

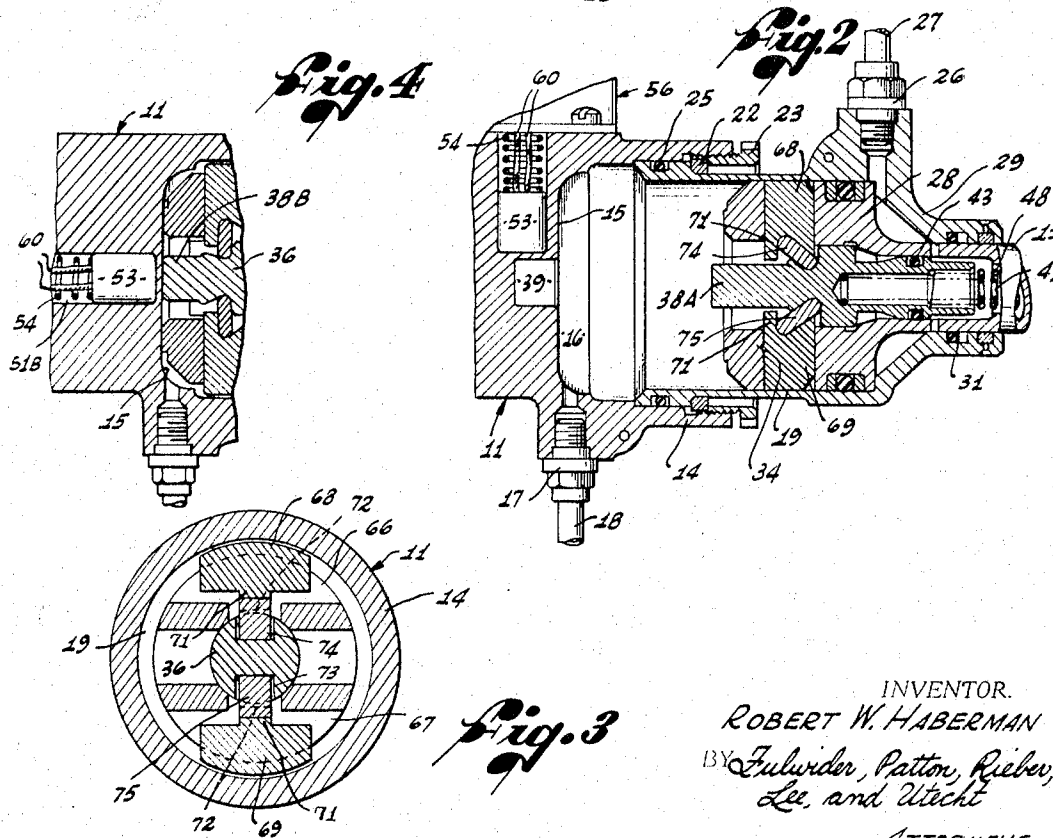
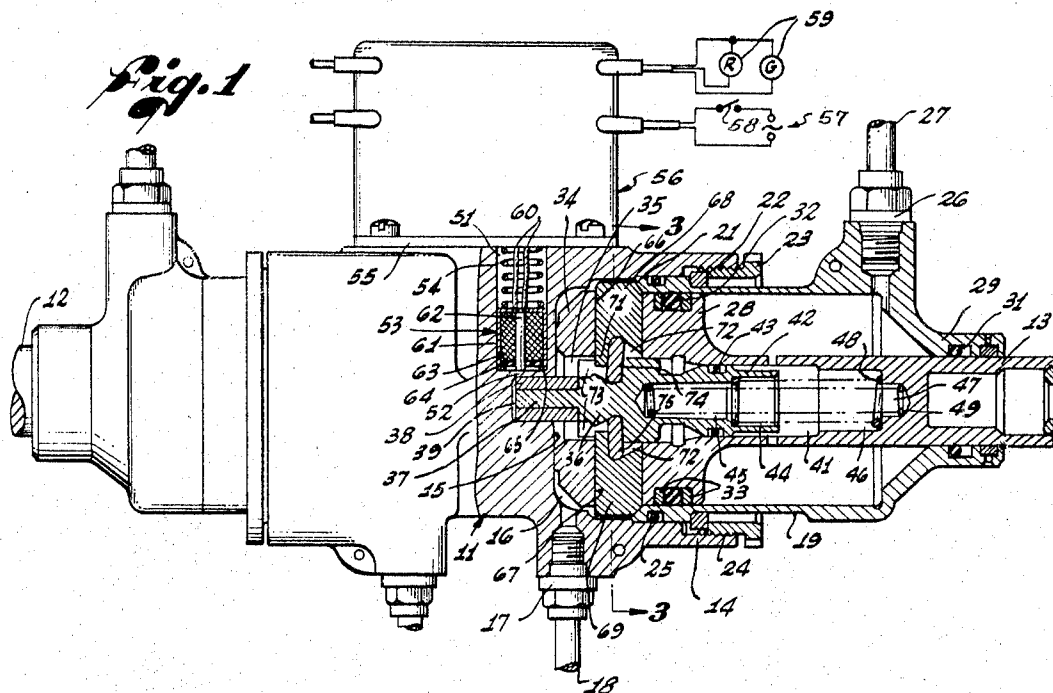
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HYDRAULIC ACTUATOR WITH PROXIMITY SENSOR OF LOCKED CONDITION

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HYDRAULIC ACTUATOR WITH PROXIMITY SENSOR OF LOCKED CONDITION

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ABSTRACT OF THE DISCLOSURE

A hydraulic actuator having a main operating piston and a concentric locking and unlocking piston movable relative thereto, with the position of the locking piston controlling the extension of locking segments which hold the main operating piston of the actuator in one extreme position. The locking piston is connected to the locking segments by dogs which move over-center in the locked position. The locking piston has a probe movable therewith and a proximity sensor is located adjacent the locking position of the probe and senses its position to signal switching circuitry to activate indicators of the locked or unlocked condition of the actuator. The proximity sensor is located exteriorly of the cylinder for the operating and locking pistons and is illustrated in the form of an electromagnet having a sensing coil about a magnet circuit with an air gap which is decreased by the probe on the locking piston to change the reluctance of the magnetic path and the reactance and impedance of the coil. Where the body of the actuator is of a dielectric material the proximity sensor may rely on a change in capacitive reactance for its response.

Background of the invention

(1) This invention is in the field of hydraulic actuators which are positively locked in an operated position and provide an indication of the locked or unlocked condition of the actuator.

(2) Hydraulic actuators positively locked in an actuated position and with mechanism giving an indication of the locked or unlocked condition of the actuator are known in the prior art. Such mechanism has usually required access through a wall defining the pressure cylinder for the operating piston of the actuator, necessitating extra seals and leaving potential leak paths at the access passages. In addition, the prior art designs have included switch actuating mechanisms of substantial weight which are undesirable where the weight of the unit is a factor.

Summary of the invention

The present invention avoids the objections to switch actuating mechanisms for indicating the locked or unlocked condition of a hydraulic actuator by the use of a proximity sensor located exteriorly of the interior wall of the cylinder of the actuator and without a connecting passage thereto. A part on the locking mechanism of the actuator moves adjacent the proximity sensor so as to affect a responsive portion thereof to secure a change in the sensor which is reflected by switching circuitry into an indication of the locked or unlocked condition of the actuator.

In the illustrated embodiment the proximity sensor comprises an electrical coil about a magnetic circuit which has an air gap which is reduced by a magnetic slug or probe on the locking mechanism for the actuator, thereby securing a change in the reluctance of the magnetic circuit and in the reactance and impedance of the coil which causes the switching circuitry to operate the indicating means being used.

Where the body of the actuator is of dielectric material the proximity sensor can be of capacitive type to be influenced by the presence of a probe to change the capacitive reactance of the sensor to effect an indication of the locked or unlocked condition of the actuator.

According to the present invention the sensor is located outside the cylinder for the operating piston of the actuator and with no passage thereto, thereby eliminating potential leak paths and the necessity for extra seals thereat. At the same time the overall unit weight can be reduced by the elimination of the switch actuating mechanism.

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

Brief description of the drawing

FIGURE 1 is a view, partly in elevation and partly in section, of a hydraulic actuator with proximity sensor indication of its locked or unlocked condition, according to the present invention.

FIGURE 2 is a partial view similar to FIGURE 1 but with the operating parts unlocked and at the opposite end of the actuator stroke. An alternate probe construction is shown.

FIGURE 3 is a transverse sectional view on the line 3-3 of FIGURE 1.

FIGURE 4 is a partial view of the actuator in locked position similar to FIGURE 1, but with the positions of the probe and sensor changed to an alternate arrangement.

Description of the preferred embodiments

The actuator of FIGURE 1 is shown in a paired relation with a body portion 11 common to a pair of actuators having oppositely directed piston rods 12 and 13 extending in opposite directions therefrom. The two actuators are independent and are simply mechanically supported on the same main body 11 so for the purposes of this invention only a single one of the actuators will be described, as shown in section in FIGURE 1.

The main body portion 11 is of a non-magnetic material such as aluminum or titanium. It has an end opening defining a generally cylindrical portion 14 and an end wall 15 defining a cylinder end chamber 16 connected by a passage and a fitting 17 to a fluid line 18. A cylinder barrel 19 is inserted within the cylindrical portion 14 of the base 11 and seats therein by positive abutment engagement at 21. A ring 22 positively engages a seat on the barrel 19 and is forced inwardly by an annular locking unit 23 threading at 24 with the inner surface of the cylindrical portion 14. The exterior surface of the cylinder barrel 19 seals to the interior surface of the cylindrical portion 14 at an O-ring 25. The interior of the cylinder barrel 19 connects through a passage and a fitting 26 to a fluid line 27.

A main operating piston 28 is reciprocally disposed within the cylinder barrel 19 and is shown as integrally connected to the piston rod 13. The cylinder barrel 19 is necked down at its outer end 29 and is sealed to the piston rod 13 by an O-ring 31. The piston 28 is sealed to the interior surface of the cylinder barrel 19 by an O-ring 32 disposed between a pair of spacer rings 33, the O-ring 32 and spacer rings 33 being disposed at an annular notch in the outer periphery of the piston 28. The piston 28 has a forward end portion 34 which engages the wall 15 at the end of the inward stroke of the piston, as shown in FIGURES 1 and 4.

The piston 28 has a central bore 35 therein in which is disposed a locking piston 36. The inward end of the locking piston 36 has a projecting finger 37 upon which is pressfit or otherwise secured a magnetic sleeve 38 re-

ceived within a well 39 in the main body portion 11 inwardly of the wall 15 and communicating with the cylinder end chamber 16.

The inner end of the piston rod 13 is provided with a bore 41 communicating with the bore 35 and receiving an outward extension 42 from the locking piston 36 which seals to the surface of the bore 41 by an O-ring 43. The extension 42 is provided with a pair of bores 44 and 45 and the piston rod 13 is counterbored at 46 and 47 to receive a pair of springs 48 and 49 concentrically mounted in the bores 44 and 46, and 45 and 47, respectively, to bias the locking piston 36 relative to the piston 28 toward the locking position shown in FIGURE 1.

A sensor receiving well 51 is directed transversely of the body portion 11 with its axis substantially intersecting and at right angles to the axis of the well 39. The well 51 is separated from the well 39 by an integral wall portion 52 which thereby separates the well 51 from any connection into the cylinder chamber 16. A proximity sensor 53 is resiliently held against the bottom of the well 51 by a spring 54 which may be held in place by the base 55 of an enclosure for reactance-responsive switching circuitry at 56. This circuitry is diagrammatically shown as connected to a power source 57 by a manual or automatic switch 58, and serving to control indicating means represented by red and green lights 59 for the unlocked and locked conditions of the actuator.

The proximity sensor 53, in the embodiment illustrated, includes an enclosing can 61 of magnetic material having a central post 62 therein, also of magnetic material, about which is wound a sensor coil 63 sealed within the can by a non-magnetic washer 64. The coil 63 is connected to the reactance-responsive circuitry 56 by leads 60. The magnetic circuit, including the can 61 and the post 62, has an air gap between the edge 65 of the can and the end of the post into which is projected the magnetic sleeve 38 on the finger 37 when the locking plunger 36 is in its locking position shown in FIGURE 1.

The piston 28 is oppositely notched at 66 and 67 to receive a pair of radially reciprocable locking segments 68 and 69. The locking segments have inwardly projecting fingers 71 notched at 72 and the locking piston 36 is complementarily notched at 73 to receive the rounded ends of locking dogs 74 and 75. The locking dogs are held within the notches 72 and 73 to rotate therein from the locked position of FIGURE 1, where the locking segments 68 and 69 are extended outwardly, to the unlocked position of FIGURE 2, where the locking segments 68 and 69 have moved radially inwardly as the operating piston 28 moved to the right after unlocking movement of the piston 36 against the bias of the springs 48 and 49.

FIGURE 2 not only shows the mechanism of FIGURE 1 at the opposite end of the stroke of the operating piston, but also shows a modified magnetic probe 38A which is an integral extension of a locking piston 36 formed of magnetic material, for example, a magnetic steel. The magnetic sleeve construction of FIGURE 1 is of more universal application should the locking piston be formed of a non-magnetic material such as a beryllium-copper alloy. In either case the cylinder barrel 19, piston 28 and rod 13 may be formed of steel, as may be the dogs 74, 75 while the locking segments 68 and 69 may be formed of steel or the beryllium-copper alloy. These materials are given by way of example only and are not to be considered restrictive of the scope of the invention.

FIGURE 4 shows a modified mounting for the proximity sensor in which the well 39 is omitted and the magnetic probe 38B shortened to terminate adjacent the wall 15 in the locked position of the actuator. A well 51B is provided for the sensor 53, the well 51B having its axis and the axis of the sensor aligned with the axis of the actuator. The probe 38B again lessens the air gap of the magnetic circuit of the proximity sensor to change the

reactance of the coil 63 to control operation of the reactance-responsive switching circuitry 56.

The operation of the hydraulic actuator and proximity sensor indicator of the present invention is as follows:

The actuator of FIGURE 1 is shown locked at the end of its inner stroke by the segments 68 and 69 which engage the inner ends of the cylinder barrel 19 to prevent the piston 28 moving outwardly. The dogs 74, 75 are over-center and positively locked at their extreme positions of rotation with respect to the upstanding walls of the notches 72 and 73. Therefore, the piston 28 is positively locked against movement until the locking piston 36 is moved relative to piston 28 to move the dogs 74 and 75 back over-center. In the locked position of FIGURE 1 the magnetic probe formed by the magnetic sleeve 38 has been placed adjacent the air gap in the magnetic circuit of the sensor 53, thereby changing the reluctance of the magnetic circuit and the reactance and impedance of the coil 63 which is connected into the reactance-responsive switching circuitry 56. The change in the reactance and impedance of the coil 63 may be reflected in known electronic circuitry to control and indicating device such as the lamps 59 schematically shown in FIGURE 1. Thus, when the actuator is in locked position with the probe sleeve 38 as shown, the increased reactance of the coil 63 causes the circuitry to light the green light at 59 whereas a decrease in reactance when the magnetic probe is withdrawn will cause the circuitry to extinguish the green light and light the red light.

To move the actuator of FIGURE 1 in an outward stroke to the position shown in FIGURE 2 the fluid line 27 is connected to the low pressure side of the system and the fluid line 18 to the high pressure side. This pressure acts on the latching piston 36 to cause it to move relative to piston 28 toward the right, as viewed in FIGURE 1, against the bias of the springs 48 and 49. This moves the dogs 74 and 75 over-center and permits the locking segments 68 and 69 to retract into the position of FIGURE 2, the dogs rotating into engagement with the inclined walls of the notches 72 and 73. The locking segments 68 and 69 retract until they clear the end of the cylinder barrel 19 and the pressure in the cylinder end chamber 16 moves piston 28 outwardly in a projection stroke to the position shown in FIGURE 2.

To move the actuator in its reverse stroke, that is, inwardly to the position in FIGURE 1 from that of FIGURE 2, the fluid line 18 is connected to the low pressure side of the system and the fluid line 27 to the high pressure side. When the pressure on the locking piston 36 is released it tends to move inwardly relative to the piston 28 under the bias of the springs 48 and 49, but is prevented from doing so by the engagement of the locking segments 68 and 69 with the inner surface of the cylinder barrel 19. The operating piston 28 and the locking piston 36 therefore move together toward the left in the inward stroke of the piston until it nears its full inward position where the piston end 34 engages the wall 15. As it approaches this position, the outer edges of the locking segments 68 and 69 clear the edge of the cylinder barrel 19 and the locking segments are projected radially into locking position as the locking piston 36 moves fully to the left under the bias of the springs 48 and 49, carrying the locking lugs 74 and 75 over-center and positively holding the segments 68, 69 in locking position.

Interposition of the solid wall 52 between the well 51 for the proximity sensor 53 and the well 39 for the magnetic probe sleeve 38 cuts off passage between the cylinder chamber 16 and the sensor for the switching circuitry whereby there is no path for fluid leakage and no necessity for seals to prevent such leakage, and indication of the locked and unlocked condition of the actuator is secured without access to the cylinder chamber 16.

The arrangement of FIGURE 4 shows a disposition

of the well 51B and proximity sensor 53 where access through the body portion 11 can be had axially of the actuator, as where a single actuator arrangement is used. In the construction of FIGURE 4, well 51B is separated from the inner wall 15 defining the chamber 16 by an integral portion of the material of the body portion 11, and the magnetic probe 38B terminates at the wall 15. The air gap of the sensor is directed toward the actuator cylinder so that the probe, in its locking position, changes the reluctance of the magnetic circuit of the proximity sensor as before, to change the reactance of the sensing coil.

While the proximity sensor used in the preferred embodiments of FIGURES 1 through 4 is shown as magnetically responsive it will be understood that if the body portion 11 of the actuator is made of a dielectric material the sensor can change reactance capacitatively by cooperation between conducting plates on the sensor and conductors or conducting plates on a probe moving with a locking element of the actuator.

Various modifications and changes may be made with regard to the foregoing detailed description without departing from the spirit of the invention.

I claim:

1. An actuator comprising:

means including a body portion providing a cylinder; means for feeding fluid pressure into said cylinder; an operating piston in said cylinder movable in opposite directions therein with movement in at least one direction being by said fluid pressure in an actuating stroke;

a piston rod connected to and moving with said operating piston and extending exteriorly of the cylinder; locking means for locking said operating piston against movement in one extreme position in said cylinder; a proximity sensor mounted exteriorly of the interior walls of said cylinder without physical access to the interior of the cylinder, said proximity sensor being located adjacent said one extreme position of the operating piston;

means movable independently of said operating piston and rod into a position to change the reactance of said proximity sensor a predetermined amount only when said operating piston is locked against movement; and

means responsive to such change in reactance for giving an indication of the locked condition of the actuator.

2. The actuator defined in claim 1 in which:

said proximity sensor comprising an electrical coil about a magnetic circuit having an air gap therein; and said means movable independently of said operating piston and rod to change the reactance of said proximity sensor being a magnetic probe reducing said air gap when the locking means is in locking position.

3. The actuator defined in claim 1 in which:

said body portion being of non-magnetic material; said proximity sensor including an electrical coil about a magnetic circuit with an air gap therein, said magnetic circuit being mounted in said body portion exteriorly of the cylinder wall and outside the bounds thereof and with said air gap including a volume connecting with the cylinder interior;

said means movable independently of said operating piston and rod to change the reactance of the proximity sensor being of magnetic material and moving into a position adjacent said magnetic circuit to diminishing said air gap and change the reactance of the coil.

4. The actuator defined in claim 3 in which:

said movable means of magnetic material being positioned adjacent the body portion end wall of the cylinder when the actuator is locked; a well in said body portion coaxial with said cylinder but outside its bounds and separated therefrom by

an imperforate wall integral with the body portion, said proximity sensor being located in said well with its air gap directed toward said cylinder to include the adjacent volume thereof therein, whereby the positioning of said movable means adjacent said cylinder end wall decreases the air gap to change the reactance of the proximity sensor coil.

5. The actuator defined in claim 1 including:

a first well in said body portion coaxial with but outside the bounds of said cylinder, a second well in said body portion and outside the cylinder bounds having an axis intersecting and at right angles to the axis of said first well with said wells overlapping and separated by a relatively thin wall of the body portion, said first well directly communicating with said cylinder; and

means mounting said proximity sensor in said second well, said first well receiving said means movable independently of said operating piston and rod to change the reactance of said proximity sensor only when said locking means is in position.

6. The actuator as defined in claim 5 in which:

said proximity sensor including a magnetic circuit having an air gap directed toward said first well and an electrical coil about said magnetic circuit; and said means movable independently of said operating piston and rod to change the reactance of said proximity sensor being a magnetic mass movable into said first well to decrease said air gap.

7. An actuator comprising:

means including a body portion providing a double ended cylinder;

means for feeding fluid pressure into the opposite ends of said cylinder;

an operating piston in said cylinder movable in opposite stroke directions as fluid pressure is alternately fed into the opposite ends of the cylinder;

a piston rod connected to and moving with said operating piston and extending exteriorly of the cylinder for connection to a part to be actuated;

locking means movable with said operating piston and movable relative to said operating piston into locking position preventing movement of said operating piston out of one extreme operating position;

a locking piston carried by said operating piston and movable relative thereto;

means connecting said locking piston to said locking means to control movement of said locking means into and out of locking position, said locking piston in one extreme position corresponding to said one extreme operating position of the operating piston positively holding said locking means in locking position;

a proximity sensor mounted exteriorly of the interior surfaces of said cylinder and outside the bounds thereof without physical access to the interior of the cylinder, said proximity sensor being located adjacent said one extreme operating position of the operating piston;

means movable independently of said operating piston and rod into a position to change the reactance of said proximity sensor when said locking means is in said locking position; and

means responsive to such change in reactance for giving indication of the locked condition of the actuator.

8. An actuator comprising:

means including a body portion providing a double ended cylinder;

means for feeding fluid pressure into the opposing ends of said cylinder;

an operating piston in said cylinder movable in opposite stroke directions as fluid pressure is alternately fed into the opposite ends of the cylinder;

a piston rod connected to and moving with said operating piston and extending exteriorly of the cylinder for connection to a part to be actuated;

locking means movable with said operating piston and

movable relative to said operating piston into locking position preventing movement of said operating piston out of one extreme operating position;

a locking piston carried by said operating piston and movable relative thereto;

means connecting said locking piston to said locking means to control movement of said locking means into and out of locking position, said locking piston in one extreme position corresponding to said one extreme operating position of the operating piston positively holding said locking means in locking position;

a proximity sensor mounted exteriorly of the interior surfaces of said cylinder without physical access to the interior of the cylinder, said proximity sensor being located adjacent said one extreme operating position of the operating piston;

means movable into a position to change the reactance of said proximity sensor when said locking means is in said locking position;

means responsive to such change in reactance for giving indication of the locked condition of the actuator; and

said means movable into a position to change the reactance of said proximity sensor being mounted on said locking piston to reach said position when said locking piston is in said extreme position positively holding said locking means in locking position.

9. The actuator defined in claim 8 in which:

said body portion being of non-magnetic material and said proximity sensor being mounted in said body portion and comprising an electrical coil about a magnetic circuit having an air gap extending into a volume at least communicating with said cylinder;

and said means movable to change the reactance of said proximity sensor including a mass of magnetic material mounted to be movable with said locking piston and moving into said air gap volume to change the reluctance of the magnetic circuit and the react-

ance of the coil when said locking piston is in said one extreme position.

10. The actuator defined in claim 9 including: means constantly biasing said locking piston toward said one extreme position, said locking piston being movable out of said one extreme position upon the application of fluid pressure to the end of said cylinder toward which said locking piston is biased.

11. The actuator defined in claim 10 in which: said locking piston being mounted axially of said operating piston;

said unlocking pressure being exerted on both said locking piston and said operating piston whereby it first moves said locking piston into an unlocking position and thereafter moves said operating piston in a working stroke.

References Cited

UNITED STATES PATENTS

2,627,183	2/1953	Greenwood et al.	92—5 X
2,764,132	9/1956	Bakke	92—25
2,949,890	8/1960	Chace	92—25
2,958,137	11/1960	Mueller.	
2,988,916	6/1961	Waugh.	
3,020,888	2/1962	Braun	91—1 X
3,024,453	3/1962	Ransom	324—41 X
3,160,836	12/1964	Farley	92—5 X
3,364,361	1/1968	Burger	92—5 X
3,392,279	7/1968	Crawford	324—41 X

FOREIGN PATENTS

924,665 5/1963 Great Britain.

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