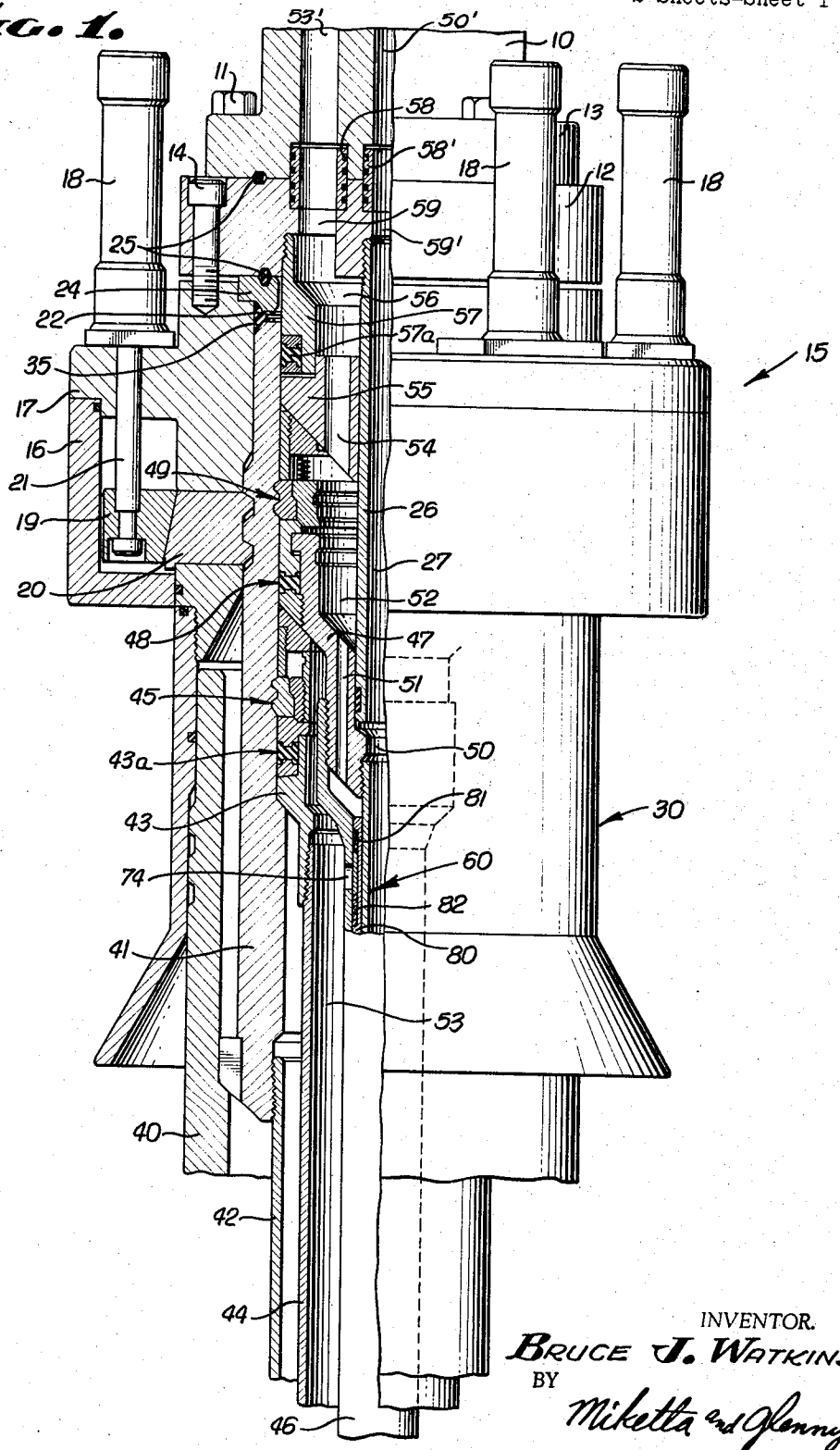
Dec. 26, 1967 B. J. WATKINS 3,360,048

ANNULUS VALVE

Filed June 29, 1964 2 Sheets-Sheet 1

Fig. 1.



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Filed June 29, 1964 2 Sheets-Sheet 2

FIG. 2.

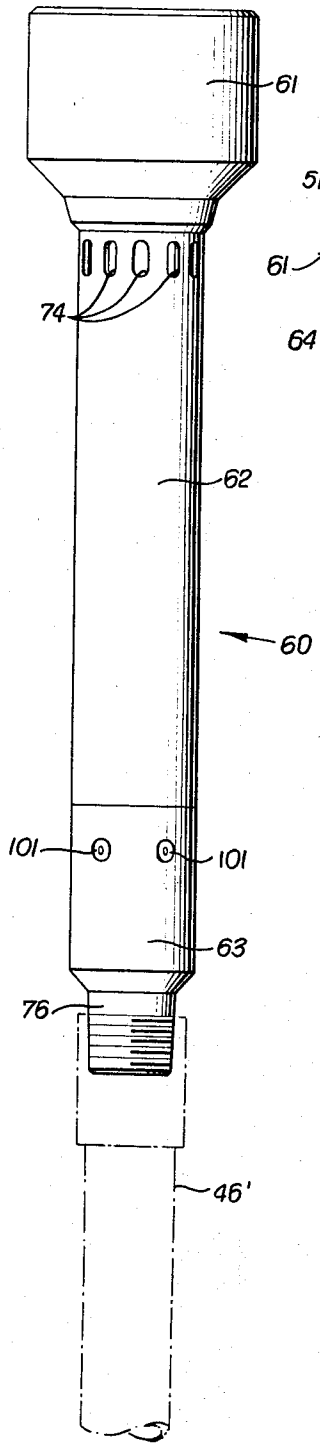


FIG. 3.

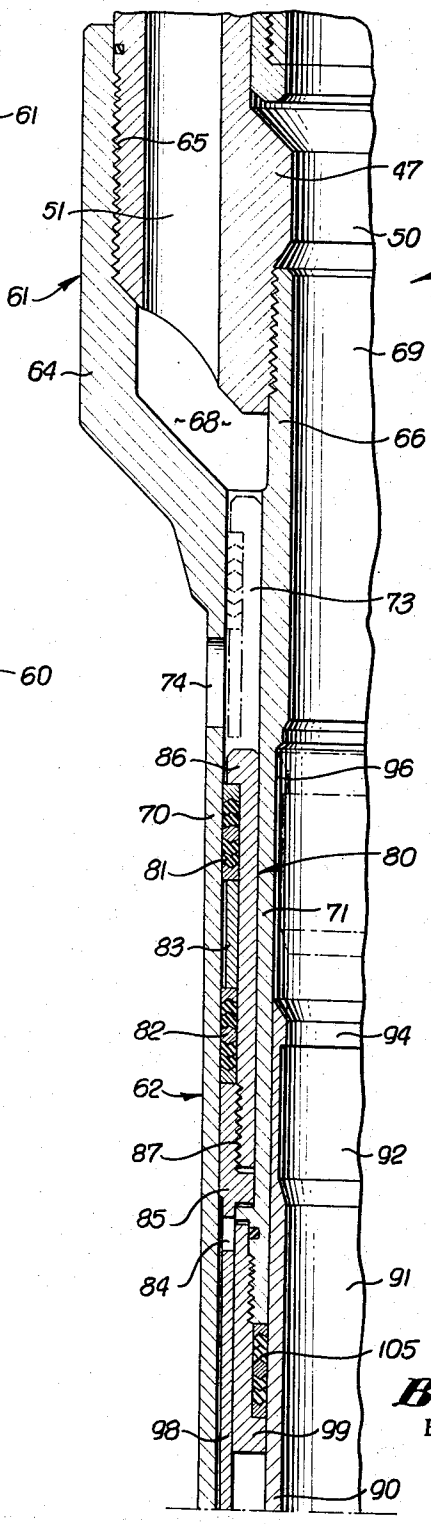
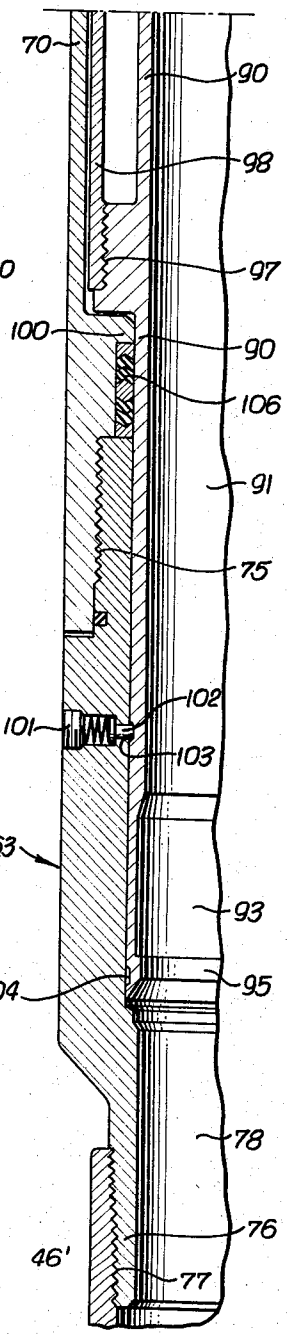


FIG. 4.



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3,360,048

ANNULUS VALVE

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15 Claims. (Cl. 166—87)

This invention relates in general to a method and apparatus for controlling fluid flow through an annulus formed between generally concentric conduits such as tubing and casing conduits employed in subsea oil well apparatus. More particularly, the present invention relates to an annulus valve operable from within an inner conduit to control fluid flow through an annulus formed between the inner and an outer surrounding conduit and to a method of controlling the operation of apparatus external of the inner conduit by manipulations within the inner conduit without allowing fluid transmission between the exterior and the interior of the innner conduit.

In oil well drilling and production operations in both land and subsea locations, oil, mud and hydraulic fluids are normally transmitted through tubing, through the tubing-casing annulus and casing annuli formed between successive generally concentric casings. Most often, these fluids are transmitted under very high pressures and with flow directions through any tube or annulus being in opposite directions during the various different operations. It has long been a problem to effectively control the flow of these high pressure fluids through the tubing-casing and casing-casing annuli. The principal solution in the past has been to seal off both the tubing and casing strings by two separate sealing elements within a casing head to effect an annulus seal. An access port into the annulus is then provided through the head between the two sealing elements. Fluid flow into or out of the annulus thus sealed off is controlled by means of a valve external of the casing head at the access port. This prior arrangement presents many problems where the casing head is not readily accessible, particularly in subsea oil well drilling and production operations where the casing head may be at the bottom of the sea perhaps hundreds of feet below the floating vessel or platform from which the drilling and production operations are being conducted. Further, the fluid flow within the annulus is not controlled within the annulus but must be directed through a valve external of the annulus. This requires additional external piping and controls which are undesirable in subsea oil well drilling and production operations. It is particularly essential to be able to easily and effectively seal off the tubing-casing annulus in such subsea operations since other fluid control means embodied in blow-out prevention equipment or the production control tree, for example, must be periodically removed during the course of the drilling and production operations.

It is, therefore, an object of the present invention to disclose and provide an apparatus for and method of controlling fluid flow through an annulus formed between subsea oil well tubing and casings which allow selective control over such annulus fluid flow from on board a remote floating vessel or platform without the use of control elements external to the casing head.

It is another object of the present invention to disclose and provide an annulus valve apparatus capable of selectably effecting a positive shut-off of a tubing-casing annulus in an oil well installation which is operable from within the tubing by standard wire line tools.

It is also an object of the present invention to disclose and provide an annulus valve as in the foregoing object which is also capable of equalizing fluid pressures exerted on opposite sides of moving parts of the valve to balance

their operation in opening and closing operations under high fluid pressures in the well.

It is a further object of the present invention to disclose and provide an apparatus for and method of controlling or positioning a device external of the tubing string in a well installation by means of positioning a controling or actuating member within the tubing.

It is another object of the present invention to disclose a method of controlling the flow of fluid in a tubing-casing annlus in a subsea oil well installation by means of manipulations of a controlling member within the tubing.

It is also an object of the present invention to disclose and provide a valve device for use in controlling fluid flow through a tubing-casing annulus formed between a casing and a tubing suspended generally concentrically within the casing by a tubing hanger where the hanger has an inner bore communicating with the tubing bore and one or more flow through passages communicating with the tubing-casing annnulus where the valve device is operable from within such inner bore to selectively open or close the annulus to the flow of fluids therethrough.

It is a further object of the present invention to disclose and provide a valve device as in the preceding object which is capable of being disposed in and made a part of the tubing and be associated with the tubing hanger to be lowered into and removed from the well with the tubing by the tubing hanger.

Generally stated, the annulus valve of the present preferred exemplary embodiment is adapted to be disposed between tubing **46** and a tubing hanger **47** at a well head. The annulus valve according to the present invention, indicated generally at **60**, and the tubing **46** suspended therefrom are supported by the tubing hanger generally concentrically within a surrounding casing **44**. The hanger bore **50** and tubing bore of tubing **46** communicate through a valve body bore **69**, **78**. The tubing-casing annulus **53** communicates with flow through passages **51** in the tubing hanger **47** through the exemplary annulus valve. Valve body **62** preferably has a head portion **61** connected to the tubing hanger **47** which provides a chamber **68** communicating with and closing off the annulus **53** therebelow from the hanger flow through passages **51**. A valve passage **73** is provided within the valve body **62** to communicate between the chamber **68** and the surrounding annulus **53** through ports **74**. Closure means, indicated generally at **80**, are provided within the annulus valve and movable in passage **73** to selectively open and close ports **74** in response to movement of internally mounted sleeve means **90**. Sleeve means **90** are mounted within the valve body and connected at **97** to the closure means, indicated generally at **80**, to be moved by wire line tools operated within the tubing bores **50**, **69** and **70** to selectively open or close the passage **73** exteriorly of the tubing bores.

Additional objects and advantages of the method and apparatus in accordance with the present invention will become readily apparent to those skilled in the art from a consideration of the following detailed description of an exemplary embodiment of apparatus in accordance with the present invention and of the method of the present invention demonstrated with such exemplary embodiment. Reference will be made to the appended sheets of drawings in which:

FIG. 1 is an exemplary embodiment of an annulus valve in accordance with the present invention shown for exemplary purposes only in an oil well installation of the subsea type;

FIG. 2 is an elevation of the exemplary annulus valve of FIG. 1; and

FIGS. 3 and 4 are detail sections of the annulus valve of FIGS. 1 and 2.

Referring now to the drawings, an exemplary embodiment of the annulus valve apparatus, in accordance with the present invention, will now be explained in detail. In FIG. 1, an exemplary form of well head latch, indicated generally at 15, is shown seated upon an oil well casing head or hanger 41 mounted generally concentrically within a well conductor 40. The lower portion of a block type Christmas tree 10 is shown secured to the top of the well head latch through an adapter flange 12. The Christmas tree 10 is secured to the adapter flange 12 through the provision of bolts 11 passing through the Christmas tree flange 13 into adapter flange 12. The adapter flange 12 is in turn bolted to the well head latch by means of bolts 14.

The exemplary well head latch, indicated generally at 15, includes a lower body portion 16 and an upper body portion 17. A plurality of vertically positioned preferably hydraulically operated latch mechanisms are mounted on the upper body portion 17. The latching mechanisms 18 may be selectively operated to move an associated camming ring 19 against dogs 20 within the well head latch against the casing head 41, as shown in FIG. 1. Camming ring 19 is moved relative to the dogs 20 by push-pull rods 21 associated with the latch mechanism 18. This exemplary form of well head latch mechanism and associated Christmas tree apparatus may employ the construction and mode of operation of the "Double Tapered Guidance Method and Apparatus" which is the subject matter of my copending application Ser. No. 326,738 filed Nov. 29, 1963. In accordance with such copending application, a double tapered guidance tool, indicated generally at 30, may be employed with the well head latch, indicated generally at 15, to facilitate and effect landing of the well head latch upon the casing head 41. As shown in FIG. 1, the well head latch is provided with sealing means 22 with a backing or retaining ring 24 between body portion 17 and adapter flange 12. In the landed position of FIG. 1, the well head latch is seated on the casing head 41 at a landing surface 35 thereon and on the seal means 22. Additional sealing means, indicated at 25, are provided between the adapter flange 12 and the associated retaining ring 24 and flange 13.

An outer casing 42 is shown suspended generally concentrically within the conductor 40 from the casing head or hanger 41. An inner casing 44 is suspended generally concentrically within the outer casing 42 and casing head 41 by a casing hanger 43 suspended within casing head 41. Sealing means and lock down means, indicated generally at 43*a* and 45 respectively, may be provided above the casing hanger 43 to hold casing hanger 43 within the casing head 41.

Tubing 46 is suspended generally concentrically within the casing 44 by a tubing hanger 47 seated on the hold-down mechanism, indicated generally at 45. Sealing means 48 may be provided to effect a seal about the tubing hanger 47 within casing head 41 and a hold-down mechanism, indicated generally at 49, may be provided to hold tubing hanger 47 in place within the casing head 41.

Tubing hanger 47 is provided with an inner bore 50 communicating with the inner bore of tubing 46 and one ore more flow through passages 51 adapted to communicate between an annulus 52 above the tubing hanger 47 and an annulus 53 below the tubing hanger and formed between the tubing 46 and casing 44. Annulus 52, in the exemplary embodiment, communicates with a passage 53' in the Christmas tree 10 through a flow through passage 54, in seating member 55, and a passage 56. Passage 56 extends through connecting or collar member 57, which is connected into the adapter flange 12 and extends down within casing head 41. Sealing means 58 are provided to effect a seal between the casing head 41 and collar 57 while a seal means 58 is provided between the Christmas tree 10 and adapter flange 12. Sealing means 58 seals the

connection between passage 53' in Christmas tree 10 and the passage 59 in adapter flange 12. Thus, the passage 53' in the Christmas tree 10, which can be interconnected by hydraulic hoses to a floating vessel or platform above the subsea location or by pipe line to a producing location, is in fluid-tight communication with the annulus 53 between tubing 46 and 44 through the seal means 58, passage 59, passage 56, flow through passage 54, annulus 52 (formed between tubing hanger 47 and an inner mandrel member 26) and the flow through passages 51 in the tubing hanger 47. In accordance with the present invention, however, the flow through passages 51 of tubing hanger 47 are enclosed by the exemplary embodiment of annulus valve, indicated generally at 60 and the annulus 53 is thereby selectively closed off from the flow through passages 51 and thus from the interconnected flow passage 53' in the Christmas tree 10.

The inner bore 50 of the tubing hanger 47 communicates with an inner bore 27 of mandrel 26 which in turn communicates through a passage 59', seal means 58' and passage 50 in the flanges 12 and 13 and Christmas tree 10.

During oil well drilling and/or production operations, it is frequently necessary to control fluid flow through the tubing casing annulus 53. Such fluid flow may be either up or down within the annulus and may be connected with the flow of fluid up or down within either or both of the tubing bore or the casing annulus between casings 42 and 44. The casing annulus between casings 42 and 44 may be interconnected to a third passage (not shown) in the Christmas tree 10 through flow through passages (not shown) in the various casing hangers and associated mechanisms. For purposes of describing the present exemplary embodiment of annulus valve according to the present invention, it is the fluid flow through the tubing-casing annulus 53 which is to be controlled and therefore the exemplary embodiment of annulus valve is disposed in the apparatus to control fluid flow through the annulus 53. However, it should be understood, the annulus valve of the present invention, may be employed in association with any annulus formed between inner and outer casing members whether generally concentric or not and that the present description of subsea oil well apparatus in which the annulus valve may be employed is exemplary of but a single use of the annulus valve of the present invention.

Coming now to the exemplary embodiment of annulus valve, in accordance with the present invention, reference will be made to the elevation of FIG. 2 and the detailed cross-sectional view of FIGS. 3 and 4. The exemplary embodiment of the annulus valve is indicated generally at 60 and includes generally, as best seen in FIG. 2, a head portion 61, a generally tubular body portion 62 and a bottom end or tail portion 63. The valve body is adapted to be disposed in and made a part of the tubing 46 and be suspended with such tubing from the tubing hanger 47, as shown in FIG. 1. As best seen in FIG. 3, the head portion 61 is provided with a generally cylindrical outer wall 64 having internal threads adapted to be screwed on to an external thread 65 on tubing hanger 47. An inner generally cylindrical wall 66, concentric to and spaced inwardly of the outer wall 64, is also provided in head portion 61 to be screwed into an internal thread 67 provided in the inner bore 50 of tubing hanger 47. Head portion 61 is thus adapted to be secured to the lower end of tubing hanger 47 by a double threaded connection. Further, the inner and outer generally cylindrical walls 66 and 64 respectively, of head portion 61 provide a generally annular chamber or cavity 68 formed therebetween. Head portion 61 may be considered to close the annulus 53 between the tubing 46 and casing 44 from the portion or associated passages, as flow through passages 51 disposed above the head 61. The chamber 68 formed within the valve head is open to the portion of annulus 53 above head portion 61 and specifically to the flow through pas-

sages in the tubing hanger, as passage **51** shown in FIG. 3. The inner bore **50** of tubing hanger **47** is open to an inner bore **69** formed within the inner wall **66** of head **61** which extends downwardly within the body portion **62**, as shown in FIG. 3.

Body portion **62** of the exemplary form of annulus valve, indicated generally at **60**, is provided with a generally cylindrical outer wall **70** and a generally cylindrical inner wall **71** generally concentric to and spaced inwardly from outer wall **70**. Inner and outer walls **71** and **70**, respectively, of the body portion **62** form an annular passage **73** therebetween which is open at its upper end to and in communication with the chamber **68** formed in the valve head **61**. A plurality of ports **74** are provided in the valve body **62** in the outer wall **70** opening the valve passage **73** to the exterior of body portion **62** and thus to the annulus **53** formed between the valve body and the surrounding casing **44**, as shown in FIG. 1.

Bottom end or tail portion **63** of the exemplary embodiment of annulus valve, indicated generally at **60**, is generally cylindrical, as best seen in FIGS. 2 and 4, and is adapted by threads **75** to be screwed into internal threads disposed at the bottom end of wall **70** of body portion **62**. A tapered nose portion **76** of tail portion **63** is adapted by external threads **77** thereon to receive and support an internally threaded tubing section **46'** of conventional form. The valve body **62** and tubing section **46'** of FIGS. 3 and 4 together may be considered to form the tubing **46** referred to in the description of the apparatus of FIG. 1. As is apparent in FIGS. 3 and 4, the inner bore **78** of the tail portion **63** communicates with the inner bore **69** of the head and body portions **61** and **62** which in turn communicates with the tubing bore **50** and associated bore **50'** of the exemplary Christmas tree **10**. In accordance with the present invention, the flow of fluids through the annulus formed about the tubing **46** and body **62** is controlled by the manipulation of standard wire line tools run through the tubing bore including the bores **50'**, **59'**, **27**, **50**, **69** and **78** as hereinafter described.

Closure means are provided in the passage between the portion of annulus **53** above head **61** and the portion of annulus **63** below head **61**. In the exemplary embodiment, the portion of annulus **53** above head **61** may be considered to include the chamber **68** and flow through passages **51** while the portion of annulus **53** below the head **61** may be considered to include the space between tubing **46** and casing **44** below the head **61**, as best seen in FIG. 1. Referring to FIG. 3, the exemplary form of closure means in accordance with the present invention includes a generally cylindrical valve or body **80** slidably mounted within the annular valve passage **73**. A pair of vertically spaced ring-like sealing means **81** and **82** are mounted on the valve or body **80** for sealing abutment against an inner surface of valve passage **73** provided by the wall **70**. The sealing means **81** and **82** may be of conventional sealing element materials and are vertically spaced on valve **80** by a spacer ring **83**. Such spacing is preferably a distance sufficient to allow said sealing means **81** and **82** to vertically straddle the plurality of annulus ports **74**, as shown in phantom line in FIG. 3. Valve **80** is shown in its open position in FIG. 3 in which the annular passage **73** freely communicates the chamber **68** through the annulus port **74** with the annulus formed exteriorly of body portion **62**. When the valve **80** is moved vertically upwardly to the position shown in phantom line in FIG. 3, wherein the sealing means **81** and **82** respectively, vertically straddle and seal the annulus port **74** from passage **73**, it may be considered to be in a closed position. The spaced walls **70** and **71** of body portion **62** forming the passage **73** may be also the means for slidably mounting valve **80** for slidable movement in passage **73** between the aforementioned opened and closed positions.

Means are also provided for communicating fluid pressure in passage **73** to the outer sides of the pair of spaced

ring-like sealing means **81** and **82** respectively, abutting the inner surface of wall **70** forming the passage **73**, to balance forces exerted thereon by the fluid pressures in either chamber **68** and/or passage **73**. Such means in the exemplary embodiment includes the provision of a port **84** extending through a lower portion **85** of the valve **80**. Any fluid pressure in the chamber **68** and/or passage **73** is communicated between valve **80** and inner wall **71**, through port **84** and between valve lower portion **85** and outer wall **70** to the bottom or outer side of the lower sealing means **82** facing downwardly in FIG. 3. The force exerted thereby upon the lower sealing means **82** balances a similar force exerted by such fluid pressures on the outer side of upper sealing means **81**, facing upwardly in FIG. 3 toward chamber **68**, and thus balances the movement of valve **80**. Such balancing of valve **80** allows its easy movement between opened and closed positions even under conditions of extremely high fluid pressures in the passage **73** and chamber **68**. When the valve **80** is in a closed position with the sealing means **81** and **82** vertically straddling ports **74**, any fluid pressure in the annulus formed between the body **62** and surrounding casing **42** are also balanced against the inner or opposed sides of said sealing means **81** and **82**. It may also be noted that in the exemplary embodiment, the upper portion **86** of valve **80** is threadably secured to the lower portion **85** by threads **87** to allow a compression of the sealing means **81** and **82** therebetween by rotation of portion **86** down on portion **85**.

Means operable from within the inner bore of the annulus valve and associated tubing are provided for moving the aforedescribed closure means within the passage **73** into and out of annulus port closure positions. In the exemplary embodiment as best shown in FIGS. 3 and 4, such means includes a generally cylindrical sleeve member **90** having a sleeve bore **91** of approximately the same diameter as the diameter of the bores **69** and **78** of the valve body. Sleeve **90** is further provided with a pair of vertically spaced generally circular internal recesses **92** and **93**, respectively, which provide opposed upper and lower shoulders **94** and **95**, respectively. It is contemplated that shoulders **94** and **95** may be selectively bumped by standard wire line tools operated within the tool bore to move the sleeve **90** upwardly or downwardly within the tool body **62**.

Sleeve mounting means are provided in the valve body for mounting the sleeve member for sliding movement vertically within the valve body recessed to the body bore. Such means in the exemplary embodiment, as best seen in FIGS. 3 and 4, includes the recessed bore portion **96** of body **62** adapted to receive and mount the sleeve **90** for vertical movement therein. Body bore recess **96** may be further adapted to mount sleeve **90** to align sleeve bore **91** with body bores **69** and **78**, as seen in FIGS. 3 and 4.

Connecting means for connecting the sleeve member **90** to the closure means **80** for moving such closure means in response to vertical sliding movement of the sleeve member **90** are provided in the exemplary embodiment by a flange **97** at a general midpoint of sleeve **90** threadably secured to a tail portion **98** of the lower body portion **85** of valve **80**, as best seen in FIG. 4. This exemplary connecting means provides a positive mechanical connection between valve member **80** and sleeve **90** whereby vertical movement of valve **80** is in direct response to vertical movement of sleeve **90**. The flange **97** extends outwardly of the inner wall **66** through an opening therein formed between inner wall terminal portion **99** and an inwardly extending flange portion **100** of outer wall **70**. Therefore, vertical movement of the sleeve member **90** within the tubing or inner wall **66** by manipulation of tooling, such as standard wire line tools, within the tubing operates apparatus disposed exteriorly of inner wall **66** (corresponding to the tubing wall) to effect an opening or closing of the annulus **53**.

Detent means **101** may be provided in the bottom or tail portion **63** including spring biased pins, as pin **102**, which are adapted to alternately engage exterior recesses **103** and **104**, respectively, in the sleeve **90**. As shown in FIG. 4, when the sleeve is in the lowered or passage opened position, the sleeve is held by detent means **101** through the spring biased pin **102** engaging recess **103**. Upon raising of the sleeve **90** by abutting the shoulder **94** from within the tubing, as by manipulating wire line tools from a floating vessel or platform above the well through the tubing, the sleeve can be raised, bringing pin **102** into engagement with recess **104**, and thus held in its raised or valve closed position. Sleeve **90** may also be considered to be part of an actuating means operable from within the tubing for actuating the closure means between the passage opened and passage closed position herein described.

Sealing means may be provided within body portion **62** for sealing the body about the actuating means operable through inner wall **66** to prevent fluid flow between the interior of the tubing and the tubing casing annulus. In the exemplary embodiment, such sealing means include the packing element or sealing means **105** which may be compressed by rotation of terminal member **99** upwardly on inner wall **66**. Sealing means **105** are also adapted to engage and seal upon the sleeve member **90** mounted within the body for sliding relation to seal means **105**. A second seal means **106** may be provided in the inwardly extending flange **100** of outer wall **70** at the bottom of the opening through inner wall **71**, through which the connecting means **97** operates, to seal upon sleeve member **90** as shown in FIG. 4. Relative rotation of the lower or tail portion **63** of the annulus valve to the outer wall **70** of body portion **62** may be used to compress the seal **106**, which may be a standard packing element, in operative condition wherein it sealingly abuts the sleeve **90**. Seal means **105** and **106** thus seal the inner bore of the annulus valve, including bore portions **69**, **91** and **78**, from the valve passage **73** and thus from the tubing-casing annulus including the portions thereof above and below the valve head **61**.

From the foregoing detailed description of an exemplary embodiment of an annulus valve, in accordance with the present invention, it can be seen readily that the valve apparatus of the present invention is capable of effecting a positive shut-off of an annulus, such as a tubing-casing annulus in a sub-sea oil well installation, by the manipulation of an actuator or sleeve member within the tubing by standard wire line tools. Further, the valve, when suspended to the tubing hanger as part of the tubing, is easily and automatically positioned in the well ready for operation by the lowering and seating of the tubing and hanger in the well. The high well fluid pressures exerted on the valve are effectively balanced and the valve is easily operated between its opened and closed positions when in operation.

In accordance with the method of the present invention, which is employed by the exemplary embodiment but not limited to such embodiment, the particular annulus formed between an inner and outer, preferably but not necessarily concentric, conduit is first completely closed to the flow of fluid therethrough.

In the exemplary embodiment, the head portion **61** closed the annulus **53** but any means could be employed. It is preferred in accordance with the present method, however, that the means for closing the annulus be associated with one of the conduits so that it is placed in position therebetween by the assembly of the conduits into a nested or telescoped position. A fluid flow passage is then established in a predetermined path through or about the means used to colse the annulus to allow fluid flow through or about said means, but only in a predetermined path. The association of the passage with one of the conduits allows ease of positioning of the passage in the annulus on assembly of the conduits. More importantly, in accordance with the present method, fluid flow through the passage is controlled by manipulations outside the annulus, either within the inner conduit or outside the outer casing. In the preferred embodiment described, the fluid flow passage **73** was associated with the inner conduit or tubing **71** and fluid flow therethrough was controlled from within the tubing. According to the present method, the fluid flow through the flow passage is controlled by selectively opening and closing the passage by a passage closure means in the passage itself. Such passage closure means is operated between passage opened and passage closed position by movement of an actuator outside of the annulus. Such actuator can be inside the inner conduit or tubing or outside the outer conduit or casing. For convenience, it is preferred that the step of opening or closing the annulus valve be effected by manipulation of an actuator within the inner conduit.

Having thus described an exemplary embodiment of the annulus valve for and the method of controlling fluid flow through an annulus formed between an inner and outer, preferably concentric, pair of conduits or casings, it should be noted that the foregoing description is exemplary of the present invention only, that various modifications, adaptations, changes and alterations can be made in the apparatus and method of the present invention which come within the scope thereof and as is defined and limited only by the following claims.

I claim:

1. An annulus valve for use in controlling fluid flow through a tubing-casing annulus formed between a casing and a tubing suspended generally concentrically within the casing by a tubing hanger where such hanger has an inner bore communicating with the tubing bore and one or more flow through passages communicating with the tubing-casing annulus, said valve device comprising:

a valve body to be interposed between the tubing and tubing hanger including a head portion to be secured to the tubing hanger, a tail portion to be connected to and support the tubing and an inner bore communicating with the hanger bore and with the tubing bore;

an annular chamber in said head portion communicating with a plurality of flow through passages in the tubing hanger;

a valve passage in said body communicating with said chamber;

a plurality of ports in said body communicating said valve passage with the tubing-casing annulus about said body;

closure means in said valve passage for closing said ports; and

means operable from within said inner bore of said body for moving said closure means in said valve passage into and out of a port closure position.

2. An annulus valve as in claim **1** wherein said closure means in said valve passage for closing said ports comprises:

a generally cylindrical body slidably mounted within said annular passage; and

a pair of spaced ring-like sealing means mounted on and extending outwardly of an outer surface of said cylindrical body for sealingly abutting on an inner surface of said valve passage, said sealing means straddling and sealing said plurality of ports when said closure means is in a port closure position.

3. An annulus valve as in claim **2** wherein means are provided for communicating fluid pressure in said valve passage to outer sides of said pair of spaced ring-like sealing means abutting the inner surface of said valve passage to balance forces exerted thereon by fluid pressures in said chamber and tubing-casing annulus.

4. An annulus valve as in claim **1** wherein said means operable from within said inner bore of said body comprises:

a generally cylindrical sleeve member having a sleeve bore of approximately the same diameter as that of said body inner bore and a pair of generally circular internal recesses in said sleeve bore providing opposed upper and lower shoulders;

sleeve mounting means in said valve body for mounting said sleeve member for sliding movement within said valve body recessed to said body bore, said sleeve bore being generally aligned with said body bore; and

connecting means for connecting said sleeve member to said closure means for moving said closure means on movement of said sleeve member.

5. An annulus valve as in claim **4** including means for mounting said connecting means within said valve body between said closure means and sleeve means for sliding movement within said body together with said sleeve member and closure means.

6. An annulus valve for use in controlling fluid flow through a tubing-casing annulus in an oil well installation between a casing and a tubing where the tubing is suspended within and generally concentric to the casing by a tubing hanger which has a hanger bore communicating with the tubing bore and flow through passages communicating with the tubing-casing annulus, said annulus valve comprising:

a valve body to be interposed between the tubing and tubing hanger including a head portion to be secured to the tubing hanger and to enclose the hanger flow through passages, a tail portion to be connected to and to support the tubing within and generally concentric to a casing mounting the tubing hanger and a valve body bore to communicate with the hanger bore and with the tubing bore;

a chamber in said head portion communicating with each of a plurality of flow through passages in the tubing hanger enclosed by said head portion;

a valve passage in said valve body communicating with said chamber and with the exterior of said valve body below said head portion;

passage closure means in said valve body for closing said valve passage; and

means within said valve body operable from within said valve body bore for operating said passage closure means between passage opened and passage closed positions.

7. The annulus valve of claim **6** wherein said valve body is provided with one or more ports in an exterior wall thereof through which said valve passage communicates with the exterior of said valve body;

said passage closure means includes a pair of spaced ring-like sealing means for abutting the interior of the ported exterior wall of the valve body to seal off said ports from said valve passage; and

said means within said valve body operable from within said valve body bore includes a generally cylindrical sleeve member mounted within said valve body bore and connecting means connecting said closure means and sleeve member to cause movement of said closure means to selectively open and close said valve passage in response to movement of said sleeve in said valve body bore.

8. An annulus valve apparatus for controlling fluid flow through an annulus between a casing and an inner tubing, said valve apparatus being connected into said tubing and comprising:

annulus closing means for closing the annulus between a casing and an inner tubing to the passage of fluid;

passage means interconnecting portions of said annulus above and below said closing means through a predetermined passage;

passage closure means;

mounting means for mounting said passage closure means for movement within said valve apparatus between passage opened and passage closed positions;

an inner bore in said apparatus aligned with the associated tubing bore; and

actuating means mounted for movement axially within said apparatus inner bore for actuating said closure means between said passage opened and passage closed positions, said actuating means being operable within said apparatus bore without removal therefrom by means removably run through said tubing and apparatus bores.

9. The annulus valve apparatus of claim **8** wherein:

said passage means is annular and is provided with a plurality of ports opening said passage to the portion of the annulus below said closing means and

said passage closure means includes:

a generally cylindrical body slidably mounted within said passage;

a pair of spaced generally circular sealing means about said cylindrical body for straddling said ports and sealing said passage against fluid flow therethrough; and

means for communicating fluid pressure in said passage to outer side surfaces of said sealing means to balance forces exerted thereon by fluid pressure in said passage.

10. The annulus valve apparatus of claim **8** wherein said actuating means comprises:

a generally cylindrical sleeve member having opposed internal upper and lower shoulders;

sleeve mounting means for mounting said sleeve member for vertical sliding movement within said apparatus bore;

connecting means for connecting said sleeve member within said apparatus bore to said passage closure means; and

means for mounting said connecting means to said apparatus for movement in response to vertical sliding movement of said sleeve within said apparatus bore to actuate said passage closure means between passage opened and passage closed positions.

11. A valve for use in controlling fluid flow through an annulus formed between a casing and an inner concentric tubing, said valve comprising:

a body portion forming a part of said tubing;

a head portion closing the annulus between the casing and tubing above said body portion and including a chamber communicating with the annulus above said head portion;

a passage in said body portion communicating with said chamber, said body portion including a plurality of ports opening said passage to the annulus between said casing and body portion below said head portion;

port closure means within said body portion for closing said ports including mounting means for slidably mounting said port closure means for movement between a port opened position and a port closed position; and

means operable from within said tubing for moving said port closure means between said port opened and port closed positions.

12. An annulus valve comprising:

a tubular body portion forming a part of a tubing positioned within a casing;

a head portion closing the annulus between the tubing and casing, said head portion including a chamber open to said annulus above said head portion;

a passageway in said body portion communicating with said chamber and the annulus between the tubing and casing below said head portion;

closure means in said body portion and associated with said passageway to close said passage to fluid flow therethrough;

mounting means mounting said closure means in said body portion for movement within said body por-

tion between passage closed and passage opened positions; and

means operable within said body portion from within said tubing for moving said closure means between aid passage closed and passage opened positions.

13. An annulus valve apparatus for controlling fluid flow through an annulus between a casing and an inner tubing wherein said valve apparatus is connected into said tubing and has an apparatus bore aligned to the tubing bore, said apparatus comprising:

annulus closing means for closing the annulus between the casing and the inner tubing to the passage of fluid;

passage means interconnecting portions of said annulus above and below said annulus closing means through a predetermined passage; and

passage closure means and associated actuating means mounted within said valve apparatus for opening and closing said passage means to control fluid flow in the annulus between said tubing and casing, said actuating means being operable within said apparatus bore without removal therefrom by means removably run through said tubing and apparatus bores.

14. An annulus valve for use in controlling fluid flow through a tubing-casing annulus formed between a casing and a tubing suspended within the casing by a tubing hanger wherein such hanger has an inner bore communicating with the tubing bore and one or more flow through passages, said valve device comprising:

a valve body to be interposed between the tubing and tubing hanger including a head portion to be secured to the tubing hanger, a tail portion to be connected to and support the tubing and an inner bore communicating with the hanger bore and with the tubing bore;

a valve passage associated with said body and communicating with at least one flow through passage

of said hanger and with the tubing-casing annulus about said body;

passage closure means in said valve body for closing said valve passage; and

actuator means mounted within said valve body and operable from within said inner bore of said valve body for moving said closure means into or out of a valve passage closure position, said actuator means being operable within said valve body bore without removal therefrom by means removably run through said hanger and valve body bores.

15. An annulus valve as in claim 14 wherein:

said actuator means comprises a generally cylindrical sleeve body slidably mounted within said valve body; and

said closure means in said valve body for closing said valve passage comprises:

a pair of spaced ring-like sealing means for sealingly abutting on an inner surface of said valve body, said sealing means straddling and sealing a portion of said valve passage where said valve passage is in communication with said tubing-casing annulus about said valve body when said sleeve body is moved within said valve body bore to a passage closing position.

References Cited

UNITED STATES PATENTS

3,045,759	7/1962	Garrett et al.	166—224
3,171,489	3/1965	Cole et al.	166—85
3,177,034	4/1965	Water et al.	166—4
3,273,646	9/1966	Walker	166—88
2,171,847	8/1939	Hall et al.	166—238
2,274,940	3/1942	Stoddard	166—238
2,970,648	2/1961	Daffin et al.	166—224
3,086,590	4/1963	Jackson et al.	166—6

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