July 3, 1962 S. J. GRAVES 3,042,065

WELL TOOLS

Filed April 13, 1959 2 Sheets-Sheet 1

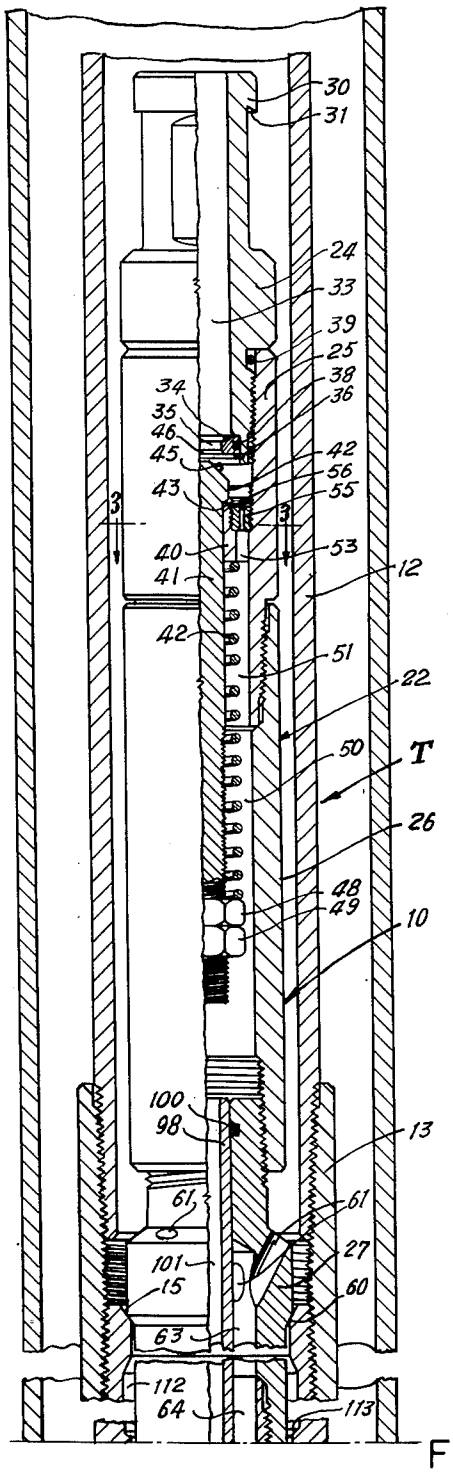


Fig. 1

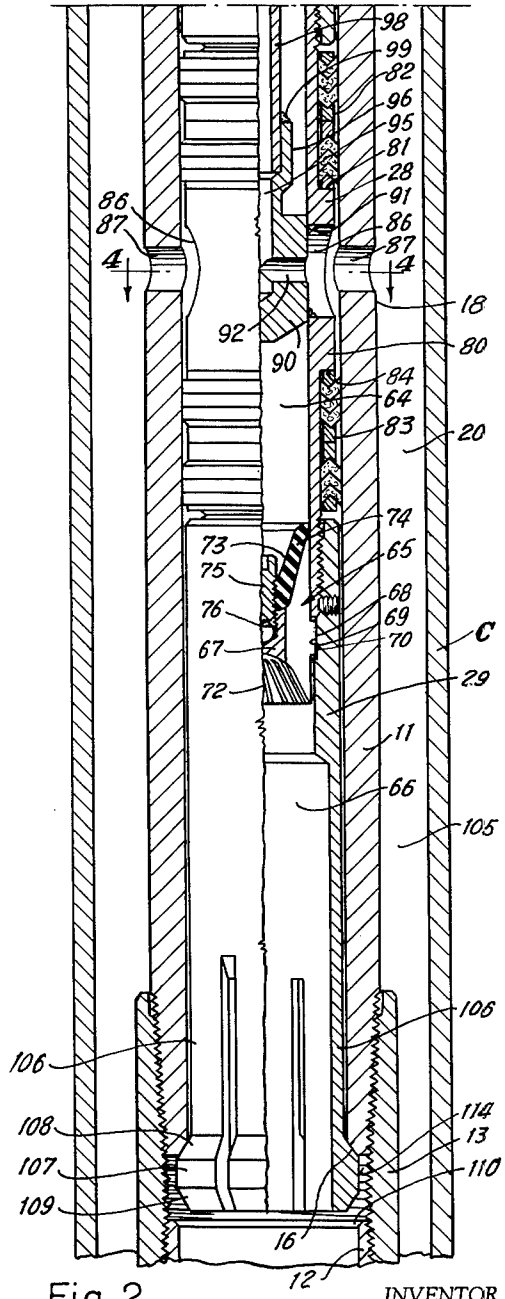


Fig. 2

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WELL TOOLS

Filed April 13, 1959 2 Sheets-Sheet 2

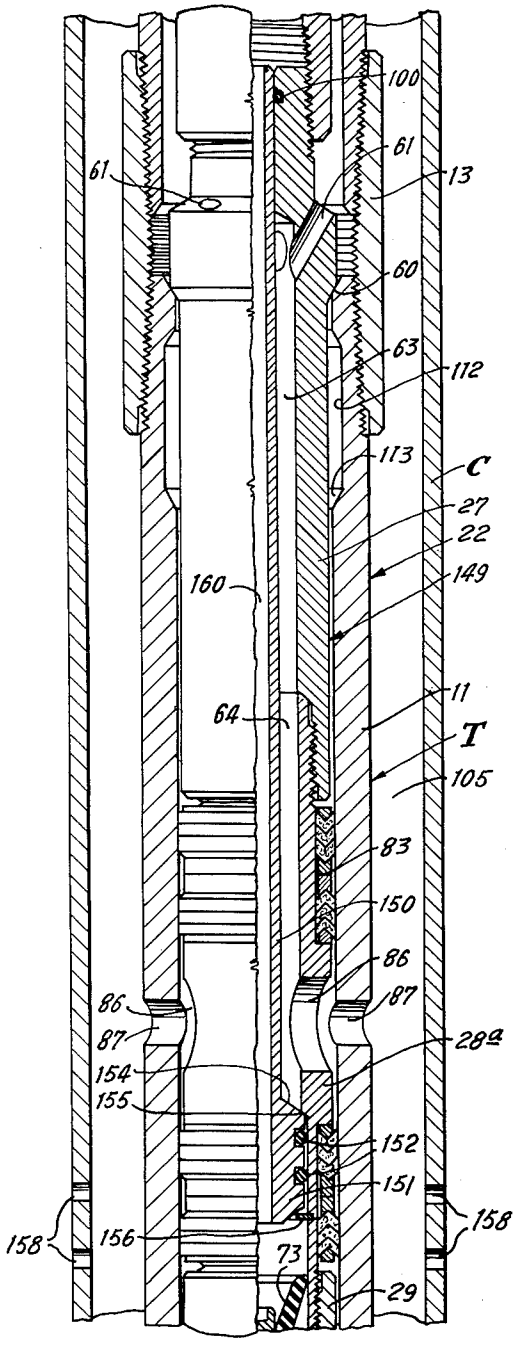


Fig. 5

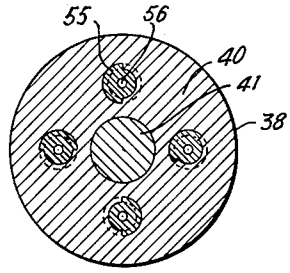


Fig. 3

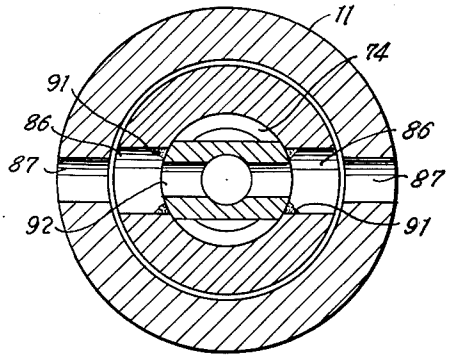


Fig. 4

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WELL TOOLS

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8 Claims. (Cl. 137—155)

This invention relates to well tools and more particularly to flow control devices which may be secured in a well flow conductor or tubing string of a well for controlling the flow of fluids from two sources into the tubing string.

An object of the invention is to provide a new and improved flow control device for use in a well flow conductor.

Another object is to provide a flow control device for well flow conductors having a pair of flow passages, each passage providing for flow of fluids from a separate source through the flow control device.

Still another object is to provide a flow control device wherein one of the flow passages opens laterally to the exterior of the flow control device intermediate its ends and the other flow passage opens downwardly of the flow control device.

A further object is to provide a flow control device wherein one of the flow passages is provided with a valve responsive to the pressure differential thereacross to control the flow of fluids through such flow passage.

A still further object is to provide a new and improved flow control device for controlling the admission of gas into a tubing string in response to the height of a column of fluid in the tubing string above the valve.

Another object of the invention is to provide a new and improved flow control device which is releasably connectable in a tubing string for controlling the admission of gas into the tubing string which opens to permit flow of gas into the tubing string when a column of fluid of predetermined height is disposed in the tubing string above the valve to aid in lifting such fluid.

Still another object of the invention is to provide a flow control device having a mandrel having a flow passage communicating with the exterior of the tubing string and closed by a valve when the pressure differential across the valve is below a predetermined value, the presusre differential decreasing below such predetermined value when the height of a column of fluid above the valve exceeds a predetermined height.

A further object is to provide a flow control device removably installable in a tubing string and provided with lift gas under pressure from the casing annulus in which the tubing string is installed which is provided with a flow passage communicating with the annulus controlled by a pressure differential responsive valve to permit flow of the uplift gas into the tubing string and with a second flow passage communicating with the tubing string below the valve for permitting flow of fluids from below the valve upwardly through and then exteriorly of the valve to permit a column of fluid from the lower end of the tubing string to flow upwardly past the valve to form a column of fluid acting downwardly on the pressure differential responsive valve whereby the pressure differential resposive valve opens when predetermined height of fluid is disposed thereabove to permit flow of the uplift gas from the casing annulus into the tubing string to lift or aid in lifting the column of fluid accumulated in the tubing string above the valve.

A still further object of the invention is to provide a flow control device for controlling the flow of fluids from two producing zones of a well through a tubing string where the flow of fluid from one producing zone

is employed to aid in lifting the fluid from the other zone through a well flow conductor.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIGURE 1, is a view, partly in elevation and partly in section, of the upper portions of the flow control device embodying the invention installed in a suitable aligning nipple of a tubing string which extends through a well casing;

FIGURE 2 is a view similar to FIGURE 1, being a continuation thereof, and showing the lower portions of the flow control device;

FIGURE 3 is a cross-sectional view taken on line 3—3 of FIGURE 1;

FIGURE 4 is a cross-sectional view taken on line 4—4 of FIGURE 2; and

FIGURE 5 is a vertical view, partly in elevation and partly in section, showing a modified form of the flow control device which utilizes the fluid of a lower producing zone of a well to aid in lifting to the surface of the well fluid produced from an upper producing zone of the well.

Referring now particularly to FIGURES 1 through 4 of the drawings, the flow control device **10** is shown positioned in a landing nipple **11** connected in and forming with the usual tubing sections **12** and connecting collars **13** the tubing string T. The landing nipple **11** has a downwardly and inwardly beveled shoulder **15** at its upper end and an inwardly an upwardly beveled shoulder **16** at its lower end. It also has lateral ports **18** which open into the annulus or flow pasage **20** between the tubing string T and the casing C of the well.

The flow control device **10** is releasably positionable in the landing nipple **11** and includes a tubular member or mandrel **22** having a top sub **24**, a valve body **25** threaded on the lower reduced end of the top sub, a spring housing **26** threaded on the lower end of the valve body, a by-pass mandrel section **27** threaded in the lower end of the spring housing, a packing mandrel section **28** threaded in the lower end of the bypass mandrel section, and a lower collet **29** threaded on the lower end of the packing mandrel section.

The top sub **24** is provided with the usual fishing neck having at its upper end an external flange **30** whose undercut annular shoulder **31** may be engaged by suitable running tools in order that the flow control device may be lowered into or removed from the tubing string. The longitudinal bore or flow passage **33** of the top sub has an enlarged lower portion to provide a downwardly facing shoulder **34** which limits upward movement of a ring seat **37** disposed in the lower enlarged portion of the bore.

Downward movement of the ring seat is limited by a split lock or retainer ring **36** which is disposed in a suitable annular internal recess of the top sub. The ring seat is provided with an external annular recess in which is disposed an O-ring or seal element **38** which seals between the top sub section **24** and the ring seat. An O-ring **39** disposed in an external recess of the top sub seals between the valve body and the top sub.

The valve body has an internal annular flange **40** through which extends longitudinally slidably an elongate solid valve **41** provided at its upper end with an external annular flange **42** whose lower shoulder **43** abuts the top of the internal flange **40** of the valve body section to limit downward movement of the valve in the valve body. The outwardly and downwardly beveled seal shoulder **45** at the upper end of the valve **41** is adapted to engage the annular upwardly and inwardly beveled seat **46** of the ring seat

when the valve is raised to an upper position to close the bore 33 of the upper sub 24.

The valve 41 is biased to its lower open position by a spring 42 disposed about the valve body below the internal flange 40 thereof and having opposite ends bearing against the lower end of the internal flange and the upper end of an adjusting nut 48 threaded on the valve. A second nut 49 also threaded on the valve locks the adjusting nut in any adjusted position on the valve. It will be apparent that the downwardly biasing force exerted on the valve by the spring 42 may be adjusted by varying the longitudinal position of the adjusting nut on the valve member to increase or decrease the compression of the spring 42.

When the valve is in the open position illustrated in FIGURE 1, fluid flow may take place from the bore 50 of the spring housing through the bore 51 of the valve body to the bore 33 of the upper sub section through a plurality of transverse bores 53 provided in the internal flange 43 of the valve body. Screws 55 threaded in the upper enlarged portions of the apertures 53 have bores 56 of restricted orifice. The screws 55 serve to restrict the effective orifice of the apertures 53.

The bypass mandrel section 27 has an external annular flange providing an upwardly and outwardly extending shoulder 60 which abuts the shoulder 15 at the upper end of the landing nipple to limit downward movement of the flow control device in the landing nipple. The bypass mandrel section has a plurality of upwardly and outwardly extending bypass ports 61 which open to the exterior of the mandrel or tubular member 22 at the upper end of the external flange of the bypass mandrel section. The ports 61 communicate with the bore 63 of the bypass mandrel section which in turn communicates with the bore 64 of the packer mandrel section.

A check valve assembly 65 is mounted in the packer mandrel section to permit only upward flow of fluids through its bore 64 from the bore 66 of the collet section. The check valve assembly includes a seal retainer element 67 having an external annular flange 68 received in the enlarged bore section 69 of the collet section 29 so that its movement in the bore of the tubular member 22 is limited by the engagement of the external flange with the lower end of the packer mandrel section and with the upwardly facing shoulder 70 of the collet section. The sleeve retainer element 67 is provided with a plurality of longitudinal slots 72 which extend radially inwardly from the outer periphery of the retainer element. The upper end of the retainer has a substantially concave recess 73 in which is disposed a substantially cup shaped resilient seal element 74 which abuts the surface of the concave recess to close the upper ends of the longitudinal slots 72. The outer upper end portion of the seal element upwardly of the upper end of the retainer element engages the internal wall of the packer mandrel section. The seal element is retained in place in the concave recess of the retainer element by a bolt 75 threaded through a suitable central aperture of the seal element into a threaded bore 76 of the retainer element.

It will be apparent that when a predetermined upwardly acting pressure differential exists across the check valve 74, the pressure exerted upwardly through the longitudinal slots 72 of the retainer element will flex the seal element inwardly out of sealing engagement with the packing mandrel section whereby upward flow of fluid will take place from the bore 66 of the collet 29 to the bore 64 of the packing mandrel section. Any tendency for the fluids to flow downwardly through the bore 64 of the packing mandrel section into the bore 66 of the collet is prevented by the engagement of the sealing element with the internal wall surfaces of the packing mandrel section.

The packing mandrel section 28 has an external flange 80 providing an upwardly facing shoulder 81 which limits the downward movement of a packing assembly 82 disposed about the packing mandrel section above the external flange. Upward movement of the packing assembly is limited by the lower end of the bypass mandrel section. A similar packing assembly 83 is disposed on the packing mandrel section below the external flange and its upward movement on the packing mandrel section is limited by the downwardly facing shoulder 84 of the external flange. Downward movement of the lower packing assembly is limited by the upper end of the collet.

The packing mandrel is provided with a plurality of lateral ports 86 which, when the mandrel 22 is properly positioned in the landing nipple in the position illustrated in FIGURES 1 and 2, is in communication with the lateral ports 87 of the landing nipple.

A weldment 90 which extents transversely through the bore of the packing mandrel section is rigidly secured therein in any suitable manner, as by welds 91, which also provides a fluid tight seal between the contacting surfaces of the weldment and of the packing mandrel section so that any flow of fluid through the lateral ports 86 of the packing mandrel section must be through the transverse flow passage 92 of the weldment whose opposite ends communicate with the lateral ports of the packing mandrel section. The transverse flow passage 92 of the weldment communicates with the bore or flow passage 95 provided by an integral tubular extension 96 of the weldment.

A tube 98 telescoped in the upper enlarged portion of the bore 95 of the weldment extension is rigidly secured therein in fluid tight relation by any suitable means, as by a weld 99. The tube 98 extends upwardly through the bores 64 and 63 of the packing mandrel section and the bypass mandrel secton, respectively, into the reduced portion of the bore 63. An O-ring or other suitable sealing element 100 disposed in an internal annular recess of the bypass mandrel section seals between the upper ends of the tube and of the packing mandrel section so that any fluid flow through the bores of the packing mandrel section and of the bypass mandrel section can flow upwardly or downwardly only through the bypass ports 61 while fluid flow into the bore 101 of the tube can take place only from exteriorly of the landing nipple through the ports 15 of the landing nipple and the packing mandrel section, of the transverse flow passage 92 and the bore 95 of the weldment 90. The packing assemblies 82 and 83 prevent any fluids from the casing annulus 105 from passing between the mandrel 22 and the landing nipple.

The collet 29 has a plurality of resilient fingers 106, whose external bosses 107 are provided with outwardly convergent upper and lower shoulders 108 and 109, respectively. The upper shoulders 108 of the collet bosses are adapted to abut the downwardly facing shoulder 16 at the lower end of the landing nipple to prevent accidental upward displacement of the flow control device in the landing nipple when the mandrel 22 is positioned in the landing nipple.

In use, when it is desired to install the flow control device in the landing nipple 11 of the tubing string T, it is lowered into the well by the use of any suitable running tool which engages the undercut shoulder 31 of the flange 30 of the upper sub. The collet fingers flex inwardly during downward movement of the gas lift valve through the tubing string upon meeting upwardly facing obstructions, such as the upper ends 110 of the tubing sections 12. When the lower shoulders 109 of the collet fingers abut the upper shoulder 15 of the landing nipple, they again flex inwardly and the collet enters into the landing nipple 11. If the landing nipple is provided, for use with other well tools, with an internal locking recess 112, the bosses 107 expand and enter such recess as they move into alignment with the recess but do not prevent further downward movement of the valve in the landing nipple since their lower cam shoulders 109 engage the downwardly and inwardly beveled shoulder 113 of the recess and thus cam the fingers inwardly again to permit the flow control device to move

downwardly to the position illustrated in FIGURES 1 and 2 where further downward movement of the gas lift valve is limited by the engagement of the lower shoulder **60** of the bypass mandrel section with the upper shoulder **15** of the landing nipple. As the valve approaches such position, the collet bosses **107** move below the lower end of the landing nipple and expand outwardly into the collar recess **114** formed by the adjacent ends of the landing section, the next lower tubing section and the collar **13** which joins them. The upper cam shoulders **108** of the bosses now engage the downwardly facing shoulder of the lower shoulder **16** of the landing nipple and prevent upward movement of the gas lift valve in the landing nipple against normal forces exerted thereon during fluid flow through the well tubing but the engagement of these two shoulders will cam the collet fingers inwardly to permit upward movement of the mandrel to release the flow control device for upward movement in the event that a running tool is secured to the upper end of the mandrel **22** and an upwardly acting force is exerted thereon to remove the flow control device from the landing nipple.

When the mandrel **22** is releasably locked in the landing nipple **11**, as illustrated in FIGURES 1 and 2, the packing assemblies **82** and **83** seal between the mandrel and the landing nipple above and below the lateral ports of the mandrel and of the landing nipple.

Gas under a predetermined pressure is then introduced into the casing annulus **105** and flows through the flow passage formed by a gas or lift fluid through the lateral ports **87** and **86** of the landing nipple and of the mandrel, respectively, the flow passage **92** of the weldment, the bore **95** of the weldment's tubular extension, the bore **101** of the tube **98**, the bores **50** and **51** of the spring housing and valve body, respectively, the apertures **53** and **56** of the internal flange **40** and the screws **55**, respectively, and the bore **33** of the top sub. The gas in this flow passage creates a pressure differential across the valve **41** which moves the valve upwardly, against the force exerted by the biasing spring **42**, into its closed position wherein its beveled shoulder **45** seats against the seat **46** of the ring seat **35** and thus prevents flow of the gas from the casing annulus into the bore **33** of the upper sub **24** and thus to the tubing string above the flow control device.

Well fluids from the tubing string below the flow control device flow upwardly through a well fluid flow passage formed by the bore **66** of the collet, the slots **72** of the seal retainer **67**, the bore **64** of the packer mandrel section, the cup seal element **74** flexing inwardly to permit such upward flow of the well fluids, the bore **63** of the bypass mandrel section **27** and the bypass ports **61** to the exterior of the mandrel **22** above the packing assembly **82**.

The continued flow of the well fluids upwardly through the latter flow passage causes a column of fluid to form in the tubing string above the flow control device and to increase in height until it reaches a predetermined height in the tubing string. When the column of fluid reaches such predetermined height, the weight of the fluid acting on the upper end of the valve **41** equalizes or reduces the pressure differential across the valve so that the valve is moved downwardly from its closed position to the open position illustrated in FIGURE 1 and the gas from the annulus flows upwardly through the gas flow passage of the flow control device into the tubing above the valve to aid in the lifting of the column of well fluids. As the column of well fluid above the valve is lifted and expelled at the surface from the tubing string, the pressure above the valve drops and, since the orifices of the screws **56** are restricted, the decrease in the pressure above the valve creates a pressure differential which acts upwardly on the valve to move it again to its closed position. The valve will thus open and close intermittently as the well fluids flow upwardly through the well fluid flow passage of the flow control device to create columns of fluid above the mandrel to permit the gas to flow through the gas flow passage of the flow control device to aid in the lifting of such well fluids to the surface of the well. It will be apparent that the check valve **74** prevents any reverse or downward flow of well fluids or of the lift gas downwardly through the well fluid flow passage.

When it is desired to remove the flow control device from the tubing string, a suitable running tool is lowered into the tubing string by means of the usual flexible line to engage the undercut shoulder **31** of the top sub. An upward pull is then imparted to the control mandrel which causes the collet fingers to flex inwardly to permit upward removal of the flow control device from the tubing string, the camming action of the upper shoulders **108** of the collet bosses of the collet fingers biasing the collet fingers inwardly upon meeting downwardly facing obstructions in the tubing string during such upward movement.

It will now be seen that a new and improved well tool or flow control device for a well flow conductor has been illustrated and described which includes a mandrel having an external shoulder **60** for locating the well tool in a predetermined position in a landing nipple against further downward movement and with a collet **66** for locking the mandrel against upward movement in the well flow conductor.

It will further be seen that the flow control device includes a mandrel which provides a gas flow passage from the exterior of the mandrel inwardly and upwardly to a valve body in which a valve **41** is slidably mounted for longitudinal movement between an upper position wherein it prevents flow of gas from the exterior of the mandrel through the gas flow passage and outwardly of the upper end thereof and a lower position wherein it permits flow of gas from exteriorly of the mandrel upwardly through the flow passage and out of the upper end of the mandrel.

It will further be seen that the mandrel also provides a well fluid flow passage which permits flow of well fluids from the exterior of the mandrel whereby a column of well fluid may be formed above the upper end of the mandrel.

It will further be seen that a check valve assembly **65** is mounted in the bore to permit only upward flow of well fluids through the well fluid flow passage and that seal means are provided on opposite sides of the lateral ports of the landing nipple in the mandrel to prevent flow of the gas except through the gas flow passage.

It will further be seen that the mandrel is provided adjacent the upper end thereof with orifice restricting means whereby a pressure differential may be created across the valve to cause it to tend to move it upwardly to closed position.

It will further be seen that the valve is responsive to the pressure differential thereacross and moves to closed position when the pressure differential exceeds a predetermined value, which value may be adjusted by adjusting the compression of the biasing spring **42** by rotation of the adjusting nut **48**.

It will further be seen that while the lifting fluid has been described as a gas introduced into the casing annulus at the surface of the well, the lifting fluid may be fluid from an upper producing zone, either liquid or gas, which is admitted into the mandrel through the gas or lifting fluid passage and flow therethrough under the control of the valve **41**.

In FIGURE 5 is illustrated a modified form of the flow control device shown in FIGURES 1 through 4 wherein the packer mandrel section **28*a*** is provided with a tube **150** instead of the weldment **90** and tube **98** of the flow control device **10**. The tube **150** is provided at its lower end with an external flange **151** having annular recesses in which are disposed O-rings or seal elements **152**. The rings seal between the flange and the packing mandrel **28*a*** below the port **86** of the packing mandrel and

the lateral ports 87 of the landing nipple 11. The tube 150 is prevented from moving upwardly in the packer mandrel by the engagement of its upper shoulder 154 with a downwardly facing shoulder 155 of an internal annular downwardly facing shoulder 155 of the packer mandrel 28*a*. Downward movement of the packer mandrel is limited by a snap or lock ring 156 which is disposed in a suitable annular internal recess of the packer mandrel spaced below the annular shoulder 155 thereof.

The upper end of the tube 150 extends into the reduced upper end of the bore 63 of the bypass mandrel section 27 and the O-ring 100 seals between the upper end of the bypass mandrel section and the upper end of the tube to prevent flow of fluid therebetween.

The flow control device 149 is similar in all other respects to the valve 10 and is used to permit fluid from a lower producing zone or formation to aid in the lifting of the fluid of the well fluid from an upper producing zone. In such use, the flow control device 149 is locked in a landing nipple 11 in the same manner as the flow control device 10. The annulus 105 between the tubing string T and the well casing C is placed in communication with the upper producing zone of the well in any suitable manner, as by perforations 158 provided in the casing so that the well fluid from such upper producing zone will flow through the perforations 158 into the casing annulus 105 and thence through a first flow passage formed by the lateral ports 87 and 86 of the landing nipple and of the packing mandrel section, respectively, the bore 64 of the packing mandrel section above the flange 151 of the tube, the bore 63 of the bypass mandrel section, and the bypass ports 61 thereof into the tubing string to form a column of fluid above the well tool. At the same time, the fluid from the lower producing zone moves upwardly through a second flow passage formed by the bore 66 of the collet, the bore 64 of the packer mandrel section below the flange 154, the bore 160 of the tube 150, the bore 50 of the spring housing, the bore 51 of the valve body, the apertures 40 and 56 of the internal flange 40 and screws 55, respectively, and the bore 33 of the top sub when the valve 41 is in its lower open position.

When the height of the column of fluid in the tubing string above the flow control device attains a predetermined height, the pressure differentil across the valve is equalized or decreased to a predetermined value allowing the valve 41 to move downwardly due to the force of the biasing spring 42. The fluid from the lower producing zone is then permitted to flow upwardly into the tubing string through the upper end of the mandrel 22 to commingle with and aid in lifting the column of well fluid from the upper producing zone to the surface of the well. As the column of fluid is discharged from the tubing string at the surface, the pressure above the valve decreases so that the pressure differential thereacross increases and is again effective to move the valve member to closed position. The valve member is thus caused to move intermittently to open and closed positions to permit the pressure of the well fluid of the lower producing zone to aid in lifting the well fluid from the upper producing zone to the surface of the well.

It will now be seen that in both forms of the flow control device the mandrel is provided with a flow passage to permit flow of fluids from the exterior of the nipple inwardly into the mandrel and upwardly above the packing assembly 83 to the exterior of the mandrel and to the interior of the tubing string.

It will further be seen that in both forms of the flow control device fluid is permitted to flow longitudinally through a second flow passage provided by a tube connected in the mandrel.

It will further be seen that in one form of the well tool the gas from the annulus of the casing is permitted to flow to the lateral ports of the landing nipple of the tubing string and of the mandrel of the tool into a central longitudinal flow passage to the upper portion of the bore of the mandrel which is provided with a valve responsive to the pressure differential thereacross which controls the flow of the fluid.

It will further be seen that in both forms of the well tool a check valve is provided in the lower portions of the bore of the mandrel below the bypass flow passage which permits only upward flow of well fluids through the bore of the mandrel.

It will further be seen that the new and improved flow control device for controlling the flow of fluids from two different sources, into a single tubing string where such fluids commingle, is easily and releasably locked in position in a landing nipple of the tubing string.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A flow control device adapted for use in a well flow conductor having a longitudinal flow passage and a lateral inlet port therein communicating with the flow passage thereof, said flow control device including: an elongate tubular mandrel having a longitudinal bore providing a central flow passage; a tubular member secured within the bore of said mandrel in sealing relationship at its ends with said mandrel and defining with its bore a portion of said central flow passage and with said mandrel a longitudinal annular flow passage surrounding said portion of said central flow passage within said mandrel; an outlet opening from said annular passage to the exterior of said mandrel adjacent the upper end of said annular passage; a lateral aperture in said mandrel adjacent the lower end of said tubular member and communicating with one of said central flow passages and said annular flow passage, said lateral aperture being adapted for communicating with the lateral inlet port of the flow conductor for admitting fluids from said lateral port through said lateral aperture; seal means spaced longitudinally on the exterior of said mandrel on opposite sides of said lateral aperture therein and adapted to seal between said mandrel and the well flow conductor for directing fluids into said lateral aperture; said other of said central flow passage and said annular flow passage providing for flow of fluids therethrough past said lateral aperture without communication with said lateral aperture whereby two separate flow passages are provided; check valve means in the lower portion of the bore of said mandrel below said annular flow passage for preventing back flow of fluids through said mandrel; and control valve means carried in the upper portion of the bore of said mandrel above said annular passage for controlling flow from said central flow passage, said control valve means cutting off all upward flow therepast from the central flow passage when closed and being openable to permit upward flow therepast.

2. A flow control device of the character set forth in claim 1 wherein said control valve means in the upper portion of the central bore of said mandrel comprises: a valve support flange member formed in the bore of said mandrel and having an axial opening therethrough; an elongate valve member slidably mounted in the axial opening of said support flange member; a valve seat in said bore above said support flange member, said valve member having a head engageable with said valve seat for closing off upward flow through said seat and outwardly from the upper portion of the bore of the mandrel; means biasing said valve member to an open position away from said seat; and flow restricting aperture means in said valve support flange member permitting controlled flow of fluids upwardly through said flange member and from said central flow passage of said mandrel when said valve member is in the lower open position.

3. A flow control device of the character set forth in claim 2, wherein the flow restricting aperture means

in the valve support flange member permitting control of flow of fluids upwardly therethrough comprises: a replaceable orificed flow controlling bean member threaded into a flow passage through said flange member spaced laterally from said axial opening therethrough.

4. A flow control device of the character set forth in claim 1, wherein the bore of said tubular member is closed at its lower end and said lateral aperture in said mandrel communicates with the bore of said tubular member above said closure and through said bore with said control valve means in the bore of the mandrel thereabove; and wherein said annular flow passage communicates with the bore of the mandrel therebelow and through the check valve means with the lower end of the bore of said mandrel.

5. A flow control device of the character set forth in claim 4, wherein said control valve means in the upper portion of the central bore of said mandrel comprises: a valve support flange member formed in the bore of said mandrel and having an axial opening therethrough; an elongate valve member slidably mounted in the axial opening of said support flange member; a valve seat in said bore above said support flange member, said valve member having a head engageable with said valve seat for closing off upward flow through said seat and outwardly from the upper portion of the bore of the mandrel; means biasing said valve member to an open position away from said seat; and flow restricting aperture means in said valve support flange member permitting controlled flow of fluids upwardly through said flange member and from said central flow passage of said mandrel when said valve member is in the lower open position.

6. A flow control device of the character set forth in claim 1 wherein: the lower end of said annular flow passage is closed and said lateral aperture in said mandrel communicates with said annular flow passage above said closure and through said annular passage with the outlet at the upper end thereof; and wherein the bore of the mandrel communicates at each end with the bore through said tubular member to provide a continuous central flow passage through said mandrel, whereby fluids flowing through said mandrel past said check valve means are directed through the bore of said tubular member to and through said control valve means in the upper portion of the bore of the mandrel above the annular flow passage.

7. A flow control device of the character set forth in claim 6, wherein said control valve means in the upper portion of the central bore of said mandrel comprises: a valve support flange member formed in the bore of said mandrel and having an axial opening therethrough; an elongate valve member slidably mounted in the axial opening of said support flange member; a valve seat in said bore above said support flange member, said valve member having a head engageable with said valve seat for closing off upward flow through said seat and outwardly from the upper portion of the bore of the mandrel; means biasing said valve member to an open position away from said seat; and flow restricting aperture means in said valve support flange member permitting controlled flow of fluids upwardly through said flange member and from said central flow passage of said mandrel when said valve member is in the lower open position.

8. A flow control device adapted for use in a well flow conductor having a longitudinal flow passage and a lateral inlet port therein communicating with the flow passage thereof, said flow control device including: an elongate tubular mandrel having a longitudinal bore providing a central flow passage; a tubular member secured within the bore of said mandrel in sealing relationship at its ends with said mandrel and defining with its bore a portion of said central flow passage and with said mandrel a longitudinal annular flow passage surrounding said portion of said central flow passage within said mandrel; an outlet opening from said annular passage to the exterior of said mandrel adjacent the upper end of said annular passage; a lateral aperture in said mandrel adjacent the lower end of said tubular member and communicating with one of said central flow passage and said annular flow passage, said lateral aperture being adapted for communicating with the lateral inlet port of the flow conductor for admitting fluids from said lateral inlet port through said lateral aperture; seal means spaced longitudinally on the exterior of said mandrel on opposite sides of said lateral aperture therein and adapted to seal between said mandrel and the well flow conductor for directing fluids into said lateral aperture; said other of said central flow passage and said annular flow passage providing for flow of fluids therethrough past said lateral aperture without communication with said lateral aperture whereby two separate flow passages are provided; check valve means in the lower portion of the bore of said mandrel below said tubular member therein and below said annular flow passage for preventing back flow of fluids through said mandrel; and control valve means carried in the upper portion of the bore of said mandrel above said tubular member and above said annular passage for controlling flow from said central flow passage, said control valve means cutting off all upward flow therepast from the central flow passage when closed and being openable to permit upward flow therepast.

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