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Fortenberry

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[54] **METHOD AND APPARATUS FOR PACKING GRAVEL IN A SUBTERRANEAN WELL**

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[52] **U.S. Cl.** **166/278**; 166/51

[51] **Int. Cl.**[2] **E21B 43/04**; E21B 43/08; E21B 43/10

[58] **Field of Search** ..... 166/278, 276, 51, 120, 166/205, 224 R, 157, 56

[56] **References Cited**

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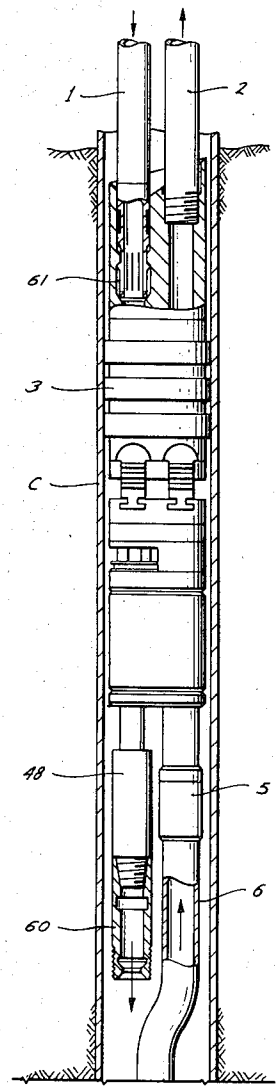
Attorney, Agent, or Firm—William C. Norvell, Jr.

[57] **ABSTRACT**

Method and apparatus for gravel packing a well, in which a dual bore packer is set in well casing above a production zone to isolate the zone from the casing fluid thereabove, a perforated liner assembly being suspended from the packer and disposed along the production zone, a pair of tubing strings communicating with the packer bores and extending from the packer to the top of the casing to provide separate flow passages for enabling fluids to be circulated to and along the production zone for the purpose of conditioning the zone, after which gravel can be pumped through one of the tubing strings into the zone and along the exterior of the liner. The circulation of the conditioning fluids and the placement of the gravel are controlled without the necessity for moving the tubing strings and of any portion of the packer.

23 Claims, 4 Drawing Figures



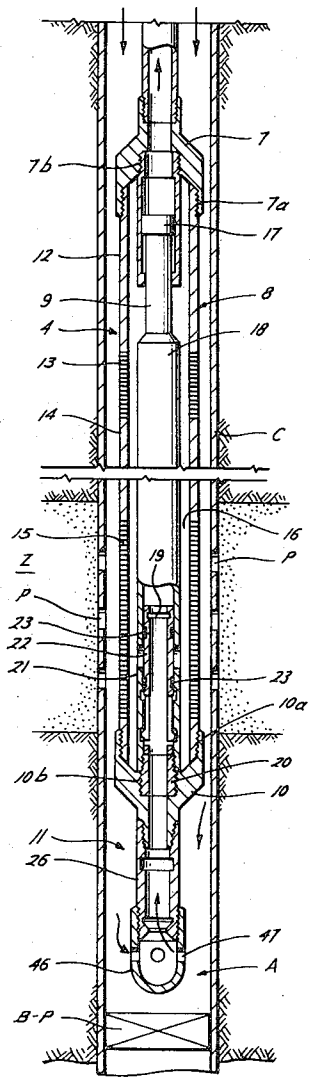


Fig. 1A

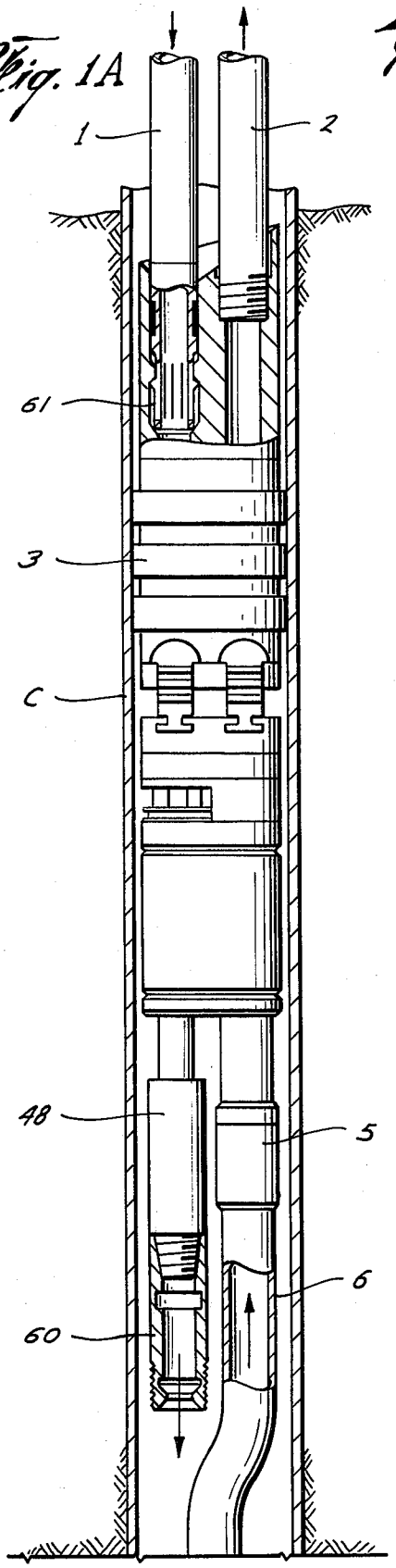

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Fig. 1B

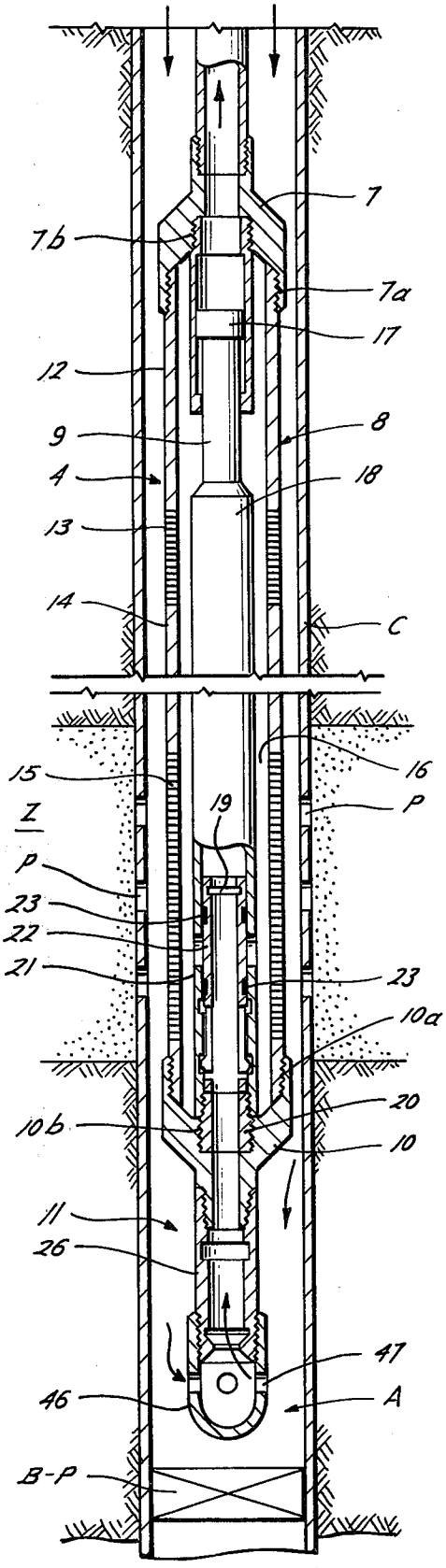
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Fig. 2

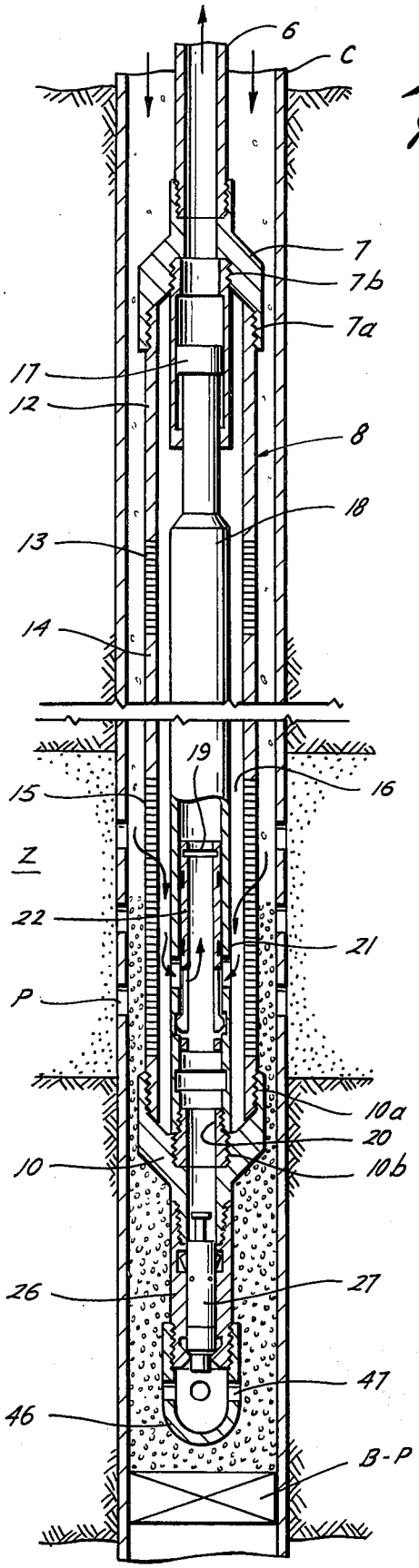
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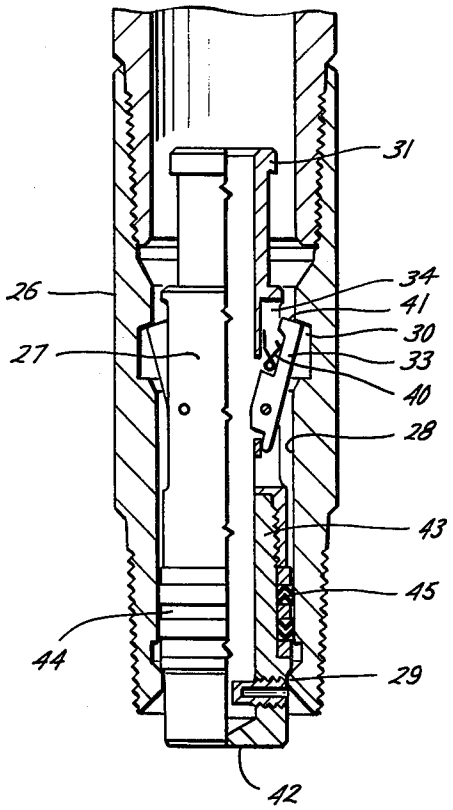
Fig. 3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METHOD AND APPARATUS FOR PACKING GRAVEL IN A SUBTERRANEAN WELL

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION:

The present invention relates to an apparatus and method for packing gravel within the bore of a subterranean well.

2. DESCRIPTION OF THE PRIOR ART:

Of considerable magnitude in the production of hydrocarbons such as oil and gas from a producing well is the problem of said flow into the well bore from unconsolidated formations. Production of sand with the flow of hydrocarbons will cause the well bore to gradually fill up with minute sand particles until production perforations in the casing and, oftentimes, the end of production tubing inserted therein are covered, resulting ina significant reduction in fluid production. In many instances, sand production will cause the well to die.

In addition to reduction of fluid production, flow of sand also may cause severe damage to equipment such as pumps, chokes, and the like. In flowing wells, fluid velocity may be sufficient to scavenge sand with in the well bore and produce it with the fluid hydrocarbon, resulting in holes being cut in the tubing and flowlines.

One well known means of controlling flow of sand into the well bore is the placement of gravel on the exterior of a slotted liner to filter out sand produced with the oil or gas and thus prevent its entry into the production tubing. It is important to size the gravel for proper containment of the sand. Additionally, the slotted liner or screen must be designed to prevent entry of the gravel itself into the production tubing.

The reverse circulation method of packing gravel provides for pumping the gravel down the well in the annulus between the production tubing and the well casing. The gravel is depostied on the outer periphery of the screen assembly while the fluid returns to the top of the well through the production tubing. A pressure buildup is noted at the surface and fluid pumping stopped when the gravel covers the screen. After gravel settlement, the tubing is disconnected from the screen assembly and pulled out of the hole.

Although other fluids have been used, treated and filtered production or nearby well or surface water, to which is generally added a desired concentration of calcium chloride or other active substance, is preferably used in most gravel packing processes during the cleaning or flushing procedure. The water is treated to remove contaminants such as cement particles, scale, and other foreign material generally resulting from the circultion of the water in the well bore. Because the volume in the annulus between the production tubing and the well casing may be as much as eight to ten times greater than the volume of the production tubing, considerably more water must be used and thus treated and filtered if clean fluid is to be used in a reverse circulation process or method than is used in conventional wash down method.

In order to provide a gravel pack apparatus which is more efficient than prior art apparatuses and primarily, to drastically reduce the amount of fluid which must be used during a gravel packing process, crossover equipment has been developed for use with screen assemblies and high performance packers. Such equipment now has made it feasible to gravel pack using only a

fraction of the volume of fluid heretofore utilized because the fluid is maintained within the tubing and is circulated only within the treatment zone which is isolated by the packing element of the packer.

Although such an apparatus has provided many advantages over the use of conventional prior art techniques, its use may be confining because it cannot be successfully utilized in high pressure wells which require the use of high density fluids, such as highly weighted muds, instead of water. If such an apparatus were utilized in conjunction with a mud system, the screen as well as the gravel pack would become plugged and would severely limit hydrocarbon production therethrough. Additionally, if such an apparatus were used in a high pressure well, it would expose the formation being gravel packed to the damaging pressure of the fluid required to control the formation pressure and because of the required longitudinal movement of tubing, precludes the possibility of installing the christmas tree for added safety against the possiblity of a well blow-out during the gravel pack operation.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide an apparatus and method for gravel packing wherein the zone being gravel packed is completely isolated from well control fluid (mud) during the gravel pack operation and will remain isolated after completion of the gravel pack operation.

It is a further object of the present invention to provide an apparatus and method which protects the production screen or perforated liner member from the well fluid as the apparatus is lowered into the well and prior to initiation of the gravel packing procedure.

It is also an object of the present invention to provide an apparatus and method for gravel packing wherein high pressures may be utilized during acidizing and squeezing of gravel into the formation.

It is a further object of the present invention to provide a gravel packing apparatus which eliminates the necessity of longitudinal movement of tubular strings to acitvate means to direct fluid flow paths.

It is also an object of the present invention to provide and apparatus which can be used to gravel pack a zone and immediately thereafter produce hydrocarbons therethrough.

Another object of the invention is to provide a gravel packing apparatus, including a well packer and a perforated liner secured thereto, capable of being lowered as a unit in the well to a desired location, in which surface control equipment can be installed prior to setting of the packer and in which all subsequent operations can be performed without moving any of the apparatus in the well, thereby maintaining control of the well at all times.

Other objects of the present invention will be readily apparent from a reading of the drawings, the specification below, and the claims.

The present apparatus enables a plurality of strings of tubing to be used which are to be affixed to a zone isolating means, such as a dual bore well packer, the bores thereof defining respective passageways for communication with the tubing strings thereabove. A perforated liner assembly extends below and is carried by the packer, the assembly including a initially imperforate inner tubular member disposed within a perforated

liner member, the ends of the members being secured together in fluid tight relation. One of the packer bores is in fluid communication with the inner tubular member; whereas, the other packer bore is in communication with the well bore annulus that surrounds the perforated liner member. The well bore below the packer can be conditioned by circulating fluid downwardly through one of the tubing strings and its associated packer bore, the fluid passing along the exterior of the perforated member, the return fluid, which will include the contaminated fluid in the well bore, passing through the other packer bore and through the other tubing string to the top of the well. Opening of an initially closed fluid passage or port in the inner tubular member then enables fluid laden gravel to be pumped through one of the tubing strings into the well annulus surrounding the perforated member to deposit a suitable quantity of gravel along the perforated liner member, the fluid in advance of the gravel and the well bore fluid below the packer being forced to return through the other tubing string to the top of the well. If desired, the well can be placed on production after the gravel packing operation has been completed, and without the necessity for moving any of the apparatus and the tubing strings attached thereto, assuming that the surface control equipment has been installed at the top of the well prior to the commencement of the gravel packing operation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1*a* and 1*b* together consitute a diagrammatic view partly in elevation and partly in vertical section, showing the apparatus positioned with in the well bore with the initial flow path used during the flushing step indicated by arrows, FIG. 1*b* being a lower continuation of the apparatus shown in FIG. 1*a* .

FIG. 2 is a diagrammatic view generally corresponding with FIGS. 1*a* and 1*b* showing a flow path through the production screen and the internal tubular member during gravel packing.

FIG. 3 is an enlarged sectional view of a blanking plug sealingly positioned within a landing nipple at the lower portion of the apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, the present invention preferably incorporates an apparatus having parallel tubular strings 1 and 2, a well packer 3 connected to the string 1 and 2 and a liner assembly 4 therebelow.

The well packer 3 has dual bores providing two separate fluid passageways within the packer. Any number fo presently known and commercially available packing appartuses may be utilized, the particular packing appartus and its method of anchoring within and packing off of the well casing not being critical to the practice of the present invention. Exemplary of such well packers are Model "A-5," Model "Al-5" and Model "ALS-5" double grip hydrostatic packers which are shown on pages 410 and 411 of the 1974–1975 Composite Catalog of Oil Field Equipment and Services (Gulf Publishing Company, Houston, Texas, 1974) and manufactured by Baker Oil Tools, Inc., Houston, Texas. Shown in the drawings is a hydrostatically activated well packer constructed and operated essentially as is disclosed in U.S. Pat. to J. F. de Rochement, No. 3,414,058, entitled "Well Bore Packer," issued Dec. 3, 1968, the specification and disclosure of which are incorporated herein by reference.

The liner assembly 4 is run into the well attached to and below the well packer 3 and is engaged to the well packer 3 by means of a shearable safety joint 5 which is designed to separate at a predetermined relatively low tensile load in order to permit the well packer 3 to be retrieved independently of the liner assembly 4 in the event that the liner assembly 4 becomes stuck in the well.

Below the safety joint 5 is affixed, such as by treads, a tubular section 6. The tubular section 6 is threadedly affixed to a tubing connector member 7 which connects at lower threads 7*a* the external tubular body 8 of the liner assembly 4 and connects at upper threads 7*b* a longitudinal internal tubular member 9 telescopically housed within the external tubular body 8. The connector member 7 thus prevents communication of fluid between the tubular section 6 and the external tubular body 8, but does permit fluid commnication between the internal tubular member 9 and the tubular section 6. The external tubular body 8 and the internal tubular member 9 are again joined at their lowermost juncture by a second connector member 10 having threads 10*a* for connection of the external tubular body 8 and threads 10*b* for connection of the internal tubular member 9. The connector member 10 terminates the external tubular body 8 but permits the internal tubular member 9 to communicate with the lower portion 11 of the liner assembly 4.

The external tubular body 8 is comprised of a section 12 of tubing affixed at its upper end to the connector member 7 and at its lower end to a circumferentially extending porous tell tale screen 13, for a purpose which will be described below. A second and elongated tubular section 14 separates the tell tale screen from a longitudinaly extending production screen 15 of a similar construction as the tell tale screen 13. The screens 13 and 15 prevent entry within the annular space 16 between the external tubular body 8 and the internal tubular member 9 of particles of gravel, but will allow flow of flushing fluid, acidic solution, and produced hydrocarbons. The production screen 15 is positioned in the well in the production zone Z adjacent to the perforations P within the casing C.

Telescopically housed within the external tubular body 8 is the internal tubular member 9 basically comprising a telescoping swivel joint 17, a section of blank tubing 18 affixed therebelow, a normally closed valve member 19, and a short tubular section 20 affixed by threads 10*b* on the connector member 10. The swivel joint 17 can be extended or shortened and can be freely rotated to facilitate assembly of the liner assembly 4. The tubing 18 is threadedly connected at its upper end to the swivel joint 17 and at its lower end to the valve member 19. Preferaably, and as is shown in the drawings, valve member 19 has a ported body 21 and a sleeve valve member 22 shiftable in the body between positions opening and closing the body ports, the sleeve valve member carrying a plurality of spaced elastomeric seal rings 23 engageable with the body. Typical of such a valve member 19 is the Model L sliding sleeve vale of Baker Oil Tools, Inc., shown on page 431 of the Composite Catalog, referenced above, and described in detail in U.S. Pat. to A. W. Kammerer, Jr. et al, No. 3,355,142 Entitled, "Sleeve or Piston Type Valve Device," issued Nov. 28, 1967, the disclosure and specifi-

cation of which are herein incorporated by reference. The valve member **19** is opened or closed by manipulating a mechanism attached to a wire line, the mechanism (not shown) being of typical construction and well known in the art.

Below the lower connector member **10** and affixed thereto by the threads **10***b* thereon is a landing nipple **26** for housing and engagement of a blanking plug **27** inserted therein which seals the lower end **11** of the liner assembly **4.**

Referring specifically to FIG. **3,** showing the landing nipple **26** and the blanking plug **27** inserted therein in more detail, the nipple **26,** which is threaded on each end, has a smooth sealing bore **28** with a restriction **29** on its lower end and a groove **30** cut into its upper end. The landing nipple **26** receives on a wire line or other known setting mechanism the blanking plug **27,** comprising a tubular outer housing **31** having a plurality of locking arms **33** affixed in side openings **34** therethrough and a packing means **44** typically consisting of chevron shaped elastomeric seals **45** mounted on a mandrel **43** with a closed lower end **43** screwed into the bottom of the housing **31.** The locking arms **33** are pivotably mounted in the housing **31** and their upper ends **41** are urged outwardly by springs **40** to engage the groove **30** in the upper end of the landing nipple **26.** The seals **45** seal off in the smooth bore **28** of the landing nipple **26.** The blanking plug **27** and the packing assembly **44** forming the lower portion thereof, are lowered on the setting mechanism (not shown) until lower travel is stopped by the restriction **29** in the lower end of the nipple **26.** The setting mechanism may be released by jarring.

Forming the lowermost end of the liner assembly **4** is a bull plug **46** for guiding the liner assembly **4** into the well and having a series of circumferentially spaced ports **47** for communication of fluid between the annulus A and the internal tubular member **9.**

Below the well packer **3** opposite the liner assembly **4** is a packer activating mechanism **48** to initiate hydrostatic setting of the well packer **3.** The mechanism may be of a construction and operation as disclosed in the above referenced U.S. Pat. No. 3,414,058.

Below the packer activating mechanism **48** and threadedly secured thereto is a landing nipple **60** for housing a blanking plug which are utilized for closing the passageway through the tubular short string **1** if desired. The construction and operation of the nipple **60** and the blanking plug are identical to nipple **26** and blanking plug **27.** Alternatively the plug may be positioned within the nipple **60** to activate the packer, omitting the mechanism **48.**

A lower isolation and/or reference point means or bridge plug B-P is positioned in the well casing C at the lower end of the zone Z to be gravel packed and the liner assembly **4** is positioned therefrom so that the porous production screen **15** straddles the perforations P in the casing C.

OPERATION OF THE APPARATUS AND METHOD

Prior to running the liner assembly **4** and the well packer **3** into the well, the reference point of the lower depth of the zone Z is established. This may be the lowermost depth of the well or may be a bridge plug B-P pre-set at a known depth as described above. Thereafter, the top of the well (not shown) is filled with the pumpable fluid, preferably a thixotropic solution (normally bentonite and water) by displacing the well fluid to a depth slightly in excess of the length of the liner assembly **4.** The liner assembly **4** and the well packer **3** are lowered into the well on the tubular long string **2** and into the thixotropic solution until the annulus **116** between the liner assembly **4** and the internal tubular member **9** is filled with the solution which will prevent the entry of contaminated well fluid into the annulus **16** and will then keep the screens **13** and **15** free of clogging well fluids when the liner assembly **4** is further lowered into the well to the approximate depth of the reference point B-P. It is important to note that the gel solution will not be lost or flow from within the annular space **16** because it is sealed off at the top by the member **7,** at the bottom by member **10,** and because valve **19** is in its normally closed position.

The liner assembly **4** and the well packer **3** are lowered within the casing C to the production zone P until the reference point B-P is reached and the production screen **15** straddles the perforations P in the casing C. The tubular short string **1** is run into the well and stabbed into the top of the well packer **3,** as for example, using latch means **61** shown in U.S. Pat. No. 3,414,058. A christmas tree may then be installed at the top of the well. The well packer **3** is then activated by first inserting a ball (not shown) at the top of the well through the tubular short string **1.** After activation as described above, the ball free falls to the reference point B-P. Thereafter, the contaminated and isolated well fluid above the reference point B-P and below the lower portion of the well packer **3** is displaced by pumping down the tubular short string **1** an aqueous solution of calcium chloride or other known displacing fluid. As shown by the arrows in FIG. **1,** the aqueous calcium chloride solution travels down the tubular short string **1** and exits at the lowermost end of the open nipple **60.** The solution forces the contaminated well fluid through the ports **47** in the bull plug **46** and through the internal tubular member **9,** the tubular section **6** communicating with the internal tubular member **9,** the safety joint **5,** and through a second bore or fluid passageway within the well packer **3** communicating with the tubular long string **2** above. The fluid is circulated through the tubular long string **2** until a clear solution indicates that all of the well fluid has been displaced. Reverse circulation may be initiated if desired.

After the annular area A has been washed and cleared of the contaminated fluid, an acidic (preferably hydrochloric) solution of a desired concentration is pumped down the tubular short string **1** and circulated through the same flow path described above for the flushing fluid and shown by the arrows in FIG. **1.** The pumping is continued until all the perforations P are covered with the acidic solution. Thereafter, a normally open valve (not shown) at the top of the well on the tubular long string **2** is closed and pressure applied within the tubular short string **1** to squeeze the acidic solution behind the perforations P for cleaning of the perforations and the production zone Z area immediately adjacent thereto.

After completion of the acid squeezing procedure as above described, the blanking plug **27** is run into the well by means of a wire line and sealingly positioned within the landing nipple **26** as described above. A shifting mechanism of a known type is run through the tubular long string **2** on a wire line to open the valve **19** to establish a flow path from the liner annulus **16**

through the internal tubular member 9 and the tubular long string 2.

Upon activating the valve 19 to open position, the shifting mechanism is retrieved from the well. Thereafter, gravel particles of a desired size are inserted at the top of the well through the tubular short string 1 and are carried to the production zone Z in a carrier solution. The gravel is placed in the well adjacent to the perforations P until the perforations P are completely covered with gravel. This point is determined by the pressure variation resulting when the gravel covers the tell tale screen 13.

The carrier solution which is used to carry the gravel travels through the tell tale screen 13 and the production screen 15 to wash mud and contaminated fluid from the pores in the screen 13 and 15 and particularly to clean the annulus 16 of the liner assembly 4, which heretofore has contained the pumpable thixotropic, preferably bentonitic, solution. The carrier solution enters the internal tubular member 9 through the ported body 21 of the valve 19 and travels through and within the internal tubular member 9 and to the top of the well through the tubular long string 2.

After the pressure variation which results when the tell tale screen 13 is covered with gravel, the gravel packing procedure is terminated. Thereafter, the hydrocarbons within the zone Z are produced to the top of the well through the perforations P, the packed gravel, thence through the porous production screen 15, through the annular area 16 within the liner assembly 4 and through the opened valve 19 and upwardly within the internal tubular member 9, the tubular section 6, the safety joint 5, the connecting bore of the well packer 3 and through the tubular long string 2. Thereafter, a blanking plug is set in the landing nipple 60 below the well packer 3 on the tubular short string 1. In some instances, a second dual string packer (not shown) may be run with the first packer to isolate an upper zone between the two packers. The short string may be opened between the packers by wire line manipulation of a sleeve valve so that the upper zone can be produced through it.

Although the invention has been described in terms of specified embodiments which are set forth in detail, it should be understood that this is by illustration only and that the invention is not necessarily limited thereto, since alternative embodiments and operating techniques will become apparent to those skilled in the art in view of the disclosure. Accordingly, modifications are contemplated which can be made without departing from the spirit of the described invention.

What is claimed and desired to be secured by letters patent is:

1. An apparatus for use in a subterranean well having a production zone and containing fluid in the well, comprising a packer having first and second fluid passages therein and having means adapted to receive first and second tubular strings extending to the top of the well, a liner assembly carried by and depending from said packer to be lowered with said packer in the well to the production zone, said assembly including a first perforated member through which fluid can flow between the exterior and the interior of said member, said first fluid passage communicating with the exterior of said perforated member, said assembly further including a second tubular member within said perforated memeber and providing a fluid passageway communicating with said second fluid passage and communicable with the interior of said perforated member, and means for selectively controlling fluid flow between the interior of said second tubular member and the exterior of said perforated member.

2. The apparatus as defined in claim 1 further comprising means securing said second tubular member to said perforated member to prevent substantial relative longitudinal movement therebetween.

3. The apparatus as defined in claim 1 further comprising means securing the opposite end portions of said second tubular member to said perforated member in sealed relation with respect to each other to prevent substantial longitudinal movement therebetween.

4. The apparatus as defined in claim 1 wherein said means for selectively controlling fluid flow includes a port in said second tubular member opening into the interior of said perforated member, and valve means in said second tubular member movable between positions closing and opening said port.

5. The apparatus as defined in claim 1 wherein said means for selectively controlling fluid flow includes a port in said second tubular member opening into the interior of said perforated member, a sleeve valve member closing said port, and means engaging said sleeve valve member for shifting said sleeve valve member to port opening position.

6. The apparatus as defined in claim 1 wherein said means for selectively controlling fluid flow includes a port in said second tubular member opening into the interior of said perforated member, valve means in said second tubular member closing said port, means for shifting said valve means to port opening position, said liner assembly having a lower passage communicating with said second tubular member and the region in the well externally of said liner assembly, and a plug adapted to close said lower passage.

7. The apparatus as defined in claim 1 wherein said means for selectively controlling fluid flow includes a port in said second tubular member opening into the interior of said perforated member, valve means in said second tubular member closing said port, means for shifting said valve means to port opening position, said liner assembly having a lower passage communicating with said second tubular member and the region in the well externally of said liner assembly, said liner assembly having means adapted to receive a plug for closing said lower passage.

8. The apparatus as defined in claim 1 wherein said means for selectively controlling fluid flow includes a port in said second tubular member opening into the interior of said perforated member, a sleeve valve member closing said port, means engaging said sleeve valve member for shifting said sleeve valve member to port opening position, said liner assembly having a lower passage communicating with the interior of said second tubular member and the exterior of said liner assembly, said liner assembly having means adapted to receive a plug closing said lower passage.

9. An apparatus for use in a subterranean well having a production zone and containing fluid in the well, comprising a packer having first and second fluid passages therein and adapted to communicate with first and second tubular strings extending to the top of the well, a liner assembly carried by and depending from said packer to be lowered with said packer in the well to the production zone, said assembly including a first

perforated member through which fluid can flow between the exterior and the interior of said member, said first fluid passage communicating with the exterior of said perforated member, said assembly further including a second tubular member within said perforated member and providing a fluid passageway communicating with said second fluid passage and communicable with the interior of said perforated member, means for selectively controlling fluid flow between the interior of said second tubular member and the exterior of said perforated member, and means securing said second tubular member to said perforated member to prevent substantial relative longitudinal movement therebetween.

10. An apparatus for use in a subterranean well having a production zone and containing fluid in the well, comprising a packer having first and second fluid passages therein and adapted to communicate with first and second tubular strings extending to the top of the well, a liner assembly carried by and depending from said packer to be lowered with said packer in the well to the production zone, said assembly including a first perforated member through which fluid can flow between the exterior and the interior of said member, said first fluid passage communicating with the exterior of said perforated member, said assembly further including a second tubular member within said perforated member and providing a fluid passageway communicating with said second fluid passage and communicable with the interior of said perforated member, means for selectively controlling fluid flow between the interior of said second tubular member and the exterior of said perforated member, and means securing the opposite end portions of said second tubular member to said perforated member in sealed relation with respect to each other and to prevent substantial relative longitudinal movement therebetween.

11. An apparatus for use in a subterranean well having a production zone and containing fluid in the well, comprising a packer having first and second fluid passages therein and adapted to communicate with first and second tubular strings extending to the top of the well, a liner assembly carried by and depending from said packer to be lowered with said packer in the well to the production zone, said assembly including a first perforated member through which fluid can flow between the exterior and the interior of said member, said first fluid passage communicating with the exterior of said perforated member, said assembly further including a second tubular member within said perforated member and providing a fluid passageway communicating with said second fluid passage and communicable with the interior of said perforated member, and means for selectively controlling fluid flow between the interior of said second tubular member and the exterior of said perforated member, said means for selectively controlling fluid flow including a port in said second tubular member opening into the interior of said perforated member, and valve means in said second tubular member movable between positions closing and opening said port.

12. An apparatus for use in a subterranean well having a production zone and containing fluid in the well, comprising a packer having first and second fluid passages therein and adapted to communicate with first and second tubular strings extending to the top of the well, a liner assembly carried by and depending from said packer to be lowered with said packer in the well to the production zone, said assembly including a first perforated member through which fluid can flow between the exterior and the interior of said member, said first fluid passage communicating with the exterior of said perforated member, said assembly further including a second tubular member within said perforated member and providing a fluid passageway communicating with said second fluid passage and communicable with the interior of said perforated member, and means for selectively controlling fluid flow between the interior of said second tubular member and the exterior of said perforated member, said means for selectively controlling fluid flow including a port in said second tubular member opening into the interior of said perforated member, a sleeve valve member closing said port, and means engaging said sleeve valve member for shifting said sleeve valve member to port opening position.

13. An apparatus for use in a subterranean well having a production zone and containing fluid in the well, comprising a packer having first and second fluid passages therein and adapted to communicate with first and second tubular strings extending to the top of the well, a liner assembly carried by and depending from said packer to be lowered with said packer in the well to the production zone, said assembly including a first perforated member through which fluid can flow between the exterior and the interior of said member, said first fluid passage communicating with the exterior of said perforated member, said assembly further including a second tubular member within said perforated member and providing a fluid passageway communicating with said second fluid passage and communicable with the interior of said perforated member, and means for selectively controlling fluid flow between the interior of said second tubular member and the exterior of said perforated member, said means for selectively controlling fluid flow including a port in said second tubular member opening into the interior of said perforated member, valve means in said second tubular member closing said port, means for shifting said valve means to port opening position, said liner assembly having a lower passage communicating with said second tubular member and the region in the well externally of said liner assembly, and a plug adapted to close said lower passage.

14. An apparatus for use in a subterranean well having a production zone and containing fluid in the well, comprising a packer having first and second fluid passages therein and adapted to communicate with first and second tubular strings extending to the top of the well, a liner assembly carried by and depending from said packer to be lowered with said packer in the well to the production zone, said assembly including a first perforated member through which fluid can flow between the exterior and the interior of said member, said first fluid passage communicating with the exterior of said perforated member, said assembly further including a second tubular member within said perforated member and providing a fluid passageway communicating with said second fluid passage and communicable with the interior of said perforated member, and means for selectively controlling fluid flow between the interior of said second tubular member and the exterior of said perforated member, said means for selectively controlling fluid flow including a port in said second tubular member opening into the interior of said perfo-

rated member, valve means in said second tubular member closing said port, means for shifting said valve means to port opening position, said liner assembly having a lower passage communicating with said second tubular member and the region in the well externally of said liner assembly, said liner assembly having means adapted to receive a plug for closing said lower passage.

15. An apparatus for use in a subterranean well having a production zone and containing fluid in the well, comprising a packer having first and second fluid passages therein and adapted to communicate with first and second tubular strings extending to the top of the well, a liner assembly carried by and depending from said packer to be lowered with said packer in the well to the production zone, said assembly including a first perforated member through which fluid can flow between the exterior and the interior of said member, said first fluid passage communicating with the exterior of said perforated member, said assembly further including a second tubular member within said perforated member and providing a fluid passageway communicating with said second fluid passage and communicable with the interior of said perforated member, and means for selectively controlling fluid flow between the interior of said second tubular member and the exterior of said perforated member, said means for selectively controlling fluid flow including a port in said second tubular member opening into the interior of said perforated member, a sleeve valve member closing said port, means engaging said sleeve valve member for shifting said sleeve valve member to port opening position, said liner assembly having a lower passage communicating with the interior of said second tubular member and the exterior of said liner assembly, said liner assembly having means adapted to receive a plug closing said lower passage.

16. An apparatus for use in a subterranean well having a production zone and fluid in said well, comprising isolation means for isolating the production zone from the fluid in the well above the zone, said means defining first and second fluid passages communicating with the zone and adapted to communicate with first and second tubular strings extending from said means to the top of the well, a liner assembly carried by and depending from said isolation means and including a first perforated member through which fluid can flow between the exterior and the interior of said member, said first fluid passage communicating with the exterior of said perforated member, said assembly further including a second tubular member within said perforated member and providing a fluid passageway communicating with said second fluid passage and communicable with the interior of said perforated member, means securing said second tubular member to said perforated member to prevent substantial longitudinal movement therebetween, and means for selectively controlling fluid flow between the interior of said second tubular member and the exterior of said perforated member.

17. The apparatus as defined in claim **16** wherein the end portions of said second tubular member are in fluid tight relation to said perforated member.

18. The apparatus as defined in claim **16** wherein said means for selectively controlling fluid flow includes a port in said second tubular member opening into the interior of said perforated member, a sleeve valve member closing said port, and means engaging said sleeve valve member for shifting said sleeve valve member to port opening position.

19. The apparatus as defined in claim **16** wherein said means for selectively controlling fluid flow includes a port in said second tubular member opening into the interior of said perforated member, a sleeve valve member closing said port, and means engaging said sleeve valve member for shifting said sleeve valve member to port opening position, said liner assembly having a lower passage communicating with the interior of said second tubular member and the exterior of said liner assembly, said liner assembly having means adapted to receive a plug for closing said lower passage.

20. The apparatus as defined in claim **16** additionally comprising means for isolating the annulus between said second tubular member and perforated member comprising a pumpable fluid in said annulus.

21. The apparatus as defined in claim **20** wherein said pumpable fluid comprises a thixotropic fluid.

22. The apparatus as defined in claim **20** wherein said pumpable fluid comprises an aqueous bentonitic solution.

23. A method for gravel packing a production zone in a well, comprising the steps of providing a packer having first and second fluid passages therein and a liner assembly carried by and depending from said packer, said assembly including a first perforated member through which fluid can flow between the exterior and interior of said member, said first fluid passage communicating with the exterior of said perforated member, said assembly further including a second tubular member within said perforated member and providing a fluid passageway communicating with said second fluid passage and communicating with the interior of said perforated member, lowering said packer and liner assembly as a unit on a first tubular string communicating with one of said fluid passages and setting said packer in the well above the production zone with said first perforated member overlapping said production zone, placing a second tubular string extending to the top of the well in communication with the other of said fluid passages, said first fluid passage communicating with the exterior of said perforated member, and pumping fluid containing gravel down one of said strings and into the zone surrounding the perforated liner, the fluid in advance of the fluid containing gravel and in the zone surrounding the perforated liner flowing through said second tubular member and through the other fluid passage and other of said strings to the top of the well.

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