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M. F. BRAMLETT

3,211,228

COMPLETION TOOL FOR OIL WELLS

Filed Nov. 21, 1962

2 Sheets-Sheet 1

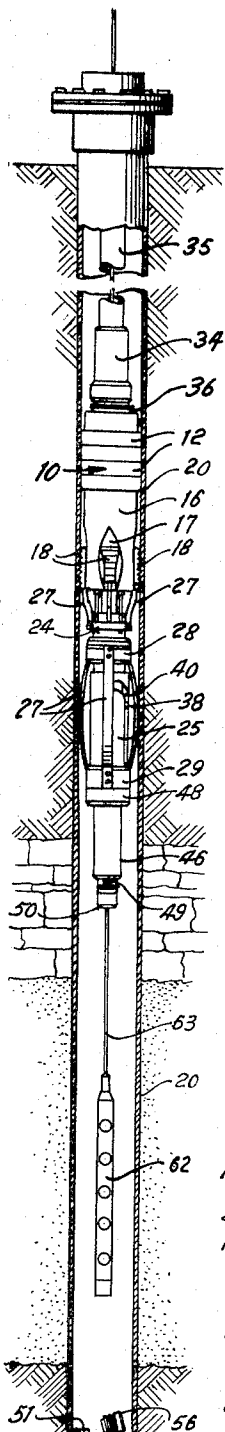


Fig. 1

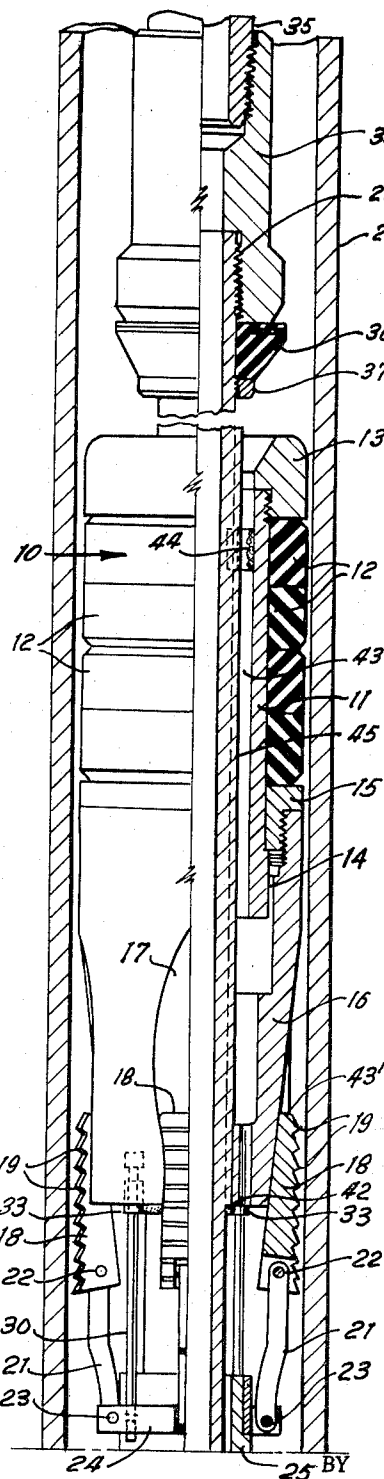


Fig. 2

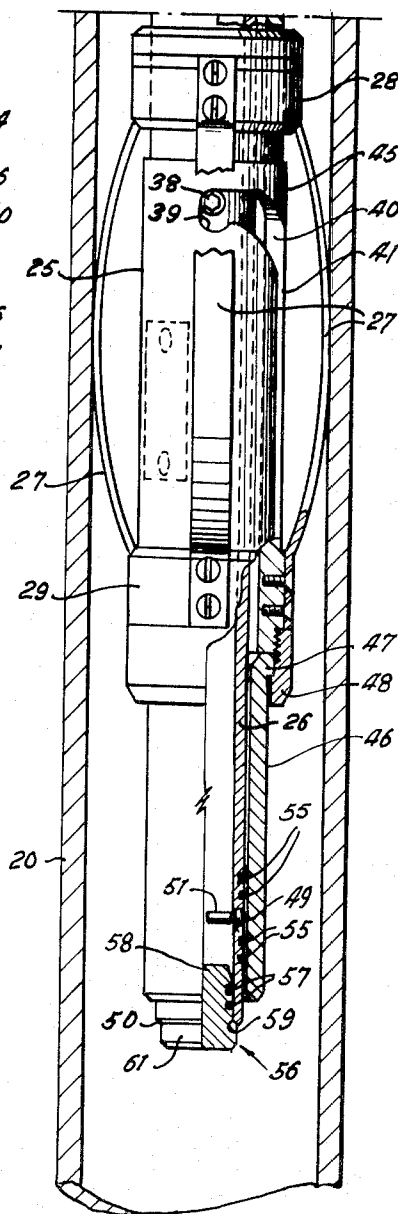


Fig. 2-A

INVENTOR

Merlin F. Bramlett

Clair L. Wood

ATTORNEY

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M. F. BRAMLETT

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2 Sheets-Sheet 2

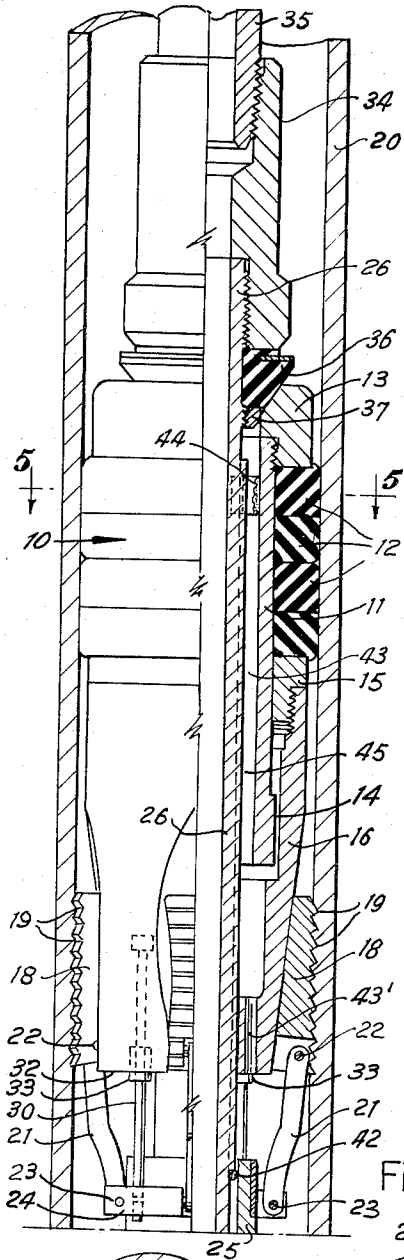


Fig. 3

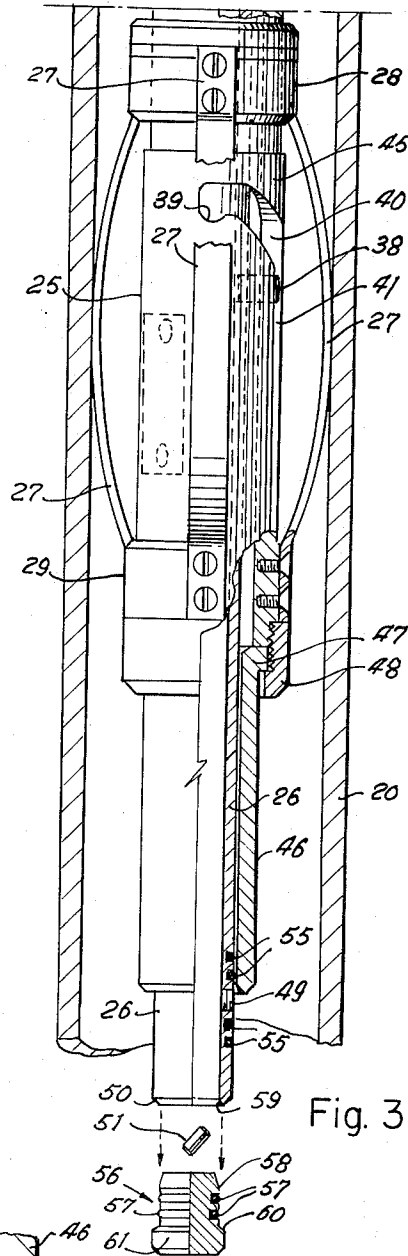


Fig. 3-A

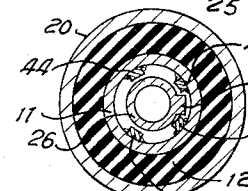


Fig. 5

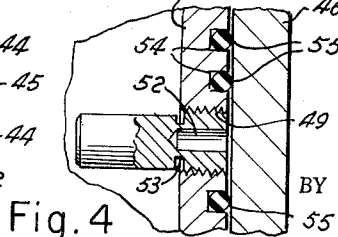


Fig. 4

INVENTOR

Merlin F. Bramlett

BY

Cecil L. Wood

ATTORNEY

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3,211,228

COMPLETION TOOL FOR OIL WELLS

Merlin F. Bramlett, Dallas, Tex., assignor to Bramlett Oil Field Service, Inc., Dallas, Tex., a corporation of Texas

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6 Claims. (Cl. 166-128)

This invention relates to oil well completion and testing tools, and it has particular reference to apparatus which is embodied into a retrievable packer assembly, generally of conventional design but having certain modifications adapting the tool to a plurality of uses in the performance of operations attendant upon the completion of oil wells and the production thereof.

The subject of the invention is related to those shown and described in my patent No. 3,095,040, dated June 25, 1963, and my copending applications, Serial Nos. 239,225 and 239,279, respectively, filed November 21, 1962.

The principal object of the invention resides in the provision of a combination tool by which a dry, or substantially dry string of production tubing can be installed in a cased well bore while sealing off the well fluids above the production zones to provide access thereto for the purpose of perforating the formations, or the performance of other operations in the well, and afford means for producing the well without swabbing the same.

Another object of the invention is that of providing apparatus which includes a packer having embodied therein automatic means for preventing premature setting thereof while the tubing string is installed, and having means for bypassing the fluids in the casing while traversing the same whereby to prevent damage to the sealing rings.

A further object of the invention is that of providing apparatus by which a dry string of tubing, or tubing having a predetermined water cushion therein, can be lowered into a well through the fluid column therein without admitting well fluids into the tubing, and providing means, after setting the tubing, to admit fluids thereinto from the production zones below the packer to equalize the pressures between the production zones and the tubing, and to open the tubing to the well fluids providing an unobstructed passage therethrough for full access to the production zones for producing the same.

A still further object of the invention is that of providing a production tool by which a dry string of tubing can be permanently set in a cased well bore and maintained sealed against the admission of well fluids thereto for indefinite periods, or caused to admit such fluids in predetermined quantities at will whereby samplings of well fluids can be obtained and analyzed, as desired, at different levels.

Broadly, the invention contemplates the provision of a tool which is simple in design and structure, easy to install and operate, and capable of a variety of uses in completing an oil well for production with expedience and economy.

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

FIGURE 1 is an elevational view of the invention as installed in a cased oil well, which is shown in vertical section, and showing a wire line tool suspended through the tubing.

FIGURE 2 illustrates the packer assembly in a well bore, shown partially in longitudinal section, and showing the mandrel open to well fluids and the sealing rings relaxed.

FIGURE 2-A shows the lower portion of the packer assembly in partial section before sealing and illustrating

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the closed lower end of the mandrel and sealing elements in partial longitudinal section.

FIGURE 3 shows the packer assembly in seated position, partially in longitudinal section, and showing the mandrel on its seat.

FIGURE 3-A illustrates the lower portion of the packer assembly in seated position, and showing the lower end of the mandrel in partial section and extended, the port therein being exposed to well fluids.

FIGURE 4 is a fragmentary enlarged sectional view showing the break-off plug closing the port in the lower end of the mandrel, and showing the sealing means on the mandrel on each side of the port, and

FIGURE 5 is a transverse sectional view through the packer, on line 5-5 of FIGURE 3, showing the concentric arrangement of the mandrel therein 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 which 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 2 and 3.

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 2 and 3, 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 slip cone 16 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 2. When the packer 10 is set, as shown in FIGURE 3, 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, as shown in FIGURE 1, and fragmentarily in FIGURES 2 and 3. 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 3.

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 3, 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 FIGURES 2-A, and cause it to enter the vertical portion 41 of the slot 40, as shown in FIGURE 3-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 2, 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 2. 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 5 illustrates, in transverse section on line 5-5 of FIGURE 3, 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 illustrated in FIGURES 1, 2-A, 3-A and 4, and comprises, among other important features, a sleeve 46 formed with a peripheral flange 47 about its upper end by which it is secured, through the medium of a nut 48, to the lowermost end of the member 29 of the packer 10 and slidably embraces the lower portion of the mandrel 26.

A port 49 is provided in the mandrel 26 a predetermined distance from its lowermost end 50 and a plug 51 is threaded into the port 49 whereby to extend laterally into the mandrel 26. The plug 51 has a concentric bore 52 in its threaded end and has a circumferential groove 53 formed therein adjacent to its threaded end, as shown in FIGURES 2-A and 4, whereby to weaken the plug 51 so that it may be readily broken off to provide a communication through the bore 52 between the mandrel 26 and the well fluids exteriorly thereof.

The mandrel 26 has a plurality of spaced circumferential grooves 54 above and below the port 49 in which O-rings 55 are stated to provide a fluid-tight seal about the mandrel 26 within the sleeve 46, as shown in FIGURES 2-A, 3-A and 4. A removable plug 56, having a plurality of O-rings 57 on its shank portion 58, is seated in the lower end 50 of the mandrel 26. A beveled seat 59 is formed about the inner rim of the mandrel 26

which is engaged by the beveled surface 60 formed about the head 61 of the plug 56.

In operation, the tubing 35, with the packer 10 attached to its lowermost end, is lowered into the cased well bore and set in the manner shown in FIGURES 1 and 3 whereupon the mandrel 26 is seated so that its lower end 50 extends below the end of the sleeve 46 to expose the port 49 which remains closed by the break-off plug 51. The removable plug 56 is retained in the mandrel 26 by the hydrostatic pressure in the casing 20 below the packer 10. To equalize the pressures the plug 51 can be broken off to open the port 49 by dropping a bar, or other tool into the tubing, such as a perforating gun 62 on a wire line 63, as shown in FIGURE 1.

In some instances it may be desirable to lower a tool, such as the perforating gun 62, to dislodge the break-off plug 51 to admit the well fluids to the tubing 35 without removing the plug 56 which will remain in place, due to the existing hydrostatic pressures, until removed by a weighted object after the pressures are equalized internally and externally of the tubing 35. This would be the case when it is desirable to obtain samples of the well fluids for testing purposes. The port 49 can be closed to well fluids at any time, after a predetermined interval, by raising the tubing 35, unseating the packer 10, and withdrawing the assembly from the well.

When both plugs 51 and 56 are removed from the mandrel 26, as shown in FIGURE 1, the installation may, if desired, remain permanent and utilized for producing the well, or for the performance of other 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 2-A and 3-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 2-A, until the tubing string 35 is rotated 90 degrees.

The invention, as shown and described, may be modified in structure and design, by persons skilled in the art, without departing from the spirit and intent thereof, or the scope of the appended claims.

What is claimed is:

1. In an access valve for completing an oil well having a casing and a string of tubing therein, a packer for providing a seal about said tubing in said casing, the said packer having a tubular mandrel slidable therein and connected to said tubing string, means comprising a plurality of slips for releasably supporting said packer on said mandrel in suspended position in said well, the said mandrel having a port near its lower end and having sealing rings thereon on each side of said port, a sleeve attached to the lower end of said packer and slidably embracing said mandrel to cover said port and said sealing rings while said packer is in its suspended position, the said mandrel being capable of extending below the lower end of said sleeve to uncover said port when said packer is set in said casing, a hollow break-off plug having an initially closed inner end threaded in said port and extending internally of said mandrel, a second plug closing the lower end of said mandrel capable of being removed when said break-off plug is broken away to admit well fluids into said mandrel.

2. An access valve for providing a full open tubing in a cased well bore having a tubing string therein, in combination with a packer on said tubing string provid-

ing a seal therearound in said cased well bore and having a tubular mandrel slidable therein and attached to said tubing string, the said packer having a slip cone and slips for supporting the same, and having a flow passage there-through and a seat at the upper end of said passage, a closure on said mandrel capable of seating on said packer to seal off well fluids therebelow when said packer is set in said casing, the said mandrel having a port near its lower end below said packer and sealing means on each side of said port, a hollow break-off plug in said port extending internally of said mandrel and having its inner end initially closed, a sleeve depending from said packer and slidably embracing said mandrel and said port when said packer is suspended on said mandrel, the said mandrel being capable of extending below said sleeve to uncover said port when said packer is seated in said casing, a second plug in the lower end of said mandrel and removable therefrom when said break-off plug is broken away to open said port to admit well fluids to said mandrel.

3. A valve for temporarily closing a flow tube in an oil well having a casing, and a packer in said casing for providing a seal around said flow tube in said casing and having a tubular mandrel slidable therein connected to said flow tube, means comprising a slip cone and a plurality of slips on said packer for supporting the same in said casing, a flow passage through said packer, the said mandrel having a closure thereon capable of seating on said packer to close said passage when said packer is set in said casing, the said mandrel having a port near its lower end, a sleeve depending from the lower end of said packer slidably embracing said mandrel, and covering said port when said packer is suspended on said mandrel, a hollow plug in said port having an initially closed inner end and extending internally of said mandrel and a groove formed therearound to weaken the same, a second plug having a plurality of sealing rings thereon fitted into the lower end of said mandrel, both of said plugs being capable of removal by a tool lowered into said flow tube when said mandrel is seated on said packer and is extended below said sleeve to uncover said port in said mandrel.

4. In a completion tool for an oil well having a casing, a string of tubing in said casing and a packer having slip means for supporting the same in said casing, and a tubular mandrel slidable longitudinally thereof of said packer and connected to said tubing whereby said packer is suspended on said mandrel until said packer is set in said casing, the said mandrel having a port near its lower end, an access valve comprising, a sleeve attached to the lowermost end of said packer and slidably embracing said mandrel and enclosing said port when said packer is suspended on said mandrel, the said port being exposed when said packer is set and said mandrel is extended below said sleeve, sealing means on said mandrel above and below said port, a hollow break-off plug in said port having its inner end initially closed and extending internally of said mandrel, whereby to open said port

when detached by a tool lowered into said tubing, a friction plug closing the lower end of said mandrel and capable of being dislodged therefrom when said port is opened whereby to admit well fluids to said mandrel to equalize pressures internally and externally thereof.

5. A tool for providing a full open tubing in a cased well bore, comprising, in combination with a string of tubing, a packer having slips thereon for supporting it in said cased well bore and having a fluid passage there-through, and a tubular mandrel slidable therein and connected to said tubing, the said mandrel having a closure thereon for closing the passage in said packer adapted to be seated thereon to separate the well fluids above and below said packer when said packer is set in said cased well bore, the said mandrel having a port therein near its lower end and a hollow break-off plug having its inner end initially closed and extending into said mandrel temporarily closing said port, a sleeve depending from said packer and slidably embracing the lower end of said mandrel, the said sleeve covering said port when said packer is suspended on said tubing, the said mandrel, when seated on said packer, extending below said sleeve to expose said port, a removable plug having sealing means thereon closing the lowermost end of said mandrel, the said break-off plug and said removable plug being capable of dislodgement by a tool lowered into said well when said packer is set therein.

6. A tool for temporarily closing a string of tubing to well fluids while being installed in a cased well bore, comprising, in combination with said tubing, a packer having slips thereon for supporting it in a cased well bore and having a fluid passage therethrough, and a tubular mandrel in said packer connected to said tubing and having a closure thereon capable of seating on said packer to close said passage to separate the well fluids above and below said packer, the said mandrel having a port near its lower end, a hollow break-off plug having its inner end initially closed and extending internally of said mandrel temporarily closing said port, a sleeve attached to and depending from the lower end of said packer and slidably embracing said mandrel to cover said port when said packer is suspended thereon, the said mandrel extending below said sleeve when said packer is seated in said casing to expose said port, a second plug removably closing the lowermost end of said mandrel, the said break-off plug and said second plug being capable of dislodgement to open said tubing when a tool is lowered thereinto.

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CHARLES E. O'CONNELL, *Primary Examiner*.