United States Patent

[11] 3,599,711

[72] Inventor **John H. Fowler**
Glenshaw, Pa.

[21] Appl. No. **839,253**
[22] Filed **July 7, 1969**
[45] Patented **Aug. 17, 1971**

[73] Assignee **Rockwell Manufacturing Co.**
Houston, Tex.

[54] **DIVERTER**
24 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **166/.5,**
166/75, 137/612
[51] **Int. Cl.** **F21b33/035,**
F21b 33/02
[50] **Field of Search** ..... 166/75, .5,
95, 91, 224; 137/612, 625.66; 243/29

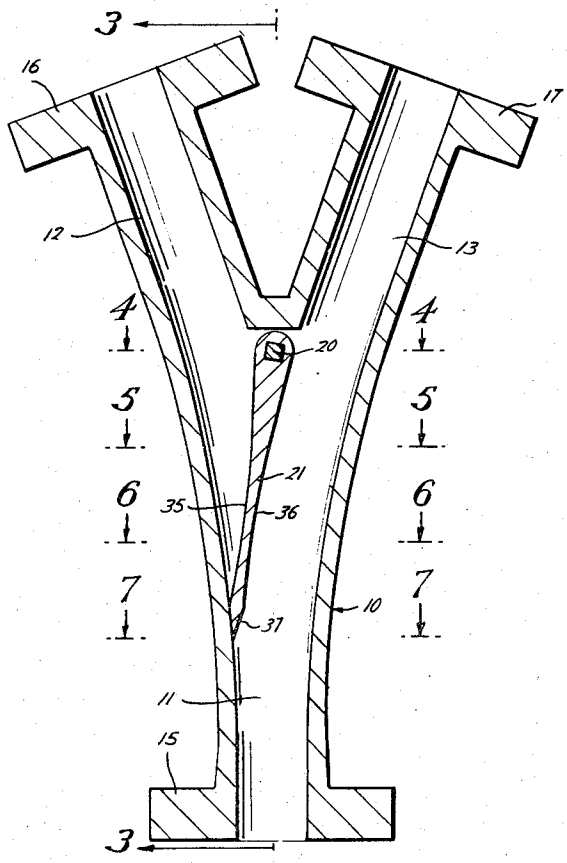
[56] **References Cited**

UNITED STATES PATENTS

1,708,380	4/1929	Deacon	137/612
3,075,539	1/1963	Yoder	251/58
3,139,932	7/1964	Johnson	166/224
3,472,317	10/1969	Fowler	166/75

Primary Examiner—James A. Leppink
Attorneys—Murray Robinson and Ned L. Conley

ABSTRACT: In an underwater well for the production of petroleum, a tool diverter comprising: a wye-branched conduit having a master section and at least two diverging branch sections, a movable blocking member mounted at the confluence of the branch sections, and a remotely operable actuator for selectively positioning the blocking member to block passage of tools into one of the branches. The blocking member may be connected to a rotatable shaft for pivoting movement thereon. At least one fluid-operated piston may be mounted in a cylinder for movement perpendicular to the shaft and engageable with a mechanism connected to the shaft to translate reciprocal movement of the piston to rotational movement of the shaft. In a preferred embodiment of the invention the branch sections of the wye conduit may be symmetrical with respect to the master sections. The blocking member may be a depending flapper the free end of which is movable from one wall of the master section to an opposite wall, each face of the flapper being symmetrically curved to provide a substantially continuous curving wall between the master section and the branch section which is not being blocked.

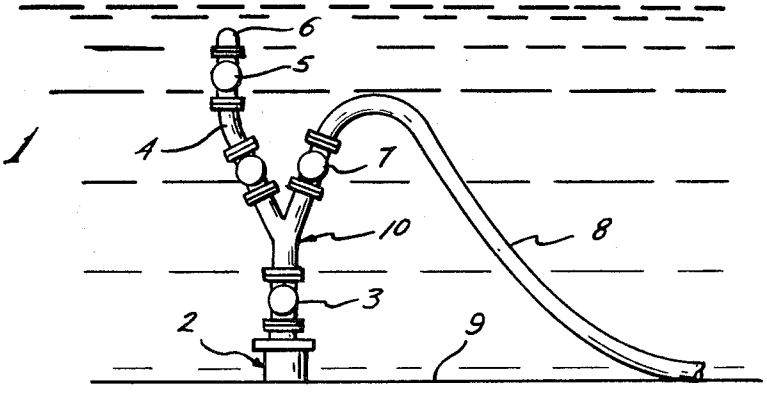


PATENTED AUG 17 1971

3,599,711

SHEET 1 OF 3

Fig. 1



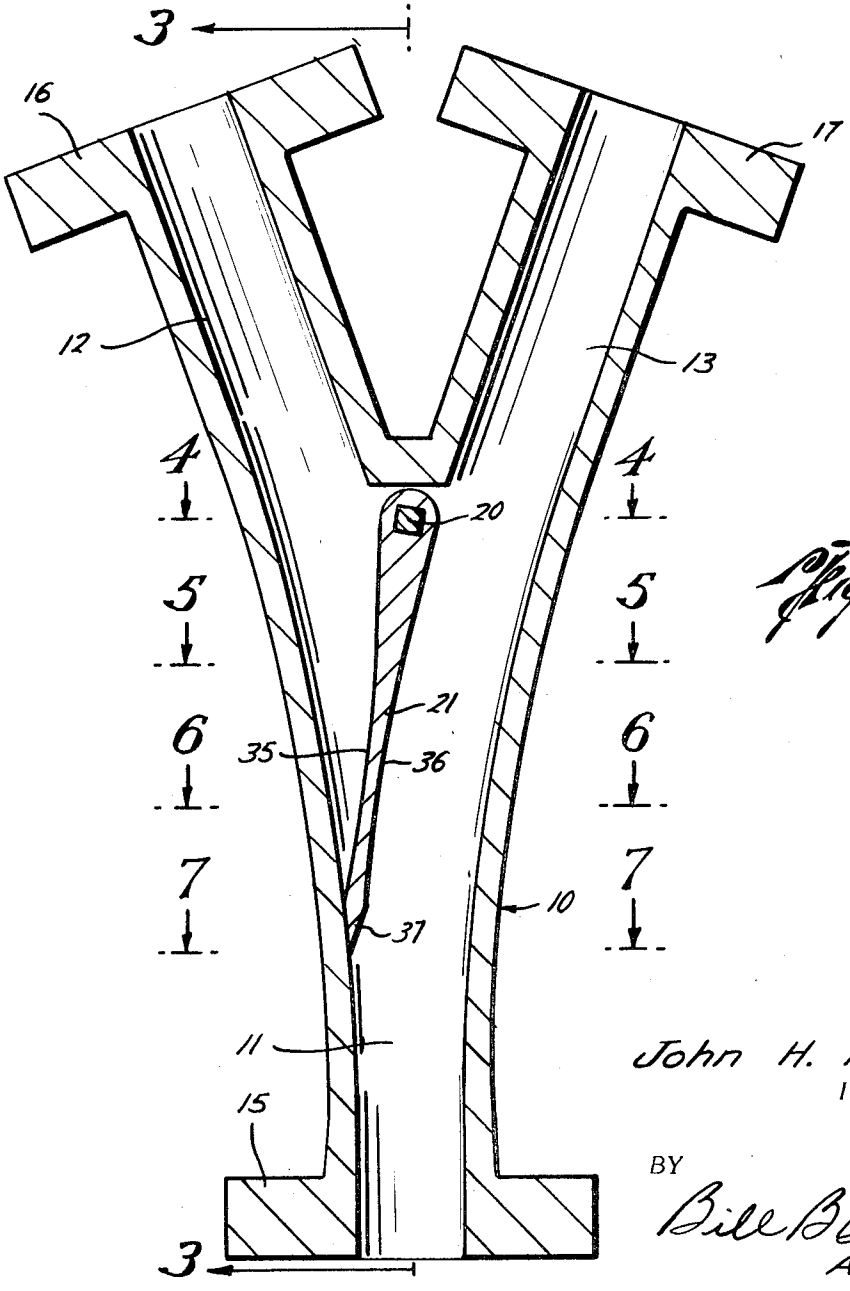


Fig. 2

John H. Fowler
INVENTOR.

BY
Bill B Berryhill
ATTORNEY

Fig. 3

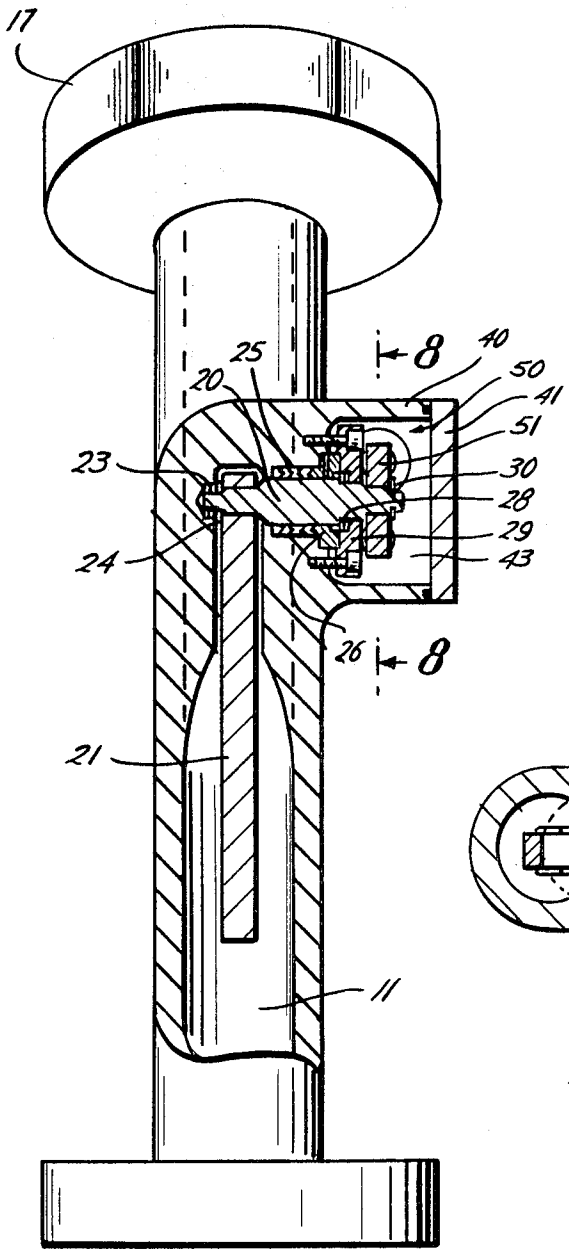


Fig. 4

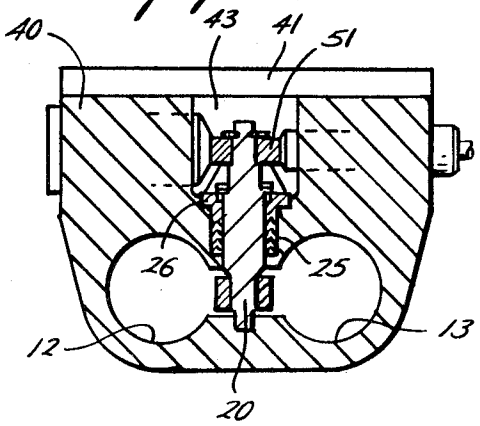


Fig. 5

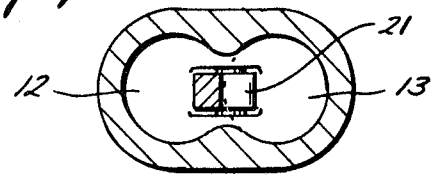


Fig. 6

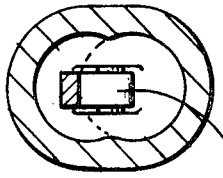
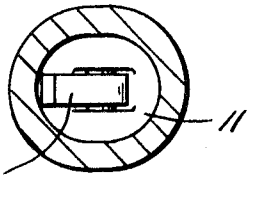


Fig. 7



John H. Fowler
INVENTOR.

BY Bill B Berryhill
ATTORNEY

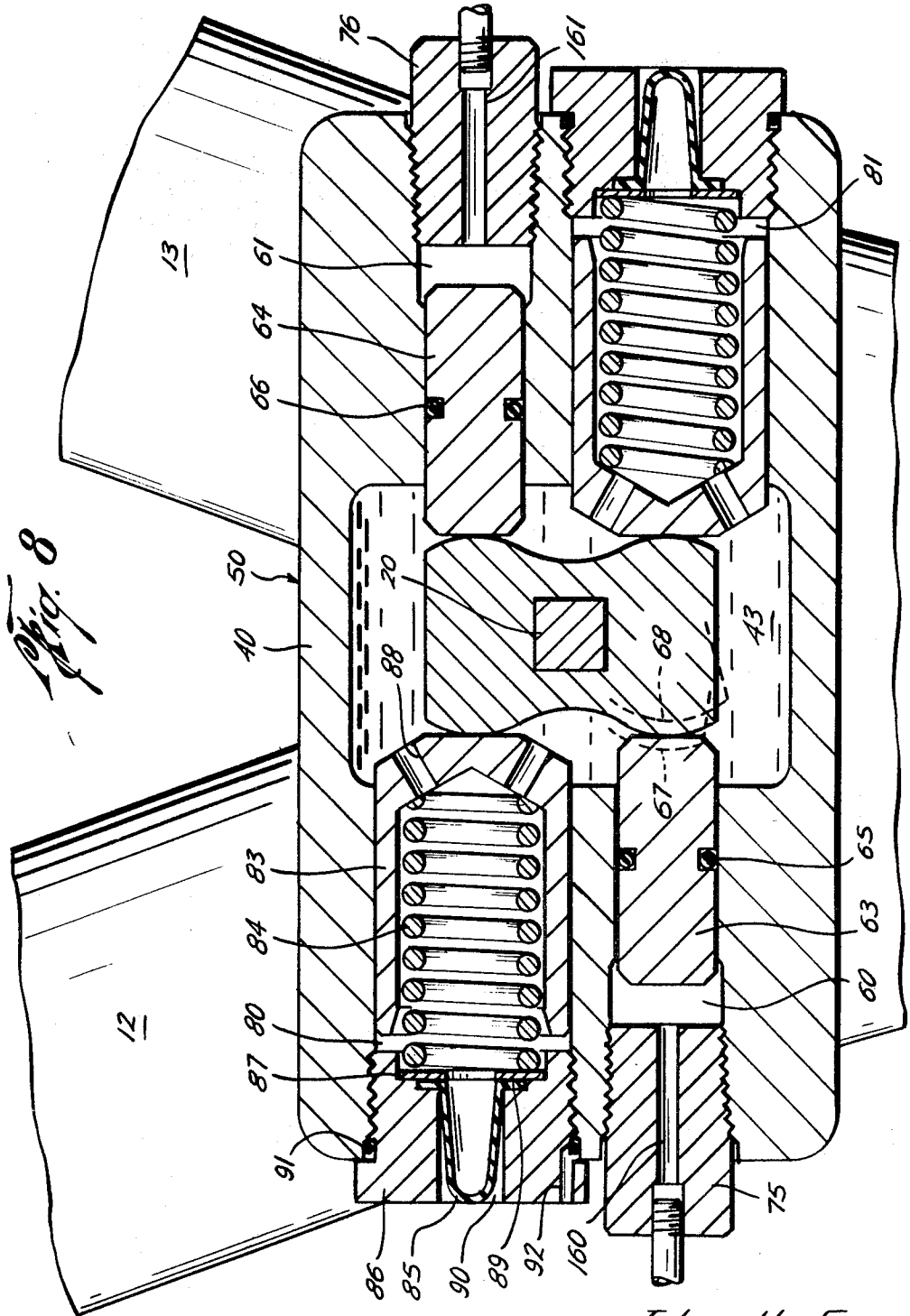


Fig. 8

John H. Fowler
INVENTOR.

BY
Bill B. Berryhill
ATTORNEY

DIVERTER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is concerned with conduit diverters. More specifically, it concerns an improved flapper-type diverter suitable for directing the passage of tools into and out of diverse conduit branches of the diverter and the production tubing string of an underwater well.

2. Description of the Prior Art

In the production of petroleum from underground deposits, it is often desirable for single conduits to branch into plural conduits. This is the case with the tubing string of most underwater wells. Usually a "wye" conduit, having a master section and two branch sections, is connected at the upper end of the tubing. One of the branches is connected to an underwater flowline, the other provides vertical access for workover operations or the like, the master section being connected to the tubing.

Underwater completions have created special problems in installing and removing downhole internally mounted production tools. The most practical method of installing or removing tools in an underwater well is to pump them into and out of the tubing through the flowline from a remote stationary surface location. A line of through-flowline tools has been developed for such a use. Otis Engineering Corporation of Dallas, Texas and Udell Garrett, Inc. of Houston, Texas both manufacture a line of these through-flowline tools which are known to the industry. However, during workover operations it may be required to pump tools into and out of a well tubing through the vertical access or "swab" branch of the "wye" conduit at the upper end of the well tubing, while blocking the flowline branch. In the past, direction of tool passage has been accomplished by deflection plugs, which are lowered on a wire line into one of the branches, thereby blocking passage into that branch, usually the vertical access extension. However, when it is desired to divert through-flowline tools into the vertical access branch, special tools are required to remove the deflection plug. Removing the deflection plug creates extra downtime, requires more equipment and increases the expense.

More recently other methods of through-flowline diversion have been developed to eliminate some of the objections to the diverter plug. Various conduit and tool designs, such as shown in U.S. Pats. Nos. 3,354,961 and 3,357,491, have been proposed. However, one of the most promising methods is the use of a "paddle"- or "flapper"-type diverter, such as the one shown and described in my pending U.S. Pat. application Ser. No. 506,202, now U.S. Pat. No. 3,472,317.

The paddle or flapper of a diverter of this type is usually pivotally mounted at the confluence of "wye" conduit branches and is movable to alternately block one branch and allow passage through the other branch. One of the critical factors in a flapper-type diverter is its effective diameter and radius of curvature as seen by through-flowline tools. The transition from the master section bore to the branch section bores must be of such a radius as to allow the passage of the tools which usually comprise rigid sections connected by some type of swivel joint. This usually results in an enlarged bore area. If the length of such an area is too great, locomotive pressure may be lost, and if the area is too large, regardless of its length, some of the tools presently in use may release their latches, causing the tools to be prematurely latched into the "wye" conduit of the diverter.

Furthermore, in the flapper designs, presently known, which are hydraulically actuated, large bending stresses are created on linkages which translate reciprocating motion of an actuator to rotary or pivoting motion of the flapper. This requires special designs and results in relatively heavy and, consequently, unwieldy and expensive diverts.

The references cited against my aforementioned U.S. Pat. No. 3,472,317 are pertinent to the general subject of diverter valves and operators therefor and among these is U.S.S.R. Pat. No. 144,584 which discloses a diverter valve having symmetrical branches.

SUMMARY OF THE INVENTION

The present invention provides a new and improved "flapper"-type diverter with reduced bending stresses and effective through-flowline passage areas permitting the use of all types of through-flowline tools commonly used today. The flapper member is mounted at the junction of a "wye"-branched conduit on a rotating shaft for pivoting from one position to another. The shaft is provided with a cam member against which oppositely directed offset forces are applied through a pair of hydraulically activated pistons to produce a torque for positioning the flapper. A pair of spring-loaded return units also bear against the cam member for returning the flapper to its original position. In a preferred embodiment of the invention the wye conduit branch sections are symmetrical with respect to the master section. Among other things, this allows the flapper member to be designed to allow smooth curving passage of all presently available tools without excessive gaps or areas which might cause some tools to be unlatched. Other features of the invention pointed out in the claims can best be set forth in the description which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

For a detailed description of a preferred embodiment of the invention, reference will be made to the accompanying drawings, but this is only exemplary of the invention which can be varied by one skilled in the art. In the drawings:

FIG. 1 is a schematic representation of an underwater wellhead having a diverter according to one embodiment of the invention;

FIG. 2 is a vertical cross section of the diverter of FIG. 1;

FIG. 3 is a vertical cross section of the diverter of FIGS. 1 and 2 taken along the lines 3–3 of FIG. 2;

FIG. 4 is a horizontal cross section of the diverter taken along lines 4–4 of FIG. 2;

FIG. 5 is a little lower horizontal cross section of the diverter taken along lines 5–5 of FIG. 2;

FIG. 6 is a still lower horizontal cross section of the diverter taken along lines 6–6 of FIG. 2;

FIG. 7 is a still lower horizontal cross section of the diverter taken along lines 7–7 of FIG. 2 at the lower end of the flapper, and

FIG. 8 is a vertical cross section of the actuator portion of the diverter taken along lines 8–8 of FIG. 3 and enlarged for greater detail.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, FIG. 1 depicts an underwater well 2 at the top of which a master valve 3 is connected to the well tubing. A "wye" conduit tool diverter 10, according to the invention, is attached above master valve 3. One branch of the diverter 10 is connected to a conduit extension 4 to which a swab valve 5 is attached with a cap 6. By removing cap 6, vertical access is provided to the well tubing for overhead servicing and workover. The other branch of diverter 10 is connected to a wing valve 7 and underwater flowline 8, which may run along the ocean floor 9 to a remote production storage facility. As previously discussed, tool diverters, such as 10, are used to direct the passage of through-flowline tools into the proper conduit. For instance, it may be used to run tools into and out of the tubing through flowline 8. It may be used to direct tools into and out of the tubing through vertical access extension 4, if overhead servicing is being performed. Or, it may be used to allow entry into the well tubing from one branch of diverter 10 and exit through the other.

Referring now to FIGS. 2—8, diverter 10 will be described in detail. The diverter 10, includes a "wye" conduit having a master section 11 and divergent branch sections 12 and 13.

Connection flanges 15, 16, 17 are welded to master section 11 and branches 12, 13, respectively. Instead of flanges 16 and 17, a curved extension, similar to 4 in FIG. 1, may be welded to the branches 12 and 13 so that all connection flanges may be in a horizontal plane.

For directing tools through the selected branch of diverter 10, a flapper member 21 is pivotally mounted on a rotating stem 20 at the confluence of branches 12 and 13. The flapper illustrated in FIG. 3 has a uniform width. However, it may have other shapes, such as a boat paddle, to more closely conform to the bore of master section 11. As seen more clearly, in FIG. 2, each face 35, 36 of flapper 21 is symmetrically curved so as to provide a substantially continuous curving wall between master section 11 and the respective branches 12, 13. The flapper 21 is normally biased in one terminal position, such as shown in FIG. 2. Thus, through-flowline tools are permitted to enter into and exit from a well tubing through a flowline and its respective branch 13, for purposes of illustration. Shaft 20 is part of an actuator assembly which will be described in more detail hereafter. For the present, it is sufficient to note that the actuator rotates stem 20 and flapper 21 from the position shown in FIG. 2 to the opposite terminal position whereby tool passage is directed through branch 12, the vertical access or swab branch in our example.

The cross section views of FIGS. 4—7 show the effective passage areas as seen by through-flowline tools passing through the diverter when flapper 21 is in the position of FIG. 2. It is important that the areas be large enough to permit passage of the tools but small enough to prevent the unlatching devices of such tools from becoming unlatched at the diverter. This has been a critical problem in prior flapper-type diverters. In some of the prior art diverters, the end of the flapper or blocking member did not rest against the conduit walls. This created a gap between the flapper and conduit which was likely to unlatch tools passing therethrough. To eliminate this problem the blocking member was tapered on its end and adapted to abut the conduit walls. However, this resulted in an enlarged area between the tapered end and the opposite wall of the conduit due to the enlargement of the conduit bore to accommodate a certain radius of curvature from the master section to one of the branch sections. This problem could be solved by providing grooves in the wall of the conduit, to receive the end of the flapper member, and making the flapper longer to accommodate the necessary radius of curvature. However, elimination of this problem created another in that, the grooves were susceptible to being filled up with paraffin, sand and other materials, capable of preventing the flapper from seating properly in the groove.

The combined flapper and "wye" conduit of the present invention has eliminated these problems. By making the "wye" a symmetrical one and properly designing flapper 21, the effective passage area as seen by through-flowline tools is substantially reduced without the necessity of grooves in the walls. As previously stated, each face 35, 36 of flapper 21 is curved so as to provide a generally continuous curved passage from master section 11 to either of the branch sections 12, 13, depending on the position of flapper 21. The end 37 of flapper 21 is tapered on each side so as to abut the respective conduit section wall.

As seen in FIGS. 3 and 4, and in much more detail in the enlarged section of FIG. 8, an actuator assembly, generally designated 50, is connected through stem 20 to flapper 21 for positioning thereof. A housing 40, which may be a part of the "wye" conduit body itself, with a cover plate 41 encloses the actuator assembly for protection against the underwater environment. The cavity 43 may be filled with oil to prevent sea water leakage thereinto. Stem 20 is mounted at one end in a thrust bearing 23 which may be sealed against well fluid by seal member 24. Stem 20 is surrounded by chevron packing 25 and packing gland 26. Holding packing gland 26 in place and supporting another thrust bearing 28 is retainer plate 29 which may be fastened to the "wye" body by any suitable means such as screws. Keyed to the opposite end of stem 20 is a cam member 51, to be more fully described hereafter. Cam member 51 is rigidly retained on the end of stem 20 by a washer and retainer ring assembly 30.

Now referring primarily to FIG. 8, actuator assembly 50 will be described in detail. The purpose of actuator assembly 50, of course, is to rotate stem 20 for positioning of flapper 21. To accomplish this, a unique balanced hydraulic piston and spring return arrangement is provided which eliminates bending stresses normally present in actuators of the prior art. Housing 40 is tranversely bored to provide a pair of piston cylinders 60, 61 and a pair of spring return cylinders 80, 81.

A pair of pistons 63, 64 are disposed in cylinders 60, 61 for sliding and sealing engagement therewith. Cylinders 60, 61 are closed at their outer ends by plugs 75, 76 which permit removal of pistons 63, 64. A remote pressure source is connected to cylinders 60, 61 through ports therein. For illustration, these ports 160, 161 are shown in the ends of plugs 75 and 76. When pressure is applied to pistons 63 and 64, they transmit oppositely directed parallel forces, a couple, against cam member 51 creating a torque about stem 20 without including any bending stresses. The torque about stem 20 causes flapper 21 to move from a first terminal position, such as shown in FIG. 2, to a second terminal position whereby branch 13 is blocked and branch 12 is opened into master section 11. In this movement cam member 51 will move from the first terminal position indicated by dotted lines 67 to the neutral position shown, and finally to the second terminal position indicated by dotted lines 68.

Mounted in cylinders 80, 81 are a pair of identical spring return units comprising, with reference to one unit only, a spring return piston 83, a helical spring 84, a nipplelike diaphragm 85, a retainer gland 86, and retainer ring 87. These spring return pistons 83 are slidingly and nonsealingly disposed in their respective cylinders. Holes 88 provide communication between housing cavity 43 and cylinder 80 so that no fluid volume is displaced by the movement of spring return piston 83. Spring 84 is mounted in the hollow interior of spring return piston 83 and bears against its head at one end and against retainer ring 87 at the other end. Retainer ring 87 holds the lip or brim 89 of diaphragm 85 within a recess provided therefor in gland 86. Gland 86 is in turn screwed into housing 50 to allow removal of the entire spring return unit. Gland 86 is provided with a cylindrical aperture 90 in which the nipple end of diaphragm 85 is disposed. A seal ring 91 is provided between gland 85 and its connection with cylinder 80. This seal 91 may be of a type which prevents leakage into cylinder 80 but permits leakage out of cylinder 80 through vent hole 92 is the pressure exceeds a certain amount. This is a safety feature which allows pressure relief should too much pressure fluid leak past piston seals 65, 66 into cavity 43. Normally the spring return units bias cam member 51 to the position indicated by dotted lines 67, so that flapper 21 appears as in FIG. 2.

When pressure is applied to cylinders 60, 61 causing pistons 63, 64 to move cam member 51 and rotate stem 20, spring return pistons 83 are reciprocated in the opposite direction and a certain amount of fluid is displaced by the pistons 63, 64. Since spring return pistons 83 do not displace any volume of fluid a return reservoir would have to be provided, except for diaphragm 85. Diaphragm 85 being a resilient material, such as rubber, expands within aperture 90 to accommodate the fluid displacement. Also, spring 84 is compressed during this movement. Now to return the actuator and, consequently, flapper 21 to their initial positions, the pressure in cylinders 60, 61 is relieved, allowing compressed springs 84 to expand, forcing spring return pistons 83, cam member 51 and pistons 63, 64 to their initial positions and allowing diaphragm 85 to contract, returning the fluid in cavity 43 to its initial state, ready for another cycle. In this particular embodiment, flapper 21 acts as the stop for actuator 50. The actuator assembly 50 could be designed with its own stop.

Thus, a unique symmetrical diverter has been shown with an equally unique remotely operated actuator. The combined

symmetrical shape of the flapper and "wye" conduit provides a smooth, uniformly curving path through either branch of the "wye" without excessive gaps which might prematurely unlatch tools passing therethrough. The actuator design is compact, efficient and eliminates bending stresses present in other flapper-type actuators. All in all the present invention offers a diverter having an ideal combination of features which promises to be enthusiastically accepted by the petroleum industry.

I claim:

1. In an underwater well or manifold for the production of petroleum, a tool diverter comprising: a wye-branched conduit having a master section and at least two diverging branch sections; a movable blocking means mounted at the confluence of said branch sections; and remotely operable actuator means for selectively positioning said blocking means to block passage of tools into one of said branches; characterized in that said actuator means comprises: rotatable shaft means extending through an aperture in said conduit and through seal means provided therearound and connected to said blocking means for movement thereof; and means for exerting oppositely directed nonaligned forces creating a couple about said shaft including a pair of equal-size fluid-operated pistons mounted in and extendable in opposite directions from a pair of cylinders disposed perpendicular to the axis of said shaft; said cylinders being coplanar and parallel to each other and equidistant from said shaft on opposite sides thereof; and a mechanism connected to said shaft and engageable with said pistons to translate reciprocal motion of said pistons to rotational movement of said shaft.

2. In an underwater well or manifold for the production of petroleum, a tool diverter comprising: a wye-branched conduit having a master section and at least two diverging branch sections; a movable blocking means mounted at the confluence of said branch sections; and remotely operable actuator means for selectively positioning said blocking means between a first position and a second position to alternately block passage of tools into one of said branches while allowing passage through the other; characterized in that said actuator means comprises: rotatable shaft connected to said blocking means for movement thereof from said first position to said second position; a pair of fluid-operated pistons mounted in cylinders for reciprocation perpendicular to the axis of said shaft; a mechanism connected to said shaft and engageable with said pistons to translate reciprocal motion of said pistons to rotational movement of said shaft from said first position to said second position; and a pair of piston return units mounted for reciprocation perpendicular to the axis of said shaft and engageable with said mechanism to force said shaft toward said first position.

3. A tool diverter as set forth in claim 2; characterized in that said cylinders and also said return units are equidistant from said shaft on opposite sides thereof producing a balanced torque thereabout.

4. A tool diverter as set forth in claim 3; characterized in that the axes of the cylinders in which are mounted said pistons are parallel to each other and the axis of reciprocation of said piston return units are parallel to each other.

5. A tool diverter as set forth in claim 4; characterized in that said axes are coplanar and one of said piston return units is coaxial with one of said cylinders and the other of said piston return units is coaxial with the other of said cylinders.

6. A tool diverter as set forth in claim 4; characterized in that said mechanism is a cam means.

7. A tool diverter as set forth in claim 6; characterized in that said cam means has four surfaces circumferentially spaced apart around the axis of the shaft, every other one of said surfaces engaging one of said pistons and the other two of said surfaces each engaging one of said piston return units.

8. A tool diverter as set forth in claim 7; characterized in that said pistons are movable in opposite directions to move said shaft from said first position to said second position and said spring return units are movable in opposite directions to return said shaft from said second position to said first position.

9. A tool diverter as set forth in claim 8; characterized in that the axes of said piston return units are parallel to the axes of said cylinders.

10. A tool diverter as set forth in claim 10; characterized in that said axes are coplanar and one of said piston return units is coaxial with one of said cylinders

and the other of said piston return units is coaxial with the other of said cylinders.

11. A tool diverter set forth in claim 2; characterized in that said branch sections of said wye are symmetrical with respect to said master section and said blocking means comprises a depending flapper member, one end of which is pivotally mounted on said shaft at said confluence, the free end of which is adjacent one wall of said master section in said first position and adjacent the opposite wall of said master section in said second position.

12. A tool diverter as set forth in claim 11; characterized in that each face of said flapper member is symmetrically curved to provide a substantially continuous curving wall between said master section and the respective branch section through which passage is allowed in both said first and second positions.

13. A tool diverter as set forth in claim 12; characterized in that the effective areas as seen by a through-flowline tool for passage therethrough, of said master section, said respective branch section and the transition area therebetween, as partially defined by said flapper member, are all substantially equal.

14. A tool diverter as set forth in claim 13, characterized in that said faces of said flapper member are symmetrically tapered at said flapper free end so as to abut the respective conduit wall.

15. In an underwater well or manifold for the production of petroleum, a tool diverter comprising: a wye-branched conduit having a master section and at least two diverging branch sections; a movable blocking means mounted at the confluence of said branch sections; and remotely operable actuator means for selectively positioning said blocking means to block passage of tools into one of said branches; characterized in that said actuator means comprises: rotatable shaft means connected to said blocking means for movement thereof; a pair of fluid-operated pistons mounted in cylinders for reciprocating movement perpendicular to the axis of said shaft from a first position to a second position; a mechanism connected to said shaft and engageable with said pistons to translate reciprocal motion of said pistons to rotational movement of said shaft; and a pair of return units mounted for reciprocating movement perpendicular to the axis of said shaft means and engageable with said mechanism to bias said shaft in a direction opposite the direction of rotation effected by said piston reciprocal motion to return said pistons to said first position.

16. A tool diverter as set forth in claim 15; characterized in that said return units comprise a hollow piston member in communication with a fluid-filled cavity and in which is mounted a helical spring, said piston member having at least one hole therethrough so that no fluid is displaced by the movement of said piston member.

17. A tool diverter as set forth in claim 15; characterized in that said mechanism and a portion of said shaft means is disposed in a fluid-filled expandable cavity, a portion of whose fluid is displaced by the said reciprocal motion of said pistons from said first position to said second position.

18. In an underwater well or manifold for the production of petroleum, a tool diverter comprising: a wye-branched conduit having a master section and at least two diverging branch sections; a movable blocking means mounted at the confluence of said branch sections; and remotely operable actuator means for selectively positioning said blocking means to block passage of tools into one of said branches; characterized in that said actuator means comprises: rotatable shaft means

connected to said blocking means for movement thereof; a pair of fluid-operated pistons mounted in cylinders for reciprocating movement perpendicular to the axis of said shaft from a first position to a second position; and a mechanism connected to said shaft and engageable with said pistons to translate reciprocal motion of said pistons to rotational movement of said shaft; said mechanism and a portion of said shaft means being disposed in a fluid-filled cavity, a portion of whose fluid is displaced by the said reciprocal motion of said pistons from said first position to said second position; said actuator being provided with a diaphragm member in fluid communication with one end of said fluid-operated pistons expandable on said reciprocal motion from said first position to said second position to accommodate fluid displaced by said pistons.

19. In an underwater well or manifold for the production of petroleum, a tool diverter comprising: a wye-branched conduit having a master section and at least two diverging branch sections; a movable blocking means mounted at the confluence of said branch sections; and remotely operable actuator means for selectively positioning said blocking means to block passage of tools into one of said branches; characterized in that said actuator means comprises: rotatable shaft means connected to said blocking means for movement thereof; a pair of fluid-operated pistons mounted in cylinders for reciprocating movement perpendicular to the axis of said shaft from a first position to a second position; a mechanism connected to said shaft and engageable with said pistons to translate reciprocal motion of said pistons to rotational movement of said shaft; said mechanism and a portion of said shaft means being disposed in a fluid-filled cavity, a portion of whose fluid is displaced by the said reciprocal motion of said pistons from said first position to said second position; and a pair of piston return units mounted for reciprocating movement perpendicular to the axis of said shaft means and engageable with said mechanism to transmit a force to said pistons in a direction toward said first position.

20. In an underwater well or manifold for the production of petroleum, a tool diverter comprising: a wye-branched conduit having a master section and at least two diverging branch sections; a movable blocking means mounted at the confluence of said branch sections; and remotely operable actuator means for selectively positioning said blocking means to block passage of tools into one of said branches; characterized in that said actuator means comprises: rotatable shaft means connected to said blocking means for movement thereof, at least one fluid-operated piston mounted in a cylinder for reciprocation perpendicular to the axis of said shaft means from a first position to a second position; a mechanism connected to said shaft and engageable with said piston to translate reciprocal motion of said pistons to rotational movement of said shaft; a spring return unit mounted perpendicular to said shaft means and engageable with said mechanism to bias said piston toward said first position; said mechanism and a portion of said shaft means being disposed in a fluid-filled cavity, a portion of the fluid of which is displaced by the movement of said piston from said first position to said second position; said spring return unit being mounted in a cylinder which is in fluid communication with said cavity; and a diaphragm member connected to said cavity, said diaphragm member being expandable on movement of said piston from said first position to said second position to accommodate said cavity fluid displaced by said piston.

21. In an underwater well or manifold for the production of petroleum, a tool diverter comprising: a wye-branched conduit having a master section and diverging branch sections; a movable blocking means mounted at the confluence of said branch sections; and remotely operable actuator means for moving said blocking means between a first position, whereby one of said branch sections is in communication with said master section and the other is blocked, and a second position, whereby said other branch section is in communication with said master section and said one branch section is blocked; characterized in that said branch sections of said wye conduit are symmetrical with respect to said master section and said blocking means comprises a depending flapper member, one end of which is pivotally mounted on a shaft at said confluence, the free end of which is adjacent one wall of said master section in said first position and adjacent the opposite wall of said master section in said second position, each face of said flapper member being symmetrically curved to provide a substantially continuous curving wall between said master section and the respective branch with which said master section is in communication; said actuator means comprising a pair of fluid-operated pistons mounted in cylinders perpendicular to the axis of said shaft and a mechanism connected to said shaft and engageable with said pistons to translate reciprocal motion of said pistons to rotational movement of said shaft from one to the other of said positions; and a pair of spring means mounted to exert a force perpendicular to said shaft and biasing said shaft and said flapper member toward said one of said positions.

22. In an underwater well or manifold for the production of petroleum, a tool diverter comprising: a wye-branched conduit having a master section and diverging branch sections; a movable blocking means mounted at the confluence of said branch sections; and remotely operable actuator means for moving said blocking means from a first position, whereby one of said branch sections is in communication with said master section and the other is blocked, and a second position, whereby said other branch section is in communication with said master section and said one branch section is blocked; characterized in that said branch sections of said wye conduit are symmetrical with respect to said master section and said blocking means comprises a depending flapper member, one end of which is pivotally mounted on a shaft at said confluence, the free end of which is adjacent one wall of said master section in said first position and adjacent the opposite wall of said master section in said second position, each face of said flapper member being symmetrically curved to provide a substantially continuous curving wall between said master section and the respective branch with which said master section is in communication; said actuator means comprising a means for exerting oppositely directed forces including a pair of similar fluid-operated pistons mounted in and extendible in opposite directions from a pair of cylinders disposed perpendicular to the axis of said shaft and a mechanism connected to said shaft and engageable with said pistons to translate reciprocal motion of said pistons to rotational movement of said shaft; said cylinders being coplanar and parallel to each other and equidistant from said shaft on opposite sides thereof producing a balanced torque thereabout.

23. A tool diverter as set forth in claim **22**; characterized in that the effective areas, as seen by a through-flowline tool for passage therethrough, of said master section, said respective communicating branch and the transition area therebetween, as partially defined by said flapper member, are all substantially equal.

24. A tool diverter as set forth in claim **22**; characterized in that the said faces of said flapper member are symmetrically tapered at said flapper free end so as to abut the respective conduit wall.

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,599,711 Dated 8-17-71

Inventor(s) John H. Fowler

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

Column 6, line 6, after "claim", delete "10" and insert -- 9 --.

Signed and sealed this 12th day of September 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents