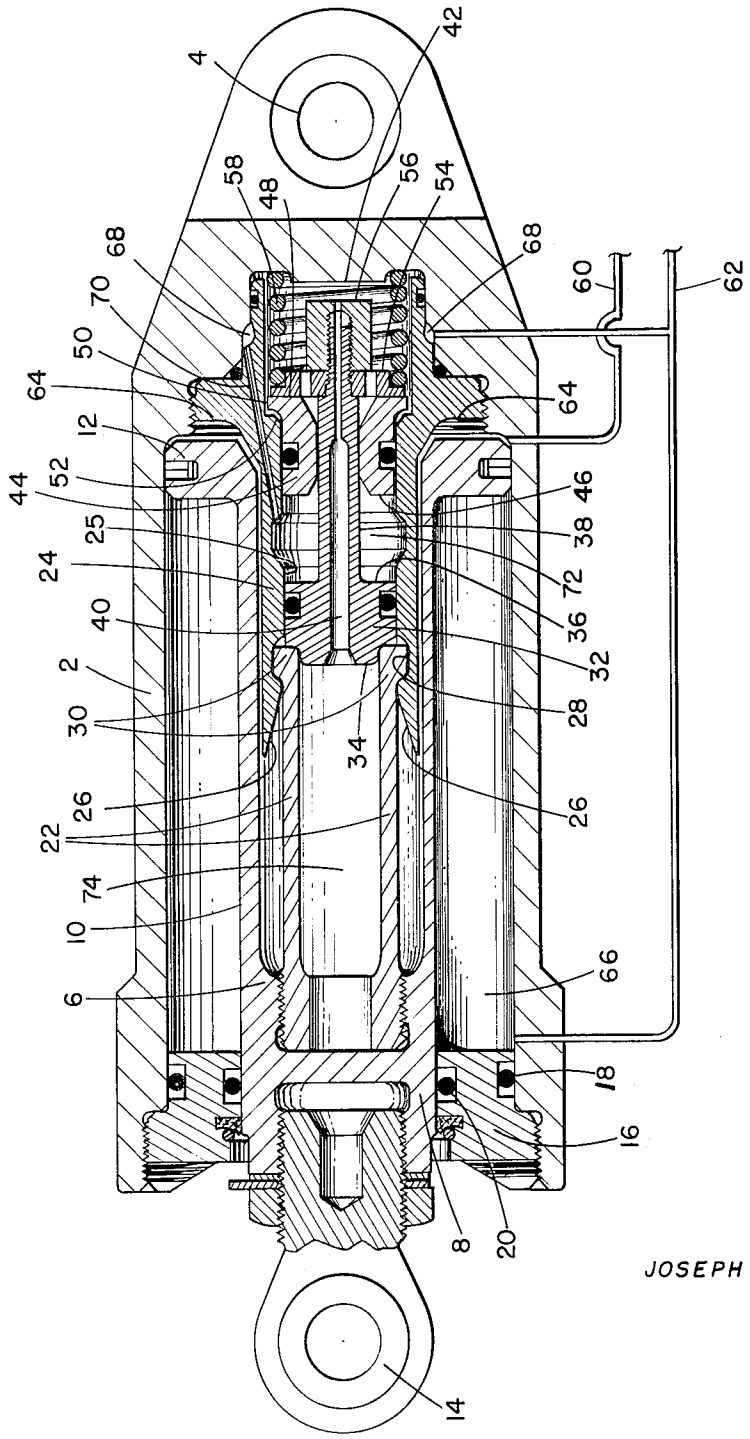
Jan. 11, 1966 J. T. DILLARD 3,228,307

BALANCE PISTON WITH DIRECTIONAL LOAD EQUALIZER

Filed June 11, 1964



JOSEPH T. DILLARD
INVENTOR.

United States Patent Office 3,228,307 Patented Jan. 11, 1966

3,228,307

BALANCE PISTON WITH DIRECTIONAL LOAD EQUALIZER

Joseph T. Dillard, Irving, Tex., assignor to Ling-Temco-Vought, Inc., Dallas, Tex., a corporation of Delaware

Filed June 11, 1964, Ser. No. 374,320
3 Claims. (Cl. 92—26)

This invention relates to hydraulic actuators and is particularly directed to novel means for securely locking the actuator piston in its retracted position.

Hydraulic actuators are employed in airplanes to extend and retract flaps, spoilers and like devices.. Conventionally, such devices are extended during landing, take-off and other low speed flight conditions. On the other hand, such devices are normally retracted during high speed flight conditions. Therefore, these devices are not constructed to withstand the forces they would encounter under high speed conditions and, should they accidentally become extended during high speed conditions, the devices might become damaged or torn off resulting in possible loss of the airplane.

In order to prevent such accidental extension, numerous devices have been proposed for locking the actuator in its retracted position. However, none of the prior art devices have been entirely satisfactory. A common means for locking the actuator piston is to provide fingers engageable with a locking cam to retain the piston in its retracted position together with a secondary piston or the like for securing the fingers in the locked position. Obviously, such locking means must be released when it is desired to extend the actuator piston and hydraulic means are generally employed for effecting the unlocking. Unfortunately, it has been found that the locking mechanisms of the prior art occasionally become released inadvertently as a result of pressure surges feeding through the return lines due, for example, to actuation of other hydraulic mechanisms connected to the same pressure system. This possibility cancels the advantages of prior art locking mechanisms and renders them treacherously unreliable.

These disadvantages of the prior art are overcome with the present invention and novel actuator locking means are provided which securely and reliably lock the actuator piston in its retracted position and which are completely insensitive to back pressure surges but which are readily releasable when desired.

The advantages of the present invention are preferably attained by providing a generally cylindrical locking cam engageable by fingers on the actuator piston for retaining the actuator piston in its retracted position, together with novel means for securing the locking fingers in engagement with the locking cam. In accordance with the present invention, a locking piston is movably mounted within the cylindrical locking cam and is resiliently urged to its locking position. The locking piston is formed with a rearward projection on which a balance piston is slidably mounted and has a fluid passage extending through the locking piston and its rearward extension. The balance piston has an effective area equal to that of the locking piston. To extend the actuator, fluid pressure is supplied between the actuator piston and the front surface of the locking piston and, through the passage in the locking piston, to the rear surface of the balance piston. To retract the actuator, fluid pressure is supplied to the front surface of the actuator piston and to a space between the locking piston and balance piston. When the actuator is locked, the pressure is withdrawn from both fluid supply lines. Consequently, any back pressure surges will be applied equally to all surfaces of the locking piston and balance piston so that any tendency to unlock will be self-cancelling.

Accordingly, it is an object of the present invention to provide an improved hydraulic actuator.

Another object of the present invention is to provide improved means for locking an actuator piston in its retracted position.

A further object of the present invention is to provide improved locking means for an actuator piston which will be insensitive to back pressure surges when said piston is in its locked position.

A specific object of the present invention is to provide an improved hydraulic actuator comprising a cylinder, an actuator piston movable within said cylinder between an extended position and a retracted position, cylindrical locking cam means mounted in said cylinder adjacent said retracted position, finger means carried by said actuator piston and engageable with said locking cam when said actuator piston is in said retracted position, locking piston means having front and rear surfaces and formed with a rearwardly extending projection and a fluid passageway extending through said locking piston and said projection and slidably mounted within said cam means, resilient means urging said locking piston toward a finger engaging position to retain said finger means in locking engagement with said cam, balance piston means slidably mounted on said projection and formed with an effective area equal to that of said locking piston, means for supplying fluid pressure between said actuator piston and said locking piston and to the rear surface of said balance piston, and means for supplying fluid pressure between said cylinder and said actuator piston and between the rear surface of said locking piston and the front surface of said balance piston.

These and other objects and features of the present invention will be apparent from the following detailed description taken with reference to the figure of the accompanying drawing.

In the drawing:

The figure is a vertical section showing a hydraulic actuator embodying the present invention.

In the form of the present invention chosen for purposes of illustration in the drawing, the figure shows a hydraulic actuator having a cylinder **2** having a clevis **4** formed at one end thereof to permit attachment of the cylinder **2** to a structural part of an airplane or the like. An actuator piston **6** is movably mounted within the cylinder **2** and is formed with a head portion **8**, a cylindrical portion **10** extending rearwardly from the head **8**, and a flanged portion **12** projecting radially from the rear end of the cylindrical portion **10** and slidably engaging the inner surface of the cylinder **2**. A clevis **14** is formed on the front end of the actuator piston **6** to permit attachment to a wing flap or other device to be positioned by the actuator. A retainer nut **16**, threadedly secured to the front end of the cylinder **2**, serves to guide the actuator piston **6** and to limit the outward movement thereof. To prevent leakage of hydraulic fluid, sealing means **18** and **20** are preferably provided.

A plurality of flexible locking fingers **22** are secured to the head portion **8** of the actuator piston **6** and project rearwardly therefrom within the cylindrical portion **10**. To engage the locking fingers **22**, a cylindrical locking cam member **24** is mounted adjacent the inner end of the cylinder **2** and projects forwardly so as to telescope with the cylindrical portion **10** of the actuator piston **6** as the actuator piston **6** moves to its retracted position, as shown. Adjacent the front end of the cam member **24**, the bore **25** is flared outwardly to form a cam surface **26** and an annular recess **28** is provided in the inner surface of cam member **24** just rearward of

the cam surface 26. Consequently, as the actuator piston 6 moves toward its retracted position, the locking fingers 22 will engage the surface 26 of cam member 24 and will be forced radially inward until they reach the annular recess 28. The free ends of the fingers 22 are provided with dogs 30 which then become resiliently seated in the recess 28 to retain the actuator piston 6 in its retracted position.

To lock the fingers 22 in engagement with the recess 28, a locking piston 32 is slidably mounted within the bore 25 of cam member 24. The locking piston 32 is formed with a front surface 34 and a rear surface 36 and is provided with a rearward projection 38. In addition, a fluid passage 40 is formed extending completely through the locking piston 32 and its projection 38 to permit hydraulic fluid to flow from in front of the locking piston 32 to a chamber 42, which is formed adjacent the rear end of cam member 24 and is slightly larger in diameter than the bore 25 of cam member 24.

A balance piston 44 is slidably carried by the rearward projection 38 of locking piston 32. The balance piston 44 has a front surface 46 and a rear surface 48 having effective areas equal to surfaces 34 and 36 of locking piston 32. Moreover, balance piston 44 is provided with a flanged portion 50 which slidably engages the walls of the chamber 42 and is formed to seat against a shoulder 52 at the intersection of chamber 42 with the bore 25 of cam member 24. Rearward movement of balance piston 44 with respect to the projection 38 of locking piston 32 is limited by a retaining member 54 which is fastened to the projection 38 by suitable means, such as nut 56. In addition, resilient means, such as spring 58, are provided in the chamber 42 and bear against the retaining member 54 to urge the locking piston 32 towards its forward position to lock fingers 22 in engagement with recess 28 of cam member 24.

Fluid pressure for controlling the actuator is provided from a suitable source, not shown, through fluid lines 60 and 62. Fluid line 60 supplies fluid to annular space 64 within cylinder 2 and rearward of flanged portion 12 of actuator piston 6 to drive actuator piston 6 forward. Fluid line 62 supplies fluid to annular chamber 66 within cylinder 2 and forward of flanged portion 12 of actuator piston 6 to drive actuator piston 6 rearward and also supplies fluid through annular chamber 68 and passage 70 to chamber 72 between the rear surface 36 of locking piston 32 and the front surface 46 of balance piston 44.

To extend actuator piston 6, fluid line 60 is connected to supply pressurized fluid while fluid line 62 is connected to a suitable sump or drain, not shown. High pressure fluid from fluid line 60 is supplied to chamber 64, urging actuator piston 6 forward, and flows between cam member 24 and the cylindrical portion 10 of actuator piston 6 to chamber 74 within cylindrical portion 10 of the actuator piston 6. As fluid pressure increases in chamber 74, pressure is applied to the front surface 34 of locking piston 32 and, through passage 40 and chamber 42, pressure is also applied to the rear surface 48 of balance piston 44. Between locking piston 32 and balance piston 44, the fluid in chamber 72 is not under pressure, since it is connected to the drain, through passage 70, annular chamber 68, and fluid line 62. Consequently, the fluid pressure on the front surface 34 of locking piston 32 is much higher than the pressure on the rear surface 36 of locking piston 32. As a result, locking piston 32 is driven rearwardly, against the action of spring 58. This releases fingers 22 and the continued pressure applied behind flanged portion 12 of actuator piston 6 by the fluid in chamber 64 will cause dogs 30 of fingers 22 to cam out of recess 28. This unlocks actuator piston 6 and allows actuator piston 6 to move forward to its extended position.

To retract actuator piston 6, fluid line 60 is connected to the drain and fluid line 62 is connected to the source of pressurized fluid. High pressure fluid from fluid line 62 is supplied to chamber 66 and begins forcing actuator piston 6 rearwardly toward its retracted position. At the same time, pressurized fluid from fluid line 62 is supplied through annular chamber 68 and passage 70 to chamber 72 to drive balance piston 44 against the retainer 54 at the end of projection 38 of locking piston 32. When chamber 72 is full, the fluid in chamber 72 cooperates with locking piston 32 and balance piston 44 to form a relatively rigid unit. This compound unit is urged forward by spring 58 until flanged portion 50 of balance piston 44 seats against shoulder 52 of the cam member 24. As actuator piston 6 moves rearward, due to the pressurized fluid supplied to chamber 66 by fluid line 62, fingers 22 engage the cam surface 26 of cam member 24 and are forced radially inward. When actuator piston 6 is fully retracted, dogs 30, fingers 22 will enter recess 28 of cam member 24 and will be locked therein by locking piston 32 under the action of spring 58.

With actuator piston 6 locked in its retracted position, fluid lines 60 and 62 are both preferably connected to the drain. Consequently, the only fluid pressure which will be supplied to the actuator is that resulting from back pressure surges and this will appear with substantially equal magnitude on both fluid lines 60 and 62. Those pressure surges appearing on fluid line 62 will be applied, through annular chamber 68 and passage 70, to chamber 72 and, hence, will be applied to rear surface 36 of locking piston 32 and the front surface 46 of balance piston 44. Since surfaces 36 and 46 are equal in area, as described above, and in opposing relationship, and since locking piston 32 and balance piston 44 are secured together by retainer 54 and projection 38, the pressure surge from fluid line 62 will provide no net translational force. Thus, there will be no tendency for locking piston 32 to release fingers 22. Pressure surges appearing simultaneously on fluid line 60 will be applied, through annular chamber 64 and chamber 74 to the front surface 34 of locking piston 32 and, through passage 40 and chamber 42, to the rear surface 48 of balance piston 44. However, as noted above, the fluid in chamber 72 cooperates with locking piston 32 and balance piston 44 to form a relatively rigid unit. Therefore, the pressure surge from fluid line 60 will produce no net translational force and, again, there will be no tendency for locking piston 32 to release fingers 22. Any tensional load applied to the actuator will be taken up by actuator piston 6, fingers 22, locking piston 32, cam member 24 and cylinder 2. Compressive loads will cause flange portion 12 of actuator piston 6 to seat against the inner end of cylinder 2 and will be distributed by actuator piston 6 and cylinder 2. Thus, it will be seen that, when actuator piston 6 is locked in its retracted position, the actuator will be insensitive to back pressure surges and will retain the actuator piston 6 securely locked, but will readily release the actuator piston 6 when high pressure fluid is supplied through fluid line 60.

Numerous variations and modifications may, obviously, be made without departing from the present invention. Accordingly, it should be clearly understood that the form of the invention described above and shown in the figure of the accompanying drawing is illustrative only and is not intended to limit the scope of the invention.

What is claimed is:

1. A hydraulic actuator comprising a cylinder, an actuator piston movable within said cylinder between an extended position and a retracted position, cylindrical locking cam means mounted in said cylinder adjacent said retracted position, finger means carried by said actuator piston and retainingly engageable with said locking cam when said actuator piston is in said retracted position, locking piston means having front and rear surfaces and formed with a rearwardly extending projection and slidably mounted within said cam means, resilient means urging said locking piston toward a finger engaging posi-

tion to retain said finger means in locking engagement with said cam, balance piston means slidably mounted on said projection and formed with an effective area equal to that of said locking piston, means for supplying fluid pressure between said actuator piston and said locking piston and to the rear surface of said balance piston, and means for supplying fluid pressure between said cylinder and said actuator piston and between said locking piston and said balance piston.

2. A hydraulic actuator comprising a cylinder; an actuator piston movable within said cylinder between an extended position and a retracted position and formed with a head portion, a cylindrical portion extending rearwardly from said head portion, and a flange portion projecting radially from the rear end of said cylindrical portion to slidably engage said cylinder; cylindrical locking cam means mounted in said cylinder adjacent said retracted position and formed for telescoping relationship with the cylindrical portion of said actuator piston; finger means carried by said actuator piston and retainingly engageable with said locking cam when said actuator piston is in said retracted position; locking piston means slidably mounted within said cam means having front and rear surfaces and formed with a rearwardly extending projection; a fluid passageway extending through said locking piston and said projection; resilient means urging said locking piston toward a finger engaging position to retain said finger means in locking engagement with said cam; balance piston means slidably mounted on said projection and formed with an effective area equal to that of said locking piston; means for supplying fluid pressure between said actuator piston and said locking piston and through said passageway to the rear surface of said balance piston; and means for supplying fluid pressure between said cylinder and said actuator piston and between the rear surface of said locking piston and the front surface of said balance piston.

3. A hydraulic actuator comprising a cylinder; an actuator piston movable within said cylinder between an extended position and a retracted position and formed with

a head portion, a cylindrical portion extending rearwardly from said head portion, and a flange portion projecting radially from the rear end of said cylindrical portion to slidably engage said cylinder; cylindrical locking cam means mounted in said cylinder adjacent said retracted position dimensioned for telescoping relationship with the cylindrical portion of said actuator piston and formed with an axial bore having an outwardly flared cam surface adjacent the front end of said bore and an annular recess located immediately rearward of said cam surface; finger means carried by the head portion of said actuator piston extending rearward within the cylindrical portion of said actuator piston and having dogs formed on the free ends of said finger means retainingly engageable with the recess of said locking cam when said actuator piston is in said retracted position; locking piston means slidably mounted within the bore of said cam means having front and rear surfaces and formed with a rearwardly extending projection; a fluid passageway extending through said locking piston and said projection; resilient means urging said locking piston toward a finger engaging position to retain said finger means in locking engagement with said cam; balance piston means slidably mounted on said projection and formed with front and rear surfaces having effective areas equal to said surfaces of said locking piston; means for supplying fluid pressure between said actuator piston and the front surface of said locking piston and through said passageway to the rear surface of said balance piston to cause said locking piston to release said finger means and to advance said actuator piston to said extended position; and means for supplying fluid pressure between said cylinder and said flanged portion of said actuator piston and between the rear surface of said locking piston and the front surface of said balance piston.

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SAMUEL LEVINE, *Primary Examiner.*