June 28, 1960 E. BURNS 2,942,664

LINER AND GRAVEL PACKING APPARATUS FOR WELLS

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FIG. 1.

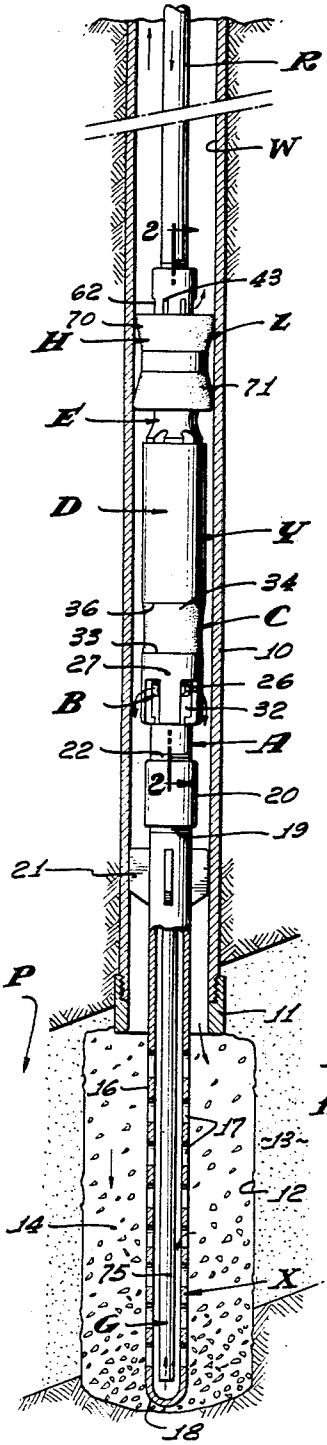

FIG. 2.

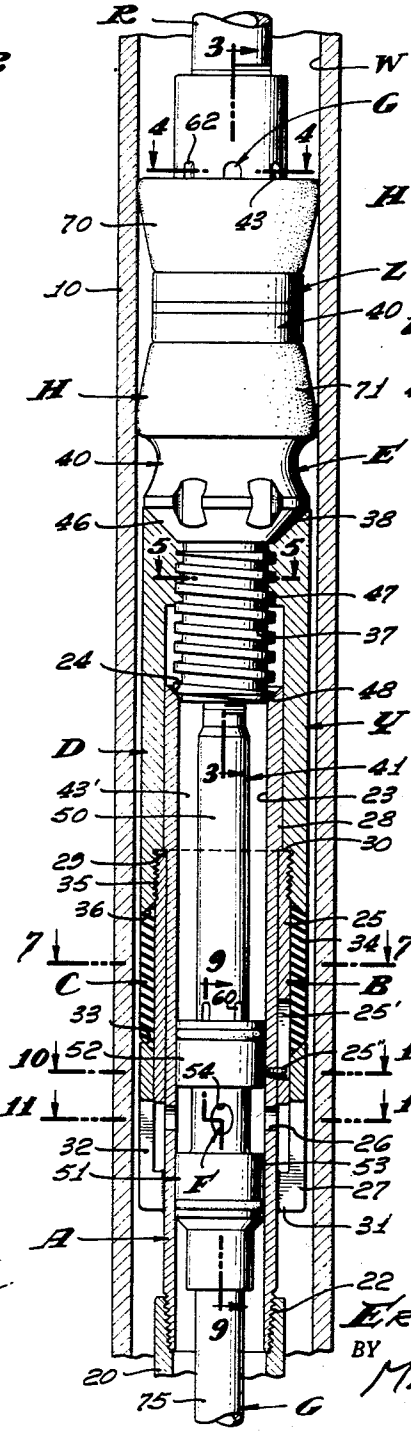

FIG. 3.

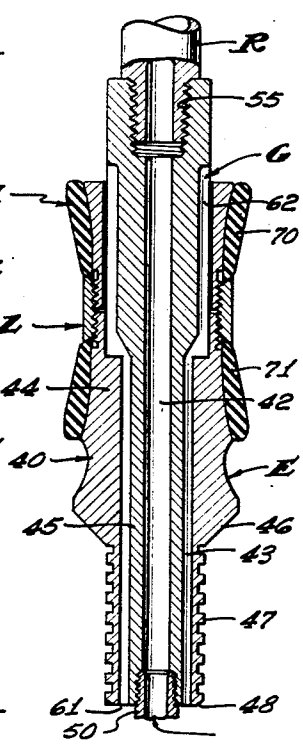

FIG. 4.

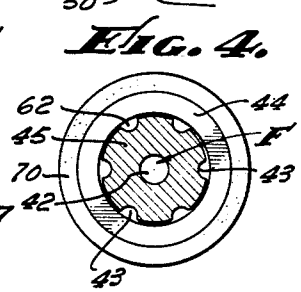

FIG. 5.

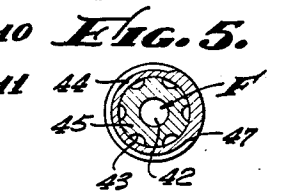

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FIG. 6.

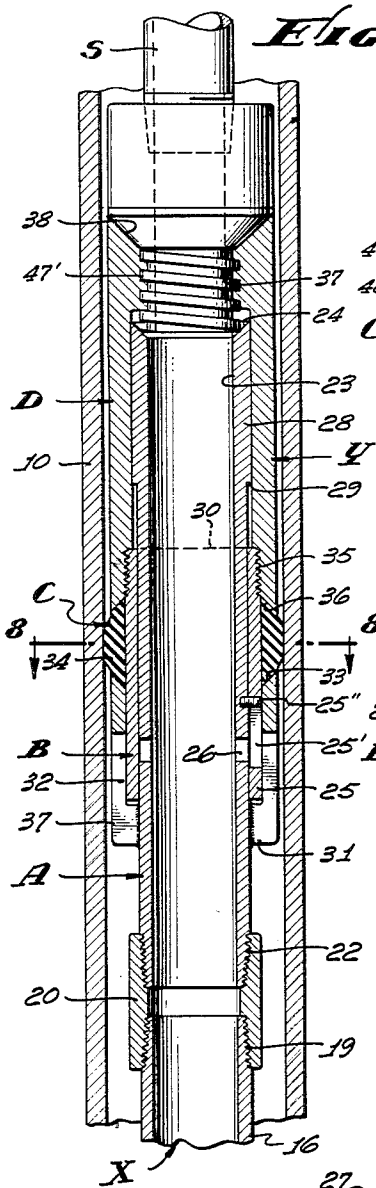


FIG. 7.

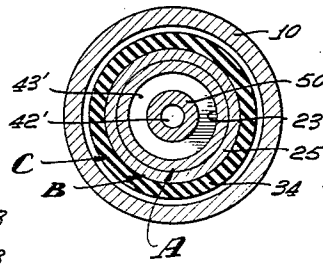


FIG. 8.

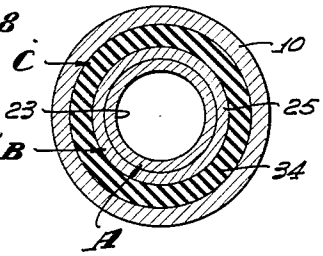


FIG. 9.

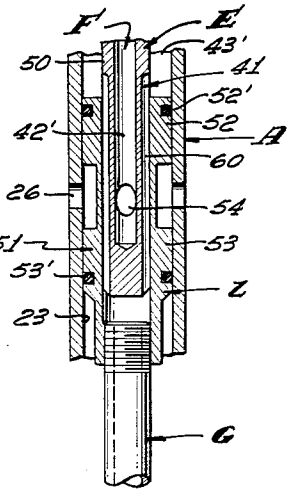


FIG. 10.

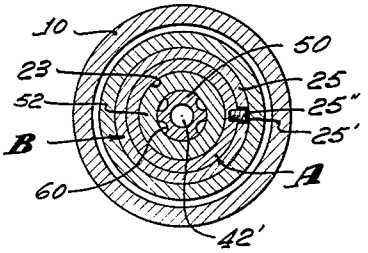
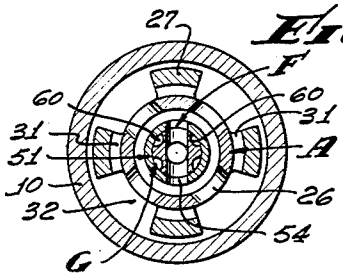


FIG. 11.



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2,942,664

LINER AND GRAVEL PACKING APPARATUS FOR WELLS

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Filed Jan. 23, 1956, Ser. No. 560,558

10 Claims. (Cl. 166—51)

This invention relates to a liner and gravel packing apparatus for wells and is particularly concerned with a well liner that enters the producing zone of a well and with an adapter and a well tool for handling said liner so that the well may be easily packed with gravel and so that the gravel may then be easily washed. It is a general object of this invention to provide a new and improved liner and apparatus for handling said liner, which apparatus is adapted to be actuated for gravel packing and for washing and which liner and a portion of the apparatus remains in the well bore at all times and handles the production of the well.

The technique of gravel packing well liners is widespread, especially in the oil field, the object being to fill the annulus between the liner and the well bore with a porous filtering layer of material that will support the wall of the well bore and also prevent sand from entering and packing in the liner. In practice, sized rock gravel is employed to pack the annulus forming interstices across which the sand of the earth formation is bridged. The sand thus remains in the layer of rock or gravel creating small passages to the end that the oil entering the liner is filtered. Tools have been provided for setting liners in well bores, for gravel packing said liners, and for the packing or sealing said liners with the casings of the wells for producing of oil from the wells. It is to be observed that the above operations are each separate operations that require a round trip of an operating string into and out of the well. That is, at least one trip is required to set the liner, another trip is required to deposit the gravel pack, and another trip is required to pack or seal the liner with the casing. The production tubing is then applied to the liner for receiving flow of oil.

An object of this invention is to provide gravel packing equipment or apparatus for wells wherein a liner and a part of the gravel packing tool are permanently set in the well. The apparatus of the present invention is provided with a tool for applying the necessary fluids and gravel to the well.

Another object of this invention is to provide a gravel packing apparatus that is associated with a liner and with a part permanently set in a well and which is adapted to receive a tool for directing fluids to the liner in the well for washing and cleaning of the liner.

Still a further object of the invention is to provide a tool for a gravel packing apparatus of the character above referred to that is adapted to lower and set the liner, that is adapted to administer gravel and fluids to the annulus surrounding the liner, that is adapted to set a portion of the apparatus in the well to pack or seal with the casing and which is adapted to be used for washing or cleaning operations all without removal of the liner and of the said portion of the apparatus from the well.

It is an object of this invention to provide a practical, rugged, and reliable apparatus or well tool and liner construction of the type under consideration that saves a

substantial amount of time and expense in the completion of a well and in the maintenance thereof.

The various objects and features of my invention will be fully understood from the following detailed description of a typical preferred form and application of my invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is an elevational sectional view taken through a well bore and showing the liner and gravel packing apparatus of the present invention. Fig. 2 is an enlarged detailed sectional view taken as indicated by line 2—2 on Fig. 1. Fig. 3 is an enlarged detailed sectional view of a portion of the structure shown in Fig. 2 and taken as indicated by line 3—3 on Fig. 2. Fig. 4 is a transverse sectional view taken as indicated by line 4—4 on Fig. 2. Fig. 5 is a sectional view of a portion of the structure taken as indicated by line 5—5 on Fig. 2. Fig. 6 is an enlarged detailed sectional view showing the tool coupled to a production string and operated to seal with the well casing. Figs. 7 and 8 are transverse sectional views taken as indicated by lines 7—7 and 8—8 on Figs. 2 and 6, respectively. Fig. 9 is a sectional view taken substantially as indicated by line 9—9 on Fig. 2, and Figs. 10 and 11 are sectional views taken as indicated by lines 10—10 and 11—11 on Fig. 2.

The apparatus of the present invention involves, generally, a liner X adapted to be set or positioned in a well W, an adapter Y at the upper end of the liner, and a liner setting and fluid handling tool Z adapted to be manipulated to cooperate with and actuate the adapter whereby the adapter and liner may be set in the wall, whereby the liner may be gravel packed and whereby the gravel pack may be washed or cleaned as circumstances require. The well W, as shown, may be a typical oil well having a casing 10 terminating at a shoe 11. The casing 10 is open at the bottom portion of the well at the production zone P, the bore 12 of the well being extended into the oil sand 13 of the production zone P. The diameter of the bore 12 is increased in the conventional manner as by underreaming or the like, to provide an enlarged annular cavity 14 for receiving the gravel pack as hereinafter described.

The liner X may be any suitable or conventional liner perforated, slotted, or provided with screens for allowing passage of fluids from the exterior to the interior of the liner X. As illustrated in the drawings, the liner X involves a tubular wall 16 having a plurality of perforations 17 in the form of slots. The liner X is closed at the lower end 18 thereof and may be set upon or spaced from the bottom of the well bore 12. The upper end of the liner X is threaded at 19 to receive a coupling collar 20 whereby the liner X is joined to the adapter Y of the apparatus that I have provided.

In accordance with the invention, the liner X is joined with the adapter Y that I have provided and these two elements of the structure are adapted to be inserted and set in the well bore as a unit. The liner X penetrates or extends to the bottom of the well bore to receive oil from the production zone P while the adapter Y is set and positioned in the lower end portion of the casing 10. In accordance with the invention, centering lugs or ribs 21 may be provided at the upper end of the liner X in order to center the liner and adapter Y in the casing. If desired, the liner X may be held in working position by any suitable anchor (not shown) it being understood that various features and methods of setting the liner may be employed without affecting the structure of the present invention.

The adapter Y comprises the lower portion of the apparatus or well tool and is adapted to be joined with the liner X to be coupled with the upper portion of the

well tool for positioning of the liner in the well and for receiving and delivering gravel to the annulus surrounding the liner. The adapter Y is also adapted to pack or seal with the inner wall of the casing 10 and involves generally, an elongate tubular body A, valve means B, packing or sealing means C, and a coupler D adapted to connect with the upper portion of the tool to operate the means B and C.

The elongate tubular body A of the adapter Y is, in effect, a continuation of the liner X and may be of the same cross sectional configuration. That, the inner and outer diameters of the body A and liner X may be alike to the end that access to the interior of the liner X is clear and unobstructed. The inner bore 23 of the body is straight and continuous and joins a beveled shoulder 24 at the upper end of the body. In practice, the lower end portion of the body A is threaded at 22 to receive the coupling collar 20 to the end that the adapter Y becomes a continuation of the liner X (see Figs. 1 and 6).

The valve means B of the adapter Y is provided to pass fluids containing gravel from the bore 23 to the exterior of the body A within the casing 10. The means B involves a valve sleeve 25 shiftable on the body A, one or more valve ports 26, and a cage 27 for guiding and protecting the sleeve 25. The sleeve 25 is slidably carried on the exterior of the body A to move longitudinally thereof and operates so that the ports 26 are covered or uncovered as desired. A slot 25' extends longitudinally of the sleeve 25 to be engaged by a pin 25'' projecting from the body A for preventing relative rotation between the sleeve and the body. In the case illustrated, the ports 26 are formed in the body A in which case the sleeve 25 is a simple tubular element that surrounds the body.

The sleeve 25 is carried on the body A between the upper and lower positions, the upper position being established by a head 28 at the upper end of the body A, the head forming a downwardly facing shoulder 29 that engages the upper end 30 of the sleeve 25. The lower position of the sleeve 25 is established or determined by the cage 27 hereinafter described. There may be one or more ports 26 formed in the body A preferably in a circumferentially spaced series and positioned so that the ports are opened when the sleeve 25 is moved upwardly and closed when the sleeve 25 is moved downwardly. When the sleeve 25 is engaged with the shoulder 29 as shown in Fig. 2 of the drawings, the ports 26 are opened whereas when the sleeve 25 is shifted to the position shown in Fig. 6 of the drawings, the ports 26 are closed.

The cage 27 of the valve means B is not only provided to guide and protect the sleeve 25 but also forms as a stop for the sleeve and as an abutment for the sealing means C. The cage 27 involves a circular part that surrounds the body A and spaced from the body A leaving an annular recess for receiving the sleeve 25. The cage 27 is secured to the body A through inwardly projecting parts 31 at the lower end thereof forming a stop for the sleeve and so that the cage extends upwardly, and also so that said recess opens upwardly (see Figs. 2 and 6). In accordance with the invention, the lower end portion of the cage 27 is opened or ported at 32 to pass fluids so that fluid issuing from the ports 26 is free to enter the annulus surrounding the body A and within the casing 10. The upper end of the cage 27 terminates in an upwardly disposed face 33 adapted to cooperate with the sealing means C as hereinafter described.

The packing or sealing means C is provided to pack or seal with the inner wall of the casing 10 and may be any suitable type of packer or the like. In practice, I employ an expanding lead or rubber-type packer carried on the exterior of the sleeve 25 and adapted to be compressed longitudinally thereof and expanded or forced outwardly into pressure engagement with the inner wall of the casing 10. As shown, the sealing means C involves a tubular body 34 of lead or rubber or the like engaged over the exterior of the sleeve 25 and set against the face 33 at the upper end of the cage 27. The face 33 is pitched inwardly and downwardly as shown.

The coupler D that connects the upper portion of the well tool with the lower portion thereof is joined to the sleeve 25 to extend upwardly therefrom and is in practice, a tubular element slidably engaged over the head 28 of the body A and is threadedly connected with the sleeve 25 at 35. The lower end of the coupler D terminates in a downwardly disposed face 36 adapted to cooperate with the sealing means C above referred to. The face 36 is pitched inwardly and upwardly as shown. The upper end of the coupler D is provided with coupling threads 37, preferably left-handed threads, adapted to receive the liner setting and fluid handling tool Z and also to receive the lower end of a string of production tubing S.

From the foregoing, it will be apparent that I have provided an adapter Y that is adapted to control flow of fluids and to seal with the inner wall of the casing 10. It is to be observed that the lead or rubber packer or sealing body 34 acts to hold the sleeve 25 upwardly in engagement with the shoulder 29 to the end that the ports 26 are normally open for going into the well. The faces 33 and 36 are pitched inwardly in a manner to retain the packer 34 on the sleeve 25 while the said packer is expanded into engagement with the casing as shown in Figs. 6 and 8 of the drawings. As shown in Figs. 2 and 6 of the drawings, the inner diameter of the threads 37 adapted to connect with the production tubing or tool Z hereinafter described, is preferably substantially the same as the diameter of the bore 23 so that the interior of the adapter Y and liner X are in effect continuations of each other and devoid of any restrictions. The upper end of the coupler D is provided with a seat 38, preferably an inwardly and downwardly tapered seat adapted to engage with and position the tool Z or production string S as desired.

The liner setting and fluid handling tool Z that I have provided cooperates with the adapter Y above described and is adapted to be joined to the adapter at the threads 37. The tool Z is carried at the lower end of an operating string R and is manipulated through the string R to control the adapter Y and is primarily employed to pass gravel-laden fluid to the ports 26, or washing fluid thereto as the case may be. As best illustrated in Fig. 2 of the drawings, the tool Z involves generally an elongate frame E having an upper section engageable with the seat 38 and a lower section adapted to enter the bore 23 above described, a fluid delivering means F for receiving fluid from the string R and adapted to deliver said fluid to the ports 26, a fluid return means G for receiving fluid at the bottom of the liner X and adapted to deliver said fluid to the annulus surrounding the operating string R, and packers H for separating the bodies of fluid occurring above and below the tool of the present invention.

The frame E of the gravel packing tool Z is an elongate element adapted to handle counter-flowing streams of fluid. The means F is incorporated in the frame E to handle gravel-laden fluid delivered to the tool through the string R while the means G is incorporated in the frame E to handle gravel-free fluid received from the interior of the liner X. The frame E may vary widely in construction as circumstances require and may involve, generally, an upper coupling section 40 and a lower fluid handling section 41. The coupling section 40 is characterized by separated fluid passages 42 and 43 for handling the counter-flowing fluids, the passage 42 being adapted to conduct downward flow of gravel-laden fluid, the passage 43 being adapted to conduct upward flow of gravel-free fluid.

In practice, the upper coupling section 40 of the frame E is fabricated and is formed of an outer coupler portion

44 and a central fluid separator 45. The coupler portion 44 is an elongate, round, head-like part having a downwardly disposed seat 46 for engagement with the seat 38 at the upper end of the adapter Y. The separator 45 is coextensive with the coupler portion 44, the passages 42 and 43 also being coextensive therewith, generally speaking. As shown, the lower end portion of the coupler section 44 is provided with coupling threads 47 adapted to cooperate with the threads 37 above described. It will be readily seen how the tool Z is joined or connected with the adapter Y through the threaded connection. It is a feature of this invention to provide a downwardly disposed beveled face 48 at the lower end of the coupler section 44, the face being adapted to engage the shoulder 24 at the upper end of the body A in order to retain the coupler D and the sleeve 25 in an up position relative to the body A when the tool Z is joined to the adapter Y through the coupling threads 37 and 47.

The lower fluid handling section 41 of the frame E is a continuation of the upper section 40 and may also vary widely as to form and construction. The lower section 41 is preferably a simple tubular part or extension 50 that depends from the coupler portion 44 and separator 45 and carries a fluid handling head 51 at or adjacent the openings 26 in the body A. With the extension 50 that I have provided, there are separated fluid handling passage 42' and 43' for handling the counterflowing fluids, the passage 42' being a continuation of the passage 42, the passage 43' being a continuation of the passage 43.

The head 51 is preferably a spool-like element having upper and lower flanges 52 and 53 provided with rings 52' and 53' for sealing with the bore 23 in the body A. The flanges 52 and 53 are spaced apart longitudinally to occur above and below the ports 26 while the extension 50 continues through the head 51 to terminate at or below the head 51. Lateral openings 54 are provided in the extension 50 between the flanges 52 and 53 so that the passage 42' is in communication with the ports 26 (see Figs. 2 and 11).

The fluid delivering means F of the present invention involves the passages 42 and 42' and the openings 54, all of which are incorporated in the parts of the tool Z as above described. The upper end portion of the tool Z is threaded at 55 to be coupled with the operating string R, the threads being formed in an upwardly projecting extension of the fluid separator 45. The inner bore of the separator 45 forms the passage 42 and is in effect, a continuation of the bore that extends through the operating string R to conduct fluids to the lower end of the well W. The inner bore of the extension 50 forms the passage 42' and is a continuation of the bore 42. As shown, the passage 42' terminates at the openings 54 (see Fig. 9) with the result that fluid conducted by the operating string R is delivered to the ports 26 and through the said ports to the exterior of the body A to enter the annulus between the body and the casing 10. Fluid thus entering the casing 10, as above described, then flows downwardly in the casing and into the enlarged bore 12 below the casing shoe 11 surrounding the liner X. It will be apparent that when gravel-laden fluid is delivered to the cavity surrounding the liner X, the said gravel is deposited in the annulus surrounding the liner, the fluid only entering the liner through the slots 17.

The fluid return means G of the present invention involves the passages 43 and 43' and in addition thereto, involves one or more openings 60 that extend longitudinally through the head 51. The passages 43 and 43' and the opening or openings 60 are incorporated in the parts of the tool Z as above described. The fluid separator 45 is channeled or grooved throughout its length so that fluid enters the coupling section 40 at 61 surrounding the extension 50 and is exhausted from the section 40 at 62 surrounding the upper extension of the separator 45. The channels or grooves may be suitably formed to suit the particular circumstances involved. As clearly illustrated in Fig. 9 of the drawings, the openings 60 that extend through the head 51 receive fluid centrally of the head 51 at the lower end thereof and conduct fluid to the bore 23 above the head 51 and surrounding the extension 50. In practice, the head 51 is a circular part that passes the lower end portion of the extension 50, there being channels or grooves in the exterior of the extension 50 forming the openings 60. In the case illustrated, the lateral openings 54 and the longitudinal openings 61 are staggered circumferentially of the head 51 (see Fig. 11).

The packers H that I have provided for separating the bodies of fluid occurring above and below the tool may be of any suitable type, it being preferred to employ cup-shaped rubber-type packers. In order to provide for a fluid seal in either direction, I have provided upwardly and downwardly faced packers 70 and 71, which packers, in accordance with the invention, are carried on the upper coupler section of the frame E to occur above the ports and below the passages 43 at 62.

In order to employ the structure that I have provided, the liner X, adapter Y, and tool Z are coupled together and lowered into the well at the end of an operating string R and when in the position to be set, the gravel-laden fluid is delivered through the string R and through the passages 42, 42', through the opening 54 and through the ports 26 to issue into the annulus surrounding the liner X. The gravel is deposited in the cavity 14 surrounding the liner while the fluid enters the liner through the slots 17. In order to insure fluid circulation coextensive with the liner X, I have provided a wash pipe 75 that is threaded to the head 51 at 76. The wash pipe 75 is substantially coextensive with the liner X and is in communication with the openings 60 in the head 51 so that fluid enters the pipe 75 at the bottom portion of the liner and flows upwardly therein. Fluid entering the wash pipe 75 enters the openings 60 and flows upwardly within the passage 43' surrounding the extension 50 and then into the passage 43 at 61 to exhaust into the annulus surrounding the operating string R at 62.

After the gravel has been deposited, the threads 37 and 47 are rotated a suitable number of turns in order to raise the operating string R relative to the tool Z whereupon the string is set down to shift the coupler D, above described, relative to the body A with the result that the sealing means C is operated into pressure engagement with the interior of the casing 10 and so that the ports 26 are closed. The operating string R is then removed from the well W and replaced with a production string of tubing S. The production string S is provided with threads 47' corresponding to the threads 47 of the tool Z so that the string R can be coupled to the adapter Y in the same manner as the tool Z. As shown in Fig. 6 of the drawings, the lower threaded portion of the string S is such as to maintain the coupler D and sealing means C in the set position.

It will be apparent from the foregoing, that the liner X is now in condition to produce from the oil bearing sand 13 the entire interior of the production string S, adapter Y, and liner X, forming a continuous unobstructed passage for the reception of any pumping and servicing equipment that may be required. In order to wash or cleanse the gravel packing deposited at the exterior of the liner X, it is a simple matter to remove the production string and to lower the tool Z into place. The tool Z may be coupled to the adapter Y at any time and fluids circulated through the gravel pack in either direction for the purpose of washing or flushing.

Having described only a typical preferred form and application of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art and fall within the scope of the following claims.

Having described my invention, I claim:

1. A well apparatus for use with a liner set in a well casing and including, a fluid handling adapter secured to the upper end of the liner and adapted to separably connect with a fluid handling tool depending from the lower end an operating string of tubing, said adapter having a port directing flow of gravel bearing fluid from within the operating string to the exterior of adapter and downwardly in the annulus between the liner and the well bore, said tool having a passage directing flow of fluid upwardly from within the liner past the adapter and to the exterior of the operating string, there being a packer around the adapter to occur between the operating string and liner separating the bodies of fluid surrounding said string and liner.

2. A well apparatus for use with a liner and including, an adapter fixed to the upper end of the liner set in a well casing to depend from the lower end thereof and adapted to releasably connect with a fluid handling tool depending from an operating string of tubing, said adapter having a port directing the flow of fluid from within the operating string to the exterior of the adapter and downwardly about the exterior of the liner, said tool having a passage directing the flow of fluid from within the liner upwardly through the adapter and to the exterior of the operating string, and said tool having fluid delivering means in communication with said port, and fluid return means in communication with said passage, there being a packer between the operating string and liner separating the bodies of fluid surrounding said string and liner.

3. A well apparatus for use with a liner set in a well casing to depend from the lower end thereof and including, an adapter fixed to the upper end of the liner and adapted to releasably connect with a fluid handling tool fixed to and depending from an operating string of tubing, said adapter comprising, a tubular body coupled to the liner and having a bore therethrough in alignment with the tubing and with the liner, a lateral port in the body joining the bore in the body with the exterior thereof, said tool comprising a frame releasably coupled to the adapter, and a fluid separator directing flow of fluid from within the tubing and to the port to enter the well surrounding the liner, and directing flow of fluid entering the liner upwardly to enter the well surrounding the operating string, there being a packer on the tool between the operating string and liner separating the bodies of fluid surrounding said string and liner.

4. A well apparatus for use with a liner set in a well casing to depend from the lower end thereof and including, an adapter fixed to the upper end of the liner and adapted to releasably connect with a fluid handling tool fixed to and depending from an operating string of tubing, said adapter having a port directing flow of fluid from within the operating string to the exterior of the adapter and downwardly around the liner, and a packer that is disengaged from the well by manipulation of the tool to pass flow of fluid from the port to the liner, said tool having a passage directing flow from within the liner to the exterior of the operating string.

5. A well apparatus for use with a liner set in a well casing to depend from the lower end thereof and including, an adapter fixed to the upper end of the liner and adapted to releasably connect with a fluid handling tool fixed to and depending from an operating string of tubing, said adapter having a port opened by operation of a valve through manipulation of said tool and directing the downward flow of fluid from within the operating string to the exterior of the adapter, and a packer carried by the tool to direct the flow of fluid from the port downwardly about the exterior of the liner, said tool having a passage directing flow of fluid from within the liner upwardly past the adapter to the exterior of the operating string.

6. A well apparatus for use with a liner set in a well casing to depend from the lower end thereof and including, an adapter fixed to the upper end of the liner and adapted to releasably and alternately connect with a fluid handling tool fixed to and depending from an operating string of fluid handling tubing and with a production string of tubing, said adapter having a lateral port directing the flow of fluid from within the operating string to the adapter to flow downwardly around the exterior of the liner, and a deformable packer on the adapter above the port, said tool having a passage directing the flow from within the liner upwardly past the adapter to the exterior of the operating string, said production string being adapted to operate the packer into engagement with the well when the said string is connected to the adapter.

7. A well apparatus for use with a liner set in a well casing to depend from the lower end thereof and including, an adapter fixed to the upper end of the liner and adapted to releasably and alternately connect with a fluid handling tool fixed to and depending from an operating string of tubing and with a production string of tubing, said adapter having a lateral port directing the downward flow of fluid from within the operating string to the exterior of the adapter, and a deformable packer on the adapter about the port, said tool having a by-pass passage directing the flow from within the liner upwardly past the adapter to the exterior of the operating string, said production string being adapted to operate the packer into engagement with the well when the said string is connected to the adapter, there being a packer above the first mentioned packer and carried by the tool and separating the bodies of fluid surrounding said operating string and said liner.

8. A well apparatus for use with a liner set in a well casing to depend from the lower end thereof and including, an adapter fixed to the upper end of the liner and adapted to releasably and alternately connect with a fluid handling tool fixed to and depending from the lower end of an operating string of tubing and with a production string of tubing, said adapter comprising, a tubular body coupled to the liner and having a bore therethrough in alignment with the tubing and with the liner, a lateral port in the body joining the bore in the body with the exterior thereof, and a packer that is disengaged from the well by manipulation of the tool to pass flow of fluid from the port to the liner, said tool comprising a frame coupled to the adapter and a fluid separator directing the flow downward of fluid from within the tubing and to the port to enter the well surrounding adapter and the liner therebelow, and directing the flow of fluid entering the liner upwardly past the adapter to enter the well surrounding the operating string, said production string being adapted to operate the packer into engagement with the well when the said string is connected to the adapter.

9. A well apparatus for use with a liner set in a well casing to depend from the lower end thereof and including, an adapter fixed to the upper end of the liner and adapted to releasably and alternately connect with a fluid handling tool fixed to and depending from an operating string of tubing and with a production string of tubing, said adapter comprising, a tubular body coupled to the liner and having a bore therethrough in alignment with the tubing and with the liner, a lateral port in the body joining the bore in the body with the exterior thereof, and a packer that is disengaged from the wall by manipulation of the tool to pass flow of fluid from the port to the liner, said tool comprising, a frame having a section coupled to the adapter, a fluid separator directing the downward flow of fluid from within the tubing, and having a section directing the flow of fluid to the port to enter the well surrounding adapter and the liner, and by-pass means directing the flow of fluid entering the liner upwardly past the adapter to enter the well surrounding the operating string, said production string being adapted to operate the packer

into engagement with the well when the said string is connected to the adapter.

10. A well apparatus for use with a liner set in a well casing to depend from the lower end thereof and including, an adapter fixed to the upper end of the liner and adapted to releasably and alternately connect with a fluid handling tool fixed to and depending from an operating string of tubing and with a production string of tubing, said adapter comprising a tubular body coupled to the liner and having a bore therethrough in alignment with the tubing and with the liner, a lateral port in the body joining the bore in the body with the exterior thereof, and a packer that is disengaged from the wall by manipulation of the tool to pass flow of fluid from the port to the liner, said tool comprising, a frame having a section coupled to the adapter, a fluid separator directing the downward flow of fluid from within the

tubing, and having a section directing flow of fluid to the port to enter the well surrounding the adapter and the liner, the latter mentioned section of the tool having bypass means receiving the flow of fluid entering the liner and directing it upwardly to the separator to enter the well surrounding the operating string above the adapter, said production string being adapted to operate the packer into engagement with the well when the said string is connected to the adapter.

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