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GATE VALVE ACTUATOR

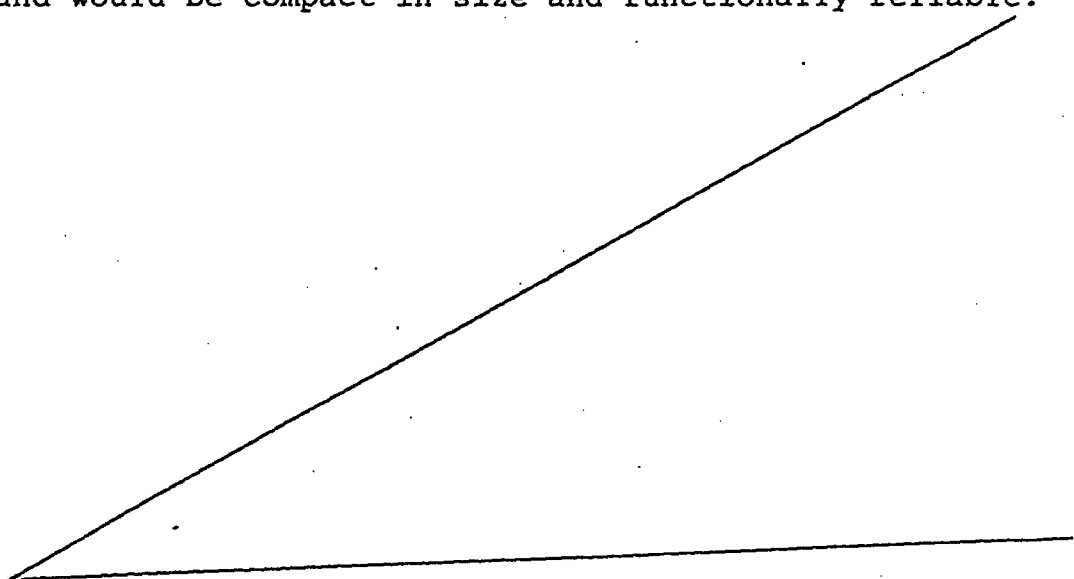
This invention relates to gate valve actuators, and more particularly to hydraulically operated actuators for subsea well gate valves.

For some time the oil and gas industry has required
5 hydraulic actuators for operating gate valves on subsea well christmas trees, pipe manifolds, and other under-water well apparatus, and such actuators of various designs are in widespread use for this purpose. Preferably, an actuator for this type of service would be capable of
10 manual operation in the event of hydraulic power failure, would have provision for external adjustment to compensate for valve gate drift, could be manually operated and adjusted with readily available tools and minimal effort, and would be compact in size and functionally reliable.

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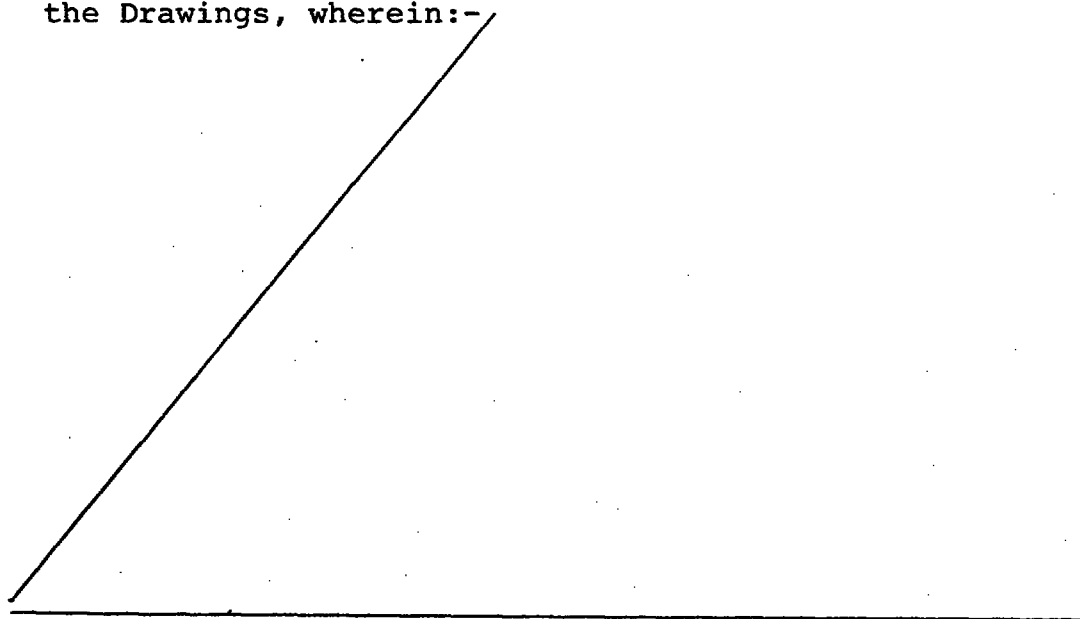


According to the present invention, a hydraulic
powered actuator for a sliding gate valve comprises,
a housing, means for attaching the housing to the
bonnet of a sliding gate valve, a hydraulic cylinder
within and attached to the housing, an actuator
5 stem extending through the housing, a piston within
the cylinder for moving the actuator stem axially
in response to hydraulic pressure, means to connect
the actuator stem to the stem of the sliding gate
10 valve, and externally accessible valve gate drift
adjustment means for adjusting the drift of the
valve gate.

The above and further features of the present
invention are illustrated, by way of example, in
15 the Drawings, wherein:-

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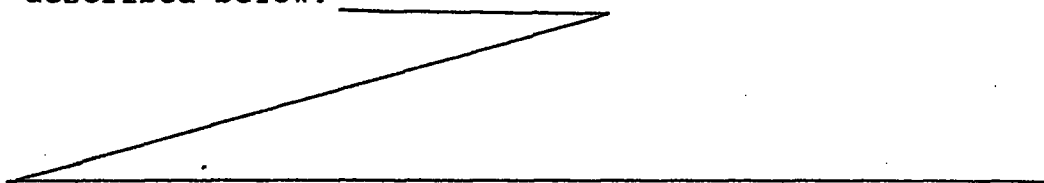
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Figure 1 is a diagrammatic side elevation of a subsea well completion system, showing valve actuators incorporating the present invention in functional position on gate valves of a subsea christmas tree; and,

5 Figure 2 is a central longitudinal section, on an enlarged scale, of a valve actuator that includes the features of the present invention.

As diagrammatically represented in Figure 1, valve actuators 8 embodying the present invention are especially
10 suitable for use on subsea well completion apparatus 10 to open and close gate valves 12 located in the christmas tree 14 that is mounted on the subsea wellhead assembly 16.

The illustrated wellhead assembly 16 typically includes a wellhead housing 18, a tree connector 20 securing the
15 tree 14 to the housing 18, and a permanent guide base 22 surrounding and secured to the housing 18 and associated wellhead components 24 by support struts 26. The actuators 8 are operated by hydraulic pressure conducted from a suitable source (not shown), through hydraulic lines
20 (not shown), and the pressure is applied to the actuator pistons through internal passages in the actuator as described below.



Referring to Figure 2, the preferred embodiment of the present invention is illustrated in one of the valve actuators 8 that is shown attached to the bonnet 30 of one of the gate valves 12 by a plurality of screws 31. The
5 actuator 8 broadly comprises a housing 32 secured to a main body 34 by threads 36, a flange body 38 connected to the main body 34 by a flange body collar 40, a stem assembly 41 comprising an outer or manual override stem 42 and an inner or actuation cylinder stem 44, a sleeve-type hydraulic
10 cylinder 46 secured by threads 48 to the main body 34, a cylinder cap 50 secured by threads 52 and a set screw 53 to the cylinder 46, a piston 54 mounted on the inner stem 44 within the cylinder 46, and a piston-return coil spring 56 surrounding the cylinder 46 and extending between the main
15 body 34 and a spring compression hub 58 that surrounds the outer stem 42.

The outer end of the housing 32; i.e., the right-hand end as viewed in Fig. 2, has a central opening into which is threaded a packing gland 60, and threaded onto the
20 outer end of the packing gland is an end cap 62 with a central opening 62a. The outer stem 42 extends through the packing gland 60 and into the end cap 62, preferably terminating within the central opening 62a when the stem is in its
"valve closed" position shown in Fig. 2. Between a radial
25 flange 60a of the packing gland 60 and the adjacent end face of the actuator housing 30 is a spacer ring 63 that is
• removed to facilitate further threading of the gland into the housing to provide a stop for the actuator stem, as will be more fully explained later. An annular static seal 64

provides fluid-tight integrity between the gland 60 and the housing 32, and annular dynamic seals 66 provide a fluid barrier between the gland and the actuator's outer stem 42.

The outer stem 42 has a radially enlarged area or
5 flange 42a located within a central bore 58a of the hub 58, and a pair of bearing assemblies 68, 70, located on opposite sides of the flange 42a, provide relative rotation support between the stem 42 and the hub 58. A retainer ring 72 holds the bearing assembly 70 in position against the stem,
10 flange 42a.

The outer stem 42 is connected to the inner stem 44 by means of a stem adjustment screw 74 that is secured to the end of the inner stem by a cap screw 76. The inner end of the stem adjustment screw 74 has a central transverse
15 tongue 74a that cooperates with a mating groove 44a in the adjacent end of the inner stem 44 to prevent relative rotation between the screw 74 and the stem 44 when properly assembled as shown. The adjustment screw 74 and the adjacent portion of the inner stem 44 reside in a central threaded bore 42b
20 in the outer stem 42, and external threads on the screw 74 cooperate with the threads in the bore 42b to axially change the location of the screw in the bore, and thus the axial position of the inner stem 44 with respect to the outer stem 42, when the outer stem is rotated with respect to the inner
25 stem.

The outer stem 42 extends through a central bore in the cylinder cap 50 and is sealed in a fluid-tight manner thereto by annular dynamic seals 78. Between the inner end of the outer stem 42 and the piston 54 is an annular bushing

80 to prevent galling of the adjacent piston face by the stem 42 when the stem is rotated with respect to the inner stem 44 into the position shown in Fig. 2. When in that position the outer stem 42 holds the piston 54 against an annular shoulder 44b on the inner stem 44, and when the actuator is operated by hydraulic pressure the piston 54, inner stem 44 and outer stem 42 translate in unison. Annular seals 82 assure a fluid-tight barrier between the piston and the inner stem.

10 When the actuator 8 is functionally connected to a gate valve the actuator's inner stem 44 is connected to the valve's bonnet stem 84 by suitable means such as the T-slot arrangement shown in Fig. 2, so that when the actuator is operated the stems 44, 84 translate in unison. The other
15 end portion of the valve bonnet stem 84 includes an annular beveled shoulder 84a that cooperates with an annular beveled backseat surface 30a on the valve bonnet 30 to establish a metal-to-metal seal between the stem 84 and the bonnet when the valve is closed as shown in Fig. 2. An annular packing
20 86, held in place in the bonnet 30 by a packing retainer nut 88, provides a dynamic seal between the bonnet and the bonnet stem 84, and annular dynamic seals 90 provide a fluid-tight barrier between the stem 84 and the packing nut 88. The packing nut 88 is sealed to the bonnet 30 by an
25 annular seal element 92, and an annular seal 94 provides fluid-tight integrity between the bonnet and the actuator main body 34.

Hydraulic Operation

The valve actuator 8 is designed for hydraulic

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operation but is provided with manual override capability when required. When operated hydraulically, control pressure is introduced through one or more ports 96 (only one shown) and conducted by an annular manifold 98 to and through a
5 plurality of circumferentially spaced longitudinal passageways 100 in the wall of the cylinder 46 into an annular chamber 102 between the piston 54 and the cylinder cap 50. Annular seals 104 between the piston and the cylinder and 106 between the cylinder cap and the cylinder cooperate with the seals
10 78, 82 to confine actuation control pressure to the chamber 102, whereby in response to this pressure the piston, the actuator stem assembly 41 and the valve bonnet stem 84 translate in unison to the left as viewed in Fig. 2, unseating the bonnet stem shoulder 84a from the bonnet backseat 30a
15 and translating the valve gate (not shown) into its open position.

Pressure compensation for the actuator 8 to ease its operation at deep sea depths is provided by an external compensator (not shown) that is functionally connected to
20 one or more ports 108 (only one shown) in the actuator main body 34. Compensated oil pressure entering port 108 is conducted by a passageway 110 into an annular chamber 112 in the cylinder 46 and in front of the piston 54, and also by a passageway 114 into the spring housing 32. This pressure
25 compensation precludes external hydrostatic pressure from crushing the housing 32 and rendering the actuator inoperable.

The actuator spring 56 functions to automatically close the valve whenever control pressure is lost or removed from the backside of the piston 54. The spring 56 provides

a force sufficient to rapidly overcome the hydrostatic head of the control pressure column situated above the water surface; i.e., platform control room height above the water. Since the above-described pressure compensation system
5 eliminates the effect of the ambient water pressure on the actuator, which pressure can be very great depending upon the depth at which the actuator is located, the size of the spring 56 required to close the valve is substantially less than if such pressure compensation were absent.

10 When the actuator is hydraulically operated by control pressure command the outer stem 42 is moved from its "valve closed" position towards the valve bonnet 30, carrying with it the spring compression hub 58 and the bearing assemblies 68, 70. This movement of the hub 58 compresses the actuator
15 spring 56 which remains compressed as long as the valve remains open. This movement of the outer stem 42 also results in relocation of the stem's outer end face 42c, so that the position of the stem, and thus the position of the valve gate, can be manually ascertained from the outside of
20 the actuator through the end cap opening 62a.

Manual Override Operation

The present invention provides manual override operation of the valve operator 8, even under valve operating pressure or hydraulic system control pressure, by removing
25 the end cap 62, installing a wheel crank 116 (Fig. 1) on the outer stem 42, and then rotating the stem. As the stem 42 rotates the stem adjustment screw 74 is forced to the left (Fig. 2); i.e., towards the valve bonnet 30, thereby translating the inner stem 44, the bonnet stem 84, and the valve gate

(not shown) to the left to open the valve. During this valve opening rotation the operation resultant forces from the stems 44 and 84 and the valve gate are reacted through the bearing assembly 70 by the stem 42, and the bearing assembly 70 is reacted by the packing gland 60.

It should be noted that the manual override feature of the present invention enables the stems 44 and 84, and of course, also the valve gate, to translate without exercising the piston 54, the spring 56 or the spring compression hub 58. Because of this, significantly less torque is required to manually open the valve, and thus an important advantage is achieved as compared with operation requiring spring compression.

When using the manual override to close the valve from its open position, the stem 42 is rotated by the wheel crank 116 in the opposite direction. This rotation causes the stem adjustment screw 74 to move to the right; i.e., towards the packing gland 60, thereby pulling the stems 44 and 84 and the valve gate in the same direction, and resulting in closing the valve. During this valve-closing rotation the operation resultant forces from the valve gate and the stems 84 and 44 are reacted through bearing assembly 68 by the stem 42. Also during this valve-closing the bearing assembly 68 is reacted by the spring compression hub 58, and the hub is reacted by the spring 56.

It should be noted that the retainer ring 72, which retains the bearing assembly 70 on the outer stem 42, is required for normal hydraulic operation of the actuator 8 when the stem 42, hub 58 and spring 56 cycle forward and aft

many times during normal actuation of a subsea valve by control pressure command.

External Adjustments

The present invention further provides for externally
5 adjusting the position of the valve gate to which the actuator
8 is connected.

External adjustment of valve gate drift is accomplished
by rotating the flange collar 40 either clockwise or counterclock-
wise. The collar 40 has two sets of internal threads 40a,
10 40b, one right-hand and the other left-hand, that engage
external threads on the flange body 38 and the main body 34.
Relative rotation of the bodies 38, 34 is prevented by an
anti-rotation key 118 that resides in opposed keyway slots
in the adjacent body surfaces. Accordingly, rotation of the
15 collar 40 either draws the main body 34 and the housing 32
towards the flange body 38 or forces them away from the body
38, thereby changing the position of the bonnet stem 84 and
the actuator's inner stem 44 with respect to the actuator
cylinder 46, and thus changing the drift; i.e., the valve
20 gate position with respect to the valve body/bonnet/ actuator
assembly.

External stop adjustment for the stems 42, 44, 84
and the valve gate is accomplished by rotation of the packing
gland 60. Thus, if it is desired to stop closing movement
25 of these stems and the gate before the stem shoulder 84a
backseats on the bonnet surface 30a, the frangible spacer
ring 63 is knocked out and the gland 60 is threaded further
into the housing 32 until its axial position stops the
movement at the desired point.

The ability to achieve these two adjustments from outside the actuator offers significant cost savings in assembly adjustment, both in the shop and in the field, as well as adjustment when in a subsea location.

5 Valve Gate Position Indication

As discussed above, the present invention facilitates determination of the position of the valve gate by viewing or feeling/measuring the relative position of the outer stem 42 to the end cap 62. A fully extended stem indicates the valve gate is closed, and of course a fully retracted stem indicates the valve gate is in its open position.

The invention also envisions determination of the valve gate position by electrical means, such as by an external electrical sensor (not shown) mounted on the end cap 62. Using a permanently magnetized stem 42, the proper sensor can determine the presence (valve closed position) of the stem or the non-presence (valve open position) thereof, and send an appropriate signal to the control room on the surface platform (not shown).

It should further be noted that although the above-described valve actuator is intended for use on gate valves on subsea well completion christmas trees and/or manifolds, the actuator also has utility on shore where remote operation of gate valves is required. Thus the adjustment features described above offer an economic advantage where valve adjustments are required in the field, either on land or subsea.

Although the best mode contemplated for carrying out the present invention has been herein shown and described,

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it will be apparent that modification and variation may be made without departing from what is regarded to be the subject matter of the invention as set forth in the Claims.

CLAIMS:

1. A hydraulic powered actuator for a sliding gate valve, the actuator comprising:-

- a) a housing;
- b) means for attaching the housing to the bonnet of a sliding gate valve;
- c) a hydraulic cylinder within and attached to the housing;
- d) an actuator stem extending through the housing;
- e) a piston within the cylinder for moving the actuator stem axially in response to hydraulic pressure;
- f) means to connect the actuator stem to the stem of the sliding gate valve; and,
- g) externally accessible valve gate drift adjustment means for adjusting the drift of the valve gate.

2. An actuator according to claim 1 wherein the means for attaching the housing to a valve bonnet comprises a main body connected to the housing and a flange body for attachment to the valve bonnet, the main body and the flange body being interconnected by the valve gate drift adjustment means.

3. An actuator according to claim 2 wherein the position of the main body relative to the flange body can be adjusted axially by the valve gate drift adjustment means.



4. An actuator according to claim 2 or claim 3 wherein the valve gate drift adjustment means comprises a collar threaded to the main body and the flange body, and wherein rotation of the collar with respect to the main and flange bodies causes relative axial movement of the bodies.
5. An actuator according to claim 4 and including a differential thread system between the collar and the main and flange bodies.
6. An actuator according to any of claims 2 to 5 and including means for preventing relative rotation between the main body and the flange body.
7. An actuator according to any of the preceding claims wherein the actuator stem comprises an assembly including an outer stem element, an inner stem element and stem adjustment means for adjustably connecting the outer and inner stem elements.
8. An actuator according to claim 7 wherein the stem adjustment means facilitates axial adjustment of the relative positions of the outer and inner stem elements.
9. An actuator according to claim 7 or claim 8 wherein the stem adjustment means comprises an adjustment screw secured to one of the stem elements and threadedly engaging the other stem element, whereby rotation of one



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element with respect to the other element changes the relative axial position of the two elements.

10. An actuator according to any of claims 1 to 9 wherein the actuator stem includes manual override means for manually operating the actuator without advancing the piston.

11. An actuator according to claim 10 and including means for biasing the piston and the actuator stem in one axial direction, and wherein the manual override means functions without exercising said biasing means..

12. An actuator according to claim 11 wherein the biasing means comprises a coil spring enclosed within the housing.

13. A hydraulic powered actuator for a sliding gate valve substantially as described and as shown by the Drawings.

