

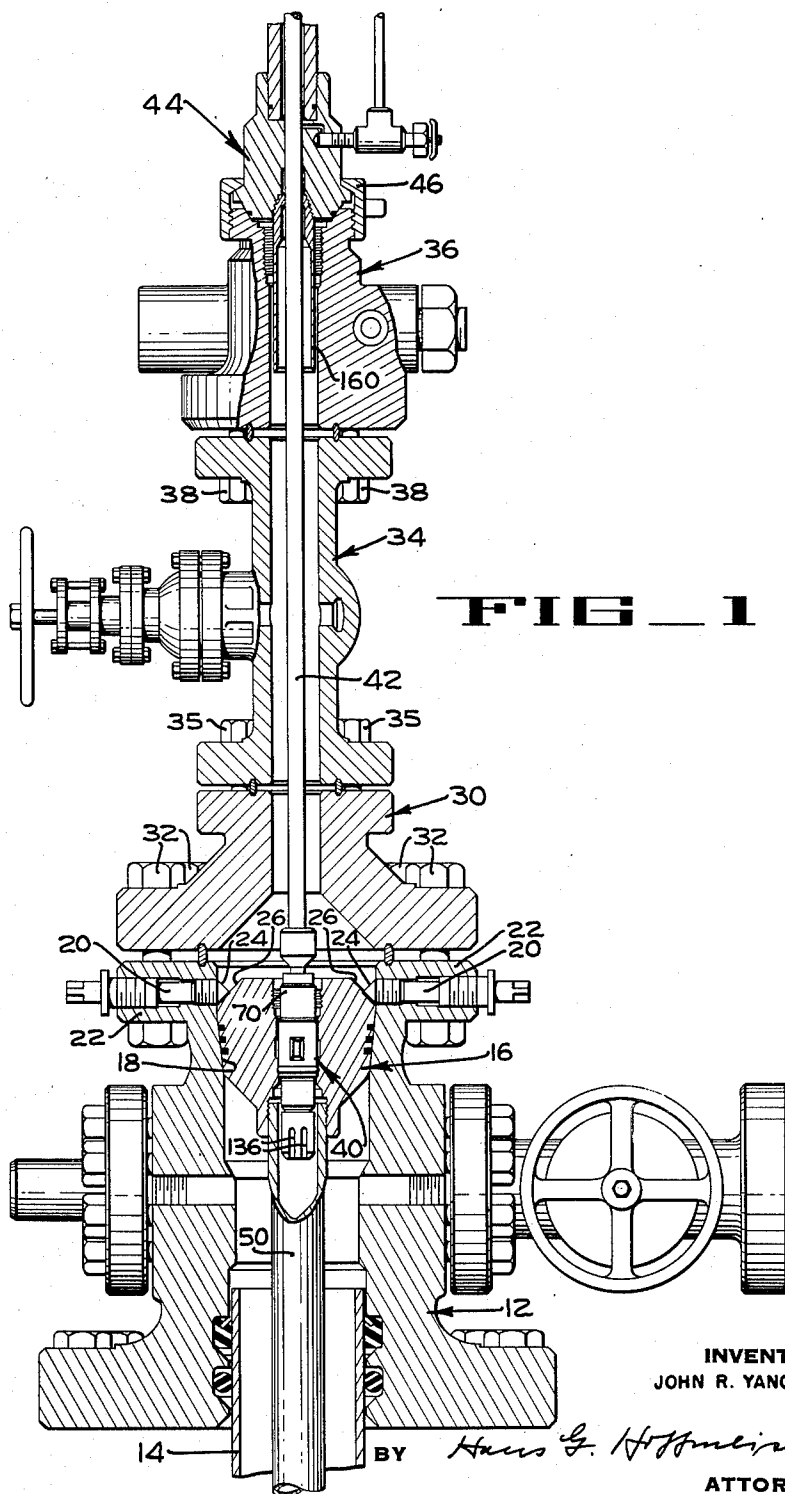
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BACK PRESSURE VALVE

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1

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BACK PRESSURE VALVE

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This invention pertains to well head equipment. More particularly the invention relates to a back pressure valve adapted to be releasably installed in a tubing string.

In certain well completion methods or other well operations that must be performed under pressure conditions, as for example, washing operations or in replacing the main cut-off valve of the Christmas tree, it is desirable to install a back pressure valve in the upper end of the tubing string to prevent escape of the well fluids therefrom. The back pressure valve so installed must subsequently be removed from the tubing string to permit the well to flow.

An object of the present invention is to provide a back pressure valve which may be run in or removed through the various assemblies of a Christmas tree, or through the blowout preventers of a recently drilled well, and detachably locked in place in the upper end of a tubing string.

Another object of the invention is to provide a back pressure valve wherein the pressures above and below the valve may be equalized prior to the disengagement of the valve assembly from the tubing string.

Another object of the invention is to provide a back pressure valve which may be released from, and resealed in, a tubing string without being removed from the Christmas tree.

These and other objects and advantages of the present invention will become apparent from the following description and accompanying drawings in which:

Fig. 1 is a vertical section through a typical well head installation illustrating the back pressure valve of the present invention installed therein, and the tool or sub used for installing and removing the back pressure valve.

Fig. 2 is an enlarged vertical section through the back pressure valve installed in a tubing hanger fixed to the upper end of a tubing string.

Fig. 3 is a partial vertical section through the back pressure valve shown in its released position and illustrating the connection between the valve and the installing and removing sub.

Fig. 4 is a horizontal section taken on line 4—4 of Fig. 3 illustrating the locking lugs in their retracted positions.

Fig. 5 is a similar section to that shown in Fig. 4 and illustrates the locking lugs in their projected or locked positions.

Referring now to the drawings, Fig. 1 illustrates a well head installation comprising a tubing head 12 fixed to the upper end of the well casing 14. A tubing hanger 16, frusto-conical in shape, is installed in the tubing head 12 and rests in a frusto-conical bowl 18 formed in the upper portion thereof. The tubing hanger 16 is held in the bowl 18 by a plurality of hold-down bolts 20 threaded laterally into the upper flange portion 22 of the tubing head 12 so that their inner conical ends 24 abut a downwardly and outwardly beveled surface 26 formed on the upper end of the tubing hanger 16. A tubing head adaptor 30 is bolted to the upper end of the tubing head 12 by a plurality of fastening members 32. Similarly, a master valve 34 is fastened to the upper end of the tubing head adaptor 30 by a plurality of fastening members 35.

2

A flow controller 36 is fastened to the upper end of the master valve 34 by a plurality of fastening members 38.

The back pressure valve 40 of the instant invention is adapted to be locked within the tubing hanger 16 and is adapted to be installed and removed by a sub 42 which is part of and extends downwardly from a back pressure valve installing assembly 44 adapted to be releasably connected to the upper end of the flow control member 36 by a quick-disconnect type connector 46.

Referring now to Fig. 2, wherein the tubing hanger 16 is shown on an enlarged scale, the upper end of a tubing string 50 is threadedly received in the lower end of the tubing hanger 16 by means of threads 52 formed at the lower end of a bore 54 which extends through the hanger 16. The bore 54 of the tubing hanger 16 is formed with an annular recess 56 adapted to receive the locking lugs 58 of the back pressure valve 40. An annular upwardly facing internal shoulder 60 is formed in the bore 54 below the annular recess 56 and is adapted to be contacted by a downwardly facing external shoulder 62 formed on the outer surface of the back pressure valve assembly 40.

Referring now to the back pressure valve assembly 40, per se, the valve assembly comprises a cylindrical housing 70 on which the previously mentioned downwardly facing shoulder 62 is formed. A tubular mandrel 72 is slidably received within the upper portion of the cylindrical housing 70. The mandrel 72 comprises an upper cylindrical body portion 73 slidably received within the bore of the housing, and a cylindrical extension 74 of reduced diameter projecting from the lower end of the body portion 73 in axial alignment therewith. Whereas the upper and lower portions 73 and 74 of the mandrel 72 are rigid with each other, they are preferably separably interconnected to facilitate assembly of the apparatus, threads 76 being employed to provide the desired rigid but separable interconnection between the mandrel parts 73 and 74. Since the mandrel extension 74 is of smaller external diameter than the body portion 73 of the mandrel 72, the extension 74 is spaced from the inner surface of the tubular housing 70. The lower end of the mandrel extension 74 is provided with an outwardly extending boss 78, the outer surface of which is in sliding engagement with the inner surface of the housing 70. Two annular grooves 80 are formed in the outer surface of the boss 78, and suitable O-ring seals 82 are mounted in the grooves 80 and abut in sealing engagement with the inner surface of the housing 70. The O-rings 82 are spaced vertically from each other for purposes which will be described hereinafter.

A sleeve 90 is slidably mounted on the outer surface of the mandrel extension 74. The sleeve 90 comprises an upper portion 92 which is of such thickness that the outer surface thereof is in sliding contact with the inner surface of the cylindrical housing 70. The lower portion 94 is of thinner cross section and of lesser outside diameter, and is, therefore, normally spaced from the inner surface of the cylindrical housing 70. A downwardly and inwardly tapered cam surface 96 connects the outer surfaces of the upper and lower portions 92 and 94, respectively, of the sleeve 90.

When the mandrel 72 is in its upper position relative to the housing 70, as illustrated in Fig. 3, the upper edge of the boss 78 abuts the lower end of the sleeve 90 and the sleeve 90 is thus raised to a position wherein the reduced diameter lower portion 94 thereof is adjacent the radially extending locking lugs 58 whereby the lugs 58 are permitted to move inwardly so that their outer ends are within the outer confines of the housing 70.

An examination of the transverse sections illustrated in Figs. 4 and 5 will show that, while the lugs 58 appear to be in opposed relation to each other in the illustration of Figs. 2 and 3 they are shown in this man-

ner for convenience only, and that the members 58 are actually three in number spaced at equal intervals of 120° around the housing 70. While it is preferred that three locking lugs spaced equally about the periphery of the housing 70 be used, the particular number of lugs forms no part of the instant invention and the structure would be equally operative with a different number of lugs, for example, two or four, equally spaced about the periphery of the housing 70. The lugs 58 are mounted in suitable openings 100 formed in the housing 70 and are enlarged at their inner ends as indicated at 102 to limit the outward movement of the lugs 58 to prevent the lugs 58 from disengaging the housing 70 through excessive outward movement with respect thereto. The inward movement of the lugs 58 is controlled by abutment thereof with the sleeve 90 mounted on the mandrel extension 74.

The movement of the mandrel 72 relative to the housing 70 is controlled by a pin 110 (Fig. 3) fixed to the mandrel 72 and extending outwardly therefrom through a helical slot 112 formed in the housing 70. The sub 42 is adapted to be releasably connected to the mandrel 72 by means of a conventional pin and J-slot connection wherein the pin 114 is formed on the lower end of the sub 42 and is adapted to be received within the J-slot 116 formed in the upper end of the mandrel 72.

A valve cage 120 is threaded to the lower end of the housing 70 as indicated at 122 and a valve seat assembly 124, provided with an outwardly extending annular flange 126, is locked to the lower end of the housing 70 with the flange 126 clamped between the lower end of the housing 70 and an upwardly facing shoulder 128 formed in the valve cage 120. A ball valve 130 is slidably mounted within the cage 120 and is adapted to be pressed upwardly against the lower end of the valve seat assembly 124 by a compression spring 132 confined between the ball 130 and the lower end 134 of the valve cage 120. As best seen in Fig. 1, a plurality of slots 136 are formed in the cage 120 to permit fluid from the tubing string 50 to enter into the cage 120 below the ball valve 130, or conversely to permit fluid pumped downwardly through the valve assembly 40 to flow outwardly through the cage 120 into the tubing string 50.

Immediately above the lower end of the housing 70 there is provided a plurality of radially extending pressure equalizing ports 140 which extend through the housing 70 and provide communication between the exterior of said housing and an annular groove 142 formed on the inner surface thereof. As can be seen in Fig. 2 the previously described O-ring seals 82 are adapted to be positioned one above and one below the annular groove 142 when the mandrel 72 is in its lower position relative to the housing 70, thus sealing the ports 140 in the manner of a sleeve valve. A suitable O-ring seal 150 is mounted in a groove 152 formed in the outer surface of the housing 70 and is adapted to abut in sealing engagement with the inner surface of the tubing hanger 16 thus providing suitable sealing between the outer surface of the housing 70 and the tubing hanger 16.

In the installation of the back pressure valve assembly 40, the mandrel 72 is raised within the housing 70, and the lugs 58 are moved radially inward to their retracted positions illustrated in Fig. 3. The sub 42 is engaged in the J-slot 116 and the sub 42 is raised until the upper end of the housing 70 engages the lower end of a spacing member 160 (Fig. 1) on the valve installing assembly 44. The master valve 34 is closed and the assembly 44 with the valve 40 connected thereto is installed on the upper end of the flow control member 36 by means of the connector 46. The valve 40 is now projecting downwardly within the flow control member 36 and the upper portion of the valve housing of the master valve 34. The master valve 34 may now

be safely opened, after which the sub 42 is moved downwardly to move the valve 40 downwardly through the valve 34 until the downwardly facing shoulder 62 on the outer surface of the housing 70 abuts the upwardly facing shoulder 60 within the tubing hanger 16. The sub 42 is now rotated clockwise to disengage the pin 110 on the mandrel 72 from its seat 162 at the upper end of the helical slot 112 formed in the housing 70. The sub 42 is further lowered to move the mandrel 72 downwardly within the housing 70 which is now supported on the shoulder 60 within the tubing hanger 16. The downward movement of the mandrel 72 causes the lower end thereof to abut the upper end of the sleeve 90 and move the sleeve downwardly so that the cam surface 96 thereon engages the lugs 58 and moves the lugs 58 outwardly into the annular groove, or recess, 56 formed in the inner surface of the tubing hanger 16. After the locking lugs 58 have been extended, further movement of the mandrel 72 causes the O-rings 82 to assume the position illustrated in Fig. 2, one above and one below the annular groove 142, thus closing the radial pressure equalizing ports 140. When the valve assembly 40 is thus locked in place within the tubing hanger 16, the sub 42 is disengaged from the J-slot 116 and removed. The desired washing steps may now be carried out, or the Christmas tree assembly may safely be removed without danger of a blowout of the well fluids.

When it is desired to remove the valve 40 from the well, the sub 42 is lowered through the master valve 34 and is engaged with the upper end of the mandrel 72 by means of the J-slot connection 114-116. The sub 42 can then be used to raise the valve 40, as follows: upward movement of the mandrel 72 initially moves the lowermost O-ring seal 82 above the annular groove 142 thus permitting well fluids from within the tubing string 50 to enter the housing 70 through the ports 140 and equalize the pressure above and below the ball valve 130. Further upward movement of the mandrel 72 and the mandrel extension 74 fixed thereto causes the upper end of the boss 78 to abut the lower end of the sleeve 90, and continued upward movement of the mandrel 72 raises the sleeve 90 so that the smaller diameter lower portion 94 thereof is adjacent the lugs 58. When the pin 110 reaches the upper end of the diagonal slot 112 the housing 70 will commence upward movement, and the beveled upper edge of the annular recess 56 in the tubing head 16 will strike the beveled upper ends of the lugs 58 and force the lugs inwardly to their retracted position. When the valve assembly 40 has been raised far enough to clear the master valve 34, the master valve 34 may be closed and the back pressure valve installing assembly 44 removed from the upper end of the flow control member 36 by disconnecting the connector 46. Thus it may be seen that whenever the valve 40 is released from its seat within the tubing head 12, the pin 110 is moved to the upper end of the slot 112 and seats on the seat 162, whereby, the valve 40 is automatically conditioned so that it may be reseated in the tubing head without the necessity of removing the valve from the Christmas tree. Thus, if the valve 40 is raised until the upper end of the housing 70 contacts the lower end of the spacer sleeve 160, and it is found that the valve 40 does not clear the master valve 34, the valve 40 may be reset in the tubing head 12 by again lowering and rotating the sub 42 in the manner described above, permitting the installing assembly 44 to be removed and a proper spacer inserted between the installing assembly 44 and the flow control unit 36.

From the foregoing description it may be seen that a novel, efficient, releasable back pressure valve assembly has been provided which is capable of being installed and removed from a well under pressure without danger of a blowout of the well fluids.

5

While a preferred embodiment of the present invention is described herein it should be noted that various changes may be made therein without departing from the spirit of the invention as defined in the appended claims.

Having thus described the invention, what I claim and desire to secure by Letters Patent is:

1. In a back pressure valve, a tubular housing, a tubular mandrel comprising a body portion slidably mounted in said housing and an extension of reduced diameter projecting from the lower end thereof, means limiting longitudinal movement of said mandrel relative to said housing, a boss on the lower end of said mandrel extension, said boss being in sliding contact with the inner surface of said housing, sealing members mounted in vertically spaced apart relation on said boss and disposed in sliding sealing engagement with the inner wall of said housing, a plurality of radial ports in said housing adapted to be closed by said sealing members being positioned one above and one below said ports when said mandrel extension is in its lowermost position relative to said housing, and a check valve assembly fixed to the lower end of said housing and adapted to prevent upward flow of fluid therethrough.

2. In a back pressure valve, a tubular housing, a tubular mandrel slidably mounted in said housing, said mandrel having a reduced external diameter lower portion, a boss on the lower end of said mandrel, said boss being in sliding contact with the inner surface of said housing, a plurality of radial ports in said housing adapted to be closed by said boss when said mandrel is in a lower position relative to said housing, a plurality of locking lugs mounted in said housing for radial movement with respect thereto, cam means mounted on the reduced diameter portion of said mandrel for movement with said mandrel with respect to said housing, said cam means having a downwardly and inwardly tapered cam surface adapted to engage the lugs and project said lugs outwardly when said cam means is moved downwardly with respect to said housing, and a check valve assembly fixed to the lower end of said housing and adapted to prevent upward flow of fluid therethrough.

3. In a back pressure valve, a tubular housing, a tubular mandrel slidably mounted in said housing, said mandrel having a smaller external diameter lower portion, a boss on the lower end of said mandrel, said boss being in sliding contact with the inner surface of said housing, sealing members mounted at vertically spaced points on said boss and adapted to abut in sealing engagement with the inner wall of said housing, a plurality of radial ports in said housing adapted to be closed by said sealing members being positioned one above and one below said ports when said mandrel extension is in its lowermost position relative to said housing, a plurality of locking lugs mounted in said housing for radial movement with respect thereto, cam means mounted on the lower portion of said mandrel for limited movement with respect thereto between the lower end of the upper portion of said mandrel and the upper end of said boss and for movement with said mandrel relative to said housing, said cam means having a downwardly and inwardly tapered cam surface adapted to engage the lugs and project said lugs outwardly when said cam means is moved downwardly with respect to said housing, and a check valve assembly fixed to the lower end of said housing and adapted to prevent upward flow of fluid therethrough.

4. In a back pressure valve, a tubular housing, a tubular mandrel having a body portion slidably mounted for longitudinal movement in said housing and a tubular extension of reduced diameter fixed to the lower end of said body portion, means limiting longitudinal movement of said mandrel relative to said housing, a boss on the lower end of said mandrel extension, said boss being in sliding contact with the inner surface of said housing, a

6

pair of sealing members mounted at vertically spaced points on said boss and adapted to abut in sealing engagement with the inner wall of said housing, a plurality of radial ports in said housing adjacent the lower end thereof and adapted to be closed by said sealing members being positioned one above and one below said ports when said mandrel extension is in its lowermost position relative to said housing, a plurality of locking lugs mounted in said housing for radial movement with respect thereto, cam means mounted on said mandrel extension for limited movement with respect thereto between the lower end of the body portion of said mandrel and the upper end of said boss and for movement with said mandrel relative to said housing, said cam means having a downwardly and inwardly tapered cam surface adapted to engage the inner ends of said lugs and project them outwardly when said cam means is moved downwardly with respect to said housing, and a check valve assembly fixed to the lower end of said housing and adapted to prevent upward flow of fluid therethrough.

5. In a back pressure valve, a tubular housing, a tubular mandrel having a body portion slidably mounted for longitudinal movement in said housing and a tubular extension of reduced external diameter fixed to the lower end of said mandrel, means limiting the longitudinal movement of said mandrel relative to said housing, a boss on the lower end of said mandrel extension, said boss being in sliding contact with the inner surface of said housing, a pair of sealing members mounted at vertically spaced points on said boss and adapted to abut in sealing engagement with the inner wall of said housing, a plurality of radial ports in said housing adjacent the lower end thereof and adapted to be closed by said sealing members being positioned one above and one below said ports when said mandrel extension is in its lowermost position relative to said housing, a plurality of locking lugs mounted in said housing for radial movement with respect thereto, a cam sleeve slidably mounted on said mandrel extension for limited movement with respect thereto between the lower end of the body portion of said mandrel and the upper end of said boss and for movement with said mandrel relative to said housing, said cam sleeve having a downwardly and inwardly tapered cam surface adapted to engage the inner ends of said lugs and project said lugs outwardly when said sleeve is moved downwardly with respect to said housing, and a check valve assembly fixed to the lower end of said housing and adapted to prevent upward flow of fluid therethrough.

6. In a back pressure valve assembly, a tubular housing, a tubular mandrel slideably mounted in said housing, a plurality of locking lugs mounted in said housing for radial movement with respect thereto, cam means mounted on said mandrel for limited movement with respect thereto, said cam means having a downwardly and inwardly tapered cam surface adapted to engage said lugs and project them outwardly when said cam means is moved downward relatively to said housing, means for limiting the movement of said cam means relative to said mandrel and defining a lost motion connection permitting movement of said mandrel relative to said housing without movement of said cam means, and a check valve assembly fixed to the lower end of said housing and adapted to prevent upward flow of fluid therethrough.

7. In a back pressure valve assembly, a tubular housing, a tubular mandrel slideably mounted in said housing, a plurality of ports in said housing, valve means connected with said mandrel and adapted to close said ports when said mandrel is in its lowermost position relative to said housing, a plurality of locking lugs mounted in said housing for radial movement with respect thereto, cam means mounted on said mandrel for limited movement with respect thereto, said cam means having a downwardly and inwardly tapered cam surface adapted to engage said lugs and project them outwardly when said

7

cam means is moved downward relatively to said housing, means for limiting the movement of said cam means relative to said mandrel and defining a lost motion connection permitting movement of said mandrel relative to said housing to actuate said valve means without movement of said cam means, and a check valve assembly fixed to the lower end of said housing and adapted to prevent upward flow of fluid therethrough.

8. In a back pressure valve assembly, a tubular housing, a tubular mandrel slidably mounted in said housing, a plurality of locking lugs mounted in said housing for radial movement with respect thereto, cam means mounted on said mandrel for limited movement with respect thereto, said cam means having a downwardly and inwardly tapered cam surface adapted to engage said lugs and project them outwardly when said cam means is

8

moved downwardly relatively to said housing, means for limiting movement of said cam means relative to said mandrel, and a check valve assembly fixed to the lower end of said housing and adapted to prevent upward flow of fluid therethrough.

5

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