

July 13, 1965

G. A. THOMAS
METHOD OF AND APPARATUS FOR COMPLETING
OIL WELLS AND THE LIKE

3,194,312

Filed Feb. 8, 1962

3 Sheets-Sheet 1

FIG. 1

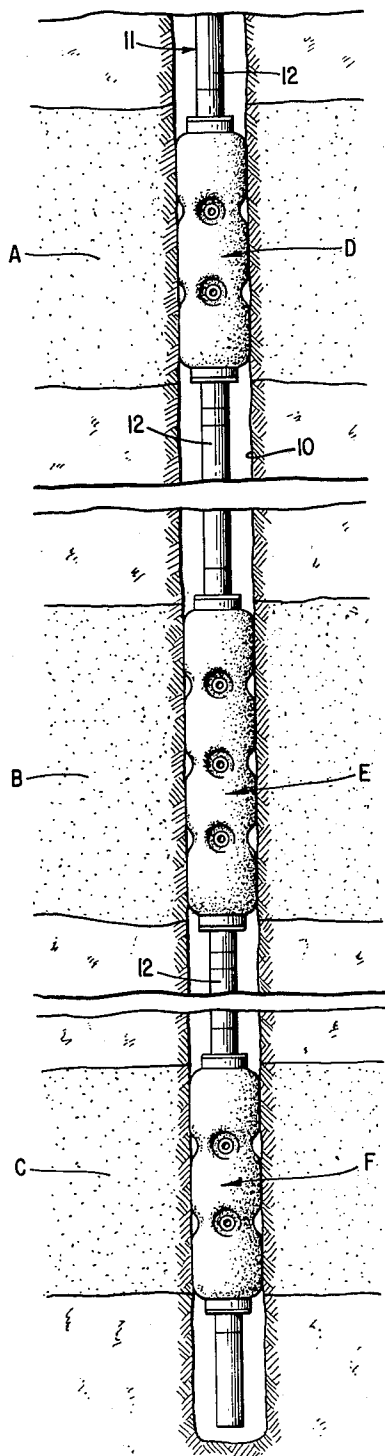
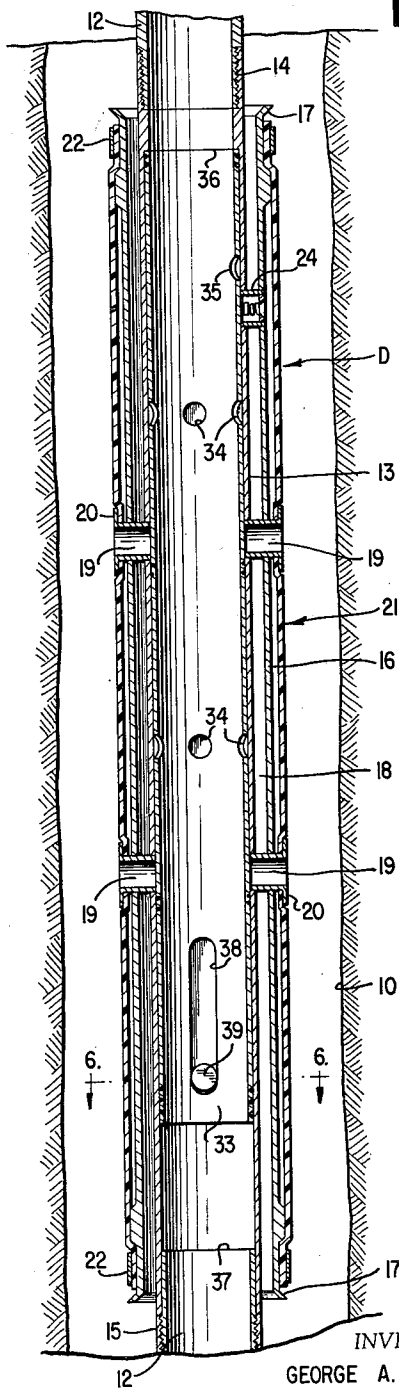


FIG. 2



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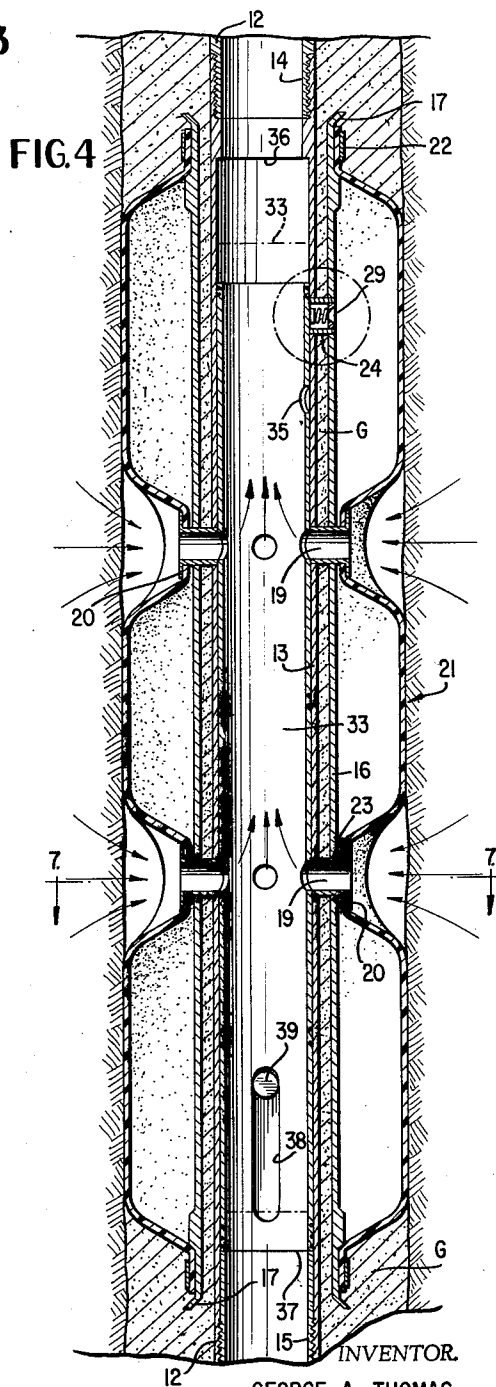
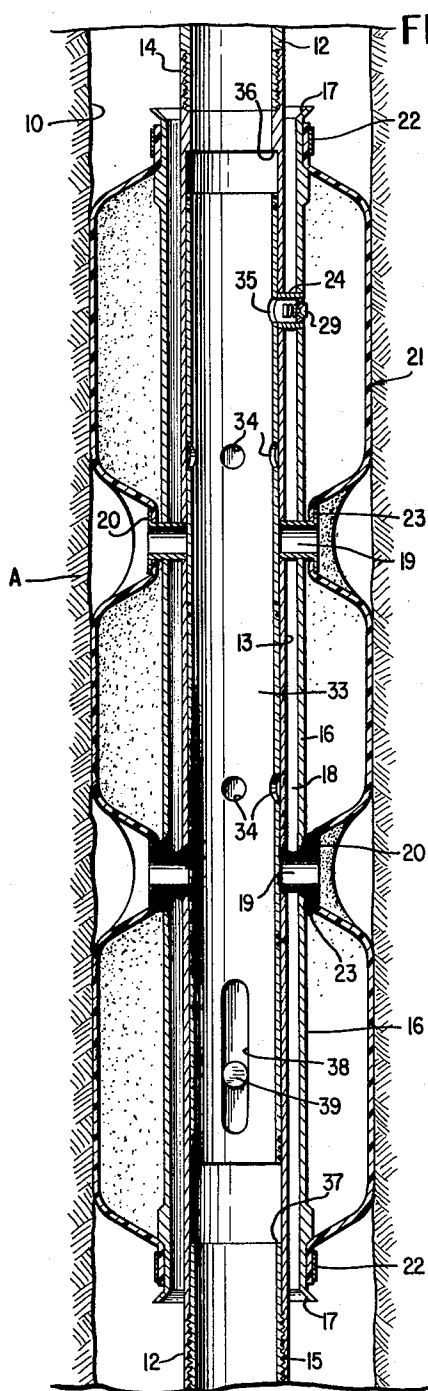
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3 Sheets-Sheet 3

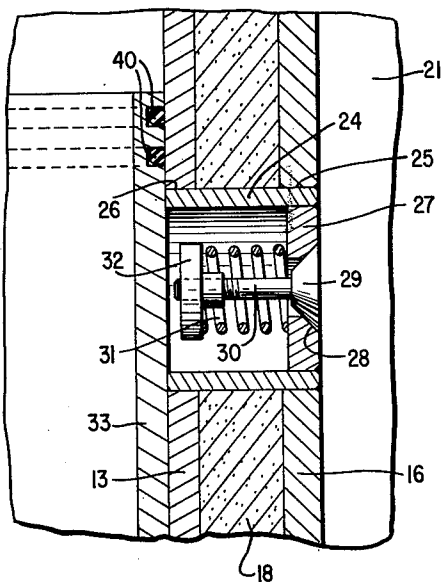


FIG. 5

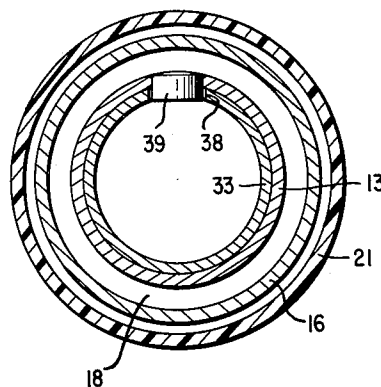


FIG. 6

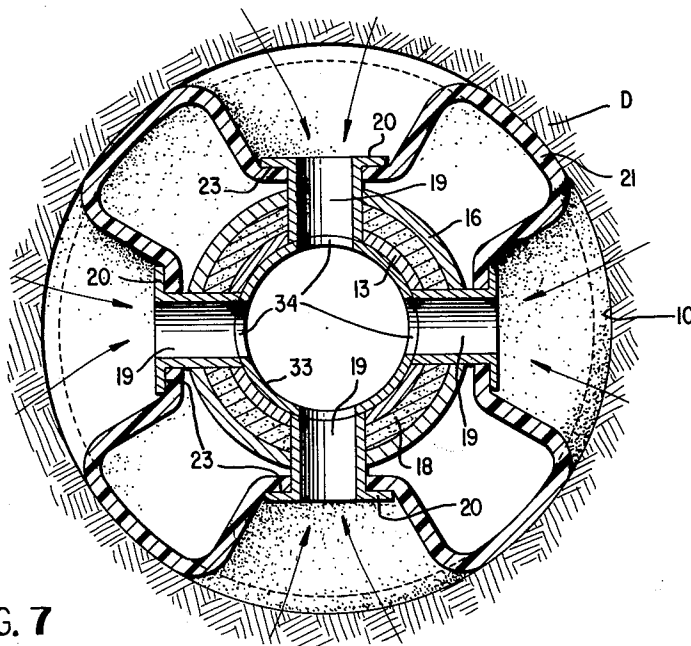


FIG. 7

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3,194,312 METHOD OF AND APPARATUS FOR COM- PLETING OIL WELLS AND THE LIKE

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Filed Feb. 8, 1962, Ser. No. 172,019
16 Claims. (Cl. 166-21)

This invention relates to a method of and apparatus for the completion and production of oil wells and the like.

A prime object of the invention is to provide a novel and simplified means to be run into the well bore with a string of well casing and positioned in the well bore to fully protect and seal one or more oil producing zones from contact with cement or other foreign matter, and including valve means operable selectively to place the producing zones in direct communication with the interior of the casing without the necessity of artificial perforation.

A further and more general object is to provide a method and apparatus for effecting well completion and production with high economy and efficiency and without interfering with normal cementing operations and other conventional well completion processes.

A further object is to provide a method and apparatus of the mentioned character which after placement in the well bore allows selective operation or production of multiple level oil producing formations or zones independently of other such zones in the well without the necessity for the usual perforation of the well casing adjacent to the producing zones.

Still another object is to provide a method and apparatus for sealing and protecting the producing formations of the well prior to and during the cementing of the casing and then operable to receive the oil from the producing formations in a controlled manner and selectively subsequent to the cementing operation.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this application and in which like numerals are employed to designate like parts of the same,

FIGURE 1 is a partly diagrammatic side elevation of apparatus according to the invention positioned in a well bore and connected in a string of casing adjacent several producing zones of the well, the diameter of the well bore being exaggerated somewhat relative to the casing for the purpose of clarity,

FIGURE 2 is an enlarged central vertical longitudinal section through a single formation protector and production valve unit according to the invention with the expandable sealing element thereof in a collapsed position and spaced from the well bore,

FIGURE 3 is a sectional view similar to FIGURE 2 with the sealing element expanded into engagement with the well bore and under the influence of internal pressure for protecting the adjacent formation prior to and during the cementing of the casing,

FIGURE 4 is a similar sectional view illustrating the unit subsequent to the cementing operation and showing the valve means adjusted for producing the adjacent formation,

FIGURE 5 is an enlarged fragmentary vertical section through a check valve circled in broken lines in FIGURE 4,

FIGURE 6 is an enlarged horizontal transverse section taken on line 6-6 of FIGURE 2,

FIGURE 7 is a similar section taken on line 7-7 of FIGURE 4.

In the drawings, wherein for the purpose of illustration is shown a preferred embodiment of the invention, the numeral 10 designates a well bore of the required depth which has been drilled in a conventional manner. For the purpose of clarity of illustration, the diameter of the well bore 10 has been exaggerated relative to the diameter of the well casing. In FIGURE 1, plural oil producing formations or zones A, B and C are illustrated at different elevations along the well bore 10, and in this connection, it should be understood that the invention is applicable to wells having a single-producing formation or multiple formations at different levels as shown in FIGURE 1. In like manner, the formation protecting and production valve units forming the subject matter of the invention are applicable to producing formations of uniform thickness or varying thickness. More particularly, in FIGURE 1, the formations A, B and C vary in thickness with the intermediate formation B being the largest and the formation C the smallest. The formation protector and production valve units according to the invention are shown generally at D, E and F in FIGURE 1 adjacent to the formation A, B and C. Each of these units may be of a different length to correspond generally to the vertical thickness of the adjacent oil producing formation. In FIGURE 1, the units D and F are of equal length to accommodate the formations A and C of nearly equal thickness while the unit E is longer to accommodate the formation B of greater thickness.

The units D, E and F in FIGURE 1 are shown connected in a conventional string of well casing 11 including casing sections 12 having interfitting screw-threaded engagement in the usual manner. After drilling the well bore 10 to the required depth and location of the producing formations A, B and C in a known manner, the casing string 11 with the units D, E and F of the invention connected therein is lowered into the well bore and the procedure in this respect is conventional throughout and is not interfered with by the presence of the invention. As shown in FIGURE 1, the invention units D, E and F are positioned in the well bore at the respective levels of the producing formations A, B and C as accurately as possible.

FIGURES 2 through 7 illustrate in detail the invention unit D which is identical to the unit F and differs from the intermediate unit E only in that it is somewhat shorter, as stated. In this connection, it is again emphasized that each invention unit may have a length to correspond generally to the depth or thickness of the adjacent producing formation of the well.

With reference to FIGURES 2 through 7, the unit D comprises an inner relatively stationary pipe 13 which is screw-threaded at its top and bottom ends, as indicated at 14 and 15 for connection with well casing sections 12 forming components of the casing string 11. Thus, in effect, the pipe 13 is assembly constitutes an integral section of the well casing. Surrounding the pipe 12 in concentric spaced relation thereto and substantially coextensive therewith is an outer relatively stationary cylindrical sleeve or pipe 16, open at its top and bottom ends and preferably including flared top and bottom mouth portions 17. An open annular passage 18 is provided between the pipe 13 and sleeve 16 for a purpose to be described. Vertically spaced groups of short radial port tubes 19 are rigidly anchored within openings of the pipe 13 and sleeve 16 by welding or the like, in a fluid tight manner, and serve to rigidly interconnect the pipe 13 and sleeve 16 permanently in assembly. Each group of port tubes 19, FIGURE 7, comprises preferably four circumferentially spaced port tubes, although any preferred num-

ber of the same may be employed in a group in equidistantly spaced relation as found desirable. Likewise, any preferred number of vertically spaced groups of the port tubes 19 may be provided in the unit depending upon the thickness of the adjacent producing formation. In this connection, the units D and F employ two groups of the port tubes 19, as shown, while the unit E adjacent to the thicker formation B employs three vertically spaced groups of the port tubes 19. Still thicker producing formations may accommodate even longer invention units having four or more equidistantly spaced groups of the radial port tubes, as should now be obvious to anyone skilled in the art.

The inner ends of the port tubes 19 are flush with the cylindrical bore of the pipe 13, whereas the outer portions of the port tubes 19 project radially beyond the outer face of sleeve 16 and carry flat annular flanges 20 at their outer extremities. All of the flanges 20 are spaced equidistantly radially from the periphery of the sleeve 16.

An expandable packing jacket or sleeve 21 of rubber-like material, including synthetic rubber and certain stretchable plastics materials, surrounds the sleeve 16 and is substantially coextensive therewith. Opposite end portions of the jacket 21 are firmly secured to corresponding end portions of the sleeve 16 in a fluid tight manner by metal clamping bands 22. Intermediate portions of the jacket 21 have radial openings receiving the port tubes 19 snugly with the flat flanges 20 engaging outwardly of the jacket 21 and securely bonded thereto in a fluid tight manner as at 23. The jacket 21 is otherwise free from attachment to the rigid sleeve 16, and the interior of the jacket 21 is adapted to receive fluid under pressure for expanding the jacket in a manner presently to be described. The interior of the pipe 13 is in direct communication with the surrounding oil producing formation through the several port tubes 19.

The sleeve or pipe 16 together with the packing jacket 21 thus constitute a complete packing means or unit according to the invention, FIGURE 4, etc.

A short radial tube 24 is rigidly anchored by welding or the like within aligned openings 25 and 26 of the sleeve 16 and pipe 13 near and below the top ends of the same, and above the uppermost group of port tubes 19. If preferred, the tube 24 may be located near the lower ends of the elements 16 and 13 or at some other point along the same. The inner end of the short tube 24 is flush with the bore of the pipe 13 as best shown in FIGURE 5, and its outer end may be flush with the periphery of the rigid sleeve 16. The tube 24 has fluid tight engagement with the pipe 13 and sleeve 16. The outer end of the tube 24 is covered by a plate 27 welded therein and having an outwardly tapering conical seat 28 formed therein for a conically tapered check valve element 29, having an inwardly extending radial stem 30 disposed centrally within the short tube 24. A compressible coil spring 31 surrounds the stem 30 and has its forward end bearing upon the plate 27 and its rear end bearing upon a collar 32, having screw-threaded engagement with the stem 30 and adjustable thereon to regulate the tension of the spring 31. The spring 31 maintains the valve element 29 normally closed or seated but allows outward opening of the valve element under the influence of sufficient fluid pressure in the tube 24. When the valve 29 is opened by fluid pressure, such fluid may enter the jacket 21 and expand the jacket into sealing and protecting engagement with the surrounding producing formation, as illustrated in FIGURES 1, 3, 4 and 7.

Slidable within the pipe 13 is an elongated open-ended cylindrical sleeve valve element 33 having groups of radial ports 34 adapted to register with the port tubes 19 upon longitudinal movement of the sleeve valve downwardly, FIGURE 4. The sleeve valve 33 has an additional radial port 35 formed therethrough adapted to register with the short tube 24, FIGURE 3. The arrangement or spacing of the ports 34 and 35 is such that all of the ports may

be out of registry with the port tubes 19 and tube 24 as shown in FIGURE 2. At this time, the sleeve valve 33 completely covers or closes the several port tubes and the tube 24 containing the valve element 29. As shown in FIGURE 3, a slight downward movement of the sleeve valve 33 shifts the port 35 into registration with the tube 24 while the ports 35 are still out of registry with the port tubes 19 and the latter remains closed by the sleeve valve. In a further downwardly adjusted position of the sleeve valve 33, FIGURE 4, the latter has its ports 34 in registry with the port tubes 19 and the port 35 has then passed below the tube 24 and is out of registry therewith and the tube 24 is covered by the sleeve valve 33. Thus, the port tubes 19 are never uncovered when the tube 24 is uncovered and vice-versa. However, all of the port tubes and the tube 24 may be covered or closed simultaneously as depicted in FIGURE 2 but these elements are never open or uncovered simultaneously as explained above.

The pipe 13 is provided near and inwardly of its opposite ends with annular shoulders 36 and 37 adapted to abut the opposite ends of the sleeve valve 33 to positively limit axial movement thereof in opposite directions. When the top of the sleeve valve 33 engages the upper shoulder 36, FIGURE 2, all of the port tubes 19 and the short tube 24 are closed by the sleeve valve. When the bottom of the sleeve valve engages the shoulder 37, FIGURE 4, all of the port tubes 19 are uncovered and the tube 24 is covered. In an intermediate elevated position of the sleeve valve 33 shown in broken lines in FIGURE 4, the same may be caused to cover all of the port tubes 19 and the short tube 24 but with the port 35 below the tube 24 rather than above it as depicted in FIGURE 2.

Means are provided to prevent rotation of the sleeve valve 33 within the pipe 13 while allowing longitudinal movement of the sleeve valve and thus preventing misalignment of the sleeve valve ports with the tubes 19 and 24. Such means may comprise a longitudinal slot or keyway 38 formed through the side wall of the sleeve valve 33 near one end thereof and receiving slidably a key element 39 rigid with the pipe 13 and projecting inwardly radially thereof. Other like means may be utilized to prevent rotation of the sleeve valve while permitting it to move longitudinally between the shoulders 36 and 37.

If preferred, the sleeve valve 33 may be constructed to rotate within the pipe 13 rather than to reciprocate therein for moving the ports 34 and 35 into and out of registration with the port tubes 19 and valve tube 24. In such case, the ports 34 and 35 are positioned circumferentially on the sleeve valve to allow the desired covering and uncovering of the tubes 19 and 24 upon turning of the sleeve valve the required distance.

The sleeve valve 33 is provided near its top and bottom ends and at suitable intermediate points with O-ring seals 40 or the like to provide a fluid tight fit between the sleeve valve and pipe 13. These seals cause the sleeve valve to have a very snug fit within the pipe 13 and to maintain a particular longitudinally adjusted position without movement. The seals 40 are arranged on the sleeve valve so that they will never pass over the mouths of the port tubes 19 or tube 24 where they might be damaged by the latter or where the seal between the sleeve valve and pipe might be lost.

The sleeve valve 33 is shifted axially by any conventional expanding type setting tool or packer, well known to those skilled in the art, and lowered through the casing string 11 to reach the sleeve valve of any particular invention unit D, E or F. These units may be operated independently or selectively as stated, and this feature is an important part of the invention.

The operation of the apparatus in the practice of the method is as follows.

The string of casing 11 is lowered into the well in the conventional manner with the invention units D, E, F,

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etc. connected therein. At this time, the jacket 21 is collapsed and lies close to the rigid sleeve 16 for each packing means and each sleeve valve 33 is elevated against the shoulder 36 and the port tubes 19 and valve tube 24 are all closed by the sleeve valve.

When the units D, E and F are positioned within the producing formations A, B and C, FIGURE 1, the sleeve valves 33 of the several units are shifted downwardly by the use of a suitable setting tool to the position shown in FIGURE 3, wherein the ports 35 register with the tubes 24 on each unit. At this time, the port tubes 19 remain covered by the sleeve valve. Fluid under pressure is now introduced into the casing string 11 and the interiors of the sleeve valves 33 and when this fluid pressure is sufficiently great, the check valves 29 are opened against the force of adjustable springs 31 and the fluid under pressure passes through the short tubes 24 and inflates or expands each elastic packing jacket 21 outwardly into fluid tight protecting and sealing engagement with the surrounding producing formation A, B or C. As shown in FIGURE 1, each expanded jacket 21 assumes an inflated cylindrical shape and uniformly engages the well bore over substantially the full area of the adjacent producing formation, except for the small dimpled local areas adjacent the flanges 20. When the fluid pressure is relieved in the casing string, the check valves 29 close automatically under influence of springs 31 and the jackets 21 remain expanded against the bore of the formation to subsequently protect and seal the same. At this time, the sleeve valve 33 of each unit may be returned to the position shown in FIGURE 2 or to the broken line position in FIGURE 4 for covering the short tubes 24 and also covering the port tubes 19. When the fluid pressure to expand the jackets 21 is created in the casing string, the bottom end of the casing may be closed off by means well known in the art.

While the jackets 21 remain expanded and the tubes 19 and 24 are covered by the sleeve valves, cement is forced downwardly through the casing string and flows upwardly exteriorly of the casing in the usual manner to cement the casing string within the well bore 10. However, the cement shown at G in FIGURE 4 cannot pass between the inflated jackets 21 and the well bore 10 and is caused to flow upwardly through the open annular passage 18 of each invention unit to cement the well casing sections 12 securely above and below and adjacent each invention unit and producing formation. When the cement G hardens in the well bore, the producing formations A, B and C remain permanently free of the cement and other foreign material and the jackets 21 may remain inflated indefinitely until they disintegrate with the passage of time. The cement may remain in the annular passage 18 of each unit and will do no harm therein. The entire well casing string is supported by cement throughout its length, above, below and opposite the oil producing formation or formations.

When the cementing of the well is completed in the described manner, a selected one or more of the sleeve valves 33 may be shifted downwardly into engagement with the bottom shoulder 37 as illustrated in FIGURE 4. When this occurs, the ports 34 register with the port tubes 19 and the valve tubes 24 are covered by the sleeve valve. The adjacent producing formation A, B or C is now placed in direct communication with the interior of the casing string through the tube ports 19 and the oil under pressure flows directly in the direction of the arrows in FIGURES 4 and 7 and upwardly through the casing. Consequently, the production from the adjacent formation is achieved without the necessity for any perforation of the casing and formation.

When it is desired to produce a different one of the several formations A, B and C, the sleeve valve 33 of the unit previously utilized may be shifted upwardly slightly to the broken line position indicated in FIG-

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URE 4 to cover the port tubes 19 of that unit and to also maintain the tube 24 covered. Another of the sleeve valves 33 in another unit E or F may now be positioned in the manner shown in FIGURE 4 to produce oil from the adjacent formation B or C. In this manner, the sleeve valves 33 are selectively operated to produce selectively the formations A, B and C. As previously stated, by means of the invention, any number of separate oil producing formations in a well may be selectively produced or closed off as the need requires, and any number of the invention units may be included in the string of casing at properly spaced intervals to be located at the producing zones. Likewise, the units of the invention may have one, two, three or any practical number of groups of the port tubes 19 provided therein depending upon the size of the producing formation to be dealt with.

Additionally, in instances where one or more of the producing formations A, B and C is exceedingly deep or thick, several of the individual invention units D, E or F may be placed in end-to-end relation in the particular formation and connected in the casing string, in lieu of a single invention unit which might be excessively long. Such multiple invention units connected closely in series could be identical to the unit D or to the unit E and may be provided individually with any preferred number of groups of the port tubes 19 and associated elements.

The invention therefore constitutes a highly efficient and economical method and apparatus for completing a well including the steps of protecting and sealing the producing formations, cementing the casing above and below and opposite each formation, and selectively obtaining the oil from each formation in the order and in the manner desired, and without the necessity for perforations.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, as well as variations in the order or sequence of method steps, without departing from the spirit of the invention or scope of the subjoined claims.

Having thus described my invention, I claim:

1. In apparatus for completing oil wells, a valve unit and formation protecting device comprising an inner pipe to be connected in a tubular string adjacent a producing formation of the well, an exterior sleeve surrounding said pipe and anchored thereto in spaced substantially concentric relation therewith to form a through passage for cement and fluid between the pipe and sleeve, an outwardly opening check valve on the pipe and sleeve and communicating with the exterior of the sleeve and the interior of the pipe, a spring normally maintaining the check valve closed but allowing it to open under the influence of fluid pressure in the pipe, an expandable elastic jacket surrounding the sleeve and secured thereto near opposite ends of the sleeve and adapted to expand against the bore of said formation under fluid pressure admitted to the jacket when the check valve is open, radial port tubes anchored to the pipe and sleeve and secured to the jacket at spaced localities thereon and communicating with the interior of the pipe and the exterior of the jacket adjacent the formation, an open-ended axially movable sleeve valve within the pipe and having radial ports adapted to register with the port tubes in one axial position of the sleeve valve and a port adapted to register with the check valve in another axial position of the sleeve valve, the sleeve valve, in intermediate axial positions thereof covering the check valve and port tubes, and guide means engaging the sleeve valve to prevent it from rotating but allowing it to shift axially within said pipe.

2. The invention as defined by claim 1, and a pair of stop shoulders on said pipe near opposite ends thereof engageable with corresponding ends of the sleeve valve to positively limit axial movement thereof.

3. The invention as defined by claim 1, and sealing rings

on said sleeve valve engaging the bore of the pipe in a fluid tight manner and positioned to avoid engagement with said port tubes and check valve in all adjusted positions of the sleeve valve.

4. The invention as defined by claim 1, and clamping bands surrounding opposite end portions of said jacket to clamp the same snugly in a fluid tight manner to said exterior sleeve.

5. The invention as defined by claim 1, and flat annular flanges on the outer ends of the port tubes and spaced radially of said exterior sleeve and bearing upon localized areas of said jacket and bonded thereto, said jacket having openings receiving said port tubes.

6. Apparatus for completing wells comprising a producing casing mounted within a well bore and extending adjacent to a plurality of suspected oil bearing formations at different elevations along the well bore, expandable means on the casing adjacent each formation to engage the latter and protect the same and forming with the casing a through passage exteriorly of the casing through which cement may be flowed to seal the well bore above and below each formation and expandable means, and selectively operable means on said casing adjacent each formation to place each formation selectively into communication with said casing.

7. Apparatus for completing a well comprising a producing casing within the well bore extending adjacent to several oil producing formations at different elevations along the well bore, fluid pressure operable packing means on the casing adjacent said formations to engage and protect the latter and having a through passage exteriorly of the casing through which cement may be introduced to seal the well bore intermediate said formations, and selectively operable sleeve valve means on the casing adjacent each formation to bring the several formations into communication with said casing in the order for obtaining the maximum yield from the several formations.

8. Well completion apparatus comprising a pipe adapted to be connected in a string of casing in a well adjacent a producing formation of the well, an exterior sleeve surrounding said pipe in spaced substantially concentric relation thereto and anchored to said pipe, radial passage means leading from the interior of the pipe through the exterior of said sleeve, an expandable jacket surrounding said sleeve and secured thereto near corresponding ends of the sleeve and jacket, said radial passage means extending through said jacket and communicating with the well exteriorly of the jacket, fluid pressure responsive valve means on said pipe and exterior sleeve adapted to open under the influence of fluid pressure in said pipe to cause expansion of said jacket into protective contact with the wall of said formation, said valve means when open defining a communicating passage between the interior of the pipe and the interior of said jacket, and a sleeve valve axially movably mounted within the pipe and having radial ports adapted to selectively register with said radial passage means and fluid pressure responsive valve means, said sleeve valve also adapted in one adjusted position thereof to cover said radial passage means and fluid pressure responsive valve means.

9. Well completion apparatus comprising a string of casing to be arranged in a well bore having a plurality of vertically spaced producing formations, a corresponding number of fluid pressure operable expandable sleeve devices on said casing string adjacent said formations each adapted when expanded to engage, cover and protect one formation substantially, intermediate open-ended sleeve means on the casing string adjacent each formation and each expandable sleeve device and disposed between the sleeve device and casing string and defining with the latter an annular through passage for cement, a first valve means connected with the casing string and operated by fluid pressure within the casing string to pressurize the interior of the expandable sleeve device for expanding the same into engaging, covering and protecting rela-

tion with the adjacent producing formation, and a second movable valve means within the casing string adjacent each formation and each expandable sleeve device and operable to place the interior of the casing string in fluid flow communication with the exterior of the expandable sleeve device at the adjacent formation.

10. Apparatus for cementing a well having multiple level producing formations and for selectively obtaining fluid from said formations after cementing, said apparatus comprising a tubular string to be placed in the well and adapted to extend adjacent said multiple level formations of the well, and a corresponding number of spaced units on said string adjacent the formations for first cementing the well above and below each formation and for then selectively obtaining fluid from the formations after completion of cementing, each unit comprising a pipe section constituting a portion of said string and connected therein, a substantially rigid intermediate sleeve surrounding said pipe section and spaced therefrom to define therewith an annular through passage for cement, an expandable packer sleeve mounted upon and surrounding said intermediate sleeve and substantially coextensive axially therewith and having its opposite ends secured to the exterior of the intermediate sleeve in substantially fluid tight engagement, spaced radial tubular port elements extending between and interconnecting said pipe section, intermediate sleeve and packer sleeve and serving to place the interior of the pipe section in fluid flow communication with the formation exteriorly of the packer sleeve, fluid pressure operable valve means connected with said pipe section and intermediate sleeve and communicating with the interior of the packer sleeve and operable in response to fluid pressure in the pipe section for expanding the packer sleeve into protective covering contact with the wall of the formation along substantially the length of said unit, and an axially shiftable open-ended sleeve valve within said pipe section and having radial side openings for registration with the tubular port elements so that the latter may be selectively covered and uncovered.

11. The invention as defined by claim 10, and interengaging means on said pipe section and sleeve valve to positively limit axial movement of the sleeve valve and to align the radial side openings of the sleeve valve with said tubular port elements in one axially adjusted position of the sleeve valve.

12. Apparatus for cementing a well having plural multi-level producing formation and for selectively obtaining fluid from said formations after cementing in a continuous cycle of operation with said apparatus, said apparatus comprising a tubular string adapted to extend adjacent to all of said formations within said well, a rigid sleeve mounted upon the exterior of said string at each formation in spaced relation to the string and defining between the sleeve and string an axial through passage for cement, a flexible expandable packer sleeve mounted upon each rigid sleeve at each formation and having opposite end portions secured snugly to the rigid sleeve near opposite ends of the rigid sleeve, a plurality of spaced radial tubular port elements connected with said string, rigid sleeve and packer sleeve at each formation and bridging said through passage and serving to place the interior of the tubular string in fluid flow communication with the exterior of the packer sleeve and said formation, valve means connected with said string and rigid sleeve at each formation and operable in response to fluid pressure within the string to admit fluid under pressure into the interior of the packer sleeve and between the packer sleeve and rigid sleeve for expanding the packer sleeve into covering engagement with the wall of the formation, and a sleeve valve element movably mounted within the string at each formation and having side ports adapted for registration with said tubular port elements to uncover the latter in one adjusted position of the sleeve valve element.

13. In a method of completing a well, the steps of lowering tubular string with a plurality of longitudinally spaced packing jackets attached thereto and spaced radially therefrom into the well, engaging and substantially covering spaced multiple level producing formations in the well exteriorly of the string and around the string with said packing jacket and while the string is positioned in the well, forcing cement downwardly through the string and then upwardly exteriorly of the string and between the string and said packing jackets covered formations to cement the string above and below and opposite each formation and maintaining each formation covered to protect it from the cement, and then selectively producing fluid from said covered formation through said packing jackets into said string for passage upwardly therein.

14. In a method of completing a well, said well having spaced multiple level producing formations, the steps of placing a tubular string with a plurality of longitudinally spaced packing jackets attached thereto and spaced radially therefrom into the well and causing said string to extend adjacent said formations, cementing the string within the well above and below and opposite each formation and exteriorly of the string and between the string and packing jackets while the packing jackets are in covering and protecting relationship with the pores of said formations, and then selectively placing the interior of the string in direct fluid flow communication with said formations through said packing jackets so that the string may receive fluid selectively therefrom.

15. In a method of completing a well, the steps of lowering a tubular string with an expandable packing means attached thereto and spaced radially therefrom into the well and positioning the packing means opposite a producing formation in the well, expanding the packing means into engaging and covering relation to said producing formation exteriorly of the string and around the string, forcing cement downwardly through the string

and then upwardly exteriorly of the string and between the string and packing means to cement the string in the well above, below and opposite said formation while maintaining the formation covered and protecting its pores from the cement, and then producing fluid from the formation into the string through said packing means.

16. Apparatus for completing a well comprising a casing string positioned within said well and extending adjacent an oil producing formation, an expandable packing means mounted on the casing string and spaced therefrom adjacent said formation and adapted when expanded to engage and cover the surface of the formation to protect the pores thereof, valve means connected with said string and packing means and operable to expand the packing means into said engagement with the formation, there then being a longitudinal through passage between the string and packing means to permit cementing the string above, below and opposite the formation, and additional valve means connected with the string and packing means adjacent the formation and operable to place the formation into fluid flow communication with the interior of the string through the packing means.

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