

April 17, 1951

T. M. RAGAN

2,549,007

WELL PACKER PLUGGING APPARATUS

Filed Dec. 22, 1945

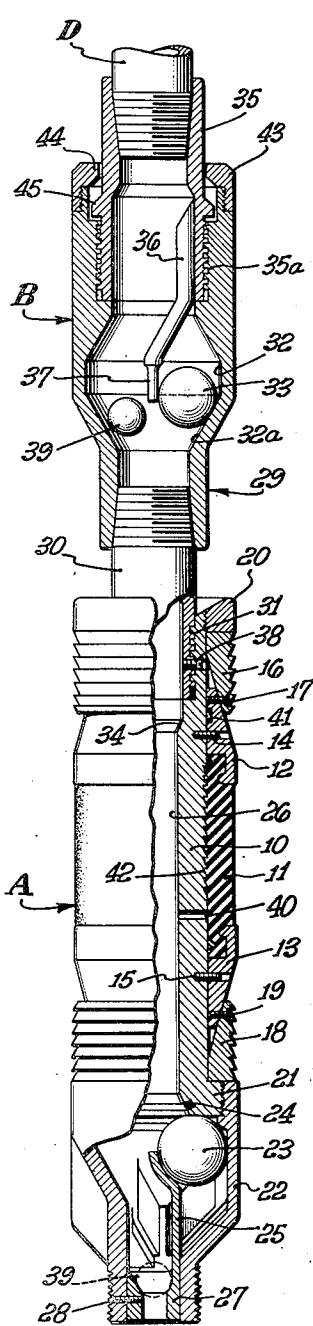


Fig. 1.

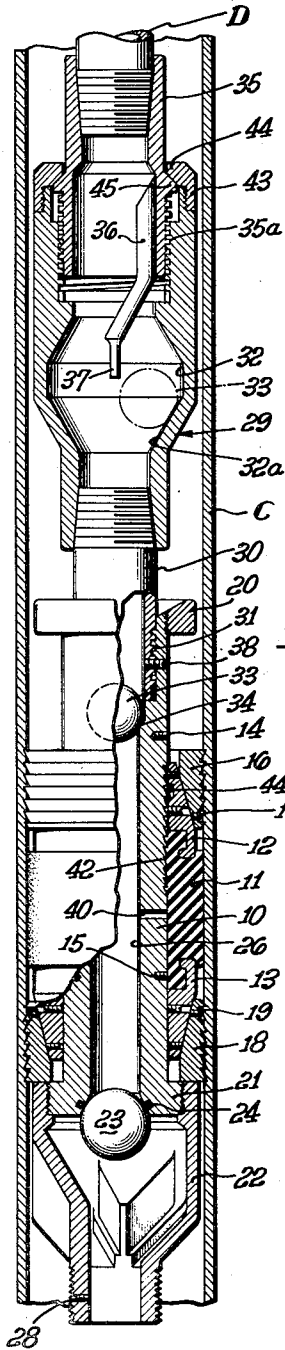


Fig. 2.

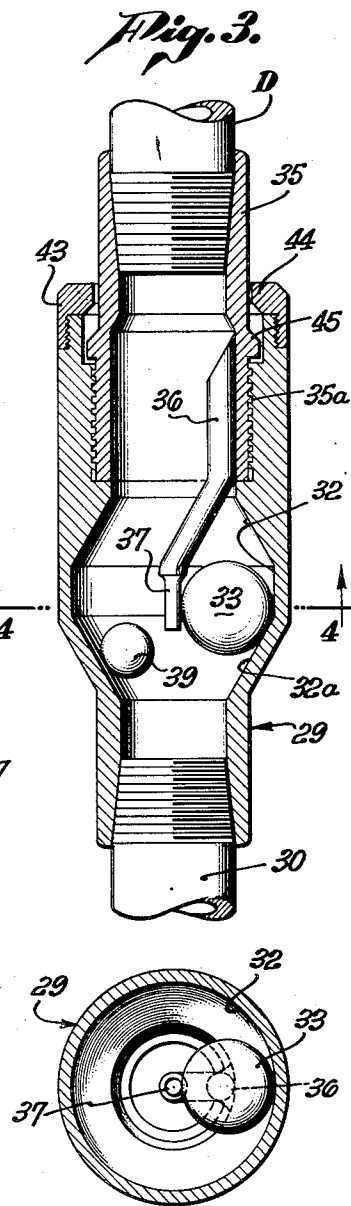


Fig. 4.

INVENTOR
Thomas M. Ragan
BY
Oscar A. Mellin
ATTORNEY

UNITED STATES PATENT OFFICE

2,549,007

WELL PACKER PLUGGING APPARATUS

Thomas M. Ragan, Downey, Calif., assignor to
Baker Oil Tools, Inc., Vernon, Calif., a corporation
of California

Application December 22, 1945, Serial No. 636,829

21 Claims. (Cl. 166-13)

1

This invention relates to well devices, and more particularly to well packer apparatus employed in the performance of bridging, cementing, acidizing, testing, and similar functions in well bores.

It is sometimes essential or desirable to permit fluid flow through the central passage of a well packer, or like device, and then close this passage against downward flow of fluent substances. Closing of the passage may be accomplished by allowing gravitation of a bridging ball or other element through the fluid in the tubular string to which the packer is secured and into engagement with a companion seat in the packer. Such mode of closing the passage entails the consumption of variable time that must elapse during dropping of the bridging element through the well tubing, especially through tubing filled with heavy drilling mud or other viscous fluid. In some instances, the bouncing of the ball along the inner wall of the tubing during its downward travel nicks or mars its surface to the point where it will fail to make a fluid tight seal with its companion packer seat.

It is, accordingly, an object of the present invention to provide an improved apparatus for insuring prompt seating of the bridging element in the packer, by obviating the need for the element to travel through the length of the tubing string to which the packer apparatus is attached.

A further object of the invention is to provide a bridging apparatus that may be secured to a well packer for the purpose of subsequently releasing a retained bridging element for engagement with the packer to close its central passage, the entire bridging apparatus, with the exception of the bridging element, being subsequently disconnectible from the well packer and bodily removable with the tubing string to the top of the well bore, leaving a minimum of material in the well for later removal by a drilling or other operation.

Yet a further object of the invention is to provide a bridging device attachable to a well packer which permits the use of a relatively large bridging element in plugging off the central passage through the well packer.

This invention has other objects which will become apparent from a consideration of the embodiment shown in the drawings accompanying and forming a part of the present specification. This form will now be described in detail to illustrate the general principles of the invention, but it is to be understood that such detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the claims appended hereto.

Referring to the drawings:

Figure 1 is a longitudinal section through the device of the present invention, with the parts

2

in the positions they assume when the device is run in a well casing;

Figure 2 is a view similar to Figure 1, showing the device anchored in packed off condition in a well casing and with the running-in string in a partially elevated position to release an initially retained bridging element.

Figure 3 is an enlarged longitudinal section through the bridging element retaining and releasing mechanism of the apparatus, with the parts holding the bridging element in restrained position; and

Figure 4 is a cross-section taken along the line 4-4 in Figure 3.

The well packer A and bridging device B illustrated in the drawings are usually lowered with in a string of casing C on the lower end of a suitable tubular string D, such as tubing or drill pipe, to the desired point at which the packer is to be anchored to the casing in packed off condition. The well packer may be of any suitable construction, the one shown being of the type specifically described in United States Letters Patent No. 2,121,051.

Essentially, the packer A consists of a tubular body 10, to which the lower end of the bridging device B is secured. The body has an inflatable packing sleeve 11 surrounding it, whose upper and lower ends are suitably secured, respectively, to upper and lower conical expanders 12, 13 attached to the body originally by one or more shear screws 14, 15. The outer surface of the upper expander 12 tapers upwardly and inwardly and is engaged by correspondingly tapered upper segmental slips 16, secured to it originally in retracted position by shear screws 17. Similarly, the outer surface of the lower expander 13 is tapered inwardly in a downward direction and engages correspondingly tapered lower segmental slips 18, secured to it originally in retracted position by shear screws 19. The upper end of the body 10 carries an abutment ring 20 engageable by the upper end of the upper segmental slips 16, and the lower end of the body is provided with a lower abutment 21 for engagement with the lower end of the lower segmental slips 18.

A valve housing and guide 22 is secured to the lower end of the body and has a back-pressure ball valve 23, preferably buoyant in cement slurry, originally prevented from engaging its companion valve seat 24 on the body by a retainer arm 25 which holds the ball against the housing to one side of the central passage 26 through the body. The arm extends upwardly from a trip ball seat 27, originally secured in the lower end of the valve housing by a suitable shear screw 28.

As aforementioned, the bridging ball retaining and releasing device B is suitably secured to the upper end of the well packer. Specifically,

this device consists of a bridging ball housing 29 threaded into the upper end of the body. For convenience of manufacture, the housing is disclosed in two parts, its lower sub 30 being attached to the packer body, preferably through a left hand threaded interconnection 31. The housing is provided with an enlarged medial chamber 32 in which a bridging ball 33 or corresponding valve element may be confined. The bridging ball, when released, may drop downwardly a comparatively short distance under gravitational influence through the lower tubular sub 30 and into engagement with a valve seat 34 provided in the upper end of the packer body 10.

The bridging ball 33 is held initially against the inner wall of the chamber 32 to one side of the central passage through the apparatus by a retainer sub 35. This sub is threaded into the upper end of the housing, preferably through the use of a left hand thread connection 35a, and has a depending arm 36 welded or otherwise secured to it and extending inwardly in a downward direction towards the axis of the apparatus, where a coaxial depending finger 37, secured to or integral with the arm, may engage the bridging ball 33, and prevent its dropping downwardly onto the valve seat 34 in the packer body. It is to be noted that the finger 37 depending from the arm 36 engages the ball 33 and holds it in the chamber 32 since the distance between the lower end of the finger and the lower downwardly and inwardly tapered wall 32a of the chamber is less than the diameter of the ball, thereby precluding dropping of the latter to its bridging position across the packer passageway 26.

Rotation of tubing string D, as to the right, causes unthreading of the retainer sub 35 from the housing and elevates its finger 37 from confining engagement with the bridging ball 33 until the distance between the finger and the tapered wall 32a of the chamber is greater than the diameter of the ball, which then allows the latter to drop downwardly through the lower sub 30 and onto the bridging ball valve seat 34, closing the central passage of the apparatus against downward flow of fluent substances.

The apparatus is made up as disclosed in Figure 1, with the retainer sub 35 threaded downwardly into the bridging ball housing 29 to its fullest extent to confine the bridging ball 33, and with the housing sub itself 30 threaded into the upper end of the body 10 of the well packer. As assurance against unscrewing of the lower sub 30 from the packer preparatory to upward unthreading of the retainer sub 35 from the housing 29, the lower sub may be prevented from rotating originally by a lateral shear screw 38 threaded through the body and into the sub.

The retainer sub 35 is secured to the lower end of the tubular string D, by means of which the apparatus is lowered through the well casing C to the desired packer anchoring point. When this position is reached a trip ball 39 is allowed to gravitate or is pumped down through the tubing string, through the central passage in the retainer sub 35, past the confined bridging ball valve member 33, through the lower sub 30 and body central passage 26, around the back-pressure ball 23 and retainer arm 25, and into engagement with the trip ball seat 27 at the lower end of the apparatus.

Engagement of the trip ball 39 with its seat 27 closes the apparatus against further downward flow of fluid and enables pressure to be built up

to a sufficient degree to initiate setting of the packer. The fluid under pressure may pass outwardly of the body through its lateral ports 40 opening into the interior of the packing sleeve 11, elongating the latter in an upward direction and exerting an upward force against the upper expander 12 to shear the expander and slip screws 14, 17, moving the expander upwardly along the body and the upper slips 16 radially along the abutment 20 into anchoring engagement with the wall of the casing.

Since the upper slips 16 prevent further upward movement of the upper expander 12, the taking of an elevating strain on the tubing string D 15 and attached bridging device B and packer body 10 first compresses the packing sleeve 11 into fluid tight sealing engagement with the packer body and casing wall and then shears the lower expander and slip screws 15, 19, causing the lower abutment 21 to shift the lower slips 18 upwardly along the lower expander 13 and radially outward into anchoring engagement with the wall of the casing. Thereafter, an increase of the fluid pressure to a predetermined degree shears the trip ball seat screw 28 and blows the seat 27, together with the back-pressure ball retaining arm 25, downwardly out of the packer apparatus, freeing the back-pressure ball valve 23 for engagement with its companion seat 24. The packer is held in its set position by engagement of a ratchet ring 41 in the upper expander 12 with annular ratchet teeth 42 on the body, which precludes downward movement of the latter with respect to the expander, slips and packing.

Further details of the construction and operation of the well packer of the type illustrated may be found in the patent above referred to.

In one use of the apparatus, cement slurry or other fluid may be pumped through the tubing string and apparatus for discharge from the lower end of the packer. The bleeding off of pressure within the tubing string allows the back-pressure ball 23 to move upwardly and engage its companion seat 24, preventing return or upward flow of fluid through the packer apparatus.

When it is desired to prevent downward passage of fluent materials through the packer apparatus, the tubular string D is rotated to the right to unthread the retainer sub 35 in an upward direction from the housing 29, elevating the attached retainer finger 37 from engagement with the bridging ball 33 and allowing the latter to gravitate into engagement with its companion seat 34 in the upper portion of the packer body 10 (see Figure 2). The bridging ball member 33 thus prevents downward passage of fluid through the well packer A, and since the back-pressure valve member 23 prevents upward passage of fluid through the apparatus, a bridging packer is provided which prevents flow of fluid through the apparatus in both directions.

It is desired to retrieve the entire bridging device B connected to the packer from the well bore after the bridging ball has been released. To accomplish this purpose, a stop ring 43 is secured to the upper end of the bridging ball housing 29 and is provided with an intumed flange or shoulder 44 engageable by an external flange or shoulder 45 on the retainer sub 35. Such engagement occurs after partial upward unthreading of the sub 35 from the housing 29, which is sufficient in extent to free the bridging ball 33 and allow it to drop onto its companion valve seat 34. However, as soon as engagement between the flanges 44, 45 occurs, further rota-

tion of the retainer sub 35 with respect to the housing 29 is prevented and continued turning of the tubular string D to the right shears the screw 38 holding the lower sub 30 to the packer body 10 and unscrews this sub from the packer body, by virtue of their left hand threaded inter-connection 31. Upon the taking of a sufficient number of turns to the right, the lower sub is completely unthreaded from the packer body, allowing the bridging device B to be removed to the top of the well bore on the lower end of the tubular string D.

The shear screw 38 need not necessarily be employed for the purpose of insuring that the upper left hand threaded connection 35a will unscrew before the left hand threaded connection 31. By suitably choosing the respective pitches of the upper and lower left hand threads, the former will become loosened and begin unthreading prior to the lower connection, upon turning of the tubular string D to the right. For example, the two threaded connections could have the same pitch, but if the pitch diameter of the upper thread 35a were greater than that of the lower, the former would unscrew first until the shoulders 44, 45 abutted, whereupon the lower sub 30 would be unscrewed from the packer body 10. Again, the pitch of the upper thread 35a may be less than that of the lower thread 31, which would also permit the former to unscrew prior to the latter. However, the use of the shear screw 38 is advantageous as a precautionary measure.

Since the finger 37 is disposed coaxial of the apparatus, rotation of the retainer sub 35 continues the position of the finger in such coaxial relationship, permitting free upward movement of the arm 35 during elevation of its retainer sub. The employment of the relatively small diameter coaxial finger 37 permits a comparatively large bridging ball 33 to be employed for engagement with the relatively large valve seat 34 in the packer body, and does not require substantial restriction of the packer passageway 26.

The complete removal of the bridging device B, with the exception of the bridging ball 33, which purposely remains in engaged position on its valve seat 34 to close the body passage 26, permits the bridging apparatus to be used over and over again. Such withdrawal from the well bore leaves only the packer A anchored to the casing for subsequent removal by a drill bit, whenever the packer obstruction in the well casing is to be eliminated. In other words, the apparatus described does not add any elements to the packer apparatus requiring drilling out at some later date.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. Well apparatus, including tubular means providing a fluid passage, valve means within said tubular means, restraining means attached to said tubular means and engaging said valve means to prevent its movement into said passage, means on said restraining means for connecting said restraining means to a running-in string, said restraining means being rotatable by said running-in string with respect to said tubular means to release said valve means for movement through said passage, and coengaging stop means on said tubular means and restraining means for limiting the extent of releasing movement of said restraining means with respect to said tubular means and for preventing rotation of said

restraining means with respect to said tubular means.

2. Well apparatus, including a tubular body having a valve seat, a tubular housing detachably secured to said body, valve means within said housing, restraining means attached to said housing and engaging said valve means to prevent its engagement with said seat, means on said restraining means for connecting said restraining means to a running-in string, said restraining means being movable by said running-in string with respect to said housing to release said valve means for engagement with said seat, and coengaging stop means on said housing and restraining means for limiting the extent of valve releasing movement of said restraining means with respect to said housing, in order to couple said restraining means to said housing and enable said housing to be detached from said body.

3. Well apparatus, including tubular means providing a fluid passage, valve means within said tubular means for closing said passage, tubular restraining means threadedly attached to said tubular means and engaging said valve means when in one position with respect to said tubular means to prevent said valve means from closing said passage, means on said tubular restraining means for connecting said tubular restraining means to a tubular string, said tubular restraining means being rotatable by said tubular string to thread said restraining means with respect to said tubular means to a position releasing said valve means for movement to passage closing position, and coengaging stop means on said tubular means and tubular restraining means for limiting the extent of their relative rotation after release of said valve means and for effecting coupling of said tubular means and restraining means by preventing their further rotation with respect to each other.

4. Well apparatus, including tubular means providing a fluid passage, a valve element within said tubular means movable downwardly to close said passage, restraining means attached to said tubular means and engaging said valve element to prevent its downward movement to passage closing position, means on said restraining means for connecting said restraining means to a running-in string, said restraining means being movable by said running-in string with respect to said tubular means to release said valve element and allow such downward movement to passage closing position, and coengaging stop means on said tubular means and restraining means for limiting the extent of their relative movement after release of said valve element.

5. Well apparatus, including tubular means providing a fluid passage, a valve element within said tubular means movable downwardly within said passage, restraining means attached to said tubular means and engaging said valve element to prevent its downward movement within said passage, means on said restraining means for connecting said restraining means to a running-in string, said restraining means being movable upwardly by said running-in string with respect to said tubular means to release said valve element for downward movement within said passage, and coengaging stop means on said tubular means and restraining means for limiting the extent of such upward movement of said restraining means after release of said valve element.

6. Well apparatus, including tubular means providing a fluid passage, a valve element within

said tubular means movable downwardly within said passage, tubular restraining means threadedly attached to said tubular means and engaging said valve element to prevent its downward movement within said passage, means on said tubular restraining means for connecting said tubular restraining means to a tubular string, said restraining means being rotatable by said tubular string to thread said restraining means upwardly with respect to said tubular means and release said valve element for downward movement within said passage, and coengaging stop means on said tubular means and restraining means for limiting the extent of such upward threading movement of said restraining means, in order to non-rotatably couple said tubular restraining means to said tubular means.

7. Well apparatus, including a tubular body having a valve seat, a tubular housing detachably secured to said body, a valve element within said housing movable downwardly therewithin into engagement with said seat, tubular restraining means threadedly attached to said housing and engaging said valve element to prevent its downward movement into engagement with said seat, means on said tubular restraining means for connecting said tubular restraining means to a tubular string, said restraining means being rotatable by said tubular string to thread said restraining means upwardly with respect to said housing and release said valve element for downward movement onto said seat, and coengaging stop means on said housing and restraining means for limiting the extent of such upward threading movement of said restraining means, in order to non-rotatably couple said tubular restraining means to said housing and enable said housing to be detached from said body.

8. Well apparatus, including a tubular body having a valve seat, a tubular housing detachably secured to said body, a valve element within said housing movable downwardly therewithin into engagement with said seat, a tubular retainer within said housing engaging said valve element to prevent its downward movement into engagement with said seat, a left-hand threaded connection between said retainer and housing for elevating said retainer with respect to said housing upon rotation of said retainer to release said valve element and allow its engagement with said seat, and coengaging stop means on said housing and retainer for limiting the extent of such elevation of said retainer after release of said valve element, in order to non-rotatably couple said retainer to said housing and enable said housing to be detached from said tubular body.

9. Well apparatus, including a tubular body having a valve seat, a tubular housing detachably secured to said body, a valve element within said housing movable downwardly into engagement with said seat, a tubular retainer attached to said housing by a left hand threaded connection, said retainer engaging said valve element when threaded downwardly within said housing to hold said valve element to one side of said housing and prevent its downward movement onto said valve seat, and said tubular retainer being rotatable to effect its threading upwardly with respect to said housing to a position releasing said valve element for downward movement into engagement with said seat, and coengaging stop means on said housing and retainer for limiting the extent of such upward threading movement after release of said valve element, in order to

non-rotatably couple said retainer to said housing and enable said housing to be detached from said tubular body.

10. Well apparatus, including a tubular body having a valve seat, a tubular housing detachably secured to said body, a ball within said housing adapted to gravitate into engagement with said seat, a tubular retainer attached to said housing and engaging said ball when in a lower position with respect to said housing to hold said ball to one side of said housing and prevent its gravitation onto said valve seat, said tubular retainer being movable upwardly with respect to said housing to a position releasing said ball for gravitation into engagement with said seat, and coengaging stop means on said housing and retainer for limiting the extent of upward movement of said retainer relative to said housing after release of said ball.

11. Well apparatus, including a well packer having a valve seat, a tubular housing detachably secured to said packer, a valve element within said housing movable downwardly into engagement with said seat, a tubular retainer attached to said housing by a left hand threaded connection, said retainer engaging said valve element when threaded downwardly within said housing to hold said valve element against downward movement onto said valve seat, and said retainer being rotatable to effect its threading upwardly with respect to said housing to a position releasing said valve element for downward movement into engagement with said seat, and coengaging stop means on said housing and retainer for preventing further relative threaded movement in an upward direction between said housing and retainer after release of said valve element, in order to non-rotatably couple said retainer to said housing and enable said housing to be detached from said well packer.

12. Well apparatus, including a tubular housing, a valve element within said housing, a tubular retainer threadedly attached to said housing, said retainer engaging said valve element to prevent its downward movement with respect to said housing, said retainer being rotatable with respect to said housing to shift it longitudinally to valve element releasing position, and coengaging stop means on said housing and retainer for limiting the extent of such longitudinal movement, after release of said valve element, to non-rotatably couple said retainer to said housing.

13. Well apparatus, including a tubular housing, a valve ball within said housing, a tubular retainer threadedly attached to said housing, said retainer having a finger coaxial of said housing and engageable with said ball to prevent its downward movement with respect to said housing, said retainer being rotatable with respect to said housing to shift it longitudinally to ball releasing position, and coengaging stop shoulders on said housing and retainer for limiting the extent of such longitudinal movement, after release of said ball, to non-rotatably couple said retainer to said housing.

14. Well apparatus, including a well packer having a valve seat, a tubular housing detachably secured to said well packer, a ball within said housing, a tubular retainer attached to said housing by a left hand threaded connection, said retainer having a finger coaxial of said housing and engageable with said ball to prevent its downward movement into engagement with said seat, said retainer being rotatable with respect to said housing to elevate and release said finger from

engagement with said ball and permit its downward movement onto said seat, and coengaging stop shoulders on said housing and retainer for positively limiting the extent of threading of said retainer with respect to said housing in one direction, in order to non-rotatably couple said retainer to said housing and enable said housing to be detached from said well packer.

15. Well apparatus, including a well packer having a valve seat, a tubular housing secured to said well packer by a left hand threaded connection, a ball within said housing, a tubular retainer attached to said housing by a left hand threaded connection, said retainer having a finger coaxial of said housing and engageable with said ball when in a lower position to prevent its downward movement into engagement with said seat, said retainer being rotatable with respect to said housing to elevate and release said finger from engagement with said ball and permit its downward movement onto said seat, and coengaging stop shoulders on said housing and retainer for positively limiting the extent of threading of said retainer with respect to said housing in the releasing direction, in order to non-rotatably couple said retainer to said housing and enable said housing to be unthreaded from said well packer.

16. Well apparatus, including tubular means providing a fluid passage, valve means within said tubular means, restraining means attached to said tubular means, said restraining means and tubular means cooperatively engaging said valve means to prevent its movement into said passage, means for connecting said restraining means to a running-in string, said restraining means being rotatable by said running-in string with respect to said tubular means to release said valve means for movement through said passage, and coengaging stop means on said restraining means and tubular means for limiting the extent of releasing movement of said restraining means with respect to said tubular means and for preventing rotation of said restraining means with respect to said tubular means.

17. Well apparatus, including a tubular body having a valve seat, a tubular housing detachably secured to said body, valve means within said housing, restraining means attached to said housing, said restraining means and housing cooperatively engaging said valve means to prevent its engagement with said seat, means for connecting said restraining means to a running-in string, and said restraining means being movable by said running-in string with respect to said housing to release said valve means for engagement with said seat, and coengaging stop means on said restraining means and housing for limiting the extent of movement of said restraining means with respect to said housing, in order to couple said restraining means to said housing and enable said housing to be detached from said body.

18. Well apparatus, including tubular means providing a fluid passage, a valve element within said tubular means movable downwardly to close said passage, restraining means attached to said tubular means, said restraining means and tubular means cooperatively engaging said valve element to prevent its downward movement to passage closing position, means for connecting said restraining means to a running-in string,

said restraining means being movable by said running-in string with respect to said tubular means to release said valve element and allow such downward movement to passage closing position, and coengaging stop means on said tubular means and restraining means for limiting the extent of their relative movement.

19. Well apparatus, including a well packer having a valve seat, a tubular housing detachably secured to said packer, a valve element within said housing movable downwardly into engagement with said seat, a tubular retainer attached to said housing by a left hand threaded connection, said retainer and housing cooperatively engaging said valve element when said retainer is threaded downwardly within said housing to hold said valve element against downward movement on to said valve seat, said retainer being rotatable to effect its threading upwardly with respect to said housing to a position releasing said valve element for downward movement into engagement with said seat, and coengaging stop means on said housing and retainer for limiting the extent of their relative rotation, in order to non-rotatably couple said retainer to said housing and enable said housing to be detached from said packer.

20. Well apparatus, including a tubular housing, a valve element within said housing, a tubular retainer threadedly attached to said housing, said retainer and housing cooperatively engaging said valve element to limit its downward movement with respect to said housing, said retainer being rotatable with respect to said housing to shift it longitudinally to valve element releasing position, and coengaging stop means on said housing and retainer for limiting their relative longitudinal movement, in order to non-rotatably couple said retainer to said housing.

21. Well apparatus, including a tubular body having a valve seat, a tubular housing detachably secured to said body, valve means within said housing movable downwardly into engagement with said seat, a tubular retainer attached to said housing and engaging said valve means when in a lower position with respect to said housing to hold said valve means to one side of said housing and prevent its downward movement on to said valve seat, said tubular retainer being movable upwardly with respect to said housing to a position releasing said valve means for downward movement into engagement with said seat, and coengaging stop means on said housing and retainer for limiting the extent of upward movement of said retainer relative to said housing after release of said valve means, in order to couple said retainer to said housing and enable said housing to be detached from said body.

THOMAS M. RAGAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
984,084	Farrah	Feb. 14, 1911
2,204,648	Baker	June 18, 1940
2,222,233	Mize	Nov. 19, 1940
2,249,172	Quintrell	July 15, 1941
2,270,648	Church	Jan. 20, 1942