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SHUT-OFF VALVE FOR DUAL COMPLETION UPPER PACKER

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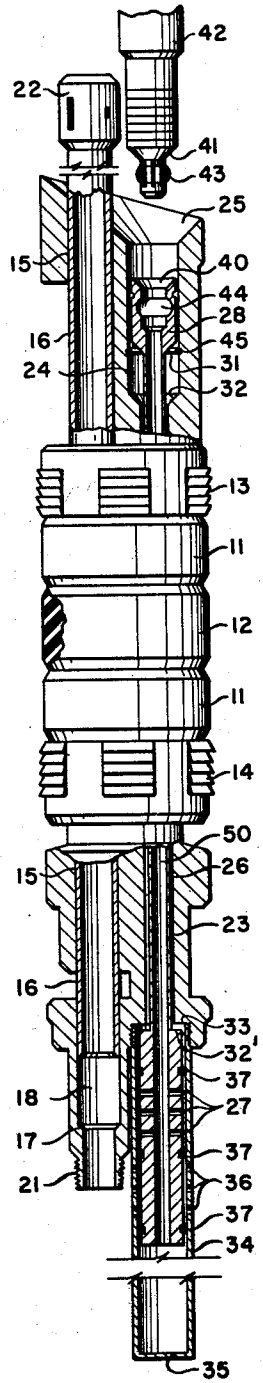


FIG. 1

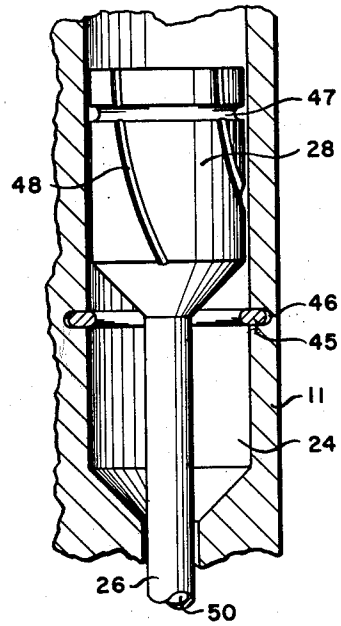


FIG. 2

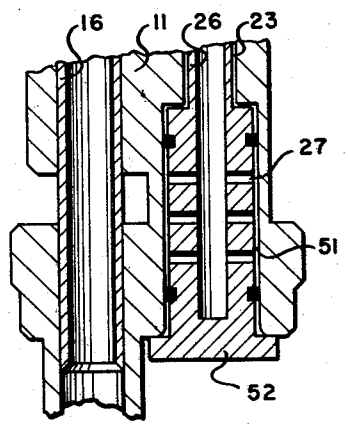


FIG. 3

INVENTOR:
D. H. HERON
BY. J. H. McCarthy
HIS AGENT

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SHUT-OFF VALVE FOR DUAL COMPLETION UPPER PACKER

David H. Heron, Maracaibo, Venezuela, assignor to Shell Oil Company, New York, N.Y., a corporation of Delaware

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The present invention relates to apparatus used in completing a well and pertains more particularly to a well packer adapted to be set in a fluidtight manner within a well to close off the space around a pair of tubing strings depending within a well casing.

In many locations, wells are completed with two strings of tubing extending from the wellhead on the surface down to one or more producing formations traversed by the well. In one type of a dual tubing-string installation, a well packer is run into the well casing while being mounted on one of the tubing strings and the well packer is subsequently set and anchored at a predetermined level within the well casing. The second string of tubing is then run down through the well casing to the top of the previously set well packer, through or into which the second tubing string is stabbed.

Dual-tubing well packers of this type have previously been provided with a flapper valve on the bottom side of the packer which is adapted to close the vertical opening in the packer through which the second tubing string is run. When the second tubing string is run through the packer, it pushes open the flapper valve and holds is open as long as the second tubing string remains in place within the well packer. This arrangement of a well packer has several drawbacks one of them being that the flapper valve has considerably more surface area than the end of the tubing string which is being used to push it open, with the result that when there is substantial well pressure below the well packer tending to hold the flapper valve closed, it has been known to bend or break a small-diameter tubing string in an attempt to open the flapper valve. Additionally, once the second tubing string has been inserted through the well packer so as to hold open the flapper valve, the flapper valve cannot close or be closed until the second tubing string has been withdrawn from the well packer. Hence, in the case of a sudden increase in pressure within the well below the well packer, this pressure is transmitted to the wellhead at the surface which must contain it.

It is therefore a primary object of the present invention to provide a well packer for dual-tubing strings which employs a valve which is automatically closed under extreme pressures below the well packer to prevent injury to equipment thereabove.

Another object of the present invention is to provide a dual-tubing well packer having a valve therein adapted to be opened or closed when a tubing string is seated or withdrawn from the top of the well packer.

A further object of the present invention is to provide a dual-tubing well packer having a valve therein adapted to be readily opened against well pressures.

Still another object of the present invention is to provide a dual-tubing well packer having a valve therein which acts as a stop member to prevent junk or wire line tools from inadvertently being run below the well packer when passing through a tubing string in communication with the valve.

These and other objects of this invention will be understood from the following description taken with reference to the drawing, wherein:

FIGURE 1 is a longitudinal view taken in partial cross-section of the well packer of the present invention as a

second tubing string is about to be stabbed into the upper end thereof;

FIGURE 2 is a view in enlarged detail, taken in partial cross-section, of the upper end of the valve apparatus of the well packer of FIGURE 1; and,

FIGURE 3 is a cross-sectional view of another arrangement of the bottom of the valve used in the apparatus illustrated in FIGURE 1.

Referring to FIGURE 1 of the drawing, numeral **11** represents the body member of any well packer which is provided with an expansible packing member **12** which is adapted to be expanded outwardly so as to seal against a surrounding well casing (not shown) in a fluidtight manner. The packing member **12** may be expanded in any conventional manner well known to the art. Additionally, the packer body member **11** may be provided with suitable slips **13** and **14** of any well known type which are adapted to be expanded against the inner wall of a well casing so as to anchor the packer body in place.

Extending through the packer body member and the entire well packer is a longitudinal conduit **15** through which a tubing string **16** is adapted to extend. The conduit **15** through the well packer may be of constant diameter throughout its length so that a string of tubing can be run therethrough or the conduit **15** may have a shoulder **17** formed on the inner wall thereof near the lower end thereof for seating a collar **18** attached to the lower end of the string **16** while further sections of the string **16**, which extend below the collar **18**, would be attached to the threaded joint **21** prior to running the well packer through the well casing. The upper end of the tubing string **16** is provided with a collar **22** or any other suitable connector means for connecting additional lengths of tubing string which extend upwardly to the surface.

A second vertical conduit **23** is formed in the packer body **11** and extends therethrough. The vertical conduit or passage **23** is enlarged in diameter at its upper end, as at **24**, while the top of the packer body member is preferably provided with a tapered surface **25** leading to the open top of the conduit or passage **23**.

Positioned for limited sliding movement within the conduit or passage **23** is a sleeve valve **26** whose lower end is provided with fluid ports **27** through the side wall thereof and whose upper end is preferably provided with an enlarged head **28**. The head **28** of the sleeve valve **26** has a shoulder **31** formed at its lower end which cooperates with an internal shoulder **32** within the enlarged passage **24** to serve as a stop for limiting the downward movement of the sleeve **26** within the passage **23**. The sleeve valve **26** is preferably of a length so that it extends below the body member **11** of the well packer with a shoulder **32'** formed on the lower end of the sleeve valve which is adapted to engage the lower end **33** of the body member **11** thus forming a stop for limiting upward movement of the sleeve valve **26**.

Fixedly secured to the lower end of the packer body member **11** and coaxially arranged to surround the lower end of the valve **26** is a valve housing **34** having a closed lower end **35**. The valve housing **34** may be of considerable length, say, 30 feet, to act as a trap for sand which may enter the apparatus. The upper end of the valve housing **34** is provided with one or more fluid ports **36** which are suitably spaced so as to register with fluid ports **27** in the lower end of the sleeve valve **26** when the valve is open. Suitable seals **37** are provided between the outer surface of the lower end of the sleeve valve **26** and the inner surface of the valve housing **34** to isolate the fluid ports **27** and **36**.

The head **28** of the sleeve valve **26** is preferably provided with a seating shoulder **40** at its upper end to receive and seat therein a cooperating shoulder **41** formed

at the lower end of a second tubing string 42 which is to be installed in the top of the well packer. The lower end of the second tubing string is provided with spring-loaded latching dogs 43 adapted to be received in a recess 44 in the head 28 of the sleeve valve 26. A snap ring 45 is mounted in a groove 46 (FIGURE 2) in the inner wall of the enlarged portion 24 of the passage 23 to serve as a positioning device for the valve, at least in its upper or closed position. The head 28 of the valve, as shown in FIGURE 2, may be provided with a circumferential groove 47 for receiving a portion of the snap ring 45 therein when the valve is in its lowermost or open position. Actually, this groove 47 need not be employed since the weight of the second tubing string 42 is sufficient to hold the valve head 28 down in its open position. Additionally, the outer surface of the valve head 28 may be provided with one or more grooves which permit fluid to pass the valve head 28 when the valve is moved from one position to the other. The bore 50 through the valve 26 is preferably of reduced diameter and thus acts to catch or stop any object which inadvertently passes down through the second tubing string 42.

In the arrangement shown in FIGURE 3, the lower end of the packer body member 11 is provided with a recess or enlarged bore of a size to receive the lower end of the sleeve valve 26 which in this arrangement has a closed lower end 52. Thus, the recessed portion 51 within the packer body member 11 serves as a valve housing. All of the ports 27 of the valve 26 are open when the valve 26 is pushed downwardly out of the recess 51.

In describing the operation of the present invention it is assumed that the packer body member 11 is positioned in a well casing in a fluid tight manner with one tubing string 16 already installed and extending through the body member. A second tubing string 42 is then run down through the well casing to the position shown in FIGURE 1 of the drawing. On further lowering of the tubing string 42, the lower end thereof contacts the tapered surface 25 at the top of the body member 11 and is guided into the enlarged passage 24 at the upper end of the passage or conduit 23. In the position illustrated the sleeve valve 26 is in its raised or closed position, being held in this position by the snap ring 45. Further lowering of the tubing string 42 causes the latching dogs 43 to be retracted as they are pushed through the bore in the head 28 of the sleeve valve 26, until the lower end of the tubing string is seated therein at which time the latching dogs 43 snap outwardly into the recess 44. Continued lowering of the tubing string 42 forces the valve head 28 past the snap ring 45 until it is seated on the shoulder 32. At this time the sleeve valve 26 is in its lowermost position with the ports 27 in register with the ports 36 in the valve housing 34. Well fluid from below the well packer is now able to enter through ports 36 and 27 and flow up through the bore 50 of the sleeve valve 26 and thence upwardly through the tubing string 42 to the surface.

In the event that flow of well fluid through the tubing string 42 has to be shut off, the tubing string is lifted an amount sufficient to pull the head 28 of the sleeve valve past the snap ring 45 at which time the ports 27 in the lower end of the valve 26 are out of register with the ports 36 and the valve housing in a manner illustrated in FIGURE 1 and the seals 37 isolate the well fluid and prevent it from entering the ports. The tension or strength of the latching dogs 43 is selected or adjusted so as to continue to exert a force greater than the force of the snap ring 45 tending to prevent movement of the sleeve valve 26. Thus, on pulling the tubing string 42 upwardly the enlarged head 28 of the sleeve valve is always pulled up past the snap ring before the latching dogs 43 are pulled out of the cooperating recess 44 within the head 28 of the sleeve valve 26.

In the event that the pressure in the well increases an undesirable amount or to a certain predetermined value, the difference in pressure acting on the sleeve valve causes the sleeve valve 26 to be raised thereby breaking communication between fluid ports 27 in the valve and 36 in the valve housing. Undesirable high pressures in the well would cause the valve 26 to be raised together with the tubing string 42 which would be raised slightly in the well casing without the snap latch 43 at the bottom of the tubing string 42 becoming unlatched from its recess 44 in the top of the valve 26. In the event that the latching dogs 43 fail to work, or are not employed, excess pressure below the packer would cause the sleeve valve 26 to be closed.

An additional advantage of the well packer of the present invention is that the packer may be run into a well casing and set therein with the sleeve valve closed in a manner shown in FIGURE 1 so that the packer can be tested as shown as it is set and prior to running the second string of tubing into place.

I claim as my invention:

1. A well packer apparatus adapted to be set in a fluid-tight manner in a well casing to close off the space around a pair of tubing strings, said well packer comprising a body member provided with outwardly expansible sealing means carried thereon and having first and second longitudinal passages therethrough, a first tubing string adapted to extend through said first longitudinal passage, a slidable sleeve valve member positioned in said second longitudinal passage for limited axial movement therein, said valve member having a flow passage therethrough in communication in its open position between the spaces above and below said body member and out of communication in its closed position, cooperating stop and valve positioning means carried by said sleeve valve member and said packer for limiting the movement of said sleeve valve member in both directions, a second tubing string having a lower end of a size adapted to be positioned in the upper end of said second longitudinal passage and seated in the upper end of the sleeve valve member, and cooperating latch means carried by the lower end of said second tubing string and the upper end of said sleeve valve member.

2. A well packer apparatus adapted to be set in a fluid-tight manner in a well casing to close off the space around a pair of tubing strings, said well packer comprising a body member provided with outwardly expansible sealing means carried thereon and having first and second longitudinal passages therethrough, a first tubing string adapted to extend through said first longitudinal passage, a slidable sleeve valve member positioned in said second longitudinal passage for limited axial movement therein, said valve member having a flow passage therethrough in communication in its open position between the spaces above and below said body member and out of communication in its closed position, cooperating stop means carried by said sleeve valve member and said packer body member for limiting the movement of said sleeve valve member in both directions, cooperating valve positioning means carried by said sleeve valve member and said packer body member for selectively positioning said sleeve valve member in one position, a second tubing string having a lower end of a size adapted to be positioned in the upper end of said second longitudinal passage and seated in the upper end of the sleeve valve member, and cooperating latch means carried by the lower end of said second tubing string and the upper end of said sleeve valve member.

3. A well packer apparatus adapted to be set in a fluidtight manner in a well casing to close off the space around a pair of tubing strings, said well packer comprising a body member provided with outwardly expansible sealing means carried thereon and having first and second longitudinal passages therethrough, a first tubing string adapted to extend through said first longitudinal passage, a tubular slidable sleeve valve member positioned in said second longitudinal passage for limited axial movement therein, said valve member being open

at the top and bottom and having fluid port means extending through the wall of the lower end of said sleeve valve member, said sleeve valve member being of a length to extend below the lower end of said packer in at least one position of the valve, cooperating stop means carried by said sleeve valve member and said packer body member for limiting the movement of said sleeve member in both directions, cooperating valve positioning means carried by said sleeve valve member and said packer body member for selectively positioning said sleeve valve member in open and closed positions, a second tubing string having a lower end of a size adapted to be positioned in the upper end of said second longitudinal passage and seated in the upper end of the sleeve valve member, and cooperating latch means carried by the lower end of said second tubing string and the upper end of said sleeve valve member, and outwardly-expandible slip means carried outwardly on said body member for fixedly positioning said well packer in a well casing.

4. A well packer apparatus adapted to be set in a fluidtight manner in a well casing to close off the space around a pair of tubing strings, said well packer comprising a body member provided with outwardly expansible sealing means carried thereon and having first and second longitudinal passages therethrough, a first tubing string adapted to extend through said first longitudinal passage, a tubular slidable sleeve valve member positioned in said second longitudinal passage for limited axial movement therein, said valve member being open at the top and bottom and having fluid port means extending through the wall of the lower end of said sleeve valve member, said sleeve valve member being of a length to extend

below the lower end of said packer in at least one position of the valve, a closed valve housing secured to the lower end of said packer in a fluidtight manner, said valve housing having port means through the wall thereof adapted to be placed in register with the port means of said sleeve valve member, the upper end of said second longitudinal passage being of enlarged diameter, cooperating stop means carried by said sleeve valve member and said packer body member for limiting the movement of said sleeve valve member in both directions, cooperating valve positioning means carried by said sleeve valve member and said packer body member for selectively positioning said sleeve valve member in open and closed positions, a second tubing string having a lower end of a size adapted to be positioned in the upper end of said second longitudinal passage and seated in the upper end of the sleeve valve member, cooperating latch means carried by the lower end of said second tubing string and the upper end of said sleeve valve member, and outwardly-expandible slip means carried outwardly on said body member for fixedly positioning said well packer in a well casing.

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