



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.07.2011 Bulletin 2011/29

(51) Int Cl.:
E21B 27/00 (2006.01) E21B 37/06 (2006.01)

(21) Application number: **10275133.6**

(22) Date of filing: **21.12.2010**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(72) Inventor: **Phimister, David**
Aboyne
Aberdeen
Aberdeenshire AB34 5HY (GB)

(74) Representative: **Crosby, Wendy Agnes**
Murgitroyd & Company
165-169 Scotland Street
Glasgow G5 8PL (GB)

(30) Priority: **21.12.2009 GB 0922267**

(71) Applicant: **Phimister, David**
Aboyne
Aberdeen
Aberdeenshire AB34 5HY (GB)

(54) **Downhole chemical injection tool**

(57) A downhole tool said tool comprises an inlet (3) for connection to a chemical flow line and an outlet (4) for injection of chemicals from the flow line into a downhole formation, the tool further comprises a plug (47) actuatable within the tool for selectively closing off the fluid flow path through the tool to allow for pressure testing of the flow lines without the need to convey test equipment into the production tubing and a method of testing a down-

hole chemical injection line in an oil well completion comprises the steps of deploying a downhole (1) into the well in the closed position, applying a pressure greater than the operating pressure to the tool, monitoring the pressure within the tool, reducing the pressure to operating values and then subsequently actuating the tool to an open position to allow for injection of chemicals into the well through the tool.

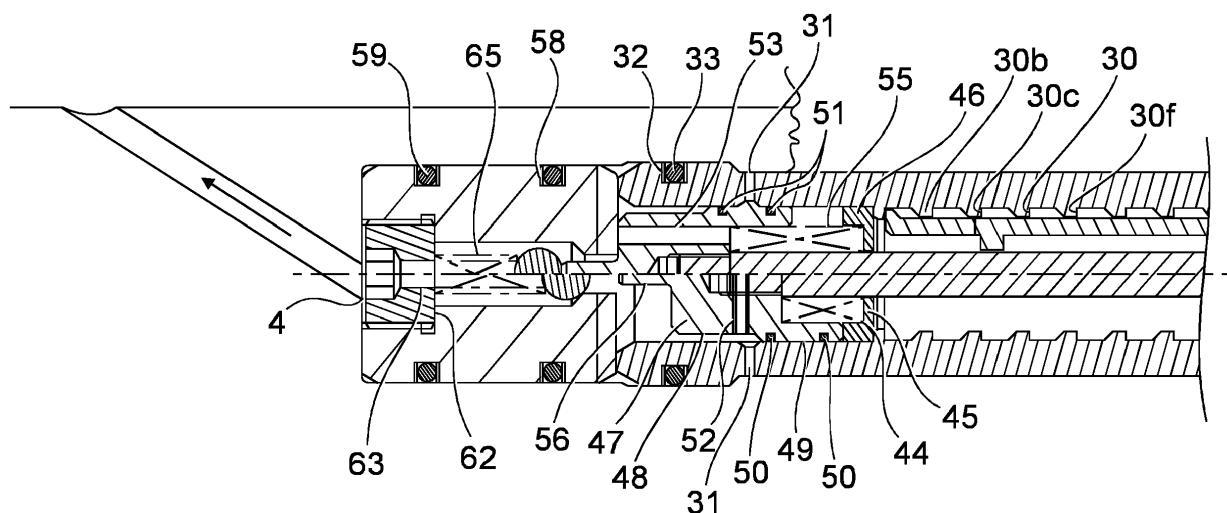


Fig. 1(c)

Description

[0001] This invention relates to a downhole tool and more particularly to a chemical injection tool which is adapted for use in a downhole environment for injecting a chemical into a production tubing of an oil or gas well.

[0002] In oil and gas production, chemicals are typically injected into the oil or gas wells in order to control or inhibit a variety of conditions such as corrosion, hydrates, asphaltenes, paraffins, scale and the like. The chemicals are pumped into the well at a controlled rate and may be introduced at selected times or locations within the well.

[0003] The tools typically comprise a body with an inlet and an outlet, the inlet being connected to a chemical line from which a chemical supply at the surface is controllably injected into the well.

[0004] Prior to the injection tool being operated downhole, the chemical line and any connections between the line and other accessories in the well must be pressure tested. In order to achieve this, a blind test plug is installed in the inner diameter of the production tubing. Once the tubing has been installed in the well, and the well bore capped with a Christmas tree, the entire chemical injection line, along with any intermediate connections made in the field will be pressure tested to a value greater than the required service pressure in the line.

[0005] On completion of pressure testing a tool must then be deployed into the well on wireline to recover the test plug and to replace it with an open plug complete with check valves to prevent well bore fluids entering the line. This operation requires significant downtime of the well and also skilled man power to recover the test plug from the well which both delays and adds a significant cost to the installation operation.

[0006] The operation of deploying a blind test plug and subsequently replacing this with an open plug typically commits the well operator to approximately 10 hours of critical path time and adds risk as incidents such as the breaking of the wire are not uncommon. In the event of a wire breaking, the tool can fall into the well causing damage both to the tool and also to components already deployed deeper in the well. Retrieving such tools can add further time and cost to the operation. Therefore use of such a wireline technique is generally limited to wells with an inclination of not more than 65 degrees from vertical to allow wire line tools to be deployed into the well under gravity.

[0007] A further drawback of using a test plug is that when the test plug is replaced with a chemical injection device with check valves it may not be possible to confirm the integrity of the seal between the device and the corresponding pocket within the chemical injection mandrel if the well is already in communication with the reservoir such as where the well has already been perforated.

[0008] As an alternative to using a blind plug as a test as described above, it is known to install a rupture disc within the chemical injection mandrel. The disc can be

selected to rupture at a pressure greater than the service pressure. This system has a limitation in that the line cannot be tested during any stage of installation to greater than a proportion of the rupture pressure. Typically discs are selected to rupture at the service pressure and the test pressure during the installation phase is usually limited to around 80% of the service pressure.

[0009] This means that there is a 20% band of uncertainty whereby any one of several field connections could fail during the final pressurisation of the system to rupture the disk thus requiring the recovery of the production tubing to repair any failed connection.

[0010] Therefore, a drawback of using rupture disks as a pressure test is that field made connections cannot be fully tested at service pressure without rupturing the disk prematurely. If the disc fails to rupture at a point of chemical line commissioning, the outcome of the failure would be either permanent loss of the facility which is a serious issue, or the recovery of the production tubing to affect a repair which could take approximately 7 days of critical path time to achieve.

[0011] The present invention aims to provide a downhole tool including a chemical injection facility which addresses the above problems and can be pressure tested to a test pressure which is greater than the operating or service pressure prior to facilitating communication between the chemical injection line and the bore of the production tubing.

[0012] According to one aspect of the present invention there is provided a downhole tool said tool comprising an inlet for connection to a chemical flow line and an outlet for injection of chemicals from the flow line into a downhole formation, the tool further comprising a plug actuable within the tool for selectively closing off the fluid flow path through the tool to allow for pressure testing of the of the flow lines without the need to convey test equipment into the production tubing.

[0013] With the plug in a closed position, the tool can be pressure tested up to and even beyond the required operating pressure before the tool is run in hole. Once deployed, with the plug still in the closed position, pressure applied to the plug can be used to check the integrity of any connections between the tool and the chemical lines connected to the tool and also the seals between the tool and the corresponding pocket in the chemical injection mandrel.

[0014] Following a successful pressure test, the plug can be actuated to the open position to allow for flow of fluid between the chemical injection line and the wellbore.

[0015] Conveniently the tool comprises an actuating rod which may be integral with or connected to the plug such that a force applied to the actuating rod causes movement of the plug between the closed and open positions.

[0016] Preferably the tool further comprises a piston which is actuable in response to pressure applied thereto. Most preferably, the piston is adapted to selectively apply a force to the actuating rod to instigate movement of the

plug between the closed and open positions.

[0017] Preferably the piston rod comprises a ratchet and preferably the ratchet is formed on the body of the piston rod.

[0018] Preferably the ratchet comprises a plurality of tapered projections. Most preferably the tapered projections are provided at an angle of 15 degrees to the longitudinal axis of the tool.

[0019] Advantageously the tool comprises an insert, said insert having a ratchet formed along one section thereof.

[0020] Preferably the insert ratchet comprises a plurality of tapered projections. Most preferably the tapered projections of the insert ratchet are provided at an angle of 45 degrees to the longitudinal axis of the tool.

[0021] Preferably the tool further comprises a sleeve. Most preferably said sleeve is adapted for sliding engagement with the piston.

[0022] Advantageously, the sleeve is a collet. Most preferably the sleeve is a double collet. In the preferred embodiment the sleeve cooperates with the ratchet body on the piston and the ratchet body on the insert.

[0023] Preferably the sleeve comprises an internally projecting annular flange. Advantageously the actuating rod comprises a radially extending boss member at the upper end thereof. Conveniently the annular flange of the sleeve is adapted to cooperate with the under surface of the boss member of the actuating rod.

[0024] Advantageously, the plug comprises an isolation spool. Most preferably said isolation spool is actuatable between a closed position and an open position. Preferably in the closed position the isolation spool closes off fluid flow from the chemical injection line through the tool and into a well. Preferably also, in the open position, the spool provides a pathway for fluids from the chemical injection line, through the tool and into the well.

[0025] Preferably also the tool further comprises a non-return valve. In use, the non-return valve functions to prevent fluids from the well entering the tool.

[0026] According to a further aspect of the present invention there is provided a method of testing a downhole chemical injection line in an oil well completion comprising the steps of deploying a tool in accordance with the first aspect of the present invention into the well in the closed position, applying a pressure greater than the operating pressure to the tool, monitoring the pressure within the tool, reducing the pressure to operating values and then subsequently actuating the tool to an open position to allow for injection of chemicals into the well through the tool.

[0027] Advantageously the method further comprises repeating the step of applying a pressure greater than the operating pressure and subsequently repeating this pressure a plurality of times.

[0028] Each successive application of pressure and reduction or bleed off of pressure represents a cycle of the tool. Preferably during each cycle of the tool, the collar is advanced along the ratchets of the piston and the in-

sert.

[0029] Thereby the tool can be operated through a number of cycles each providing for pressure testing of the tool before being set to the open position to allow for injection of chemicals into the well.

[0030] An embodiment of the present invention will now be described with reference to the accompanying drawings in which:-

Fig 1 (a) - Fig 1(c) are successive partial cross-sections of a chemical injection mandrel according to one aspect of the present invention in which everything on the right of the centre line is shown in the open position and everything on the left is shown in the closed position.

[0031] Turning now to the Figures there is shown a chemical injection mandrel 1 according to one aspect of the present invention. The mandrel comprises a hollow tubular body 2 which has an inlet 3 at the upper end (in use) and an outlet 4 in the lower end (in use). The inlet provides a connection point for a 3/8 inch chemical injection line (not shown). The connection point may be provided through a threaded connection such as a bolt or screw 5 in the upper end of the body.

[0032] A retaining cap 6 is mounted within the upper end of the tubular body 2. The retaining cap comprises a plug 7 which has an upper portion (in use) which is substantially tubular with an outer diameter which substantially matches the inner diameter of the hollow tubular body, and a lower portion 8 which is connected to the upper portion through a horizontal flange 9. The lower portion has an outer diameter which is smaller than that of the upper portion.

[0033] A longitudinal bore 10 is formed through the upper portion of the plug. In the region of the horizontal flange, the diameter of the bore increases such that the bore through the lower portion of the plug has a greater diameter than through the upper portion of the plug.

[0034] A lateral bypass port 11 extends from the bore at a point just above the horizontal flange 9, the purpose of which will be described further below.

[0035] The plug is sealingly mounted within the upper part of the tubular body. An annular groove 12 is formed in the outer surface of the plug in the region towards the lower end of the upper portion but above the opening of the bypass port. A gland or o-ring 13 sits within the groove and provides a seal between the outer surface of the plug and the inner surface of the tubular body 2.

[0036] A piston 14 is slidably mounted within the bore 10 in the lower end of the plug. The piston comprises a substantially elongate tubular body 15. The upper end (in use) of the piston is slidably received within the lower end of the bore of the plug. In its upper position, the upper end 16 of the piston is spaced from the upper end of the lower portion of the plug to form a chamber 17 as will be described further below.

[0037] An annular groove 80 is formed in the upper

end of the piston and a gland or o-ring 81 sits within the groove and provides a seal between the outer surface of the piston and the lower end of the plug.

[0038] A collar 18 is provided on the piston which extends horizontally from the main body of the piston. The outer diameter of the collar matches the outer diameter of the lower portion of the plug 7. The collar abuts the lower edge of the lower portion of the plug 8 when the piston is in its upper position.

[0039] The lower end of the piston has a ratchet form 19 with a plurality of profiled shoulders 20 the purpose of which will be described further below. In the present embodiment, the slope of the profiled shoulders is approximately 15 degrees.

[0040] An elongate insert 21 is mounted in the mandrel 1. The insert has a slightly smaller outer diameter at least at the top end than the outer diameter of the plug 7 and a slightly smaller outer diameter than the inner diameter of the tubular body. Therefore an annulus 22 is provided between the outer surface of the insert 21 and the inner surface of the tubular body 2.

[0041] The upper end (in use) of the inner surface 23 of the insert sits over the lower portion of the plug 8. A circumferential groove 24 is formed in the outer surface of the lower portion of the plug adjacent the lower end of the plug. A gland or o-ring 25 is located in the groove and forms a seal between the outer surface of the lower portion of the plug and the inner surface of the upper portion of the insert.

[0042] The insert is provided with an internal horizontal annular flange 26 in the upper part of the insert. A spring 27 surrounds the tubular body 15 of the piston and bears against the underside of the collar 18 of the piston at one end and the upper surface of the annular flange 26 of the insert at the other end and biases the piston 14 towards an upper position within the lower portion of the plug 8.

[0043] The lower end of the internal surface of the insert 28 has a ratchet form 29 with a plurality of internal annular projections 30 each with a tapered lower edge which extend into the bore of the insert. The tapered lower edges of the insert are provided at approximately 45 degrees to the vertical axis of the insert.

[0044] The number of projections on the ratchets of the piston rod 15 and the insert 28 determines the number of cycles of the device which can be carried out. It is envisaged that the number of projections will be selected to be greater than the number of cycles required in order that several cycles may be provided in reserve should they be required as will be described further below.

[0045] Horizontal ports 31 are provided through the body of the insert 21 below the ratchet 29 and spaced from the lower end of the insert. The ports provide communication between the annulus 22 around the insert and the inner bore of the insert.

[0046] The lower end of the insert is sealingly mounted within the tubular body. An annular groove 32 is provided in the outer surface of the lower end of the insert and a gland or o-ring 33 is mounted within the groove to provide

a seal between the outer surface of the lower portion of the insert 21 and the inner surface of the tubular body 2.

[0047] A double collet 34 is mounted around the lower end of the piston 14. The double collet comprises a sleeve 35 with a tubular body which in use sits between the outer surface of the piston and the inner surface of the insert 21.

[0048] The upper edge of the sleeve has an internal horizontal shoulder 36 which forms an abutment surface which cooperates with the ratchet 19 on the lower end of the piston. The internal surface of the sleeve above the internal shoulder is tapered 37, the slope of the taper matching that of the ratchet of the piston.

[0049] An internally projecting stop member 38 is provided towards the lower end of the sleeve, the purpose of which will be explained further below.

[0050] The lower end of the sleeve is provided with an externally projecting foot 39 which has a tapered upper surface 40, the slope of which matches the slope of the tapered under surface of the ratchet 29 of the insert 21.

[0051] An actuation rod 41 is mounted within the insert 21 at a position below the piston 14. The actuation rod is a generally elongate member which sits in use below the piston rod of the mandrel. The upper end of the actuation rod comprises a horizontally projecting boss 42 which extends beyond the outer diameter of the actuating rod. The lower surface of the projecting boss provides a stop surface 43 against which the inner projecting stop member 38 of the sleeve of the double collet abuts in the raised position.

[0052] The lower end of the actuation sleeve extends beyond the ratcheted inner surface of the insert. An annular spacer member 44 is mounted around the lower end of the actuating rod. The spacer member in the illustrated embodiment comprises a planar upper surface 45 with an annular depending sleeve 46. The upper surface of the spacer member abuts the underside of the lowest internal annular projection of the insert.

[0053] The outer surface of the lower end of the actuation rod 41 is threaded as will be described further below.

[0054] An isolation spool 47 is mounted on the lower end of the actuation rod 41 and is moveable by the rod between a closed and an open position. The spool may be integral with the lower end of the actuation rod.

[0055] The isolation spool comprises a body 48 which surrounds the lower end of the actuation rod. The upper end (in use) of the spool body comprises an upwardly extending external rim 49 which abuts against the annular depending sleeve 46 of the spacer member in the open position. The external surface of the rim 49 has two annular grooves 50 within which a sealing member such as a gland or o-ring 51 is located to provide a seal between the external surface of the rim of the spool and the inner surface of the lower end of the insert 21. The interior surface of the isolation spool has a thread which cooperates with the thread of the actuation rod such that the rod can be securely connected to the isolation via the threaded connection.

[0056] A horizontally extending aperture 52 is provided through one side of the body of the spool which is adapted to receive a locking means such as a spring pin (not shown). The locking means prevents the actuation rod from unscrewing from the isolation spool. A vertical equalisation port 53 is provided through the other side of the body of the spool.

[0057] A spring 55 is mounted between the under surface of the spacer member 44 and the upper surface of the spool body 48. The spring acts to bias the spool body into a lower, closed position. As the actuation rod 41 is connected to the spool, biasing of the spool to the closed position also biases the actuation rod in the closed position.

[0058] The lower end (in use) of the spool comprises a circular boss 56 which extends from the lower end of the body of the spool.

[0059] A non return valve assembly 57 is mounted in the bottom of the tubular body 2 of the tool. Seals are provided between the outer surface of the valve assembly and the inner surface of the tubular body. In the illustrated embodiment two grooves 58 are provided around the outer surface of the valve body and a gland or o-ring 59 is mounted in each groove.

[0060] The valve is of a standard design having a substantially annular body 60 with a vertical bore 61 extending therethrough. The bore is lined up with the central axis of the tool and in the closed position the boss 56 of the isolation spool extends into the bore in the valve.

[0061] A valve seat 62 is mounted within the lower end of the valve body surrounding the lower end of the bore. A vertical channel 63 is provided through the valve seat to allow for communication between the bore of the valve body and the outlet of the tubular body of the tool.

[0062] An actuation member 64 which in this embodiment is in the form of a ball is mounted at the top of the bore of the valve. The ball is biased in a raised position within the bore by a spring 65 which is mounted on the upper surface of the valve seat 62.

[0063] Operation of the tool will now be described. In the open position which is shown in the top half of Figure 1, the collet 34 is provided in the upper position between the insert 21 and the actuating piston 14 and in this position, the horizontal shoulder 36 at the upper edge of the sleeve of the collet abuts the upper profiled shoulder 20 of the piston, the internally projecting stop member 38 of the sleeve abuts the underside of the boss 42 of the actuating rod and pulls the actuating rod upwardly within the insert.

[0064] As the actuating rod 41 moves upwardly within the insert, the spool 47 is pulled upwardly against the bias of the spring 55.

[0065] In this position, the horizontal channel 52 of the spool is in communication with the lower bypass ports 54 of the insert to provide a fluid path through the tool from the retaining cap 6, through the upper bypass port 11, between the body and the insert, through the lower bypass ports 54 and through the spool 47.

[0066] In the closed position as shown in the lower half of figure 1, the spool spring 55 holds the spool in the closed position at the bottom of the insert of the tool and the collet 34 is pulled downward along the ratchet 19 of the piston until the externally projecting foot 39 of the sleeve is held on the ratchet 29 of the insert.

[0067] In this closed position, the spool is held in its lowermost position with the seals 51 straddling the lower by-pass ports 31 thus preventing communication between the by-pass gallery 22 and the well.

[0068] Before deployment of the tool into a well, the tool can be subjected to a series of pressure tests in a workshop or on site to apply a test pressure greater than the working or service pressure of the well. The non return valve assembly 57 can be pressure tested prior to assembly into the tool in a dedicated test.

[0069] A proof pressure test can be carried out via the chemical line connecting port 3 at the upper end (in use) of the tool. Pressure applied via the control line port 10 forces the actuating piston 14 downwards reacting against the actuator return spring. Downward travel of the actuating piston 14 is limited by the proximity of its lower end to the top of the actuating rod. In the illustrated embodiment, this piston stroke has been determined by design to be equivalent to 1 ½ times the ratchet pitch 20. The pressure required to translate the actuating piston fully downward is a function of control line fluid density, wellbore fluid density, final true vertical depth of the installed tool, piston cross sectional area and actuation return spring stiffness. Once the range of well parameters has been established the piston diameter and spring stiffness shall be sized to yield a suitable actuating pressure.

[0070] The lateral bypass ports 11 connect the control line port with the a by-pass gallery 22 surrounding the insert main body 21 and then in turn via the set of lower by-pass ports 31 through the insert main body back into the void below the actuating piston. The isolation sleeve 47 straddles these ports when the tool, is in its closed position.

[0071] After assembly of the tool in the workshop a proof pressure test will be carried out via the chemical line connecting port. Initial pressurisation will force the actuating piston 14 downwards compressing the return spring 27. As the actuating piston continues to travel downward, the internal tapered shoulder 37 of the double collet 34 will engage and cooperate with the second ratchet 20a with the horizontal face 36.

[0072] The actuating piston 14 will continue to travel downwards compressing the return spring 27 further until the lower face 70 of the actuating piston 14 abuts the upper face of the boss 42 of the actuating rod 41. At this point, the actuating rod can travel no further and pressure in the chamber 17 will increase until the required proof test pressure is reached. This maximum possible piston stroke places the horizontal face 36 of the double collet 34 midway between ratchet 20a and 20b.

[0073] Proof test pressure is then bled off. A point of equilibrium will be met where the return spring 27 over-

comes pressure in piston chamber 17 and the actuating piston begins to retract. As it does so, the horizontal face 36 of the double collet 34 will cooperate with second ratchet 20a on the actuating piston 14. Return spring 27 force acting on both the actuating piston 14 and the double collet 34 acts to translate the double collet upwards forcing the foot 39 on the lower end of the double collet 34 to collapse inwardly over the 45 deg taper of the annular projection 30 within the insert 21. On completion of the upward stroke of the actuating piston which is dictated by the collar 18 abutting the lower end of the piston housing 8, the lowermost horizontal face of the double collet foot 39 will be positioned immediately above the horizontal face of the second ratchet 30b on the insert 21.

[0074] The application of a proof pressure test, followed by release of this pressure has the effect of advancing the internally projecting stop member 38 on the double collet 34 upwards by one pitch of the ratchet system. This completes the first cycle of the device.

[0075] The tool can then be made up into a sub assembly and internally pressure tested i.e. pressure applied at 4 to the required test pressure for the well design. As the non return valve is stung open at the point test pressure is applied against the hollowing seals: 25, 33, 51 and 81. This means that no pressure can be trapped in the tool. Further to this, because there are no burst discs in the system then there is no need to partially disassemble the tool during sub assembly testing.

[0076] It should be noted that the non return valve assembly shall be pressure test prior to assembly into the tool in a dedicated test fixture. Following its installation into the tool it shall be pressure tested from below using a test insert (i.e. un-stung) prior to full assembly of the remaining components.

[0077] Internal pressure testing of the sub-assembly (via the lower port 4) does not cause the actuating piston 14 to stroke downwards and therefore does not cause the tool to consume further operating cycles.

[0078] The tool sub assembly will then be shipped to the field and is installed in the completion string for deployment into the well. At this point, the chemical injection line will be made up to the mandrel and a pressure test applied equal to or above the required service pressure for the chemical injection line.

[0079] As test pressure is applied via the chemical line the actuating piston 15 will travel downwards, overcoming the upward bias of the return spring 27. The actuating piston will continue to travel downwards until its lowermost face 70 abuts the upper face of the boss 42 of the actuating rod 41. This effective piston stroke is greater than the pitch of the ratchet 20 on the lower end of the actuating piston so at full stroke the horizontal face 36 of the double collet 34 cooperates with the next upper ratchet 20b on the actuating piston 15. The pressure test will be held and recorded.

[0080] As test pressure is bled off at the end of the test period the return spring 27 force acting on both the actuating piston 14 and the double collet 34 acts to translate

the double collet upwards forcing the foot 39 on the lower end of the double collet 34 to collapse inwardly over the 45 deg taper of the annular projection 30 within the insert 21. On completion of the upward stroke of the actuating piston which is dictated by the collar 18 abutting the lower end of the piston housing 8, the lowermost horizontal face of the double collet foot 39 will be positioned immediately above the horizontal face of the third ratchet 30c.

[0081] The application of this first field pressure test, followed by release of this pressure has the effect of advancing the internally projecting stop member 38 on the double collet 34 upwards by one pitch of the ratchet system. This completes the second cycle of the device.

[0082] At this point, a low pressure will be re-applied to the chemical line below the threshold at which the actuating piston 14 starts to stroke. This pressure will be maintained throughout the running of the completion to monitor for leaks in the system occurring.

[0083] Once the completion tubing has been run the chemical injection line will be terminated to the underside of the tubing hanger and a further pressure test of the line carried out.

[0084] Finally the tubing hanger would be landed in the tree and tree/TH chemical line interface pressure tested. At this juncture the remaining cycles can be carried out.

[0085] On completion of the penultimate cycle, the upper face of the internally projecting stop member 38 within the double collet 34 will abut the underside of the boss 43 of the actuating rod 41 and the horizontal face 36 at the upper end of the double collet 34 will have cooperated with the penultimate ratchet profile 20f on the actuating piston 14. Furthermore, the foot 39 on the lower end of the double collet 34 will have cooperated with ratchet 30f of the insert 31.

[0086] With a final application of pressure through the chemical injection line the actuating piston 15 will travel downwards, overcoming the upward bias of the return spring 27. The actuating piston will continue to travel downwards until its lowermost face 70 abuts the upper face of the boss 42 of the actuating rod 41. This effective piston stroke is greater than the pitch of the ratchet 20 on the lower end of the actuating piston so at full stroke the horizontal face 36 of the double collet 34 cooperates with the uppermost ratchet 20g on the actuating piston 15.

[0087] Pressure is bled off and the return spring 27 forces the actuation piston 15 in concert with the double collet 34 and the actuating rod 41 upwards until the flange 18 abuts the underside of the piston housing 8. As the actuating rod travels upwards so does the isolation spool 47 and in doing so compresses the spring 55 and exposes the lower by-pass ports 31 thus establishing a flow path between the gallery 22 and the non return valve assembly 57. At the same time the ball 64 is allowed to contact the seat 62 thus preventing fluids from the well entering the chemical injection line. Furthermore, the foot 39 on the lower end of the double collet (34 will have

cooperated with the uppermost ratchet 30g of the insert 31 thus maintaining the isolation spool, independent of the force of the return spring 27, in the upper position therefore maintaining the entire assembly in the open position.

[0088] Chemicals can now be pumped via the chemical injection line and through the tool into the well unhindered.

[0089] At this point the not return valve can be verified by pressure testing the tubing and monitoring the chemical injection line for returns at surface.

[0090] The pressure during the tests can be monitored to ensure that no loss of pressure is occurring which would indicate a failure of the tool such as a burst seal.

[0091] In the event that the chemical line is damaged during run in hole, the drop in pressure applied to the actuating piston 14 will cause the actuating piston to retract within the insert 21 thereby completing a further cycle of the tool. If necessary the line can be spliced and retested prior to recommencing run in hole.

[0092] The embodiment as described is envisaged to fit within a 1 ½ inch diameter pocket in the mandrel. It is envisaged that the mandrel would be deployed complete with the internal components made up directly to the tubing string as described above. Alternatively however the components of the tool could be packaged to be run or pulled on a wireline kickover tool or into the pocket of a conventional side pocket mandrel. This would allow the tool to be run pre installed in an existing side pocket mandrel to provide a safety override feature should the device fail to open or be opened prematurely.

Claims

1. A downhole tool said tool comprising an inlet for connection to a chemical flow line and an outlet for injection of chemicals from the flow line into a downhole formation, the tool further comprising a plug actuable within the tool for selectively closing off the fluid flow path through the tool to allow for pressure testing of the flow lines without the need to convey test equipment into the production tubing.
2. A downhole tool according to claims 1, wherein the tool comprises an actuating rod which cooperates with the plug such that a force applied to the actuating rod causes movement of the plug between the closed and open positions.
3. A downhole tool according to claim 1 or 2, wherein the tool further comprises a piston which is actuatable in response to pressure applied thereto.
4. A downhole tool according to claim 3 when dependent upon claim 2, wherein the piston is adapted to selectively apply a force to the actuating rod to instigate movement of the plug between the closed and

open positions.

5. A downhole tool according to any of claims wherein the piston comprises a ratchet.
- 5 6. A downhole tool according to claim 5, wherein the ratchet comprises a plurality of tapered projections.
7. A downhole tool according to any of the preceding claims, wherein the tool comprises an insert, said insert having a ratchet formed along one section thereof.
- 10 7. A downhole tool according to any of the preceding claims, wherein the tool comprises an insert, said insert having a ratchet formed along one section thereof.
- 15 8. A downhole tool according to claim 7, wherein the insert ratchet comprises a plurality of tapered projections.
9. A downhole tool according to claim 3 or any of claims 4-8 when dependent upon claim 3, wherein the tool further comprises a sleeve adapted for sliding engagement with the piston.
- 20 10. A downhole tool according to claim 9, wherein the sleeve is a collet.
- 25 11. A downhole tool according to claim 10, wherein the sleeve is a double collet which cooperates with the ratchet body on the piston and the ratchet body on the insert.
- 30 12. A downhole tool according to claim 11, wherein the sleeve comprises an internally projecting annular flange.
- 35 13. A downhole tool according to claim 2 and any of claims 3-12 when dependent upon claim 2, wherein the actuating rod comprises a radially extending boss member at the upper end thereof.
- 40 14. A downhole tool according to claim 13 when dependent upon claim 12, wherein the annular flange of the sleeve is adapted to cooperate with the under surface of the boss member of the actuating rod.
- 45 15. A downhole tool according to any of the preceding claims wherein the plug comprises an isolation spool which is actuatable between a closed position and an open position.
- 50 16. A downhole tool according to claim 15, wherein in the closed position the isolation spool closes off fluid flow from the chemical injection line through the tool and into a well and, in the open position, the spool provides a pathway for fluids from the chemical injection line, through the tool and into the well.
- 55 17. A downhole tool according to any of the preceding claims, wherein the tool further comprises a non-re-

turn valve which functions to prevent fluids from the well entering the tool.

- 18.** A method of testing a downhole chemical injection line in an oil well completion comprising the steps of
deploying a downhole tool according to any of claims 1-17 into the well in the closed position, applying a pressure greater than the operating pressure to the tool, monitoring the pressure within the tool, reducing the pressure to operating values and then subsequently actuating the tool to an open position to allow for injection of chemicals into the well through the tool.
- 19.** A method according to claim 18, wherein the method further comprises repeating the step of applying a pressure greater than the operating pressure and subsequently repeating this pressure a plurality of times.
- 20.** A method according to claim 18 or 19, wherein during each cycle of the tool, the collar advances along the ratchets of the piston and the insert.

5

10

15

20

25

30

35

40

45

50

55

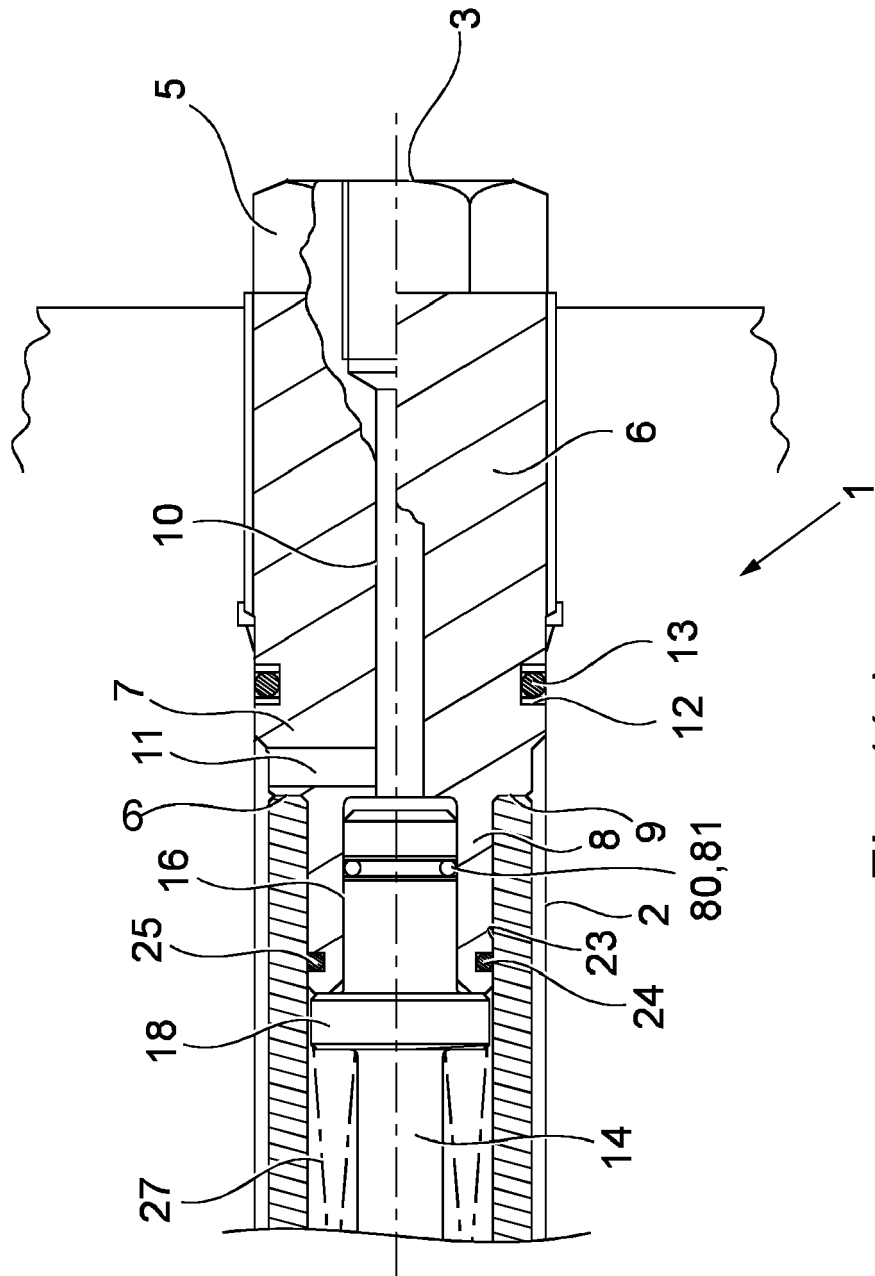


Fig. 1(a)

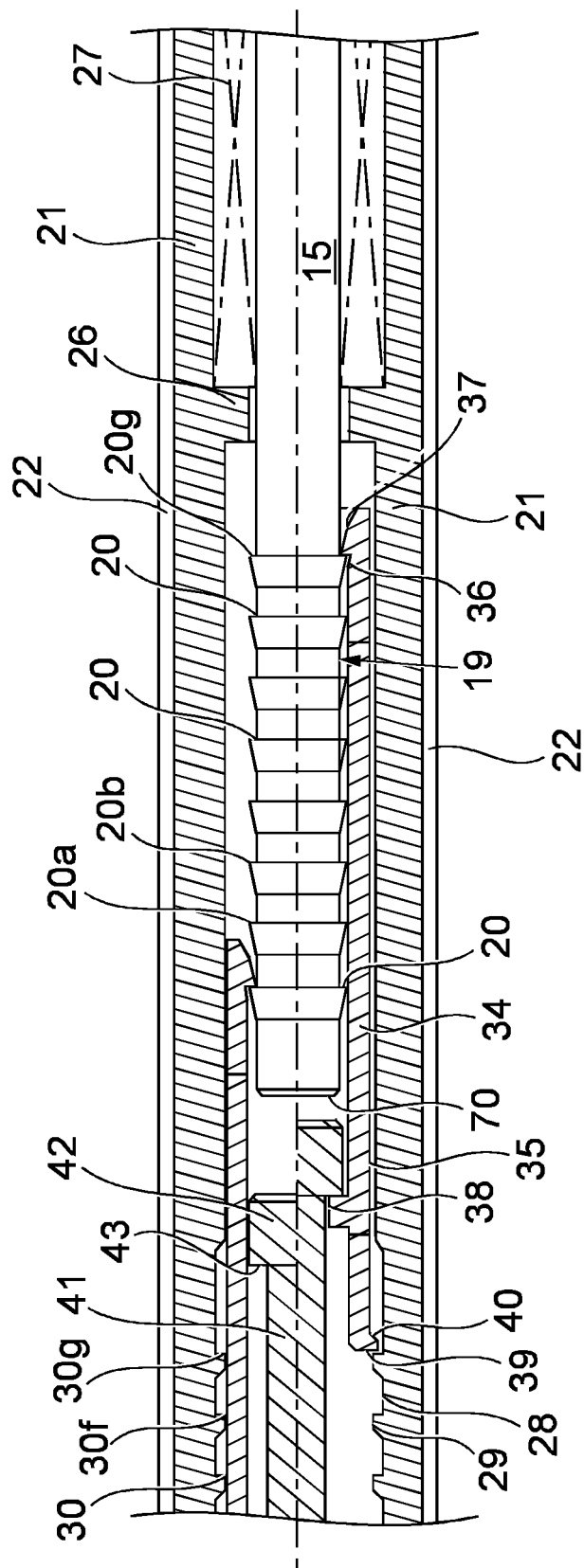


Fig. 1(b)

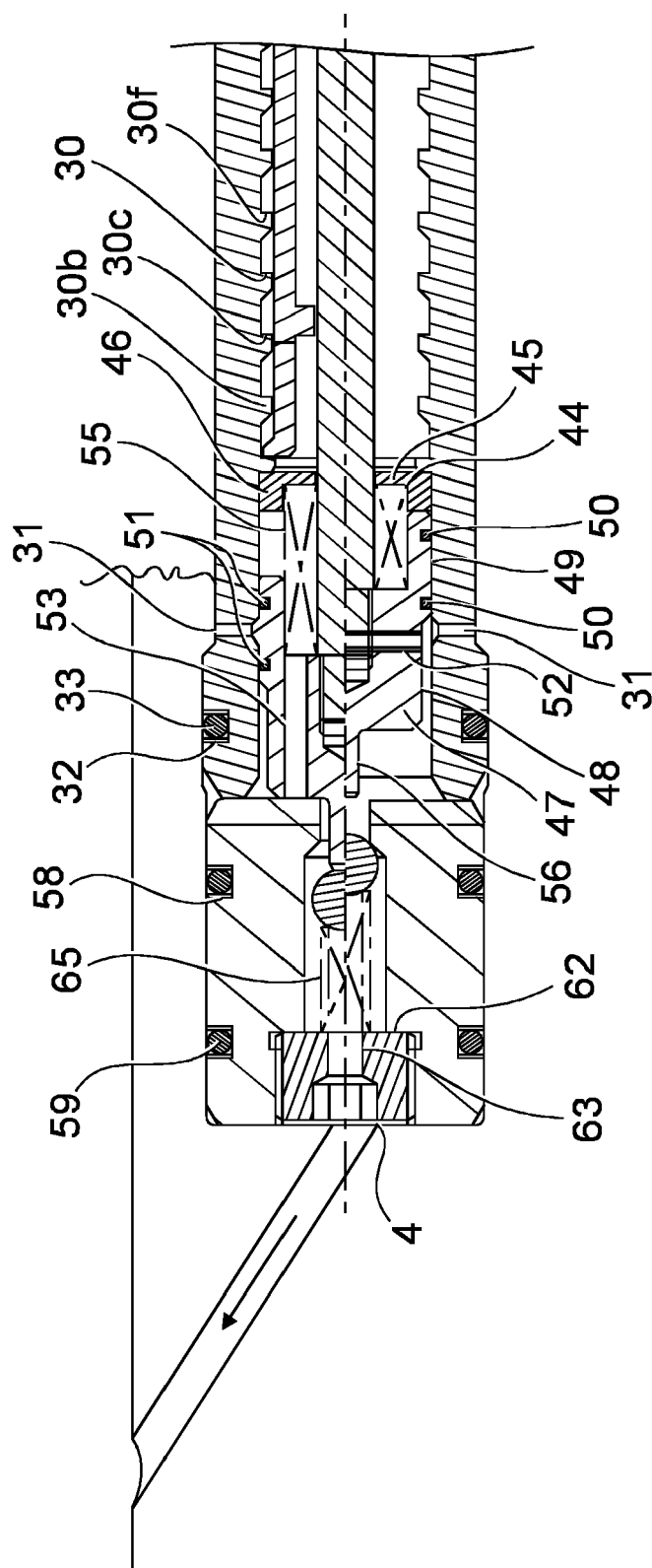


Fig. 1(c)