May 1, 1962 W. J. BIELSTEIN 3,032,108

WELL PACKER APPARATUS

Filed April 27, 1959

FIG. 2.

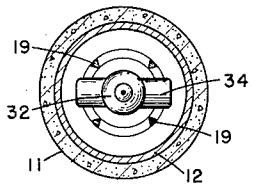


FIG. 1.

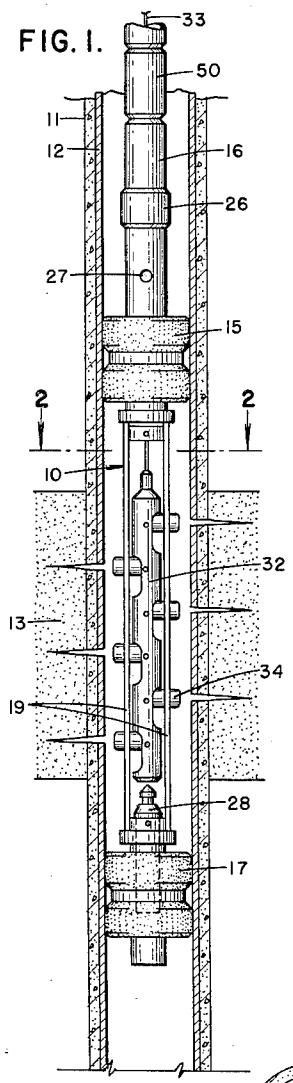


FIG. 3.

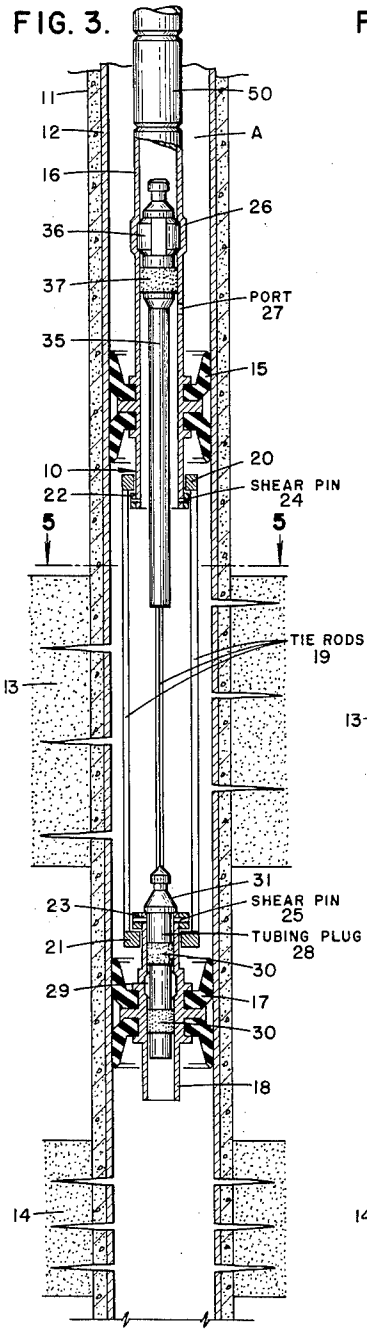
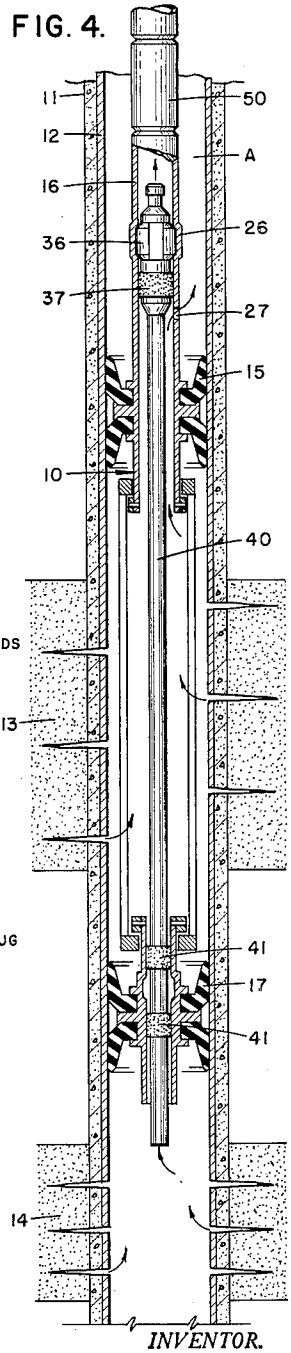


FIG. 4.



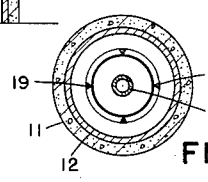


FIG. 5.

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WELL PACKER APPARATUS

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This invention concerns a single and multiple zone separation and completion well tool. More particularly, the invention concerns a retrievable packer device which seals off and isolates zones in the run-in position and provides for selectively producing single or multiple completions and recompletions in these or other zones without removing the device from the well bore.

The particular construction of this apparatus which comprises essentially spaced-apart sealing elements interconnected by rod members, permits performance of all known operations performed in wells including perforating, stimulation, and remedial work without pulling tubing. Also, because the packer is pressure balanced, hold-down devices as, for example, slips which are required on existing production packers are unnecessary. Further, the well tubing can be set in full tension because tubing weight is not required to hold the packer in place. This latter function is generally a requirement for existing production packers. Opposed cup packers are shown and described herein as the sealing element for purposes of illustration; mechanically or hydraulically operable expansible type packers may be used instead.

Other advantages of the invention include the ability to control undesired gas or water production by placing the appropriate sealing element within the perforated interval; and abandonment of an interval by setting both sealing elements above or below this interval.

These and other advantages and objects of the invention will be apparent from a description thereof taken in conjunction with the drawing wherein:

FIG. 1 is a cross-sectional view of a well bore showing the tool of the invention positioned adjacent a formation and a swing jet perforator arranged between the sealing elements thereof;

FIG. 2 is a view taken on lines 2—2 of FIG. 1;

FIG. 3 is a cross-sectional view of a well bore showing the tool and auxiliary equipment arranged for working over the upper zone of a dual completion;

FIG. 4 is a cross-sectional view of a well bore showing the tool and auxiliary equipment arranged for duel completion producing operations; and

FIG. 5 is a view taken on lines 5—5 of FIG. 3.

Referring to the drawings in greater detail in FIGS. 1, 3, and 4 is shown the tool, generally designated 10, arranged in a borehole 11 in which is arranged a casing 12. In FIG. 1 borehole 11 penetrates a single formation 13 and in FIGS. 3 and 4 borehole 11 penetrates upper and lower formations 13 and 14, respectively. The details of the tool are seen more clearly in FIG. 3 and include upper opposed cup packer elements 15 connected to a pipe string 16 and lower opposed cup packer elements 17 mounted on a tubular member 18 interconnected by means of a plurality of elongate, spaced-apart tie rods 19. The tie rods are provided with upper and lower annular collars 20 and 21, respectively. Adjacent collars 20 and 21, the lower end of pipe string 16 and the upper end of tubular member 18 have secured thereto flanges 22 and 23, respectively, by means of shear pins 24 and 25, respectively.

To facilitate workover and producing operations for dually completed wells, pipe string 16 may be provided with a landing nipple 26 for supporting tubular extensions and a closable port 27 positioned below landing nipple 26

for permitting fluid circulation between pipe string 16 and the annulus A between casing 12 and pipe string 16.

Various operations are illustrated in FIGS. 1 to 5. In FIGS. 1 and 2, positioning of a gun perforator prior to producing a single formation is shown. A tubing plug 28, lowerable on a wire line through pipe string 16, is arranged in tubular member 18. This tubing plug is provided with releasable latch means 29 (see FIG. 3) which is adapted to releasably engage the interior wall of tubular member 18 and sealing elements 30 which are adapted to seal off the annulus between the wall of tubular member 18 and plug 28. The upper end 31 of plug 28 is formed tapered or streamlined to eliminate fouling by junk.

In operation, tool 10 is run-in borehole 11 on pipe string 16. As seen in FIG. 1, packer elements 15 and 17 are set astride the formation or zone 13 to be perforated. Then, plug 28 is run in through pipe string 16 and latched in lower packer 17 to seal off the well bore below formation 13. Then, a perforating gun 32 is run in the borehole through pipe string 16 on a wire line 33 and fired to perforate formation 13. If desired, a differential into the well bore can be created by swabbing prior to perforating the formation. As seen more clearly in FIG. 2, when employing a swing jet type perforating gun, tie rods 19 may be formed triangular in cross-section to provide streamlining to aid the swing jets 34 of gun perforator 32 to attain proper orientation. Although this embodiment is preferred, any gun orienting means may be employed to avoid damage to the tie rods 19 in lieu of a swing jet gun type perforator.

FIG. 3 illustrates an arrangement of the apparatus which may be utilized for working over upper formation 13 of a dually completed well. In this instance, prior to perforation of formation 13, as described supra, a gun perforator adapted to be lowered through tubular member 18 is lowered through pipe string 16 and tubular member 18 to adjacent formation 14 and fired to perforate formation 14. Then the gun perforator is removed from the well bore through pipe string 16 and plug member 28 is lowered on a wire line into position within packer 17. Then, gun perforator 32 is lowered to adjacent formation 13 and the upper formation is perforated, as described supra. Plug 28 isolates formations 13 and 14 from each other. Then, a tubular extension 35 provided with a suitable latching mechanism 36 and sealing means 37 adapted to seal off the annulus between tubular extension 35 and pipe string 16 above opening 27 is arranged in landing nipple 26. For working over the upper zone, as, for example, for cementing operations, the circulation of fluid may be down pipe string 16 through open-ended tubular extension 35 and up annulus A via port 27.

In FIG. 4, producing operations are illustrated for a dually completed well wherein the production fluids from each zone or formation are maintained separate. In this operation, formations 14 and 13 are perforated, as described supra, and then a tubular extension 40 provided with a suitable latching mechanism 36 and sealing means 37 is supported in pipe string 16. Tubular extension 40 extends through the bore of packer 17 and is provided with additional sealing means 41 for sealing off the annulus between tubular member 18 and tubular extension 40. Production fluids from the lower formation 14 flow upwardly through tubular extension 40 and pipe string 16 whereas production fluids from the upper formation 13 flow upwardly through port 27 and annulus A to the surface of the earth.

The elements of the packer are readily removable or retrievable from the well bore. However, in case packer elements 15 and 17 become stuck, flanges 22 and 23 and collars 20 and 21 aid in jarring loose the packer elements

when upward pull is applied to pipe string **16**. Shear pins **24** and **25** are provided to effect retrieval of the upper packer **15** in case the lower packer **17** is stuck. Thus, upon upward movement of pipe string **16**, lower shear pin **25** first shears after which upper shear pin **24** shears.

If it is desirable to retrieve just the pipe string **16**, a conventional tubing safety joint **50** may be employed as shown.

Although only gun perforating, upper zone workover, and dual zone producing installations are illustrated and described herein, the invention is not to be considered limited to these particular operations. For example, squeeze job apparatus may be readily installed.

Having fully described the objects, nature, elements, and operation of my invention, I claim:

1. Well apparatus comprising a pipe string extending downwardly in a well, an upper packer arranged on said pipe string adjacent the lower end thereof for sealing off the space between said pipe string and the well wall, a plurality of horizontally spaced-apart vertically extending tie rods attached at the upper ends thereof to the lower end of said pipe string, a tubular member provided with an opening therethrough attached to the lower ends of said tie rods, a lower packer arranged on said tubular member for sealing off the space between said tubular member and said well wall, said upper packer being positioned above an upper productive zone, said lower packer being positioned below the upper productive zone and above a lower productive zone, said pipe string being provided with an opening above said upper packer fluidly communicating the interior of said pipe string and the annulus between said pipe string and the well wall, a tubular extension suspended in said pipe string and extending downwardly through said tubular member opening to adjacent the lower productive zone, said tubular extension being provided with an upper sealing means adapted to seal off the space between the tubular extension and the pipe string above the opening in the pipe string and lower sealing means adapted to seal off the space between the tubular extension and the wall of the tubular member opening whereby fluid from said upper productive zone may be produced through said pipe string opening and the annulus between said pipe string and the well wall and fluid from the lower productive zone may be produced through said tubular extension and said pipe string.

2. Well apparatus comprising a pipe string extending downwardly in a well; an upper packer arranged on said pipe string adjacent the lower end thereof for sealing off the space between said pipe string and the well wall; a plurality of horizontally spaced-apart, vertically extending tie rods arranged in said well; a tubular member arranged in said well below the lower end of said pipe string; a lower packer arranged on said tubular member for sealing off the space between said tubular member and said well wall; means including upper and lower shear pins releasably attaching the upper ends of said tie rods to the lower end of said pipe string and the lower ends of said tie rods to said tubular member, respectively, each shear pin being adapted to rupture upon application of a predetermined upward pull applied to said pipe string.

3. Apparatus as recited in claim 2 wherein said lower shear pin is adapted to rupture upon application of less pull applied to said pipe string than the pull applied to said pipe string required to rupture said upper shear pin.

4. Well apparatus comprising:

a pipe string extending downwardly in a well;

an upper packer arranged on said pipe string adjacent the lower end thereof for sealing off the space between said pipe string and said well wall;

a plurality of horizontally spaced-apart, vertically extending tie rods triangular in cross section attached at the upper ends thereof to the lower end of said pipe string;

a tubular member provided with an opening therethrough attached to the lower ends of said tie rods;

a lower packer arranged on said tubular member for sealing off the space between said tubular member and said well wall;

said upper packer being positioned above an upper productive zone, said lower packer being positioned below said upper productive zone and above a lower productive zone, a plug arranged in said tubular member adapted to close off the opening therethrough to isolate said upper and lower productive zones one from the other;

and a gun perforator positioned between said upper and lower packers adjacent said upper productive zone and having extendible, retractable gun elements mounted thereon, said gun elements cooperating with said tie rods to position said gun elements when extended between said tie rods so that said tie rods are not damaged when said gun elements are fired.

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