

Nov. 15, 1955

W. H. MIDDLETON ET AL
WELL STRING VALVE AND ACTUATOR

2,723,677

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2 Sheets-Sheet 1

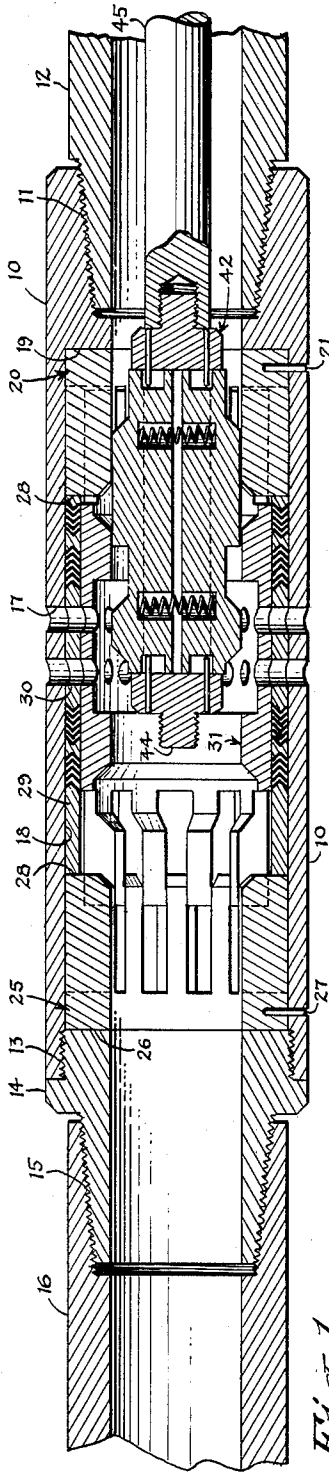


Fig. 1

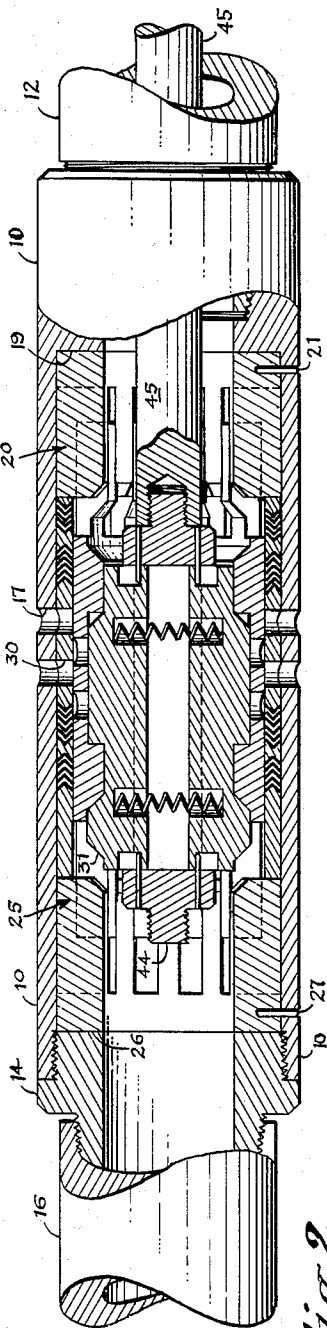


Fig. 2

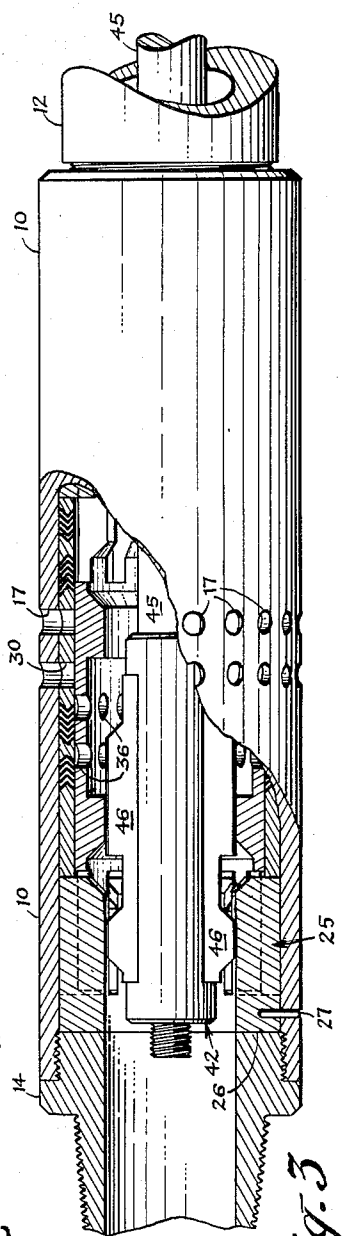


Fig. 3

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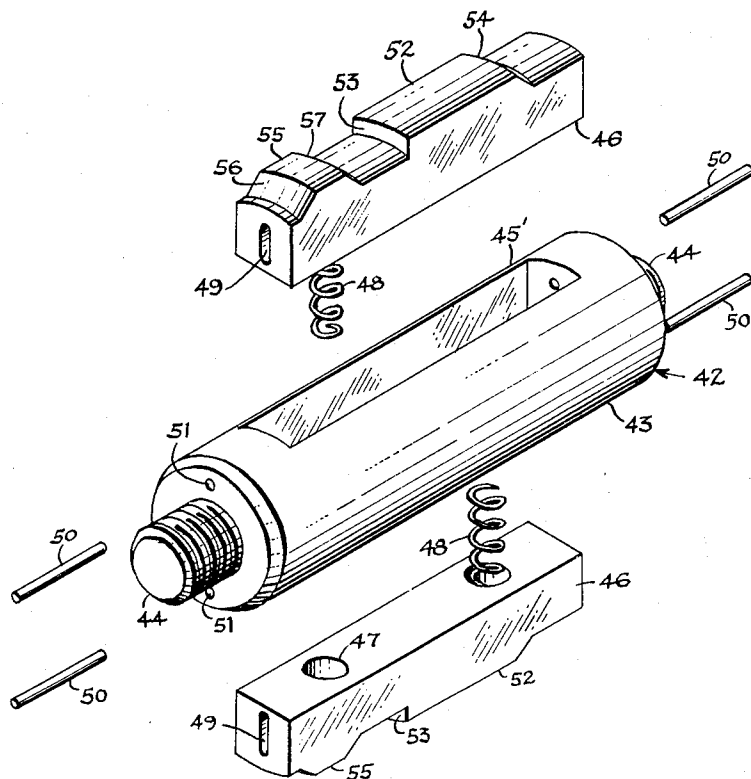


Fig. 4

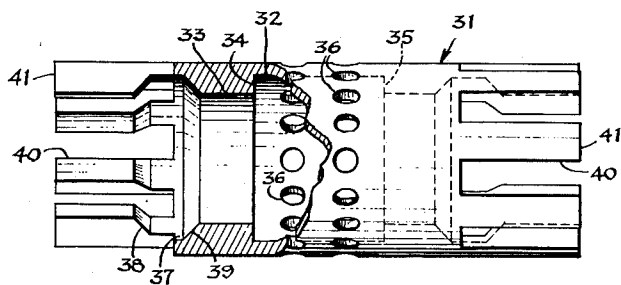


Fig. 5

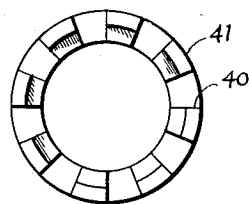


Fig. 6

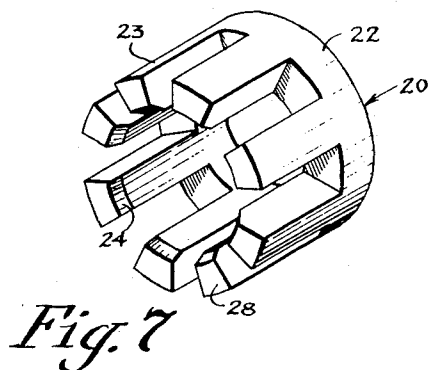


Fig. 7

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2,723,677

WELL STRING VALVE AND ACTUATOR

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12 Claims. (Cl. 137—270)

This invention relates to wells and more particularly to a valve which may be located at the desired point in a well string together with an actuator which may be operated from the surface of the earth to open or close the valve and to indicate the position of such valve.

Heretofore, numerous valves for use in well strings have been proposed but many of these were incorporated as part of the well string and consequently required the tubing constituting the well string being perforated even though certain of these valves could be operated from the surface of the earth to open or close the same, there was no positive means for indicating the open or closed condition of the valve. Furthermore, many of these prior art valves included relatively complicated mechanisms which frequently became jammed or otherwise inoperative, thereby necessitating withdrawing the valve from the well and replacing or repairing the same. Obviously, this required an appreciable amount of time and consequently, materially contributed to maintenance costs and to loss of production from the well. Also, certain of these prior art valves required special operators, such as rods or the like and consequently, were not easily adapted to normal well drilling or well operating procedures and equipment, since it was necessary to supply special equipment therefor.

It is accordingly an object of this invention to provide a well string valve and actuator which valve may be conveniently incorporated at any desired position in the well string and which eliminates any necessity for perforating such string.

A further object of the invention is the provision of a well string valve and actuator which may be conveniently operated to move the valve from opened to closed position and vice versa, from the surface of the earth and, at the same time, afford a positive indication as to the open or closed condition of the valve.

A still further object of the invention is the provision of a well string valve and actuator in which the valve is a self-contained unit to be coupled into the well string at any desired point together with a separate actuator which may be lowered into the well by means of a cable or any other desired means to actuate the valve from opened to closed position or vice versa.

Another object of the invention is the provision of a well string valve and actuator which may be positioned in any desired location in the well string and after movement of such valve to open or closed position as desired, the actuator may be completely removed from the well string thereby permitting the free flow of fluid there-through.

A further object of the invention is the provision of a well string valve and actuator which may be conveniently manufactured from readily available materials and in which all of the parts may be made of sufficient size and strength to withstand any desired pressures.

A still further object of the invention is the provision of a well string valve and actuator in which the valve requires only one movable part and in which the actuator

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is lowered into the string for operation of the valve and removed after such operation.

Further objects and advantages of the invention will be apparent from the following description taken in conjunction with the accompanying drawing wherein:

Fig. 1 is a longitudinal sectional view of the well string valve of this invention showing the same in open condition and also showing the actuator partially inserted preparatory to closing the valve;

Fig. 2, a view similar to Fig. 1, but showing the valve actuator engaging valve member and with the valve member partially moved toward closed position;

Fig. 3, a side elevational view with parts broken away and in section for greater clarity and showing the valve member in closed position and the actuator disengaged therefrom;

Fig. 4, an exploded perspective view showing the actuator for operating the valve member incorporated in the valve of this invention;

Fig. 5, a side elevational view with parts broken away and in section for greater clarity and showing the valve member utilized in the valve of this invention;

Fig. 6, an end elevational view of the valve member shown in Fig. 5; and

Fig. 7, a view in perspective showing one of the cam rings utilized in the valve of this invention for releasing the valve actuator from the valve member.

With continued reference to the drawing there is shown a well string valve and actuator constructed in accordance with this invention and which may well comprise a tubular body 10 provided at one end with a tapered threaded coupling for connecting to one end of a well string tubing 12. The opposite end of the body 10 is internally threaded at 13 to threadedly receive a hollow plug 14 which in turn is provided with a tapered threaded portion 15 for coupling to the end of a well string tubing 16. It will therefore, be seen that by this arrangement the body 10 of the valve of this invention may be inserted between the sections 12 and 16 of a well string tubing at any desired location.

Substantially midway of the length of the body 10 there is provided through the outer wall thereof a plurality of apertures 17, the purpose of which will be presently described. The inner surface 18 of the body 10 terminates adjacent one end of the body in a shoulder 19 and snugly received in the body 10 and abutting against the shoulder 19 is a cam ring 20 which is held in place and against rotation relative to the body 10 by a pin 21 extending through the outer wall of the body 10 and into the cam ring 20.

With particular reference to Fig. 7, the cam ring 20 may well comprise a circular hollow base portion 22 from one side of which extends in a longitudinal direction, a plurality of fingers 23, each finger being provided on the end thereof with a beveled cam surface 24.

A second cam ring 25 identical in every respect with the cam ring 20, described above, is positioned within the body 10 adjacent the opposite end thereof in engagement with the inner end 26 of the plug 14 and held against rotation with respect to the body 10 by a pin 27 extending through the outer wall of the body 10 and into the cam ring 25.

Disposed between the inner ends 28 of the cam rings 20 and 25 is a packing sleeve 29 of any suitable packing material and such sleeve 29 is provided with a plurality of apertures 30 registering with the apertures 17 in the outer wall of the body 10.

Slidably received in the body 10 and in engagement with the inner surface of the packing sleeve 29 and between the cam rings 20 and 25, is a cylindrical valve member 31 which, as shown in Figs. 5 and 6, is provided with an annular recess 32 in the inner wall 33

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with the recess 32 being located substantially midway of the length of the valve member 31 with the recess 32 terminating at each end in a shoulder 34 and 35. A plurality of apertures 36 are provided in the wall of the valve member 31 and such apertures communicate with the annular recess 32. Spaced inwardly from each end of the valve member 31 is an annular groove 37 and it is to be noted, that each end of this groove 37 is provided with a beveled surface 38 and 39. Also each end of the valve member 31 is slotted as at 40 to provide a plurality of longitudinally extending fingers 41 which are complementary to and may mesh with the fingers 23 on the cam rings 20 and 25. It is to be noted, that the slots 40 extend an appreciable distance into the annular grooves 37 and the purpose thereof will be presently described.

As mentioned above, the valve member 31 is slidably received in the body 10 in fluid tight engagement with the packing sleeve 29 and such valve member 31 is movable from an open position, as shown in Fig. 1, with the apertures 36 registering with the apertures 30 in the packing sleeve 29 and the apertures 17 in the body 10, to a closed position as shown in Fig. 3, with the apertures 36 out of registration with the apertures 30 and 17. It is further to be noted, that with the valve member 31 in the position shown in Fig. 1, the fingers 41 at the right hand end of the valve member 31 are in meshing engagement with the fingers 23 on the cam ring 20 and when the valve member 31 is in the position shown in Fig. 3, the fingers 41 on the left hand end thereof are in meshing engagement with the fingers 23 of the cam ring 25. This inter-engagement of the fingers on the valve member 31 and the fingers on the cam rings 20 and 25 prevent relative rotation between the valve member 31 and the body 10 and consequently, maintain the apertures 36 in the valve member 31 in alignment with the apertures 30 and 17 when the valve member 31 is in open position for fluid to pass in either direction through the aligned apertures.

Since the valve body 10 is located in a well string far below the surface of the earth, it is necessary to move the valve member 31 from open to closed position and vice versa, from the surface of the earth and it is further necessary, that the operator be informed as to the open or closed position of the valve member 31. In order to accomplish this operation there is provided a valve member actuator 42 shown in operation in Figs. 1 to 3, and in enlarged detail in Fig. 4. The actuator 42 may well comprise an elongated cylindrical mandrel 43 having an outer diameter to permit the same being slidably received within the inner surface 33 of the valve member 31, the mandrel 43 being provided at each end thereof with a threaded stud 44 to permit convenient attachment of the same to an operating member 45 which may be a rod, wire cable or any other desired operating member. The mandrel 43 is also provided with an elongated diametrically disposed slot 45' within which is slidably received opposed jaw members 46 and such jaw members 46 are provided on their inner sides with recesses 47 for receiving the ends of compression springs 48 which serve to urge the jaw members 46 radially outwardly of the mandrel 43. In order to limit the radial outward movement of the jaw members 46, each member is provided in its ends with elongated recesses 49 which serve to slidably receive fins 50 extending through apertures 51 in the ends of the mandrel 43 and into the recesses 49. As clearly seen from an inspection of Fig. 1, the jaw members 46 may move radially in or out of the slot 45' to the extent permitted by the elongated recesses 49.

Each jaw member 46 is provided on the outer side thereof with an elongated lug 52, this lug having an abutment 53 at one end thereof and a tapered surface 54 at the other end. Spaced from the lug 52 and having substantially the same outward diameter, is a beveled cam 55 having oppositely extending beveled surfaces 56 and

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57, this cam 55 being complementary to the annular grooves 37 in the valve member 31. It is also to be noted, that the lug 52 is of such length as to be received in the annular recess 32 in the valve member 31 with the abutment 53 in engagement with either the shoulder 34 or the shoulder 35 depending upon which direction it is desired to move the valve member 31.

In operation and with particular reference to Figs. 1 to 3, the actuator 42 is attached to the operating member 45 and lowered into the well string until the beveled cams 55 are positioned in registry with the left hand annular groove 37 in Fig. 1, at which time, the jaw members 46 will expand under the action of compression springs 48 to move the lugs 52 into the annular recess 32 in the valve member 31 and the beveled cams 55 into the left hand annular groove 37. It is to be noted that expansion or outward movement of the jaw members 46 is prevented prior to registration of the lugs 52 with the annular recess 32 and the beveled cam members 55 with the annular groove 37 by engagement of the outer surfaces of the lugs 52 and cams 55 with the inner surface 33 of the valve member 31. With the lugs 52 received in the annular 32, the abutments 53 on the lugs 52 will engage the shoulder 34 in the valve member 31 and continued movement of the actuator 42 toward the left, as viewed in Fig. 1, will move the valve member 31 toward the left, as shown in Fig. 2, and to the closed position as shown in Fig. 3, with the apertures 36 out of registration with the apertures 30 and 17. At this time, the beveled surfaces 56 on the beveled cam 55 will engage the beveled cam surfaces 24 on the fingers 23 of the cam ring 55 and this engagement will act to cam the jaw members 46 inwardly of the mandrel 43 until the abutments 53 are disengaged from the shoulder 34. At this time, the actuator 42 may again move toward the left with relation to the valve member 31 and completely out of such valve member and into the well string section 16. This will, of course, leave the valve member 31 in closed position and such additional movement of the actuator 42 will indicate to the operator that the valve member 31 has been moved to closed position. The actuator 42 may now be withdrawn from the well string without moving the valve member 31, since the tapered surfaces 54 on the jaw members 46 will cam such jaw members inwardly and permit movement of the actuator 42 toward the right and out of the body 10 as viewed in the drawing. When it is desired to move the valve member 31 in the opposite direction to open position, the actuator 42 is reversed and lowered into the well, at which time the lugs 52 will move into the annular recess 32 with the abutments 53 in engagement with shoulder 35 and movement of the actuating member 42 toward the right, as viewed in the drawing will result in moving the valve member 31 to open position with the apertures 36 in registration with the apertures 30 and 17.

As will be seen, the actuator 42 may be completely removed from the drill string and consequently, a full flow of fluid therethrough is permitted and such actuator is only introduced when it is desired to move the valve member 31 from opened to closed position or vice versa. Obviously, such valve will control the flow of fluids in either direction through the apertures 17, 30 and 36, and movement of the actuator 42 through the valve member 31 after moving such member to either closed or open position will provide a positive indication to the operator that movement of the valve member has been completed.

It is also to be noted that a plurality of valves constructed in accordance with this invention may be installed at spaced locations in a well string and actuated independently of each other by providing different dimensions and spacings for the annular recesses 32 and annular grooves 37 with the lugs 52 and beveled cam members 55 on the jaws 46, so proportioned as to fit the recesses and grooves in only the intended valve. An actuator 42 would be provided for each valve in the well string and obviously,

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such actuator would pass through all valves without operating the same until engaging in the valve member corresponding to the jaws of the particular actuator. There is thereby provided an arrangement whereby inadvertent actuation of a valve is prevented and positive operation of the desired valve and positive indication of such operation is provided.

It will be obvious to those skilled in the art that various changes may be made in the invention without departing from the spirit and scope thereof and therefore the invention is not limited by that which is shown in the drawing and described in the specification, but only as indicated in the appended claims.

What is claimed is:

1. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, a plurality of apertures in the wall of said body substantially midway of the length thereof, a cam ring fixed in said body inwardly of each end thereof, a plurality of axially disposed, inwardly extending fingers on each cam ring, a beveled cam surface on the inner end of each finger, a packing sleeve in said body between said cam rings, apertures in said sleeve registering with the apertures in said body, a cylindrical valve member slidably mounted in said body between said cam rings and with the outer surface thereof in engagement with said packing sleeve, an annular recess in the inner wall of said valve member substantially midway of the length thereof, shoulders at each end of said recess, a plurality of apertures in the wall of said valve member communicating with said recess, an annular groove in the inner wall of said valve member inwardly of each end, a beveled surface on each end of each groove, longitudinally extending fingers on each end of said valve member with the spaces between said fingers extending into said grooves, said last named fingers being so proportioned as to slidably mesh with the fingers on said cam rings to prevent rotation of said valve member relative to said body, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating member, an elongated diametrically disposed slot in said mandrel, opposed elongated jaws received in said slots for radial sliding movement, resilient means to urge said jaws outwardly of said mandrel, means to limit outward movement of said jaws, an elongated lug on the outer side of each jaw having an abutment at one end and a tapered surface at the other, a beveled cam on the outer side of each jaw spaced from said lug and complementary to said annular grooves whereby upon axial movement of said actuator into said valve member said beveled cams will move said jaws inwardly and permit movement of said actuator to a position with said lugs engaging in said annular recess and said abutments engaging the shoulder on one end of said recess and with said beveled cams engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the apertures therein into or out of registry with the apertures in said sleeve and body and upon completion of the movement of said valve member said beveled cams will engage said beveled cam surfaces on said fingers to cam said jaws inwardly and permit movement of said actuator in the same direction out of said valve member.

2. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, a plurality of apertures in the wall of said body, a cam ring fixed in said body inwardly of each end thereof, a plurality of axially disposed inwardly extending fingers on each cam ring, a beveled cam surface on the inner end of each finger, a packing sleeve in said body between said cam rings, apertures in said sleeve registering with the apertures in said body, a cylindrical valve member slidably mounted in said body between said cam rings and with the outer surface

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thereof in engagement with said packing sleeve, an annular recess in the inner wall of said valve member, shoulders at each end of said recess, a plurality of apertures in the wall of said valve member, an annular groove in the inner wall of said valve member inwardly of each end, a beveled surface on each end of each groove, longitudinally extending fingers on each end of said valve member with the spaces between said fingers extending into said grooves, said last named fingers being so proportioned as to slidably mesh with the fingers on said cam rings to prevent rotation of said valve member relative to said body, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating member, an elongated diametrically disposed slot in said mandrel, opposed elongated jaws received in said slots for radial sliding movement, resilient means to urge said jaws outwardly of said mandrel, means to limit outward movement of said jaws, an elongated lug on the outer side of each jaw having an abutment at one end and a tapered surface at the other, a beveled cam on the outer side of each jaw spaced from said lug and complementary to said annular grooves whereby upon axial movement of said actuator into said valve member, said beveled cams will move said jaws inwardly and permit movement of said actuator to a position with said lugs engaging in said annular recess and said abutments engaging the shoulder on one end of said recess and with said beveled cams engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the apertures therein into or out of registry with the apertures in said sleeve and body and upon completion of the movement of said valve member said beveled cams will engage said beveled cam surfaces on said fingers to cam said jaws inwardly and permit movement of said actuator in the same direction out of said valve member.

3. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, a plurality of apertures in the wall of said body, a cam ring fixed in said body inwardly of each end thereof, a plurality of axially disposed inwardly extending fingers on each cam ring, a beveled cam surface on the inner end of each finger, a packing sleeve in said body between said sleeve between said cam rings, apertures in said sleeve registering with the apertures in said body, a valve member slidably mounted in said body between said cam rings and with the outer surface thereof in engagement with said packing sleeve, a recess in the inner wall of said valve member, shoulders at each end of said recess, a plurality of apertures in the wall of said valve member, an annular groove in the inner wall of said valve member inwardly of each end, a beveled surface on each end of each groove, longitudinally extending fingers on each end of said valve member with the spaces between said fingers extending into said grooves, said last named fingers being so proportioned as to slidably mesh with the fingers on said cam rings to prevent rotation of said valve member relative to said body, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating member, an elongated diametrically disposed slot in said mandrel, opposed elongated jaws received in said slots for radial sliding movement, resilient means to urge said jaws outwardly of said mandrel, means to limit outward movement of said jaws, an elongated lug on the outer side of each jaw having an abutment at one end and a tapered surface at the other, a beveled cam on the outer side of each jaw spaced from said lug and complementary to said annular grooves whereby upon axial movement of said actuator into said valve member said beveled cams will move said jaws inwardly and permit movement of said actuator to a position with said lugs engaging in said recess and said abutments engaging the shoulder on one end of said re-

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cess and with said beveled cams engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the apertures therein into or out of registry with the apertures in said sleeve and body and upon completion of the movement of said valve member and said beveled cams will engage said beveled cam surfaces on said fingers to cam said jaws inwardly and permit movement of said actuator in the same direction of said valve member.

4. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, a plurality of apertures in the wall of said body, a cam ring fixed in said body inwardly of each end thereof, a plurality of axially disposed inwardly extending fingers on each cam ring, a beveled cam surface of the inner end of each finger, a valve member slidably mounted in said body between said cam rings, a recess in the inner wall of said valve member, shoulders at each end of said recess, a plurality of apertures in the wall of said valve member, an annular groove in the inner wall of said valve member inwardly of each end, a beveled surface on each end of each groove, longitudinally extending fingers on each end of said valve member with the spaces between said fingers extending into said grooves, said last named fingers being so proportioned as to slidably mesh with the fingers on said cam rings to prevent rotation of said valve member relative to said body, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating member, an elongated, diametrically disposed slot in said mandrel, opposed elongated jaws received in said slot for radial sliding movement, resilient means to urge said jaws outwardly of said mandrel, means to limit outward movement of said jaws, an elongated lug on the outer side of each jaw having an abutment at one end and a tapered surface at the other, a beveled cam on the outer side of each jaw spaced from said lug and complementary to said annular grooves whereby upon axial movement of said actuator into said valve member said beveled cams will move said jaws inwardly to permit movement of said actuator to a position with said lugs engaging in said recess and said abutments engaging the shoulder on one end of said recess and said beveled cams engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the apertures therein into or out of registry with the apertures in said body and upon completion of the movement of said valve member, said beveled cams will engage said beveled cam surfaces on said fingers to cam said jaws inwardly and permit movement of said actuator in the same direction out of said valve member.

5. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, a plurality of apertures in the wall of said body, a cam ring fixed in said body inwardly of each end thereof, a plurality of axially disposed inwardly extending fingers on each cam ring, a beveled cam surface on the inner end of each finger, a valve member slidably mounted on said body between said cam rings, a recess in the inner wall of said valve member, shoulders at each end of said recess, a plurality of apertures in the wall of said valve member, an annular groove in the inner wall of said valve member inwardly of each end, a beveled surface on each end of each groove, longitudinally extending fingers on each end of said valve member with the spaces between said fingers extending into said grooves, said last named fingers being so proportioned as to slidably mesh with the fingers on said cam rings to prevent rotation of said valve member relative to said body, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating mem-

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ber, a slot in said mandrel, opposed jaws received in said slot for radial movement, resilient means to urge said jaws outwardly of said mandrel, an elongated lug on the outer side of each jaw having an abutment at one end and a tapered surface at the other, a beveled cam on the outer side of each jaw spaced from said lug and complementary to said annular groove whereby upon axial movement of said actuator into said valve member said beveled cams will move said jaws inwardly and permit movement of said actuator to a position with said lugs engaging in said recess and said abutments engaging the shoulder on one end of said recess and with said beveled cams engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the apertures therein into or out of registry with the apertures in said body and upon completion of the movement of said valve member said beveled cams will engage said beveled cam surfaces on said fingers to cam said jaws inwardly and permit movement of said actuator in the same direction out of said valve member.

6. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, a plurality of apertures in the wall of said body, a cam ring fixed in said body inwardly of each end thereof, a plurality of axially disposed inwardly extending fingers on each cam ring, a cam surface on the inner end of each finger, a valve member slidably mounted in said body between said cam rings, a recess in the inner wall of said valve member, shoulders at each end of said recess, a plurality of apertures in the wall of said valve member, an annular groove in the inner wall of said valve member inwardly of each end, longitudinally extending fingers on each end of said valve member with the spaces between said fingers extending into said grooves, said last named fingers being so proportioned as to slidably mesh with the fingers on said cam rings to prevent rotation of said valve member relative to said body, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating member, a slot in said mandrel, opposed jaws received in said slot for radial movement, resilient means to urge said jaws outwardly of said mandrel, an elongated lug on the outer side of each jaw having an abutment at one end and a tapered surface at the other, a cam on the outer side of each jaw spaced from said lug and complementary to said annular grooves whereby upon axial movement of said actuator into said valve member said cams will move said jaws inwardly and permit movement of said actuator to a position with said lugs engaging in said recess and said abutments engaging the shoulder on one end of said recess and with said cams engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the apertures thereinto or out of registry with the apertures in said body and upon completion of the movement of said valve member said cams will engage said cam surfaces on said fingers to cam said jaws inwardly and permit movement of said actuator in the same direction out of said valve member.

7. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, an aperture in the wall of said body, a cam ring fixed in said body inwardly of said end thereof, a plurality of axially disposed inwardly extending fingers on each cam ring, a cam surface on the inner end of each finger, a valve member slidably mounted in said body between said cam rings, a recess in the inner wall of said valve member, shoulders at each end of said recess, an aperture in the wall of said valve member, an annular groove in the inner wall of said valve member inwardly of each end, longitudinally extending fingers on each end of said valve member with the spaces between said fingers extending into said grooves, said last

named fingers being so proportioned as to slidably mesh with the fingers on said cam rings to prevent rotation of said valve member relative to said body, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating member, a slot in said mandrel, opposed jaws received in said slot for radial movement, resilient means to engage said jaws outwardly of said mandrel, an elongated lug on the outer side of each jaw having an abutment at one end and a tapered surface at the other, a cam on the outer side of each jaw spaced from said lug and complementary to said annular grooves whereby upon axial movement of said actuator into said valve member said cams will move said jaws inwardly and permit movement of said actuator to a position with said lugs engaging in said recess and said abutments engaging the shoulder on one end of said recess and with said cams engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the aperture therein into or out of registry with the aperture in said body and upon completion of the movement of said valve member said cams will engage said cam surfaces on said fingers to cam said jaws inwardly and permit movement of said actuator in the same direction out of said valve member.

8. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, an aperture in the wall of said body, a cam ring fixed in said body inwardly of each end thereof, a plurality of axially disposed inwardly extending fingers on each cam ring, a cam surface on the inner end of each finger, a valve member slidably mounted in said body between said cam rings, a recess in the inner wall of said valve member, shoulders at each end of said recess, an aperture in the wall of said valve member, an annular groove in the inner wall of said valve member inwardly of each end, longitudinally extending fingers on each end of said valve member with the spaces between said fingers extending into said grooves, said last named fingers being so proportioned as to slidably mesh with the fingers on said cam rings to prevent rotation of said valve member relative to said body, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating member, opposed jaws carried by said mandrel for radial movement, resilient means to urge said jaws outwardly of said mandrel, a lug on the outer side of each jaw having an abutment at one end and a tapered surface at the other, a cam on the outer side of each jaw spaced from said lug whereby upon axial movement of said actuator into said valve member said cam will move said jaws inwardly and permit movement of said actuator to a position with said lugs engaging in said recess and said abutments engaging the shoulder on one end of said recess and with said cams engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the aperture therein into or out of registry with the aperture in said body and upon completion of the movement of said valve member said cams will engage said cam surfaces on said fingers and cam said jaws inwardly and permit movement of said actuator in the same direction out of said valve member.

9. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, an aperture in the wall of said body, a cam ring fixed in said body inwardly of each end thereof, a plurality of axially disposed inwardly extending fingers on each cam ring, a cam surface on the inner end of each finger, a valve member slidably mounted on said body between said cam rings, a recess in the inner wall of said valve member, shoulders at each end of said recess, an aperture in the wall of said valve member, an annular groove in the inner wall of said valve member inwardly of each end, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating member, a jaw carried by said mandrel for radial movement, resilient means to urge said jaw outwardly of said mandrel, a lug on the outer side of said jaw having an abutment at one end and a tapered surface at the

member inwardly of each end, longitudinally extending fingers on each end of said valve member with the spaces between said fingers extending into said grooves, said last named fingers being so proportioned as to slidably mesh with the fingers on said cam rings to prevent rotation of said valve member relative to said body, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating member, a jaw carried by said mandrel for radial movement, resilient means to urge said jaw outwardly of said mandrel, a lug on the outer side of said jaw having an abutment at one end and a tapered surface at the other, a cam on said jaw spaced from said lug whereby upon axial movement of said actuator into said valve member said cam will move said jaw inwardly and permit movement of said actuator to a position with said lug engaging in said recess and said abutment engaging the shoulder on one end of said recess and with said cam engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the aperture therein into or out of registry with the aperture in said body and upon completion of the movement of said valve member said cam will engage said cam surfaces on said fingers to cam said jaw inwardly and permit movement of said actuator in the same direction out of said valve member.

10. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, an aperture in the wall of said body, a cam ring fixed in said body inwardly of each end thereof, a cam surface on the inner end of each cam ring, a valve member slidably mounted in said body between said cam rings, a recess in the inner wall of said valve member, shoulders at each end of said recess, an aperture in the wall of said valve member, an annular groove in the inner wall of said valve member inwardly of each end, means to prevent rotation of said valve member relative to said body, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating member, a jaw carried by said mandrel for radial movement, resilient means to urge said jaw outwardly of said mandrel, a lug on the outer side of said jaw having an abutment at one end and a tapered surface at the other, a cam on said jaw spaced from said lug whereby upon axial movement of said actuator into said valve member said cam will move said jaw inwardly and permit movement of said actuator to a position with said lug engaging in said recess and said abutment engaging the shoulder on one end of said recess and with said cam engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the aperture therein into or out of registry with the aperture in said body and upon completion of the movement of said valve member said cam will engage said cam surfaces on said cam ring to cam said jaw inwardly and permit movement of said actuator in the same direction out of said valve member.

11. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, an aperture in the wall of said body, a cam ring fixed in said body inwardly of each end thereof, a cam surface on the inner end of each cam ring, a valve member slidably mounted on said body between said cam rings, a recess in the inner wall of said valve member, shoulders at each end of said recess, an aperture in the wall of said valve member, an annular groove in the inner wall of said valve member inwardly of each end, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively coupling the same to an operating member, a jaw carried by said mandrel for radial movement, resilient means to urge said jaw outwardly of said mandrel, a lug on the outer side of said jaw having an abutment at one end and a tapered surface at the

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other, a cam on said jaw spaced from said lug whereby upon axial movement of said actuator into said valve member, said cam will move said jaw inwardly and permit movement of said actuator to a position with said lug engaging in said recess and said abutment engaging the shoulder on one end of said recess and with said cam engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the aperture therein into or out of registry with the aperture in said body and upon completion of the movement of said valve member, said cam will engage said cam surface on said cam ring to cam said jaw inwardly and permit movement of said actuator in the same direction out of said valve member.

12. A well string valve and actuator comprising a tubular body, means at each end of said body to couple the same to a well tubing, an aperture in the wall of said body, cam means fixed in said body inwardly of each end, a cam surface on each cam means, a valve member slidably mounted on said body between said cam means, a recess in the inner wall of said valve member, shoulders at each end of said recess, an aperture in the wall of said valve member, an annular groove in the inner wall of said valve member inwardly of each end, a valve member actuator comprising an elongated mandrel, means at each end of said mandrel for selectively cou-

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pling the same to an operating member, a jaw carried by said mandrel for radial movement, resilient means to urge said jaw outwardly of said mandrel, a lug on the outer side of said jaw having an abutment at one end and a tapered surface at the other, a cam on said jaw spaced from said lug whereby upon axial movement of said actuator into said valve member said cam will move said jaw inwardly and permit movement of said actuator to a position with said lug engaging in said recess and said abutment engaging the shoulder on one end of said recess and with said cam engaging in one of said annular grooves, further movement of said actuator in the same direction serving to move said valve member axially and the aperture therein into or out of registry with the aperture in said body and upon completion of the movement of said valve member said cam will engage said cam surface on said cam means to cam said jaw inwardly and permit movement of said actuator in the same direction out of said valve member.

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