March 8, 1955 C. J. COBERLY 2,703,585

CONTROL VALVE FOR FLUID OPERATED MOTORS

Filed Dec. 1, 1949 3 Sheets-Sheet 1

FIG. 1.

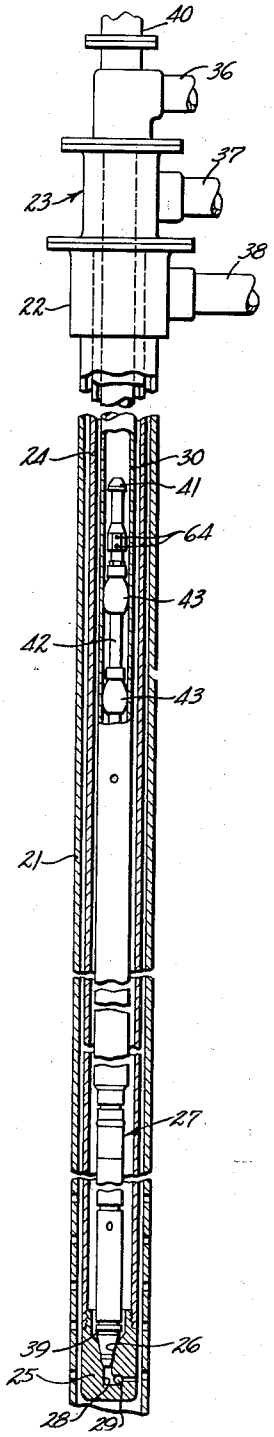


FIG. 4.

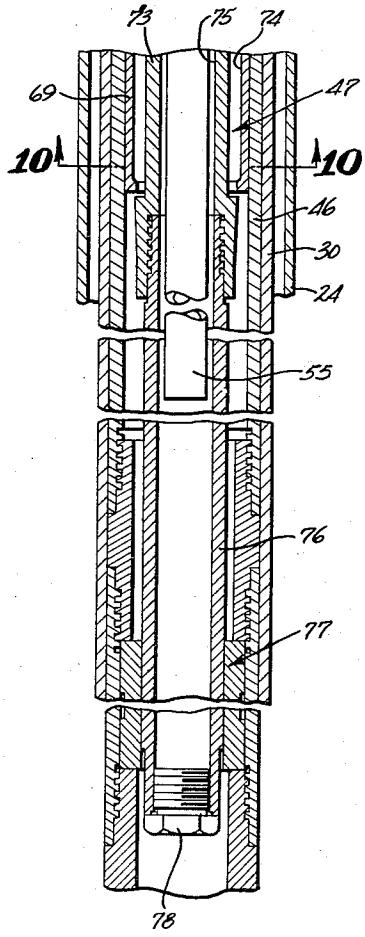
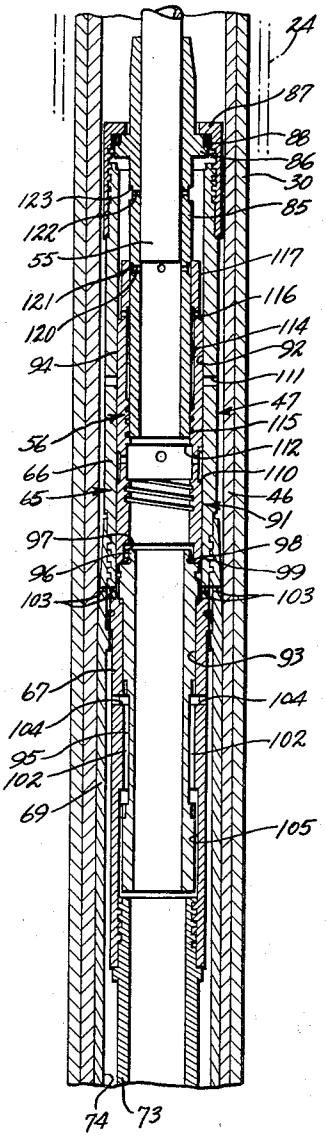


FIG. 5.



INVENTOR.
CLARENCE J. COBERLY
BY HIS ATTORNEYS.
HARRIS, KIECH, FOSTER & HARRIS

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FIG. 2.

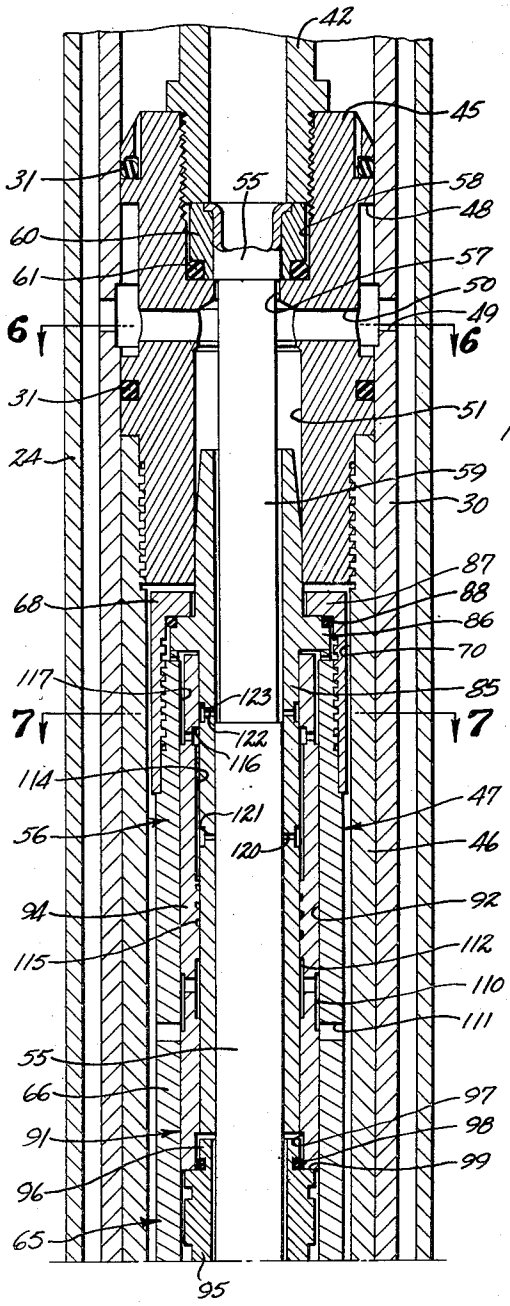
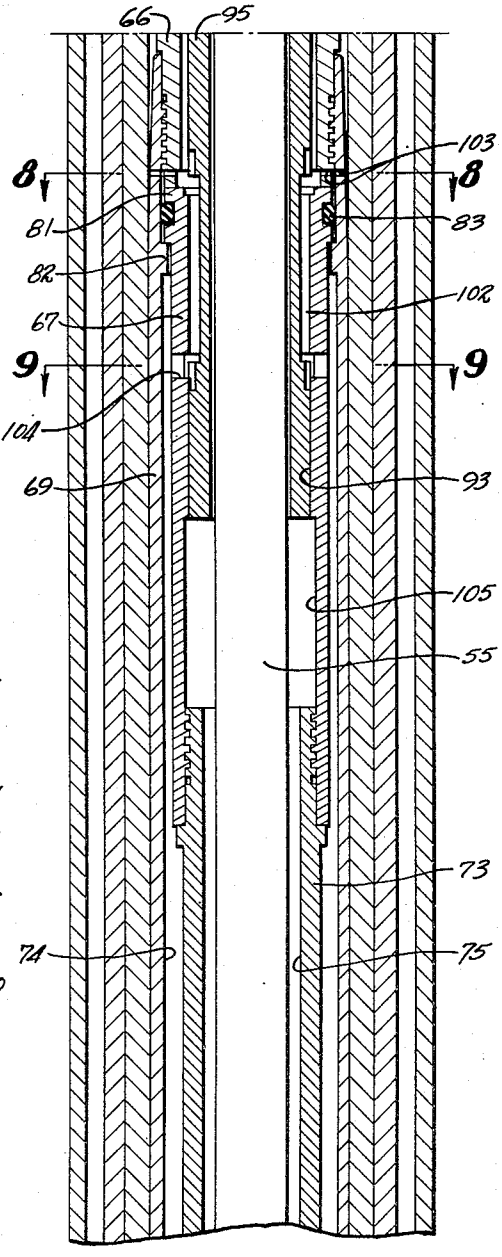


FIG. 3.



INVENTOR.
CLARENCE J. COBERLY
BY HIS ATTORNEYS.
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Fig. 6

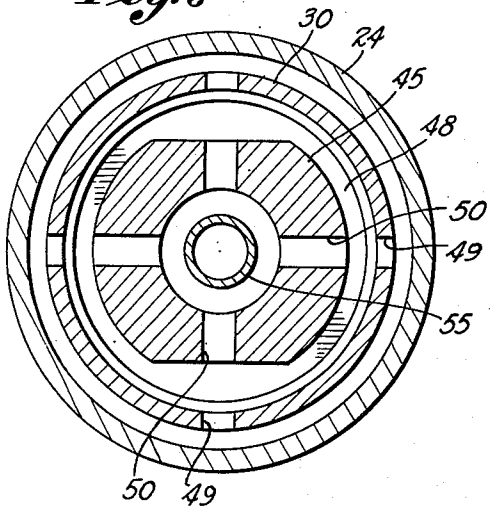


Fig. 9

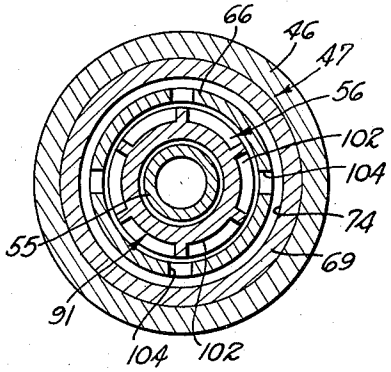


Fig. 10

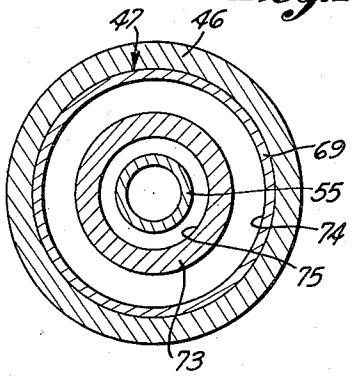


Fig. 7

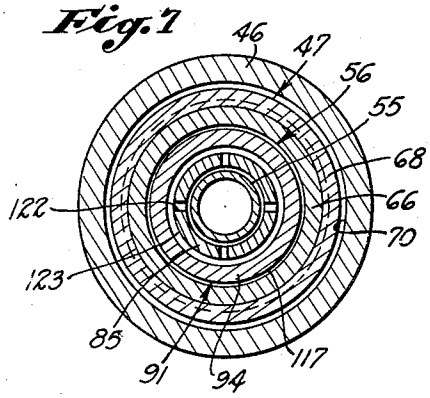
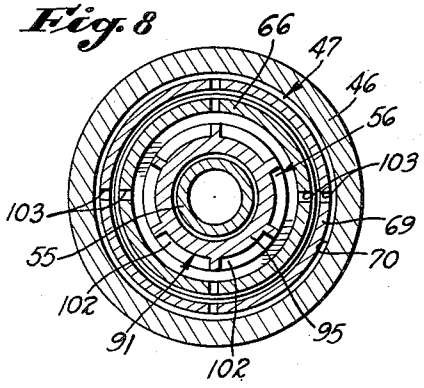


Fig. 8



INVENTOR:
CLARENCE J. COBERLY
By HIS ATTORNEYS
HARRIS, KIECH, FOSTER & HARRIS
By

United States Patent Office 2,703,585 Patented Mar. 8, 1955

2,703,585

CONTROL VALVE FOR FLUID-OPERATED MOTORS

Clarence J. Coberly, Los Angeles, Calif., assignor, by mesne assignments, to Kobe, Inc., Huntington Park, Calif., a corporation of California

Application December 1, 1949, Serial No. 130,533

11 Claims. (Cl. 137—622)

This invention relates in general to fluid-operated pumps of the displacement type and a primary object thereof is to provide an improved control valve for a pump of this type.

Fluid-operated pumps are used extensively in the oil industry for pumping oil and other fluids from wells and comprise coupled fluid motor and pump units set in the wells at the levels from which well fluid is to be pumped. The fluid motor unit includes a motor piston reciprocable in a motor cylinder and is actuable by an operating fluid, such as oil, under relatively high pressure which is delivered thereto through a supply tubing extending downwardly into the well from the surface. The fluid motor unit also includes a motor valve for regulating delivery of operating fluid to the motor cylinder in such a manner as to apply to the motor piston fluid pressure differentials tending to displace the motor piston first in one direction and then in the opposite direction so as to reciprocate the motor piston in its cylinder. The pump unit of such a fluid-operated pump includes a pump piston which is reciprocable in a pump cylinder to draw well fluid into the pump cylinder from the well and to discharge such well fluid therefrom as production fluid into a production tubing set in the well and leading upwardly to the surface, the motor and pump pistons being coupled together so that reciprocatory movement of the former is communicated to the latter.

An important object of the invention is to provide an improved motor valve construction for such a fluid-operated pump.

More specifically, an important object of the invention is to provide a motor valve whose components need not be machined accurately so as to reduce manufacturing costs. I prefer to accomplish this by making various elements of the motor valve self-aligning, which is another object of the invention.

Another object is to provide a motor valve having a generally tubular valve member which is reciprocable in the valve body and which includes a pair of elements so connected as to provide for limited relative lateral movement therebetween, thus rendering such elements of the valve member self-aligning.

A further object is to provide a motor valve having a floating valve bushing which is laterally movable relative to the valve body to provide for proper alignment of the valve bushing with respect to the elements of the valve body.

Yet another object is to provide a motor valve having a floating valve rod to provide for proper alignment of the valve rod with other components of the valve.

The foregoing objects of the invention and the advantages suggested thereby, together with various other objects and advantages which will become evident, may be attained through the exemplary embodiments illustrated in the acompanying drawings, which are for the purpose of illustration only, and described in detail hereinafter. Referring to the drawings:

Fig. 1 is a utility view illustrating a fluid-operated pump which embodies the invention as installed in a well;

Figs. 2, 3 and 4 are enlarged vertical sectional views of the pump, Figs. 3 and 4 being downward continuations of Figs. 2 and 3, respectively, and Figs. 2 and 3 being on a larger scale than Fig. 4;

Fig. 5 is a vertical sectional view duplicating portions of Figs. 2 and 3 on a reduced scale, but illustrating other operating positions for various components of the pump;

Figs. 6, 7, 8 and 9 are transverse sectional views respectively taken along the broken lines 6—6, 7—7, 8—8 and 9—9 of Figs. 2 and 3 of the drawings; and

Fig. 10 is a transverse sectional view taken along the broken line 10—10 of Fig. 4 of the drawings.

Referring particularly to Fig. 1 of the drawings, the numeral 21 designates a well casing which is set in an oil well with its lower end open to an oil producing zone of the well, as by being provided with perforations therein through which oil and other fluids from oil producing formations surrounding the well may enter the interior of the casing. Connected to the upper end of the casing 21 is a casing head 22 having a tubing head 23 mounted thereon and rigidly connected thereto. Suspended from the tubing head 23 and extending downwardly into the casing 21 is a production tubing 24 which is provided at its lower end with an intake fitting 25. The intake fitting provides a tapered seat 26 for a fluid-operated pump 27 which embodies the invention, and is provided with an intake passage 28 therethrough for conveying well fluid from the interior of the casing 21 to the intake of the pump. A check valve 29 prevents outflow through the passage 28.

The pump 27, in the particular construction illustrated, is of the so-called "free" type in that it is movable hydraulically through a supply tubing 30 between the surface of the ground and an operating position wherein it is seated on the pump seat 26. The tubing 30 is also suspended from the tubing head 23 and extends downwardly into the tubing 24, direct fluid communication between the tubings 24 and 30 being prevented when the pump 27 is in its operating position by a pair of annular sealing elements 31 which, as shown in Fig. 2 of the drawings, are carried by the pump and are adapted to engage the interior wall of the tubing 30. Although I have illustrated and described the invention in connection with a pump of the "free" type, I do not intend to be limited thereto.

The tubing 30 is adapted to convey operating fluid under pressure downwardly to the pump 27 to actuate it as will be discussed in more detail hereinafter, the operating fluid under pressure being delivered to the supply tubing through a pipe 36 which is connected to the tubing head 23 in communication with the supply tubing. The well fluid entering the pump 27 through the inlet fitting 25 is discharged into the production tubing 24 as production fluid and is conveyed upwardly thereby to the surface. The production fluid flows from the production tubing 24 into a pipe 37 which is connected to the tubing head 23 in fluid communication with the production tubing. As will become apparent, the operating fluid is also discharged into the production tubing 24 after it has actuated the pump 27, although it will be understood that the spent operating fluid may be conveyed to the surface separately from the production fluid. A vent pipe 38 is connected to the casing head 22 and communicates with the interior of the casing 21 so that gas may be drawn off from the top of the casing or pressure applied thereby.

As is well known in the art, the pump 27 may be removed from the well hydraulically by introducing the operating fluid under pressure into the production tubing 24, rather than into the supply tubing 30. The pressure of the operating fluid introduced into the production tubing 24 acts on an annular area 39 at the lower end of the pump 27 to unseat the pump, the pressure of the operating fluid thereafter being applied to the entire area of the pump to move it upwardly through the supply tubing 30 to the surface. As will be understood, the check valve 29 closes to prevent loss of fluid from the tubing 24. Connected to the upper end of the tubing head 23 in alignment with the supply tubing 30 is a tube 40 for receiving the pump 27 when it reaches the surface, the tube 40 being provided with means (not shown) for retaining the pump when it reaches the surface, as by engaging a conical head 41 at the upper end of a packer mandrel 42 which extends upwardly from the body of the pump. The packer mandrel 42 carries packers 43 which are adapted to expand into engagement with the interior wall of the supply tubing 30 to prevent upward flow of fluid past the pump 27 during the operation of removing the pump from the well. When the pump 27 is in its operating position and operating fluid under pres-

sure is being delivered thereto through the supply tubing **30**, the packers **43** contract to permit downward flow of operating fluid to the pump.

The foregoing completes a general description of an installation in which the fluid-operated pump **27** embodying the invention may be incorporated and the pump **27** will now be considered in detail with particular reference to Figs. 2, 3 and 4 of the drawings. As shown in Fig. 2 of the drawings, the body of the pump **27** is provided at its upper end with a fitting **45** onto the lower end of which is threaded a tube providing a motor cylinder **46** for a motor piston **47**. The fitting **45** carries the aforementioned annular sealing elements **31**, which are respectively disposed on opposite sides of an external annular groove **48** in this fitting. When the pump **27** is in its operating position, the annular groove **48** communicates with the interior of the production tubing **24** through radial ports **49** in the supply tubing **30**. The fitting **45** is provided with radial ports **50** therein which communicate at their outer ends with the annular groove **48** and at their inner ends with a counterbore **51** in the fitting, the counterbore **51** communicating with the upper end of the motor cylinder **46** so that the fluid pressure in the upper end of the motor cylinder is always equal to the pressure of the column of production fluid in the production tubing **24**.

Centrally disposed in the motor cylinder **46** and encompassed by the motor piston **47** is a tubular valve rod **55** which, as will be discussed in more detail hereinafter, forms part of a main valve mechanism **56** of the pump **27**, the main valve being carried by the motor piston in the particular construction illustrated. The valve rod **55** constitutes a pilot valve means of the invention. From the motor cylinder **46**, the valve rod **55** extends upwardly through the counterbore **51** in the fitting **45** and through a bore **57** in this fitting into a counterbore **58** therein, the valve rod **55** having a reduced-diameter portion **59** of smaller diameter than the diameter of the bore **57** so as to provide a clearance therebetween. The valve rod **55** is provided at its upper end with a head **60** which is disposed in the counterbore **58** and which is of smaller diameter than the counterbore to provide a clearance therebetween, an annular sealing element **61** being disposed between the head **60** and the walls of the counterbore **58**. It will be apparent that, with this construction, the valve rod **55** is free to move laterally relative to the body of the pump **27** to a limited extent to compensate for any inaccuracies in manufacture which affect concentricity, which is an important feature of the invention.

Axial movement of the valve rod **55** downwardly is prevented by engagement of the head **60** thereon with the base of the counterbore **58** in the fitting **45**, and axial movement thereof upwardly is prevented by engagement of the head **60** with the lower end of the packer mandrel **42**, which is threaded into the counterbore **58**. The packer mandrel is threaded into the counterbore **58** a distance sufficient only to prevent any substantial axial movement of the valve rod, but insufficient to prevent lateral movement thereof. As will be noted, the packer mandrel **42** is tubular, the packer mandrel communicating at its upper end with the supply tubing **30** through ports **64**, Fig. 1, and communicating at its lower end with the tubular valve rod **55**. Thus, the fluid pressure in the tubular valve rod **55** is always substantially the pressure of the operating fluid in the supply tubing **30**.

The motor piston **47** includes a valve body **65** which forms part of the main valve **56** and which includes upper and lower tubular elements **66** and **67**, respectively, the tubular element **66** having a cap **68** threaded thereon at its upper end. Threaded onto the lower end of the tubular element **66** and encompassing the tubular element is an outer sleeve **69** of the motor piston **47**, this sleeve being in slidable, fluid-tight engagement with the motor cylinder **46** throughout the major portion of the length of the sleeve. The upper end of the outer sleeve **69**, the upper tubular element **66** and the cap **68** are of smaller diameter than the motor cylinder **46** to provide an annular space **70** which continuously communicates with the upper end of the motor cylinder and which thus continuously contains fluid subjected to the production column pressure.

Threaded into the lower end of the lower tubular element **67** is an inner sleeve **73** of the motor piston **47**, the inner sleeve being spaced inwardly from the outer sleeve **69** to provide an annular space **74** therebetween and being spaced outwardly from the valve rod **55** to provide an annular space **75** therebetween. Threaded into the lower end of the inner sleeve **73** is a tubular pump piston **76**, Fig. 4, which is reciprocable in a pump cylinder **77** adapted to communicate with the intake passage **28** in a manner not specifically shown, the pump piston being closed at its lower end, as by a plug **78** threaded thereinto. As will be apparent, the lower end of the tubular valve rod **55** communicates with the interior of the pump piston **76** so that the interior of the pump piston continuously contains operating fluid under pressure. The operating fluid thus continuously applies a downward force to the pump piston. The annular space **75**, between the inner sleeve **73** of the motor piston **47** and the valve rod **55**, communicates at its lower end with the interior of the pump piston **76** so that it always contains operating fluid under pressure.

In order to prevent axial movement of the lower tubular element **67**, it is provided with a head **81** thereon, Fig. 3, which is disposed between the lower end of the tubular element **66** and an internal annular flange **82** on the outer sleeve **69**. The outer sleeve **69** is threaded onto the tubular element **66** an extent sufficient to prevent substantial axial movement of the tubular element **67**. Fluid leakage between the lower tubular element **67** and the outer sleeve **69** is prevented by an annular sealing element **83** carried by the head **81**. By making the valve body **65** in the two parts **66** and **67**, standard tube stock can be used, thus avoiding a costly and difficult axial drilling operation heretofore required with one-piece valve bodies used for similar purposes.

The main valve **56** includes a tubular valve bushing **85** which is disposed in the valve body **65** and through which the valve rod **55** extends in slidable, fluid-tight engagement. The valve bushing **85** is restrained axially by disposing an annular flange **86** thereon between the upper end of the upper tubular element **66** of the valve body and an internal annular flange **87** on the cap **68**, an annular sealing element **88** being disposed between the annular flange on the valve bushing and the cap **68** to prevent fluid leakage therebetween. As will be noted, the valve bushing **85** is of smaller diameter than the cap **68** to permit limited lateral movement of the valve bushing relative to the cap to compensate for any lack of concentricity, which is an important feature of the invention. The cap **68** is threaded onto the upper tubular element **66** of the valve body **65** a distance sufficient only to prevent substantial axial movement of the valve bushing, but insufficient to prevent lateral floating movement thereof.

The main valve **56** includes a reciprocable main valve member **91** of the differential-area, two-speed, throttling type which is disposed in the valve body **65** on the valve bushing **85**. The main valve member **91** includes a major portion which is disposed in a major bore **92** in the upper tubular element **66** of the valve body and which is in slidable, fluid-tight engagement with the upper tubular element **66** and with the valve bushing **85**. The main valve member **91** also includes a minor portion which is disposed in a minor bore **93**, Fig. 3, in the lower tubular element **67** of the valve body **65** and which is in slidable, fluid-tight engagement with the lower tubular element **67**.

The main valve member **91** comprises upper and lower tubular elements **94** and **95**, Figs. 2 and 3, the former constituing the aforementioned major portion of the valve and the latter constituting the aforementioned minor portion thereof. The upper and lower tubular elements **94** and **95** are connected in a manner permitting limited relative lateral movement therebetween to compensate for any lack of concentricity, which is an important feature of the invention. The element **95** is provided with a tubular projection **96** which is disposed in a recess **97** in the element **94**, the diameter of the projection **96** being less than the diameter of the recess **97** to permit relative lateral movement. Leakage between the two elements **94** and **95** is prevented by an annular sealing element **98** which encircles the stem **96** and engages the peripheral wall of the recess **97**. No connecting means for preventing axial separation of the upper and lower tubular elements **94** and **95** is required since the fluid pressures acting on the upper end of the upper element and the lower end of the lower element hold these

ments in assembled relation. Axial insertion of the projection **96** into the recess **97** is limited by a shoulder **99** on the lower tubular element **95** which engages the lower end of the upper tubular element **94**. By making the main valve member **91** in the two parts **94** and **95** standard tube stock can be used, thus simplifying construction and reducing the cost thereof.

In operation, the interior of the pump piston **76** is, as previously indicated, in continuous communication with the supply tubing **30** through the tubular valve rod **55** so that the pressure of the operating fluid continuously acts downwardly on the pump piston, the net area on which the operating fluid in the pump piston acts downwardly being equal to the external cross-sectional area of the valve rod. Also, as indicated previously, the upper end of the motor cylinder **46** is in continuous communication with the production tubing **24** so that the upper end of the motor piston is continuously exposed to the production column pressure, the latter pressure acting on an annular area at the upper end of the motor piston which is equal to the difference between the cross-sectional area of the motor piston and the external cross-sectional area of the valve rod. The lower annular end of the motor piston is alternately exposed to the operating fluid and production column pressures by the main valve **91** in a manner to be described hereinafter, the area on the lower end of the motor piston to which the operating fluid and production column pressures are alternately applied being equal to the difference between the cross-sectional area of the motor piston and the external cross-sectional area of the pump piston **76**. As will be apparent, when the annular area at the lower end of the motor piston **47** is exposed to the production column pressure, the motor and pump pistons are moved downwardly by the action of the operating fluid within the pump piston applied to the area of the valve rod. Conversely, when the annular area at the lower end of the motor piston is exposed to the operating fluid pressure, the motor and pump pistons are moved upwardly, the annular area at the lower end of the motor piston being greater than the external cross-sectional area of the valve rod **55** to accomplish this.

The main valve member **91** is reciprocable between an upper position wherein it connects the lower end of the motor cylinder **46** with the upper end thereof to apply the production column pressure to the annular area at the lower end of the motor piston, and a lower position wherein it connects the lower end of the motor cylinder with the interior of the pump piston **76** to apply the operating fluid pressure to the annular area at the lower end of the motor piston. The upper and lower positions of the main valve member **91** are shown in Figs. 2 and 3 and in Fig. 5 of the drawings, respectively. Referring to Figs. 3 and 8 of the drawings, the lower element **95** of the member **91** is provided with external passages **102** therein which span radial ports **103** and **104** when the valve member is in its upper position. As shown in Fig. 3 of the drawings, and as best shown in Fig. 8 thereof, the radial ports **103** extend through the upper tubular element **66** of the valve body **65** and the outer sleeve **69** of the motor piston **47** to connect the passages **102** with the annular space **70** leading to the upper end of the motor cylinder **46** when the main valve member **91** is in its upper position. The radial ports **104** extend through the lower tubular element **67** of the valve body **65** to connect the annular space **74** between the outer sleeve **69** and the inner sleeve **73** of the motor piston to the passages **102** when the main valve member **91** is in its upper position. The annular space **74** leads to the lower end of the motor cylinder **46** so that, when the valve member **91** is in its upper position, annular area at the lower end of the motor piston **47** is exposed to the production column pressure continuously obtaining in the upper end of the motor cylinder through the annular space **70**, the radial ports **103**, the passages **102** in the main valve member **91**, the radial ports **104** and the annular space **74**. Under such conditions, the motor and pump pistons **47** and **76** move downwardly as a unit in their respective cylinders **46** and **77**.

Referring to Fig. 5 of the drawings, when the main valve member **91** is in its lower position, the passages **102** therein connect the radial ports **104** to a chamber **105** in the lower tubular element **67** of the valve body **65**, this chamber being in continuous communication with the interior of the pump piston **76** through the annular space **75** between the valve rod **55** and the inner sleeve **73** of the motor piston **47**. Under such conditions, since the fluid pressure within the pump piston **76** is always the operating fluid pressure, the annular area at the lower end of the motor piston **47** is exposed to the operating fluid pressure through the annular space **75**, the chamber **105**, the passages **102**, the radial ports **104**, and the annular space **74** between the outer and inner sleeves **69** and **73**.

Referring to Fig. 2 of the drawings, when the main valve member **91** is in its upper position, it connects the lower end of the motor cylinder **46** to the production column pressure in the manner hereinbefore described so as to effect the downward stroke of the motor and pump pistons **47** and **76**. The main valve member **91** is held in its upper position during the entire downstroke of the pistons by a fluid pressure differential impressed thereacross, the lower end of the valve member, which is of relatively small area, being continuously exposed to the operating fluid pressure in the chamber **105**, and the upper end of the valve member, which is of relatively large area, being exposed to the production column pressure during the downstroke of the motor and pump pistons in a manner about to be described. The main valve member **91** is provided with an external annular channel **110** which registers with radial ports **111** in the upper tubular element **66** of the valve body **65** when the valve member is in its upper position, the radial ports **111** communicating with the production column pressure obtaining in the annular space **70** between the valve body and the wall of motor cylinder **46**. The main valve member **91** is provided with an internal annular channel **112** which is connected to the external annular channel **110** by radial ports in the valve member, the internal annular channel **112** communicating with another internal annular channel **114** through an internal helical groove **115** in the valve member. The internal annular channel **114** in the main valve member communicates with an internal annular groove **116** therein, which groove communicates through radial ports with an external annular channel being formed by reducing the diameter of the upper end of the valve member slightly. Thus, the main valve member **91** is maintained in its upper position during the downstroke of the motor and pump pistons by exposing the upper end of the valve member to the production column pressure through the radial ports **111**, the external annular channel **110**, the internal annular channel **112** and connecting radial ports, the internal helical groove **115**, the internal annular channel **114**, the internal annular groove **116** and the external annular channel **117** and connecting radial ports.

Referring to Fig. 5 of the drawings, when the motor and pump pistons **47** and **76** approach the end of the downstroke, the lower end of the valve rod **55** uncovers radial ports **120**, see Fig. 2 also, in the valve bushing **85** to admit operating fluid under pressure thereinto. The ports **120** communicate at their outer ends with an external groove **121**, which groove communicates with the internal annular channel **114** in the main valve member **91** when the main valve member is in its upper position, as shown in Fig. 2 of the drawings. Thus, when the motor and pump pistons reach the end of the downstroke, the operating fluid pressure is applied to the upper end of the main valve member **91** to move it downwardly into its lower position, as shown in Fig. 5 of the drawings, by way of the radial ports **120** and the groove **121**, the internal annular channel **114** in the valve member **91**, the internal annular groove **116** in the valve member, the external annular channel **117** and the radial ports connecting the groove **116** and channel **117**. With the main valve member **91** in its lower position, the operating fluid pressure is applied to the annular area at the lower end of the motor piston **47** to effect the upstroke of the motor and pump pistons. The operating fluid pressure is applied to the upper end of the main valve member **91** during the upstroke of the motor and pump pistons to hold the valve member in its lower position by way of the internal helical groove **115** in the valve member, the internal annular channel **114** therein, the internal annular groove **116** therein and the radial ports connecting this groove to the external channel **117**. Under such conditions, the operating fluid pressure is communicated to the lower end of the internal helical groove **115** through

an annular clearance between the valve member **91** and the valve rod **55**.

When the motor and pump pistons **47** and **76** reach the end of the upstroke, the lower end of the reduced diameter portion **59** of the valve rod **55** registers with radial ports **122** in the valve bushing **85**, these radial ports communicating through a groove **123** with the upper end of the main valve member **91**. Thus, the upper end of the main valve member is exposed to the production column pressure obtaining in the counterbore **51** in the upper fitting **45** to permit the valve member to move upwardly into its upper position. As previously discussed, this effects the downstroke of the motor and pump pistons. It will thus be understood that the valve rod **55** acts as a pilot valve in response to movement of the piston assembly to control the application of fluid pressure to the large upper end of the main valve **91**.

Although I have disclosed an exemplary embodiment of my invention for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated in such embodiment without departing from the spirit of the invention.

I claim as my invention:

1. In a control valve for a fluid-operated motor, the combination of: a tubular valve body, including a pair of valve body elements substantially axially aligned; a lateral-lost-motion connection connecting said valve body elements together; tubular main valve means disposed in said valve body; and pilot valve means extending into said main valve means for applying a fluid pressure differential to said main valve means to move said main valve means axially.

2. In a control valve for a fluid-operated motor, the combination of: a tubular valve body; a tubular valve bushing extending into said valve body; a lateral-lost-motion connection connecting said valve bushing and said valve body together and providing limited lateral movement therebetween; tubular main valve means disposed in said valve body radially between said valve body and said valve bushing; and pilot valve means extending into said valve bushing for applying a fluid pressure differential to said main valve means to move said main valve means axially.

3. In a control valve for a fluid-operated motor, the combination of: a tubular valve body; tubular main valve means disposed in said valve body, including a pair of tubular valve elements substantially axially aligned; a lateral-lost-motion connection connecting said valve elements together and providing limited lateral movement therebetween; and pilot valve means extending into said main valve means for applying a fluid pressure differential to said main valve means to move said main valve means axially.

4. In a control valve for a fluid-operated motor, the combination of: a tubular valve body, including a pair of valve body elements substantially axially aligned; a lateral-lost-motion connection connecting said valve body elements together and providing limited lateral movement therebetween; tubular main valve means disposed in said valve body; pilot valve means extending into said main valve means for applying a fluid pressure differential to said main valve means to move said main valve means axially; and another lateral-lost-motion connection connecting said pilot valve means to said valve body and providing limited lateral movement between said valve body and said pilot valve means.

5. In a control valve for a fluid-operated motor, the combination of: a tubular valve body, including a pair of valve body elements substantially axially aligned; a lateral-lost-motion connection connecting said valve body elements together and providing limited lateral movement therebetween; a tubular main valve means disposed in said valve body; a tubular valve bushing extending into said main valve means; another lateral-lost-motion connection connecting said valve bushing and said valve body together and providing limited lateral movement therebetween; and pilot valve means extending into said valve bushing for applying a fluid pressure differential to said main valve means to move said main valve means axially.

6. In a control valve for a fluid-operated motor, the combination of: a tubular valve body, including a pair of valve body elements substantially aligned; means connecting said valve body elements together; tubular main valve means disposed in said valve body, including a pair of tubular valve elements substantially axially aligned; a lateral-lost-motion connection connecting said valve elements together and providing limited lateral movement therebetween; and pilot valve means extending into said main valve means for applying a fluid pressure differential to said main valve means to move said main valve means axially.

7. In a control valve for a fluid-operated motor, the combination of: a tubular valve body, including a pair of valve body elements substantially axially aligned; means connecting said valve body elements together; tubular main valve means disposed in said valve body, including a pair of tubular valve elements substantially axially aligned; a lateral-lost-motion connection connecting said valve elements together and providing limited lateral movement therebetween; a tubular valve bushing extending into said main valve means; another lateral-lost-motion connection connecting said valve bushing and said valve body together and providing limited lateral movement therebetween; and pilot valve means extending into said main valve means for applying a fluid pressure differential to said main valve means to move said main valve means axially.

8. In a control valve for a fluid-operated motor, the combination of: a tubular valve body, including a pair of valve body elements substantially axially aligned; a lateral-lost-motion connection between said valve body elements; means providing a fluid-tight seal between said valve body elements; tubular main valve means disposed in said valve body; and pilot valve means extending into said main valve means for applying a fluid pressure differential to said main valve means to move said main valve means axially.

9. In a control valve for a fluid-operated motor, the combination of: a tubular valve body; a tubular valve bushing extending into said valve body; a lateral-lost-motion connection connecting said valve bushing and said valve body together and providing limited lateral movement therebetween; means providing a fluid-tight seal between said valve body and said valve bushing; tubular main valve means disposed in said valve body radially between said valve body and said valve bushing; and pilot valve means extending into said valve bushing for applying a fluid pressure differential to said main valve means to move said main valve means axially.

10. In a control valve for a fluid-operated motor, the combination of: a tubular valve body; tubular main valve means disposed in said valve body, including a pair of tubular valve elements substantially axially aligned; a lateral-lost-motion connection connecting said valve elements together and providing limited lateral movement therebetween; means providing a fluid-tight seal between said valve elements; and pilot valve means extending into said main valve means for applying a fluid pressure differential to said main valve means to move said main valve means axially.

11. In a control valve for a fluid-operated motor, the combination of: a plurality of tubular elements which have substantially coinciding axes and which are arranged in at least two radially spaced pairs; and lateral-lost-motion connections between the elements of the respective pairs and providing limited relative lateral movement between the elements of the respective pairs.

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