United States Patent [19]

Ridley

[11] **3,785,214**

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[54] **FLUID PRESSURE OPERATED ROTARY ACTUATORS**

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[21] Appl. No.: **238,221**

[52] **U.S. Cl.** **74/89.21**
[51] **Int. Cl.** **F16h 29/02**
[58] **Field of Search** 74/89.21, 89.22, 74/89, 108, 99

[56] **References Cited**

FOREIGN PATENTS OR APPLICATIONS

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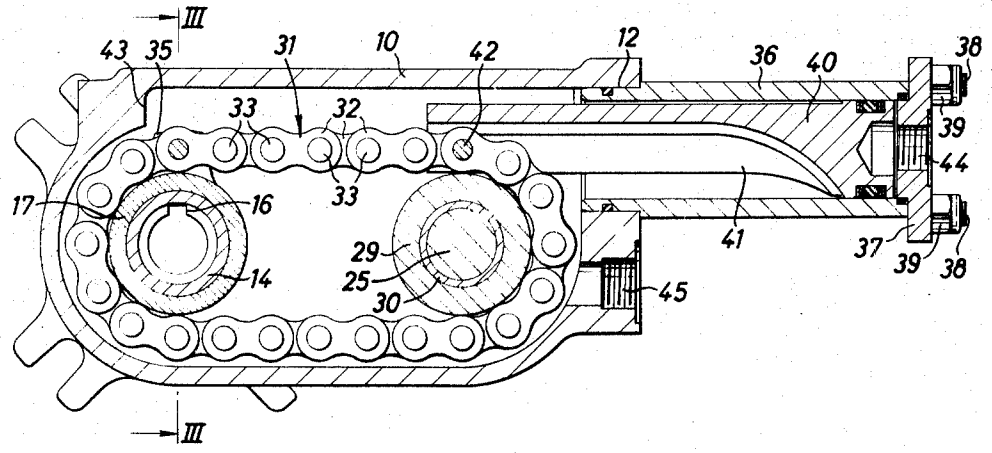
Primary Examiner—Charles J. Myhre
Assistant Examiner—F. D. Shoemaker
Attorney—J. A. Young

[57] **ABSTRACT**

A fluid pressure operated rotary actuator in which rectilinear movement of a piston in a cylinder by the action of fluid pressure is converted into rotary movement of an output shaft. The piston is fixed to a closed loop pivoted link chain of the kind known as a leaf chain, which passes around the output shaft and a rotary idler member so that one run of the closed loop is substantially parallel to the line of movement of the piston. The chain is fixed to the output shaft at a point spaced from the point at which it is fixed to the piston. The output shaft, rotary idler member and the closed loop of the casing may be in communication with the cylinder or may be separated from the cylinder by a packing gland through which extends the piston rod.

7 Claims, 4 Drawing Figures



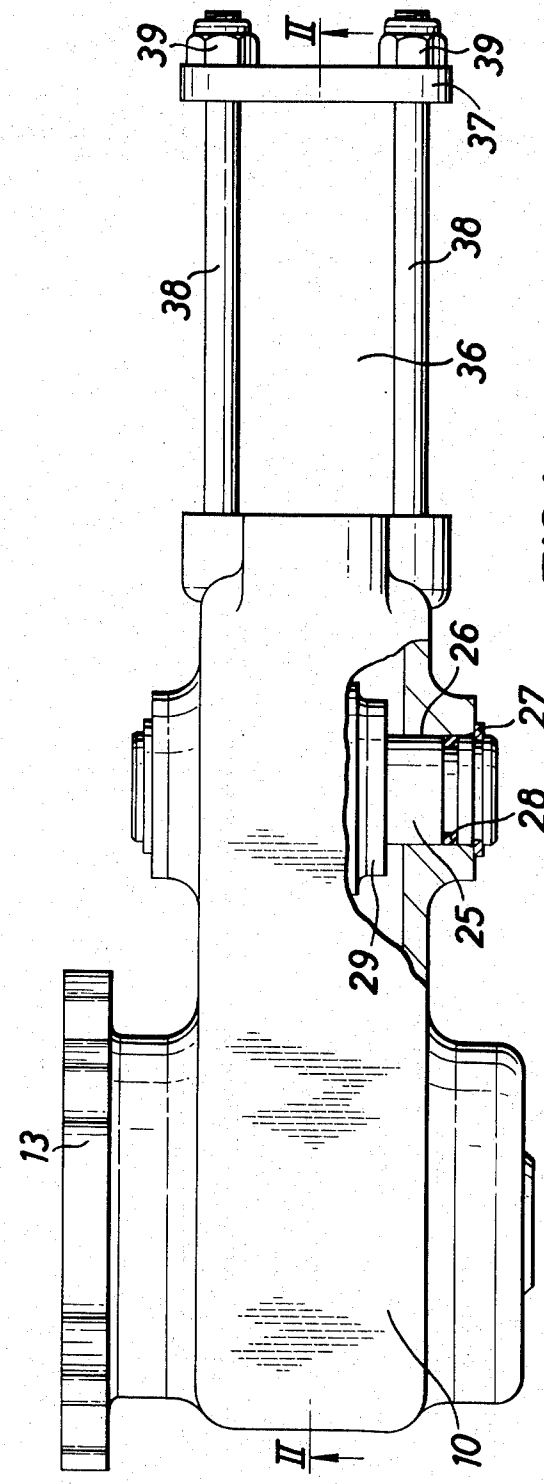


FIG.1.

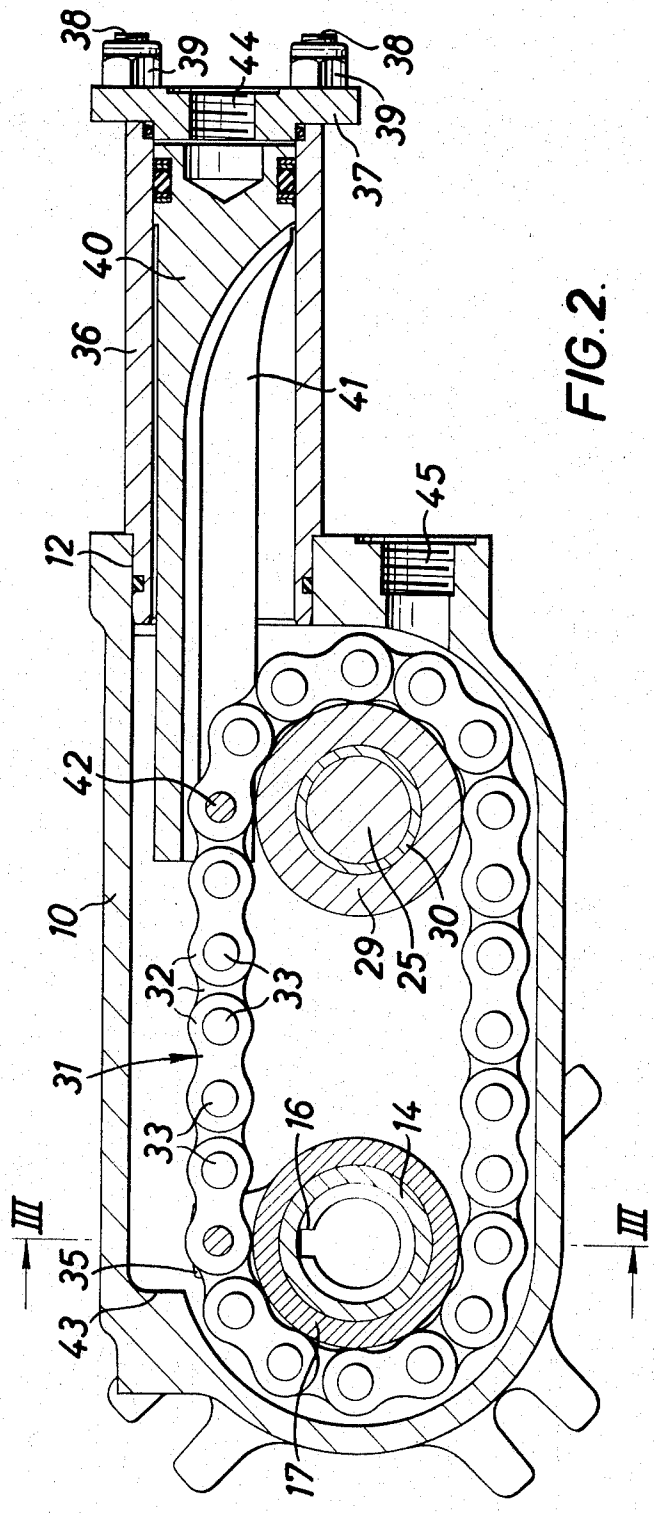

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FIG. 2.

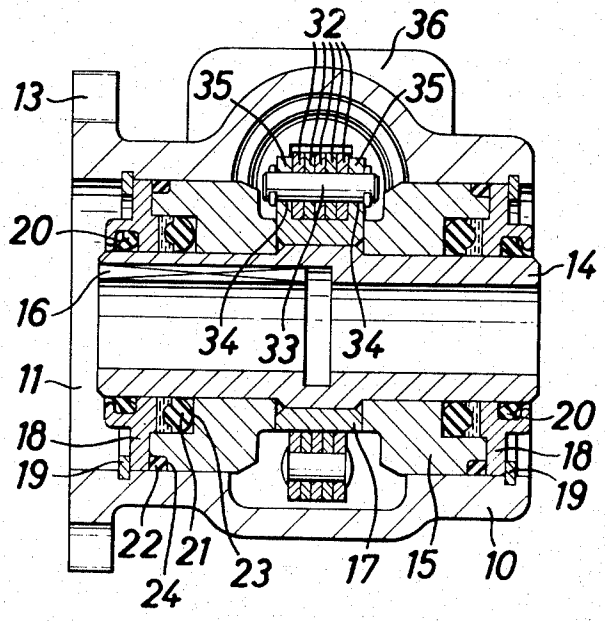

FIG. 3.

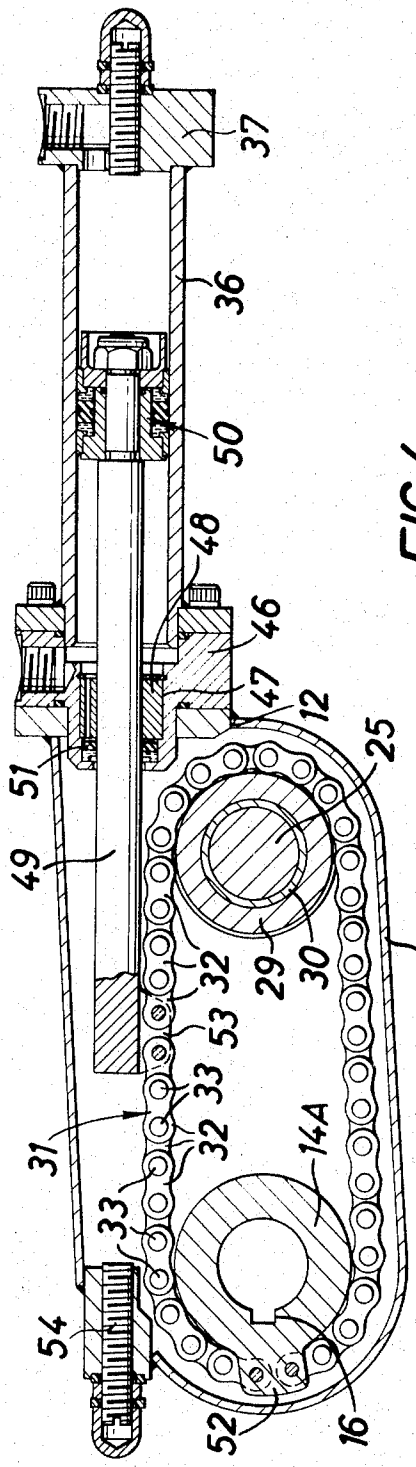

FIG. 4.

FLUID PRESSURE OPERATED ROTARY ACTUATORS

This invention relates to fluid pressure operated rotary actuators and, more specifically, to fluid pressure rotary actuators in which the rectilinear movement of a piston in a cylinder by the action of fluid pressure is converted into rotary movement of an output shaft.

It is the object of the invention to provide an improved rotary actuator.

According to this invention there is provided a fluid pressure operated rotary actuator including a piston movable in at least one direction in a cylinder by the action of fluid pressure, an output shaft so positioned in relation to the piston and cylinder that the line of movement of the piston is tangential to a circle about the output shaft, a rotatable idler member mounted for rotation about an axis parallel to the axis of the output shaft, and a closed loop flexible driving member passing around the output shaft and the rotatable idler member so that one run thereof between the output shaft and the idler member is substantially parallel to the line of movement of the piston, the closed loop flexible driving member being fixed at one point to the piston and being engaged drivingly with the output shaft so that longitudinal movement of the piston rotates the output shaft.

Preferably, the output shaft is a tubular shaft to receive a rod or spindle to be rotated by the actuator, the bore of the output shaft being conveniently formed with a keyway or splines to co-operate with a key or splines on the rod or spindle.

The flexible driving member is preferably a pivoted link chain, conveniently a leaf chain as herein defined, and the said flexible driving member, output shaft and idler member are preferably housed in a closed casing to which one end of the cylinder is secured.

The end of the cylinder which is secured to the casing may be open to the interior of the said casing, or the piston may comprise a head mounted on a rod which passes through a partition dividing the bore of the cylinder from the interior of the casing, a fluid-tight seal being provided in the partition.

The idler member is preferably positioned in the casing between the output shaft and the end of the casing to which the cylinder is secured.

Two embodiments of this invention will be described now by way of example only with reference to the accompanying drawings, of which:

FIG. 1 is a plan view of a rotary actuator according to one embodiment of this invention, part of the outer casing of the actuator being broken away to show a detail of the actuator in section;

FIG. 2 is a section on the line II—II of FIG. 1;

FIG. 3 is a section on the line III—III of FIG. 2; and

FIG. 4 is a transverse section similar to FIG. 2, of a rotary actuator according to another embodiment of this invention.

Referring to FIGS. 1 – 3 of the drawings, the rotary actuator comprises a closed casing 10 of elongate form having a transverse aperture 11 at one end and a second aperture 12 at the other end, the axis of the second aperture 12 being normal to the axis of the transverse aperture 11. The casing has an integral annular flange 13 which defines one of the mouths of the transverse aperture 11 and which serves as a mounting for the rotary actuator.

A tubular shaft 14 is supported for rotation coaxially within the transverse aperture 11 by a coaxial pair of annular bearings 15 carried by the casing 10. The tubular shaft 14 is formed with a keyway 16 in its bore. Thus a spindle to be driven by the actuator can be inserted into the bore of the tubular shaft 14 and coupled therto rotationally by a key. One drum 17 is fixed to the tubular shaft 14 and is positioned between the two annular bearings 15. The two annular bearings 15 and the drum 17 are restrained against movement axially of the transverse aperture 11 by two annular end plates 18 between which they are located. Each annular end plate 18 is held in position within the transverse aperture 11 by a respective circlip 19. Each end plate 18 carries an annular wiper ring 20 which is in sealing engagement with the tubular shaft 14, and two annular sealing rings 21 and 22 are located in respective annular recesses 23 and 24 formed in the annular bearings 15, the sealing rings 21 and 22 sealing against the flow of working fluid outwardly through the mouths of the transverse aperture 11.

An idler shaft 25 is fixed in the casing 10 near to said other end of the casing 10 and with its axis parallel to the axis of the tubular shaft 14. Each end of the idler shaft 25 which is a tight fit in a respective aperture 26 in the casing 10 (see FIG. 1) carries a circlip 27 which engages the outer surface of the casing 10 so as to locate the idler shaft 25 against axial movement, and an annular sealing ring 28 which seals against leakage of working fluid from within the casing through the aperture 26. Another drum 29, of the same diameter as said one drum 17, is supported for rotation on the idler shaft 25 by an annular bearing 30.

A closed loop 31 of leaf chain which comprises groups of flat side-by-side link members 32, each two adjacent groups being connected by a pivot pin 33 and the link members 32 of one group extending between adjacent link members 32 of the next group so that the connecting pin 33 passes through holes in link members 32 of both groups, passes around the two drums 17 and 29 and is fixed to the drum 17 on the output shaft 14 by one of the chain pivot pins 33 extending through holes 34 in two or more ears 35 projecting radially from that drum 17.

An open-ended cylinder 36 has one end spiggotted coaxially into the second aperture 12 in a fluid tight manner so that the axis of the cylinder 36 is parallel to the plane which includes the axes of the two drums 17 and 29. The cylinder 36 projects from the second aperture 12 of the casing 10. A cylinder end plate 37 is held in fluid tight engagement with the other end of the cylinder 36 by the action of a pair of tension rods 38, each of which is fixed at one end to the casing 10 and which extends through the cylinder end plate 37 each rod 38 carrying a nut 39 which engages the face of the cylinder end plate 37 remote from the cylinder 36. Thus the cylinder 36 is held axially relative to the casing 10.

An elongate piston 40 is mounted slidably in the cylinder 36 and projects into the casing 10. The piston 40 is slotted longitudinally at 41 for a substantial part of its length to accomodate the closed loop 31 of leaf chain, which is secured to the piston 40 by an elongated chain pivot pin 42 which is engaged in holes in the sides of the slot 41 in the piston 40, the common axis of the said holes intersecting the axis of the piston 40. The path of linear movement of the piston 40 is limited at one end by engagement of the piston 40 with the cylin-

der end plate **37** and at the other end by engagement of the piston **40** with an abutment **43** defined by the inner surface of the casing **10** at the opposite end of the casing **10.**

The distance between the points of connection of the chain to the output shaft drum **17** and to the piston **40** is equal to half the circumference of the circle around the drum **17** on which the axes of of the pivot pins **33** of the part of the closed loop **31** of leaf chain embracing the drum **17** lie, and the distance between the axes of the two drums **17** and **27** is substantially equal to the said half circumference, so that the linear movement of the piston **40** produces 180° of angular movement of the output shaft **14.**

A port **44** in the cylinder end plate **37** communicates with the cylinder space between the piston **40** and the cylinder end plate **37.**

A port **45** in the casing **10** communicates with the interior of the casing **10.**

In use of the rotary actuator, the ports **44** and **45** are connected to a suitable selector valve (not shown). The selector valve is operable to connect a selected one of the two ports **44** and **45** to a source of working fluid under pressure and to connect the other of the two ports **44** and **45** to drain so that one side of the piston **40** is vented, working fluid under pressure is applied to the other side, the piston **40** is moved in one direction and the output shaft **14** is rotated accordingly; the selector valve being operable to reverse the connections of the ports **44** and **45** to the source of working fluid under pressure and to drain so that the piston **40** is moved in the opposite direction and the output shaft **14** is rotated accordingly.

Referring now to FIG. **4** which illustrates another form of rotary actuator according to this invention and in which parts similar to the rotary actuator illustrated in FIGS. **1 – 3** of the accompanying drawings are given the same reference numerals a flanged bush **46** is mounted in said other opening **12** of the casing **10.** The bush **46** provides a partition between the casing **10** and the cylinder **36,** and has mounted in the bore **47** thereof a bearing sleeve **48** for a piston rod **49** carried by a piston **50** slidable in the cylinder **36,** and a sealing ring **51** engaging the piston rod **49.**

The diameter of the drum **29** carried by the idler shaft **25** is less than the diameter of the tubular output shaft, which is modified so that the separate drum **17** of the actuator illustrated in FIGS. **1 – 3** of the accompanying drawings is dispensed with, and which carries the reference **14A.**

The arrangement is such that a part of the loop **31** of leaf chain extending around the tubular output shaft **14A** and idler drum **29** lies parallel and adjacent to the piston rod **49.** The chain loop **31,** which is fixed at one point to a fixing block **52** projecting radially from the tubular output shaft **14A,** is also fixed at a point along its length spaced from the fixing block **52,** to a lateral projection **53** on the piston rod **49,** so that longitudinal movement of the piston **50** and piston rod **49** carries the chain loop **31** to move and rotate the tubular output shaft **14A** .

Provision is made for supplying fluid pressure selectively to the two ends of the cylinder **36** to move the piston **50** in opposite directions and thereby move the chain loop **31** to rotate the output shaft **14A** in opposite directions, the available angle of rotation of the output shaft **14A** depending on the relation between the radius of the circle on which the chain pivot pins **33** lie about the output shaft **14A** and the length of the straight run of the chain alongside the piston rod **49.** An adjustable stop **54** in the casing **10** and an adjustable stop in the cylinder end plate **37** are provided to limit the stroke of the piston **50** to the required length.

A scale may be provided on the casing, cooperating with an index fixed to the tubular shaft **14A,** to indicate the angular position of the shaft **14A,** and an adjustable striker may be mounted on one end of the shaft **14A** to operate a limit switch at the ends of the angular movement of the shaft **14A.**

In either embodiment of the invention described above, the closed loop flexible driving member, instead of being a leaf chain, may be a roller chain or any other suitable driving member such as a belt. The idler shaft may be mounted in bearings in the casing and have the respective drum fixed thereto.

I claim:

1. A fluid pressure operated rotary actuator including a cylinder, a piston movable in at least one direction in the cylinder by the action of fluid pressure, an output shaft so positioned in relation to the piston and cylinder that the line of movement of the piston is tangential to a circle about the output shaft, a rotatable idler member mounted for rotation about an axis parallel to the axis of the output shaft and a flexible driving member which is fixed to the piston and is engaged drivingly with the output shaft so that longitudinal movement of the piston rotates the output shaft, the flexible member being engaged with the rotary idler member and comprising a closed loop which is passed over the output shaft and the rotary idler member so that one run of the closed loop between the output shaft and the rotary idler member is substantially parallel to the line of movement of the piston, and wherein the idler member is disposed between the piston and the output shaft.

2. A fluid pressure operated rotary actuator according to claim **1,** wherein the improvement further comprises the output shaft being a tubular shaft, the bore of the tubular shaft being arranged to receive a rod or spindle to be rotated by the actuator.

3. A fluid pressure operated rotary actuator according to claim **1,** wherein the improvement further comprises the flexible driving member being a pivoted link chain.

4. A fluid pressure operated rotary actuator according to claim **3,** wherein the improvement further comprises the pivoted link chain being a leaf chain as herein defined.

5. A fluid pressure operated rotary actuator according to claim **1,** wherein improvement further comprises the said flexible driving member, output shaft and rotatable idler member being housed in a closed casing to which one end of the cylinder is secured.

6. A fluid pressure operated rotary actuator according to claim **5,** wherein the improvement further comprises the cylinder being open to the interior of the said casing.

7. A fluid pressure operated rotary actuator according to claim **1,** wherein the idler member is positioned in the casing between the output shaft and the end of the casing to which the cylinder is secured.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,785,214 Dated January 15, 1974

Inventor(s) JOHN CECIL RIDLEY

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 1, line 11, after "flexible", insert

-- driving -- .

Signed and sealed this 13th day of August 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

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* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.