Nov. 5, 1957 R. C. BODEM ET AL 2,811,951

ACTUATOR AND LOCKING MEANS THEREFOR

Filed Aug. 31, 1954 2 Sheets-Sheet 1

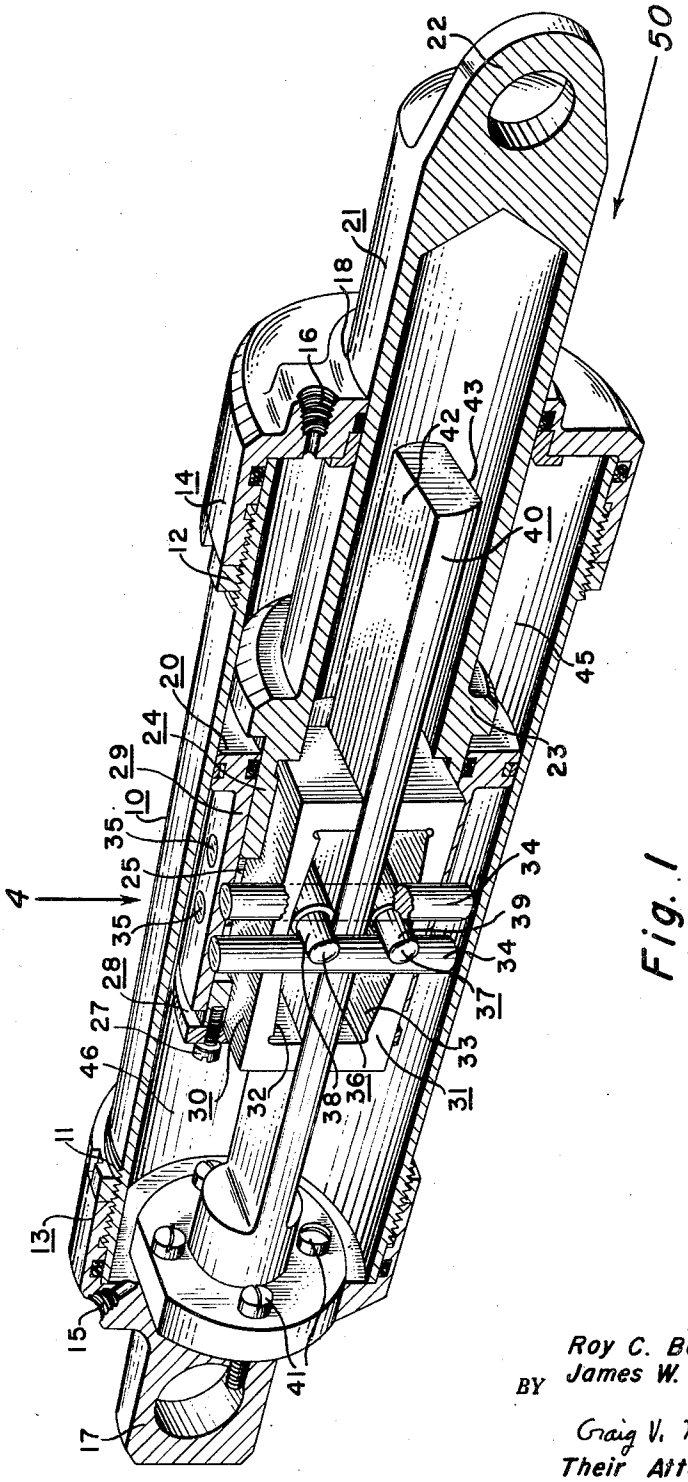

Fig. 1

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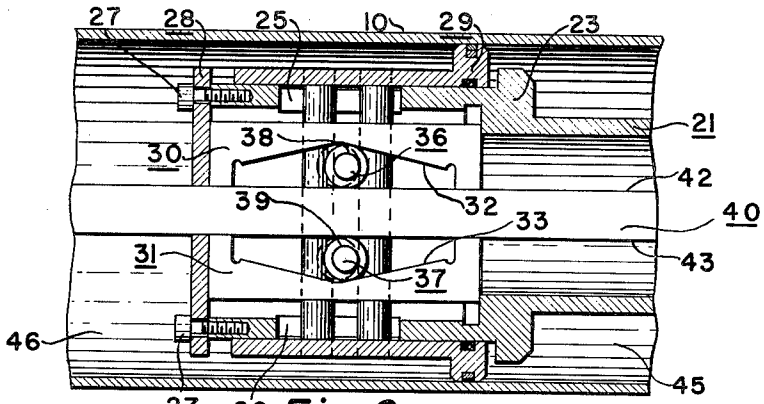

Fig. 2

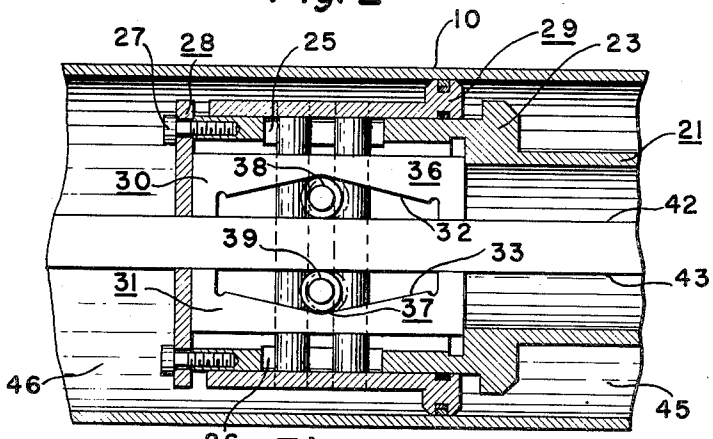

Fig. 3

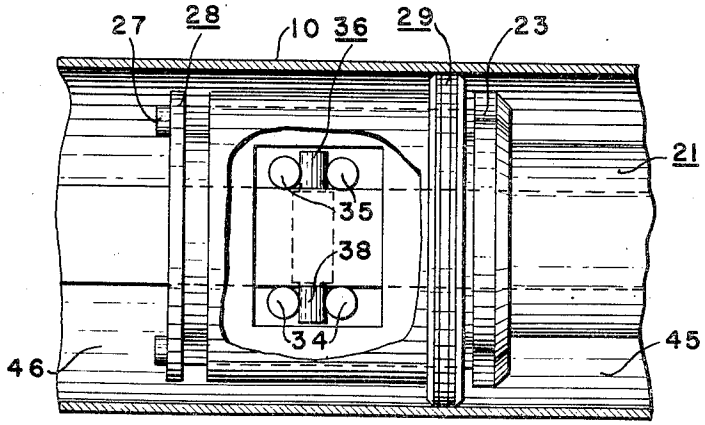

Fig. 4

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ACTUATOR AND LOCKING MEANS THEREFOR

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Application August 31, 1954, Serial No. 453,369

11 Claims. (Cl. 121—40)

This invention pertains to self-locking actuators, and particularly to an improved actuator assembly of this type.

Heretofore, actuators of the type including a cylinder having disposed therein a reciprocable piston capable of fluid pressure actuation in both directions, have embodied various types of locking means which operate to prevent relative movement between the piston and cylinder when the actuator is inactive. For example, a friction type brake is disclosed in copending application Serial No. 394,660, now Patent #2,774,336, filed November 27, 1953, in the name of Howard M. Geyer; a toothed type brake is disclosed in the Geyer Patent No. 2,643,642; and a roller type brake is disclosed in copending application Serial No. 296,607, filed July 1, 1952, in the name of Howard M. Geyer, now Patent No. 2,705,939. All of the aforementioned locking actuators include a screw shaft operatively connected to the piston so as to rotate upon piston reciprocation, the locking means being operatively associated with the screw shaft. This invention obviates the necessity of a screw shaft, and, hence, greatly simplifies the actuator assembly without effecting its operation and advantageous features. Accordingly, among my objects are the provision of locking means for a fluid pressure operated actuator; the further provision of locking means which are automatically released upon the application of fluid pressure to the cylinder; and the still further provision of actuator locking means which are automatically operable to restrain piston movement upon the interruption of fluid pressure application to the cylinder due to the load to which the actuator is subjected.

The aforementioned and other objects are accomplished in the present invention by the provision of a roller lock including a stationary locking bar and a plurality of locking rollers. Specifically, the actuator comprises a cylinder having disposed therein a reciprocable piston assembly capable of fluid pressure actuation in both directions. The piston assembly includes a diametrically slotted skirt, or annular sleeve portion which slidably supports a piston head capable of movement relative thereto. Thus, it may be said that the annular sleeve, or skirt, which is integral with a piston rod, has a lost motion connection with the piston head. The piston head is connected to four spaced, transversely extending lock release pins which are disposed adjacent the ends and on opposite sides of a pair of locking rollers. The axis of the locking rollers are disposed in a plane located substantially at right angles to the pins. The locking rollers engage a centrally disposed, stationary locking bar, and are operatively associated with a pair of cam members disposed on opposite sides of the locking bar and operatively connected with the piston assembly so as to be movable therewith.

When the actuator is inactive, and, hence, fluid under pressure is not being applied to the cylinder, the load to which the actuator piston rod is subjected will cause the locking rollers to be wedged between the locking bar and the cam member, thereby restraining movement of the piston assembly. During locking movement of the piston rod, the piston head, which frictionally and sealingly engages the cylinder, will remain stationary, by reason of the lost motion connection between the piston head and the rod assembly. Thus, when the actuator is inactive, the actuator will be locked by the load imposed upon the actuator rod. As stated hereinbefore, the piston head is adapted for reciprocable movement relative to the rod assembly, which relative movement is limited by an annular shoulder on the rod and an end plate spaced therefrom. Moreover, as only the piston head assembly frictionally and sealingly engages the cylinder walls, upon the interruption of fluid pressure application to the cylinder, the load imposed upon the piston rod will effect movement of the piston rod relative to the piston head.

The locking means are automatically released upon the application of fluid pressure to the cylinder in the following manner. If pressure fluid is applied to the cylinder in assisting relation to the load, the piston head assembly will move relative to the piston rod assembly, thereby moving the locking rollers out of wedging relation with the cams and locking bar. Thereafter, the head assembly and the rod assembly will move in unison. However, if pressure fluid is applied to the cylinder in opposition to the applied actuator load, relative movement between the piston head assembly and the rod assembly will occur when the applied unit area pressure exceeds the applied load unit area pressure. Thus, the rod assembly will be moved relative to the head assembly, thereby moving the locking cams out of wedging relation with the locking rollers so as to release the locking means. Thus, the locking means of the instant actuator may be called load sensitive.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a view, partly in section and partly in elevation, of an actuator constructed according to this invention.

Fig. 2 is a fragmentary view, partly in section and partly in elevation, illustrating the locking means in the locked condition.

Fig. 3 is a view similar to Fig. 2 with the locking means in the released position.

Fig. 4 is a fragmentary sectional view taken generally in the direction of arrow 4 in Fig. 1 with the locking means in the locked condition.

With particular reference to Fig. 1 of the drawings, the actuator includes a cylinder 10 having externally threaded portions 11 and 12 adjacent opposite ends thereof. The threaded portion 11 receives a head cap assembly 13 which is formed with an extend port 15 and an integral fixture portion 17 by which means the actuator cylinder may be attached to a fixed support, not shown. The threaded portion 12 of the cylinder receives a tail cap assembly 14 having a retract port 16 and a centrally disposed opening 18. The cylinder has disposed therein a piston assembly, generally designated by the numeral 20, capable of fluid pressure actuation in both directions relative to the cylinder. The piston assembly includes a recessed piston rod 21, which projects through the opening 18 in the head cap assembly 14, the rod 21 having an integral fixture portion 22 which is arranged for connection to a relatively movable load, not shown.

The piston rod 21 is formed with an annular shoulder 23 intermediate its ends, the diameter of the annular

shoulder being less than the bore of the cylinder **10**, as depicted in Figs. 2 through 4. The piston rod **21** is also formed with an annular skirt, or sleeve portion, **24** having diametrically aligned openings **25** and **26**. The end of the sleeve portion **25** has attached thereto by means of circumferentially spaced bolts **27**, an end plate **28**. The piston assembly **20** also includes a reciprocable head assembly **29**, which is slidably supported on the sleeve portion **24** between the shoulder **23** and the end plate **28**.

The piston head **29** sealingly engages the sleeve portion **24** and the internal periphery of the cylinder **10**. In addition, the piston head **29** frictionally engages the bore of the cylinder **10**, so that the rod assembly **21** is capable of movement relative thereto. To facilitate relative movement between the piston rod assembly **21** and the piston head **29**, a lost motion connection is provided between the rod assembly **21** and the piston head. This lost motion connection results from the fact that the distance between the shoulder **23** and the plate **28** is greater than the longitudinal extent of the piston head **29**.

The actuator assembly also includes a locking bar **40** which is attached to the head cap assembly **13** by means of bolts **41**. The locking bar **40** is coaxially disposed within the cylinder **10** and includes a portion having spaced parallel flat surfaces **42** and **43**. Inasmuch as the locking bar is attached to the head cap assembly **13**, which is, in turn, rigidly connected with the cylinder **10**, it will be appreciated that the locking bar **40** is restrained against movement relative to the cylinder **10**.

The piston assembly **20** also includes releasable locking means for preventing relative movement between the piston rod **21** and the cylinder **10** when the actuator is inactive. The locking means includes a pair of U-shaped cam members **30** and **31** disposed on opposite sides of the locking bar **40**, the leg portions of the U-shaped members **30** and **31** engaging the flat surfaces **42** and **43** of the locking bar. The interior surface of the base of each U-shaped member **32** and **33**, respectively, is substantially V-shaped. Thus, the portions of the inner surface of the base of each U-shaped member adjacent the legs is spaced a lesser distance from the locking bar than the medial portion thereof.

The piston head assembly **29** carries two pairs of spaced, transversely extending lock release pins **34** and **35** which extend transversely within the cylinder **10**. The pins **34** project through the diametrically aligned openings **25** and **26** in the sleeve portion **24**. The locking means also include a pair of locking rollers **36** and **37** disposed on opposite sides of the locking bar **40** and confined within the U-shaped cam members **30** and **31**, respectively. Each end of the locking rollers **36** includes a reduced diameter portion **38**, while each end of the rollers **37** includes a reduced diameter portion **39**. The reduced diameter portions of the rollers **36** and **37** are disposed between the pair of lock release pins **34** on one side and between the pair of lock release pins **35** on the other side.

The locking means operate in the following manner. When the rollers **36** and **37** are wedged between the inclined bottom surfaces of the U-shaped members **30** and **31**, respectively, and the flats **42** and **43**, respectively, of the locking bar **40**, movement of the piston assembly **20** relative to the cylinder **10** is precluded. This phenomenon is depicted in Fig. 2. However, as shown in Fig. 3, when the locking rollers **37** and **38** are maintained in the medial portion of the cam members **30** and **31**, respectively, the piston assembly **20** can be moved relative to the cylinder **10** in either direction by the application of fluid under pressure.

Operation

Operation of the self-locking actuator is as follows. Assuming that the fixture **17** is connected to a fixed support, while the fixture **22** is connected to a load, which load is acting in a direction tending to effect movement of the rod assembly **21** to the left, as viewed in the drawings, in the absence of fluid pressure application to the cylinder, the applied load will lock the actuator, as depicted in Fig. 2. Thus, by reason of the head assembly **29** frictionally engaging the cylinder **10**, and by reason of the lost motion connection between the head assembly **29** and the rod assembly **21**, the rod **21** will move to the left under the applied load relative to the head assembly **29**. Inasmuch as the cams **30** and **31** are constrained for movement with the rod assembly **21** by reason of their confinement between the shoulder **23** and the end plate **27**, the cams **30** and **31** will move into wedging engagement with the rollers **36** and **37**, which are then stationary. In other words, the rollers **36** and **37** will become wedged between the surfaces **32** and **33** of the U-shaped cams **30** and **31** and the flats **42** and **43** of the locking bar during relative movement between the rod assembly **21** and the head assembly **29** due to the applied actuator load depicted by the arrow **50** in Fig. 1. In order to release the locking means so as to permit adjustment in the position of the load device, fluid under pressure must be applied to the actuator cylinder. If pressure fluid is applied to the retract chamber **45** through the retract port **16** while the extend chamber **46** is connected to drain through the extend port **15**, it is apparent that the fluid under pressure is being applied to the actuator in a direction assisting the applied load. By reason of the fact that the head assembly **29** is capable of movement relative to the rod assembly **21**, the fluid pressure acting upon the head assembly **29** will move the head assembly to the left, as viewed in Fig. 2, relative to the rod assembly **21**. Accordingly, the two pairs of lock release pins **34** and **35** will move to the left with the head assembly **29** and move the locking rollers **36** and **37** out of wedging relation with the cams **30** and **31** and surfaces **42** and **43**, respectively, of the locking bar **40**. When the locking rollers **36** and **37** have been moved to the full line position shown in Fig. 3, the entire piston assembly **20**, including the head **29** and the rod **21**, will move to the left relative to the cylinder **10** under the urge of fluid under pressure in the retract chamber **45**.

However, if pressure fluid is applied to the extend chamber **46** while the retract chamber **45** is connected to drain, with the applied load acting in the direction of arrow **50**, the following sequence of events will transpire. When the unit area pressure acting on the end plate **28**, which results from the application of fluid pressure to the extend chamber **46**, exceeds the unit area pressure acting on the rod assembly **21** due to the applied load in the direction of arrow **50**, the rod assembly **21** will move relative to the then stationary head assembly **29**. Thus, the cams **30** and **31** will move to the right, as viewed in Fig. 2, while the head assembly **29** remains stationary. When the rod assembly **21** has moved from the position of Fig. 2 to the position of Fig. 3, the locking means will be released, thereby permitting movement of the entire piston assembly **20** to the right relative to the cylinder **10**.

From the foregoing, it is manifest that the present invention results in a self-locking actuator which is structurally more simple than actuators heretofore designed. Furthermore, the instant actuator does not require an independent lock release piston and cylinder combination for releasing the locking means concurrently upon the application of fluid pressure to the cylinder, which arrangement was necessary in the actuators constructed according to the hereinbefore mentioned patents.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. An actuator including in combination, a cylinder, a reciprocable piston assembly disposed in said cylinder capable of fluid pressure actuation in both directions, a stationary locking bar disposed in said cylinder, and two-way locking means carried by said piston assembly and

cooperable with said locking bar for preventing reciprocation of said piston assembly in the absence of fluid pressure application to said cylinder under the action of the load applied to said piston assembly, said locking means comprising cam means and roller means adapted to be wedged between said cam means and said locking bar.

2. An actuator including in combination, a cylinder, a reciprocable piston assembly disposed in said cylinder capable of fluid pressure actuation in both directions, a stationary member disposed in said cylinder, and load applied, fluid pressure releasable, two-way locking means carried by said piston assembly and cooperable with said stationary member for preventing movement of said piston assembly in the absence of fluid pressure application to said cylinder, said locking means comprising cam means and roller means adapted to be wedged between said cam means and said stationary member.

3. An actuator including in combination, a cylinder, a reciprocable piston assembly disposed in said cylinder capable of fluid pressure actuation in both directions, a stationary member disposed within said cylinder, and load applied, fluid pressure releasable locking means carried by said piston assembly and cooperable with said stationary member for preventing piston movement in the absence of fluid pressure application to said cylinder, said locking means including a pair of cams disposed on opposite sides of said stationary member and a pair of rollers adapted to be wedged between said cams and said stationary member.

4. An actuator including in combination, a cylinder, a reciprocable piston assembly disposed in said cylinder capable of fluid pressure actuation in both directions, a stationary member disposed within said cylinder, and load applied, fluid pressure releasable locking means carried by said piston assembly and cooperable with said stationary member for preventing piston movement in the absence of fluid pressure application to said cylinder, said locking means comprising a pair of U-shaped cam members disposed on opposite sides of said stationary member and having V-shaped internal surfaces, a pair of rollers capable of wedging relation between said cam members and said stationary member, and means for effecting relative movement between said rollers and said cam members so as to move said rollers into and out of wedging relation with said cam members and stationary member.

5. The combination set forth in claim 4 wherein said last recited means comprises a plurality of pins, the axes of which are disposed at right angles to the axes of said rollers, and wherein said piston assembly includes a rod portion and a head portion capable of relative movement, said pins being attached to and movable with said head portion.

6. The combination set forth in claim 5 wherein said rod portion includes an annular skirt upon which said head portion is slidably supported, and means limiting relative movement between said head portion and said rod portion.

7. An actuator assembly including in combination, a cylinder, a reciprocable piston assembly disposed in said cylinder, said piston assembly comprising a rod having an annular sleeve portion and a head assembly slidably mounted on said sleeve portion for movement relative thereto, a stationary member disposed within said cylinder and extending through said piston assembly, a pair of U-shaped cams disposed on opposite sides of said stationary member and constrained for movement with said rod, and means carried by said head capable of wedging relation between said cams and said stationary member for preventing movement of said piston assembly when the actuator is inactive.

8. The combination set forth in claim 7 wherein said piston assembly includes means for limiting relative movement between said head assembly and said rod.

9. The combination set forth in claim 7 wherein the means carried by said head assembly comprise a plurality of pins and a pair of locking rollers disposed on opposite sides of said stationary member, the ends of said locking rollers being confined between the ends of pairs of said pins and the axes of said rollers being disposed in a plane 90° to the plane of the axes of said pins.

10. The combination set forth in claim 9 wherein said stationary member is formed with spaced parallel flat surfaces, and wherein said cam members are formed with V-shaped internal surfaces, said locking rollers being capable of wedging relation therebetween.

11. The combination set forth in claim 7 wherein said head assembly frictionally and sealingly engages said cylinder, wherein said rod includes an annular shoulder limiting relative movement between said head and rod in one direction, and an annular plate for limiting relative movement between the head and rod in the other direction.

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