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HYDRAULIC ACTUATOR WITH CENTER LOCK

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Fig. 2

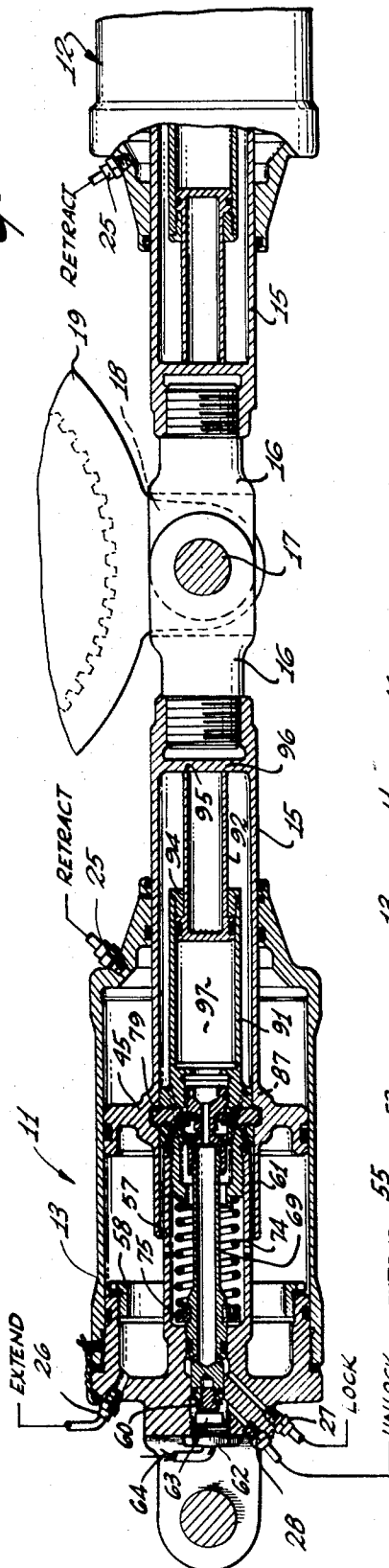
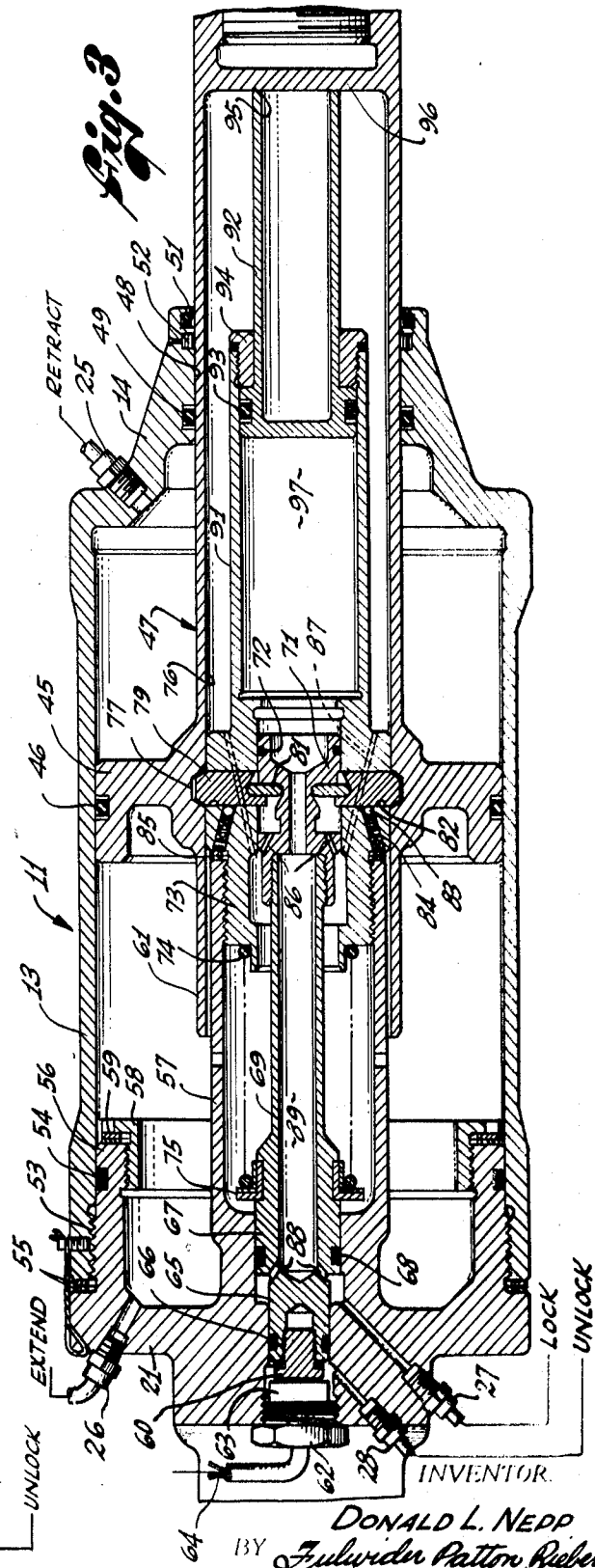


Fig. 3



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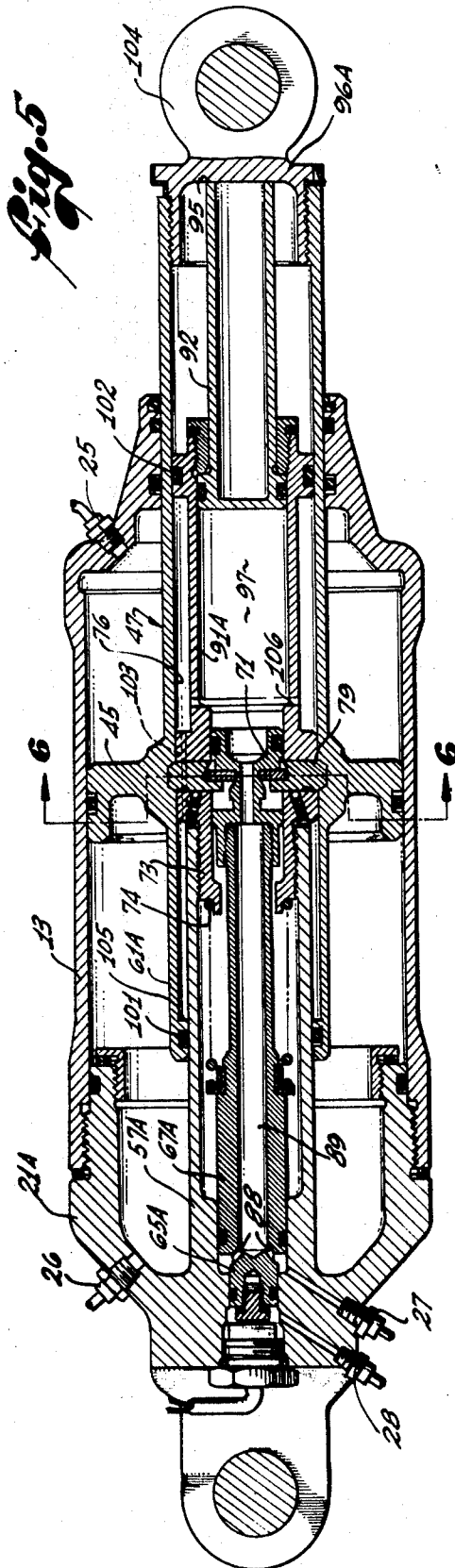
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3 Sheets-Sheet 3



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HYDRAULIC ACTUATOR WITH CENTER LOCK
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10 Claims

ABSTRACT OF THE DISCLOSURE

A hydraulic actuator having a main piston movable to extended and retracted extreme positions of operation and provided with a center lock in a position intermediate the extreme positions. The lock is located internally of the piston for compactness and a locking-unlocking piston is provided to operate the locking elements. An auxiliary piston is provided for moving the main piston to its center locked position by abutting a part movable with the main piston, for movement in one direction only. Actuators may be mounted in face-to-face pairs to secure movement in opposite directions to the dead center position, or a single actuator may include a working surface on the main piston for moving it to its dead center locked position in the direction opposite to the direction of movement by the auxiliary piston. Spring biased detent means hold the locking elements in unlocked position against involuntary, random movements.

BACKGROUND TO THE INVENTION

(1) This invention is directed to the field of hydraulic actuators and operators for effecting limited movements of operated parts in opposite directions by the selective application of hydraulic fluid under pressure.

(2) Hydraulic actuators with locking means are well known in the art, but center lock actuators have been complicated and bulky and have located the locking means on the outside of the main piston rod. Such structures have lacked a holding means for the locking elements in their unlocked position. Also, the structure for centering the main piston in locking position has been complex.

SUMMARY OF THE INVENTION

In the hydraulic actuator of the present invention, a center lock position is provided intermediate the extreme operating positions, and the main piston is moved to its dead-center, locking position in one direction only by abutting engagement with an auxiliary piston subjected to the locking pressure which is also exerted on a locking piston which moves locking elements into a locking notch or groove.

In order to shorten the actuator and make it more compact, the locking means for the main piston is preferably located internally of the main piston rod. The main piston rod is therefore substantially a hollow cylinder with both the locking-unlocking piston and the auxiliary piston located coaxially therein, and operated to locking positions in opposite directions by the application of the same locking pressure thereto.

Ball detents are provided engaging in complementary holes in the locking elements in their unlocked position to hold the elements against involuntary, random movements and rattling.

The auxiliary piston abuts a part movable with the main piston to move it in an extending direction only toward its dead-center position and movement in a retracting direction toward dead-center position may be secured from a second actuator mounted in face-to-face relation so that one actuator retracts when the other actuator extends.

Alternatively, the main operating piston may present a

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working surface on which the locking pressure may operate to move the main piston in a retracting direction toward dead-center position. In this latter case, only a single actuator may be used and the retracting movement to dead-center position is terminated at dead center by engagement with the auxiliary piston whose effective area is greater than the effective area of the retracting surface on which the locking pressure works.

Other objects and features of the invention will be apparent from the following specification and the appended drawings.

SHORT DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational and diagrammatic view of 15 paired, face-to-face actuators according to the present invention;

FIG. 2 is an enlarged view of the paired actuators with one shown in longitudinal vertical section, and the other partially broken away;

FIG. 3 is an enlarged view of an actuator according to the present invention in its center, locked position;

FIG. 4 is a view similar to FIG. 3, but showing the main piston unlocked ready for movement to either extreme position;

FIG. 5 is a longitudinal sectional view through a modified, single actuator arrangement; and

FIG. 6 is a transverse sectional view on the line 6-6 of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is first made to the embodiment of the invention shown in FIGS. 1 through 4 of the drawing, with the understanding that FIG. 6 may be a section common to both embodiments of the invention and also to be included in the disclosure of the first embodiment. Actuators 11 and 12 are of identical construction, having main cylinder barrels 13 with integral forward end caps 14 having bores therethrough which extend the main piston rods 15. Into the ends of the piston rods 15 are threaded mounting eyes 16 which are pivotally connected by a bolt 17 to an attachment lug 18 extending from an operated member 19. The barrels 13 are closed by back end plugs 21 threaded thereto and having integral mounting brackets 22 by which the actuators are pivotally connected to fixed parts 23, as by bolts 24.

Each of the actuators 11 and 12 has a first main port 25 pressurized to retract its main operating piston and piston end 15 and a second main port 26 pressurized to extend the operating piston and its rod. Each actuator is also provided with a port 27 pressurized to effect locking and a port 28 pressurized to effect unlocking. The port 25 on the actuator 11 is connected to the port 26 on the actuator 12 by a line 29 which is, in turn, connected by a line 31 to a control valve 32. The other side of the valve 32 is connected to a pressure line 33 and a return line 34. The port 26 on the actuator 11 is connected to the port 25 on the actuator 12 by a line 35 which is, in turn, connected by line 36 to the valve 32. The two lock ports 27 on the actuators are connected together by a line 37 and by a line 38 to a control valve 39 whose other side is connected to a return line 41 and a pressure line 42. The two unlock ports 28 of the actuators are connected together by a line 43 and to the valve 39 by a line 44.

Within the barrel 13 is mounted a main operating piston 45, sealed to the interior surface of the barrel by sealing ring 46. Integrally secured to the main piston 45 is a piston rod 47 which extends outwardly through the bore 48 through the forward end cap 14 where it is sealed by a sealing ring 49. A scraper ring 51 and a felt ring 52

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also surround the piston rod 47. The end plug 21 is threaded into the barrel 13 at 53 and is sealed thereto by sealing ring 54. Its position on the barrel may be adjusted by means of shim rings 55. The end plug 21 has a pair of annular sleeves 56 and 57 extending therefrom inwardly of the barrel 13. The outer extension 56 has the threads 53 and sealing ring 54 thereon and on its inner end is threaded a stop ring 58 engaged by the piston 45 in its extreme retracted position. The position of stop ring 58 may be adjusted by shim rings 59.

The inner end plug extension 57 extends within the back end 61 of the piston rod 47 and carries the locking mechanism and the auxiliary piston. The extension 57 has a multiplicity of varied diameter bores therein for receiving the locking-unlocking system. One bore extends through the end plug 21 and has an end plug 62 sealably threaded therein and carrying a proximity element 63 electrically connected by wires 64 to an exterior indicating system. The proximity element 63 senses the closeness of a magnetic stud 60 in the end of the locking-unlocking piston. In another bore in the end plug extension 57 is mounted a locking-unlocking piston 65 sealed to the bore at 66 and having an integral larger diameter portion 67 sealed to a complementary bore in the extension 57 at 68. From the enlarged portion 67 extends a hollow piston rod portion 69 carrying on its end a supporting head 71 also having a bore therethrough and having its exterior surface sealed at 72.

In the end of the extension 57 is threaded an elongated hollow member 73 which carries the locking elements and the auxiliary piston. A compression spring 74 is disposed between the end of the member 73 and a ring 75 on the enlarged portion 67 of the piston 65 and biases the locking-unlocking piston into its locking position, shown in FIG. 3. The spring 74 is strong enough to hold the locking elements in their locking position until pressure is applied in the unlocking direction to the locking-unlocking piston. It is also strong enough to move the piston to locking position in the absence of locking pressure.

The piston rod 47 has an interior surface therein which adjacent the main operating piston 45 is provided with annular locking groove 77. The member 73 is provided with a plurality of radially extending slots 78, of which four are shown in FIG. 6, which receive locking elements 79 serving to lock the main operating piston 45 in its dead-center position, the locking segments 79 moving radially only and being held against longitudinal movement by the member 73. Between the head 71 and the locking segments 79 are pivoted toggle lugs 81 in suitable shaped notches therein. These toggle lugs 81 are slightly over the center in the lock position of FIG. 3, so that any force on the operating piston 45 only tends to make the locking by the elements 79 more secure. In the unlocked position of FIG. 4, the toggle lugs 81 are collapsed to the other side of center to permit the elements 79 to move inwardly to unlock the main piston.

One face of the locking elements 79 is provided with concave, spherical holes 82 adapted to receive ball detents 83 in the unlocked position of the locking elements, shown in FIG. 4. Ball detents 83 are biased into their latching positions by springs 84 which are held in place by adjusting shims 85 between the member 73 and the end of the extension 57.

The member 73 is provided with passageways 87 leading from the exterior of the piston rod 69 to the exterior of the member 73 forward of the locking elements 79. The locking-unlocking piston 65 is provided with passageways 88 leading from the space between the seals 66, 68 to the central bore 89 through the piston rod 69.

The forward portion of the member 73 is extended, at 91, to form an auxiliary cylinder in which reciprocates a piston-plunger 92 sealed thereto at 93 and having its outer movement limited by an end cap 94. The end of the piston-plunger 92 at 95 is adapted to engage with an end

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wall 96 across the interior of the piston rod 47, in abutting relation. The chamber 97 in back of the piston-plunger 92 communicates by way of a passage through the head 71 with the interior bore 89 of the piston rod 69 so as to be fed by the locking pressure through port 27.

The operation of the device shown in FIGS. 1 through 4 and 6 will now be described. As shown in FIG. 3, the parts are in dead-center, locked position and all pressures may be off and the locking elements 79 held in their locked position by the bias of spring 74 exerted on the locking-unlocking piston 65. To unlock the main piston, the valve 39 is manipulated to pressurize the line 43 and unlocking ports 28. This applies pressure to the back face of the locking pistons 65, which therefore move from the position of FIG. 3 to the position of FIG. 4 to permit the locking elements 79 to move radially inwardly to unlocking position. Once the toggle lugs 81 are over center, any force exerted on the locking elements 79 by the main piston 45 aids the unlocking movement and cams the locking elements into unlocked position. Either simultaneously with or after pressurizing the port 28, the appropriate ports 25, 26 are pressurized to effect movement of the main pistons 45 in the desired directions, they bottoming out against either the face at the forward end cap 14, or on the stop ring 58, depending upon which direction pressurization and movement is effected in the individual actuator. The surface 76 engages the ends of the locking elements 79 in sliding relation and, in the inner, unlocking positions of the elements, the ball detents 83 enter the spherical holes 82 and hold the locking elements 79 against rattling.

When a main piston 45 is in one extreme operating position and it is desired to move it into its other extreme position, the appropriate port 25, 26 is pressurized so to move it, unlocking pressure being maintained. If it is desired to move the piston 45 to its dead-center, lock position, the locking port 27 is pressurized and at the same time, the appropriate main port 25, 26 is pressurized to move the main piston toward its dead-center position. When the port 27 is pressurized with the main piston out of dead center, the locking piston 65 is prevented from moving by the engagement of the outer ends of the locking elements 79 with the inner surface 76 on the piston rod 47. As the main piston reaches its dead-center position with the groove 77 opposite the locking elements 79, the locking piston 65 is free to move toward the left, as viewed in FIG. 3, thus moving the locking elements into the groove 77 as the toggle elements swing through center from the position of FIG. 3.

The above relates to the positive pressure actuation of the main piston into its dead-center, locked position. In the event of a failure of the main power system while the locking and unlocking system remains operative, the plunger-piston 92 is brought into play to effect movement of the main piston in one direction into its dead-center, locked position. In this condition, only the port 27 is pressurized and neither of the ports 25 and 26. Locking pressure is now applied to the head of the plunger-piston 92 through the passageways 88, the bore 89, and the bore through the head 71 into the chamber 97. The plunger-piston 92 thereby moves outwardly until it engages the limiting cap 94. In the paired actuators construction of FIG. 1, depending upon which side of center the main pistons are located, one or the other of the plunger-pistons 92 in one or the other of the actuators 11 and 12 will have its end 95 engage the wall 96 and move the paired piston assembly into dead-center position where it will be retained by both the plunger-pistons 92. The locking pressure is also applied to the forward working areas of the locking-unlocking piston 65, and it moves into the locking position of FIG. 3, with the locking elements 79 extended into the groove 77.

Therefore, the plunger-piston 92 can be considered as a back-up system or emergency operation, insuring movement of the main pistons 45 into their dead-center,

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locked position. If desired, the plunger-piston 92 may be used, regardless of the availability of the main pressure system, but the plunger-piston back-up is essentially a low pressure, low speed operation, and normally the high force and speed operation of the main operating system will be preferred. In either case, so long as locking pressure is applied, the elements 79 will snap into the groove 77 in locking relation whenever the pistons 45 reach dead-center position. Absent locking pressure, the spring 74 will move the locking elements.

In the embodiment of FIG. 5, the main operating structure is substantially the same as that shown in FIGS. 3 and 4, and only the changes will be pointed out. In this embodiment, the extension 61 on the piston rod 47 has been changed to 61A and provided with interior end sealing means 101 sealing against the outer surface of the extension 57A. Extension 57A, the locking piston enlargement 67A, end plug 21A, and similar parts are elongated to accommodate the extension 67A. The cylinder 91A is also provided with a seal 102 against the inner surface 76 of the piston rod 47. The passages 87 are omitted and through passages 103 provided to intercommunicate the chambers on opposite sides of the member 73 between the seals 101 and 102.

The piston-plunger 92 operates as before by having its end 95 engaging the piston rod end wall 96A, which is formed, as shown in FIG. 5, on a sealably screwed-in eye connection end 104. This embodiment need not be used in paired relationship, but may be used alone. To secure movement of the main operating piston 45 from right of dead-center back to dead-center position, the chamber to the right of the working surface 105 is pressurized from the locking port 27 through the passages 88, the bore 89, and the bore through the head 71, the chamber 97 and passages 106 and 103. This moves the main piston 45 to the left, as viewed in FIG. 5, until the wall 96A engages the end 95 of the piston-plunger 92, at which time the main piston 45 will be in the dead-center, locking position shown. The operation of the main piston under locking pressure applied on the area of surface 105 will normally be considered as a back-up emergency arrangement, and in normal operation, the movement to dead-center position will be effected by pressurizing one of the main ports 25, 26 to secure high force and speed operation of the main piston. Again, to secure locking, port 27 is normally pressurized, but so long as unlocking pressure is off, the locking elements 79 will move into the locking position of FIG. 5, either under locking pressure if it is used, or under the bias of spring 74. At any time in either embodiment that the main piston 45 arrives in dead-center position, locking will be effected so long as the unlocking port 28 is not pressurized.

In either embodiment, when one of the main ports 25, 26 is energized, the force on the main piston 45 will be much greater than the force on the piston-plungers 92, 92A and on working surface 105, to the latter of which only locking pressure is applied. Therefore, should there be a conflict in the operation, the force of the main operating piston will normally override the forces exerted by the back-up systems to produce movement of the main piston in accordance with the pressurization of the ports 25, 26.

While certain preferred embodiments of the invention have been specifically illustrated and described, it will be understood the invention is not limited thereto, as many variations will be apparent to those skilled in the art, and the invention is to be given its broadest permissible interpretation.

I claim:

1. A hydraulic actuator comprising:
an operating cylinder;

a main operating piston in said cylinder and movable in opposite directions to first and second extreme positions;

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ports for the opposite ends of said cylinder on opposite sides of said main piston;

a central, lock position for said piston centrally located between said first and second extreme positions;

inwardly facing locking means on said piston;

locking elements cooperating with said locking means to lock the main piston in its central position against movement in both directions;

said elements being held against longitudinal movement and mounted to move only inwardly and outwardly to unlock and lock said main piston, respectively;

piston means for moving said elements into locking and unlocking positions;

ports for said piston means for effecting such movements thereof;

said main piston having an axial bore therein;

said locking means being an inwardly opening annular groove in said bore;

a fixed part in said bore; and

said locking elements being mounted in said bore on said fixed part so as to move only inwardly and outwardly relative thereto.

2. The actuator defined in claim 1, in which:

said piston means is mounted coaxially with said bore and reciprocable along its axis in response to opposite pressurization of said piston means ports while effecting locking and unlocking movements of said elements.

3. The actuator defined in claim 1, in which:

said fixed part being extended in the forward direction to form a chamber;

a piston-plunger in said chamber;

passages connecting said chamber to the piston means port which, when pressurized, effects movement of said piston means in locking direction; and

an abutment surface movable with said main piston and engageable by said piston-plunger for moving said piston in one direction only toward its central, locked position when the piston is on the side of the central position toward said piston-plunger.

4. A pair of actuators as defined in claim 3, mounted in face-to-face relation and having their main pistons pivotally connected to a part to be operated;

the main pistons thereby operating in a reverse sense to effect movement of said operated part, one piston moving forwardly while the other piston moves rearwardly; and

whereby the piston-plungers of said pair of actuators cooperate to effect movement of both main pistons in opposite directions into their central, lock positions.

5. A pair of actuators as defined in claim 4, including:
means for pressurizing said operating cylinder ports in the opposite sense to effect concurrent operative movements of the main pistons in the opposite sense relative to their operating cylinders; and

means for pressurizing said piston ports in parallel so that both locking ports are pressurized together and both unlocking ports are pressurized together.

6. A hydraulic actuator comprising:

an operating cylinder;

a main operating piston in said cylinder and movable in opposite directions to first and second extreme positions;

ports for the opposite ends of said cylinder on opposite sides of said main piston;

a central locking position for said piston centrally located between said first and second extreme positions;

locking elements cooperating with said piston for locking it in said central position;

piston means for moving said elements into locking and unlocking positions;

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ports for said piston means for effecting such movements thereof;
 means providing a stationary cylinder coaxial with said main piston and operating cylinder and extending forwardly of said central position;
 a piston-plunger in said stationary coaxial cylinder and movable to opposite ends thereof;
 an abutment surface movable with said main piston and engageable by said piston-plunger whereby the latter effects movement of said main piston in one direction only towards said central position;
 said piston-plunger bottoming in said one direction when said main piston is in its central position; and
 passages connecting said stationary coaxial cylinder with the piston means port which pressurizes said piston means for movement in the locking position.

7. A pair of actuators as defined in claim 6, mounted in face-to-face relation;
 means pivotally connecting said main pistons to a part to be operated;
 means pressurizing said main cylinder ports for movements of the main pistons in opposite directions relative to their operating cylinders; and
 means pressurizing the piston means ports on the pair of actuators in the same sense for locking and unlocking movements of the piston means;
 the piston-plungers on said actuators moving in the same sense, but in opposite directions due to the face-to-face mounting of the actuators whereby to effect movement of the main pistons by the piston-plungers in both directions into the central position of the pistons.

8. The actuator defined in claim 6, including:
 means movable with the main piston defining a working area which, when pressurized, effects movement

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of the main piston in the direction opposite to that in which it is moved by said piston-plunger;
 passages for introducing the locking pressure of said piston means to said working area; and

whereby in a single actuator both said piston-plunger and said working area are subjected to the locking pressure for the piston means so that said main piston will be moved from either side of its central position into the central, lock position.

9. The actuator defined in claim 6, including:
 spring-biased detent means latching said locking elements in their unlocked position to hold the elements against involuntary, random movements.

10. The actuator defined in claim 1, including:
 spring-biased detent means latching said elements in their unlocked position to hold the elements against involuntary, random movements.

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U.S. Cl. X.R.

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