

June 7, 1960

D. GERTZ

2,939,284

HYDRAULIC DRIVE WITH INTEGRAL SUMP

Filed Oct. 8, 1958

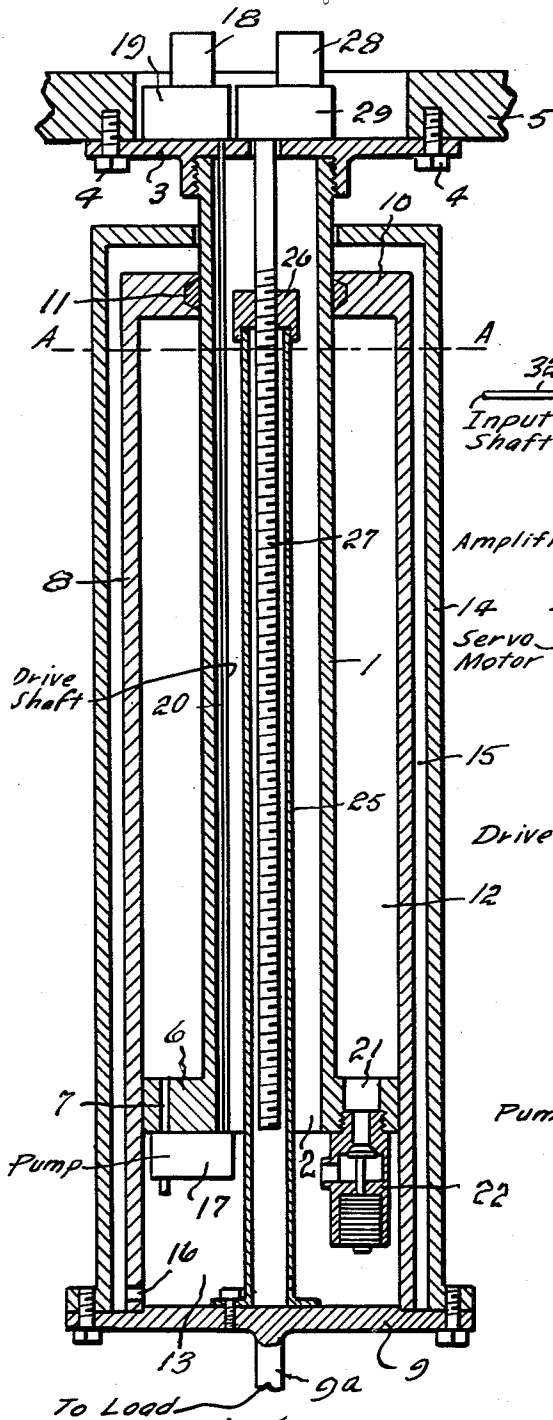


Fig. 1

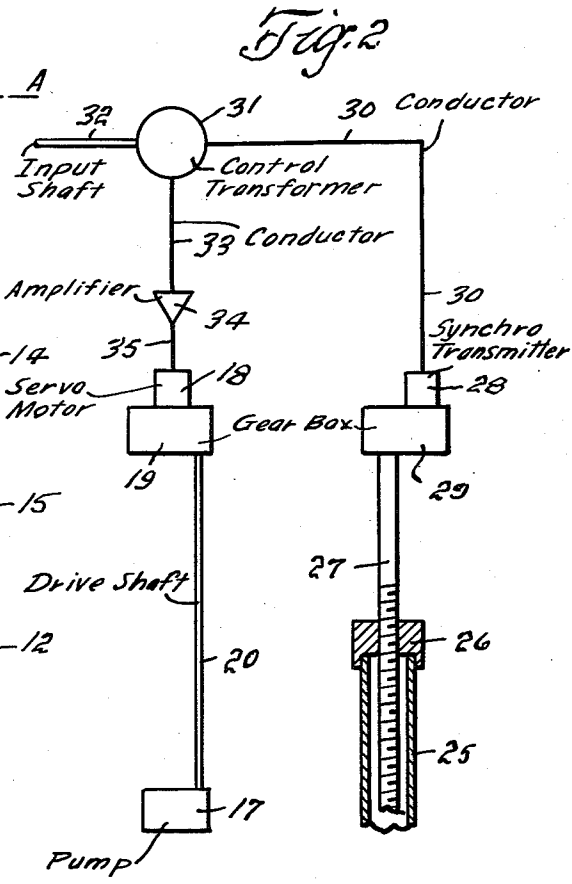


Fig. 2

INVENTOR

Donald Gertz

BY Victor N. Horst

ATTORNEY

1

2,939,284

HYDRAULIC DRIVE WITH INTEGRAL SUMP

Donald Gertz, 50 Clearland Ave., Carle Place, N.Y.

Filed Oct. 8, 1958, Ser. No. 766,115

8 Claims. (Cl. 60—52)

This invention relates to hydraulic drive mechanism and to a control means therefor by which the operation of the mechanism is either manually or automatically controlled; and this application is a continuation-in-part of my copending application Serial No. 656,148, which was filed April 30, 1957, and is now abandoned.

The mechanism was especially designed for use with nuclear reactors, but is equally well adapted for use with many other types of apparatus. It comprises generally a stationary piston which is rigidly secured to the lower end of a downwardly extending tubular piston rod, the upper end of which is rigidly secured to a fixed support. An inner cylinder is slidably mounted on the piston and the piston rod. The upper end of the cylinder is provided with a cylinder head through which the piston rod extends and a suitable packing gland is provided to prevent leakage of fluid around the piston rod. An outer cylinder is disposed about the inner cylinder, coaxially therewith. The inside diameter of the outer cylinder is substantially greater than the outside diameter of the inner cylinder, thereby providing an annular chamber between the inner and outer cylinders. The lower ends of both the inner and outer cylinders are connected to and closed by a common cylinder head which is adapted to be operatively connected to the apparatus to be driven by the mechanism. A chamber which is provided between the bottom of the piston and the lower end cylinder head within the inner cylinder communicates with the annular chamber between the two cylinders through a passageway in the inner cylinder wall adjacent the lower end thereof. The inner cylinder, both above and below the piston, is always maintained full of fluid, and when the cylinders are in their uppermost position the annular chamber between the cylinders is filled with fluid to a level slightly below the top of the inner cylinder. The chamber below the piston and the communicating annular chamber constitute a sump to and from which operating fluid is pumped during operation.

For this purpose a reversible pump is secured to the bottom of the piston within the chamber therebelow, and is connected to the chamber above the piston by a fluid passageway through the piston. The pump is selectively driven in either direction, through a shaft which extends down through the tubular piston rod, by a suitable motor and gear box which are mounted in fixed position above the fixed upper end of the piston rod. When it is desired to lower the cylinders, fluid is pumped from the chamber above the piston into the sump which allows the cylinders to drop by gravity; and when it is desired to raise the cylinders, fluid is pumped from the sump into the chamber above the piston which forces the cylinders upwardly under pressure.

The construction is such that the sump, to and from which fluid is pumped during operation, is self-contained in the mechanism so that all leakage of fluid around the piston and/or the piston rod drains back directly into the sump, thereby preventing any leakage of fluid to the

2

surrounding environment which is a very important advantage in many installations, especially nuclear reactors.

In many installations the drive mechanism is hidden or is located in a remote position so that it cannot be seen, which is especially true of nuclear reactors. A control means is therefore provided which is so constructed and arranged that an attendant can always be assured that the cylinders move to the correct position in response to a signal which is either manually or automatically imparted thereto.

Any leakage of fluid from the chamber above the piston will cause the cylinders to drift downwardly. The control mechanism is therefore also so constructed and arranged that it will automatically compensate for any drifting and return the cylinders to their proper set position.

The control means for the drive mechanism comprises a tube which is rigidly secured to the lower cylinder head and extends upwardly into the tubular connecting rod in axial alignment therewith. A ball shaft which is rotatably mounted in fixed position extends downwardly through a ball nut which is rigidly secured to the upper end of the tube. The construction and pitch of the co-operating threads of the ball shaft and ball nut are such that any relative vertical movement between the ball nut and the ball shaft will cause rotation of the ball shaft. The ball shaft, when rotated, is adapted to actuate, through a suitable gear box, a standard synchro transmitter which when actuated is adapted to impart a feedback electrical signal to a standard control transformer which is adapted to have an input signal mechanically imparted thereto, either manually or automatically. The output of the control transformer, which is electrical, is imparted to a conventional amplifier, the output of which operates a standard servo motor. The servo motor operates the reversible pump through a suitable gear box and a drive shaft which extends down through the tubular connecting rod from the gear box to the reversible pump. The pump when operated will effect the raising or lowering of the inner and outer cylinders in unison which will cause rotation of the ball shaft. The ball shaft will then cause the synchro transmitter to impart a feedback signal to the control transformer. When the feedback signal to the control transformer and the input signal thereto are equal the output of the control transformer will be zero, and the servo motor will stop operating the pump. The movement of the cylinders will therefore stop and they will remain in stopped position, until another input signal is imparted to the control transformer.

In the event of any downward drifting of the cylinders due to leakage of fluid around the stationary piston and/or the piston rod the ball shaft will be rotated, which will cause the synchro transmitter to impart a different feedback signal to the control transformer which will unbalance the input and feedback signals to the control transformer and cause an output from the transformer which will effect operation of the pump until the feedback and input signals to the control transformer are again in balance, whereby the cylinders are automatically returned to their proper position in accordance with the input signal imparted to the control transformer.

As a modified type of control mechanism the pump may be selectively operated in either direction by a reversible motor which is controlled by a manually operated switch; and the synchro transmitter utilized to operate a dial by which the relative positions of the cylinders and piston are visually indicated.

One of the principal objects of the invention is to provide a hydraulic drive mechanism, of the aforesaid character, having a self-contained sump into and out of which operating fluid is pumped, and into which any

3

leakage of fluid drains directly, thereby preventing any leakage of fluid to the surrounding environment.

Another object of the invention is to provide an operating and control means, for a hydraulic drive of the aforesaid character, by which the reciprocal power cylinder thereof is accurately moved to and maintained in a set position in response to a signal imparted to the control means.

Another object of the invention is to provide in a hydraulic drive mechanism of the aforesaid character means by which any downward drifting of the power cylinder due to the leakage of operating fluid is automatically compensated for and the cylinder returned to its proper set position.

Another object of the invention is to provide a hydraulic drive mechanism of the aforesaid character having means incorporated therein which is operative to effect the operation of an indicator by which the relative position of the movable power cylinder and the stationary piston are visually indicated.

Having stated the principal objects of the invention, other and more limited objects thereof will be apparent from the following specification and the accompanying drawings forming a part thereof in which:

Fig. 1 is a central vertical sectional view through a hydraulic drive mechanism constructed in accordance with my invention; and

Fig. 2 is a diagrammatic view illustrating the operating and control mechanism therefor.

The construction and operation of the mechanism will now be described in detail in connection with the drawing by the use of reference characters in which the numeral 1 indicates a vertically disposed tubular piston rod having an open lower end 2, and a cap 3 at the upper end thereof by which the piston rod 1 is rigidly secured by bolts 4 to a fixed supporting member 5. A piston 6 having a fluid passageway 7 therethrough is rigidly secured to the piston rod 1 about the open lower end 2 thereof.

An inner cylinder 8, which is reciprocally mounted on the piston 6, is provided with an imperforate lower cylinder head 9, and an apertured upper cylinder head 10 through which the piston rod 1 extends. The cylinder head 10 is provided with a packing gland 11 about the piston rod 1, and the lower cylinder head 9 is provided with a boss 9a through which the drive mechanism is adapted to be connected to the apparatus to be actuated thereby. The piston 6 divides the cylinder 8 into an upper expansible chamber 12 and a lower expansible chamber 13.

The inner cylinder 8 is enclosed within an outer cylinder 14 which is also secured to the lower cylinder head 9, coaxially with the inner cylinder 8. The inner wall of the outer cylinder 14 is spaced from the outer wall of the inner cylinder 8, thereby providing an annular chamber 15 between the two cylinders. A communicating fluid passageway 16 between the lower chamber 13 and the annular chamber 15 is provided in the wall of the inner cylinder 8 adjacent the lower cylinder head 9.

The communicating lower chamber 13 and annular chamber 15 constitute a self-contained sump from which operating fluid is pumped into and out of the upper chamber 12 through the fluid passageway 7 in the piston 6 during operation. For this purpose a reversible pump 17, which is connected to the fluid passageway 7 in the piston 6, is secured to the lower face of the piston 6 within the lower chamber 13. The pump 17 is adapted to be rotated in either direction by a standard servo motor 18 through a gear box 19 and a drive shaft 20. The gear box 19 and servo motor 18 are mounted in fixed position above the drive mechanism on any suitable stationary support. As shown herein they are mounted on the cap 3, but they could be mounted equally well on the supporting member 5. The drive shaft 20 extends down through the tubular piston rod 1 from the gear

4

box 19 to the pump 17. The upper chamber 12 and the lower chamber 13 are always maintained full of operating fluid, preferably oil, and when the cylinders 8 and 14 are in their uppermost position, as shown in Fig. 1, the fluid level in the annular chamber 15 and in the tubular piston rod 1 is slightly below the upper cylinder head 10 of the inner cylinder 8, as indicated by the dot-and-dash line A—A on Fig. 1. In operation, when it is desired lower the cylinders 8 and 14 and with them the lower cylinder head 9 fluid is pumped from the upper chamber 12 into the lower chamber 13 thereby permitting the cylinders to drop by gravity; and when it is desired raise the cylinders and the lower cylinder head fluid is pumped from the lower chamber 13 into the upper chamber 12 thereby forcing the cylinders upwardly under pressure. Sometimes during operation it is desirable to quickly drop the cylinders 8 and 14 and the lower cylinder head 9 to which the apparatus to be actuated is connected. For this purpose an enlarged fluid passageway 21 between the chambers 12 and 13 is provided in the piston 6. The passageway 21 is normally maintained closed by a solenoid operated dump valve 22, which when opened permits fluid to quickly flow from the chamber 12 into the chamber 13. During downward movement of the cylinders 8 and 14 the liquid level in the annular chamber 15 drops, but the volumetric capacity of the annular chamber 15 is such that the liquid level therein never drops below the piston 6. Any leakage of operating fluid from the upper chamber 12, which fluid is always under pressure, past the packing gland 11 and/or the piston 6 will drain directly into the self-contained sump constituted by the lower chamber 13 and the annular chamber 15, thereby preventing any leakage of fluid to the surrounding environment which in some installations, especially nuclear reactors, is a very important feature.

A control mechanism by which the operation of the pump 17 is automatically controlled, in accordance with an input signal imparted to the control mechanism, is provided which will now be described. A tube 25 which is rigidly secured to the lower cylinder head 9 and extends upwardly therefrom into the tubular piston rod 1, coaxially therewith, has a ball nut 26 rigidly secured to the upper end thereof. A ball shaft 27 is rotatably mounted in fixed position above the drive mechanism and extends downwardly therefrom through the ball nut 26 into the tube 25. The pitch and construction of the cooperating threads of the ball nut 26 and ball shaft 27 are such that any movement of the ball nut 26 up or down the ball shaft 27 will impart rotation to the ball shaft in one direction or the other depending on whether the ball nut is moving up or down the ball shaft. The ball shaft, when rotated, actuates a conventional synchro transmitter 28 through a gear box 29. The synchro transmitter 28 when actuated will, through a conductor 30, impart an electrical feedback signal to a standard control transformer 31. The control transformer 31 is of the type having an electrical output which is the resultant of an input signal mechanically imparted thereto and a feedback signal which is electrically imparted thereto. The input signal is mechanically imparted to the control transformer 31 through a shaft 32, either manually or automatically. The electrical output of the control transformer 31 is imparted, through a conductor 33, to a standard type amplifier 34 the electrical output of which is delivered to the servo motor 18, through a conductor 35, which energizes the servo motor 18.

In operation, an input signal is imparted to the control transformer 31, through the shaft 32, which through the conductor 33, amplifier 34 and conductor 35 energizes the servo motor 18. The servo motor 18, through the gear box 19 and shaft 20 operates the reversible pump 17. The pump 17 being operated effects the raising or lowering of the cylinders 8 and 14, the lower cylinder head 9 and the ball nut 26. The ball nut 26 being raised or

5

lowered on the ball shaft 27 causes rotation of the ball shaft 27 which, through the gear box 29, actuates the synchro transmitter 28, which being actuated imparts a feedback signal to the control transformer 31. When the input signal to the control transformer 31 and the feedback signal thereto are equal, or in balance, the output of the control transformer 31 to the amplifier 34 is zero. Consequently the output of the amplifier 34 will be zero and the servo motor 18 and the pump will stop operating and the movement of the cylinders 8 and 14 will be stopped in the correct position desired in accordance with the input signal imparted to the control transformer 31.

As long as the input signal to the control transformer 31 and the feedback signal thereto are in balance there will be no output from the control transformer, and consequently the pump 17 will not be operated by the servo motor 18, and the cylinders 8 and 14 will remain stationary in set position. But if the input signal and the feedback signal are thrown out of balance, either by a change in the input signal or the feedback signal, the servo motor 18 and pump 17 will be operated until the input signal and feedback signal are again in balance. Therefore whenever the cylinders drift downwardly from set position due to a leakage of operating fluid from the upper chamber 12 past the piston 6 and/or the packing gland 11, the ball nut 26 will impart rotation to the ball shaft 27 which will again actuate the synchro transmitter 28. The synchro transmitter will then impart a different feedback signal to the control transformer 31 causing an unbalancing of the input and feedback signals thereto. The servo motor 18 and pump 17 will therefore be operated until the input and the feedback signals to the control transformer are again in balance at which time the cylinders 8 and 14 will again be back in correct set position. It will therefore be seen that the drive mechanism will always be automatically maintained in correct set position regardless of any downward drifting thereof due to leakage of operating fluid.

In some installations the automatic control is not essential, in which case the operation of the servo motor 18 may be controlled by a suitable manually operated switch; and the synchro transmitter 28 utilized to effect the operation of an indicating mechanism by which the position of the cylinders 8 and 14 with respect to the piston 6 is visually indicated.

From the foregoing it will be apparent to those skilled in this art that I have provided a very simple and efficient hydraulic drive mechanism, and control means therefor, by which the objects of the invention are accomplished.

It is to be understood that I am not limited to the specific construction shown and described herein, as various modifications may be made therein within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A hydraulic drive mechanism of the character described comprising a vertically disposed tubular piston rod having an open lower end, means by which the upper end of said piston rod is adapted to be rigidly secured to a fixed support, a piston having a fluid passageway therethrough rigidly secured to said piston rod about the open lower end thereof, an inner cylinder reciprocally mounted on said piston, said inner cylinder being provided with an imperforate lower cylinder head and an apertured upper cylinder head through which said piston rod extends, said piston dividing said inner cylinder into upper and lower expansible chambers, an outer cylinder coaxially mounted about said inner cylinder with the lower end thereof secured to said lower cylinder head and the inner wall thereof spaced from the outer wall of said inner cylinder thereby providing an annular chamber between said inner cylinder and said outer cylinder, a communicating passageway between said lower chamber and said annular chamber, said lower chamber and said annular chamber providing a self-contained fluid sump from which operating fluid is adapted to be pumped into and out of said

6

upper chamber, a reversible pump secured to the lower face of said piston within said lower chamber and connected to said fluid passageway, said pump being operative to pump operating fluid into and out of said upper chamber to thereby raise and lower said cylinders with respect to said piston, a rotatable pump operating shaft connected to said pump and extending up through said tubular piston rod, and power means mounted in fixed position above said drive mechanism by which said shaft is rotated.

2. A hydraulic drive mechanism as defined in claim 1 in which a control mechanism is provided which is operative to control the operation of said power means in accordance with an input signal imparted to said control mechanism.

3. A hydraulic drive mechanism as defined in claim 2 in which said control mechanism is also operative to automatically effect the return of said cylinders to set position in the event of any downward drifting of said cylinders due to the leakage of operating fluid from said upper chamber.

4. A hydraulic drive mechanism as defined in claim 3 in which said control mechanism includes: a tube which is rigidly secured to said lower cylinder head and extends upwardly into said tubular piston rod, a ball nut rigidly secured to the upper end of said tube, a ball shaft rotatably mounted in fixed position above said tubular piston rod and extending downwardly therefrom through said ball nut into said tube, whereby reciprocation of said tube and ball nut with said cylinders imparts rotation to said ball shaft.

5. A hydraulic drive mechanism as defined in claim 1 having means incorporated therein which is rendered operative by the movement of said cylinders to effect the operation of an indicating mechanism.

6. A hydraulic drive mechanism as defined in claim 5, in which said means comprises a tube rigidly secured to said lower cylinder head and extending upwardly therefrom, a ball nut rigidly secured to the upper end of said tube, and a ball shaft rotatably mounted in fixed position above said tubular piston rod and extending downwardly therefrom through said ball nut into said tube, whereby reciprocation of said tube and ball nut in unison with said cylinders imparts rotation to said ball shaft.

7. A hydraulic drive mechanism as defined in claim 1 in which; a tube is rigidly secured to said lower cylinder head and extends up into said tubular piston, a ball nut rigidly secured to the upper end of said tube, a ball shaft rotatably mounted in fixed position above said tubular piston rod and extending downwardly therefrom through said ball nut into said tube, whereby reciprocation of said tube and ball nut with said cylinders imparts rotation to said ball shaft, and a control mechanism by which the operation of said power means is controlled in accordance with an input signal imparted to said control mechanism, said ball shaft being operatively connected to said control mechanism and operative when rotated to control the operation of said control mechanism.

8. A hydraulic drive mechanism of the character described comprising a vertically disposed tubular piston rod having an open lower end, means by which the upper end of said piston rod is adapted to be rigidly secured to a fixed support, a piston having a fluid passageway therethrough rigidly secured to said piston rod about the open lower end thereof, an inner cylinder reciprocally mounted on said piston, said inner cylinder being provided with an imperforate lower cylinder head and an apertured upper cylinder head through which said piston rod extends, said piston dividing said inner cylinder into upper and lower expansible chambers, an outer cylinder coaxially mounted about said inner cylinder with the lower end thereof secured to said lower cylinder head and the inner wall thereof spaced from the outer wall of said inner cylinder thereby providing an annular chamber between said inner cylinder and said outer cylinder, a communicating passageway between said lower chamber and said

annular chamber, said lower chamber and said annular chamber providing a self-contained fluid sump from which operating fluid is adapted to be pumped into and out of said upper chamber, a reversible pump secured to the lower face of said piston within said lower chamber and connected to said fluid passageway, said pump being operative to pump operating fluid into and out of said upper chamber to thereby raise and lower said cylinders with respect to said piston, a rotatable pump operating shaft connected to said pump and extending up through said tubular piston rod, a tube rigidly secured to said lower cylinder head and extending upwardly therefrom into said tubular piston rod, a ball nut rigidly secured to the upper end of said tube, a ball shaft rotatably mounted above said piston rod and extending downwardly therefrom through said ball nut into said tube, whereby reciprocation of said tube and ball nut in unison with said cylinders imparts rotation to said ball shaft, and operating and control mechanism by which said pump operating shaft is rotated in accordance with an input signal imparted to said control mechanism, said operating and control mechanism comprising; a control transformer adapted to have an input signal mechanically imparted thereto and

a feedback signal electrically imparted thereto to produce an electrical output, an amplifier to which the output of said control transformer is imparted, a servo motor which is operatively connected to the upper end of said pump operating shaft and is adapted to be energized by the output of said amplifier, and a synchro transmitter which is operatively connected to said ball shaft and is operative when actuated by said ball shaft to impart an electrical feedback signal to said control transformer, the arrangement being such that when the feedback signal balances the input signal the output of the control transformer will be zero.

References Cited in the file of this patent

UNITED STATES PATENTS

1,836,813	Rankin	Dec. 15, 1931
1,948,951	Walker	Feb. 27, 1934
2,049,335	Stephens	July 28, 1936
2,127,961	Ray	Aug. 23, 1938
2,676,571	Parsons	Apr. 27, 1954

FOREIGN PATENTS

544,066	France	June 14, 1922
---------	--------	---------------