April 22, 1958 T. A. HUBER 2,831,540

APPARATUS FOR PERMANENT WELL COMPLETION

Original Filed May 5, 1954 2 Sheets-Sheet 1

FIG. 1.

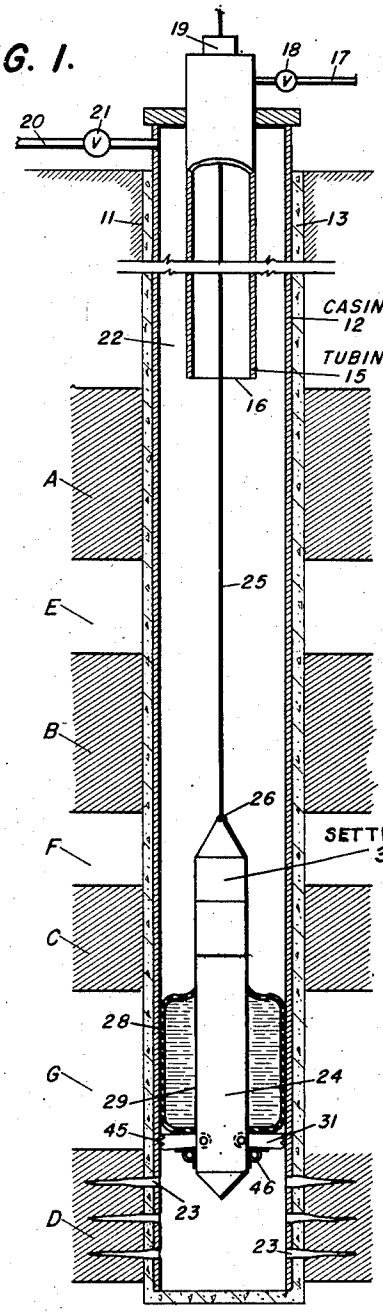
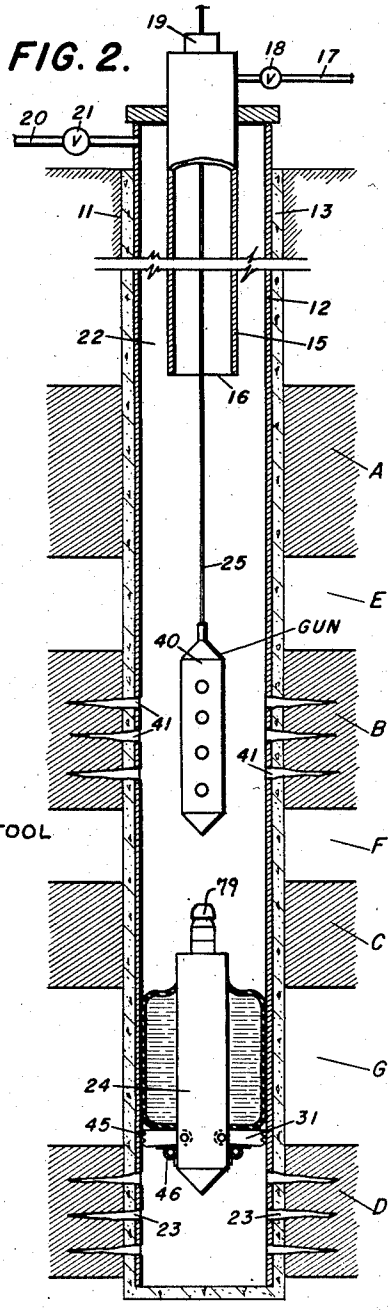


FIG. 2.



INVENTOR.
Theodore A. Huber,

BY

ATTORNEY.

April 22, 1958 T. A. HUBER 2,831,540

APPARATUS FOR PERMANENT WELL COMPLETION

Original Filed May 5, 1954 2 Sheets-Sheet 2

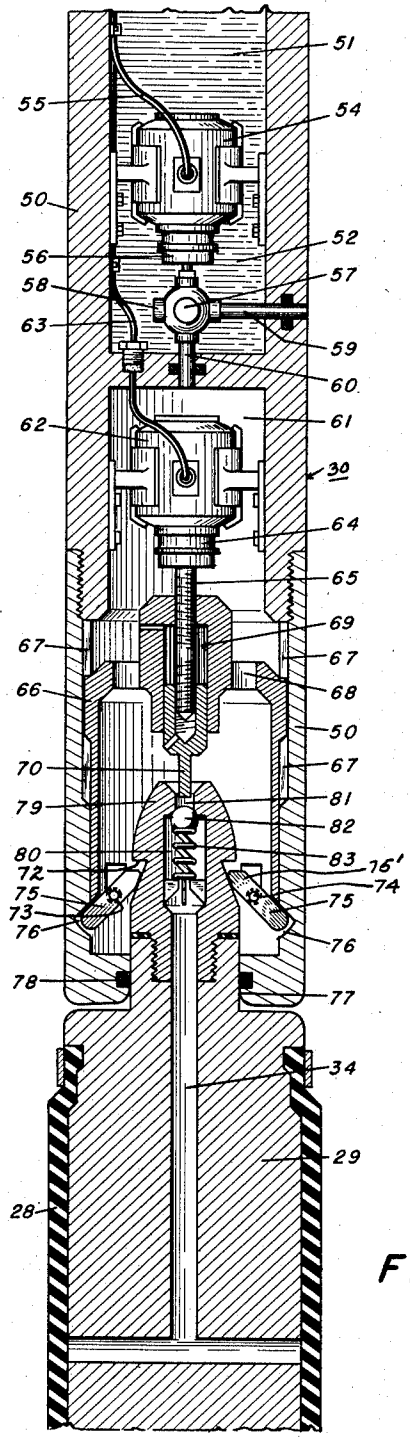


FIG. 3.

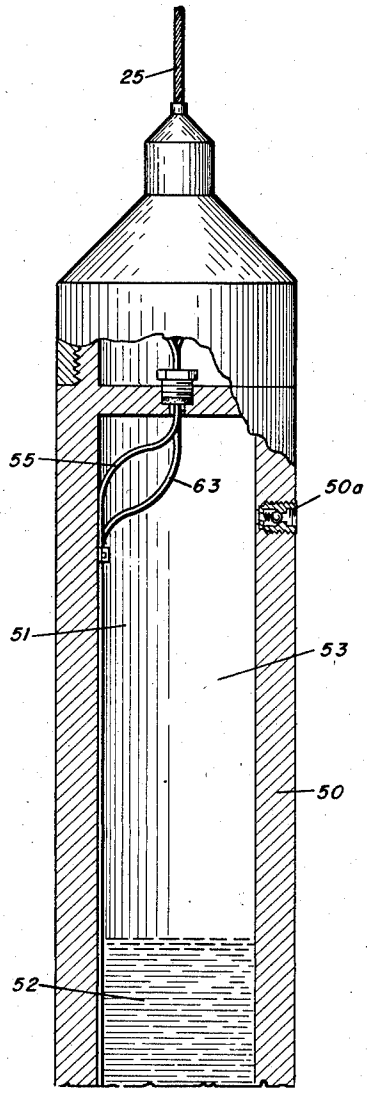


FIG. 3A

INVENTOR.
Theodore A. Huber,
BY
ATTORNEY.

United States Patent Office 2,831,540 Patented Apr. 22, 1958

2,831,540

APPARATUS FOR PERMANENT WELL COMPLETION

Theodore A. Huber, Houston, Tex., assignor, by mesne assignments, to Esso Research and Engineering Company, Elizabeth, N. J., a corporation of Delaware

Original application May 5, 1954, Serial No. 427,715. Divided and this application May 13, 1955, Serial No. 508,156

3 Claims. (Cl. 166—123)

This invention is directed to apparatus employed in completing wells. More particularly, the invention concerns surface operable apparatus for plugging off wellbores. This apparatus is especially adaptable for use in "permanent well completion" operations wherein well completion and servicing operations are conducted through a "permanently" set tubing.

This application is a divisional application of U. S. application Serial No. 427,715, entitled "Permanent Well Completion Method" filed May 5, 1954, in the name of Theodore A. Huber.

Briefly, this invention comprises a barrier member for use in a well having a tubing and a casing arranged therein comprising, in combination, a mandrel sufficiently small in diameter adapted to be lowered through the tubing; an inflatable member carried by the mandrel; pipe gripping means carried by the mandrel operatively responsive to expansion and retraction of the inflatable packing member; said packing member and said pipe gripping means being adapted to move through the tubing when retracted; a setting tool releasably connected to the mandrel, said setting tool including a body sealingly engaging with the mandrel, said body enclosing first and second spaced apart chambers, said first chamber providing a reservoir for fluid adapted to expand said inflatable packing member, said mandrel being formed to provide a conduit having one opening fluidly communicating with a space on the exterior of the mandrel enclosed by said inflatable packing member and another opening fluidly communicating with said second chamber; a first valve means in said conduit adapted to prevent and permit fluid flow to and from said second chamber; motor operated second valve means carried by said setting tool fluidly communicating said first chamber and said second chamber when in a first position, fluidly communicating the exterior of said body and said second chamber when in a second position and preventing fluid communication between said first and second chambers and between the exterior of said body and said second chamber when in a third position; releasable latching means arranged in said setting tool for engaging said setting tool with and disengaging said setting tool from said mandrel and motor operated releasing means for releasing said releasable latching means and for actuating said first valve means to permit release of fluid from said inflatable packer to said second chamber.

An object of this invention is to provide a surface operable packing member adapted to be releasably engaged with a setting tool.

A further object of this invention is to provide a surface operable fluid inflatable packing member adapted for movement through tubing when retracted and for sealing off a casing when inflated.

The barrier member employed in the practice of the present invention is suitably a plug or a deformable member which may be lowered through the tubing. For example, the barrier member may be constructed of rubber or other elastic material and lowered in a non-expanded

or collapsed condition through the tubing to the level in the casing where it is to be placed and employed to obstruct the casing. Fluid is contained within the barrier member for expansion thereof. It is also contemplated that the barrier member will be provided with means for holding same firmly against the walls of the well bore to resist pressure from below the barrier member and allow the barrier member to be held firmly in place. It is contemplated that a fluid plastic material may be used to inflate the packer or barrier and then allow same to set to form a barrier. In this situation, the barrier would not be movable but remain where placed. Employment of a plastic to inflate the barrier may be desirable where high pressures are to be sealed off.

The barrier member is conveniently lowered through the tubing on an electrical conductor cable and the like which will provide energy for pumping up or pumping out the barrier member to obstruct the casing or to allow the barrier member to be moved vertically in the casing.

The present invention will be further illustrated by reference to the drawing in which:

Fig. 1 shows an arrangement of a barrier member to obstruct the casing to terminate flow of well fluid from the first hydrocarbon stratum;

Fig. 2 shows the barrier member and a gun perforator lowered through the tubing to form perforations in a second hydrocarbon productive stratum; and

Figs. 3 and 3*a* are detailed sectional views of a releasable setting tool for use in Figs. 1 and 2.

Referring now to the drawing in which identical numerals will be employed to designate identical parts, numeral **11** designates a well which has been drilled in the earth to penetrate hydrocarbon productive intervals, zones or stratum A, B, C and D which are separated by nonproductive intervals E, F and G. These nonproductive intervals may be shale, and the like, and may separate productive zones from nonproductive zones in the same stratum. Likewise, it is contemplated that a higher interval in the same stratum may be hydrocarbon productive after a lower interval or level in the same stratum has become commercially unattractive as to hydrocarbon production or hydrocarbon production may have declined or become reduced in amount. The present invention may be employed in all such instances.

The well **11** is provided with a casing **12** which is cemented in place with cement **13**. Arranged in the casing **12** from the earth's surface **14** is a tubing string **15** which is set with its lower end **16** above the hydrocarbon producing interval or stratum A. The tubing **15** is provided with flow line **17** controlled by valve **18** and a lubricator **19** through which the various well servicing equipment is lowered. The casing is provided with a conduit **20** controlled by valve **21** for flow through the annulus **22** as may be desired under some circumstances.

The well **11** has initially been completed in the interval or stratum D by forming perforations **23** through the casing **12** and cement **13** and hydrocarbon production, such as oil and gas, has been secured from the stratum D until the production of hydrocarbons has declined or become noncommercial due, for example to invasion of water or to production of excessive quantities of gas when oil is the principal hydrocarbon productive fluid. Under these conditions, a barrier member, such as **24**, is lowered through the tubing **15** by means of electrical cable **25**. The barrier member **24** is attached to the cable **25** by means **26**.

The barrier member **24** comprises a deformable or expandable member **28** which is designed to be expanded by fluids to obstruct the casing **12**.

Referring now to Fig. 2, it is to be noted that the barrier member **24** has obstructed the casing **12** and the set-

ting tool 30 has been disengaged from the mandrel 29. Thereafter, a gun perforator, such as 40, which may be a bullet gun or a shaped charge perforator is lowered on the conductor cable 25 adjacent the stratum B or C as may be desired. For purposes of this illustration, the gun perforator 40 has been lowered adjacent the stratum B and perforations 41 have been made in the stratum or interval B by firing the bullets or shaped charges as the case may be. Such gun perforators are commercially available and their use is well known in the art. After forming the perforations 41, the gun perforator 40 is retrieved through the tubing 15 and production is then had through the perforations 41 and up the tubing.

It is contemplated that after production from the stratum B has declined or become noncommercial for the aforementioned reasons, it may be desirable to place a barrier in the casing adjacent the nonproductive stratum or interval E and this may conveniently be done by lowering another barrier member, such as 24, through the tubing and placing same adjacent the stratum E following which the casing would be perforated in the stratum A. If desired not to provide a second barrier member, the deformable member 28 may be re-engaged by lowering the setting tool 30 connected to fishing tool 26 connected to cable 25 to engage with a suitable locking device, not shown, connected to the mandrel 29. The dogs or gripping means 31 are disengaged by collapsing the deformable member 28 by releasing the inflating fluid from the packer member which allows springs 46 to move the dogs 31 upwardly. An upward pull then serves to move the barrier 24 upwardly in the casing to a level adjacent the stratum E for obstructing the casing at that level.

It is to be noted that the gripping means for the barrier member 24 has been illustrated by dogs 31 provided with pipe engaging teeth 45. Also it is to be noted that the dogs 31 are biased outwardly by means of the packer 28 overcoming springs 46 which serves to urge the dogs 31 into engagement with the casing 12.

Referring now to Figs. 3 and 3*a*, apparatus is illustrated which allows the mandrel 29 and the deformable member 28 to be re-engaged and/or released. In this apparatus a setting tool, such as 50, is provided with an internal chamber 51 in which a body of hydraulic fluid is indicated by the shaded portion 52 which is arranged below a body of gas, such as 53, which serves to pressure the fluid in the chamber 51. The reservoir 51 may be filled at the earth's surface with a suitable hydraulic fluid such as oil, aqueous fluid and the like by way of plugged opening 50*a* in the upper end of body 50. Arranged within the chamber 51 is a valve operating motor 54 which is energized by electrical connecting means 55 which extends preferably to the earth's surface through cable 25 and is connected to a source of electrical energy. The valve motor 54 is connected by a reduction gear unit 56 to a three-way valve 57 which connects by way of conduit 58 to the chamber 51 and by conduit 59 to the exterior of the tool 50. Also a conduit 60 communicates with a chamber 61 in the lower portion of the setting tool 50. Arranged in the chamber 61 is a second motor 62 which operates to cause the tool 50 to disengage and re-engage with the mandrel 29 and to cause relief of fluid contained in packer 28. The motor 62 is provided with electrical connecting means 63 for energizing same, the electrical connecting means being carried to a source of electrical energy preferably at the earth's surface through electrical cable 25.

The latching-on motor 62 has a reduction gear unit 64 which is connected to a driving screw 65. Driving screw 65 is provided with left-hand threads on its upper portion and right-hand threads on its lower portion.

Operably mounted on the upper portion of driving screw 65 is a latching dog yoke 66. Yoke 66 is confined to vertical motion in body 50 by keyways 67. Yoke 66 is also provided with ports 68 at its upper end.

Yoke 66 defines adjacent its upper end a cylindrical splined cavity 69. Slidably arranged in cavity 69 and threadably connected to the lower end of driving screw 65 is a valve actuating plunger 70, which protrudes from the lower end of splined cavity 69. Upon turning of driving screw 65 to the right the yoke 66 is forced down and the valve actuating rod 70 is forced up. Upon turning the screw 65 to the left the yoke 66 is forced up and the actuating rod 70 is forced down.

A plurality of spring-biased latching dogs 75 are pivotally mounted on pins 74, which latter are connected to the inner wall of body 50. A running or retrieving head 79 is attached to the upper end of casing plug 29 and extends through opening 77. Head 79 is formed to provide a shoulder 72 and body 50 is formed to provide a shouldered recess 76 on its inner wall. Springs 73 bias the ends 75' of dogs 75 inwardly. Thus, recess 76 holds the outer ends of dogs 75 against upward movement and the inner ends 75' of dogs 75 are adapted to engage with shoulder 72 upon upward movement of body 50.

Downward movement of yoke 66 engages the outer ends of dogs 75 causing the dogs to pivot in an outwardly direction against the bias of spring 73. In this manner, the inner ends 75' of dogs 75 are moved outwardly until they are positioned to clear shoulder 72 upon upward movement of body 50.

Body 50 defines in its lower end an opening 77, having a circular groove containing a sealing means such as O-ring 78.

Head 79 defines a valve cavity 80 which is in fluid communication with an opening 81 in the upper end of head 79. A ball valve 82, arranged in cavity 80 and biased upwardly by spring 83 normally closes the opening 81. Cavity 80 is in fluid communication with passageway 34 and deformable sleeve 28 of plug assembly 29. The device of Figs. 3 and 3*a* operates in the following manner.

The device is lowered into the casing with parts in the position shown to the depth the plug 29 is to be set.

Motor 54 is activated therefore opening valve 57 and allowing the fluid in chamber 51 to be forced down through conduit 60, chamber 61, opening 81 in head 79, passageway 34 of plug 29 and inflating sleeve 28.

When plug 29 is suitably set, valve 57 is again turned by motor 54 so as to close off the passage of fluid through conduit 58, therefore allowing ball valve 82 to close off opening passage 81 in head 79.

Body 50 is then ready to be withdrawn from the well. Motor 62 is then activated so as to rotate driving screw 65 to the right. This forces the yoke 66 down therefore unlatching the dogs 75 from the head 79, and allowing body 50 to be disconnected from plug 29.

If it is desired to remove plug 29 from the casing, the device 50 is again lowered until the body 50 is again latched to head 79 as shown. Valve 57 is rotated so as to place conduit 60 in fluid communication with conduit 59. Motor 62 is then activated so as to turn drive screw 65 to the left. This rotation of screw 65 forces the plunger 70 down so as to push ball valve 82 off its seat and allowing fluid in plug to escape by way of conduits 60 and 59 therefore deflating the sleeve 28.

The entire assembly is then ready to be withdrawn from the well or, if desired, to be set at another depth.

The nature and objects of the present invention having been completely described and illustrated, what I wish to claim as new and useful and to secure by Letters Patent is:

1. A packer apparatus for use in a well having a tubing and casing arranged therein which comprises, in combination, a mandrel adapted to be lowered through said tubing, an inflatable member carried by said mandrel, pipe gripping means carried by said mandrel operatively responsive to expansion and retraction of said inflatable packing member, said packing member and said pipe gripping means being adapted to move through said tubing when retracted, a setting tool releasably connected to said mandrel, said setting tool including a body seal-

ingly engaging with said mandrel, said body enclosing first and second spaced-apart chambers, said first chamber providing a reservoir for fluid adapted to expand said inflatable packing member, said mandrel being formed to provide a conduit having one end fluidly communicating with a space on the exterior of the mandrel enclosed by said inflatable packing member and another end fluidly communicating with said second chamber, a check valve arranged in said conduit adapted to permit and prevent fluid flow to and from said second chamber, motor operated valve means carried by said setting tool fluidly communicating said first chamber and said second chamber when in a first position, fluidly communicating the exterior of said body and said second chamber when in a second position and prevailing fluid communication between said first and second chambers and between the exterior of said body and said second chamber when in a third position, releasable latching means arranged in said setting tool having a first position adapted to engage said setting tool with said mandrel and a second position adapted to disengage said setting tool from said mandrel and motor operated releasing means having first and second positions adapted to release said releasable latching means and to actuate said check valve to release fluid

from said inflatable packing member when said releasing means is in said second position.

2. A device as recited in claim 1 wherein said releasable latching means includes spring-biased dogs pivotally arranged on said setting tool and said motor operated releasing means includes a rotatable screw member provided with spaced apart left and right-handed screw threads, dog engaging means threadedly connected to one of said screw member threads and check valve actuating means threadedly connected to said other screw member threads.

3. A device as recited in claim 2 wherein said motor operated releasing means and said motor operated valve means are provided with electrical means operable from the earth's surface.

References Cited in the file of this patent

UNITED STATES PATENTS

1,549,168	Townsend	Aug. 11, 1925
2,187,007	Barnes	Jan. 16, 1940
2,552,433	Kirby	May 8, 1951
2,618,344	Turechek et al.	Nov. 18, 1952