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3,211,231

OIL WELL COMPLETION TOOL WITH DROP-OFF PLUG

Filed Nov. 21, 1962

2 Sheets-Sheet 1

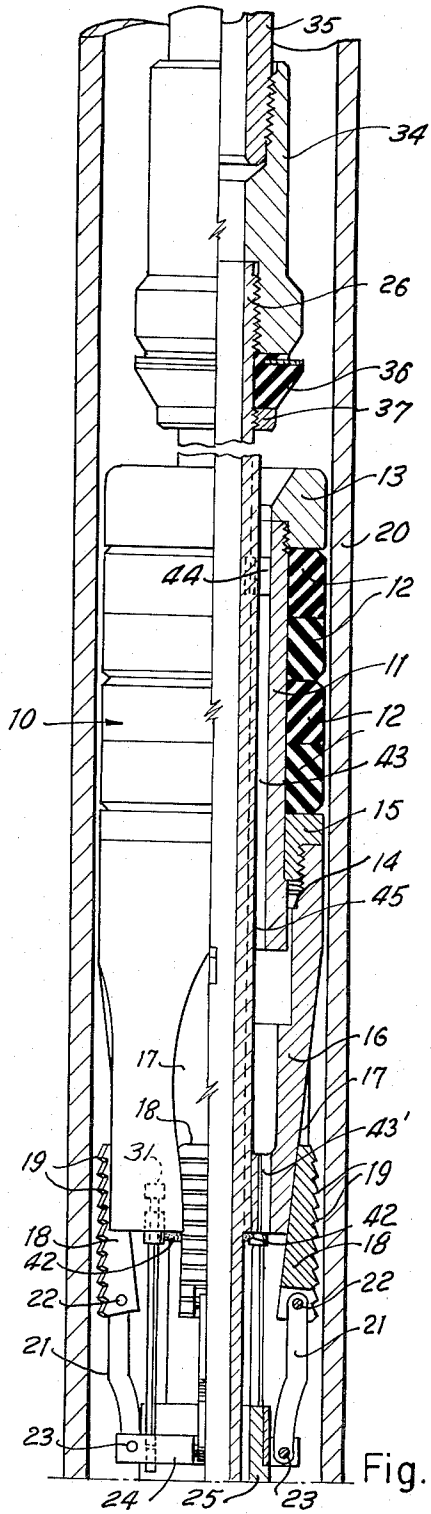


Fig. 1

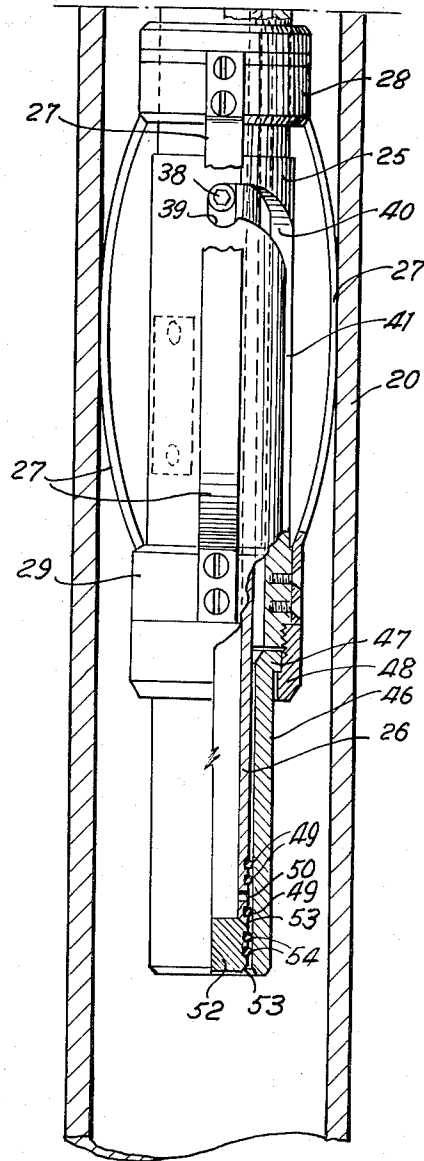


Fig. 1-A

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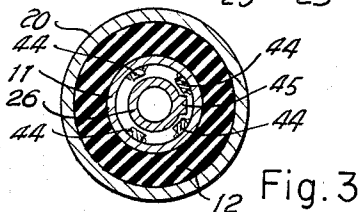
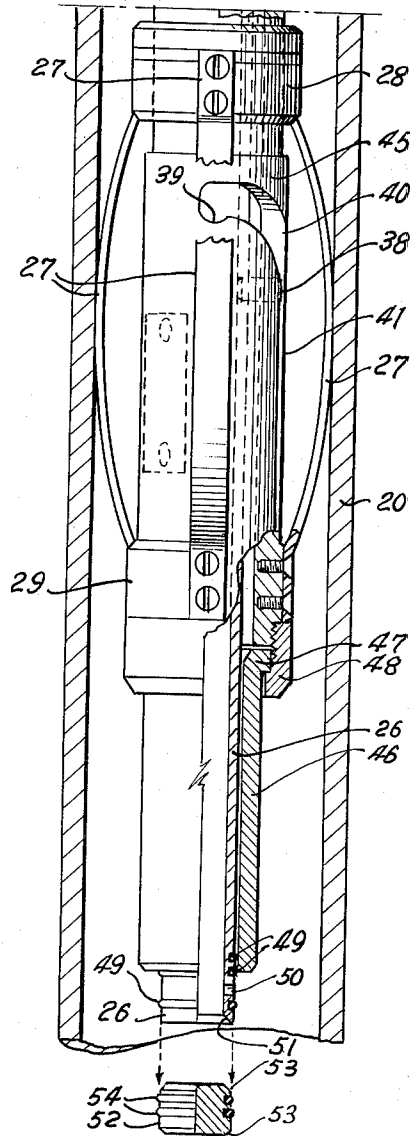
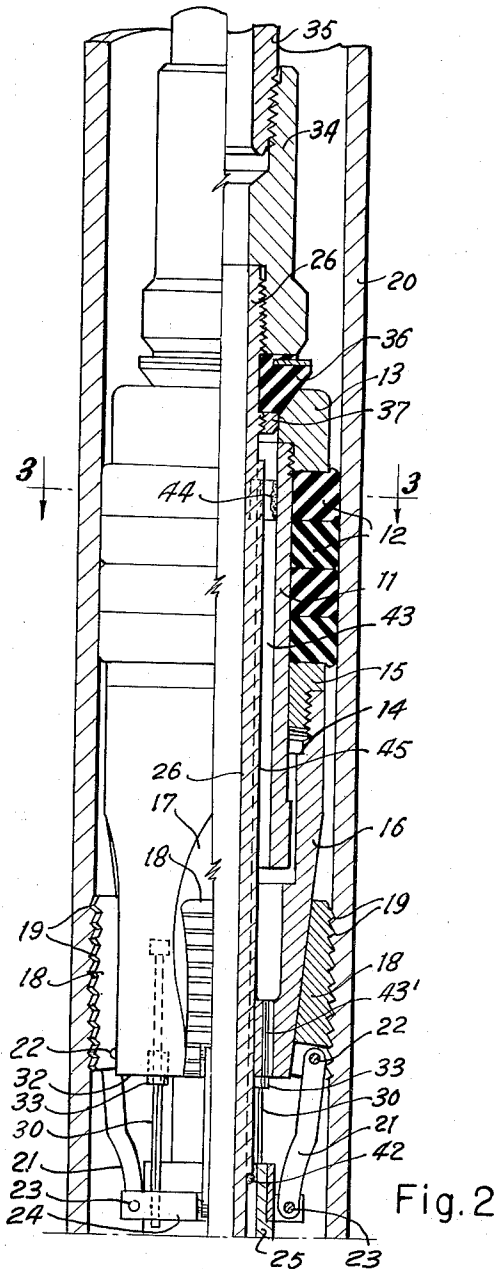
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3,211,231 OIL WELL COMPLETION TOOL WITH DROP-OFF PLUG

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1 Claim. (Cl. 166—152)

This invention relates to oil well completion tools, and it has particular reference to apparatus which can be operated as an access valve by which a fully open tubing can be provided into a production zone below a packer, and the invention shown and described in my Patent No. 3,095,040 and my co-pending applications bearing Serial Nos. 239,224 and 239,279, respectively, filed November 21, 1962.

A prime object of the invention resides in the provision of apparatus adapted for use in connection with a retrievable packer which may be generally of conventional design but which includes certain novel innovations by which it is especially adapted for the application of the invention hereinafter described.

An object of the invention is that of providing a tool by which a tubing string can be installed in a cased well bore having a column of fluid therein, while excluding the well fluid from the tubing, setting a packer in the casing above the producing zones, equalizing the pressures between the producing zones and the tubing, and causing the tubing to be fully opened at its lower end to provide for access to the producing zone for the purpose of perforating the same or for performing other normal operations therein.

A still further object of the invention is that of providing a well completion tool by which the well can be caused to produce without the conventional swabbing operations, and whereby excess hydrostatic pressures in the producing zones can be readily and easily released to avoid damage to the production formations.

A further object of the invention is that of providing a packer-valve combination by which a "dry" tubing string can be installed and the packer set without fully opening the tubing, and by which, when pressures are equalized between the tubing and producing zones, the tubing is automatically fully opened to provide access to the producing zones.

Yet another object of the invention is that of providing means for preventing the premature setting of the packer while the tool is being installed and providing an improved fluid bypass in the packer whereby the tool can be installed with greater speed and safety, and by which the tool is capable of withstanding the substantial hydrostatic pressures encountered in the well.

Broadly, the invention contemplates the provision of a completion tool which is simple and economical in design and structure, yet capable of minimizing or eliminating numerous and expensive operations which are ordinarily attendant upon completing an oil well for production purposes, such as sealing off undesirable well fluids for more perfect perforation operations, and swabbing to induce flow.

While the foregoing objects are paramount, other and lesser objects will become apparent as the description proceeds when considered with the appended drawings wherein:

FIGURE 1 is a view of the packer and mandrel, partially in longitudinal section, as the invention is lowered into a well casing, the latter being shown in vertical section, and showing the mandrel retracted from its seat on the packer.

FIGURE 1-A is an illustration of the lower portion of the packer, showing the lower end of the mandrel, the

mandrel sleeve, the removable plug in the lower end of the mandrel, and showing the improved J-slot.

FIGURE 2 is an illustration of the packer and mandrel assembly, partially in longitudinal section, installed in a well casing, shown in longitudinal section, the mandrel being seated and the packer expanded.

FIGURE 2-A shows the lower portion of the packer and mandrel assembly, in partial longitudinal section, the packer being set and the mandrel extended to expose the part therein, and showing the plug removed therefrom, and

FIGURE 3 is a transverse sectional view on line 3—3 of FIGURE 2 showing the concentric arrangement of the mandrel through the packer and the guide lugs in the packer sleeve.

While the invention is embodied in an assembly which includes a retrievable packer 10, generally of conventional design, and is not per se a part of the invention, it is nevertheless expedient to provide a detailed description of the packer, and its operation, in order to insure a proper understanding of the invention. It is intended, however, that the packer assembly hereinafter described may be modified in accordance with any requirements which may become manifest.

The packer assembly

The packer 10 comprises a sleeve 11 upon which a plurality of packing rings 12 are arranged and secured at the upper end of the sleeve 11 by a valve seat 13 threaded thereon. The sleeve 11 has a shoulder 14 formed thereon near its lowermost end which is engaged by a retainer nut 15 when the packer is extended, against which the lowermost of the packing rings 12 is impinged, as shown in FIGURES 1 and 2.

The retainer nut 15 is threaded into the upper end of a slip cone 16 whose outer surface has a plurality of circumferentially spaced, inwardly tapered recesses 17 formed therein, each adapted to slidably receive a tapered slip 18 having cross-cut wickers 19 therein to engage the wall of the casing 20 in which the assembly is suspended. The slips 18 are usually four in number and each has a rein strap 21 hingedly attached to its lowermost end by a pin 22, as apparent in FIGURES 1 and 2, the lower ends of these members being hinged by pins 23 to a collar 24 rotatably arranged about the upper end of a cylindrical body 25 which, with the sleeve 11, concentrically embraces the mandrel 26.

A plurality of friction springs 27 are arranged about the body 25 and each is bowed outwardly to frictionally engage the inner casing wall to aid in setting the packer 10. Each of the springs 27 is attached at its upper end to a collar 28 slidably embracing the upper end of the body 25 while the lower ends of the springs 27 are secured about an annular boss 29 formed on the lower end of the body 25.

A plurality of hold down bolts 30 are arranged about the mandrel 26 whereby to connect the body 25 with the sleeve 11 and suspend the lower portion of the packer assembly as the packer 10 is lowered into the casing 20, having their lowermost ends threaded into the collar 24 while their heads 31 extend into bores (not shown) formed in the lowermost face 32 of the cone 16 and through a bushing 33 threaded into the bores to be engaged by the heads 31 in the extended position of the members 16 and 25, as shown in FIGURE 1. When the packer 10 is set, as shown in FIGURE 2, the bolts 30 project up into the cone 16.

The mandrel 26 is of a length adapting it to extend longitudinally through the packer 10, and beyond the ends thereof. A fitting 34 is threaded upon the upper end of the mandrel 26 and provides a coupling by which it can be connected to the lower end of a tubing string 35

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fragmentarily shown in FIGURES 1 and 2. A conical sealing member 36 is arranged about the upper end of the mandrel 26 and is seated against the underside of the fitting 34 and secured by a retainer nut 37. The sealing member 36 is adapted to engage the internally beveled seat 13 when the packer is set, as illustrated in FIGURE 2.

The overall structure and operation of the packer 10, with the mandrel 26, is generally conventional. The packer 10 is lowered into the well casing 20 on the lower end of a string of tubing 35, the sealing members 12 being relaxed.

In order to set the packer 10, in the manner illustrated in FIGURE 2, the tubing string 35 is rotated 90 degrees clockwise, while the friction springs 27 engage the casing wall to restrain the rotation of the packing elements 12 and the slip cone 16, to move the dowel pin 38 out of the right-angular portion 39 of a J-slot 40, formed in the body 25, as it appears in FIGURE 1-A, and cause it to enter the vertical portion 41 of the slot 40, as shown in FIGURE 2-A, to enable the slips 18 to engage the casing walls so that the weight of the tubing string is imposed thereon whereby to expand the packer rings 12.

It will be noted, by reference to FIGURE 1, that while the packer 10 is lowered into the well bore, the entire packer assembly, including the sleeve 11, with its packing rings 12, the slip cone 16, with the slips 18, and the body 25 are supported on the mandrel 26 by the dowel pin 38 therein, and by a circumferential bead 42 formed about the mandrel 26 against which the lowermost end of the cone 16 rests when the packer assembly is extended, as shown in FIGURE 1. As the packer 10 is lowered into the well casing 20, static fluids therein are bypassed through the annulus 43 around the mandrel 26 and the open seat 13 after entering through ports 43' in the lower end of the cone 16.

FIGURE 3 illustrates, in transverse section on line 3-3 of FIGURE 2, a plurality of guide lugs 44 welded, or otherwise formed, on the inner surface of the sleeve 11 whereby to center the mandrel 26 therein. A spline or bead 45 is formed longitudinally of the mandrel 26, on one side thereof, to slidably move between a pair of the lugs 44 to prevent the rotation of the sleeve 11 on the mandrel 26.

The invention

The primary embodiment of the invention is shown in FIGURES 1-A and 2-A and comprises, among other important features, a sleeve 46 having a peripheral flange 47 formed about its upper end by which it is attached, through the medium of a nut 48, to the threaded lower end of the member 29 of the packer 10 and embraces the lower portion of the mandrel 26. A plurality of O-rings 49 are arranged in circumferential grooves formed externally of the mandrel 26 near its lower end to provide a fluid-tight seal. A port 50 is provided in the mandrel 26 near its lowermost end 51 and between the upper and lower O-rings 49.

The lowermost end of the mandrel 26 is internally beveled to form a seat 51 which is engaged by a drop-out plug 52 having a beveled surface 53 formed about each end to conformably engage the seat 51, when inserted into the lower end of the sleeve 46 while the mandrel 26 is in its uppermost position, as shown in FIGURE 1-A, and is frictionally retained by a plurality of O-rings 54 arranged in circumferential grooves formed therearound, aided by the hydrostatic pressures in the casing annulus as the tool is installed.

Substantial hydrostatic pressures are encountered in running a dry, or substantially dry, string of tubing in a cased well bore, and such pressures increase in relation to the depth of the bore. The plug 52 seated in the lower end of the mandrel 26 cannot be readily dislodged against such pressures while the tubing 35 is sealed. When the packer 10 is traversing the fluid column in the well bore the sealing rings 12 are relaxed and the entire weight of

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the packer assembly is suspended on the mandrel 26 so that the seat 13 is withdrawn from the sealing member 36 to permit the fluids in the casing 20 to bypass the mandrel 26. In this condition the port 50 in the lower end of the mandrel 26 is withdrawn into the sleeve 46 and is closed to well fluids, being sealed off by the O-rings 54 on the plug 52 and the lowermost of the O-rings 49 in the sleeve 46, as shown in FIGURE 1-A.

When the packer 10 is set, and supported by the slips 18, the tubing string 35 is lowered to close the seat 13 and expose the port 50 in the mandrel 26 whereby to admit well fluids to the tubing 35 through the mandrel 26 and the pressures will become equalized with the result that the plug 52 will drop off its seat 51 to provide a fully open and unobstructed passage whereby access may be had for the normal operation of various tools there-through.

The plug 52 will drop off its seat 51 when the port 50 is exposed a sufficient period to cause the pressures externally and internally of the mandrel 26 to become equalized. It is contemplated that the plug 52 may be formed in such manner and materials as to be readily disintegrated in the well so as not to impair its usefulness or interfere with normal operations therein.

An important feature of the invention is the provision of means to prevent premature setting of the packer 10 while the assembly is being installed. In FIGURES 1-A and 2-A, the upper end portion 39 of the J-slot 40 is shown curved upwardly and around the body 25 guiding the dowel pin 38 in a cam action into and out of the elongated portion 41 of the J-slot 40. This arrangement differs from the conventional right-angular form of J-slot generally provided. The cam action of the improved J-slot 41 will enable the packer 10 to be picked up more readily since the dowel pin 38 is automatically guided into its locked position. Conversely, by reason of the curvature of the portion 39 of the J-slot, the dowel pin 38 would tend to remain in the locked position, or that shown in FIGURE 1-A, until the tubing string 35 is rotated 90 degrees.

The invention, as shown and described, is capable of certain modifications in design and structure, by persons skilled in the art, without departing from the spirit and intent thereof, or the scope of the appended claim.

What is claimed is:

In apparatus for completing an oil well having a casing and a string of tubing therein, an access valve comprising, in combination, a packer adapted for setting in said casing and having a fluid passage therethrough and a seat on the upper end of said passage, a tubular mandrel slidable in said packer having a port near its lower end and means thereon for releasably supporting said packer while traversing said casing, the said mandrel having a sealing element on its upper end capable of seating on said packer to close said fluid passage when said packer is set in said casing, a sleeve attached to the lower end of said packer slidably embracing said mandrel and covering said port, when said packer is supported on said mandrel, and whereby said port is open to well fluids when said packer is set in said casing, and a plug on the lower end of said mandrel retained in the lower end of said sleeve by a plurality of O-rings thereon when said packer is traversing the well bore and by hydrostatic pressure in said bore until said port is uncovered and releasable when pressures internally and externally of said mandrel are equalized through said port.

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