Oct. 12, 1965 M. F. BRAMLETT 3,211,229

OIL WELL COMPLETION TOOL

Filed Nov. 21, 1962 2 Sheets-Sheet 1

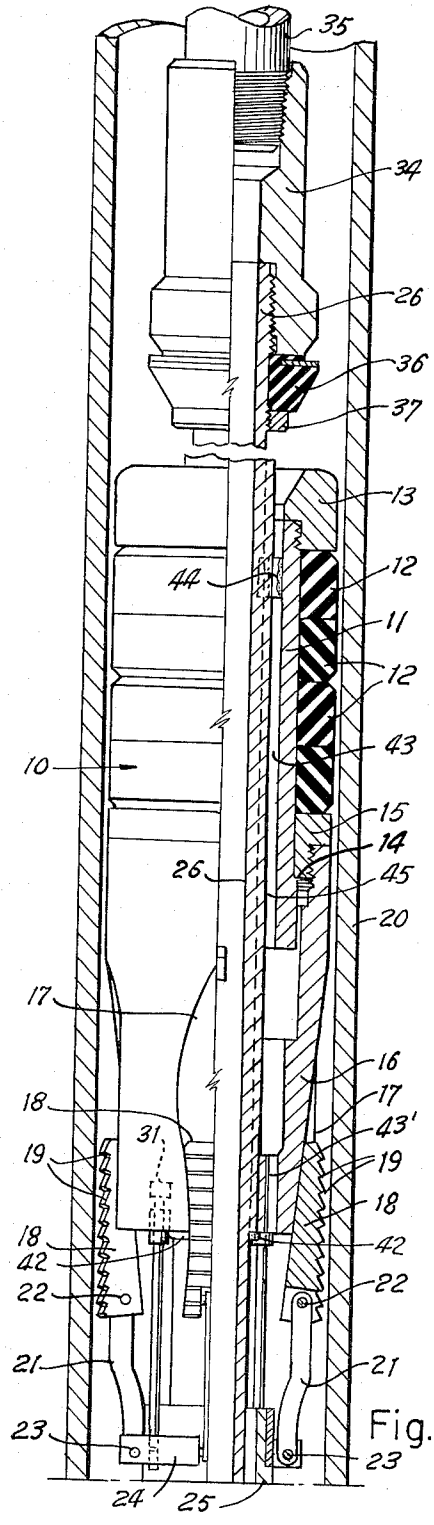

Fig. 1

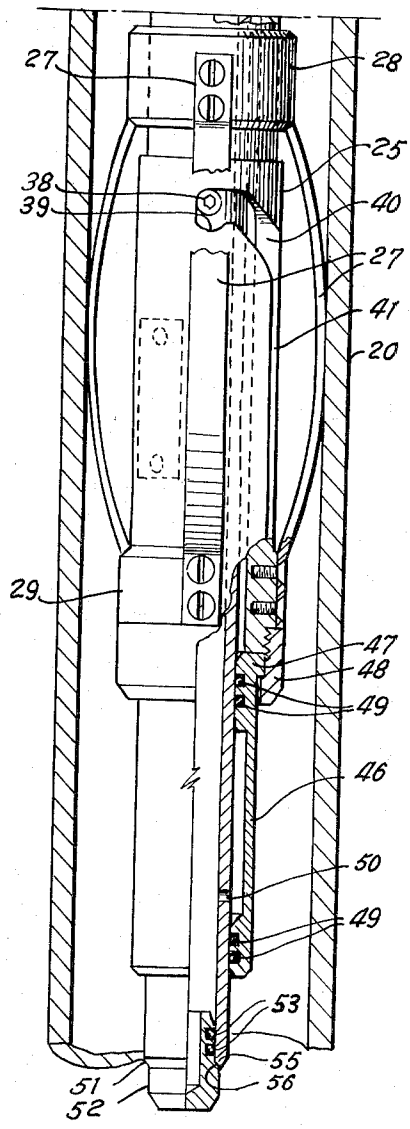

Fig. 1-A

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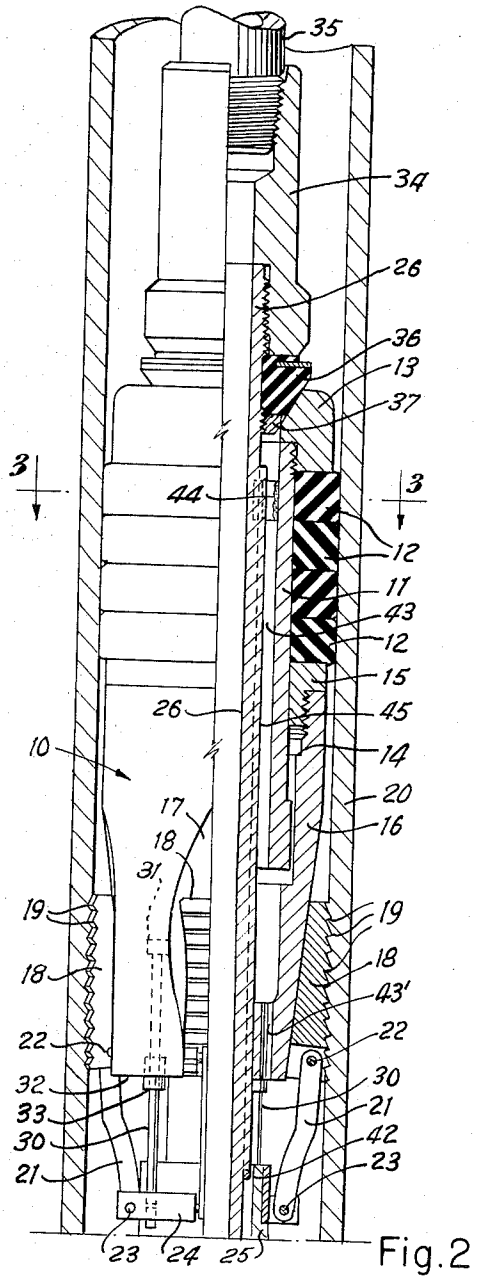

Fig.2

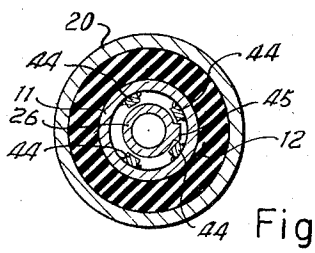

Fig.3

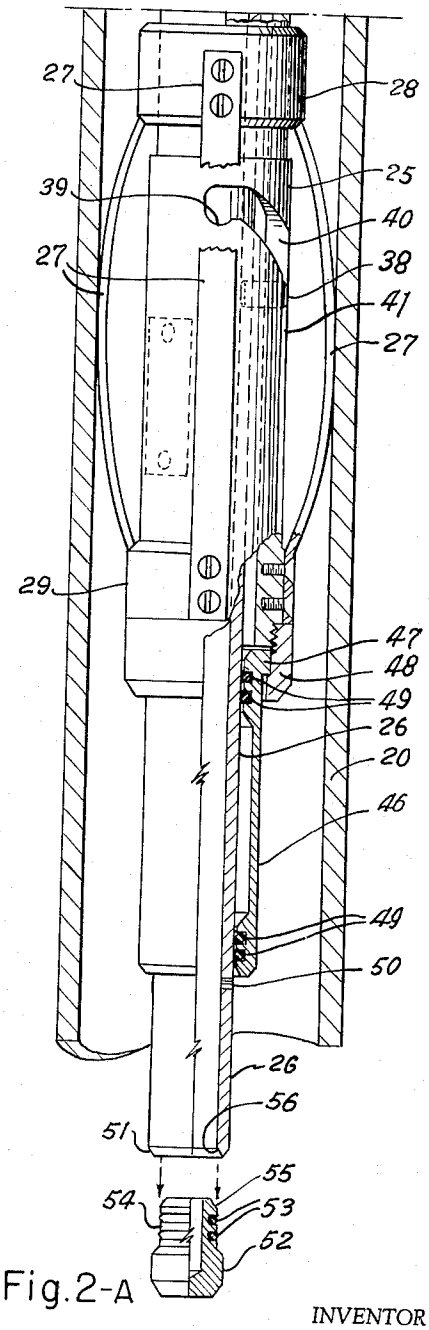

Fig.2-A

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OIL WELL COMPLETION TOOL

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4 Claims. (Cl. 166—128)

This invention relates to the art of completing and testing oil wells, and it has particular reference to apparatus in which is embodied a packer-valve combination by which an oil well can be completed by conventional methods, such as in the use of perforating tools, and providing means for testing the well fluids from the producing zones of a well bore, and relates to the subject matter in my Patent No. 3,095,040, dated June 25, 1963, and my co-pending applications, Serial Nos. 239,224 and 239,225, filed November 21, 1962.

A primary object of the invention resides in the provision of a valve capable of installation with a retrievable type packer whereby a string of tubing can be lowered into a well, while closed to well fluids, and be fully opened, or unobstructed, so that the producing zones of the bore can be perforated, or other normal operations performed, and the well caused to flow without the usual swabbing operation.

Another object of the invention is that of providing a tool by which the tubing can be installed in a well in a socalled "dry" state while the fluids in the casing annulus about the tubing is isolated therefrom above and below the packer, when the latter is set, and affording means whereby fluids in the well bore below the packer can be admitted to the tubing string in desired quantities and trapped therein so that samplings of well fluids can be obtained at different elevations in the producing formations.

A still further object of the invention is that of providing a well completion tool whereby a string of production tubing can be lowered into the cased well bore, and through the static fluid column therein while excluding such fluid from the tubing, packing off the casing annulus above the producing zones, admitting the well fluids into the tubing to equalize the pressures between the producing zones and the tubing, and affording means to fully open the lower end of the tubing to enable the normal operation of other tools therethrough, such as a perforating tool, or the like, without interference.

Yet another object of the invention resides in the provision of a combination retrievable packer and access valve in which the packer assembly has embodied therein automatic means for preventing premature setting thereof while the tubing string is lowered into the well bore.

An object of the invention is that of providing a combination valve-packer tool in which is provided a fluid by-pass open to the well fluids displaced by the closed tubing while being lowered into a well.

Broadly, the invention contemplates the provision of a tool which is durable in construction and capable of withstanding the severe hydrostatic pressures normally existing in oil wells at substantial depths, and affording apparatus which, while especially designed for use as an access valve and for testing purposes, is adapted for use as a production tool.

While the foregoing objects are paramount, other and lesser objects will become apparent, as the description proceeds, when taken in connection 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 mandrel being 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, the mandrel being shown 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 port therein, and showing the plug removed, 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.

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 provided a coupling by which it can be connected to the lower end of a tubing string

35 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 invention comprises the provision of a sleeve 46 having a peripheral flange 47 formed about its upper end, as shown in FIGURES 1–A and 2–A, 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 internal grooves in each end of the sleeve 46 to provide a fluid-tight seal about the mandrel 26 which has a port 50 therein spaced a predetermined distance from its lowermost end 51.

A removable plug 52 is provided to close and seal the lower end 51 of the mandrel 26, and has a plurality of O-rings 53 seated in circumferential grooves formed in the shank portion 54 by which to seal the mandrel 26 when the plug 52 is inserted therein and its beveled shoulder 55 engages the conforming seat 56, as illustrated in FIGURES 1–A and 2–A.

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 in the lower end of the mandrel 26 cannot be readily dislodged while the tubing 35 is sealed. When the packer 10 is traversing the well bore the sealing rings 12 are relaxed and the entire weight of the packer assembly is suspended on the mandrel 26 so that the seat 13 is withdrawn from the sealing member 36 to permit the static 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 closed to the well fluids, being sealed off between the sets of 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 well fluids can enter the latter and the tubing 35 and an equilization of pressures will result so that the plug 52 can be dislodged by any suitable means, such as by a weighted wire line, a drop bar, or the like, so that an unobstructed full open access may be provided for the normal operation of various tools therethrough.

In operating the device for testing the well fluids at different production levels the port 50 may be permitted to remain open for predetermined periods to trap desired quantities of well fluids for analysis, and this operation may be repeated at different elevations.

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 port 50 in the mandrel 26 is spaced upwardly from its lower end 51 sufficiently to locate the port within the sleeve 46 and between the sets of O-rings 49 therein while the assembly is being lowered into a well bore, as shown in FIGURE 1–A, the packer assembly being suspended thereon so that the mandrel 26 is in its uppermost position and the seat 13 is full open. By being so located, the port 50 will be exposed just below the lower end 51 of the mandrel 26 when the packer is set and the seat 13 closed, as shown in FIGURE 2–A. With this arrangement test samplings of well fluids can be readily taken and the port 50 quickly closed by raising the tubing 35. Due to existent hydrostatic pressure in the casing 20 the plug 52 will remain in the mandrel 26 until dislodged by any suitable device.

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 oil well completion and testing tool, in combination with a string of tubing, a packer on said tubing having means comprising a slip cone and a plurality of slips thereon for setting in a cased well bore, and a tubular mandrel connected to said tubing and slidable in said packer and having a port near its lower end, an annular fluid passage around said mandrel internally of said packer, the said passage having a seat on its upper end, a closure for said seat on said mandrel and supporting said mandrel on said packer when the latter is set, a valve means for closing said mandrel and tubing to well fluids while being installed in said well bore, the said valve means comprising, a sleeve connected to the lower end of said packer and slidably embracing said mandrel whereby to close said port therein when said packer is suspended on said tubing in unset position, the said mandrel, when supported by said packer, being extended below said sleeve to open said port, and a removable plug in the lowermost end of said mandrel below said port.

2. In a tool for completing and testing oil wells, in combination with a string of tubing, a packer on said tubing, a tubular mandrel slidable in said packer and connected

to said tubing, said packer having a fluid passage longitudinally thereof exteriorly of said mandrel and said packer having means thereon for setting the same in a cased well bore, said tubular mandrel slidable in said packer and having a closure thereon adapted to seat on said packer to close said fluid passage when said packer is set, the said mandrel having a port near its lowermost end, means below said packer for closing said port when said packer is suspended on said tubing and before seating the same in said well bore, the said port closing means comprising a sleeve attached to said packer and slidably embracing said mandrel, the said mandrel, when seated on said packer, being extended below said sleeve to open the port therein to admit well fluids thereto, and a plug closing the lower end of said mandrel to hydrostatic pressure externally thereof and removable upon equalization of pressures internally and externally of said mandrel.

3. A well completion and testing tool, comprising a packer having a tubular mandrel slidable therethrough defining an annular fluid passage therein, said packer passage having a seat on its upper end, a closure on said mandrel adapted to engage said seat and close said passage when said packer is set in a well casing, the said mandrel having a port near its lowermost end, a sleeve attached to the lower end of said packer slidably embracing said mandrel and closing said port before said packer is set, the said mandrel, when said closure is seated on said packer, being extended below said sleeve to expose and open said port to admit well fluids into said mandrel, and a plug initially retained in the lower end of said mandrel

by hydrostatic pressures externally thereof, and removable when pressures internally and externally of said mandrel are equalized through said port.

4. In an oil well completing and testing tool, in combination with a string of tubing, a packer on the lower end of said tubing and having a tubular mandrel slidable therein and defining a fluid passage through said packer exteriorly of said mandrel, a closure on said mandrel adapted to close said passage when said packer is set, said mandrel having a port therein near its lowermost end, a sleeve attached to the lower end of said packer and slidably embracing said mandrel whereby to close said port when said packer is suspended on said tubing, the said mandrel being extended below said sleeve to expose said port when the mandrel is seated and supported on said packer, and a plug initially removably closing the lowermost end of said mandrel capable of being dislodged when pressures internally and externally of said mandrel are equalized.

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