designated by the numeral 83, is associated with the passageway 34. It consists of a lock valve face 84, being a circular flat disc preferably of Buna rubber disposed transversely to the passageway 34 and backed up by a spacer 86. The disc and spacer are held in a housing 88 which girdles the disc and spacer. The disc is designed to engage the lock valve seat 76 and is constructed to seal the valve seat aperture 74. The lock valve is urged towards this sealing (closed) position by a biasing spring 89.

The lock valve is manually controllable as by means of an actuating member and handle. One of the piston rods, here the left piston rod 26, is tubular so that the rod has an internal bore 90 extending through it. An actuating member which is an elongated bar 92 is disposed within the bore 90 of the tubular rod 26. External to the cylinder 16, the bar is joined to an actuating handle 94, being a small member pivotally attached to the bar 92 and shaped for convenient gripping by the human hand. The bar is in slidable sealing engagement inside the piston rod with a portion of the rod near the left face 31 of the piston. This engagement is effected by O-rings 96 and a liner 98 disposed within the bore 90 and seated about the bar 92. The bar 92 includes a bar extension 100

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which is gripped by the housing 88. The handle 94 via the bar 92 is joined to the lock valve 83.

A check valve 102 is associated with the shunt portion 80 of the passageway 34. The check valve contains a conical depression 104 which acts as a valve seat for the check valve. The shunt portion passes through this depression 104. The depression is located at the foot of a valve cage including four spaced fingers 106. The check valve further includes a valve ball 108 within the cage and of proportions to fit into and block the depression 104. A spring 110 lightly biases the ball into a closed (blocking) position. This spring is considerably weaker than the lock valve spring 89. A large coil spring 112 which acts as a return spring or counterbalance is disposed within the cylinder 34 and optionally within the right compartment 30, and is mounted to oppose in compression rightward movement of the piston 24.

Turning now to the operation of the instant device, it will be appreciated that the cylinder 16 via its bracket 64 is pivotally joined to one of the two associated relatively movable members, here the seat 66 of the chair 12. The piston 24 via the piston rod 28 is pivotally connected to the second associated member, here the tiltable back 14 of the chair. When the piston is caused to experience movement relative to the cylinder, the associated members will expand or contract, as the case may be.

Since liquid fills both the compartments 30, 32 into which the cylinder is hydraulically divided, and the passageway 34 through the piston 24, the piston can experience motion in either direction only when the passage is unblocked so that liquid can flow therethrough.

The lock valve 83 has its disc 84 mounted so that it blocks the first portion 70 of the passageway at the valve seat aperture 74. The biasing spring 89 holds the lock valve to a normally closed position, thus blocking the passageway, preventing fluid flow and immobilizing the piston when the lock is in repose. Without actuation, the relative position of the piston and the cylinder are fixed or locked in place, thereby locking or fixing the position (distance) between the two associated members.

When the user of the chair wishes to change the distance between the two members, that is, to expand or contract the lock 10, he must swing the handle 94 so that the end of the handle presses against the outer end of the rod 26. Since the distance from the handle pivot to the nearby end of the handle exceeds the distance from said pivot to the nearby edge of the handle such swinging of the handle shifts the bar 92 to the left, pulling the valve disc 84 away from valve seat 76, against the force of the biasing spring 89. With this lock valve open, liquid flow is permitted through the passageway.

The lock valve 83 is also operable by a relatively high predetermined hydraulic pressure from only one compartment. This unidirectional effect is obtained by placing the disc 84 of the lock valve transversely across the passageway 74, and mounting the disc so that pressure from one compartment only acts on the exposed face of the disc 84, i.e. in a valve opening direction.

It will be seen that by hydraulic pressure from the left compartment 32 will act in the same direction as the spring 89 to urge the lock valve to a closed position. Such pressure would be caused when the piston, by means of the piston rods, is urged strongly to the left, developing internal hydraulic pressure in the left compartment. Pressure caused by a leftward movement of the piston will not cause the lock valve to open, but rather will urge it to tightly seal the aperture 74.

Conversely, a predetermined relatively high hydraulic pressure in the right compartment 30 caused in the same way will be transmitted through the liquid via the passageway 74 against the disc 84 of the lock valve, causing it to move away from the lock valve seat 76 and open the aperture 74. The amount of pressure necessary to open the lock valve is determined by the compression resistance of the spring 89. Once this excessively high pressure

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from the right compartment has terminated, the lock valve will again be closed by the spring 89. It will be now appreciated that the lock valve may be opened either by turning the handle 94 or by an excessively high pressure only in one compartment, here the right hand compartment.

Means is provided for varying the rate of expansion and the rate of contraction between the two associated members. It will be recalled that the passageway 34 has a first portion 70 with which the lock valve is associated. This portion is in series with a second portion 78 and also in series with a shunt portion 80, the latter two being in parallel. The check valve 102, comprising the ball member 108 biased by the spring 110, is normally disposed to block the shunt portion. The check valve is opened by flow in a direction against the force of its biasing spring, and is closed by flow in a direction cumulative to the force of the spring or by the spring alone when no flow is taking place. The second portion 78, which is of smaller cross-sectional area than that of either the first portion or the shunt portion, always remains open.

When the lock valve is open, force applied to the rods will cause flow to pass through the first portion and, if the flow is in a direction prevented by the check valve, flow will pass then only through the second portion 78 of restricted cross-sectional area. The second portion's cross-sectional area will restrain the rate of movement of the piston in that direction; in the instant embodiment this occurs when the piston moves leftward and the lock contracts.

When flow passes in a direction permitted by the check valve, the ball 108 is moved to an open position, and flow will then pass through the shunt portion 82, as well as through the restricted portion 78. Liquid flowing through the shunt portion passes from one end of the shunt portion proximal the right face 29 of the piston through the depression 104 around the valve ball 108 which is removed from the depression 104 and through the spaces between the fingers 106 of the valve cage. The shunt portion's cross-section area, being considerably larger than the cross-sectional area of the restricted portion, influences the rate of movement when that channel is utilized and allows relatively free flow of liquid in this direction. In the instant embodiment this occurs when the piston moves rightward and the lock expands.

The large coil return spring 112 is situated within the right compartment 30 and functions in compression to urge the piston leftward, tending to contract the lock. It can only do so when the lock valve is opened and liquid flow takes place.

When a user desires to increase the tilt of the back of his chair, he sits in the chair, turns the handle 94 so as to operate the actuating bar 92 thus opening the lock valve 83. He now leans back in his chair, the back then exerting an expansive force on the rod 28, applying force to the piston and causing liquid to flow from the right compartment 30 through the passageway 34 to the left compartment 32. When flow takes place in this direction, the check valve is opened and liquid flow will pass through the shunt portion 82, allowing relatively free movement of the piston. The right hand movement of the piston will compress the large coil spring. When the chair back has been tilted sufficiently the user swings the handle to the illustrated closed position for the lock valve.

When the user wishes to rotate the back to a more upright position, he need only sit up and turn the handle again so as to open the lock valve, the expansion force of the coil spring acting as a counterbalance against the tiltable back causes the piston to move leftward to contract the lock. At this time, flow will tend to move the check valve to its closed position, fluid then passing only through the restricted second portion so that the back does not snap up, but contracts at a desired safe rate.

If the user were to accidentally fall into or otherwise exert an excessively high expansive force on the lock, a force which might otherwise harm the interior of the lock or damage a member, pressure from the right compartment will be exerted on the disc 84 of the lock valve, opening the lock valve and permitting flow until the force has abated. The design of the lock will prevent such opening upon the application of a reverse pressure.

It thus will be seen that I have provided a device which achieves the several objects of my invention, and which is well adapted to meet the conditions of practical use.

As various possible embodiments might be made of the above invention, and as various changes might be made in the embodiments set forth, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. A hydraulic position lock comprising an elongated cylinder having end walls, a piston mounted for reciprocal movement within said cylinder and in slidable sealing engagement therewith, said piston hydraulically dividing said cylinder into two closed compartments, two piston rods integral with said piston, each rod extending through an adjacent cylinder end wall in slidable sealing engagement therewith, at least one of said rods being tubular, a passageway through said piston communicating between said compartments, said passageway including a first portion, a second portion having a cross sectional area smaller than the cross sectional area of the first portion, and a shunt portion having a cross sectional area larger than the cross sectional area of the second portion, said shunt portion bridging the second portion, an incompressible liquid filling said compartments and said passageway, a manually controllable lock valve associated with the passageway, said valve having a member mounted for movement between a closed position blocking said passageway preventing liquid flow and immobilizing the piston, and an open position unblocking said passageway permitting liquid flow and allowing the piston to experience motion, said lock valve having a face mounted and arranged to oppose hydraulic pressure exerted by only one compartment, a spring biasing said lock valve to its closed position so that said passageway is normally blocked, said spring being mounted to oppose lock valve movement caused by said pressure on the valve face, an actuating member disposed within said tubular piston rod to act against said biasing spring, said member being mounted to selectively move said lock valve to its open position, and a check valve associated with the shunt portion of said passageway and mounted for movement between a closed position blocking said shunt portion and an open position unblocking the shunt portion, said check valve being responsive to unidirectional liquid flow, so that when the lock valve is in its open position, liquid flow in one direction will open the check valve and flow through the passageway including the second portion and the shunt portion allowing the piston to experience comparatively free movement, and liquid flow in the opposite direction will close the check valve and flow through the passageway including the second portion but not the shunt portion allowing the piston to experience comparatively restrained movement.

2. A hydraulic position lock as set forth in claim 1 wherein the check valve is biased by a spring to a closed position.

3. A hydraulic position lock as set forth in claim 1 wherein a coil spring biases the piston to a position adjacent an end wall.

4. A hydraulic position lock as set forth in claim 1 wherein the compartment which exerts pressure on the lock valve face is the same compartment as that from which liquid flows to move the check valve to an open position.

5. A hydraulic position lock comprising an elongated cylinder having end walls, a piston mounted for reciprocal movement within said cylinder and in slidable sealing engagement therewith, said piston hydraulically dividing said cylinder into two closed compartments, two piston rods integral with said piston, each rod extending through an adjacent cylinder end wall in slidable sealing engagement therewith, at least one of said rods being tubular, a passageway through said piston communicating between said compartments, said passageway including a first portion, a second portion having a cross sectional area smaller than the cross sectional area of the first portion, and a shunt portion having a cross sectional area larger than the cross sectional area of the second portion, said shunt portion bridging the second portion, an incompressible liquid filling said compartments, and said passageway, a manually controllable lock valve associated with the passageway, said valve having a member mounted for movement between a closed position blocking said passageway preventing liquid flow and immobilizing the piston, and an open position unblocking said passageway permitting liquid flow and allowing the piston to experience motion, and actuating member disposed within said tubular piston rod to act against said biasing spring, said member being mounted to selectively move said lock valve to its open position, and a check valve associated with the shunt portion of said passageway and mounted for movement between a closed position blocking said shunt portion and an open position unblocking the shunt portion, said check valve being responsive to unidirectional liquid flow, so that when the lock valve is in its open position, liquid flow in one direction will open the check valve and flow through the passageway including the second portion and the shunt portion, allowing the piston to experience comparatively free movement, and liquid flow in the opposite direction will close the check valve and flow through the passageway including the second portion but not the shunt portion allowing the piston to experience comparatively restrained movement.

6. A hydraulic position lock as set forth in claim 5 wherein means is provided to bias the check valve to a closed position.

7. A hydraulic position lock as set forth in claim 5 wherein the check valve includes a valve ball, and a conical valve seat to receive said ball.

8. A hydraulic position lock as set forth in claim 5 wherein the check valve includes a valve ball and a valve seat constructed to receive said ball, said seat including a conical portion through which the shunt portion passes, several spaced fingers extending from the conical portion, and a spring biasing said ball into said conical portion so as to normally block said shunt portion.

9. A hydraulic position lock comprising an elongated cylinder having end walls, a piston mounted for reciprocal movement within said cylinder and in slidable sealing engagement therewith, said piston hydraulically dividing said cylinder into two closed compartments, two piston rods integral with said piston, each rod extending through an adjacent cylinder end wall in slidable sealing engagement therewith, at least one of said rods being tubular, a passageway extending through said piston and communicating between said compartments an incompressible liquid filling said compartments and said passageway, valve means in the passageway providing relatively restricted liquid flow in one direction and relatively free liquid flow in the other direction at all times that liquid passes through said passageway whereby the piston moves in the cylinder at one speed in one direction and at a different speed in the other direction, a manually controllable lock valve associated with the passageway, said valve having a member mounted for movement between a closed position blocking said passageway preventing liquid flow therethrough and immobilizing the piston, and an open position unblocking said passageway permitting liquid flow therethrough and allow-

ing the piston to experience motion, said lock valve having a face mounted and arranged to oppose hydraulic pressure exerted by only one compartment, a spring biasing said lock valve to its closed position so that said passageway is normally blocked, said spring being mounted to oppose lock valve movement caused by said pressure on the valve face, and an actuating member disposed within said tubular piston rod to act against said biasing spring, said member being mounted to selectively move said lock valve to its open position.

10. A hydraulic position lock comprising an elongated cylinder having end walls, a piston mounted for reciprocal movement within said cylinder and in slidable sealing engagement therewith, said piston hydraulically dividing said cylinder into two compartments, at least one piston rod integral with said piston extending through an adjacent cylinder end wall, a passageway extending through said piston and communicating with said compartments, a liquid filling said compartments and said passageway, first valve means normally blocking said passageway so as to prevent liquid flow therethrough whereby to normally immobilize said piston, said first valve means being manually controllable externally of the cylinder and being manipulatable to selectively unblock the passageway so as to permit liquid flow therethrough whereby to allow movement of the piston, and second valve means in said passageway separate from said first valve means enabling comparatively

free liquid flow through the passageway in one direction and comparatively restricted liquid flow in the other direction at all times that liquid passes through said passageway whereby the piston moves in the cylinder at one speed in one direction and at a different speed in the other direction, said first valve means including a single directional valve override means momentarily unblocking said passageway to permit temporary liquid flow therethrough in response to a relatively high predetermined pressure transmitted from only one selected compartment so that excessive pressure in only said selected compartment can unblock the passageway.

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